electronics

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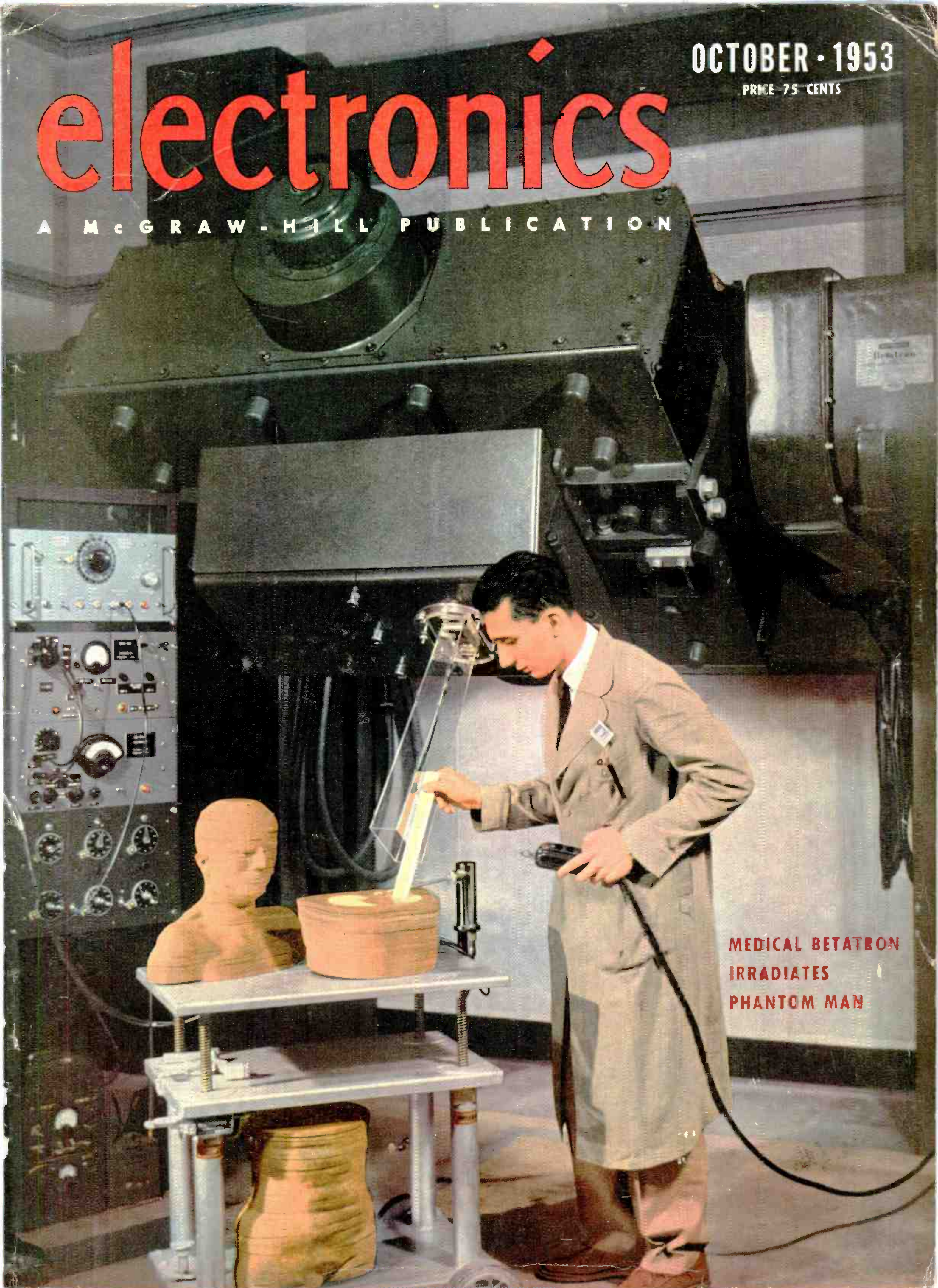
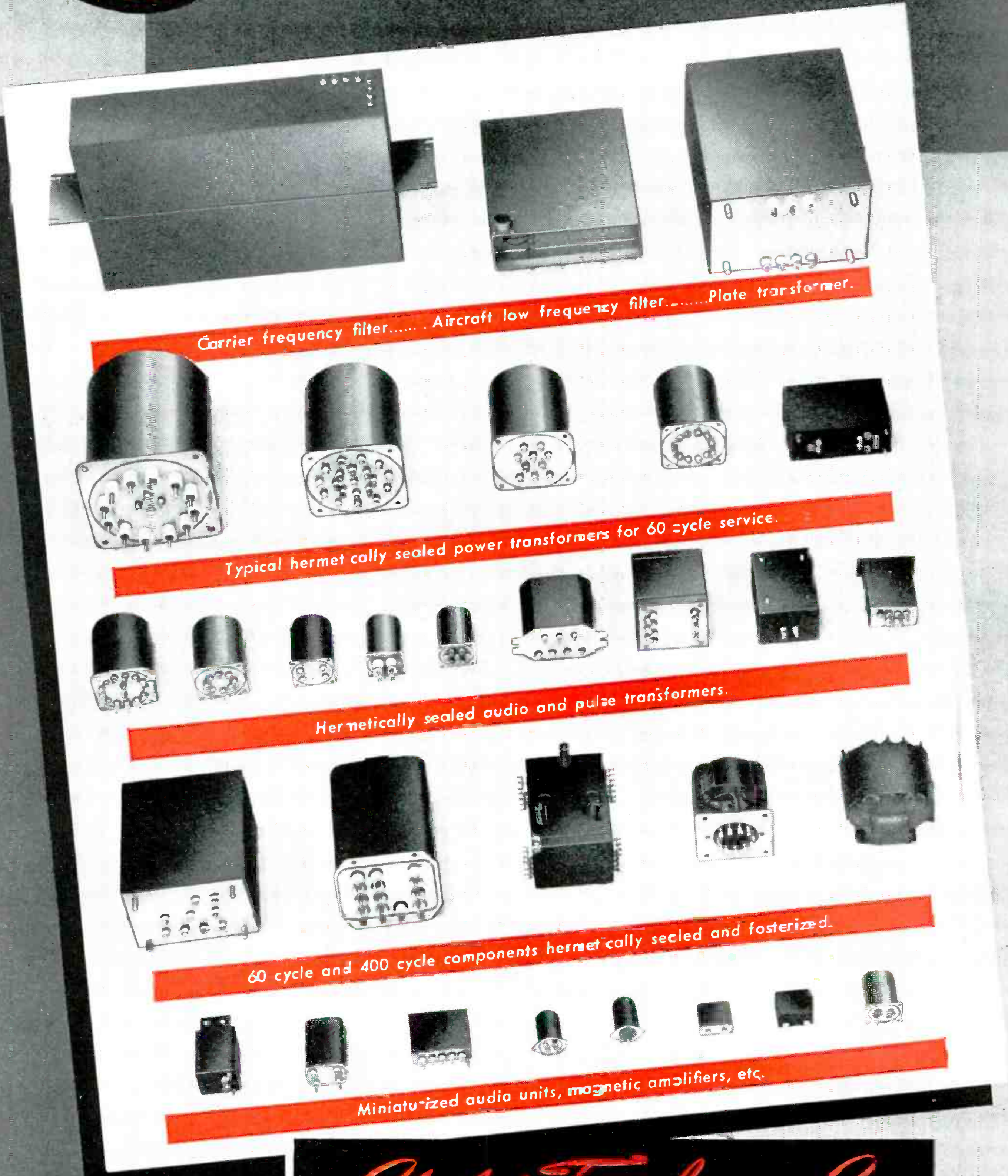


MEDICAL BETATRON IRRADIATES PHANTOM MAN

UTC for Military Components

UTC was the largest supplier of transformer components in World War II. Present UTC production is on a similar basis. Illustrated below are a few of the thousand military types in UTC 1953 production.



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MEDICAL BETATRON IRRADIATES PHANTOM MAN—Preparing for test exposure to check distribution of high-energy x-rays from 24-mev betatron, designed especially for cancer therapy, at Memorial Center for Cancer and Allied Diseases, New York City. Wood and cork model simulating human body is constructed to allow insertion of anthracene crystal probe at selected spots. Photo by Syd Karsen. (See p 146) .... COVER

October, 1953 ELECTRONICS Vol. 26, No. 10

Member ABC and ABP

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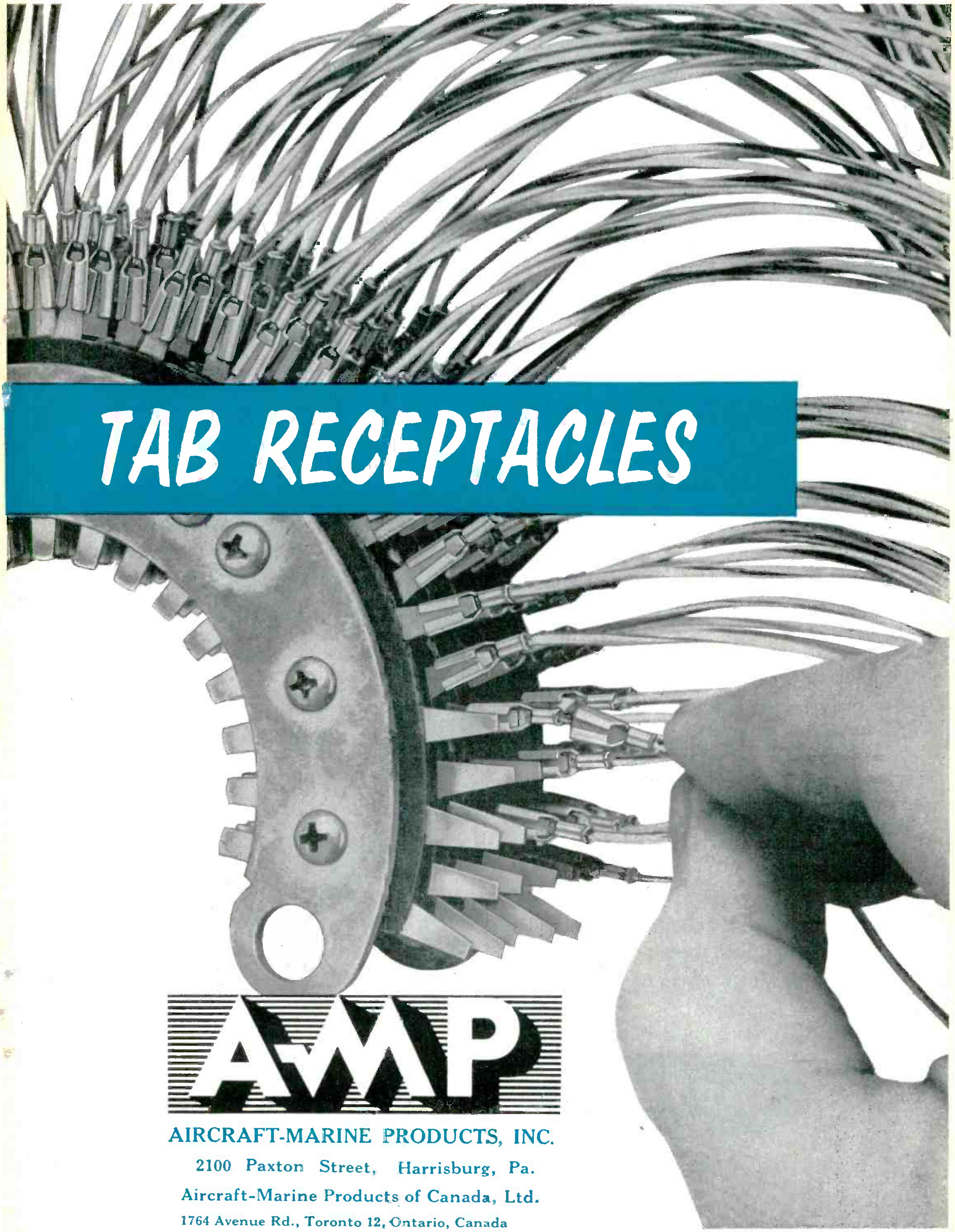
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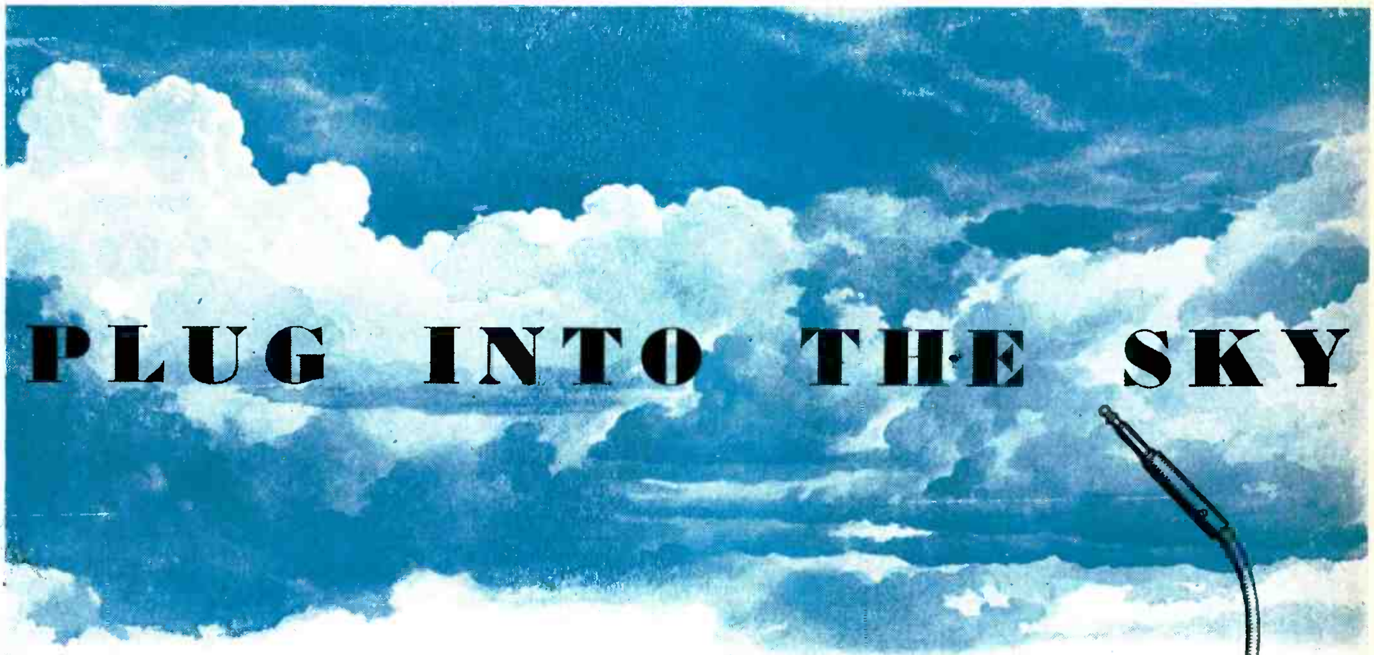

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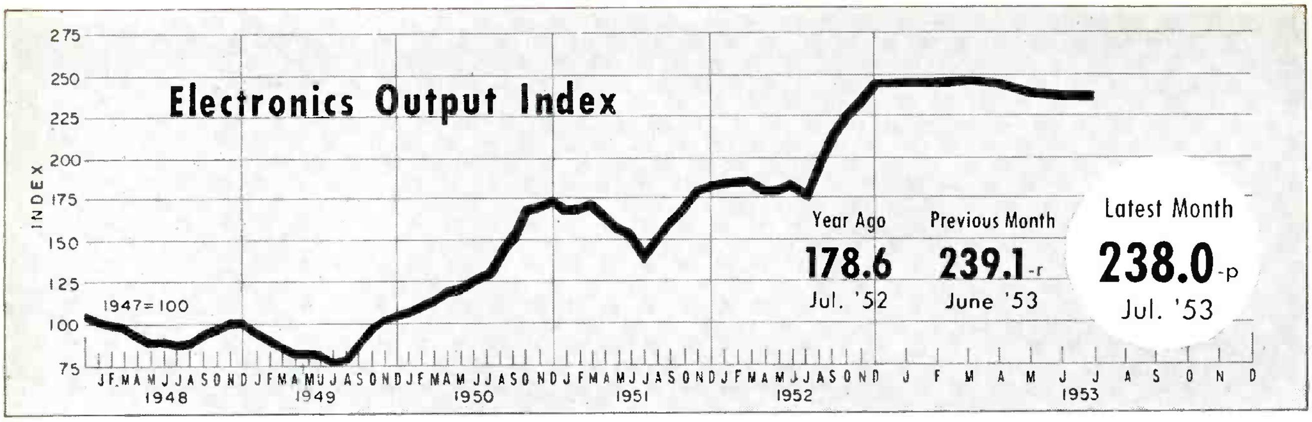


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago	Previous Month	Latest Month
	July '52	June '53	July '53
Television sets	198,921	524,479	316,289
Home sets	203,868	287,724	172,197
Clock Radios	61,295	131,144	87,620
Portable sets	81,353	239,189	78,434
Auto sets	95,220	505,774	336,208

RECEIVER SALES

(Source: RETMA)	July '52	June '53	July '53
Television sets, units	......	431,089	340,406
Radio sets (except auto)	......	449,116	366,666

RECEIVING TUBE SALES

(Source: RETMA)	July '52	June '53	July '53
Receiv. tubes, total units	20,944,831	42,505,685	26,462,069
Receiving tubes, new sets	11,504,503	26,478,801	15,393,307
Rec. tubes, replacement	6,795,252	12,965,382	9,480,208
Receiving tubes, gov't.	1,956,905	708,174	313,684
Receiving tubes, export	688,171	2,353,328	1,274,870
Picture tubes, to mfrs.	239,625	517,395	421,248

SEMICONDUCTOR SALES

(Source: RETMA)	July '52	June '53	July '53
Germanium Diodes	......	1,344,636	3,868,026

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Year Ago	Previous Quarter	Latest Quarter
	2nd '52	1st '53	2nd '53
Vacuum (non-receiving)	$12,110,000	$11,340,000	$10,400,000
Gas or vapor	$3,150,000	$3,140,000	$3,300,000
Phototubes	$480,000	$930,000	$700,000
Magnetrons and velocity modulation tubes	$9,830,000	$10,070,000	$10,500,000
Gaps and T/R boxes	$2,140,000	$2,050,000	$1,700,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago	Previous Month	Latest Month
	Aug. '52	July '53	Aug. '53
Sets in Use—total	18,354,300	24,519,000	24,895,000

BROADCAST STATIONS

(Source: FCC)	Aug. '52	July '53	Aug. '53
TV Stations on Air	109	224	253
TV Stns CPs—not on air	34	284	270
TV Stns—Applications	855	524	521
AM Stations on Air	2,356	2,466	2,476
AM Stns CPs—not on air	112	122	117
AM Stns—Applications	291	251	177
FM Stations on Air	622	578	579
FM Stns CPs—not on air	21	21	18
FM Stns—Applications	12	8	7

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	June '52	May '53	June '53
Aeronautical	32,603	42,213	39,315
Marine	35,500	40,076	40,357
Police, fire, etc.	11,143	13,238	13,631
Industrial	13,680	16,850	17,378
Land Transportation	5,027	5,830	5,922
Amateur	113,092	111,011	111,289
Citizens Radio	1,401	2,124	3,829
Disaster	71	189	191
Experimental	488	439	414
Common carrier	985	1,193	1,214

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	June '52	May '53	June '53
Prod. workers, comm. equip.	268,200	408,200-r	400,200
Av. wkly. earnings, comm.	$64.80	$65.20-r	$65.93
Av. wkly. earnings, radio	$61.58	$62.49-r	$63.60
Av. weekly hours, comm.	40.5	40.0 -r	40.2
Av. weekly hours, radio	40.3	39.3 -r	39.5

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Aug. '52	July '53	Aug. '53
Radio—TV & Electronics	291.1	272.4	280.0
Radio Broadcasters	279.6	269.3	274.8

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	TOTALS FOR FIRST SEVEN MONTHS 1952	1953	Percent Change
Television set production	6,096,279	2,517,157	4,150,525	+ 64.8
Radio set production	10,934,872	5,280,079	7,941,001	+ 50.3
Television set sales	6,144,990	......	3,116,306	......
Radio set sales (except auto)	6,878,547	......	3,383,862	......
Receiving tube sales	368,519,243	181,128,357	269,622,417	+ 48.8
Cathode-ray tube sales	6,120,292	2,084,934	4,571,931	+119.2

INDUSTRY REPORT

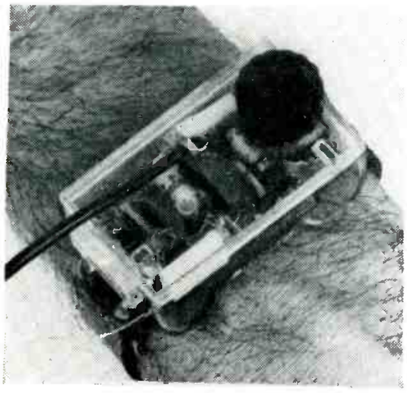
Signal Corps Radio Uses Five Transistors

A WRIST radio worthy of mention in even the most imaginative comic strip has been developed by the Army Signal Corps.

Using five transistors and capable of receiving stations as much as 40 miles distant, the two and five-eighths ounce experimental receiver is contained in a plastic case two inches long, one and an eighth inches wide and three quarters of an inch thick. The small size is made possible through the use of transistors and miniature components, such as the mercury battery scarcely larger than the tip of a pencil. A printed-circuit chassis is used.

A short antenna and the cord connecting the hearing-aid type ear piece, are concealed by the user's sleeve. A miniature on-off switch and a frequency control knob on the face of the set are the only adjustments.

The set operates over the upper part of the standard broadcast band from 1,000 to 1,500 kc.



Five transistors are used in Signal Corps wrist radio, which can pull in broadcast stations 40 miles away

PROJECT TINKERTOY combines printed-circuit techniques and assembly equipment with a system of equipment design so that a . . .

Robot Plant Makes Electronic Gear

Joint NBS-BuAer project yields building-block system for design and production

DEVELOPMENT of a system for the automatic production of electronic equipment was announced September 19 by the Navy Bureau of Aeronautics and the National Bureau of Standards.

The program, code-named Project Tinkertoy, resulted in the simultaneous development of two systems: a production system utilizing automatic fabrication and assembly equipment, and a compatible, general system of electronic equipment design using a modular concept. The two systems exploit printed-circuit techniques, the use of conducting paints for wires, thin ceramic capacitors, adhesive-tape resistors, and automatic dip soldering.

From June, 1950, through June, 1953, approximately $4,700,000 was allocated by the Navy to the National Bureau of Standards for Project Tinkertoy. About 85 percent of this amount was expended in the procurement of equipment from industry largely through subcontracts.

▶ **Companies Involved**—Design and construction of most of the production equipment was done by the Kaiser Electronics Division of Willys Motor Co. Some special machines were also designed and built by the Doughnut Corp. of America at Ellicott City, Md. Specially designed automatic production test equipment was obtained principally from Communication Measurements Laboratory, Inc. of Plainfield, N. J. Some major engineering applications to equipment were made by Sanders Associates, Inc., Nashua, N. H., including environmental studies of completed units. The Davis Laboratories, of Riverdale, Md. and the Navy Post Graduate School at Monterey, Calif. also rendered assistance in some phases of the work.

▶ **MDE Design System**—The Modular Design of Electronics system employs a series of mechanically-standardized and uniform modules (or building blocks), producible within a wide range of electrical characteristics.

Each module consists of 4 to 6 thin ceramic wafers, bearing various circuits associated with an electronic stage. Individual modules are combined to form a major subassembly of tubes and components.

▶ **MPE Production System**—The Mechanized Production of Electronics system consists of the mechanized production of ceramic wafers, titanate capacitors, and tape resistors and their automatic mechanical assembly and testing. The wafers and tube sockets are made from a controlled combination of talc, kaolin and barium carbonate. The three minerals are mixed, filtered and dried to a powder which is further refined and loaded into a mechanical device which presses the wafers or tube sockets and cuts riser-wire notches.

▶ **Automatic Inspection** — During each stage in the mechanized production provision is made for 100-percent automatic inspection by both physical gaging and electronic comparison. Printed circuits, resistors and capacitors are compared with their electronic equivalents both before and after assembly by use of electronic computers, bridge circuits and other comparison devices. The testing code is contained on punched cards that accompany the wafers all through the production process.

Color TV Timetable

INDUSTRY thinks FCC will formally adopt NTSC color tv standards before the end of 1953. At Commission's Sept. 8 deadline, no major objections had been filed against adoption. Interest now centers in date color receivers and color programs will be generally available.

• • •

Commission is scheduling color demonstrations and tests to cover all possible conditions . . . various light levels . . . via coaxial cable and microwave . . . close-ups . . . indoor and outdoor shots, including rapid motion . . . slides.

• • •

Estimates on how many sets at what price by when are variable . . . W. R. G. Baker of GE says up to 75,000 at $800 next year . . . Emerson's Ben Abrams pledges a price only 25 percent above black and white 18 months after FCC decisions . . . CBS thinks first color receivers will be around $1,000.

• • •

Crux of getting color to the viewers soon seems to be cost of receiver tube and three-eyed tv camera . . . RCA color picture tube is quoted at anywhere from $175 to $250 . . . Lawrence tube is claimed possible at $100 . . . CBS estimates cost of matched trio of camera orthicons at $5,700.

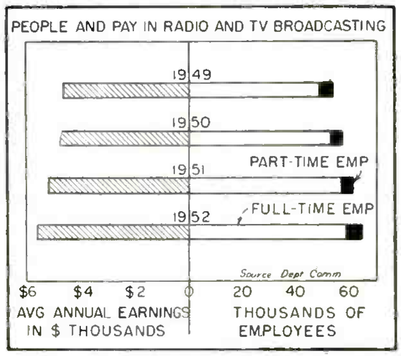
Broadcasting Is Up On All Fronts

Income and employment as well as wages and taxes have moved up substantially since 1949

BROAD view of the financial pattern that radio and tv broadcasting has followed in the past 4 years is seen in figures recently released by the Department of Commerce.

People and pay have increased steadily. A total of 65,000 full and part-time employees, 11,000 more than were employed in 1949, were working for stations last year. Average annual earnings for full-time employees increased during the period, from $4,469 to $5,559.

▶ **Income**—Radio and tv broadcasters took in $404 million in 1952. In 1949, the figure was $262 million. Breakdown for last year's amount shows that broadcasting corporations paid out $339 million in wages, salaries and extras; $31 million in taxes; $23 million in dividends, leaving $7 million as undistributed corporate income. The remaining $4 million represents income of unincorporated stations.

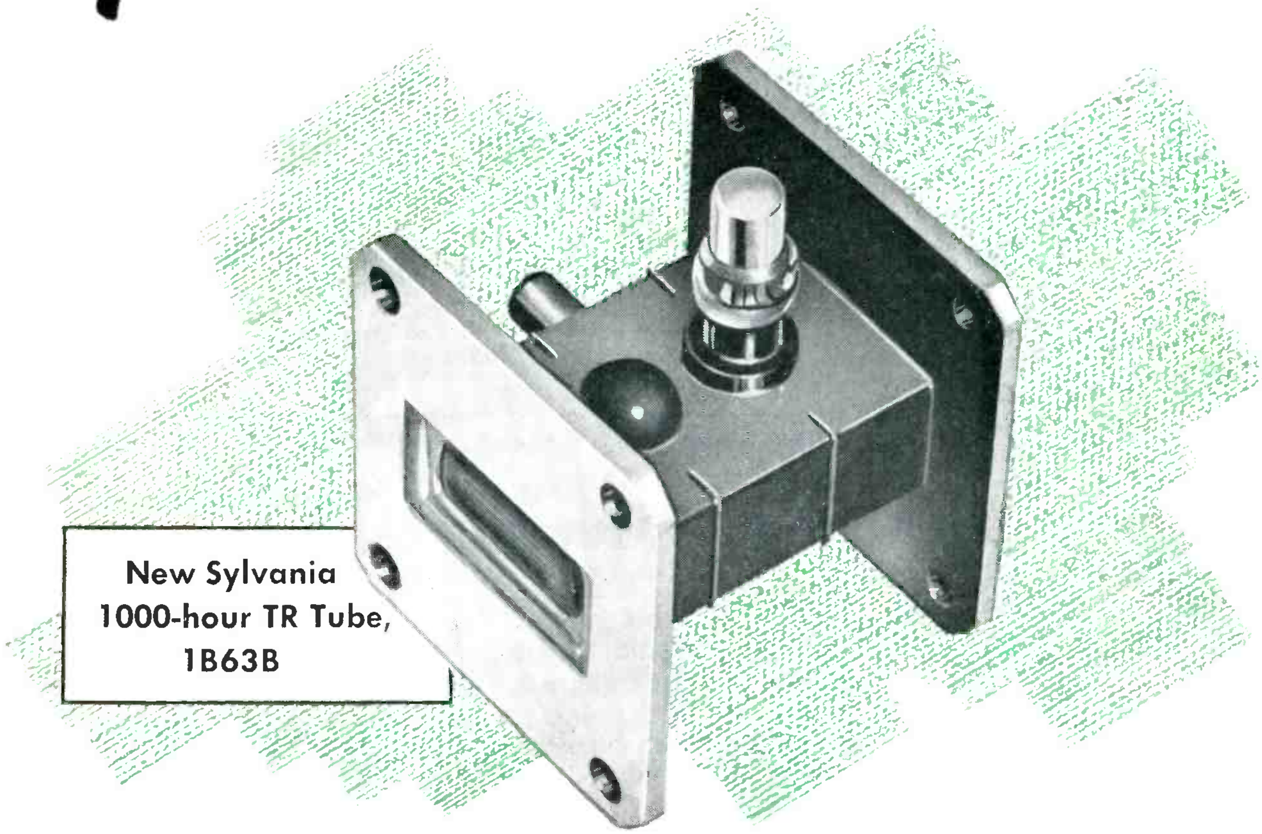


In 1949, the following payments were made: wages and salaries, $227 million; taxes, $16 million; dividends, $8 million. Undistributed corporate income amounted to $9 million. Unincorporated stations received the remaining $2 million in 1949.

▶ **Corporations**—Most radio and tv stations are set up as corporate org-

(Continued on page 8)

Sylvania announces...



New Sylvania 1000-hour TR Tube, 1B63B

. . . the most important advance in TR Tube design in the past 4 years

Sylvania engineers are engaged in a continuing program to provide increased dependability and longer life to their electronic tubes . . . for both commercial and civilian applications.

One of the most important results of this program is the recent development of the cermet ignitor electrode. This new electrode is capable of withstanding extremely high temperatures for long periods of time, thus making possible Sylvania's 1000-hour tube, the 1B63B.

This new ignitor is an important step forward in TR Tube design . . . one more reason why it pays to specify SYLVANIA!

For further information concerning the full line of Sylvania TR and ATR Tubes, simply mail the coupon.

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anizations at present. However, there are still a number of unincorporated stations. According to the Commerce Department, there are 1,000 stations in the U. S. owned by entrepreneurs or partnerships and the number has remained constant for the past 4 years. Nearly all new stations that have come on the air since 1949 have been set up as corporations.

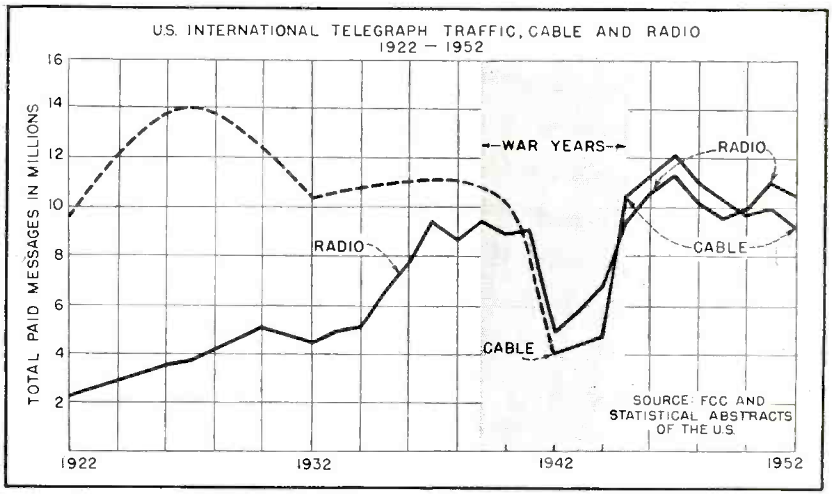
U. S. Studies Electronic Employment Trends

HIGH employment in the electronics industry will not only be sustained throughout this year but may even go higher than the top 546,000 workers set in March of this year, if the brisk radio and tv market anticipated by manufacturers develops, according to a Labor Department study of employment trends in the industry.

While indications are that military contracts will begin to taper off the last of the year, it is expected that there will be substantial amount of military electronic production for several years, making use of a sizeable number of workers. In mid-1953, almost 200,000 workers were estimated to be engaged in military electronics production, according to the report.

▶ **Future**—Although radio and tv set production probably will employ a smaller proportion of the industry's work force in the years ahead than before Korea, the study concludes that it will be the most important determinant of electronic employment for the next decade. The report predicts that while electronic tube manufacturing is likely to decline moderately after the defense peak, it will remain at a high level due to the large replacement market for defense equipment along with growing civilian markets.

Commercial and industrial electronics manufacturing is seen as having great expansion in the future but the report notes that this segment of the industry employs only a relatively small part of the electronics work force.



THIRTY-YEAR trend in transocean telegraph shows clear crossover point, as . . .

Wireless Finally Passes Cable

Radiotelegraph carriers handle most paid traffic; overseas phone calls rise

THREE dots picked out of the æther at St. Johns, Newfoundland a half century ago marked the birth of a precocious infant in the world of communications.

Proponents of transoceanic radiotelegraph were quick to foretell the demise of the ocean cable and the rapid ascendancy of the new art. However, change is not always accomplished overnight even in electronics and it has only been within the past two years that Marconi's brainchild, now matured to a mellow middle age, has become the prime carrier of international communications.

▶ **Trends**—The chart depicts thirty years of international communications in and out of the United States. A steady growth in radiotelegraph traffic is evident through the years.

The large decline in traffic during the war years may be misleading since only paid messages are counted. During the war, both radio and cable facilities were placed at the disposal of the government and total traffic for the period is not available. The smaller peaks and valleys primarily denote world business fluctuations.

The ocean-cable business, already a mature industry in the early twenties, shows a slight decline. However, the cables are still vital and for several reasons, particularly their use in diplomatic communications, will retain an important role for many years to come. (Note: Prior to 1942 ocean-cable traffic figures were made available only at 5-year intervals.)

▶ **Radio Expansion** — Radiotelegraph carriers have been steadily expanding their plants. In 1948, 69 countries were linked with the U. S. by radiotelegraph circuits; by 1952 this had grown to 84. Traffic handling capacity has likewise been upped by increasing use of automatic equipment and various kinds of multiplex systems. Customer convenience has been enhanced by private-line arrangements that make international communications as simple as typing a memo.

▶ **Transients**—The marked postwar decline in cable traffic is largely accounted for by a reduction in the number of messages transiting the U. S. on their way to other countries. Traditionally these messages have made at least one leg of their journey over the important North Atlantic cable circuits. In recent years, there has been a trend to direct radiotelegraph communication even between the smaller coun-

(Continued on page 10)

DEPENDABILITY

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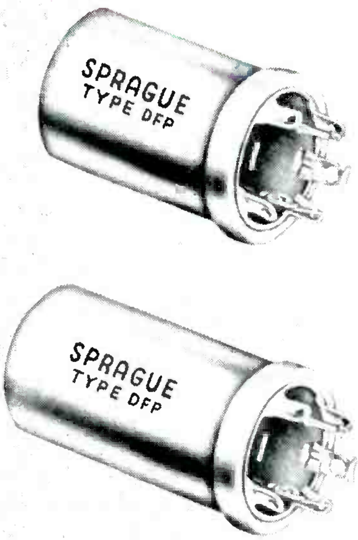

Leading television set makers rely on Sprague as their major source for electrolytic capacitors.

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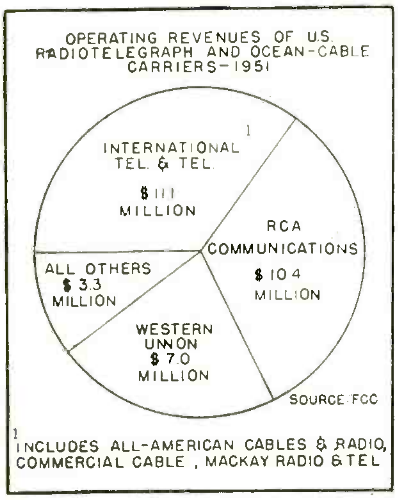


tries of the world.

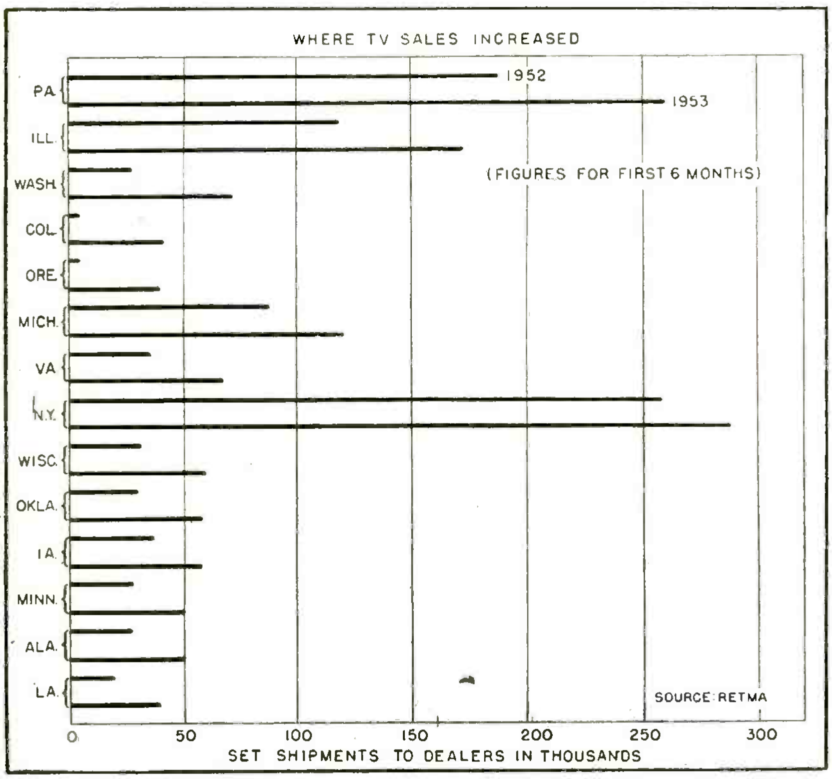
A drop in cable traffic also occurred when the Commercial Pacific Cable suspended operations in November 1951. Transpacific traffic is now handled by radiotelegraph.

▶ **Telephone**—A bustling parvenu in the communications picture is radiotelephone. From a prewar average of 50,000 paid calls yearly, international telephone now handles nearly one million calls a year. Radiotelephone service is available to 93 countries as against 81 in 1948.

Increasing use of single sideband and multiplexing equipment is an important trend in radiotelephone too.

▶ **Economics** — International telegraph is a thirty-million-dollar business. Profits accruing to the stockholders are, however frequently measured in only five figures—even for large companies. The pie-chart illustrates how the three largest interocean carriers divide the total.

Where TV Sales Are Higher This Year



PENNSYLVANIA led all other states in increased tv set business for the first six months of 1953 with a 75,000 unit increase over shipments for the same period last year.

Thirteen other states, shown in bar chart, had increases of over 20,000 sets each. Far and mid-west states fared best in increased sales. All states had a higher volume except Connecticut, Delaware, New Jersey and Rhode Island.

Supply of Technicians Is Critically Short

Lack of subprofessional aids aggravates engineer shortage; training programs lagging

ELECTRONICS engineers are still critically short in number and college enrollment figures indicate that the shortage will persist at least through 1956. Industry can make the best use of available engineers by freeing professionally trained engineers from routine chores and aiding them in implementing their designs. Both these tasks require well-trained technicians and competent craftsmen. Unfortunately, the supply of qualified electronics technicians is also critically short and apprentice training has been on the downgrade for some time.

▶ **Technical Institutes**—Technician training is the function of 67 technical institutes throughout the U. S. Toal enrollment, including part-time and evening students, is over 50,000. Eleven of these schools with a full-time enrollment of 1,858 and a part-time enrollment of 1,594 are devoted entirely to training electronics technicians; 38 other schools offer courses in electronics to their 13,303 full and 22,877 part-time students. The schools include state and municipal institutes, private endowed and proprietary institutes, extension divisions of colleges and universities and YMCA schools.

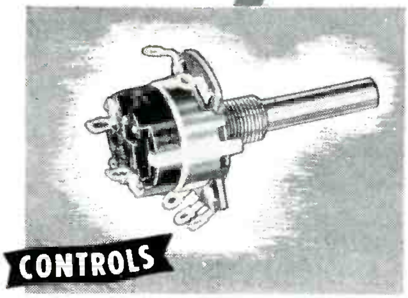
▶ **Management**—Proprietary institutes have long held the lead in electronics training. But the balance is shifting as college extension programs expand rapidly. In 1951, 90 percent of all electronics technicians came from proprietary schools as against 81 percent in 1952. Graduates of college extension programs accounted for 1¼ percent of the class of 1951 and 11½ percent of 1952 graduates.

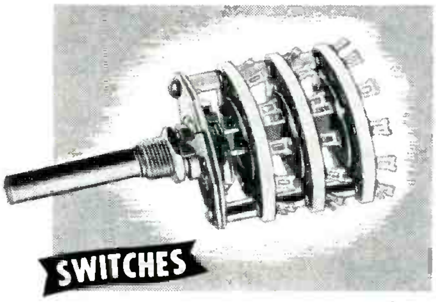
▶ **Curriculum**—Technical institutes offer intensive training in vacuum-

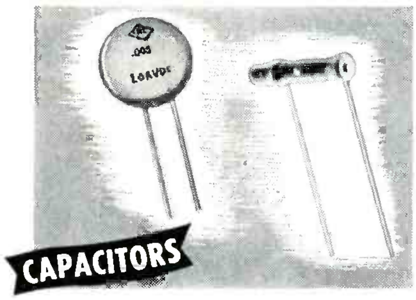
(Continued on page 14)

To GAIN THE MOST IN

performance







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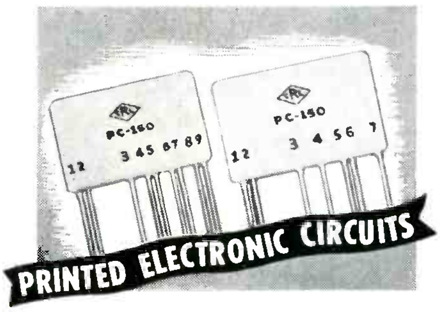

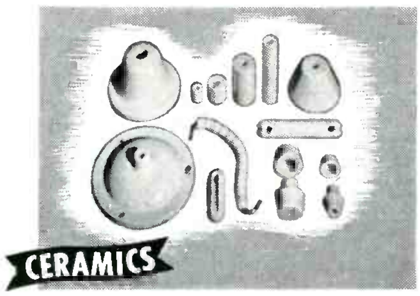

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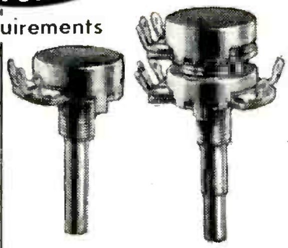
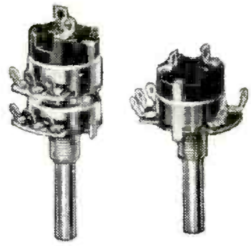
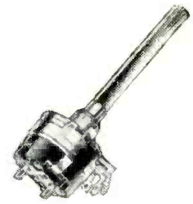
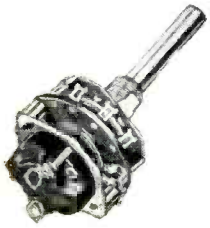
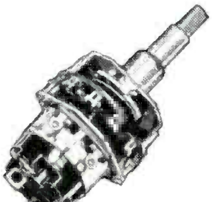

Model 2 Radiohm

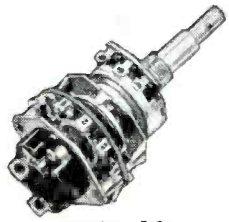

Model 2 Radiohm
(including JAN types)

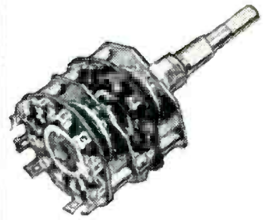

Wirewound Radiohm
Three watts

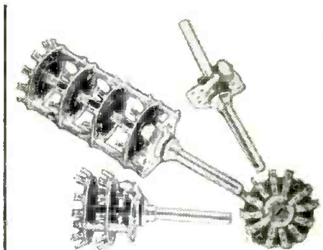

Model 2 EXPRESS (†)
for immediate
production needs

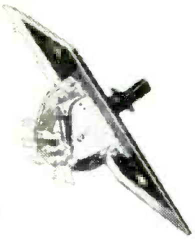

Series 20 Miniature
with a. c. line switch

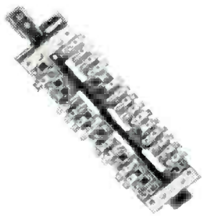

Series 30
Dual Concentric
Switch and Control


Series 30
Dual Concentric
Control and Switch


Series 30
Dual Concentric
Dual Switch

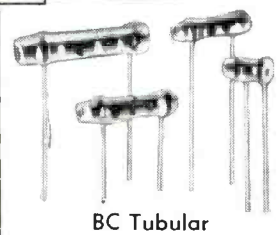

Standard Phenolic

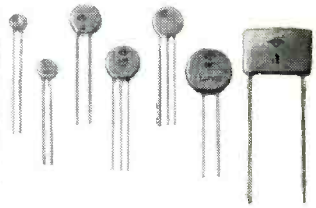

Lever Switch

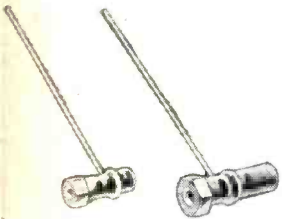

Slide Switch

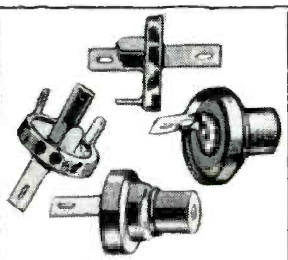

Industrial Switch Kit

3 CAPACITORS


BC Tubular

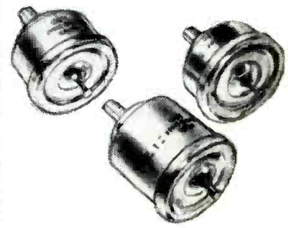

BC Discs

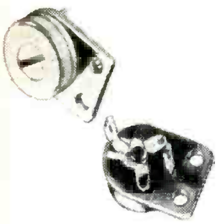

Stand-off


Button-Style


Feed-Thru HI-KAPS®

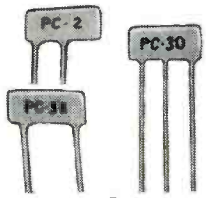

Miniature
Feed-Thru HI-KAPS®


High Accuracy
Capacitors

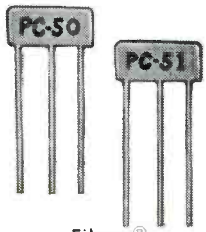

Ceramic Trimmers

4 PRINTED ELECTRONIC CIRCUITS

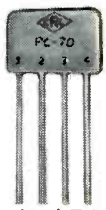
Ceramic Min-Kaps®

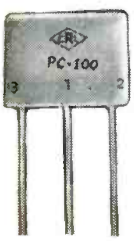


Miniature Resistor and
Resistor-Capacitor Units

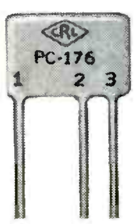


Filpec®
(balanced load
diode filter)

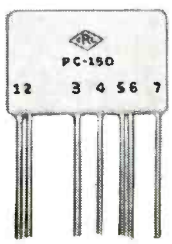

Standard Triode
Couplate®



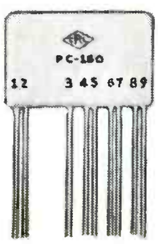
Vertical Integrator



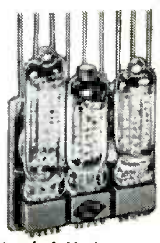
Special Plates
to suit manufacturer's
requirements

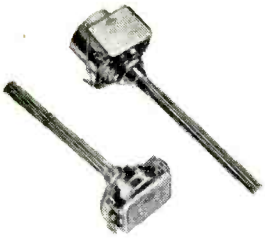


Audet®
Audio-detector plate



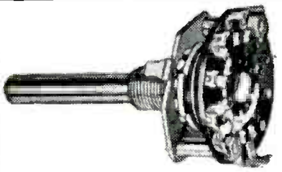
Pendet (†)
(Pentode detector
coupler)


Model II Ampec®
Standard 3-stage
amplifier

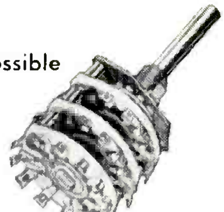


Compentrol (†)
Infinitely variable
loudness control

2 SWITCHES — 100's of variations possible



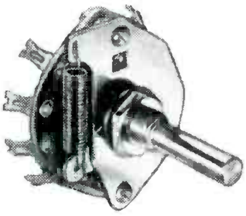
Series 20 Miniature
Phenolic insulation



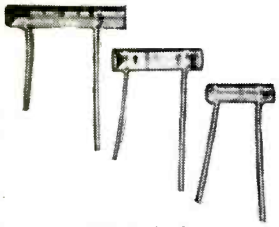
Series 20 Miniature
Ceramic insulation

Standard Ceramic

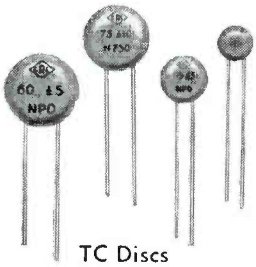
Tone Switch



Spring Return Switch

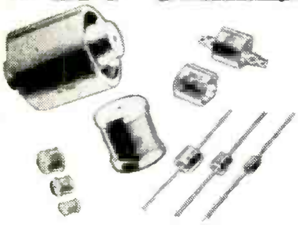


TC Tubular

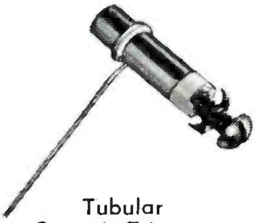


TC Discs

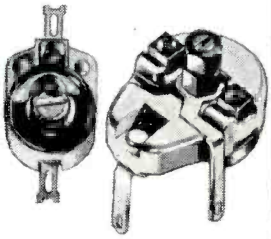
TV HI-VO-KAPS®



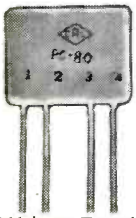
Transmitting
Capacitors



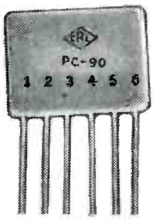
Tubular
Ceramic Trimmer



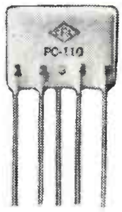
Ceramic Trimmers



Midget Triode
Couplate (†)

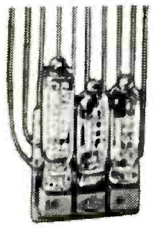


Pentode Couplates (†)



Filplate®
(by-pass & filter
application)

5 CERAMICS



Model III Ampec®
Miniature 3-stage
amplifier

Custom Ceramics
(Steatite, Centradite,
Zirconite.)

Metalized Ceramics

For Sale!

These and 100,001 other Centralab quality electronic components

WHETHER you buy electronic components in small lots or by the carload — no other single manufacturer can offer you such a *wide choice* in standard or special units. That's why Centralab is the industry's No. 1 electronic components source. Consider these facts:

- Centralab has pioneered more electronic "firsts" than any other manufacturer in the field.
- Introduced Printed Electronic Circuits — more than 30,000,000 in use, offering a new concept in reducing extra parts, time, errors and costs.
- Centralab ceramics are second to none — you can obtain grade *L5 and L6 Steatite.*
- You can count on the production facilities of *seven* conveniently located plants.
- Over 200 research and production engineers are constantly seeking to improve present CRL products.
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You can rely on Centralab electronic components. Each is the result of more than 30 years' experience working in cooperation with manufacturers all over the world. For complete performance data on products shown — and engineering specifications — check information wanted and mail the coupon.

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tube technology, basic science and mathematics. Options are available in radio and television, electronics, and industrial instrumentation. Graduates qualify for various positions in plants and laboratories. These positions range from production-line tester to junior engineer. Placement figures for a typical class in advanced electronic technology give the following percentage breakdown by job title:

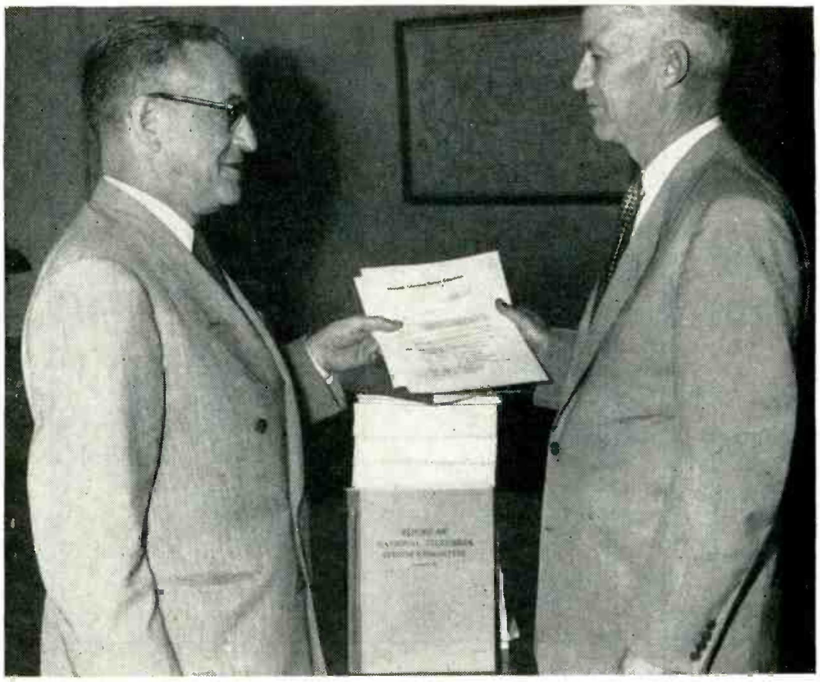
Job Title	Percent
Junior engineer	8.8
Laboratory technician	37.0
Instructor	9.5
Transmitter engineer (radio)	12.8
Tv technician (production)	24.3
Tv final tester (production)	7.6
	100.0

▶ **Typical School**—A branch of New York State University, the Long Island Agricultural and Technical Institute at Farmingdale offers study options in radio communications, electronic equipment and industrial instrumentation. Full-time students take an intensive two-year course that presents roughly the technical content of a four-year E. E. course less the advanced math and design problems. Since 1948, 274 students have been graduated in the electrical-technology curriculum.

▶ **Job History**—A typical 1948 graduate shows that his first job was as a production technician, later moving to production supervisor and finally taking charge of a line. Thirty-three 1952 graduates responding to a job questionnaire listed their occupations as follows: junior engineer, 2; customer engineer, 3; transmitter engineer, 1; instructor, 1; technician, 6; tester, 15; instrument repairman, 1; utility layout man, 1; meter man, 1; and electrician's helper, 2.

In addition, the institute runs an evening division in which electronics courses are also offered. About 250 students are participating. Regular courses include radio and tv servicing and are pursued both vocationally and avocationally. Special courses are frequently run in conjunction with local industry for upgrading personnel.

▶ **Craftsmen**—Industry is likewise plagued by a manpower shortage on the skilled craftsman level. Here the shortage is being combatted chiefly through in-plant apprentice-training and skill-improvement programs. A survey of 510 electronics plants showed 1,756 apprentices training—largely in the metal trades. Other in-plant training, mostly short term, was being given to 30,439 workers. Training programs are confined mainly to larger establishments; 62 percent of the plants with 5,000 or more workers maintained training programs while among plants having 100 or fewer employees, only 14 percent had training programs.



NTSC CHAIRMAN W. R. G. Baker presents FCC Chairman Rosel H. Hyde 52 pounds of technical documents supporting the NTSC-proposed color television standards while . . .

Hopes Run High For Color TV In 1954

Early adoption of new standards seen spurring receivers and programming

POINTING UP the electronic industry's almost unanimous support of FCC's proposed adoption of NTSC color television standards was the formal presentation of fifty-two pounds of technical documents. W. R. G. Baker, chairman of NTSC, handed over 3,823 pages of data representing a million engineering man-hours to FCC Chairman Rosel H. Hyde. The $10 million cost of this research was borne by the industry.

Besides their concurrence in the NTSC petition, several companies independently filed endorsements. They included Admiral, GE, Hazeltine, Motorola, Philco, RCA and Sylvania. CBS, whose incompatible system is favored by existing rules, came out strongly for the new standards.

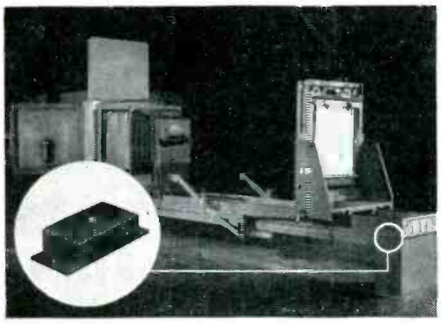
Objections by U. A. Sanabria's American Television, Inc. were economic rather than technical; want the Department of Commerce to study the effect upon industry and the general economy before final FCC action.

▶ **Closing the Books**—Interested parties filed all petitions and comments with FCC by Sept. 23, at which time the books closed and the Commission began its final deliberations. In the opinion of

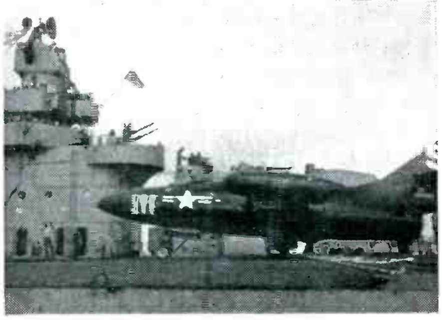
(Continued on page 16)

SHOCK – VIBRATION – NOISE

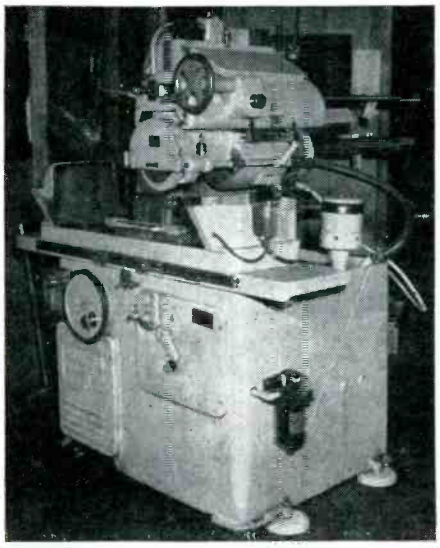
ISOLATION NOTES



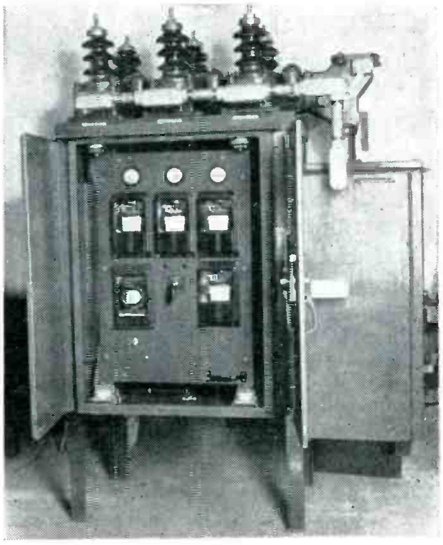
A PHOTO-ENGRAVER'S CAMERA "floated" on Barrymounts, is isolated from floor vibrations. Result: sharper images and faster operation.



MEET DEMANDS OF MILITARY SERVICE Barry unit vibration isolators and mounting bases protect delicate electronic equipment in military aircraft and in guided missiles.



GRINDER ACCURACY PROTECTED Barrymounts, used to isolate grinders from building-borne vibration, eliminate chatter marks. Result: higher output and better finish.



INSTRUMENT AND CONTROL PANELS mounted on Barry isolators, are unaffected by vibration from nearby heavy machinery. Result: sensitive adjustments "stay put," and frequent recalibrations are avoided.

IN ANY FIELD OF MILITARY OR INDUSTRIAL INTEREST

the wide range of Barry products, and the experience of Barry engineers, can help you solve shock, vibration, and noise problems. Call our nearby sales representative, or write directly to us.

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industry leaders, the outcome is bound to be favorable, but will not be announced until around the first of the year.

▶ **Pioneer Lookers**—Because there are always lobbyists, engineers and others able or willing to pay some $1,000 for an early model, the first color programs will not be seen merely by the vast audience with monochrome receivers. By the end of 1954, according to one estimate, there may be upwards of 75,000 color receivers in operation.

Engineers will have at least a year of grace in which to get the bugs out of their more complex equipment; studio technicians will learn to handle stronger lights.

Instrument Business Sets Volume Record

Shipments have increased $100 million in 5 years and expansion continues

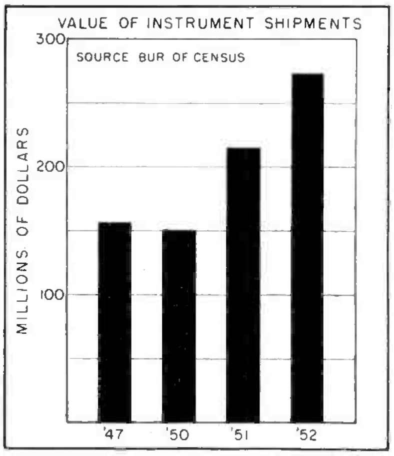
VALUE of electrical instrument shipments reached a total of over $273 million last year, an increase of $117 million over 1947 shipments, according to figures released by the Bureau of Census. The volume confirms the growth of the business that has been evident from the plant expansions and acquisitions of firms in the field during the past few years.

▶ **Breakdown** — Census divides measuring instruments into three groups, integrating instruments, test equipment and other instruments. Of the three, test equipment for testing electrical, radio and communications circuits and motors was the big item, accounting for $139 million of the grand total last year. The other categories accounted for $58 million and $75 million respectively. In 1949 test equipment shipments were valued at $54 million while integrating instruments totaled $63 million and other measuring instruments reached a volume of $37 million.

▶ **Companies**—Indication of how companies in the field fared last year is seen in the following sales figures taken from a list compiled by the National City Bank of New York:

Company	1952 Sales (Thousands)
Applied Research Labs	$2,954
Beckman Instruments	14,400
Consol. Eng. Corp.	8,001
Norden Laboratories	3,252
Nuclear Instrument	1,178
Servomechanisms	10,152
Taylor Instrument	21,623
Telecomputing Corp.	1,665
Tracerlab	12,275
Ultrasonic Corp.	2,108
Victoreen Instrument	1,803
Vitro Manufacturing	2,240

▶ **Expansions**—Further indication of the growth of the instrument business is seen in the following plant expansions and acquisitions that have been announced since the



first of the year by companies in the field:

American Car & Foundry entered the business recently with the purchase of Avion Instruments; Beckman Instruments has announced plans for a $2 million plant in California and has opened a large new plant in New Jersey; Bendix entered the field with the purchase of the Ultra-Viscoson, a device that meters fluid flow; DuMont opened a 118,000 sq ft plant for the manufacture of cathode-ray instruments this year; T. A. Edison acquired Measurements Corp.; General Instrument has acquired a fourth plant; G. M. Giannini built a $500,000 plant and opened a European subsidiary; Texas Instruments is completing a $1 million plant in Dallas.

▶ **Abroad**—Companies overseas are also cashing in on increasing instrument business. H. F. Dever, president of Brown Instrument Division of Minneapolis Honeywell estimated that the use of instrumentation and automatic control equipment in Great Britain and on the continent had increased at least 50 percent since the end of World War II.

U. S. Surveys TV Purchasing Plans

More people plan to buy receivers this year than last and expect higher cost

PROPORTION of people planning to buy tv sets this year increased substantially over the proportion with such plans last year, according to the Federal Reserve's survey of consumer finances made early this year. The higher level of tv sales so far this year seems to substantiate the survey's results.

According to the study of all appliance purchases planned in 1953, ranging from tv to washing machines, plans to buy tv sets showed the largest increase along with furniture. The figure for those people with definite or probable plans to buy tv sets increased by 3 percent since 1951. The proportion of those people that only indicated uncertain tv spending plans also increased in the two-year period by 1.4 percent.

▶ **Cost**—Although the percentage of respondents to the survey expecting prices in general to be stable or to decline during 1953 was much larger than a year earlier, the amount to be spent on specific items was expected to be greater. For tv sets, people expected to spend $250 in 1951, $300 in 1952 and $320 in 1953.

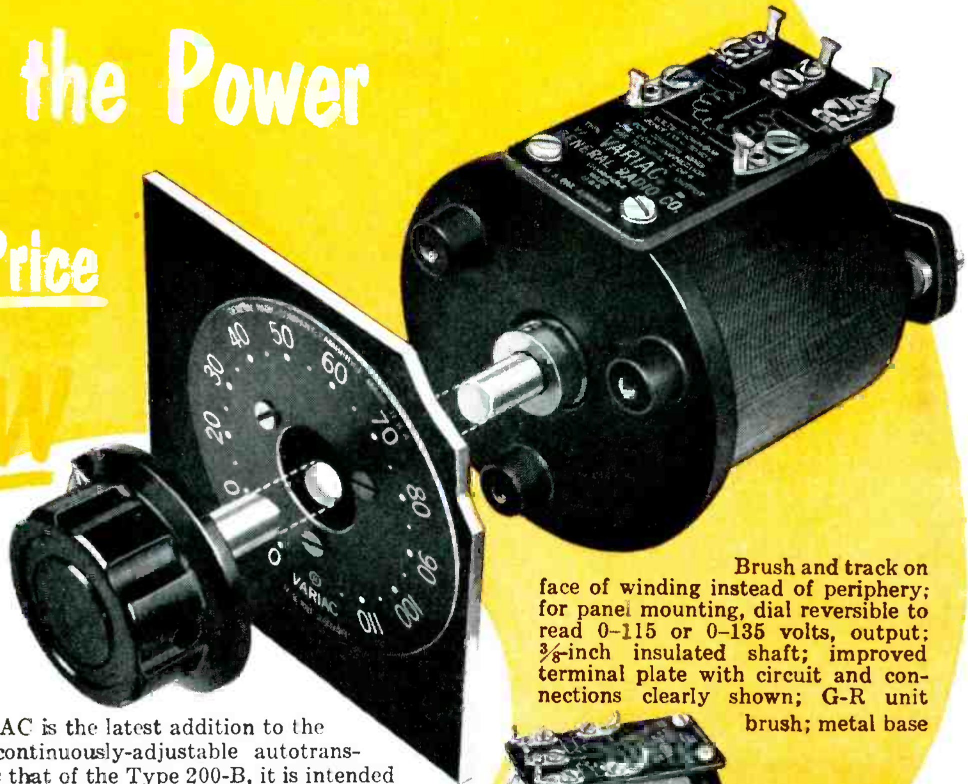
▶ **Income Factor**—The survey shows that in 1952 people with incomes of $5,000 or more purchased tv sets much less frequently than in 1951 while the lower income brackets bought at about the same or a slightly higher rate. This difference probably reflects the ac-

(Continued on page 18)

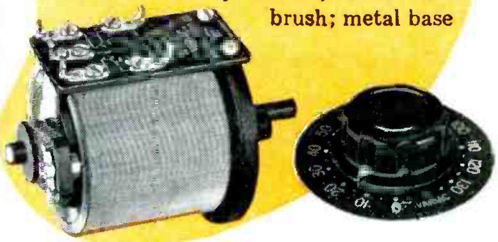
Twice the Power for the Same Price

with the NEW

type V-2 Variac



Brush and track on face of winding instead of periphery; for panel mounting, dial reversible to read 0–115 or 0–135 volts, output; ⅜-inch insulated shaft; improved terminal plate with circuit and connections clearly shown; G-R unit brush; metal base



The *new* Type V-2 VARIAC is the latest addition to the popular "V" series of VARIAC continuously-adjustable autotransformers. With a power rating of *twice* that of the Type 200-B, it is intended eventually to supplant the latter.

The Type V-2 represents a considerable improvement over the 200-B, making it even more adaptable to a wide variety of applications where a relatively low-power, moderately-priced, a-c voltage control with all of the latest exclusive VARIAC features is needed. Its electrical and mechanical features include:

- New DURATRAK brush-track coating
- Load rating of 0.345 kva (instead of 0.17 kva)
- Output voltages continuously adjustable from 0 to 135 v, or 0 to 115 v.
- Line frequency 50 to 60 cycles; no load loss at 60 c.: less than 3.5 watts
- ★ Standard mounting holes (interchangeable with Type 200-B)
- ★ Considerably less panel space
- ★ Metal Base for improved cooling and added strength
- ★ More rugged stops
- ★ G-R Unit Brush construction
- ★ Terminal board with circuit and connections clearly shown
- ★ Molded knob-pointer and reversible dial plate for panel installation
- ★ Meets applicable requirements of Military Specification for Transformers: MIL-T-27
- ★ **Moderate Price: $12.50**

The new DURATRAK coating is one of the most important improvements in VARIACS; another step in the continuing process of development which makes the VARIAC the best voltage control available

NOW ALL "V" TYPE VARIACS HAVE *New* Duratrak CONSTRUCTION

for Increased Performance

Even Longer Life

The new DURATRAK brush-track coating eliminates all brush track oxidization problems which formerly might become critical under severe conditions of operation.

DURATRAK construction adds these features to increase the utility of VARIACS:

Long Life — *insures a life as long as that of fixed-ratio power transformers operated at rated loads*

Unaffected By Surges — *VARIACS with DURATRAK will withstand initial surges as high as ten times rated current*

Minimum Maintenance — *the brush track will not deteriorate under normal operation — only maintenance needed is occasional wiping of track with alcohol-moistened rag*

Write for the NEW VARIAC BULLETIN for Complete Specifications

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

90 West St. NEW YORK 6 920 S. Michigan Ave. CHICAGO 5 1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors Decade Inductors ☆ Decade Resistors ☆ Distortion Meters Frequency Meters ☆ Frequency Standards ☆ Geiger Counters Impedance Bridges ☆ Modulation Meters ☆ Oscillators Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls Noise Meters ☆ Null Detectors ☆ Precision Capacitors Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes quisition of sets by the higher income groups in previous years.

In early 1952, more than one-half of the respondents with incomes of $5,000 or more owned tv sets as compared with much smaller proportions among the lower income groups.

▶ **Where**—Nearly one-half of the people surveyed in northeastern states owned sets in early 1952 in contrast to about three-tenths in the west and one-eighth in the south.

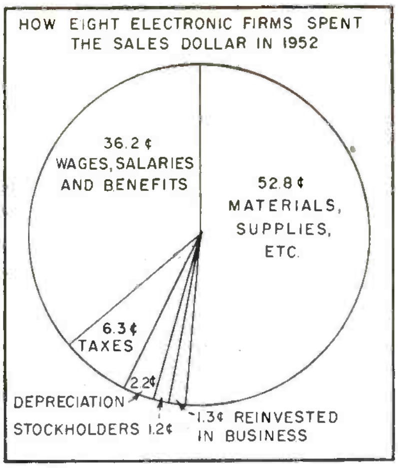
Electronic Firms Size Up The Sales Dollar

Material and labor costs took almost 90 cents from each consumer dollar collected

SHINY SALES FIGURES set down by companies in the electronics field so far this year lose some of their luster when an analysis is made of where sales dollars go. Last year, for every dollar collected from customers by eight major electronic manufacturers, only 2.5 cents was left, by the time all bills were paid, for payments to shareholders and for reinvestment in the business. This year, the amount may be even smaller if material and labor costs keep rising and cannot be offset by price increases.

In 1952, materials, supplies and services bought from outside suppliers by these companies took 52.8 cents out of each sales dollar. Employment costs took an additional 36.2 cents, taxes accounted for 6.3 cents, depreciation cost 2.2 cents for each dollar leaving 1.2 cents for shareholders and 1.3 cents for reinvestment in the business.

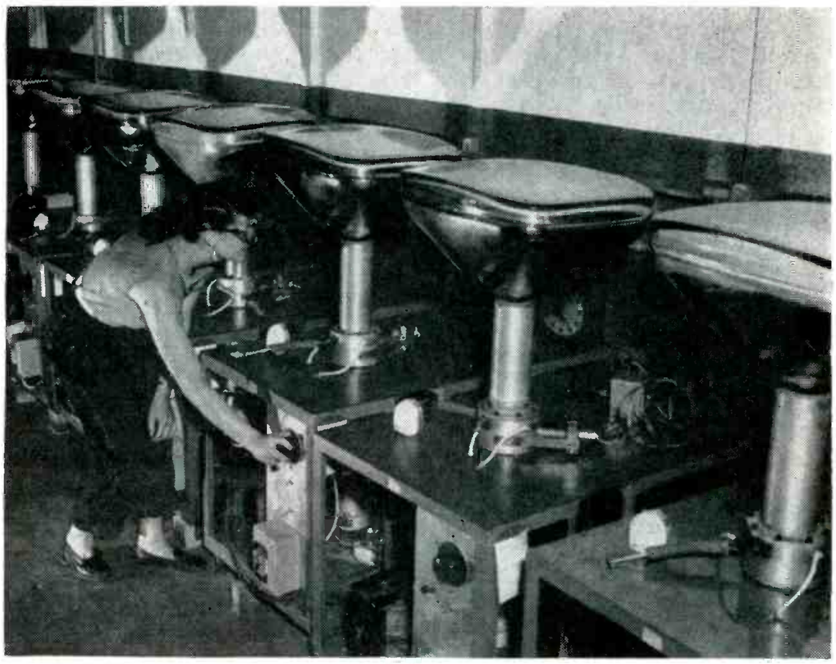
▶ **Companies**—Breakdown of expenditures for each of the eight firms varied considerably, however, for some of the items. For materials, top payment was 66.4 cents of each sales dollar. The low was 42.3 cents. Wages ranged from 28.2 cents to 41.5 cents. Taxes also varied widely from 2.1 cents to 16.4 cents. Payments for depreciation, to



shareholders and for reinvestment in the business were relatively constant for the group during 1952.

▶ **Changes**—Compared to 1951, material costs for many electronic manufacturers went up substantially last year, as much as 5 cents for each sales dollar collected, in some cases. Higher sales volume last year over 1951 dropped labor's percentage of the sales dollar however, even though the total cost was higher. Other items showed relatively little change for the years 1951 and 1952.

Indications are that material and labor costs are taking a still bigger bite out of the sales dollar this year. Most recent price increases have been blamed on rising labor and material costs. However, rising sales may lower the percentage.



ALUMINIZED picture tube output gains in volume as . . .

Picture Tube Makers Expand Plants

Some tube manufacturers are jumping on the aluminizing bandwagon; others hold out

TELEVISION picture tube production is way ahead of last year's output yet some manufacturers are still expanding facilities and expect even greater production in the future. Output of picture tubes through July of this year is more than double last year's production for the period.

▶ **Pro**—One reason for the plant expansions in the face of present high output is that some companies see a continuing rise in the demand for aluminized tubes from set-makers and they want to be ready for it. They feel that, like the rectangular

(Continued on page 20)

Designers—The right tube . . . find it with G.E.'s

NEW SPOT-RATING SERVICE ON THYRATRONS!

YOUR electronic circuit may require a control tube with special performance. Even General Electric's 36 thyratrons—largest choice in the industry—may not include a type whose published ratings are identical with the tube you need.

Here G. E.'s Thyratron Spot-rating Service takes over. Published tube ratings, such as those listed on this page, apply to *only one set of pre-established conditions.* Under different circuit conditions, a G-E thyratron's voltage or current capacity may be greater. For example, if your peak voltage is less than 1250 v, Type GL-3C23 in practice may be found able to handle in excess of 1.5 amp current.

General Electric always is glad to recommend such possibilities, after study. You can have a thyratron that custom-fits your circuit—at the same time, one that's industry-tested for performance. You will save by installing a type already in large production! . . . With the list below as your guide, write pinpointing your thyratron needs! *General Electric Company, Tube Department, Schenectady 5, N. Y.*

FOR EVERY APPLICATION, A CHOICE OF ***PROVED*** G-E THYRATRONS!

Primary application and type number	Average amp	Peak amp	Peak volts, inverse
MOTOR CONTROL			
GL-C1J	1	8	700
GL-3C23	1.5	6	1250
GL-5720/FG-33 (3 electrodes)	2.5	15	1000
GL-5560/FG-95 (4 electrodes)	2.5	15	1000
GL-5544	3.2	40	1500
FG-172	6.4	40	2000
FG-105	6.4	40	2500
GL-6044	6.4	77	500
GL-5545	6.4	80	1500
GL-414	12.5	100	2000
GL-5855	12.5	150	1500
WELDING CONTROL			
GL-5560/FG-95	0.5	30	1000
GL-5632 (gas)	2.5	30	1250
GL-6011 (gas and mercury)	2.5	30	1250
FG-172 (metal)	2.5	77	750
FG-105 (glass)	2.5 4	77 16	750 10000
REGULATED POWER SUPPLY			
FG-81-A (3 electrodes)	0.5	2	500
FG-98-A (4 electrodes)	0.5	2	500
FG-97	0 5	2	1000
GL-5557/FG-17	0.5	2	5000

Primary application and type number	Average amp	Peak amp	Peak volts, inverse
GL-393-A	1.5	6	1250
FG-27-A	2.5	10	1000
GL-5728/FG-67	2.5	15	1000
GL-5830/FG-41	12.5	75	10000
HIGH CURRENT AMPLIFICATION			
GL-5663	0.02	0.06	500
GL-2D21	0.1	0.5	1300
GL-5727 (special heater-cathode construction)	0.1	0.5	1300
GL-502-A (metal)	0.1	1	1300
GL-2050 (glass)	0.1	1	1300
GL-627	0.64	2.5	2500
GL-678	1.6	6	15000
FG-154	2.5	10	500
GL-5559/FG-57	2.5	15	1000
GL-672-A	3.2	40	2500
MODULATOR SERVICE			
GL-6130	0.045	35	3000
GL-5948	1	1000	25000
SPECIAL APPLICATIONS			
*GL-5662	(fuse tube)		200
**GL-885 (2.5-v heater)	0.075	0.3	350
**GL-884 (6.3-v heater)	0.075	0.3	350

*for electronic-blanket control **for oscilloscope sweep circuits

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

Diamond Anniversary

GENERAL ELECTRIC

163-1AB

tube, the aluminized tube is here to stay and is a feature that will not be by-passed.

Aluminizing proponents estimate that it increases the light output by approximately 2 to 1 over nonaluminized tubes. They say that the tubes enable set makers to use smaller power tubes because of the increased brightness. One major tube maker now estimates that aluminized tubes account for half of its total production and may reach 75 percent when new facilities are completed.

▶ **Other side**—But not all tube manufacturers are convinced that aluminizing is worth the problems that it brings about. Dissenters point out that the aluminizing operation takes as much space as the exhausting operation and substantially decreases the number of tubes that can be produced in a day.

With rejects higher and costs up between 10 and 15 percent on each tube, these companies do not at present favor the operation. They say the difference in picture brightness is affected by viewing conditions so that in the wrong light, the difference in picture brightness is not noticeable. They also point out, that despite statements made by aluminizing proponents, the demand for the tubes has not been an important factor.

Radio-TV Fair Trade Hearing Set By FTC

THE Federal Trade Commission has announced a hearing on proposed business rules for the radio and television industry to be held in Washington at the Federal Trade Commission Building on October 8th.

The business rules represent a proposed revision and extension of rules promulgated in 1939 for the radio receiving set manufacturing industry (ELECTRONICS, March, 1952, p. 6). Rules have to do with misbranding, misrepresentation and deceptive selling methods.

The purpose of the proceedings is to provide for a cooperative prevention of unfair and deceptive practices in the radio and television industry. Interested parties may submit their views not later than October 8th, at which time they will be given an opportunity to be heard orally. Copies of the proposed rules may be obtained from the Commission.

Industrial Television Sales Outlook Is Bright

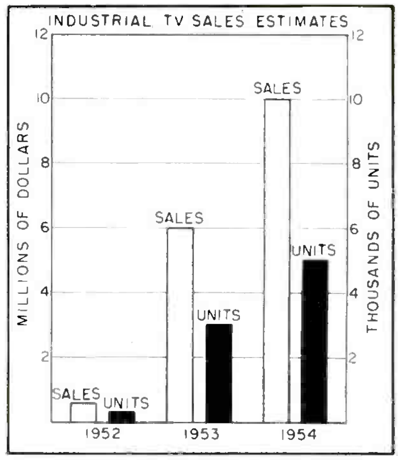
Companies see $6 million in sales for this year as applications and output increase

DESPITE the large amount of promotion that industrial television has received, sales of equipment in the past have not been large. But now, with more companies in the field, better equipment and lower prices, sales of the units have become substantial and manufacturers estimates indicate that sales this year may reach $6 million, a ten-fold increase over last year's estimated business.

This year prices roughly average $2,000 for a camera and the prediction of $6 million in sales represents the beginning of sizable production. The vidicon tube has come down in price, from approximately $500 at its introduction to a July price of about $345. Sales managers and customers agree that similar price reductions have been a main factor accounting for sales increases this year. They expect prices to be even lower next year.

▶ **Applications**—Finding new ways to use tv is still a problem, despite price reductions. One company recently demonstrated that the equipment could be used in a butcher shop to show shoppers at the counter choice cuts of meat from inside the icebox. The military is also taking to tv. GI's trucked cameras to mock battle lines so that brass hats could witness the progress of battle as it took place.

Perhaps the most unusual application made recently took place in Hollywood, California. There the equipment was used to detect a gang of thieves in the act of pilfering the stockroom of an RCA television service branch. The camera, concealed in the rafters and focused on the loading platform, gave Hollywood police watching a receiver in an upstairs room a front-row seat.



Financial Roundup

BRIGHT profits for this year continued to be reported by companies in the electronics field along with new security transactions. In almost every case, firm's reported earnings substantially above those for similar periods in 1952. For 19 companies, the net profit picture for six months looked as follows:

Company	Net Profit 1953	Net Profit 1952
American Phenolic	$688,889	$573,651
AT&T	204,994,197	174,946,339
Arvin (3 m).....	910,596	778,639
Audio Devices...	74,165	53,883
Bendix (m).....	4,021,952	3,797,119
Clevite Corp.	2,015,419	1,786,379
CBS (26 wks)...	4,003,377	2,851,415
Daystrom (3 m)..	324,219	401,499
Decca Records ..	430,063	270,923
T. A. Edison.....	560.227	316,095
Federal Mfg. & Eng. (12 m)...	176,783	212,696
General Precision.	1,469,067	361,112
IBM	15,575,997	13,937,142
Sangamo Electric	1,186,714	1,027,749
Servomechanisms.	183,716	179,040
Sperry	7,997,470	6,575.265
Standard Coil ...	2,736,431	1,490,547
Webster-Chicago .	345,973	*272,432

*Loss

▶ **Offerings**—G. M. Giannini offered an issue of 18,316 shares of common stock (par $1) at $12 per share. Proceeds will be used for general corporate purposes.

Soundscriber offered to common stockholders the right to subscribe for 15,588 additional shares of common (no par) at $6.25 per share, at the rate of 1 new for 7¼ shares

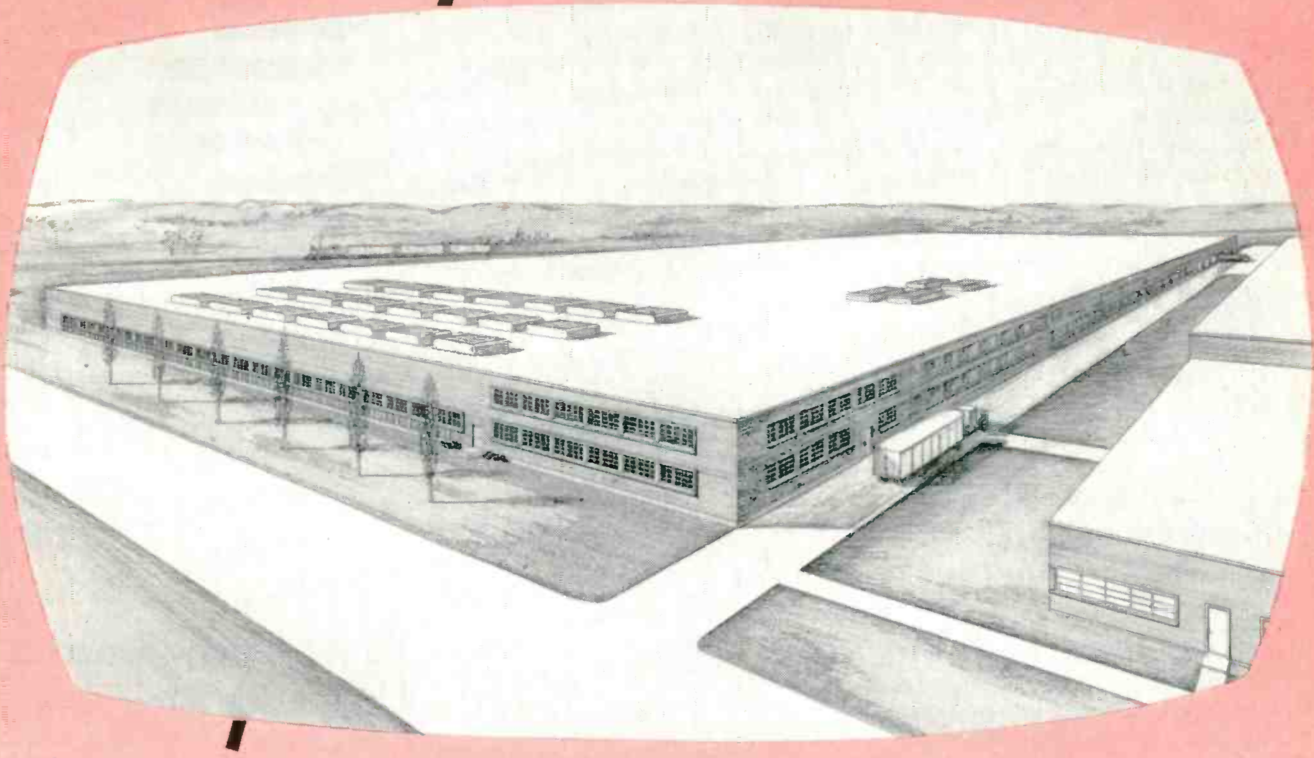
(Continued on page 22)

BIGGER—BETTER

RAYTHEON

Picture Tubes

FROM THIS NEW PLANT



The very newest equipment, and the most advanced production techniques combine in this great new Raytheon plant, to produce the finest quality big screen (21″, 24″, 27″) TV Picture Tubes ever made.

To make possible efficient mass production of giant size picture tubes, Raytheon had to originate specifications for some of the world's largest tube manufacturing units.

Under this one roof, to insure perfect screens and most economical production, you'll find

— THE WORLD'S LARGEST SETTLING CONVEYOR, capable of handling two hundred and ten 27″ tubes at a time

— A BAKE-OUT OVEN 103 FEET LONG; the largest built

— THE BIGGEST EXHAUST MACHINE EVER BUILT; 303 feet long; a steel-lined, electrically fired beauty that conveys the big tubes smoothly on specially designed tube carriers supported from the side instead of on undesirable floor rails

Add to these major manufacturing miracles, mechanical handling, automatic testing and super-automatic processing equipment that (1) flashes the getter, (2) bases the tube, (3) solders the leads to the base, (4) sparks the tube, (5) ages the tube.

It totals up to this:

RAYTHEON PICTURE TUBES are *Right for Sight!*

RAYTHEON®

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — for application information call

Newton, Mass. Bigelow 4-7500 • Chicago, Ill. NAtional 2-2770 • New York, N. Y. WHitehall 3-4980 • Los Angeles, Calif. Richmond 7-5524

RAYTHEON MAKES ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES • GERMANIUM DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES held. Proceeds are for notes and general corporate purposes.

▶ **Filings**—Raytheon filed with SEC covering 6,000 shares of common (par $5) to be offered at market (estimated $9.75 per share). Proceeds are to be used for general corporate purposes.

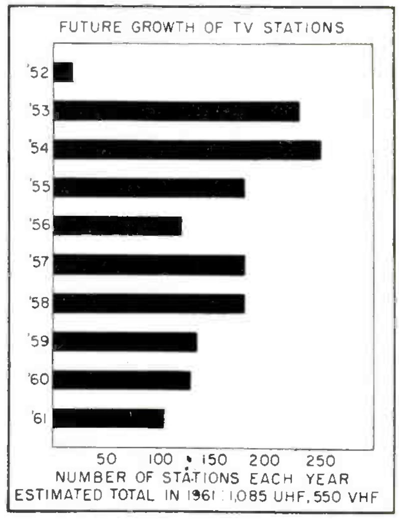
Clary Multiplier filed with SEC covering 30,000 shares of common (par $1) to be offered at market (approximately $6.75 per share). Net proceeds are to be used for working capital.

Dynatronics of Reno, Nevada filed with SEC covering 200,000 shares of common stock to be offered at par ($1 per share). Proceeds are to be used for working capital for electronic equipment.

Sonic Research filed with SEC covering $40,000 of 6-percent notes convertible into no par common to be sold at par in $1,000 units. Proceeds will be used for working capital to develop sonic and vibration equipment.

AT&T plans to issue, in what is said to be the largest offering ever made by any company, about $625 million of new convertible debentures, if stockholders approve. Proceeds are to be used to continue construction of new facilities to meet demands for telephone service. Some half-million people are waiting for service and over a million party-line customers want better service, the company said. The offering will help finance the expansion.

TV Equipment Makers Look Ahead



Major tv broadcast equipment manufacturers seem to agree in general with these station predictions mode by one company in the field. Next year may be the peak for transmitter sales. At $250,000 a station, this schedule could mean potential sales of nearly $400 million for manufacturers over the next 8 years

British Setmakers Show Wares

Radio show spotlights $350-million industry; export models featured

EARLY this month, Britain's electronics industry flexed its muscles at the 20th national radio and television show in London. Employing 135,000 workers, the industry produces $350-million worth of equipment annually; nearly $70 million of this is earmarked for export. Over 100 firms were represented at the show.

▶ **Television** — British setmakers are following U. S. trends in home-instrument design. Nearly every manufacturer is introducing a 17-inch table model this year and at least two firms have 21-inch sets. Rectangular tubes have now been generally adopted. Many tubes are both aluminized and provided with an ion trap to prevent screen burning. Major circuit improvement of the year is automatic picture control that keeps brightness and contrast despite signal-strength variation.

Although British sets generally have but one channel, multichannel sets made to both North American and European scanning standards are being produced for export. Radio and tv home-instrument sales account for about $\frac{1}{3}$ of Britain's electronics export business. In all, more than 120 television receivers were on display at the show of which more than half were making their commercial debut.

▶ **Electronics**—Other new devices shown included a public clock controlled by radio standard time pulses, medical electronic equipment for testing heart and lungs, electronic equipment for factory and office, a microscope with tv-sized screen and one of Britain's electronically-controlled guided missiles.

Several lines of improved electronic components were displayed and a strong trend towards miniaturization noted.

▶ **Poachers**—An interesting piece of equipment shown was a radio direction finder used by the General Post Office to ferret out operators of unlicensed television receivers. Britain's noncommercial tv service is sustained by an annual $2.80 license fee collected by the GPO from each viewer.

An estimated 200,000 unlicensed sets are in operation. Licenses outstanding total nearly 2,500,000.

Radar Safety Beacons Urged For Aircraft

Equipment would be similar to ground racons that are now in operation

PRIMARY RADAR now in use at many airports has several limitations resulting from its basic nature. A revolving antenna sprays out high energy pulses and receives relatively weak pulses reflected from objects within its range.

Often weather fronts and precipitation adversely affect performance. Sometimes the antenna pattern has holes at certain angles and the aircraft is lost for a time.

Jet-turbine aircraft are so small that the radar often has difficulty obtaining sufficient reflection to track them. When a plane is flying near fixed obstacles it is sometimes obscured. And, worst of all, all blips on the airport primary radar look the same. The Radio Technical Com-

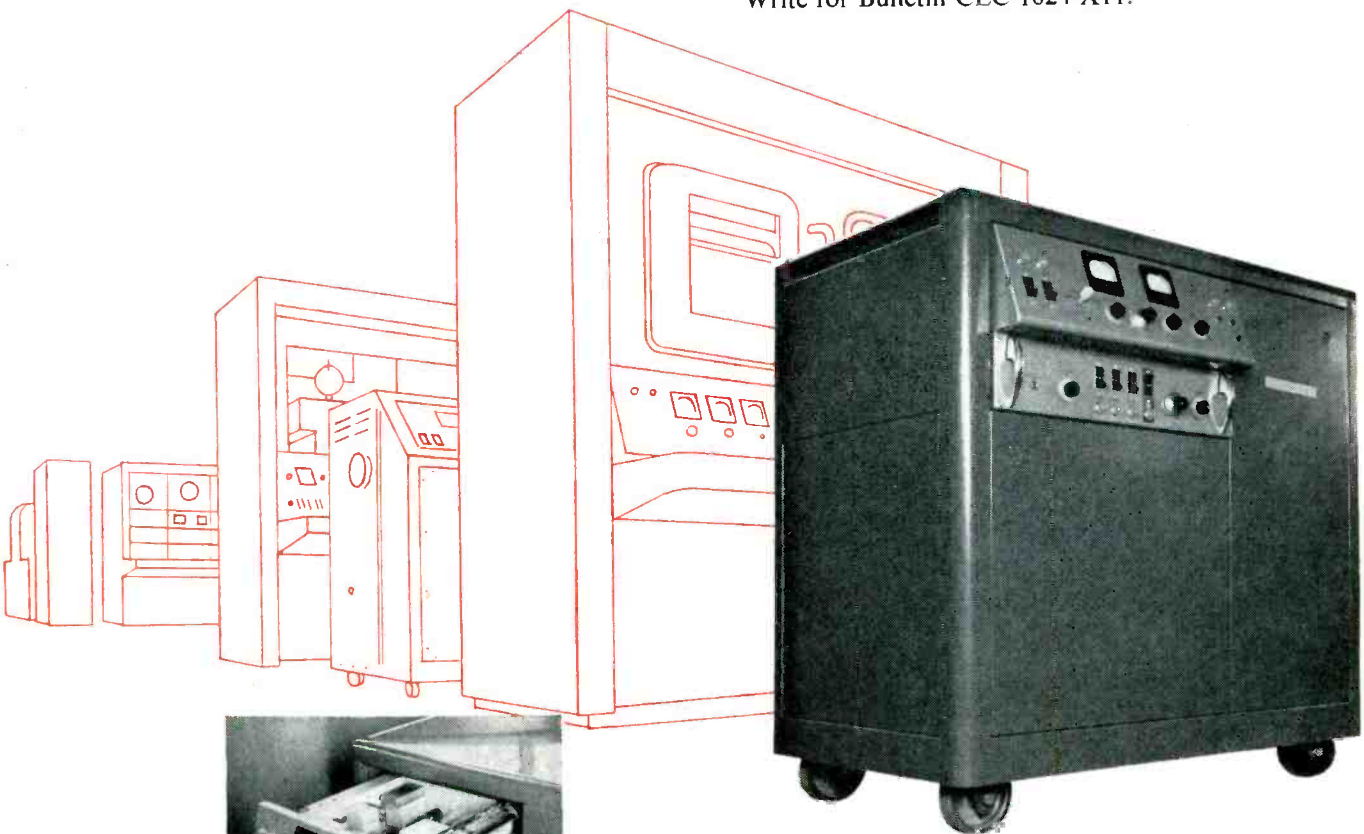
(Continued on page 24)

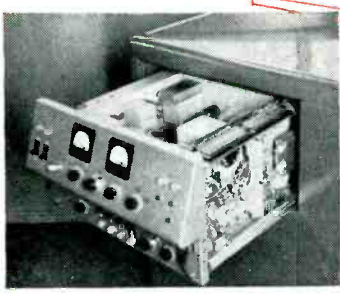
Newest in the line . . .

A single instrument for Process control Leak detection Research

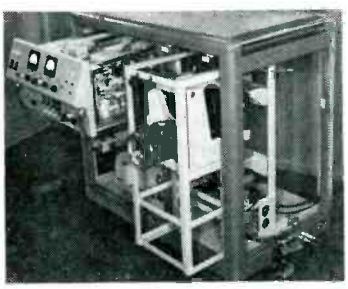
THE latest mass spectrometer in America's accepted standard line is the Consolidated Model 21-610, a precision electronic instrument with extreme stability for unattended process monitoring in the petro-chemical industries. Used with a hand-held probe it, operates as a detector for tracing leaks of any gas within its mass range. The Model 21-610 is suitable for qualitative and quantitative component determinations in gaseous and light-liquid mixtures. Moderately priced and economical to operate, needing no expensive refrigerants, this new instrument brings mass spectrometry as a control procedure within reach of small refineries and chemical manufacturers.

Write for Bulletin CEC-1824-X11.





All components are accessible: either by removing side panels or by pull-out chassis containing circuits and controls.



Electronic and vacuum/analyzer assemblies may be removed intact and operated independently.

Model 21-610 Mass Spectrometer

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

analytical instruments for science and industry

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mittee for Aeronautics therefore urges that a plan be formulated for equipping aircraft with a special transmitter to send out a coded signal when triggered by the airport radar pulse.

▶ **Racons in Use**—This direct-transmission idea is not new, having been used during the war on military craft under the designation IFF (Identification Friend or Foe). The scheme is now being used in reverse to identify ground locations. Racons (Radar Beacons) are triggered by the radar pulses from aircraft or surface vessels and send out an identifying code.

At present, there is a total of 117 listed as operating throughout the world. Eight of them in the United States operate at 3,256 mc and 77 on 9,310 mc. There are seven in Alaska and the Pacific Isles. Twenty-five others are scattered throughout the world.

MEETINGS

SEPT. 28-30: Ninth annual National Electronics Conference, Sherman Hotel, Chicago, Ill.

SEPT. 29–OCT. 1: AIEE Middle Eastern District Meeting, Daniel Boone Hotel, Charleston, W. Va.

OCT. 2–11: First Annual National Electronic Show, Santa Monica Pier, Santa Monica, Calif.

OCT. 5–8: Fall Technical Meeting sponsored by Canadian National Committee, URSI and IRE Antenna Group, Ottawa, Canada.

OCT. 13: Joint Meeting AIEE-IRE, Some Recent Advances in Microwave Tubes, Stewart Avenue School, Garden City, L. I., N. Y.

OCT. 13–15: National Conference On Tube Techniques sponsored by the Subpanel On Tube Techniques of the Department of Defense, Western Union Auditorium, New York, N. Y.

OCT. 14–16: Sixth Annual AIEE Special Conference on Machine Tools, Hotel Cleveland, Cleveland, Ohio.

OCT. 14–17: Audio Fair And 5th Annual Convention of the Audio Engineering Society, Hotel New Yorker, New York, N. Y.

OCT. 17–23: 35TH National Metal Congress and Exposition, Cleveland, Ohio.

OCT. 20–22: Thirtieth Annual Session Of A.A.R. Communications Section, Hotel Plaza, San Antonio, Texas.

OCT. 22–NOV. 1: First Brazilian Exposition of Radio, Television, Electronics and Telecommunications, Automobile Club of Brazil, Rio de Janeiro, Brazil.

OCT. 26–28: Radio Fall Meeting, RETMA, RTMA of Canada and IRE, King Edward Hotel, Toronto, Ontario, Canada.

NOV. 9–12: National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

NOV. 9–12: Conference on Radio Meteorology, Austin, Texas.

NOV. 12–13: IRE Fourth Annual Meeting of Professional Group On Vehicular Communications, Hotel Somerset, Boston, Mass.

NOV. 13–14: Annual Electronics Conference, Hotel President, Kansas City, Missouri.

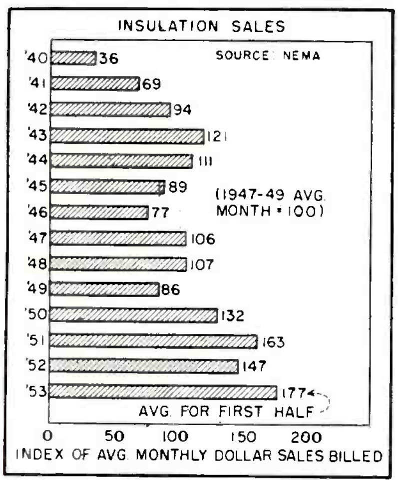
DEC. 8–10: Joint AIEE-IRE-ACM Computer Conference and Exhibition, Statler Hotel, Washington, D. C.

SEPT. 13–24, 1954: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 1954: International Scientific Radio Union, Amsterdam, Netherlands.

Insulating Materials Head For Big Year

ELECTRONIC manufacturers have been responsible for a large part of the record sales set by companies in the electrical insulating materials



field during the first six months of this year.

Billings have been higher for the period than in any previous first half on record for laminated products, electrical mica, porcelain, varnished fabric and paper, vulcanized fiber and the other components that make up the NEMA index.

Industry Shorts

▶ **Combination** of the world's most powerful electron linear accelerator with a high-energy electron scattering apparatus that can peer 10 times deeper into the atom than ever before, enough to distinguish particles within nucleus only two one-hundredths of a trillionth of an inch apart, has been perfected by Stanford University physicists.

▶ **Air-conditioning** field garners another electronic manufacturer with Emerson introducing a line of units next spring.

▶ **Passengers** on Southern Pacific's "Cascade" streamliner are now able to talk by radio-telephone with any part of the world through facilities installed recently by Bell.

▶ **Number** of technical session, technical papers, exhibitors, booths and total attendance at the 1953 Western Electronic Show and Convention all approximately doubled over those at the show held in 1951.

▶ **Intricate** laboratory apparatus, including a photometer and an oscilloscope, was used by GE scientists recently to determine that the average light output of Cleveland fireflies was 6-thousandths of a lumen, and the brightest produced 9-thousandths of a lumen.

▶ **Canadian** Broadcasting Corp. has selected Vancouver, B. C. as the site for its fourth tv station and has ordered complete equipment for it from Marconi.

▶ **Patent** held by Celanese Corp. on an electronic device designed for increasing efficiency in production of warp-knit fabrics is being made available on a royalty-free basis to the entire textile industry.

130° C.

WITH IMPROVED

BH "649"

Laboratory tested for retention of flexibility and original rated electrical protection after

130 C° — 1500 hours
150 C° — 500 hours
160 C° — 24 hours
232 C° — 3 hours

BH "649" is a braided Fiberglas sleeving coated with an improved vinyl-chloride formulation. Available in all standard sizes and colors, in grades A-1 (7000 V.), B-1 (4000 V.) and C-1 (1500 V.). Send for data sheets and samples from current production.

Another Bentley, Harris First!

Bentley, Harris Manufacturing Co.
Conshohocken, Pa.
Address Dept. E-10

BH *Fiberglas** SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

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The Reader ABC His Mark

THE ABC that appears in the symbol at the top of this page stands for Audit Bureau of Circulations. The symbol itself is an emblem of cooperation, in which every subscriber to this magazine has an interest.

The Audit Bureau of Circulations is a voluntary, non-profit, cooperative association. It was founded in 1914 and now consists of 3450 advertisers, advertising agencies and publishers in the United States and Canada. This magazine is proud to be a member.

ABC originally was set up to help take the racket out of publishing, to eliminate the waste and guesswork then so prevalent in publishing and advertising, to establish order and confidence in place of the misunderstanding and misrepresentation that arose from unverified circulation claims and dubious circulation practices. Its mission was to protect the interests of both readers and advertisers.

THIS IT DID by first defining the term "paid circulation." Then it established standards and rules to govern subscription sales practices and records. Finally it set up an auditing organization to verify the claims and report the facts concerning the circulation of each member publication. It now maintains on that job a working staff of sixty-five full-time auditors. So the ABC symbol has become the hallmark of circulation standards and advertising values. Each member publication must maintain those standards if it wishes to retain its membership and display the ABC symbol.

This ABC audit is no perfunctory affair. When a business publication, such as this one, becomes a member of the Bureau, it agrees that the auditors shall have "the right of access to all books and records." Their inspection, therefore, may cover any part of its operations. Original subscription orders, payments from subscribers, paper purchases, postal receipts, arrears of payments, and many more items are painstakingly checked by the auditors. In many instances they go behind the records to seek verification from subscribers themselves as to the terms of their subscriptions.

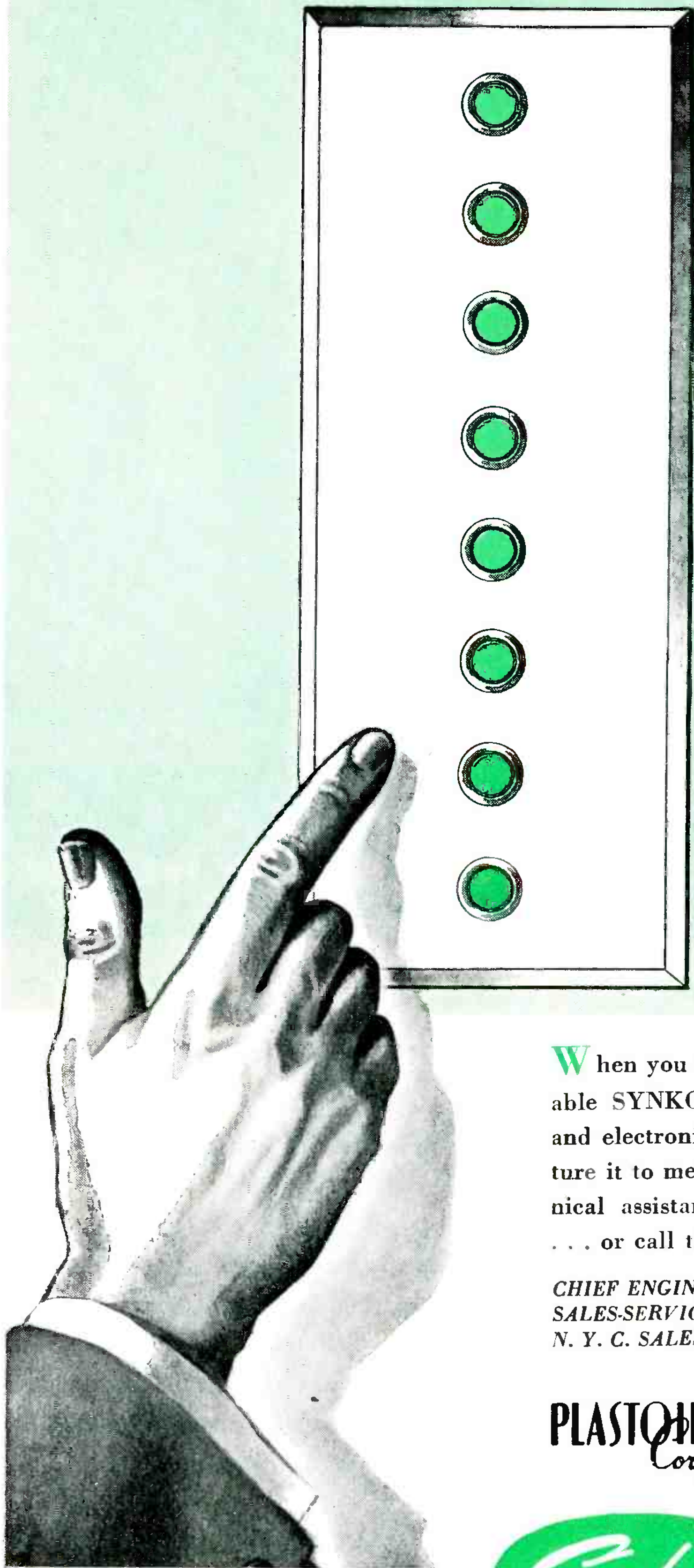
IN DOING ITS JOB, ABC has created many values for both publishers and readers as well as for advertisers. That is because the publication that becomes a member of ABC thereby offers the strongest possible guarantee of its primary devotion to the interests of its readers. The function of a business magazine is to be useful to its readers. When this service is rendered by an ABC publication, it is constantly subject to the practical test of reader acceptance and approval. As each subscriber has the right to purchase or refrain from purchasing an ABC publication, that collective right confers upon the readers the power to say whether or not the publication will survive. Thus the report on its ABC audit provides the most direct assurance that a publication stays in business only because of a voluntary demand by readers who find its editorial service responsive to their needs.

Naturally, the editor of each business publication follows closely the score thus racked up by his paper in its ABC reports. In the scope and tone of his editorial coverage and treatment, in the selection and presentation of his editorial content, he must constantly labor to maintain and enhance the readers' acceptance of his efforts. That is why the editorial standards established by ABC publications set the editorial standards for all publishing. That is how the ABC constantly stimulates its member publications to become even more useful to their readers.

AND THAT IS WHY the ABC symbol has become the Mark of the Reader, a constant reminder that his willingness to pay for an ABC publication is the acid test of its value both to him and to its advertisers.

McGraw-Hill Publishing Company

Almost as easy as this...



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Coaxial Cable

Multi-Conductor Cable

Microphone Cable

Thermostat Wire

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Aircraft Cable

High-Temperature (Teflon) Wire

When you need wire, it's good to know that there's a dependable SYNKOTE construction for every conceivable electrical and electronic use. If we don't have it in stock, we'll manufacture it to meet your requirements. For prices, samples or technical assistance, contact your nearest Plastoid representative . . . or call these men:

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N. Y. C. SALES-SERVICE: W. Grant; phone: STillwell 6-6200 (New York)

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MANUFACTURERS OF DEPENDABLE *Synkote*® INSULATED WIRE AND CABLE

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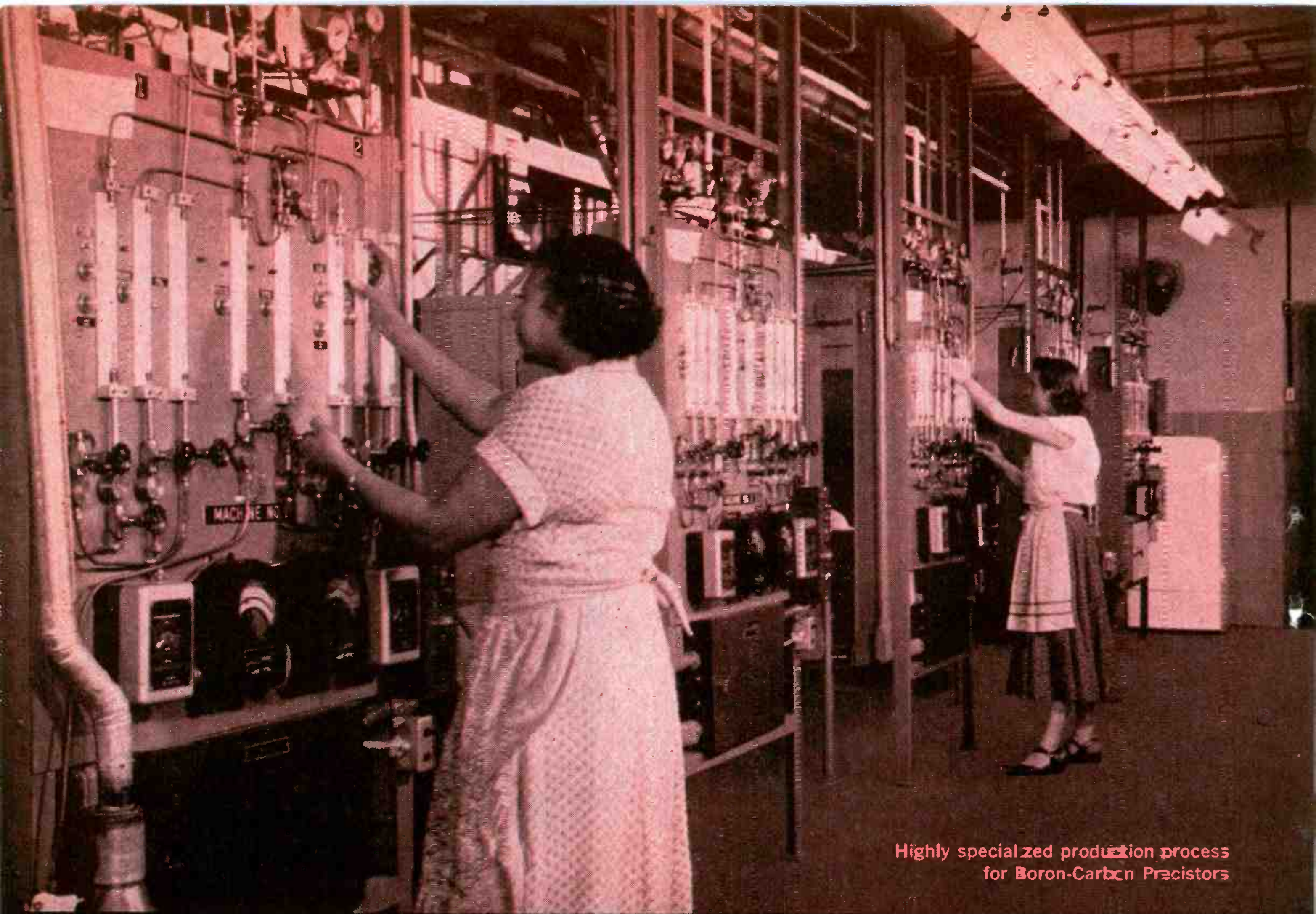
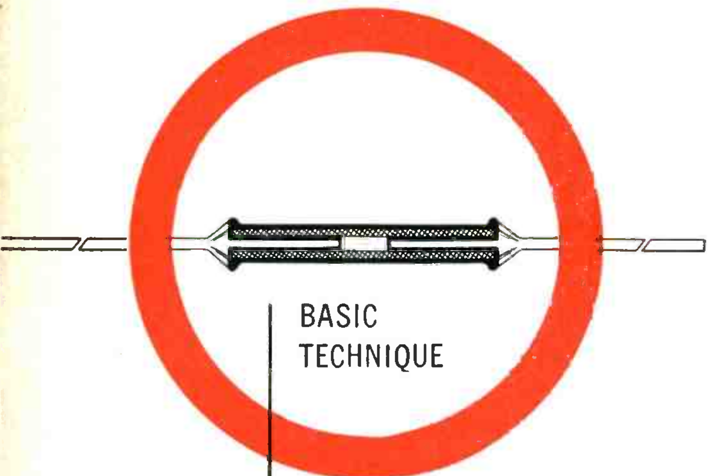


Highly specialized production process for Boron-Carbon Precistors

ONLY FILM TYPE RESISTORS MEET HIGHER



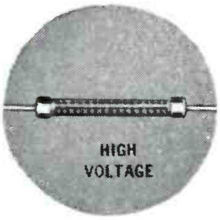
BASIC TECHNIQUE

A thin coating of pre-cured and stabilized resistance material is bonded to special glass or an inorganic core to form IRC's exclusive filament type element. This is in contrast to the carbon pill or slug principle of construction. Its uniformity and stability have proved superior since the earliest days of radio.

Advancing requirements of instrumentation, military electronics and television focus emphasis on greater stability for non-wire wound resistors. IRC believes its filament type construction offers the best answer to more exacting standards. For over 28 years the film type resistance element has proved its superior stability—even in today's newest IRC Boron-Carbon Precistor.

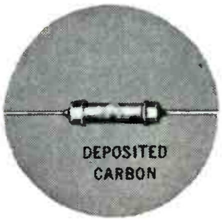
high popularity—high stability

More IRC Filament Type BT Resistors are used in radio and TV sets than any other brand. They meet and beat JAN-R-11 specifications, and have been tested and approved by most producers of government equipment. Exceptionally stable—in ⅓, ½, 1 and 2 watts. Send coupon for Data Bulletin.



high voltage—high stability

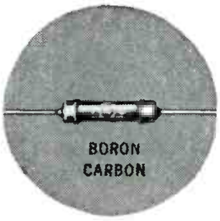
IRC Type MV High Voltage Resistors offer outstanding stability even in very high resistance values. Filament resistance coating in helical turns on ceramic tube provides a long, effective conducting path. 2 to 90 watts. Check the coupon for detailed information.



high economy—high stability

Type DC Deposited Carbon Resistors combine accuracy and economy with high stability. Excellent where carbon compositions are unsuitable and wire wound precisions too large or expensive. Available in ½, 1 and 2 watts. Use coupon for further facts.

STABILITY STANDARDS



high accuracy—high stability

The ultimate in *stable* non-wire wound resistors, Type BOC Boron-Carbon Precistors conform to all requirements of MIL-R-10509. Voltage coefficient less than 20 parts per million per volt. Extraordinary load life. ½, 1 and 2 watts. Send for Bulletin.

NEW

resistor

MOLDED

boron-carbon precistor

Eliminates Possibility of End-Cap Trouble

Eliminates Danger of Mechanical Damage

Improved Electrical Characteristics

The new Type MBC ½ watt, 1% resistor offers the inherent superiority of a Boron-Carbon resistor plus the advantage of a fully insulated unit. Send coupon for full details.

Boron & Deposited Carbon Precistors • Power Resistors • Voltmeter Multipliers • Low Wattage Wire Wounds • Insulated Composition Resistors • Volume Controls •

Wherever the Circuit Says

IRC

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Low Value Capacitors • Selenium Rectifiers • Insulated Chokes • Hermetic Seal Terminals •

INTERNATIONAL RESISTANCE CO.

403 N. Broad St., Philadelphia 8, Pa.

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Send me full data on: ☐ DC Deposited Carbon; ☐ BT Insulated Filament Type Resistors; ☐ MV High Voltage Resistors; ☐ BOC Boron-Carbon Precistors; ☐ MBC Molded Boron-Carbon Precistors

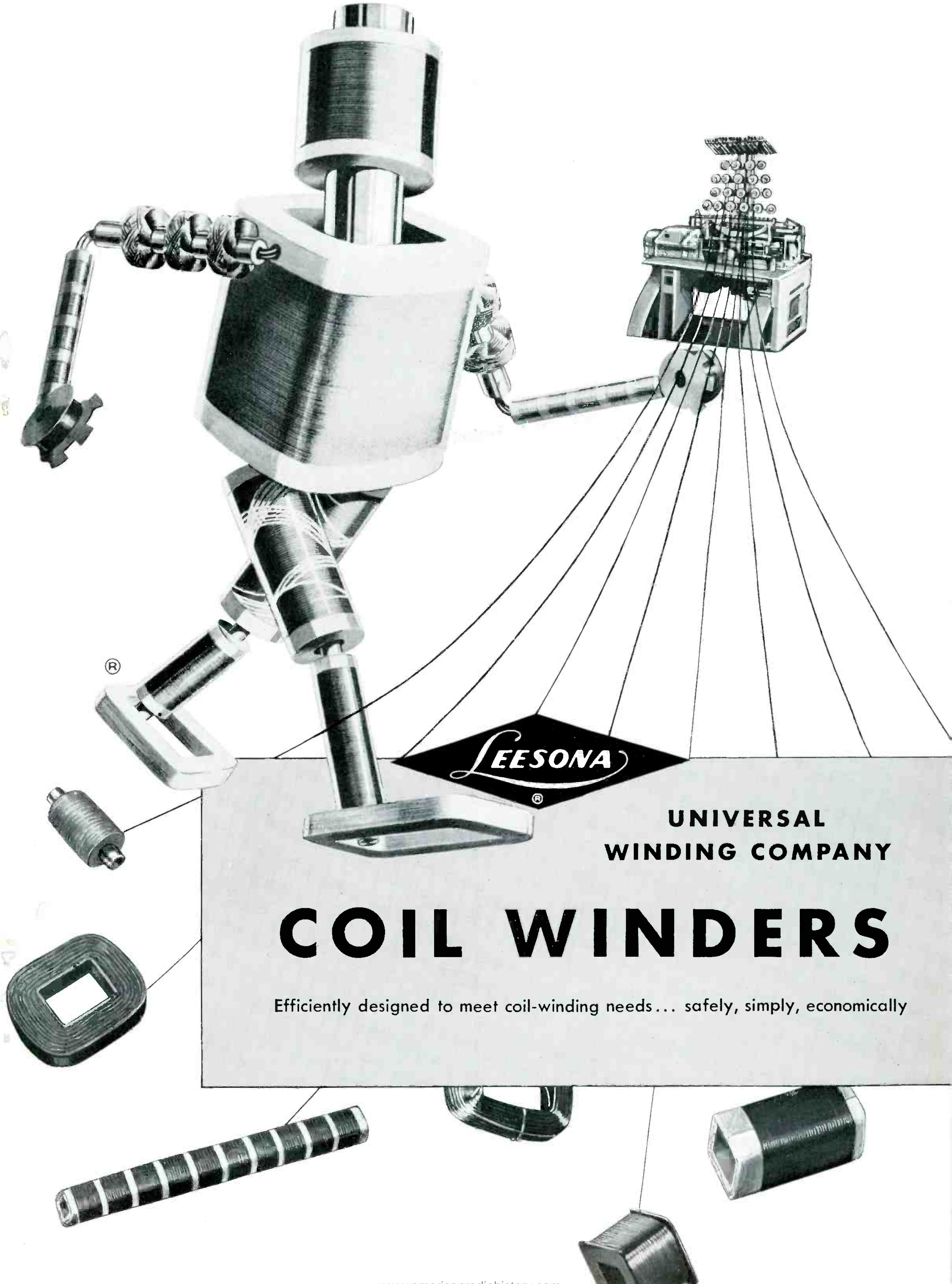
Name ____________________

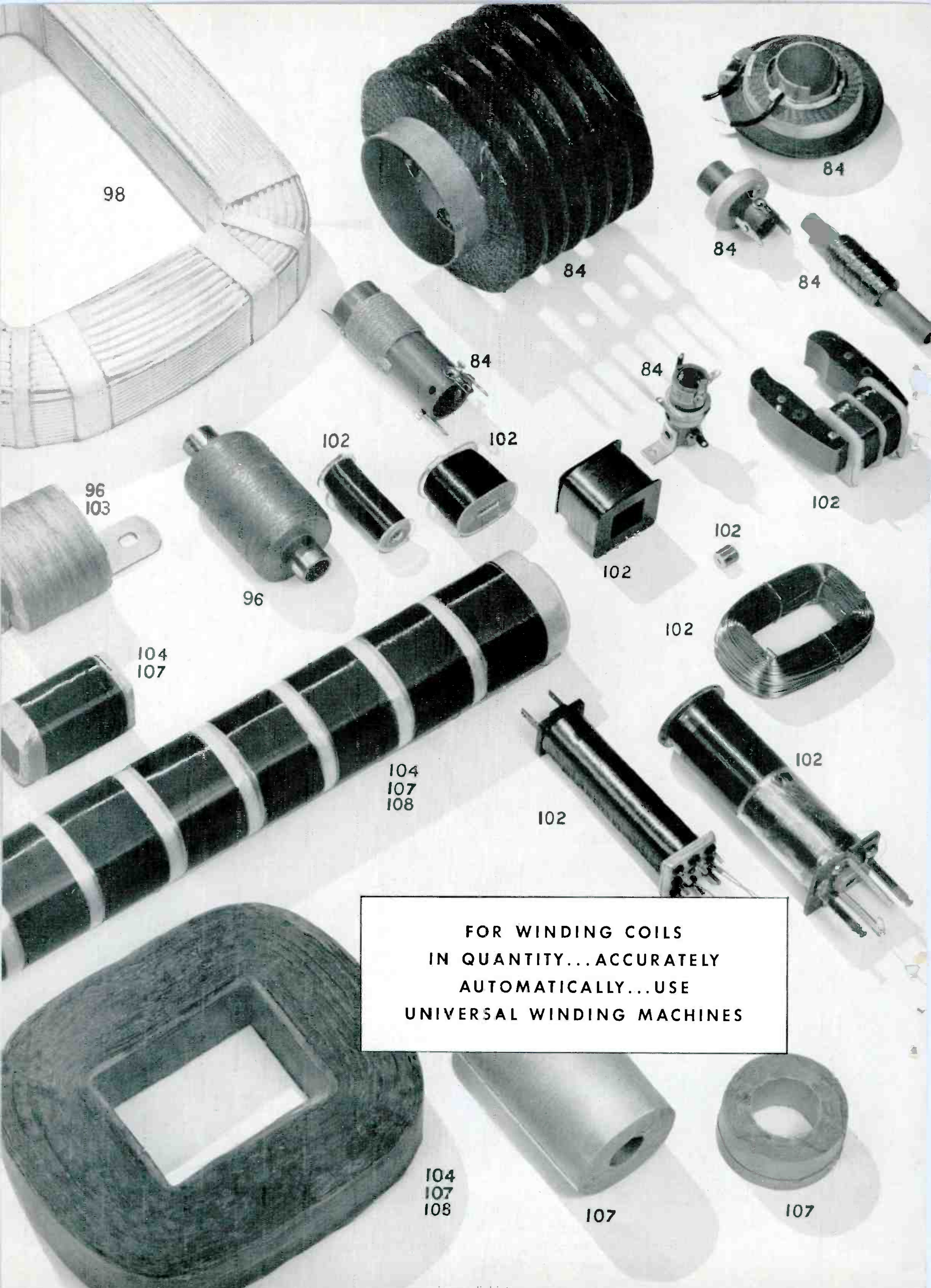
Title ____________________

Company ____________________

Address ____________________

City ____________ Zone ______ State ________


LEESONA®
UNIVERSAL WINDING COMPANY
COIL WINDERS
Efficiently designed to meet coil-winding needs... safely, simply, economically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FOR WINDING COILS
IN QUANTITY...ACCURATELY
AUTOMATICALLY...USE
UNIVERSAL WINDING MACHINES
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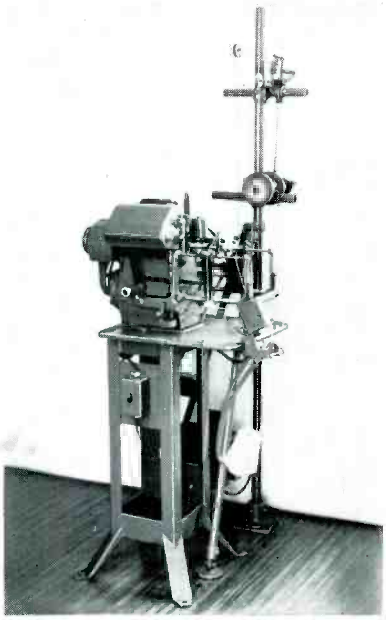
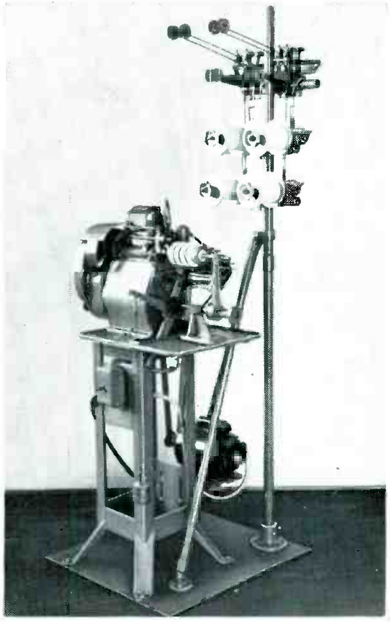
107

Numbers on coils opposite indicate machines on which they are wound.



Layer-wound Cotton Insulated Coils are automatically wound on this No. 96 Universal Coil Winder. Such coils include meter coils (square), solenoid coils (round) and meter potentiometers (flat wire).

This machine winds both cotton-interwoven and uninsulated coils. On cotton interwoven, it eliminates need for flanged coil bobbins, provides ample insulation where current is most apt to short circuit. It can also produce coils with Glassine or Kraft insulating papers (manually inserted) and is widely used for laboratory and experimental work as well as for quantity production.

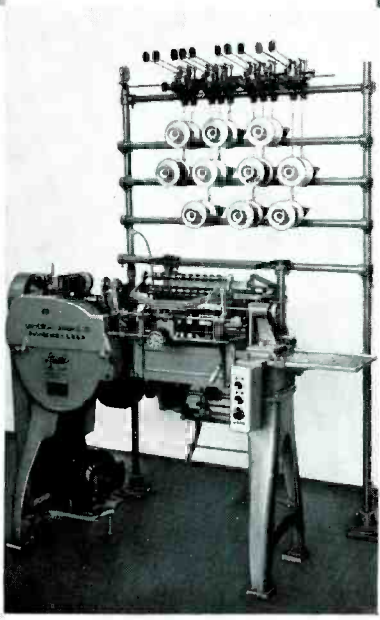


Cross-wound Coils for TV, Radio and General Electronics are wound on this No. 84 Universal Coil Winder. Such coils include intermediate frequency transformers, television flyback transformers, progressive wound coils, linearity coils, large diameter pie-windings and peaking coils.

Producing up to four coils at once, the No. 84 machine gives a high rate of production. Coils are wound with extreme accuracy assuring highest efficiency and uniformity, thus reducing rejects.

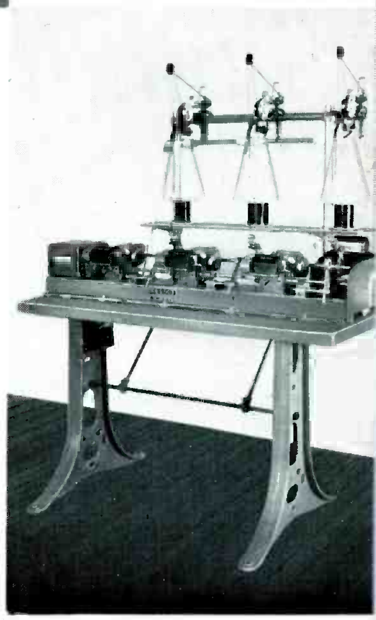
Three to Fourteen Paper-insulated Coils in Stick Form are wound simultaneously on the No. 104 Universal Automatic-Feed Coil Winder now equipped with an electronic drive. Such coils include round or square coils, fluorescent ballasts, oil burner secondaries, automotive ignition secondaries and outboard ignition secondaries.

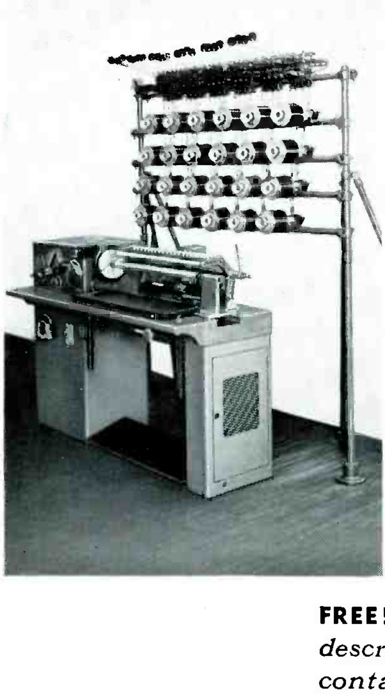
This machine handles papers of various grades and thicknesses such as Glassine, Kraft and Acetate film.



Hi-speed Spool-wound Coils are produced on this No. 102 Universal Coil Winder. Such coils include those used in electric shavers, bell ringers, aviation and telephone relays (fine wire), and hearing aids.

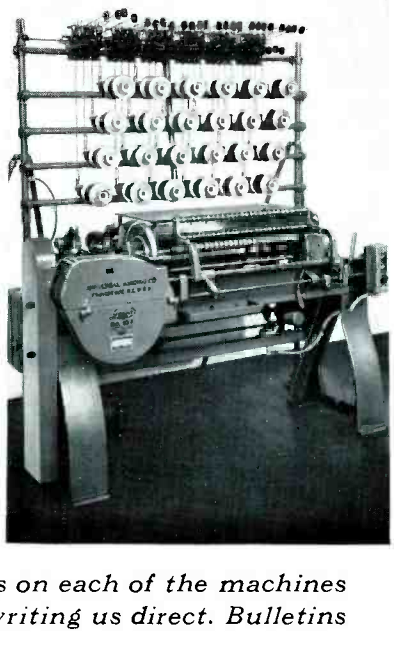
This machine makes possible synchronized production of non-insulated coils at speeds up to 5000 rpm. The individually operated heads enable synchronizing winding and handling time thus increasing production per operator on high-turn coils, resulting in lower winding costs.





Four to Thirty Paper-insulated Coils in Stick Form are wound on the No. 108 Universal Hand-Feed Coil Winder.

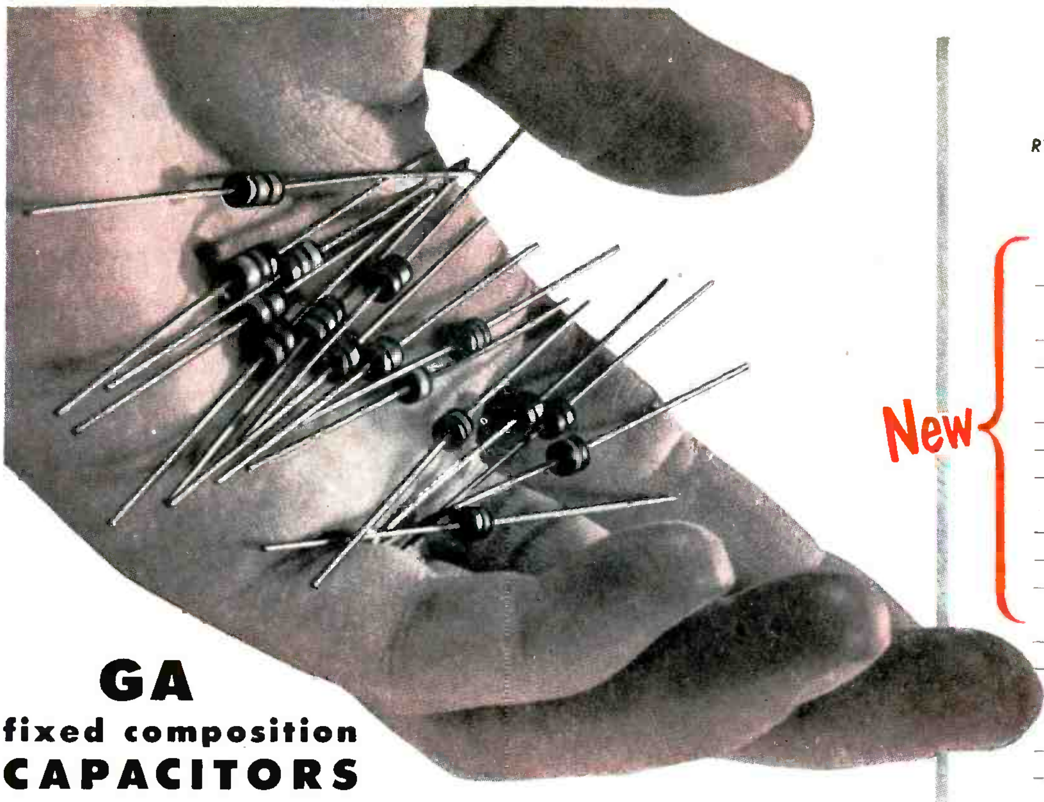
This machine meets the need for a modern hand-feed winder with quick set-up features where varied lot sizes and short runs are called for. Operator can make principle adjustments in three minutes with its easily operated external controls. No gears, or cams to remove. Set-up time is reduced to a minimum.



Four to Thirty Paper-insulated Coils in Stick Form are wound simultaneously on the No. 107 Universal Automatic-Feed Coil Winder.

This machine provides the quickest, easiest way to wind paper-insulated coils accurately. You can safely handle wire sizes from No. 19 to No. 42 (B&S). The electronic drive assures a slow smooth start that results in less breaks when winding fine wires.

FREE! *Separate, 4-page bulletins on each of the machines described above can be had by writing us direct. Bulletins contain detailed specifications.*



GA fixed composition CAPACITORS

22 new values

FOR THE ULTRA HIGHS

Stackpole GA fixed composition capacitors represent the simplest, most inexpensive capacitor design ever produced—and their operating stability is more than ample for the great majority of applications.

Pioneered by Stackpole, these sturdy little units are now available in an expanded range of values from 0.10 to 10.0 mmf. Insulated bodies, dielectrics and electrodes are integrally molded for maximum stability and durability. Leads are securely anchored and treated for easy soldering.

Although Stackpole GA capacitor bodies range only from 0.330″ to 0.170″ in length, they can now be supplied with as many as four easily distinguished color bands.

Up to 4 Color bands

STACKPOLE TYPE GA FIXED COMPOSITION CAPACITORS

RTMA PREFERRED VALUES in mmf

New

20%	10%	5%
.10	.10	
	.12	
.15	.15	
	.18	
		.20
.22	.22	.22
		.24
	.27	.27
		.30
.33	.33	.33
		.36
	.39	.39
		.43
.47	.47	.47
		.51
	.56	.56
		.62
.68	.68	.68
		.75
	.82	.82
		.91
1.0	1.0	1.0
		1.1
	1.2	1.2
		1.3
1.5	1.5	1.5
		1.6
	1.8	1.8
		2.0
2.2	2.2	2.2
		2.4
	2.7	2.7
		3.0
3.3	3.3	3.3
		3.6
	3.9	3.9
		4.3
4.7	4.7	4.7
		5.1
	5.6	5.6
		6.2
6.8	6.8	6.8
		7.5
	8.2	8.2
		9.1
10.0	10.0	10.0

New

Electronic Components Division **STACKPOLE CARBON COMPANY, St. Marys, Pa.**

Want more information? Use post card on last page.

NOW CELENAMEL IS AVAILABLE IN SIZES #40 TO #48

MAGNET WIRE THAT CUTS YOUR PRODUCTION COSTS!

No stripping problem. Celenamel Film removed when dipped in solder. Large economies effected in your production. New facilities make Celenamel available now in sizes 40 to 48.

OVER 50 YEARS *Wiremaker for Industry*

Belden Manufacturing Co.
4625 W. Van Buren St.
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Belden CELENAMEL *

Belden
WIREMAKER FOR INDUSTRY

* TRADEMARK REGISTERED

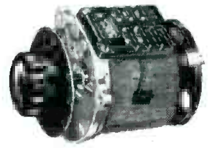
powerstat *Variable Transformers*

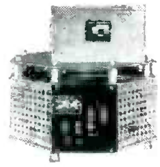
AN ***EFFICIENT, ACCURATE, DEPENDABLE*** SOURCE
of CONTINUOUSLY-ADJUSTABLE A-C VOLTAGES

any type

MANUALLY-OPERATED OR MOTOR-DRIVEN . . . LOCAL OR REMOTE CONTROL . . . WALL, BENCH or BACK-OF-PANEL MOUNTING . . . EXPOSED OR ENCLOSED TERMINAL BOARD . . . FUSED or UNFUSED . . . DIRECT WIRING OR CORD-PLUG WITH OUTPUT RECEPTACLE CONNECTIONS


TYPE 116


TYPE 116U

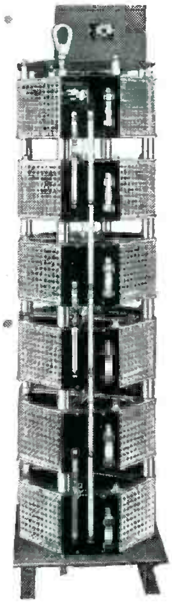

TYPE M-1256

any capacity


TYPE 10

FROM 150 VA TO 100 KVA . . .

SINGLE AND MULTIPLE PHASE DUTY . . . 120, 240 and 480 VOLT SERVICE . . . FREQUENCIES OF 25, 50/60, 400/800 CYCLES . . . FROM ZERO TO OR ABOVE LINE OUTPUT VOLTAGES WITH THE MAXIMUM OUTPUT CURRENT AVAILABLE AT ANY SETTING


TYPE MW1156-6

for any job

IN THE EXPERIMENTAL AND RESEARCH LABORATORY . . . THE TESTING AND INSPECTION DEPARTMENTS . . . ON THE PRODUCTION LINE . . . AS THE VARIABLE A-C VOLTAGE COMPONENT OF ANY EQUIPMENT . . . WHEREVER A CONTINUOUSLY-ADJUSTABLE VOLTAGE IS REQUIRED TO CONTROL HEAT, LIGHT, SOUND, POWER OR ELECTRONIC APPARATUS

under any conditions

AIR-COOLED ASSEMBLIES FOR NORMAL SURROUNDINGS . . . OIL-COOLED and EXPLOSION-PROOF UNITS FOR USE IN CORROSIVE or HAZARDOUS ATMOSPHERES . . . SPECIAL DESIGNS FOR SHIPBOARD, AIRBORNE and other MILITARY APPLICATIONS


TYPE 0-1126


TYPE X-1126


400/800 CYCLE MIDGET FRAME SIZE

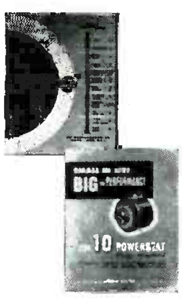
and all featuring

EXCELLENT REGULATION . . . HIGH EFFICIENCY . . . CONSERVATIVE RATINGS . . . ZERO WAVEFORM DISTORTION . . . RUGGED MECHANICAL CONSTRUCTION . . . SMOOTH CONTROL . . . EASY MOUNTING

SEND NOW FOR COMPLETE INFORMATION

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

- STABILINE Automatic Voltage Regulators
- POWERSTAT Variable Transformers
- VARICELL D-C Power Supplies
- VOLTBOX A-C Power Supplies
- SUPERIOR 5-Way Binding Posts
- POWERSTAT Light Dimming Equipment



THE SUPERIOR ELECTRIC CO.
210 Mae Avenue, Bristol, Conn.

Please send literature on POWERSTAT variable transformers.

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COMPANY ____________________

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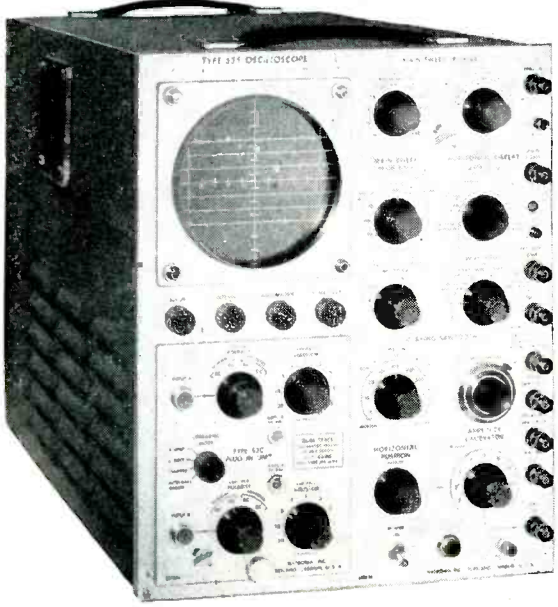
CITY __________ ZONE ____ STATE __________

Want more information? Use post card on last page.

New Versatility in the Cathode-Ray Oscilloscope

Now a single cathode-ray oscilloscope with its associated plug-in pre-amplifiers does the work of three or more separate high-quality laboratory oscilloscopes.



...the Tektronix Type 535

Quickly Adaptable to Changing Requirements with Plug-in Vertical Pre-amplifiers

1. Dual-Trace Unit—Performance superior to dual-beam scope in most applications.
2. Differential-Input High-Gain DC Unit—Sensitivity to 1 millivolt/cm.
3. Wide-Band DC Unit—10 megacycle bandwidth.

New Sweep Circuit Provides Widest Range Ever Offered

1. Accurately calibrated time bases from 0.02 μsec/cm to 5 sec/cm.
2. New sweep delay permits jitter-free display of details in pulse trains.
3. Calibrated interval between sweeps.

High Intensity for Low Repetition Rates and Single Sweeps

1. 10 KV accelerating potential.
2. New Tektronix 5" flat-faced metallized cathode-ray tube.

The fast growth of the electronic industry is bringing more complex problems to the engineer every day. The need for an oscilloscope quickly adaptable to almost any phase of laboratory investigation is evident. The Type 535 Cathode-Ray Oscilloscope is designed to fill this need.

Plug-in vertical pre-amplifiers enable the Type 535 to cope with a wide variety of signals. Wide range time base has single shot, recurrent, and triggered operation to permit observation of the very slow as well as the very fast. Flexible sweep delay circuitry provides both jitter-free delay and stable viewing of time-modulated or jittery signals. High crt accelerating potential increases the brightness at low repetition rates. With dual-trace plug-in unit precise time comparisons may be made, free from errors inherent in dual-beam cathode-ray tubes.

CHARACTERISTICS

Basic Unit

TIME BASE RANGE—MAIN SWEEP
24 calibrated time bases from 0.1 μsec/cm to 5 sec/cm. Continuously variable uncalibrated time base from 0.1 μsec/cm to 10 sec/cm.

SWEEP MAGNIFIER
Accurate 5x magnification on all ranges including the 0.1 μsec/cm range.

DELAYING SAWTOOTH
Automatic main sweep lockout with controllable reset. Permits delaying the start of the main sweep from 10 μsec to 20,000 μsec in 9 calibrated ranges. Calibrated interval between sweeps, 20 to 20,000 μsec (50 cps to 50 kc).

TRIGGER SELECTION
Automatic triggering or amplitude selection.

BALANCED DELAY NETWORK
0.25 μsec, superior transient response.

10 KV ACCELERATING POTENTIAL
New Tektronix 5" metallized cathode-ray tube, Type 51P2.

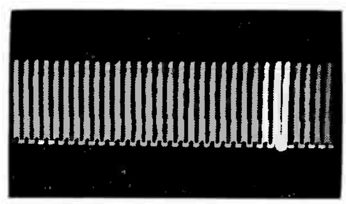
AMPLITUDE CALIBRATOR
0.2 mv to 100 v square wave.
Price (with Type 53A Plug-in Unit)—$1385

Plug-In Vertical Pre-Amplifiers

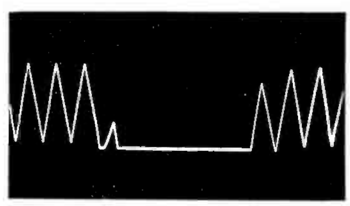
Type 53C—Dual-trace Unit
Two identical amplifier channels, activated on alternate sweeps—or nonsynchronously at approximately 100 kc.
Risetime—0.04 μsec.
Bandpass (with Type 535)—DC to 8.5 mc.
Sensitivity—0.05 v/cm to 20 v/cm, ac or dc, in 9 calibrated steps. 0.05 v/cm to 50 v/cm continuously variable. 4 position ac-dc and polarity reversal switches.
Price—$275

Type 53D—Differential-input High-gain Unit
Sensitivity—1 mv/cm to 50 v/cm in 24 calibrated steps. Sensitivity variable between steps.
Bandpass—DC to 250 kc at 1 mv/cm to DC to 750 kc at 50 mv/cm and lower.
Price—$145

Type 53A—Wide-band DC Unit
Risetime—0.035 μsec.
Bandpass (with Type 535)—DC to 10 mc.
Sensitivity—0.05 v/cm to 20 v/cm, ac or dc, in 9 calibrated steps. 0.05 v/cm to 50 v/cm continuously variable.
Two signal inputs—60 db isolation.
Price—$85



Input signal displayed on the delaying sawtooth. Position of the main sweep is indicated by a bright region on the delaying sawtooth.



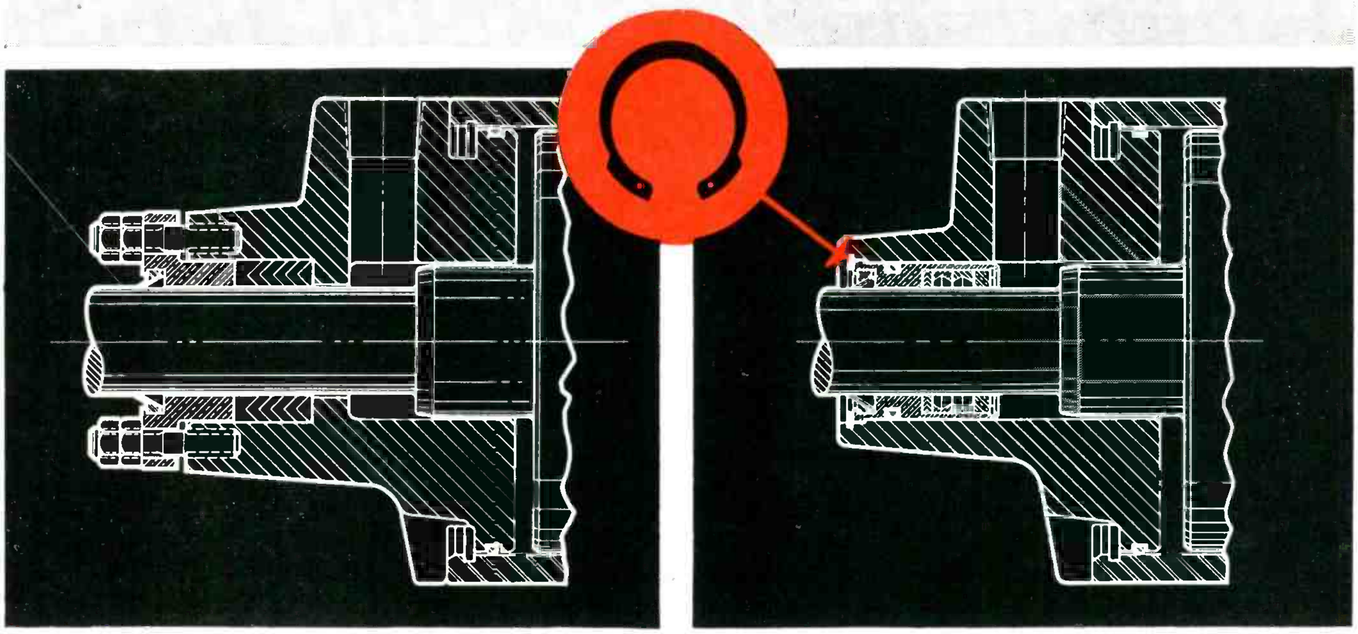
Same signal displayed on the main sweep. The main sweep may be ranged out along the delaying sawtooth and positioned to start after the desired amount of delay.

PLEASE WRITE FOR COMPLETE SPECIFICATIONS

Tektronix, Inc.

P. O. BOX 831A
PORTLAND 7, OREGON
Cable: TEKTRONIX

Waldes Truarc Ring Saves $2.84 Per Unit, Cuts Labor-Time and Materials in Hydraulic Packing Unit



OLD STYLE stuffing box required skilled worker to install packing rings one at a time, then adjust packing glands by trial and error. Disassembly was equally difficult, time-consuming and costly.

NEW Monopak Cartridge is smaller, lighter, streamlined and installed with one Truarc Retaining Ring. Disassembly and reassembly with new cartridge takes unskilled worker just 1 minute.

Hydraulic Accessories Company of Van Dyke, Michigan, uses a single Waldes Truarc Inverted Ring (internal series 5008) to hold Monopak Cartridge in cylinder head.

New design eliminates costly machining and saves 2⅛ lbs. of material. Re-design with Waldes Truarc Retaining Ring reduces stuffing box diameter from 3½" to 2⅞", and reduces length from 5⅞" to 4⅜". Allows savings in assembly, adjusting and testing.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS PER UNIT

MACHINE TIME SAVED:	
Chucking, facing and boring	$ .72
Drilling and tapping 3 holes	.18
Drilling and counterboring 3 holes	.12
Assembling, adjusting, testing	.90
MATERIAL SAVED:	
1½ lbs. cast iron	.30
½ lb. bronze	.23
3 studs	.36
3 nuts	.03
TOTAL	**$2.84**

Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool.

SEND FOR NEW CATALOG

WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print) E-105

Name..........

Title..........

Company..........

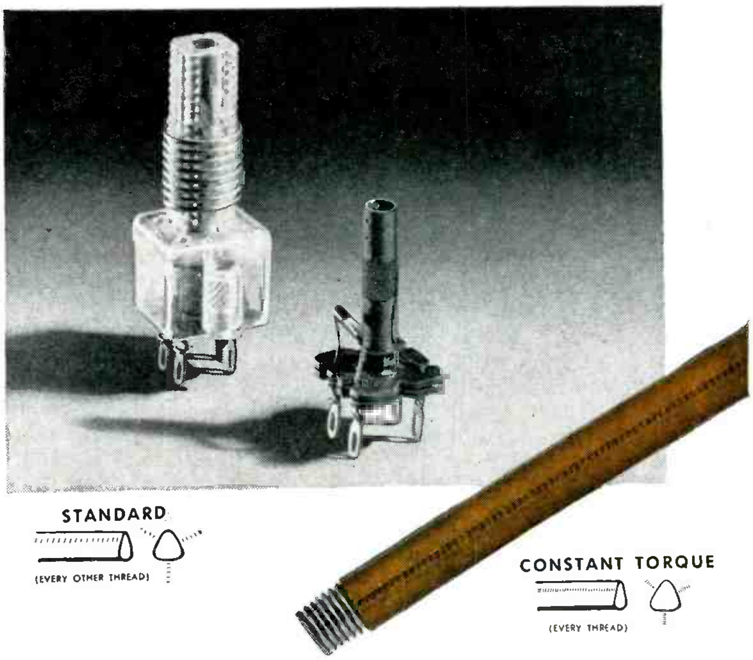
Business Address..........

City.......... Zone.......... State..........

C-D-F SPIRAL TUBING

A UNIFORM, HIGH QUALITY PRODUCT AT LOW COST

Good dielectric strength • Low dielectric loss properties
Good mechanical strength and moisture resistance



C-D-F is a dependable source of supply for all of your coil form spiral tubing needs. Uniform, high product quality is maintained by rigid standards of manufacture. C-D-F offers you fabricating skill, backed by exacting technical and inspection control. A recent C-D-F development is Grade 5 Constant Torque Tubing for use in coil forms. After the threaded iron tuning core is inserted and finally adjusted, you obtain the same stable torque rating.

Constant Torque features: exact internal threading . . . every thread engaged. 3-point contact with core prevents binding and permits positive tuning and re-tuning. Outer surface of tube has no weak spots, no external embossing to cause cement leakage. Available in lengths up to 14" to take .248" to .250" core with 28 threads per inch and also 6-32, 8-32 and 10-32 screw sizes. Write for samples.

Grade 5 Tubing is also custom-fabricated by C-D-F in conventional shapes to accommodate other sizes of tuning cores.

C-D-F produces spiral tubing in grades to meet most requirements. Use the Grade Selector Chart when requesting samples and additional information.

AVAILABLE GRADES

IMPREGNATED

1 General Electrical and Mechanical Grade.
1A Electrical and Mechanical Grade—Special Punching.
2 Mild Stapling, Riveting, and Post Forming Quality.
2A Intermediate Fabricating and Stapling Quality.
3 Severe Stapling, Riveting, and Post Forming Quality.
5 Constant Torque and Formed-to-Shape Coil Form Tubing.
6 Special for High Humidity Applications.
6A Extra Hard, High Strength Tubing.
7 Soft Varnished Kraft Tubing.
7A Hard, Rigid Rectangular Tubing.
8 Varnished Diamond Insulation—Tubing.
9 "Deflection Coil" Tubing.
10 Larger Size, Heavy Wall Tubing for Mechanical Uses.

UNIMPREGNATED

20 Special Wound in Specified Combinations of kraft paper, fish paper, etc.
21 Plain Kraft Paper Tubing.
22 Plain Diamond Insulation Tubing.
23 Plain Chipboard Tubing.

○ Round
Formed (fluted shape)
Formed and Notched
Square, Rectangular

SELECTION OF THE PROPER GRADE

While the differences between some of the grades are not great, they are quite distinct when specific requirements are considered. For most uses, the proper grade can be selected from the descriptions, size range, and properties tables in our catalog. If this should prove difficult in some cases, it is desirable for our C-D-F sales engineer to have as much information as possible about the application, especially fabricating requirements, in order that we may make suggestions. Your blueprint is usually sufficient if it carries some indication as to the quality desired. In other cases, the following check list will be found to be helpful:

Type of Application.

Properties required or the customer's specification for the material.

Fabricating quality desired. This is important where stapling, riveting, punching, or forming operations are to be performed by the customer.

Any unusual conditions which may affect the suitability of the material for the job. For tubing that is to accommodate tuning cores, actual samples of the cores are essential along with torque requirements (if known).

Get all the facts. Write for 8-page Technical Folder ST-53 describing standard grades of C-D-F Spiral Tubing, their properties, sizes and tolerances, and how to select the proper grade for your application. Free test samples are available upon request. Call your C-D-F Sales Engineer (offices in principal cities). He's a good man to know!

THE NAME TO REMEMBER CDF SPIRAL TUBING

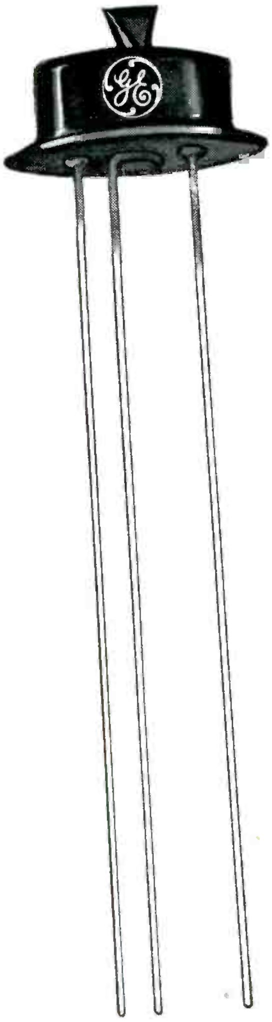
Continental-Diamond Fibre Company

NEWARK 16, DELAWARE

Want more information? Use post card on last page.

ANOTHER NEW PRODUCT OF

VACUUM



FIRST In Features:
Vacuum Sealed Junction
Welded Seam Construction

ONCE again you have proof of the inherent quality...superior performance...of a General Electric product painstakingly developed through intensive research. Not just an ordinary transistor to answer current application demands; new G-E vacuum sealed junction transistors represent a design with radically improved characteristics and keyed to the tools of mass production for *low component cost.*

First junction *diodes* and now junction *transistors.* This logical product sequence has given General Electric almost two years of production experience on junction devices *before* announcing junction transistors. The result: anticipation and solution of many problems *plus* the addition of unique features to enhance the range of application.

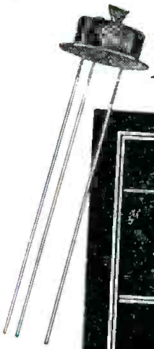
Your decision to use this new G-E product assures you of a basic component that is thoroughly tested and *proved superior in every performance characteristic!*

- **HERMETIC SEAL**...unaffected by moisture.
- **VACUUM SEALED JUNCTION**...contaminating gasses permanently eliminated!
- **WELDED SEAM CONSTRUCTION**...free from solder-flux contamination.
- **HIGH POWER OUTPUT**...Case design makes possible a collector dissipation of 150 MW.
- **HIGH FREQUENCY PERFORMANCE**...Completely successful operation at audio and supersonic frequencies.
- **HIGH TEMPERATURE OPERATION**...Rated for a maximum junction temperature of 100°C.
- **LONG LIFE**...stable performance throughout the life of your equipment.
- **SMALL SIZE**...extremely compact design provides added flexibility for all applications.

GENERAL ELECTRIC PROGRESS!

JUNCTION TRANSISTORS

FIRST In Performance: High Power Output



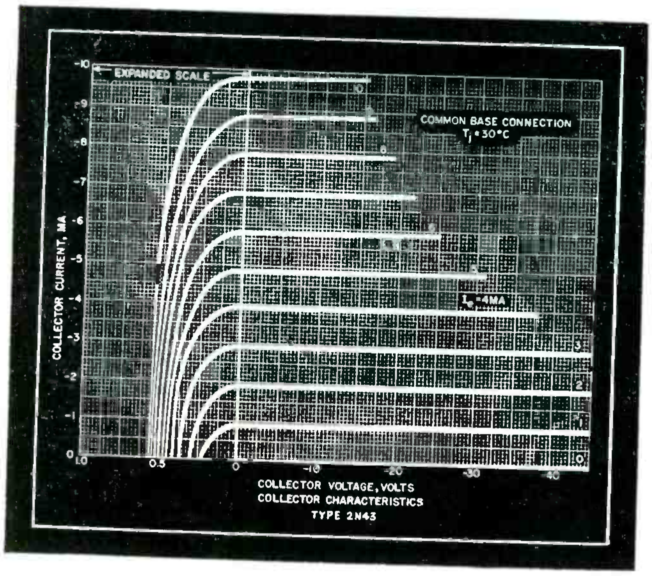
Actual Size

ABSOLUTE MAXIMUM RATINGS:

Collector Voltage (referred to base), V_c	−45 volts
Collector Current, I_c	−10 ma
Emitter Current, I_e	10 ma
Junction Temperature, T_j	100°C

AVERAGE CHARACTERISTICS:
(Common Base, $T_j = 30°C$, $f = 270$ cps)

	2N43	2N44	2N45	
Collectar Voltage	−5.0	−5.0	−5.0	volts
Emitter Current	1.0	1.0	1.0	ma
Current Amplification (output short circuit), h_{21}	−0.98	−.955	−0.92	
Collector Cutoff Current, I_{co}	10	10	10	μa
Noise Figure (V_c, −1.5V; I_e, 0.5 ma; f, 1kc; BW, 1 ~), NF	22	22	22	db
Maximum Power Gain (Common Emitter)	40	39	38	db
Frequency Cutoff, f_{co}	1.0	1.0	1.0	mc
Output Capacitance, C_c	40	40	40	mmf



COLLECTOR CHARACTERISTICS
TYPE 2N43

NEWS FROM OUR ADVANCED DEVELOPMENT LABORATORIES

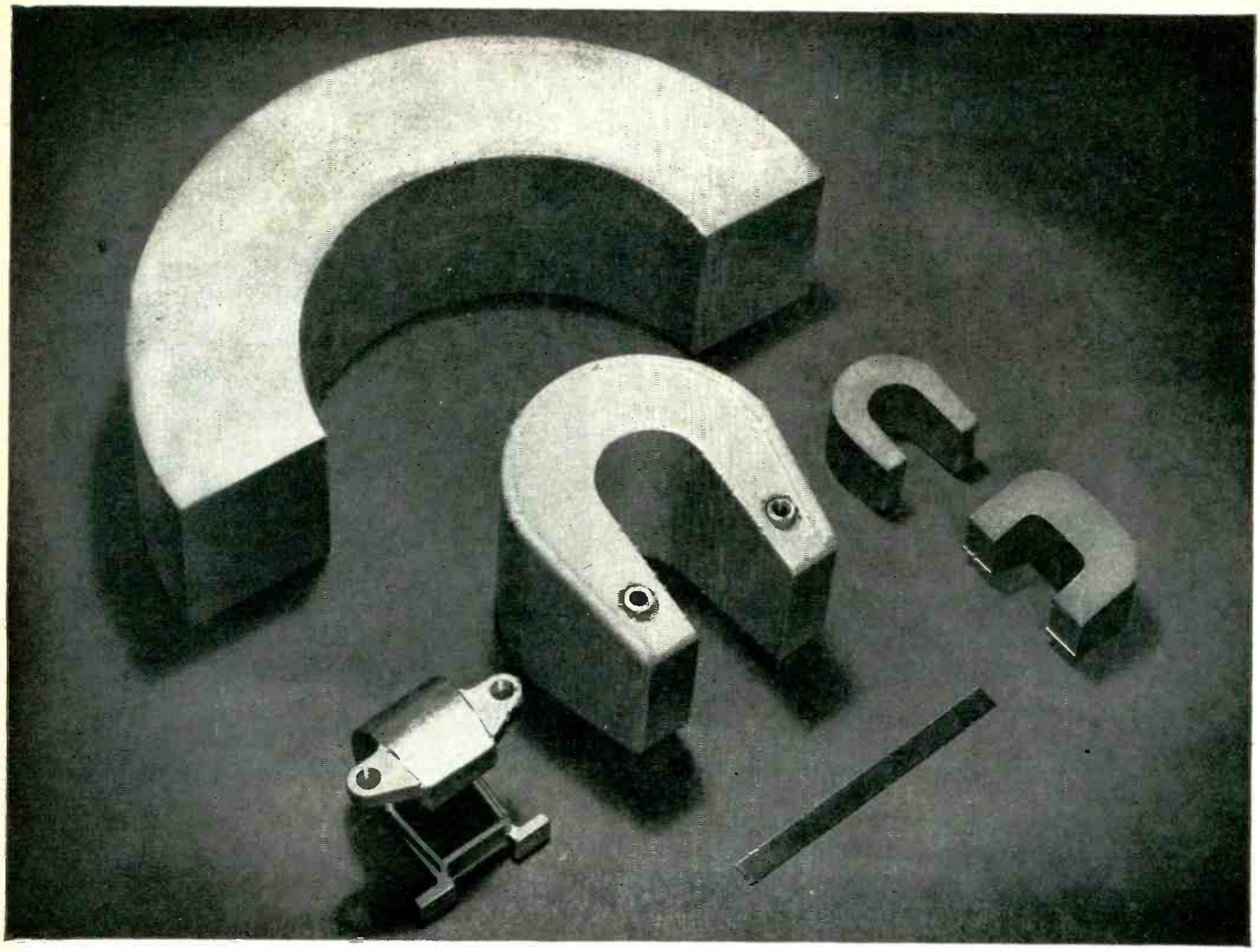
• Double-base junction diodes are semi-conductor devices having thyratron-like properties. Lab units have been used successfully in low-voltage circuits to switch currents larger than ½ ampere.

TRANSISTOR REFERENCE GUIDE and new TRANSISTOR BULLETINS NOW AVAILABLE!

Write to: General Electric Company, Section 4103, Electronics Park, Syracuse, New York.

1878 75 1953
YEARS OF ELECTRICAL PROGRESS

GENERAL ELECTRIC



PERMANENT MAGNETS and ASSEMBLIES for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

Made to your Specifications

. . . ANY SIZE, SHAPE OR COATING REQUIRED

★ *We'll welcome your inquiries*

W&D 4698

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

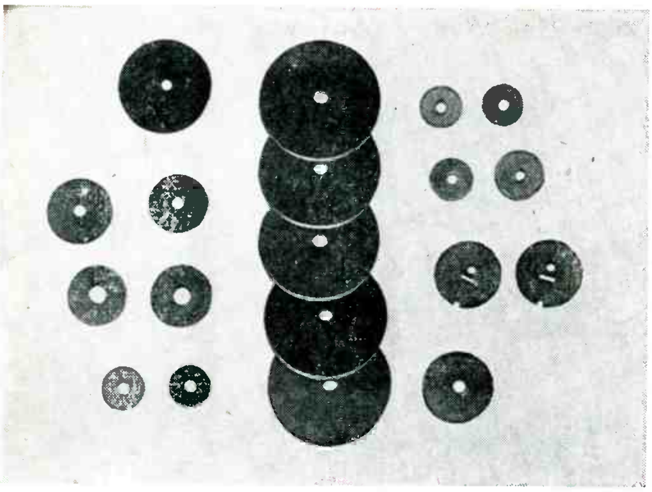
General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

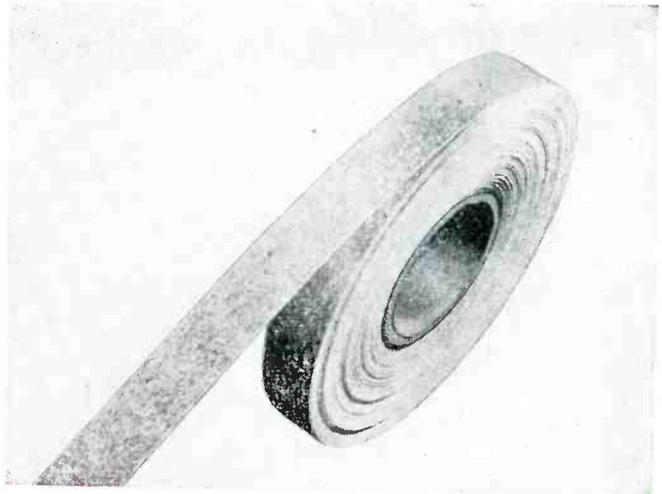
Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

Want more information? Use post card on last page.

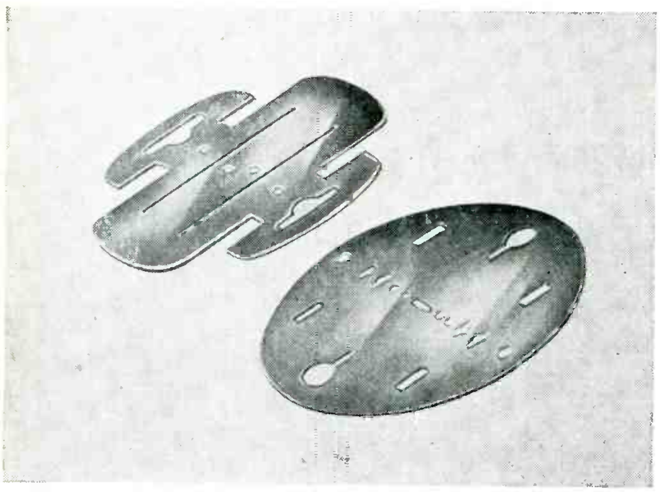
Do you have any of these problems?



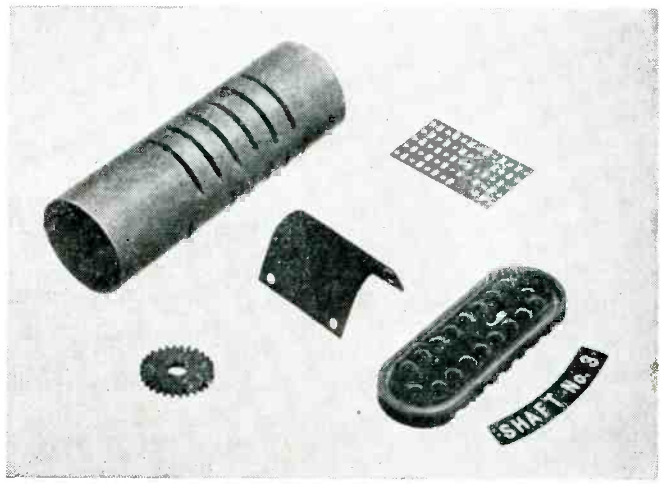
1. Need a combination of gasket sealing and mechanical and electrical properties? Various grades of LAMICOID® — laminated plastic made with organic and inorganic binders — are combined with natural or synthetic rubber to obtain the excellent insulating and mechanical properties of LAMICOID and the sealing properties of rubber.



2. Need a mica tape that can be run on taping machines at high speed? ISOMICA* tapes are made from long rolls of thin continuous mica sheet... are more uniform in mechanical and dielectric strength ... have no high spots or voids. For electrical insulation of class B or class H motors, generators and transformers.



3. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO. We have 60 years of experience in this field.



4. Need special mechanical and electrical properties for brackets, terminal blocks, access panels, etc.? LAMICOID® is half as heavy as aluminum and, weight for weight, stronger than steel. Offers high impact strength, high dielectric strength, excellent abrasion and moisture resistance.

Whatever electrical insulating materials you need, MICO makes them best. We manufacture all standard types and many special materials, and fabricate parts to your specifications. Send us your blueprints or problems today.

**Trademark*

1893-1953 60 Years of Leadership in Electrical Insulation

MICA Insulator COMPANY

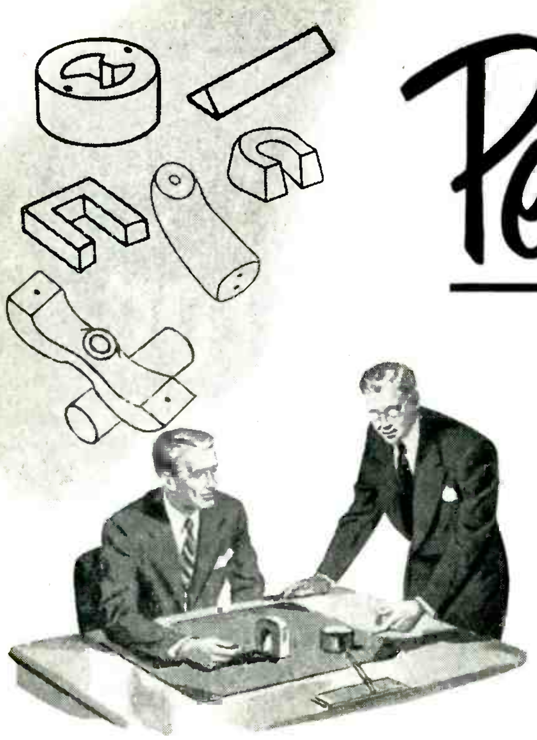
Schenectady 1, New York

Offices in Principal Cities

LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIRE ® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA •

Want more information? Use post card on last page.

Perpetual Energy



Consumer Market

Perpetual energy is at work all around us. Shown here are only a few of the many examples of permanent magnets at work—all of which *add to the salability* of the product.

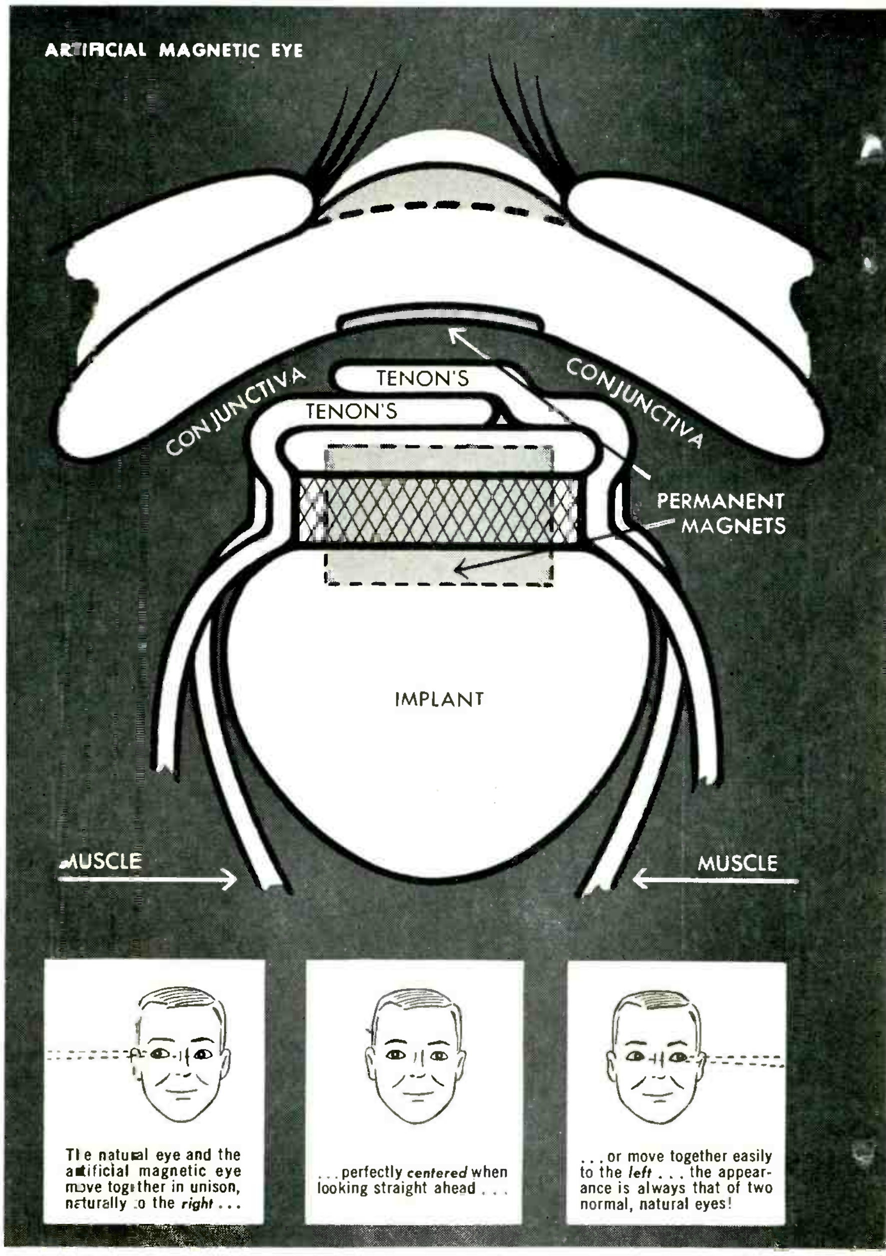
Artificial Magnetic Eyes —

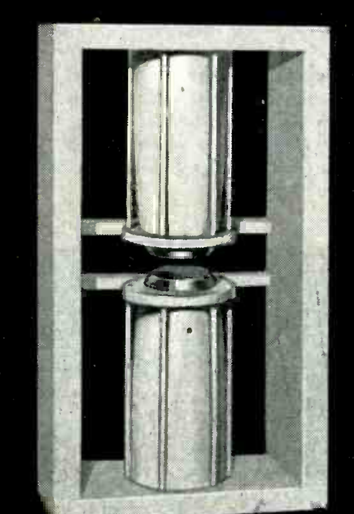
An artificial eye looks practically normal if it moves in unison with the natural one. To achieve this, a New York doctor developed an implant wherein is imbedded an Alnico permanent magnet.

After removal of a diseased or injured eye, recti muscles, originally attached to the natural eye, are attached to an implant, thereby imparting motility to this implant. Further operative procedure requires that the implant be covered with layers of tissue (tenons and conjunctiva) in order that the implant may be completely buried.

A custom-fitted plastic artificial eye is then made which also has a very thin Alnico magnet. As a result of the attraction between the magnet in the implant and the one in the artificial eye, and also due to the shape of the artificial eye, the eye can then move in unison with the natural one, as motility is imparted from the recti muscles to the implant and, in turn, to the artificial eye.

Applications: Among other consumer products that rely on permanent magnets are can openers with a magnetic lid-lifter, and the thermostat used in your home.



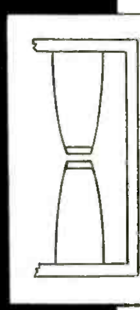


NUCLEAR RESONANCE RESEARCH ASSEMBLY

Basic Research

Research—A highly specialized example of the use of permanent magnets in research is the nuclear resonance assembly shown on the left.

The Alnico V permanent magnets used in this assembly built for the University of Chicago by INDIANA produce a field of approximately 5,500 gauss. The assembly not only is *much less costly* than the electromagnetic models but it also does not require much of the expensive equipment required to maintain a stable field.



Permanent Magnet

Can Work For You!

Perpetual Magnetic Energy ... a Timeless Force ... is hard at work in many fields and in many products ... from Artificial Magnetic Eyes to Nuclear Resonance Research!

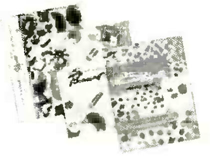
You can't see it . . . smell it . . . or hear it. Nor can you taste it or feel it, but the "perpetual energy" of permanent magnets is at work for you in each one of these applications—and thousands more. Permanent magnets won't wear out. They can't be used up. They're a source of permanent energy instilled in your product "perpetually."

. . . *Unlimited are the future possibilities of permanent magnets in new product designs.* The field produced by the myriad of spinning electrons, the essence of permanent magnets, can work for you in these three ways: transformation of mechanical to electrical energy • transformation of electrical to mechanical energy • tractive effort. If you need a component to perform one of these three functions, INDIANA PERMANENT MAGNETS may be the solution to your design problem.

INDIANA provides you with the largest facilities in the world for the manufacture of permanent magnets and complete permanent magnet sub-assemblies. It will pay you to take advantage of INDIANA's wealth of experience, research leadership, and specialized engineering "know-how."

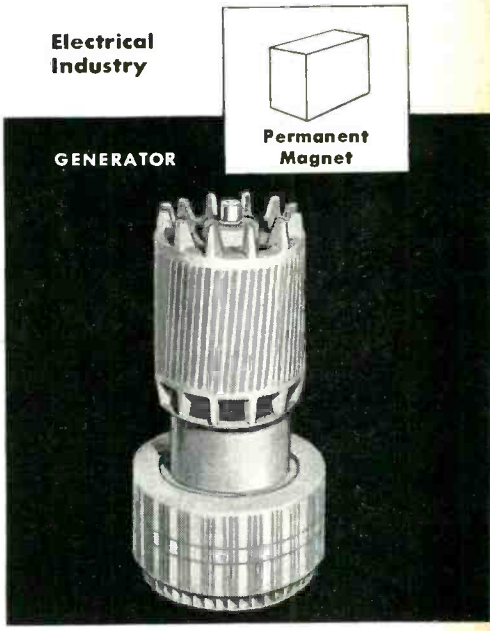
The Indiana Steel Products Co.
VALPARAISO, INDIANA

SALES OFFICES FROM COAST TO COAST—BOSTON • CHICAGO
CLEVELAND • NEW YORK • PHILADELPHIA • ROCHESTER • LOS ANGELES



Write for
DESIGN MANUAL No. 4-A10
CAST CATALOG No. 11-A10
SINTERED CATALOG No. 12-A10

Electrical Industry



Generators—A well-known application in the electrical field is the permanent magnet generator. This 15 kva, 120/208-volt, 400-cycle model incorporates 28 Hyflux Alnico V, bar-shaped permanent magnets.

Long service and *minimum maintenance* are two things sought by users of generators. Permanent magnets help to provide these qualities. *Elimination of slip rings and commutators* means no sparking or radio interference. And there's no heat from the field coils nor is excitation power needed.

Applications: Magnetos, motors, gyroscopes.

In 24 Hours—You can have INDIANA PERMANENT MAGNETS for your experimental work

Loudspeakers—Typical of the applications in this field is this 15-inch high fidelity speaker which uses a 10½ lb INDIANA Hyflux Alnico V magnet to achieve a frequency range from 30 to 16,500 cycles per second! INDIANA Hyflux Alnico V provides an energy product of 5¼ million BH Max or more, thereby assuring a magnetic field of high strength. Permanent magnets, in this case, are a *functional necessity* to this design—no substitute can do the job.

Applications: INDIANA magnets are consistently doing an outstanding job in many other typical products in this field such as focusing coils, ion traps, centering devices, radar, and guided missiles.

Magnetic Separators—There is almost an endless list of mechanical or holding applications. One of the more widespread, industrial applications is this permanent magnet separator, using three or more Hyflux Alnico V, U-shaped magnets each of which can exert a pull of 150 lb.

Here permanent magnets exert an effective pulling force through a distance of several inches . . . permitting your product to do the job better and safer, insure *uninterrupted production* flow by snatching "tramp" iron from materials to be processed . . . thereby preventing damage to machinery. And permanent magnets *require no electrical power, no wiring* . . . hence, they never spark, eliminating a definite fire hazard.

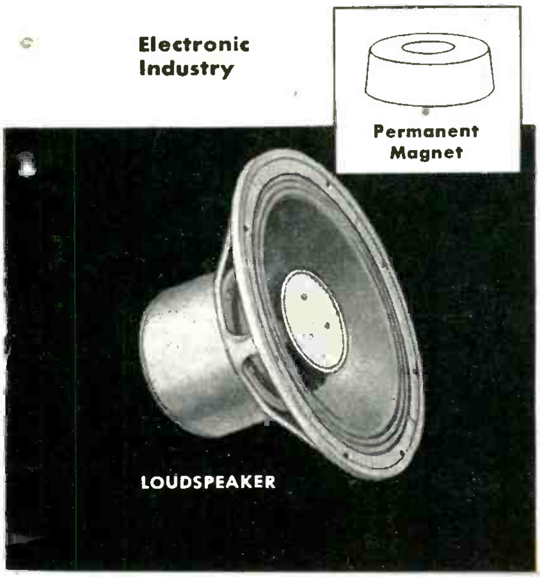
Applications: Among the many mechanical applications are: magnetic conveyors, magnetic sweepers, magnetic chucks and clutches.

Watt Hour Meters—One of the hundreds of different instruments requiring permanent magnets is this single-phase, 15-amp, 240-volt rating for 3-wire services watt hour meter. It uses an Alnico 1, horseshoe-shaped magnet weighing only 0.2 lb.

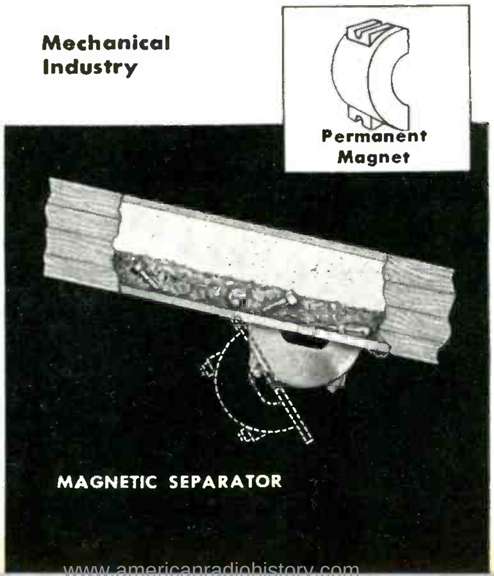
Here, the high quality of this permanent magnet material provides the uniformity and stability of field so necessary for *maintaining the initial accuracy* of this meter over a long period of years.

Applications: Mass spectrometers, vibration pick-ups, galvanometers, medical instruments, speedometers, fluxmeters.

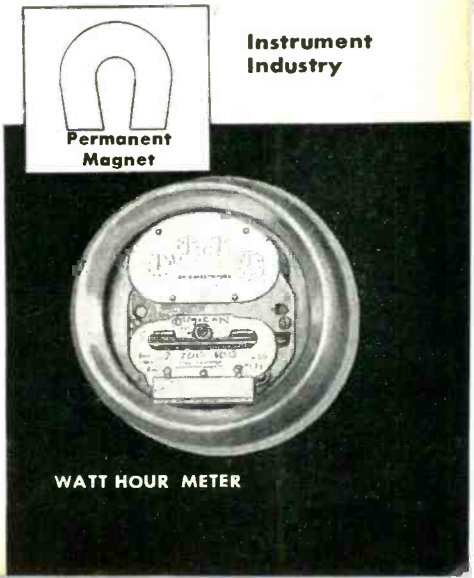
Electronic Industry



Mechanical Industry



Instrument Industry



Why do so companies make

FOR one thing, it's *easy* to make an ordinary relay. Requirements are not rigid. Little equipment is needed. You can even *buy* the component parts in a pinch. Dozens of companies do a good job of making these relays, as long as the service requirements are not too severe.

But when you need top reliability, when you need relays that will withstand temperature extremes, tremendous shock loads, moisture, continuous service—come to an expert to get the kind of relay performance you need.

Union Switch & Signal has been making relays for over 70 years, most of them in vital railroad signaling service. Many of them operate continuously, yet remain unattended for years. In fact, we regularly encounter "Union" relays that have been in service for over 40 years. And they are still in good operating condition.

This vast relay engineering skill has been used to produce the "Union" type M miniature relay. Hermetically sealed, weighing only 3½ ounces, this 26.5 v.d.c. relay meets all requirements of Military Specifications MIL-R-5757 A & B.

"Union" type M relays are available in quantity *now*—in either 6-pole or 4-pole doublethrow models. Write for more information.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18 PENNSYLVANIA

NEW YORK CHICAGO ST. LOUIS SAN FRANCISCO

Want more information? Use post card on last page.

many relays?

TYPICAL PERFORMANCE DATA

Service Temperature	-65°C to 125°C	-55°C to 85°C
Style FM (6-pole)	303125	303085
Coil Resistance	325 ohms	325 ohms
Nominal Voltage	26.5	26.5
Max. Pull-In Voltage at Max. Rated Temperature	18	18
Max. Drop-Out Voltage at Max. Rated Temperature	13	13

Service	Continuous
Shock	40 G's for 10 milliseconds
Vibration	10 to 55 cycles per sec.—0.060 total excursion
Life Expectancy	1,000,000 operations minimum
Contact Rating	2 amps. at 26.5 Volts—Resistive Load
Breakdown Voltage at Sea Level	1000 volts a.c. between case and contacts or coil

General Apparatus Sales
Union Switch & Signal Division
Westinghouse Air Brake Company
Pittsburgh 18, Pa.

Please send additional information on "Union" type M relays.

Name .... Title ....

Company ....

Address ....

City, Zone & State ....

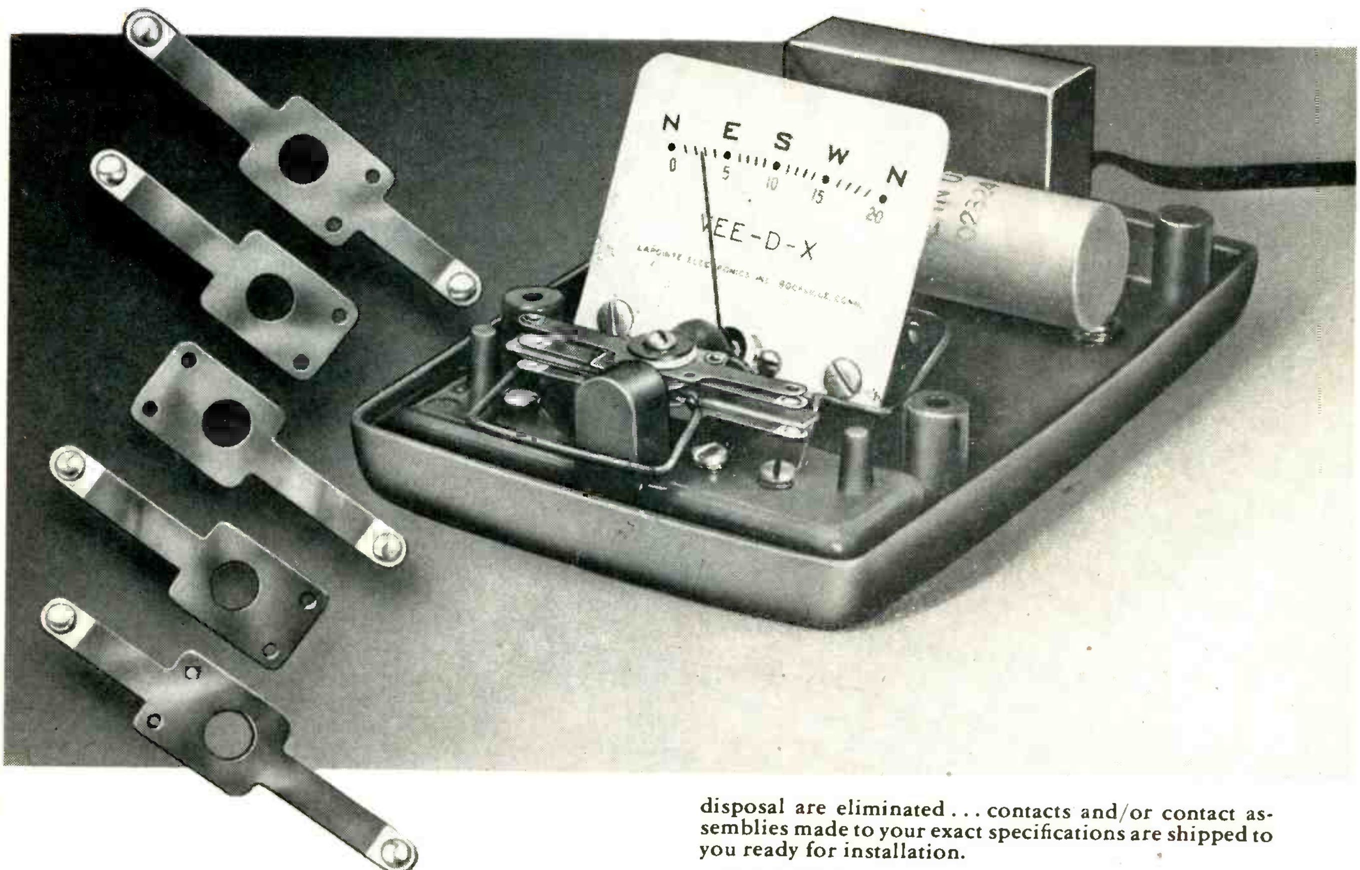
Want more information? Use post card on last page.

PROBLEM:

Reduce Fabrication and Assembly Costs for Electrical Contact and Switch Blade Assemblies

SOLUTION:

General Plate Provided the Solution with Fabricated Composite Contact Elements Ready for Assembly



A leading manufacturer of Antenna Rotators required contact and switch blade assemblies for a control switch that operated two synchronized circuits. To produce the assemblies by attaching a separate contact, rivet or button to the spring blades meant high fabrication and assembly costs and special machinery.

The problem was presented to General Plate whose engineers provided an economical solution with fabricated composite contact elements ready for assembly.

The complete contact and blade elements are made from a General Plate striped composite metal. The contact is a silver alloy which gives the necessary electrical performance. The blade is phosphor bronze which provides the spring properties required for the contact supporting member.

The result — initial savings of $7,000 in assembly costs alone by using General Plate fabricated composite contact elements.

By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble ... needless equipment cost and problems of scrap disposal are eliminated ... contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

If you fabricate your own parts, General Plate Composite Contact Materials will still save you money and allow you to make contact assemblies superior to those produced by other methods.

The long experience, diverse facilities, and manufacturing skill of General Plate will benefit you in the form of service, quality, and savings.

Write for complete information and Catalog PR700.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
310 FOREST STREET, ATTLEBORO, MASS.

Another NEW Shunt Diode by

UNITED

High peak power capabilities of type X-80 in relation to its physical size have been accomplished through an unusually forceful combination of design features.

1. Exclusive UNITED bonded *thoria tungsten core filament* for high electron emissivity.

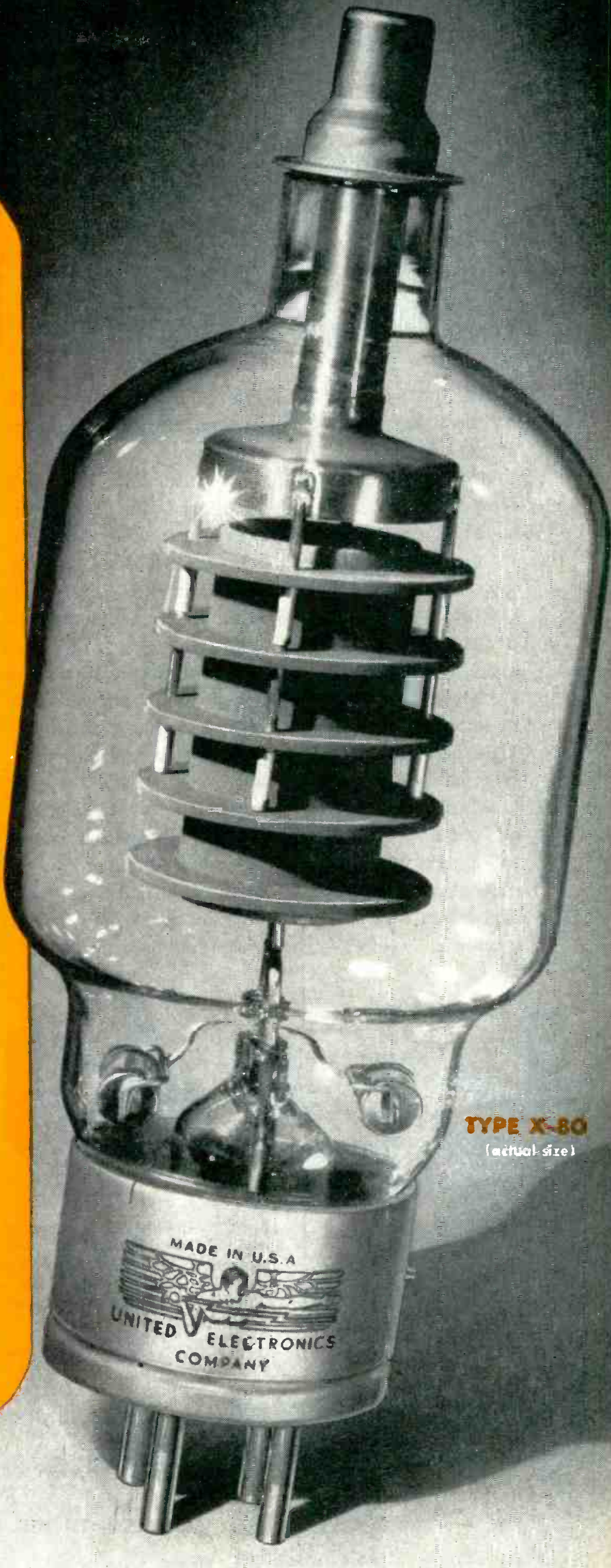
2. Exclusive UNITED *graphite anode* for maximum thermal dissipation.

3. Exclusive UNITED *isolated getter traps* for retention of hard vacuum and high voltage internal insulation.

Type X-80 will serve importantly as a high current clipper tube in radar equipment employing the large hydrogen thyratrons, as well as in power supply rectifier applications.

Write for detailed specifications.

40 Kilovolts Inverse Peak	80 Amperes Peak Plate Current as shunt diode
800 mAdc (average) as a rectifier	Filament Ratings 11 Volts Nominal 15.5 Amperes



TYPE X-80
(actual size)

UNITED ELECTRONICS, 42 Spring Street, Newark 2, N. J.
(TRANSMITTING TUBES EXCLUSIVELY Since 1934)

JETS GET OFF TO A *flying start* WITH

Seletron

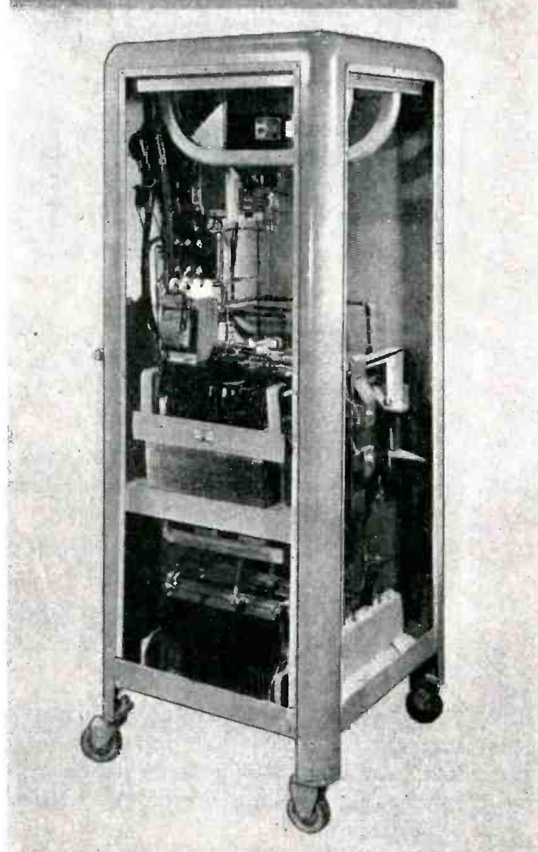
SELENIUM RECTIFIERS

Jets must conserve their power for actual flight. Thus on the flying field the big engines are turned over by means of a starter.

Almost six years ago our customer, Ther Electric & Machine Works, Chicago, developed the portable jet engine starter pictured here, in cooperation with a famous engine manufacturer who was dissatisfied with previous units. Important components in each Ther starter are four Model FH1BA6S1G SELETRON selenium rectifier stacks.

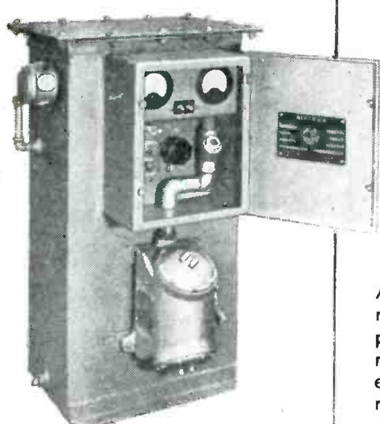
Ther tells us the service record of the jet engine starters has been outstanding during six grueling years, and credits its trouble-free SELETRON rectifiers for much of the top-flight performance. "They have proved far superior to other similar units."

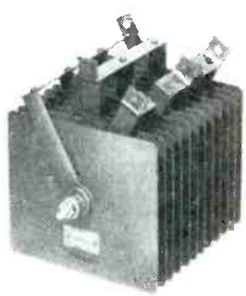
When rectification is indicated, SELETRON engineers can certainly assist you with circuit information as well as the right type of SELETRON rectifier to do the job. We make them from the small half-wave ones for radio and TV, all the way up to giants for industrial use. See our catalog in Sweet's Product Design file—or write us.



Ther's Portable Jet Engine Starter

750 amps; 24-30 volt DC output. Adjustable to compensate for line and load fluctuations. Includes four Seletron rectifiers, Model FH1BA6S1G.





Also Ther-built with Seletron selenium rectifiers: an oil-immersed cathodic protection unit for the Navy, built for location in hazardous atmosphere. Arcing contacts are immersed in oil or in sealed-off explosion proof fittings. Includes 2 Seletron Model WH1BA2S1G rectifier stacks.

Manufacturers also of Germanium Transistors and Diodes

Seletron and Germanium Division

RADIO RECEPTOR COMPANY, Inc.

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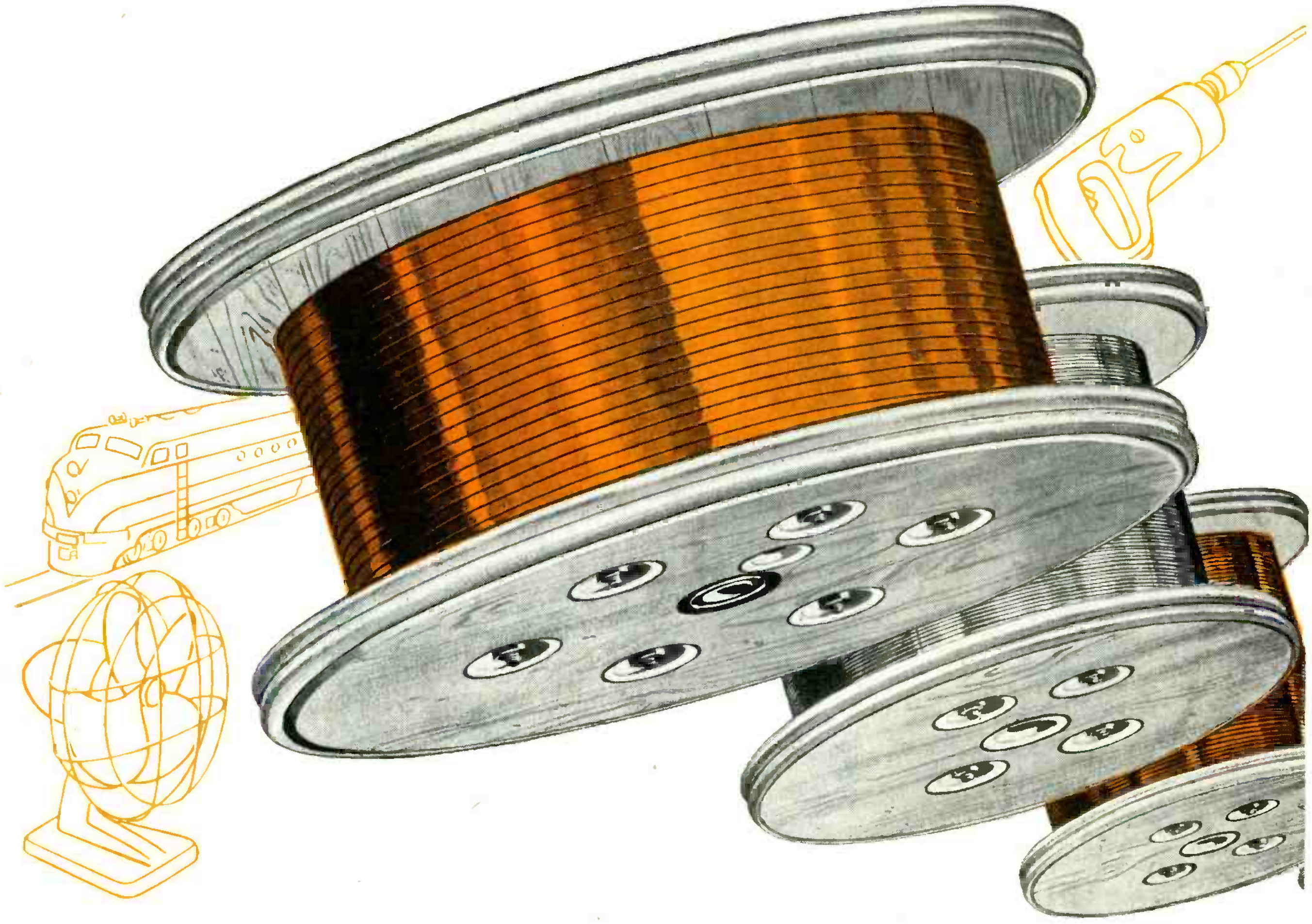
THE RIGHT WIRE TRANSFORMER,



First for Lasting Quality—from Mine to Market!

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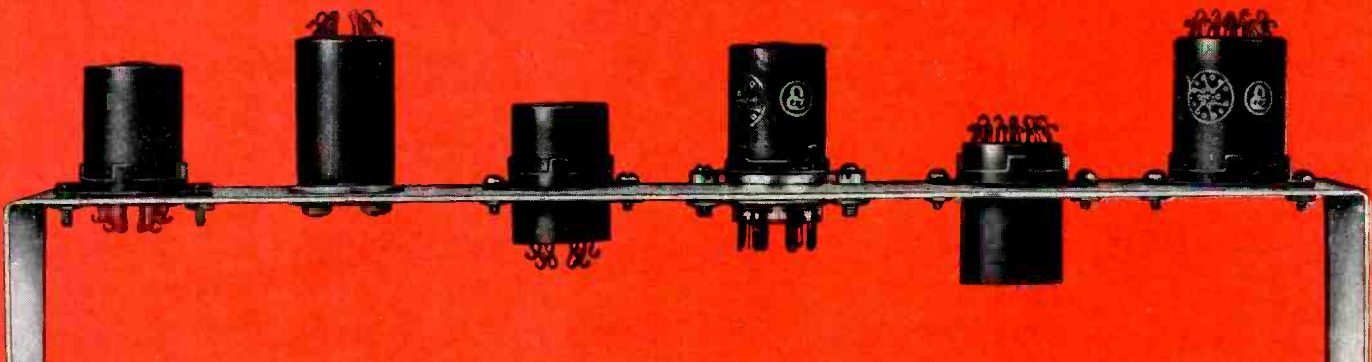
50 G MINIATURE RELAY

APPROVED MIL-R-5757A

SIX DIFFERENT MOUNTINGS



1. Standard Mounting
2. Flush Mounting—2 Studs at ⅝" Centers
3. Thru-Chassis Mounting—Terminals Down
4. Plug-In Mounting With Socket
5. Thru-Chassis Mounting—Terminal Up
6. Flush Ring Mounting

6-POLE
MH-18

4-POLE
MH-12

2-POLE
MH-6

FEATURES

Wide Ambient Temperature Range: *55°C to 85°C standard—65°C to 125°C MHB-type*

Vibration Resistant: *15G's vibration to 500 cycles* • **Operating Shock:** *no contact chatter to over 50G's*

High Altitude: *seal-tested to 70,000 feet*

Dependable Operation: *life expectancy of over 1 million operations at rated load*

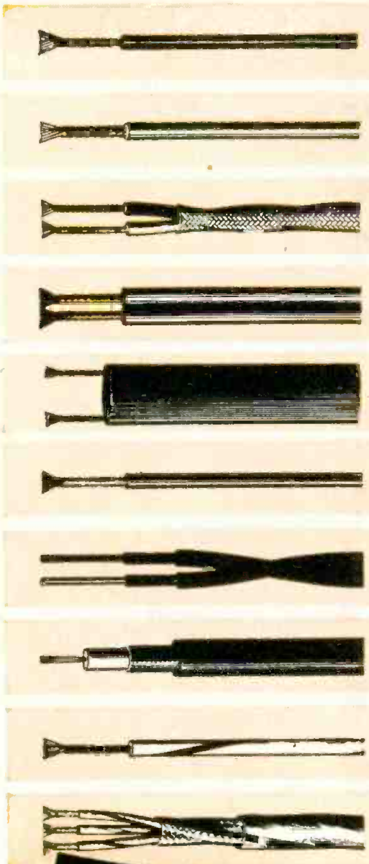
High Speed: *operate-to-make time under 8 ms.*
release-to-make time under 4 ms.
release-to-break time under 2 ms.

ALLIED CONTROL COMPANY, INC.
2 EAST END AVENUE, NEW YORK 21, N. Y.

Put your finger on EXTRA DEPENDABILITY by specifying...

CHESTER plasticord-plasticote WIRES & CABLES

CHESTER means dependability *plus* in wires and cables for every electronic and electrical application. The compounds used in all CHESTER Wire and Cable constructions are made in the CHESTER plant. Thus, complete control over selection of raw materials and manufacturing techniques, provides full control of quality . . . your assurance of uniformity in every foot of conductor bearing the CHESTER label!



- JAN-C-76 WIRES* SRIR, SRHV, SRRF, WL
- 105°C, 90°C, 80°C, UL APPROVED; 120°C*
- SHIELDED WIRES & CABLES
- FLEXIBLE CORD
- TV LEAD-IN WIRES
- INSTRUMENT WIRES
- COMMUNICATION WIRES & CABLES TO SPECIFICATION
- COAXIAL CABLE
- LACQUERED AND NYLON COVERED WIRES
- SPECIAL WIRES & CABLES TO SPECIFICATIONS

*Solid colors or spiral marking

CUSTOM CONSTRUCTIONS to specification using Polyethylene, Polyvinyl claride, Nylon, Braided and Lacquered Wires, Special Insulating Materials, Glass, Yarn, etc. Inquiries invited.

ASK "Chesty" FOR the New Chester Literature. Complete data on wires and cables for electrical and electronic wiring. Request yours, today!

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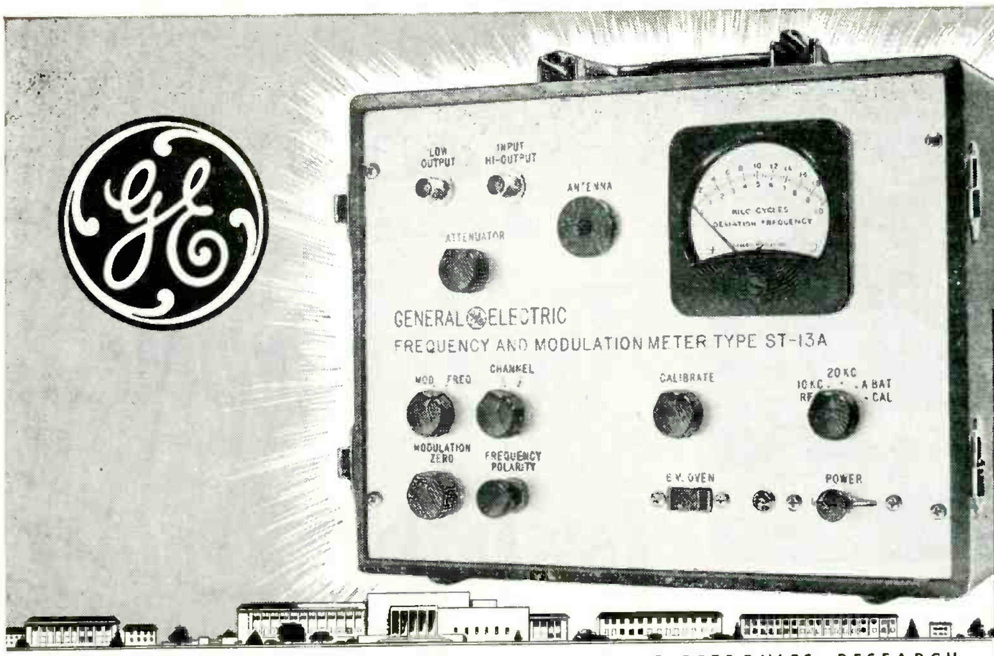


ELECTRONICS PARK — G-E HEADQUARTERS FOR ELECTRONICS RESEARCH

Accessories include: External antenna mount (above), adaptor cable, and crystal ovens.

New! G-E FREQUENCY AND MODULATION METER

Measures both carrier frequency displacement and square wave modulation with direct reading on 2-range 3½" meter

Here is a quality FM Communications instrument with features that are *unmatched in the industry!* The ST-13A is engineered to give you hairline accuracy . . . lowest possible cost . . . plus full provision with oven accessories for future split-channel adjustments. This unit meets today's demand for accuracy and economy and provides for tomorrow's more stringent needs. Two RF outputs for receiver testing and alignment. New case design is durable and good looking.

SPECIFICATIONS—MODEL ST-13A

FREQUENCY RANGES
One or two specified frequencies in the following ranges:
25 MC to 50 MC, 72 MC to 76 MC, 148 MC to 174 MC
Quartz crystal operating range: 4 MC to 6 MC

REFERENCE OSCILLATOR ACCURACY
.001% from 32°F to 122°F
Greater accuracy will be obtained over a more limited temperature range. External connection, internal wiring and a socket are provided for 6 V oven operation where wider temperature range with greater accuracy is available.

MODULATION ACCURACY
± (5% + 200 cycles)
On sinusoidal or square wave modulation (complete limiting).

METER RANGES
0 to 10 KC and 0 to 20 KC. These scales are calibrated in terms of carrier frequency displacement from the internal reference oscillator and deviation due to square wave modulation. Sinusoidal modulation is 1.57 times this value. A conversion curve appears in the cover.

INPUTS
Eighteen-inch collapsible whip antenna.
Fifty-ohm BNC connector. This input can handle only limited power as it is followed by a molded carbon potentiometer attenuator.

OUTPUTS
Low RF output—adjustable around 1 microvolt.
High RF output—adjustable from about 100 to several thousand microvolts, depending on frequency.
Both outputs come out on 50-ohm BNC connectors.

POWER—INTERNAL BATTERIES
2—45 volt batteries; 2—1.5 volt flash light cells; 2—1.5 volt pen light cells.

TUBE COMPLEMENT
2—1L4, 2—1U4

G-E OSCILLOSCOPE—MODEL ST-2A

Here's the ideal scope for shop and general laboratory use. Size and weight have been held to a minimum yet you are assured of quality G-E construction and materials. Features high sensitivity . . . exceptional stability. Special features include a DC vertical amplifier to adapt the equipment to a wide range of applications. Deflection pattern expands to several times tube diameter.

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

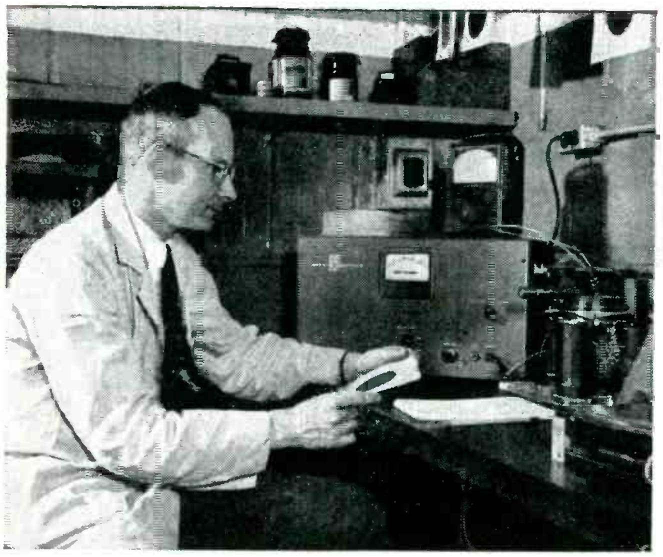
General Electric Company, Section 4103
Electronics Park, Syracuse, N. Y.

Please send me a copy of the following bulletins:
☐ ST-13A (ECL-15) ☐ ST-2A (ECL-9)

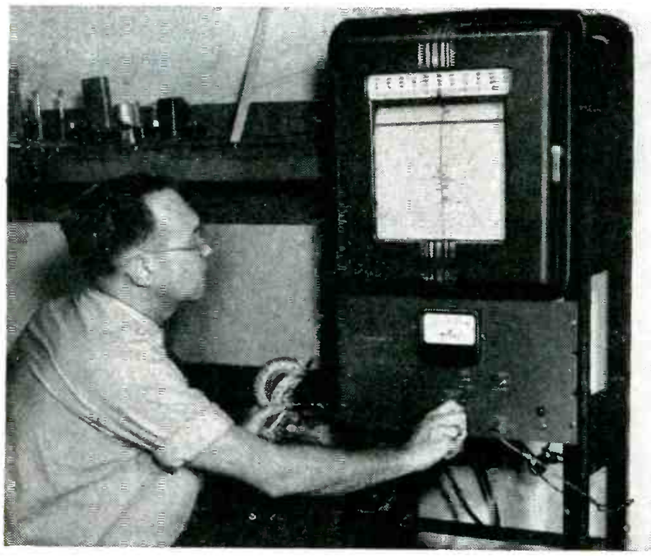
NAME...
COMPANY..
ADDRESS...
CITY.......................STATE.............

GENERAL ELECTRIC

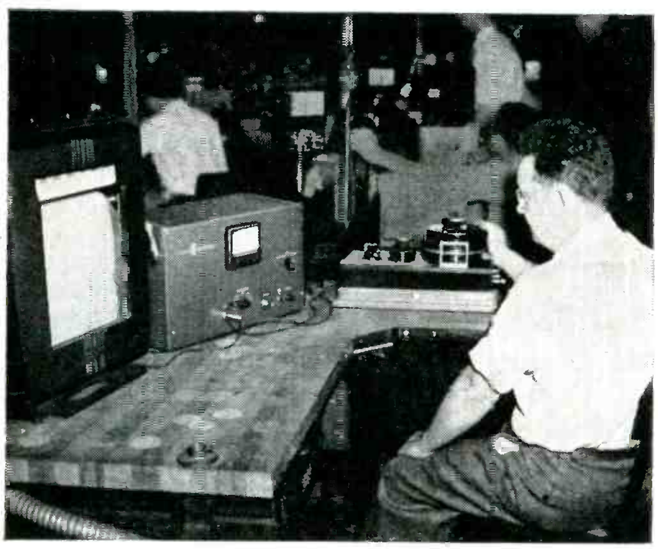
Want more information? Use post card on last page.



As a Direct-Reading Instrument *The extreme sensitivity of the d-c amplifier is utilized to check plasticizer insulation resistance values in the megamegohm range.*



As a Recorder Preamplifier *The rack-mounted amplifier above is being used to increase the sensitivity of a recorder in running special tests of switches.*



As a Null Detector *The d-c Amplifier is being used above for factory checking and calibration of instruments.*

L&N Low Level d-c Amplifiers are

Triple Purpose... for Triple Service

● In response to the constant demand for versatility in precision instruments, these d-c Indicating Amplifiers combine the functions of three useful instruments in one:

1. **A Direct-Reading Instrument** that is always ready to use . . . never any readjusting of zero, either initially or during a series of readings. Simply select the range in which you want to work by turning scale-multiplier knob.

2. **A Recorder Preamplifier** — Values measured by Stabilized d-c Amplifiers can be recorded directly on Speedomax recorders.

3. **A Null Detector** more sensitive than most reflecting galvanometers, yet with full scale response time of only 2 to 3 seconds. These instruments are unaffected by vibration; leveling is not necessary. At the turn of a range knob, a wide choice of sensitivities can be obtained without external shunts. A non-linear response characteristic is also available for easy balancing.

These amplifiers are suitable for handling low level measurements with thermocouples, strain gages, bolometers—bridge and potentiometer circuits—ionization, leakage and phototube currents—almost any measurement of extremely small direct current or voltage.

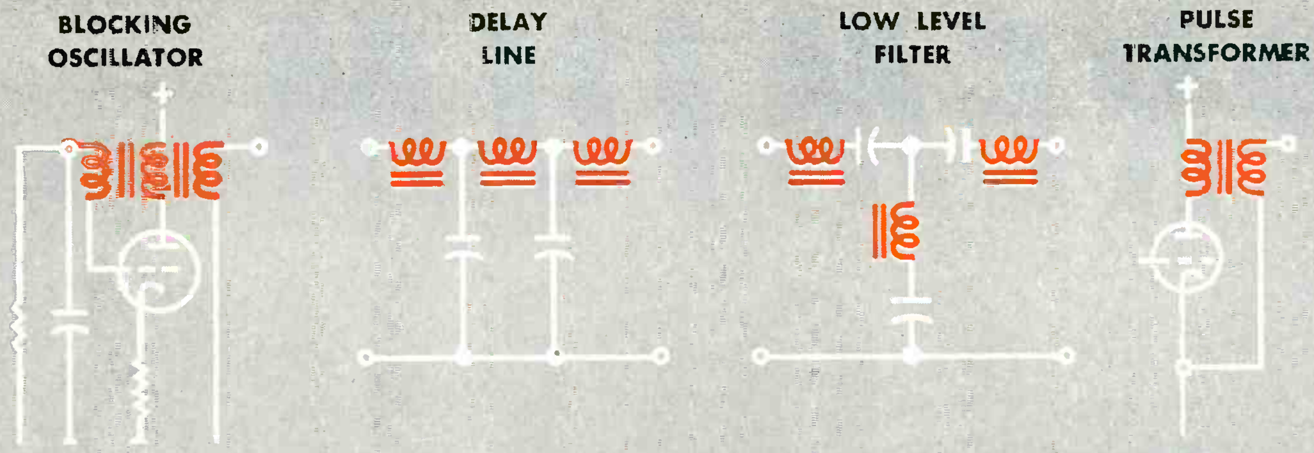
Self-contained, the unit can either be used "as is" or removed from case and mounted on a 19″ relay rack.

For details, including complete specifications, send for Folder EM9-51(1). Write our nearest office, or 4979 Stenton Ave., Phila. 44, Penna.

LEEDS LN NORTHRUP

instruments *automatic controls • furnaces*

Jrl. Ad. EM9-51(3)



A HIGH -μ POT CORE FXC WITH GREAT VERSATILITY

... designed for modern miniaturization

Alert designers of electronic circuits are finding this versatile pot-core structure superior in a wide variety of applications. Of a size compatible with modern miniaturization requirements, this core assures high effective permeability *with negligible external fields* and low losses.

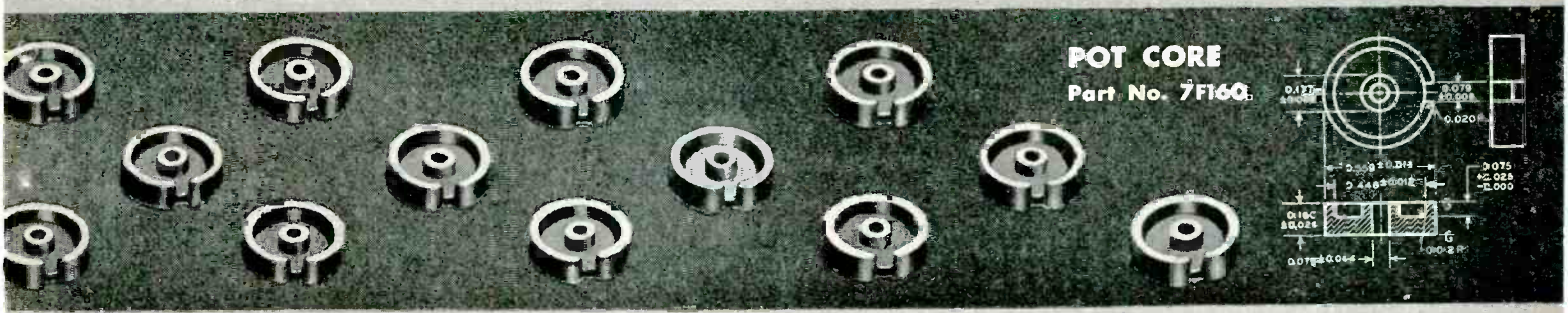
Extremely easy to use and install—mount Ferroxcube Part 7F160 anywhere with a single screw. It is being used with excellent results in single and multiple stacking arrangements. Some of the very successful large scale applications are: Blocking oscillators, Delay lines, Low level filters, Pulse transformers, etc.

Ferroxcube miniature pot core Part 7F160 is production geared for large quantity deliveries. For your convenience, nylon bobbins designed specifically for use with 7F160 are carried in stock too, to make your winding problem even easier.

The performance, versatility and usefulness of this part are unusual—it deserves careful investigation.

Write for detailed engineering bulletin giving complete data. Your copy will be sent to you at once.

WRITE FOR DETAILED ENGINEERING BULLETIN GIVING COMPLETE DATA.



FERROXCUBE CORPORATION OF AMERICA

A Joint Affiliate of Sprague Electric Co. and Philips Industries, Managed by Sprague

35 EAST BRIDGE STREET • SAUGERTIES, NEW YORK

PREMIUM...

with COLLINS

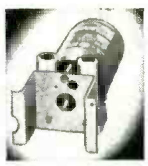
Now available for incorporation into your own designs

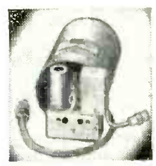
Check the specifications on the chart below. If your equipment design calls for a stable oscillator in any of the frequency ranges shown, a major portion of your design problem is solved. Collins precision oscillators, long famous for their accuracy and stability, are now available for incorporation into your own designs.

The years of research and development work that have gone into every detail of these oscillators can improve your equipment and effect a substantial saving in your development costs.

Collins oscillators are mechanically stable, sealed against atmospheric changes, compensated for changes in temperature and voltage. Their output frequency is essentially independent of environment. *We are now supplying engineering samples and quotations on production quantities.*








TYPE	70E-1	70E-8A/B	70E-12	70E-15	70H-2	70H-3
Frequency Range	1.0—1.5 mc	1.6—2.0 mc	1.955—2.955 mc	2.0—3.0 mc	2.455—3.455 mc	1.5—3.0 mc
Calibration Linearity	±750 cycles	±750 cycles	±1000 cycles	±750 cycles	±500 cycles	±1000 cycles
Maximum Frequency Drift 40°F to 120°F	250 cycles	400 cycles	600 cycles	400 cycles	100 cycles oven on	600 cycles
Max. Drift with ±10% Plate Voltage Change	75 cycles	75 cycles	150 cycles	150 cycles	100 cycles	100 cycles
RF Output	13—30v rms 25 mmf load	5.5—12v rms 33 mmf load	0.5—2.0v rms 15 mmf load	1.2—2.5v rms 100 mmf load	2v rms 1000 ohms	5—13v rms no load
Plate Power	250v @ 7 ma	180v @ 8 ma	150v @ 12 ma	150v @ 12 ma	180v @ 10 ma	150v @ 12 ma
Heater Power	12.6v @ 150 ma	6.3v @ 300 ma	6.3v @ 600 ma	6.3v @ 600 ma	6.3v @ 300 ma	12.6v @ 300 ma
Oven Power	none	none	none	none	26v @ 2.0 amp	26v @ 3.0 amp
Electrical Connections	plug	plug	solder	solder	plug	plug
Tubes	one 12SJ7	one 6SJ7	two 6BA6	two 6BA6	one 5749	two 5749
Shaft Size	0.1869—0.1873	0.2488—0.2498	0.1869—0.1872	0.1869—0.1872	0.1869—0.1872	0.1869—0.1872
Rotation for Increased Frequency	clockwise	clockwise	counter-clockwise	counter-clockwise	counter-clockwise	counter-clockwise
Tuning Rate	50 kc/turn	25 kc/turn	100 kc/turn	100 kc/turn	100 kc/turn	150 kc/turn
Tuning Torque	3—4 inch oz	10 inch oz	10 inch oz	10 inch oz	10 inch oz	10 inch oz
Size	2¾"sq.x5"	2¾"sq.x4 11/16"	2½"dia.6 11/16"	2½"dia.x5"	3½"dia.x6-5/32"	2-27/32"dia.x6 5/16"

Collins Radio Co., Cedar Rapids, Iowa

Please send complete information on your permeability tuned precision oscillators.

NAME __________

COMPANY __________

ADDRESS __________

CITY __________ STATE __________

COLLINS RADIO COMPANY
Cedar Rapids, Iowa

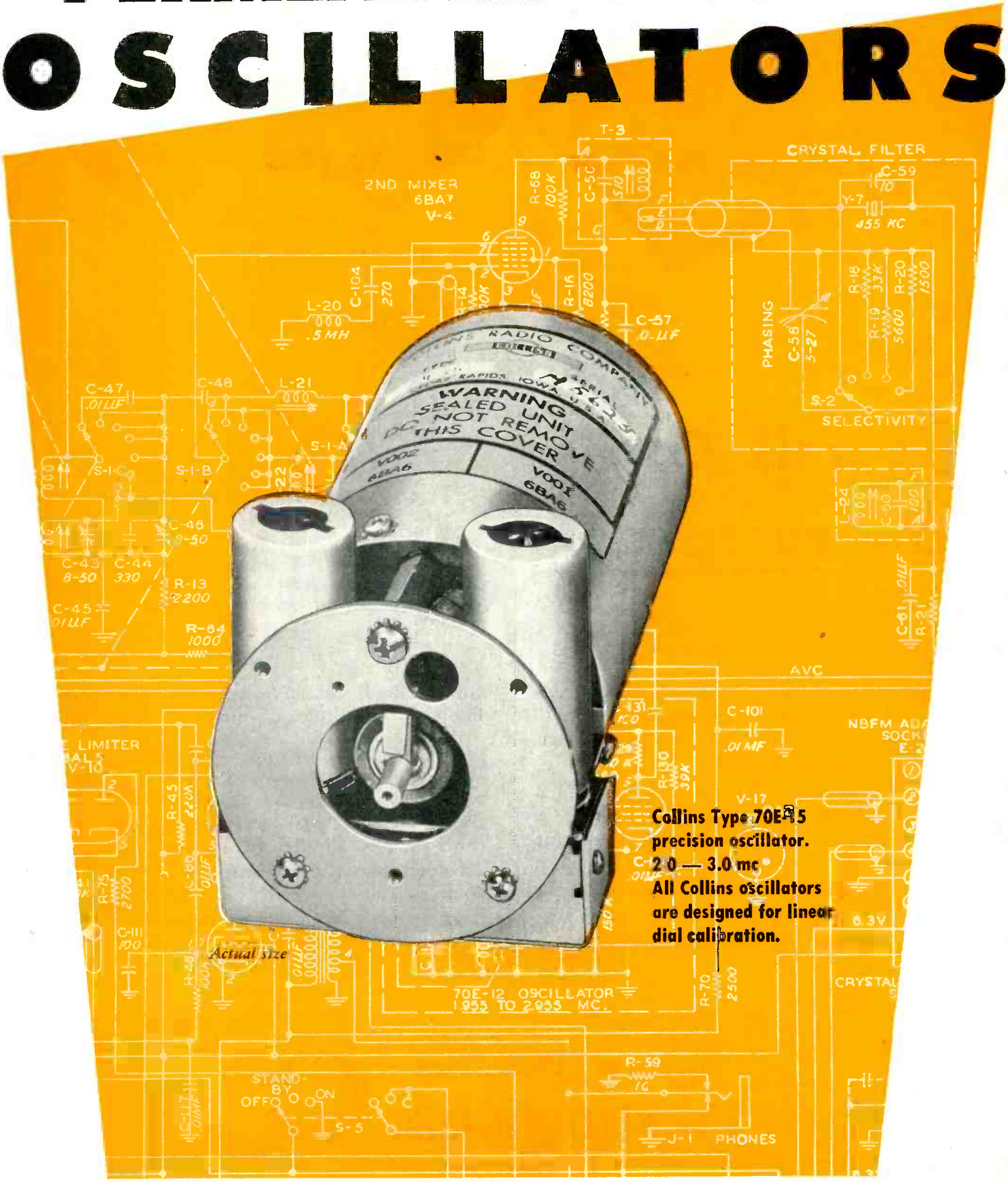
11 W. 42nd St.
New York 36

1930 Hi-Line Drive
Dallas 2

2700 W. Olive Ave.
Burbank

STABILITY and ACCURACY

PERMEABILITY TUNED OSCILLATORS

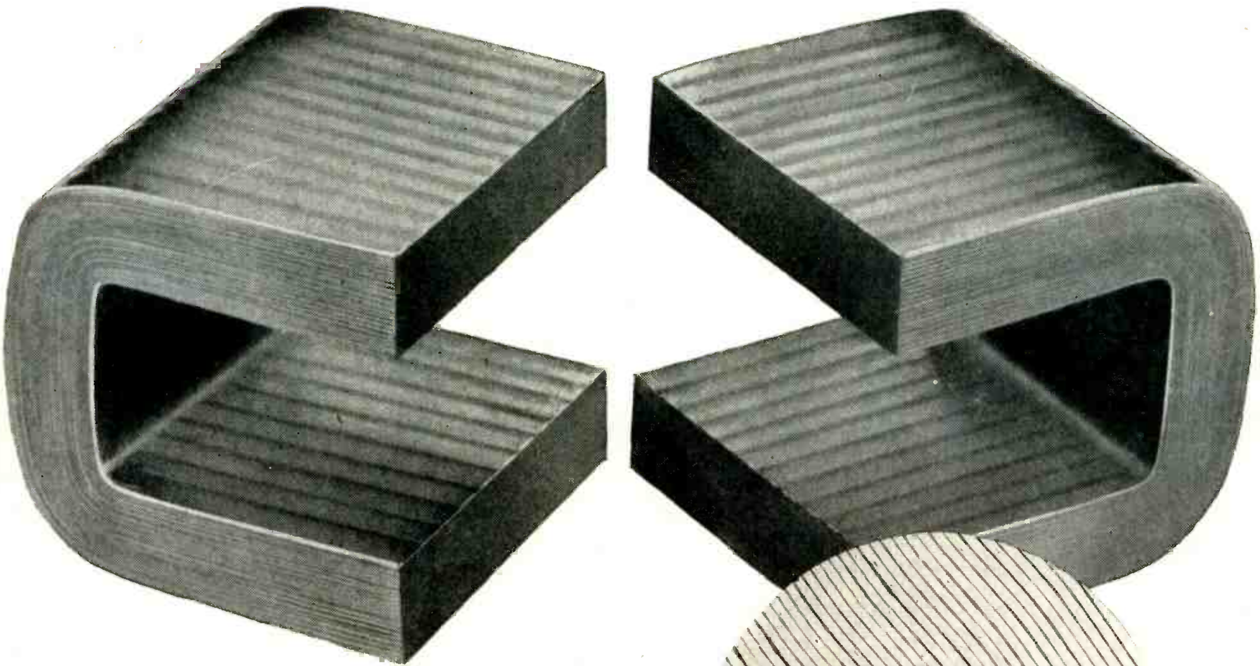


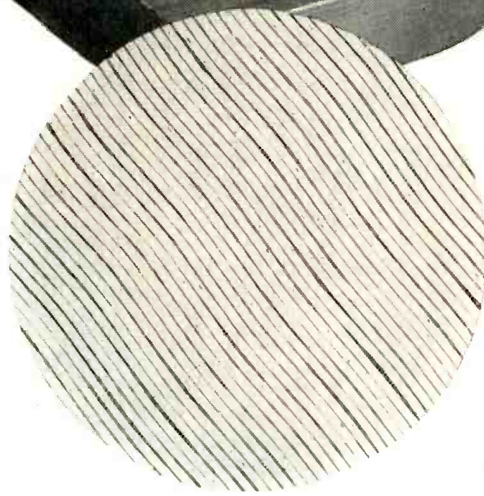
Actual size

Collins Type 70E-15 precision oscillator. 2.0 — 3.0 mc

All Collins oscillators are designed for linear dial calibration.

Want more information? Use post card on last page.





Hipersil® Cores now rustproof

Butt joint section of 5-mil Hipersil Core, magnified 10 times. Distinct separation between the laminations channels the flux, increases core efficiency.

A new process now coats a microscopic film of rustproof iron phosphate on all Westinghouse Hipersil Cores. This coating will not chip, scratch or flake, nor will it affect core performance.

Rustproofing eliminates all possibility of deterioration. This means you can safely carry samples or a stock of cores in advance of immediate production needs . . . keep your assembly lines flowing smoothly.

This thin coat prevents any loss of the inherently high flux carrying capacity . . . another reason why Hipersil Cores make it unnecessary to design excess core material, and, therefore excess size and weight, into your transformer assemblies.

Advancements like this continue to make the Westinghouse Hipersil Core the best on the market today. Because they are 100% active in carrying flux, they solve size, weight and loss problems for you. The simple, two-piece assembly helps cut your transformer fabricating costs. Get a more complete story by writing today for Booklet B-5402. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70694

YOU CAN BE **SURE**...IF IT'S

Westinghouse

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company OCTOBER 1953

Precision Connectors Use Kel-F to Provide Superior RF Insulation ...5,000v. Capacity...Cut Moisture Dissipation

Consistently high RF insulation and dimensional stability were prime requirements for the dielectric inserts in connectors required for an Atomic Energy installation. "Kel-F" plastic was found to be the material answering these and other "tough" requirements.

"Kel-F" maintains high RF insulation under conditions that cause other materials to fail. It is readily molded or machined to within .002″ of the critical dimensions required for the parts. And, because of its excellent wear characteristics, "Kel-F" maintains the precision of the critical insulators for a longer time. Frequent "connects", "disconnects" and operational vibration have negligible effect on the insulation because of the high strength—impact, compressive and flexural—of this fluorocarbon plastic. It takes rough handling without chipping, cracking or "freezing".

Exposure of the insulators made of "Kel-F" to high humidity fails to affect their dimensional stability or superior electrical properties. Zero water absorption and "non-stick" properties of this plastic reduce the need for maintenance by preventing the formation of fungus under high humidity or the accumulation of conductive residues.

The precision RF connectors illustrated are manufactured by the Dage Electric Company, Inc. of Beech Grove, Ind. for use in electronic equipment specified for nuclear studies. One of the insulating parts of "Kel-F" used is injection-molded for this company by the Brilhart Plastics Corporation of Mineola, N. Y. Another is machined from extruded Kel-F by Insulating Fabricators of New England, Inc., Watertown, Mass. The precision parts are then incorporated in special metal connector housings that are gold-plated.

Refer to Report E-115

Sea-Going "Pot" of Kel-F® Harnesses 10,000 Volt Currents...Maintains Hermetic Seal Under Shock and Vibration...At All Temperatures

At the polar cap or in the humid tropics, in the "moth ball fleet" or on the firing line, the variable capacitor "pot" shown here guards against leakage of 10,000 v. currents and loss or contamination of the insulating "potting" oil. Molded of "Kel-F" trifluorochloroethylene polymer plastic, this six-pound unit will maintain a high level of insulation resistance indefinitely due to the high dielectric strength of the plastic . . . at high and low temperatures (—320 to 390°F) and in spite of salt-laden sea air. The chemical inertness of "Kel-F" polymer eliminates any corrosion from the insulating oil, loss of the oil or dimensional change resulting in a break in hermetic seal. The toughness—high tensile, impact and compressive strength—of the polymer prevents cracking of the pot or loosening of electrical leads under shock or vibration, even during "big gun" salvos.

The variable capacitor "pot", one of the heaviest single pieces ever molded from "Kel-F" trifluorochloroethylene polymer, is compression-molded for the Armed Forces by Fluoro Plastic, Inc. of Philadelphia, Pa. Mounting lugs, undercuts and the dimensions of the bore of the pot and cover are all provided for during molding, on standard molding equipment. The choice of "Kel-F" plastic was based also on its zero water absorption, non-porosity and "non-stick" properties which prevent any current shorting caused by water or exposure to high humidity.

Refer to Report E-113

(SEE REVERSE SIDE)

® Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymers.

KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
MOLDING POWDERS
KEL-F
FLUORO CHLORO CARBON PLASTIC
KEL-F
DISPERSION COATINGS
KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
OILS WAXES GREASES

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

MOLDING POWDERS

KEL-F

FLUORO CHLORO CARBON PLASTIC

KEL-F

DISPERSION COATINGS

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

DESIGN and PRODUCTION NEWS

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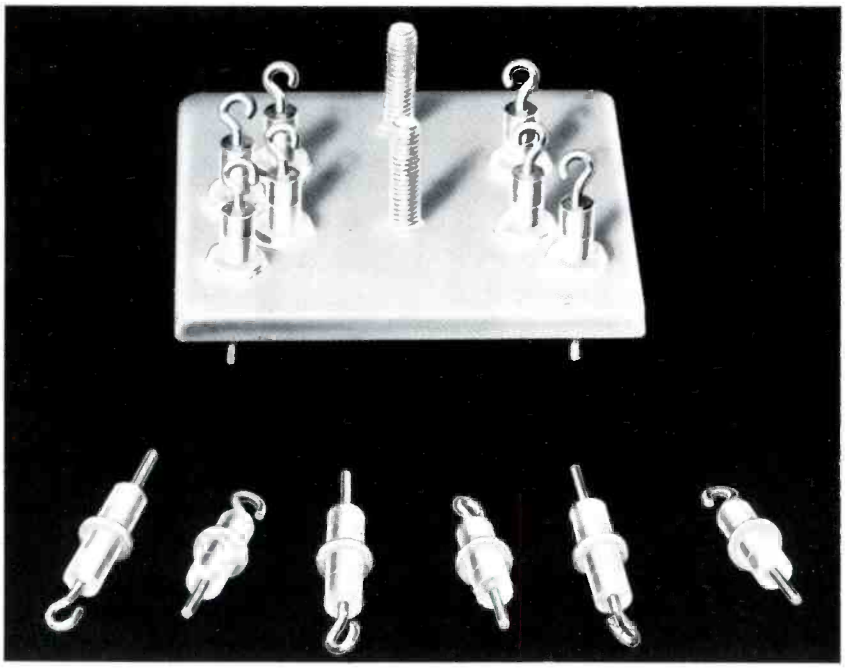


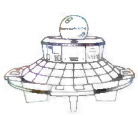
Improved Terminals Handle Currents up to 7500 Volts RMS Without "Flash"... Under High Humidity... Maintain Hermetic Seal Under Stress

Rough handling, severe operational current and temperature cycling and environmental restrictions are all taken in stride by the new hermetically sealed terminal pictured here. Two factors make this an outstanding terminal: The use of Kel-F® polymer plastic as the insulation and important refinements in the art of terminal manufacture.

"Kel-F" trifluorochloroethylene polymer was chosen to insulate this terminal, enabling it to handle 15 ampere currents up to more than 2,000 volts RMS *without corona* . . . up past 7,500 volts RMS *without flash-over or tracking.* Injection-molded under precise control, these terminals of "Kel-F" have higher heat and cold resistance . . . providing perfect electrical insulation at minus 148°F. as well as at over 300°F. The consistent dimensional stability of "Kel-F" at both high and low temperatures, combined with a new method of crimping the conductor prevent loss of the vital hermetic seal—"Kel-F" refuses to shrink, swell or age and the special crimping prevents lateral or longitudinal movement of the conductor.

Brilhart Plastics Corporation, Mineola, N. Y., produces these improved terminals by injection molding, using standard methods and multi-cavity molds. All parts of the terminal, designated as the "Type BTX-1"* are made in this company's plant. The new terminal uses specially-designed parts and a "post-molding" treatment to achieve a hermetic seal that will pass a 20 psi pressure test after "wiggle" and "pull" tests that cause other terminals to fail.

*Patented



Remember "Kel-F" at The Chemical Show in November . . .

Interesting and unusual applications of "Kel-F" polymer plastics in the chemical industries will be displayed at the "Kel-F" Booth Nos. 835, 839 and 843 at the 24th EXPOSITION OF CHEMICAL INDUSTRIES, November 30th to December 5th, 1953. The place: Commercial Museum and Convention Hall, Philadelphia, Pa.

Refer to Report E-114

Molders of the Month

Leading molders and extruders specialize in fabrication of materials and parts made of Kel-F . . . each month this column will spotlight several of these companies with their principal services and products.

Cinch Manufacturing Corporation
Chicago, Ill.
Injection Molding
Electrical & Electronic Components
Tube Sockets & Connectors

Elastic Stop Nut Corporation of America
Union, N. J.
Injection Molding
Elastic Stop Nuts & Fasteners

Industrial Coatings Corporation
Chicago, Ill.
Dispersion Coating

Jet Specialties Company
Los Angeles, Calif.
Extrusion
Rod & Tube

Juno Tool Corporation
Minneapolis, Minn.
Compression & Transfer Molding
Injection Molding
Electrical & Electronic Components

Molding Corporation of America
Providence, R. I.
Compression & Transfer Molding
Electrical & Electronic Components
Tubes, Sockets & Connectors
Terminals
Pump, Valve Diaphragms & Parts

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service

CHEMICAL MANUFACTURING DIVISION

THE M. W. KELLOGG COMPANY

P. O. Box 469, Jersey City 3, N. J. or offices in Boston, Chicago, Dayton, Los Angeles and New York

KELLOGG — SUBSIDIARY OF PULLMAN

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TIME PROVED

Eimac 4W20,000A gives 25 kw peak sync power output through channel 13 with only 500 watts driving power

TYPICAL OPERATION
Class-B Linear Amplifier—Television Visual Service
(Per tube, 5 mc bandwidth, 216 mc.)

Load Impedance	650 ohms
D-C Plate Voltage	7000 volts
D-C Screen Voltage	1200 volts
D-C Control-Grid Voltage	—150 volts

	Peak Sync Level	Black Level	
D-C Plate Current	6	4.5	amps
D-C Screen Current	230	100	ma
D-C Grid Current	90	45	ma
Peak RF Grid Voltage	280	220	volts
Driving Power	500	300	watts
Plate Power Input	42	32	kw
Plate Dissipation	16	16.5	kw
Useful Plate Power Output	26	15.5	kw

FOR THREE YEARS THE EIMAC 4W20,000A has been proving itself an outstanding power tube in a variety of electronic applications. In VHF-TV operation it gives an easy 25 kw peak sync power output with only 500 watts driving power. This high power output with low driving power requirements is typical of Eimac radial-beam power tetrodes. Rugged 4W20,000A construction includes a ceramic envelope that minimizes losses and increases operational life. In pulse service, FM and TV operation the 4W20,000A is the only time proved tetrode in its power class.

Eimac TUBES

Information about the 4W20,000A or any of Eimac's complete line of electron power tubes can be obtained by writing our Application Engineering department.

The Power for TV

EITEL-McCULLOUGH, INC., SAN BRUNO, CALIFORNIA

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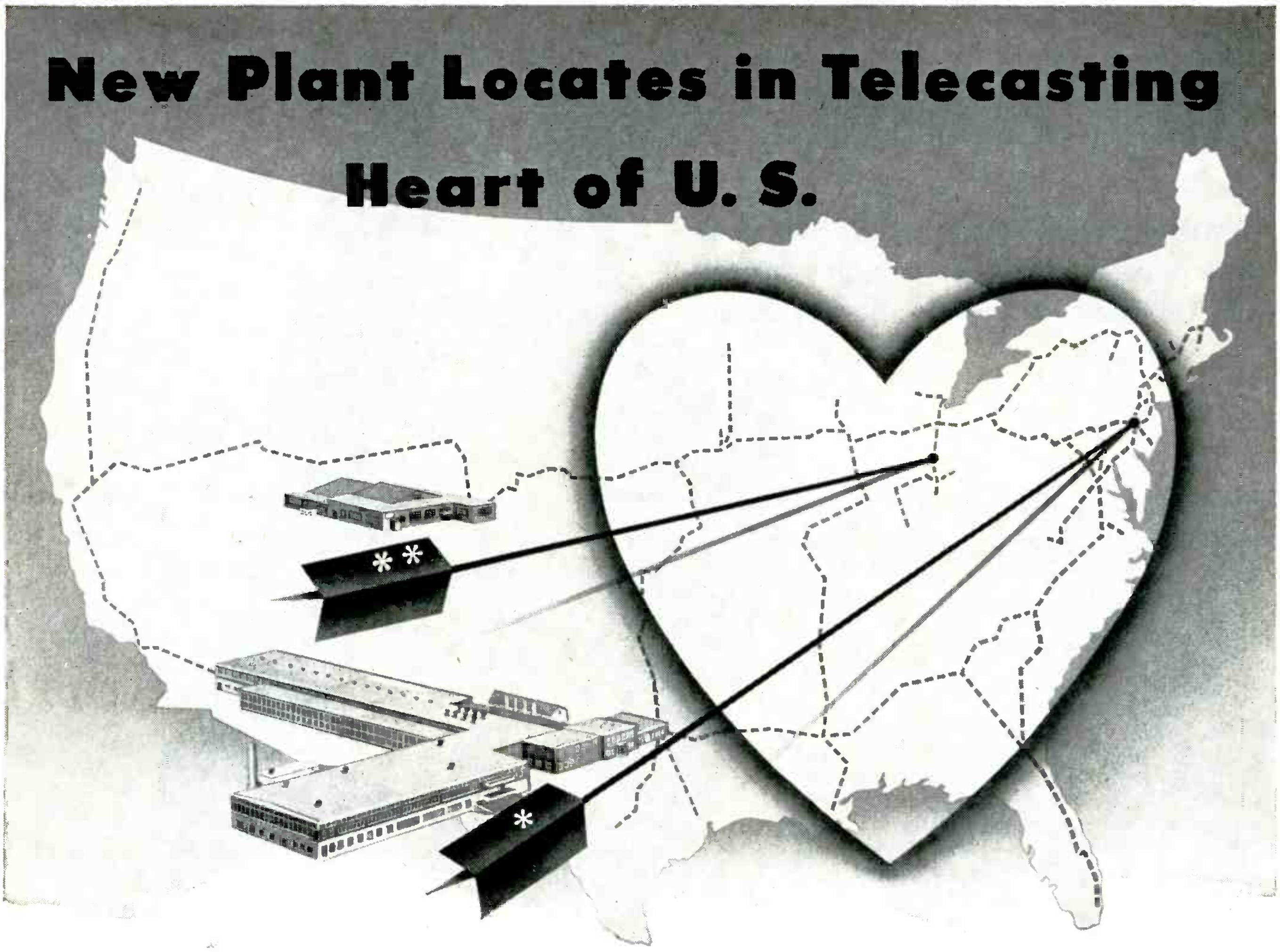
New Plant Locates in Telecasting Heart of U. S.



Things are humming in Wapakoneta, Ohio. There, about 10 miles west of the Dayton-Toledo coaxial cable is the new plant of Superior Tube Company. This plant complements the production capabilities of the Superior main plant, takes care of your ever-increasing demands for television and military purposes.

Superior nickel cathodes are made in a wide range of types, O.D.'s, wall thicknesses and lengths—with or without bead—and in active, normal and passive alloys, depending upon the application and the degree of emission required.

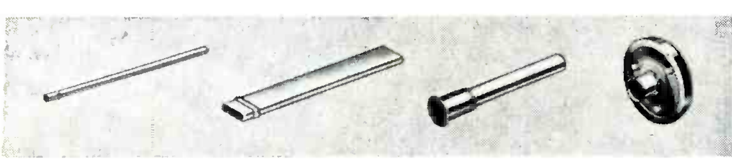
Superior produces both Seamless and Lockseam† nickel cathodes. For many electron tubes Lockseam—made by a patented process from strip stock—has an economic advantage. Superior Seamless shows great advantages in uniformity, close tolerances, and small O.D. for sub-miniature tubes.

Superior equipment is more than matched by the care taken in production. Each melt of alloys is laboratory-checked for emission and performance. Many extraordinary precautions are taken in manufacture to avoid contamination.

Before you order cathodes, first see what Superior engineering, quality, and delivery can do for you.

*Main Superior Tube plant at Norristown, Pa.
**NEW Superior Tube plant at Wapakoneta, Ohio

Many other types of nickel cathodes—made in Lockseam† from nickel strip, disc cathodes, and a wide variety of anodes, grid cups and other tubular fabricated parts are available from Superior. For information and Free Bulletin, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.



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THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" Max. wall) up to 1⅝" O.D.

Seamless Nickel Cathode Round, single bead, .045" O.D. x .002" Wall. 27 mm long.	Lockseam† Nickel Cathode Rectangle, single bead, .030" x .100" O.D. x .0021" Wall. 13 mm long.	Seamless Monel, Expanded and flanged. (Exp. to .165"/.168" I.D.—Fl. to .230") .139 O.D. x .005" Wall x 1.100" long.	Disc Cathode .121" O.D. .312" long.

†Manufactured under U.S. Patents

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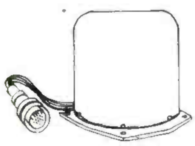
A Robot's Secret

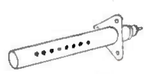
Iron Fireman learned many years ago that the real secret of any automatic device is in the controls and instruments which regulate its operation. This is the reason that Iron Fireman has long had a separate division for producing the instruments, controls and motors used with its world-famous heating equipment.

Today, many types of precision devices are mass-produced at the large Electronics Division plant—by people with a *quarter-century* of experience. This experience has made possible aircraft and electronics components featuring new and better designs.

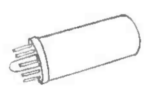


Vertical Gyros

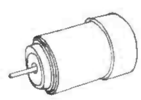
Motor-driven Timers



Fire and Heat Detectors



Hi-Speed Relays and Choppers



Spin Motors

For more information write

IRON FIREMAN *Electronics* DIVISION

2800 S. E. NINTH AVENUE, PORTLAND 2, OREGON

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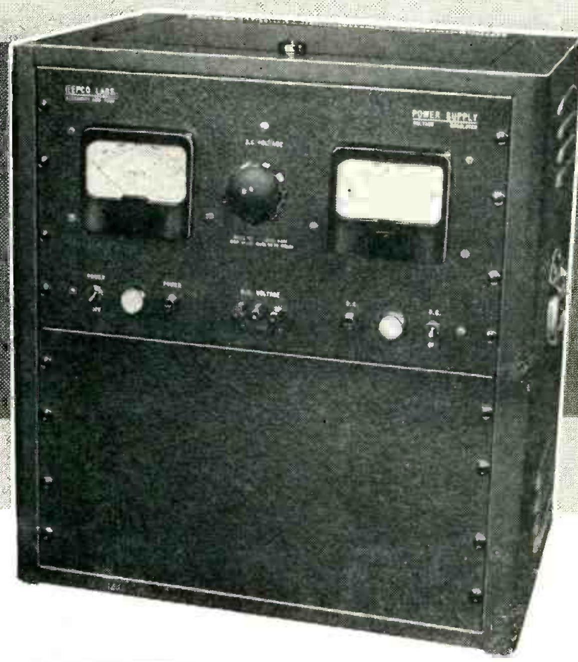
VOLTAGE REGULATED POWER SUPPLY

MODEL 700



The Kepco Model 700 features one regulated voltage supply with excellent regulation, low ripple content and low output impedance.

SPECIFICATIONS

OUTPUT VOLTAGE DC: 0-350 volts continuously variable.

OUTPUT CURRENT DC: 0-750 milliamperes continuous duty.

REGULATION: In the range 30-350 volts the output voltage variation is less than ½% for both line fluctuations from 105-125 volts and load variation from minimum to maximum current.

RIPPLE VOLTAGE: Less than 10 millivolts.

FUSE PROTECTION: Input and output fuses on front panel. Time delay relay is included to protect rectifier tubes.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles.

OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. Either positive or negative terminal of the supply may be grounded. DC terminals are isolated from the chassis. A binding post mounted on the front of the panel is available for connecting to the chassis. All terminals are also brought out at the back of the chassis.

METERS:

Ammeter: 0-1 ampere, 4" rectangular.

Voltmeter: 0-500 volts, 4" rectangular.

PHYSICAL SPECIFICATIONS: Cabinet height 22¾", width 21¾", depth 15¼". Rack panel height 21", width 19", color gray, panel engraved.

CONTROLS: Power on-off switch, H.V. on-off switch, H.V. control.

FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. #1

ADDITIONAL MODELS AVAILABLE IN THE 700 SERIES VOLTAGE REGULATED POWER SUPPLIES

Volts	Current	Model
0-350	0-0.75 Amp.	700
0-350	0-1.50 Amp.	710
0-350	0-2.25 Amp.	720
0-350	0-3.00 Amp.	730
0-600	0-0.75 Amp.	750
0-600	0-1.50 Amp.	760
0-600	0-2.25 Amp.	770
0-600	0-3.00 Amp.	780

KEPCO LABORATORIES

131-38 SANFORD AVENUE FLUSHING 55, NEW YORK

Gems of Precision Engineering

GLASS-TO-METAL VACUUM SEALS COMPETITIVELY PRICED

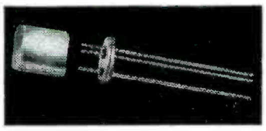
These glass-to-metal vacuum seals are quality products manufactured from glass and metals carefully selected for their closely matched expansion coefficients. Thermal shock tests are performed on every seal during the hot tin dipping operation which is conducted at the extreme temperature of 530° F. This plating procedure insures clean parts which will solder readily whether heating is accomplished by hot plate, soldering iron, hot strip, or soft flame, AND WITHOUT DANGER OF BREAKAGE DUE TO THERMAL SHOCK.

Experience, selected materials, engineering skill, and controlled manufacturing combine to make Constantin vacuum seals leaders for their sturdiness, long life, and excellent electrical performance.

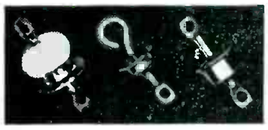
Seals are available in both High Compression and Kovar to hard glass types.

MULTI-PIN CON PLUGS
A wide variety of standard sizes and configurations available. Leaders in the field specify CONSTANTIN CONNECTORS for their ruggedness and reliable performance.

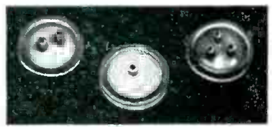
MULTI-PIN HEADERS
Vacuum tight, glass-to-metal sealing makes CONSTANTIN HEADERS ideal for use in products demanding a stabilized atmosphere, and protection from temperature extremes and climatic conditions.



TRANSISTOR MOUNTS
Constantin glass-to-metal vacuum sealed transistor mounts are available as a standard line in various sizes and configurations. Other types may be fabricated to your design specifications.



TERMINALS
Available in all combinations of hooks, eyes, tubes and pierced flats. Precision built and especially noted for sturdiness and high electrical performance.



CONDENSER END SEALS
Manufactured to assure a stabilized atmosphere under any conditions, these seals are excellent for capacitors, filters, delay lines, and precision resistors.

Also manufacturers of —
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VACUUM COATING EQUIPMENT

L. L. Constantin & Co.

MANUFACTURING ENGINEERS

Rt. 46 and Franklin Ave., Lodi, N. J.

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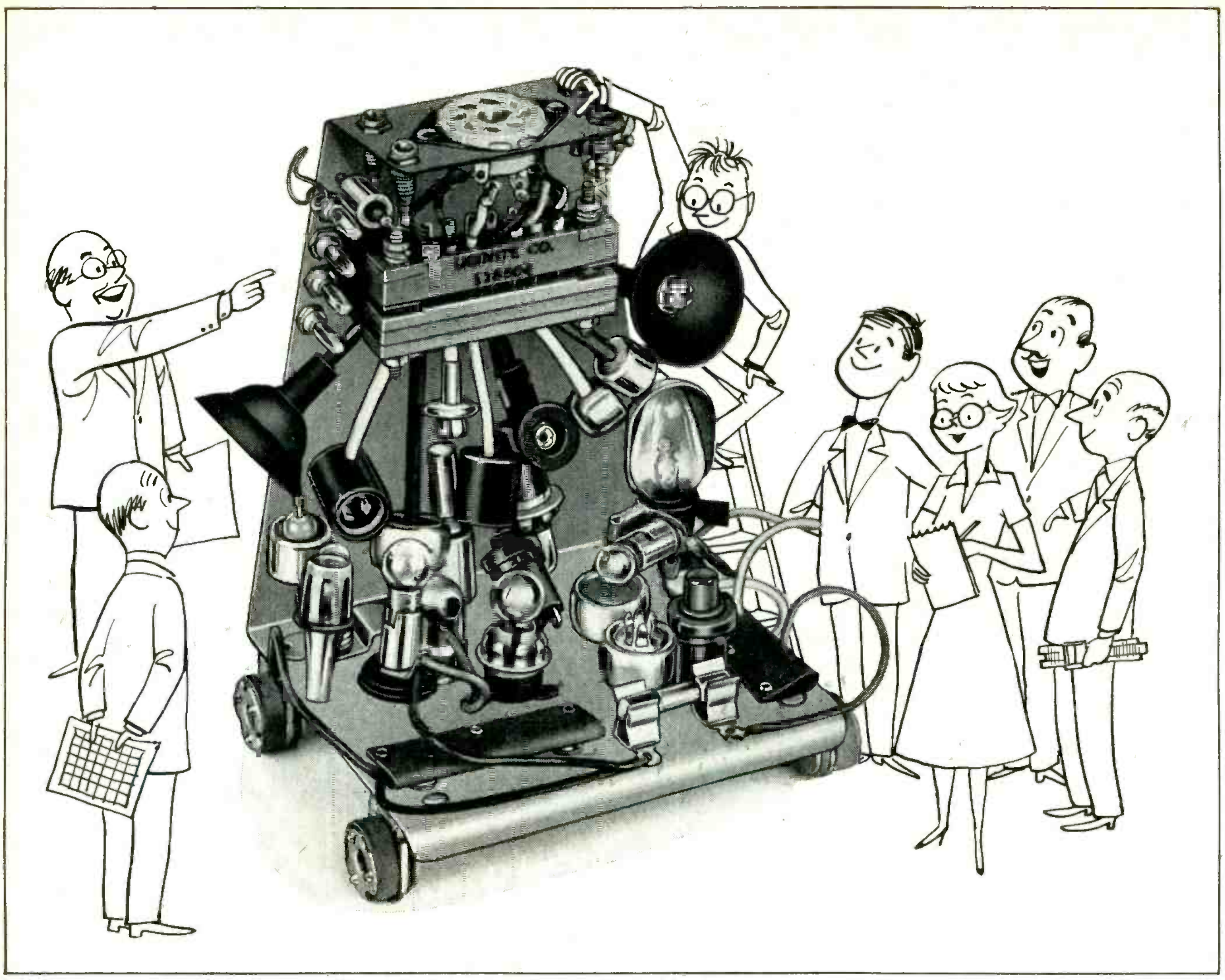

Robot Electronic Thermotipple...

Being the only *genuine* thermotipple in existence, she's apt to be temperamental. At low frequencies, her transient response gets so transient it takes a shot of plutonium to make her respond at all. The only thing that keeps her from being outright neurotic is the fact that all her components are standard Ucinite parts and assemblies.

Switches, connectors, sockets, mountings . . . every one of the precision-made devices shown here is evidence of our ability to fill the varied and highly specialized requirements of our customers.

With an experienced staff of design engineers... plus complete facilities for volume production, we are capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information, or write directly to us.

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Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

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ELECTRICAL ASSEMBLIES,
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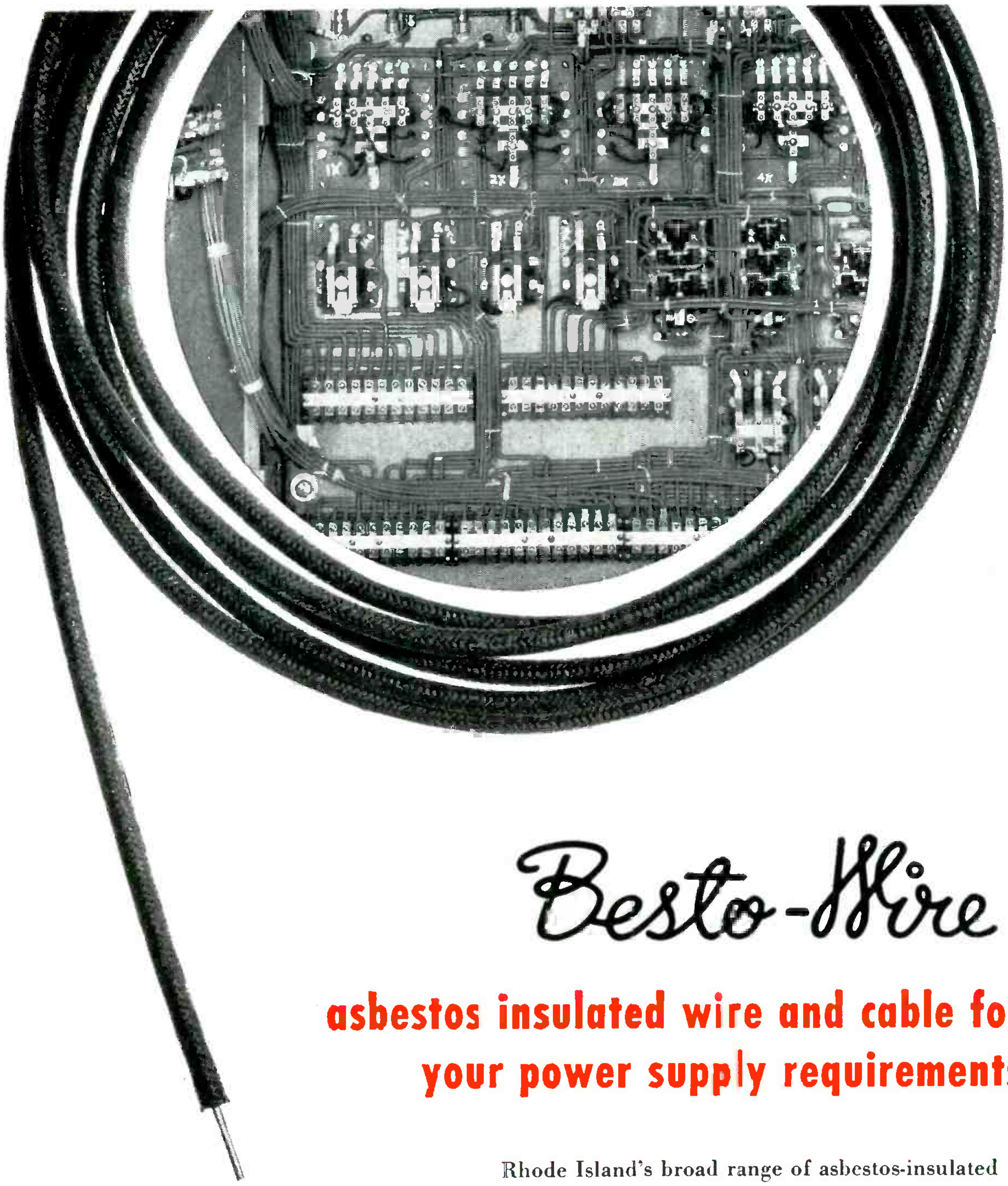

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asbestos insulated wire and cable for your power supply requirements

Rhode Island's broad range of asbestos-insulated Besto-Wire includes a variety of fixture wires, U. L. approved for 300-volt service at 150° C. . . . switchboard cables for 600 volts at 125° C. . . . heater cords for all types of appliances . . . specially constructed range wires for easy stripping and high heat applications.

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ELECTRONIC TEST

New *Multi-purpose*

New!

-hp- 612A — VERSATILE, DIRECT READING. FOR UHF-TV, OTHER WORK 450 TO 1,200 mc

This master oscillator-power amplifier generator is especially designed for UHF-TV measurements including receiver and amplifier gain, selectivity, sensitivity and image rejection. It is also a convenient, direct-reading laboratory power source for driving bridges, slotted lines, antennas and filter networks. Both frequency and output are directly set on large, precisely calibrated dials. No charts or interpolation are required.

Model 612A has a maximum output of 0.5 volts into 50 ohms over its entire frequency range. The instrument also has low incidental fm and broad band modulation up to 5 mc. It may be modulated internally or externally, amplitude modulated, or pulse modulated (good rf pulses 0.2 μsec or longer). Pulse modulation may be applied to the amplifier; or direct to the oscillator when high on-off signal ratios are required.

BRIEF SPECIFICATIONS

Frequency Range: 450 to 1,200 mc, 1 band.

Accuracy: Calibration $\pm 1\%$. Resettability better than 5 mc at high frequencies.

Output: 0.1 μv to 0.5 v continuously variable. Calibrated in volts and dbm. Impedance 50 ohms. Max. VSWR 1.2. Accuracy ± 1 db entire range.

Modulation: Amplitude: From 0 to 90% indicated by panel meter.

Envelope Distortion: 2% at 30% modulation.

Internal: Fixed modulation frequencies, 400 and 1,000 cps.

External: Any frequency 20 cps to 5 mc.

Pulse Requirements, External Modulation:

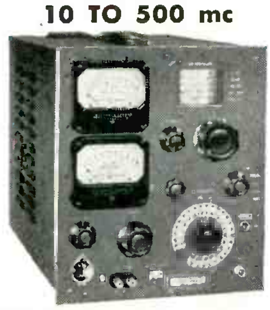
Pulse to Amplifier: Good pulse shape at 0.2 μsec length.

Pulse to Oscillator: 1.0 μsec minimum.

Size: Cabinet 12" x 14" x 18" deep.

Price: $1,200.00

10 TO 500 mc



-hp- 608A VHF Signal Generator provides output ranging from 0.1 μv to 1.0 v into 50 ohms. Accuracy is ± 1 db. Direct reading frequency and output calibration; no charts or interpolation required. Pulsed, cw or amplitude modulated output (50 cps to 1 mc). Resettability better than 1 mc. Has master oscillator-power amplifier for widest modulation capabilities. Constant internal impedance. Maximum VSWR 1.2. $850.00

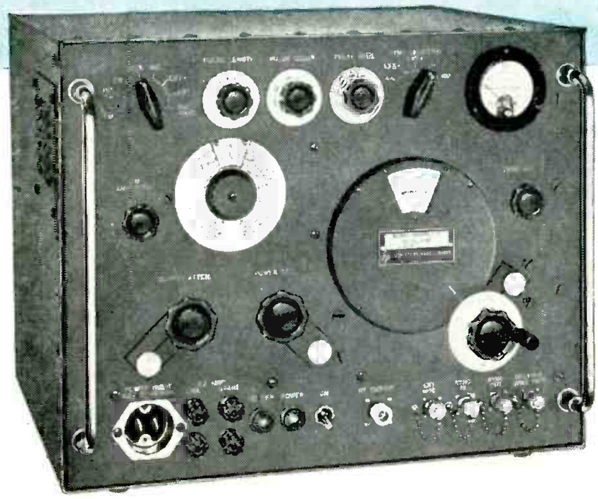
800 TO 2,100 mc

-hp- 614A UHF Signal Generator provides output ranging from 0.1 μv to 0.223 v (1 mw) into 50 ohms. Accuracy ± 1 db. Has single dial, direct reading frequency and output, no charts or interpolation. Offers cw, fm or pulsed output. Widely variable pulsing, synchronizing, delay and triggering features. Extremely fast rise/decay time of 0.1 μsec. Constant internal impedance. Maximum VSWR 1.6. $1,950.00

Complete Coverage HEWLETT-PACKARD

INSTRUMENTS

SIGNAL GENERATORS



New!

-hp- 618B — VARIED PULSING CAPABILITIES, DIRECT READING. RANGE 3,800 TO 7,600 mc

Model 618B offers faster, more accurate measurement of component performance in radar, radio relay and TV carrier systems and similar field and laboratory applications. Frequency is generated in a reflex klystron oscillator; accuracy and stability are high throughout the instrument's wide frequency range. Frequency and voltage are directly set and read. Dial tuning is tracked automatically, and no voltage adjustment is required during operation.

Extremely wide pulsing capabilities have been built into *-hp-* 618B. The instrument may be internally or externally pulse modulated, internally square wave modulated and frequency modulated. The repetition rate is continuously variable between 40 and 4,000 pps. Pulse width is variable 0.5 to 10 μsec. Sync-out signals are simultaneous with the rf pulse or in advance by any time-span from 3 to 300 μsec. The instrument also may be synchronized with an external sine wave, or with positive or negative pulse signals.

BRIEF SPECIFICATIONS

Frequency Range: 3,800 to 7,600 mc. 1 band.

Calibration: Direct. Accuracy better than 1%.

Stability: Frequency: less than 0.006% per °C change.
Line Variation: ± 10 v causes less than 0.01% frequency change.

Output: 1 mw/0.223 v to 0.1 μv into 52 ohms. (0 to –127 dbm).

Modulation: Internal or external pulse, fm, or internal square wave.

External Sync: (1) Sine wave 40 to 4,000 cps, 5 to 50 v rms.
(2) Pulse signals 40 to 4,000 pps, 5 to 50 v (pos. and neg.). Pulse width 0.5 to 5 μsec. Rise time 0.1 to 1.0 μsec.

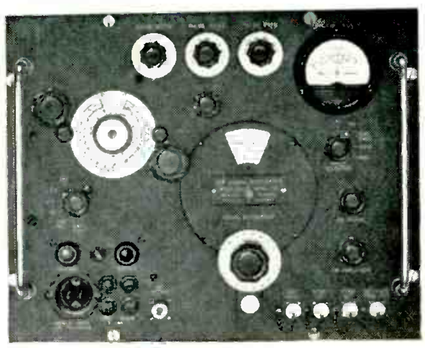
Size: Cabinet 16¾" x 13½" x 16" deep.

Price: $2,250.00

Data subject to change without notice. Prices f.o.b. factory.

1,800 TO 4,000 mc

-hp- 616A UHF Signal Generator offers the same simple operation, wide pulsing capabilities, high stability and accuracy as *-hp-* 618B, but is designed for UHF frequencies. Output ranges from 0.1 μv to 0.223 v (1 mw) into a 50-ohm load. Accuracy is ±1 db. Output may be cw, fm or pulsed. Modulation and synchronizing features are similar with *-hp-* 618B. Oscillator section is a reflex klystron. Frequency changes are automatically tracked and no voltage adjustment is needed during operation. Frequency and output are directly set and read on large, carefully calibrated dials. No charts or interpolation are needed. $1,950.00



For complete details, see your -hp- field representative or write direct

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INSTRUMENTS ***Complete Coverage***

Here are the plain facts that speak for themselves of $24,300 savings.

To increase the "talk-back" range of one-hundred cars from 20 miles to 25 miles—corresponding to an increase of 50% in area coverage—one-hundred 15 watt transmitters must be replaced with 60 watt transmitters . . . at an approximate cost of $25,000.

You can get the same coverage by installing an Andrew 3000-type antenna for only about $700.

One postcard can save you over $24,000. Before you buy, write us for a complete analysis of costs and antenna types to meet your needs.

Andrew
CORPORATION
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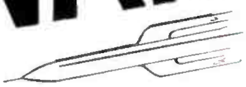
You Can Depend on COMMUNICATION ACCESSORIES for

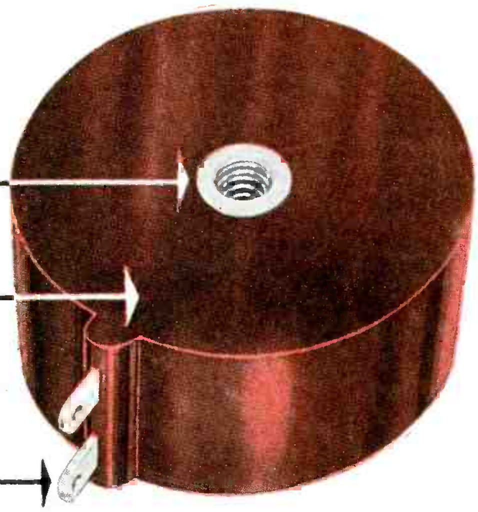
ADVANCED DESIGN



THROW AWAY the special washers and tubings used in your present mechanical mountings of toroids. C-A-C Advanced Design provides a molded-in brass bushing with center hole sizes to clear (type A) or tapped (type B) for a 6/32 screw.

PRESSURE ENCAPSULATION in low loss plastic provides a dense molding of extremely uniform dimension. We've cycled them from —73° C to 150° C—boiled them for hours in salt water—without any significant change.

TERMINALS are brass, silver-plated. Located for ease of connection. Any reasonable number of terminals may be provided. Units may be stacked and mounted with a single screw.



AN EXCLUSIVE C-A-C DEVELOPMENT

Compression MOLDED PLASTIC TOROIDS

THE C-A-C MP (molded plastic) Toroid is the result of years of development and exhaustive tests to determine the most suitable materials and method of manufacture. The small, extra cost of the molded unit is more than justified by the superior protection of the unit from damage in assembly and operation—and the elimination of complicated mounting arrangements. The assemblies are compact (see table for dimensions). Complete data available on request; samples will be furnished for your evaluation.

Via C.A.C. Beechcraft, we are only hours away from you—we solicit the invitation to discuss your problems across your own desk

TOROIDAL INDUCTORS
Data For Standard Types

	Type	Normal Lmax.	Appr. Size O.D. x H	Useful Freq. Range	Qmax @ Freq.	T.C.	Iac-ma
*	206	3.0 Hy	.90x .40	Up to 15 KC	140 @ 9 KC	1	23
**	930	17.5 Hy	1.20x .60	Up to 15 KC	170 @ 7.5 KC	1	42
	254	35 Hy	1.85x .85	Up to 15 KC	220 @ 5 KC	1	67
	466	60 Hy	2.15x1.00	Up to 15 KC	260 @ 5 KC	3	95
*	848	1.4 Hy	.90x .40	10- 50 KC	170 @ 20 KC	1	33
**	395	8.0 Hy	1.20x .60	10- 50 KC	220 @ 20 KC	1	61
	381	17.0 Hy	1.55x .65	10- 50 KC	250 @ 17.5 KC	3	71
*	608	600 Mh	.90x .40	30- 75 KC	165 @ 60 KC	3	50
	579	7.5 Hy	1.55x .65	30- 75 KC	185 @ 30 KC	2	110
*	041	320 Mh	.90x .40	50-200 KC	115 @ 120 KC	3	68
	013	4.0 Hy	1.55x .65	50-200 KC	145 @ 70 KC	3	150

REMARKS

Qmax—Values taken at approx. .01 Iac. Q decreases with increasing current to about .50 Qmax at 1.0 Iac—higher inductance values have lower Qmax at lower frequency due to dielectric losses of winding distributed capacity. All values are for inductors wound with Heavy Formex wire.

T.C.—Temperature characteristics as follows:
1—approx. 100 ppm/°F
2— ± .1% 55 to 90°F
3— ± .1% 30 to 130°F
(most types with temp. characteristic 1 are available with characteristic 3 at no sacrifice in performance)

Iac—r.m.s. current which raises 0.1 Hy inductor to max. (2% above initial) inductance — (1% increase occurs at approx 0.35 Iac.

* FINISHED SIZE — 1-1/16" O. D. x 1/2" THICK
** FINISHED SIZE — 1-5/16" O. D. x 11/16" THICK

COMMUNICATION ACCESSORIES *Company*
HICKMAN MILLS, MISSOURI

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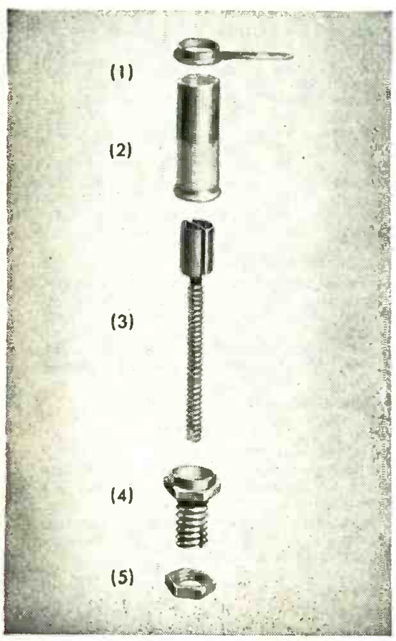
Shown approximately full size.

C.T.C.'s new CST-50 capacitor

with greatly increased range, greater stability



Exploded view of the CST-50 capacitor shows: (1) ring terminal with two soldering spaces; (2) metallized ceramic form; (3) spring-type S-shaped tuning sleeve*; (4) split mounting stud; (5) locking nut.

* Patent Applied For

Surpasses the range of capacitors many times larger in physical size.

The new CST-50 variable ceramic capacitor embodies a tunable* element of such unusual design it practically eliminates losses due to air dielectric. As a result, a large minimum to maximum capacity range (1.5 to 12 MMFD) is realized — despite the small physical size of the capacitor. This tunable* element is a spring-type, S-shaped tuning sleeve* which maintains constant maximum pressure against the inside wall of the ceramic form.

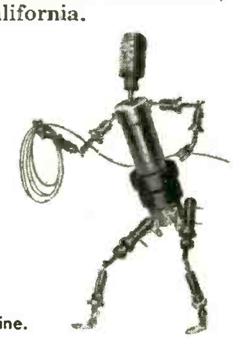
Other Design Features

The CST-50 stands only 19/32″ high when mounted, is less than ¼″ in diameter and has an 8-32 threaded mounting stud. The mounting stud is split so that the tuning sleeve* can be securely locked without causing an unwanted change in capacity. The tuning sleeve* is at ground potential. The CST-50 is provided with a ring terminal which has two soldering spaces.

All C.T.C. materials, methods and processes meet applicable government specifications. For further information on C.T.C. components and C.T.C.'s consulting service (available without extra charge) write us direct. Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles and 988 Market St., San Francisco, California.

CAMBRIDGE THERMIONIC CORPORATION

custom or standard . . . the guaranteed components



Write for Free Catalog #400 containing complete data on the entire CTC line.

A Major Achievement in Molded Capacitor Construction and Performance

New ASTRON **BLUE-POINT**† BONDED *Capacitors*

engineered and produced exclusively by ASTRON

†Trade Mark

TIGHT SEAL ... BONDED BLUE-POINT | **TOUGH SHELL** ... MOLDED PLASTIC TUBULAR

DEPEND ON — INSIST ON

ASTRON CORPORATION

PATENT PENDING

Now — Heat and Moisture PROTECTION To A Degree Never Before Possible!

Outstanding Performance in Hot and Humid Climates!

Here at last is a capacitor that affords *absolute protection* under every condition—a capacitor you can rely on completely—ASTRON BLUE-POINT, the *bonded* capacitor.

This capacitor is produced by an exclusive new design and manufacturing process (patent pending) developed by Astron engineers.

The all-important *blue point* which distinguishes this new capacitor actually *bonds* itself to the tough, heat-resistant outer shell and leads—forming the *tightest seal against moisture* ever produced!

The Blue-Point *dry-assembly* process—as used in hermetically sealed metal encased capacitors—prevents contamination, provides still further protection against moisture, and assures uniform *quality* and *dependability* for every Blue-Point.

The Blue-Point is mineral oil impregnated* for continuous operation at 85°C. The blue point seal itself makes ingenious use of a special thermo-setting, heat-resistant, non-inflammable *bonding agent* as a positive protection against moisture.

With the Astron Blue-Point, you may solder leads as close to the capacitor as you like. Leads will not pull out, nor will the heat of the soldering iron damage the lead or the connection.

Further, every Blue-Point is clearly marked with rated voltage and capacitance, and is imprinted with outside foil identification.

The Astron Blue-Point Capacitor gives you greater protection against heat and moisture at every stage—assuring long life and dependable performance from *every* unit—to a degree never before possible with molded plastic capacitors.

From now on, look for the Blue-Point—ask for exclusive Astron Blue-Point Capacitors by name . . . more than ever before, *depend on, insist on* . . . ASTRON!

***For bulletin AB-20A, with complete engineering data and listings, write: Astron Corporation, 255 Grant Avenue, East Newark, N. J.**

Astron manufactures a complete line of dry electrolytic capacitors, metallized paper capacitors, plastic molded capacitors, standard and subminiature paper capacitors and RF interference filters for every radio, television and electronic use.

Export Division: Rocke International Corp., 13 E. 40th St., N.Y.C. In Canada: Charles W. Pointon, 1926 Gerrard St., East, Toronto.

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mitchell-rand

electrical insulation headquarters

features

miraglas-A fiberglas tapes

for general purpose class A electrical insulation

COMPARED WITH COTTON OR RAYON FOR GENERAL PURPOSE CLASS A APPARATUS

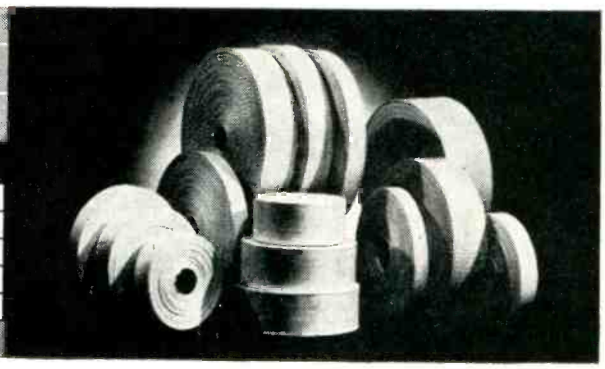
MIRAGLAS-A FIBERGLAS TAPES ARE MUCH MORE ECONOMICAL . . . being half as thick they cover more area . . . having twice the tensile strength they provide longer life and better performance . . . woven of long staple fiberglas yarn they withstand high temperatures and won't burn or rot . . . and MIRAGLAS-A FIBERGLAS TAPES are specially treated for machine or hand winding.

MITCHELL-RAND CAN MAKE IMMEDIATE DELIVERIES

Specify **MIRAGLAS-A FIBERGLAS TAPES FOR CLASS A INSULATION USE**

TYPE	CX	plain weave	THICKNESS	.004"	
Available Widths	½"	¾"	1"	1¼"	1½"
Approx. Yds./Lb.	280	224	168	134	100

		total ends	type yarn	nominal breaking strength
WARP	½"	26	150 1/0 waxed	65
	¾"	38	150 "	90
	1"	50	150 "	125
	1¼"	62	150 "	150
	1½"	74	150 "	180
FILLING	24 ends per inch—150 1/0 waxed yarn			



Write to MITCHELL-RAND for free samples and descriptive data.

MITCHELL-RAND mr Electrical Insulation Headquarters SINCE 1889

mitchell-rand INSULATION COMPANY, INC.

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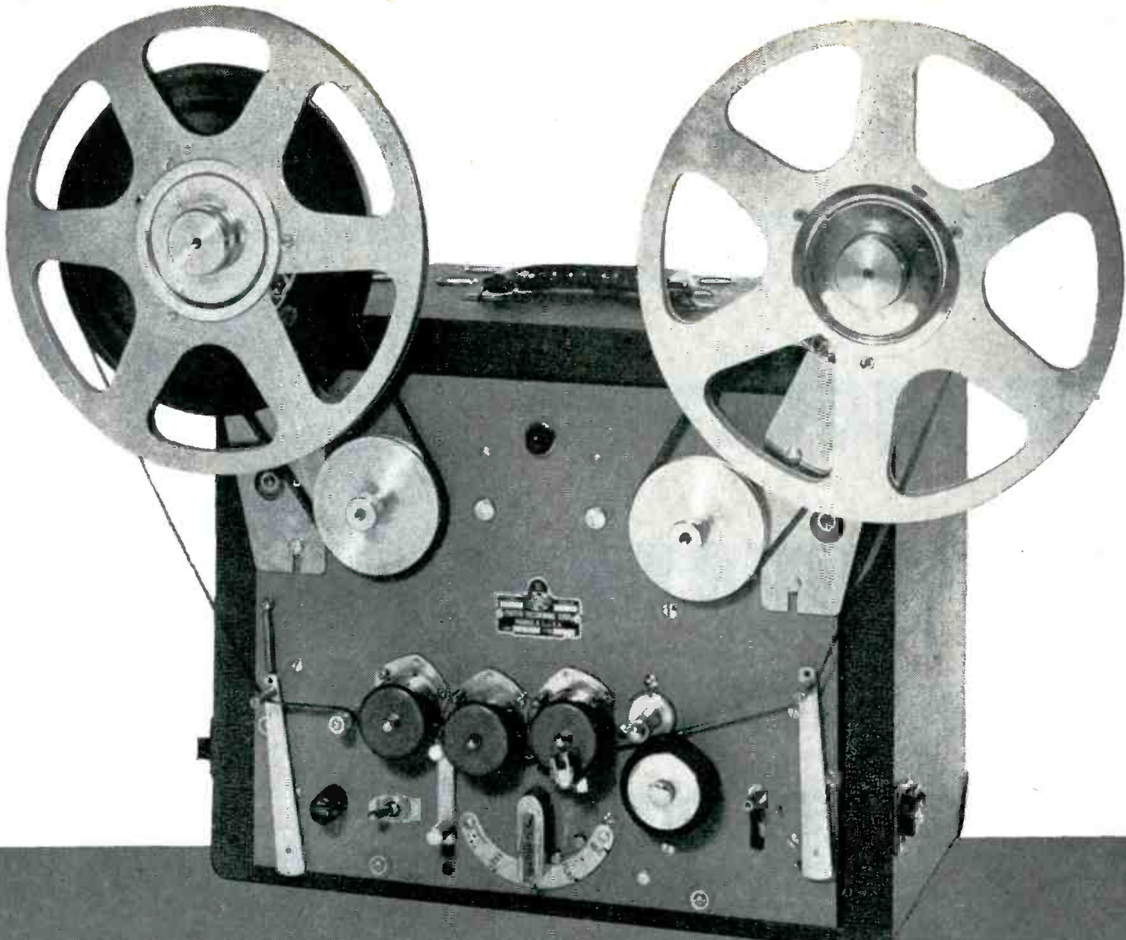
MIRAGLAS VARNISHED TAPES, CLOTHS AND SLEEVINGS • MIRAGLAS TAPES, BRAIDED SLEEVINGS AND TYING CORDS • MIRAGLAS SILICONE TREATED CLOTHS, TAPES AND TUBINGS • MICA TAPES, CLOTHS AND MICA-FIBERGLAS COMBINATIONS • FIBRE, PHENOL FIBRE AND MIRALITE POLYESTER RESIN SHEET INSULATING PAPERS—DURO, FISH, PRESSBOARD, ETC. • VARNISHED CAMBRIC TAPES, CLOTH AND SLOT INSULATIONS • COTTON TAPES AND SLEEVINGS • TWINES AND TIE TAPES • ASBESTOS TAPES, SLEEVINGS AND CLOTH, TRANSITE AND ASBESTOS EBONY • ARMATURE WEDGES AND BANDING WIRE • VARNISHED TUBINGS, HYGRADE, MIRAGLAS, HYGRADE VF, MIRAGLAS SILICONE • THERMOFLEX AND FLEXITE EXTRUDED PLASTIC TUBING • PERMACEL MASKING TAPES AND ELECTRICAL TAPES • BI-SEAL, BI-PRENE; FRICTION TAPES AND RUBBER SPLICE • COMPOUNDS—TRANSFORMER, CABLE FILLING, POTHEAD, ETC. • INSULATING VARNISHES OF ALL TYPES.

you don't buy one of these every day!



PRESTO RC-7 with RA-1 reel adapter

Compare these RC-7 features:

- Instantaneous speed accuracy
- Dynamic range better than 50db. at 3% distortion
- Three-motor drive
- No friction clutch or friction brakes
- Heavy duty construction throughout
- Separate-erase-recording-playback heads
- Twin speed: 7½"/sec. or 15"/sec.
- Frequency response to 15,000 cps.
- Reel size: to 10½" (with RA-1 adapter)

Purchase of a tape recorder is a major investment. And, with so many unproven brands on the market, it simply does not pay to select anything but a recognized, precision built and proven recorder.

The PRESTO RC-7 is just such a unit. Designed and manufactured by the world's foremost producer of precision recording equipment, the RC-7 with RA-1 reel adapter is today's No. 1 buy in fine tape recorders. Here is a unit that is fully portable for field recording, yet with the rugged construction and precision operation characteristic of the finest studio equipment.

If you're planning to replace an existing unit or add an additional tape recorder, your selection of a PRESTO RC-7 will pay long term dividends in faultless service, ease of operation and the genuine satisfaction of owning the best.

Do you own a Presto RC-7? The RA-1 adapter will allow you to use reels up to 10½" diameter. Write for full details and price.

PRESTO RECORDING CORPORATION

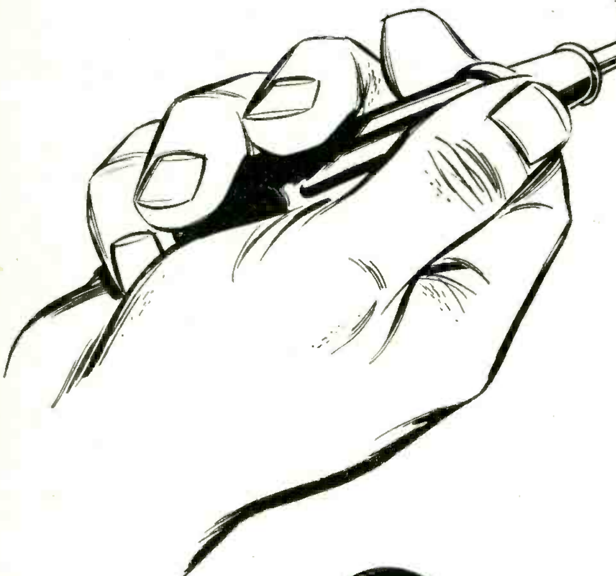
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

WESTON Ruggedized Instruments

have *EXCLUSIVE* zero correctors



No desirable instrument features were sacrificed in order to produce these truly ruggedized and effectively sealed instruments. With typical WESTON thoroughness, every feature has been retained including even the zero corrector. And *true* ruggedness has been achieved by new but thoroughly proved design concepts, such as shock-resistant spring backed jewels . . . flat windows of tough, anti-static, and glare reducing plastic . . . new high-strength tubular pointers, and a method of shock mounting and sealing that assures accurate indications under extremes of shock, vibration, temperatures, humidity, and downright abuse. Available in 2½″ and 3½″ D-C, R-F, A-C movable iron and rectifier types. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Connection terminals molded into internal rubber increase current carrying capacity.

Tough, flat plastic windows reduce glare and are *really* shock resistant.

WESTON *Instruments*

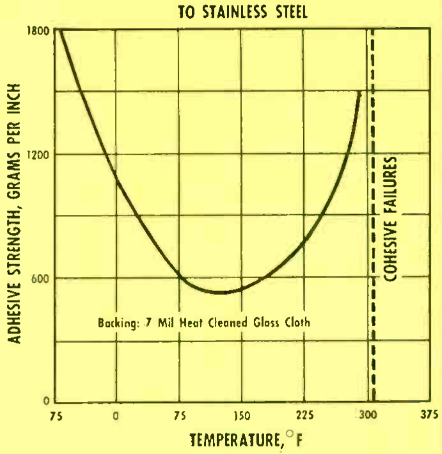
DOW CORNING **Silicone News**

Vol. I, Number 1 • PUBLISHED BY DOW CORNING CORPORATION, MIDLAND, MICHIGAN

New Pressure Sensitive Silicone Adhesives Stick To Most Surfaces; Retain Their Excellent Adhesive Strength From -55F To Over 250F

The newest products to come out of our development laboratories are pressure sensitive silicone adhesives that stick to almost any materials including silicones and Teflon. Adhesive strengths in the range of 1800 grams per inch at −55 F and over 1200 grams per inch at 265 F, are far superior to those of conventional pressure sensitive tapes. The adhesive strength between a stainless steel surface and glass tape coated with silicone adhesives is plotted against temperatures ranging from −75 to 285 F in this Figure.

ADHESIVE STRENGTH OF SILICONE ADHESIVES TO STAINLESS STEEL



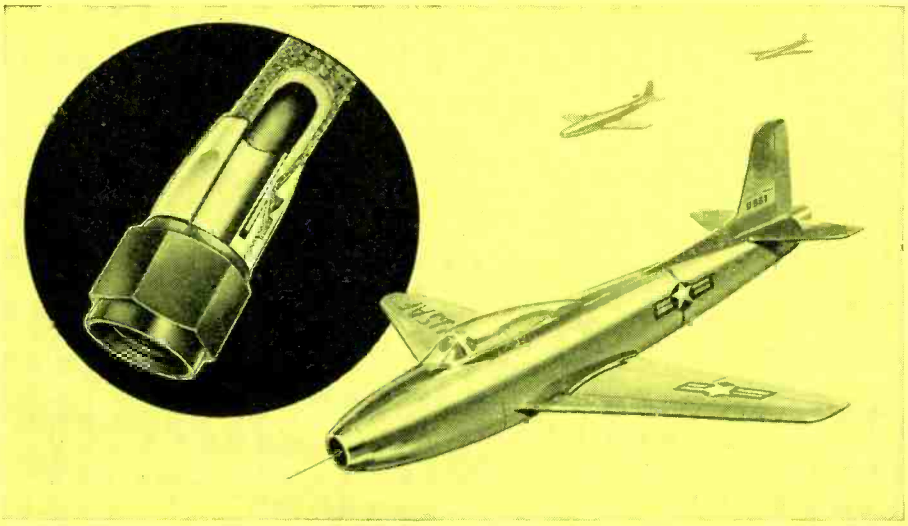
Uses for tapes coated with silicone adhesives include high temperature electrical and electronic applications; weather and moisture resistant wrapping and sealing tapes for low temperature applications. One electrical equipment manufacturer is already using these pressure sensitive adhesives to bond mica matt and integrated mica to glass cloth. *No. 1*

Silicone-based Aluminum Paints Outlast Organic Finishes 10 to 1 at Sterilizing Temperatures

Trays containing vials of aureomycin and other antibiotics at the Lederle Laboratories Division of American Cyanamid Company are loaded onto racks and sterilized for 3 hours at 446 F to destroy pyrogens.

The organic aluminum finish on these racks began to crack and peel, permitting rust to form, after 9 to 15

(*continued page 2*)



Flexible Silastic* Tubes Carry Air at 500 F; Prevent Engine Failure Due to Icing Over Jet Air Scoops

Reinforced with stainless steel braid, Silastic tubing requires minimum space; endures heat and high frequency vibration.

It was discovered shortly after certain jet engines were put into service that the formation of ice over air intake scoops could choke off the air supply and cause engine failure.

The obvious solution to this problem was to pipe air at 500 F from the compressor to the scoops. But that simple solution involved many problems.

The jet engines were so tightly fitted in their nacelles, that very little room was left for hot air ducts of any kind. High frequency vibration set up by the engine and plane introduced the problem of fatigue failure.

This was a job for a flexible tubing, a tubing that could carry hot air without melting, withstand the vibration and permit fast and easy assembly and disassembly. Engineers of the Aeroquip Corporation of Jackson, Michigan, solved the problem with flexible Silastic tubing. Reinforced with stainless steel braid, Silastic tubing is light and flexible. It is held mechanically to the stainless steel braid so tightly that the tube will not collapse even when subjected to a vacuum.

The high temperature problem of attaching a fitting to the hose was ingeniously solved by the new Aeroquip "Little Gem" fittings. The total assembly proved to be so effective that these anti-icing hoses have become standard equipment.

Despite internal and external temperatures as high as 500 F, the Silastic hoses are still in excellent condition after hundreds of hours of service. Aeroquip has supplied thousands of them to jet manufacturers. From 5 to 20 are required per engine, depending upon its design.

The usefulness of Silastic in this application confirms data collected by our development engineers on effects of accelerated aging at high temperatures on the properties of Silastic. Heat resistant organic rubber becomes brittle in a few hours; Silastic 80 does not crack on flexing over a ⅜ inch mandrel, and hardness increases only 9 points after more than 670 hours of continuous aging with all surfaces of the test sample exposed in an air circulating oven at 480 F.

Silastic 80 readily meets SAE-ASTM Specification TA805 which requires that it have a minimum tensile strength of 500 psi; a minimum ultimate elongation of 50 percent. After 70 hours aging in an air oven at 450 F, increase in hardness is not more than 15 points; drop in tensile strength is less than 25 percent and loss of ultimate elongation, less than 40 percent.

In oil resistance tests, decrease in hardness is less than 45 points; increase in volume, less than 60 percent after 70 hours immersion in ASTM No. 3 oil at 300 F. After 70 hours immersion in ASTM No. 1 oil at 300 F, loss in tensile strength and ultimate elongation is less than 20 percent; decrease in hardness,

(*continued page 2*)

*T. M. REG. U. S. PAT. OFF.

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING **SILICONE NEWS** PUBLISHED BY DOW CORNING CORPORATION

NEW DEVELOPMENT AND TECHNICAL DATA

For copies of any of the publications reviewed in this column or for data relating to any of the articles printed in this issue of the Dow Corning Silicone News, simply circle the corresponding reference number on the coupon below.

Expansible resins. Two new silicone resins, Dow Corning XR-543 and XR-544, can be expanded to produce heat-stable, non-flammable, unicellular foams with densities from 8 to 24 lbs per cubic foot. Highly resistant to thermal shock, these silicone foams show practically no structural or dimensional change after 20 hours at 700 F. Weight loss after 220 hours at 570 F is less than 2%; moisture absorption less than 0.05% after 7 days at 96% RH. Resins are easily foamed in place, made up as sandwich structures or machined with wood working tools. *No. 5*

•

Dow Corning 1109, a durable new silicone water repellent treatment for leather footwear, gloves, luggage and sporting goods; minimizes water absorption and transmission; improves resistance to oils and chemicals without changing the "breathing" characteristics of leather. *No. 6*

•

Now available, the new 1953-54 Reference Guide to Dow Corning Silicone Products summarizes properties and applications for commercially available silicones. A complete revision of previous guide which some designers have reported to be one of the most helpful catalogs ever produced. *No. 7*

•

Silastic 6-127 paste, an excellent cloth coating material and bonding agent for silicone rubber, retains good dielectric properties over a wide range of temperatures and frequencies. It has superior resistance to heat and moisture; remains flexible down to —100 F. *No. 8*

•

"Tall Tales and Fabulous Facts" is a new 24 page booklet built around the idea that, in our times, the tallest tales are told in technical terms. In this publication, the tall tales our ancestors told about such legendary characters as Paul Bunyan, Davy Crockett and Pecos Bill are related to some equally fabulous facts about Dow Corning silicone products. *No. 9*

•

Air drying silicone water repellent for application to glass, plastic and ceramic insulator bodies and to electronic parts and components maintains high surface resistivity under humid conditions; minimizes adhesion of dirt and chemical dust; reduces maintenance. *No. 10*

Small Electric Machines and Electronic Parts Can Now Be Designed to Operate at 180 C.

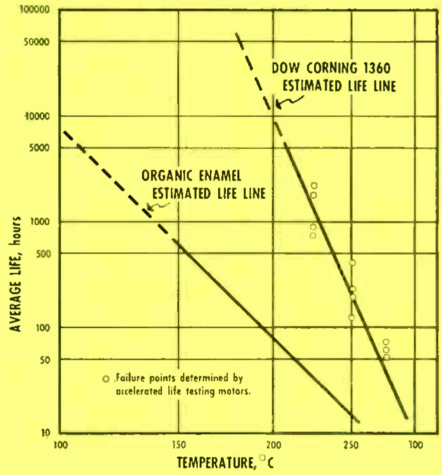
Life and reliability can be increased, or the size and weight of electronic devices and fractional or miniature motors can be reduced through the use of bare magnet wire insulated with Dow Corning 1360 Wire Enamel

Flexibility, scrape hardness and dielectric strength compare favorably with those of the best organic wire enamels. Dow Corning 1360 coated wire also shows superior resistance to a wide variety of solvents, oils and salt water.

The results to date of the accelerated life testing at temperatures in the range of 200 to 275 C of several electric motors wound according to standard commercial procedures with 1360 coated wire are plotted in the chart at right.

These data show that motors wound with magnet wire insulated with Dow Corning 1360 Wire Enamel have a life in the range of 1500 hours at 225 C (437 F), compared with 30 hours for identical motors wound with the best grade of Class A wire.

Based on the results to date of this motor test program, we expect that the



life of machines wound with 1360 coated wire at 180 C will be comparable to that of identical machines wound with conventional Class A wire at their maximum operating temperature of 105 C.

Extrapolating from the data plotted above, we find that the life expectancy at 180 C of magnet wire insulated with this new enamel is in the range of 50,000 hours compared with 200 hours for wire insulated with the best organic enamels. *No. 4*

SILASTIC *continued*

less than 15 points. It shows no shrinkage and swell is less than 20 percent.

After 168 hours immersion in water at 158 F, swell is less than 10 percent and decrease in hardness is less than 10 points. It does not become brittle on continuous exposure at —65 F.

Silastic 80 offers another advantage in that it can be blended with Silastic 50 to fabricate parts having any Shore hardness between 50 and 80. These stocks can be blended to fabricate parts that meet SAE-ASTM Specification TA604. Heat-stable pigments can be used to give these stocks almost any desired color.

In electrical applications such as wire covering and cable coating, Silastic 80 retains excellent dielectric properties over a wide range of temperatures and frequencies. Cable insulated with Silastic 80 has a dielectric strength of 450 volts/mil at 50 C; 430 volts/mil at 250 C. *No. 3*

PAINTS *continued*

hours of such service. That introduced a costly hazard because any bit of rust or paint chips in a tray could cause rejection of a whole rack of carefully prepared antibiotics.

Some time ago, the racks were sand blasted, sprayed with a silicone-based aluminum paint. So far, the silicone finished racks have endured 150 hours at sterilizing temperatures with no sign of deterioration. As a result of that experience, Lederle is now using silicone-based paint to refinish sterilizing equipment throughout their plant.

At temperatures in the range of 500 to 1000 F. silicone-based aluminum finishes are used to protect stacks, exhaust mufflers, dryers, and furnaces. Modified silicone enamels in a wide variety of colors are used to protect appliances such as stoves, space heaters and incinerators at temperatures in the range of 400 to 700 F. *No. 2*

DOW CORNING CORPORATION - Dept. BEI-10
Midland, Michigan

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First in Silicones

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Silicone Molding Compounds
Expansible Silicone Resins
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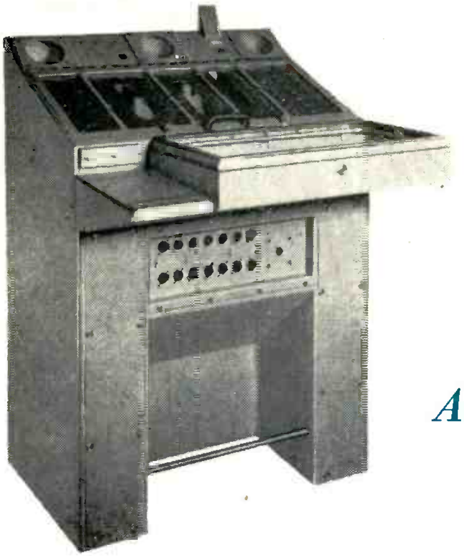
Silastic



SOME of our customers are equipped to do their own sub-assembly work; others find it more economical to have us do it.

Either way, we deliver the finest in sheet metal cabinets, chassis, housings and enclosures.

If we do your sub-assembly, all that's left for you to do is that which you and you alone must supervise—the wiring, assembly and testing of *your* equipment. The result: faster, cheaper, more efficient assembly.

Another Karp facility—sub-assembly:

the gathering place for extra enclosure-economies

And like our Assembly Department, the entire plant is dedicated to the principle of producing the finest sheet metal cabinets, chassis, housings and enclosures *at the lowest possible price.* How well we live up to the principle is easily proved: simply send us your blueprints. We'll promptly quote prices and delivery.

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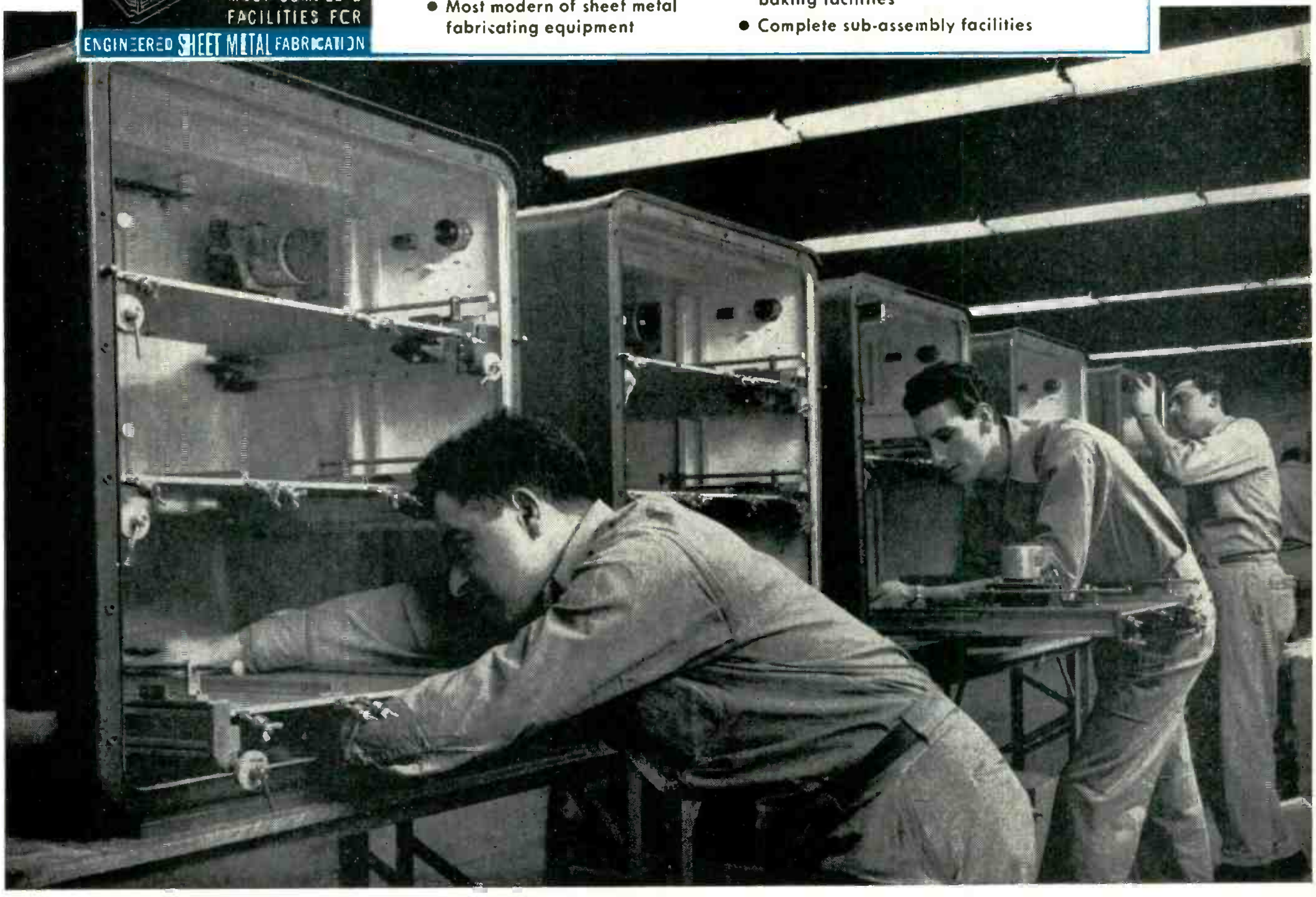

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Products of Pye scientific research cover ever-widening fields of application. Information gained through experiment on each project is constantly used to develop and improve all allied manufactures. Through advances thus achieved Pye lead the world in quality and design of radio, television and telecommunications equipment.

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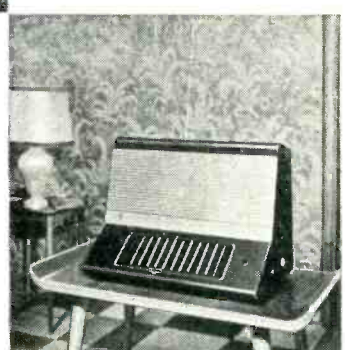
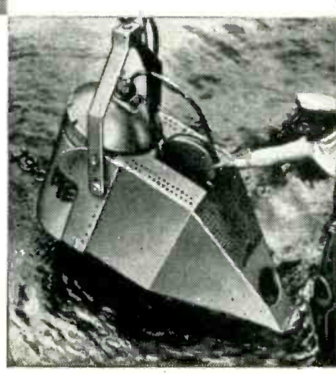


MULTI-WAVEBAND
RADIO RECEIVER



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when to use Hermetic's New Vac-tite* Compression Seals

and why...

The following styles of proven VAC-TITE compression seals are available:

1. Individual terminals and feed-throughs with a full range of hooked, flattened and pierced, turret and lug-type terminations for every application.
2. All-glass construction multi-terminal headers featuring larger leakage paths and an absence of moisture pockets.
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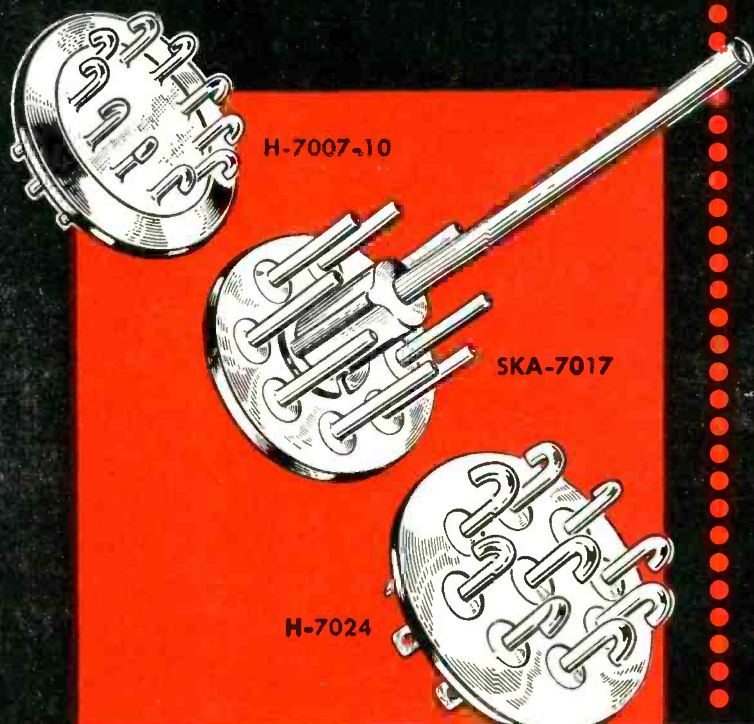
when vacuum tightness is a requisite, HERMETIC's proven compression seals are guaranteed to be vacuum tight, as evidenced by Mass Spectrometer Test.

when a RUGGED seal is required for application under adverse design conditions, the massive compression construction resists destructive deflection and permits direct mounting of components on the metal body.



Write for complete information on how HERMETIC engineers can apply "All-Glass" Compression Seals to your regular or special applications. Available, too, is HERMETIC's Brochure CS on Compression Seals, as well as a 32-page catalog on its standard line.

*VAC-TITE is HERMETIC's new vacuum proof compression-construction glass to metal seal.

SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO., 31 South Sixth Street, Newark 7, New Jersey

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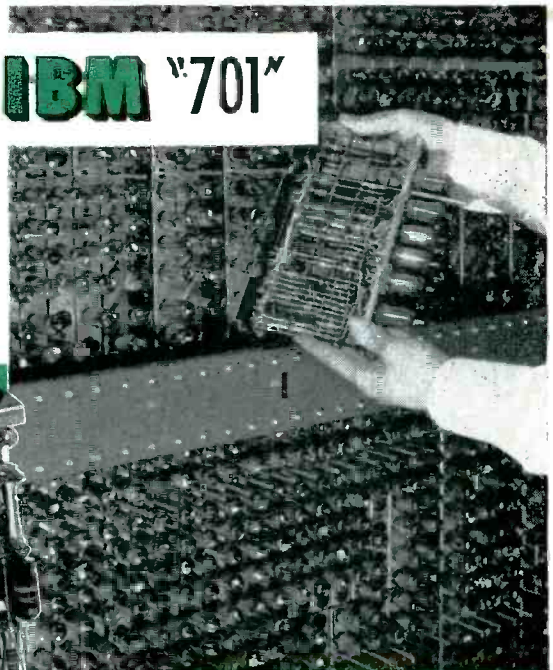
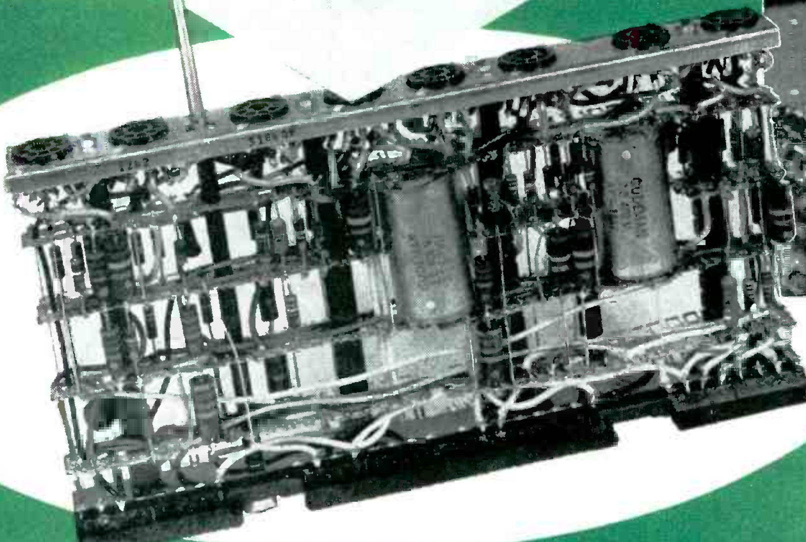
A "BRAIN CELL" for the IBM "701"

Electronic Calculator by

ERIE

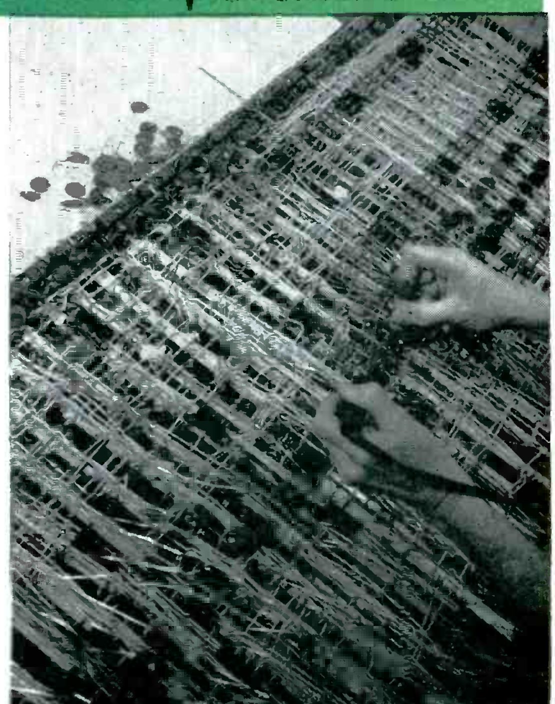




One of the units being installed in the Analytical Control Unit.

One of the 274 eight tube multiple pluggable units furnished completely wired and assembled by Erie for every "701".

All the disc capacitors shown in this maze of back panel wiring are Erie Ceramicons.



IBM's "701," designed to shatter the time barrier confronting technicians working on vital defense projects, is the latest development in electronic calculators. Its overall speed is 25 times that of its predecessor, the IBM Selective Sequence Electronic Calculator, popularly known as "the electronic brain." The "701," known as the IBM Electronic Data Processing Machines, consists of eleven compact and connected units. It performs in a few minutes calculations which would require seven years for a competent operator using desk model calculating machines.

The actual calculations are performed in the Electronic Analytical Control Unit. Erie assembles and wires 274 different eight tube multiple pluggable units similar to that shown above for every IBM "701." Erie also furnishes the four tube units used in the tape amplifiers. Erie Disc Filter Capacitors are used on inputs of all the DC service voltages supplied to the pluggable units, and all ceramic capacitors in the Power unit are Erie products.

For several years Erie has had in operation a department engaged exclusively in electronic subassemblies of this nature.

Write for further details.

25th Anniversary

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RESISTOR CORP.

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

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when PRECISION frequency control is VITAL . . .

NORTHERN RADIO *NEW*

VARIABLE MASTER OSCILLATOR

- **1 cycle per megacycle stability**
- **continuously variable to *any* frequency from 2 to 4 mc.**

In addition to accomplishing these new highs in stability with variability, Type 173 Model 1 is so easy to operate that it can be handled by completely unskilled personnel.

It is excellent as the basic control oscillator for diversity receivers, HF transmitters, and other communication devices, or as a laboratory standard. It also provides both a crystal-controlled BFO and a time base 100 kc crystal oscillator as a secondary standard; stability of the latter is 1 part in 5 million.

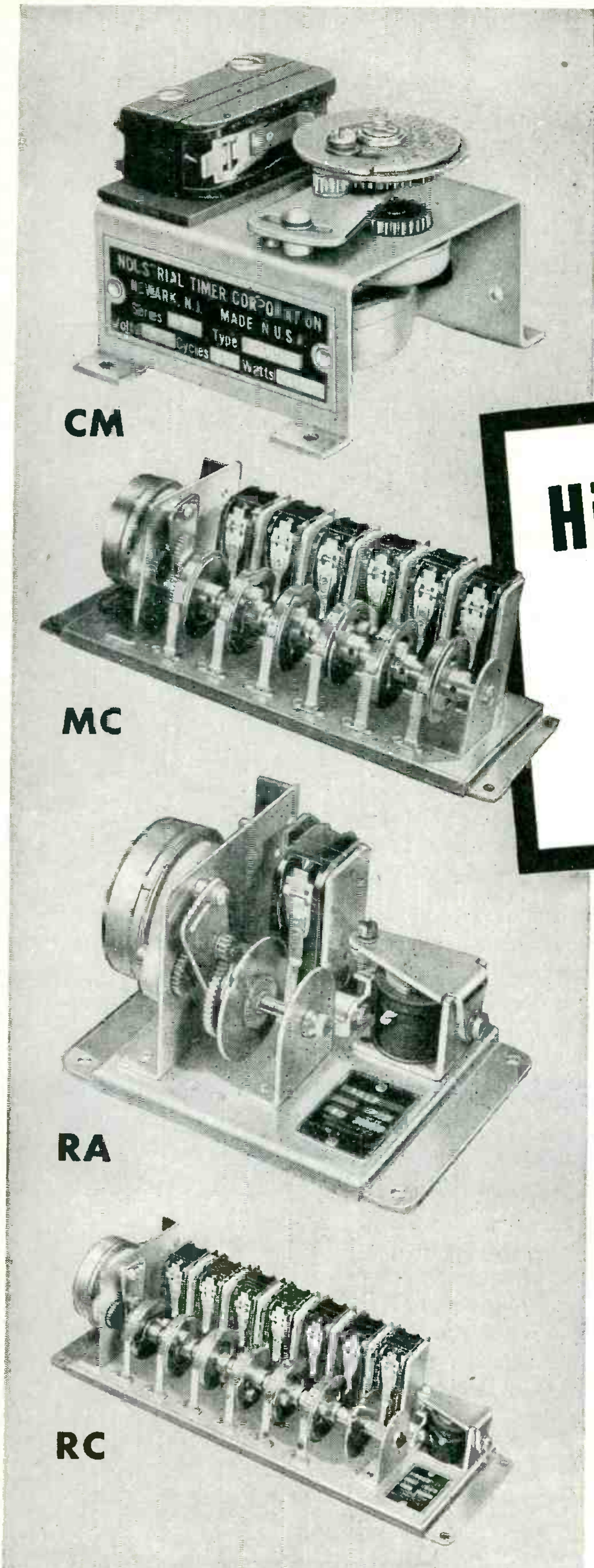
NORTHERN RADIO COMPANY, inc.
147 WEST 22nd ST., NEW YORK 11, NEW YORK
Pace-Setters in Quality Communication Equipment

Northern Radio has long *specialized* in the design and construction of Frequency Shift equipment of the types listed below. Their dependable performance for U. S. and Allied Commerce, Governments and Armed Forces all over the world has earned for Northern Radio a reputation for unquestioned leadership in communications engineering and precision manufacture.

- Frequency Shift Keyers
- Master Oscillators
- Diversity Receivers
- Frequency Shift Converters
- Multi-Channel Tone Systems
- Tone Keyers
- Demodulators
- Radio Multiplex Systems
- Monitors
- Tone Filters
- Line Amplifiers

Write for complete information.

Want more information? Use post card on last page.



These Industrial Timer Corporation timers provide accurate and highly dependable instruments for control of a single operation or multiple operations (simultaneously or in sequence).

OUTSTANDING FEATURES ARE:

(1) the wide range of over-all time cycles obtainable from any one model;

(2) the ease with which over-all time cycles can be changed;

(3) the simplicity with which individual cams can be adjusted for ON and OFF periods, and positioned in specific timing sequence.

Highly Dependable
Synchronous Motor Driven
Cam Timers

Series CM CAM RECYCLING TIMERS

The Series CM Cam Recycling Timer repeats a definite electrical ON and OFF time cycle continuously. The cam is coupled to the motor by means of a simple gear and rack assembly—and the over-all time cycle can be easily changed by substituting gear racks. (Bulletin 33)

Series MC MULTI-CAM TIMERS

The Series MC Timer is identical to the CM Timer, but operates 2 to 6 circuits. All cams are mounted on a single shaft, which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. (Bulletin 34)

Series RA SINGLE CYCLE CAM TIMERS

The Series RA Timer provides a single time cycle upon being actuated electrically from remote control. A pawl on the cam eliminates necessity for prolonged closing of relay switch when starting. (Bulletin 35)

Series RC SINGLE CYCLE MULTI-CAM TIMERS

The RC is identical to the RA, but operates from 1 to 6 additional circuits. Thus it provides all the features of the Series MC Timer, plus the single cycle control afforded by the RA. (Bulletin 35)

Send us specifications, and we shall make recommendations based on your particular needs. Bulletins sent free on request.

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY— Time Delay Timers • Manual Set Timers • Tandem Automatic Recycling Timers • Running Time Meters • Instantaneous Reset Timers

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INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
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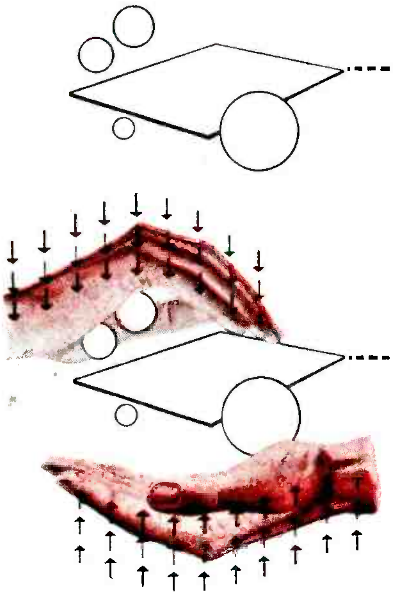
Selenium available today is remarkably free of unwanted impurities. Bradley controls it still further through an exclusive vacuum process. This laboratory control method, applied at Bradley on a production line basis, is further assurance of uniform quality and more stable rectifier performance. You pay no more for this extra quality — frequently, less.

Vacuum Processed Bradley Rectifiers

a <u>plus</u> in your circuit but not in your cost



Plates for Bradley rectifiers — from miniature types to large power stacks — have selenium applied under vacuum. Vacuum processing removes undesirable impurities and permits closely controlled modification of selenium with desired "impurities".

Vacuum processing also prevents entry of atmospheric impurities during the crystallization of selenium on the plate — a most critical period. Better crystallization results and this, in turn, means a better rectifier.

RECTIFIER STABILITY, longevity and uniformity are the sum of many things. One determining factor is the quality of the selenium crystalline structure. The better or more closely controlled this structure, the better the rectifier.

Bradley, through its unique vacuum process, uses the most advanced safeguards to assure excellent crystalline structure. It's one big reason why we can rate our rectifiers conservatively, why you can be sure of Bradley stability and long life under operating conditions. Vacuum processing is coupled at Bradley with engineer inspection at all points of production. This laboratory control saves time and materials, which are translated into low unit cost to you. For a plus in your circuit but not in your cost, specify Bradley rectifiers.

For further information or consultation, write or phone our sales engineering department. Special problems are welcomed.

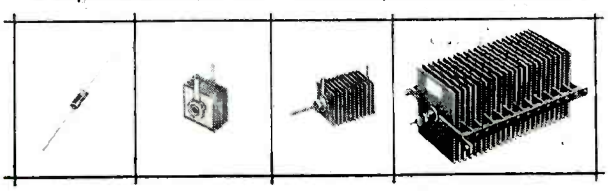
SELENIUM AND COPPER OXIDE RECTIFIERS

VACUUM PROCESSED for PERFORMANCE AS RATED

SELF-GENERATING PHOTOELECTRIC CELLS

Bradley
LABORATORIES, INC.

The complete selenium rectifier line — from microamperes to thousands of amperes



BRADLEY LABORATORIES, INC., 168E Columbus Avenue, New Haven 11, Conn.

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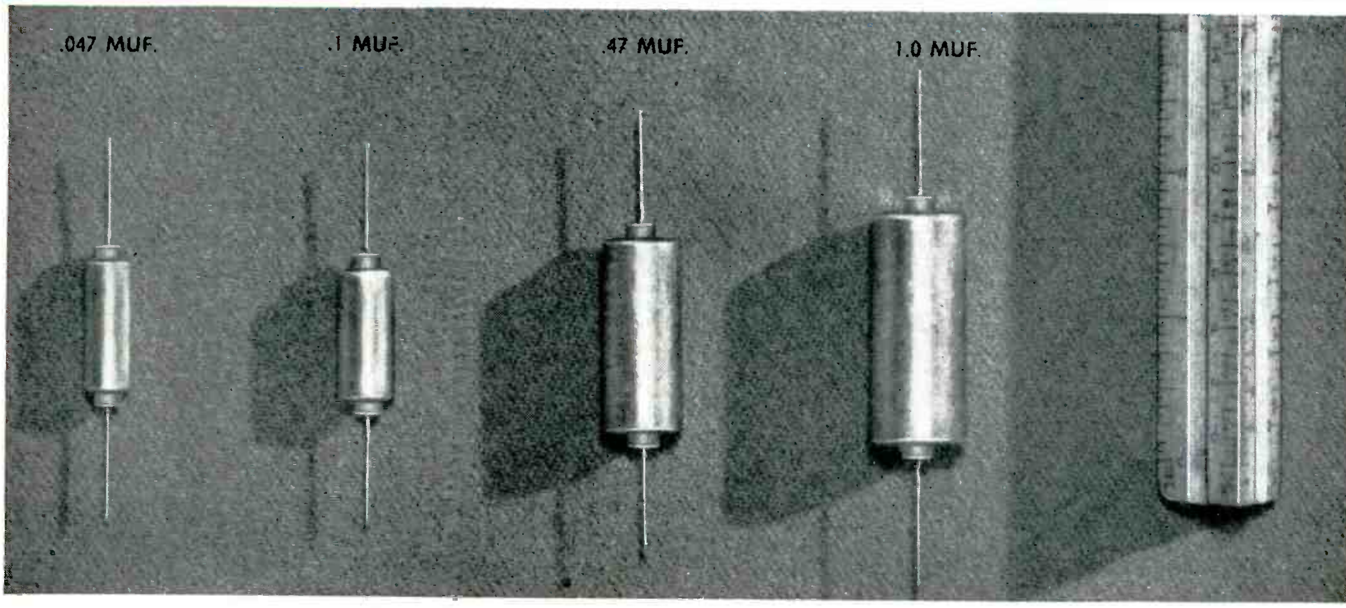
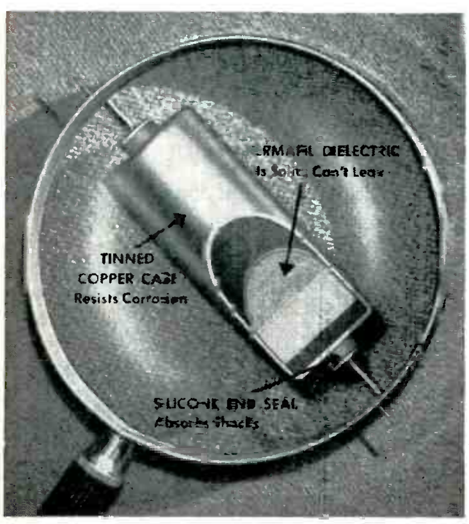
DESIGNER'S



New metal-clad subminiature capacitors withstand extreme temperatures



RUGGEDLY CONSTRUCTED G-E subminiature metal-clad capacitors meet all requirements of JAN-C-25 and the proposed MIL-C-25.

Permafil solid dielectric permits operation up to 125C without derating

Here's a complete new line of General Electric metal-clad subminiature capacitors designed to meet difficult operating conditions. Now you need no increase in capacitor size for applications with high working temperatures.

G.E.'s exclusive permafil solid dielectric eliminates the possibility of leakage without derating from −55C to +125C—and up to +150C with proper derating. Silicone bushings give high shock resistance—both thermal and physical—and leads can be soldered right up to the bushing.

Muf ratings range from .001 to 1.0 muf in 100, 200, 400 and 600 volts d-c working. They can be operated at full voltage up to altitudes of 50,000 feet.

If you need even smaller capacitors, G.E. has introduced another line of new Pyranol* (liquid-filled) metal-clad capacitors. These are designed for operation from −55C to +85C without derating and offer the same electrical advantages as their permafil cousins. For further information on permafil capacitors, send for new Bulletin GEC-987.

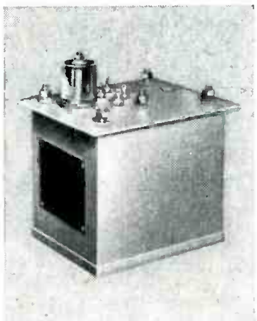
GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

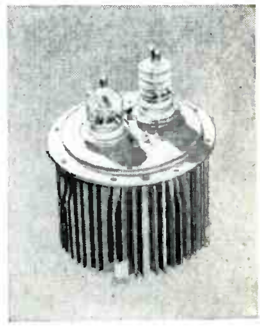
Compact high-voltage components built for extra long service life

These G-E high-voltage components offer a continuous-service life for long periods under extreme temperatures and mechanical shocks. All are oil-filled and hermetically sealed to resist moisture, dirt and dust. For applications 5000 volts and higher, where corona must be held to a minimum, a wide range of ratings can be tailored to meet your needs. In your inquiry, please include all functional requirements, any physical limitations, and expected quantities. Contact your G-E Apparatus Sales representative for more information.

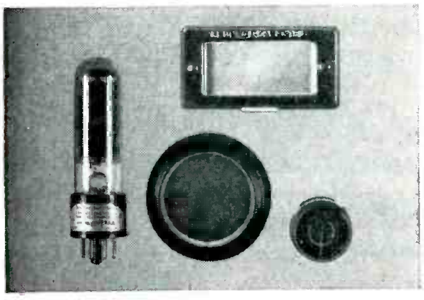


Rectifiers

Reactors



Transformers

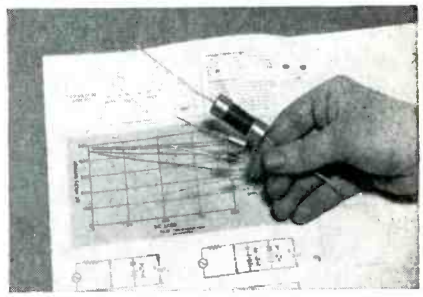


Detects, measures light accurately

G-E photovoltaic cells—for applications where electronic amplifiers are not practical—provide extra-high output with stability and long life in capturing light energy and converting it into electrical energy. This self-generating power plant can detect, measure, and control light—and can measure variations in colors. These G-E cells are available in a hermetically sealed series with standard mountings, and in a wide variety of mounted and unmounted sizes. See Bulletin GEC-690.

Speeds solution to field problems

The G-E analog field plotter offers a valuable aid to electronics equipment engineers in simplifying complex field studies. Problems in electrostatics, electromagnetics, and many other fields are rapidly solved with this sensitive, versatile plotting board and associated equipment. It needs only a low-voltage d-c supply, and is not affected by line-voltage variations. Explanation and instructions are covered in a 50-page manual accompanying plotter. For details, see Bulletin GEC-851.



Cover wide temperature range

From −55C through +100C—that's the wide range covered by these new G-E miniature selenium rectifiers. Stacks—available for either lead or bracket mounting—have the same outstanding features as larger G-E selenium cells: long life, good regulation, high reverse resistance, and low heat rise. For protection, they are enclosed in either Textolite* tubes, or hermetically sealed in metal-clad casings. For more data, contact your G-E Apparatus Sales representative.

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- Insulation testers
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Please send me the following bulletins:

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X for immediate project

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- ☐ **GEC-851 Analog Field Plotter**
- ☐ **GEC-987 Permafil Capacitors**

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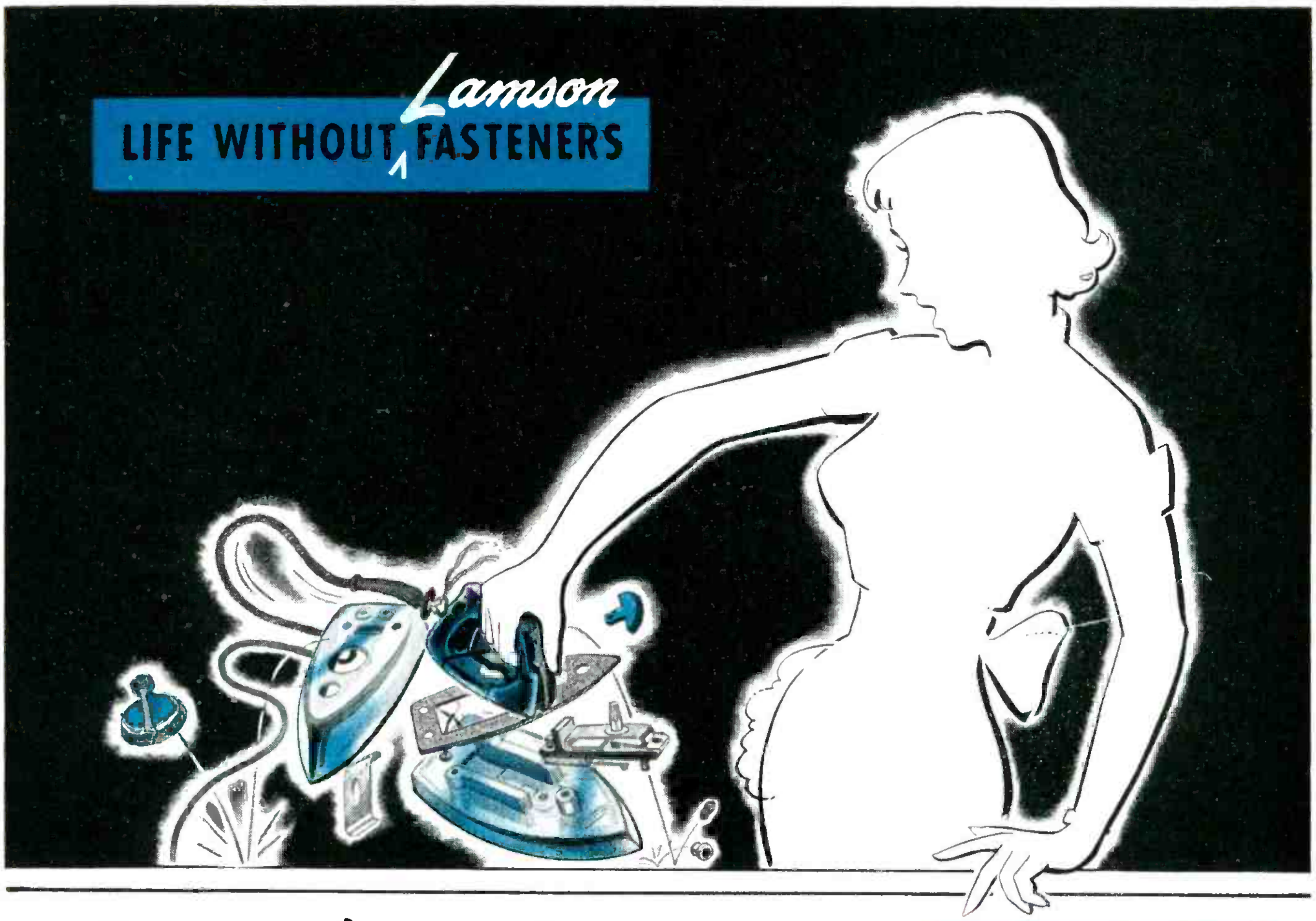

"Scrap" Iron!

This lady has "pressing problems". She's all set to iron but suddenly the fasteners that hold her gleaming new iron together have disappeared. Without them, her beautiful iron is just scrap.

This is graphic proof that the "unseen workmen"— the fasteners that hold your products together ARE important. Without them there *is* no product.

So take a tip from Lamson and pay attention to the bolts, nuts and screws that go into your product. Chances are there are many opportunities for you to save time and money on the assembly line by using more efficient, or less expensive fasteners.

Lamson & Sessions will be happy to help you ferret out these opportunities for saving money on fasteners. Just call on us . . . *anytime.*

PHILLIPS HEAD SCREWS

Self-aligning and straight-driving features assure you of fast, economical assembly.

Their neat, modern appearance in the finished product show the potential customer the careful attention to detail spent on the product. Sales often "hinge" on just such attention.

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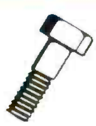
MACHINE SCREWS
Precision made for fast, economical assembly.

PLUG NUTS
Ideal for blind or hard-to-reach places.

TAPPING SCREWS
Choice of round, pan, truss, flat oval, hexagon and Phillips heads.



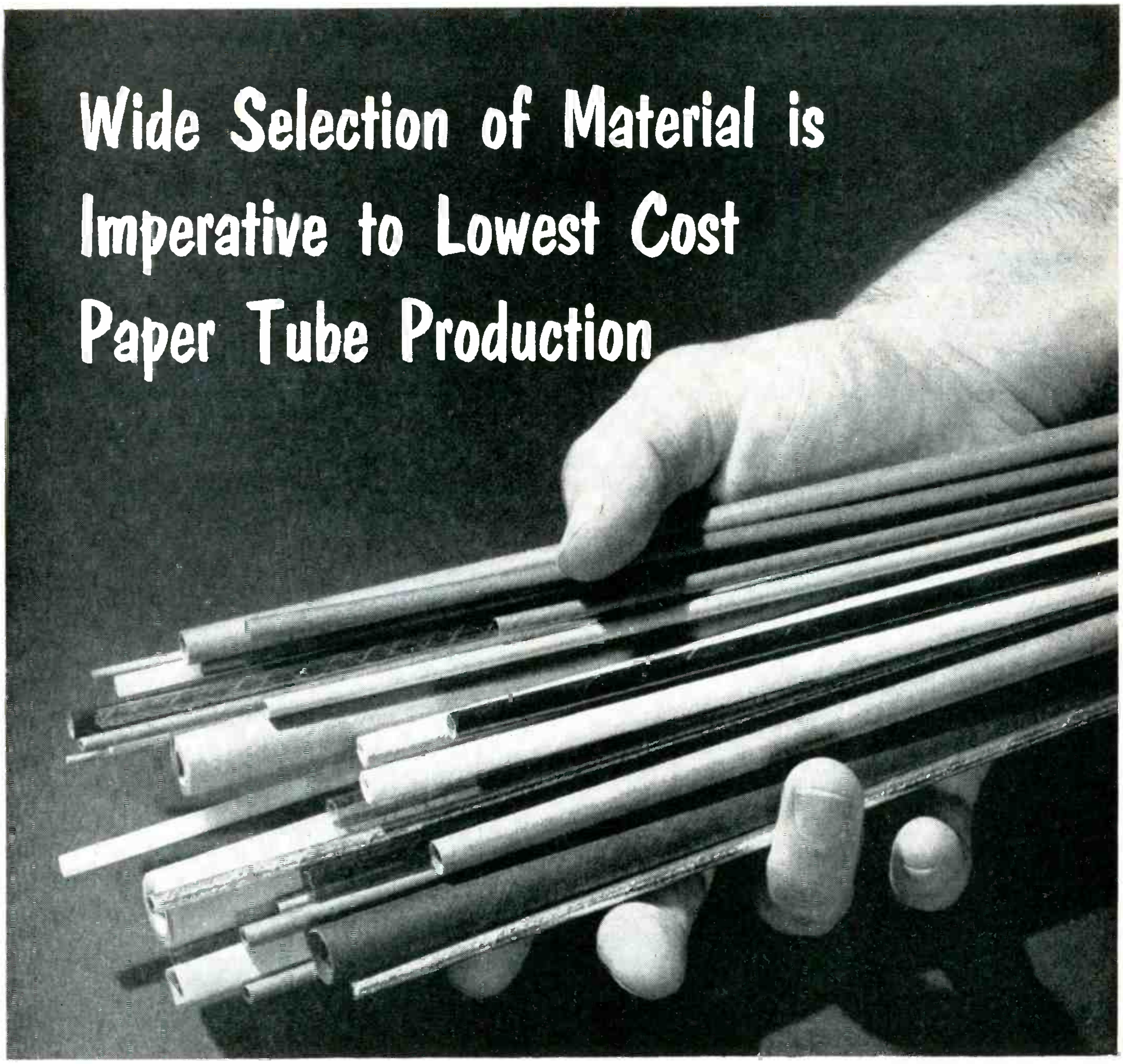
CAP SCREWS
"1035" Hi-Tensile Heat-treated steel.

SQUARE AND HEX MACHINE SCREW NUTS
Also semi-finished, hot pressed and cold punched nuts.

LOCK NUTS
Economical, vibration proof. Can be used repeatedly.

COTTER PINS
Steel, brass, aluminum and stainless steel.

"1035" SET SCREWS
Cup point type, hardened and heat-treated.



Actual size photograph unretouched

Stone has more than 200 kinds, grades and thicknesses of materials available for the production of your small diameter paper tubes.

This wide selection means that Stone spiral wound paper tubes have a flexibility of application not found in other more standardized materials. Naturally, this results in the lowest possible cost to you.

Included in this extensive selection of more than 200 stocked by Stone for immediate production are numerous grades of hi-dielectric kraft, fish paper, absorbent papers, asbestos, and plastic films such as acetates and polystyrenes.

Stone's well known precision production methods guarantee that these materials will meet your most rigid specifications. Call or write us today for prompt attention.

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MEPCO PRECISION RESISTORS

MIL-R-93A NEW SEALED TYPES

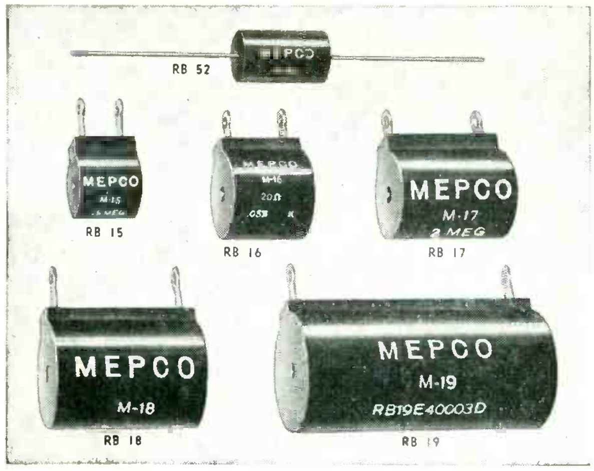
Over 2 years of laboratory development and testing were required to achieve a sealed resistor design up to Mepco's standard of quality. No sacrifice of our standard time-proven features has been made in order to perfect this sealed resistor.

Completely hermetically sealed, these resistors provide perfect protection against immersion and high humidity.

All requirements of MIL-R-93A and JAN-R-93 are exceeded.

The operating temperature is —65°C to +125°C. Temperature coefficients of ±.003%/°C to ±.017%/°C depending upon your requirements. (Refer to MIL-R-93A).

Other sizes available on special order.



MIL-R-93A JAN-R-93 STANDARD TYPES

Our standard time proven JAN, MIL and Commercial lug terminal resistor.

Manufactured and 100% tested in accordance with the applicable specifications, these resistors are used by every major electronic equipment manufacturer in the country.

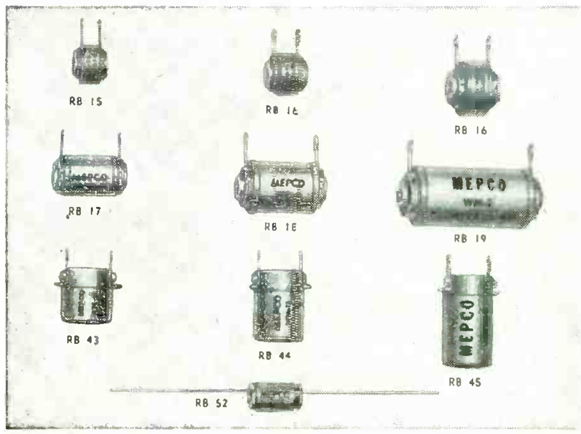
Reversed and balanced PI-windings for low inductance, with use of only the finest resistance alloys.

Impregnated with approval fungus, moisture and salt waterproofing compounds.

JAN approved non-hydroscopic steatite bobbin, specially treated prior to winding in order to provide additional protection for fine enameled wire.

Protective fungi resistant acetate label.

Rigid hot solder coated brass terminals for easier soldering.



WIRE TERMINAL TYPES

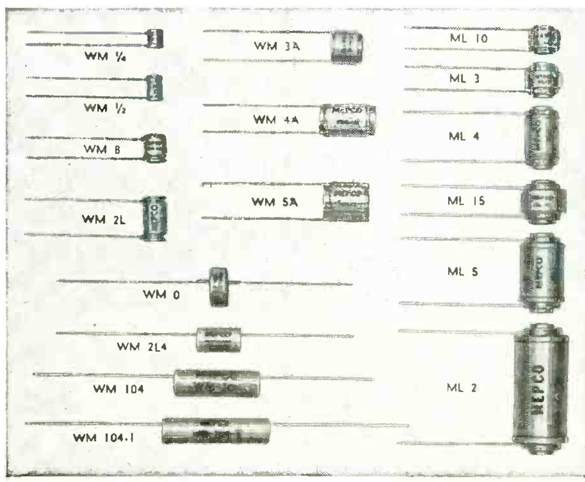
Designed for direct connection into circuit without use of additional leads.

These resistors are of the same basic construction and materials as standard JAN and MIL types therefore providing equal dependability and long life.

Low Temperature Coefficient alloys provide ±.003%/°C from —65°C to +125°C unless otherwise specified by your requirements.

Resistance tolerances range from ±1% down to ±.02%. Sets of matched resistors can be supplied ±.005% or lower.

Special types not shown can be manufactured to your exact specifications.



JAN-R-29 METER MULTIPLIERS

Surpass all requirements of JAN-R-29

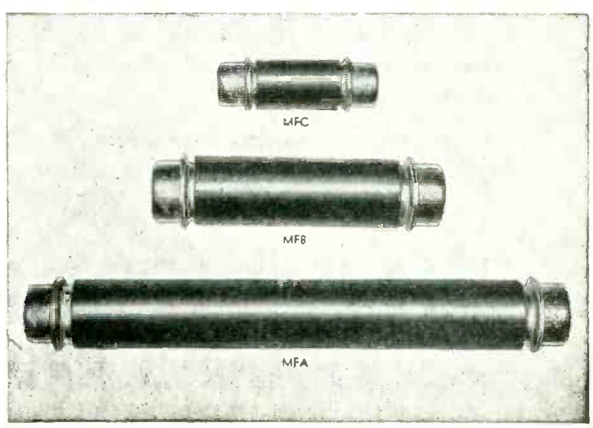
HERMETICALLY SEALED: Insures dependable operation under most severe moisture conditions.

STEATITE PROTECTIVE CASING: Glazed surface prevents high voltage leakage.

WINDINGS: "Certified" low temperature coefficient resistance alloys properly "aged" to provide long term stability.

REPLACEABLE INTERNAL SECTIONS: Eliminate complete loss of unit if damaged.

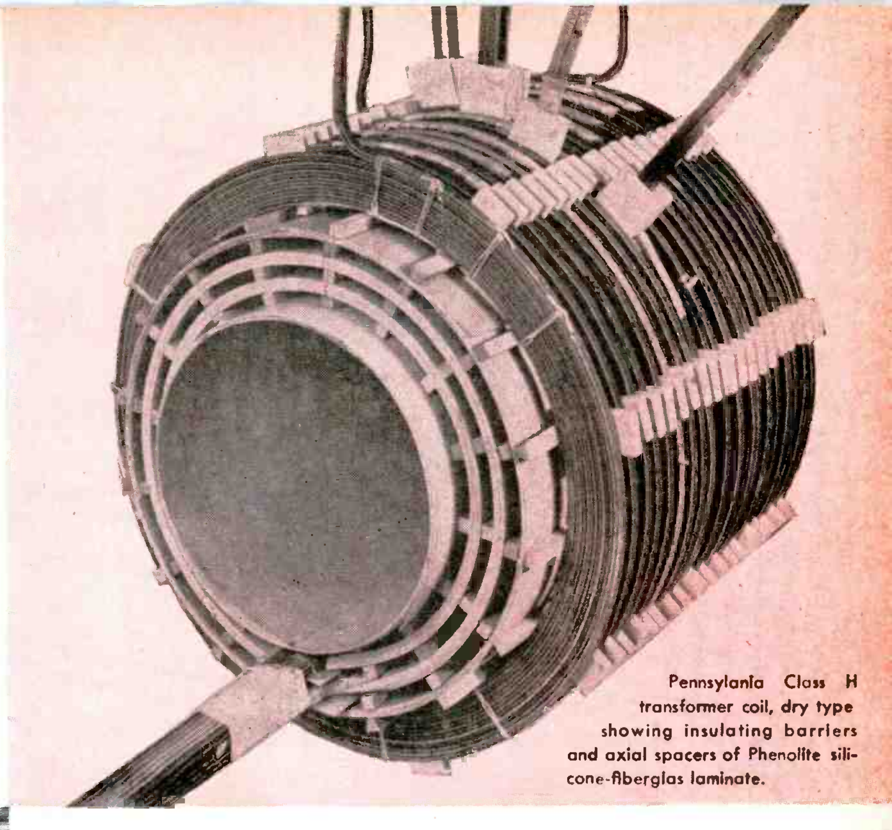
FERRULE TERMINALS: Heavy nickel plated brass. Corrosive resistant. Fit standard fuse clips.



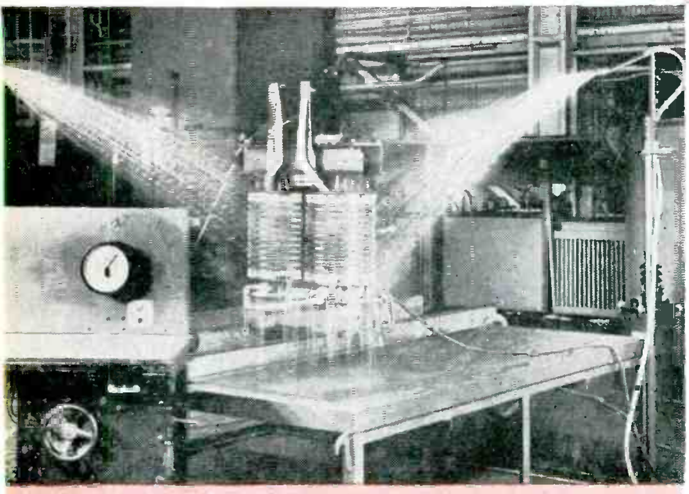
MEPCO, INC. MORRISTOWN, N. J.

class h insulation by National Vulcanized Fibre Co.

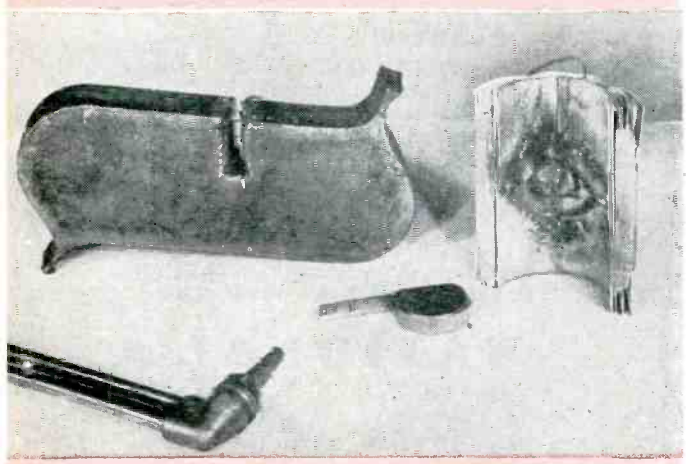
used by Pennsylvania Transformer Co. to build new, safe, and reliable Sealed Dry Type Transformers



Pennsylania Class H transformer coil, dry type showing insulating barriers and axial spacers of Phenolite silicone-fiberglas laminate.



Transformer core and coil assembly under full voltage excitation withstands heavy water shower. The insulation resistance remained at infinity megohms during the entire two-hour water test.



Class H insulation resists fire and combustion. The heat of the 5000° F. Oxygen-Acetylene torch, applied for the same interval, burned through the 2-inch steel plate, yet merely melted some of the glass fabric in the barrier.

Using Class H insulation (Phenolite silicone-fiberglas laminate), the Pennsylvania Transformer Company (a McGraw Electric Co. Division) builds Sealed Dry Type Transformers having many superior and safe operation features. The Class H Insulation eliminates the hazards of fire and explosion, permits up to 50 per cent weight reduction, makes possible efficient operation in humid atmosphere, reduces maintenance, allows operation at high temperatures, and permits frequent overloads. The coil barriers are made from 1/32 inch silicone sheets bonded with silicone rubber. The sheets are rolled directly onto the lathe during the coil winding operation, saving the high cost of a mandrel. Ideal for station auxiliary, unit substation and network service, these Sealed Dry Type Transformers are an outstanding example of National cooperative engineering and research. Perhaps you have an insulating problem where National Vulcanized Fibre Company can give you real help in solving your particular problem . . . economically. Write us—our engineering service is immediately available.

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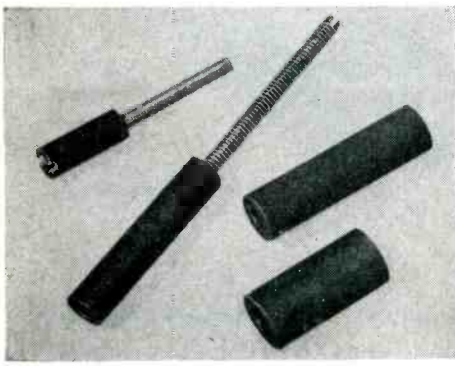
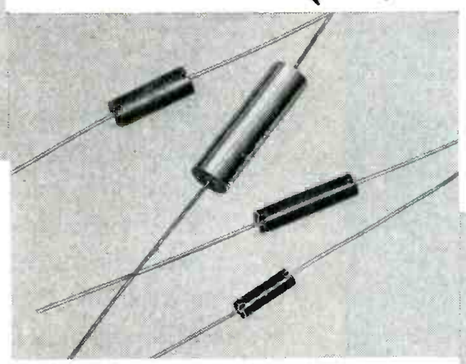
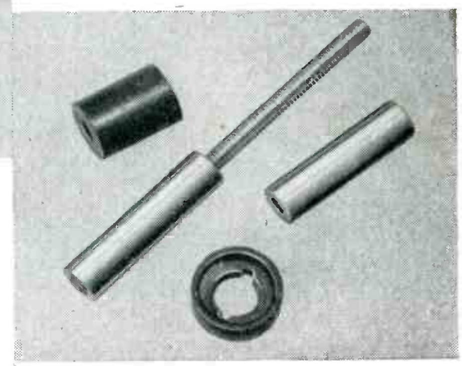


FERRICORES



MOLDED COIL FORMS



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Through years of continued engineering and research
Moldite has produced cores of guaranteed dependability,
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Specify a Moldite core specially designed
and precision made for you,
with absolute uniformity from first to last.

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for design, pre-production, and test purposes

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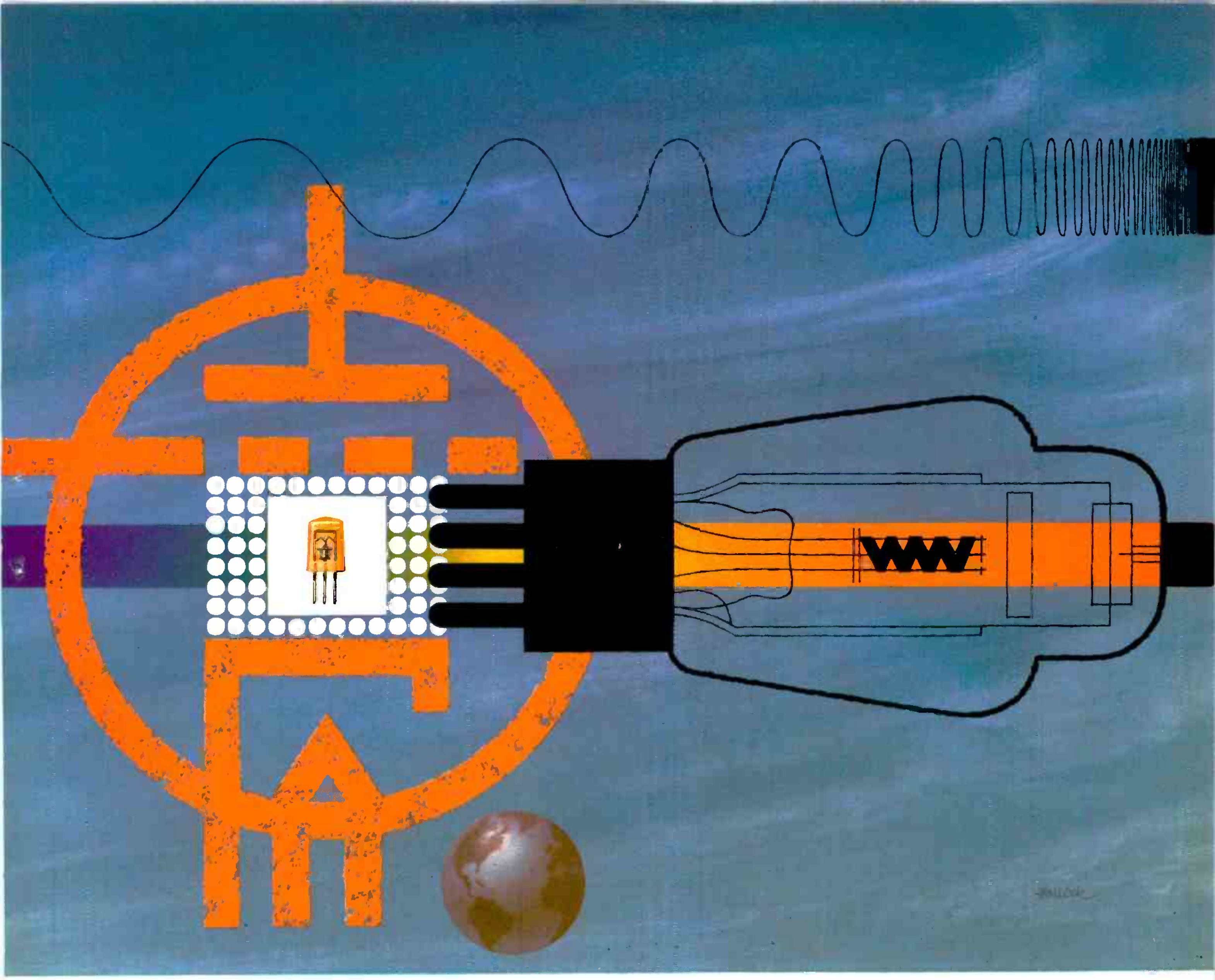

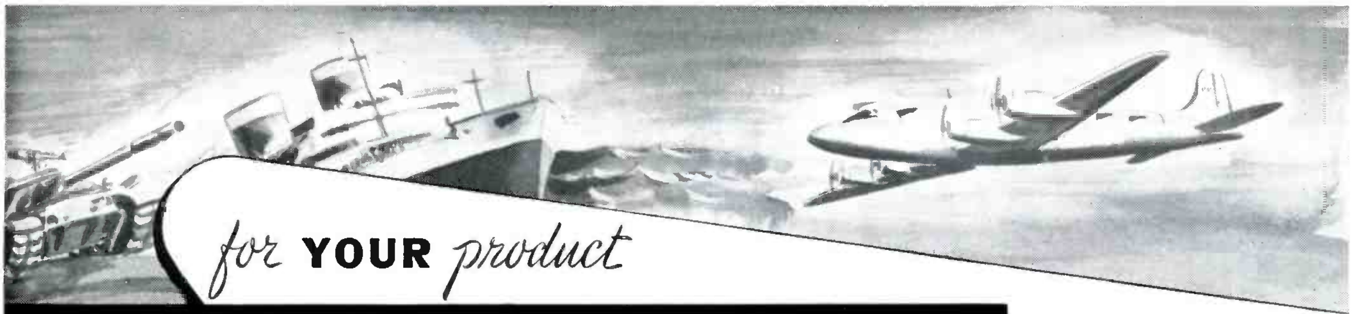

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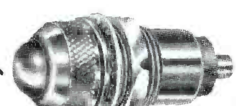
This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

or

this LITTLE one



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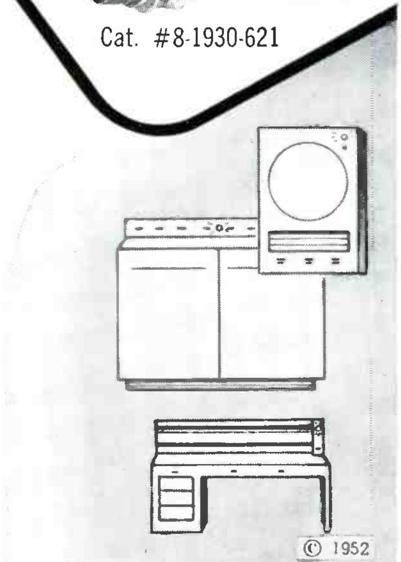
The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

Samples to suit your own special conditions and requirements will be sent promptly and *without cost*. Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.



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*4 WAYS to help speed defense production

You'll find SHAKEPROOF fastenings at many vital connection points on modern military equipment . . . from tanks to walkie-talkies. Those shown here, and hundreds of others, are used by the millions by leading manufacturers because they save assembly time and assure dependable performance. Whether your plant is engaged in military or civilian production—or both—Shakeproof engineers are at your service to help your staff develop fast, economical and acceptable solutions to specific assembly problems. Call them in today.

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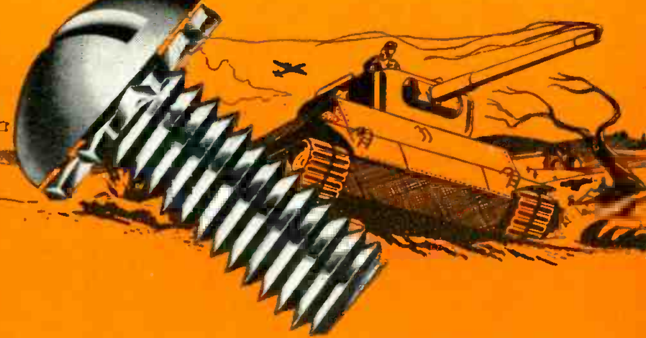
Samples of the Shakeproof products illustrated here are available on request. Make your own tests and see how you can save. Write today . . . specify the samples you want by name.



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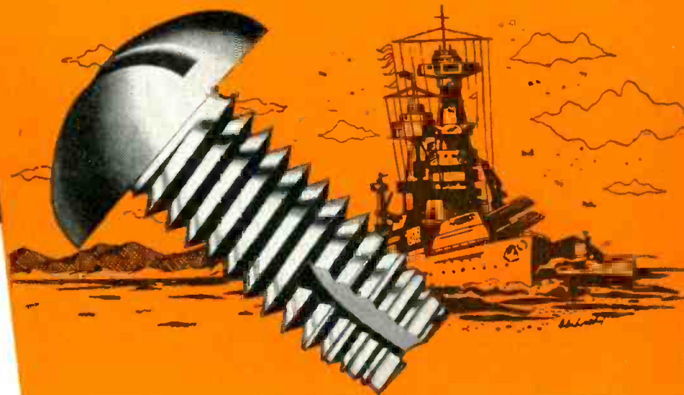
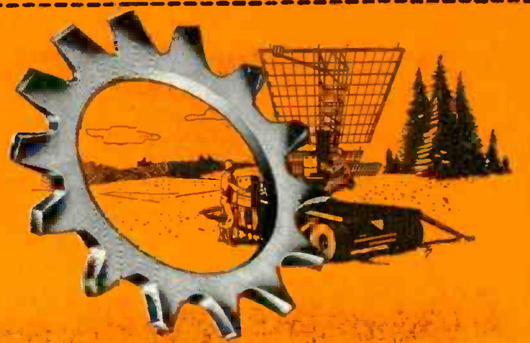
. . . pre-assembled screws and SHAKEPROOF Lock Washers eliminate separate washer handling, save assembly time.



*** SHAKEPROOF® THREAD-CUTTING SCREWS**

. . . cut their own threads in metal or plastic, positively eliminate costly tapping operations.



*** SHAKEPROOF® LOCK WASHERS**

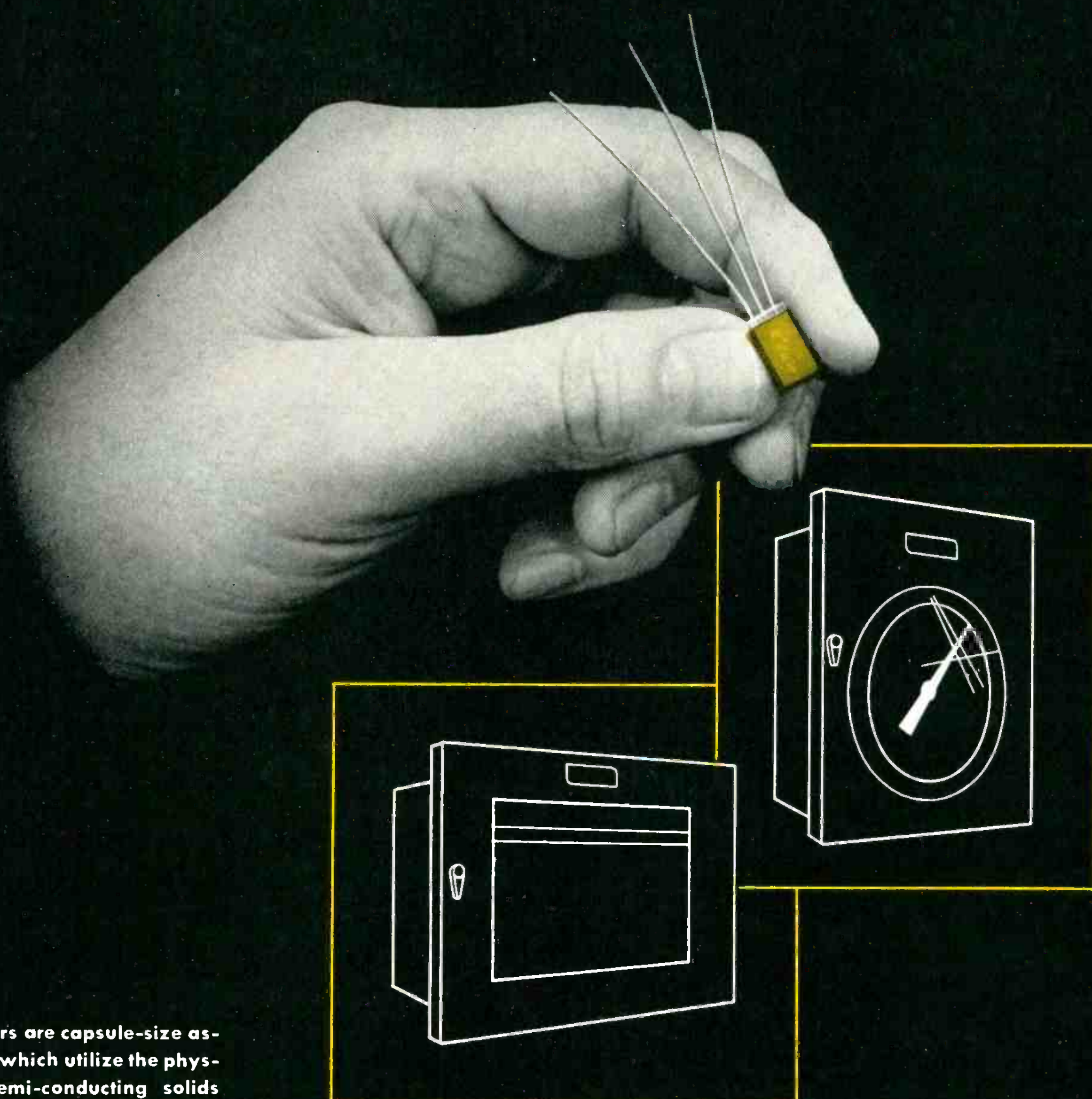
. . . hold vital connections tight, reduce equipment failures due to loose fastenings.

*** KEPS®**

. . . speed assembly operations because nut and lock washer are pre-assembled . . . every nut is locked against vibration loosening.

Transistors*

in instrumentation...



*Transistors are capsule-size assemblies which utilize the physics of semi-conducting solids to produce the same effects as an electronic tube . . . but without cathode and/or filament and their circuitry components.

"O.K. But what's your price for performance?"

Here's a purchasing agent buying resistors on a price basis. But doing it the *right* way.

Some day we may even be able to quote resistor prices in terms of performance—so many cents per thousand hours of trouble-free operation. Then we'll be able to tell you exactly how much *less* Ward Leonard resistors really cost than the so-called "bargain" resistors now on the market.

But until then, remember, it's *performance* you pay for when you're buying resistors. There's a lot more than just a few cents difference in the performance you'll get from the two resistors above.

The one made by Ward Leonard will perform at its rated value for the life of the product it goes into. There's a chance the so-called "bargain" resistor will too. But you can't afford to take *any* chances on your product's failure—even once out of a hundred times. Not when you consider the actual cost of such failure, figured in terms of returned merchandise, replacement cost, customer and dealer dissatisfaction.

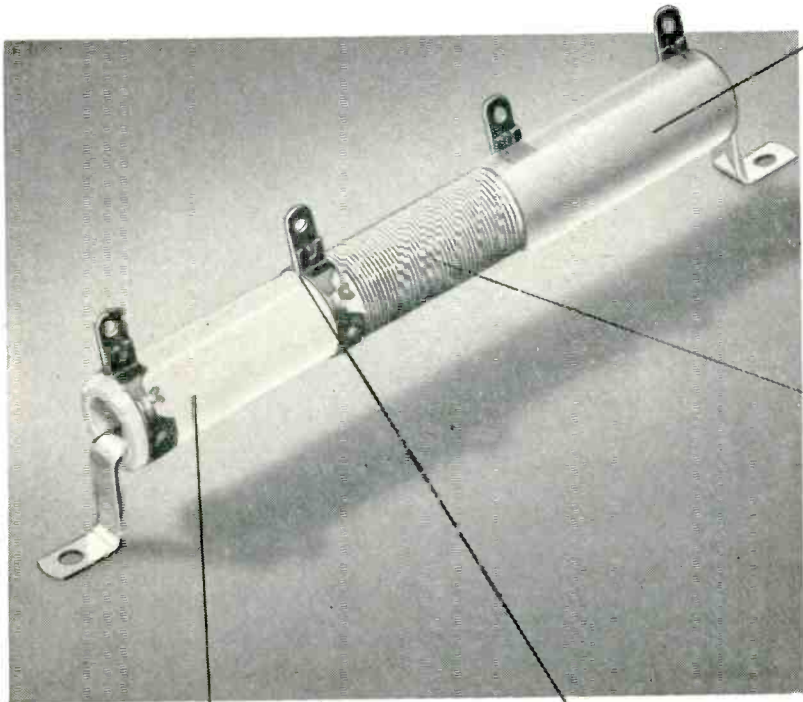
That's why, even on a price basis, the accuracy, dependability and uniformity of Ward Leonard resistors make them far better buys than any of the questionable bargains you'll find on the market. Send for *new* Resistor Catalog No. 15. Ward Leonard Electric Co., 31 South Street, Mount Vernon, N. Y.

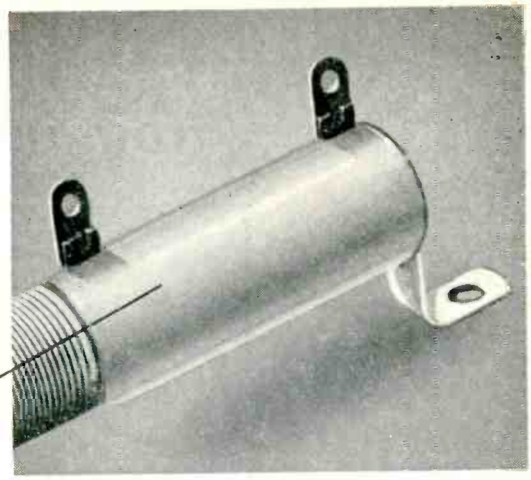
3•18

WARD LEONARD

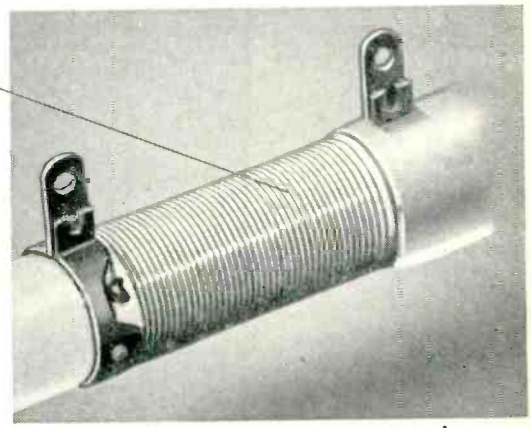
WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK
Result-Engineered Controls Since 1892

This check list shows you how to get the most for your money in terms of resistor performance

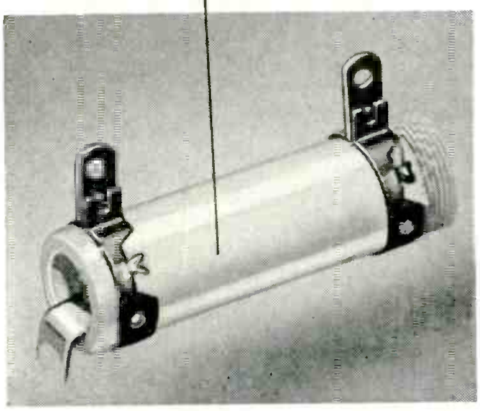




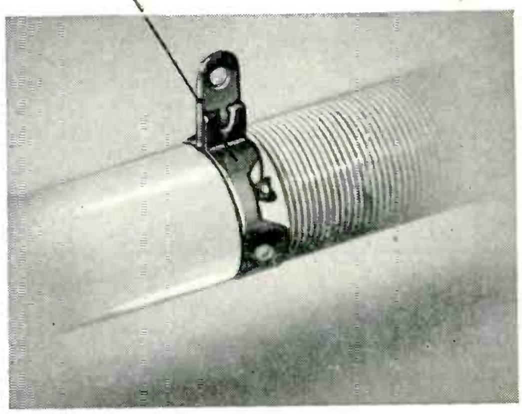
COATING. Vitrohm enamel coating of all Ward Leonard resistors provides a complete hermetic seal highly resistant to shock, high humidity, extreme temperatures, acids, alkalies, and electrolysis. Unlike most resistor manufacturers, we manufacture our own vitreous enamel.



RESISTANCE WIRE. The resistance wire is drawn to Ward Leonard's own specifications for each particular resistor type. It is capable of withstanding heavy overloads, has a uniformly low coefficient of resistivity. Many of the "bargain" resistors are wound with resistance wire of ordinary grade.



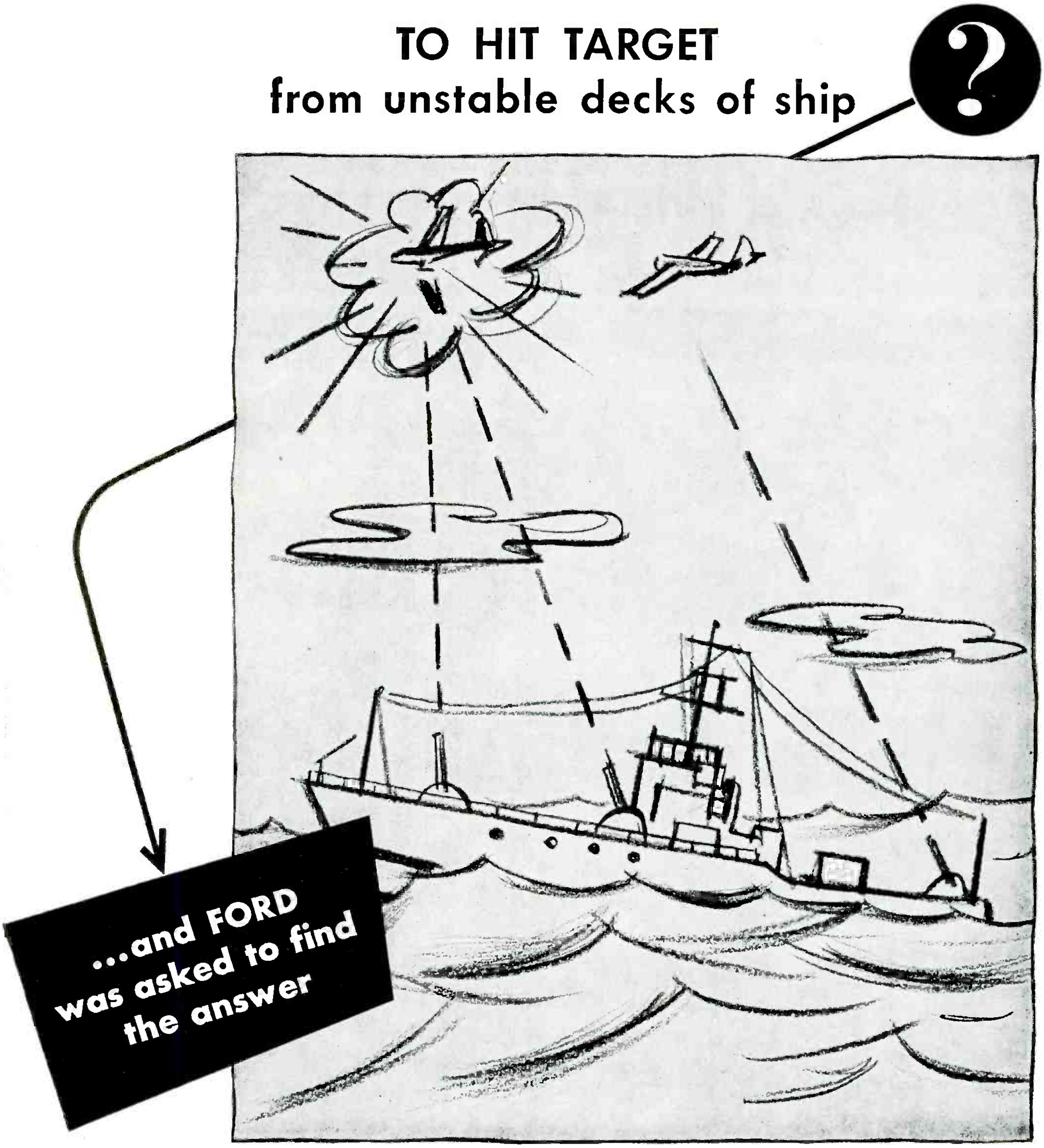
RESISTOR CORE. Ward Leonard's own manufactured cores upon which the resistance elements are wound consist of a perfectly cylindrical ceramic body of high density, low porosity, and high dielectric strength, with a thermal coefficient of expansion correlated to the expansion of the enamel.



TERMINALS. In Ward Leonard resistors, special alloy terminals insure proper expansion and adherence to the enamel, are designed to provide strong anchorage. Every wire-to-terminal junction is joined mechanically first, then specially silver-brazed for lasting contact.

Want more information? Use post card on last page.

TO HIT TARGET from unstable decks of ship



A rolling, pitching ship... under attack from speedy, diving aircraft... counts on its anti-aircraft guns for protection... these guns must be able to stay on the target regardless of sea conditions. That's why the Ford Instrument Company was called on to design and build a control system that tracks and holds the target range with deadly accuracy.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

4

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

31-10 Thomson Avenue, Long Island City 1, N. Y.

TAYLOR ***Bone Grade Vulcanized Fibre***

is an extremely tough and dense grade of vulcanized fibre. It is excellent for applications where difficult machining operations are required . . . resistant to organic solvents, oils and gasoline . . . has excellent electrical characteristics.

Want to make something of it?

Make it into gears, cams, fairleads, bushings and grommets, slot wedges, threaded and tapped pieces, rail joint insulation and other applications where mechanical strength, good finish and intricate machining are required. Color: gray.

Make it from sheets or rolls with these specifications:

SPECIFICATIONS

Thickness range	1/32″ to 1/2″
Finish	Pressed and calendered
Punching	Up to 3/16″ thickness
Sheet size	Approx. 56″ x 90″
Roll width	56″ for thicknesses of 1/32″ through .060″. Coils down to 7/32″ for thicknesses of 1/32″ through .090″.

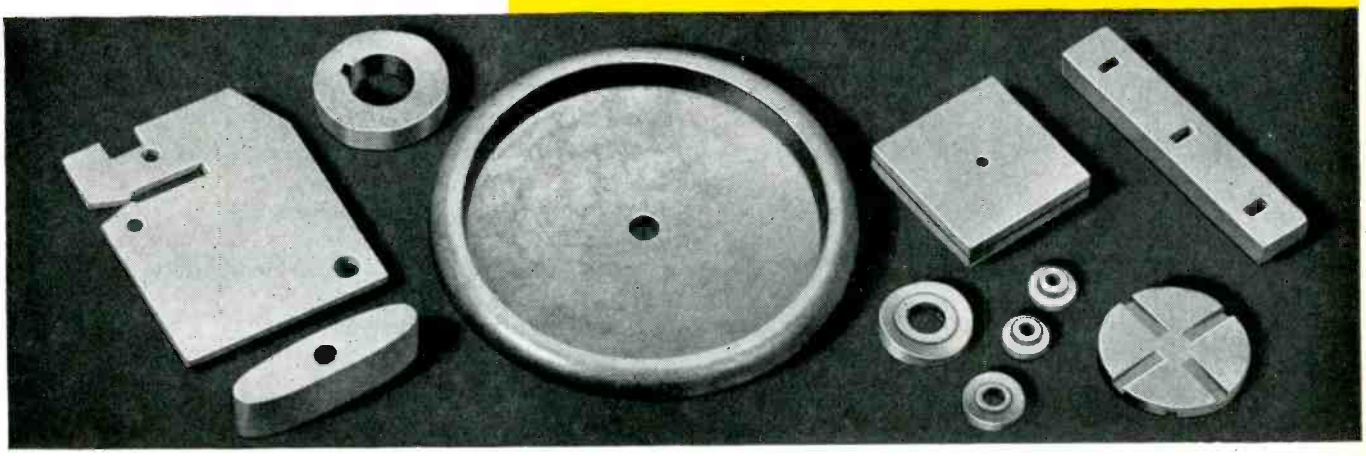
PROPERTIES

Mechanical

Flexural Strength, psi	(Lengthwise)	14000 min.
	(Crosswise)	12000 min.
Tensile Strength, psi	(Lengthwise)	7500 min.
	(Crosswise)	5500 min.
Compressive Strength, psi	(Flatwise)	30000 min.
Izod Impact Strength, Ft.-Lbs./inch	(Lengthwise)	3.0
	(Crosswise)	2.4

Electrical

Dielectric Strength, VPM	(1/32″)	250 min.
	Short Time Test (1/8″)	175 min.
Arc Resistance, seconds		100



Make it from turned rods. Diameters from 1/8″ through 1/2″ with ground or buffed finish.

Make it easy for yourself the next time you are looking for an extremely dense, abrasion resistant material. Call your Taylor Engineer . . . he will be glad to work with you . . . go over your requirements . . . and help you select the correct grade of Taylor Vulcanized Fibre to fit your needs—Bone, Commercial, Super White, Abrasive and Built Up. Ask him about Taylor Laminated Plastics, too. He will be glad to give you samples of *Phenol, Melamine and Silicone Laminates* for your inspection.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
Vulcanized Fibre

Want more information? Use post card on last page.

Uniformity

We have used every type of GA & F Carbonyl Iron Powder thus far produced. The overall quality and batch-to-batch uniformity of your products have always been gratifying to us. Because of this product dependability, we feel that incoming inspection of your powders is unnecessary.

Richard D. Poneman

President

Pyroferric Company, Inc.
621 East 216th Street
New York 67, N. Y.

GA&F® CARBONYL IRON POWDERS

Want more information? Use post card on last page.

Here's how to plot a plane's Angle-of-Climb...

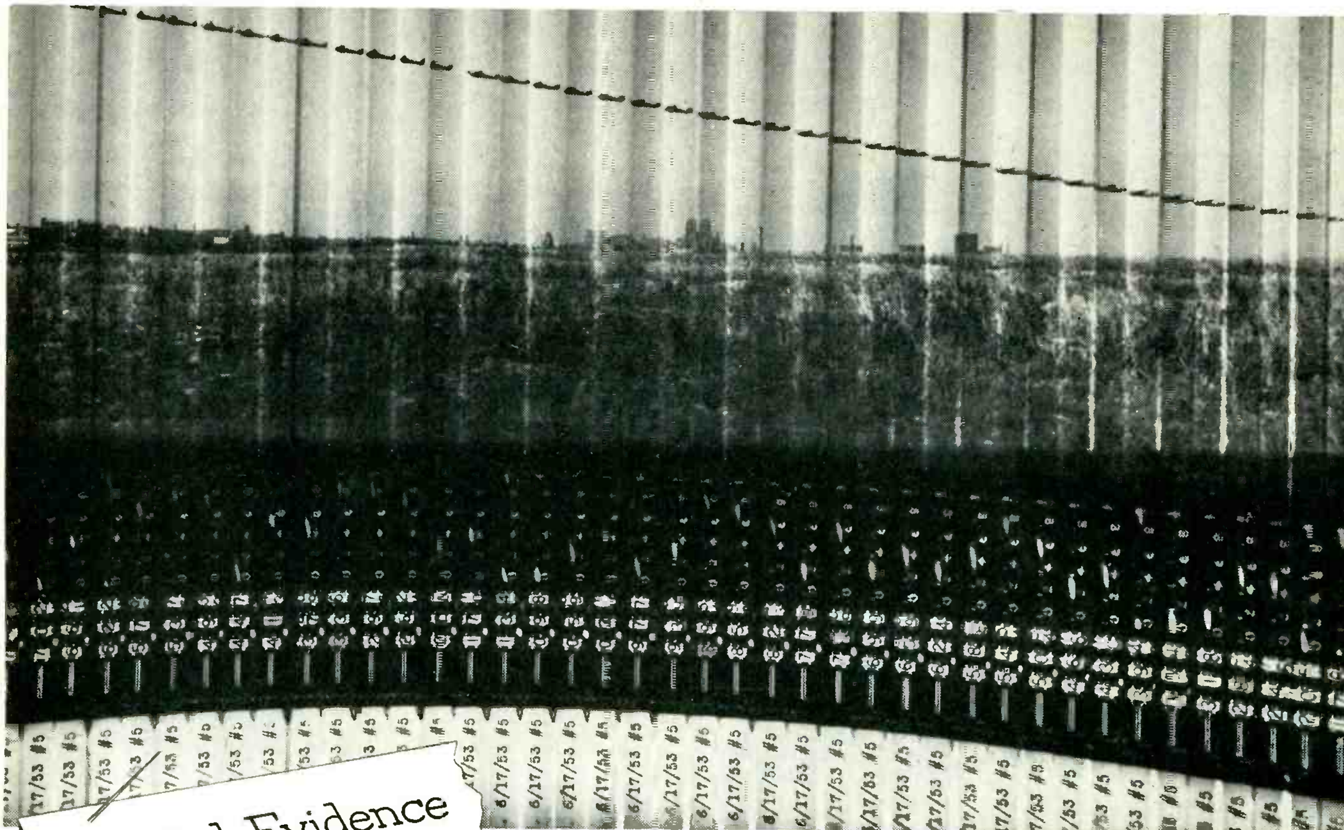


Photo by Sherman Fairchild & Associates' Flight Analyzer Camera, New York City

Added Evidence that______

Everyone Can Count on

VEEDER-ROOT

New take-off technique yields an 8° climb, as this progressive *single photo* shows. And this is 100% improvement over old techniques . . . increasing safety and decreasing noise-annoyance at city airports.

Here you actually see 53 separate exposures. And each, reading from bottom up, shows the date and number of the flight photographed. Next above is a device which records the time ...exact to 1/1,000th of a second. And in the heart of this device is a Veeder-Root Counter.

So here again you see one of the heretofore uncounted ways in which "Everyone Can Count on Veeder-Root". What's *your* problem? Let us put our mathematical eyes on it. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

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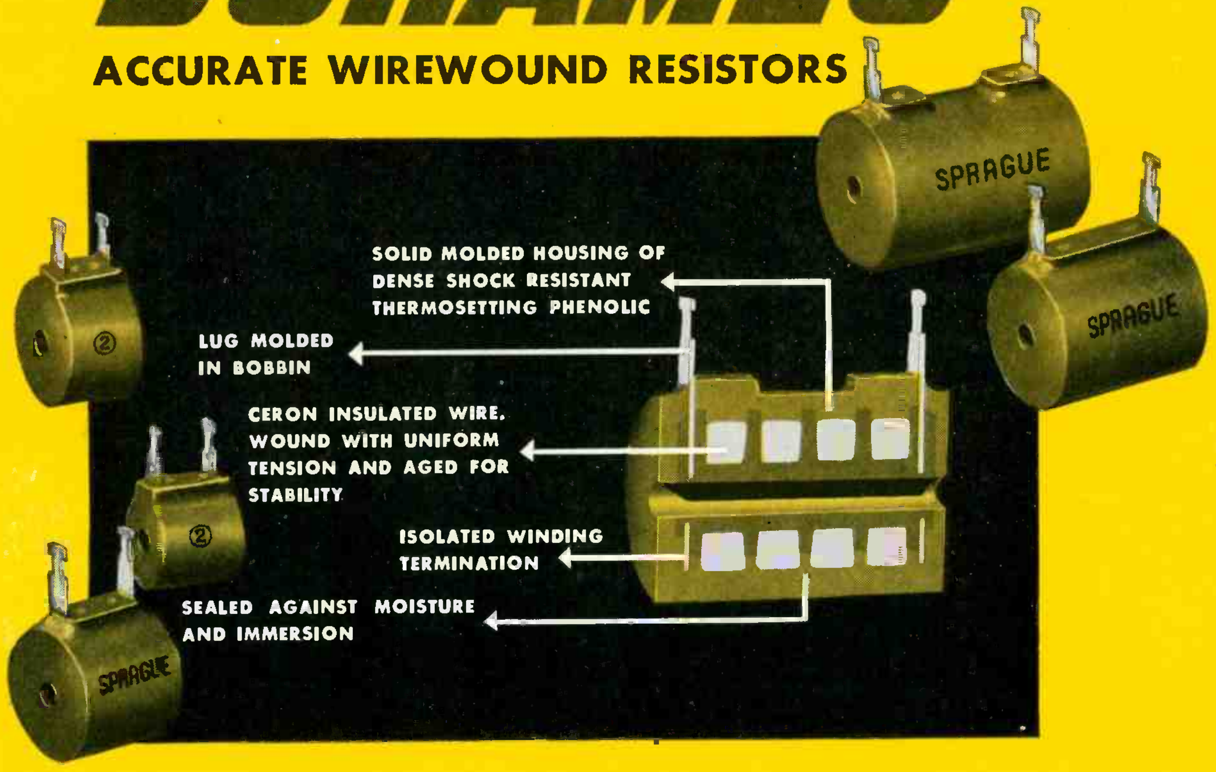
ABOVE AND BEYOND MIL-R-93A SPECIFICATIONS

DURAMEG®

ACCURATE WIREWOUND RESISTORS



DURAMEG WATTAGE RATINGS ARE BASED ON FULL RATED DISSIPATION AT 105° AMBIENT. THESE RATINGS ARE FROM 4 TO 5 TIMES THE 85°C MIL RATINGS FOR THE BEST OF CONVENTIONAL RESISTORS.

The engineered combination of Ceron wire, Durameg molding technique and aging treatment permits dissipation of full rated wattage at 105°C—the same temperature at which MIL ratings prescribe zero dissipation.

Equipment designers who must consider initial resistance tolerance as well as shifts in resistance value with repeated temperature cycling and operation at full load, are using Duramegs with outstanding results.

Durameg long-term stability and positive protection against electrolysis failure enable you to design now for dependable, permanent, peak performance.

Duramegs are the first high-accuracy wirewound resistors to operate successfully up to a hot spot temperature of 150°C as against the usual 105° limit—made possible with Sprague's patented ceramic insulated Ceron wire.

Durameg molded phenolic housings are tough and resistant to mechanical damage—installations require no secondary insulation for mounting—they'll even withstand the salt water immersion cycling for characteristic A in former specification JAN-R-93.

Durameg Resistors are now available for commercial application in dimensions identical to MIL styles. We will be pleased to send you complete data upon request. ★ ★ ★ ★ ★ ★

WRITE, WIRE OR PHONE FOR ENGINEERING BULLETIN 120

SPRAGUE ELECTRIC COMPANY 35 MARSHALL STREET NORTH ADAMS, MASS.

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT

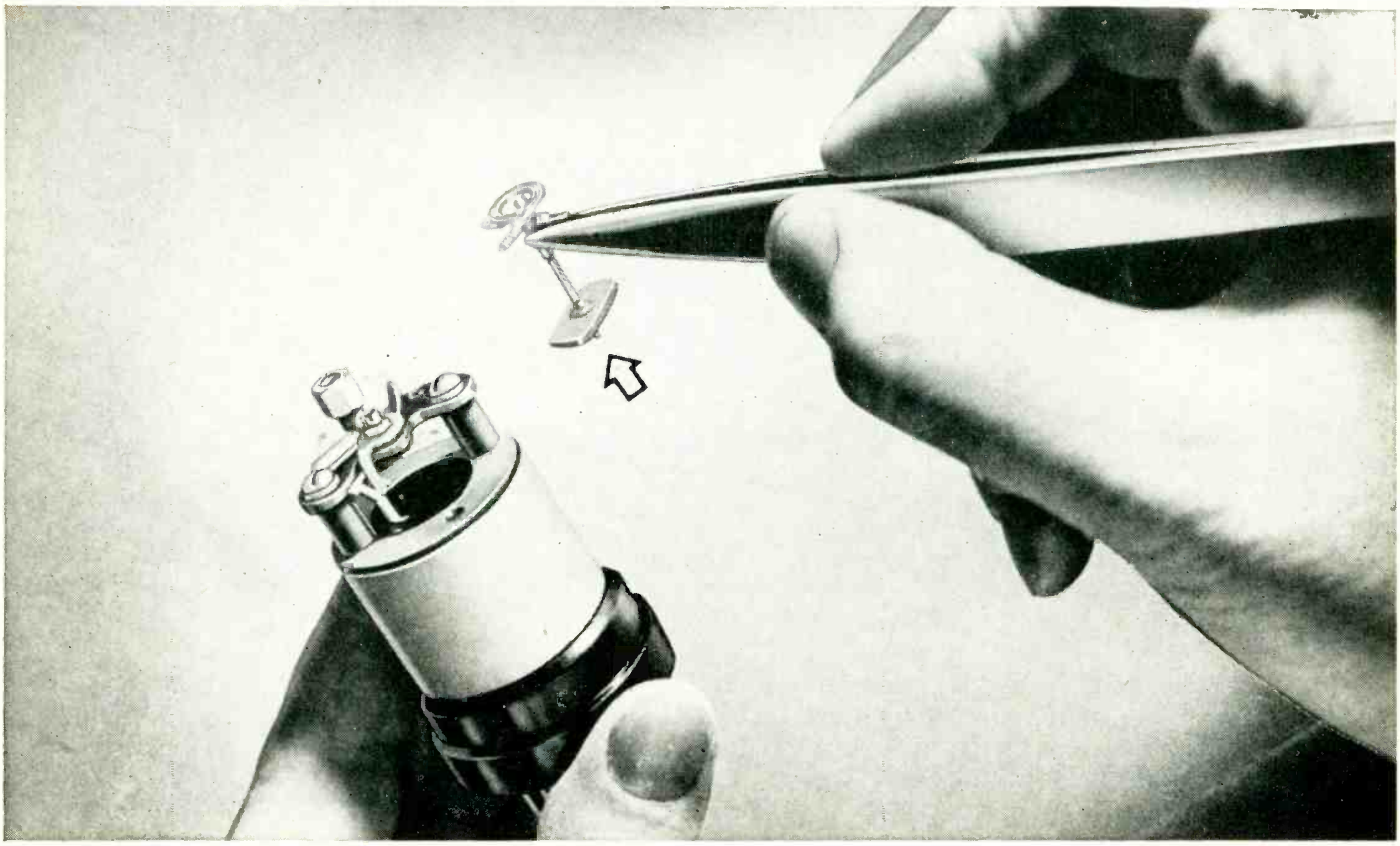
For benefits* like these, use

Here are typical benefits which you can *expect and get* by using Carboloy permanent magnets in your electrical products.

Check these case histories. Maybe a Carboloy permanent magnet can improve *your* product, too. Why not contact a Carboloy magnet engineer without delay. He'll lend you a hand in magnet design and application. His services will cost you **nothing.**

Carboloy permanent magnets retain their efficiency under most conditions of temperature, shock and vibration . . . high resistance to demagnetizing influence of stray magnetic fields . . . provide *powerful, lasting* magnetic energy.

Available in all sizes and shapes; can be cast or sintered to your needs. Send coupon for catalog and for design **manual.**



*Finer product performance

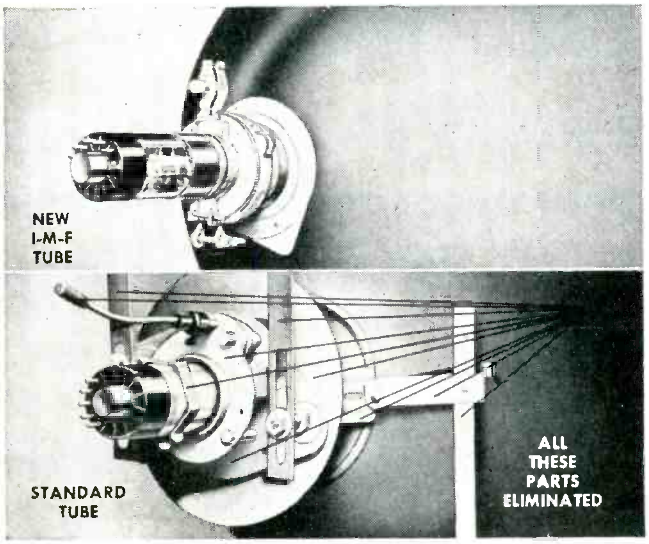
A small, powerful Carboloy permanent magnet enabled Thomas A. Edison, Inc. to design a revolutionary sensitive relay capable of operating from the current generated by a heated thermocouple. This power-packed magnet eliminated the need for electronic amplification, thus greatly simplified design of their aircraft fire-detecting system.

* YOU GET ALL THESE ADVANTAGES FROM CARBOLOY PERMANENT MAGNETS

- Cool—generate no heat
- Require no electrical energy
- Cost nothing to operate
- Eliminate coils, windings, wiring, etc.
- Need no maintenance—no coils to burn out, no slip rings to clean or replace, etc.
- Simplify mechanical assemblies—exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication simple
- Save space—great magnetic strength in small sizes
- Powerful—and power is constant
- Combine electrical and mechanical features—transform electrical energy into mechanical motion; mechanical motion into electrical energy
- No power failures ever
- Resist moisture—no coils to collect dampness
- Give uninterrupted operation
- Create savings—often eliminate costly, power-supplying parts
- Simple—no operating parts
- Reduce weight, product size
- Supply a permanent source of energy

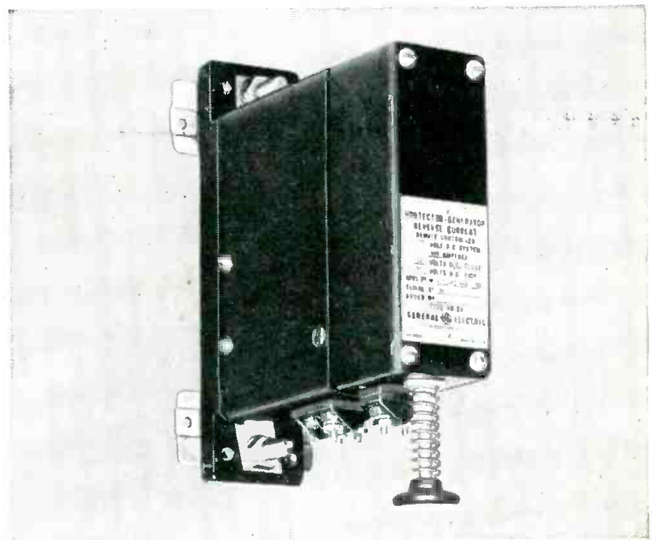
Want more information? Use post card on last page.

Carboloy® permanent magnets



***Fewer Parts**

New GE I-M-F television picture tube has its ion trap and magnetic focus device *inside end* of tube. Pictures are clearer, *prefocused* and many parts are eliminated . . . thanks to Carboloy permanent magnets.

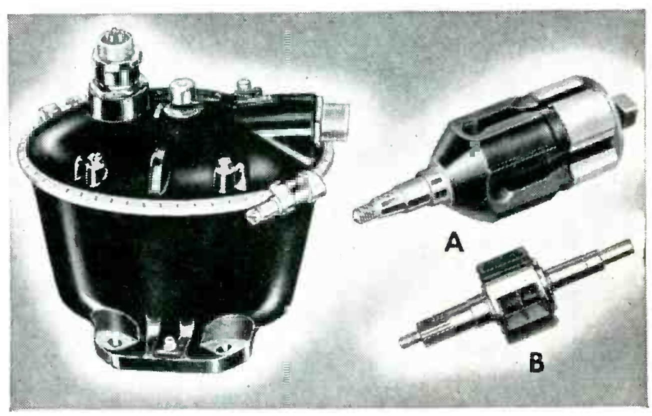


***Improved Design**

In this circuit breaker a Carboloy magnet assembly simplifies the trip element. It eliminates a coil and polarizing connection ... makes possible reverse-current tripping independent of system voltage.

***More dependability**

New all-magnetic, all-transistor hearing aid (by E. A. Myers & Sons, Inc., Pitts.) uses magnets in *both* microphone and receiver. Hearing aid failure caused by operational heat and humidity is now eliminated.



***Less weight and space**

Fig. A shows chrome magnet rotor once used in Scintilla aircraft magneto. It weighed 4 lbs. 9 ozs. New rotor (Fig. B) is made of Carboloy Alnico. It weighs only 2 lbs. 4 ozs., is considerably smaller.

Silver Anniversary
1928 1953
QUARTER CENTURY OF PIONEERING IN CREATED-METALS
CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY

"Carboloy" is the trademark for the products of the Carboloy Department of General Electric Company

Carboloy Department of General Electric Company
11139 E. 8 Mile Ave., Detroit 32, Michigan

Rush me, without cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

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Company__________

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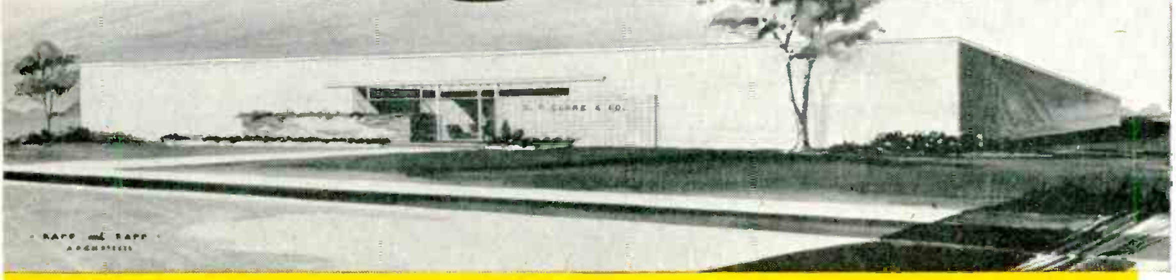
BIG NEWS!



C. P. Clare & Co. This is a young-minded progressive organization, ever alert to discover and test new and better materials and manufacturing methods.

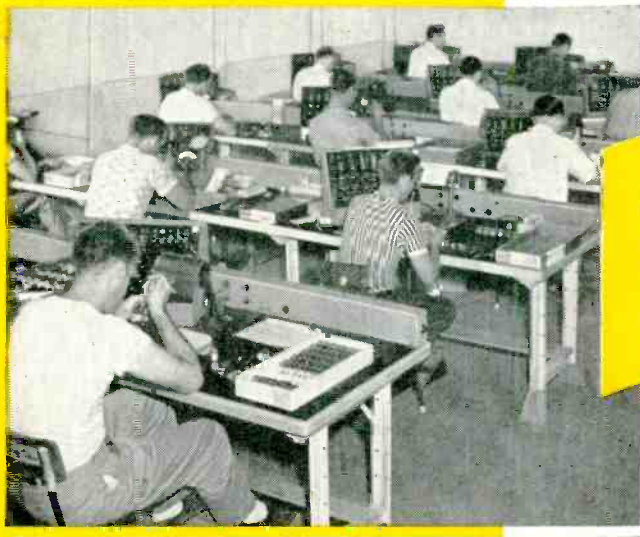
The new plant is the product of years of research and experiment. It is the natural development of Clare's unwillingness to offer their customers anything less than the most perfect relays that can be built.

• • •

If yours is a product whose long life, reliable performance and freedom from maintenance depend on the use of relays—it will pay you to know ALL about Clare relays. A sales representative, fully experienced in every type of relay problem, is located near you. Consult him, or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

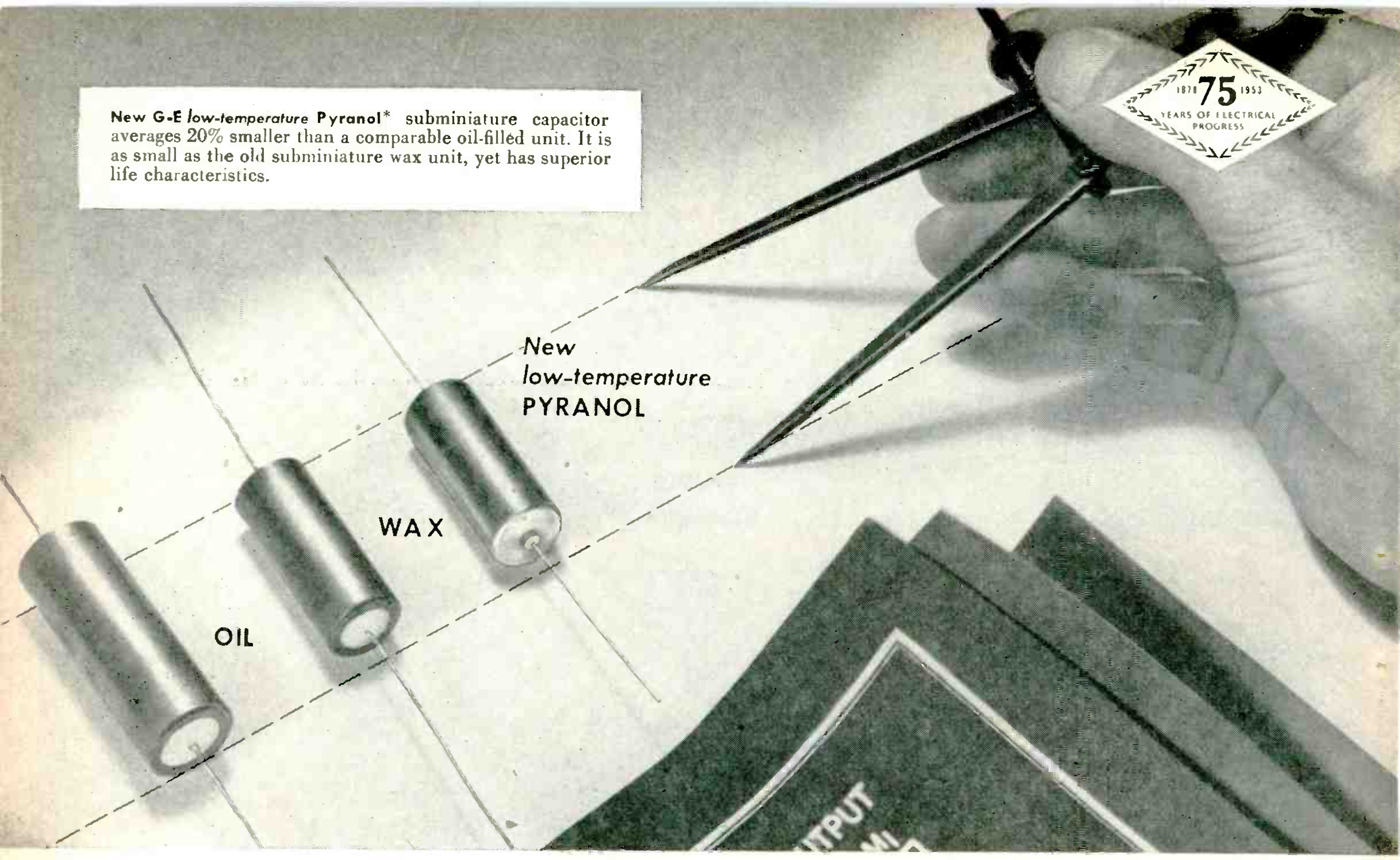
CLARE RELAYS

Automatic control of air temperature and humidity increases accuracy of assembly and adjustment of delicate parts.



Multiple test circuits of variable voltages on bench channels facilitate adjusting of relays to customers' specifications.

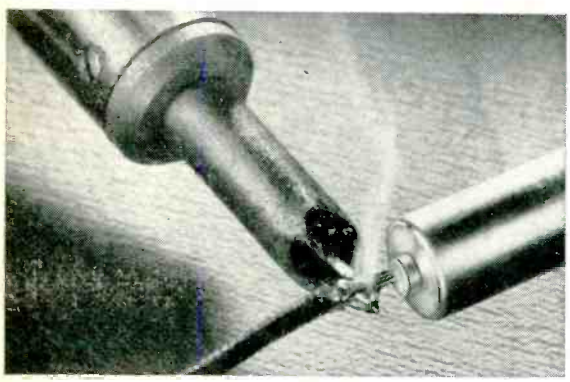
Diminutive parts of high frequency impulse relay require laboratory-clean assembly conditions.



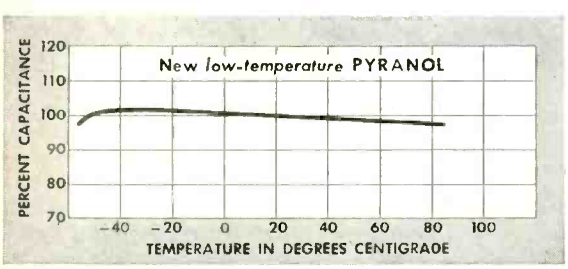
New G-E ***low-temperature*** **Pyranol*** subminiature capacitor averages 20% smaller than a comparable oil-filled unit. It is as small as the old subminiature wax unit, yet has superior life characteristics.

G-E subminiature metal-clad capacitors feature new *low-temperature* PYRANOL dielectric

NO DERATING OVER RANGE −55 TO +85 C



Solder right up to the bushing. No danger of cracking because G-E end seals are silicone rubber—not glass.



Capacitance vs. temperature is shown by this typical curve. G-E *low-temperature* Pyranol subminiature metal-clad capacitors have only a small capacitance change through the entire range from −55 to +85 C.

If you need a wax replacement because of the elimination of characteristic J (wax) from the proposed MIL-C-25 specifications, you need not go to a larger capacitor (or continue to use an unacceptable product). General Electric's new *low-temperature* Pyranol subminiature capacitors are as small as wax units, yet have superior life characteristics which make them a "natural" for military equipment.

High dielectric strength with exceptional stability is provided by new *low-temperature* Pyranol liquid dielectric. New, improved *low-temperature* Pyranol makes possible a small-size tubular capacitor with practically flat temperature vs. capacitance characteristics.

Silicone end seals, a G-E exclusive, provide exceptional resistance to physical and thermal shocks—and permit soldering right up to the bushing without danger to the seal.

Designed for applications in the temperature range from −55 to +85 C *without derating* these capacitors can be supplied in either tab or exposed foil designs in ratings from .001 to 1.0 muf. in voltages of 100, 200, 400, and 600 volts d-c working.

For high-temperature operation, −55 to +125 C *without derating*, another new tubular line—Permafil solid-dielectric subminiature capacitors, is available. These capacitors meet all requirements of JAN-C-25.

If your requirements demand the highest performance standards for subminiature capacitors, it will pay you to check with your nearest G-E Apparatus Sales Office, or write General Electric Company, Section 442-9, Schenectady 5, N. Y.

*Reg. trade-mark of General Electric Company

You can put your confidence in—

GENERAL ELECTRIC

BRITONS CAN HAVE PROSPERITY —If They Want It

What is required to get Britain, our key ally in the grand alliance of the free world, firmly back on her economic feet? The purpose of this message is to throw light on this crucial problem, which afflicts our other European allies also.

At the moment, Britain is enjoying a respite from the economic crises (of 1947, 1949 and 1951-52) which have plagued her postwar course. This respite may well continue for some time. But almost no one whose judgment is trustworthy believes that Britain has acquired sufficient economic strength to safeguard her against further economic crises in the years immediately ahead.

Two British Views

New and clear light on what should be done to that end has recently been shed by two noteworthy British publications. One is a book, "We Too Can Prosper," by Graham Hutton, distinguished British economic writer and administrator. The other is an article, "The Riddle of Prosperity," published by THE (London) ECONOMIST, Europe's most eminent economic journal.

Combined, these two publications present in sharp relief the basic problem that must be handled successfully if Britain is to be safely solvent. As is implied by its title, ***the Hutton book demonstrates that Britain can be made prosperous by readily feasible procedures, patterned on what has been done in the United States, to increase its industrial efficiency. But, says THE ECONOMIST, with Mr. Hutton's book in mind, this is not the most basic problem, which is, "How shall we make the British people determined to be prosperous?"*** This is a problem of incentive or motivation.

Compared with that of the United States, average industrial efficiency in Britain, as in most of Western Europe, is low. In his book Mr. Hutton remarks that "fifty years ago an American industrial worker turned out roughly the same amount in a day as his opposite number in Britain, Germany or France. . . . Today, he turns out from two to five times as much."

In large part it is this lag in output per hour or "productivity," as the technicians call it, which makes Britain and other key countries in Western Europe a continuing prey to economic crises. Moreover, the great disparity in productivity between the U.S.A. and most of Western Europe is a major barrier to knitting the free world into a smoothly working economic whole. As one observer put it, "when the American economy catches a cold, the European economy gets pneumonia." This is largely because Europe is so much weaker in productive strength.

No Shortage of Knowledge

Yet the knowledge which would enable the countries of Western Europe, and particularly Britain, to increase their industrial productivity has been mobilized and is readily available to them. It is with this process for Britain that Mr. Hutton's book is concerned. In the book he summarizes the findings and conclusions, virtually all of them unanimous, of 66 teams, composed of British industrial managers, technicians, shop workers and labor leaders. Over a period of three years these teams completed a comprehensive series of inspection and study trips in the United States under the sponsorship of the Anglo-American Council on Productivity. The product of that effort, he remarks, is "a set of documents the like of which, on such a scale and of such practical value, has never been seen in the history of international and cultural borrowing."

Psychology the Key

From study of these documents, Mr. Hutton concludes that better capital equipment is the key technical ingredient of higher industrial productivity in Britain, and constitutes "the most urgent . . . need of British industry." But he finds that ***even without new capital equipment a "15% rise in productivity can still be achieved by reorganization of work," and that such an increase would "solve Britain's chief social and economic problems."***

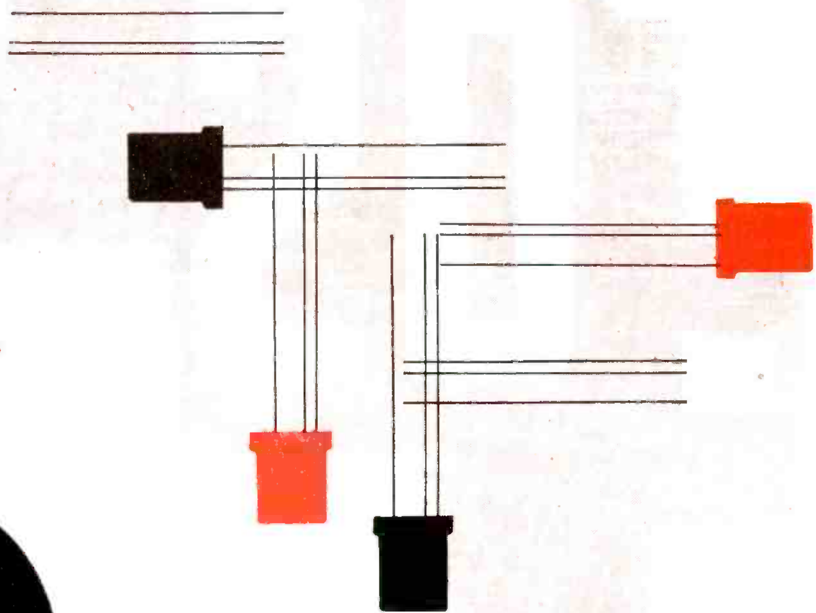
Then why is not such an increase in productivity, demonstrated by the Anglo-American productivity teams to be so clearly within technical grasp, promptly forthcoming? Mr. Hutton, quoting one of the team reports, remarks that, ***"'the greatest obstacles to increased productivity are psychological rather than technical.'*** We have to deal first and foremost with men, not machines." And THE ECONOMIST, pursuing the line of inquiry suggested, reaches the conclusion that, by and large, the people of Britain do not want to prosper by being more efficient. THE ECONOMIST says:

> "The real secret of American productivity is that American society is imbued through and through with the desirability, the rightness, the morality of production. . . . But in Britain, if any moral feeling at all survives about economic matters, it is usually a vague suspicion that economic success is reprehensible and unworthy. From this difference in attitudes everything else follows."

"How," asks THE ECONOMIST, "shall we set about restoring some belief in the rightness of effort, the morality of success?" For this question it has no ready answer. Neither have we. We are confident that the British people will neither be cajoled nor coerced into trying to match our productivity. Basically the problem seems to be to demonstrate clearly to them the truth of the proposition, set down by Graham Hutton, that "there is no goal, aim or end before a Good Society which the raising of that society's material productivity cannot render easier of achievement." Doing that in an old and settled country like Britain is obviously an extremely formidable undertaking. But ***until it is done, the crucial job of getting Britain and the rest of Western Europe firmly on its economic feet will remain to torment all of us.***

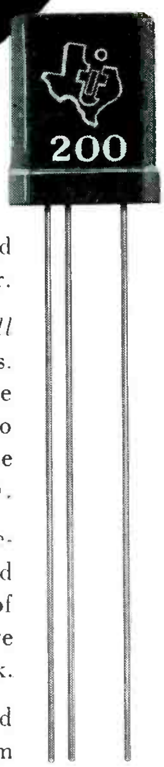
McGraw-Hill Publishing Company, Inc.

twenty times *tested!*



hermetically sealed transistors

TWICE SIZE



EVERY Texas Instruments grown junction and point contact transistor must pass more than 20 tests—in addition to continual visual checks—before it is granted the TI trademark and shipped to the user.

Texas Instruments inspects *all* transistors *all along* the manufacturing process. This 100% inspection insures that the completed product will adhere closely to published specifications (see distribution curves at lower right).

All TI transistors have moisture-proof glass-to-metal hermetic sealing. And they are *all* aged a minimum of *24 hours* at rated output as a positive operating double-check.

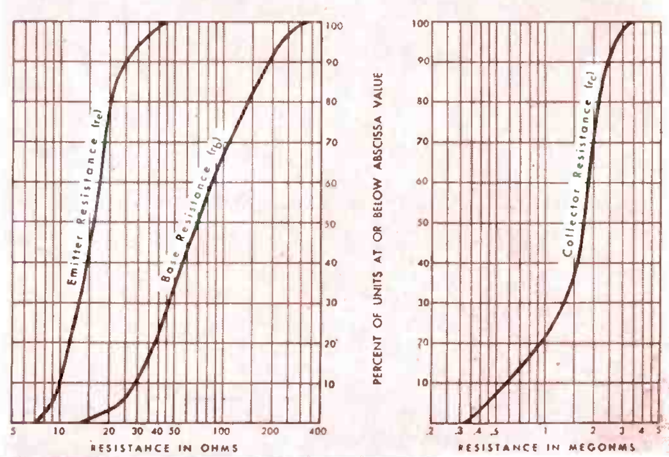
If *you* want transistors of this insured high quality, they are now available from Texas Instruments Incorporated. Write for new junction transistor bulletin DL-S 310.

ELECTRICAL DATA

RATINGS, RECOMMENDED MAXIMUM:	n-p-n Junction Type 200	Type 201
Collector Voltage	30 volts	30 volts
Collector Current	5 ma.	5 ma.
Collector Dissipation (at 30°C)	50 mw.	50 mw.
Ambient Temperature	50°C	50°C
AVERAGE CHARACTERISTICS (at 30°C):		
Collector Voltage	5 volts	5 volts
Emitter Current	−1 ma.	−1 ma.
Collector Resistance (minimum)	0.2 megohms	0.4 megohms
Base Resistance	150 ohms	150 ohms
Emitter Resistance	30 ohms	30 ohms
Current Amplification Factor (minimum)	0.90	0.95
Collector Cut-Off Current	10μa	10μa
Collector Capacitance	12$\mu\mu$fd.	12$\mu\mu$fd.
Noise Factor (average value)	22 db.	22 db.

STATISTICAL DISTRIBUTION CURVES

Based on 250 Type 200 Transistors



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INCORPORATED

6000 LEMMON AVENUE DALLAS 9, TEXAS

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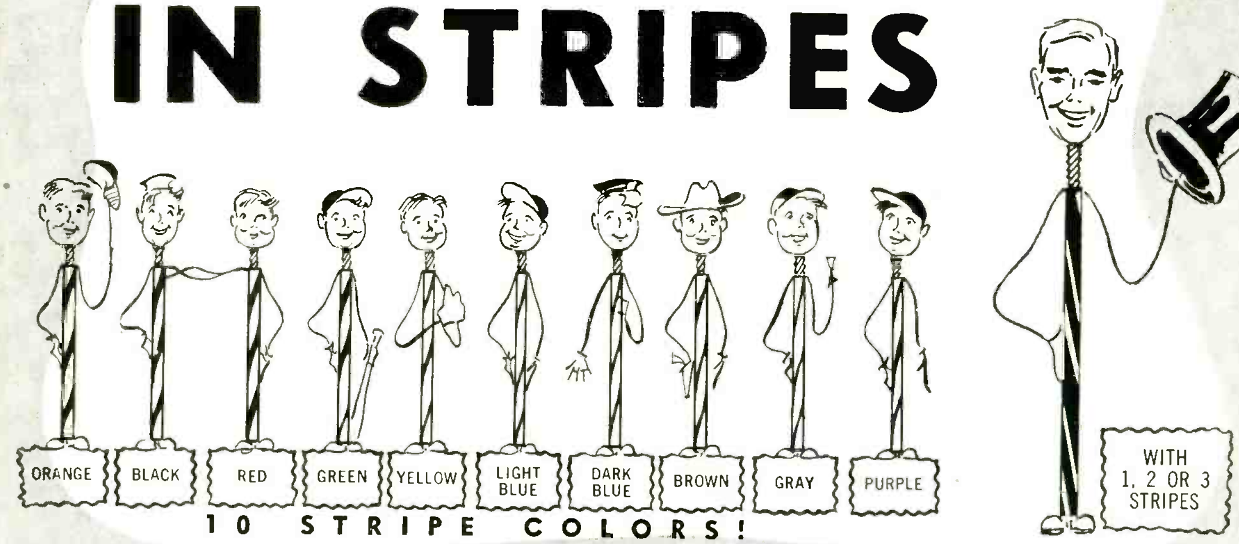
NOW KEL-F* WIRE IN STRIPES



REX-KF† THE WONDER WIRE

(WITH KEL-F* INSULATION)

The Rex Corporation announces REX-KF Wire (Kel-F* insulated) with one, two, or three stripes in any combination of ten colors. Over 300 sharply distinguishing color codes are now easily available.

Striping removes the final obstacle to the broader use of wonderful trifluorochlorethylene insulation.

Write for full information on this remarkable advance in wire technology, and the story of REX-KF Wire, champion in every quality that makes wire good.

*T. M. of M. W. Kellogg Co.
†T. M. of The Rex Corporation
**Reg. U. S. Pat. Off.

THE REX CORPORATION

Insulated Wire Specialties, Microwall Wire, Cast Plastics, Rexolite U. H. F.
Insulating Materials, Rextrude** 105 Electrical Tubing and Custom Plastic Extrusions.

WEST ACTON, MASSACHUSETTS

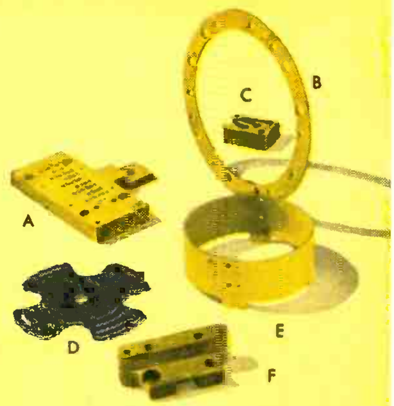
SYNTHANE —making bigger payloads pay off

Synthane bushings, spacers, and bearings in the landing gear of this giant of the skies share the landing shock loads of twenty-five tons. But Synthane parts have many virtues in addition to their ability to withstand the jolts of heavy landings.

Parts made of this hard-working laminated plastic are unaffected by oils, and are dimensionally stable. They resist abrasion, and weigh half as much as aluminum.

Because Synthane is so easy to machine, it is appropriate for fair-leads and cable-sheaves in control systems. Because it is an excellent electrical insulator, you will find it at work in engine ignition systems, flight instruments, automatic controls, and radar sets. Because Synthane is light and corrosion-resistant, it's used for the flapper valves in fuel cell baffles.

Synthane has all these properties and many more. It might be a good material for you to try. Start by sending for the complete Synthane Catalog. Synthane Corporation, 17 River Road, Oaks, Penna.



Synthane . . . in Aviation

- A Propeller brush block base
- B Separator ring for propeller hub
- C Propeller brake plug base
- D Brush carrier
- E Card drum
- F Propeller brush block base

Synthane-one of industry's unseen essentials

SYNTHANE
OAKS S PENNA.
LAMINATED PLASTICS

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WIDE RANGE

FAST-PULSE GENERATOR

PG-200A Pulse Generator
PGA-210 Range Extenders

SPECIFICATIONS

PULSE POWER

- Amplitude 100 volts open circuit
- Continuously variable over a range of -10 db
- 50 db attenuation in steps of approx. 10 db
- Driving impedance 50 ohms or less
- Max. average current (50 ohms load) 0.1 amp. for pos. pulses, 0.07 amp. for neg. pulses
- Max. recurrence rate at least 20,000 pps
- Max. duty cycle 50%, min. pulse interval (trailing edge to leading edge) approx. 40 µs

PULSE WAVEFORM

- Rise and decay times 0.03 µs or less (10% to 90% amplitude)
- Crest and base line overshoots and ripple less than 5% of average pulse amplitude
- Duration calibrated 0.1 to 50 µs, accuracy below 5000 pps within 5% or 0.1 µs whichever is greater, accuracy above 5000 pps subject to additional 0.3 µs error, min. pulse width less than 0.05 µs (50% amplitude)

PULSE POSITION

- Delay after external sync signal fixed at approx. 10 µs or adjustable from approx. 20 to 70 µs
- Advance or delay with respect to sync out trigger calibrated 0.1 to 50 µs, accuracy below 5000 pps within 5% or 0.1 µs whichever is greater, accuracy above 5000 pps subject to additional 0.3 µs error

features

- DURATION AND POSITION .05 TO 1000 µs
- RISE AND DECAY TIMES CONSTANT .03 µs
- SINGLE PULSES TO 20,000 PER SECOND
- 100 VOLTS, 50 OHMS DRIVING IMPEDANCE
- CALIBRATED WIDTH, POSITION AND RATE
- TRIGGER OR SINE WAVE SYNCHRONIZATION
- NEGLIGIBLE INTERACTION OF CONTROLS

RANGE EXTENDER

- 19 additional time increments of 50 µs each
- Continuous calibrated coverage from 0.1 to 1000 µs, accuracy within 5%
- Plugs into top of Pulse Generator directly above position or duration control

SYNCHRONIZATION

- Externally by almost any 5 volt waveform from essentially 0 to 20,000 per sec.
- Internal single pulses, power line freq. or adjustable from 20 to 20,000 pps
- Recurrence rate meter, accuracy within 5%
- Sync out trigger 50 volts, 1 µs duration

TELETRONICS LABORATORY INC.

54 KINKEL STREET, WESTBURY, LONG ISLAND, NEW YORK

Want more information? Use post card on last page.

25% LESS WEIGHT!

castohm®

FIXED WIREWOUND POWER RESISTORS

. . . new homogeneous core and coating

✓ REDUCES SIZE AND WEIGHT

✓ ELIMINATES SHORTED TURNS

- 350°C hot spot operation
- Higher power dissipation with less weight, smaller diameters
- Higher maximum resistances
- Closer tolerances—to 1% (5% standard)
- Better heat conductivity
- Exceptional resistance to thermal shock

By eliminating the heavy ceramic core with the wire-bunching and shorted turns characteristic of vitreous enamel types, Shallcross has developed a radically new wirewound resistor that outperforms *all other* types of high temperature fixed power resistors. Through a unique process, the windings are imbedded in a special ceramic which forms an integral coating and core. Designed to MIL-R-10566 specifications, Castohms are destined to leave MIL-R-26A types far behind.

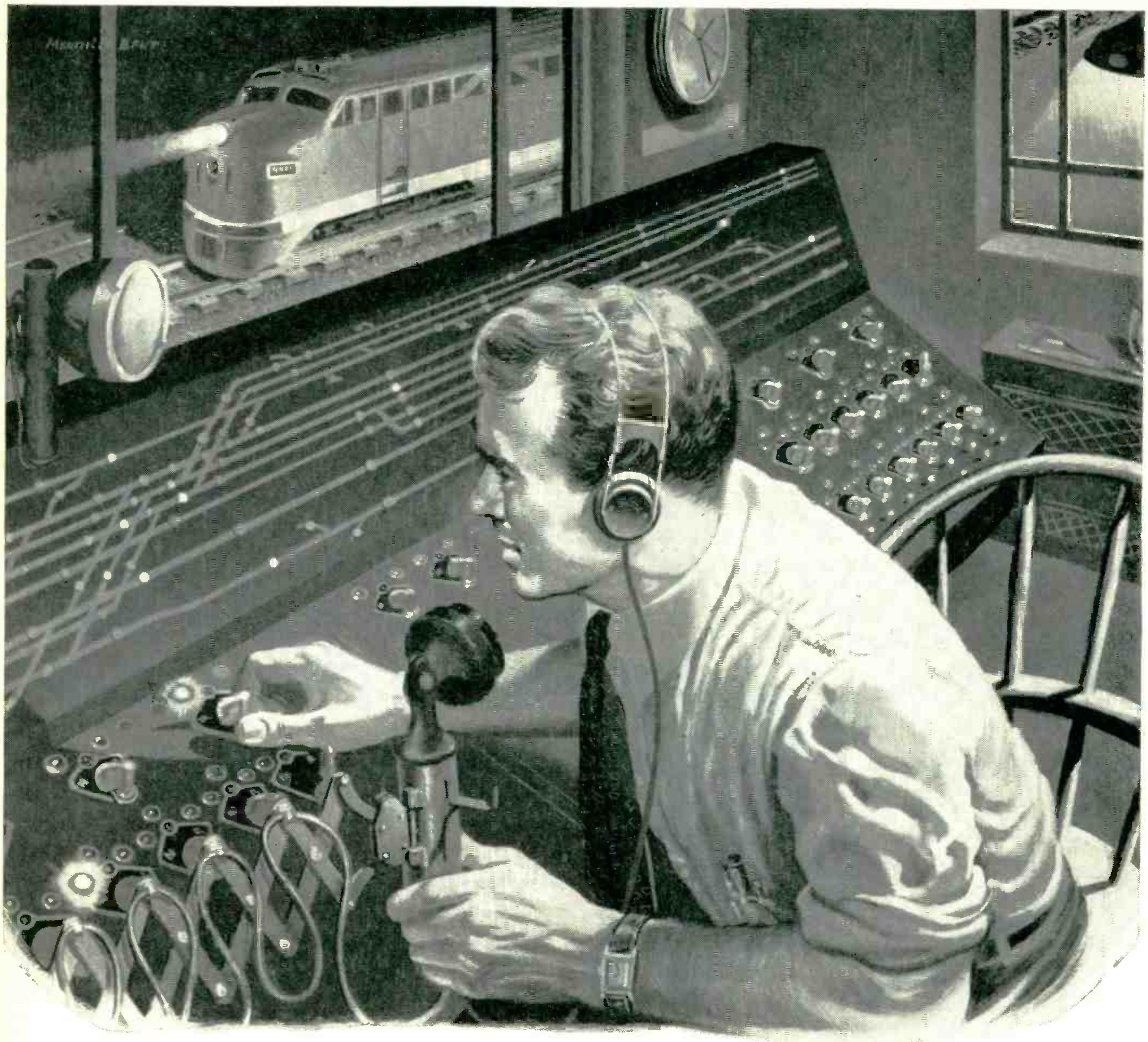
Find out how Castohms can reduce size and weight in your equipment - improve efficiency and reliability as well. Write, wire, or phone for details. Ask for Engineering Bulletin L-29.

SHALLCROSS MANUFACTURING CO.,
522 Pusey Avenue, Collingdale, Pa.

Designed to MIL-R-10566 Specifications

R-30— 8 watts
R-33— 28 watts
R-37—125 watts
R-46—225 watts

Shallcross



You know you're on the right track

Director of destinations, the towerman deftly sorts out traffic . . . fans it out far and wide, so that the right shipments get to the right places at the right time.

The same practiced precision goes into traffic control in the modern mills at Bristol. Here every operation is safe in hands that have the same deft touch . . . that keep things moving so that every shipment of Brass sheet, rod and wire gets through to its destination without switching, sidetracking, or running behind time.

And this is just *part* of what is meant by "Bristol-Fashion".

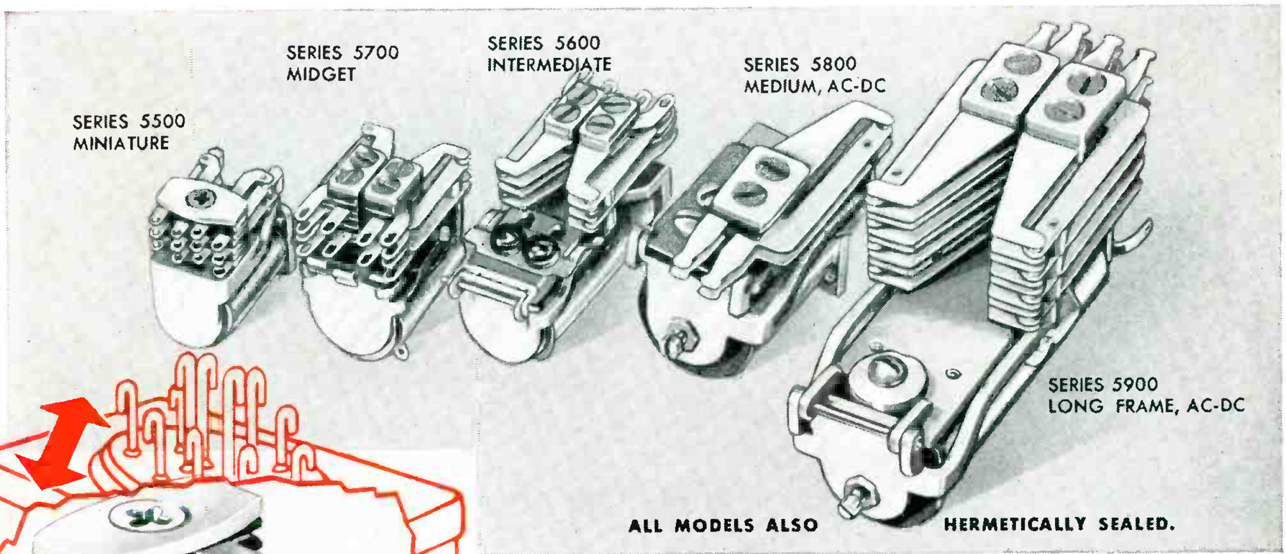
• • •

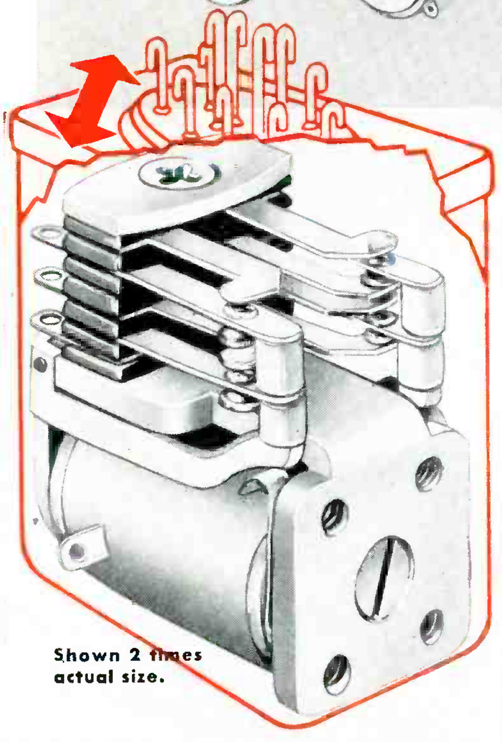
The BRISTOL BRASS CORPORATION, makers of Brass since 1850 in Bristol, Conn. Offices or warehouses in Boston, Chicago, Cleveland, Dayton, Detroit, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Providence, Rochester.

"Bristol-Fashion" means **Brass at its Best**

NOW ANOTHER . . . **NEW MINIATURE added to HUSKY LINE**

OF TELEPHONE-TYPE RELAYS!





Shown 2 times actual size.

SMALL! LIGHT! RELIABLE!

The latest addition to the Husky line of telephone-type relays, and our answer to the demand for smaller, lighter-weight aircraft relays is the series 5500—available in open style or hermetically sealed.

The series 5500 relay meets all applicable requirements of MIL-R-6106. It is a miniaturized conventional relay, designed to keep pace with the trend towards reduction in size and weight in electronic equipment, especially for aircraft applications.

HERMETICALLY SEALED

The 5500 HS (hermetically-sealed model) provides complete protection against tampering or harmful atmospheric conditions, including moisture, salt spray, dust and temperature extremes. Altitude tests reveal no leakage at 81,000 feet.

Unique Husky construction features:

1. Longer, more flexible contact arms, resulting in reliable operation with low coil wattage.
2. Single stack screw, with positive locating pins (in stack) assuring precision contact alignment.
3. Specially designed spring- tempered clamp plate and high tensile strength screw prevents loosening of stacks under severest conditions of shock, vibration and temperature variations.

Specify Husky Series 5500 relays for all applications where reliability, small size and light weight are prime factors. Write, wire or phone for further information . . . File 5500.

SPECIFICATIONS

OPERATING VOLTAGES: 6 to 48 volts DC.
MAXIMUM COIL RESISTANCE: 5,000 ohms.
CONTACT CAPACITY: Standard contacts are rated at 3 amps 115 volts AC or 24 volts DC, non-inductive.
CONTACT COMBINATIONS: Up to 6 Form A, or 4 Form C (total of 12 springs).

PRICE ELECTRIC CORP., FREDERICK, MD.
HUSKY RELAYS AND CONTROLS

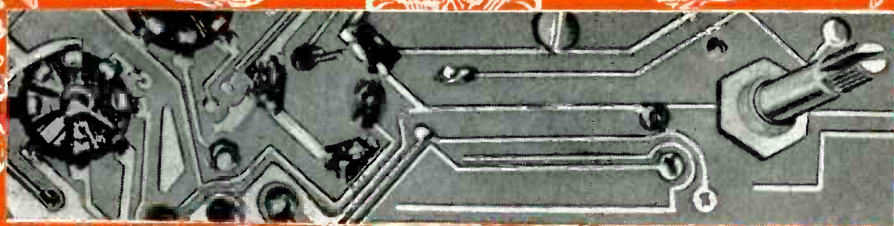
Price Electric CORPORATION

1500 CHURCH, FREDERICK, MARYLAND

Want more information? Use post card on last page.

A NEW CTS FAMILY

Of Variable Resistors



FOR PRINTED CIRCUIT APPLICATIONS

Note these unique design features:

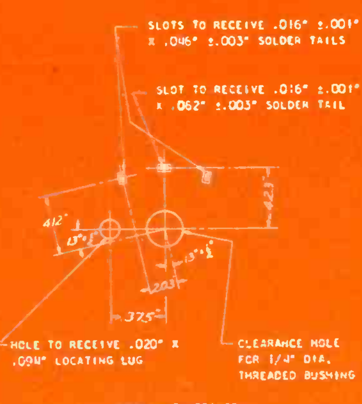
❶ Protection against bending during handling is achieved by recessing each blade-type terminal in a notch in the bakelite base of the control.

❷ Valuable mounting space is conserved on the printed circuit panel by placing the terminals close in to the mounting bushing.

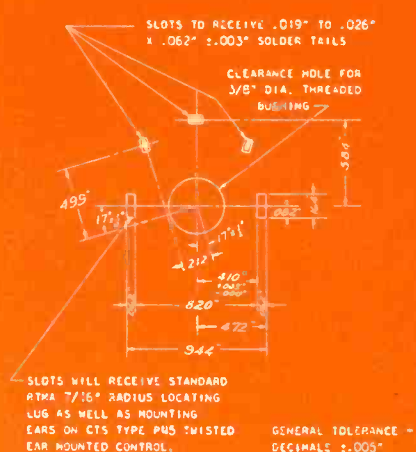
❸ Adequate clearance for circuit paths is provided by ample spacing between terminals.

❹ Available in *miniaturized* ¾" diameter (U70) and in $^{15}/_{16}$" diameter (U45, GC-U45, WF-U45).

For your printed circuit applications, CTS offers consultation without obligation.



Ample spacing between printed circuit terminal openings for the miniature Type U70 series provides adequate clearance for circuit paths.



Ample spacing between printed circuit terminal openings for Types U45, GC-U45 and WF-U45 provides adequate clearance for circuit paths.

Type U70, 3/4″ diameter *miniaturized* variable composition resistor with special printed circuit terminals. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms.

Type U45, 15/16″ diameter, variable composition resistor with blade-type printed circuit terminals. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms and 1/4 watt with 500 volts maximum across end terminals for resistances over 100,000 ohms.

Type GC-U45, 15/16″ diameter, variable composition resistor with blade-type printed circuit terminals same as U45 except with attached SPST, 3 ampere, 125 volt "GC" type switch. Also available with type "WF", DPST, 3 ampere, 125 volt switch. (Variable resistor type WF-U45.)

CTS

CHICAGO TELEPHONE SUPPLY
Corporation

ELKHART • INDIANA

REPRESENTATIVES

Henry E. Sanders, McClatchy Bldg.
69th & Market St., Upper Darby, Penna.
Phone: Flanders 2-4420

W. S. Harmon Company, 1638 So. La Cienega Blvd.
Los Angeles 35, California • Phone: Bradshaw 2-3321

John A. Green Company, 6815 Oriole Drive
Dallas 9, Texas

IN CANADA

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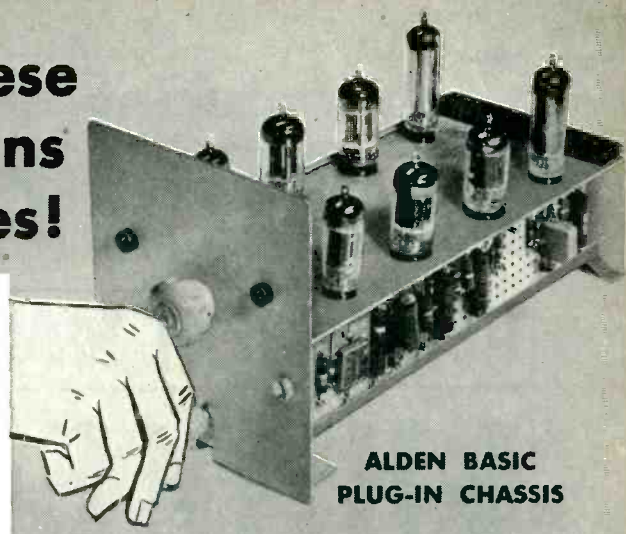
OTHER EXPORT

Sylvan Ginsbury
8 West 40th Street, New York 18, N. Y.

Specialists in Precision Mass Production of Variable Resistors

Wrap up your circuitry in these tremendously flexible plug-ins to get these vital advantages!



1. **GET "1-SHOT ENGINEERING"** — you pre-solve Parts Design, Production Layout and Procurement all in "one shot".
2. **SLASH ASSEMBLY COSTS** — manufacture goes fast at low cost, because subdivided into units on which operations are simple and out-in-the-open.
3. **YOUR CUSTOMERS SAY "WONDERFUL!"** — Installation simplified to non-technical push-in connects done in the field as fast as unloaded. Reliability of service provided by 30-second plug in of replacement spares when tell-tales warn.

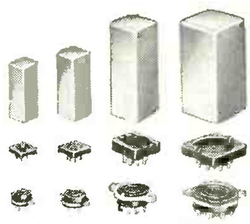
ALDEN BASIC PLUG-IN CHASSIS

To move circuitry from layout to completed equipment — IT'S AS SIMPLE AS THIS . . .

ALDEN PLUG-IN PACKAGE

4 SIZES OF PLUG-IN PACKAGES

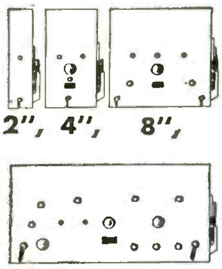
Alden standard Bases, Lids, Handles, Cans, Sockets for 7, 9, 11 and 20-pin packages house Terminal Card Circuitry with tremendous flexibility for endless variety of open and shielded packages . . . making it easy and inexpensive to give your equipment reliability in service with instantly replaceable plug-ins for all sub-units.



7-pin 9-pin 11-pin 20-pin

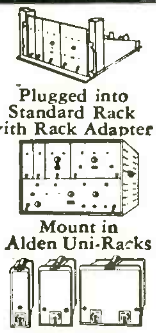
Package components and matching sockets.

4 SIZES OF ALDEN BASIC CHASSIS



2", 4", 8", 17"

Your circuitry on Terminal Card strips snaps right into Alden Basic Chassis. Vertical mounting and hinged front panel give beautiful accessibility and space saving. Chasses can be plugged interchangeably into Standard Racks, Alden Uni-Racks, Alden Portable Cases. Alden Rack Adapter mates Standard Rack to Chassis.

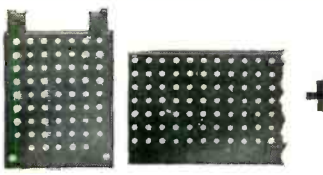


Plugged into Standard Rack with Rack Adapter

Mount in Alden Uni-Racks

Plugged into Portable Cases

Subdivided function by function, your circuitry drops naturally onto Alden Terminal Mounting Cards —



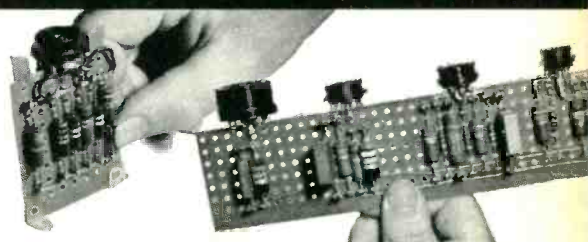
ALDEN PREPUNCHED TERMINAL MOUNTING CARDS cut to proper sizes for 7-pin, 9-pin, 11-pin and 20-pin packages. Or in 3' strips for chassis — cut it off as you require.

+ ALDEN MINIATURE STAKING TERMINALS Lay out in any pattern on Terminal Mounting Cards; ratchet slots hold elements for soldering without pliering or wrap-around.

+ ALDEN JUMPER STRIP stakes right under Terminals providing common circuit without soldering.

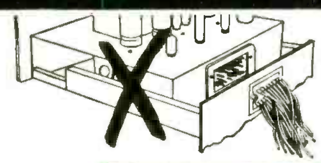
+ ALDEN CARD-MTG. TUBE SOCKETS for min. 7-pin, 9-pin and octal tubes.

=

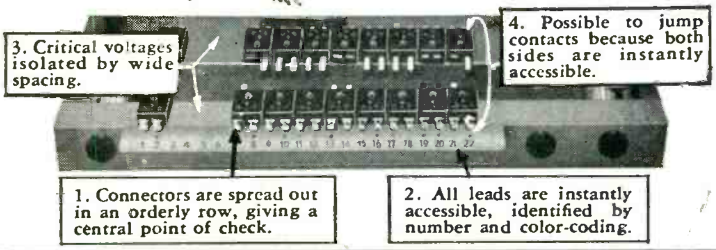


CIRCUITRY TO MOUNT IN PACKAGE AND CHASSIS

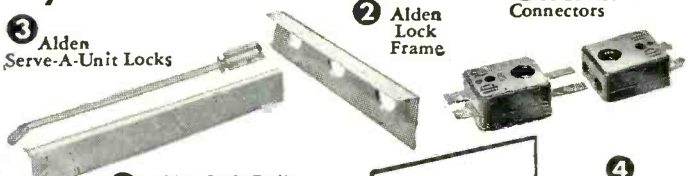
Your chassis circuitry is easily organized with 1 point of check and 30-second replacement —



Alden's new concept in Rack-and-Panel Connectors, eliminates congested rats' nest of blind wiring and provides —

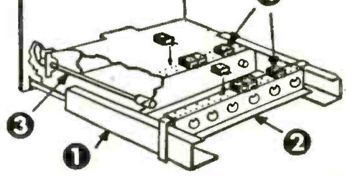


All you need is this Kit —



It's as simple as this —

Arrange Alden Side Rails (1) and Alden Lock Frame (2) to suit your chassis. Alden Serve-A-Unit Locks (3) mount in your chassis to engage prepunched holes in Alden Lock Frame (2) to pilot, draw in, lock or eject.



Tiny tell-tales assigned unit by unit spot trouble instantly —

See how compact front panel easily mounts six tiny Alden Sensing Elements—specifically designed to lick the problem of having only a small amount of space. Assembled by simplest methods.

ALDEN MINI-TEST POINT JACK

For checking critical voltages from front of panel.

ALDEN "PAN-i-LITE"

Miniature indicator light with unbreakable 1-piece light-lens unit replaceable from front.

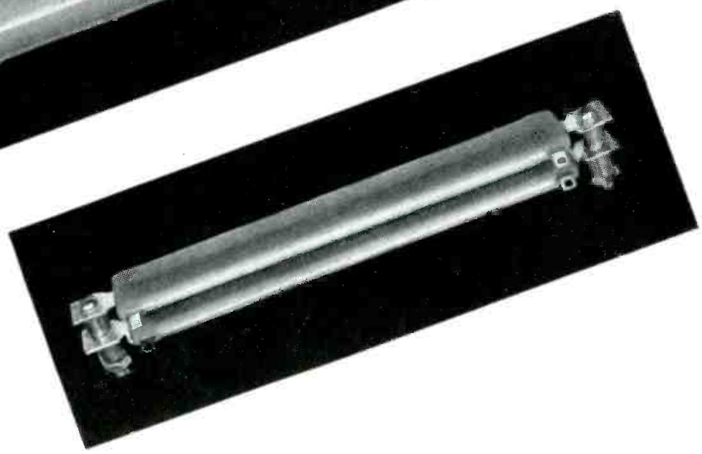
ALDEN "FUSE-LITE"

Fuse blows — Lite glows. Simple unscrew 1-piece light-lens unit and blown fuse comes out with it.

GET THE COMPLETE STORY — REQUEST "ALDEN HANDBOOK" — SENT FREE

NA-ALD **ALDEN PRODUCTS CO.** 127 N. Main St., Brockton 64, Mass.

TWO YEARS FIELD EXPERIENCE WINS TITLE... "H-H LONG-LIFE RESISTORS"



The greatly increased protection made possible by the development of our *high-temperature* gray enamel is the most important improvement of these resistors, but it is not all. True, this enamel is thermo-shock-proof and crazeless; but in addition

THESE RESISTORS OFFER . . .

- **Stronger core with higher resistance to vibration and shock.**
- **Finer resistance wire—made to H-H specifications, especially adapted to these resistors. More uniformly wound, so that failures under stress are eliminated.**
- **Special alloy terminals more securely fastened to the ceramic body by spot-welding—highly resistant to corrosion.**
- **All wire connections are protected by a positive non-corrosive bonding.**

The fixed, the ferrule and the flat types are especially designed for and manufacturd in accordance with JAN-R-26A specifications.

HARDWICK, HINDLE, INC.

Rheostats and Resistors

Subsidiary of

THE NATIONAL LOCK WASHER COMPANY

Established 1886

Newark 5, N. J. U. S. A.

the mark of quality

for more than a quarter of a century

Hardwick, Hindle, Inc.
40 Hermon St., Newark 5, N. J.

Please send additional information about your new resistors and rheostats.

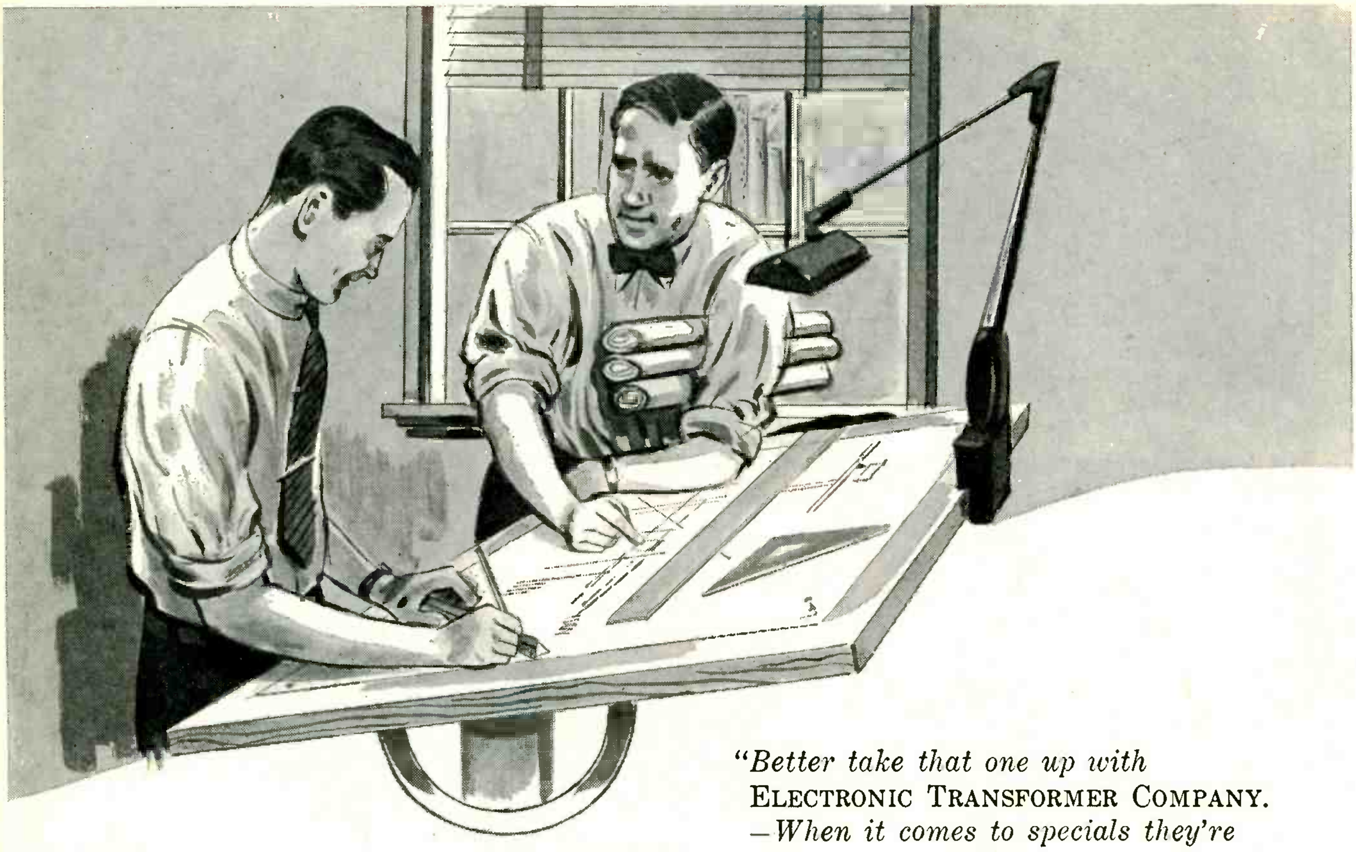
Name____________________

Title____________________

Company____________________

Address____________________

Want more information? Use post card on last page.



"Better take that one up with ELECTRONIC TRANSFORMER COMPANY. *—When it comes to specials they're always on the ball."*

Here at ETC we can start from scratch, assimilate your circuitry and follow through so that your special transformers are custom-designed and custom-built to your exacting requirements.

That's what we've been doing intensively since 1938 for both government and industry.

If the prints call for specials, our staff of highly trained transformer engineers is at your service. Supporting these experts is our modern laboratory as well as a production shop geared for transformer pilot production up to several thousand units.

Let us *prove* that we are on the ball. We'll gladly make recommendations without obligation if you outline your problem to us.

ELECTRONIC TRANSFORMER COMPANY

Transformers, Reactors and Filters Tailored to your Needs

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ETC

ELECTRONIC TRANSFORMER COMPANY

IRVINGTON extra-flexible Silicone Rubber-Coated Fiberglas* Tubing

The extreme flexibility of Irvington's Silicone *Rubber*-Coated Fiberglas—at both high and low temperatures—was an important factor in its acceptance by the electrical industry when this new Class "H" insulation was introduced almost two years ago.

Originally, Irvington Silicone *Rubber*-Coated Fiberglas Tubing was supplied only in white. Because of its rapidly growing use, Irvington has now taken steps to supply this tubing in a range of *colors* also—subject to minimum order requirements.

Immediate delivery can be made on white tubing for wire sizes from #24 to #0—prices and deliveries will be quoted on request on colored tubing.

For preliminary technical data, just mail the coupon below.

Look to
IRVINGTON
for Insulation Leadership
- INSULATING VARNISHES
- VARNISHED CAMBRIC
- VARNISHED PAPER
- VARNISHED FIBERGLAS
- INSULATING TUBING
- CLASS "H" INSULATION

*T. M. Reg. U. S. Pat. Off. by Owens-Corning Fiberglas Corp.

Send this convenient coupon now

Irvington
VARNISH & INSULATOR COMPANY
11 Argyle Terrace, Irvington 11, New Jersey
Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

EL-10/53

Irvington Varnish & Insulator Company
11 Argyle Terrace, Irvington 11, New Jersey

Gentlemen:

Please send me technical data sheet on Silicone Rubber-Coated Fiberglas Tubing.

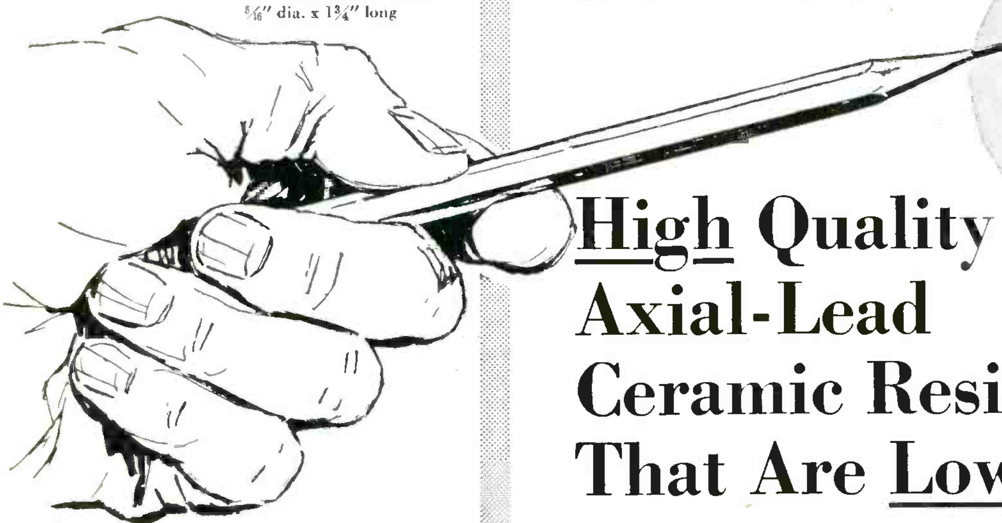
Name........................ Title..................

Company........................

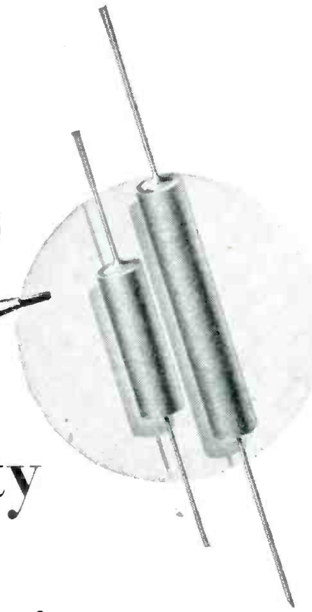
Street........................

City........................ Zone.......... State..........

Available sizes:
4 watt . . . 10 to 1000 ohms
5/16" dia. x 1" long
7 watt . . . 10 to 5000 ohms
5/16" dia. x 1¾" long



NEW!



High Quality Axial-Lead Ceramic Resistors . . . That Are Low In Cost

THESE new resistors are designed especially for television and radio applications, where the combination of high quality and low cost is a prime requisite. They are conservatively rated . . . will withstand overloads up to 100% of rated value. Resistance values are held to ±10%.

Check over these advantages . . . then be sure your next axial-lead ceramic resistors are Mallory.

Rigid resistance values are maintained over the entire operating range by the exclusive Mallory Yard-ohm wire. The wire is accurately wound on a braided Fiberglas core. There is no organic material to burn, blister or crack.

Securely clinched, high-grade tinned leads prevent open circuits, resistance changes and pull-outs. Resistor ends are sealed by special heat and moisture resistant compound that assures high stability . . . even in humid atmosphere.

Resistance element is securely held by special inorganic cement that prevents corrosion. The cement is injected under pressure to eliminate air pockets . . . assuring maximum heat dissipation and long life.

Sturdy, non-porous steatite tubes afford ample protection against thermal and mechanical shock.

Be sure and get in touch with Mallory engineers while your new models are still in the design stage. They will be glad to work with you . . . help you match related circuit components.

MORE NEWS!

This factory assembled dual carbon control, with or without switch, is part of a completely new line of half-watt carbon controls for TV and radio service.

The line incorporates a new carbon element of unusual density and smoothness which assures a low noise level and greatly reduced resistance drift. They are available in resistances from 250 ohms through 10 megohms.

Expect more . . . Get more from **MALLORY**

Parts distributors in all major cities stock Mallory standard components for your convenience

P.R. MALLORY & CO. Inc. MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical — Resistors • Switches • Television Tuners • Vibrators
Electrochemical — Capacitors • Rectifiers • Mercury Batteries
Metallurgical — Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., INDIANAPOLIS 6, INDIANA

CROSS TALK

► **TIMETABLE** . . . Everything points toward early adoption of NTSC-proposed compatible-color-tv standards by the FCC. The effect of the new standards upon our industry is already being widely discounted.

The speed with which color-tv will become a major factor in the market is a profitable subject for speculation. There are too many economic and technical problems still ahead to permit preparation of a bulletproof timetable, but we will say this: We're bullish on color-tv, won't sell it short.

► **ARMISTICE** . . . Since the Korean cease-fire many market forecasters have asked us how much electronics business is military and how much civilian.

The question is impossible to answer with accuracy because of the extremely varied nature of products within our field, the difficulty of determining end-point use in many cases and the fact that neither the military people nor our own draw a particularly fine bookkeeping line between electronic and allied products.

Some few manufacturers of electronic equipment are selling almost exclusively to the government, but it is our impression that these companies are for the most part small. Middle-size firms seem to have their hands about equally on both markets. Larger companies appear to be heavy on the civilian rather than the military side.

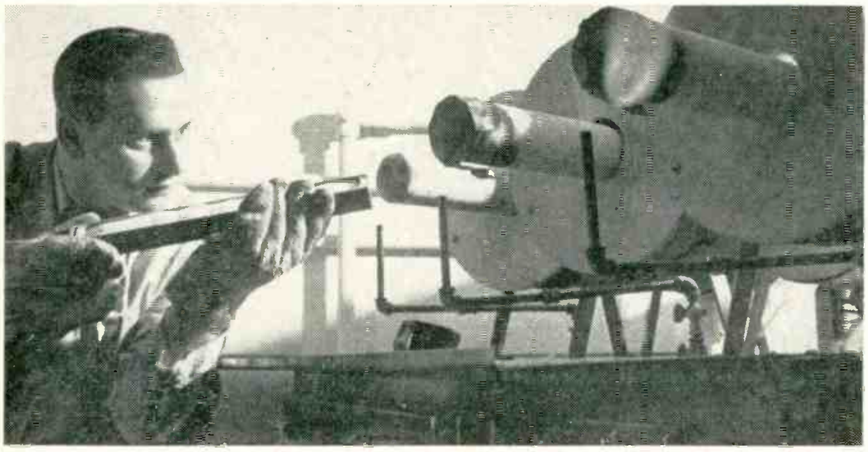
Estimates on the military slice of the overall pie range from about 20 percent to 50 percent. We are inclined to believe that the first-mentioned figure is nearer the mark.

CURTIS WHITTLESEY McGRAW

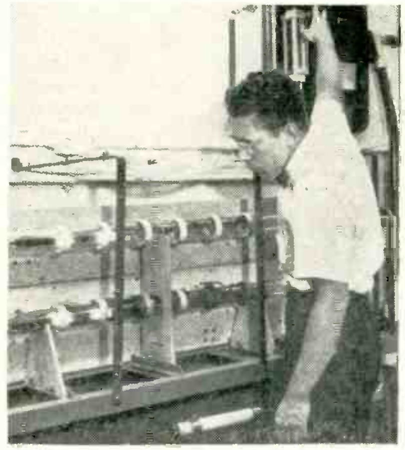
Everybody who knows ELECTRONICS has known Curtis McGraw, President and Chairman of the Board of the McGraw-Hill Publishing Company. The enduring mark of his leadership in the task of keeping business well-informed, shaping the technical development of industry, and holding the nation to an awareness of its power for greatness and goodness must remain on these pages. But it is something out of the lives of all of us that he died last month.

Production Techniques in

Point-contact and junction transistors require germanium slabs cut from single-crystals

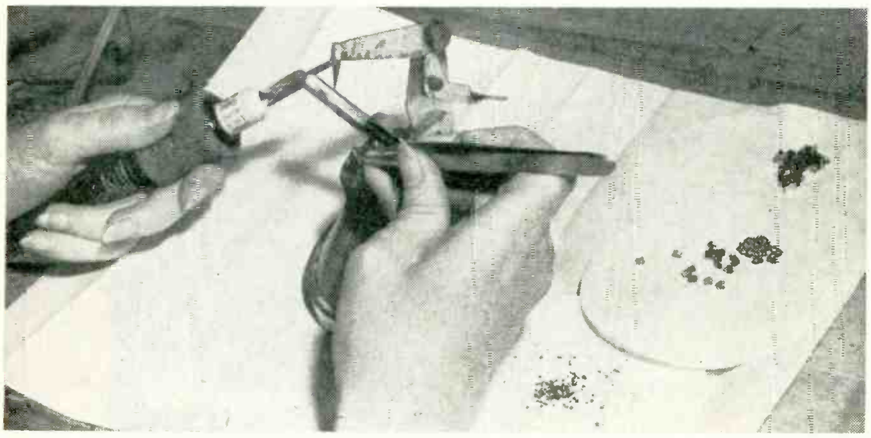


REDUCTION of germanium dioxide powder is achieved by heating in hydrogen atmosphere at carefully controlled temperatures up to 1,050 C. The metallic germanium undergoes a two-hour cooling period with the furnace turned off



ZONE-REFINING process further purifies metallic germanium. Boats containing metal are pulled through six zones

Fabrication of point-contact units involves use of mechanical and optical aids that per-

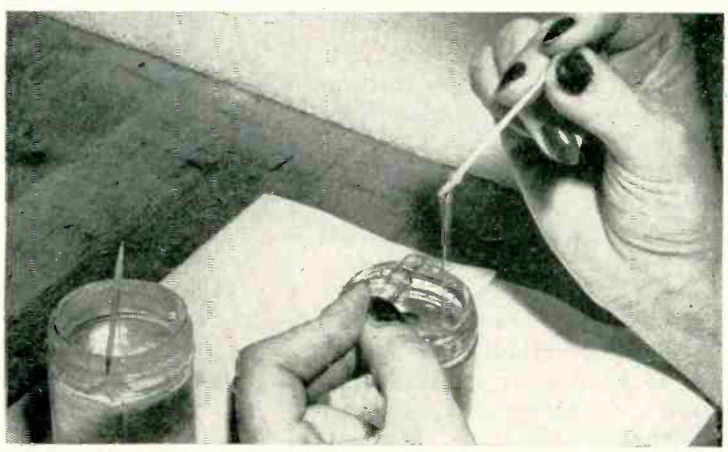


GERMANIUM PELLET for point-contact transistor is held in place by needle-point fixture for welding to tinned shelf that also serves as base connection. Point-contact pellets are 0.045 in. square

ETCHING to ensure uncontaminated surfaces is achieved on merry-go-round fixture that moves pellets under acid

Care must be taken in encasing point-contact transistors to see that the points remain

ASSEMBLY of point-contact transistors is accomplished using high-power microscope and micromanipulator to set contacts at a tolerance of 0.00025 in.



POLYISOBUTYLENE, a nonhardening resilient wax, is applied to the point-contact area to provide semi-fluid environment. A protective coating of quick-hardening polystyrene dope holds the wax in place

Transistor Manufacture

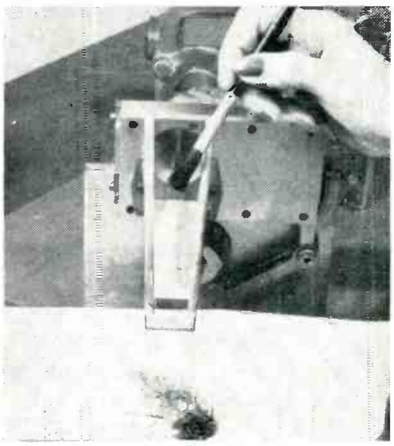
Complete details of the many steps involved, including pertinent timing data, temperatures, materials, dimensions, etching and other special processes. First technical article describing transistor manufacture at RCA's Harrison plant

By JAMES D. FAHNESTOCK
Associate Editor, ELECTRONICS

of controlled impurity . . .

GROWING of single germanium crystals comprises final step in germanium preparation. Subsequent process is sawing

mit close point spacing . . .



POINT CONTACTS are shaped in machine shown from spools of wire. Hair-thin contacts are visible as blur

fixed on base block . . .

ARALDITE, an opaque white plastic is poured over the transistor, using medicinal capsules as molds

ALTHOUGH TRANSISTORS are currently available on a commercial basis, many of the production methods used in their manufacture are small-scale operations in comparison with modern mechanized tube-making techniques. The processes to be described are those presently in use at RCA's commercial pilot-production setup at Harrison, New Jersey.

Industry needs for transistors are expected to exceed tens of thousands per day within a few years, and obviously automatic production methods will become mandatory to meet those demands.

Germanium Preparation

The first step in manufacturing transistors is the preparation of ultrapure germanium. The main source of germanium in this country is germanium dioxide, a by-product of the zinc-refining process. Removing the oxygen from the white germanium dioxide powder is accomplished by placing a boat containing approximately 450 grams of the oxide in a long tube inside a reducing furnace.

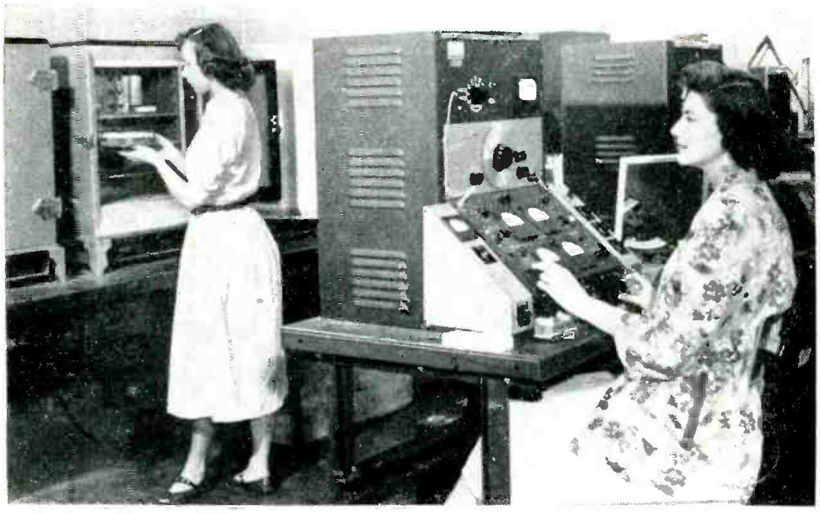
Inside the furnace a constantly circulating stream of dried and purified hydrogen is passed over the oxide. A cam-operated timing mechanism heats the germanium dioxide to a temperature of 650 C for 3 hours, 850 C for 1 hour, and 1,050 C for 1 hour. During this time the powder becomes metallic as oxygen is removed (in the form of water vapor) by the hydrogen.

The metallic germanium resulting from this preliminary purification process has a volume resistivity of between 1½ and 3 ohm-cm, but is still much too variable in its characteristics for use in transistors. A second process, called zone refining, is used to further purify the metal to a volume resistivity of as high as 50 ohm-cm. The intrinsic volume resistivity for pure germanium is 60 ohm-cm.

In RCA's zone refining process, the semi-pure germanium from the reduction furnace is pulled through one of two tubes in a boat similar to the one used in the reduction furnace. The boat must pass through six sets of induction heating coils each of which heats the metallic germanium under its turns to the melting point.

As the germanium leaves the influence of each set of coils, it again cools and solidifies and since most of the impurities commonly found in germanium prefer to be in molten metal rather than in solid metal, these impurities actually move toward the trailing end of the boat in each melting zone.

The result of the zone refining process is a bar of germanium, roughly 65 percent of the weight of



CURING AND TESTING comprise final steps in manufacture of point-contact transistors. Araldite polymerizes during 72-hour baking at 105 C. Shrinkage is held to about 0.5 percent. Testing position at right contains all necessary circuits for checking electrical parameters of transistors

germanium dioxide used, with resistivity ranging from 50 ohm-cm at one end and falling off to about 30 ohm-cm two thirds of the way toward the end that trailed in traversing the furnace. The six-foot tubes in the zone refining machine are traversed in two to three hours in an atmosphere of 90–10 forming gas.

Crystal Growing

The proper amount of impurity is added and the bar of germanium formed into a single crystal for transistors, in the vertical "growing" machine. The zone-purified germanium is melted in a hydrogen-atmosphere furnace. By a precise mechanical linkage a single germanium crystal or seed is carefully lowered onto the top of the germanium puddle. The germanium immediately begins to crystallize around this seed. Complete and instantaneous crystallization is prevented by mechanically pulling the crystallized part away from the melt while imparting a spinning motion. Pulling speed is approximately 0.032 inch per minute, and the forming crystal is spun about its axis at 60 rpm.

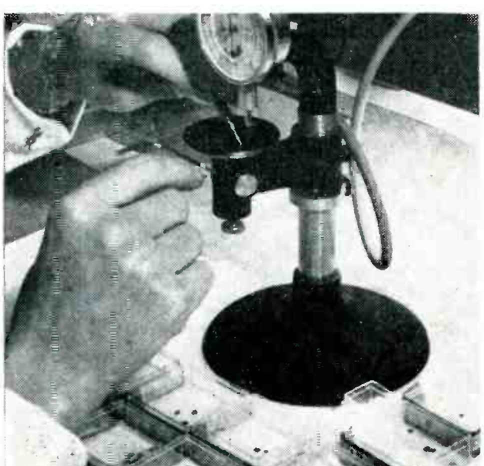
This growing process takes several hours. The result is a single crystal of germanium (some impurities are added prior to the growing process to obtain the desired characteristics) about as big as a thumb and six or eight inches in length. These bars are subsequently sawed with diamond wheels into minute pieces for use in transistors. The dimensions for the pellets used in point-contact transistors are 0.045 in. square by 0.010 in. thick and for the junction transistors the pellets are 0.090 × 0.130 × 0.005 inch.

Point-Contact Units

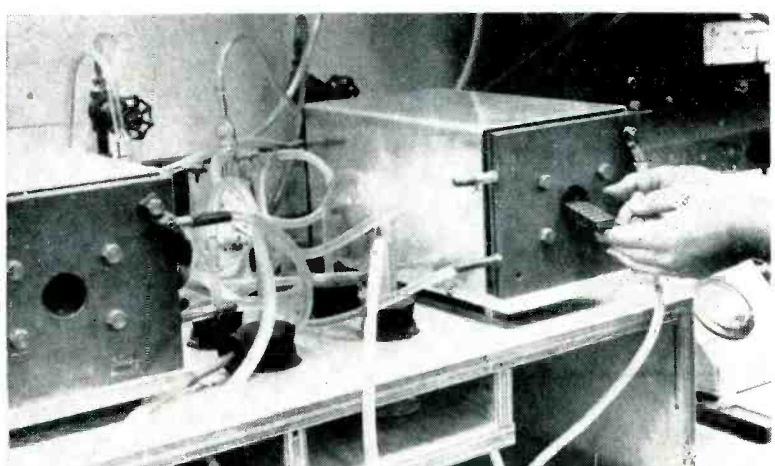
The 0.045-in. square pellet coming from the diamond saw contains mechanical surface irregularities that cannot be tolerated in transistors. An even surface is obtained by placing the pellets in a pre-etch bath. After the etch, the pellet is soldered to a support that has previously been tinned (with pure tin). The tinned surface of the support is first coated with Divco No. 335 solder flux, the germanium pellet placed on this surface, and a small soldering iron is then applied underneath the support to form a bond between the pellet and the support without contamination.

The next process involves the squirting of a fine stream of hydrogen peroxide and hydrofluoric acid on the surface of the pellet as one of the final cleaning steps before

Processing junction transistors also requires close tolerances in dimensions, temperatures



JUNCTION-TRANSISTOR base slabs are gaged to proper thickness by Ames gage. Thin slabs are rejected; thick slabs are re-etched



ALLOYING process takes place in hydrogen-atmosphere oven at about 550 C. Twenty-five base slabs are placed in machined holes in jig along with nickel tab that will serve as base connection applying the point contacts. This special etching process is carried on in a merry-go-round device in which the supports are fixed to the spokes of a rimless wheel in such a way that when the wheel rotates the pellets come under the nozzles of the acid streams and subsequent wash-water streams.

Used acid is collected beneath the wheel, and only fresh acid touches the germanium. When the supports reappear at the opening, the pellets have been completely processed and are ready for the locating of cat-whisker emitter and collector and the base lead.

A preformed point subassembly comprises three parallel wires 0.018 inch in diameter and held together by a glass bead. The center lead is shorter than the two outside leads which are formed to meet at one end for temporary mechanical rigidity. This assembly is held firmly in the movable portion of a jig that also serves as one electrode of a precision resistance welder of the type commonly used in tube manufacture.

The first step in assembly is to weld the almost invisible preformed emitter and collector wires to the side rods. The latter operation is done with the aid of a 10-power microscope.

The germanium pellet and its support are next placed in the fixed portion of the jig, which is arranged to slide the points into contact with the germanium pellet. Again, using a microscope, the operator determines the position at which both emitter and collector points come in contact with the germanium plus 0.002 in., causing the cat-whiskers to exert slight pressure on the surface of the germanium. The base connection is then welded to the center lead of the glass bead assembly.

A third step in this operation, using a modified optical comparator, consists of bending the side rods closer together or farther apart to adjust spacing between the bevelled points. This process sets the spacing to within 0.00025 in. of the desired value, which is 0.0015 to 0.002 in. depending on the resistivity of the germanium.

The transistor is now assembled, but mechanical, thermal, moisture, and light protection must be added. First, a coating of polyisobutylene is applied to the contact area by an operator using a toothpick and a magnifying glass. Since this material is resilient, a protective covering such as quick-hardening Amphenol 912 polystyrene is applied over it for mechanical protection. The latter hardens in air in about 3 minutes.

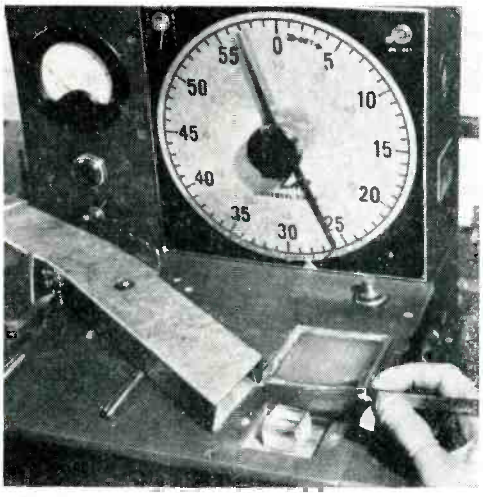
The point-contact transistor is finished by surrounding it with an ordinary medicinal capsule. A small paint brush and an ordinary eye dropper are used to seal and fill the capsule with Araldite, an opaque white plastic chosen for its low shrinkage. The transistors are then baked in electric ovens for 72 hours at 105 C to polymerize the Araldite—by this treatment shrinkage is held to about 0.5 percent. The electrical forming process consists of discharging a charged capacitor across the collector-base terminals of the transistor a number of times to obtain certain specified electrical properties. This process has been discussed in the literature and will not be explained here.

Alloyed-Junction Transistors

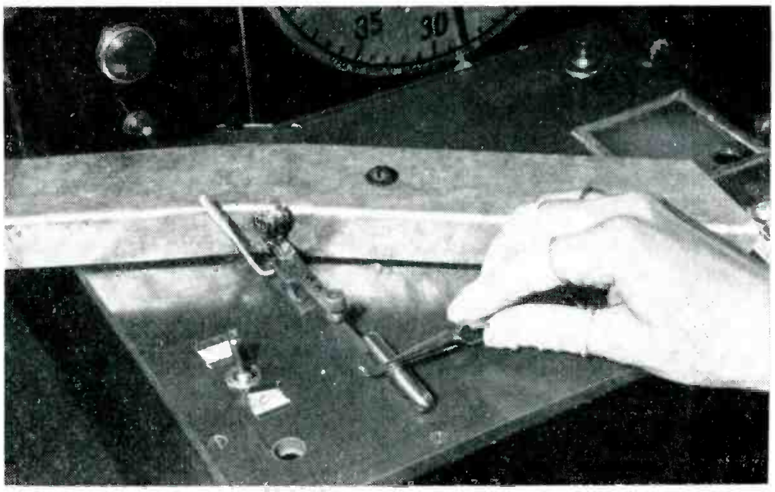
The alloyed-junction transistor uses the same germanium base material as the point-contact transistor, but the dimensions are different as mentioned previously. A small slab 0.090 × 0.130 in. by 0.005 in. thick is desired. These slabs are saw cut slightly over-size, so that an initial etching process to obtain surface smoothness may be applied.

After this etching process, the individual slabs are gaged and divided, according to thickness, into ten groups. Those having thicknesses less than 0.0045 in. are scrapped. Those between 0.00475 and 0.00525 are suitable for use. Those thicker than 0.00525 in. are re-etched in batches for a length of

and timing. Testing before final fabrication saves time and minimizes rejects . . .

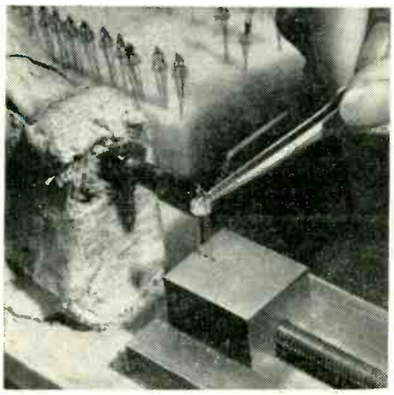


ETCHING position for germanium base with collector and emitter pellets in place. Wash bath and air blast are behind etch dish

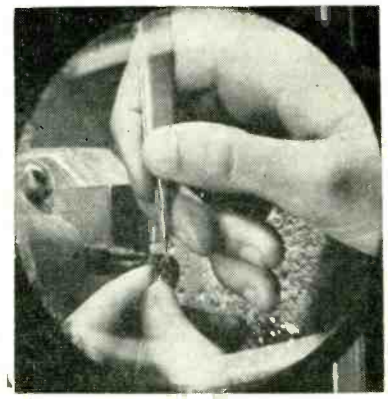


RESISTANCE of alloyed junctions is checked prior to assembly. Operator holds transistor base in tweezers that form one contact of ohmmeter which checks back resistance

Final operations on junction transistors are soldering, checking and electrical testing



HOT HYDROGEN melts solder that attaches tinned wires to emitter and collector pellets on opposite sides of junction transistor base



FINAL ASSEMBLY is checked for mechanical strength and arrangement of leads adjusted by inspector using pair of tweezers and magnifying glass

PLASTIC ENCASEMENT completes junction transistor manufacture. Junction is first dipped in polystyrene and then covered with black paint and Araldite

time depending on the amount of germanium to be removed. After the second etch, thickness is again checked. The slabs falling into the 0.0045 to 0.00475 in. category are held aside for a special subsequent processing.

Next comes the process in which emitter and collector pellets are fixed on opposite sides of the germanium slab. To make *pnp* junctions, indium pellets are used; for *npn* junctions, lead-antimony pellets are used. The pellets are cylindrical in shape, with an axial length thickness of 0.015 in. The emitter pellet has a diameter of 0.015 in., while the collector pellet is 0.045 in. in diameter.

Base Contact

Twenty-five of the germanium slabs are placed in precision slots in a jig. At the same time a tinned nickel tab is placed in contact with the germanium slab to serve as a contact point for the base connection. First, the collector pellets are brought into contact with one side of the wafers. The jig is then inserted in a close-fitting nichrome tube through which 100 amperes of current flows. The resulting heat penetrates the stainless-steel jig and fuses the tinned nickel tab and the collector pellet to the germanium slab.

The atmosphere in the furnace is one of purified and dehumidified hydrogen. The temperature is controlled in the range of 520 to 550 C to secure proper penetration of the pellet material into the germanium slab. After 1½ minutes in the furnace, the jig is removed, turned over, and the emitter pellets are inserted in the smaller holes on the opposite side of the germanium. The jig is then returned to the oven for a 4-minute firing. Shorter times are used for the undersize germanium slabs.

The individual transistors are then immersed in an etch solution of nitric and hydrofluoric acids for 25 seconds to remove any contamination on the exposed junction surface, taking care not to dip the nickel tab in the solution with the accompanying possibility of cross deposition of the metal. The acid action is stopped by washing the transistor in a circulating bath of hot water and a blast of purified air removes water particles for the short-circuit test that follows.

Resistance Testing

To facilitate rapid testing for low barrier resistance, a special ohmmeter is adjacent to the etching position. The nickel tab is held in a pair of metal tweezers. The tweezers are placed across a metal bar which forms one side of a circuit containing a 3-volt battery and a 0 to 100 microammeter. The circuit is completed by bringing the collector pellet in contact with a spring contact.

A current reading of 6 μa represents a collector barrier resistance of 500,000 ohms which is the low limit for acceptance on an initial etch. If more than 6 μa is indicated, the resistance is too low and the transistor is re-etched. If re-etching the second or third time is successful the transistor is accepted—if not, it is scrapped. A reversing switch on the tester permits testing of *npn* as well as *pnp* junctions.

The next step in the fabrication of RCA alloyed-junction transistors involves the connection of 0.005-inch copper-plated tungsten wires to the collector and emitter pellets and the base lead. This is accomplished by first tinning the ends of the wires with Cerrobend, a solder having a melting point of 90 C. The base wire is welded to the nickel tab by means of a small resistance welder. The emitter and collector wires, which have previously been welded to the base assembly, are brought into contact with the indium pellets in a stream of hot hydrogen. This operation is observed through a microscope to ensure a thorough bond. No flux is used in this operation. An inspector pulls on the soldered wires to insure firm mechanical bond.

The finished junction is then dipped in Amphenol 912 polystyrene. Because of the photosensitivity of the junction a coat of black paint is applied over the polystyrene and allowed to dry. The unit is then cast in room-setting Araldite using flexible molds similar to plastic ice-cube trays, to facilitate easy removal after the plastic hardens.

Backward-Wave Tube

Electron-stream amplifier utilizing backward-wave mode forms microwave oscillator continuously tunable over a three-to-one bandwidth by a single voltage control. Tubes have been built for frequency bands centering about 6,000, 10,000 and 50,000 mc

By H. HEFFNER
Bell Telephone Laboratories
Murray Hill, N. J.

VARIATION OF electromagnetic waves along an electron stream is the principle underlying much recent work in broadband microwave amplifiers and oscillators.

The backward-wave tube is a wave-type device that can form a microwave oscillator continuously tunable over a three-to-one frequency bandwidth merely by varying a single voltage. The tube can also be made to function as an extremely narrow-band, high-gain amplifier likewise tunable by varying a single voltage. Power outputs range from milliwatts to watts.

Loaded Waveguides

Any loaded waveguide capable of slowing down an electromagnetic wave is a potentially useful circuit for a traveling-wave tube. These loaded guides can often be described simply in terms of the lumped-constant filter analogy. In a filter composed of many identical sections of the type shown in Fig. 1A, the phase shift per section is approximately given by

$$\sqrt{BX} = \omega\sqrt{LC}$$

where B is the shunt susceptance and X is the series reactance. For energy fed in at the left, the phase progresses to the right. Thus energy traveling to the right has a progression of phase or phase velocity to the right given by

$$v_p = \omega/\sqrt{BX} = \omega^2/\sqrt{LC}$$

If L and C are made large enough, the wave travels slowly enough to keep in step with an electron beam. Figure 2 illustrates one method of loading a guide to slow down the phase velocity and indicates its equivalent lumped-constant filter circuit.

If the amplified output of the tube is fed back directly to the input, oscillations are built up at the frequency for which the output is in phase with the input. Although it would appear that the frequency could be continuously tuned by adjusting the phase shift in the feedback loop so that the total phase shift remained $2n\pi$ as frequency changed, in practice this scheme never worked very well. Since the circuit must be many wavelengths long to give reasonable gain, and the gain occurs over a large frequency range, one adjustment of the phase allowed favorable output-input addition at many different frequencies depending upon the number of wavelengths total phase shift. Thus as the phase shifter was tuned the oscillations would jump from mode to mode rather than tune continuously. Although several schemes were invented to circumvent the moding, they operated only over narrow bandwidths.

Energy traveling from left to right along a filter composed of several sections of series capacitance and shunt inductance as shown in Fig. 1B experiences a phase advance to the right. The phase shift per section is approximately

$$-\sqrt{BX} = -1/\omega\sqrt{LC}$$

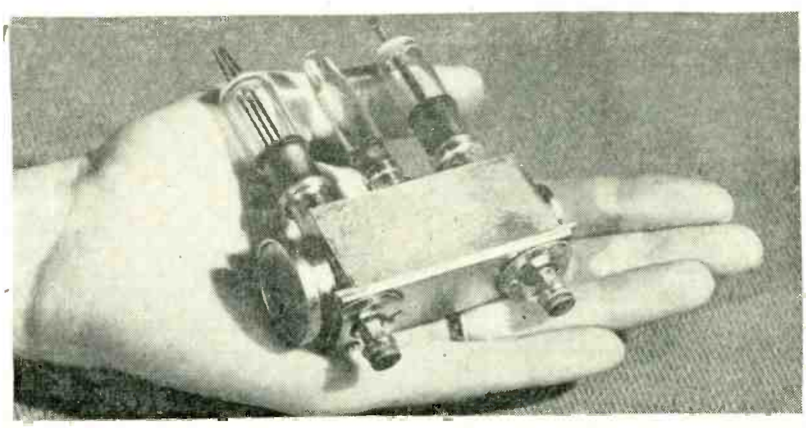
where B is the shunt susceptance and X the series reactance. The phase velocity of the wave is

$$v_p = -\omega/\sqrt{BX} = -\omega^2/\sqrt{LC}$$

Unlike the previous case, the direction of the phase velocity is opposite to the direction of energy transfer. Thus, the circuit is said to support a backward wave.

Backward Wave

The phase velocity of a backward-wave circuit is a rapidly changing function of frequency as contrasted with forward-wave circuits, which may have an essentially flat velocity-frequency characteristic. Figure 3 shows typical variations of phase velocity with frequency for forward and backward-wave circuits. Despite the fact that a backward-wave circuit changes phase velocity rapidly with



Millman 50,000-mc amplifier in which backward-wave oscillations were observed frequency, over a large band the phase velocity may be much slower than the velocity of light.

Feedback Circuit

A backward-wave tube is shown schematically in Fig. 4. Consider a feedback loop composed of an r-f electromagnetic field propagating energywise from right to left and and r-f conduction current induced by this field flowing from left to right which itself induces the original field on the circuit.

The electric field traveling along the backward-wave circuit experiences a phase advance of $\omega L/v_p$ where L is the total circuit length and v_p the circuit phase velocity. The electric field velocity modulates the electrons within the beam traveling along with it. One quarter of a cycle later, these electrons by virtue of the speeding up or slowing down have formed bunches giving rise to an r-f current. Thus the r-f current lags the electric field by 90 deg or $\pi/2$ radians. This r-f current travels down the tube with the beam velocity, u_o, and in a length L suffers a phase delay of $\omega L/u_o$. This r-f beam current in turn induces an electric field on the circuit. It can be shown that the conversion process introduces an additional 90-deg phase lag.

For the returned field to add in phase with the originating field, the total phase shift must be an integral number of cycles. Thus adding the phase advance on the circuit, the $\pi/2$ phase lag in converting electric field to current, the phase delay in the electron beam and the additional $\pi/2$ phase lag in converting again to the electric field gives

$$(\omega L/v_p) - \pi/2 - (\omega L/u_o) - \pi/2 = 2n\pi$$

or

$$(1/v_p - 1/u_o)\omega L = (2n + 1)\pi$$

as the condition for phase reinforcement.

Loop Gain

Integral phase shift is not the only condition for oscillation; loop gain must equal unity. Because there is loss inevitably present, the tube must amplify by traveling-wave-type interaction to satisfy this condition.

In any traveling-wave tube, the amount of amplification per wavelength is dependent upon the ratio of circuit impedance, Z, to d-c beam impedance V/I, and the difference between the electron velocity and the circuit phase velocity. The relative beam and circuit velocity is fixed by the condition that the feedback loop be an integral number of wavelengths. The condition to start oscillations is

$$ZN^3I/V = \text{constant}$$

where N is the length of the circuit in wavelengths and the constant depends upon which integer value of n is picked in the phase-reinforcement relation. As n becomes larger so does the value of the constant, indicating that more beam current is required to start oscillations for the higher oscillation points. This is to be expected since a larger value of n means that the difference between beam velocity and phase velocity is larger with the result that the wave and beam tend to get out of step, causing the amplification to fall off.

Backward-Wave Oscillator

If the beam current is adjusted to the value required to start oscillations for the $n = 0$ conditions, the tube will oscillate at a frequency determined by the phase-reinforcement relation

$$\omega = \pi/(1/v_p - 1/u_o)L$$

When the beam velocity u_o is changed by varying the beam voltage, the frequency also changes. Since the phase velocity of the circuit is a smoothly varying function of frequency, the frequency will be a smoothly varying function of beam velocity and the oscillator will exhibit no holes or jumps. It will be continuously voltage tunable.

Backward-Wave Amplifier

Such a regenerative-type oscillator acts as a high-gain amplifier when operated just below the start-oscillation current. The gain is a maximum for the frequency at which the length of the feedback path insures exact phase addition and falls off rapidly as the frequency changes and the feedback goes from positive to negative. Gains of 40 to 50 db can be achieved depending upon how close the beam current is to the start-oscillation value. Figure 5A shows a typical variation of gain as a function of current. The formal relation of gain as a function of current at the frequency of maximum gain may be expressed as

$$\text{Power-gain ratio} = K/(I - I_s)^2$$

where K is a constant depending upon the impedance and tube length and I_s is the start-oscillation current.

Gain falls off rapidly away from the critical frequency-velocity point where the feedback is positive, that is, when circuit phase shift minus beam phase shift is equal to π. Since for many tubes, the magni-

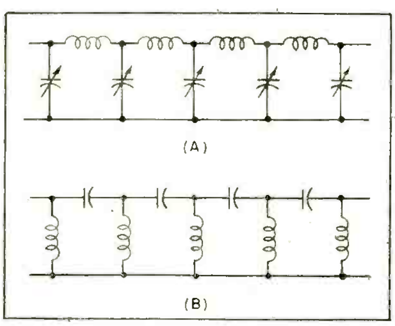


FIG. 1—Filter that propagates a forward-wave (A) and backward-wave (B)

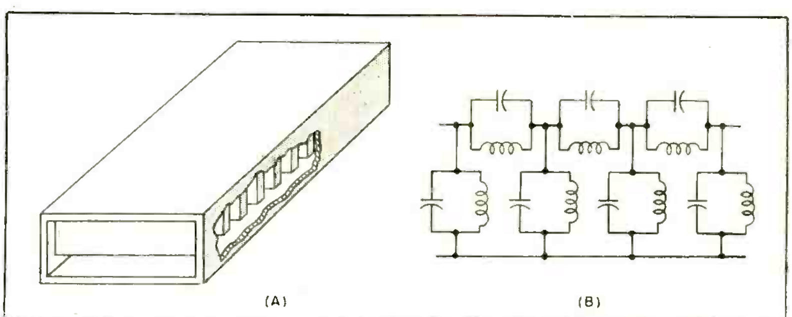


FIG. 2—Loaded waveguide (A) and its equivalent representation using the lumped-constant filter analogy (B)

tudes of these phase shifts may be near 100, it requires only a small frequency change to make their difference vary from π to 2π resulting in a change from positive regenerative feedback to negative degenerative feedback. The effective Q of the backward-wave amplifier is defined as the ratio of the frequency deviation required to reduce the gain by half to the frequency of maximum gain. On this basis, backward-wave tubes have been built which have values of Q running into the thousands. These tubes have been constructed not only in the centimeter-wave region but also in the millimeter-wave band where cavity Q's above several hundred are nearly impossible to attain.

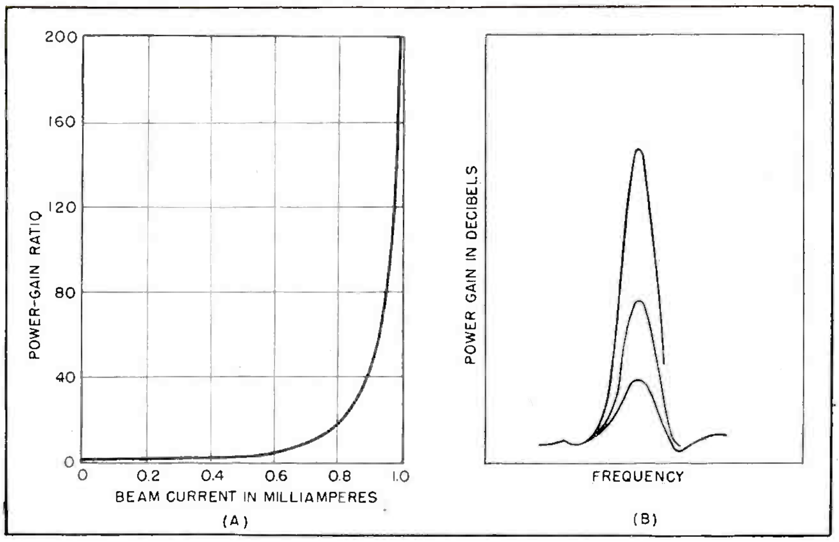


FIG. 5—Variation of backward-wave gain with beam current (A) and power-gain as a function of frequency

Selectivity and Bandwidth

Figure 5B illustrates the variation in amplification with frequency in the backward-wave amplifier. As the beam current becomes closer to the start-oscillation value the maximum gain increases but in addition the gain curve becomes more sharply peaked indicating that the effective Q increases with increased current.

The phase-shift relation that insures regenerative feedback indicates that the entire gain curve can be shifted along the frequency axis by merely changing beam velocity. Thus it is possible to build a high-gain microwave amplifier that can be swept over a wide band at rates up to several million times a second and can distinguish with a high degree of resolution between two signals differing only slightly in frequency.

Bandwidth of a backward-wave oscillator depends upon the circuit used, its pass band and the detailed phase velocity variation of frequency. See Fig. 3. The oscillation bandwidth can be no greater than the circuit bandwidth, but it can be less. For example, the phase velocity can become so high that it is difficult or even impossible for electrons within the beam to travel fast enough to satisfy the phase relation for regeneration. Nevertheless circuits are known that allow the frequency to be tuned over a three or even four-to-one ratio. A backward-wave oscillator has been built that will tune anywhere from 3,000 to 9,000 mc.

Other Advantages

Another great advantage of the backward-wave tube is its immunity to frequency pulling. Unlike the magnetron and the klystron, the frequency of oscillation does not change as the impedance of the load is changed. This characteristic makes unnecessary the insertion of an isolation element such as a fixed attenuator between oscillator and load.

The efficiency of early backward-wave oscillators, defined as the ratio of r-f power developed to d-c beam power, was low, probably less than one percent. Since then, by the use of better circuits and better focused electron beams, the efficiency and the power output have been increased such that a group working at Stanford University has reported continuous power outputs of 125 watts with 12-percent efficiency.

Frequency modulation of a backward-wave oscillator is obtained by varying the beam voltage, while amplitude modulation results from beam-current variations. The resultant modulation of the backward-wave oscillator, in common with most electron-beam-type oscillators, is not pure frequency or pure amplitude variation. There is a small amplitude variation as beam voltage is changed and a small frequency variation as beam current is changed. These effects are not so pronounced as they are in the klystron but under certain circumstances they may be troublesome enough to require correction.

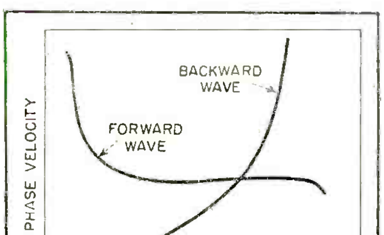


FIG. 3—Phase-velocity variation in forward and backward-wave circuits

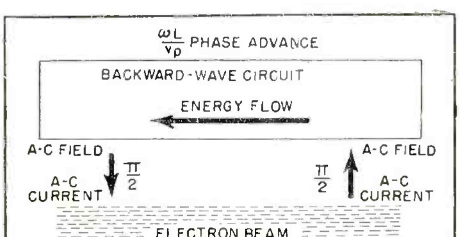


FIG. 4—Operating principle of backward-wave tube

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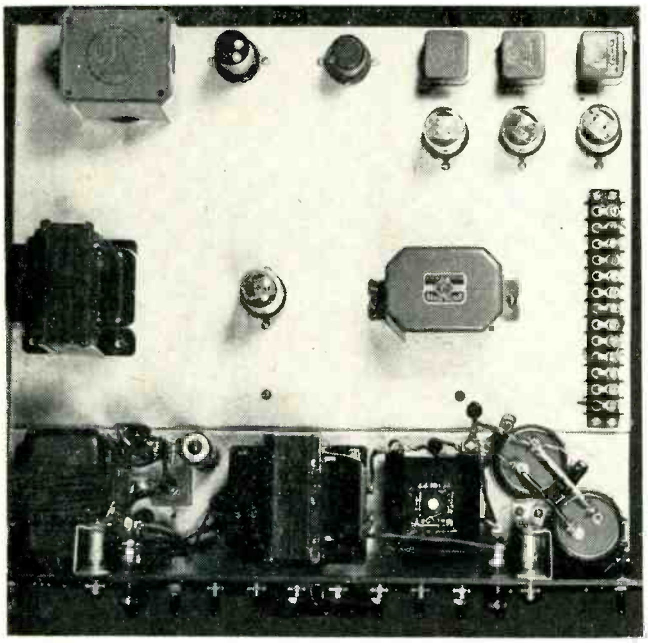
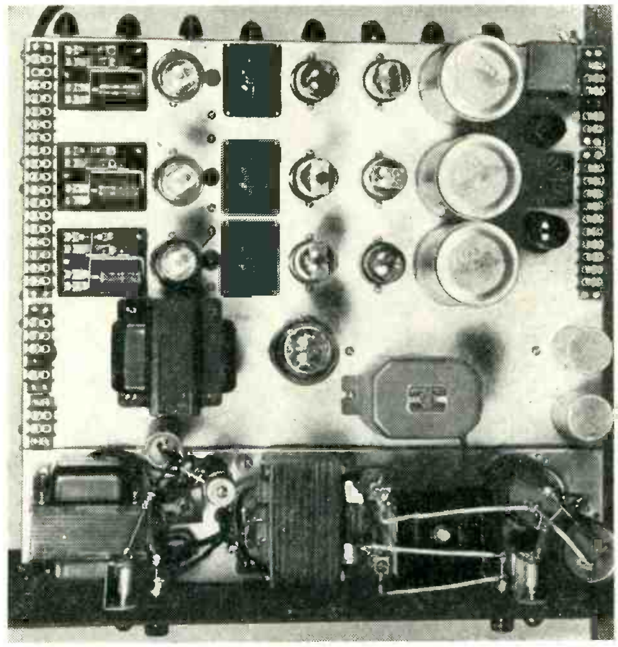


Top view of control chassis



Top view of remote chassis

Remote-Control System

By A. V. TIDMORE *Owner and General Manager WPPA Pottsville, Pa.*

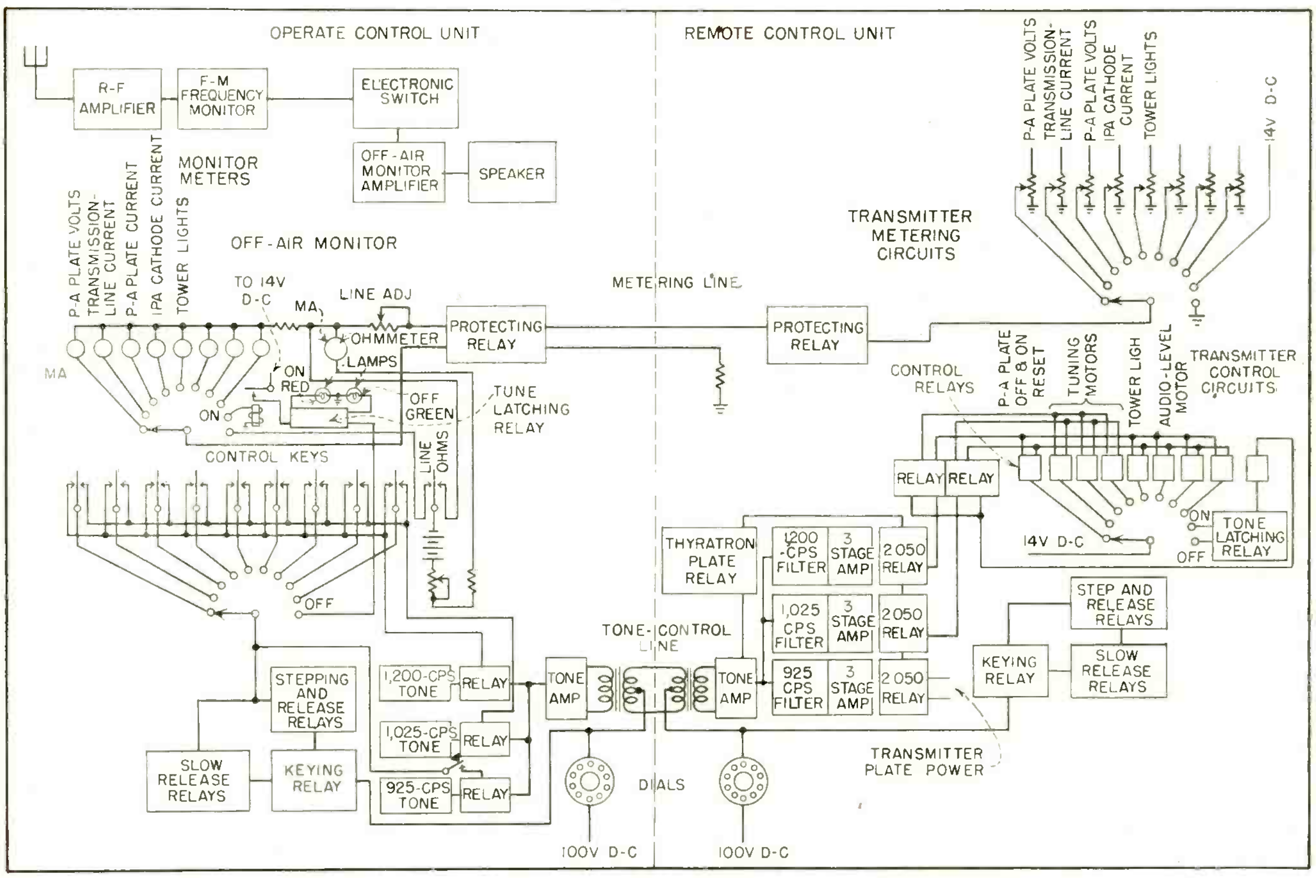


FIG. 1—Block diagram of complete transmitter remote-control system

TABLE I—FCC SPECIFICATIONS FOR TRANSMITTER REMOTE-CONTROL EQUIPMENT

The equipment at the operating and transmitting positions shall be on the premises under the control and supervision of the licensee at all times and shall not be accessible to persons other than the licensee or his agents.

The control circuits from the operating position to the transmitter shall provide positive on-and-off control and shall be such that open circuits, short circuits, grounds or other line faults will not actuate the transmitter; and any fault causing loss of such control will automatically place the transmitter in an inoperative condition.

A metering system shall be provided so that the operator at the remote-control position shall have indications of the operating constants of the last radio stage (total plate current and plate voltage) and the r-f transmission-line meter reading.

Means shall be provided for calibration and adjustment of the metering system to provide the accuracy prescribed in the Standards of Good Engineering Practice concerning f-m broadcast stations.

Means shall be provided so that the operator at the remote-control position shall have an indication as to the condition of the tower lighting.

Frequency and modulation monitors shall be installed at the remote-control position to indicate continuously the carrier frequency and percentage of modulation.

Provision shall be made so that the necessary tuning of the transmitter and control of its output can be accomplished from the remote-control position

For F-M Broadcasting

Positive and fail-safe operation of remote f-m broadcast transmitter is achieved using stepping-switch function selector and audio-tone control working over telephone lines. Remote metering circuits monitor five important circuit functions

REMOTE CONTROL of WPPA's transmitter is provided by the equipment to be described. The operate-control unit is located at the a-m transmitter site and the remote-control unit is installed at the f-m transmitter ten miles away. Two telephone lines are used to operate the transmitter. One line connects meters mounted on a panel at the operating location to appropriate circuits at the transmitter. The other carries dial impulses and audio tones to tune the transmitter. Output of the f-m transmitter is monitored off the air by a vhf receiver installed at the operating point.

Metering Panel

Six quantities are metered remotely: power-amplifier plate voltage, transmission-line current (in percent of maximum), power-amplifier plate current, intermediate-power-amplifier cathode current, number of tower lights lit and resistance of the metering line. Lamps on the metering panel indicate the condition of the tuning-control latching relay. A red lamp indicates that the latching relay is in ON position and that the transmitter is tunable by remote control. The green lamp denotes that the relay is in OFF position and that remote controls are inoperable.

The function to be monitored is selected by a telephone-type dial that sends a series of d-c pulses over a phantom circuit on the tone-control line. The number of pulses corresponds to the number dialed and actuates a stepping-switch relay that selects the transmitter function to be monitored.

Tuning is accomplished remotely by a tone-control system. Transmission-line current and power-amplifier grid and plate currents are adjusted by tuning motors in the transmitter. Audio tones sent over the line in response to left or right motion of double-throw key-type switches determine whether the tuning motors will advance the controls clockwise or counterclockwise. Audio tones are also used to turn the plate-reset relay off and on and to control tower lights. A separate audio tone holds the transmitter plate relay on and releases in case of control-equipment or line failure, putting the transmitter off the air.

Ten lamps on the control panel show what transmitter function is currently being monitored. Many of the fuses in the remote-control equipment are equipped with failure-alarm lamps to facilitate troubleshooting. Table I lists specifications for transmitter remote-control equipment as established by the Federal Communications Commission.

Dial System

The block diagram, Fig. 1, shows the operate-control unit at the a-m transmitter and the remote-control

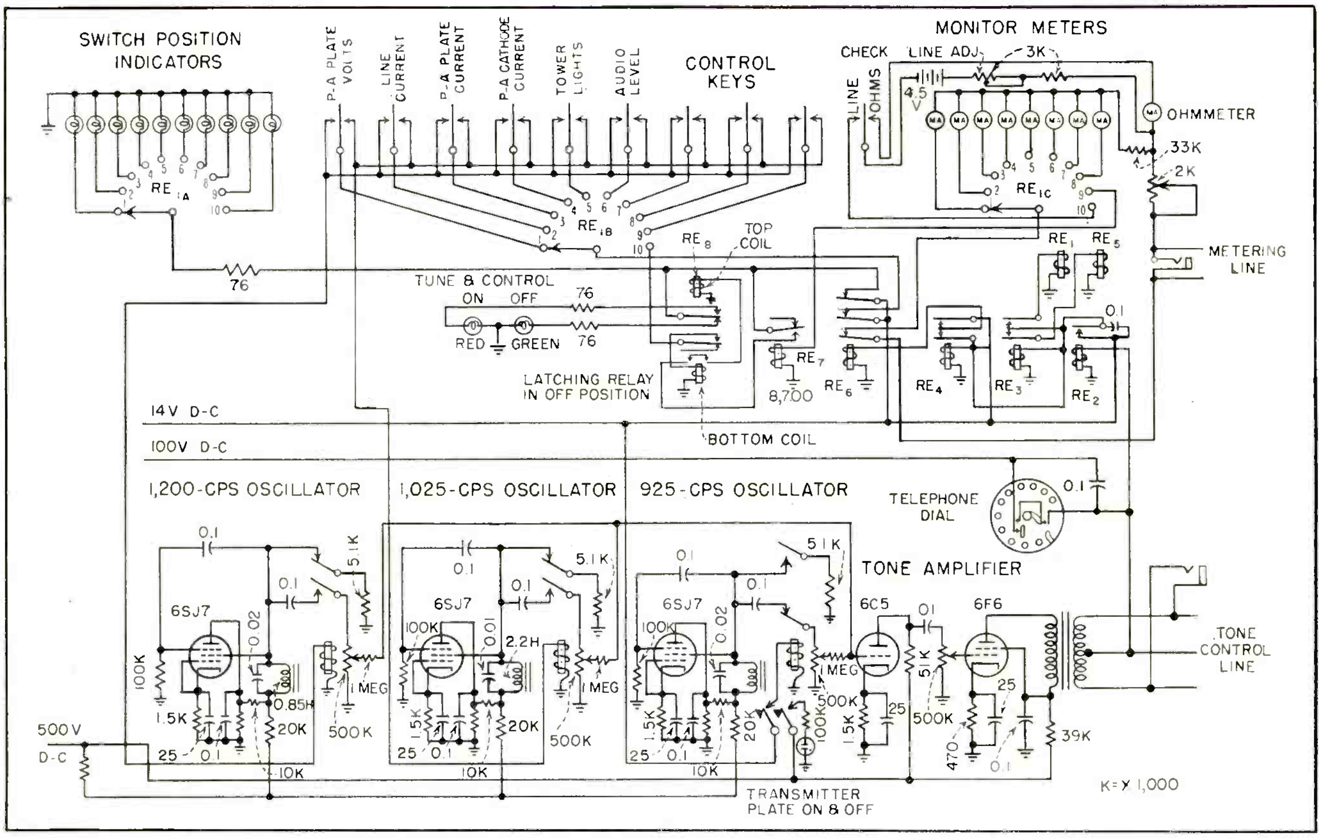


FIG. 2—Operate control unit includes three audio oscillators that provide control tones

unit at the f-m transmitter. Both are coupled to the connecting telephone line through transformers. The center tap of each transformer is connected to ground through a keying relay. Either telephone dial puts 100-volt pulses on both keying relays so the system can be operated from either the operate or remote-control point. This allows the engineer to check equipment performance by operating it at the remote site. Dial points and keying-relay contacts have 0.1-μf capacitors connected across them to suppress arcing.

When either telephone dial is dialed clockwise, a pulse or pulse train is impressed from the center taps of both transformers to ground through the two keying relays. The keying relay in the operate-control unit is shown in Fig. 2 and the keying relay in the remote-control unit may be seen in Fig. 3. Both relays are designated RE_2. Dialing circuits for both units are practically identical.

The keying relays close intermittently at both transmitter and control point in response to pulses from the telephone dial. This supplies 14 volts d-c to a pair of slow-release relays, RE_3 and RE_4. Protecting relays, RE_6, prevent voltage from arcing on the contacts of the stepping-switch relay, RE_1, during the switching operation. The protecting relays are energized through the normally-open contacts of slow-release relays, RE_4, and are kept energized through the normally-closed contacts on the same relays while they are energized.

Before slow-release relay, RE_3, can operate in response to the signal from the keying relay, the release relay, RE_5, is actuated through the normally-closed contacts of the slow-release relay. The release relay resets the stepping relay, RE_1, to its initial position. The stepping relay is then energized through the normally-open contacts on the slow-release relay, RE_3, and the stepping switch is set to position 1.

When number 1 is dialed, no pulses are applied since the stepping relay is automatically set to position 1 as it comes to rest. The dial pulse consists of removing the 14 volts d-c for a fraction of a second.

When number 2 is dialed the counterclockwise movement of the dial impresses one pulse on the tone-control line to ground and also across keying, stepping and slow-release relays. The dial pulse has no effect on the slow-release relays but actuates the stepping relay, moving the switch arm to position 2.

Ten positions can be achieved with nine pulses from the telephone dial. The stepping relay automatically resets on each clockwise motion of the dial. When the dial is at rest, all relays are dëenergized. The pulses of the dial can be heard by connecting a pair of earphones from the center tap of either line transformer to ground.

Operate-Control Unit

The operate-control unit incorporates three audio oscillators that generate control tones for the f-m transmitter. Transitron oscillators tuned to 925, 1,025 and 1,200 cps are coupled to the tone-control line through a two-stage amplifier. The 1,025 and 1,200-cps tones control transmitter switches and tuning motors when actuated by tuning-control key switches. The 925-cps tone is always on the line when the transmitter is operating under remote control. It actuates the

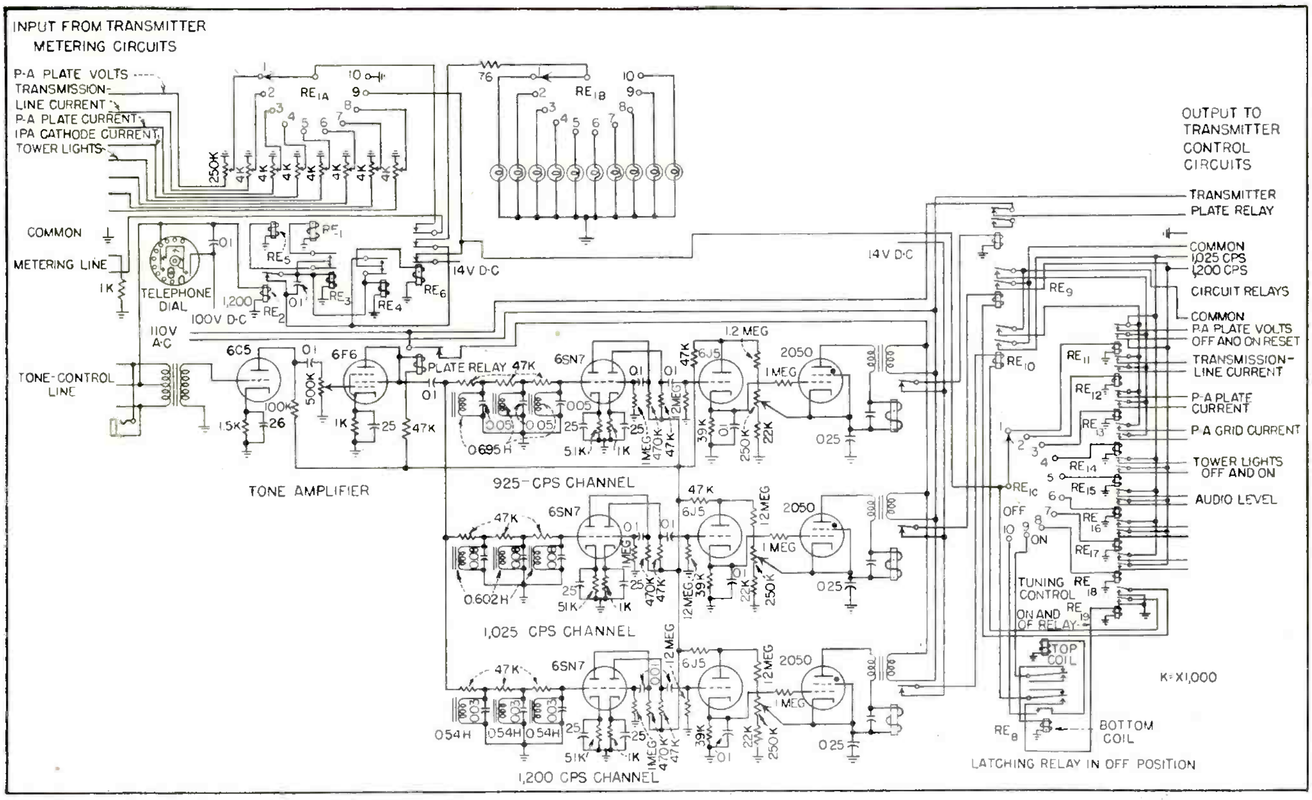


FIG. 3—Remote-control unit has sharp-bandpass filters that feed control tones to proper thyratron relay tube

transmitter plate relay through circuits in the remote control unit.

The stepping switch consists of three decks of ten contacts each. The first deck connects to a bank of ten lamps that tell the operator at a glance what position the arm is in. The second deck selects one of the first nine control key switches. The arm is connected to 14 volts d-c. The tenth key switch is connected through contacts on the third stepping-switch deck and actuates an ohmmeter used for checking line resistance.

Each key switch controls a transmitter adjustment. When the key is moved to the right, 14 volts d-c is applied to a relay in the plate circuit of the 1,025-cps oscillator that connects its output to the tone amplifier. When the key is moved to the left, the 1,200-cps tone is put on the line. The outputs of both tone oscillators are normally loaded to ground and disconnected from the tone amplifier. The 1,025 and 1,200-cps tones are used either to turn tuning motors clockwise or counterclockwise or to turn switches off and on at the f-m transmitter.

The third deck of the stepping switch selects one of six meters. Meters one to five read: p-a plate voltage, transmission-line current (in percent), p-a plate current, ipa cathode current and number of tower lights lit. The meters have 500-microampere movements and 33,000-ohm multipliers. Sixteen volts d-c across the metering line causes full-scale deflection.

When number 10 is dialed, an ohmmeter is connected into the circuit. The ohmmeter has a 1-milliampere movement. When key switch 10 is thrown to the right, the ohmmeter may be calibrated to zero; when thrown to the left, the ohmmeter reads the resistance of the metering line. The line-compensating resistor (LINE ADJ) is used to adjust line resistance to the value determined when the meters were calibrated. Line resistance changes little, however, and has little effect on the meter readings.

The tuning-control latching relay provides a safety feature that prevents the transmitter's being tuned accidentally. Before a tuning

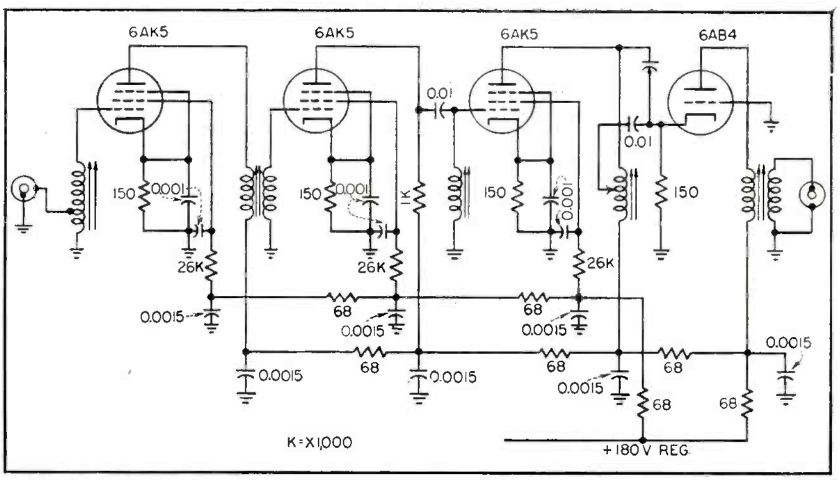


FIG. 4—Radio-frequency amplifier used in off-air monitoring

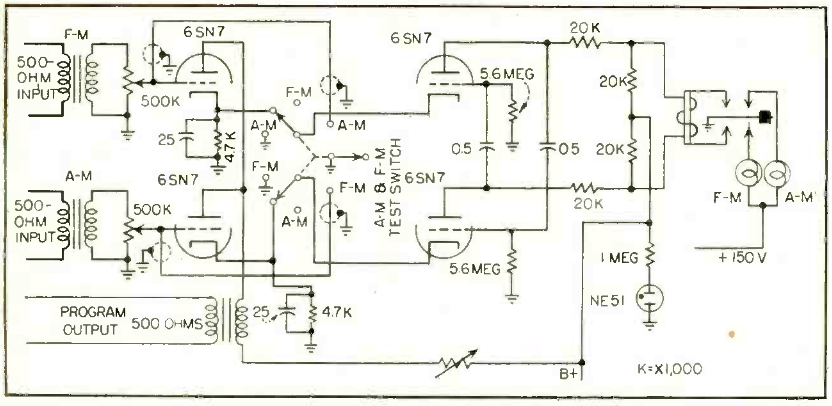


FIG. 5—Electronic switch permits simultaneous monitoring of a-m and f-m signals

control can be actuated, it is first necessary to place the latching relay in ON position. This is done by dialing number 9. This connects 14 volts d-c to the line to energize the sensitive relay, RE_7 in the operate-control unit. The sensitive relay in turn applies 14 volts d-c to the latching relay RE_8 turning it on. The ON position is indicated by a red lamp. With the tuning-control latching relay in ON position, RE_9 and RE_{10} in the remote-control unit are energized. These relays are in the tuning-control circuits and permit the control relays to be actuated in response to tone signals.

When number 10 is dialed at either control point, the tuning-control latching relay is placed on OFF position.

Remote-Control Unit

The signals from the tone-control line are transformer-coupled to a two-stage audio amplifier. After amplification, the audio tones are separated by three parallel band-pass filters sharply tuned to 925, 1,025 and 1,200 cps respectively. The output each filter is amplified, rectified and applied to the grid of a 2050 thyratron. Each thyratron has a relay in its plate circuit that is energized when the tube conducts. The 925-cps tone is always on the line and the output of this channel keeps the transmitter plate relay energized.

The 1,025 and 1,200-cps channels carrying tuning control signals. The switch arm of deck number three of the stepping switch selects a set of relays from RE_{11} to RE_{19} depending upon the number dialed by the operator. These control relays actuate tuning motors or throw switches depending upon the transmitter function being adjusted. The relays are energized when current flows in the thyratron relay tube and the frequency of the audio tone thus determines the direction of tuning-motor rotation.

Number-two deck of the stepping switch connects one of ten indicator lamps to give visual indication of the position of the arm. Number-one deck is connected to 8 potentiometers. One end of each potentiometer is connected to its individual transmitter metering circuit. The other end is connected to ground. The potentiometers are adjusted so that remote meter readings correspond to meter readings of the f-m transmitter. Transmitter meter readings are taken from the ground side of the transmitter circuits. Protective parallel resistors are placed in circuits where high voltage is found. Should one of the resistors open or become defective, high voltage will not appear in the remote-control units. Since it was impossible to get a true sampling current from the p-a grid and still keep one side of the transmitter metering circuit grounded, the ipa cathode current is metered instead.

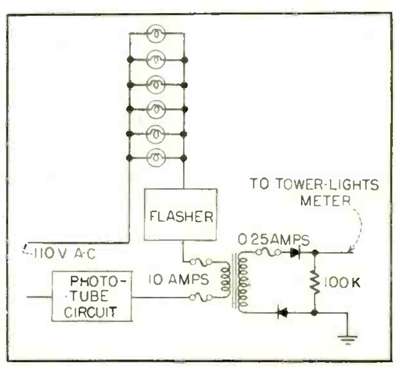


FIG. 6—Simple circuit indicates number of tower lights burning

CONELRAD

The remote-control equipment complies with the CONELRAD requirement. The transmitter is taken off the air if any of the following units fail: tone-control line, two-stage tone preamplifiers, 6F6 plate-relay circuit (the 6F6 plate removes the 110 volts a-c from the thyratron), 925-cps sharp-band-pass filter, three-stage amplifier, thyratron control tubes or the d-c plate voltage supply.

R-F Amplifier

The frequency and modulation monitor is operated off the air by picking up the f-m signal on 101.9 mc, at the operate-control point using an eight-element Yagi antenna and amplifying the r-f signal in the four-stage r-f amplifier shown in Fig. 4. Several low-power tubes are used to reduce television interference. The r-f amplifier can pass f-m with sufficient bandwidth. The d-c power supply is electronically regulated.

Electronic Switch

The off-the-air audio monitor is operated by an electronic switch (Fig. 5) through the use of a multivibrator circuit. The f-m and a-m monitoring program is fed to the master monitoring amplifier with three-second periods of f-m alternating with three-second periods of f-m and a-m. Lamps indicate which program is in operation. The f-m and a-m signals can be monitored separately by turning the test switch to the left for f-m or to the right for a-m. The center position is used for the a-m and f-m monitoring.

Tower-Light Metering

The tower-light metering circuit is shown in Fig. 6. This consists of a current transformer and a full-wave selenium rectifier. This unit is calibrated to register on the meter the exact number of lamps lit. Arrangements are also provided for talking between operate and remote-control points by capacitively connecting a telephone to the metering line.

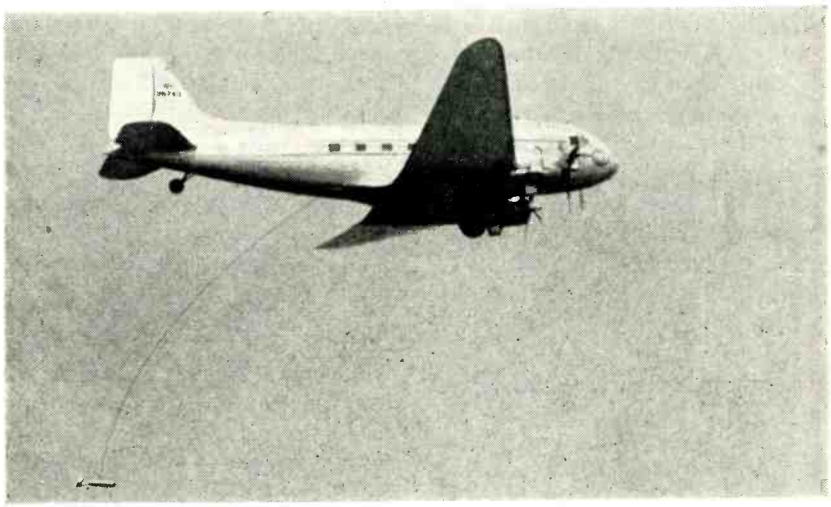
Magnetics In Geology

Three-coil sensing head and bridge circuit measure the magnetic susceptibility of rocks in the ground for correlation with readings obtained with airborne magnetometer. Change in self-inductance of coil ordinarily caused by rock irregularities is avoided in design that is also independent of frequency

By HAROLD MOONEY
Assistant Professor of Geophysics
University of Minnesota
Minneapolis, Minn.

INTERPRETATION of aeromagnetic measurements must generally be made in terms of magnetic rock studies since the magnetic effect produced by a given structure depends upon the contrast between it and surrounding rock. The instrument to be described was developed for measuring magnetic susceptibility of rocks in place.

All previously published data on the magnetic susceptibilities of rocks have been based on laboratory methods using a few grams of sample. It has been shown[1] that many such measurements are needed to describe adequately the magnetic properties of a large rock body.



Surveys with sensitive magnetometer suspended below plane indicate possible presence of iron ore and oil in land below

Reducing Errors

Measurements made on the rock in place should reduce sampling errors, since the effective volume of rock under measurement is several thousand times greater than for laboratory measurements. It should eliminate changes in magnetic properties produced by crushing or grinding, eliminate demagnetization errors and permit direct correlation with geology.

The basic instrument consists of three coils and a portable bridge for measuring mutual inductance. Coils A and B are connected in series, so wound that their fields nearly cancel at the position of coil C. Mutual inductance between C and the system A and B then reduces to a small value, about 200 μh for the particular arrangement used here. When the assembly is placed on a rock surface, asymmetry of the coil system causes the mutual inductance to change. Magnetic susceptibility of the rock can be related to measurable electrical quantities through the following analysis.

The mutual inductance between two coaxial circular coils is

$$M = 8\,\pi\, n_1\, n_2 \sqrt{r_1\, r_2} \left[\left(1 - \frac{t^2}{2} \right) K - E \right] 10^{-3}\ \mu\text{h}, \qquad (1)$$

where $K(t)$ and $E\ (t)$ are complete elliptic integrals of the first and second kinds, $t^2 = 4\, r_1 r_2 / [(r_1 + r_2)^2 + z^2]$ and n, r and z represent respectively number of turns,

Table I—Coil Characteristics

	Coil A	Coil B	Coil C	
Radius in Cm	9.8	31.0	9.8	
Number of Turns	227	200	200	No. 29 Formex
Resistance in Ohms	39.1	109.0	34.5	
Self Inductance in Mh	27.2	74.9	18.539*	*Effective value, determined indirectly
Mutual Inductance with Coil C in Mh	−2.331	+2.543		Calculated

Analysis of airborne magnetometer findings depends upon field surveys. Portable instrument mounted on tripod is also used directly above rock formations

radius in cm, and axial offset in cm.

Smythe[2] derives an equivalent equation. The change in mutual or self-inductance owing to the rock can be calculated in terms of the mutual inductance between a particular coil and the image of the same or another coil. The image, of strength $2\pi k/(1 + 2\pi k)$ where k represents magnetic susceptibility, is located at the reflection position.

Inductance Calculation

To illustrate, the mutual inductance between two coplanar coils 5 cm above the level surface of a rock of susceptibility k would be determined from the above formula with $z = 0$. The change in mutual inductance ΔM due to the rock would be calculated by the same formula with $z = 10$ and M multiplied by $2\pi k/(1 + 2\pi k)$. A change in self-inductance can be computed as the mutual inductance between the coil and its image.

It is convenient to separate each of the results into a factor G dependent on the geometry of the system and a factor $k/(1 + 2\pi k)$ involving only rock susceptibilities. The effects produced by the rock can then be written as a change in mutual inductance $\Delta M = G_1 k/(1 + 2\pi k)$ and a change in self-inductance $\Delta L = G_2 k/(1 + 2\pi k)$, where each G is the sum of one or more terms in the form of Eq. 1. Typical values for G_1 and G_2 are 9,608 and 10,220 microhenrys, calculated for the dimensions shown in Fig. 1.

Let it be assumed that the magnetic properties of the rock have changed the apparent coil constants to $M + \Delta M$, $L_c + \Delta L_c$, and $R_c + \Delta R_c$; the bridge is now found to balance at $R_1 + \Delta R_1$, $R_3 + \Delta R_3$. By substituting these new values into the balance conditions shown in Fig. 2 it may be shown that

$$\frac{\Delta R_3}{R_3} = \frac{M \Delta L_c - L_c \Delta M}{(L_c - M)(M + \Delta M)} \quad (2)$$

where the changes are not restricted to small values because products such as $\Delta R_3 \Delta M$ have not been dropped. Approximating $L_c - M$ by L_c, the final relationship becomes

$$\Delta R_3 = \frac{k}{1 + 2\pi k} \frac{\frac{R_2 R_3}{R_2 + R_3} G_2 - R_3 G_1}{M + G_1 \frac{k}{1 + 2\pi k}} \quad (3)$$

The bridge readings give R_3, ΔR_3 and (from the balance conditions) M. The unknown k can then be calculated from the electrical and geometrical constants of the system. In principle, M should be constant for a given coil arrangement, but temperature change and mechanical shock produce small changes that cannot be neglected.

For this reason each susceptibility determination is preceded by a base reading of R_3, on a tripod well away from the rock. A small correction for the effect of the rock must be applied to the tripod reading. In practice, Eq. 3 is plotted as a calibration curve of k vs ΔR_3, using three values of R_3 as parameter for each point of the curve.

The unusual coil arrangement of Fig. 1 minimizes an important source of error, that due to irregularities of the rock surface. The calibration equation assumes an infinite plane surface; failure to satisfy these assumptions may produce large errors.

Rock Irregularities

It has been shown[1] that, for this instrument, a hemisphere of 50-cm radius will approximate an infinite half space. In addition, Eq. 3 can be used to demonstrate that, with a proper choice of coil arrangement, the electrical change ΔR_3 produced by a given rock can be made to pass through a maximum as the coils are lifted from the rock surface. The maximum occurs at $F = 3.3$ cm in Fig. 1.

At the peak, therefore, small errors in measuring F produce only slight errors in ΔR_3. This predicted effect has been verified experimentally. To the extent that surface irregularities are equivalent to an error in measuring F, the coil arrangement of Fig. 1 will minimize their effect.

Paterson[3] and Duffin[4] have described instruments for determining magnetic susceptibility on rock outcrops. Paterson measured the change of self-inductance of a coil laid on the rock; Duffin measured mutual inductance for the three coplanar coils of a model 625 mine detector. Maximum sensitivity for both instruments coincides with maximum variation with distance from the rock surface, as shown in Fig. 3. As a result, surface irregularities can cause large errors.

To provide comparative data on outcrop vs laboratory measurements, a laboratory instrument similar to one described by Duffin was constructed. Coils were so wound that the same measuring circuit could be used as for the outcrop instrument.

Circuits

The complete circuit shown in Fig. 4 includes oscillator, bridge and detector.

The null-measurement characteristic of a bridge was chosen over a direct-reading meter to avoid uncertainties produced by variable oscillator output and variable amplification. The circuit, essentially a Heydweiller bridge, has three features desirable for this application: balance conditions are independent of frequency, so oscillator stability is not critical. Both variable adjustments are resistive and balance conditions are independent, which permits quick, accurate balancing.

To provide the desired accuracy, changes in R_3 must be measurable to about 1 part in 5,000 (although R_3 itself need not be known this closely). Resistance R_3 has been built up, therefore, as a series of five fixed and one variable resistor as shown in Fig. 4. Individual shorting switches across the fixed resistors permit coarse variation in R_3. A type-A Helipot, linear within 0.5 percent, provides the required accuracy in the variable resistance.

Resistance R_1 includes components similar to R_3. It has not proved necessary to measure the out-of-phase component given by R_1, although this could be used to determine rock conductivity.

The chief requirement on the fixed bridge components is stability rather than precision, since the actual values can be measured on a laboratory bridge. Wire-wound resistors and a mica capacitor provide this stability.

Oscillator

The oscillator circuit includes a 1G6 duotriode oscillator, a 1G4 buffer-amplifier, and a 1G6 push-pull triode output. Requirements of the oscillator include low harmonic content, fair amplitude and frequency stability, frequency low enough to avoid effects due to rock conductivity and output voltage sufficient

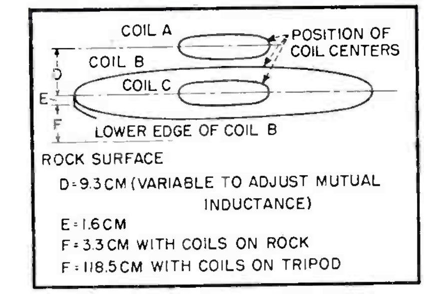


FIG. 1—Design of three-coil sensing head

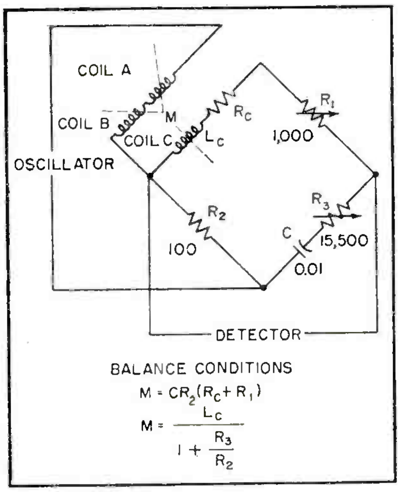


FIG. 2—Diagram of bridge circuit using three coils

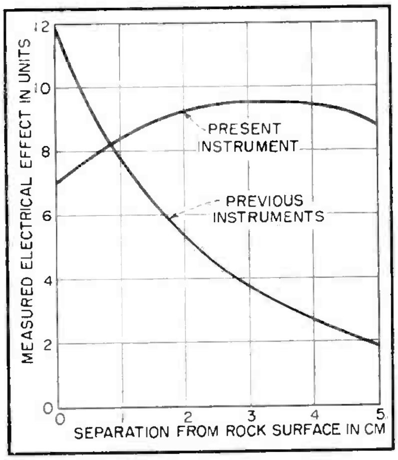


FIG. 3—Improved performance of new magnetic instrument shown graphically

to produce a magnetic field of 0.5 oersted near the coils.

Geologic considerations dictate the last requirement; rock susceptibility varies with field strength, so measurements should be made at a magnetic intensity roughly equal to that of the earth. This requires about 15 v input to the bridge circuit, a setting that is made by means of a dropping resistor at the grid of the buffer tube.

The oscillator combines simplicity with stability. The tuned grid circuit using a toroidal permalloy inductor determines the frequency of 975 cps. Cathode coupling introduces negative feedback for amplitude stability.

The buffer stage proved necessary to maintain good waveform. Power is supplied by three flashlight cells and a 90-volt battery. The oscillator is completely shielded.

Output from the bridge feeds through a step-up transformer and volume control to the grid of a 1U4. Two stages of class-A R-C amplification lead to a cathode follower, which provides an impedance match to the phones. The plate circuits are tuned to 575 cps, well below the oscillator frequency, to reduce harmonics. The maximum voltage gain is 1,325, input transformer to phones. This characteristic drops 0.5 db at 975 cps, 4 db at 1,950 and 25 db at 4,875 cps.

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(3) R. G. Paterson, Determination of Magnetic Susceptibilities of Rocks in Situ. *Am. Inst. Min. Met. Eng. Transactions*, **164**, 1945.

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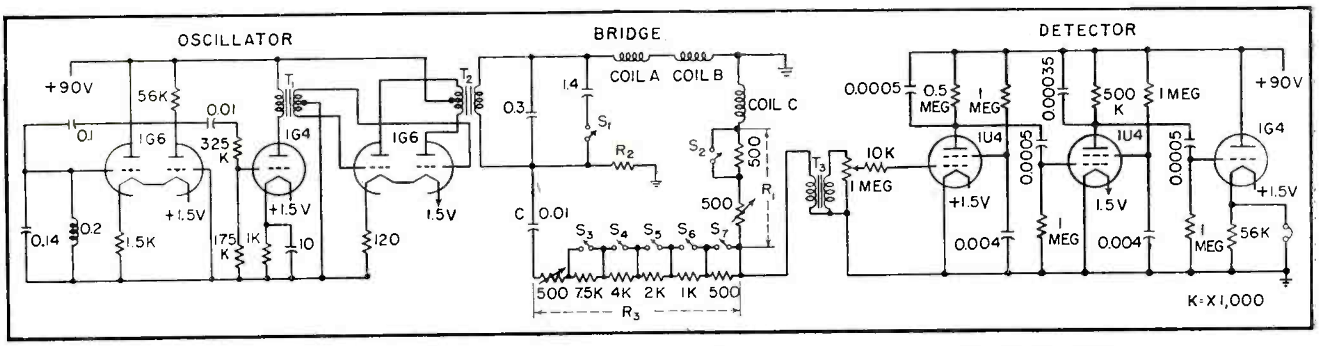
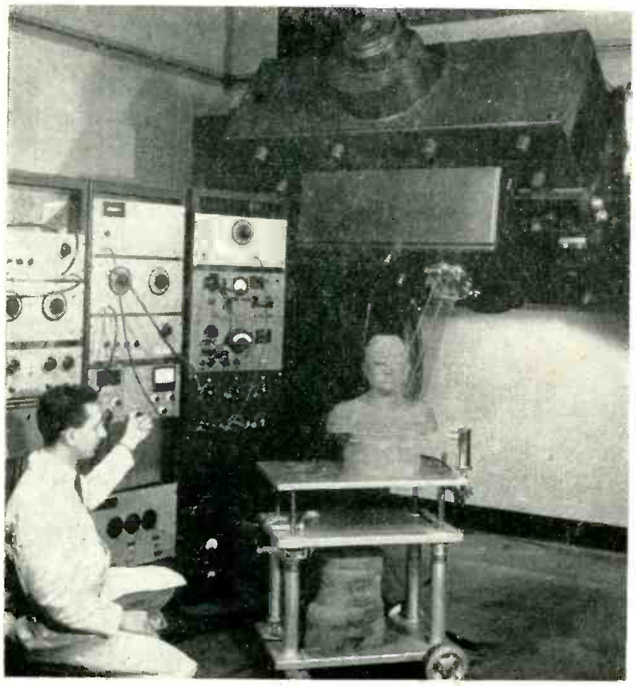


FIG. 4—Oscillator, bridge and detector units are battery powered for portability in the field



Wooden phantom constructed to simulate density of the human body is used to determine dosages from 24-mev medical betatron. Scintillation crystal placed within phantom transmits light to multiplier phototube in housing, right

THE BASIC BETATRON

The betatron is a magnetic-induction accelerator in which electrons are continuously accelerated in a circular orbit by a changing magnetic field. The evacuated acceleration chamber, or donut, has a toroidal shape. The time rate of increase of flux in the core of the magnet at the center of the donut produces a continuous increase in momentum of the electrons.

As the momentum of the electrons increases, the field intensity at the orbit must be increased to keep the electrons in a stable orbit of fixed radius.

Radial and vertical stability are obtained by shaping the magnet pole faces. At approximately 12 microseconds following zero field, electrons are injected into the donut. The injector consists of a tungsten filament mounted inside a molybdenum grid and plate structure having an opening in the direction of injection.

After the electrons have been injected, they are continuously accelerated by increasing magnetic flux. When the electrons have reached the desired energy they can either be brought out as a beam or caused to strike a target mounted in the donut and produce x-rays.

In the Memorial betatron, a shunt consisting of laminated magnetic material with high permeability and high limit of saturation is used to extract the beam. It contains a horizontal slot tangent to, and just outside the equilibrium orbit of the electrons. When the electrons have been accelerated to the desired energy, an automatic pulse through a coil inside the equilibrium orbit causes the instantaneous electron orbit to expand to larger radii. The

High-Power Betatron

Twenty-four mev medical betatron irradiates deep-seated tumors with minimum damage to surrounding tissue. Electronic equipment controls acceleration of electron beam and measures high-energy x-ray output

In the last two decades a variety of high-energy accelerators have been built to operate at continually increasing energies. Though most of these accelerators have been used almost exclusively for nuclear research, the betatron has found practical applications in medical therapy and diagnosis in hospitals and medical institutes.

Low-energy x-ray beams produced by ordinary medical x-ray equipment produce their maximum dose on the skin, do not penetrate to great depths in tissue, are not well defined because of scatter and are particularly destructive of bone. The high-energy x-ray beam produced by the 24-mev betatron at the Sloan-Kettering Institute, Memorial Center for Cancer and Allied Diseases, New York has been effective in irradiating deep-seated tumors in the human body with minimum damage to surrounding tissue. The electron beam of the betatron can be used in the treatment of lesions near the surface with a minimum of penetration.

Electronic Equipment

All of the timing and control operations of the 24-mev medical betatron, as well as associated instruments for various measurements, involve electronic circuits. Accurately timed pulses a few microseconds in duration are required for injection of the electrons and expansion of the orbit. This pulse timing is critical and must be adjustable to a fraction of a microsecond.

Primary Power Circuit

The primary betatron power circuit is shown in Fig. 1. The primaries of the static frequency-tripling transformers are wye connected and the secondaries are in delta connection. In the saturation range of the silicon-steel tripler transformers, the third harmonic is approximately 60 percent shunt provides a field-free region where electrons entering the slot can escape the guiding magnetic field.

The presence of this magnetic shunt inside the donut perturbs the orbit somewhat at injection time and prevents the capture by the orbit of all the injected electrons. This effect is minimized by placing around the shunt a coil that is energized at injection time in such a way as to oppose the magnetic field induced in the shunt.

X-rays are produced by having an accelerated beam of electrons strike a target. The relative efficiency of electrons for the production of x-roys depends on their energy and the atomic number of the target material. The higher the energy of the electron and the greater the atomic number of the target material, the greater is the percentage of the energy of the electron that will produce x-rays.

As is true of all x-ray spectra produced by electrons striking a target, the spectrum of x-rays from the betatron is continuous. The maximum energy of the x-rays is determined by the maximum energy of the electrons. Taking into consideration the relativistic change of mass of the electron, the maximum energy of the betatron is

$$E = 3 \times 10^{-4} Hr - 0.51$$

where H is expressed in gauss, r in cm, and E in mev Lr the Memorial betatron, H is a little over 4,000 gauss, r is about 20 cm and the maximum energy is 24 mev. To reach this energy the electron makes approximately 250,000 revolutions during the quarter cycle of 1/720 second

Betatron control room has water window through which operator can watch patient under radiation. High-energy x-ray beam makes possible treatment of deep-seated tumors with minimum damage to surrounding tissue

for Cancer Therapy

By J. S. LAUGHLIN, J. OVADIA, G. SHAPIRO and Z. ABDUN-NABI

Department of Physics and Biophysics
Sloan-Kettering Institute
Memorial Center for Cancer and Allied Diseases, New York, N. Y.

of the fundamental. The other harmonics are suppressed or negligible. A capacitor neutralizes the inductance of the tripling transformer. The capacitance in the tuned betatron circuit consists of four banks of air-cooled capacitors with approximately 41½ µf in each bank.

An auxiliary transformer provides 180-cps power for other circuits. The betatron's main tuned circuit is resonated by varying the number of capacitors in the bank or by varying the inductance. The inductance can be adjusted by changing the air gap in the three legs of the betatron magnet.

Injection of electrons occurs in a burst a few microseconds in duration about 12 microseconds after the magnetic field passes through zero. Injection voltage and injection time are related so that the momentum of the injected electrons will equal the momentum equivalent of the magnetic field of the equipment.

Injection voltage is usually set somewhere in the neighborhood of 60,000 volts, which corresponds to 12 microseconds after zero-field time for the 24-mev betatron.

Figure 2, shows the essential features of the injection circuit. Capacitor C is periodically charged through the power supply and is discharged when the 5C22 hydrogen thyratron is triggered. The capacitor discharges into the injector pulse transformer producing a secondary pulse of 60 kv, negative with respect to ground.

Pulsing

The output winding of the filament transformer is connected to the pulse-transformer secondary so that the betatron's filament is pulsed approximately 60 kv negative with respect to the plate which is grounded. A grid structure partially surrounds the filament and is attached to it. The grid focuses the electrons from the filament towards the opening in the plate. The plate and grid are constructed of molybdenum, and the filament is made of thoriated-tungsten wire.

The trigger pulse originates in a secondary winding on a strip of high-permeability material across the gap of the pulse transformer in the primary betatron circuit. This strip is saturated during all of the cycle except when the current and magnetic field pass through zero. The reversal of flux in this strip at that time induces the trigger pulse at zero-field time. A bias winding fluxes the strip to change the time at which the strip actually passes through its zero-field value. By changing the current in the bias winding the pulse can be varied for approximately 40 microseconds on either side of normal zero-field time.

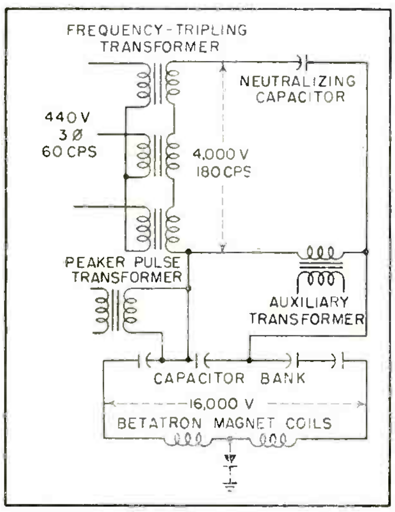


FIG. 1—Primary power circuit of betatron. Magnet coils and capacitor bank form 180-cps tuned circuit

Contraction

The entire injector structure is at a larger radius than the equilibrium orbit. If all the injected electrons are to be captured in the equilibrium orbit, it is important that they do not strike the injector structure on their first few revolutions after injection. This requires that their instantaneous orbit radius be rapidly contracted to the radius of the equilibrium accelerating orbit.

Contraction of the orbit of the rotating electrons at the critical injection time is facilitated by providing flux in opposition to the main field flux by the circuit of Fig. 3A. Two coils having a radius slightly greater than the normal orbit are located on the poles of the betatron, one above and one below the donut. When the GL-5632 thyratron is triggered, the contractor coils are essentially shorted through a 25-ohm resistor. The main magnetic-field flux passing through these coils will induce a counteracting flux in the opposite direction that serves to contract the orbit.

Since the thyratron is triggered at zero-field time when the time rate of change of flux is maximum, the contraction effect is also maximum at this time. As the magnetic-field intensity increases and the time rate of flux change decreases, this contraction effect becomes less important, disappearing by the time maximum acceleration is reached.

The thyratron is triggered by a pulse from a winding on another strip of high-permeability material on the same pulse transformer used to trigger the injector circuit. A separate bias winding is provided for this strip so that the actual time at which the thyratron is triggered can be varied to produce maximum capture of electrons during injection.

Expansion

To produce x-rays the electrons are deflected from their normal equilibrium orbit and caused to strike a target. In this betatron the target is mounted on the end of the injector, just outside the normal equilibrium orbit. To strike the target, the radius of the beam orbit must be increased. The flux through the orbit is increased by passing a current pulse through two series-connected coils located above and below the donut on the poles of the betatron. The coils have a radius slightly smaller than the equilibrium orbit. Figure 3B shows the circuit employed to pass the current pulse through these coils.

Since the electrons have their maximum energy when the magnetic field has reached its maximum value, expansion is timed to occur at the end of the quarter cycle when the field is at its maximum. Capacitor *C*, of Fig. 3B, is periodically charged through an FG-280 mercury-vapor rectifier. The power source can be either the auxiliary transformer in the primary betatron circuit or a couple of windings around one of the legs of the betatron magnet. When the GL-415

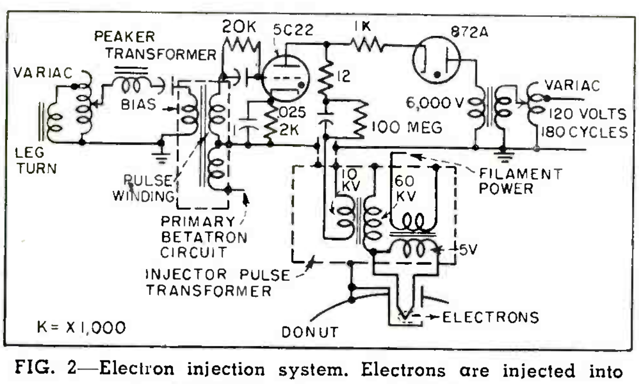


FIG. 2—Electron injection system. Electrons are injected into donut by 60-kv pulse every 1/180 second

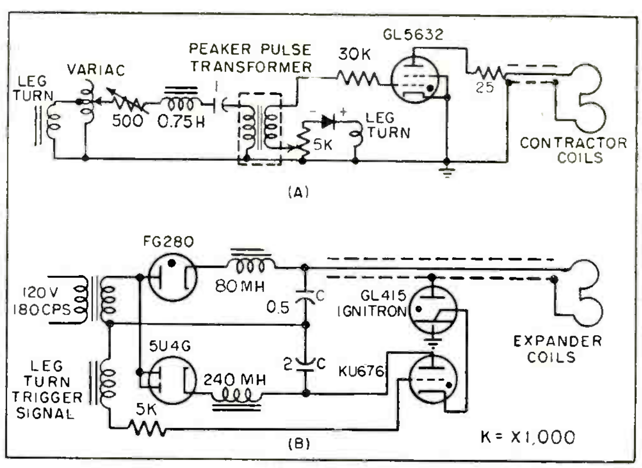
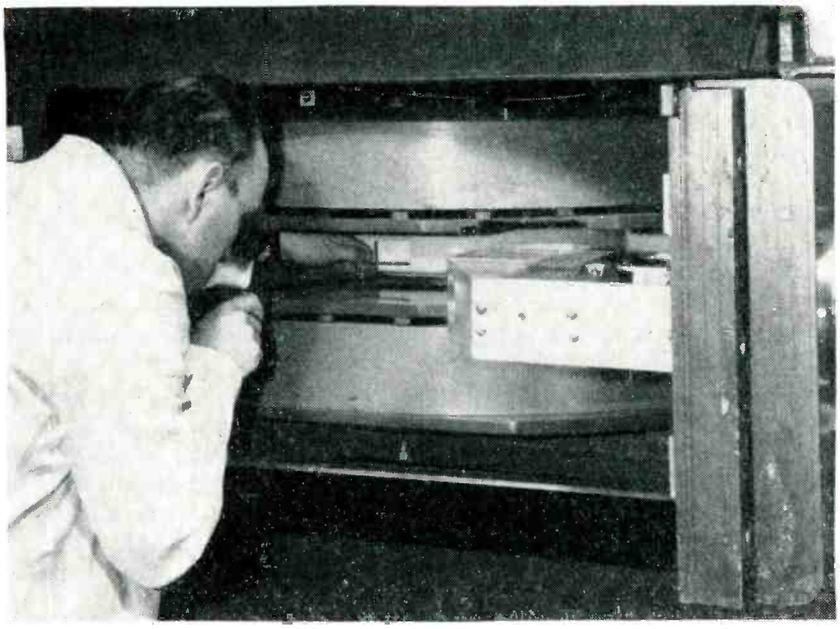


FIG. 3—Contractor (A) and expander (B) circuits bring electron beam into proper orbit, expand it to hit x-ray producing target

ignitron is triggered, C will be discharged through the two coils on the poles of the betatron adding to the flux provided by the main betatron coils.

The ignitron is fired by the discharge of the C' that occurs when the KU-673 thyratron is triggered. This thyratron fires when its grid passes through zero value and becomes positive. The grid is connected to a leg turn so that its potential varies sinusoidally 90 deg out of phase with the magnetic-field intensity. This phase relation causes the expansion pulse to occur when the magnetic field is at its maximum value.

A variation of a few microseconds in the firing time of this circuit will not cause any important variation in the maximum energy of the electrons, since the magnetic-field intensity changes slowly near its peak value.



Porcelain donut of medical betatron can be seen between magnet-coil boxes. Output tube and monitoring apparatus are mounted on heavily shielded door, right

Beam Monitor

When the betatron is being used to produce x-rays the beam is monitored by an ionization chamber. This chamber is mounted on the inside of the lead shield in front of the betatron in the path of the x-ray beam. The ion chamber consists of nine aluminum plates, two millimeters apart. The chamber is sealed air tight so that its calibration will not change with fluctuation in ambient pressure and temperature. A 385-volt potential difference between aluminum plates is supplied by the circuit shown in Fig. 4.

This circuit uses the ionization collected in the ion chamber to give a continuous indication of the rate of x-ray output, and also to integrate the total output in any desired interval of time.

Upon irradiation, capacitor C is discharged. The potential of the grid of the 2A3 triode is about −385 volts, which is also the potential of the collecting plates in the ion chamber. As a result of the irradiation and the consequent production of ionization in the gas of the monitor ion chamber, a charge accumulates on C and the potential of the 2A3 grid begins to increase expotentially.

The 2A3 is a low grid-current triode and extreme measures are taken to prevent any leakage from the grid to other electrodes. The 2A3 is coupled as a cathode follower to the grid of the 502A thyratron.

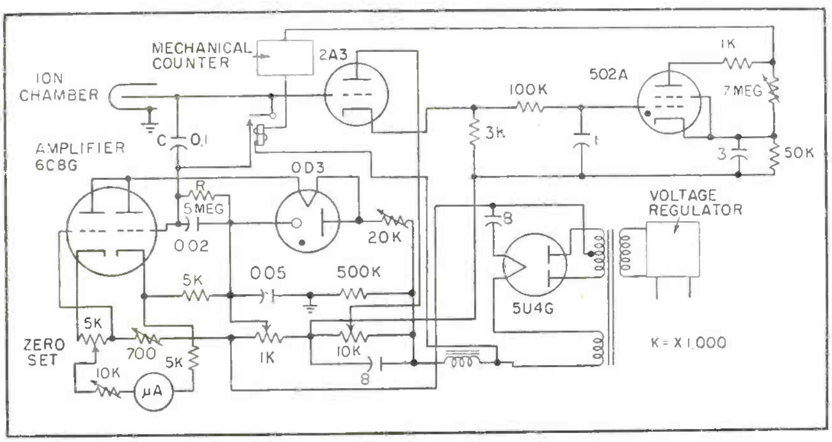


FIG. 4—Beam-monitor circuit measures beam intensity using ion chamber and indicates total exposure on mechanical counter

Before the grid of the 2A3 has increased sufficiently to affect the collection efficiency of the ion chamber, the 502A fires, operating a relay that discharges C, and returns the potential across the ion chamber to 385 volts. At the same time the relay also operates a mechanical counter. By adjusting circuit constants the mechanical counter can be made to indicate a specific number of roentgens in the x-ray beam.

Indication of the continuous rate of x-ray production is accomplished by the amplifier circuit, which includes the 6C8G triode. The potential across grid resistor R is proportional to the rate of charging of C. This potential appears on the grid of one of the triode sections and determines the potential drop across R. The unbalance of the cathode resistor network of the 6C8G is indicated by the meter and is proportional to the rate of x-ray production. The timing controls of the injector and contractor circuits are adjusted to maximize the rate indicated by the meter.

Pulse Monitor

The actual width of the x-ray or electron pulses from the betatron can be displayed on an oscilloscope by the circuit in Fig. 5. The radiation burst is detected in an anthracene crystal. Fluorescence caused in this crystal by absorption of the radiation is amplified by a 1P21 multiplier phototube. This signal is applied to the grid of a 6AK5 used as a cathode follower to feed an oscilloscope.

The anthracene crystal has a response time of 10^{-8} sec and radiation-pulse widths of less than a microsecond are easily displayed. The width of the betatron beam can be varied from less than a microsecond to over 100 microseconds. The injection pulse can be displayed simultaneously on the oscilloscope with the radiation pulse, and the time between these pulses, normally 1/720 sec, can be measured.

Beam-Energy Control

The maximum energy of the x-ray beam or the absolute energy of the homogenous external electron beam can be varied from 2 to 24 mev. This is accomplished by varying the maximum amplitude of the magnetic-field intensity. The internal electron beam is still expanded against the target or into the magnetic shunt, depending upon whether an x-ray or electron beam is desired, when the field is at its maximum. The energy is proportional to the value of this maximum-field intensity at the orbit.

Calorimetric Measurement

Although the output of the betatron is continuously monitored with a ion chamber, a further measurement is necessary for absolute calibration. This is accomplished by totally absorbing the x-ray beam in a thermally insulated absorbing block. Under certain conditions the total heat rise in this block is equal to the total energy absorbed from the beam.

The temperature rise in the absorbing block is measured with thermistors. A thermistor in one arm of a bridge circuit is mounted in the beam-absorbing block and a thermistor in a nonirradiated block is used in an opposite arm. Precision resistors are used in the other arms of the bridge and the unbalance of the bridge is amplified by a chopper amplifier.

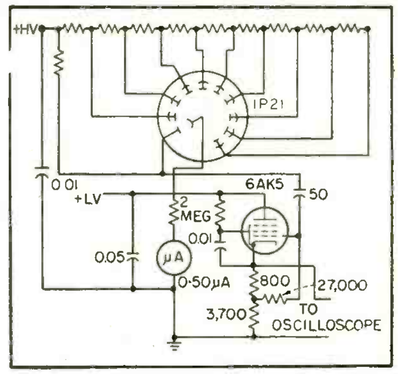


FIG. 5—Pulse monitor measures duration of radiation burst from betatron

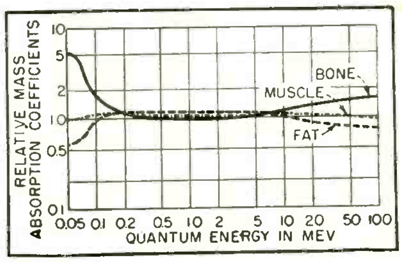
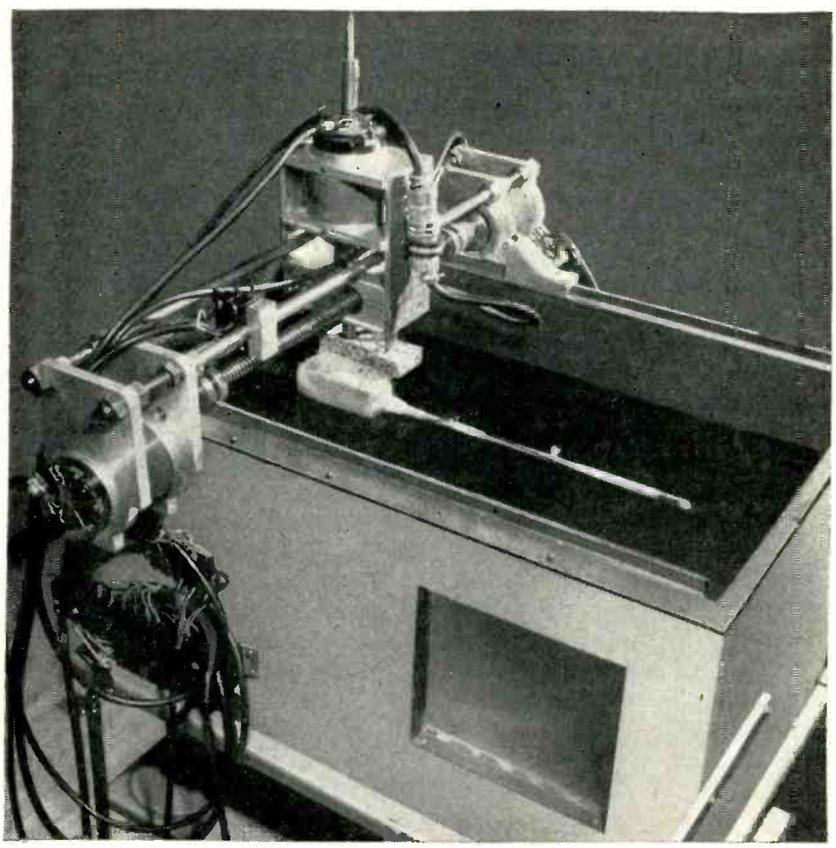


FIG. 6—Absorption coefficients of body tissues. At higher beam energies the absorption values are about the same

Use of a chopper amplifier makes it possible to utilize a-c amplifier stability for a small d-c signal. The output of this amplifier is recorded on a strip-chart recorder. It is possible to measure temperature changes of the order of 10^{-5} deg C with this calorimeter.

Automatic Isodosimetry

In conducting a cancer treatment with the betatron it is important for the doctor to know precisely what dose he is giving the lesion and any other irradiated portions of the patient's body. The absorption of radiation by the human body can be simulated very closely by water or with wood having a unit density. A large water bath used for dose measurements is shown in the photograph. A small ionization chamber is positioned inside the water tank, usually termed a water phantom, to measure ionization. An ion chamber is located on the end of a rod attached to a preamplifier. The output of the preamplifier goes to a d-c linear amplifier in the control room. The actual position of the small ion chamber in the water phantom can be controlled from the control room by synchro motors. The betatron output is measured by an ion cham-



Water bath with ion chamber used for plotting isodose curves that indicate regions of like dosage produced by x-ray beam ber connected to another d-c amplifier and the ratio of these two ion currents is measured by a third amplifier. By making ratio measurements, fluctuations in the output of the betatron do not affect the measured dose distributions. A scintillation crystal and multiplier phototube can be used alternatively with the ion chamber and preamplifier.

A servo loop to balance the output of one amplifier against the other is used to obtain the ratio. By incorporating the position of the small detecting ionization chamber into the overall servo loop, a balance is obtained for any preset ratio. An isodose curve representing the contours of the region in which the dose is uniform, is obtained when the detector chamber is scanned across the x-ray beam. A complete set of isodose curves can be obtained automatically for a horizontal plane. As shown in the illustration, wood phantoms can also be used for determination of the dose at any desired point in a simulated human body. The lungs are represented with cork, and air passages are present as in the normal body. Films are also used as well as ion chambers and scintillation crystals in this phantom.

Medical Applications

Use of high energy betatron x-rays in cancer therapy has the advantage of low skin dose. Great penetration is also possible because of the high energy of the x-rays, making it possible to produce an effective dose at great depths in the body.

Maximum radiation dose is produced 3 to 5 cm below the skin of the patient and side scatter is negligible. At these energies the beam is well defined permitting effective localization of the dose. As indicated in Fig. 6, when high-energy x-rays are used, bone does not absorb any more per unit mass than tissue. This consideration removes a serious limitation present in lower-voltage therapy.

In Fig. 7, top, the path of a high-energy x-ray beam from the betatron is shown on a film. This film was mounted inside a block of tissue-like material and exposed with the film parallel to the x-ray beam. The film density is proportional to radiation dose. The minimum dose on the skin, the maximum at a depth of a few cm, the lack of side scatter and the great penetration are evident. These factors make this type of beam particularly applicable to deep-seated lesions in the human body.

Absorption of Electrons

Absorption of electrons is quite different from the absorption of x-rays. In a substance of low atomic number such as water or human tissue, over 90 percent of the energy of the electron will be absorbed by ionization and excitation processes.

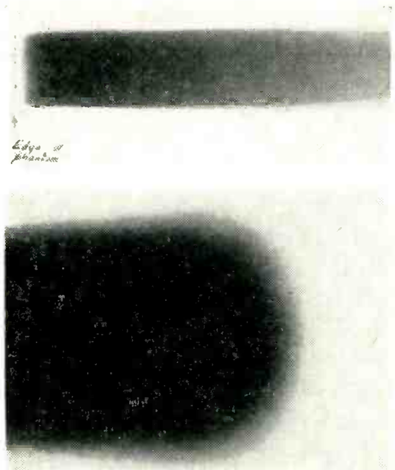


FIG. 7—The ex-ray beam, top, produces a narrow beam of great penetration in phanton body with minimum exposure near the surface. High-energy electron beam, bottom, has uniform exposure to a definite, adjustable depth. Radiographs not to scale

These processes occur with uniform probability over most of the length of the electron track. As a consequence, the energy dissipated by the electrons is fairly uniform along the beam and terminates very abruptly at a definite range. The range of the electrons in tissue or water is directly proportional to the energy. An approximate rule is that the electrons penetrate 1 cm for every 2 mev of energy.

Figure 7 shows the density path in a film exposed parallel to a 17-mev electron beam from the betatron. There is a definite maximum depth of penetration proportional to the incident energy. The rate of decrease near the end of the penetration is steep, so that healthy tissue at greater depths is not exposed. The dose is uniform from the surface to the end of penetration, making the high-energy electron beam applicable for the treatment of lesions adjacent to the body surface. The lesion will be exposed uniformly, from the skin to any desired depth, with rapid decrease of radiation dose immediately beyond the lesion.

Diagnostic Applications

High-energy x-rays also have diagnostic applications. Low-energy x-rays are absorbed in bone to a greater extent than in tissue. This is advantageous in making radiographs since the greater absorption in bone will cause the bone to stand out sharply relative to tissue. However, there are other applications in which it is desired that the contrast of bone not be great relative to tissue. For such applications, the high-energy x-rays produced by the betatron are advantageous.

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Microsecond Timer

Velocity of shock wave traveling down a concrete beam is measured by microsecond interval timer during nondestructive elasticity test. Timer has one-microsecond accuracy and is useful in a wide variety of timing applications

By J. H. J. FILTER

National Physical Laboratory
South African Council for Scientific and Industrial Research
Pretoria, South Africa

ELASTICITY of concrete beams may be determined nondestructively by a microsecond-interval timer used in conjunction with two phonograph pickups. The timer operates by measuring voltage across a capacitor charged from a constant-current source during the interval of interest.[1] It has five ranges covering time intervals from 50 to 5,000 microseconds. Its accuracy, independent of tube characteristics, is ± one microsecond or ± two percent whichever is larger.

In a long thin beam $K=(E/d)^{1/2}$ where K = velocity of longitudinal compression waves in the beam; E, Young's modulus of elasticity; and d, density of the material.

The instrument measures the time taken for a longitudinal shock wave, applied at one end of the beam, to pass two phonograph pickups placed a convenient and known distance apart. Assuming d is known, K and hence E can be calculated. The instrument can also be used for a large variety of other timing applications.

Circuit Design

A block diagram of the system is shown in Fig. 1. The amplified pulses from the pickups actuate switching circuits that start and stop a constant charging current through a capacitor. The voltage across the capacitor is measured and is proportional to the time taken for the shock wave to pass the pickups.

The circuit is shown in Fig. 2. Pentode V_9 controls the current through the timing capacitor, the voltage across which is measured by V_{10}.

Switching the current through a pentode can be done by any one or more of its three grids. However, the current through V_9 is switched by the control grid only; the magnitude of the current passed is regulated by adjusting the screen voltage. This has the disadvantage that the pentode cannot be completely cutoff as the screen is at a positive potential.

The charging current must be large so that the ratio of charging to discharging or cutoff current is large. Investigation of several pentodes showed that all types gave the same order of cutoff current. A type 6AG7 was chosen since it can handle fairly large currents and, because of its high transconductance, the bias voltage excursions can be relatively small. The plate current of the 6AG7 is constant for fairly large variations in plate voltage, thus providing a good constant-current source.

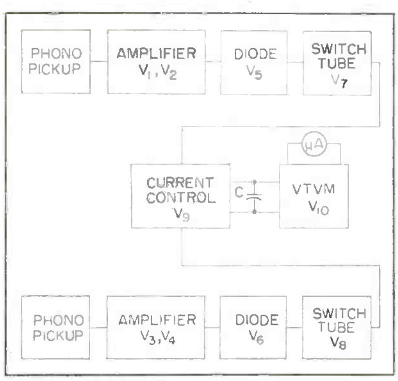

FIG. 1—Block diagram of test setup

For the vacuum-tube voltmeter V_{10} a differential amplifier was used to give a linear voltage scale and minimize the effect of changes in tube constants and of power-supply variations. Best results were obtained when the meter was more or less critically damped. Resistor R_1 provides damping and is also used as a fine-sensitivity control for one particular range. The maximum current that can flow through the meter, when the left-hand grid of V_{10} is at zero potential, is limited to approximately 700 microamperes, thus protecting the meter against overloads.

Switch S_3 connects various resistors between the cathodes to change the sensitivity, at the same time selecting the capacitor for the appropriate time scale. Electrical zero is adjusted by R_2.

The switch circuit consists of two flip-flops V_7 and V_8. The circuit components are so chosen that when V_{7A} and V_{8B} are both cutoff the voltage at the grid of V_9 is slightly positive. The low grid-input resistance for positive voltages minimizes the effect of any changes in plate voltage of V_{7A} and V_{8B} on the voltage at the grid of V_9. When either V_{7A} or V_{8B} is conducting the resulting voltage at the grid is approximately −35 volts, cutting off V_9.

When the RESET switch S_1 is in position a, resistances are connected in series with the negative

Checks Concrete Beams

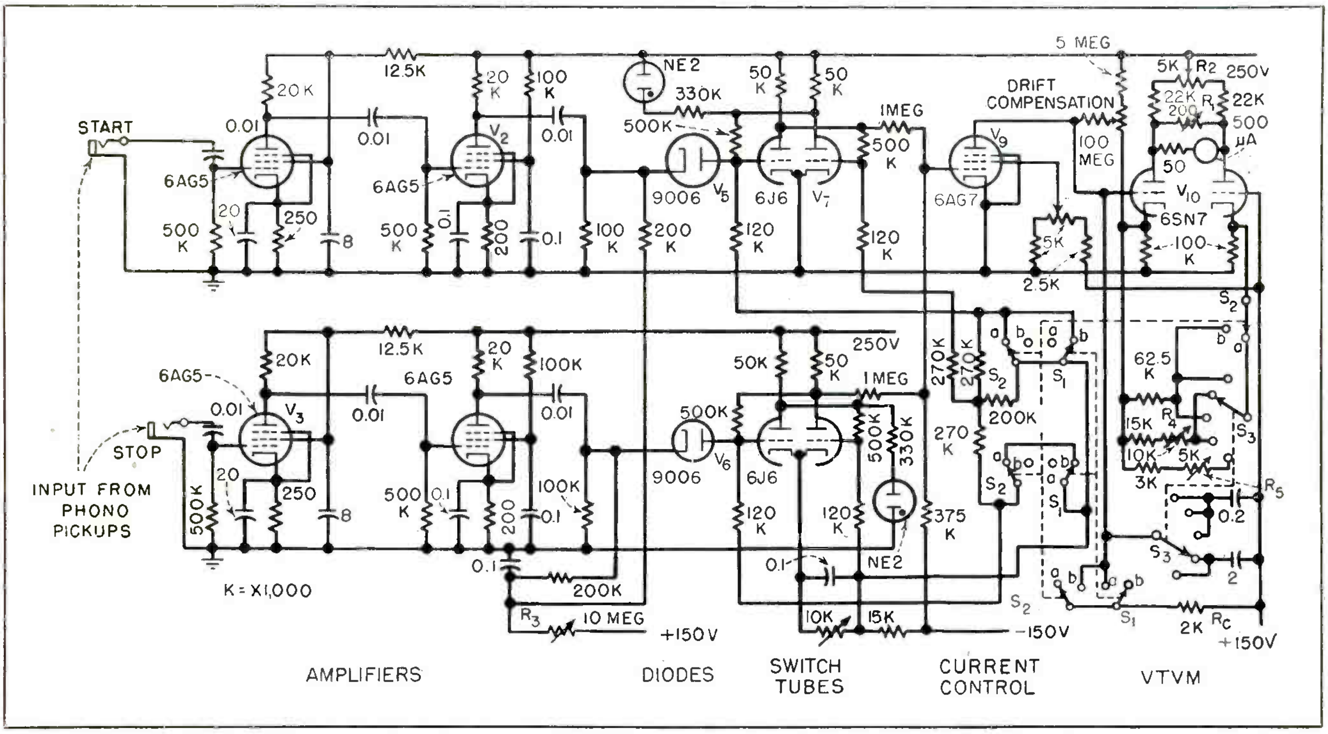

FIG. 2—Vacuum-tube voltmeter measures potential across capacitor charged from a constant-current source during interval of interest. Tube V_8 is the switch tube in the stop channel

supply to the grids of V_{7A} and V_{8A}, and the two triodes conduct. At the same time the capacitor is discharged through R_c. The flip-flops remain reset when S_1 is returned to position *b*.

A negative pulse through V_5 cuts off V_{7A}, the voltage at the grid of V_9 rises to zero, and the capacitor is charged through V_9. A negative pulse through V_6 cuts off V_{8A}, V_{8B} conducts and V_9 is cutoff. Positive pulses and any subsequent negative pulses cannot alter the state of the flip-flops until they have been reset. Neon indicators show the state of the flip-flops, the circuit being reset when both neons glow.

Two-stage 6AG5 amplifiers with high-frequency boost amplify the signals from the pickups that have to be so placed that a negative impulse is obtained when the compression wave arrives. The sensitivity is varied by changing the positive bias on the cathodes of V_5 and V_6 by R_3.

Various currents, such as: leakage through the capacitor, switches and tube bases; cutoff current of the pentode and grid current of the vacuum-tube voltmeter charge or discharge the capacitor. To reduce leakage, high-quality components were used. The vacuum-tube voltmeter could have been so designed that the grid current was either positive or negative, as required to balance all the currents for a certain potential at the plate of V_9. This potential could then have been chosen as the zero of the vacuum-tube voltmeter. The potential was found, however, to vary with variations both in pentode cutoff and in vacuum-tube voltmeter grid currents due to changes in tube temperature, heater voltage and characteristics of different tubes.

Compensating Current

It was decided, therefore to balance the leakage currents by injecting an adjustable compensating current. As the leakage currents were found to be more or less constant with changes in potential at the left-hand grid of V_{10} the compensating current had to be more or less constant. To eliminate use of a floating battery and to avoid to some extent the disadvantages of using a fixed voltage point, the compensating current is injected through a 100-megohm resistor from a voltage tapped between the plate and cathode of the vacuum-tube voltmeter. As the cathode follows to some extent the potential at the grid, especially when the cathode-to-cathode resistor is large, the voltage across the 100-megohm resistor tends to be more constant. This gives better compensation over the whole range, especially those ranges where the voltage changes at the left-hand grid have to be large, and the meter does not return to zero as quickly as when injecting current from a fixed voltage.

Range Constants

The values of the range constants are obtained from the equation: $V = I \times t/C$. Where: V = voltage across capacitor for full scale deflection of vacuum tube voltmeter; C, capacitance of capacitor; I, charging current; and t, full-scale time range. A capacitor charging current of only 20 milliamperes was chosen due to limited power-supply regulation. The range constants were chosen as shown below:

Full-Scale Microseconds	Capacitor Microfarads	Voltmeter Sensitivity Volts for 500 μA
50	0 2	5
200	0.2	20
500	0.2	50
2,000	2.0	20
5,000	2.0	50

Smaller voltages for full-scale deflection made the meter sensitive to plate-supply voltage and tube variations and use of larger voltages caused errors due to changes in charging current with plate voltage of the pentode.

Calibration Technique

Calibration is by a variable voltage supply and voltmeter connected across the grids of the vacuum-tube voltmeter with the negative to the left-hand grid. The range switch is set to either 500 or 5,000 microseconds. The voltage between the grids is set to 50 and the meter deflection to 500 microamperes with the shunting resistor R_5. The voltage is then adjusted to 20 volts for the 200 or 2,000-microsecond ranges and the meter again set to full-scale deflection using R_4. The process is repeated for the 50-microsecond scale with the voltage set to 5 and adjusting R_5.

If the capacitance of the timing capacitor is known, the exact value of the integrating current necessary to give the values in the table can be calculated. In this case two timing capacitors are used and thus two values of charging current are necessary.

The value of the calibrating resistor R_c is measured and the voltage drop across it calculated for the respective charging currents. This will be approximately 40 volts. When switch S_2 is in position b the flip-flops are switched so that the bias on V_9 is zero. At the same time the voltmeter is switched to 50 volts full scale and R_c is connected between the vtvm grids.

The current is then set to the desired value by adjusting the screen voltage of V_9 until the voltmeter is made to indicate the calculated reading.

Switch S_2 automatically returns to position a when released and its function is independent of the position of the reset switch S_1.

Consider pentode V_9 to be a constant-current generator giving a current I and shunted with its plate resistance R_p. Let C be the capacitor connected in parallel with R_p so that the pentode current charges C. The current flowing through the plate resistance $I = V/R_p$ where V is the voltage across the capacitor. The differential equation for the voltage across the capacitor is $dv = (1/C)\ (I - V/R_p)$ dt. The solution is $V = IR_p(1 - \epsilon^{(-t/RpC)}$ IR_p (1-e exponential $- t/R_pC$).

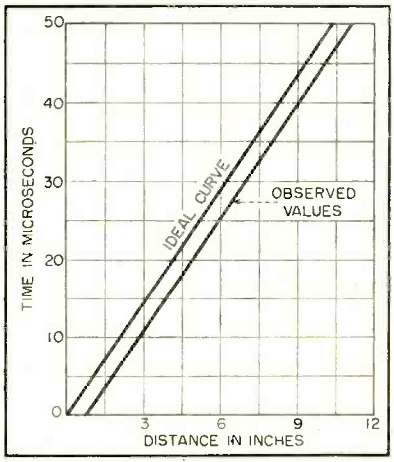

FIG. 3—Measured and calculated results show close agreement

Expanding the exponential term as a series

$$V = \frac{I \times t}{C}\left(1 - \frac{t}{2R_pC} + \frac{t^2}{6R_p^2C^2} - \ldots\right)$$

Errors

The greatest error will be introduced for large values of V, that is on the 50-volt ranges; R_p was found to be approximately 250,000 ohms for the working range. Thus for $t = 500$ microseconds, $C = 0.2\ \mu$f; or $t = 5{,}000\ \mu$sec, $C = 2\ \mu$f; the meter will read 0.5 percent low at full scale. This was considered good enough.

The current gain of the vacuum-tube voltmeter is approximately given by

$$\frac{\text{Output current}}{\text{grid-to-grid voltage}} =$$

$$\frac{-\mu}{2\left[R_p + \dfrac{(\mu + 1)\ R_kR_c}{2\ R_k + R_c}\right]}$$

where R_p = plate resistance of triode; R_k, cathode-to-ground resistor; and R_c, cathode-to-cathode resistor.

In the worst case, for the 50-microsecond range (R_c approximately 4,000 ohms, R_k = 100,000 ohms), the gain changes approximately 2 percent for a 10-percent variation in R_p for a 6SN7. As each range is adjusted at full scale, variations in sensitivity do not introduce a large absolute error for less than full-scale deflection. For the 20 and 50-volt ranges the change for a 10-percent variation in R_p is 0.6 percent and 0.2 percent respectively.

Tests

The instrument was tested by checking it against a steel rod in which the velocity of sound had been previously determined. Figure 3 shows an example of the results. The curve is displaced to the right of the ideal curve due to differences between the pickups. If the pickups are interchanged the curve lies to the left of the ideal curve.

The energy of the impact has to be fairly constant. An increase in energy tends to move the curve nearer to the theoretical curve. For each sample a zero correction has to be determined by taking readings for at least two different distances between the pickups. With these precautions an accuracy of $\pm$ 1 micro second or $\pm$ 2 percent, whichever is the greater, can be obtained.

The instrument is fairly independent of vacuum-tube characteristics and can be easily and accurately calibrated without the use of pulses of known time interval. The time scale is linear so that the scale need not be specially graduated or calibration charts used, and the capacitor holds its charge long enough for readings to be taken accurately.

Acknowledgements

The author wishes to thank members of the Electrical Standards staff for advice and help in the development of the instrument.

This paper is published by permission of the South African Council for Scientific and Industrial Research.

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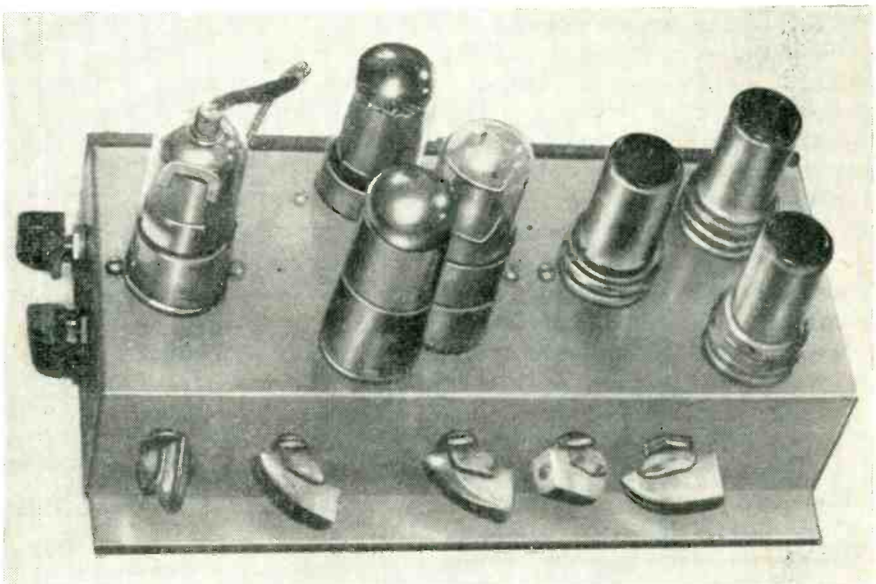
Simulating Piano Tones Electronically

All-electronic instrument uses phase-shift oscillators and distortion amplifiers to simulate decay curve of piano notes. System duplicates three-string tonal timbre and provides controls for loud, soft and sustaining effects obtained from a standard piano

By LEON KATZ
New York, N. Y.



Chassis holds (left to right) keying tubes, distortion amplifiers, linear amplifier and cathode follower, resistance adder and phase-shift oscillators

SIMULATING the tone of a particular instrument is achieved by producing a wave shape comparable to that instrument. This can and has been done by innumerable electrical, mechanical or electronic means.

Since the piano is a percussion and string instrument, it presents several difficulties. For many of the tones of the piano, three strings are used; for others, two, and for the very low notes, one string is used. The purpose of the multiple strings struck simultaneously by the same hammer is to render a dramatic quality to the sound through the production of beats. An extremely slight detuning of the two or three strings of the same note will produce the familiar throbbing sensation of the tone due to the subjective production of the beat frequency. This is due to the nonlinearity of the ear.

Although this is a subjective sensation, it is of the utmost importance in duplicating a true piano sensation. Two additional tone production systems must be added intentionally to produce slightly detuned signals. The three separate signals of one tone are, however, still combined by straight addition, not by heterodyning.

The second additional difficulty in reproducing a piano tone is in matching its amplitude-time envelope. Almost all stringed musical instruments, including the piano, contain one or more large radiating surfaces known as sound boards. The energy of the vibrating string is transmitted to the sound board by a mechanical structure common to the string and sound board known as the bridge. It is the sound board thus excited that radiates most of the sound energy.

Tone Curve

The decay curve of a piano tone depends on the absorption and radiation characteristic of all components. An idealized typical intensity time curve for the piano is shown in Fig. 1.

The ordinate is plotted to a decibel scale to give a rough indication of the sound sensation and to indicate the deviation from exponential response, which would show as a straight line on a logarithmic plot.

An all-electronic method of producing a piano tone is shown in block diagram form in Fig. 2. Any audio frequency sine wave oscillator may be used.

For any particular note, for example 440 cps, the off-frequency oscillators are best detuned by ear. In general, detuning is a fraction of a cps. The distortion amplifiers used are overdriven amplifiers. Since the piano tone contains both even and odd harmonics, the distortion circuit should be proportioned to destroy half-wave symmetry that might tend to exist from symmetrical cutoff.

The standard piano is so designed that the string is struck near one end, about one seventh

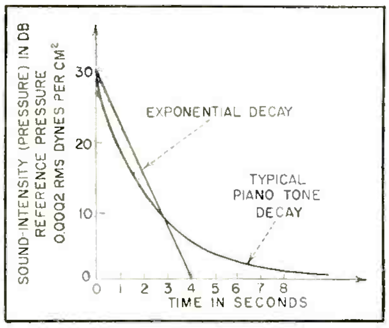


FIG. 1—Typical piano tone decay curve

to one ninth of the total length from that end, so that the resultant vibration is lacking only some of the higher frequency components.

The adding circuit may be any one of the many electronic adding circuits used in analog computer work, or addition may be done directly at the input of the keying circuit by means of a resistance adding network.

The keying circuit itself prevents a tone from being produced until the key is depressed and then gives the tone the proper amplitude-time envelope after the key is depressed.

Keying

The keying circuit depends on two properties of the pentode tube when used as an ordinary amplifier. First, within the limits of proper design, the gain is given by the well-known expression $K = -g_m Z_L$. Secondly, for pentodes the g_m may be considered a function only of grid bias, provided all signal voltages on the grids are small and plate voltage variations are not too large.

Thus for a pentode, variation of the bias of one of the grids will vary the gain; and therefore the signal voltage output will vary for fixed signal voltage input. This is the familiar principle of automatic volume control and the reactance-tube f-m modulator.

The keying circuit (Fig. 3) and the characteristic curves (Fig. 4) aid in showing how these principles are used in forming an intensity-time envelope approximating that of a piano. The note involved is prevented from appearing at the input of the linear amplifier by means of the hold-off bias of the keying tube (enough greater than the cutoff value to prevent even the slightest conduction on the positive peaks of the signal) in spite of the continual appearance of the tone voltage in the grid circuit of the keying tube.

When the key corresponding to the tone is depressed, the capacitor which has been maintained at a steady d-c voltage somewhat below the hold-off bias is connected across the resistor in the grid circuit forming an *RC* discharge circuit. This brings the bias suddenly from below cutoff to a value only slightly negative. The discharge of the capacitor allows the bias to again approach the hold-off value exponentially.

The variation of bias with time will vary the g_m of the tube and therefore the intensity-time envelope of the output will vary also, since $E_o = -g_m Z_L E_s$ (E_s is small compared to the hold-off bias).

Experimental adjustment of the hold-off bias, the peak voltage to which the *C* is charged, the *RC* time constant of the keying circuit, and the type and operating voltages of the tube used all provide endless variety to the amplitude-time curves available. Although the value of *RC* determines intensity-time envelope, a quick recharge in

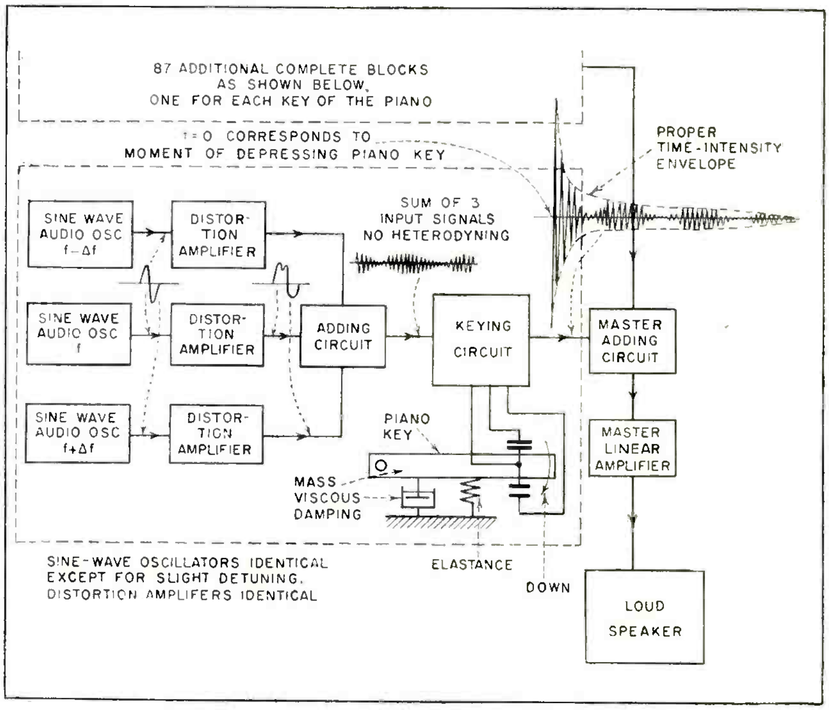


FIG. 2—Block diagram for one key circuit

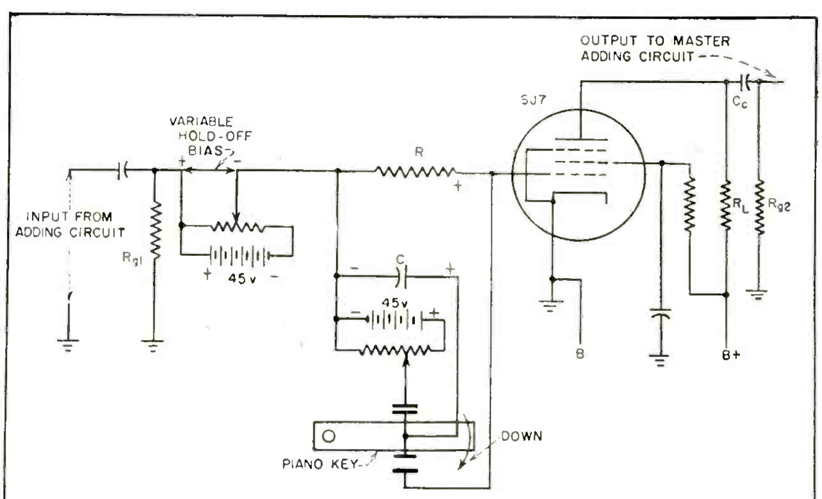


FIG. 3—Schematic of keying tube circuit

readiness for rapid restriking of the key dictates as large a value of R and small value for C as the grid circuit resistance limitations of the tube permit.

Typical operating values found to give fair simulation of the piano tone were with two sine-wave oscillators set at 440 cps feeding overdriven amplifiers each putting a 1 volt rms signal into the grid circuit of the keying tube, a hold-off bias of 19 volts, a charging voltage of 16 volts; a charging capacitor of 1 μf, and discharge resistor of 2.5 megohms ($RC = 2.5$ seconds).

The sudden lowering of keying tube plate voltage due to the sudden application of the capacitor voltage to the grid circuit of the keying tube will produce momentary grid blocking of the following linear amplifier. This will be of negligible duration, however, if the time constant of the coupling circuit is made as short as possible and yet long enough adequately to couple the signal frequency into the grid circuit of the linear amplifier. These are not difficult conditions to meet.

Complete Circuit

The complete piano would consist of 88 combinations of oscillators, distortion amplifiers, and keying tubes, one set for each key. Only one linear amplifier is necessary

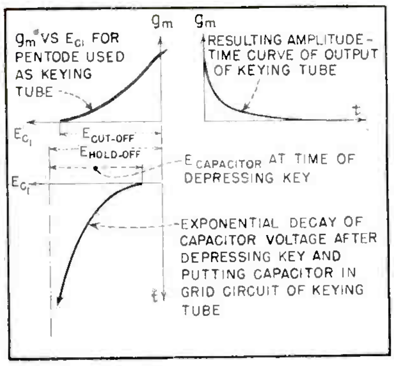


FIG. 4—Pentode characteristics in keying tube circuit

since the signals from the separate keying tubes are coupled to it by a straight adding circuit. The addition could also take place after one stage of linear amplification for each keying tube, acting as a buffer.

Dynamics could be handled in either of two ways. The first would be to control the gain of one of the overall linear amplifiers by varying its g_m with a bias voltage controlled by a pedal. The second method, which would more nearly approach the performance of the piano, would be to have the keying capacitor charged to a voltage which would depend upon the velocity of the key. This could be effected by having the charging voltage developed by electromagnetic induction. Such an arrangement would complicate the mechanical and electrical design of the key, but would produce dynamics which would depend upon how each key is struck, which is the way dynamics are produced on the standard piano.

The effect of the loud pedal could be simulated by introducing a small positive voltage in the grid circuit of all the keying tubes when the loud pedal is depressed. This will produce the almost constant background of sound characteristic of the loud pedal of the piano.

The effect of the soft pedal would require only a reduction of the gain of the linear amplifier. The sostenuto effect would be accomplished by keeping the capacitor of any depressed key connected across its discharge resistor even after the key is released, provided the sostenuto pedal is held in the depressed position. The proper mechanical feel of the key or action, as it is called, can be obtained by providing the key with the mass, elastance, and viscous damping that the piano key has.

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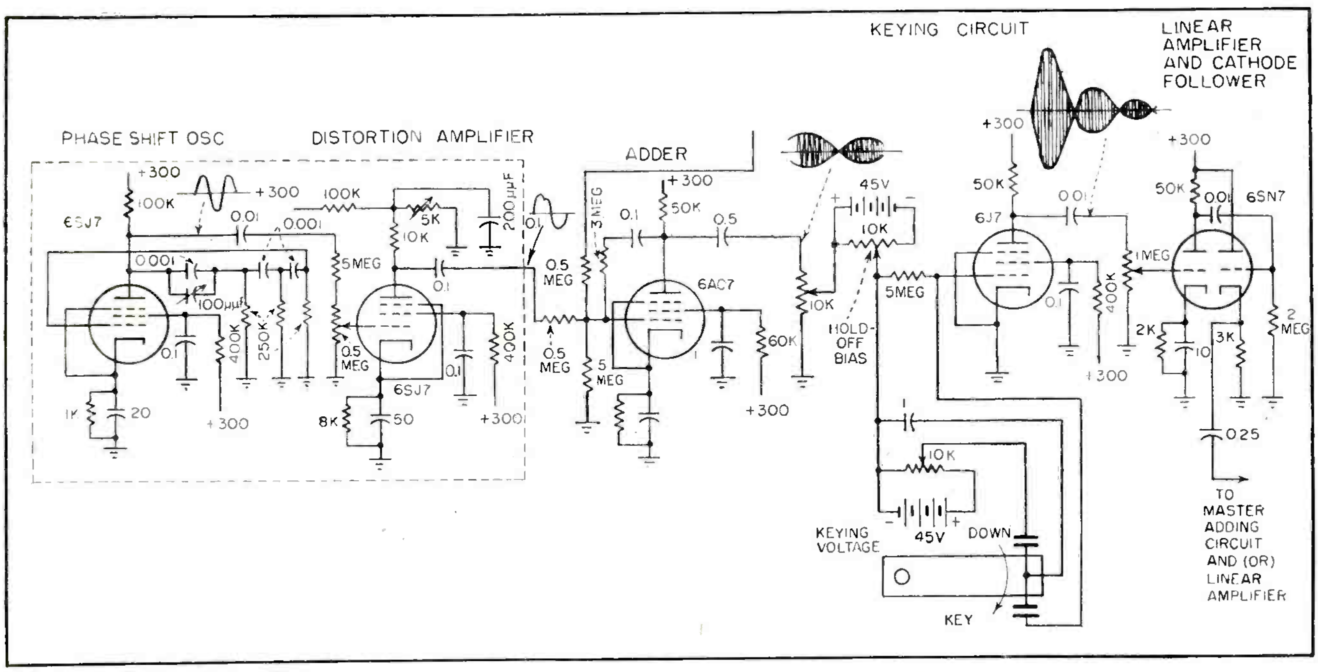

FIG. 5—Complete circuit diagram for one key (f=220 cps)

TRANSISTORS: Theory and Application

Small-Signal

Part VIII

By ABRAHAM COBLENZ and HARRY L. OWENS

Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

SMALL-SIGNAL parameters are of considerable importance in specifying transistor operation. Most of the parameters discussed thus far in this series are based on small-signal operation, and large errors can result from neglect of this qualifying phrase.

Power Gain

In Part VII of this series, equations were developed which express the input and output resistance and the voltage gain of point-contact and junction transistors. Typical numerical values were given to serve as a general orientation with regard to orders of magnitude (see Table I). The power gain of an electrical device is, obviously, an important concept to the design engineer and equations will be developed for computation of this parameter of a transistor.

Figure 1 shows the familiar circuit of a generator with voltage e_g and internal resistance R_g supplying a load whose resistance is R_L. The maximum power that can be developed across R_L for a given generator may be found as follows: Since

$$E = \frac{e_g R_L}{R_g + R_L} \qquad (1)$$

$$P_o = \frac{e_g^2 R_L}{(R_g + R_L)^2} \qquad (2)$$

Differentiation with respect to R_L shows that the power delivered across the load will be a maximum if R_g is equal to R_L. Under these conditions the maximum possible power that can be drawn from generator e_g under any circumstances will be

$$P_m = \frac{e_g^2}{4R_g} \qquad (3)$$

The power output of a grounded-base transistor amplifier (Fig. 2) is in general given by $i_2^2 R_L$ where i_2 is

$$i_2 = \frac{-e_g(r_b + r_m)}{[(R_g + r_b + r_e)(R_L + r_b + r_c) - r_b(r_b + r_m)]} \qquad (4)$$

The power gain of the transistor will then be given by the ratio of $i_2^2 R_L$ to P_m, the maximum power which may possibly be drawn from the generator (generator internal resistance exactly matched by input resistance of the transistor). In general, this will not be the case and less power will be drawn from the generator than is indicated by Eq. 3. The power gain is given by

$$PG = \frac{i_2^2 R_L}{e_g^2/4R_g} = \frac{4R_L R_g i_2^2}{e_g^2} \qquad (5)$$

The power gain so determined for a given value of i_2 and R_L will be a lower limit or a minimum value since the power expression in the denominator is the maximum possible under these conditions.

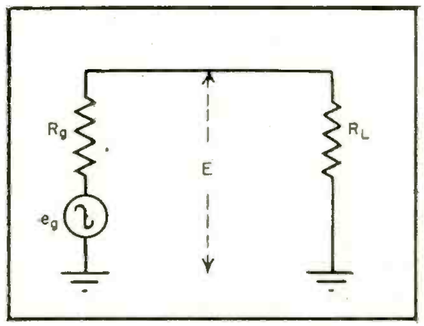

FIG. 1—Equivalent circuit illustrates condition for maximum load power

Substituting the value of i_2 from Eq. 4 into the expression for the power gain in Eq. 5

$$PG = \frac{4R_L R_g (r_b + r_m)^2}{[(R_g + r_b + r_e)(R_L + r_b + r_c) - r_b(r_b + r_m)]^2} \qquad (6)$$

This expression can be simplified somewhat since r_b is small compared to r_c or r_m (see Table I) and Eq. 6 becomes

$$PG = \frac{4R_L R_g r_m^2}{[(R_g + r_b + r_e)(R_L + r_c) - r_b r_m]^2} \qquad (7)$$

Typical Values

Using the typical values of the parameters as given in Table I for the point-contact transistor, a typical power gain is very nearly 100 representing 20 db whereas for the junction type a typical power gain is very nearly 440 representing 46 db.

Importance of Alpha

It is often desirable to know power gain as a function of the alpha of the circuit. Dividing numerator and denominator of Eq. 6 by $(r_e + r_b)^2$

INDEX TO PREVIOUS ARTICLES IN THIS SERIES

Transistor Operation

Different approaches to mathematical analysis of small-signal transistor operation are explained in detail, along with listings of advantages and disadvantages of each. Power gain and other important parameters are discussed

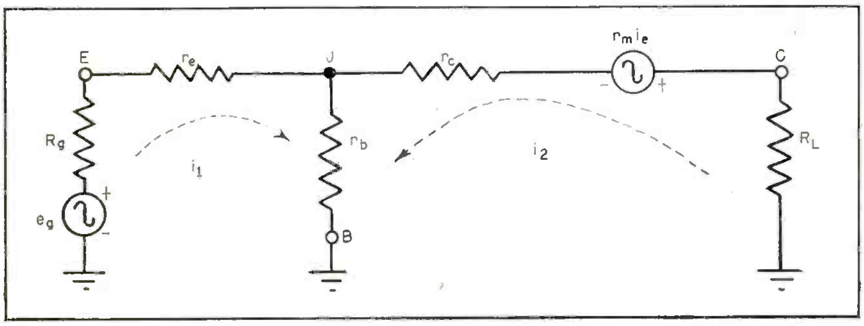

FIG. 2—Equivalent circuit of grounded-base transistor from which design equations for small-signal operation are devised

$$PG = \frac{4R_L R_g \alpha^2}{\left[(R_g + r_b + r_e)\left(1 + \frac{R_L}{(r_e + r_b)}\right) - r_b\alpha\right]^2} \quad (8)$$

Similarly, the power gain may be expressed as a function of VG and α.

$$PG = \frac{4R_g\alpha(VG)}{(R_g + r_e + r_b)\left(1 + \frac{R_L}{r_b + r_c}\right) - r_b\alpha} \quad (9)$$

Also, the expression for the VG obtained in the previous article[1] may be written as a function of α.

$$VG = \frac{\alpha R_L}{(R_g + r_e + r_b)\left(\frac{R_L}{r_b + r_c} + 1\right) - r_b\alpha} \quad (10)$$

Equations 8, 9 and 10 show why alpha is one of the important parameters for evaluation and comparison of transistors. Also, the relation $\alpha = -i_c/i_e$ shows the further usefulness of alpha as a comparison number for current gain.

Grounded-Base Equations

In the previous article of this series[1], Eq. 11 and 12 were derived to express conditions in the grounded-base transistor arrangement.

$$i_1(R_g + r_e + r_b) + i_2 r_b - e_g = 0 \quad (11)$$
$$i_1(r_b + r_m) + i_2(R_L + r_b + r_c) = 0 \quad (12)$$

If in Eq. 11 $r_e + r_b = r_{11}$ and $r_{12} = r_b$ according to the definitions laid down in the previous article[1], and $v_1 = e_g - i_1 R_g$, which is the net voltage acting at the transistor terminals, Eq. 11 becomes

$$v_1 = r_{11}i_1 + r_{12}i_2 \quad (13)$$

In deriving Eq. 12 it was assumed that there was no generator voltage acting in loop 2 of Fig. 2. If there were, Eq. 12 could be written as

$$r_{21}i_1 + i_2R_L + i_2r_{22} = e_{g2} \quad (14)$$

where again $r_m + r_b = r_{21}$ and $r_c + r_b = r_{22}$. As before, if $v_2 = e_{g2} - i_2R_L$, the net effective voltage after the i_2R_L drop in Eq. 14 becomes

$$v_2 = r_{21}i_1 + r_{22}i_2 \quad (15)$$

Small-Signal Parameters

Consider a dependent variable y which varies with, or is a function of an independent variable x. Mathematically

$$y = y(x) \quad (16)$$

Differentiating both sides with respect to x

$$\frac{dy}{dy} = \frac{dy(x)}{dx} \quad (17)$$

Essentially, Eq. 17 is a tautology, or self-evident identity, and does not provide any particularly useful information. But in the form

$$dy = \frac{dy(x)}{dx}\,dx \quad (18)$$
$$= y'\,dx$$

the equation states a very important and useful fact. Equation 16 will, in general, avoiding special curves, give a graph like in Fig. 3.

Equation 18 says that if, for a given or selected change in x, say of dx, it is desired to find the corresponding change in the value of y, when y depends on x in the manner shown in Fig. 3 and symbolized in mathematics shorthand by Eq. 16, the slope of the curve at the point in question is multiplied by the given value of dx.

If y is a dependent variable which varies with either or both of two parameters, x and z, Eq. 16

Table I—Typical Transistor Parameters

Parameter	Point Contact	Junction
r_e	150 ohms	25 ohms
r_b	120 ohms	500 ohms
r_m	35 kilohms	0.96 megohm
r_c	15 kilohms	1.0 megohm
R_g	500 ohms	500 ohms
R_L	20 kilohms	100 kilohms
α	2.3	0.96
e_g	0.01 volt	0.001 volt

will then become

$$y = y(x,z) \qquad (19)$$

Since a change in y, dy, may now be due to a change in either or both of x and z, an equation entirely analogous to Eq. 17 would be Eq. 20

$$dy = \left.\frac{dy}{dx}\right]_{z-k} dx + \left.\frac{dy}{dz}\right]_{x-k} dz \qquad (20)$$

This is usually written

$$dy = \left.\frac{\partial y}{\partial x}\right]_z dx + \left.\frac{\partial y}{\partial z}\right]_x dz$$

The dimension of each term on the right-hand side of Eq. 20 is dy, since dx and dz cancel—at least dimensionally. This must be so for any physically valid interpretation. Also dy/dx, the first term right-hand side, is not quite the same as in Eq. 17 because the change in dy is measured for a unit change in dx, while z is kept constant. A similar remark applies to dy/dz for x = constant.

In general, V_e, the d-c emitter voltage, will depend on the emitter and collector currents or on the operating point. Thus

$$V_e = V_e(I_e, I_c) \qquad (21)$$

Applied to Eq. 19, $y \approx V_e$, $I_e \approx x$, $I_c \approx z$. The dependent variable is voltage V_e and the independent variables are I_e and I_c. This shows that the transistor is a current-operated device and the currents are the independent variables. In transistor work the currents are adjusted to the correct operating point, and the voltages appearing are then fixed by the current values.

To illustrate further the effect of this concept in practice, the static characteristics of transistors are plotted, by common consent, with current as abcissa and voltage as ordinate, in keeping with the mathematical convention of plotting the independent variable along the x direction.

Analogous to Eq. 20, obtained from 19, is Eq. 22 for Eq. 21.

$$dV_e = \left.\frac{dV_e}{dI_e}\right]_{Ic-k} dI_e + \left.\frac{dV_e}{dI_c}\right]_{Ie-k} dI_c \qquad (22)$$

The d-c collector voltage also depends on emitter and collector currents, and

$$V_c = V_c(I_e, I_c) \qquad (23)$$

Again on differentiating

$$dV_c = \left.\frac{dV_c}{dI_e}\right]_{Ic-k} dI_e + \left.\frac{dV_c}{dI_c}\right]_{Ie-k} dI_c \qquad (24)$$

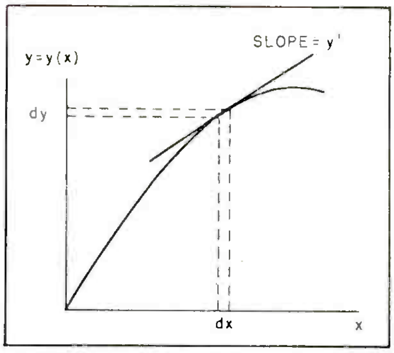

FIG. 3—Typical curve showing y as a function of x. Slope is $y' = dy(x)/dx$

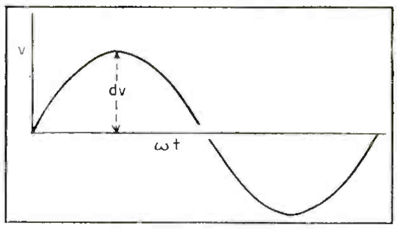

FIG. 4—Sinusoidal voltage (or current) used to simulate differential increments

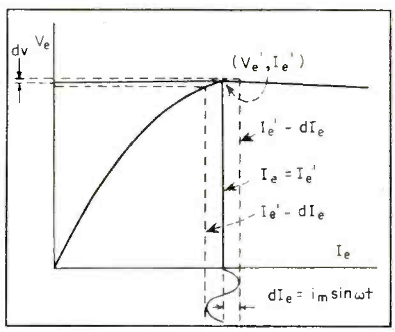

FIG. 5—Plot of emitter voltage versus emitter current

Equations 22 and 24 are extremely important in transistor analysis.

Small Changes

A simple explanation of Eq. 24 might be based on an a-c voltage and current wave as shown in Fig. 4, where the sinusoidal voltage wave $v = v_m \sin \omega t$ where $v_m = dv$.

In an interval $\omega t = \pi/2$, the amplitude changes from 0 to dv, and in the next interval of time from dv to 0, so that, disregarding the sign, the amplitude changes by dv for each ¼ cycle. In general, Eq. 22 and 24 apply properly if dv is actually infinitesimal, or extremely small, but in actual application a practical value of dv may be used.

In Fig. 5 is shown a possible plot of d-c values of voltage vs current, say of the emitter voltage V_e and emitter current I_e for a transistor. Assuming the operating point of the transistor is at V_e', I_e', if the emitter current is modulated sinusoidally by a small signal so that I_e varies at most by dI_e, then I_e will vary from I_e' to $I_e' + dI_e$, from $I_e' + dI_e$ to I_e', from I_e' to $I_e' - dI_e$, and so forth. The quantitative relation between the change dI_e in I_e' and the change dV_e in V_e, assuming that V_e depends on I_e alone, is

$$dV_e = \frac{dV_e}{dI_e} dI_e$$

as in Eq. 18.

Just as $dy/dx = y'$ is the slope of the $y = y\ (x)$ curve, so dV_e/dI_e is the slope of the characteristic curve of Fig. 5. (Note that dV_e/dI_e has the dimensions of a resistance, so that in this case the slope is a resistance, hence designated by R.) The slope of the curve must be taken virtually at a point if the relation is to be true.

$$dV_e = RdI_e \qquad (25)$$

Signal Limitations

If in using Eq. 25 the slope over a large region is used the condition shown in Fig. 6 occurs. The slope at point (V_e', I_e') is actually S_1 as shown, but using a large swing about (V_e', I_e') gives a slope S_2 which is in general not equal to S_1. Thus, using a large distance about the point in question to compute the slope may introduce large errors; the larger the distance used, the larger may be the error, particularly as the curve departs more and more from a straight line. If a sinusoidal current is used to simulate dI_e, it must be a very small current or signal, or else large errors may be introduced.

In view of these remarks, the differential quantity dV_e is representable, for purposes of a laboratory experiment, by an a-c voltage, and dI_e by an a-c current, *provided they are suitably small.*

Regardless of whether V_e is a function of one or two variables, the remarks about the size of the signal are still valid.

Equations 22 and 24 may be written (Eq. 26 and 27 respectively) in terms of small a-c v's and i's by applying the foregoing principles.

$$v_e = \left.\frac{v_e}{i_e}\right]_{I_c=k} i_e + \left.\frac{v_e}{i_c}\right]_{I_e=k} i_c \quad (26)$$

$$v_c = \left.\frac{v_c}{i_e}\right]_{I_c=k} i_e + \left.\frac{v_c}{i_c}\right]_{I_e=k} i_c \quad (27)$$

There are several comments which must be made about these two equations: (1) Note the use of small letters for a-c values, and capitals for d-c values, in keeping with the convention adopted by the authors for this series, and which is a proposed standard.

(2) Consider the $I_c = k$, $I_e = k$ factors of Eq. 26 and 27. If a change dI is representable by a small a-c current, $i \sin \omega t$, as has been shown, of amplitude i, then 0 change in d-c current, $I_c = k$, or $I_e = k$, will be represented by an a-c current of 0 amplitude. Using this fact we may properly write Eq. 26 and 27 as

$$v_e = \left.\frac{v_e}{i_e}\right]_{i_c=0} i_e + \left.\frac{v_e}{i_c}\right]_{i_e=0} i_c \quad (28)$$

$$v_c = \left.\frac{v_c}{i_e}\right]_{i_c=0} i_e + \left.\frac{v_c}{i_c}\right]_{i_e=0} i_c \quad (29)$$

(3) At $i_c = 0$, v_e/i_e is r_{11} as described in Part VII of this series.

$$r_{11} = \left.\frac{v_e}{i_e}\right]_{i_c=0} \quad (30)$$

Using the definitions laid down in Part VII

$$\left.\frac{v_e}{i_c}\right]_{i_e=0} = r_{12}$$

$$\left.\frac{v_c}{i_e}\right]_{i_c=0} = r_{21}$$

$$\left.\frac{v_c}{i_c}\right]_{i_e=0} = r_{22}$$

Hence Eq. 28 and 29 can be rewritten

$$v_e = r_{11}i_e + r_{12}i_c \quad (31)$$

$$v_c = r_{21}i_e + r_{22}i_c \quad (32)$$

Equation 31 states that a potential v_e is acting in a circuit and produces the two potential drops $r_{11}\, i_e$ and $r_{12}i_c$ which together make up v_e. Similar remarks apply to Eq. 32. Replacing subscript e in the emitter circuit by subscript 1, and subscript c by 2, Eq. 31 and 32 become

$$v_1 = r_{11}i_1 + r_{12}i_2 \quad (33)$$

$$v_2 = r_{21}i_1 + r_{22}i_2 \quad (34)$$

Equations 13 and 15 are identical to Eq. 33 and 34 respectively, but were arrived at by entirely different methods of reasoning. Equations 13 and 15 were obtained from a circuit analysis using Kirchhoff's law for the voltage loops; Eq. 33 and 34 were derived on a mathematical basis from the simple concept that V_e and V_c are dependent on both I_c and I_e in small-signal operation.

As has been mentioned, the ultimate fact mathematically expressed by these equations is that, given all the other data, it is possible to find two numbers, i_1 and i_2, that satisfy these equations. The fact that they happen to represent a current, in milliamperes perhaps, does not influence the mathematical description of how to determine these two numbers. Since Eq. 33 and 34 are linear equations (that is, they contain no products like $i_1 \times i_2$, or i raised to some power) the delineation is unique; that is, the equations will define only one pair of values, i_1 and i_2, and no other.

Consequently, whatever assumptions were made to find Eq. 33 and 34 are also binding on Eq. 13 and 15 because they represent the same numbers.

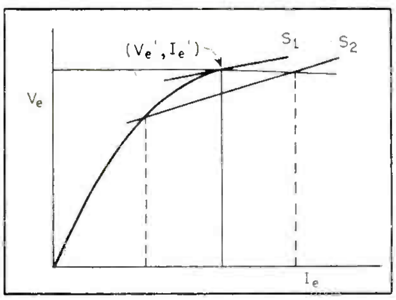

FIG. 6—Sketch shows error in determining slope with large signal input

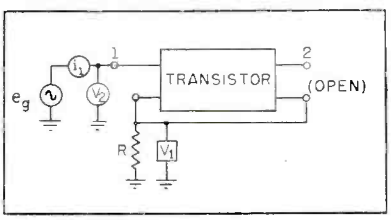

FIG. 7—Connections for measuring r_{11}

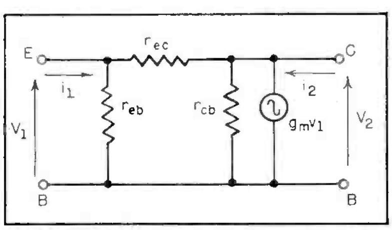

FIG. 8—Equivalent pi circuit of transistor

Assumptions

First, from the discussion in connection with Eq. 31 and 32, the parameters are open-circuit values, that is, $i_c = 0$, when measuring r_{11} and r_{21} and $i_e = 0$ when measuring r_{12} and r_{22}. This condition has already been met for Eq. 13 and 15[1].

Second, from the discussion in connection with Eq. 26 and 27, the parameters are measured using ratios of a-c values. This condition has also been met[1].

Third, the symbol convention that

$$v_1 = e_{g1} - i_1R_g$$

$$v_2 = e_{g2} - i_2R_L$$

assumed to obtain Eq. 13 and 15, is binding on Eq. 33 and 34.

Last, and probably most important, from the discussion in connection with Eq. 26 and 27, the use of small signals is assumed. This means that the four-pole parameters r_{11}, r_{12}, r_{21} and r_{22} are small-signal parameters.

In selecting an amplitude for the measurement of the four-pole parameters, several factors must be considered.

If the signal is not truly small, different signal amplitudes will give different values of parameters.

In practice, a signal of some convenient size is selected, and the parameter, say r_{11}, measured. Then the signal is reduced slightly, and the parameter measured again. If the value of r_{11} obtained in the second trial is close to the r_{11} originally obtained, within the accuracy desired, the signal is a small signal and conversely.

It might appear that there is no objection to using a very small amplitude signal originally, so that there is no question about the signal being small. If the V-I characteristic is very curved, it is very difficult to guess what constitutes a truly small signal. The test suggested above should therefore always be made. Too small a signal introduces measuring problems such as noise and the general difficulty of measuring fractions of a microvolt at a-c.

When feasible, the parameter may be measured by the volt-ammeter method tacitly assumed here, and the resulting value compared to that obtained by using an entirely different measuring scheme. Other possible methods include the bridge method, scope presentation, and variations and combinations of these. The results must compare within the accuracy desired if the signal is truly small.

Open Circuit

Let us now review in a general way the data that has been assembled regarding r_{11}, r_{12}, r_{21} and r_{22}. Because these parameters are so important in the specification of transistor characteristics, much experimental and theoretical work has been done and is continuing regarding these and other suitable parameters.

These parameters are called small-signal open-circuit grounded-base four-pole parameters. In this and previous articles the terms small-signal, grounded-base, and four-pole parameters have been explained. To understand the open-circuit term, consider Fig. 7 which shows the circuit arrangement for measurement of r_{11}.

Both V_1 and V_2 are vacuum-tube voltmeters, and R is a small resistance of known value placed in the signal generator return to measure the current $i_1 = V_1/R$. Voltmeter V_2 measures the voltage across the input of the transistor, and $r_{11} = V_2/i_1$. There is not a true open circuit across the output or collector circuit since whatever scheme is used to bias the collector, a d-c return path to the base is essential, and thus a d-c path is always present to act as a closed circuit across the collector. The internal resistance of the d-c bias supply may be made very high by using a choke of several hundred henries but not infinite. In most tests $f = 270$ cps.

Also, there is an a-c shunting path always present due to internal transistor and stray capacitance. The impedance of this shunting path decreases as the frequency increases.

A typical value of C_c, the collector capacitance, is 50 $\mu\mu$f and a typical circuit may have an additional stray capacitance of 10 $\mu\mu$f. At 270 cps, $X_c = 9.8$ megohms. If r_{22} were three megohms, at 270 cps the 9.8 megohms would represent a shunt path of some importance, and it is not true that measurements are being made under open-circuit conditions.

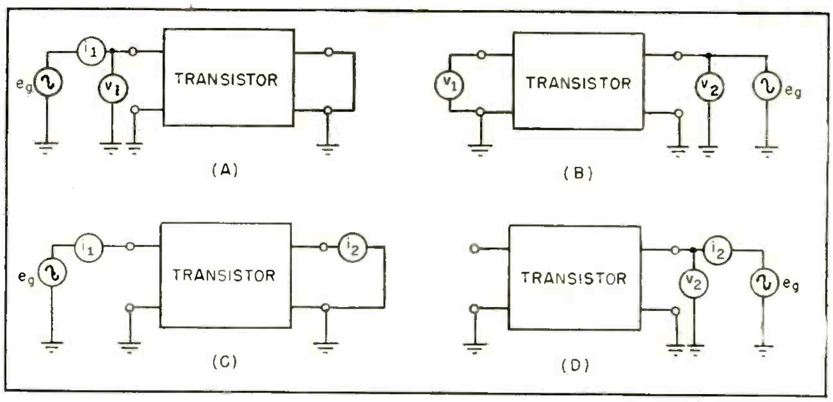

FIG. 9—Sketches show connections for measuring g's or short-circuit conductances

Two principal approaches to this problem have been adopted.

(1) The arbitrary convention that the circuit is open if the shunt resistance is fifty times the internal transistor resistance. Thus when measuring r_{11} and r_{21}, where the collector circuit must be open, the shunt path shall be $50 \times r_{22}$; and when measuring r_{12} or r_{22} the shunt path shall be $50 \times r_{11}$. Or, where feasible, the collector-to-base resistance (or emitter-to-base resistance) may be doubled. If the value of the parameter measured remains invariant within the accuracy desired, the circuit is truly an open circuit.

(2) Measurement of other parameters such as the g's and h's described below to characterize transistor operation, whose measurement does not require the use of an open circuit across high impedance elements. Then, if desired, parameters such as the r's may be derived mathematically from the quantities measured. Or, the performance of the transistor may be expressed in terms of these new parameters directly, it being assumed that with experience engineers will readily compare transistor performance in terms of these parameters.

Conductances

It was mentioned that the equivalent T as characterized by Eq. 13 and 15 is not the only equivalent circuit for the specification of the allegorical black box. The black box or transistor is equally well represented by an equivalent circuit which is a π network,[2] as in Fig. 8. This circuit is analyzed by means of Eq. 35 and 36 using conductances.

$$i_1 = g_{11}v_1 + g_{12}v_2 \qquad (35)$$

$$i_2 = g_{21}v_1 + g_{22}v_2 \qquad (36)$$

Using Eq. 35 and 36 all the four g's can be measured. For illustration, setting $v_2 = 0$, $g_{11} = i_1/v_1$ and similarly one can find g_{12}, g_{21} and g_{22}; see Fig. 9. These g's are sometimes called the short-circuit conductances.

While it is true that resistances and conductances are reciprocals, the r_{11} which appears in Eq. 13 is not the reciprocal of g_{11}. In Eq. 13 r_{11} was obtained using an open-circuited collector, but g_{11} is obtained by using a short-circuited collector. Hence, r_{11} is not $1/g_{11}$ and is, in fact, given by

$$r_{11} = \frac{g_{22}}{g_{11}g_{22} - g_{12}g_{21}} \qquad (37)$$

To obtain g_{11}, v_2 is set to 0. In other words, the output is short circuited. This does away with the need for establishing an open circuit. Like any other good idea in engineering, it has its drawbacks. To find g_{12} the emitter circuit may be shorted, making $v_1 = 0$, and so on for all the other parameters.

The disadvantage of the g method is that some point-contact transistors may be short-circuit unstable. If the input or the output is a-c short-circuited, the units may break into parasitic oscillations. Fortunately, the applicability of this method is greatest for junction types, where this instabil-

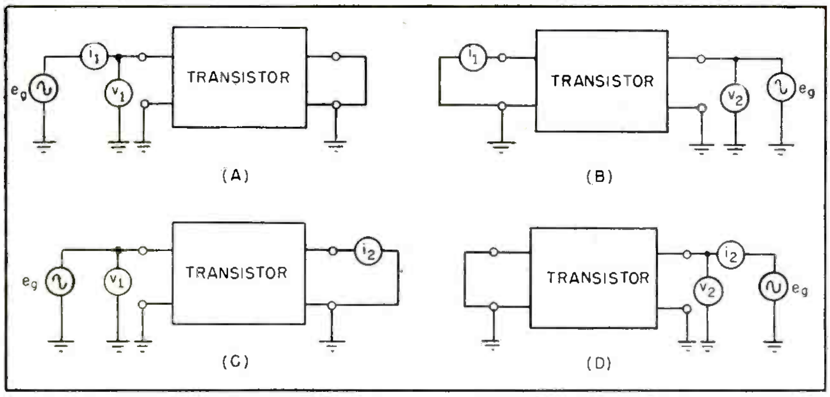

FIG. 10—Circuits for measuring *h*'s or hybrid transistor parameters

ity is not normally encountered. The inference is that for point-contact units, the r's may be suitable, and with junction units, the g's may be preferable.

Hybrid Parameters

Because the use of the g's suggests that two different parameters are needed to take care of point-contact and junction units, an entirely different set has been suggested.[3] These are the hybrid parameters, or h's, characterizing the transistor by the following equations

$$v_1 = h_{11}i_1 + h_{12}v_2 \quad (38)$$

$$i_2 = h_{21}i_1 + h_{22}v_2 \quad (39)$$

To find h_{11}, the output is shorted, (see Fig. 10) $v_2 = 0$, and

$$h_{11} = \frac{v_1}{i_1} \quad (40)$$

The r_{11} of Eq. 13 was obtained with open-circuited output, hence h_{11} is not the same as r_{11}. As g_{11} was obtained with $v_2 = 0$, $h_{11} = 1/g_{11}$, so that the g_{11} of Eq. 35 is the reciprocal of h_{11} in Eq. 35; and since the reciprocal of a conductance is a resistance, h_{11} is of the nature of a resistance, dimensionally.

To find h_{12}, i_1 is made 0 by making the input an open circuit, placing the generator in the collector circuit, and measuring v_1 and v_2. Then

$$h_{12} = \frac{v_1}{v_2} \quad (41)$$

As this is the ratio of two voltages, h_{12} has no dimensions. A similar analysis will show, for Eq. 39, that $h_{21} = i_2/i_1$ for a short-circuited collector. This is α_{ce} by definition; $h_{22} = i_2/v_2$ is conductance but not identical with g_{22} of Eq. 36 since all the parameters of Eq. 36 are obtained under short-circuit conditions. Note that h_{22} is obtained under open-circuit conditions.

Thus the hybrid parameters contain two pure numerics, h_{12} and h_{21}, a resistance h_{11} and a conductance h_{22}. They possess, however, some of the advantages of both the r's and the g's:

(1) In the matter of avoiding the necessity for maintaining an open circuit in the high-resistance collector, the h method shares the advantage of the g system in that h_{11} and h_{21} are made with collector shorted.

In the matter of avoiding the necessity for maintaining a short circuit in the low-resistance emitter circuit, the h system shares the advantage of the r system, since both h_{12} and h_{22} are made with emitter open circuited. Since the input resistance of some transistors may be quite low, of the order of tens of ohms, difficulties are encountered in effectively a-c short circuiting such impedances. In the h system, the input is open circuited for such measurements (h_{12} and h_{22}).

(2) Measurements for alpha in the g and r methods are indirect. In the r method, r_{21} and r_{22} are found; their ratio is alpha $= r_{21}/r_{22}$. In the g method, alpha $= g_{21}/g_{22}$; but in the hybrid parameter method, alpha $= -h_{21}$ directly.

The principal disadvantages of the h's is that they are not directly amenable to circuit analysis. Whereas most engineers are acquainted with resistances and conductances and use them readily in circuit analysis, few are prepared to use h's directly. If transformations are necessary, and these are quite cumbersome, the advantages mentioned above may well be overshadowed. Engineers are currently studying the relative merits of each set of parameters. The indications are that considerable additional experience is needed before a single set of parameters to characterize transistors will be generally adopted.

Resume

In resume, the following are the salient points:

(1) Typical power gains that are possible with the grounded-base transistor connection are: point-contact, 20 db; junction, 46 db.

(2) In transistor terminology r_{11}, r_{12}, r_{21} and r_{22} are called small-signal, grounded-base, open-circuit, four-pole, equivalent-circuit parameters. Each part of the name has significance.

(3) A test to determine whether a signal is truly a small signal is to measure the parameters using a selected amplitude of signal, decrease the signal by approximately 50 percent and remeasure the parameters. The measured values must compare within the orders of accuracy required.

(4) Either the r's, or the g's or h's may be used to characterize the transistor equivalent circuit. Considerations such as common usage, short-circuit stability, and effective open and short circuit are involved in selecting the parameters for a given analysis.

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(3) D. A. Alsberg of Bell Telephone Laboratories, Murray Hill, N. J., before IRE, March, 1953, in talk entitled "Transistor Metrology."

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Signal-Noise Meter Checks TV Links

Noise ratio of studio-transmitter microwave links, intraplant coaxial cables and other broadcasting equipment are determined with a single portable meter. Techniques and equipment applied to propagation studies on 7-kmc relay paths are applicable to broadband communications circuits

By ROY MOFFETT
Staff Engineer
Development Engineering
National Broadcasting Co.
New York, N. Y.

INCREASED USE of television program networks and improvement of transmission standards has created a need for a simple device for testing and maintenance of circuits. A signal-noise meter described below was used originally to align, test and maintain the NBC Philadelphia-to-Washington microwave relay. The technique depends upon using test tones in the region between 60 and 300 cycles and a noise amplifier with cutoff below 1,000 cycles. It can be employed to measure the signal-to-noise ratio of single or cascaded links. Noise measurements of coaxial cable lines within the television plant can likewise be made.

This meter measures the peak-to-peak signal to the peak-to-peak noise ratio in db. The signal-noise ratios measured between microwave facilities are usually about 10 db less than free-space calculations made on a power basis, that is, signal watts to noise watts. It should be noted that noise can be other than the thermal noise originating in the head-end of a receiver. For example, it could be interference from an f-m station introduced into the i-f amplifier of the receiver.

The noise on long runs of coaxial cable within a tv plant can also be measured using this equipment. Usually these cables are a few hundred to a thousand feet long. The noise is of random nature and therefore a cro is used to measure the noise output of the amplifier. It is not necessary to use a 60-to-300 cycle test signal in this case. The noise is amplified to a one-volt level and the amplification required in db is the signal-noise ratio, since 1 volt peak-to-peak is standard picture level.

Elements of System

The block diagram of the signal-noise meter is shown in Fig. 1. The meter comprises a 60-db video attenuator that can be adjusted in 2-db steps, a 1-kc to 10-mc amplifier having a maximum gain of 60 db, a peak-to-peak vacuum-tube voltmeter and a 1-mc calibrating oscillator. The cathode and grid *RC* time constants of the amplifier were selected so that the amplifier has a cutoff below 1,000 cycles.

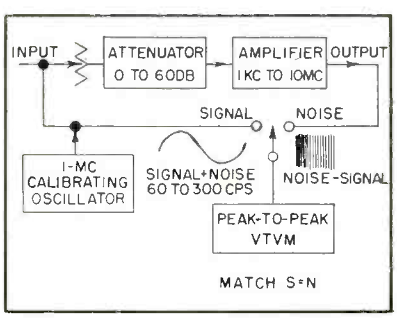


FIG. 1—Block diagram of signal-to-noise measurement meter used for tv

The schematic diagram of this test instrument is shown in Fig. 2. Filaments and plate wiring have been isolated by means of suitable filters. The plate supply with total drain of about 60 ma is regulated by means of a type VR-150. It is important that there be no feedback between the NOISE and SIGNAL sides of the switch to avoid oscillation.

Measurement Procedure

The meter can be calibrated in the following manner: arbitrarily set the attenuators for 50-db attenuation, turn on the 1-mc calibrating oscillator and read the level of the 1-mc calibrating signal on the vtvm with switch on SIGNAL; connect the vtvm to the output of the amplifier, switch on NOISE, and adjust the gain of the amplifier until the 1-mc signal level is the same as it was out of the oscillator. Note that the peak-to-peak vtvm is not calibrated in volts but is used to match the readings. The instrument is now calibrated and the 1-mc calibrating oscillator can be turned off.

The following procedure is used

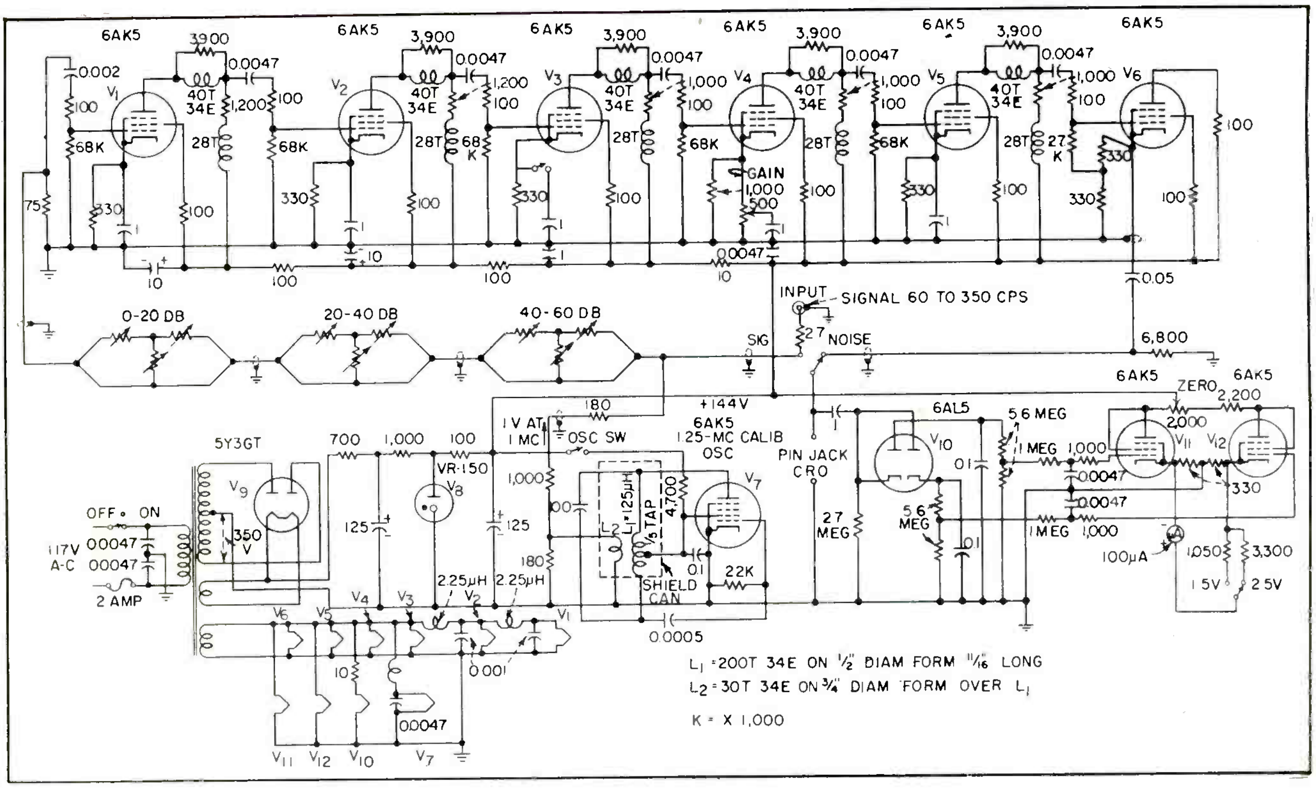


FIG. 2—Schematic diagram of portable meter used in lining up NBC microwave tv links

in making a signal-noise measurement on a studio-transmitter type microwave relay. Modulate the transmitter with an audio oscillator using a sine wave somewhere in the frequency range between 60 and 300 cycles and having the same peak-to-peak amplitude as the normal composite picture signal. The output signal from the microwave receiver is fed to the input of the signal-noise meter. Switch the vtvm to SIGNAL and note the scale reading. Now switch the vtvm to NOISE and then decrease the attenuators until the readings are the same within 1 db. The value in db removed from the attenuators is the signal-noise ratio in db. For example, if the attenuators were decreased from 50 db to 20 db, then the ratio is 30 db.

Field Measurements

Many measurements have been made during the last five years on television microwave relays in both the 2,000 and 7,000-mc bands. A plot of miles vs signal-to-noise ratio in db for 7,000-mc equipment is shown in Fig. 3. An arbitrary line has been drawn to average the individual measurements. A good example of a relay path under different conditions of both transmission propagation and equipment is shown by the two dots plotted at 31 miles; there is a 6-db difference in the signal-noise ratios.

A bench test of microwave equipment, using an attenuating coupler that approximates 10 miles of transmission, is likewise plotted. Various equipments and attenuators were used in this example. It will be noted that there is a good 6-db spread between the various measurements. Both the output power of the transmitter and the noise factor of the receiver, beside variations in the attenuators, would account for the discrepancy.

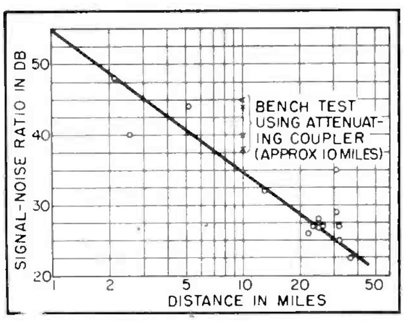


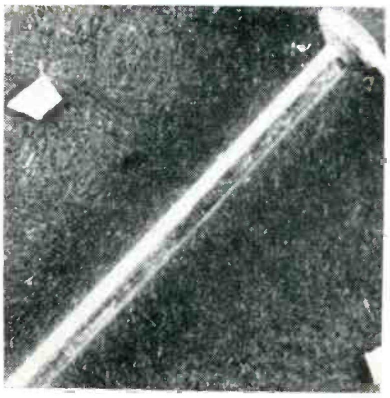
FIG. 3—Comparison of bench and field tests of 7-kmc equipment using 4-ft parabolic reflectors and about 0.1 watt

An attenuating coupler that has a known transmission-path attenuation in db or miles can be used to check transmitter and receiver. The transmitter and receiver are aligned and tuned using a sine-wave test signal and also a composite resolution test pattern. Modulation should be at the same peak-to-peak level with a 60 to 300-cycle sine wave.

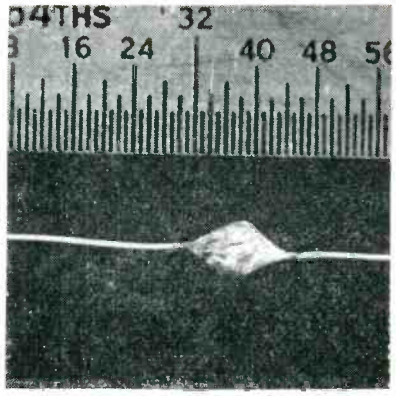
Improvements

If the measured signal-noise ratio is below that expected, various portions of the system can be checked. The crystal in the head end of the receiver should be changed, and also the first and second tubes following the microwave converter, likewise the output klystron of the transmitter.

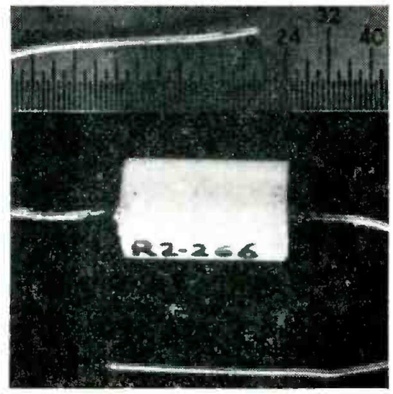
The transmission path is checked next. It is assumed that this relay path provides line-of-sight transmission. The parabolic reflector dishes should be panned in using the signal-noise meter for determining minimum noise. The signal should also be observed on a cro. This method is more accurate than using carrier meter on microwave receiver for checking signal.



Tiny dielectric amplifier capacitors be-before mounting



Dielector with leads for applications where sealing is unnecessary



Complete hermetically sealed unit is shown at roughly half normal size

Nonlinear Capacitors for

By GEORGE S. SHAW and JAMES L. JENKINS

Radiation, Incorporated
Melbourne, Florida

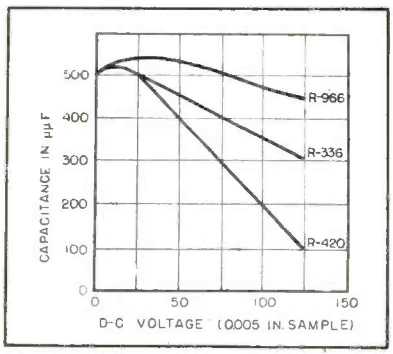


FIG. 1—Curves show incremental capacitance as a function of voltage for several typical dielectors

ALTHOUGH somewhat overshadowed in recent years by transistor developments, the dielectric amplifier still promises to be an important factor in the electronics industry of the future. Extremely versatile dielectric amplifiers have been built, but their operation is presently limited to environments of carefully-controlled conditions.

Continuing research for new and better materials for use in dielectric amplifiers is showing profitable results day by day.

Incremental capacitance is plotted as a function of d-c voltage applied to several typical dielectors in Fig. 1. Such information provides certain useful criteria for designing amplifiers and other circuitry. The linearity of this type of curve is a measure of linearity of the output signal of the amplifier. The gain of a dielectric amplifier is proportional to the slope of this curve which can be evaluated by defining δ as $\dfrac{2(C_1-C_2)}{(E_1-E_2)\,(C_1+C_2)}$ which is the mean fractional change in capacitance per unit change in bias voltage in the interval between E_1 and E_2.

For certain compositions, values of δ of 0.08 have been obtained, with values as large as 0.1 being realized under special conditions. These bodies should by no means be

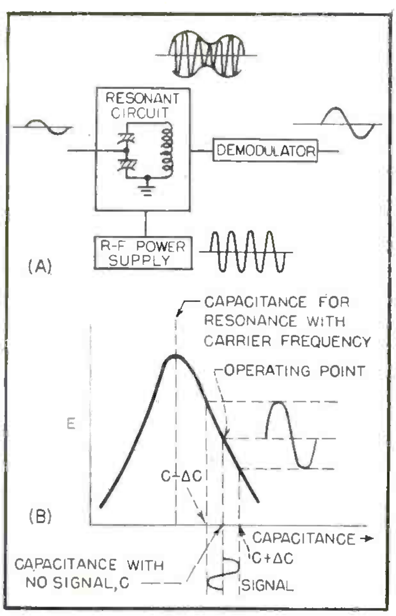


FIG. 2—Typical application for nonlinear capacitors is modulator circuit

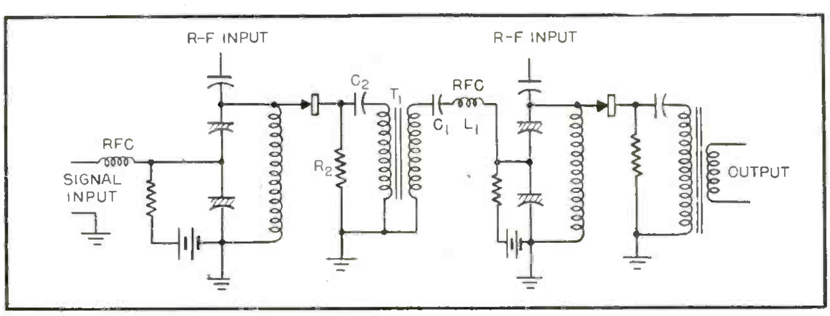
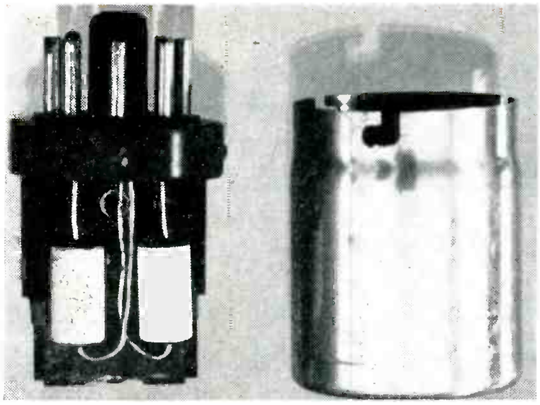
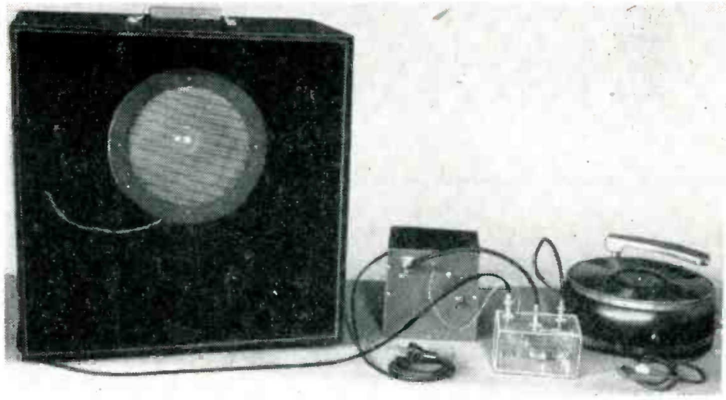


FIG. 3—Circuit of small broadcast receiver using dielectric amplifiers at r-f and a-f frequencies



Two dielectors are installed in temperature-controlled oven that maintains 90 deg C



Laboratory model of two-stage audio amplifier that gives 300 mw output. The r-f power source is shown at center

Dielectric Amplifiers

Using an r-f power source, a typical two-stage dielectric amplifier produces 300 milliwatts output from a 0.3 milliwatt signal source. Although still vulnerable to atmospheric conditions, progress is being made in developing new materials

considered as optimum since there is a great deal of research work yet to be done before the mechanism of voltage sensitivity will be fully understood and controllable.

At the present time, all of the dielectrics known to be appreciably voltage sensitive have dielectric constants in the order of 2,000 to 6,000. Dielectors suitable for circuit applications at the higher frequencies and with small signal voltages must have small capacitance values and must be made from thin dielectrics so that the signal voltage gradient will be adequate.

This immediately presents a problem since a capacitor having a value of 100 $\mu\mu$f with a dielectric material 0.005 in. thick, and having a dielectric constant of 4,000 would be approximately 0.0236 inch square, or less than 1/32 inch on each side. This is small indeed and presents serious problems in manufacture and mounting. Nevertheless dielectors are currently being produced with a dielectric thickness as small as 0.005 in. and with zero-voltage capacitances as low as 100 $\mu\mu$f.

At the present time, the voltage sensitivity of the commercial dielectric amplifier capacitors shown in the photographs, varies somewhat with temperature. For operation in circuits where the sensitivity must be constant, the units may be operated in a small temperature-controlled oven as shown.

Circuit Application

Usable amplification is obtainable from dielectors in several ways. An example is shown in Fig. 2A, representing a typical arrangement for a modulator-amplifier. A qualitative explanation of the circuit can best be given by considering Fig. 2B.

A value of capacitance is chosen such that an operating point is established on one side of the resonance curve. If the capacitance is varied by some means, such as a small signal voltage applied to a dielector, the voltage E will vary. Thus there is produced an amplitude-modulated r-f voltage which can be demodulated to recover the amplified signal. No energy is required from the signal except to replenish the small capacitor losses since all the energy supplied to the load as an amplified signal comes from the r-f carrier supply. It is evident that the higher the Q of the circuit, the greater will be the change in voltage E for a small change in capacitance.

Figure 3 is a diagram of a two-stage audio-frequency dielectric amplifier which has been built that has an overall power gain of 30 db. The input signal power is 0.3 milliwatt and the power output is 300 milliwatts.

As a nonlinear circuit element the dielector has possible applications other than in amplifiers; the more obvious being in multivibrators, memory and storage devices, frequency and amplitude modulators, and electrically-adjustable filters.

Appreciation is expressed to L. R. Culver of Radiation, Inc. for his suggestions and assistance, and to Josephine LeGault for the exhaustive experimental work entailed.

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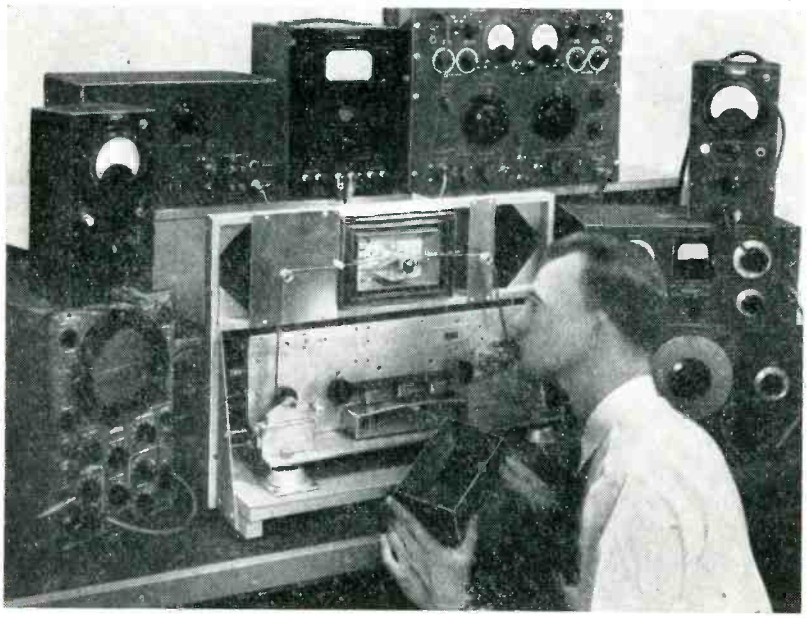
Electron-Beam Head for

Standard magnetic tape run over neck of special miniature cathode-ray tube causes electron beam to deflect between two collecting plates alternately at the recorded audio rate, so that current output of tube is linearly proportional to magnetization on tape



Bench setup used in obtaining performance characteristics of new tape playback head, just visible inside triple-shielded housing from which cover has been removed. Magnetic fields as weak as one-hundredth of the earth's magnetic field will give an output voltage, hence the need for magnetic shielding

SINCE THE TIME of Poulson's invention[1] of magnetic recording over 50 years ago only one principle of reproduction has been employed. This is the generation of a varying electric current in a coil by the variations of magnetic flux from the tape.

A disadvantage of this kind of reproduction lies in the fact that the output signal is proportional to the rate of change of the flux in the tape rather than to the instantaneous values. The resulting frequency characteristic increases from zero linearly until limited by the gap size.[2] Since flux here is directly proportional to the input signal, the output from a conventional head is not a true reproduction of what was recorded. Equalizing networks must be incorporated in the reproducing circuits to restore the balance between low and high frequencies so the reproduction will sound like the recorded signal.

Beam-Type Head

In the new pickup head[3] described herein, the magnetic flux in the tape is guided by a magnetic structure into a tiny cathode-ray tube where it deflects the electron beam in proportion to the instantaneous magnitude of the flux. The magnitude of the output signal is independent of the recorded frequency and of the speed of the tape. In fact, if the tape is moved very slowly or even stopped altogether the amplitude of the output signal is not decreased. The tube also acts as a deflection type of amplifier, giving output voltages many times those from conventional heads.

Figure 1A shows a sectional view of the new type of reproducing head, with the old type shown in Fig. 1B for comparison. The new head has a conventional gap in contact with the tape, and a magnetic core structure which guides the flux through the glass walls of the tube. The internal magnetic pole pieces carry the flux into the deflecting region where it produces a magnetic field that deflects the electron beam.

Figure 1C shows a cutaway view of the tube. The miniaturized electron gun at the left sends a beam of electrons between the pole pieces toward the split target. The deflection of the electrons is at right angles to the flux and hence parallel to the pole faces. This property of magnetic deflection is advantageous in increasing the sensitivity since the pole pieces never get in the way of the deflected beam. The pole pieces are thin moly-permalloy and the other metal parts of the tube are nonmagnetic stainless steel.

Figure 2 shows the basic circuit connections. The small plate located just behind the slit between the target plates is grounded to repel

Magnetic Tape Playback

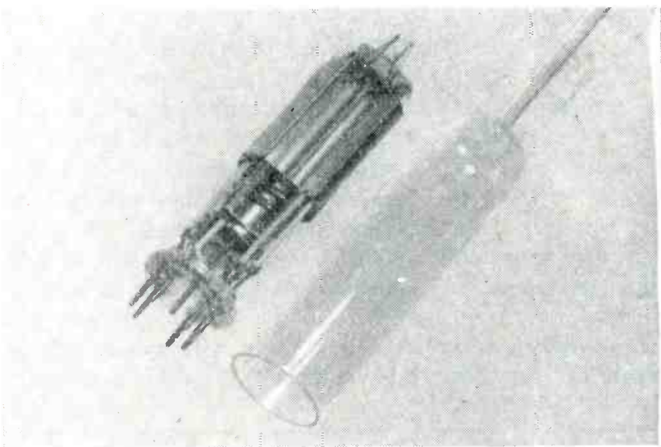
By A. MELVIN SKELLETT, *National Union Radio Corp. Orange, N. J.*

LAWRENCE E. LEVERIDGE *National Union Radio Corp. Orange, N. J.*

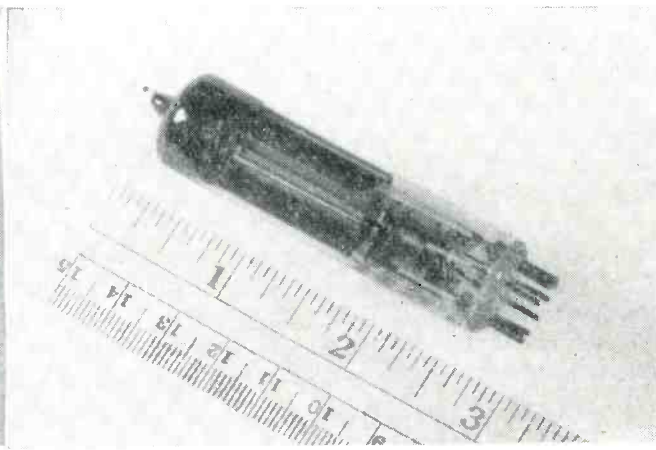
and J. WARREN GRATIAN *Stromberg-Carlson Co. Rochester, N. Y.*

those electrons that pass through the slit and thus reduces the effective slit width. For zero flux and zero deflection the beam is equally split between the output plates of the target, giving zero output voltage across the 100,000-ohm load resistors. In operation the beam swings back and forth between the two plates depending on whether the flux is negative or positive. When the beam is deflected the target currents are no longer equal and hence a net output voltage is developed across the two load resistors.

The output characteristic in Fig. 3 shows output voltage measured across the output plates for different values of flux in the beam-gap. The characteristic is linear



Tube structure and bulb before sealing



Miniature cathode-ray tube after sealing

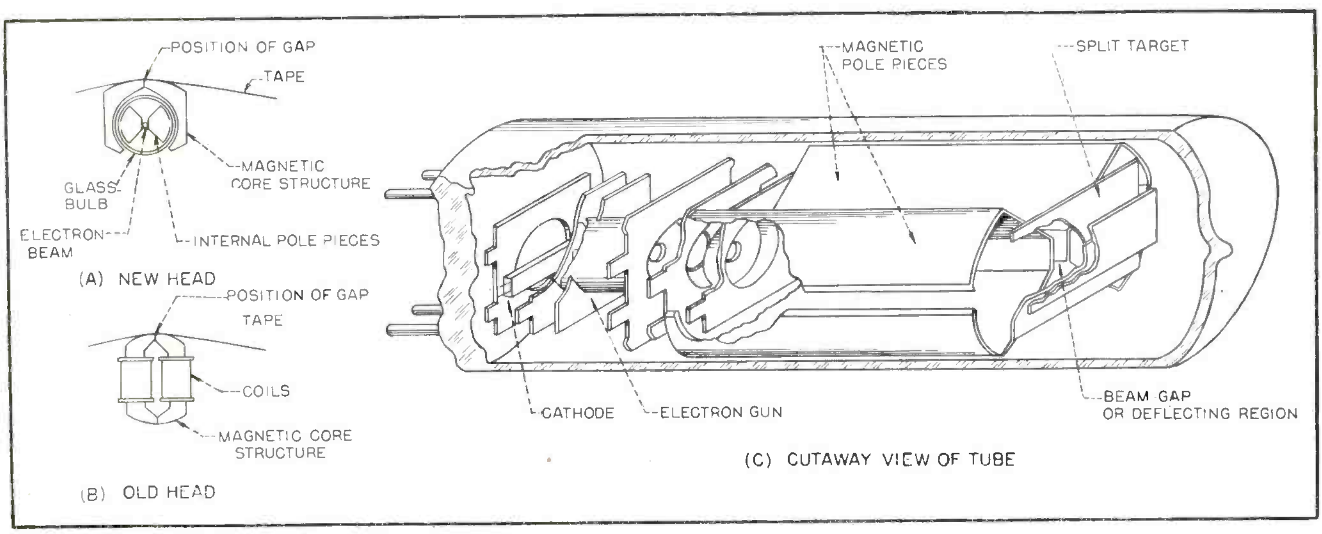


FIG. 1—Cross-sections of new and conventional magnetic tape playback heads, and cutaway view of cathode-ray tube used in new head

over a range of ± 1 gauss. This range is about 50 times greater than the maximum flux variation from standard ¼-inch magnetic tape when used with the complete head under typical operating conditions.

Magnetic Structure

The magnetic head structure design of Fig. 1A was abandoned early in the work, in favor of the strip-type magnetic structure shown in Fig. 4. The magnetic gap caused by the deflecting region in the tube introduces a very high reluctance, making the reluctance of the elements in the magnetic circuit negligible in comparison with the beam-gap reluctance. The magnetic elements may therefore be reduced to the smallest practical dimensions without appreciable loss of flux. A single lamination of Mu metal 0.014 inch thick proved to be adequate.

The strip-type structure is assembled by using Hysol thermosetting casting resin, which has good adhesion to the metal and is easy to handle. A molybdenum spacer 0.0003 inch thick controls the pickup gap. The wings of the head extend out in the direction of the tape to increase the effective length of the magnetic core, and also act to extend and flatten the low-frequency response of the pickup, for improved performance.

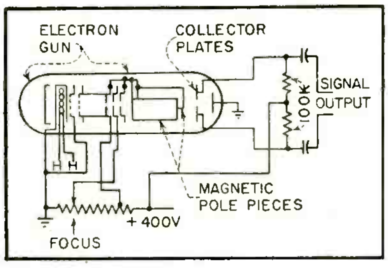


FIG. 2—Cathode-ray tube circuit

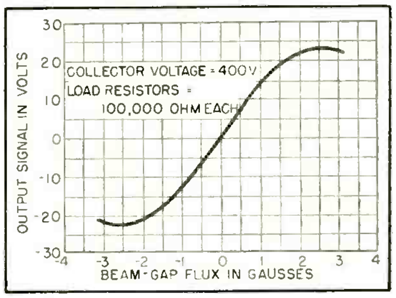


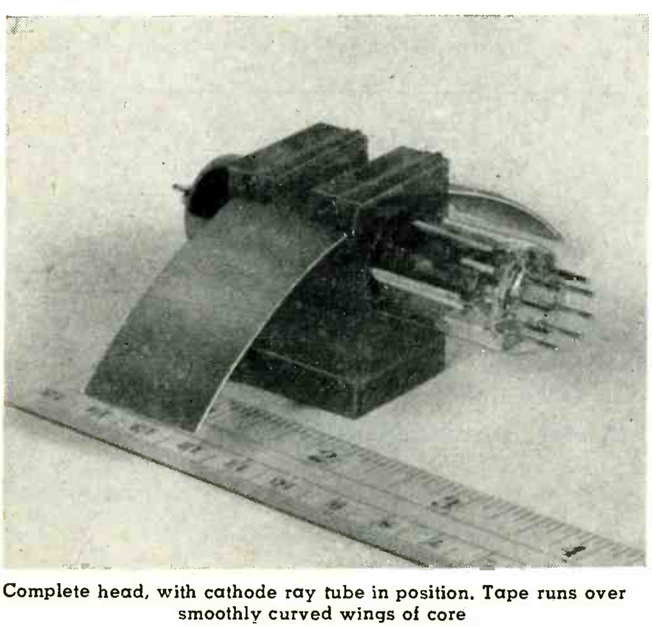
FIG. 3—Output characteristic of new electron-beam playback head

Sensitivity

To determine the flux density at the electron beam, a calibrated vibrating probe was used to measure the flux density in the gap between a pair of dummy pole pieces mounted in proper relation to the external magnetic structure. With a saturated tape recording, a field intensity of approximately 0.04 gauss was available for deflection of the electron beam.

Reluctances and leakage factors of the various portions of the magnetic circuit were determined by additional measurements and calculations. Using these values, it was shown that the total flux in the beam gap should approximate 8 percent of that available from the recording. The cross-section area of the magnetic tape coating was approximately 1/1,200 that of the beam gap. A saturated recording on a typical tape having a retentivity of 600 gausses should provide a beam-gap flux density of $600 \times 0.08 \times 1/1{,}200 = 0.04$ gauss, which is in agreement with the earlier measurements.

Tube sensitivity was determined by measuring the tube voltage output with a known applied magnetomotive force. The beam-gap flux density was calculated from the known mmf and previously determined magnetic circuit parameters, thus permitting the tube sensitivity to be expressed in terms of tube voltage output per gauss of beam-gap flux density. With the sensitivity of the tube equal to 15 volts per gauss and a beam-gap flux density of 0.04 gauss, a maximum output voltage of 0.6 volt peak plate-to-plate was expected. Tests with recordings on tape confirmed these figures within


Complete head, with cathode ray tube in position. Tape runs over smoothly curved wings of core

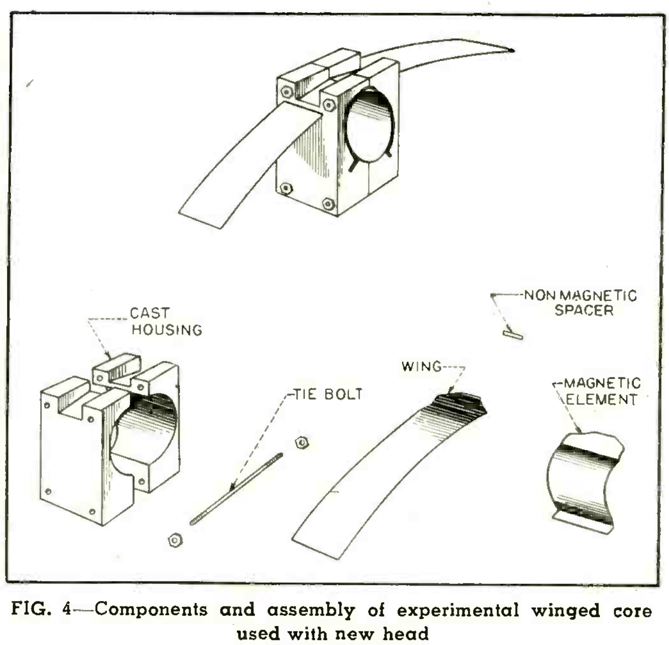


FIG. 4—Components and assembly of experimental winged core used with new head

experimental error.

These figures indicate the high sensitivity of the cathode-ray tube. It will give satisfactory output voltages on field strengths from one-tenth to one-hundredth the strength of the earth's magnetic field.

Frequency Characteristics

Curve *A* of Fig. 5 gives the frequency response of the new head without any equalization. Curve *B*, shown for comparison, is the frequency characteristic of a conventional pickup head, also without equalization. It should be noted that the scales are quite different for curves *A* and *B*. For example, the maximum output obtained by the conventional head is only 10 millivolts, whereas the level of most of the frequency range of the new head is about 0.2 volt. These curves were taken with conventional longitudinal recordings, and demonstrate the superior low-frequency performance of the new head.

At the upper-frequency end of the curves the deterioration in output is caused by the so-called gap effect which comes about because the gap itself is comparable in length with the wavelength of the recorded pattern. The curves show that this effect is more serious with the new type of head. The reason is that the steeply ascending curve of the conventional head partly compensates for this gap effect, whereas the flat characteristic of the new head has no compensating feature.

Calculation indicates that a simple single-section R-C equalizing network used in conjunction with the new head will modify the characteristic to curve *C*. A two section R-C filter will give an even better effect, as shown by curve *D*.

Magnetization Pattern on Tape

All of the discussion given above was based upon conventional longitudinal recording on the tape. For very low frequencies, corresponding to long wavelengths in the tape, this is not the optimum type of recording pattern. For the long wavelength the gap has access only to the leakage flux near the center of the elementary magnet; therefore, as the head is moved slowly over a long recording, such as for a square wave, the response will be a maximum at the ends and a minimum at the center of the square pulse.

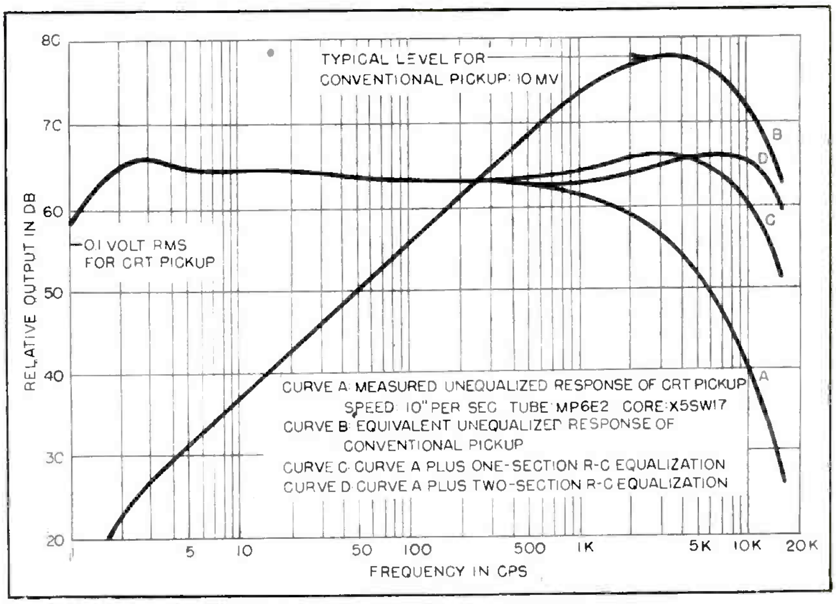


FIG. 5—Frequency response curves for cathode-ray and conventional heads

Either perpendicular or transverse magnetization would be more suitable, but both of these suffer at the high-frequency end. The work to date has been restricted in general to longitudinal recording since the overall response was more important than the low-frequency end of the spectrum.

Applications

Work is being carried on, however, on perpendicular recording involving magnetization through the tape. Indications are that this may be made to give much superior results at the low-frequency end without too great a loss at the high-frequency end of the spectrum.

This new type of head offers advantages over conventional heads in a number of uses. In spite of the excellent results obtained with well-equalized conventional recording of music, it is believed that ultimately the quality obtained with the new head will surpass that possible with conventional types.

There are certain commercial and military applications where it is desirable to record very low frequencies, d-c levels or pulses without distortion. For these the new head is ideally suited, whereas the old type will not perform adequately without considerable complexity of the apparatus, such as the dithering head and the use of frequency modulation for d-c recording.

The inherent amplification of the tube and the cheaper equalization circuits required by the new head give rise to the hope that a simpler, cheaper magnetic tape recorder may be possible. This would further popularize and widen the field of magnetic tape recording.

This development has been sponsored by the Bureau of Ships of the United States Navy under Contract NObsr-57452. The tube has been under development at National Union Radio Corp. and the magnetic head structure at Stromberg-Carlson Co. This paper was presented at a meeting of the Institute of Radio Engineers in San Antonio, Texas on Feb. 7, 1953.

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(1) V. Poulson. U. S. Patent No. 661,619, November 13, 1900.

(2) S. J. Begun, "Magnetic Recording," p 81, Murray Hill Books, Inc., New York City, 1949.

(3) A. M. Skellett. U. S. Patent No. 2,165,307.

Fluoroscope Image

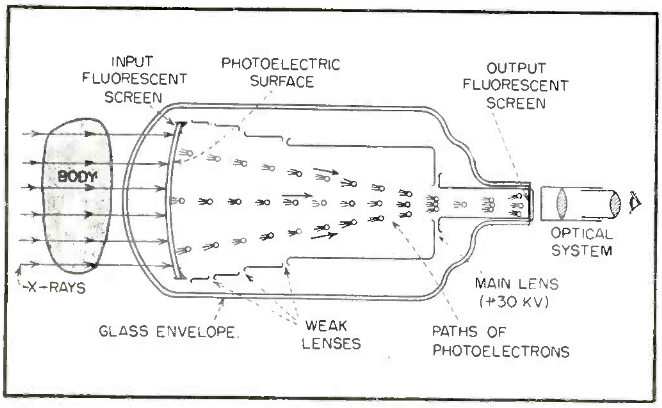
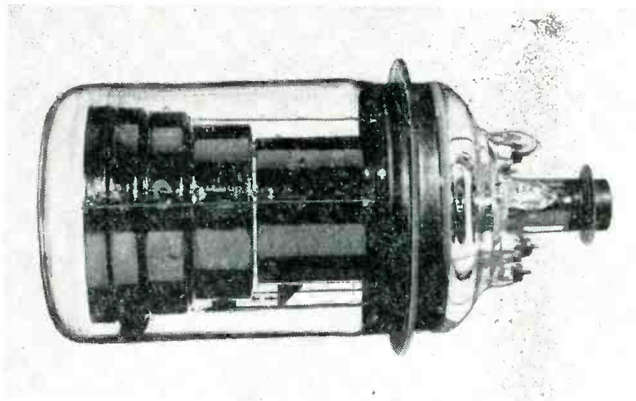


FIG. 1—Cross-section of image-amplifier tube, showing method of brightening x-ray image



Closeup of amplifier tube. Image is viewed on screen in neck of tube through lens system

THE ELECTRONIC fluoroscope is a device designed to replace the conventional medical fluoroscopic screen on which the physician sees the x-ray shadowgraph of the patient. It presents the x-ray image in the same size but increased in brightness by a factor of 200.

For a standard abdomen examination the best fluoroscopic resolution is about 20 lines per inch, obtained after several minutes of dark adaptation by the physician. The brightness amplification of the electronic fluoroscope doubles this, yielding 40 lines per inch without long dark adaptation.

Operating Principle

The heart of the new device is the large image tube shown in the photograph and Fig. 1. X-rays pass through the patient and through the glass window of the tube, to strike the input fluorescent screen, similar to a conventional fluoroscopic screen. The resulting light from the screen releases photoelectrons from a photosurface deposited on the back of the screen. Amplification is accomplished by accelerating the photoelectrons through a 30-kv potential difference. The accelerated electrons strike an output fluorescent screen, releasing more light than was released from the input screen by x-rays. The brightened output image on the other side of this screen is viewed through a system of optical lenses and mirrors.

By present manufacturing specifications the total brightness amplification of the x-ray image tube is 200. However, true amplification by voltage acceleration accomplishes only about 10 of this amplification. The remaining factor of 20 is obtained by geometrical size reduction of the image. An electrostatic electron-optical system is used to form an output image reduced in size relative to the input image by a factor of about 4.5 in diameter, or 20 in area. Brightness, or emerging light flux per area. is thereby increased by a factor of 20. Light from the output screen emerges diffused into all forward directions.

The 20-fold increase in brightness is not lost when the image is magnified back to size in the light-optical system. The eye is effectively brought very close to the image at the output screen by a lens introduced to accommodate the focus of the eye. Brightness remains unchanged, for the increased magnification is exactly balanced by the increased solid angle of light intercepted by the pupil as the eye is brought closer. This action holds for any magnifier system having an exit aperture larger than the pupil of the eye.

Focusing Lenses

The main electron-optical lens of the image tube is an eighth-inch gap between electrodes across which most of a 30-kv potential difference is applied. A partially satisfactory image can be obtained using only this main lens, but the resolution is good only at the center. The system of weak auxiliary electron lenses corrects the image for good resolution over its full diameter.

Screens

The input x-ray phosphor must have high efficiency and its light must be spectrally matched to the photosurface. Phosphors in the zinc sulfide and zinc cadmium sulfide family have given the best results.

The intermediate photosurface uses blue-sensitive cesium antimony which has a high threshold energy for escape of any large number of thermal electrons at room temperature. As a result, the output image shows no detectable background glow due to thermally emitted electrons, yet the threshold energy is not so high as to involve photoelectron velocities great enough to cause difficulty in focusing.

For the output electron phosphor, zinc cadmium sulfide was chosen because of high efficiency and because its yellow-green spectral output matches the response of the eye. This screen is aluminum-backed to increase forward light yield and prevent feedback of light.

The electron-optical demagnification ratio was determined from an estimate of the maximum magnifi-

Amplifying Tube

New tube converts x-ray image into photoelectron stream for intensification by 30-kv electron lenses. Resulting image on aluminum-backed output screen appears 200 times brighter than standard fluoroscope when viewed at original size through magnifying optical system

By FITZ-HUGH MARSHALL

Research Department
Westinghouse Electric Corp.
East Pittsburgh, Pa.

cation which could be expected from a satisfactory light-optical system.

Amplification in the image tube brought out a defect of phosphorescence in the input phosphor which was not anticipated. The zinc sulfide was shown to have a composite phosphorescence, with several different decay constants. It was found that persistence gradually builds up due to low-intensity components with very long decay constants. As successive patients were examined, the output image was so obscured by a general background glow that the tube became useless until the next day. The brightness of this persistence glow was too low to be seen directly at the blue-emitting screen itself, but it was brought out by the amplification of the tube. The defect was first corrected by the use of infrared light for quenching between exposures, but recent improvements in the cathode composition has reduced the persistence to satisfactory levels.

Amplification

Another problem encountered during development work concerned the difficulty of measuring the amplification of the tube. The conventional screen emits light on the green side of yellow-green, for best response of the dark-adapted eye. The output light of the electronic fluoroscope is on the yellow side of yellow-green, matching the unadapted eye.

Comparison photometry must be done at some one brightness, but visual amplification varies with brightness level. With some spectral combinations amplification at high brightness has probably been as much as double the value at low brightness. However, apparent amplification also seems to vary with such observer factors as time in the dark, recent hours in bright sunlight and tendency to look off-center to bring in parafoveal vision, all of which influence the effective degree of observer dark adaptation.

Amplification also varies with quality of the radiation, as influenced by x-ray voltage and equivalent patient thickness. To avoid confusion, an arbitrary specification of conditions for amplification measurement has been adopted. The actual comparison measurements are now made by phototube.

A value of 500 was originally suggested as a reasonable practical amplification limit.[1] Actually, this amplification has been exceeded in some tubes under some conditions.

In the meantime, the Patterson B conventional fluoroscope screen has been superseded by the brighter Patterson B-2 screen, changing the comparison standard. Relative to the old standard, the present specified amplification of 200 would be nearer 300. The remaining difference represents an effort to be conservative, both in avoiding nontypical conditions of measurement and in accepting a production goal which can be met in reasonable quantity.

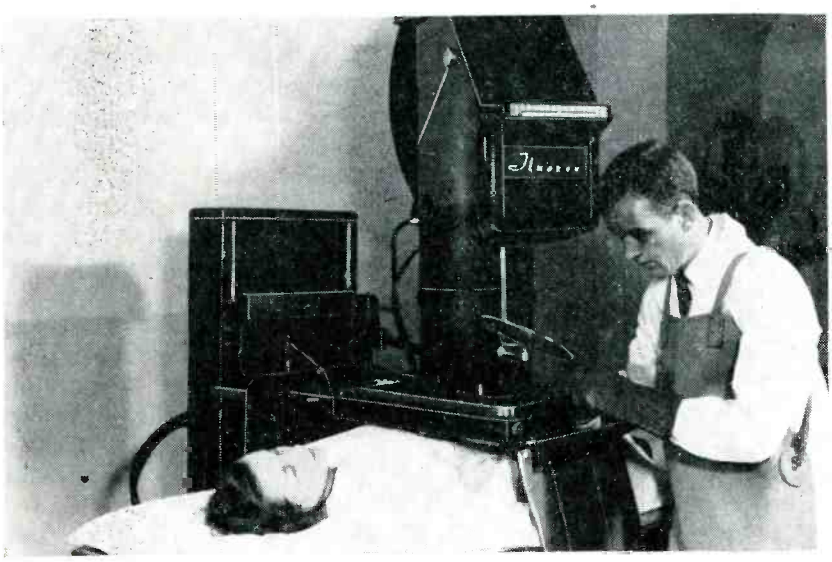


Image amplifier tube and optical system in housing over patient take the place of a regular fluoroscope screen. The X-ray tube is here located under the table. Intensified image, magnified by optical system at top of housing is viewed in mirror of Fluorex machine

REFERENCE

(1) J. W. Coltman, Fluoroscopic Image Brightening by Electronic Means, *Radiology*, 51, p 359, Sept. 1948.

By LOUIS W. ERATH
Vice-President
Southwestern Industrial Electronics Co.
Houston, Texas


Test setup, with R-C oscillator at left. Frequency ranges are so chosen that readings of single 1-120 scale on tuning dial are multiplied by powers of 10

Bridge-Stabilized

BY modifying a conventional Wien bridge type of R-C oscillator so no arm of the bridge is shunted by a low impedance, the influence of vacuum tubes on the oscillator can be virtually eliminated. The only bridge shunting elements then are vacuum-tube grids. This unique arrangement gives extreme frequency stability and very low harmonic distortion. The oscillator has a small general drift for several hours due to warm-up, but the short-time frequency stability is of the order of 1 part per 100,000 over an operating range of 1 cps to 120,000 cps. One application for an instrument with this degree of stability is in conjunction with digital-type frequency counters used in designing sharply tuned filters. The wide frequency coverage, from 1 to 120,000 cps in five overlapping ranges, is useful as well for research in geophysics, medicine and ordnance.

A well-regulated power supply minimizes the influence of line voltage variations on frequency and contributes to a low hum level.

The type of output circuit used provides a low generator impedance. The output level control keeps the undesired voltages at a constant percentage of the desired output voltage, which may be as high as 20 volts.

Circuit Details

The oscillator circuit is composed of two separate amplifiers, joined together by a bridge network as shown in Fig. 1. This network is both frequency and amplitude sensitive with respect to the conditions of its balance.

The two amplifiers are entirely separate, except that the screens and cathodes of V_1 and V_2 are fed from the same points on the voltage-divider networks as are the corresponding electrodes of V_3 and V_4. This is done to avoid the necessity of bypassing the a-c currents in these elements to ground with capacitors.

Four-terminal network *A-B-C-D* serves to connect the two amplifiers together. This network is a Wien bridge which has been modified to be amplitude-sensitive by the use of quasilinear elements in the resistive bridge arms. At zero and infinite frequencies, terminals *A* and *C* are at the same potential. Amplifier No. 1 then has its output connected directly to its input degeneratively, and the amount of negative feedback is equal to the gain of this amplifier alone.

At a frequency which is determined by the reactive arms of the bridge, the two amplifiers are coupled together regeneratively by a network having a loss which is less than the gain of the amplifiers; under these conditions, oscillations start. As the amplitude of the oscillations increases, the loss in the bridge network also increases until it has become numerically equal to the average gain of the two amplifiers. This is the stable operating condition.

The voltage across R_3 contains the fundamental frequency plus about ½ percent of even-order harmonic distortion. The voltage across R_4 contains an out-of-phase fundamental component, but the even-order harmonic components are in phase with those appearing across R_3. A special amplifier having dual input circuits is used to combine these voltages into a single voltage with respect to ground, which is essentially free of even-order harmonic distortion.

Both the oscillator and the amplifier have been provided with overall d-c negative feedback, and the internal potentials of the vacuum tubes have practically no effect on the d-c operating potentials of the circuit. Approximately 40 db of negative a-c feedback is used in the amplifier, adjustable through choice of values for R_5 and R_6. The net a-c gain of the amplifier is less than 2.

Tube V_7 has been used as a load resistor for V_6 so that all of the signal power may be delivered to the load.

The power line frequency comparator tube V_8 has its target powered by the low-angle peaks of the 450-volt power transformer secondary. This allows frequencies which are related to the power line frequency by the factors ⅓, ½, 1, 2, 3, 4 and 5 to be spotted with ease.

Performance

When the oscillator is operating properly, the harmonic content of

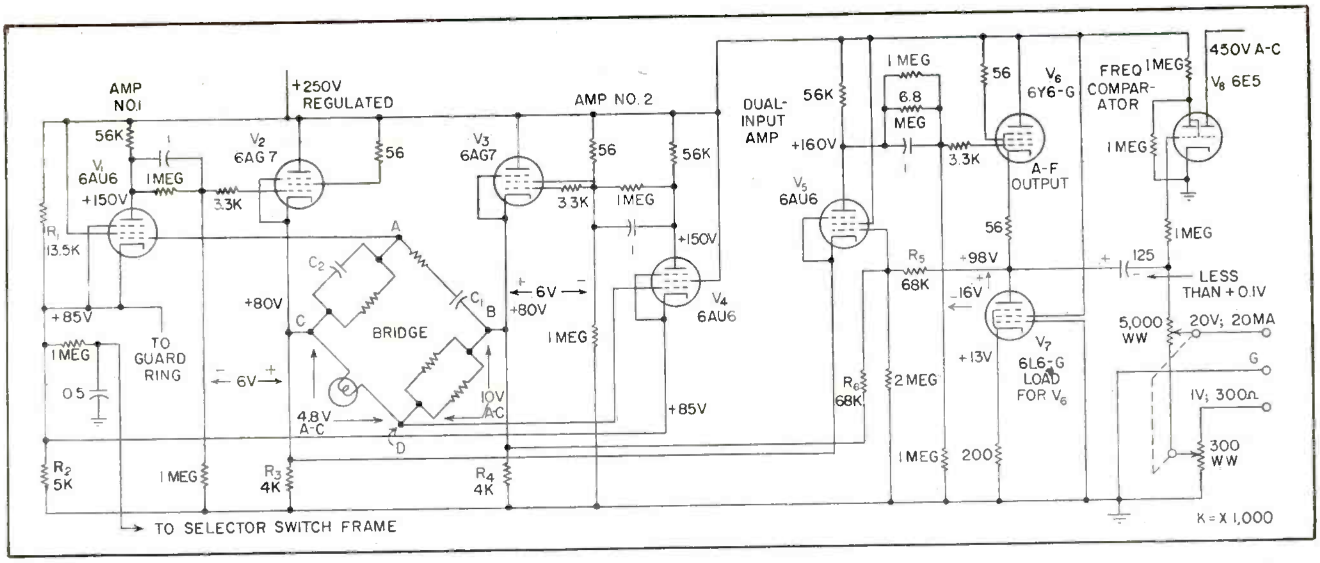


FIG. 1—Circuit of oscillator. Stabilized power supply, not shown, uses 5U4-G as full-wave rectifier with 900-v c-t transformer, with two 6Y6-G, one 6AU6 and one 0B2 in regulator circuit

Ultrasonic Oscillator

Two-amplifier variation of Wien-bridge R-C oscillator gives exceptional frequency stability and low harmonic distortion, for digital-type frequency counters as well as for audio and ultrasonic research. Five overlapping ranges cover 1 cps to 120,000 cps

the output voltage is about 0.1 percent in the range from 20 to 20,000 cycles per second. Above 20,000 cycles per second, the second harmonic increases slightly due to the increased loading by the stray capacitances to ground. Below 20 cps, the third harmonic increases slightly due to cooling of the thermal avc element during the cycle. It reaches a value of about 1 percent at 1 cps.

Low distortion at low frequencies may be obtained by replacing the 6-watt 120-volt lamp in the bridge circuit (Fig. 2) with a 10-watt 120-volt lamp and changing R_7 to 560 ohms. Under this condition the output drops to about 6 volts, and the harmonic content at 1 cps is less than 0.2 percent. With the 10-watt lamp, the amplitude requires a much longer time to stabilize after a change in frequency is made, but otherwise the performance of the instrument is the same.

Extreme amplitude stability may be had at a sacrifice of good waveform at the lower frequencies by replacing R_8 and R_9 with a type 1C thermistor and leaving the 6-watt lamp in place. Under these conditions, the harmonic content at 10 cps is about 2 percent and increases rapidly at lower frequencies. The distortion decreases at frequencies above 10 cps. The harmonic content may be observed by using a parallel-T null network to reject the fundamental and an a-c millivoltmeter for measuring the rms value of harmonics which remain.

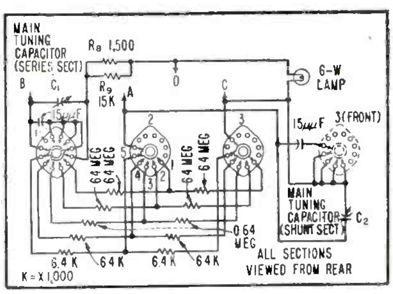


FIG. 2—Bridge circuit and range switch. The ten resistors in the frequency-determining legs of the bridge, below the switch, are all 1 percent deposited carbon units. Frequencies for the five switch positions are: 1—1-12 cps; 2—10-120 cps; 3—100-1,200 cps; 4—1,000-12,000 cps; 5—10,000-120,000 cps

Current passed by the 125-μf electrolytic output coupling capacitor gives in the output a d-c voltage that is less than 1 percent of the output signal.

The 20-volt output circuit has a variable internal impedance which reaches a maximum of about 1,250 ohms when the control is set at half value. If a lower output impedance is desired, 2 volts can be produced across a 100-ohm resistor which is connected across the 20-volt output terminals. The 1-volt output circuit has a constant internal impedance of 300 ohms. Output currents up to 20 ma rms can be drawn without an increase in distortion.

Measuring Impedance of

Unknown resistor is connected across a special coaxial cavity that is fed by an unmodulated signal generator and is tuned linearly to resonance by an inward-projecting precision micrometer spindle. Resulting voltage across resistor is detected, measured and converted to impedance with accuracy better than 5 percent up to 400 mc

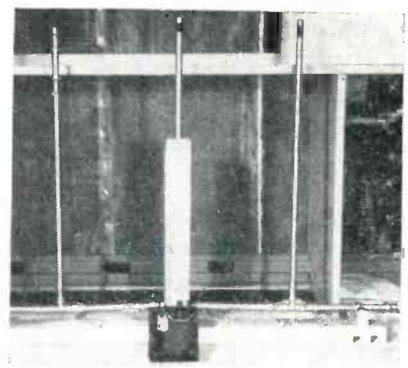
By CHARLES L. WELLARD

International Resistance Co.
Philadelphia, Pa.

MEASUREMENT of resistor impedance in the so-called middle band of frequencies around 400 mc necessitates the application of special techniques since this range is too high for conventional bridge methods and too low for convenient use of slotted line and waveguide techniques. The band of frequencies between 30 mc and 400 mc may be thought of as the region of transition from lumped parameters to distributed parameter circuits.

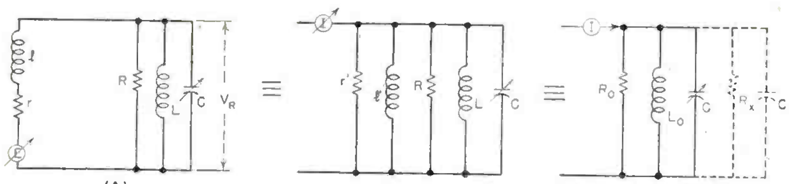
The special middle-band equipment to be described uses a tuned coaxial cavity of the correct length for resonance at the desired frequency. Measurements are made at the discrete frequencies of 2, 10, 25, 50, 100, 200, 300 and 400 mc on impedances up to and including one megohm. The measurements at frequencies below 100 mc are obtained by adding lumped inductances on the end of the cavity.

An earlier cavity application for this purpose[1] allowed comparative measurements to be made at discrete points, namely 100, 200, 300 and 400 mc. One cavity was essentially designed for 200-mc operation, but by reducing the length of the inner conductor, satisfactory 400-mc operation was attained. However, the cavity could not make use of the susceptance variation technique, and as such had to depend on a comparison with impedances established by other methods.



Adjustable padders and tuning stubs used across generator output line to vary cavity impedance

A number of other approaches to measurement of impedances in this frequency range have been tried,[2] but all of them had serious drawbacks. The cavity-type equipment described here overcomes these limitations and yet provides adequate range and excellent stability.



(A) BASIC RELATIONS

$$I = \frac{E}{r + j\omega L}$$

$$r' = \frac{r^2 + \omega^2 \ell^2}{r}$$

$$\ell' = \frac{r^2 + \omega^2 \ell^2}{\omega^2 \ell}$$

$$R_0 = \frac{R r'}{R + r'}$$

$$L_0 = \frac{L \ell'}{L + \ell'}$$

(B) RESISTANCE VARIATION METHOD

$$V_r = I_1 R_0 \quad (1)$$

$$V_r = I_2 \frac{R_0 R_x}{R_0 + R_x} \quad (2)$$

$$C_x = C_1 - C_2 \quad (3)$$

$$R_x = \frac{R_0}{\left(\frac{I_2}{I_1}\right) - 1} \quad (4)$$

$$\Delta ATT(db) = 20 LOG_{10} \frac{I_2}{I_1} \quad (5)$$

$$R_x = \frac{R_0}{LOG^{-1} \frac{\Delta A}{20} - 1} \quad (6)$$

(C) SUSCEPTANCE VARIATION METHOD

$$R_T = \frac{R_0 R_x}{R_0 + R_x} \quad (7)$$

$$V_R = I_1 R_T \quad (8)$$

$$Z = \frac{1}{\frac{1}{R_T} + j\omega C} \quad (9)$$

$$R_T = \frac{\sqrt{\left(\frac{I_2}{I_1}\right)^2 - 1}}{\omega \Delta C} \quad (10)$$

$$R_T = \frac{\sqrt{LOG^{-1} \frac{\Delta A}{10} - 1}}{\omega \Delta C} \quad (11)$$

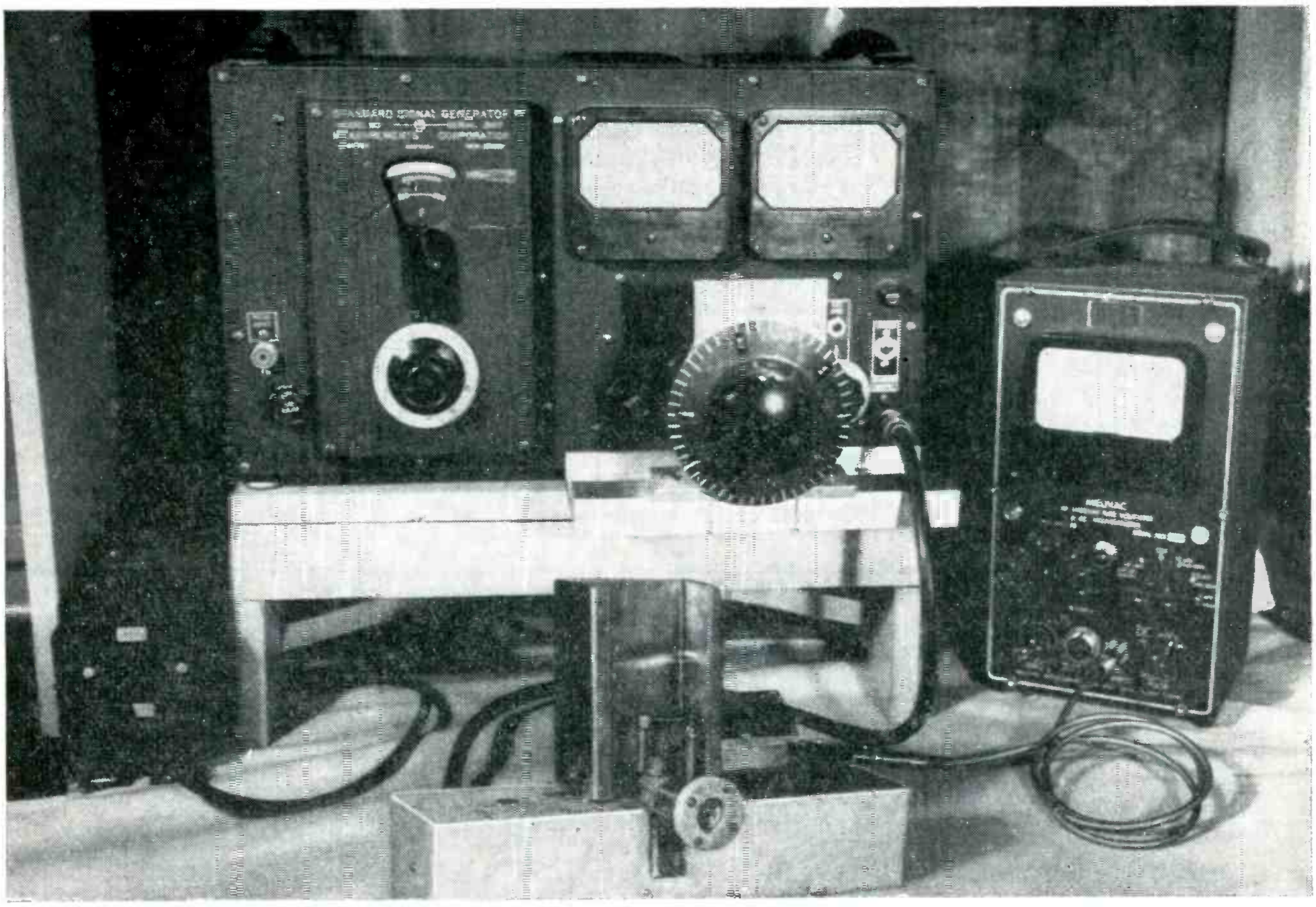
FIG. 1—Three-step simplification of tunable resonant circuit to arrangement fed by current source I, along with basic relations for the simplified circuits and the equations for two methods of using the circuit for measuring high-frequency impedance

Theory of Cavity Operation

Consider a tunable resonant circuit connected to a generator of internal impedance $r + j\omega l$ as shown in Fig. 1. This circuit can be simplified in the successive steps of Fig. 1B and 1C to a resonant circuit fed by a current source I.

The unknown under consideration is indicated as R_x and C_x. The impedance R_o of the tuned circuit at resonance is a function of the original tuned circuit and the internal impedance of the generator supply.

High-Frequency Resistors



Complete measuring setup using modified Signal Corps Engineering Laboratories design of cavity (in foreground) which is permanently tuned to 400 mc. Signal generator is Measurements Corp. model 80, measuring instrument at right is Millivac vtvm with built-in d-c amplifier. Calibrated attenuator is on wooden stand in front of generator

Essentially, the two methods which may be employed with such a setup to measure an unknown are the resistance variation method and the susceptance variation method.

Resistance Method

To understand the resistance variation technique, consider the resonant circuit of Fig. 1C. The circuit is tuned to resonance first without the unknown. The voltage V_r across the resonant circuit then is equal to $I_1 R_o$, where I_1 is the current from the source. The tuning capacitor is now at C_1. Next, the unknown is inserted and resonance is again obtained by retuning the variable capacitor to C_2. The current generator output I_1 is then increased to a value I_2 such that V_r is made equal to the same value as before the unknown was inserted. Equations 1, 2 and 3 in Fig. 1 portray these conditions, and give Eq. 4 as the value of R_x. If an attenuator is employed on the generator, the ration I_2/I_1 may be expressed in decibels as in Eq. 5, giving for R_x the more convenient expression of Eq. 6.

In this analysis R_o has been assumed constant, which requires the output impedance of the signal generator to be constant for all attenuator settings. A piston-type attenuator essentially fulfills this requirement.

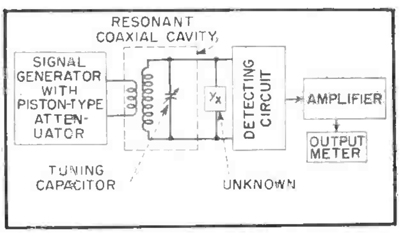


FIG. 2—Measuring setup, showing how unknown resistor is connected across resonant coaxial cavity

Susceptance Method

In the susceptance variation method, the parallel combination R_t of R_x and R_o is Eq. 7 of Fig. 1. At resonance, V_r is then given by Eq. 8. If the resonant circuit is now detuned by a known amount ΔC, Eq. 9 gives the circuit impedance.

If the output of the generator is next increased to some value I_2 such that the same value of V_r is maintained, then $V_r = I_2 |Z|$ where Z is given by Eq. 9. The two expressions for V_r can be equated, solved for R_t and simplified to the form of Eq. 10.

If the generator has a piston-type attenuator, Eq. 11 can be used. Here R_t is given in terms of the change in attenuator setting and the known change in ΔC. Since without any unknown impedance connected into the circuit $R_t = R_o$, this relationship may be utilized to measure the R_o of the resonant circuit. It may be desirable to prepare tables such that only a few seconds are needed to convert attenuator and capacitor readings into actual resistance values.

Circuit Arrangement

A block diagram of the equipment is shown in Fig. 2. A resonant coaxial cavity is fed by the unmodulated output of a signal generator equipped with a piston-type attenuator. The output of the resonant cavity is converted into a d-c voltage by a detector circuit, and amplified and measured by a commercially available d-c amplifier with built-in output meter.

For practical reasons, three separate cavities have been used. Although all are essentially the same in principle, they vary in design. The input is inductively coupled into the cavity, and the degree of coupling may be varied by rotating the coupling loop. Sections are available for operation at 100, 200, 300 or 400 mc, as shown in Fig. 3. In addition, a set of coils is available for measurements at 2, 10, 25 and 50 mc.

One cavity has been used principally for measurements at 2, 10, 25, 50 and 100 mc, because assembly and disassembly of the cavity results in a change in characteristics, particularly in R_o, necessitating a new determination of R_o for each use, while two others are left permanently at 200 and 400 mc respectively.

The capacitor design causes some trouble at 400 mc after long periods of use. This is because the electrical contacts become dirty, and is remedied by disassembly and cleaning.

Construction

The cavity has a center conductor that increases in diameter at one end to accommodate a linear capacitor. The center conductor has a coaxial hole bored down the center on the enlarged diameter end. A special micrometer for waveguide use is inserted in this hole to provide a linear capacitance variation of 5 μμf per inch, which allows incremental values of capacitance as low as 0.001 μμf to be measured.

A capacitive probe provides the

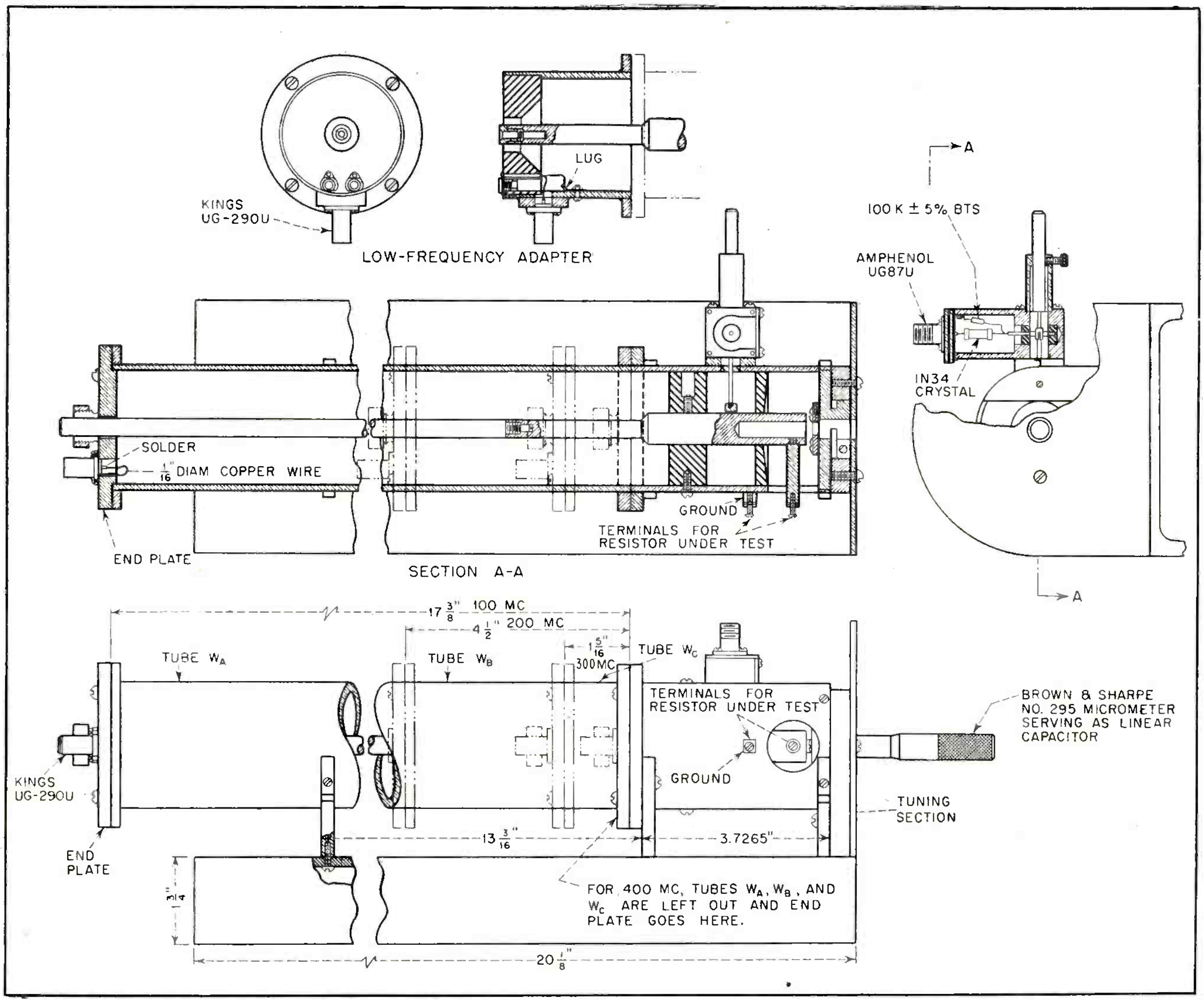
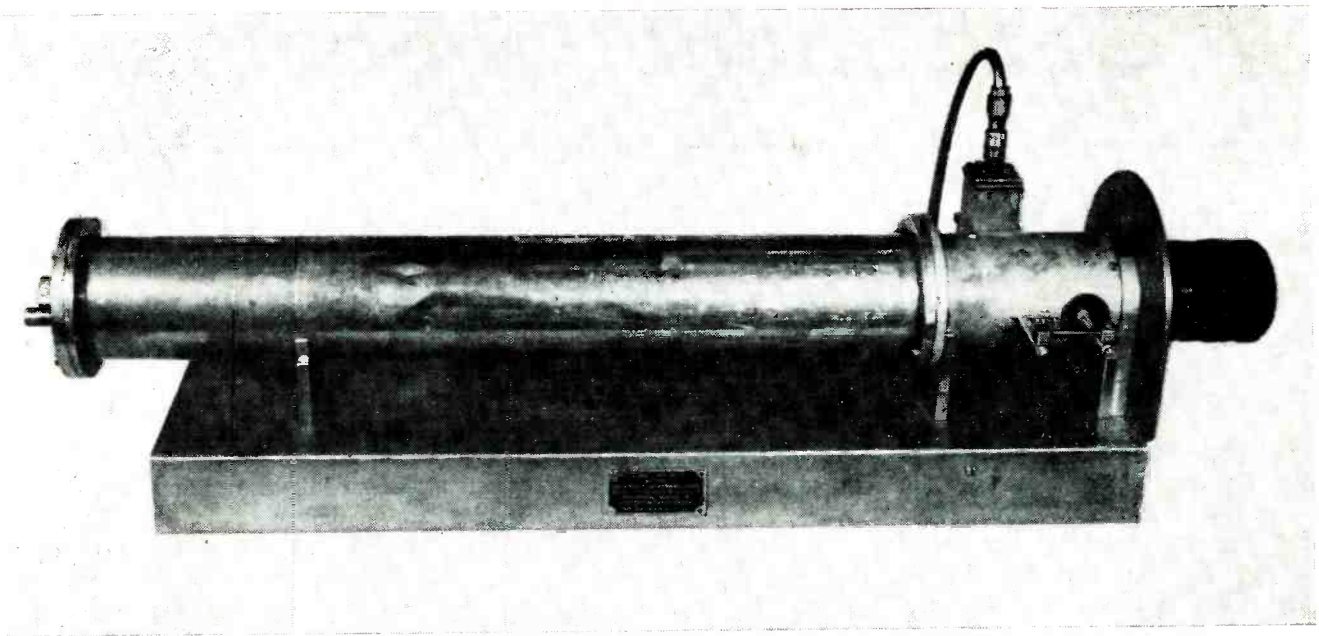


FIG. 3—Three views of coaxial cavity arrangement. For 400 mc, end plate at left is fastened directly to tuning section. For 300 mc, shortest tube is inserted between tuner and end plate. For 200 mc, medium-length tube is inserted. For 100 mc, largest tube is inserted. For still lower frequencies, low-frequency adapter having lumped inductances is used on 100-mc tube in place of end plate



Cavity setup for 100-mc measurements. Unknown resistor is connected between screw terminals projecting forward from tuning section at right; grounded terminal can be inserted in one of seven different holes to accommodate different lengths of resistors

input to the detector and is adjustable in position. A crystal arrangement is used as the detector.

One of the cavities is kept at the 100-mc position for measurements at 2, 10, 25, 50 and 100 mc. Two cavities of modified Signal Corps Engineering Laboratories design are permanently set, one at 200 mc and the other at 400 mc. A shield on each cavity eliminates the effects of variable stray capacitance.

Components of various diameters and lengths are accommodated by moving the ground terminal. Units of various sizes (within limitations) are all given the same lead length, same orientation and same parallel distance to a grounded conducting plane, all without adding losses to the system.

Cavity Impedance

The impedance R_o of the 400-mc cavity is in the order of 90,000 ohms. Former cavities were limited to approximately 50,000 ohms at 400 mc. This increased R_o comes as a result of special precautions in plating the interior of the cavity and improved mechanical connections of the cavity. It is important, however, to be able to control the R_o of the cavity since the greatest accuracy occurs when the value of R_o is near the value to be measured.

To increase the range of R_o materially, simple adjustable padder and tuning stubs may be connected across the line from the generator to the resonant cavity. These give characteristic impedances of anything from a few thousand ohms to 12,000 ohms at 400 mc. The range attainable increases as the frequency decreases.

Results

Typical high-frequency performance curves obtained with this equipment are given in Fig. 4. It was found that in all cases performance suffered as resistance value increased. There are exceptions to this, but usually they are limited to performance over a very narrow bandwidth. The data on this curve may also be used to draw a composite curve which plots percent of d-c resistance versus frequency times resistance if that type of relationship is desired.

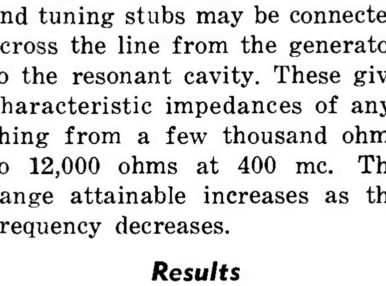


FIG. 4—Typical frequency characteristics for different values of special high-frequency carbon resistors, showing that highest ohmic values drop fastest with frequency

The accuracy of this method of measurement is dependent only on the signal generator, the ability to accurately measure db, and the ability to calibrate a linear capacitor. The precision is a function of how well the attenuator, capacitor and output meter can be read. A consideration of the possible errors and a square-root sum-of-the-squares analysis indicate an accuracy no worse than 2.5 percent.

The work described was done under Signal Corps Contract W36-039-SC-44526, sponsored by Signal Corps Engineering Laboratories and the United States Air Force. Development of the cavity was done in cooperation with the Moore School of the University of Pennsylvania in the initial phases. Acknowledgement is made to the following individuals: I. Bady, Signal Corps Engineering Laboratories; R. Showers, University of Pennsylvania; W. Littleton, International Resistance Co.; S. Parker, formerly International Resistance Co.; E. Thompson, International Resistance Co.

References

(1) I. Bady, Techniques in the Measurements of Several Components, *Proc. Nat'l Electronics Conf.*, Chicago, 1951.

(2) "Components Handbook", Vol. 17, MIT Radiation Laboratory Series, McGraw-Hill Book Co., New York, 1949.

Ceramic Tile Sorter

Automatically matches colored bathroom and kitchen wall tiles against a standard, then accurately sorts into acceptable, light and dark glazes at speeds up to 60 tiles per minute. Phototube output pulses feed special d-c amplifier which is free from slow drift

By F. LEPRI and R. SANNA
Coelettronic Co.
Rome, Italy

RANDOM CHANGES of color occur in ceramic tiles during the manufacturing process. Differences in temperature and atmosphere of baking ovens and variations in the biscuit base are some of the causes. The daily production of an average-size ceramic tile works ranges from 20,000 to 50,000 pieces, hence visual inspection and manual sorting are impractical. The problem led to development of a pulse-type electronic color comparator.

Principle of Operation

A standard tile of the desired color is placed in a receptacle of a gravity-roller conveyor, with its enameled face slightly below the upper edge of the rollers, as shown in Fig. 1. A parallel light beam is projected onto this standard surface, and the 45-degree reflected light is collected by a lens system for projecting through a colored glass filter onto the cathode of a high-vacuum phototube.

Samples to be checked roll over the standard surface, intercepting the light beam and substituting their reflected light for that of the standard during a short comparison time. Thus there appears across the phototube terminals an electric pulse having an amplitude and polarity which depend on the color difference between standard and sample. This pulse is measured after amplification in a memory-free pulse amplifier. The ordinate of the flat top of the pulse gives, by amplitude and sign, the amount of color difference between sample and standard.

The instrumental condition thus obtained is that of the best laboratory-type colorimeters, involving only one phototube, one lamp, one beam and one filter. Moreover, the pulse-comparison principle enables the device to work in a condition known as suppressed zero without the need of a bucking emf. A further advantage is the absence of zero drift and instability.

Circuits

A first model employed a conventional R-C coupled negative-feedback pulse amplifier, followed by a double-triode symmetrical difference amplifier. Pulses of opposite signs coming off the plate circuits of this stage feed two externally-gated triode amplitude discriminators switched on during the middle portion of the pulse by means of a multivibrator. The latter is triggered by a mechanical switch located at a convenient point on the conveyor and operated by the samples in their run.

Positive pulses from the lighter samples start a control signal coming off the first discriminator, while the darker samples operate the second discriminator. Two power tubes driven by the discriminators trigger an electromechanical three-way deviator located at the output end of the conveyor, effecting automatic direction of samples into three bins according to their color shade.

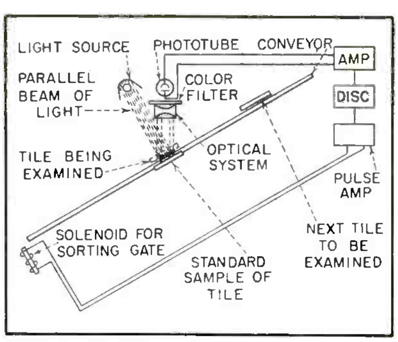


FIG. 1—Gravity roller conveyor carries tiles past photoelectric color comparator to sorting gates at bottom of conveyor

Although good sensitivity, stability and speed were obtained, the exceedingly slow recovery of the amplifier was a drawback. This consideration led to specifying direct-coupled amplifiers having the following overall characteristics: Gain—10,000 to 20,000 to obtain a 10-v output pulse corresponding to the slightest perceivable color difference of the darker samples; zero drift—less than 0.5 v output, or equivalent to a referred-to-input drift of less than 50 microvolts; frequency response—flat from zero to 1,000 cps or more, so the height of the flat top of the pulse is independent of the transit speed of the sample within the limits of 1.5 to 16 feet per second; recovery time—10^{-2} sec, corresponding to a memory of the order of one tenth of the 0.1 to 0.5 sec pulse duration or less, or nearly null overshoot; overload—the amplifier must stand a severe overloading without blocking.

D-C Amplifiers

The absence of coupling and decoupling capacitors renders d-c amplifiers basically free from memory, averaging and blocking. However, conventional d-c amplifiers, even when equipped with the more elaborate antidrift provisions, have far too large a slow drift to be employed for factory equipment required to work continuously without attendance and to give uniform

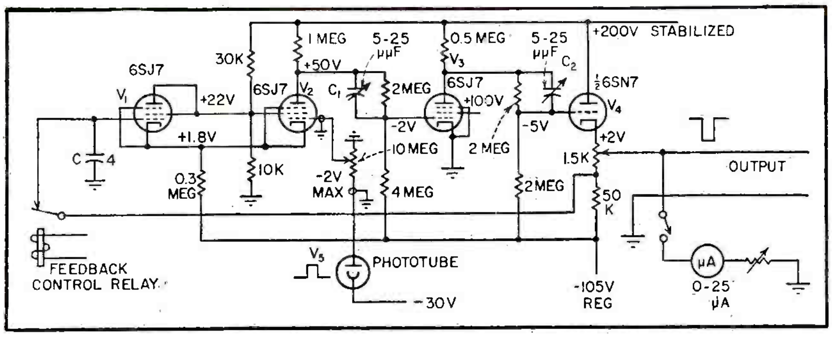


FIG. 2—Circuit of d-c pulse amplifier, showing use of negative feedback to one section of cathode-coupled double input tube. Phototube output pulse produced by sliding tile goes to other section of input tube. Snap-action switch actuated by tile operates feedback control relay as a tile reaches the color-comparing position on the machine

results within close tolerance limits.

The desired amplifier stability can be obtained with a d-c pulse amplifier in which overall negative feedback provides zero setting during the rest period between samples, while full gain is allowed during the operating period when the negative feedback loop is disconnected.

The d-c amplifier circuit used is shown in Fig. 2. The negative feedback is applied from the output terminal to the input grid of the amplifier through relay contacts that are closed during the rest period.

If no voltage is applied across the input terminals, the input and output levels are set by the negative feedback to a common value depending upon the characteristics of the coupling networks between the plate of the first tube and the grid of the cathode follower. Any change in output level due to heater voltage drift, changes in interstage coupling resistors or other causes is immediately counteracted by the negative feedback; the amplifier gain being very high, the output level drift is equal to the referred-to-grid drift of the first tube considered alone.

With the feedback relay contacts closed, capacitor C is in parallel with the cathode load of the cathode-follower output stage; when these contacts are open, C is simply in series with the input.

The function of C is to maintain the input grid bias during the operating time at the level reached during the rest time, this level being whatever is needed to counteract the output level shifts. The cathode-follower output stage provides a low-impedance charging path for C; if a 6SN7 is used, an equivalent resistance of some 1,000 ohms can be relied on in evaluating the time constant of this circuit. If $C = 4$ μf, 16 milliseconds is the reset time needed to compensate any output change due to drift.

The photoelectric input circuit is isolated from capacitor C and the negative feedback grid by using a cathode-coupled double input tube. Here V_1 is a cathode follower, the grid of which is connected to the negative-feedback network, while the input is applied to the grid of pentode V_2. In this manner amplification between the grid of V_1 and the plate of V_2 is accomplished without inversion, which allows an even number of stages to be used with proper feedback.

No other special features are provided elsewhere in the circuit, which is a straight direct-coupled amplifier with interstage coupling circuits returned to a negative potential to obtain proper grid bias for V_3 and V_4.

Stability against phase-shift oscillations is achieved by means of small adjustable capacitors C_1 and C_2 in parallel with the plate resistors of V_2 and V_3. These capacitors are adjusted to overcompensate slightly the frequency characteristics of the interstage dividers, thus making the total phase shift less than 180 degrees when the high-frequency gain reaches unity. The proper setting is found experimentally by connecting the output to a cathode-ray oscilloscope having an input gain of 100. A sawtooth oscillation occurs at a frequency between 1,000 and 10,000 cps when the capacitors are both set to zero; the two capacitors are then adjusted until a stable non-oscillating condition is reached.

Sensitivity control is accomplished by means of a 10-meg step attenuator in the control grid circuit of V_2. The setting of this attenuator changes the input tube grid level (depending on steady current of phototube V_5) and hence the output level.

A reference-level potentiometer in the cathode circuit of V_4 is used in conjunction with a microammeter to adjust to zero the high output terminal. This potentiometer has to compensate for a maximum of up to 2 volts difference, corresponding to the maximum sensivity setting and the maximum phototube illumination.

The microammeter also allows the amplifier to be used for steady-state comparison measurements of samples for standardization purposes. A full-scale sensitivity of 25 microamperes is enough to measure the slightest shade differences of the dark samples. With the feedback switch closed and the meter connected, the amplifier acts as a precision negative-feedback tube voltmeter of high stability.

Associated circuits serve for pulse comparison, for directing samples, for operation of the feedback control relay and for the generation of a single-shot sweep to be used with a cro for testing purposes.

The relay timing circuit and the single-sweep generator are conventional. Operation of both is started by a mechanical trigger consisting of a snap-action switch operated by the front edge of the sample at the correct location on the gravity conveyor.

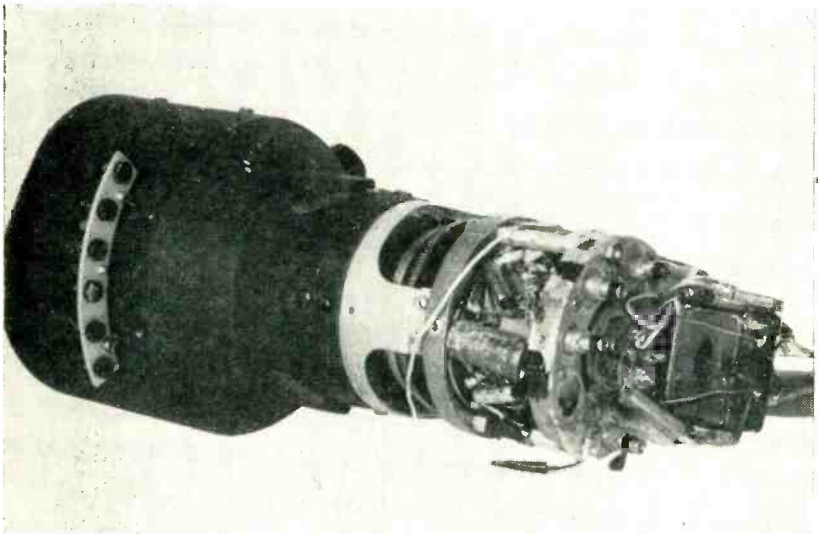
Pulse-comparison is accomplished by an externally gated time selector circuit centered to operate at the middle of the pulse, followed by multiple comparison stages and power output stages feeding the electromechanical sorting devices. These circuits are conventional.

Direct coupling is employed integrally, and the recovery of all associated circuits is equally as fast as that of the amplifier.

Transistorized Radar

By
RAYMOND S. MARKOWITZ

Senior Engineer
Philco Corporation
Philadelphia, Pennsylvania



Transistorized scope display unit shows location of point-contact transistors around crt socket. Power consumption is one-tenth that of vacuum-tube predecessor

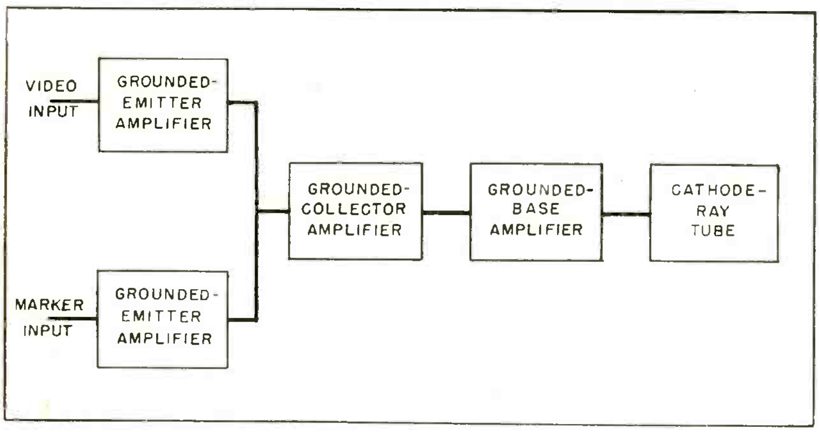


FIG. 1—Block diagram shows functions of four point-contact transistors in radar scope display unit

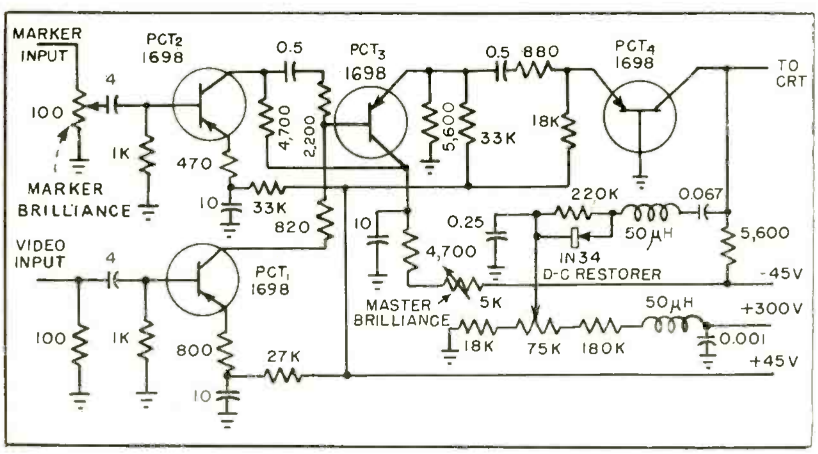


FIG. 2—Complete circuit of radar display unit. Two batteries were used to provide plus and minus 45 volts, but any 90-volt center-tapped d-c source could be used

SUBSTITUTING four transistors and a crystal diode for the vacuum-tubes in a standard airborne radar indicator has reduced power consumption to one tenth without sacrificing performance.

Other advantages of the transistorized version are greater mechanical ruggedness and the possibility of increased miniaturization limited only by the size of other components which themselves may be derated in many cases because of the lower power and lower internal operating temperatures.

Frequency Response

It is worthwhile to review the basic frequency limitations of presently available point-contact transistors. The base, emitter and collector resistances are substantially independent of frequency, and the transistor frequency response can be expressed by the variation in r_m, a forward transfer impedance, or the current gain, alpha, as a function of frequency. Alpha cutoff, defined as the frequency where alpha is 3 db down from its low-frequency value, occurs as a result of the difference in the path length of the holes arriving at the collector. An approximation for transit time in seconds of the hole carriers going from emitter to collector is $\tau = S^3/\mu\rho I_e$ where S is the point spacing in centimeters, μ is the mobility in centimeters per volt second, I_e is the emitter current in amperes, ρ is the germanium resistivity in ohm-centimeters and τ is an inverse function of frequency response.

Collector capacitance is generally negligible in point-contact transistors, except in the case of very high impedance circuits, while the

Scope Display Unit

Four point-contact transistors and a crystal diode replace four tubes (two multipurpose) with accompanying simplification and reduction of power drain from ten watts to one watt. Reduced size and weight with increased ruggedness are added advantages

emitter impedance makes the emitter capacitance negligible also. Available point contacts for video application are rated at about 5 mc, but considerable selection is necessary to obtain usable transistors. Type 1698 transistors were employed in the indicator unit although other transistors having equally good high-frequency characteristics with much improved temperature coefficients will be available shortly.

General Description

The unit was designed to handle a maximum peak positive pulse of 2 volts, to drive the cathode of a 5BP7 display scope, requiring approximately 20 to 30 volts drive for blooming. The indicator is powered by two 45-volt batteries. The original model employed four tubes and six tube functions, including two d-c restorers; four transistors and a crystal diode (only one d-c restorer is needed) are used as the replacement. As shown, video and marker signals are separately amplified and combined, amplified again and coupled to the crt.

The unit is essentially a video voltage amplifier. The problem is to obtain stability at all levels and with all changes in operating point without overload and with minimum distortion, and still to achieve the required gain and bandwidth (4 mc) with polarity inversion. No attempt was made to achieve unrestricted transistor interchange, although design centers were chosen to allow a maximum of replaceability, at least without the introduction of instability among transistors having the required alpha cutoff.

Two grounded-emitter amplifiers working into a common load impedance (the input impedance of the grounded-collector stage) are employed for video mixing, giving at the same time the required 180-degree phase reversal. The signal input stage is direct-coupled to the base of the grounded-emitter stage, whereas the marker stage is a-c coupled. This was done to minimize collector dissipation of the grounded-collector stage and make it easier to establish the optimum operating points of the respective stages. The mutual loading between the grounded-emitter stages necessitated the insertion of isolating impedances in the respective collector circuits. Since this reduces the gain somewhat, a more efficient mixing system has been devised employing a diode-coupling network.

The master brilliance control varies the collector potential of both the grounded-collector and the marker grounded-emitter stages, and though the control variation is rather nonlinear, it is the simplest method of variation in which the signal does not appear on the control itself (no tendency toward instability is encountered).

The grounded-collector stage, having a relatively high input impedance and low output impedance, is loaded by the grounded-base input impedance plus the series emitter impedance, which establishes the saturation level with a 3-ma emitter-current bias. The last stage has a voltage gain of 16 db, and can deliver approximately a 25-volt peak pulse to the crt.

The video signal is brought to the indicator through a cable terminated in 100 ohms. The problem of a-c coupling into the low input impedance (300 ohms) of the grounded-emitter stage arises here. The most immediate solution is the use of tantalum capacitors having high capacitance and low voltage ratings plus small size. Future designs, however, will incorporate d-c coupling, but this is now difficult because of the nature of the operating bias at the cathode follower in the receiver video amplifier.

Temperature Test

The indicator was tested in accordance with standard temperature specifications. When the overall unit was operated at 70 C, a marked deterioration in gain resulted (18 db) because of the shift in operating point resulting in a decrease in r_c and an increase in alpha. As was expected, the greatest change occurred in the grounded-emitter and grounded-collector stages.

Up to about 60 C, the grounded-base stage remained practically unchanged. It appears that temperature-compensating circuitry plus optimization of operating point as a function of variation of alpha and r_c might stabilize the unit up to 60 C. However, reports of developmental 1689 and 1729 point-contact transistors having a temperature variation of -1 percent per degree for r_c as compared with -5 percent per degree with 1698, while performing a similar function, indicates that satisfactory operation at 70 C should be obtainable (although the temperature specification on transistorized equipment might be subject to change). The present model, however, is rated at 50 C maximum temperature.

Neutralizing Pentodes

Design procedure for canceling the effect of grid-plate capacitance in pentode amplifiers without use of additional components, tapped coils or balanced tuned circuits. Two experimental methods are given for determining proper capacitor values for radar and television applications

By JOSEPH C. TELLIER

Research Division
Philco Corp.
Philadelphia, Pa.

GRID-PLATE capacitance of pentode voltage amplifiers used in television and radar i-f stages, although relatively small, may have an appreciable effect on the stability and passband characteristics of the amplifier.

Where the plate tuned circuit of the amplifier is at resonance, a slight increase in the grid-to-ground voltage will result in a larger increase, of opposite polarity, in the plate-to-ground voltage. The net voltage change across the grid-plate capacitance is therefore much larger than the grid voltage increase alone, and more current flows in this capacitance than would flow if the amplifier had no gain. The value of the capacitance, as seen looking into the grid, is thus exaggerated.

The mathematics of this situation are well treated in the literature.[1,2] From a purely physical viewpoint, however, it may be inferred that the effect of grid-plate capacitance is proportional to stage gain. Also, when the plate circuit is not resonant at the frequency of the grid input signal, the effect of grid-plate capacitance is lessened. Since the plate voltage is not in exact phase opposition with the grid voltage, a positive or negative resistive-damping term is reflected into the grid circuit in addition to the exaggerated capacitance.

These factors affect circuit design adversely because they produce interaction between amplifier stages that is a function of gain and frequency. If agc is applied to the amplifier, the effect on passband characteristics is ordinarily intolerable.

Neutralizing Circuit

A circuit which provides for the neutralization of the grid-plate capacitance without using additional components, tapped coils or balanced tuned circuits is shown in Fig. 1A. The screen neutralizing capacitor, C_N, occupies the position in the circuit normally assigned to the screen bypass capacitor. Basically, the circuit functions by providing slightly less than complete screen bypassing.

In determining the value of C_N, this circuit is usually assumed to be a bridge, and the plate and screen are taken as the output terminals of the tube. Almost all of the output voltage occurs across inductance L. For a single-tuned stage, the bridge-circuit concept gives an accurate-value for the neutralizing capacitor, but in double-tuned stages the error introduced by considering the plate and screen as the tube output terminals is considerable. The bridge circuit is most useful, therefore, in stages with single-tuned circuits.

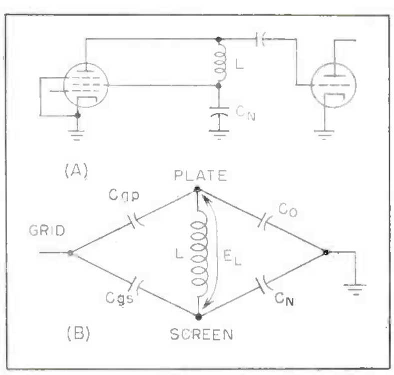


FIG. 1—Voltage-amplifier circuit (A) and equivalent bridge (B) used to calculate value of neutralizing capacitor

The elements of the bridge are shown in Fig. 1B. Here, C_{gp} is the conventional grid-plate capacitance and C_o is the total output capacitance, including the input capacitance of the next stage and stray capacitances from plate to ground. The neutralizing capacitance is C_N. The portion of the input capacitance between grid and screen is C_{gs}. It is normally about one-third of the total input capacitance and for a 6CB6 is about 2.2 μμf.

The bridge theory states that for the voltage E_L, developed across L, to produce zero voltage from grid to ground, the balance relation is

$$C_N = \frac{C_{gs}}{C_{gp}} C_o$$

For a single-tuned stage using a 6CB6 tube, this gives

$$C_N = \frac{2.2}{0.02} \times 15\ \mu\mu f = 1{,}650\ \mu\mu f$$

When a double-tuned stage or an

in Radar I-F Stages

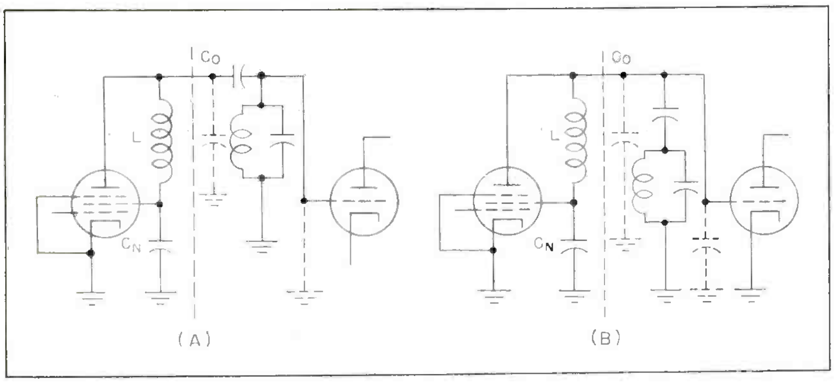


FIG. 2—Double-tuned (A) and absorption-trap (B) stages. In making calculations all capacitances to the right of dotted line must be substituted for C_o of Fig. 1B

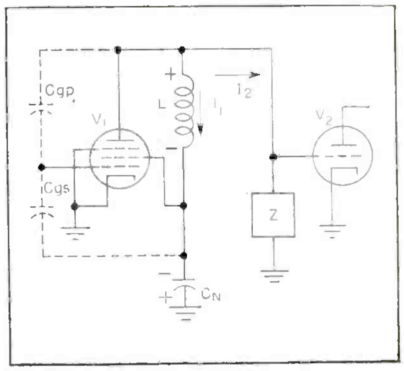


FIG. 3—Amplifier circuit having an output capacitance varying with frequency

absorption-trap stage is used, C_o is an effective capacitance varying with frequency, and the required value of C_N would apparently be a function of frequency. These stages are shown in Fig. 2A and 2B respectively. In both circuits everything to the right of the dashed line must be substituted for C_o in the bridge circuit of Fig. 1B.

A more accurate representation of the neutralizing circuit will show that no trouble is actually encountered from effective capacitance. It will also show that C_N is determined by the reactance of L, and this does vary with frequency. This variation is not as drastic, however, as the variation of the equivalent value of C_o in the circuits of Fig. 2.

In Fig. 3, regardless of the impedance of Z relative to L and C_N, some current I_1 will flow in the latter portion of the plate tank. This current will vary, as will I_2, if Z varies rapidly with frequency, but whatever current flows through L will also flow through C_N. This is true because C_N is an order of magnitude greater than C_{gs}. The polarity of voltage drops across L and C_N will be as shown, and the screen side will be below ground potential when the plate is above. The grid of V_1 can be established at ground potential by choosing C_N such that the screen has the correct potential, since the grid is established at a potential between plate and screen by the divider C_{gp} and C_{gs}. The required value of C_N is

$$\omega C_N = \frac{C_{gs}}{C_{gp}} \cdot \frac{1}{\omega L}$$

Although C_N will vary somewhat with frequency, over a relatively narrow band the change will be small. In the example given, a variation of 1 percent in frequency will cause a 2-percent change in C_N. It is more important that C_o does not appear in the expression.

In the single-tuned stage, over the bandwidth of interest, $1/\omega L$ can be closely approximated by ωC_o. When this substitution is made, the two formulas become identical.

Practical Considerations

Depending on the tube used, type of circuit and operating frequency, the calculated value of C_N may or may not be easy to obtain. For example, consider the value of 1,650 $\mu\mu$f obtained previously for 6CB6 single-tuned stages. At 40 mc, the lead inductance of a capacitor of this value could be large enough to cause the combination to approach series resonance, increasing the effective value of the capacitor. In such instances a smaller nominal value must be chosen, such that the effective capacitance is the correct value for neutralization. Care must then be exercised to maintain control of lead lengths in order to obtain the correct value consistently.

Occasionally, when a neutralizing capacitor is selected by experimentation, a value is found which is greatly different from the calculated value. If lead length does not account for the discrepancy, this is usually a sign that some form of feedback other than grid-plate capacitance is being neutralized, or that improper design has increased the effective grid-plate capacitance of the pentode.

The use of an unbypassed cathode resistor to neutralize variations of the input capacitance with bias has a slight effect on the neutralizing capacitance required. The effect is not very great unless the value of the cathode resistor becomes very large, or unless the suppressor is internally connected to the cathode.

A degree of neutralization may still be obtained in the latter case, but it is generally unsatisfactory and wherever possible a tube having the suppressor brought out separately should be used. The suppressor should then be grounded by the shortest possible lead to the chassis. The neutralizing capacitor should be returned to this same ground point.

Most of the output capacitance of a pentode is between plate and suppressor elements. Consequently, large values of current flow in the lead from suppressor to ground,

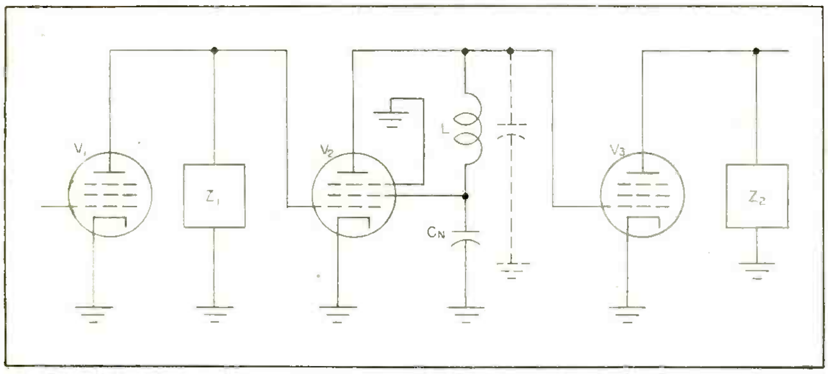


FIG. 4—Neutralization of stages in cascade. Two techniques for determining value of neutralizing capacitor are described in text

because this lead is part of the resonant plate tank circuit.

In tubes where the suppressor grid is brought out to a pin adjacent to the grid lead, the mutual coupling between the leads is sufficient at high frequencies to cause plate tank current to induce an appreciable voltage in the grid lead. As a result the effective grid-plate capacitance of the tube is increased, the added value being proportional to the square of the frequency.[3] For a 6BA6, the increase is from 0.0035 μμf at zero frequency to 0.008 μμf at 32 mc. In amplifiers for operation at 40 mc or higher, a tube having the suppressor lead well removed from the grid lead should be used.

It is difficult to neutralize tubes in which the nominal grid-plate capacitance is large. Under these conditions a very small value of neutralizing capacitance is called for, and as a result the screen is poorly bypassed. This not only leads to instability, but results in the effective grid-plate capacitance becoming larger, since the screen is no longer an effective shield.

Sometimes it is found that there are apparently two values of C_N which give neutralization. One of these, the larger, is the normal one. The second, usually much smaller, is caused by an increase in effective grid-plate capacitance due to poor shielding by the screen.

Test Procedures

The methods used to determine experimentally the optimum value of neutralizing capacitance are described with reference to Fig. 4. The tube to be neutralized is V_2, and it is necessary that both plate and grid circuits of this tube be operating normally.

The first method to be described is used when C_N is to be determined very precisely. A low-impedance signal generator, amplitude-modulated at a particular audio frequency, is connected to the grid of V_1, effectively shorting out any frequency-selective circuits in the input of V_1. Next, an i-f detector is coupled very lightly to the grid of V_2. Two methods of coupling have been found satisfactory. When Z_1 is a single-tuned circuit, or any other two-terminal network, and the same signal exists at the plate of V_1 and the grid of V_2, it is convenient to return the external shield of V_1 to ground through an impedance of several hundred ohms, and to connect the detector directly to the shield. Because of the capacitance between the plate of V_1 and the shield, an adequate signal will be presented to the detector. When Z_1 is a four-terminal network, such as a double-tuned transformer, it may be more satisfactory to connect the detector directly to the grid of V_2 through a 1-μμf capacitor.

The detector is followed by a high-gain audio amplifier, preferably tuned to the audio frequency with which the signal generator is modulated. If it is so tuned, high gain may be used without interference from hum or other sources of spurious audio-frequency signals. The output of this amplifier is then presented either as a scope or as a voltmeter indication. The carrier frequency of the signal generator is then adjusted to be within the i-f passband. The degree of neutralization is checked by varying the tuning of the plate tank circuit of V_2. If a change is observed in the output, neutralization is incomplete. The magnitude of the change is a measure of the departure from correct neutralization. The value of C_N is then varied, until a minimum change is noted.

It may be desirable, in searching for the correct value of C_N, to remove part or all of the damping from Z_1 and from the tank circuit. This will greatly magnify the effect of grid-plate feedback, and will make the null point, as C_N is varied, much sharper. It will also be desirable, when the correct value of C_N has been found, to make a check of the completeness of neutralization by shorting coil L. If there is negligible difference in output between the conditions of normal L and shorted L, neutralization is good.

As a final step, the carrier frequency of the generator should be adjusted to various frequencies in the i-f passband, and the tests repeated to insure that neutralization is complete over the entire range of frequencies to be used. When the precision of measurement required is not so great, a second method of testing for neutralization is useful. In this method, the modulated signal generator is replaced by a sweep-frequency generator, connected to V_1 grid. The high-gain audio amplifier following the detector is replaced by an oscilloscope. When the frequency of the generator is swept, the response observed on the scope will be that of impedance Z_1. In fact, the correct response may be observed by shorting the coil L, or connecting a 1,000-μμf capacitor from the plate of V_2 to ground. When L is unshorted the observed response curve should not change, and kinks and ripples should not pass through it when the tuning of the plate tank circuit is varied. When the curve remains unchanged under these conditions, neutralization is complete.

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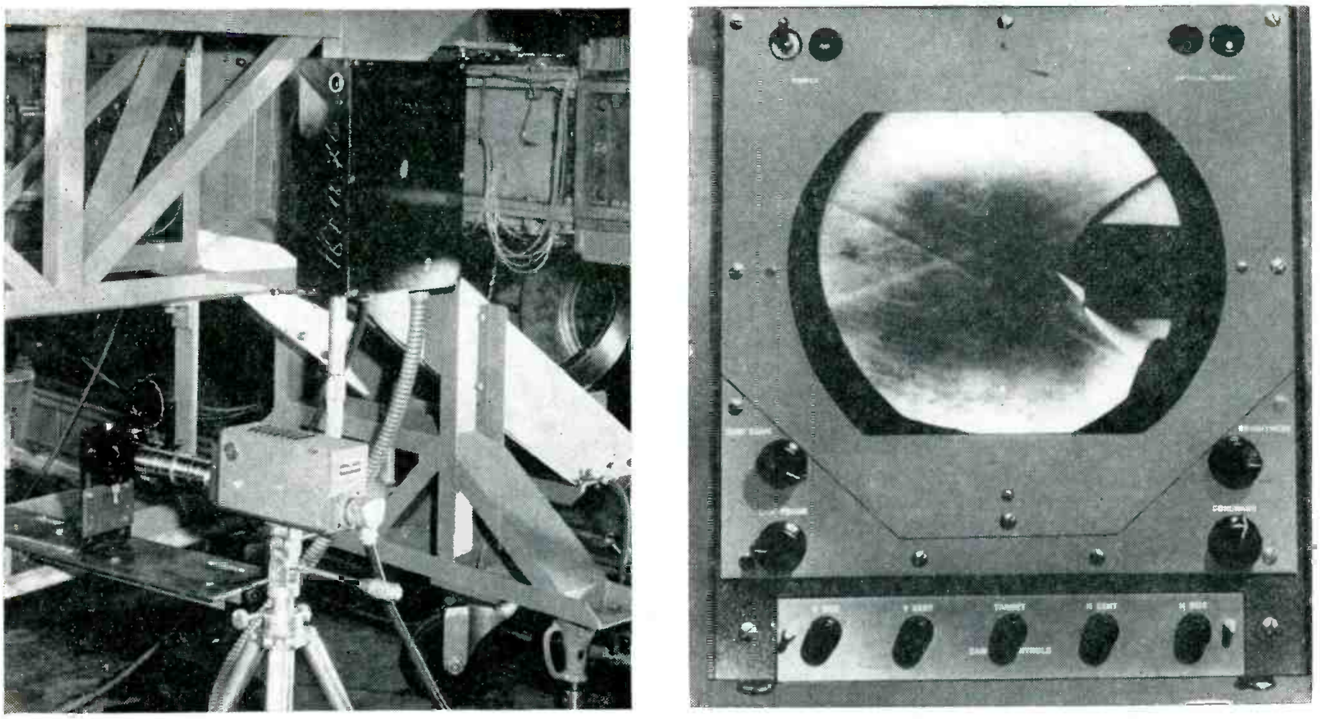


FIG. 1—Vidicon mounted in small supersonic wind tunnel (left) shows Schlieren picture of shock waves and airflow around supersonic probes (right)

Television Monitors Rocket Engine Flame

Industrial tv cameras used in propulsion research probe inaccessible locations, reduce personnel hazards and promote economy. Special design problems include high noise level, corrosive atmosphere and need for fine detail despite wide range of light intensities

By FRANK A. FRISWOLD

Aeronautical Research Scientist
Lewis Flight Propulsion Laboratory
National Advisory Comm. for Aeronautics
Cleveland, Ohio

MUCH functional know-how has been gained in recent years with television as an observation instrument. Television has been particularly useful in research, on rocket engines, where many untried propellants are poisonous and corrosive.

To insure safety of personnel conducting hazardous experiments with untried propellants, a remotely-located test cell has been equipped with television to permit remote viewing of the rocket in operation. A special cubical, mounted on skids to facilitate moving, houses the television camera.

During a 30-second rocket firing, with scarce propellants, television can justify itself on a purely economic basis.

In one test, the television monitor warned that a propellant valve had failed to open and the operating engineer immediately shut down the rocket. If the test had continued, a quantity of expensive propellant would have been wasted.

In another instance, while a remote-controlled rocket was being observed by television, observers saw a hole that had been burned through the injection head. Flame started to issue from this aperture and the test equipment was in danger of being seriously damaged; but quick action in shutting down the engine prevented a serious fire.

Liquified gases at very low tem-

FIG. 2—Console for remote controls, 10-inch monitor and power supply for image orthicon equipment

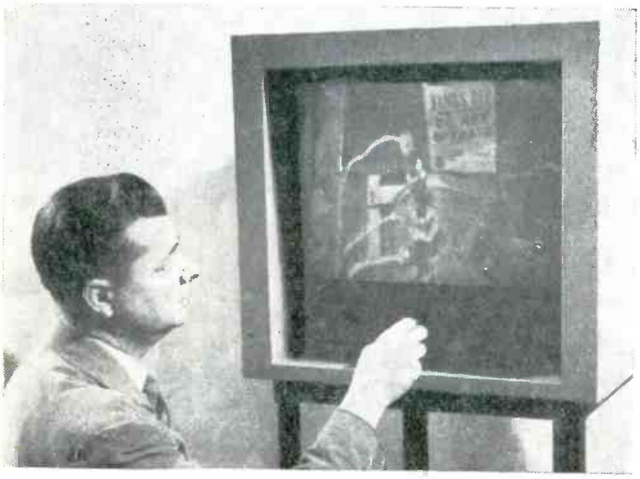


FIG. 3—Twenty-inch viewer for rocket specialists

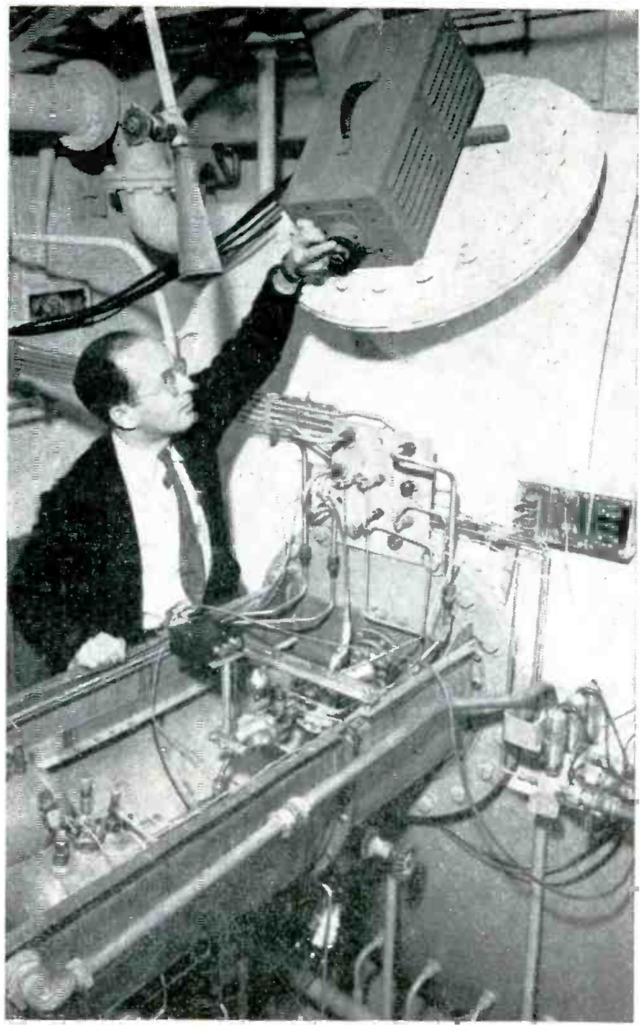


FIG. 4—Image orthicon camera televising rocket test

peratures for use as propellants warrant investigation. In one series of tests, to conserve expensive and scarce fuel, an inexpensive oxidant was injected first to reduce the temperature of the combustion chamber below that of the fuel. Spilling of the oxidant as a liquid rather than a vapor indicated the proper conditions. Television provided the most satisfactory and consistent means of monitoring this operation.

Camera Tubes

Cameras using an industrial-type vidicon, the image dissector and the image orthicon were tested to determine applicability under various conditions.

The industrial vidicon was first tried in a small supersonic tunnel (Fig. 1). Research on the design of supersonic probes was being carried on with the aid of Schlieren apparatus. This equipment renders visible the shock waves and airflow around the probe. By observing the televised Schlieren image at the control room, the tunnel operator can easily control the airflow through the tunnel to obtain the required Schlieren pattern. Resolution was more than adequate; noise level was about 100 db and had no effect on the picture.

Observation of flame by television is always difficult because of blooming. When the vidicon was used, the blooming was not objectionable. The noise level on this particular test was in excess of 140 db and there were noise striations visible on the kinescope. An acoustic shield around the camera probably would have eliminated this difficulty.

Because the image dissector is not a storage-type device, it can cover a wide range of luminosity without adjustment of controls. This is useful in observing flame since there is no blooming, and it is possible to observe a brilliant flame and still see details of the rocket engine and its auxiliary equipment which are at lower light levels. The image dissector is an instantaneous device and when it is observing rapidly-moving objects, a stroboscopic phenomena occurs. This effect was noticeable when the flame issuing from the rocket nozzle was televised, but was not considered detrimental. The pickup tube was not sensitive to noise in the 110-db range.

The image orthicon suffers from blooming and accordingly cannot be used successfully for flame studies. Because of the multiplicity of elements within the tube, it is prone to microphonism and is not recommended for use in high-noise-level areas. The resolution of

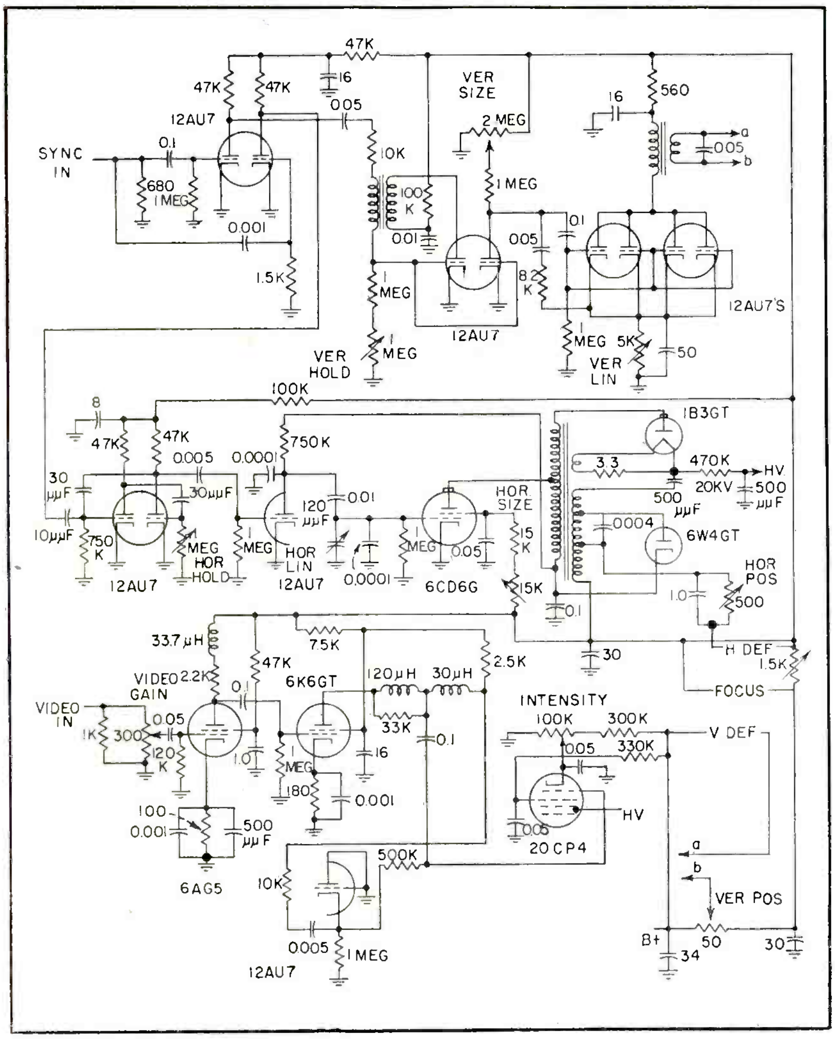


FIG. 5—Circuit diagram for twenty-inch viewer

this equipment is good and the illumination required on the viewed object is easily obtained. Some early-type image orthicons tend to be noisy. Care must be taken to scan only the area of the orthicon face on which the picture actually appears since over-scanning will contribute to the noise factor.

Monitor

A control console housing all controls except optical focusing, and having an a-c power supply and a 10-inch monitor was constructed. This unit is shown in Fig. 2. The following standards which produced a 320-line picture were adopted: vertical scanning rate 60 cycles per second noninterlaced; horizontal scanning 19,200 cycles. The commercial 10-inch monitor used has its own power supply and contains a two-stage video amplifier. This monitor is used in adjusting the picture quality. A 20-inch viewer was constructed for the use of research engineers in the control rooms and is shown in Fig. 3.

Figure 4 shows the camera mounted above an experimental rocket installation. The picture is televised back to the control room where the research engineer can view the experiment. Figure 5 shows the viewer schematically.

Color

Frame-sequential color television was tried in the altitude wind tunnel (Fig. 6) with a view toward using it in rocket research. The subject viewed was the tail cone of a jet engine after-burner. For combustion study, the color of a flame contains a wealth of information concerning its characteristics. Observation of the flame becomes of increased importance since it provides the only method of obtaining certain information.

The color rendition of the frame-sequential system was excellent on highly illuminated slow-moving objects. However, when the camera was viewing something as rapidly moving and randomly fluctuating as flame from a high-pressure combustor, serious color break-up occurred.

The color camera was operated at the following standards: vertical scanning 180 frames per second, horizontal scanning 525 lines per frame. The required bandwidth of the video amplifiers was 18 megacycles.

The conversion of the image orthicon was supervised by George Rohrer, formerly with this laboratory.

FIG. 6—Frame-sequential color television camera mounted at port of high-altitude wind tunnel views tail cone of jet engine afterburner inside tunnel

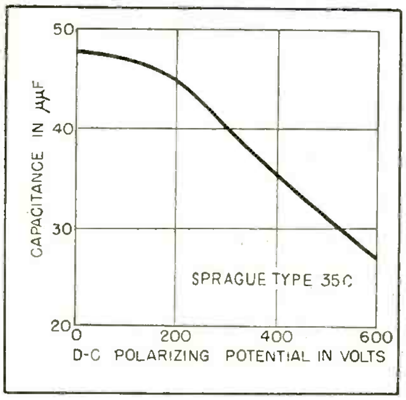


FIG. 1—Capacitance versus polarizing potential for barium titanate capacitor at 28 C

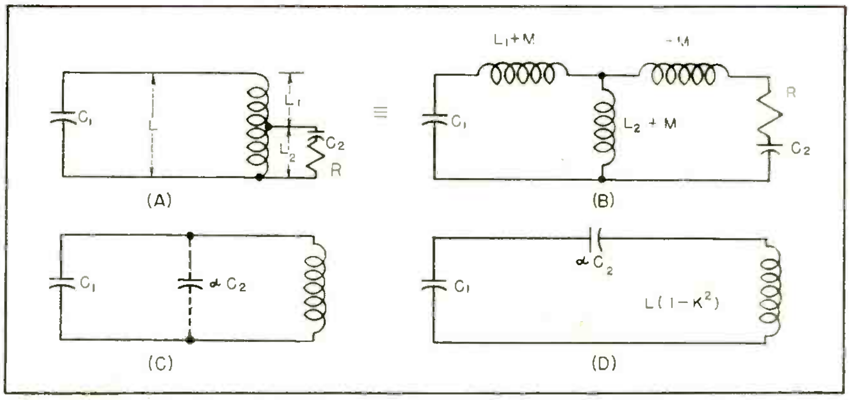


FIG. 2—Inductively coupled resonant circuit (A) and its equivalent circuit (B). Circuits (C) and (D) are equivalent circuits for the two possible operating modes of the resonant system

Capacitor-Modulated

Barium titanate capacitor coupled to oscillator tank circuit gives f-m deviations up to ±2 percent of carrier frequency in 50 to 500 mc range. Response is flat to better than 100 kc. Multichannel telemetering systems, portable and mobile equipment are among applications

Several papers on the behavior and applications of titanate dielectrics[1,2] have suggested that the voltage coefficient of capacitance of these ferroelectrics be used as the basis of a simple frequency-modulation system. The system would employ a titanate ceramic capacitor as one element of an oscillator tank circuit, its capacitance being varied by means of a modulating voltage. Such a system would be useful in uhf and vhf applications where conventional reactance-tube and phase-modulation methods are unwieldy. However, the direct application has proved unfruitful because the dielectric constant of suitable titanates is so high that a practical capacitance for the high frequencies presents manufacturing difficulties. Additional difficulty is encountered in excessive r-f losses at high frequencies, and temperature variation of the capacitance value, as well as the voltage coefficient of capacitance.

This paper describes a method of coupling the titanate capacitor to the tuned circuit in such manner that these drawbacks are largely overcome.

Capacitor Operation

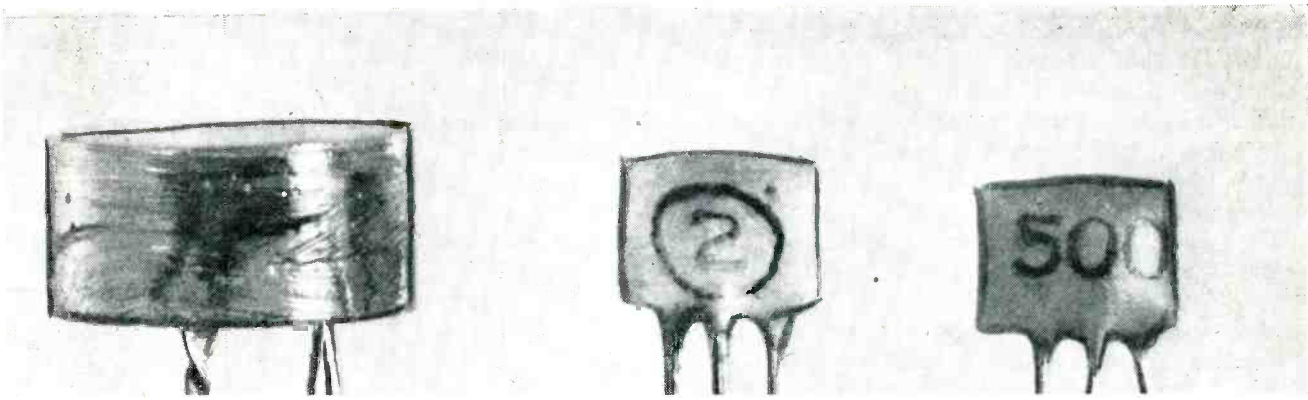
The typical nonlinear behavior of a titanate ceramic capacitor as a function of the polarizing potential is shown in Fig. 1. The linear region of the curve is suitable for modulation purposes. The d-c polarizing potential impressed upon the titanate defines the operating point and a center value of capacitance C_o. A superimposed a-c signal or pulse varies the capacitance about this operating point. The highest voltage coefficient of capacitance occurs at the Curie point of the ceramic, the Curie point being defined as the temperature at which the dielectric constant of the material is a maximum.

For f-m circuit applications, a nonlinear dielectric having a maximum voltage coefficient of capacitance and minimum temperature coefficient of capacitance is desired. By using a solid mixture of barium and strontium titanates with small amounts of lead zirconate, a ceramic dielectric is obtained having a broad Curie point over an extended temperature range at the expense of only a slight decrease in the voltage coefficient of capacitance of the unit.[3]

A typical titanate material would require a 10-μμf capacitor for use at 100 mc to be a disk 0.010-inch thick and 0.04 inch in diameter. Use of such a minute capacitor at a temperature near the Curie point in a practical oscillator results in such severe local heating that a degenerative loss cycle results. As the temperature increases the losses become more severe, causing a further rise in temperature. This not only reduces the sensitivity of the titanate capacitor to the modulating voltage, but eventually causes permanent damage to the capacitor.

Transformer Coupling

For high-frequency applications of titanates, a circuit is required that effectively reduces the potential across the titanate to a low



Potted ceramic capacitors used in f-m modulator make use of the nonlinear variation of capacitance with applied voltage exhibited by barium titanate. Capacitors at left comprise two series-connected 100 $\mu\mu f$ units. Center and right are dual units of 100 and 500 $\mu\mu f$, respectively

Wide-Range F-M System

By MAURICE APSTEIN and H. H. WIEDER
National Bureau of Standards
Washington, D. C.

value to minimize the dielectric heating effect while retaining its nonlinear characteristics.

Figures 2A and 2B show how the difficulties outlined above may be overcome by transformer-coupling the titanate capacitor to the resonant circuit. Such a circuit has two modes of operation depending upon whether the coupled resonant frequency is above or below the uncoupled resonant frequency of the circuit.

Operating Modes

The equations for the resonance modes of the circuit are

$$(\omega')^2 = \frac{1}{L\,(C_1 + \alpha\, C_2)} \quad (1)$$

$$(\omega'')^2 = \frac{1}{L_1 \dfrac{\alpha\, C_1\, C_2}{C_1 + \alpha\, C_2}} \quad (2)$$

$$K = \frac{L_2 + M}{\sqrt{L\,L_2}} \gtrless 0.5 \quad \alpha = \frac{L_2}{L} \quad (3)$$

Figure 2C indicates the behavior of the circuit of Fig. 2A for the ω' mode. The titanate capacitor C_2 will appear in shunt with the main tuning capacitor and have a value of αC_2. For the ω'' mode, as shown in Fig. 2D, C_2 will appear in series with the main tuning capacitor, with α the transformation ratio. In addition, the total apparent inductance will be reduced by $L' = L\,(1 - K^2)$.

The Q's corresponding to the two resonant modes are

$$Q' = Q_2 \left(1 + \frac{C_1}{\alpha\, C_2}\right)^{1.5} \quad (4)$$

$$Q'' = Q_2 \left[\left(1 + \frac{\alpha\, C_2}{C_1}\right)\left(1 - K^2\right)\right] \quad (5)$$

where Q_2 is the reciprocal of the loss tangent of the titanate capacitor.

If the circuit described above is used as the tank circuit of an oscillator, Eq. 4 and 5 determine the mode of operation. The circuit will oscillate in the mode having the higher Q.

Practical Oscillator Design

The oscillator shown in Fig. 3 was built using the tank circuit de-

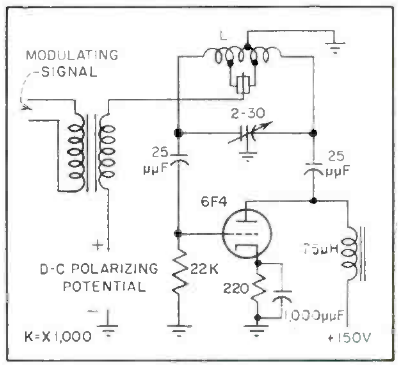


FIG. 3—Circuit of experimental f-m oscillator using transformer-coupled titanate capacitor modulator

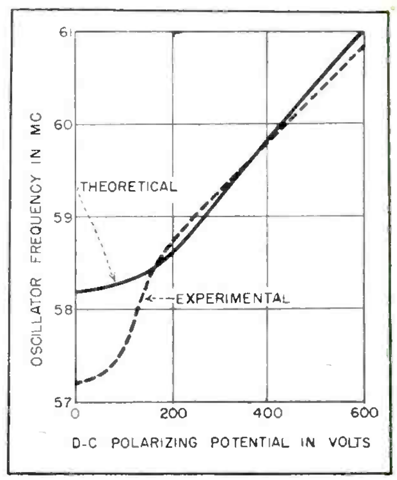


FIG. 4—Relationship of change in oscillator frequency to change in d-c polarizing potential

sign equations outlined above. The modulating capacitor is composed of two barium titanate ceramic capacitors, of the type shown in the photograph, connected in series with respect to the r-f potential and in parallel with respect to the modulating potential.

The polarization potential $V_{d\text{-}c}$ defines the center value of capacitance C_o. If a sinusoidal voltage is superimposed upon the d-c bias, the instantaneous capacitance of the titanate over its linear range is

$$C = C_o - n\, V_{max} \cos \omega_m t \qquad (6)$$

where $n = \Delta C / \Delta V$, f_m is modulating frequency and V_{max} the peak a-c modulating voltage. The instantaneous frequency for the ω' mode is $f' = f'_c\,(1 + m_f \cos \omega_m t)$. The modulation index m_f is

$$m_f' = \frac{n\, V_{max}}{2\,(C_1 + \alpha\, C_o)} \qquad (7)$$

and f_c is the carrier frequency. For the ω'' mode, the modulation index is

$$m_f'' = \frac{n\, C_1\, V_{max}}{2\, C_o\,(C_1 + \alpha\, C_o)} \qquad (8)$$

Figure 4 indicates the static curves of frequency versus d-c polarization potential for the ω' mode. Good agreement was obtained between the measured and calculated curves. Similar results were obtained for the ω'' mode.

Figure 5 indicates dynamic measurements of deviation by the use of proper Bessel function harmonics for the ω' mode. Push-pull, cathode-coupled, and Colpitts resonant-line oscillator circuits gave essentially similar results. In the frequency range of 50 to 500 mc, deviations of $\pm$ 2 percent were obtained in either mode. Under extreme conditions the a-m is appreciable but not serious for many applications. For smaller deviations the a-m is negligible.

The frequency deviation versus modulation frequency curve shown in Fig. 6 is for the ω' mode using the experimental oscillator described. Results indicate that excellent broad-band response is obtainable up to 100 kc. It has been experimentally verified that the modulation frequency may be raised to 500 kc for a pure sine-wave signal with good linearity response.

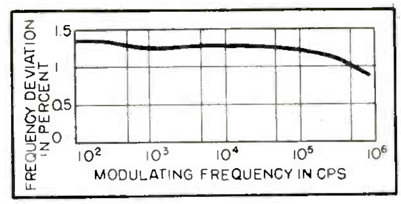


FIG. 6—Deviation in percent as related to modulating frequency

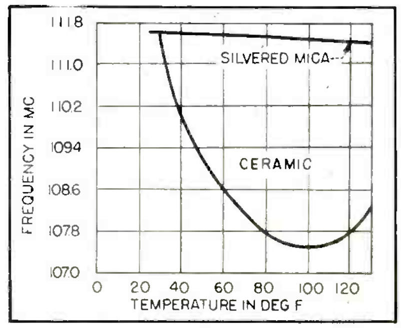


FIG. 7—Frequency-temperature characteristics of barium titanate capacitor

Temperature Compensation

No complete study of oscillator performance with respect to temperature has been made. However, the curves of Fig. 7 show that the nonlinear capacitors used have a considerable temperature coefficient. If the oscillator is to be used over an extended temperature range, a temperature-regulated enclosure operated at approximately 100 deg F would be required.

Problems of capacitance creep with age, electrostatic memory effects and other unsolved problems for the entire ferroelectric family of materials may make an additional means compensation necessary. There are a number of methods for obtaining temperature compensation with presently available materials. Use of a larger proportion of barium zirconate with barium strontium titanate will produce a nonlinear dielectric having a broader Curie region with only a slight decrease in the voltage coefficient of capacitance. If two or more capacitors having different Curie points are connected in series, the Curie region can be staggered over a broader temperature range. Another method of compensation is to use a conventional afc system whose rectified output would be used to bias the titanate capacitor in such a manner as to keep the carrier frequency constant.

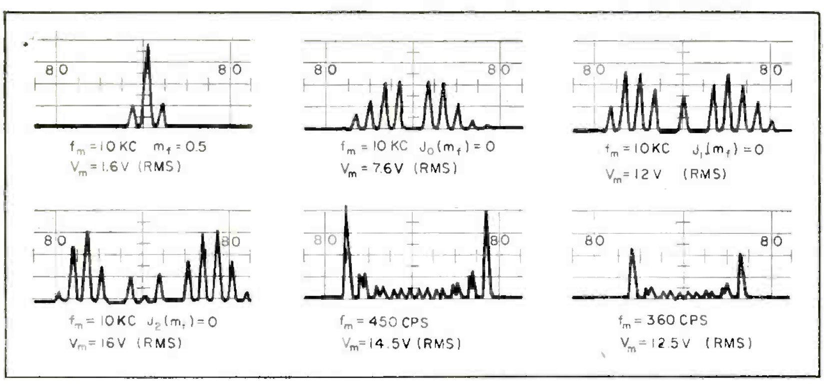


FIG. 5—Deviation in kc as a function of modulating signal on a 60-mc carrier with 450-volt polarizing potential

Conclusion

The system should find application in vehicular communication systems, portable uhf equipment and multichannel f-m telemetering systems that require both a wide deviation and broad frequency response.

The principle of coupling the nonlinear element into the main frequency-determining circuit can be extended to include distributed lines and cavity resonators. Preliminary experiments indicate that a reflex klystron can be successfully modulated by this method over a wider band than that obtainable by repeller voltage modulation alone.

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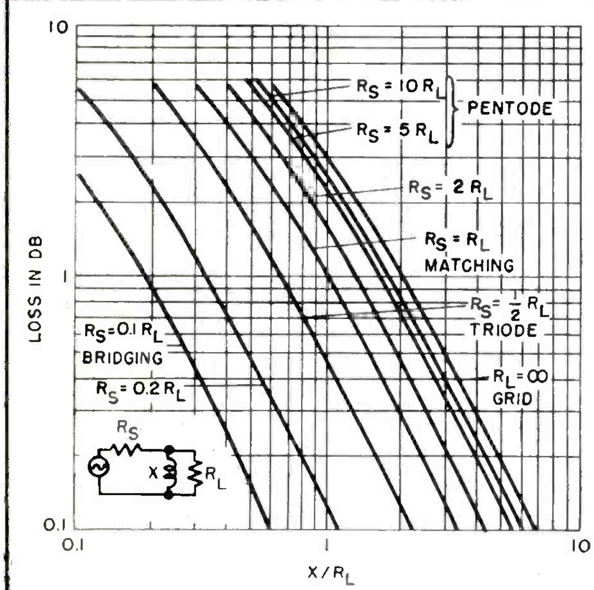

FIG. 1—Primary inductance insertion-loss curves. Curve marked grid refers to an abscissa for X/R_S

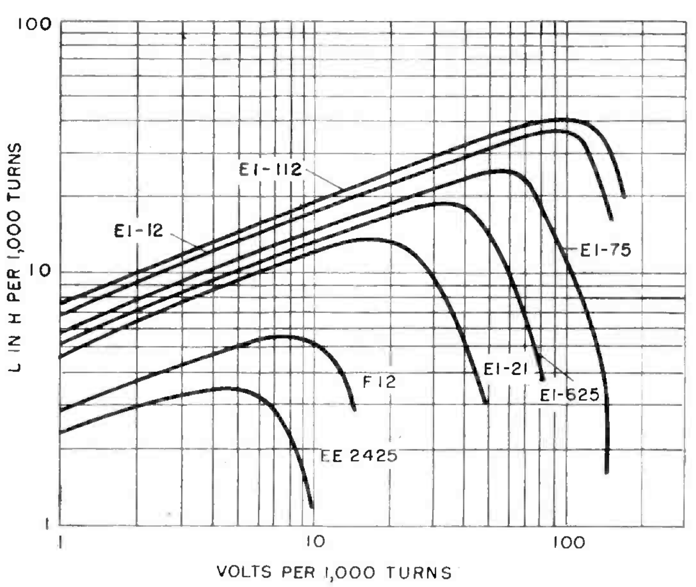

FIG. 2—Characteristics of several lamination types for 4-percent silicon steel, 29 gage, laminated 1 × 1, square stack only

Audio Transformer Design Charts

Six graphs showing primary-inductance insertion loss, 60-cycle inductance, leakage inductance, insertion loss from leakage inductance, phase shift and effect of open-circuit impedance on reflected impedance speed design of power and audio transformers

By **THEODORE HALABI**

Chief Engineer
AJF Industries, Inc.
Brooklyn, N. Y.

PROGRESS in transformers for electronic applications has kept well abreast of advances in electronics, but the art of their design has long been esoteric. In the past few years, several good books have been published that enable the average engineer, unfamiliar with transformers, to initiate an original product design.

Several time-saving charts for audio transformers used by the writer and other engineers are shown. Two of the curves are empirical while the others are calculated.

Figure 1 is a calculated plot of the familiar db or insertion-loss curve employed for low-frequency-response calculations. It is used primarily to find the inductance required for a given db loss. The advantage of the curve in this form is that it covers all types of audio transformers on one graph. It includes matching transformers where $R_{\text{LOAD}} = R_{\text{SOURCE}}$; triode-output transformers where $R_{\text{LOAD}} = 2R_{\text{SOURCE}}$; pentode or beam-power-output transformers where $R_{\text{SOURCE}} = 5$ to $10R_{\text{LOAD}}$; bridging transformers where $R_{\text{SOURCE}} = 0.1\,R_{\text{LOAD}}$; and grid transformers where R_{LOAD} is infinite.

For pentode-output transformers where $R_{\text{SOURCE}} = 20R_{\text{LOAD}}$ the curve of $R_{\text{SOURCE}} = 10R_{\text{LOAD}}$ may be used in Fig. 1 since the curves practically coincide. Another advantage of Fig. 1 is that the unknown quantity X, the primary reactance, is found in terms of the load impedance instead of the source impedance as is often done. Specifying X in terms of the source impedance leads to confusion when the exact source impedance is unknown, as in numerous pentode output transformers. For grid transformers with an unloaded secondary, X is obtained from the chart in terms of the specified source impedance. A loaded grid transformer is treated as a matching transformer.

After obtaining the inductance from Fig. 1, the turns required to meet that inductance on a given lamination size can be calculated from two types of graphs. If there is a net unbalanced d-c in the transformer, Hanna's curves, or some variation of them, are most commonly used for the incremental inductance calculations. If there is no d-c in the coil the turns can be calculated from permeability curves. A faster method is the use of a set of graphs similar to Fig. 2. For comprehensive designs including all types of transformers a more complete set of graphs covering various types of steels and lamination sizes is necessary.

Figure 2 is an empirical set of curves of 60-cycle inductance on 29 gage silicon-steel laminations, interleaved 1×1. Its use is illustrated by the problem: find the inductance at 2 volts, 60 cycles of a 700-turn coil on an EI-75 lamination with a square stack. Two volts at 60 cycles on 700 turns is equivalent to 2.85 volts on a 1,000-turn coil for the same flux density. From the curve is obtained an inductance of 9 henrys per 1,000 turns.

Since inductance varies as the square of the turns, $L = 9(700/1{,}000)^2 = 4.4$ henrys. If the coil had been on a stack of $1\frac{1}{2}$ inch, the inductance would be found on the curve at 1.42 volts per 1,000 turns since the flux density is one half of that on a square stack. At this

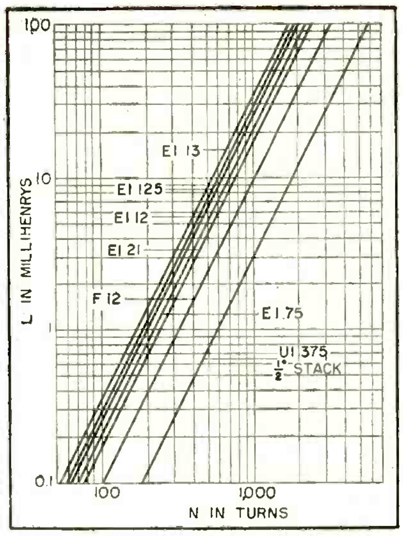

FIG. 3—Leakage inductance vs turns for square-stack layer-wound coils of two windings only

voltage L from the curves is 6.6 henrys per 1,000 turns. Hence the inductance of the coil is $(700/1{,}000)^2 \times 6.6(1.5/0.75) = 6.4$ henrys. This last calculation utilizes the fact that the inductance of a given lamination varies directly as the volume.

Figure 3 shows an empirical graph of leakage inductance against turns as obtained from measurements on various transformers. Since the lines are so close together, the leakage inductance of standard lamination sizes that are missing can be extrapolated easily. This chart can be used to find the leakage inductance only for two winding coils, of square stacks, normal winding lengths and normal insulation between windings.

If the deviations for a given coil from these requirements are too great, the theoretical formulas as listed in standard reference handbooks should be used to calculate the leakage. In many cases, where the leakage inductance is sought, however, an approximate value will usually suffice. Hence if the coil margins are larger than normal or if there is unusual insulation in the transformer or if even part of the window space is occupied by a third winding, Fig. 3 can still be used to determine the order of magnitude of the leakage.

Leakage inductance obtained from Fig. 3 is employed mainly in audio-transformer design for predicting high-frequency response

(continued on p 196)

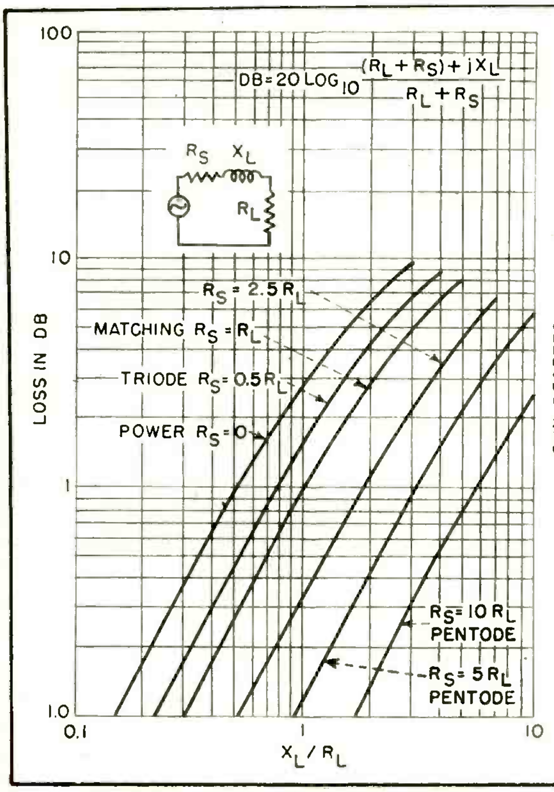

FIG. 4—Insertion loss due to leakage reactance for six different types of transformers

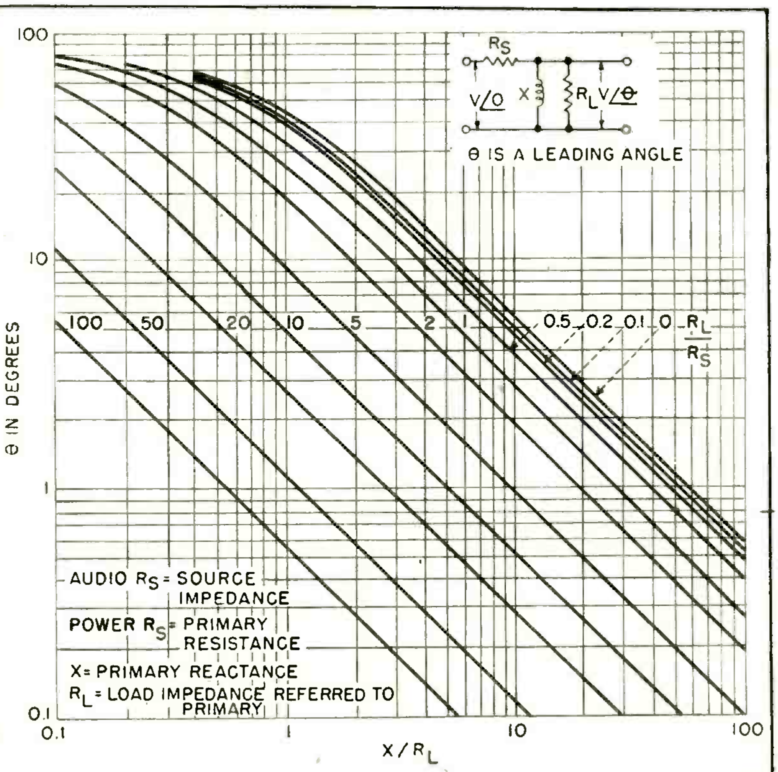

FIG. 5—Phase shift vs X/R_L for varying ratios of R_L/R_S as explained in the text

and Fig. 4 is used for these calculations. This type of curve neglects the capacitance in the windings and can be used with reasonable accuracy if the impedance of the transformer is less than 12,000 ohms or the highest frequency of the transformer is less than 10,000 cycles. These curves can also be used for power transformers with a frequency range of 50 to 2,400 cycles for estimating the voltage loss due to leakage inductance at the high-frequency end. For power transformers the loss in db as obtained from the curve is converted to percent voltage drop.

Figure 5 is a plot of phase-shift calculations at the low-frequency end of an audio transformer due to primary or open-circuit inductance. The graph may be also used for phase shift in power transformers between the primary d-c resistance and inductance, in which case R_s, the source impedance is actually the primary resistance.

Phase Shift vs X/R_s

Figure 6 can be used for quick and fairly accurate calculations of the shunting effect on reflected impedance R_L by the open-circuit inductance. The graph will not only give the total impedance but the phase angle, the resistive and reactive components. In instances where a more nearly exact impedance looking into the transformer is required, the primary shunt loss (core loss) and the leakage reactance must be added vectorially to the impedance from the curves.

The following example illustrates the use of five curves in a typical design. It is desired to design an output transformer for a beam-power tube, 7,000 ohms to 500 ohms, 5 watts output, 42 ma d-c in the primary and a tube plate resistance R_s of 75,000 ohms. The required frequency response is to be ± one db from 300 to 6,000 cycles.

In Fig. 1 at $R_s = 10\ R_L$, for 1-db loss, X/R_L equals 1.8 from which the necessary primary inductance can be calculated. At 300 cycles, $L = 1.8 \times 7{,}000/2\pi 300 = 6.7$ henrys. From tabulated data on output transformers, the lamination size is determined as an EI 625 (square stack) using 29 gage silicon steel. Hanna's curves for this

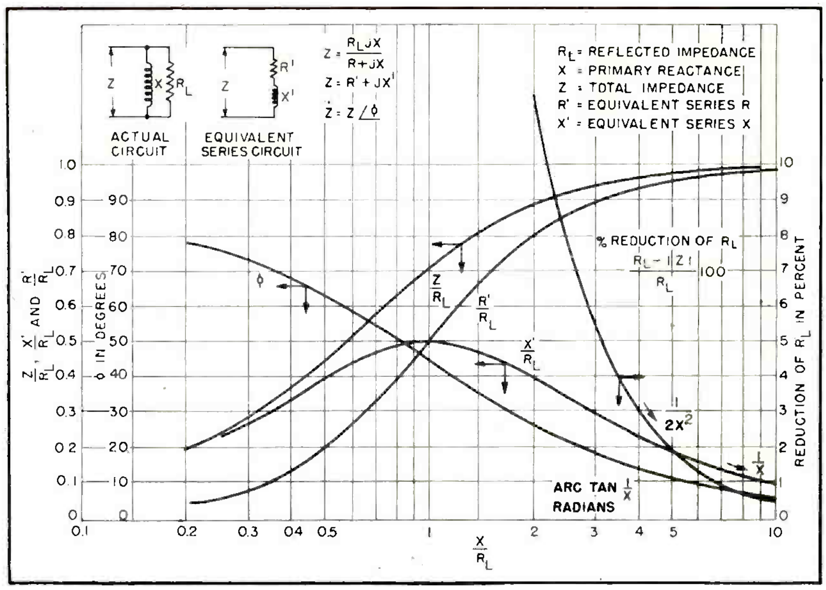

FIG. 6—Effect of primary inductance on reflected impedance

lamination size and 6.7 henrys of inductance indicate 2,600 turns for the primary.

For an impedance ratio of 7,000 on the primary and 500 ohms on the secondary, the secondary turns are then 700, since turns ratio equals the square root of impedance ratio. Assuming equal primary and secondary copper losses, the wire chart for an EI 625 shows 38 wire for the primary and 32 on the secondary. Primary d-c resistance is 580 ohms and that of the secondary 32 ohms. To check the high-frequency end of the transformer the leakage inductance of the transformer referred to the primary is found from Fig. 3. The EI 625 lamination is not listed but the inductance can be estimated as being roughly halfway between the EI 75 and the EI 21.

In addition, the turns listed do not go up to 2,600 on the chart but since L varies as N^2 the value at 260 turns can be used. This yields a leakage inductance of 130 millihenrys, which is equal to 4,900 ohms reactance at 6,000 cycles. Neglecting the d-c resistance, the ratio $X_L/R_L = 0.7$. From the curve $R_s = 10R_L$ in Fig. 4 loss due to leakage reactance is less than 0.1 db and therefore well within the 1-db requirement. Figure 5 shows the phase shift of the transformer at 300 cycles. For this case, the secondary resistance should be included in the calculations. The value of R_L is then 7,400 ohms or 500 ohms plus 32 ohms times the turns ratio squared.

The ratio X/R_L is 1.7 at which point on the curve $R_L/R_s = 0.1$ is found a phase shift of 28 degrees. This high phase shift results from the high plate resistance of the beam-power tube. A triode for the same response and load impedance would have a phase shift of 15 degrees. Figure 6 can now be used to check the primary impedance. For the impedance at 300 cycles, $X/R_L = 1.7$ where again R_L includes the secondary resistance. From the curve at this point, $R'/R = 0.75$ or $R' = 5{,}550$ ohms and $X'/R_L = j\,0.44$ or $X' = 3{,}250$ ohms.

This represents the reflected impedance as viewed from the primary side of the transformer converted into a series value of resistance and inductive components. Adding the primary d-c resistance, $Z_{PRI} = 5{,}550 + 580 + j\,3{,}250 = 6{,}800$ ohms. A more exact calculation of primary impedance would have required adding 130 millihenrys of leakage inductance and the shunt core loss vectorially.

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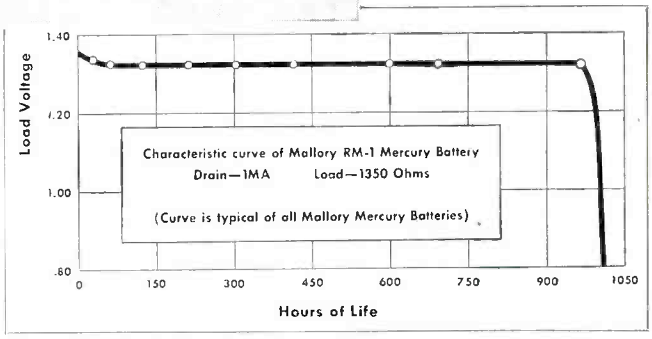

The constant discharge voltages shown in the curves are characteristic of the uniform, dependable power delivered by Mallory Mercury Batteries. This is especially important in mobile communications equipment, hearing aids, delicate optical equipment and many kinds of instruments in which constant discharge voltages are imperative for best performance.

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ELECTRONS AT WORK

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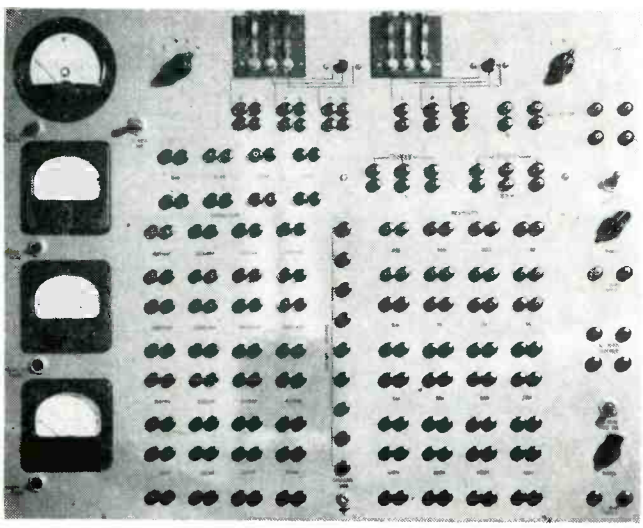
Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS

featured in this issue:

Transistor Test Board Speeds Circuit Choice



Front-panel view shows spring clips (top center) to hold transistor leads

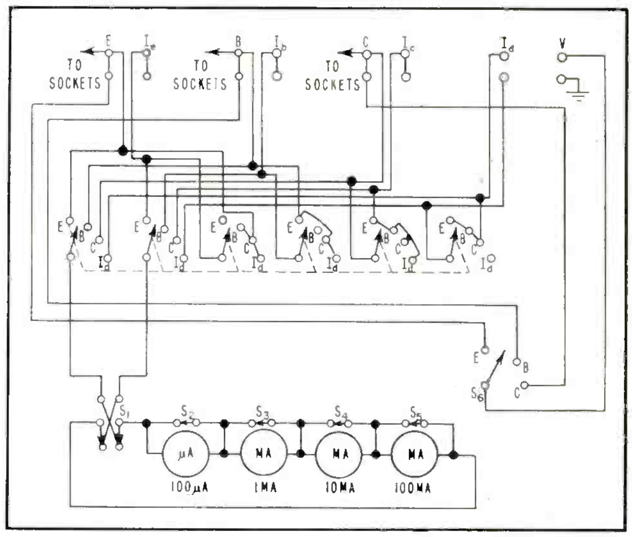


Fig. 1—Circuit of the transistor hookup device to speed testing employs switches

By R. L. Riddle

Radio Corp. of America Princeton, N. J.

In testing a new electronic device it is often easiest to connect it directly into a circuit to determine its operating characteristics. For rapid fabrication of a multitude of transistor circuits the test board described below was constructed.

This board comprises two sets of transistor sockets, a metering circuit, bias supply controls and a selected group of circuit elements.

Of the two sets of transistor sockets one set is connected into a metering circuit that enables the measurement of emitter, collector and base currents and voltages. This circuit arrangement is shown in Fig. 1 and the photograph.

In addition to the above-mentioned currents that may be measured, a set of terminals is included that permits the measurement of currents anywhere in the external circuit by inserting the appropriate leads in the terminals marked I_d.

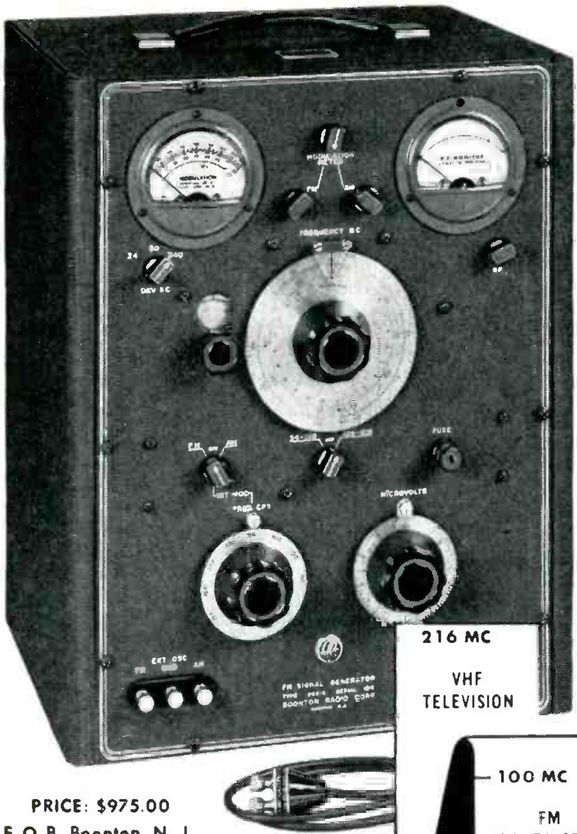
The circuit components included are four decades of resistors, four decades of capacitors, a set of electrolytic capacitors and two center-tapped coils. These components permit the construction of many transistor circuits.

A second set of transistor sockets is included to enable two-stage transistor circuits to be constructed.

With the use of this test board and simple external equipment the characteristics of transistor circuits may be obtained rapidly.

ASR Using MTI Feeds PAR

New and improved airport surveillance radar system (ASR) recently installed at Norfolk, Va. Municipal Airport gives CAA traffic controllers a clearer picture of aircraft within a 60-mile radius. Equipped with moving-target-indicator (MTI) circuits, it automatically blanks out permanent or stationary radar targets and displays only moving aircraft. During periods of poor visibility the device helps the control tower feed



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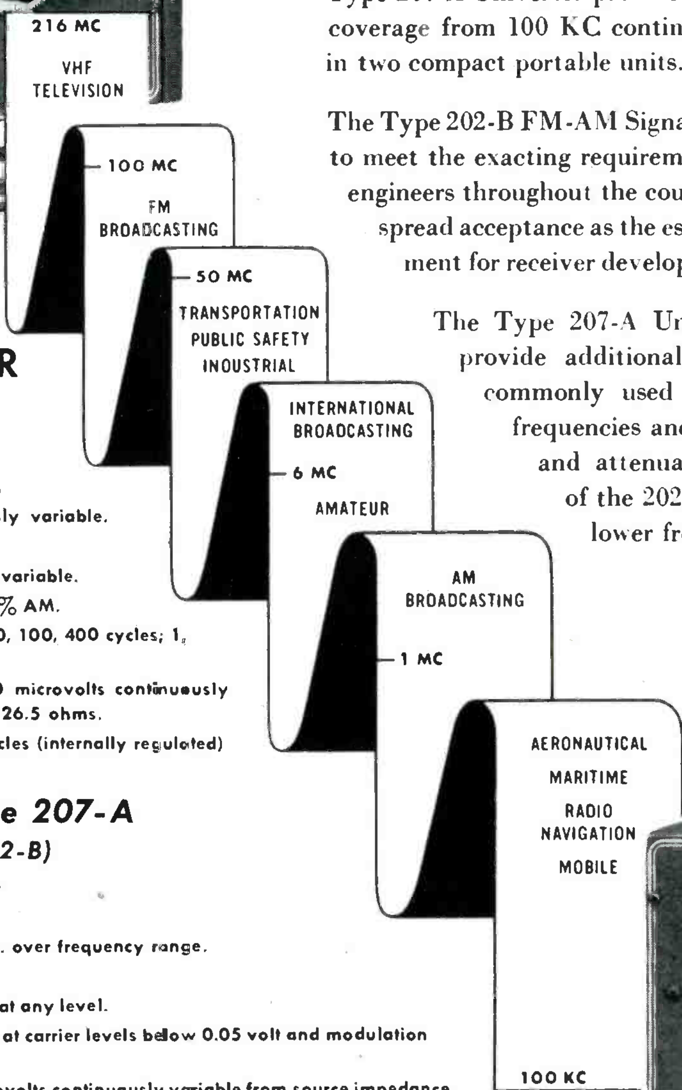
The Type 207-A Univerter was designed to provide additional frequency coverage of commonly used intermediate and radio frequencies and enables the modulation and attenuation calibration features of the 202-B to be utilized at these lower frequencies.



FM-AM SIGNAL GENERATOR
Type 202-B

SPECIFICATIONS

FREQUENCY RANGE: 54—216 MC ± 0.5%
FM MODULATION: 0—240 KC continuously variable.
FM DISTORTION: Less than 2% at 75 KC.
AM MODULATION: 0—50% continuously variable.
AM DISTORTION: Approximately 5% at 50% AM.
INTERNAL MODULATING FREQUENCIES: 50, 100, 400 cycles; 1, 5, 7.5, 10, 15 KC.
R. F. OUTPUT VOLTAGE: 0.1 to 200,000 microvolts continuously variable from source impedance of 26.5 ohms.
POWER SUPPLY: 105—125 volts, 50/60 cycles (internally regulated)

UNIVERTER *Type 207-A*
(When used with 202-B)

SPECIFICATIONS

FREQUENCY RANGE: 100 KC—55 MC.
FREQUENCY RESPONSE: Flat within ± 1 db. over frequency range.
FM-AM MODULATION: See 202-B.
FM DISTORTION: No appreciable distortion at any level.
AM DISTORTION: No appreciable distortion at carrier levels below 0.05 volt and modulation of 50%.
RF OUTPUT VOLTAGE: 0.1 to 100,000 microvolts continuously variable from source impedance of 26.5 ohms; also approximately 1.5 volts from 330 ohms into open circuit.
POWER SUPPLY: 90—130 volts, 60 cycles (internally regulated).

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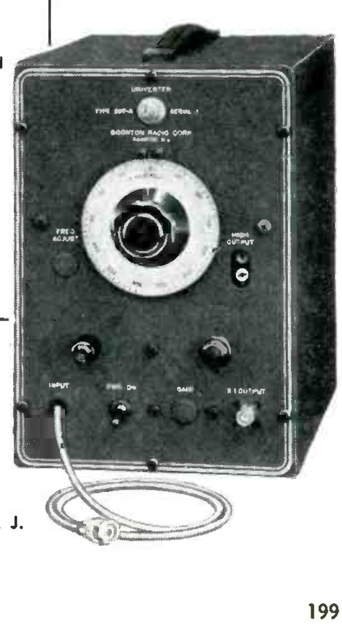

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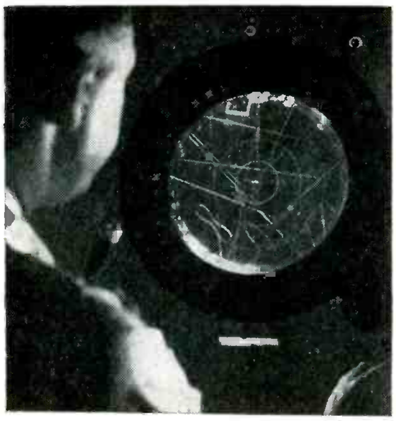


First of 23 GE surveillance radars for CAA was installed at Norfolk, Va. Only moving aircraft are displayed on controller's screen above

arriving planes into the precision approach radar system (PAR) most efficiently.

Map overlays show controllers the locations of obstructions dangerous to approaching aircraft. Two-way radio from ground to plane permits passing the information from airport to pilot.

The radar set and its rotating antenna can be located up to two miles from the airport control tower with incoming information to the viewing screen brought from the antenna by coaxial cable.

Sync-Circuit Noise Reduction

NOISE PULSES entering the sync circuit of tv receivers can be cancelled or greatly reduced by the circuit shown in Fig. 1. A noise pulse at the grid of the 3rd i-f will appear as a negative pulse at the screen grid. The same noise pulse will appear as a positive spike at the sync take-off point in the plate of the video amplifier. By direct-coupling the 3rd i-f screen to the sync take-off, the noise pulse entering the sync circuit is reduced by the negative pulse from the screen.

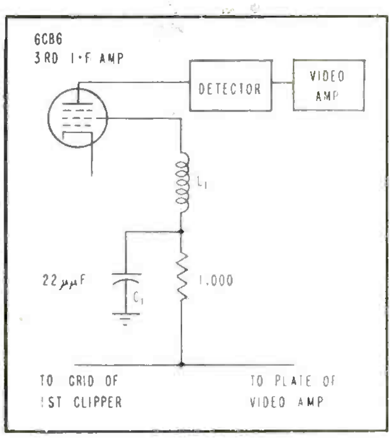


FIG. 1—Noise reduction circuit couples i-f screen to sync take-off point to cancel noise pulses

A resonant filter, consisting of coil L_1 and capacitor C_1, on the screen of the 3rd i-f bypasses the intermediate frequencies but does not lose sync and video frequencies.

The circuit greatly improves both vertical and horizontal sync stability, particularly in the medium fringe and fringe areas.

Another feature of this circuit is that no control is needed to adjust for different signal levels or various types of noise.

The circuit was developed by Albert Massman and Richard Kraft of Motorola, Inc.

Suppressor Grid Frequency Doubler

W. G. SHEPARD
Physical Research Unit
Boeing Airplane Company
Seattle, Washington

TOTAL CATHODE EMISSION in the type 6AS6 pentode is fairly constant for a fixed control-grid voltage, but the path that the electrons take is controlled by the suppressor-grid voltage. The main electron path is to the screen grid for a large negative suppressor voltage and to the plate for a zero or positive suppressor voltage. The suppressor grid, therefore, can act as a second control grid as far as plate current is concerned. These characteristics make the 6AS6 useful as a frequency doubler.

If 180-deg out-of-phase sine-wave signals are placed on the control grid and suppressor grid simultaneously, it will be found that although the total cathode current is a sine wave of the original frequency, the electron flow reaching the plate contains a large amount of second harmonic.

This may be explained by the fact that as the electron-flow cycle reaches its maximum the electrons are deflected to the screen grid because the suppressor grid is most negative at this time. This causes the plate current to decrease at the peak of every cycle of total electron flow as well as at the minimum of every cycle; thus accounting for the frequency doubling. If the incoming sine waves are of the proper amplitude, the fundamental is almost entirely eliminated, leaving a fairly good sine wave at the doubled frequency.

A practical circuit for frequency doubling is shown in Fig. 1. The unbypassed cathode resistor effectively develops the 180-deg out-of-phase signal on the suppressor even though the suppressor is grounded, because the cathode tends to follow the grid signal, and such a signal at the cathode has the same effect as a 180-deg out-of-phase signal placed directly on the suppressor. In the circuit shown, the input signal should be about 1.2 volts, which produces an output of approximately 2.4 volts.

A frequency doubler of this type will work down to the lowest frequencies, but its top useful frequency without employing tuned circuits is probably around 100 kc. Various capacitances interfere with proper operation at frequencies higher than this and other methods of frequency doubling are more satisfactory at these higher frequencies.

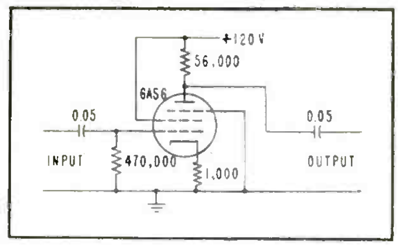


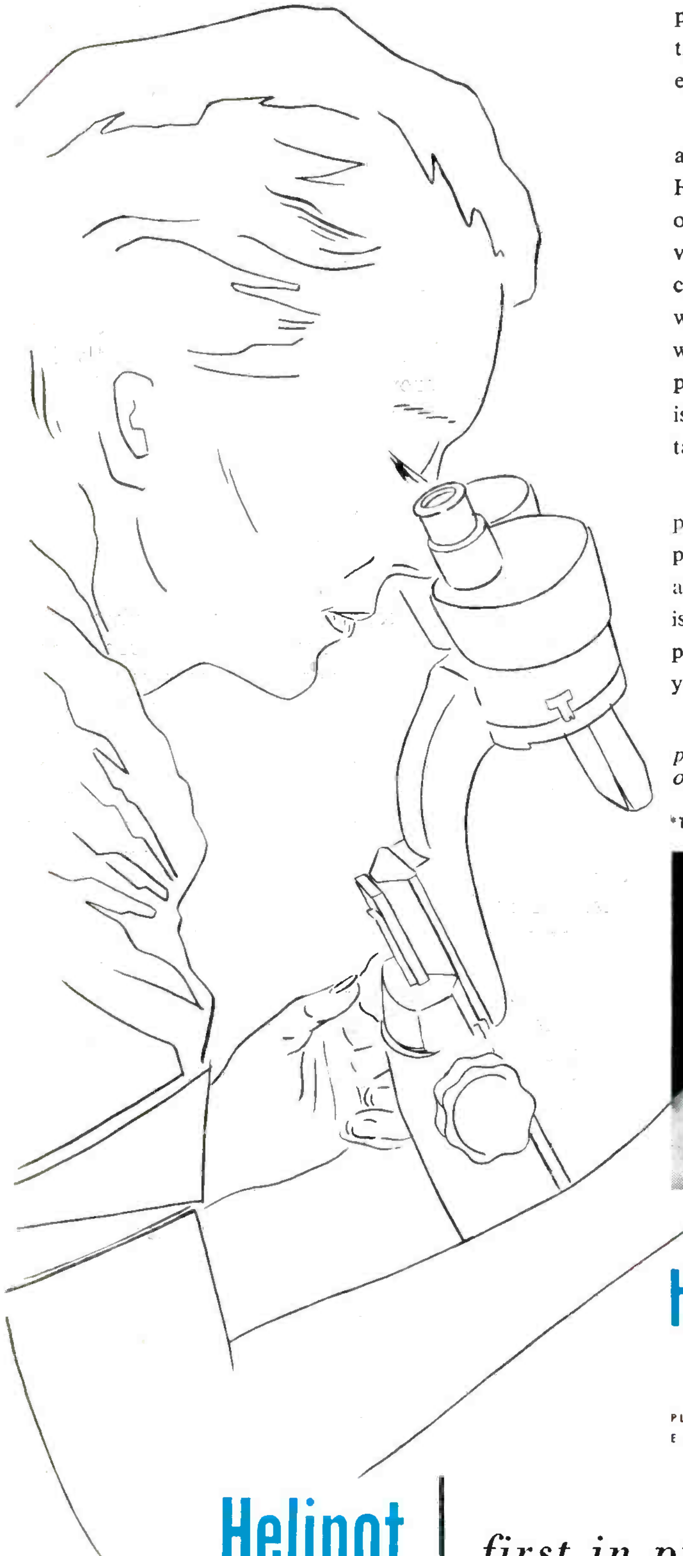
FIG. 1—Frequency-doubler circuit uses unbypassed cathode resistor to produce effect of 180-deg out-or-phase signal on suppressor grid

Four-Track Film for Stereo Sound

BY NARROWING the size of the picture frame and cutting the width of the sprocket holes along the edge of the film, four sound tracks for a stereophonic system can be placed on the same strip of film as the picture.

The new system permits the showing of films using stereophonic

Having the RIGHT CONNECTIONS *is a big help!*



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The spot welding process offers the further advantage of providing the strongest possible type of connections . . . vibration proof, shock proof, corrosion proof, unaffected by temperature and humidity changes. And to cap the climax, the new process is efficient and economical . . . another example of the Helipot policy offering the lowest price consistent with the high quality you expect in Helipot products.

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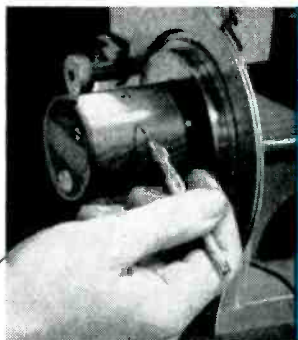

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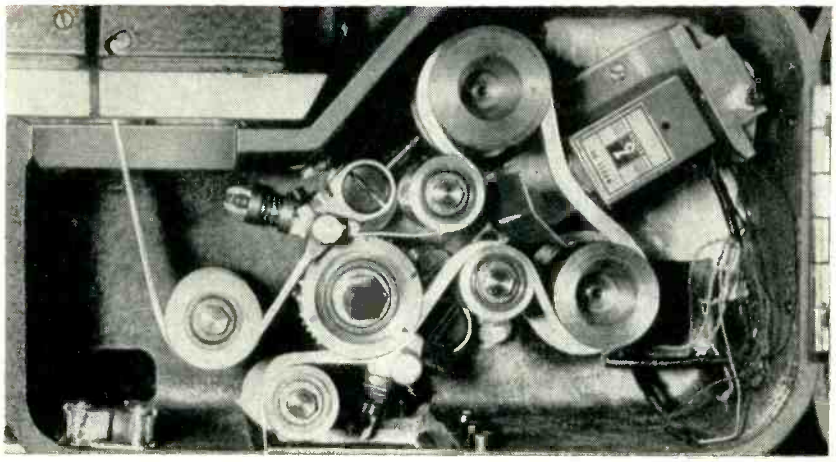


Path of film through magnetic-pickup unit. Rollers act as mechanical filter to prevent flutter and wow. Pickup head contains four pickup units side by side

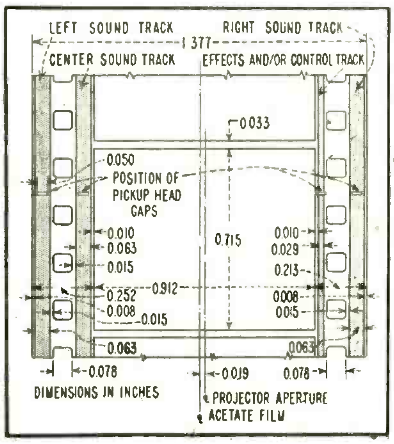


FIG. 1—Four magnetic sound strips are placed on same film with picture. Smaller sprocket holes are made possible by higher dimensional stability of new film materials

sound with minimum adaptation of projection room equipment. Changes required in the projector are the installation of the magnetic-tape pickup unit shown in the photograph and an alteration in the size and spacing of the film sprocket wheels. The alterations do not affect the running of regular ms in the projector.

The new film, introduced by 20th Century-Fox for use with their Cinemascope wide-screen pictures is shown in Fig. 1. Three sound tracks 0.063 inch wide provide a separate channel for sound to speaker systems placed to the right, center and left of the theater. A fourth track, narrower than the others is used for recording background and special-effect sounds such as thunder or crowd noises.

Response of the tape tracks is flat to 8,000 cycles $\pm$ 1 db, with a 50 db signal level as compared to 40 db for a regular optical sound track. The film is run through the projector at standard speed, giving a tape speed of 18 inches per second. Crosstalk between strips is down 40 db at 1,000 cycles.

The tape coating 0.005 to 0.007-inch thick is painted on the film in an acetate solvent. The solvent softens the acetate film base and when dry the magnetic-tape strip has become an integral part of the film.

Kerosene Cooled Transistors

By J. E. MAYNARD and R. L. BROCK
Physical Research Unit
Boeing Airplane Co.
Seattle, Washington

A SOLUTION to the problem of self-heating of the contacts of point-contact transistors consists in the use of a fluid to remove heat. External means of cooling may be applied in addition in order to control ambient conditions. An indication of the problem of self-heating at the point contact may be gained from a calculation of the current density that may be encountered. With a contact area one thousandth of an inch in diameter and a contact current of three milliamperes, the current density would be 3,820 amperes per square inch. The essential feature of the transistor unit described here is that kerosene coolant is circulated around the junction between the point contact wires and the germanium. Circulation is maintained by the natural convection currents set up in the fluid as a result of the temperature differential between the contacts and the surrounding fluid. Temperature rise at the contact point is considerably reduced.

During normal continuous operation the point-contact temperature is lower for given external ambient conditions than the contact temperature that exists when the transistor contacts are enclosed by a viscous or solid material. The measure of control over contact temperature achieved by convection cooling results in greatly improved stability of operation in transistor circuits, with some subsequent extension at the upper end of the allowable ambient temperature range.

Method of Stabilization

The transistor unit shown in the photograph is one in which the point contacts and surrounding region are fully exposed to the cooling fluid. Convection currents in the fluid minimize the initial temperature rise at the contacts and maintain continued reduced temperature contributing to more stable and predictable operation of the transistor.

Coolant

Cooling fluids having dielectric constants much greater than unity would introduce large, undesirable capacitance effects about the transistor elements. Low viscosity and a large thermal expansion coefficient are necessary to obtain satisfactory convection currents. A large thermal capacity is necessary to absorb rapid temperature rise in the contact region. Some of the

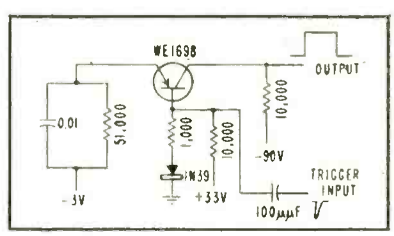
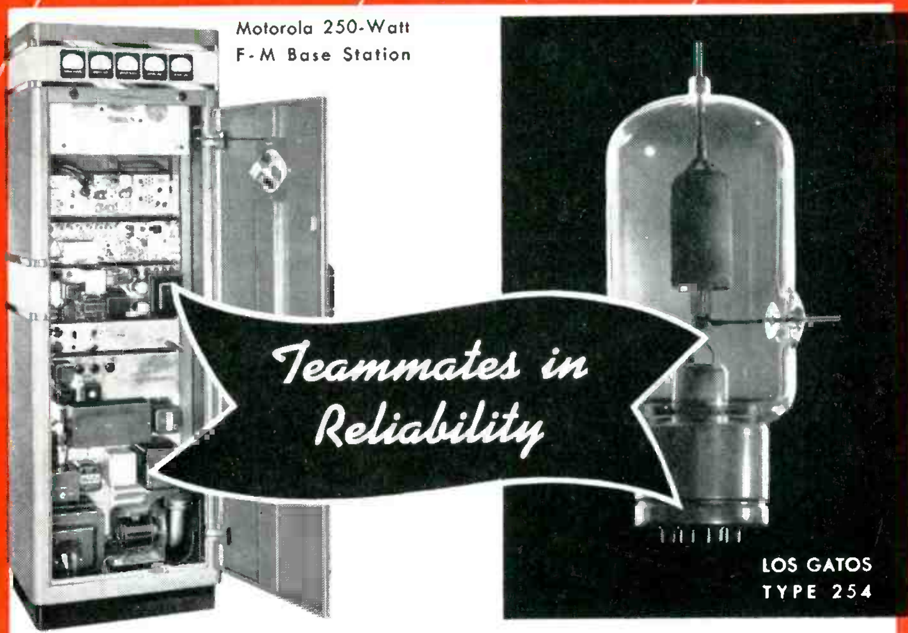


FIG. 1—Bistable multivibrator circuit used in temperature stability experiments



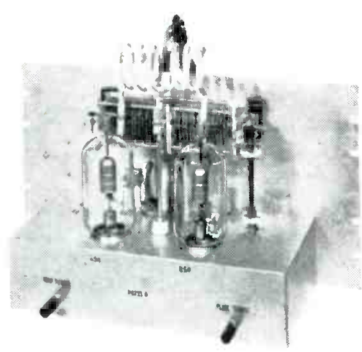
MOTOROLA AND LOS GATOS WORK TOGETHER FOR RUGGEDNESS, CONTINUITY OF SERVICE

Two Los Gatos Brand Type 254 triodes, operating in push-pull, energize the 250-watt final r-f power amplifier in the Motorola "Research" line of 25- to 50-mc 250-watt f-m radio systems.

Because this equipment was designed to provide dependable two-way communication in mobile or point-to-point service, the choice of these long-lived Los Gatos tubes was natural.

A rear-view close-up of the power amplifier chassis with the two Los Gatos 254's in position is shown below.

If you have a problem calling for electron tubes with rugged dependability, check with Los Gatos—either through your nearby representative, or write:



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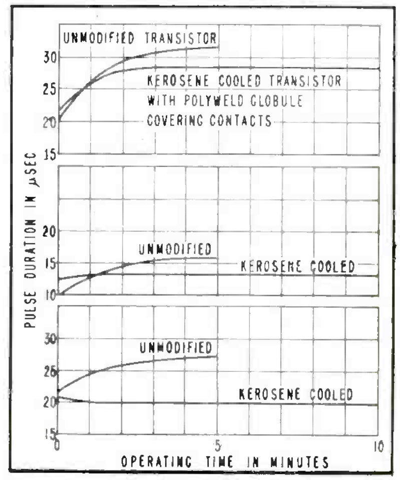


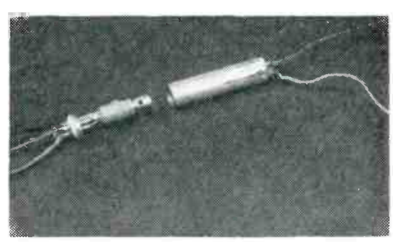
FIG. 2—Variation of pulse duration during warmup of transistor multivibrators

liquids that meet these requirements are light petroleum, turpentine, carbon tetrachloride, benzene, trichloro-ethylene and kerosene.

First laboratory tests were made with benzene as the coolant, but the benzene was found to attack the germanium surface. The aromatic hydrocarbons, of which benzene is a member, cause significant damage to the back-voltage characteristic of crystal diodes.[1] The same action would be experienced at least qualitatively by a transistor immersed in such a liquid, and the results would be such as to impair greatly the ability of the transistor to perform as an amplifier.

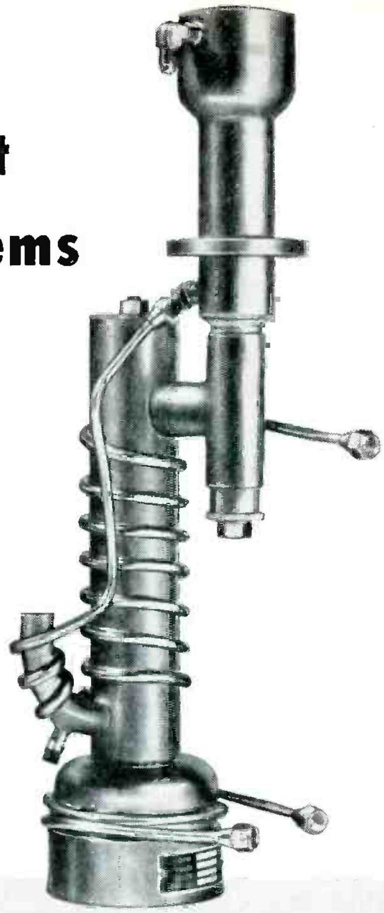
Aliphatic hydrocarbons do not in general exhibit these effects. Kerosene, one of this group, was chosen as the coolant for the preliminary experiments. The results have been excellent with no deleterious effects observed in many hours of operation in the kerosene.

The experimental model used for testing the temperature stabilization process is a Western Electric type 1698 point-contact transistor having the insulation material removed by soaking in trichloro-



Kerosene cooled transistor unit removed from tube to show construction

It's easy to convert tube exhaust systems with these pump and port units



For most rotary exhaust machines—

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ethylene. The transistor, mounted in a suitable socket, was inserted in a brass tube. The tube was then sealed at one end with a Kovar glass-to-metal seal and filled with kerosene. The other end was made with a tight fitting cover.

The monostable multivibrator circuit shown in Fig. 1 was used in the temperature stability experiments. The curves in Fig. 2 indicate the variation of time duration of the quasistable state of the multivibrator as a function of time elapsed after initiation of the supply voltages and trigger pulses. For the two transistors compared in the grease-filled and the kerosene-filled conditions there is essentially no significant thermal creep in pulse duration during or after warmup when operated in kerosene. The other transistor tested was given a small polyweld globule, covering a surface area of about 0.1 mm diameter, on the contact junctions and then immersed in the kerosene. The curves for this transistor indicate a small reduction in creep effect when operated in kerosene over that existing for grease-filled operation; comparison with the curves of the two other transistors clearly indicates the necessity for allowing the coolant to be in direct contact with the collector and emitter point contacts.

In further observations made with cooled transistors operating both in single and double transistor bistable multivibrator circuits, milliammeters in the collector circuits indicated an absence of the usually observed thermal creep.

The assistance of Robert C. McCarty and Tom Ross of the Physical Research Unit is gratefully acknowledged.

REFERENCES

(1) O. M. Steutzer, Junction Fieldistors, *Proc. IRE*, 40, p 1377, Nov. 1952.

Increasing Range of Geiger Tubes by Pulsed Operation

WHEN OPERATED at a constant potential, the upper limit of Geiger tube operation is governed by the time required for deionization of the gas after discharge. When the interval between counts approaches

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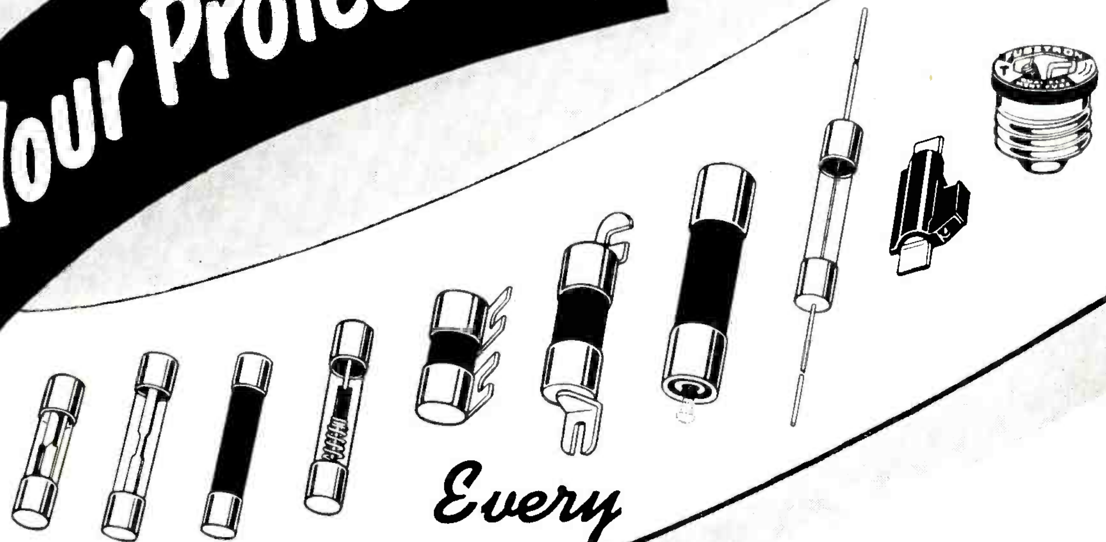

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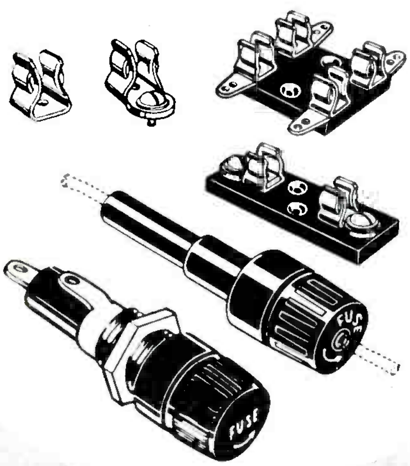

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the discharge time, saturation occurs. Further extension of the radiation intensity measuring range requires either the use of Geiger tubes having lowered sensitive volumes or their replacement with other devices more suitable for use in strong radiation fields.

Two methods developed by the Naval Research Laboratory[1] for extending the range of Geiger tubes use a pulsed voltage for tube operation. One method uses a pulsed voltage superimposed on a constant d-c potential to improve quenching action of the tube. The other method employs the pulsing voltage alone to gate the Geiger tube, permitting measurement of radiation only during the brief interval of pulse duration.

Continuous Sensitivity

The extension of range possible with the superimposed pulse method is illustrated in the graph in Fig. 1. The pulse acts as a catalyst, speeding recovery from discharge without materially affecting performance below the saturation point for d-c alone. The degree of range extension possible by this method is dependent on tube dead time, and the width, amplitude and repetition rate of the pulse.

Variation of the tube operating voltage within the Geiger operating plateau has only a small effect on the range extension, provided the pulse amplitude is maintained at not less than 20 percent of the tube voltage.

Pulse rate should be selected so that the period of the pulse is equal to the dead time interval of the tube. If the pulse period is longer than this the tube will become saturated and blocking up will occur. If the period is shorter there

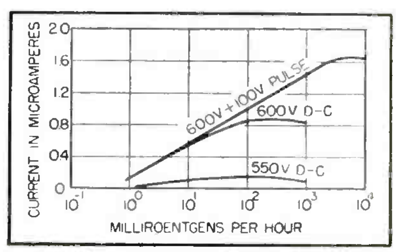
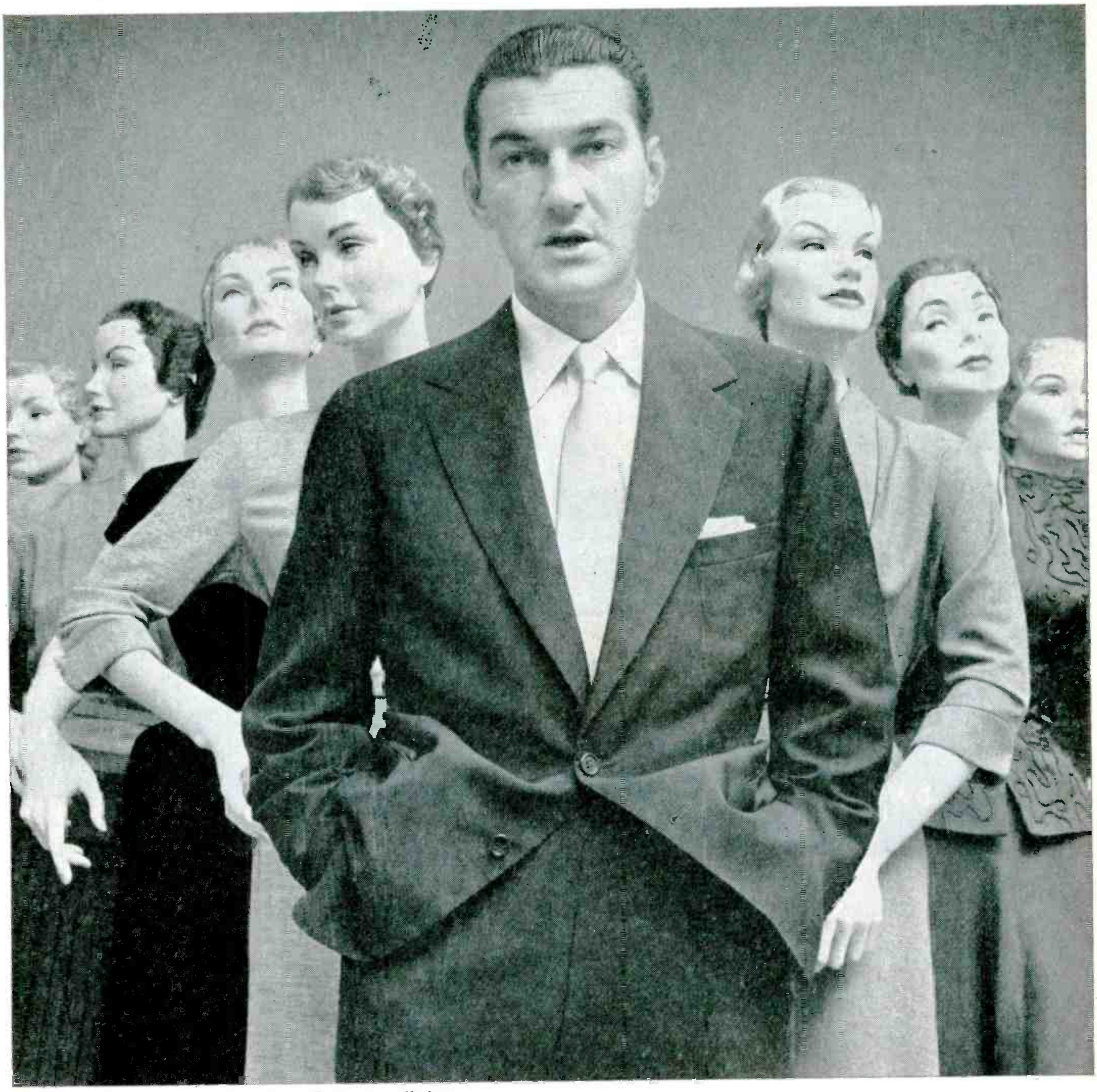


FIG. 1—Curves showing increase in tube current in a type GC-120 counter tube by use of superimposed 2,550-pps pulse. Pulse width is 20 μsec



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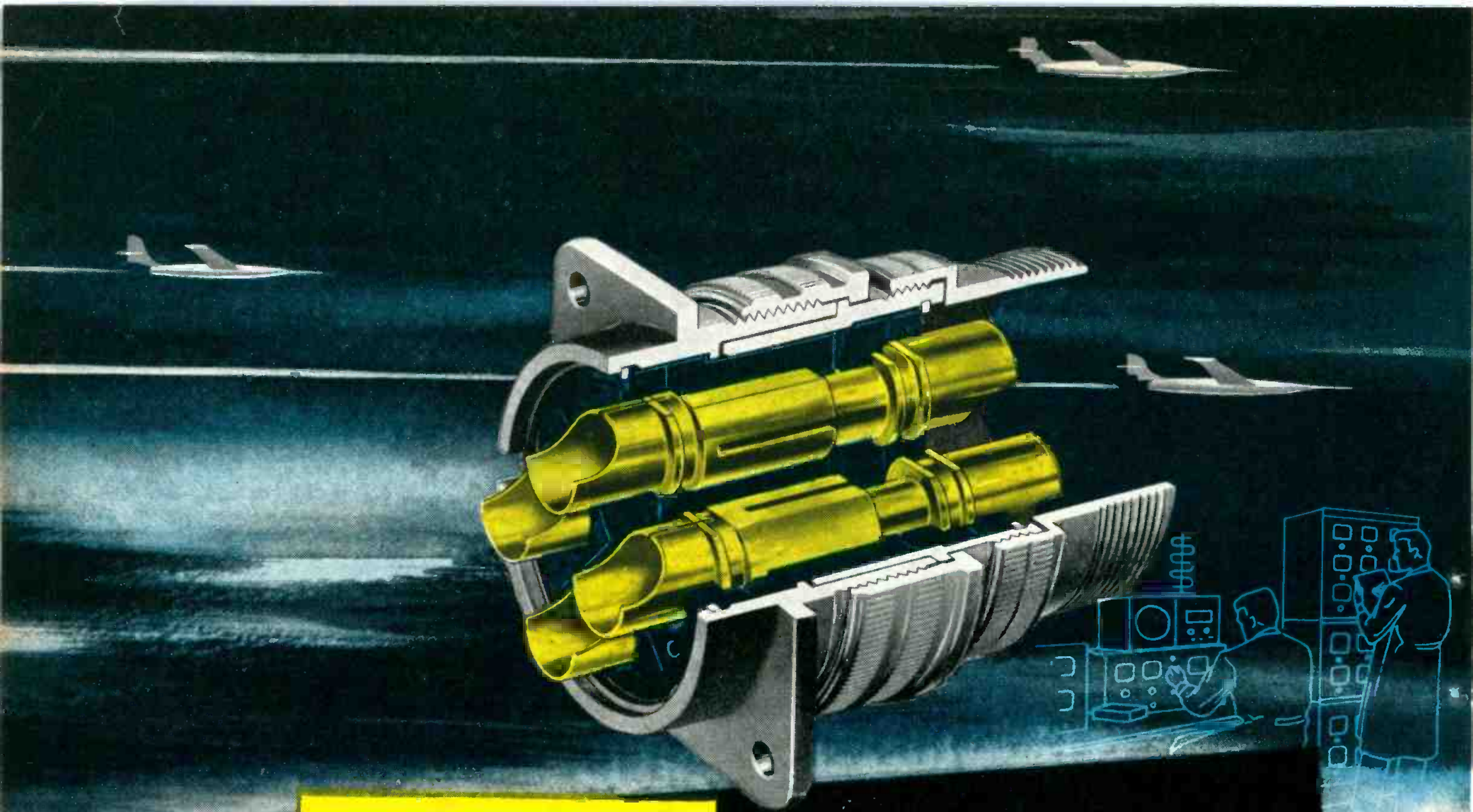

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will not be complete recovery between pulses with consequent lowering of the range and maximum Geiger current.

Pulse width must be much less than tube dead time. In experimental work improvement in measuring range was evident down to the narrowest pulse used, about one half microsecond. Theoretical work indicates that a reduction of pulse width will be accompanied by a corresponding increase in counting range until the pulse becomes sufficiently narrow as to approximate the transit time of the electrons. In this region the behavior of the counter tube would alter markedly in accordance with transit time theory. One of the changes would probably be a reduction in the influence of the pulses upon tube performance.

Intermittent Operation

The second method, using only a pulse voltage, extends the range of the tube by allowing it to measure the radiation for brief intervals at a periodic rate. When the pulse is used to trigger the tube in this manner the measured count rate will be a fraction of the count measured with constant voltage applied to the tube.

The ratio between the two count rates may be called the scale factor SF. Experimental work has shown that measurement rate varies directly with pulse width, repetition rate and the intensity level of the radiation field. For pulse widths considerably less than the tube dead time, SF is equal to the reciprocal of the duty factor

$$SF = 1/wf$$

where w is the pulse width and f is the repetition frequency.

This relationship shows that by pulsed trigger operation the total potential count at the tube is lowered by the duty factor wf. This feature for all practical purposes removes the saturation limitations of Geiger tubes in high radiation fields.

The trigger pulse repetition rate must not exceed the rate prescribed by the reciprocal of the deionization time of the tube. Otherwise the discharge will be reignited by the triggering pulse and will be self-sustained at the trigger pulse rate.

The use of a narrow triggering pulse eliminates the possibility of gaseous discharge except where the pulse coincides with an external ionization source. This feature extends the counter operation far beyond the usual limitations imposed by the Geiger plateau. At these high overvoltages the ultimate limitation of the impressed voltage is determined by the insulating capabilities of the tube rather than by the restrictions imposed by the gaseous vehicle.

The use of higher voltages brings with it the benefit of dealing with larger charges from each counter pulse. If the triggering pulse is narrowed sufficiently the tube voltage can be raised to a region where tube current becomes largely independent of the amplitude of the impressed voltage. This characteristic may be useful in radiac designs by either reducing or eliminating entirely the dependence of instrument calibration upon tube overvoltage. It also furnishes a basis for dispensing with the need for high voltage stabilizers for counting tubes.

REFERENCES

(1) S. W. Lichtman, Pulsed Geiger Tube Operation, Naval Research Laboratory Report No. 4013, July 25, 1952.

Commercial, Ruggedized and Premium Tubes

BY FLOYD A. PAUL

Research Engineer
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, Calif.

VACUUM TUBES fall into three categories that are generally known as commercial, ruggedized and premium. The latter are also known as reliable and 5-star tubes. Furthermore, these tubes may be accepted as JAN tubes. Tubes are not, how-

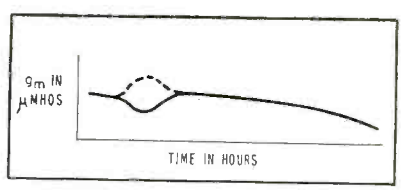

FIG. 1—Tube-aging curve with either type of protuberance is characteristic of new tubes

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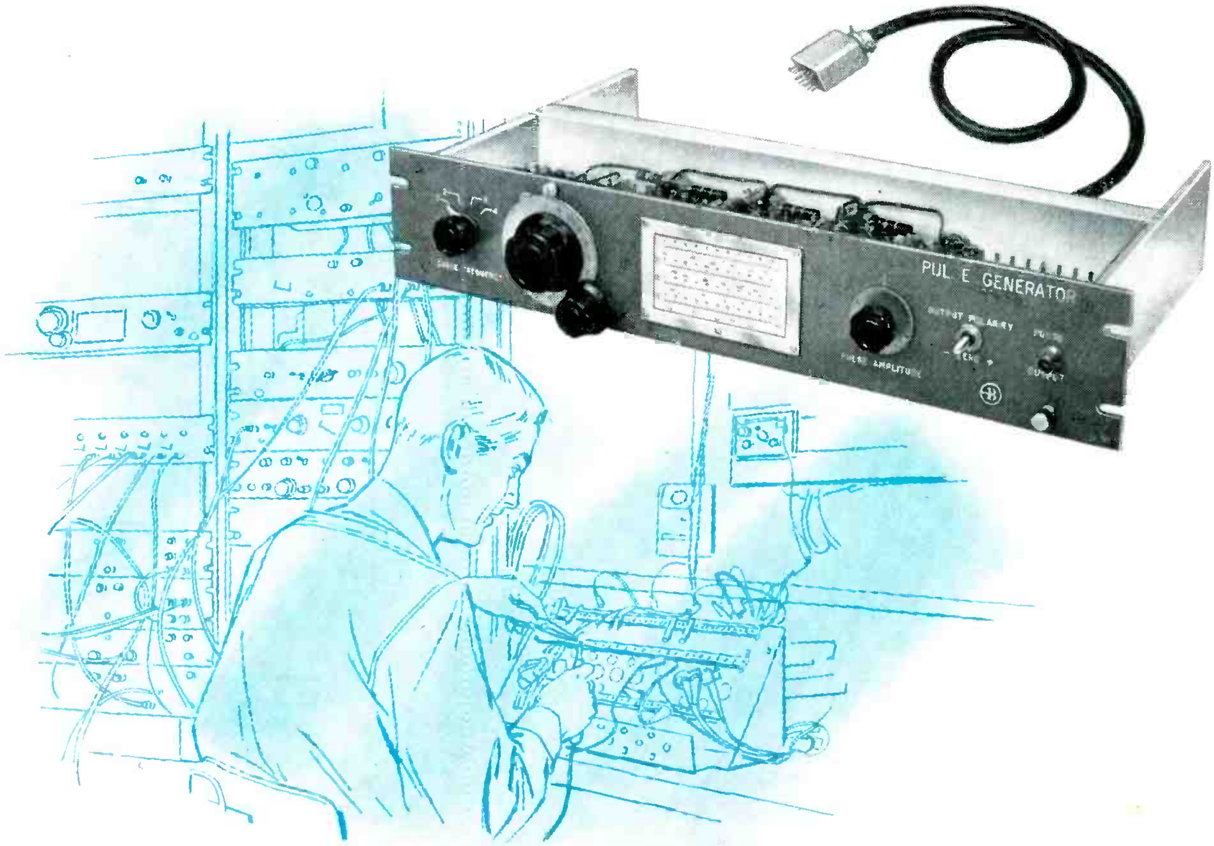

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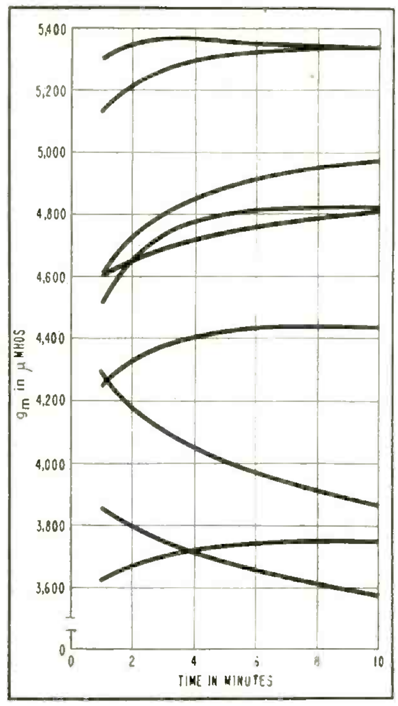


FIG. 2—Aging curves of nine 6AK5's show change in g_m

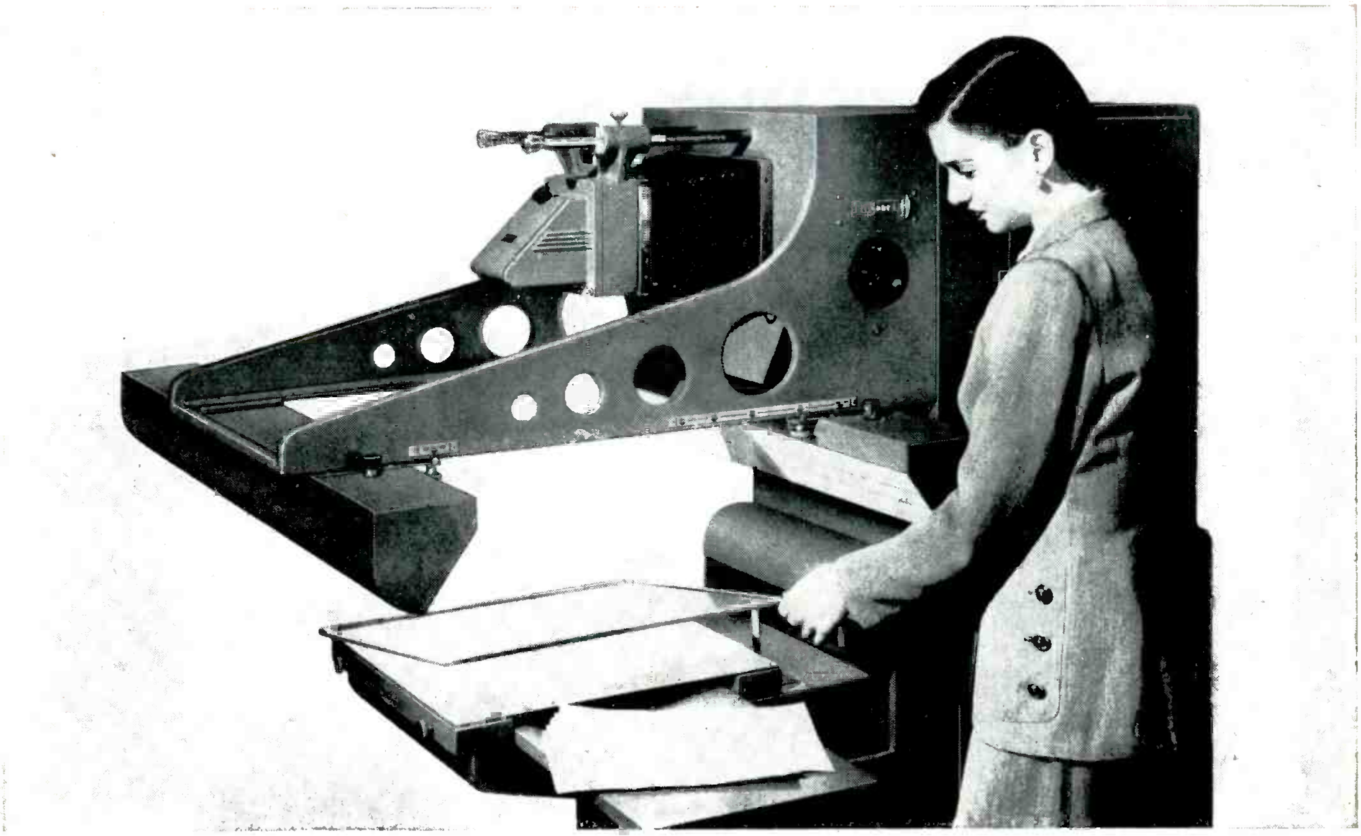
ever, JAN tubes unless they are inspected at the factory under a qualified inspector and labeled JAN, showing that sample batches have passed certain qualification tests.

JAN specifications state the conditions to be met before tubes can be stamped with the letters JAN. Since some commercial specifications are more rigid than JAN specifications, it has been suggested by tube companies that a JAN-stamped tube is not necessarily better than a commercial tube. Since ruggedized and premium tubes are improved commercial tubes, JAN specifications for these types are less meaningful than for commercial tubes.

Table I compares the various

Table I—Comparison of Tube Controls

	Commercial	Ruggedized	Premium
Visual inspection	limited	general	100 percent individual-element inspection
Electrical inspection	limited	limited	a mean reject limit and a cycled filament test
Aging	1 hr	1 hr	48 hr
Tube structure	original design	mechanically improved structures redesigned; better supports	mechanically improved structures redesigned; better supports



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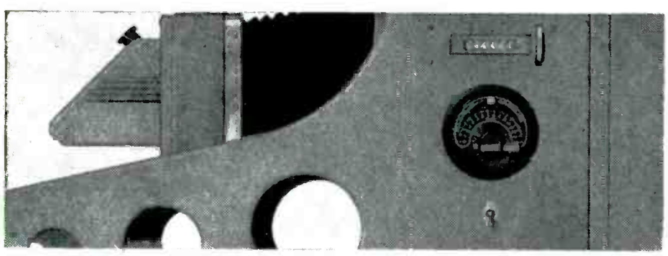

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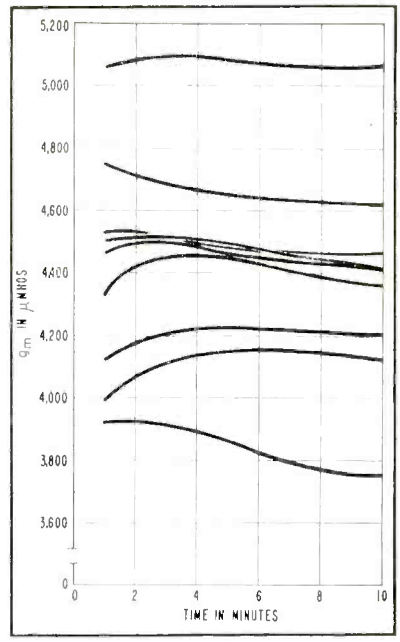


FIG. 3—Nine type 5654 tubes show aging characteristics

tests and the characteristics of commercial, ruggedized, and premium tubes as reported by tube manufacturers. From this comparison it can be generally concluded that premium tubes have better quality control than commercial tubes as well as the other advantages shown.

A sampling of 100 tubes of the commercial type 6AK5 and 100 tubes of the premium type 5654 was carried out at this laboratory. Table II shows the mean transconductance g_m of each group of tubes, and a calculation shows the standard deviation value of each group.

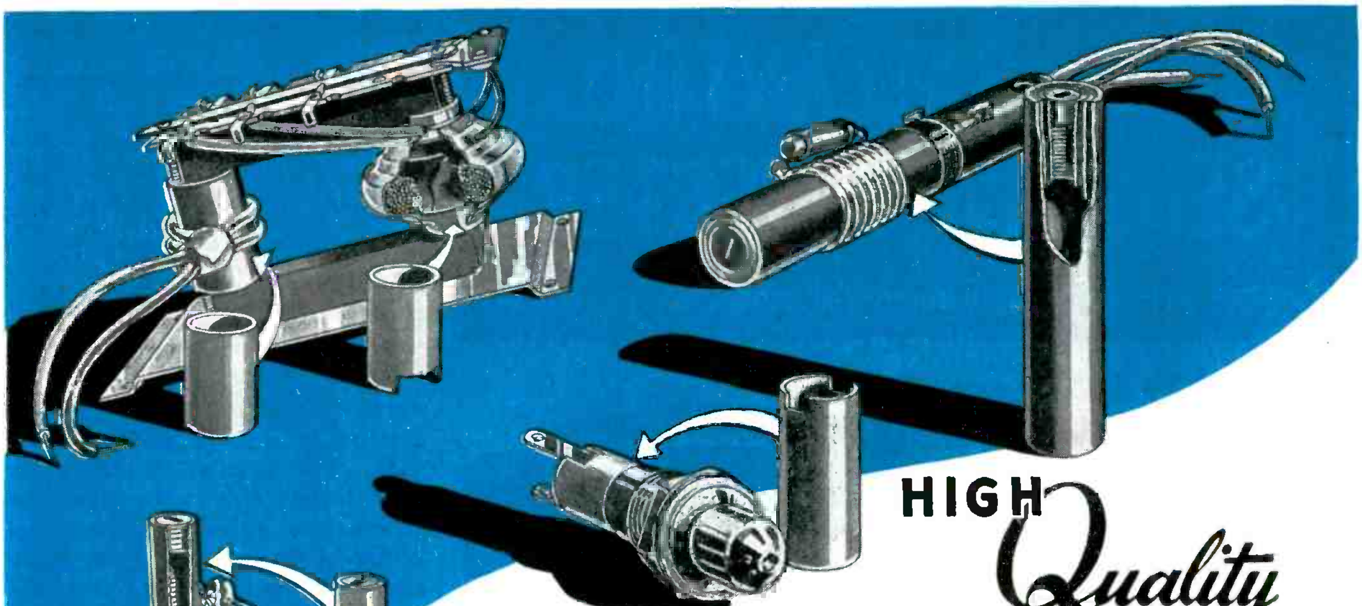
Most electronic systems using d-c amplifiers and r-f amplifiers require good electrical stability. If there is a change in tube characteristics, a variation of gain or an unbalanced condition could result. It has been known for some time that a tube-aging curve that plots g_m vs time of new tubes has a peculiar shape described in Fig. 1.

The reason for the projection in this curve other than aging is unexplained by tube engineers, but all

Table II—Mean Transconductance of Tube Groups

Tube	Quantity	Mean g_m in μmhos	Standard Deviation in μmhos
6AK5	100	4,717	484
5654 (Premium 6AK5)	100	5,041	375

JAN mean g_m is 5,000 μmhos.



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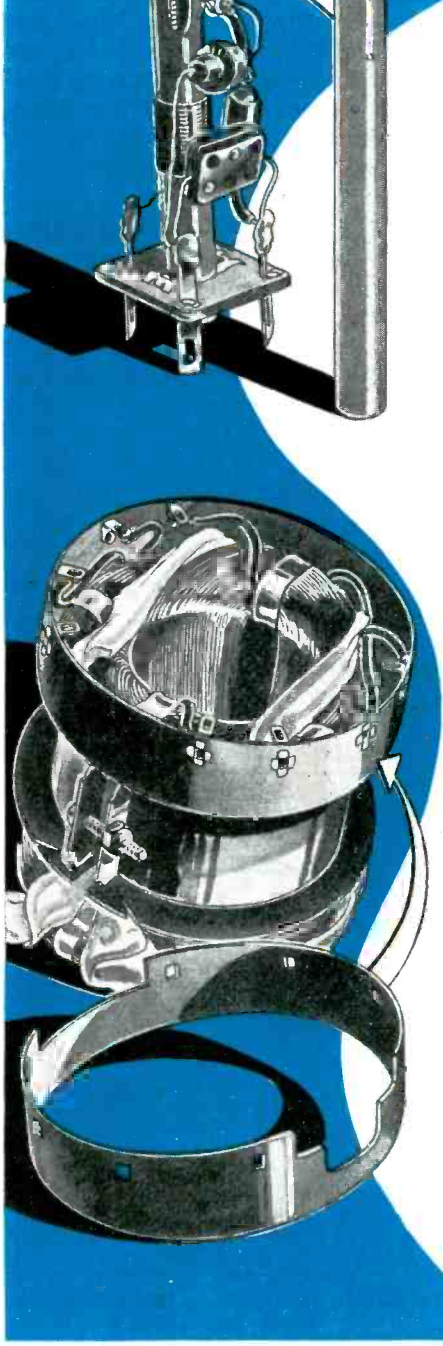

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Table III—Change in Transconductance

Quantity	Type	Hours Aged by Factory	Mean g_m in μmhos	Average Change of g_m from First to Tenth Minute (%)
9	6AK5	1	4,500	5.3
9	5654	48	4,400	1.9
8	5654	500	3,700	1.9

agree that it exists. Its general location is in the 10-to-50-hour region. The apex of the projection may deviate from a fraction of a percent to several percent and either in the positive or the negative direction. This is one of the reasons why premium tubes are aged 48 hours. Some programs call for additional aging. Having been aged beyond this projection point, premium tubes can be expected to have a more stable electrical life than commercial tubes.

To compare the speed required for variously aged tubes to reach stability after application of JAN voltages, 26 tubes were used in a test that measured the g_m of each tube every minute for 10 minutes. The following tubes were used: nine 6AK5's, nine 5654's, and eight 500-hour 5654's. The individual curves of each tube showing g_m vs time are plotted in Fig. 2, 3 and 4, respectively.

Defining g_m stability in a vacuum tube as the time in which $\Delta g_m/\Delta_{time} \leq 20$ percent/hr $= 1$ percent/3 min the graphs of the 26 tubes show that 6AK5's required 3.6 minutes

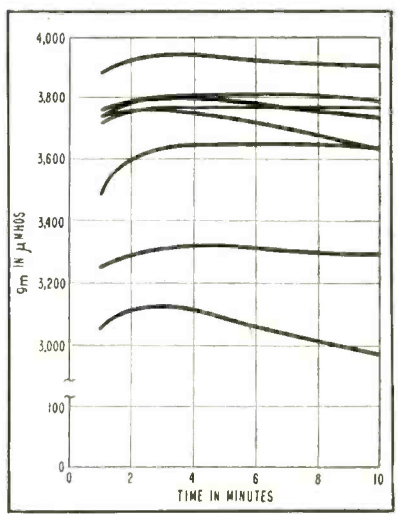
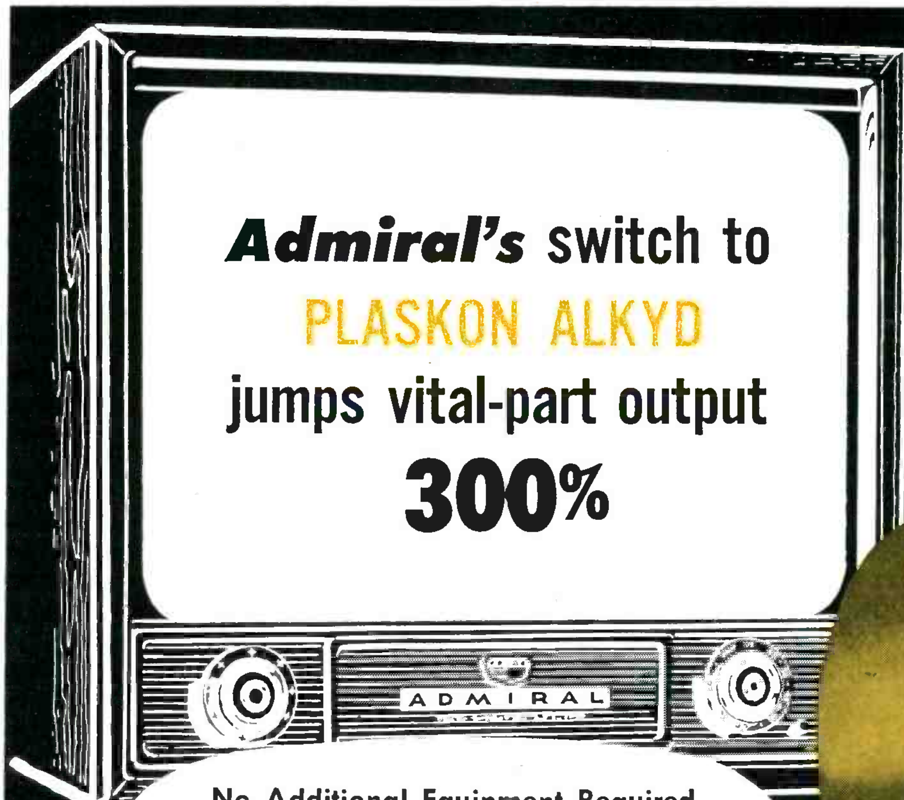


FIG. 4—Eight 500 hour 5654's show less aging than in Fig. 3



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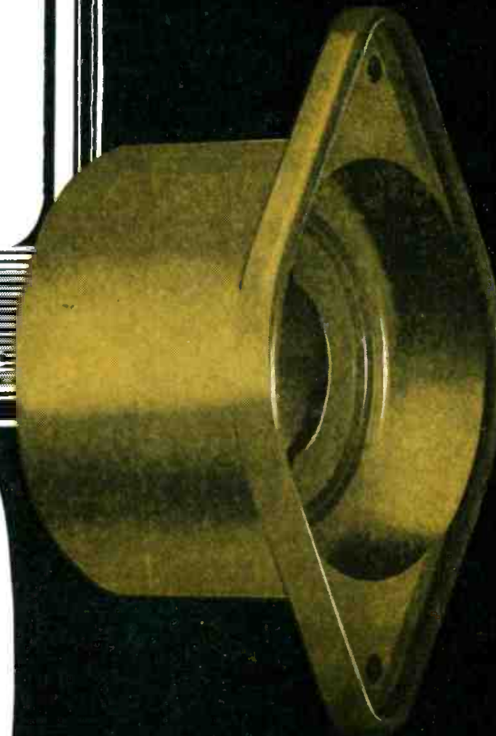

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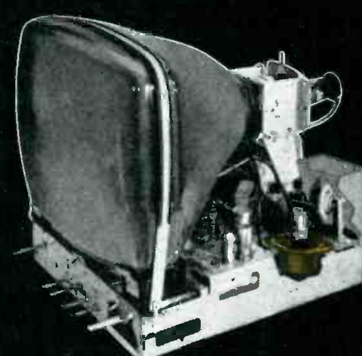

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to stabilize, 5654's required 1.5 minutes, and 5654's (500 hour) required 1.8 minutes to stabilize.

Table III groups the 26 tubes by type and states the average percentage of change of g_m from the first minute to the tenth minute for each type.

An examination of the three groups shows the 6AK5's to have more g_m variation with time than the 5654's Although the mean percentage of change of g_m from the first minute to the tenth minute for the 500-hour 5654's is not better than for the 48-hour 5654's, it appears that some 500-hour tubes that have extremely small changes of g_m after the first 3 minutes of warmup could be hand-selected.

An electronic system using numerous commercial tubes might suffer an extended unstable period if its tubes were aged to the protuberant condition while in operation. Premium tubes are aged beyond this condition.

Premium tubes, then, are to be preferred over commercial tubes.

This paper presents the results of one phase of research carried out at the Jet Propulsion Laboratory, California Institute of Technology, under Contract No. DA-04-495-Ord 18, sponsored by the Department of the Army, Ordnance Corps.

Design Equations for Broadbanding by Stagger Tuning

By Domenick Barbiere
Radiation Laboratory
Johns Hopkins University
Baltimore, Maryland

Obtaining a broadband response by the staggering of single-tuned circuits requires that the poles of the individual circuits be arranged correctly in the complex Z-plane. Poles in the frequency plane may be obtained by the equation

$$f_n = f_o\left[\frac{Z_n}{2} + \left(1 + \frac{Z_n^{2}}{2}\right)^{\frac{1}{2}}\right] \qquad (1)$$

The absolute value of f_n yields the center frequency of the n^{th} stagger while its imaginary component gives its bandwidth. For a Butterworth stagger the poles are arranged on a semicircle in the Z-plane, and for a Tschebyscheff stagger they are arranged on a

semiellipse.

The procedure for finding the Z_n's is not difficult and is discussed elsewhere[1,2]. Equation 1, however, is laborious to solve by brute force since it relates complex quantities. This is especially true when several stagger schemes must be computed to compare their relative merits.

In "Broadbanding by Stagger Tuning" (ELECTRONICS, p 118, Feb. 52) a nomograph for Eq. 1 is presented for the designer's use. The nomograph is difficult to read, however, for small values of $|Z_n|$ and also when the individual bandwidths of the stagger are small. The latter case usually arises in the Tschebyscheff stagger and also when the number of stages in the stagger is large. For example, a seven-pole Tschebyscheff stagger with a fractional bandwidth of unity and a gain tolerance of 1 db can not be read with sufficient accuracy from the nomograph.

In the method for obtaining f_n from Z_n given below the final Eq. 12 and Eq. 12′ are exact, but an approximation is made in their solution. For $|Z_n| \leqq 1$ the error in the worst case is no more than 3 percent. The specification that $|Z_n| \leqq 1$ is a range large enough to cover most cases. For $|Z_n| \leqq 1.5$, by the way, the error is no more than 8 percent in the worst case. Let

f_o = center frequency of the overall response (2)

$f_n/f_o = R_n < \psi_n$, where (3)

$R_n f_o$ = center frequency of the n^{th} stage. and (4)

$2 f_o R_n \sin \psi$ = bandwidth of the n^{th} stage (5)

$Z_n = \rho n < \theta_n$ = pole position of the n^{th} stage in the Z-plane (6)

Instead of starting from Eq. 1, solve the inverse form

$$Z_n = \frac{f_n}{f_o} - \frac{f_o}{f_n} \quad (7)$$

From the substitutions into Eq. 7

$$Z_n = \rho_n < \theta_n = \rho_n \cos\theta + j\,\rho_n \sin\theta_n = Re(Z_n) + jIm(Z_n) \quad (8)$$

and

$$\frac{f_n}{f_o} = R_n < \psi_n \quad (9)$$

obtain

$$Z_n = R_n e^{j\psi_n} - \frac{1}{R_n} e^{-j\psi_n} \quad (10)$$

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$$Z_n = \left(R_n - \frac{1}{R_n}\right)\cos\psi_n + j\left(R_n + \frac{1}{R_n}\right)\sin\psi_n \qquad (11)$$

Equating imaginaries and reals yields

$$Re\,(Z_n) = \left(R_n - \frac{1}{R_n}\right)\cos\psi_n \qquad (12)$$

$$Im\,(Z_n) = \left(R_n + \frac{1}{R_n}\right)\sin\psi_n \qquad (12')$$

The quantities on the left-hand sides of the above equations are numbers that have already been obtained. The equations must be solved for R_n and $\sin\psi_n$ so that the center frequency and bandwidth of the n^{th} stage may be obtained.

The approximation is now made that $\cos\psi_n = 1$. Even when $\psi_n = 30$ deg, corresponding to a fractional bandwidth for the n^{th} stage equal to unity, $\cos\psi = 0.87$. Equation 12 is a quadratic, however,

$$\left(R_n - \frac{1}{R_n} - \frac{(Z_n)\ \text{real}}{\cos\psi_n} = 0\right)$$

of which $\cos\psi_n$ affects only one term, so that the error introduced in R_n by the approximation is much less than the error in $\cos\psi_n$ itself. With the approximation, it follows that

$$Re\,(Z_n) = R_n - \frac{1}{R_n} \qquad (13)$$

$$Im\,(Z_n) = \left(R_n + \frac{1}{R_n}\right)\sin\psi \qquad (13')$$

Equation 13 is a simple quadratic from which R_n may be readily obtained with the positive root only being retained. With R_n known, Eq. 13′ may be solved for $\sin\psi_n$. The center frequency of the n^{th} stage is f_oR_n, and its bandwidth is $2f_oR_n\sin\psi$.

The above method was found useful in the design of a Tschebyscheff staggered octuple. Calculations were first made for a septuple with various gain tolerances, and it was found that the requisite gain could not be obtained. Calculations were then made for an octuple with various gain tolerances, and the smallest gain tolerance yielding sufficient gain was chosen. The computations would have been laborious indeed if Eq. 1 were solved for each case and each stage. Comparison of results obtained from Eq. 13 and 13′ and those obtained from the original

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exact equation show an error of 3 percent for values of ρ less than or equal to 1. For ρ equal to 1.5 the maximum error was 8 percent.

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Transmission Characteristics of Nonsymmetrical Networks

BY HANS KLEIN

Siegfried Junghans
Schorndorf, Wuerttemberg
Germany

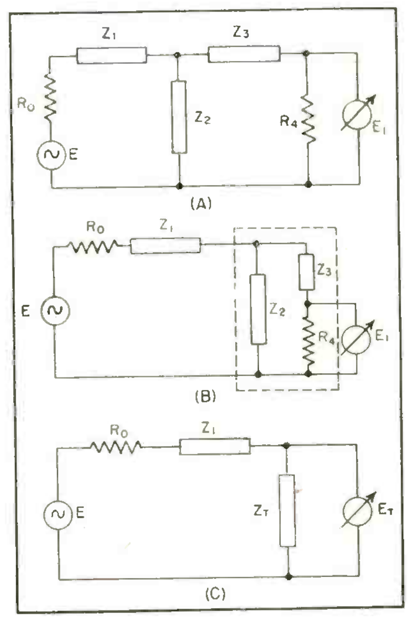

FIG. 1—Simplification of circuit for calculation of insertion loss

THOUGH FOUR-TERMINAL networks will usually be inserted between equal resistance terminations there are cases where this condition cannot be fulfilled. The E. J. Purington[1] paper provides an excellent means for an easy and rapid calculation of the transmission characteristic of four-terminal-networks that possess electrical and structural symmetry. It seems, therefore, reasonable to extend his method to the nonsymmetrical case.

This is done only for the T-configuration, inserted between nonequal resistance terminations, though the method is applicable to other forms of four-terminal networks. Three steps are necessary:

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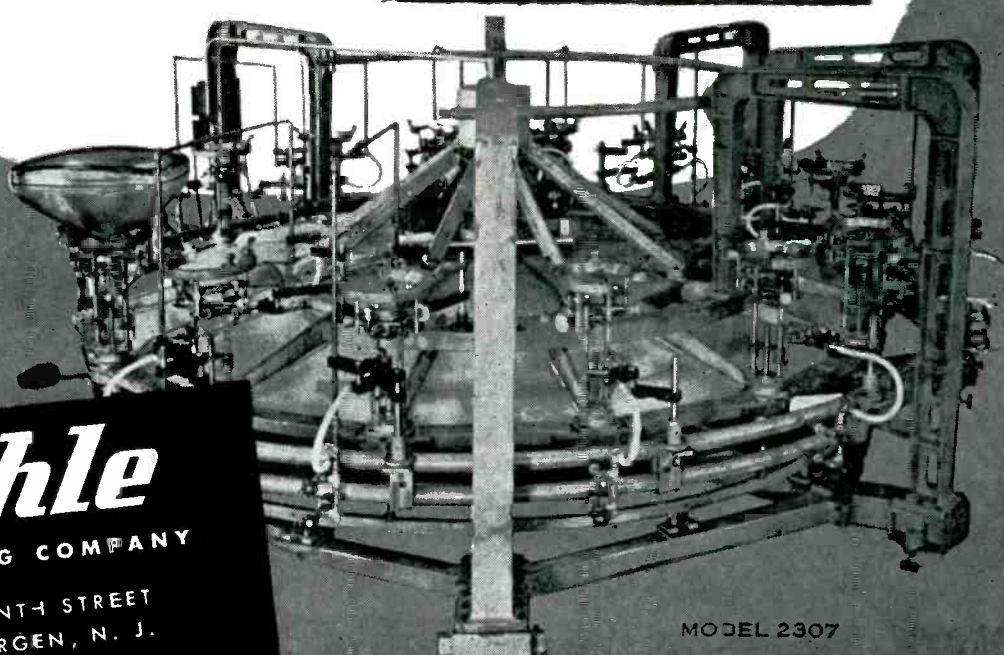

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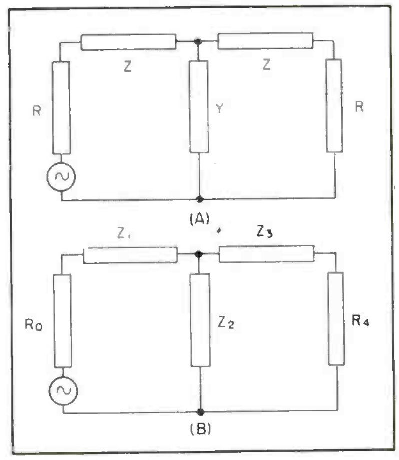


FIG. 2—Determination of T-network with desired characteristics

(1) Calculation of the insertion loss of the T-network.
(2) Determination of a T-network that will, for given terminals, produce the desired transmission characteristic.
(3) Determination of the transmission characteristic of a given T-network provided that it satisfies a certain condition given below.

In the network of Fig. 1, insertion loss $= \frac{1}{2} \cdot \frac{E}{E_1}$ (1)

Rearranging Fig. 1A in the manner of Fig. 1B it is simple to obtain the insertion loss by considering voltage ratios in the different parts of the circuit. For this purpose the value of the impedance Z_T in Fig. 1C is needed. This can be obtained by simple comparison with Fig. 1B. From this follows

$$\frac{1}{Z_T} = \frac{1}{Z_2} + \frac{1}{Z_3 + R_4} =$$

$$\frac{Z_1 + Z_2 + R_4}{Z_2\,(Z_3 + R_4)}$$

or

$$Z_T = \frac{Z_2\,(Z_3 + R_4)}{Z_2 + Z_3 + R_4} \qquad (2)$$

From Fig. 1B and 1C

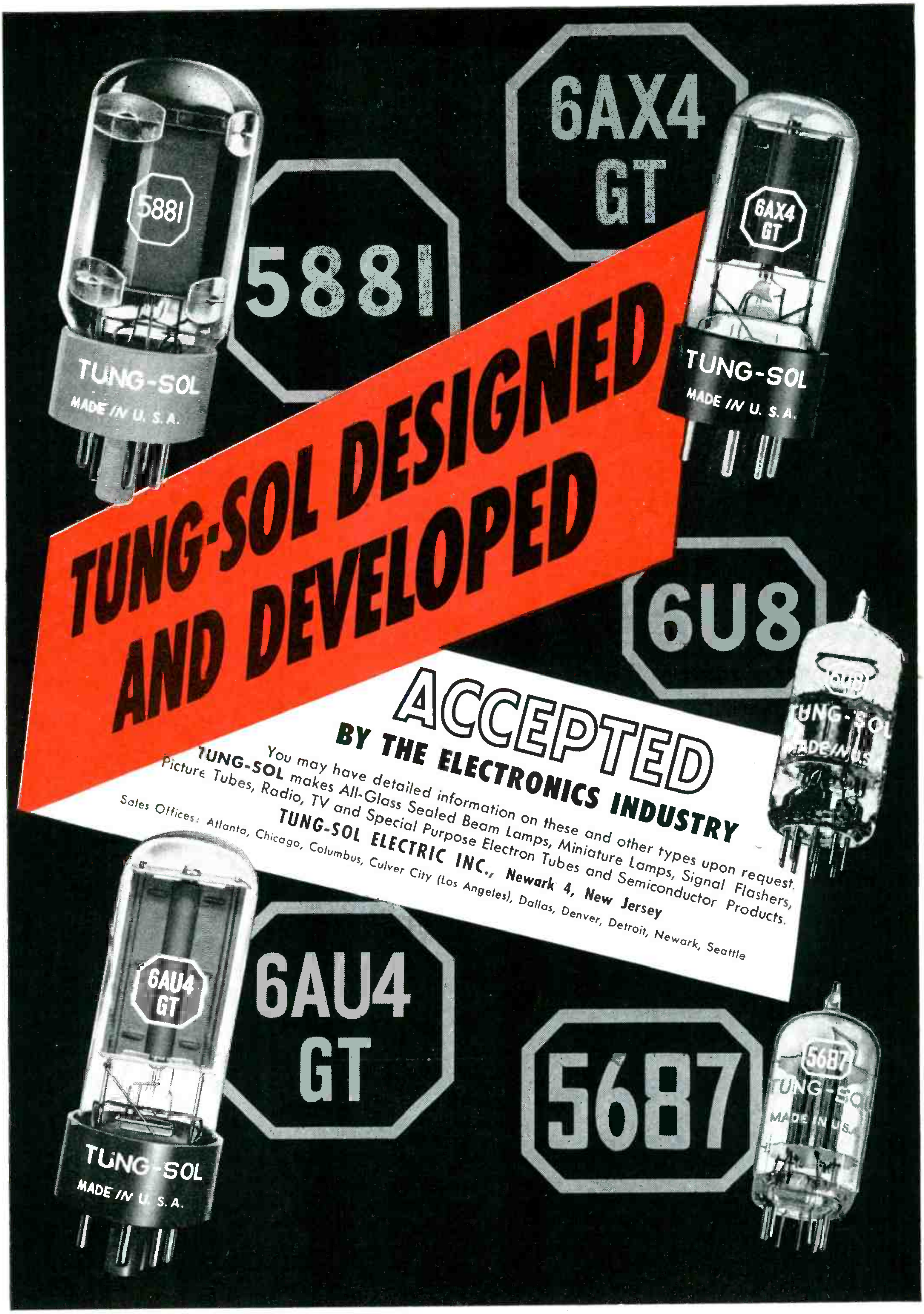
$$\frac{E_T}{E_1} = \frac{Z_3 + R_4}{R_4}$$

$$\frac{E}{E_T} = \frac{(R_0 + Z_1) + Z_T}{Z_T}$$

Therefore insertion loss =

$$\frac{E}{2E_1} = \frac{1}{2} \cdot \frac{Z_3 + R_4}{R_4} \cdot \frac{R_0 + Z_1 + Z_T}{Z_T}$$

Introducing the above value for Z insertion loss =



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$$\frac{E}{2E_1} = \frac{1}{2} \cdot \frac{Z_3 + R_4}{R_4} \cdot \left[1 + \frac{(R_o + Z_1)(Z_2 + Z_3 + R_4)}{Z_2(Z_3 + R_4)}\right] \quad (3)$$

To solve the second problem, the determination of a T-network with a desired transmission-characteristic, the nonsymmetrical problem is reduced to the symmetrical with

$$R = \frac{1}{2}(R_0 + R_4) \quad (4)$$

Suppose

$$Z_1 = Z_3 = Z \qquad Z_2 = Y \quad (5)$$

to be the desired solution, as indicated in Fig. 2A, which can be found by the method proposed by Purington, or by any other.

Conversion of this solution by the formulas given below, results in the T-network of Fig. 2B.

$$\begin{aligned} R_0 &= \lambda R \qquad R_4 = (2-\lambda) R \\ Z_1 &= \lambda Z \qquad Z_3 = (2-\lambda) Z \\ Z_2 &= \lambda(2-\lambda) Y \end{aligned} \quad (6)$$

wherein

$$\lambda = \frac{2R_0}{R_4 + R_0}, \; 2 - \lambda = \frac{2R_4}{R_4 + R_0} \quad (7)$$

To prove that the T-network of Fig. 2B has the desired transmission characteristic, the two insertion losses corresponding to the elements given by Eq. 5, 6 and 7 can be calculated. From Eq. 3 in the symmetrical case

$$\frac{E}{2E_1} = \frac{1}{2} \cdot \frac{Z+R}{R} \times \left[1 + \frac{(R+Z)(Y+R+Z)}{Y(Z+R)}\right] = \frac{1}{2} \cdot \frac{Z+R}{R}\left[2 + \frac{R+Z}{Y}\right]$$

The nonsymmetrical case gives

$$\frac{E}{2E_1} = \frac{1}{2} \cdot \frac{(2-\lambda)}{(2-\lambda)} \cdot \frac{Z+R}{R} \times \left[1 + \frac{\lambda(R+Z)(2-\lambda)[\lambda Y + R + Z]}{(2-\lambda)\lambda(2-\lambda)(Z+R)Y}\right]$$

$$= \frac{1}{2} \cdot \frac{Z+R}{R}\left[1 + \frac{\lambda}{2-\lambda} + \frac{1}{2-\lambda} \cdot \frac{R+Z}{Y}\right]$$

$$= (2-\lambda) \cdot \frac{1}{2} \cdot \frac{Z+R}{R} \times \left[2 + \frac{R+Z}{Y}\right]$$

By comparison of the above equations, the insertion loss of the nonsymmetrical T-network is equal to $(2-\lambda)$ times the loss of the sym-


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metrical T-network.

Therefore, the two insertion ratios for the symmetrical and the nonsymmetrical T-network have the same value but for the mismatching factor $(2-\lambda)$. This factor cannot be avoided and will be equally present without inserting the T-network between the two terminal resistance.

The physical meaning of the conversion equations 6 and 7 is to maintain the same relative impedance-level throughout the nonsymmetrical network as in the symmetrical network. In both cases the amount of impedance is approximately the same because

$$Z_1 + Z_3 = 2 Z_1 R_0 + R_4 = 2 R_1 Z_2 \approx Y$$

as long as

$$\lambda (2 - \lambda) = 4 \cdot \frac{R_0 \quad R_4}{(R_0 + R_4)^2} \approx 1$$

The inverse problem, to calculate the transmission characteristic of a given nonsymmetrical T-network, can naturally only be solved if the two impedances Z_1 and Z_3 satisfy the condition

$$\frac{R_0}{R_4} = \frac{Z_1}{Z_3} = \frac{\lambda}{2-\lambda} = \text{real constant}$$

which implies that these impedances are of the same nature. In this case we can convert the nonsymmetrical T-network to symmetrical one by means of Eq. 6 and 7 and calculate the transmission characteristic by the method previously indicated.

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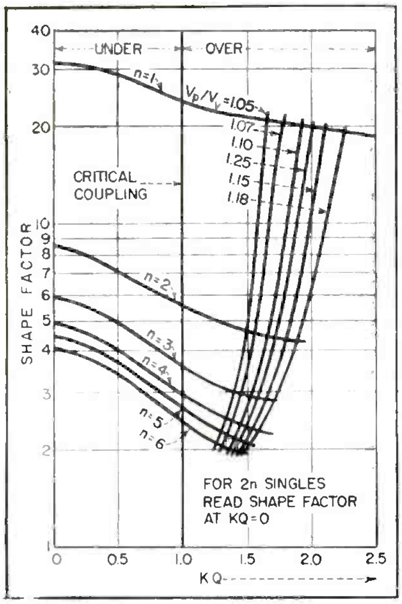
Shape Factor as a Criterion of Skirt Selectivity

BY JOHN J. DOUGHERTY, LT. USN
U. S. S. Bennington, CVA20 c/o FPO, New York, N. Y.

SHAPE FACTOR is a term being used to specify the degree of skirt selectivity required of an i-f amplifier. It is defined usually as the width of the passband 60-db down from maximum response divided by the passband width 6-db down. Figure 1 shows the theoretically minimum shape factor obtainable from a given i-f transformer using equal



'IG. 1—Variation of shape factor, coupling, number of single or double tuned stages, and peak to valley ratio

Q, L, and C in the primary and secondary, and shows that shape factor improves as coupling is increased.

Shrinkage factor is the amount by which the 3-db passband width of a parallel resonant circuit is increased or decreased as an identical circuit is coupled to an increasing degree until critical coupling is reached, and then n such transformers are cascaded to form an i-f strip.

In a resonant circuit with a Q of 100, at 1 mc the expected passband would be simply the ratio of the two, or 10 kc. The resonant impedance would be Q times the inductive or capacitive reactance of either branch.

As the secondary is coupled, the response approaches that of two resonant circuits coupled by a very high impedance. If this impedance be a pentode, the response is that of a pair of cascaded synchronously-tuned singles. As coupling increases until critical is reached, the passband has increased by the square root of two. This is the shrinkage factor. The resonant impedance, due to the presence of the secondary, is decreased to half its decoupled value. If the tuned circuit is the plate load of a pentode, the gain is half its former value, but in i-f design, this decrease is compensated for by doubling the L/C ratio.

As n such transformers, separated by pentodes, are cascaded, the shrinkage factor decreases and becomes, for n such stages

$$S = \frac{\sqrt{2}}{1.1\, n^{1/4}} \tag{1}$$

These factors can be combined into one simple equation giving the required tuning capacitance directly, providing that identical transformers and tuned circuits are used for primary and secondary. This equation is

$$C = \frac{S g_m n}{4 \pi B A} \tag{2}$$

where S is the shrinkage factor, B is the overall 3-db bandwidth desired and A is the overall gain, as a pure number, from the grid of the tube preceding the first transformer to the input of the tube following the last transformer. The output load must exceed by a factor of ten the load impedance of the transformer ($\frac{1}{2}QX_L$).

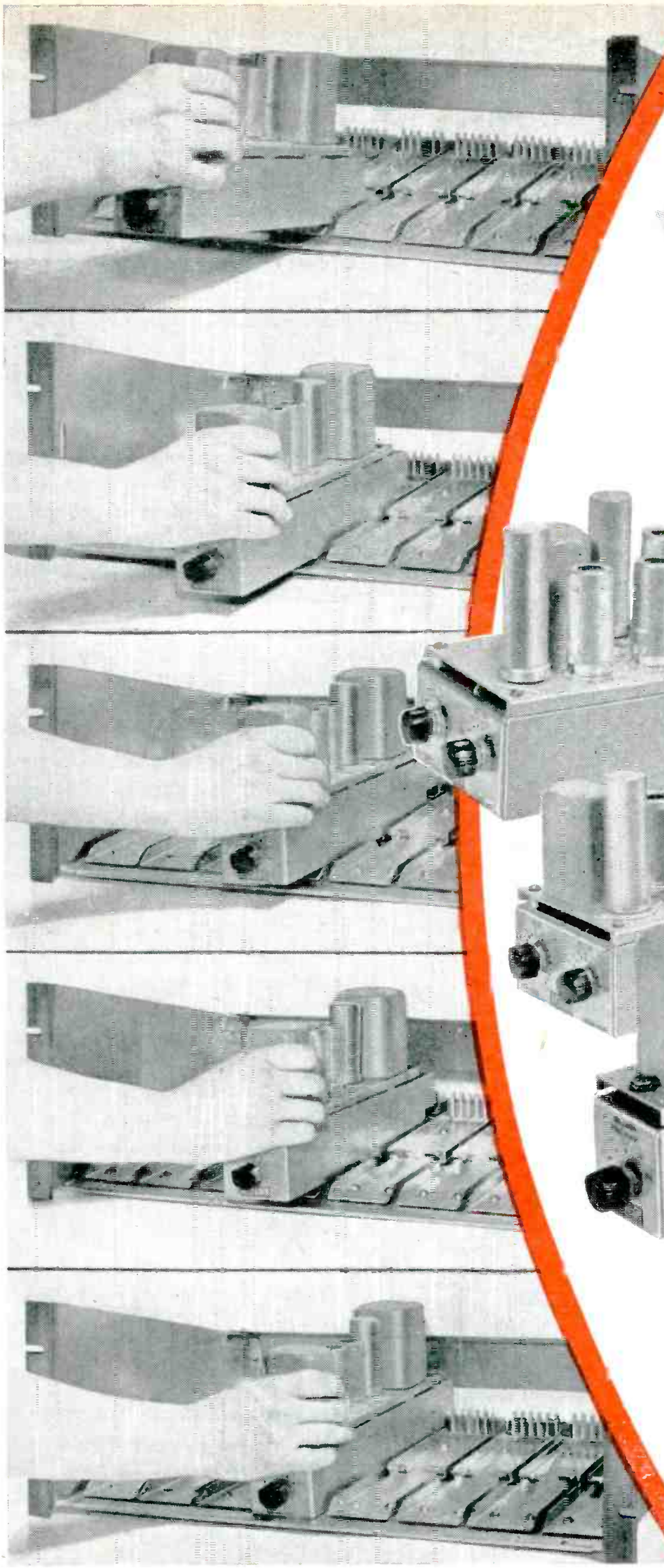
The geometrical mean transconductance of tubes involved, g_m, is the nth root of the product of all transconductances involved. These may not all be the same. For example, if the first tube is a mixer, then its mutual conductance as a mixer must be used. And if the cathodes of the tubes to which agc is applied are left unbypassed to minimize the Miller effect, then the g_m of those tubes must be decreased by that negative-feedback factor.

Having solved for the required tuning capacitance, the required inductance can be found from the resonance equation. All factors have now been found except the required Q of the coil being used. This is simply the ratio of the operating frequency multiplied by the shrinkage factor to the overall 3-db passband width.

$$Q_{coil} = \frac{Sf}{B} \tag{3}$$

Should the inherent Q of the coils be much higher than this they may be loaded down by calculating a parallel resistance which will decrease the resonant impedance to the desired value, and connecting such a value across both primary and secondary.

If required to begin calculations with a required shape factor, then from Fig. 1 the required number



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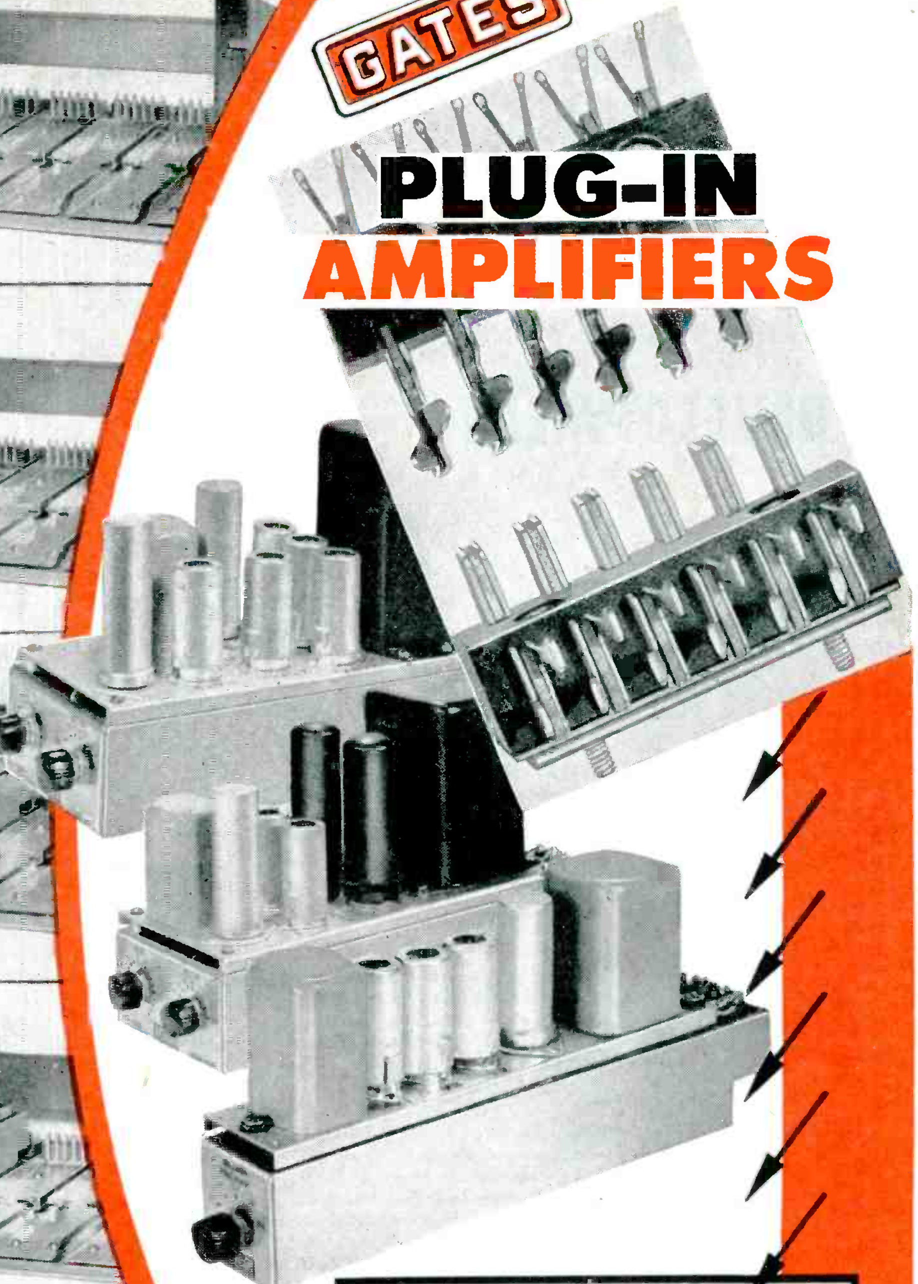

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of stages could be estimated and degree of coupling required. The curves show that a considerable improvement in shape factor is obtained by the use of critically coupled transformers over cascaded singles, and over under-coupled transformers. Since Eq. 1, 2 and 3 apply only to the critically coupled case, this simplified design would be a strong point in the favor of using critically coupled transformers. If, however, shape factor requirements are very stringent, a further improvement is possible by using overcoupled transformers, as well as an approach to the more desirable flat-top response. The solution here calls for a higher Q coil, and the solution for the circuit constants is simplified by readily-available nomographs covering overcoupled circuits.

Figure 1 can be used to estimate quite closely the degree of coupling of a given transformer. By merely taking its 6-db and 60-db bandwidths, dividing them, and entering the curves for $n = 1$, a value for QK is determined.

By using Fig. 1, and cooling techniques it was recently possible in a five-tube, five-transformer i-f strip to achieve a shape factor of 2.9, only seven percent higher than the theoretical minimum, with a stable gain of 140 db (ten million) at ten megacycles.

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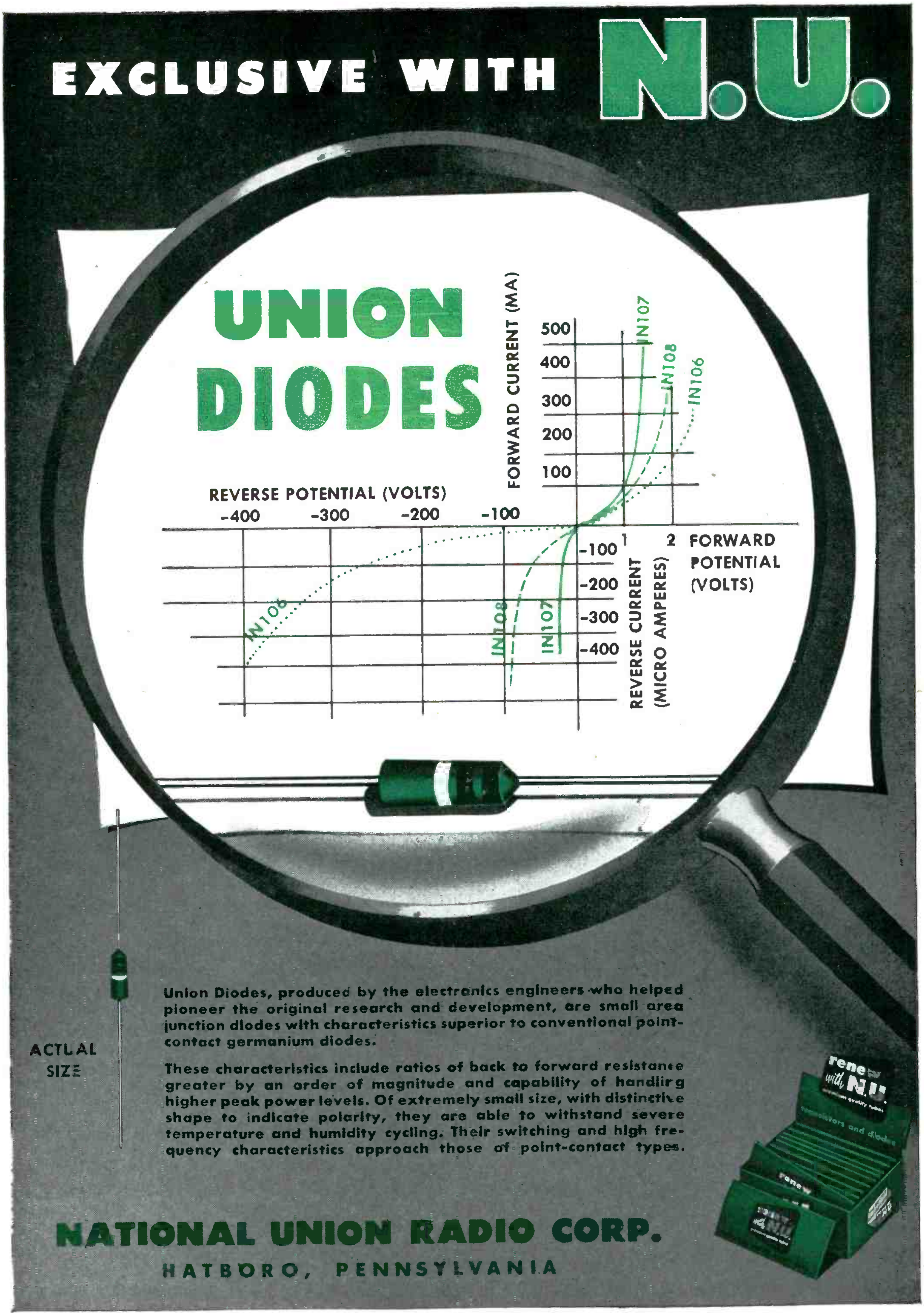
Loss and Singing Margins in Radio and Carrier Channels

By HOWARD H. SMITH
*Federal Telephone and Radio Corp.
Clifton, N. J.*

BASICALLY, any radio or carrier circuit consists of two one-way transmission paths. At various places in the transmission path, the original voice-frequency currents may be changed into single or double-sideband carrier currents, pulse-modulation signals, or amplitude or frequency-modulated radio-frequency currents. The net



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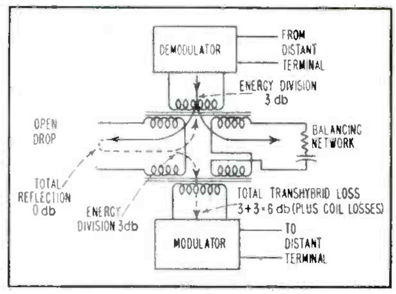


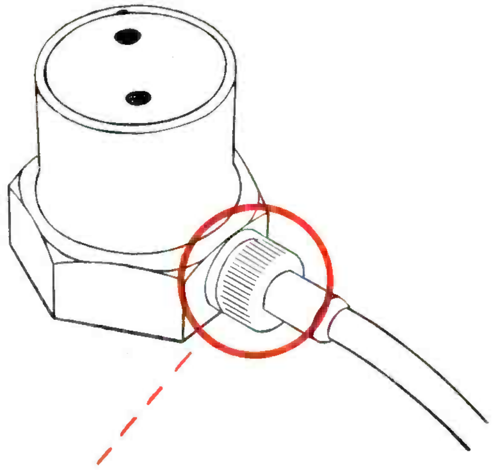
FIG. 1—Hybrid transformer circuit showing the effect of an open drop on the trans-hybrid loss

effect provides a stable voice-frequency transmission path between input and output terminals that may be adjusted to give an overall gain or loss as desired. The two one-way transmission paths together are known as the four-wire portion of the channel.

Carrier or radio channels must usually be connected to ordinary two-wire telephone circuits at both ends. If the sending and receiving circuits were merely connected in parallel to the two-wire circuits, part of the received speech would enter the sending circuit and travel around the circuit as circulating currents causing the circuit either to sing or be resonant and hollow sounding. A Wheatstone bridge or a differential-balance hybrid transformer circuit may be used to prevent this.

In either arrangement, the demodulator and modulator circuits are connected so that a null condition is obtained by balancing a dummy two-wire circuit against the real one. When balance is perfect no current can pass from the demodulator (oscillator or battery) to the modulator (detector or galvanometer). A Wheatstone bridge causes a 6 db loss, since the energy fed into it divides between four arms. A hybrid transformer circuit substitutes a pair of equal or differential windings for the ratio arms of a Wheatstone bridge, saving half of the energy loss. The output of the demodulator is divided equally between the drop and the balancing network. This reduces the theoretical loss to 3 db, but transformer losses usually raise the practical figure to 3.5 or 4 db.

This is the insertion loss to the



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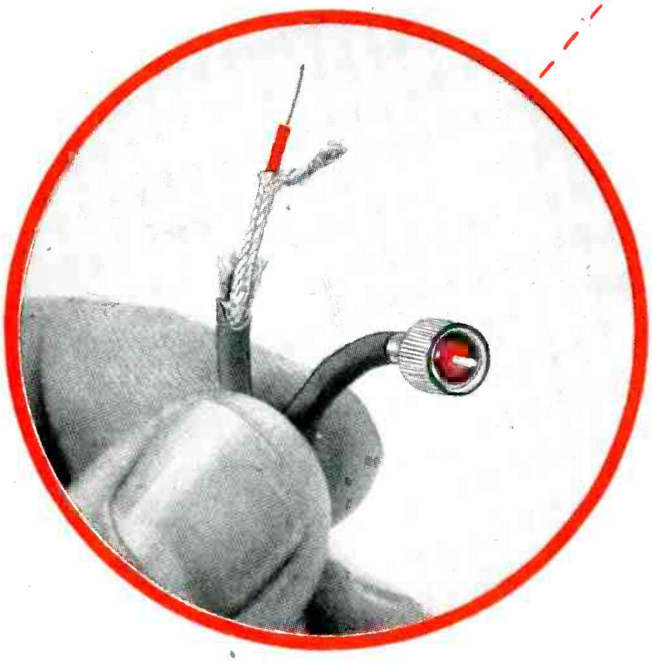

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speech currents passing through the hybrid circuit. Similar loss is introduced in the path from the drop to the input of the modulator, energy being equally divided between the modulator input and the demodulator output circuits. In passing over a channel from two-wire drop to two-wire drop, the speech currents pass through two hybrid circuits, with a total insertion loss of about 6 db. The four-wire circuit can be adjusted to obtain the desired overall net loss.

The null or balanced condition is reached only if equal speech voltages generated in the differential windings of the hybrid coil cause equal currents to flow in the drop and network circuits. This must be true for all frequencies that can pass over the four-wire portion of the circuit, usually a range of about 200 to 3,400 cps. Accurately matching the impedance of the actual drop over this frequency band requires a network including from three to five elements comprising resistance, capacitance and sometimes inductance. Such precision is seldom required except for hybrids associated with two-wire telephone repeaters where an overall two-wire gain up to 15 db or more must be obtained.

The impedance connected to the drop side of a channel hybrid through a switchboard may vary from an open circuit in the idle condition, to a few hundred or thousand ohms, including capacitance or inductance as well. Changing the network to match each different connection that might be made would be difficult, but if the channel is operated at an overall loss of several decibels or more the degree of balance is not critical. Circuits between switchboards may be operated with losses between 2 or 3 and 8 or 10 db, using a fixed network.

The effectiveness of the hybrid circuit in keeping the demodulator output out of the modulator input circuit is measured by its trans-hybrid loss. If the balance is perfect the loss is infinite; in actual practice it will be less. Worst balance usually occurs during idle condition when the drop circuit is marion

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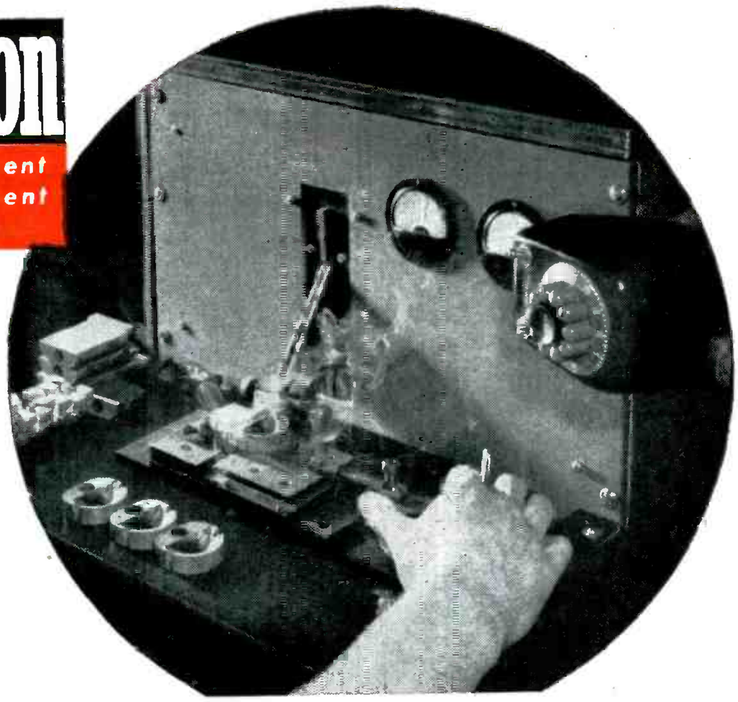

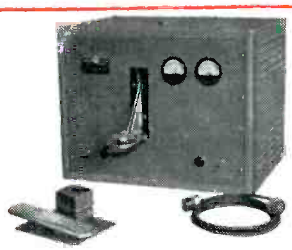

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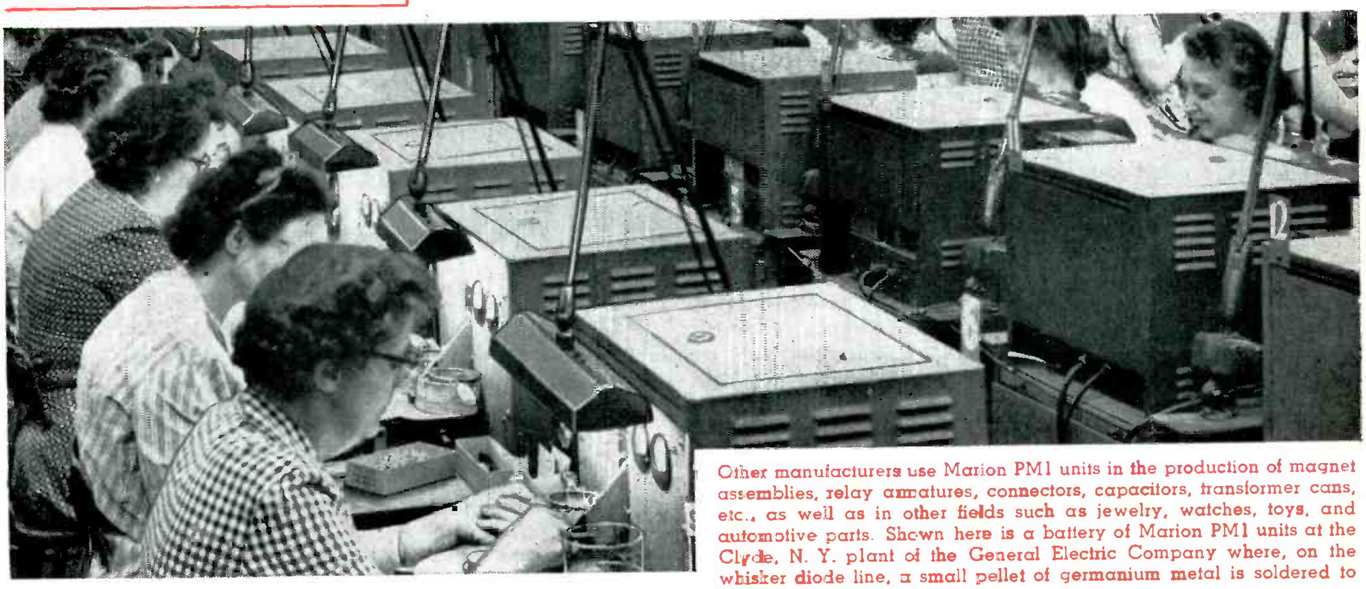

Other manufacturers use Marion PM1 units in the production of magnet assemblies, relay armatures, connectors, capacitors, transformer cans, etc., as well as in other fields such as jewelry, watches, toys, and automotive parts. Shown here is a battery of Marion PM1 units at the Clyde, N. Y. plant of the General Electric Company where, on the whisker diode line, a small pellet of germanium metal is soldered to the end of a nickel pin.

The Marion Model PM1 speeds up production, reduces costs and improves quality. Heat is generated within the work itself — even in parts otherwise inaccessible. Oxidation, scaling and damage to surface finish are minimized. Soldering of an entire seam or several jig-located parts at one time is readily accomplished.

This is an example of how Marion's belief in "Advancement in Instrument Design" has produced a production tool which not only improves Marion instruments but also provides other manufacturers with better soldering equipment. **Marion Electrical Instrument Company, 401 Canal Street, Manchester, N. H.**

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practically an open circuit. At this time energy entering the hybrid from the demodulator output tries to divide equally between the network and the drop, with a loss of 3 db. However, the open drop cannot absorb the energy and reflects it back into the drop windings of the hybrid. There it divides into two equal parts again, half going back into the demodulator branch and half going into the modulator circuit accounting for 3-db more loss. Thus the minimum transhybrid loss is about 6 db. With transformer losses, the figure will be nearer 8 db.

If the hybrid circuits at both ends of a circuit are unbalanced, a path exists for currents to circulate. If the sum of the net gains of the two sides of the four-wire portion is greater than the sum of the actual transhybrid losses of the two hybrid circuits, any sound starting around this path will increase in amplitude each time around resulting in a sustained oscillation. If the gains are slightly less than the losses, sounds will circulate for a long time, giving a hollow or mushy effect. If the gains are considerably less than the losses, circulating currents rapidly die out.

If the channel is adjusted for zero net loss, each side of the four-wire circuit will have a net gain of about 8 db, giving a four-wire loop gain of 16 db. This is just equal to the sum of the two transhybrid losses if both ends of the circuit are in the open-circuited idle condition. Thus the circuit is on the verge of singing, and will sound hollow. If the net loss is increased from zero to 6 db, the four-wire loop gain will be reduced by 12 db. The circulating current path now has a loss of 12 db, and will rapidly damp out circulating currents, resulting in a circuit virtually free from echoes.

For each decibel that the overall circuit net loss is increased above zero, the loss to circulating currents is increased two decibels. In the interests of stability and quiet operation, therefore, it is desirable to operate radio relay and carrier telephone channels at a fair overall net loss. A value of 6

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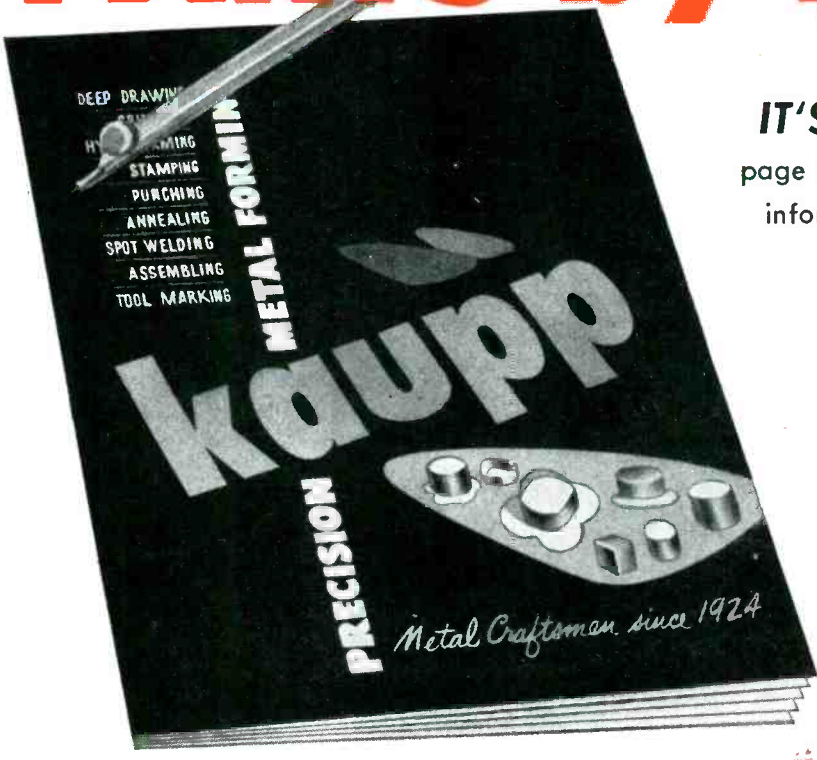

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to 8 db is generally quite satisfactory for use in average private communication systems.

To select the proper circuit net loss, several things must be considered. The microphone in a commercial telephone set gives considerable amplification. If two telephones are connected over a circuit with zero loss, the received speech will be very loud. Loss between telephones can be increased to 25 to 30 db or more if the circuit is not very noisy, and satisfactory conversations can be held.

In a private telephone system, where no telephone is very far from a switchboard, and where not more than two or three circuits will ever be used in tandem between switchboards, the net loss of individual circuits can be 6 to 8 db. Since this is in accordance with the desirable loss from a circulating current standpoint 6 to 8 db turns out to be the optimum range for such private systems. This avoids the need for adjustable balancing networks, and the overall performance of connections involving from one to three such circuits in tandem through switchboards will be quite satisfactory from a loss standpoint.

Ferrite Applications at Microwave Frequencies

By Dwight Caswell
Cascade Research Corp.
Los Gatos, Calif.

Utilization of the unusual high-frequency characteristics of ferrite materials makes it possible to build transmission lines that will transmit energy in one direction and not in the other, or have different electrical lengths when measured in opposite directions. Switches and variable attenuators can be built with no moving parts, as well as antennas that may be electrically scanned.[1]

The ferrites have high resistivity which classes them as dielectrics. They also exhibit the Faraday effect, characterized by a rotation of the microwave polarization when a magnetic field is applied in the direction of propagation or in the

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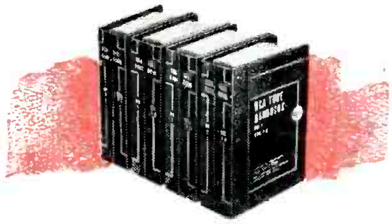

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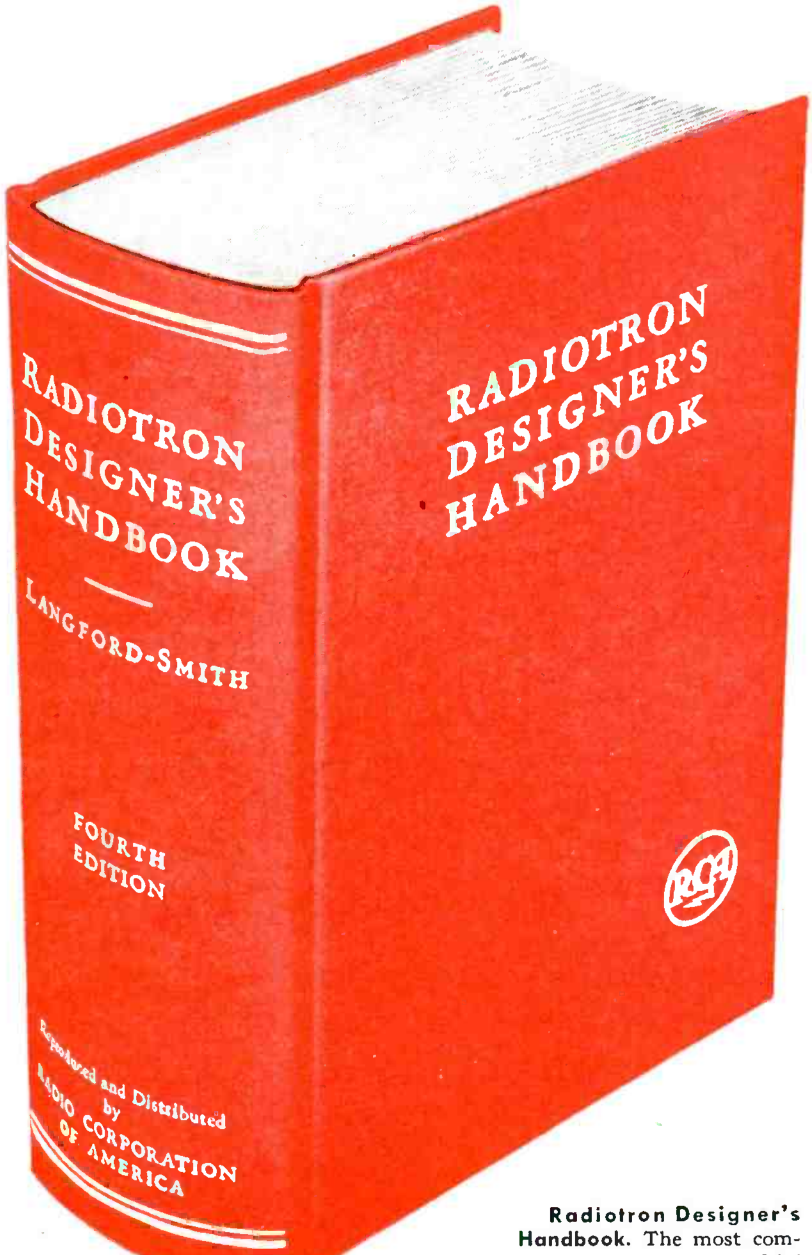

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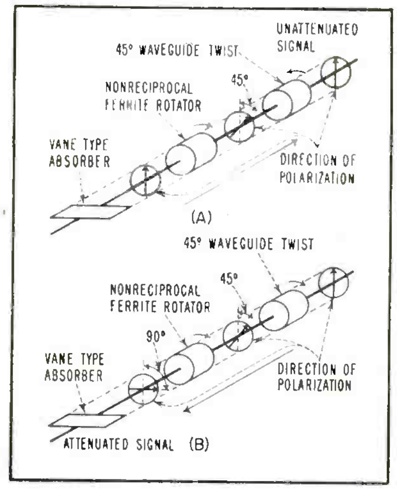


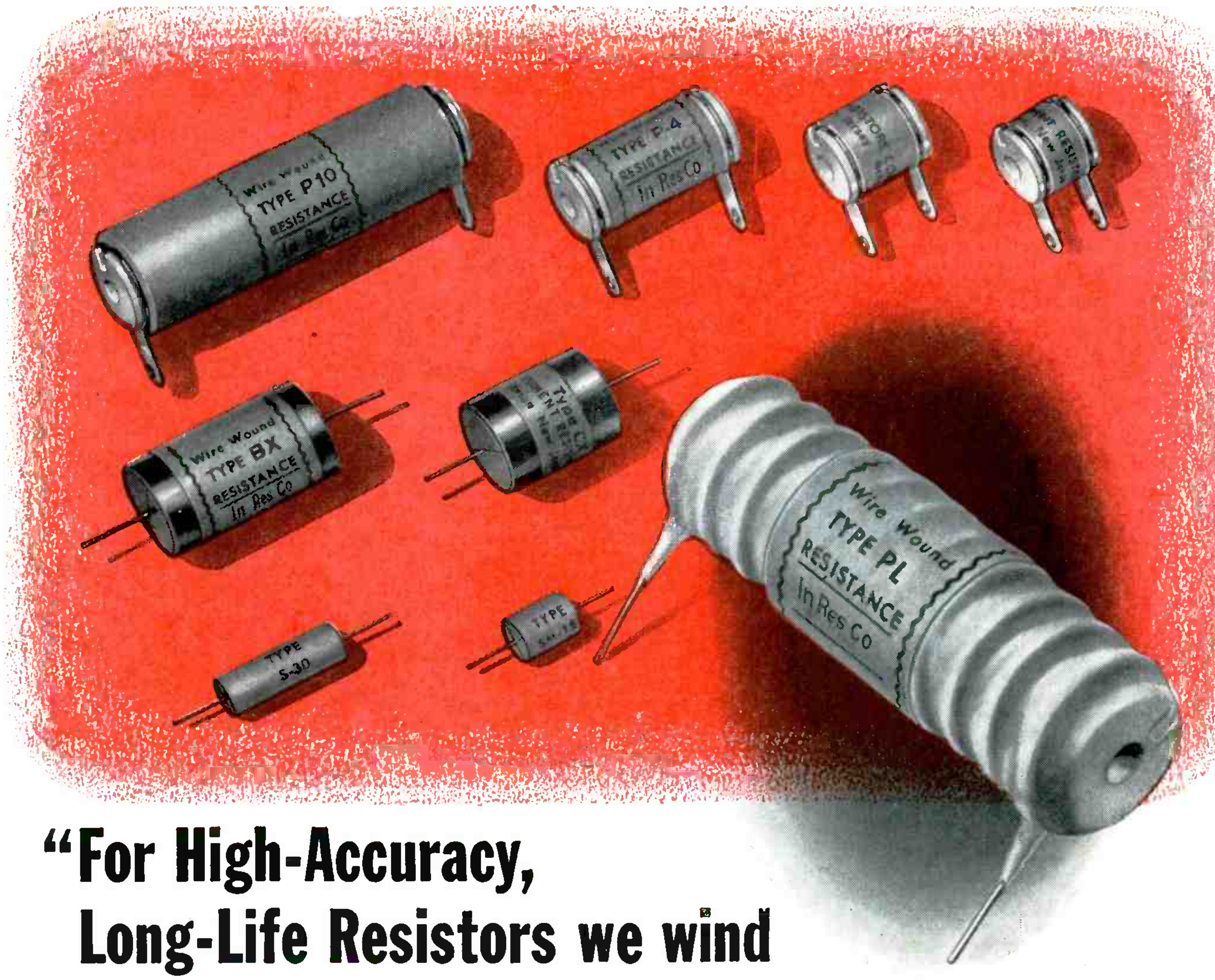
FIG. 1—Unidirectional transmission line uses nonreciprocal ferrite rotator to bring wave coming from unwanted direction, into line with wave type absorber

opposite direction. The rotation of the microwave field is determined by the direction of the magnetic field and is independent of the direction of propagation of the microwave energy. This is a non-reciprocal effect. In a reciprocal device, rotation of the microwave field is related to the direction of propagation rather than a direction in space. The amount of rotation is a function of the magnetic field applied to the material

The Faraday effect is caused by the interaction of electron-magnetic moments of the ferrite with the applied magnetic field. A plane-polarized wave passing through a material can be resolved into two circularly-polarized waves of opposite rotation. Normally the index of refraction of these two waves is the same, so they may be combined at any point and a plane wave of unaltered polarization is obtained. However, for materials exhibiting the Faraday effect, the index of refraction for waves propagated in the direction of the magnetic field is different for the two circularly polarized components. When these circularly polarized components are combined a plane wave will result, but the plane of polarization will be found to rotate as the wave progresses through the material.

Unidirectional Transmission Line

The rotation of a plane-polarized wave in a cylindrical waveguide is always in the same direction with



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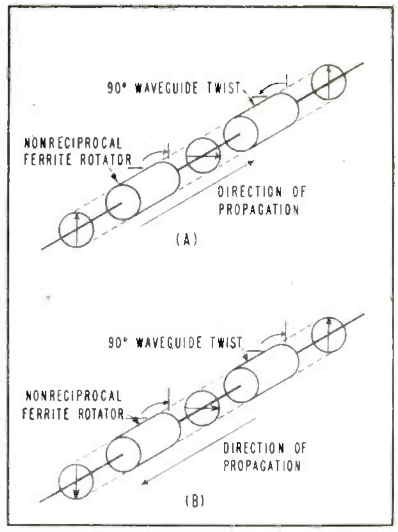

FIG. 2—Waveguide with ferrite rotator produces effect of longer electrical length in one direction by rotating wave 180 degrees

respect to the magnetic field, independent of the direction of propagation. This in shown in Fig. 1. A vane type absorber is located in the input end with the absorber lying in a plane perpendicular to the E-field of the input wave; in this position it does not absorb appreciable energy. The wave is then passed through a piece of ferrite located in the field of either a permanent or electromagnet that causes a rotation of 45 degrees. A transformer-to-rectangular waveguide or other output is provided at the second end at an angle of 45 degrees to the input. Energy is thus coupled out unattenuated. Energy traveling in the reverse direction, as shown in Fig 1B, is introduced into the cylindrical waveguide at 45 degrees to the input and is rotated an additional 45 degrees upon passing through the ferrite material. The E-field now lies in the plane of the absorber and is absorbed. This unit is particularly useful in isolating the load from a magnetron or klystron power source with essentially no power loss.

Microwave Gyrator

The gyrator is a microwave transmission line having an electrical length 180 deg longer in one direction than in the other. In construction it resembles the unidirectional transmission line except that the rotation introduced by the ferrite material is 90 degrees instead

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of 45 degrees and no absorber is required. Operation is shown in Fig. 2. A 90 deg twist is provided so that the flanges will have similar orientations. If the *E*-vectors entering and leaving the gyrator are in the same direction when the propagation is from left to right, they appear to be an integer number of wavelengths apart. If the propagation is from right to left, the directions of the *E*-vectors are opposite, hence the electrical distance appears to be an integer number of wavelengths apart plus 180 deg. The difference in the electrical length of the line as measured in the two directions is 180 degrees plus an integer, with the integer normally equalling zero.

Microwave Switch

Operation of the microwave switch is based on the rotation of the plane of polarization of the microwave energy as a function of the applied magnetic field. This is illustrated in Fig. 3. With no magnetic field, guide *A* is excited so that energy is propagated in this guide and not in guide *B*. If a magnetic field is applied such that the plan of polarization is rotated 90 degrees, then guide *B* is excited and energy is propagated in this guide rather than in guide *A*. Switching action is thus accomplished.

Microwave Modulator

The modulator is similar to the microwave switch except that an absorber is placed on the output of one of the guides. The output in the other guide may be modulated by varying the applied electromagnetic field. In actual practice a vane type absorber and a single-

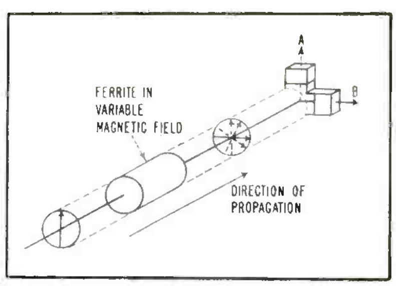

FIG. 3—Ferrite microwave switch rotates wave to selected guide, either *A* or *B*. Switch can be used as a modulator by varing the magnetic field producing the rotation

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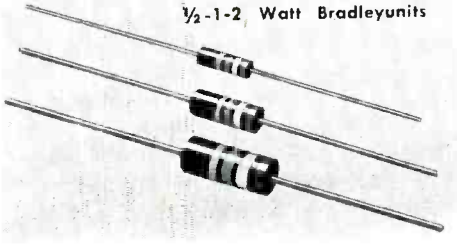

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output waveguide yields a simpler design. This may be used as a variable attenuator by controlling the magnetic field. It is thus possible to build a simple agc circuit at microwave frequencies. One of the advantages of modulation at microwave frequency is that a reflex klystron may be operated c-w and the output modulated. This eliminates the frequency modulation which occurs when a square wave is applied to the reflector.

A coaxial microwave modulator[2] may be built by using a ferrite as the dielectric in a coaxial line. A magnetic field can be applied to adjust the frequency of the resonant absorption to that of the propagated frequency thus controlling the loss introduced. This may be used as an on-off switch.

A microwave magnetometer[3] is similar to a switch or modulator except that the magnetic field is the unknown quantity and either the rotation or attenuation caused by the ferrite is measured. Continuous measurement of the magnetic field is possible. The output can either be read directly or used to control the magnetic field.

Electrically Scanned Antennas

The index of refraction of one circularly polarized component may be varied as a function of the applied magnetic field. This can be used to alter the phase of a received signal by varying the magnetic field applied to a ferrite. A microwave antenna may be scanned[4] by adjusting electromagnetic fields to produce phasing of the antenna elements, or a microwave switch may also be used to switch antenna elements.

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(1) C. L. Hogan, The Microwave Gyrator, *Bell System Technical Journal*, 31, p 1, Jan. 1952.
(2) Frank Reggia and Robert W. Beatty, Characteristics of the Magnetic Attenuator at UHF, *Proc. IRE*, **41**, No. 1, p 93.
(3) P. J. Allen, A Microwave Magnetometer, *Proc. IRE*, **41**, No. 1, p 100.
(4) N. G. Sakiotis, A. J. Simmons, and H. N. Chait, Microwave-Antenna Ferrite Applications, ELECTRONICS, **25**, p 156, June 1952.

Microwave Frequency Standards

STANDARD FREQUENCIES in the microwave region are obtained at the National Bureau of Standards by frequency multiplication of the

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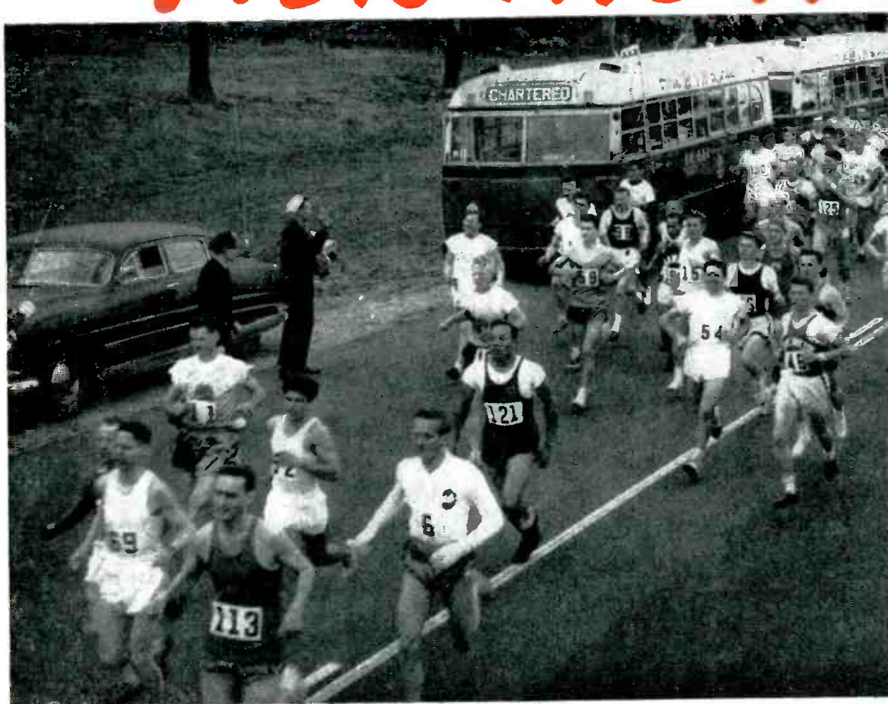
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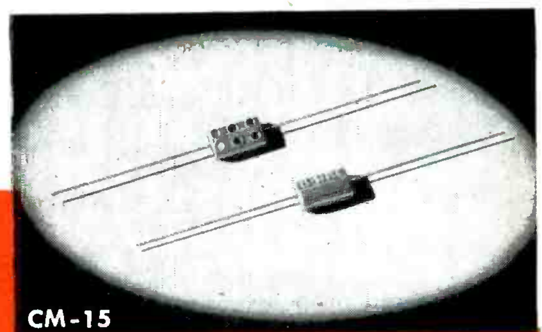

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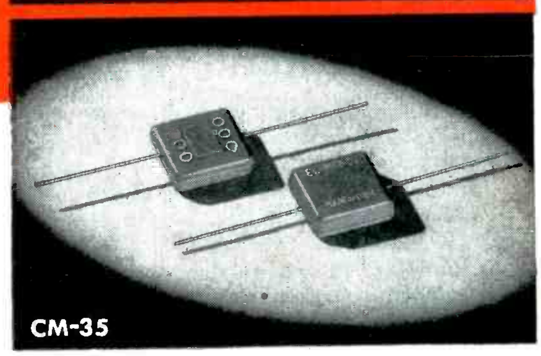

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signal from 100-kc oscillator used as a time and frequency standard. The frequency of this oscillator is measured to better than one part in a billion by comparison with other standard oscillators and astronomical observations made at the Naval Observatory.

The 100-kc oscillator, using a Meacham bridge circuit, has a short-time stability of one part in 10^{10} and a long-time stability of 10^{9}.

Two multiplying systems are used to obtain the high-frequency standards. As a variable standard conventional tube circuits yield frequencies up to several hundred megacycles. For frequencies up to 25 kmc, klystron multipliers are used. Beyond 25 kmc the standard frequencies are obtained by crystal-rectifier harmonic generators. The desired frequency is selected through transmission cavity filter.

Fixed-Standard Method

The fixed-frequency standard, the second method used, gives a higher output than the variable standard but sacrifices versatility. The signal is obtained by mixing a number of standard frequencies. The strongest signals are obtained at the following mixing combinations: 10-mc intervals through 5,000 mc; 50-mc intervals through 25,000 mc; and 250-mc intervals through 40,000 mc. The klystron amplifiers and multipliers used are placed in a temperature-regulated oil bath and are operated well below their ratings in order to obtain good power stability and long life.

When relatively high power outputs, on the order of one milliwatt, are needed, c-w klystron oscillators are synchronized with the standard oscillator. There is some loss of precision with this method.

In calibration of secondary standards the signal from the primary standard and the output of the secondary standard are applied to a crystal-diode mixer that generates all the sum and difference combinations of the signals inserted. The signal wanted is selected by a tunable transmission filter. The resulting intermediate frequency is fed to a spectrum analyzer and the matching sections are adjusted for maximum signal strength.

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Production Techniques

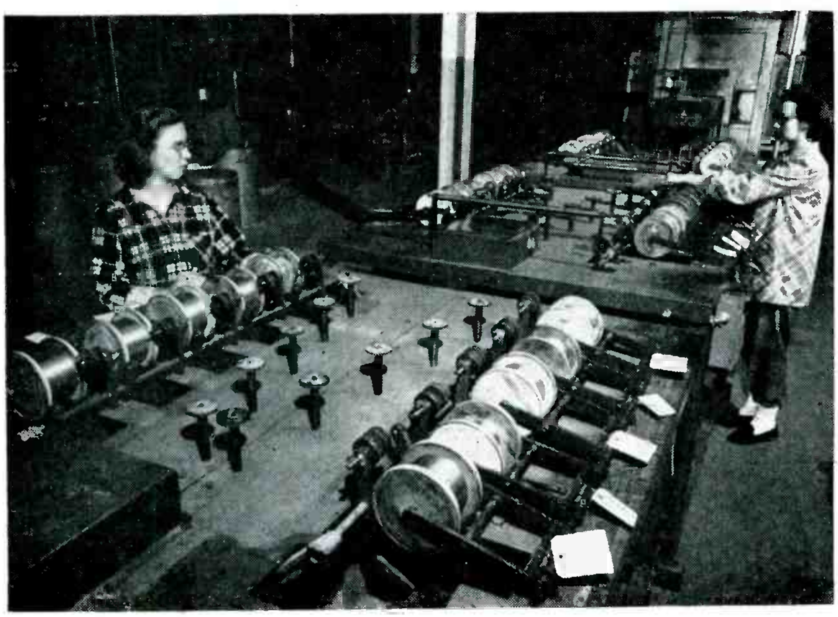
Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

Annealing Nickel-Clad Copper Wire

CONSTANT WIRE SPEED through an electric annealing furnace is achieved by using rubber-covered pulleys for direct friction drive to the wire on the takeup spools, in an annealing setup at Sylvania's Warren, Pa. plant. The wires are pulled through the furnace from racks of 30 reels at the input of the furnace, which maintains a hydrogen atmosphere at 1560F for heat treatment of 0.01-inch diameter nickel-clad copper wire used in tube manufacture.

The rubber-covered wheels, approximately the size of automobile wheels, are located under the work table and are on shafts driven through gear reducers by variable-speed drives. The takeup spools are directly above, and individually pivoted. The spools rise as they fill, but always turn at constant speed because the rubber tire of the driving wheel is bearing against the wire on the spool. A traversing head in front of each spool is worm-driven from the main drive shaft; these heads therefore oscillate to wind the wire back and forth.



Constant-speed wire-pulling arrangement for spooling 30 individual wires simultaneously after annealing in furnace in background

Assembling for Dip-Soldering

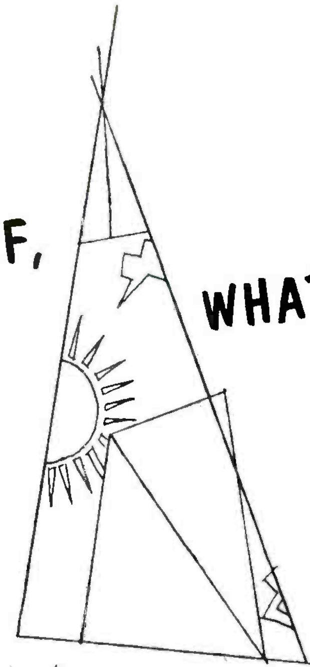
TO GUIDE OPERATORS who insert leads of component parts in the tubular terminals of the dip-soldered subassembly used in some GE

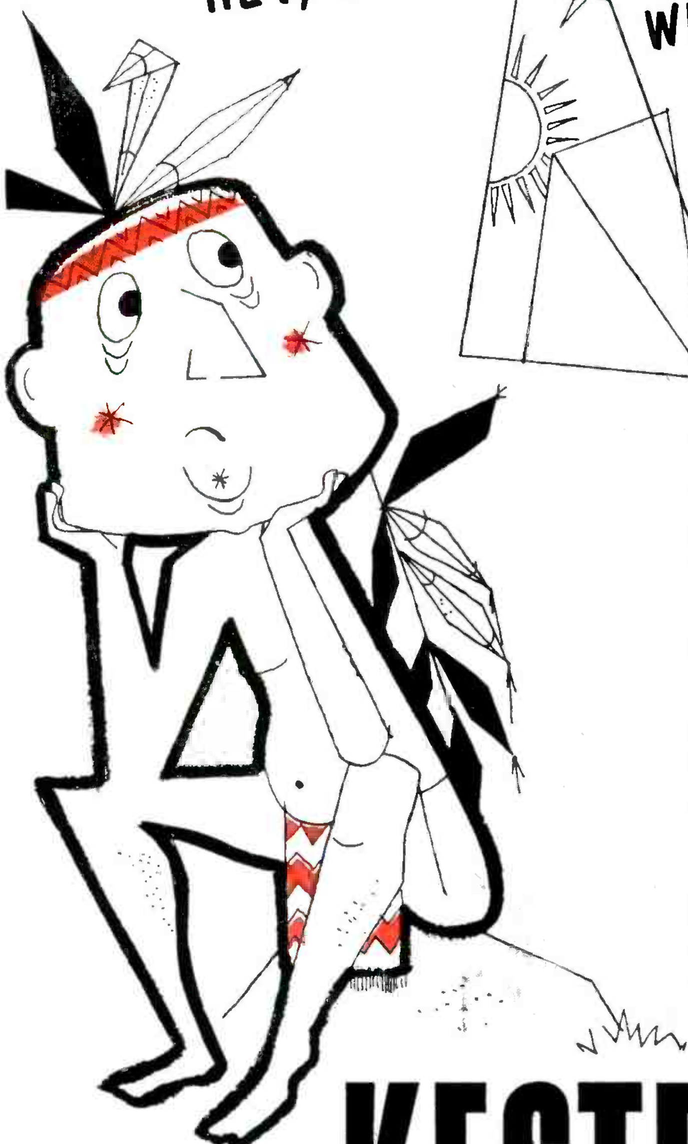
Inserting small parts in panel set into metal carrier on moving conveyor line. Sample panels hang from overhead wire. After all parts have been inserted, conveyor brings panel over pool of molten solder, and air cylinders bring up solder pot to solder all joints simultaneously

television receivers, a sample panel is kept in front of each work position. Only the parts that are to be inserted at a particular position are mounted on the sample panel.

A stranded steel cable running the length of the assembly line just over the heads of the operators serves to support the panels, as well as schedule cards and other records applying to the job that is on the line. Wide spring steel paper clips slide along this line and serve to

HEY, CHIEF, WHAT'S A WIGWAM WITHOUT WAMPUM?





Whether it's shells or beads – or good old American dollars, for that matter – you just can't operate successfully without showing a profit. That's why so many progressive companies depend on Kester quality and performance to insure maximum results in production at the lowest possible cost. And we'll bet Kester Solder can mean more "wampum" in *your* "wigwam," too!

An engineered adaptation can be made to your specific requirements with Kester "44" Resin, "Resin-Five" or Plastic Rosin-Core Solder . . . varied core sizes or flux-contents are available in many different diameters.

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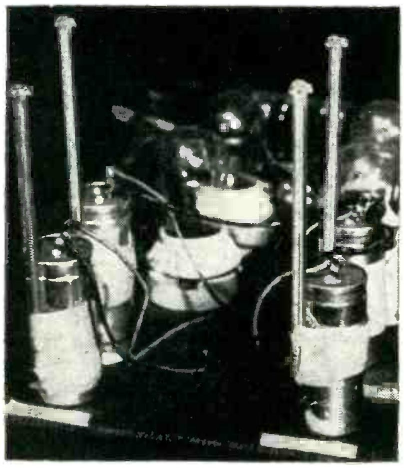
grip either panels or cards.

Since the leads of most parts have been cut and preformed in preliminary operations, operators are able to insert parts rapidly. To facilitate reaching for parts, special metal parts bins with larger openings are used on the mechanized dip-solder assembly lines.

Taking Temperature on Life Runs

TO OBTAIN temperature readings conveniently during life tests of a-c motor-starting capacitors, ordinary glass thermometers are fastened to the capacitor housings with masking tape. Each thermometer is positioned for maximum ease of reading before being taped.

In this particular test, full 115-volt a-c line voltage is applied for ½ second every half minute. A two-watt neon lamp is connected to each capacitor to serve as a failure indicator in the East Newark, N. J. plant of Astron Corp.



Taking temperature of capacitors on life runs with taped-on thermometers

Moth Balls Protect Silver-Plated Cavities

TO PREVENT SILVER-PLATED component parts of r-f coaxial tuners from tarnishing during pre-assembly storage, Motorola Inc. of Chicago packs standard home-variety paradichlorobenzene moth balls in the closed containers used for the parts. Unless protected, the heavily silver-plated parts would tarnish quickly upon exposure to an industrial atmosphere containing gases of sulphur-bearing fuels. Tarnish interferes with efficient soldering by induction soldering units.

The necessity of replating the tuned cavities for appearance after soldering is eliminated by keeping the component parts within the vapor of the moth balls. Immediately following the soldering and assembly a protective lacquer is applied. If applied before soldering, this lacquer would interfere with soldering.

Transferring silver-plated cavities from moth balls to soldering fixture built around work coils of induction heater controlled from pushbutton station at right on bench. Finished units go into vhf two-way radio tuner in operator's left hand

Masking Capacitor Ends for Molten-Metal Spray

TO PROVIDE a solid metallic surface to which connecting leads can be soldered, the ends of metallized

Applying masking tape to prevent sprayed molten metal from entirely covering ends of metallized paper capacitor units. Simple wood stand on bench, anchored by weight of solder spool, supports rolls of tape

paper capacitor units are sprayed with molten metal. Since impregnating compound must be able to penetrate between the layers of foil in a subsequent process, it is necessary to leave a portion of each end exposed.

This problem is solved at the Pyramid Electric Co. plant in North Bergen, N. J. by the use of masking tape. Before being sprayed with metal, the capacitor bodies are placed in a box-like band of corrugated cardboard so that both ends of the bodies are accessible. Pieces

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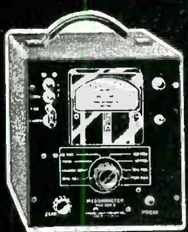
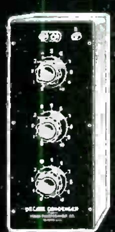
Low Frequency "Q" Indicator



No. 1020B
Megohmmeter



Decade Inductors

No. 1040
Vacuum Tube Voltmeter

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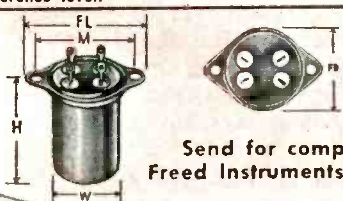
PROFESSIONAL MINIATURE AUDIO TRANSFORMERS

These high quality, miniature transformers feature hermetic sealing for maximum protection from moisture penetration with subsequent electrolysis and corrosion of fine wires. While primarily intended for non-military equipment, these units are constructed in accordance with MIL-T-27 Specifications.

CATALOG NO.	APPLICATION	IMPEDANCE LEVEL OHMS PRIMARY	IMPEDANCE LEVEL OHMS SECONDARY	MAXIMUM POWER LEVEL V.U.*	RATIO	MAX PRI DC PER SIDE Ma.	D.C. UNBAL. Ma.	FREQ. RESPONSE C.P.S.	CASE NUMBER
PMA 1	Line or microphone to single or push-pull grids	50/ 200/ 500	60,000 C.T.	+8	1:11	0	0	±2.0 DB 30-20000	DM-12
PMA 2	Dynamic microphone or speaker voice coil to single or P.P. grid	4/8	60,000 C.T.	+8	1:86.6	0	0	±2.0 DB 30-20000	DM-12
PMA 3	Line or microphone to single or push-pull grids. Magnetically shielded.	50/ 200/ 500	60,000 C.T.	+8	1:11	0	0	±2.0 DB 30-20000	DM-12
PMA 4	Single triode plate to single or push-pull grids	15,000	60,000 C.T.	+8	1:2	0	0	±2 DB 30-10000	DM-12
PMA 5	Single triode plate to push-pull grids	15,000	60,000 C.T.	+8	1:2	2	2	±2 DB 200-10000	DM-12
PMA 6	Single triode plate to multiple line	15,000	50/200/500	+8	5.48:1	0	0	±2 DB 30-20000	DM-12
PMA 7	Single triode plate to multiple line	15,000	50/200/500	+8	5.48:1	2	2	±1 DB 200-10000	DM-12
PMA 8	Push-pull triode plates to multiple line	30,000 C.T.	50/200/500	+8	7.75:1	2	0.25	±2 DB 30-20000	DM-12
PMA 9	Crystal mike or pickup to multiple line	60,000	50/200/500	+8	11:1	0	0	±2 DB 30-20000	DM-12
PMA 10	Mixing or matching	50/200	50/200/500	+8	1:1.50	0	0	±2 DB 30-20000	DM-12
PMA 11	Parallel Feed Reactor	40 hy.	3 ma dc,		3500 ohms D.C. resistance				DM-12

* 1 mw. reference level.



DM-12 CASE DIMENSIONS

FL - 1 1/2
FD - 1 1/32
W - 15/16
H - 1 15/32
M - 1 7/32

Screws - 4-40
Cut out - 7/8
Wgt. - 1.5oz.

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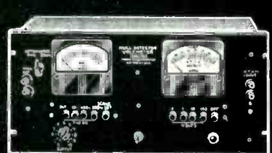
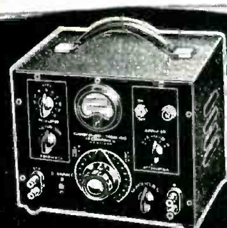


No. 1210
Null Detector & Vacuum Tube Voltmeter



No. 1010
Comparison Bridge

No. 1110A
Incremental Inductance Bridge

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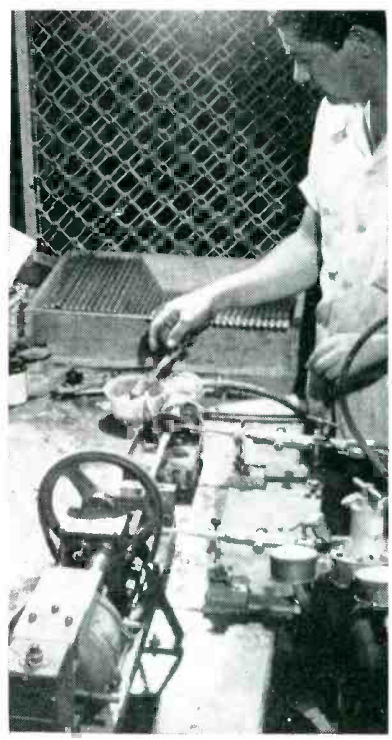
of rolled cardboard are used to fill out empty spaces and prevent the molten metal from getting on the sides of the bodies. The box is then set on a wood jig that supports it at an angle within easy reach of the operator. Strips of quarter-inch masking tape are placed across the ends of the capacitors in such a way that a strip goes across the center of each end. The strips are anchored to the sides of the box, and are easily pulled off after spraying.

Water-Cooled Setup for Silver Brazing

AN IMPROVISED LATHE driven by an electric motor rotates a length of copper tubing slowly during the operation of silver- brazing brass ferrules to the ends of the tubing. Water-cooling arrangements prevent heat from traveling far in either direction from each joint.

In the operating procedure devised by Weller Mfg. Co. for its



Setup for brazing ferrules for copper tubing. Air cylinder at tailstock end of lathe is operated by foot pedal to move tailstock in and out for easy loading and unloading. Operator applies silver solder flux with inexpensive paint brush while tubing is rotating slowly under the flames of the two acetylene torches, which can be swung out of the way when the desired flow of solder occurs

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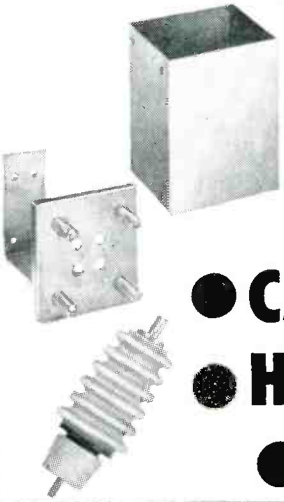

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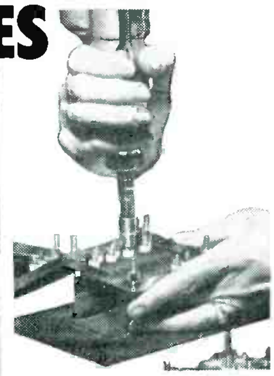

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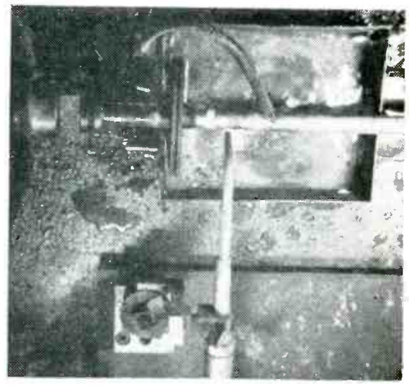


Headstock end of lathe, showing torch in foreground and stream of cooling water directed onto copper tubing at right of flame. Aluminum wheel rotating in water at left of flame cools end of brass ferrule, to prevent internal threads from oxidizing

plant in Bayamon, Puerto Rico, the operator assembles the brass ferrules and ring-shaped silver solder preforms on a length of tubing, inserts the tubing between aluminum discs on the headstock and tailstock of the lathe, then applies silver solder flux to each joint with a brush as the joints are heated by oxyacetylene torches. The discs rotate in pans of cold water and thereby serve to draw heat away from the ferrules. An electric motor drives the lathe through a gear box and speed-reducing belt.

The water-cooling arrangement is used to prevent the intense heat of brazing from discoloring the ferrules and tubing, and to prevent the internal threads of the ferrules from oxidizing. A stream of cold water is directed at each end of the copper tubing about an inch away from its torch flame. Thus, at each joint an aluminum disc keeps the ferrule end cooled on one side of the flame and the water stream cools the tubing on the other side of the flame.

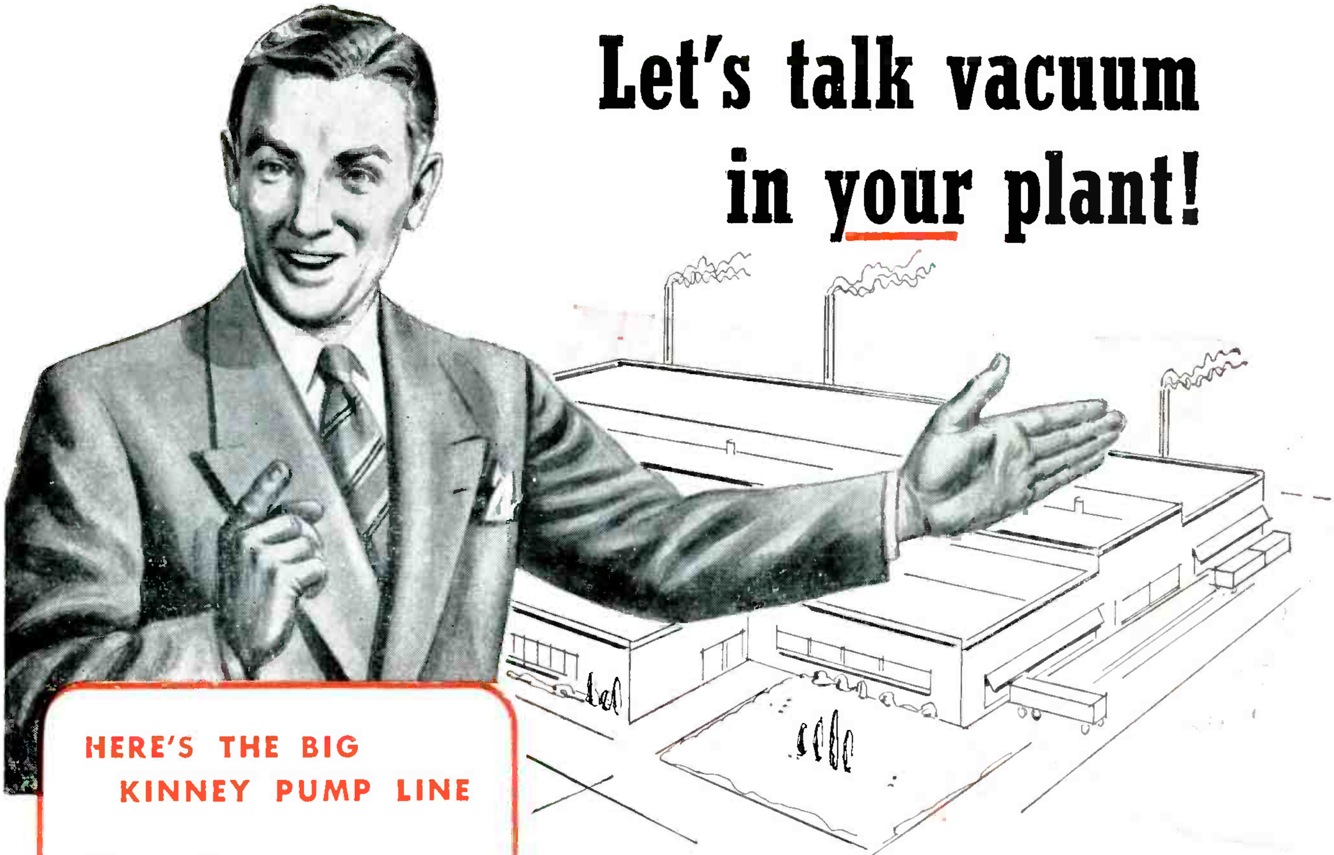
After brazing, the tubing is bent to form the single-turn secondary winding for the Weller soldering gun.

Cable Cutter

MULTIPLE-CONDUCTOR cable is cut precisely to correct length with an Amphenol-recommended procedure that permits quick readjustment to any other length.

On the front of the bench allo-

Let's talk vacuum in your plant!



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Model DVH 27.20.34	1800 CFM
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Model DVD 14.9.18	311 CFM
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Model DVD 8.8.10	110 CFM
Model VSD 8.8.11	52 CFM
Model VSM 7.7.8	27 CFM
Model VSM 5.5.6	13 CFM

Compound

Model CVM 8.6.10	46 CFM
Model CVM 5.5.6	15 CFM
Model CVM 3534	5 CFM
Model CVM 3153	2 CFM

There's a qualified Kinney Vacuum Engineer in your region, ready to talk vacuum in *your* plant. Call on him. See how the BIG LINE . . . the *Kinney* line of vacuum pumps can be profitably used in exhausting lamps and tubes, freeze-drying pharmaceuticals and antibiotics, vacuum metallizing, vacuum production of titanium and other miracle metals, vacuum fumigation and impregnation — and in the countless other ways vacuum serves industry today. Kinney Manufacturing Co. — manufacturers of vacuum and liquid pumps. Boston, New York, Chicago, Detroit, Cleveland, Atlanta, Pittsburgh, Philadelphia, Los Angeles, Charleston (W. Va.), Houston, New Orleans, San Francisco, Seattle, and foreign countries.

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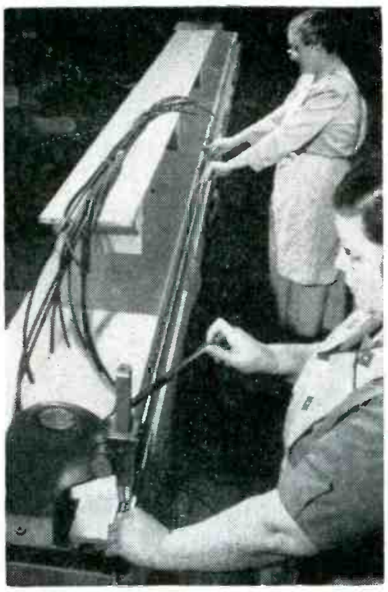


Cutting multiple-conductor cable with arbor press while second operator holds end of cable against stop in precision length-measuring trough

cated for cable cutting is a V trough consisting of a length of angle iron as long as the longest cable to be cut. A section of steel tape measure is bolted to the inside of this trough to provide an accurate, easy-reading length scale for the operators.

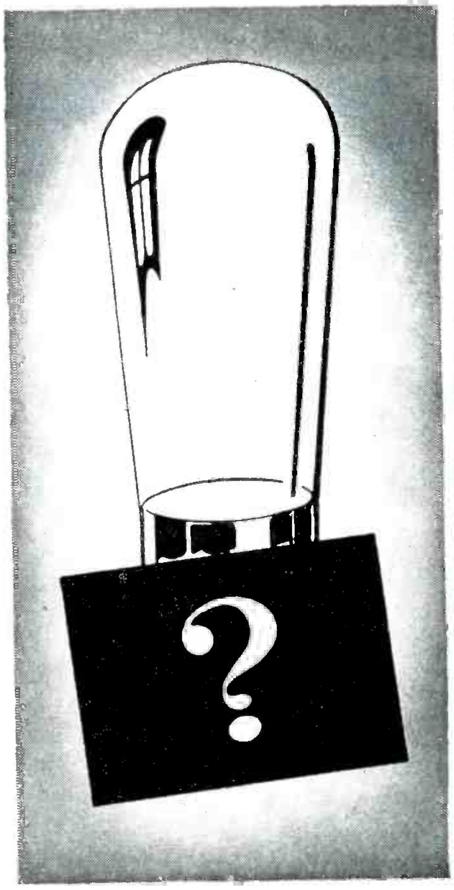
An adjustable cable stop is so machined that it slides freely on the trough but comes down over the outer sides and hence cannot be lifted off. A locking lever-handle screw pushes a V-shaped solid metal stop against the inside bottom of the trough to lock the stop in position at the desired point.

Two operators are needed for this cutoff arrangement. One runs the cable into the trough from a reel off to the left. The other brings this cable up to the stop and holds it there, after smoothing out any irregularities so the cable lies flat in the bottom of the trough. The first operator now operates a modified arbor press having a slicing blade that gives smooth, precise cutoff of the cable at the desired point.

Visual Inspection of Mica

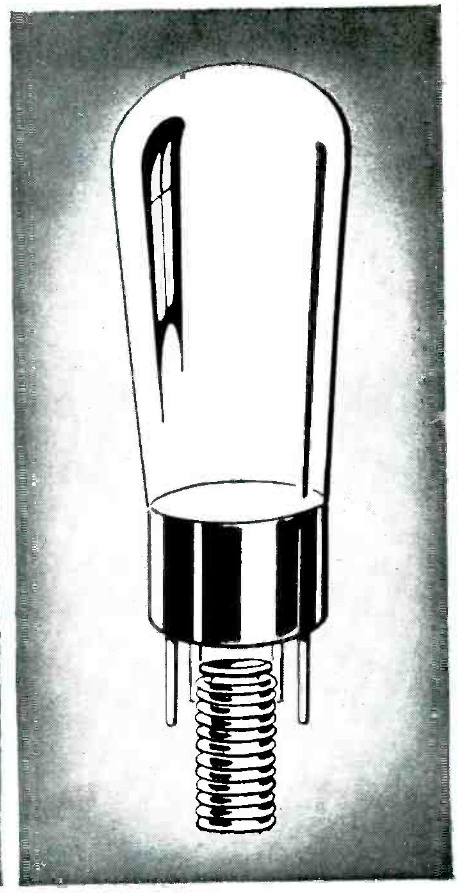
A SINGLE SYLVANIA 14-WATT daylight fluorescent lamp mounted under a sheet of frosted glass serves as an inspection table for detecting defects in punched mica

IDEAS that started in a BELLOWS



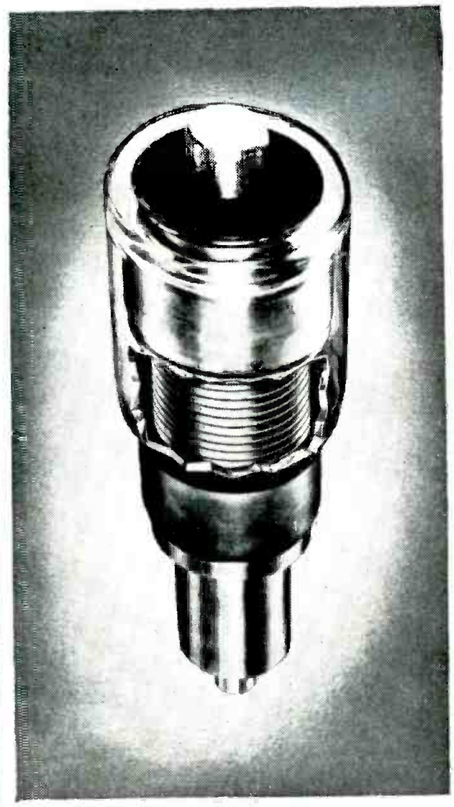
ONCE THOUGHT IMPOSSIBLE

How to reach into a high vacuum tube without breaking the seal — once stumped many an engineer.



NOW "STANDARD PROCEDURE"

Today Clifford supplies a whole line of bellows to make a wide range of adjustments and settings inside a vacuum.



AND HERE'S THE ANSWER

Moving variable plate inside vacuum capacitor was the problem solved through the use of Clifford Hydron bellows assemblies by Jennings Radio Manufacturing Company. Being leakproof and flexible, Clifford Hydron bellows form a perfect seal for the vacuum while permitting full movement of the variable plate.

Have you ever worked with Bellows?

"Bellows" haven't been in the engineering courses — but they have helped to solve some of today's knottiest engineering puzzles.

Clifford Hydron Bellows make flexible hermetic seals, permit extension, retraction and 360° rotation with 100% metallic seal.

In the electronic field Clifford Hydron Bellows are used for changing frequency inside magnetron tubes, making adjustments inside hermetically-sealed instruments, moving variable plates inside vacuum capacitors. They are also being used as expansion chambers in mercury-filled wave guides, oil filled transformers and other electronic and electrical equipment.

Clifford Bellows come in monel, stainless steel and other metals having very low gas transmission and emission properties. They are assembled to meet individual requirements. Coupon will bring you additional information.

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spacers for tubes. The glass is set over a hole cut in the bench, with the lamp mounted about four inches below the glass under the bench, in the arrangement used by Sylvania Electric of P. R. Inc., Rio Piedras, Puerto Rico.

Frosted glass illuminated from below permits inspection for defects just as fast as operator can separate mica spacers with her nimble fingers

Applying Cement and Pitch

ENDS of tubular paper capacitors are sealed with creamy white cement at high speed in a special filling setup at Pyramid Electric Co., using 60 to 80 lb air pressure

Squirting cement into ends of tubular paper capacitors with high-pressure cement gun. Racks are inverted for filling other ends of units

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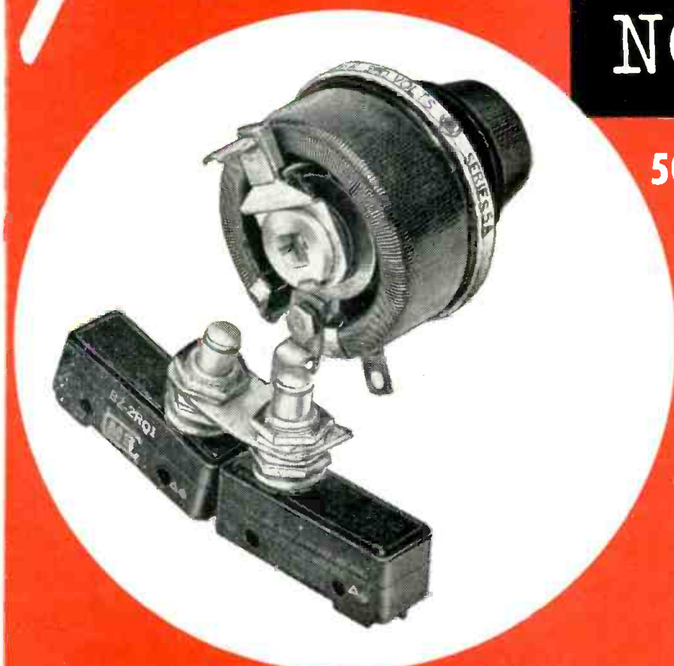
NOW Available!



50 watt - 75 watt - 100 watt - 150 watt
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★ off positions
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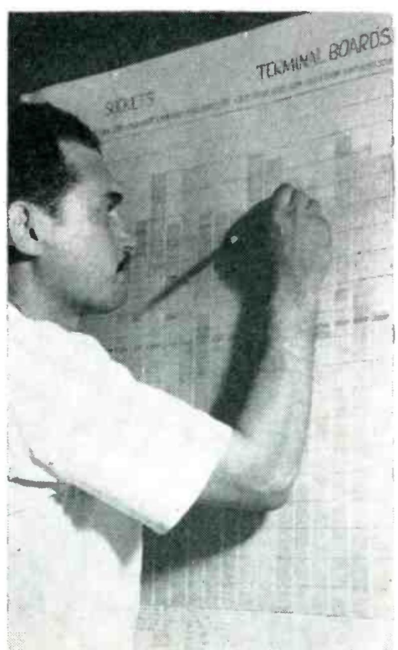
to force the cement out of the nozzle of a trigger-operated gun. The operator can aim and control the cement flow precisely, making it easier to fill the end of each unit completely and smoothly without overflow.

Capacitors are prepared for cementing by inserting empty cardboard tubes between the two wood strips of the rack, then tightening wing nuts just enough to hold the tubes in position. This loading is done over a jig that centers the tubes lengthwise. At another position, an operator inserts a rolled capacitor unit in each tube and bends its leads over metal rods. This insures that the rolled units will stay in place when the loaded rack is turned over for filling the other end of each capacitor. The pressure tank utilizes air from the master air pressure system of the plant.

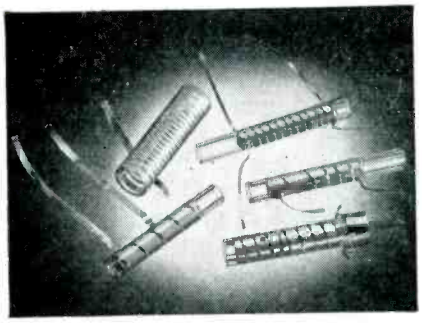
Production Control Chart

WHEN DAILY PRODUCTION of each subassembly for a large electronic system is plotted on a vertical bar-type chart, subassemblies that are lagging behind the production schedule can be seen at a glance. The lowest bar also serves to tell

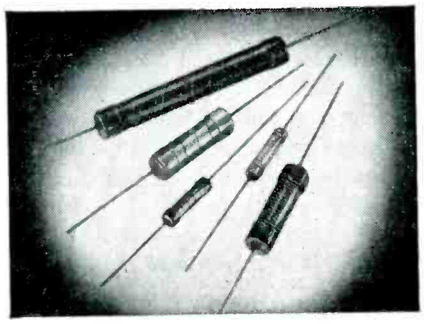


Foreman Victor Berlingieri increases height of bar for terminal board No. 5535 with blue pencil, to incorporate previous day's production of this unit of a military radar system

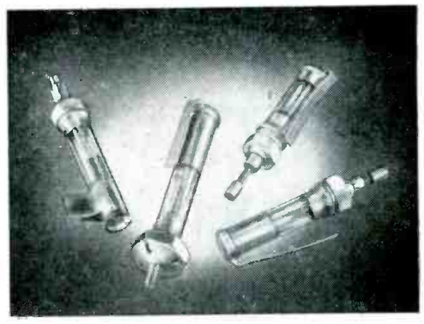
Are you overlooking the advantages of Corning metallized glass components?



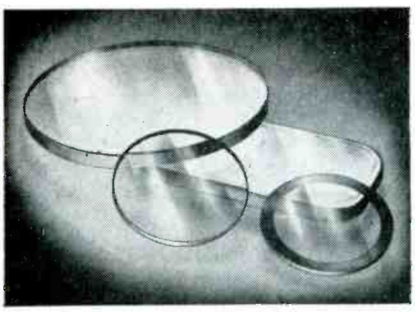
Corning Metallized Glass Inductances are noted for their exceptionally high electrical stability and negligible drift characteristics, even under widely variable ambient temperatures. High Q is inherent. They can be furnished with uniform, variable, or double-pitch windings and for fixed tuned, permeability tuned, or permeability tuned inductance trimmer combinations. They can be duplicated within very close tolerances in any quantity.



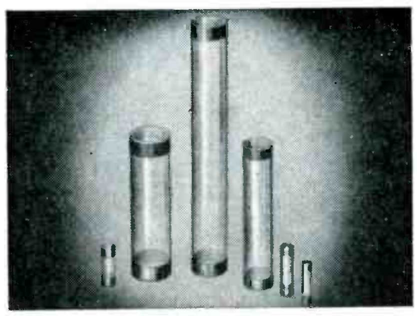
Corning Film-Type Resistors afford a tough unit with unusual stability and capable of withstanding high ambient and high operating temperatures. Type N has a resistance tolerance of 1% and is capable of operating at ambient temperatures up to 140° C.; Type S has a normal resistance tolerance of 2% and is capable of operating at ambient temperatures up to 200° C.



Corning Metallized Glass Midget Trimmer Capacitors have practically zero temperature coefficients in the VHF range. Capacity shift is negligible even with widely variable ambient temperatures. They are available in standard types from .3 to 12 u.u.f., or can be designed to meet your specific requirements. With direct traverse trimming, there is negligible capacity shift under vibrations, and an absolutely smooth capacity curve.



Corning Metallized Glass Instrument Windows are made of tempered glass with a metallized band on the edge. They are easy to solder, provide a perfect hermetic seal. Temperature and humidity changes resulting from leaks in gaskets, cements and oils are virtually eliminated. These windows are available in a number of standard sizes, or can be furnished to your specifications.



Corning Metallized Glass Tubes for hermetic encasement of capacitors, resistors, Selenium rectifiers and other electronic components offer a number of advantages. The metallizing makes possible a true hermetic seal, the electrical characteristics of the glass are excellent, transparency permits visual inspection, units are impervious to moisture, corrosive atmospheres, molds, etc. Available in 15 sizes ranging from 1½″ to 7″ in length, O.D. 15″. I.D. .295″.

Corning Metallized Glass Bushings and Standoff Insulators are ideal for high voltage applications. The bushings provide hermetically sealed insulators for high-voltage capacitors and transformers, are available in 12 standard sizes ranging from 25/32″ to 7/32″ in length. Installation is fast and easy. The standoff insulators are made of tempered, low-loss glass, are completely nonhygroscopic. Both these components can be furnished in special sizes on order.

It will pay you to investigate the possibilities of Corning Metallized Glass Components. The coupon below will bring you the detailed information you need, or write and give us the details of the application you have in mind.

Corning Glass Works

New Products Division

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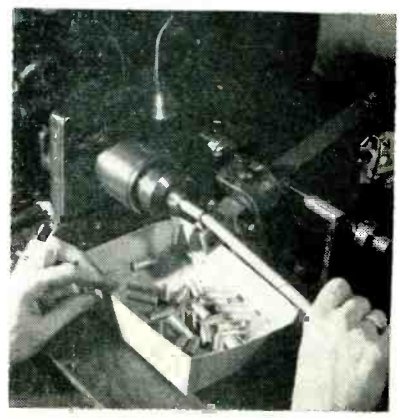
how many complete systems can be turned out with the subassemblies already produced.

In the plant of Caribe Aircraft Radio Corp. in Coamo, Puerto Rico, this type of chart is mounted on a large piece of plywood fastened to the end of one of the assembly lines. As soon as production figures for the day are available, the foreman increases the heighth of the bar for each subassembly in accordance with the number of subassemblies produced during the working day. The height of each bar then represents the total number of units produced to date.

Cutting Metal Tubing for Capacitor Housings

Two methods of cutting metal housings for hermetically-sealed tubular capacitors are employed at the plant of Pyramid Electric Co. One method, used when trimming



Improvised lathe for cutting metal tubing to size for capacitor housings. Pressure of cutting tool makes arbor rotate tubing which is loosely held by right hand of operator

drawn cap-shaped housings to length for single-lead capacitors, employs an ordinary metal-working lathe and a disk-type cutoff tool. An arbor, grooved to the shape of the cutting blade, is mounted in the headstock of the lathe. The drawn brass housing is placed over the rotating arbor with the closed end firmly against the end of the arbor. The cutoff disk in the tool holder is then brought forward by depressing a foot pedal to cut off the excess metal. Pressure of the cutting tool against the housing

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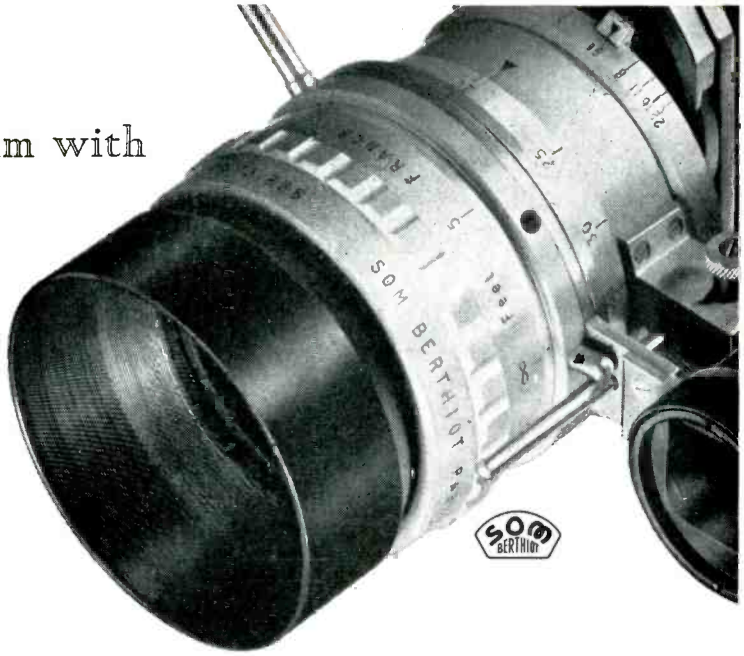

For broadcast TV . . . Industrial TV . . . open or closed circuits . . . more stations and industries are discovering the tremendous savings possible with this versatile lens!

Introduced a year ago, it has been a godsend to every budget-conscious purchaser.

At last the small station TV cameraman can *follow* action . . . *hold* action . . . *create* action and a virtually unlimited variety of special effects from one camera position! Rock-steady pictures are assured because dolly-ins are done optically. Zooming-in for close-ups is a 'must' in TV commercials. With the Pan Cinor, just a touch of the turret lever . . . and you're in!

The industrial user training his camera on factory operations or demonstrations can re-direct his attention from close-up to telephoto from a flat-footed stance. RCA reports most focusing can be remotely controlled automatically, and Dage assures us they can operate the turret lever by push-button if desired.

In addition . . . the Pan Cinor has a standard "C" mount . . . it fits not only the Dage and RCA TV cameras, but can be used on a majority of the 16mm movie cameras used in studios and industry today.

Maximum aperture F:2.8. Focusing range: 5 feet to infinity. Diaphragm stops to F:22. Weight, including viewfinder, 2.1 lbs. All lens elements are coated. Complete with coupled viewfinder for use with 16mm movie cameras. Som Berthiot Pan Cinor lens $447^{50}

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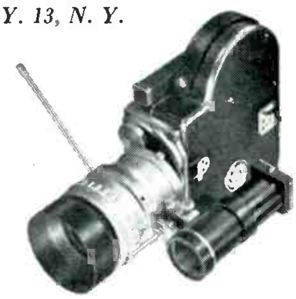
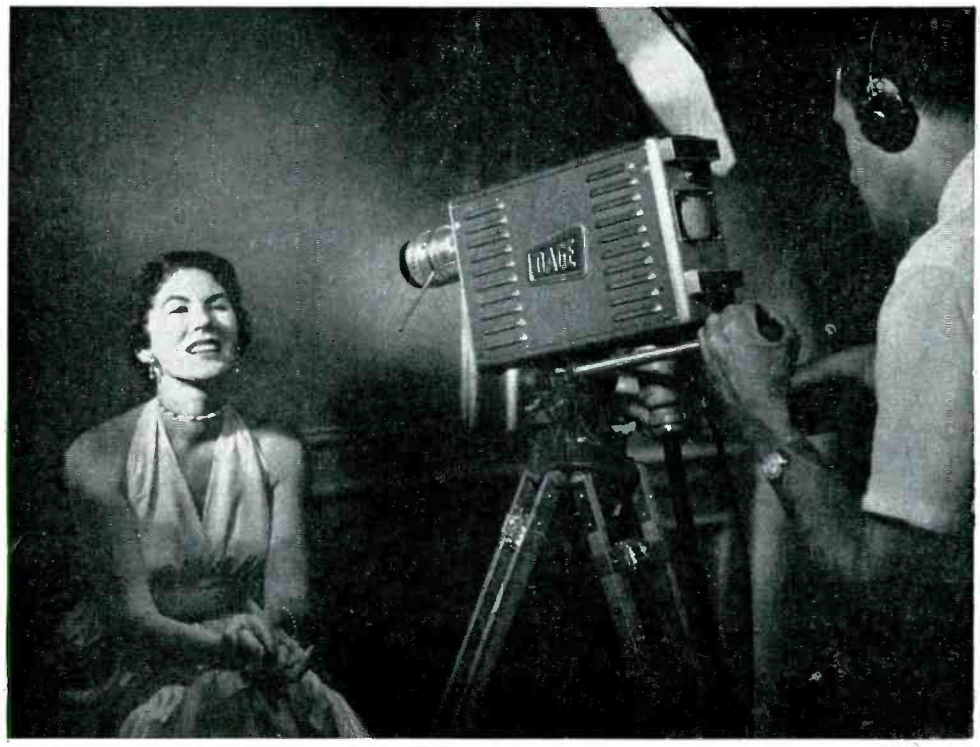
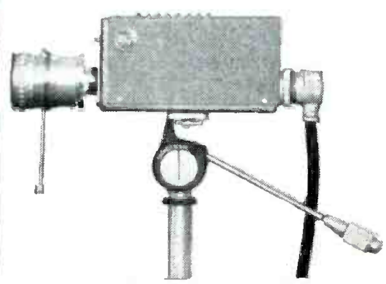


Pan Cinor Zoom-type lens with coupled viewfinder has standard "C" mount. Fits most 16mm movie cameras without modifications:



Budget size TV camera zooms in for a commercial close-up with the Pan Cinor Lens.



R.C.A. industrial TV camera with Pan Cinor.

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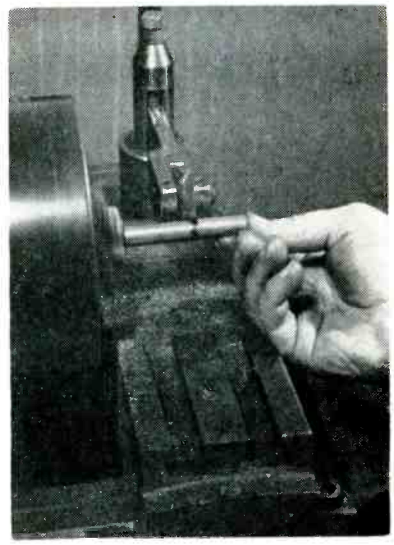

Lathe setup for trimming brass caps to length. After making a cut, the operator pushes off the finished housing and the waste metal with her fingers

gives the required friction between housing and arbor to get the rotation needed for cutting action.

The second method, for cutting tubing to short lengths for housings of two-lead capacitors, uses a drill chuck and motor mounted on a metal plate. A short grooved arbor is placed in the drill chuck. The foot-operated cutting disk works exactly the same as on the lathe. The length of the cut is governed by the distance of the cutoff tool from the jaws of the chuck. The position of the cutoff tool is adjusted by moving it along a shaft parallel to the arbor, and the arbor is then correspondingly positioned in the chuck.

Insulating Cold-Headed Iron Core-Bobbin

USE OF AN IRON core as its own bobbin for aircraft relays eliminated the cost and other drawbacks of separate bobbins but presented the problem of achieving adequate insulation between core and winding. This was solved in the plant of Phillips Control Corp. in San Juan, Puerto Rico, by using split acetate tubing and split fiber-base plastic washers.

The flanges that serve to hold in the winding are cold-headed on each end of the solid iron rod used as the relay core. One end of the core is

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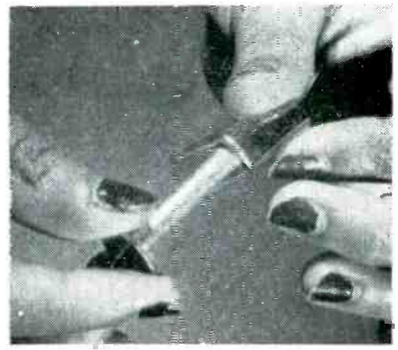
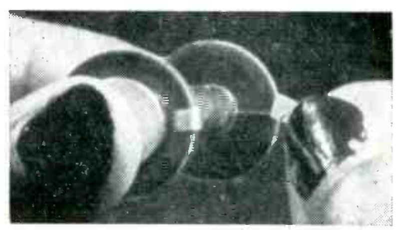


Applying split acetate sleeve to iron core-bobbin

Placing split laminated washer over insulated core



Applying tab of tape to hold together the two types of insulating washers

flush, while the other has an extension that is used later for staking the core to the relay frame.

The core is insulated first by slipping a length of split acetate tubing over the smaller headed end. This tubing has sufficient curl so that it laps over itself when on the core.

Two laminated fiber-base Bakelite header washers, each split along a radius, are next slipped over the insulated core and pushed against each header. Split acetate headers of similar size are put on next and pushed against each of the laminated headers, in such a way that the splits of adjacent washers do not line up. Finally, a small tab of Scotch No. 6 yellow "miniaturized"

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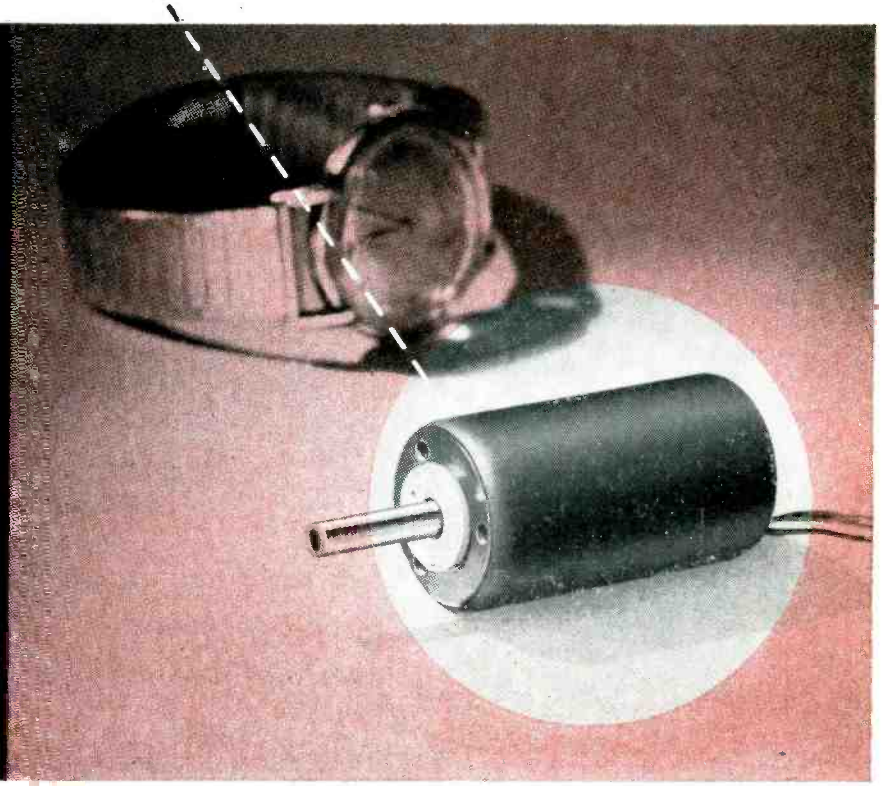
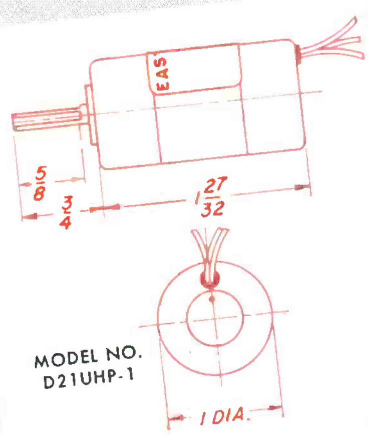


MODEL NO. D21UHP-1 (ACTUAL SIZE)



MODEL NO. D21UHP-1

SPECIFICATIONS

Capacitor run induction motor, 115 volts, 400 cycles, single phase, 11,000 R.P.M., .1 Amp., 1/300th H.P., .1 MFD.-220 V., 35% efficiency, weight—3½ oz.

APPLICATIONS

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Units are available in this small frame size for 400 cycle or variable frequency operation, with 400 cycle power ratings ranging up to approximately 1/100 H.P. Modifications include high ambient and high altitude versions as well as servo, synchronous and gear motors.

400 CYCLE OPERATING CHARACTERISTICS

APPROXIMATE R.P.M.	7,000	10,500	21,000
PHASES	1,2	1,2,3	1,2,3
INPUT VOLTAGE (MAXIMUM)	115	115	115

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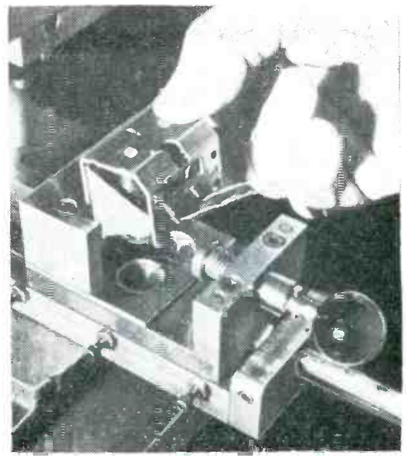
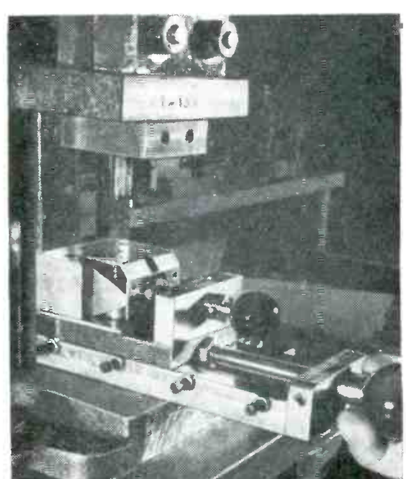


Method of inserting relay assembly in fixture preparatory to staking the two cores to the frame. Recesses in bottom of fixture serve to center the coils. Upper plunger is released by rotating back knob 90 degrees, to hold frame against fixture. Lower plunger is used to push sliding fixture in under staking dies of press

acetate tape is applied over the split in each acetate header and brought outward over the other type of washer to hold the two together. The insulated core is now ready for the winding machine.

The coils are wound on a Leesona No. 102 three-spindle semiautomatic winding machine modified to take the cold-headed bobbins. A typical coil would get 3,700 turns of No. 34 enameled copper wire.

While the machine is winding automatically, the operator keeps busy by soldering insulated lead wires to the enameled leads of previously wound cores. Other in-be-



Operator withdraws slide by pulling out knob after press has staked cores to frame

tween duties include cutting tabs of Scotch tape in readiness for anchoring the start and finish of each winding on the machine.

The next step is staking the cores into position on a relay frame. Each relay gets two coils. The projecting core ends are inserted in their frame holes and the assembly is placed in the slide of a holding fixture mounted on the bed of a punch press. A spring-loaded rod holds the frame in position. Re-

Machine used for winding three aircraft relay coils at a time on insulated solid iron core-bobbins

cesses in the fixture serve to center the lower ends of the coils precisely. The operator now pushes the slide in and operates the press. This stakes both cores in one operation. A spring-loaded pushrod in between the staking dies holds the frame tightly against the cores during staking.

Resistor Coating Techniques

MOTOR-STIRRED varnish dispensers and tilted drying racks permit efficient manual application of protective coatings to deposited carbon resistors at Radell Corp., San Juan, Puerto Rico.

One protective coating employed for this purpose is a mica-filled melamine varnish. This is applied cold but is kept thoroughly stirred by means of a stirring fan on the shaft of a fractional horse-power motor. The dispensing container is completely covered to prevent splattering as well as to minimize evaporation, with the exception of an opening only slightly larger than the resistor to be coated, located at the nozzle-shaped front end of the dispenser. The operator grasps

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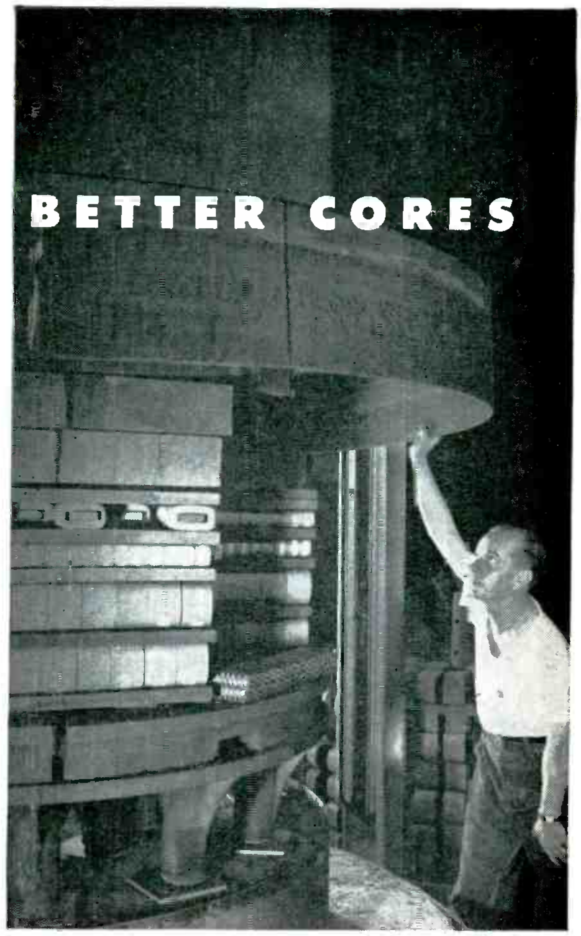

Skill and care mark every operation in the meticulous manufacture of Moloney HiperCore Electronic Cores. Under the watchful eyes of conscientious craftsmen, the windings of cold-rolled, oriented silicon steel are annealed in an inert gas atmosphere at carefully controlled temperatures to relieve any stresses that might affect their superior qualities. To prevent physical distortion, the cores are impregnated with a thermo-setting resin that bonds the insulated laminations into rigid, heat resistant units. Because of this planning and care, Moloney HiperCore Electronic Cores can be accurately cut to eliminate many costly operations in your assembly line.

Because Moloney HiperCore Electronic Cores have lower losses and greater flux carrying capacities, they enable you to make a better product. Moloney HiperCore Electronic Cores are *wound* cores that offer the advantages of less weight, less bulk—plus the "extra" that is always found in Moloney products.

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Motor-stirred varnish dispenser for applying protective coatings to resistors. Boards with drilled holes, raised above the bench by end blocks, serve as self-counting trays for uncoated resistors

the resistor by its leads with gloved hands, holds it in the opening of the dispenser, and rotates it until the entire body is covered. The resistor is then placed on a draining rack mounted on an angle and designed in such a way that surplus coating flows down the rack rather than down the resistor lead.

After draining and drying in the air for about 1½ hours, resistors are transferred to a clean rack for baking 30 minutes at 300 F to set the material. When a synthetic resin enamel is used as the coating, the motor-driven stirrer is not required but the remainder of the technique is the same.

Racks must be changed between drying and baking because once the

Method of rotating body of resistor in dispenser opening

Shrimp boats encounter rough seas. Their safe return can depend upon the reliable electrical power supply, provided by Onan generators.

To insure performance for these and all AC and DC, military and commercial regulated power units they manufacture, D. W. Onan & Sons Inc., has standardized on Regohm voltage regulators. Whether on sea, land or air applications, this low cost, compact, electro-mechanical controller demonstrates rugged ability to withstand severe vibration, shock or ambient temperature conditions. And you can't beat the band of Regohm's voltage regulation. Standard models provide constant voltage output within less than ±2%.

Shrimp boats are a'comin'...

Powered by Onan Electric Generators

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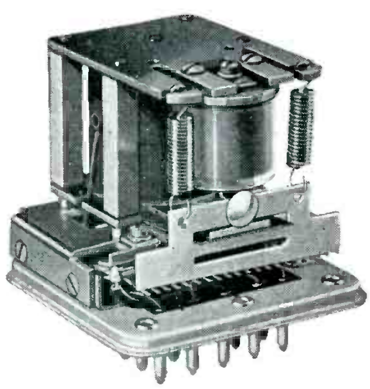
Voltage Regulators



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5. Long Life—In properly engineered installations, Regohm's life is measured in years. Shelf life is substantially unlimited.

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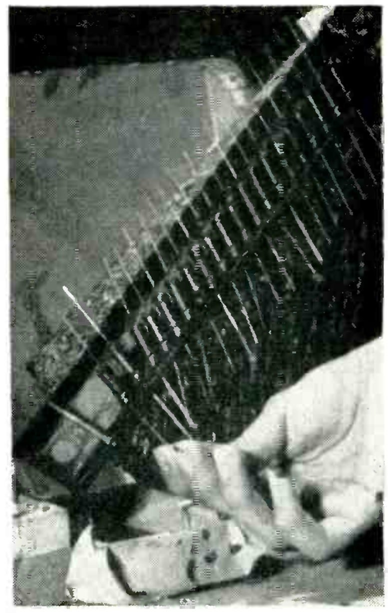


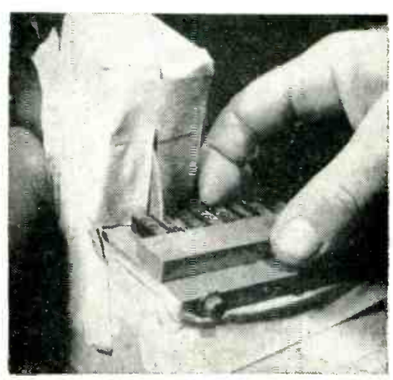
Placing resistor on slanting rack used for draining off surplus coating. Note that coating does not drain down the resistor leads. Wrapping paper fastened to benches with masking tape is replaced each day to give clean appearance to messy job

thermosetting material is baked onto a rack, it cannot be cleaned off with solvent.

Liquid level is maintained at the dipping opening of the dispenser by tipping the entire dispenser forward as the coating material is consumed. This is made possible by a mounting involving a shaft with locking wing nut.

Cutting Phenolic Plastic

MASKING TAPE and cardboard serve to improvise an inexpensive means of collecting the irritating phenolic dust produced when cutting off one section of a five-terminal molded plastic strip, in the San

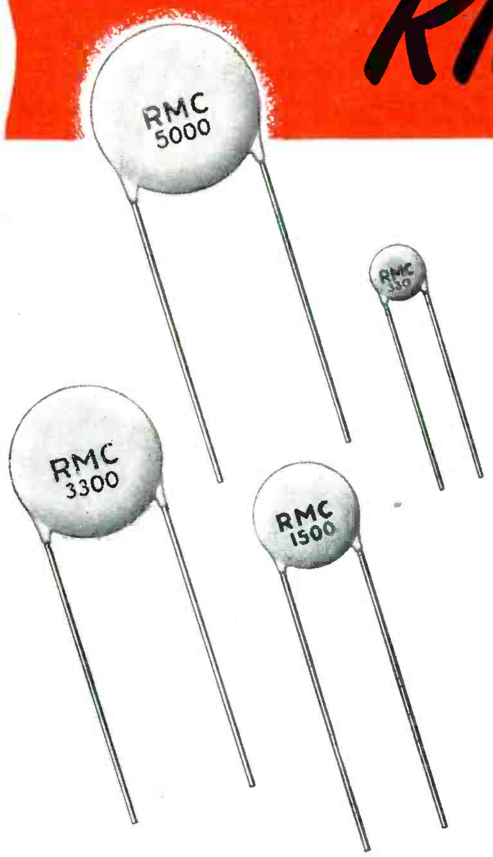


Dust-collecting setup used in cutting phenolic terminal strips

for stability plus

RMC DISCAPS®

TYPE D



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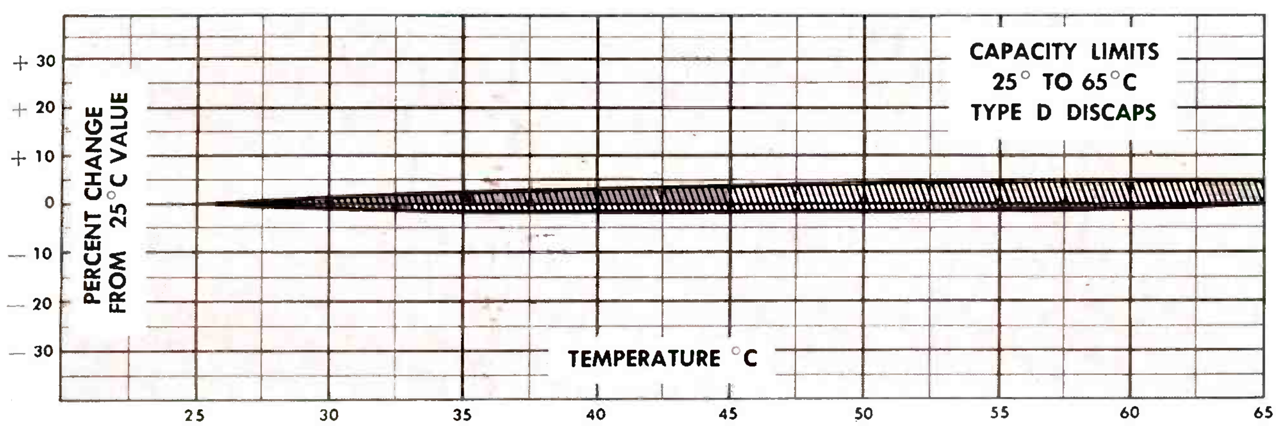

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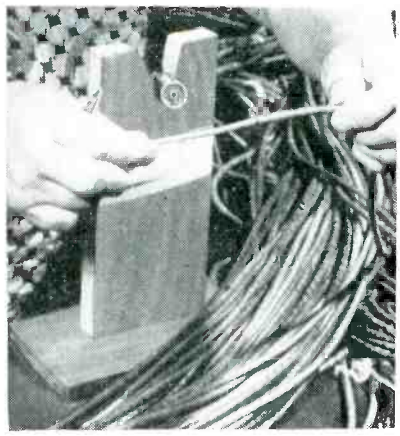
Juan, Puerto Rico plant of Phillips Control Corp. of P. R. The tape served to complete the enclosing of the cutoff wheel on the grinder. Cardboard combined with tape provided a dust-tight collecting box under the sliding holder on which the terminal strips were placed.

The cutoff operation permitted salvaging strips on hand for use in a redesigned product, without waiting for delivery of new strips.

Preparing Cable Leads

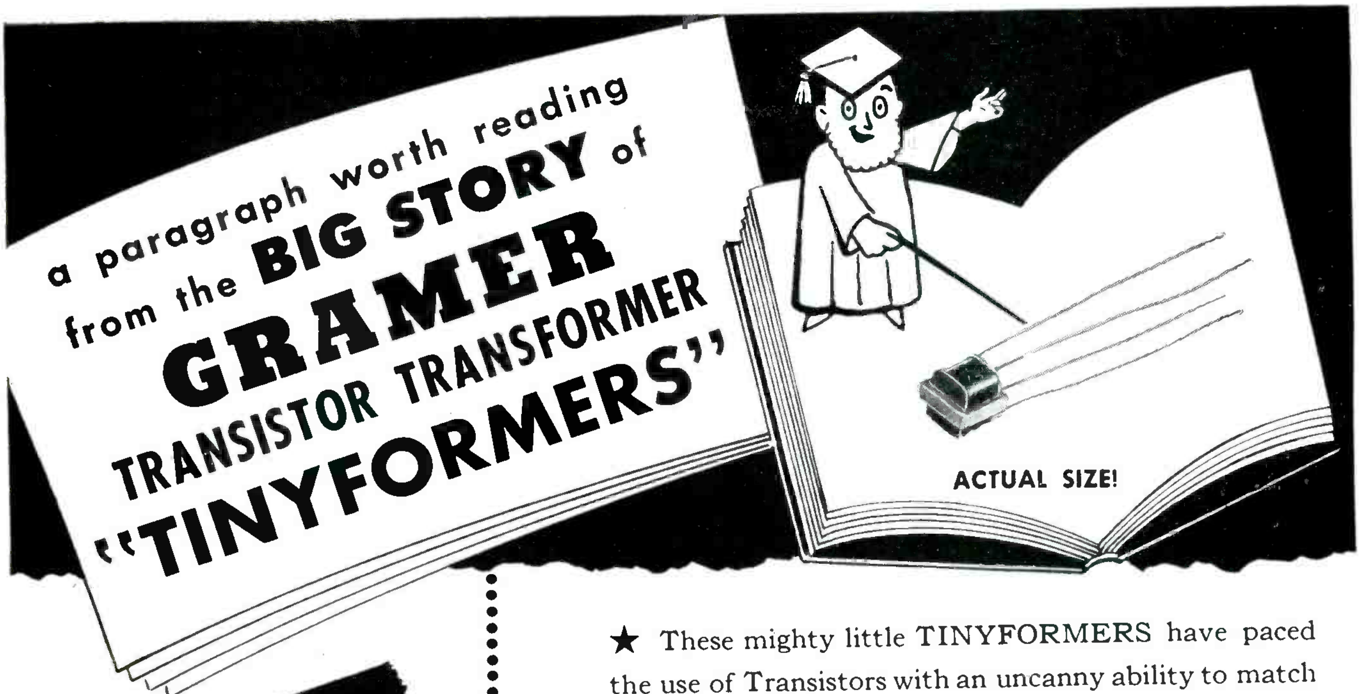
IN THE ASSEMBLY procedure recommended by Amphenol for preparing leads of multiple-conductor cables for soldering to the contacts of audio connectors, the cable is first cut to length and its outer jacket stripped off with an Artos auto-



Recommended method of using gas flame for burning off excess strands of filler on multiple-conductor audio cable. Gas torch is supported in V notch of wood fixture

matic machine. The wrapping cord and filler are then unraveled and cut off. Under proper control, using the fixture shown, a gas torch can be used to burn off the excess strands of filler rapidly and cleanly.

The next operation involves cutting the individual leads and stay cords to length. A simple pattern drawn on paper and cemented to the workbench can be used to do this quickly and accurately. The operator places the outer jacket at the reference line on the drawing, places a heavy metal block over the cable to hold it in this position, then cuts each wire in turn to the indicated length with special Wiss in-



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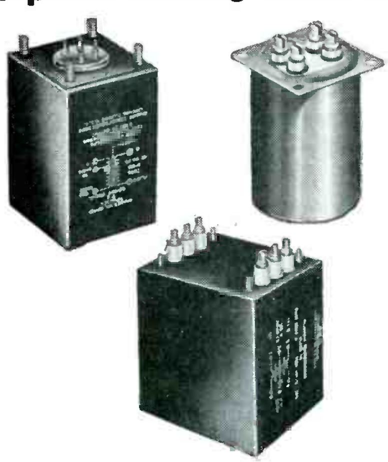

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M4	Output	600	50	66	7.7	11/32x3/8x3/8	.005
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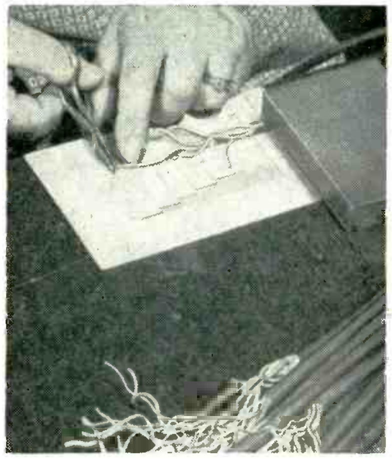
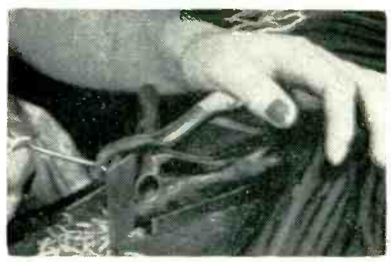


Using diagram cemented to bench as guide for cutting cable conductors to correct length while metal block holds cable in position

dustrial shears. If the conductors are color-coded, the drawing can be similarly colored. The stay cord is cut out at this time also, if it is not needed for strain relief purposes.

The next operation is stripping of individual conductors. This can be done either with a commercial hand-operated wire stripper or with the simple diagonal cutter setup shown. Here, one handle of an ordinary pair of diagonal cutters is welded to a metal plate that is clamped to the bench. A section of pipe welded to the plate provides additional support at the pivot of the cutters.

To use the stripping tool, the operator inserts a conductor in a notch in the cutter jaws, applies pressure with her left hand to the movable upper handle of the cutters to cut through the insulation, then pulls on the conductor to strip off the insulation. An upright metal plate, also welded to the base plate, serves as a stop or guide for insuring that exactly the correct length

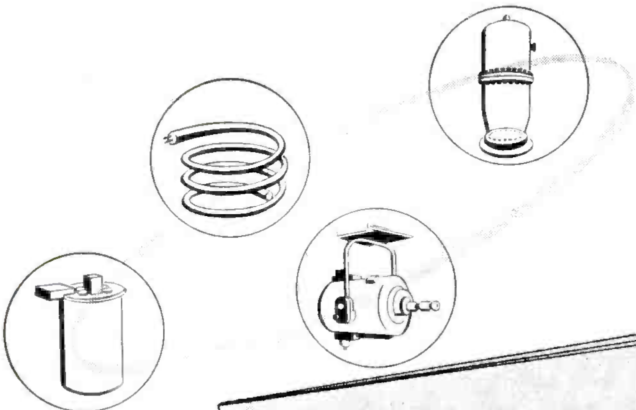


Diagonal cutters, welded to metal plate that is clamped to bench, serve for stripping leads of audio cable. Cutter blades are notched to prevent damage to inner conductor

If You Use Dielectrics—Here's an Important

NEW TECHNICAL BULLETIN ON GENERAL CHEMICAL SULFUR HEXAFLUORIDE

inert, non-toxic, dielectric gas



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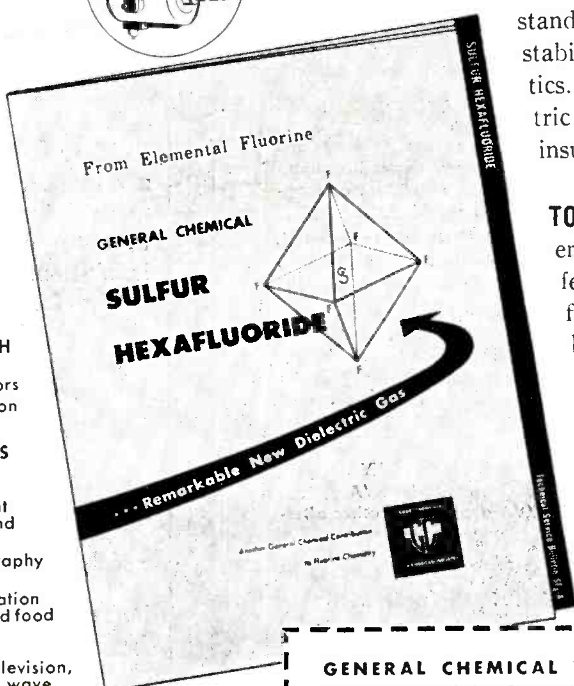
TO HELP YOU KNOW MORE about this inert, non-toxic gas, General Chemical is offering its specially prepared Sulfur Hexafluoride Technical Bulletin (SF_6A). The bulletin contains selected data on the physical properties of Sulfur Hexafluoride, as well as details concerning the advantages of its use for high voltage electrical equipment. The information in this bulletin may suggest applications for your products and processes which you will want to investigate further.



Some Suggested Uses Found for Sulfur Hexafluoride

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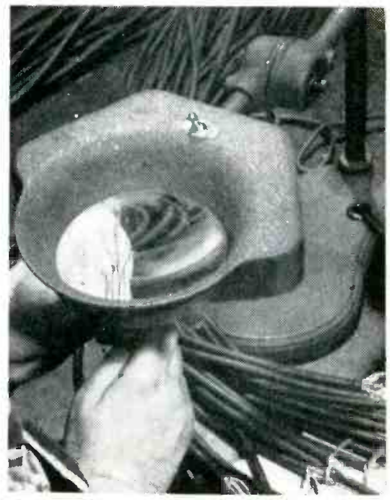


Inspecting tinned leads of cable with illuminated magnifier to make certain there is no damage to insulation

of insulation is stripped each time for optimum soldering into connector contacts. The same procedure is used for stripping leads at the other end of each cable.

The next operation is tinning. If it is possible to position all conductors so they line up, they can be fluxed simultaneously and tinned by a single careful immersion in a solder pot.

After tinning, individual leads are inspected under an illuminated magnifying glass to make certain that there is no damage to the insulation.

The foregoing procedure is abstracted from a booklet, "OK Methods", available from American Phenolic Corp., Chicago 50, Ill.

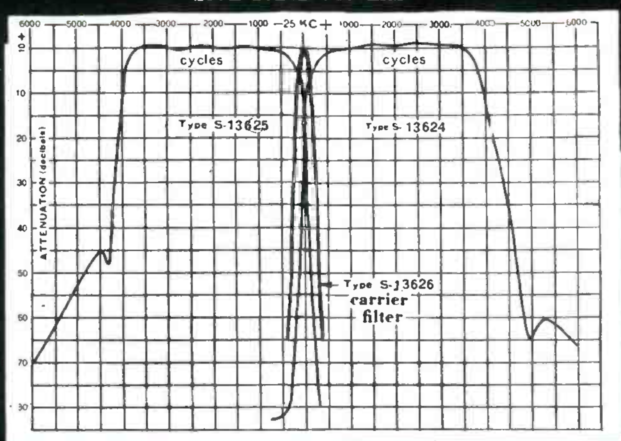
Testing Tubular Paper Capacitors

SIX electrodes arranged in the form of a two-runner slide permit checking paper capacitors at high speed for capacitance value and leakage at Pyramid Electric Co. The operator starts by holding the capacitor across the top electrodes of the slide. Here she glances at the meter on a resistance bridge to see if the unit is within tolerance. The capacitor is now slid down the slide to the middle pair of contacts for charging through a neon lamp to a predetermined voltage that is usually about twice the rated voltage. A normal capacitor here gives only a dim glow, whereas an excessively

RIGHT ON TOP

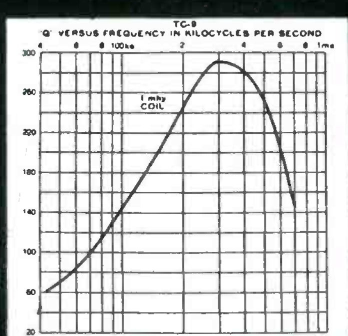
Burnell records a few of it's most recent engineering achievements in Toroids and Filter Networks.

SIDE BAND FILTERS



Our most recent engineering achievement in communications filters has already stirred the interest of the leading receiver manufacturers in the country.

Our new side band filters which eliminate, for most applications, the necessity for expensive crystal filters are expected to accelerate the advancement of single side band communications.



SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from 1/2 inch provides high Q in the frequency range between audio and RF.

The tiny toroid about the size of a dime has been welcomed by designers of sub miniature electronic equipment for the transistor, guided missile and printed circuit field.

PLUG IN DECADES

An entirely new development in inductance decades eliminating disadvantages of switch boxes. Inductance units plugged together in various combinations providing decade steps of inductance with minimum number of units required.

MINIATURE TELEMETERING FILTERS

In recognizing the need for miniaturization of the presently bulky telemetering equipment, our engineering staff has succeeded in reducing the size of telemetering filters to as little as 25 to 50% of the original volume.

BURNELL & COMPANY is very pleased to announce that it now has available a 12 page catalog which includes valuable and complete information on toroids, high quality coils, and various audio filter networks.

The catalog includes complete descriptions, attenuation and Q curves that will prove valuable for equipment design engineers.

Write for Catalog 101-A.

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

Exclusive Manufacturers of Communications Network Components

Want more information? Use post card on last page.

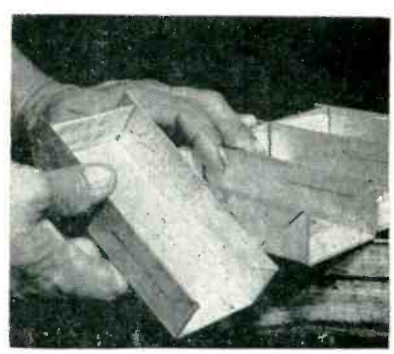
In the position shown here, the capacitor in the fingers of the operator is being discharged by the lowest electrodes on the slide. Where capacitance need not be checked, only the two lower pairs of electrodes on the slide are used

leaky or shorted unit gives a bright glow that is easily recognized by the operator. The charged unit is then slid down onto the third pair of electrodes for discharging through a resistance load.

In practice, a capacitor is moved from the top to the bottom of the slide in one steady motion. This permits testing at a production rate that can be as high as 50 per minute.

Interlocking Parts Trays

SMALL TRAYS MADE from galvanized sheet metal by Caribe Aircraft Radio Corp. of Coamo, Puerto Rico, are so designed that any desired number can be quickly locked together to hold the various parts

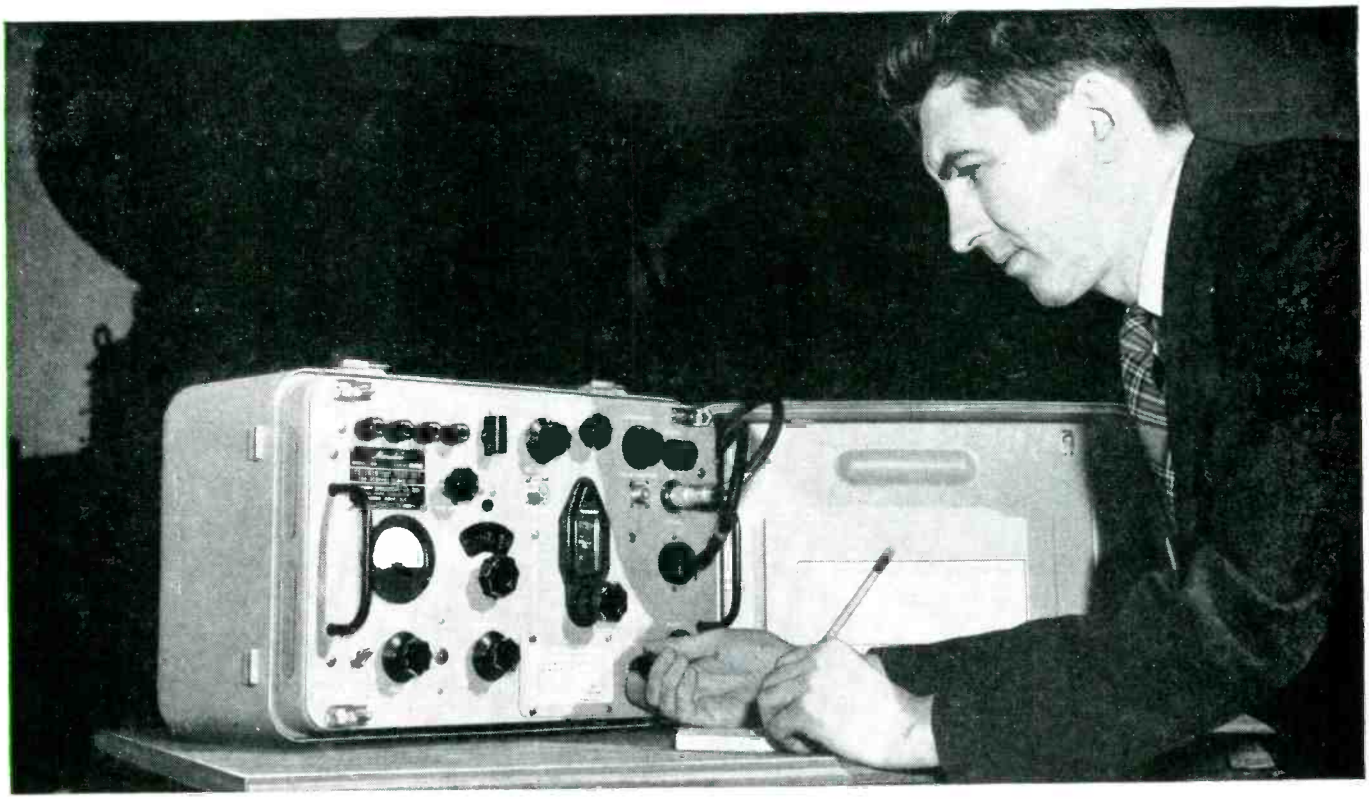


Method of locking trays together. Pieces of masking tape applied to front, bottom and rear end of tray serve as easily changed identifying labels for contents

Accurate Field Testing of X-Band Radars

WITH MICROLINE* TEST SET AND RANGE CALIBRATOR

Included in Sperry's complete line of Microline instruments are the 38A Test Set (TS 147B/UP) and the AN/UPM-11 Range Calibrator for the accurate testing of X-band radars. These equipments, of rugged design for field usage, can also be employed in laboratory and production testing.



MODEL 38A Test Set (TS 147B/UP)

This portable test set is suitable for measurements on all radar, beacon or missile systems in the 8500-9600 mc. range. It supplies microwave signals of known frequency and power, either continuous wave, frequency modulated or externally modulated. It also measures the power and frequency of external signals in the above frequency range. Model 38A contains a direct reading frequency meter, wattmeter and signal generator which allow the measurement of power and frequency of radar transmitters as well as receiver sensitivity, bandwidth, recovery time and AFC action. Tuning of the frequency meter is accomplished with both a direct and a 5 to 1 reduced drive mechanism for ease of determining narrow pulsed signals as short as 0.2 microseconds.

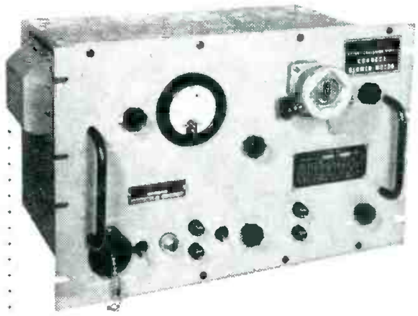
SPECIFICATIONS:

R-F Power Output: Adjustable from −7 to −85 dbm (decibels relative to one milliwatt).

R-F Power Input: From +7 to +30 dbm.

Accuracy: ±1.5db. A calibration chart is supplied.

Frequency Meter Accuracy: ±2.5 mc. absolute at 25°C and 60% RH. Calibration point 9310 ± 1.0 mc.



MODEL AN/UPM-11 RANGE CALIBRATOR

This instrument is used to test X-band fire-control radars which operate in the 8500-9600 mc. frequency band. It receives microwave signals from a radar and responds with accurately spaced pulses thereby providing a means of calibrating the radar range. It can also be used to boresight the antenna axis of any X-band radar system.

SPECIFICATIONS:

Range Markers: 200 to 50,000 yds. depending on delay line

Accuracy: ± 5 yards

Repeatability of readings (same radar system): ± 1 yard

Tuning: Manual or AFC

* T. M. REG. U. S. PAT. OFF.

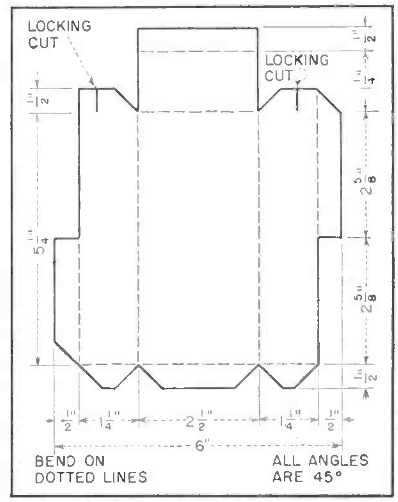
Our nearest district office will be happy to supply further information on these and other Microline instruments.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION

GREAT NECK, NEW YORK • CLEVELAND • NEW ORLEANS • BROOKLYN • LOS ANGELES • SAN FRANCISCO • SEATTLE
IN CANADA • SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

needed at a particular work position during production of small job-lot quantities of electronic subassemblies.

The tray design, shown on the accompanying diagram, permits fabrication without need for soldering or riveting. After bending the cut-out sheet, the tray is ready for use. The locking cuts on the sides at the rear serve to lock adjacent trays together.

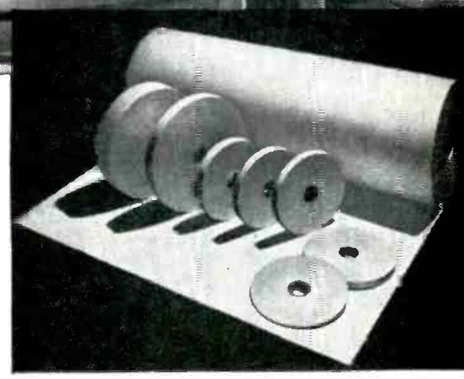


Pattern for self-locking nesting trays

Vacuum Cleaner Speeds Sealing of Packages

As an aid in obtaining climate-proof packaging of electronic equipment, air is evacuated from the outer wrapper of the package with a vacuum cleaner just before heat sealing, in the Brooklyn, N. Y.

Removing air and moisture from carton bag before final heat-sealing on machine standing over conveyor. Vacuum cleaner is under conveyor



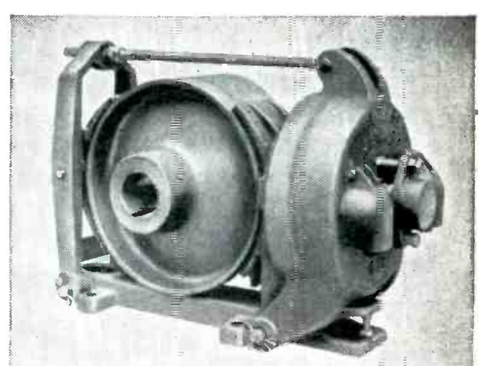
Quinorgo Electrical Insulations are high dielectric, heat-resistant sheet materials made of purified asbestos for use on equipment up to 130 C. Available in tape and roll forms.

How Cutler-Hammer, Inc. protects coils of giant Supermagnets with Quinorgo® *electrical insulation*

PROTECTING COILS in giant C-H Supermagnets is difficult because of the heat generated by the tightly packed pancake coils. This problem is complicated by the need to utilize every bit of space to gain maximum lifting power. After experimenting with many insulating materials, including coatings, Cutler-Hammer chose Quinorgo No. 3000 for Supermagnet strap insulation.

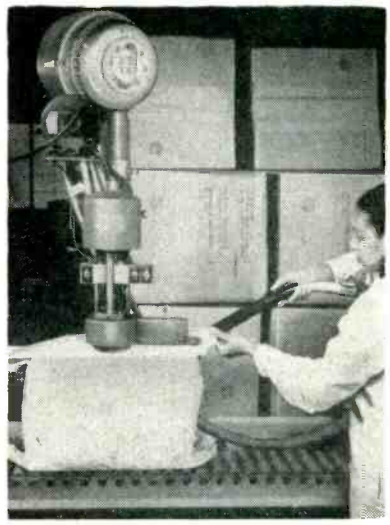
Quinorgo fully meets the exacting requirements of Cutler-Hammer—as well as those of other well-known electrical manufacturers. Quinorgo is a moderate priced, high-temperature insulation, for use alone or in "composites." Available in two types with slightly different impregnation characteristics. Both types combine high dielectric and mechanical strengths, with uniform texture and caliper. They maintain these properties under operating temperatures up to 130 C.

Quinorgo Electrical Insulations may lower your production costs and improve product performance. For more information write for the 32-page booklet "PYROLYSIS PROTECTION PAYS WELL" (EL-40A) Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.



Cutler-Hammer's success with Quinorgo No. 3000 on giant Supermagnets led the company to use this insulation as a component of the series wound Type "M" magnetic brakes which are so widely known throughout the industry.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville ELECTRICAL INSULATIONS**



Method of extracting air from bag during packaging of control box for electronic equipment. Here the vacuum cleaner is mounted directly on top of the automatic heat sealer

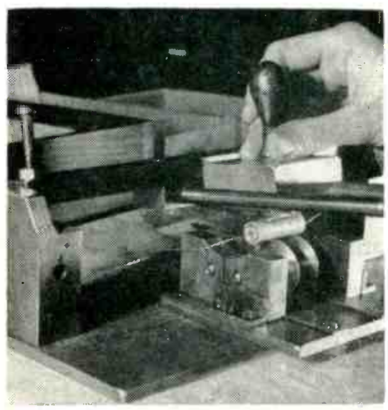
plant of Cargo Packers, Inc.

The flat nozzle of an ordinary vacuum cleaner is inserted in one of the flaps of the moisture-proof wrapping material and left there throughout the sealing operation on the automatic sealing equipment. This removes air and moisture from within the bag.

Stamping Tubular Paper Capacitor Cases

STAMPING of part numbers and capacitance ratings on metallized capacitors is accomplished rapidly on a jig used at Pyramid Electric Co.

A rubber-stamp holder slides on



Jig used for stamping ratings and type numbers on capacitors. Pressure of rubber stamp rotates capacitor as stamp is moved

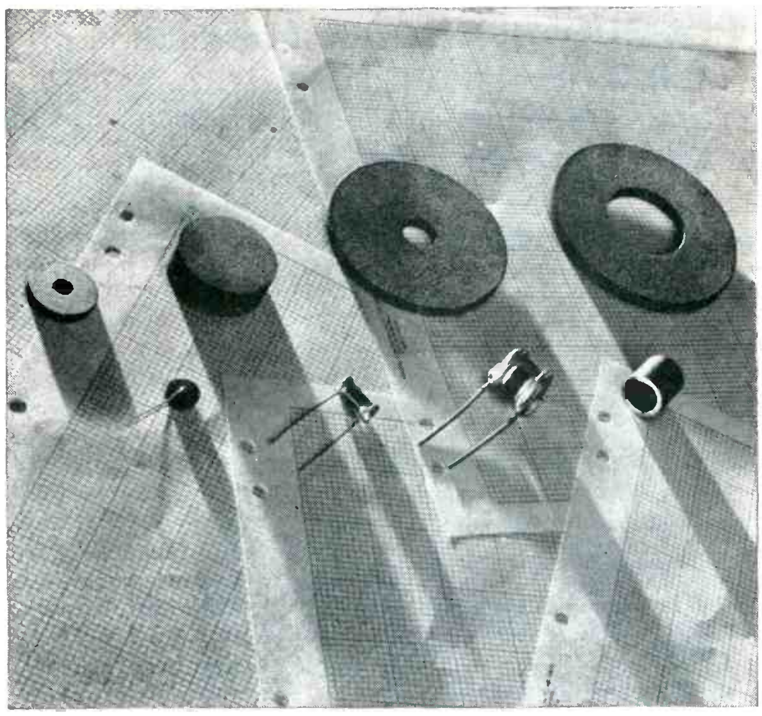
How can GLOBAR® VOLTAGE SENSITIVE RESISTORS cut your product's cost...yet add to its reputation?

➡ Many manufacturers count on GLOBAR type BNR voltage sensitive resistors to reduce surge voltages and contact arcing time—in both AC and DC circuits. Because their resistance decreases sharply as applied voltage is increased, BNR resistors:

Reduce surge voltage peaks from 50% to 90%. This feature permits use of lower voltage ratings in your components . . . saves product costs.

Reduce contact arcing time up to 95%. By drastically limiting the duration of arcing after a circuit break, contacts last much longer...with less pitting, less sticking. Cuts maintenance costs for your customer, helps give your product a better reputation.

Used in low voltage devices, BNR resistors also substantially reduce radiations which interfere with radio and television receivers.



GLOBAR Type BNR resistors are built for long life. They withstand repeated high voltage stresses without danger of sudden failure. They are manufactured in both cylindrical and disc shapes . . . to meet your *exact* circuit and engineering requirements.

OUR ENGINEERS will be glad to show you, without obligation, how GLOBAR Ceramic Resistors can help you make a better product at less cost. Write, giving details of your problem, to The Carborundum Company, Dept. E 87-313, Niagara Falls, New York.

● Engineering data on these and other important uses for GLOBAR Type BNR resistors . . . in Bulletin GR-2. Write for your copy.

GLOBAR® Ceramic Resistors

CONVENTIONAL • TEMPERATURE SENSITIVE • VOLTAGE SENSITIVE

by CARBORUNDUM

REGISTERED TRADE MARK

87-313

Springs on edges of rack prevent capacitors from coming in contact with each other while varnish coating is drying

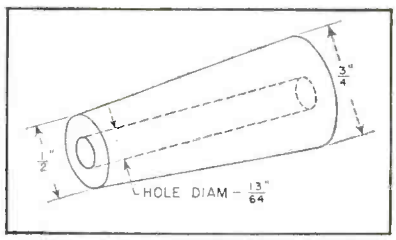
two rods projecting from a metal frame. The capacitor is placed on two pairs of rotating disks beneath the stamp-pad guides. When slid down the track toward the frame, the rubber stamp rotates and imprints the capacitor.

A screw and locknut at each end of the frame permit raising or lowering of guide rods to accomodate various sizes of capacitors.

After stamping, the capacitor markings are coated with varnish. To keep the units from touching each other while the varnish is still wet, a rack is used having a coil spring stretched along each side and one in the center. When placed in the rack, the leads of the capacitors lay within the turns of the spring.

Tuner Shaft-Centering Jig

INSTALLATION of uhf tuners in cabinets is expedited by slipping a tapered wood jig over the tuner shaft from the front of the cabinet after placing the tuner in position;



Shaft-centering jig which can be turned down from a piece of broom handle

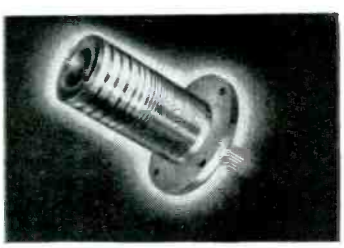
Now available the revolutionary ELECTRO TEC process* for your LARGE SLIP RING ASSEMBLIES

featuring

- LOWER COST
- CLOSER TOLERANCES
- ONE-PIECE CONSTRUCTION
- JEWEL-LIKE FINISH
- UNIFORM RING HARDNESS
- REDUCED WEIGHT

↑ *An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".*

→ *Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D. approx. $5\frac{3}{8}$".*



→ *An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.*

→ *Cylinder type assembly approx. $3\frac{3}{4}$" long with 24 hard silver rings. $1\frac{5}{8}$" O.D. with wall thickness less than $\frac{1}{4}$".*

*PATENTS PENDING

Now a Complete Service in all sizes of Slip Ring Assemblies

ELECTRO TEC is now tooled up, with new expanded facilities for production of large Slip Ring Assemblies to exact customer specification. Sizes range up to 24" in diameter, either cylindrical or disc type.

The exclusive ELECTRO TEC PROCESS*—the electro-deposition of hard silver rings into an accurately machined plastic blank—consistently yields a high degree of dimensional accuracy, excellent concentricity, and a jewel-like ring finish. This process also eliminates expensive tooling and mold charges, frequently lowers costs to 30% of other methods of manufacture. The silver rings are uniformly hard for long life—75-90 Brinell.

ELECTRO TEC one-piece construction precludes dimensional variation due to accumulated errors. The plastic base is fully cured before rings are plated into it, thus preventing separation of base material from the rings.

ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

Every user knows the ELECTRO TEC reputation for quality and superiority in miniature and sub-miniature slip ring assemblies.

Our Engineering Department is available for consultation on any of your slip ring problems without obligation.

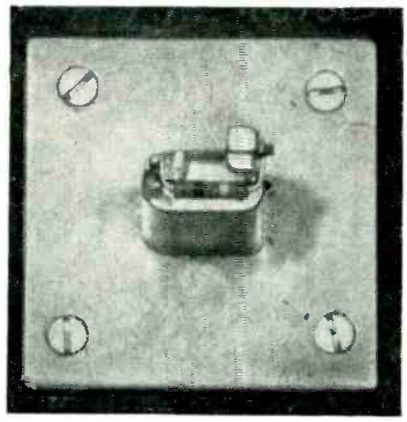
ELECTRO TEC CORPORATION
SOUTH HACKENSACK • NEW JERSEY

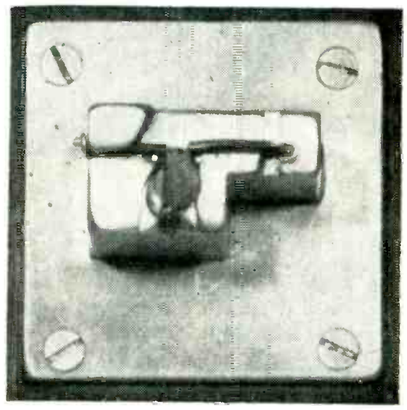
Want more information? Use post card on last page.

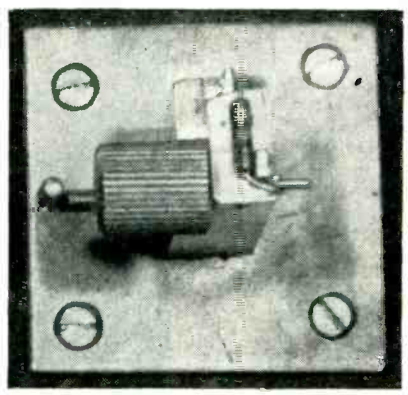
when the jig is pushed into the cabinet hole, the shaft is precisely centered. The jig leaves both hands free for tightening the mounting screws. The idea is the suggestion of Parke M. Good of Lancaster, Pa., and received a Philco Idea Award.

Bending Tiny Leads in Ceramic Molds

LEADS of components for subminiature subassemblies are precision-bent on specially designed ceramic







Examples of ceramic molds used for preforming leads of small parts. Hooks at ends are formed around steel pins embedded in the molds. Where pins are at right angles as in bottom mold, one is made movable and spring-loaded so it can be retracted to remove finished component after bending

For *Critical* Applications

Triplett 630-A Has No Counterpart

Accuracy
to 1½%

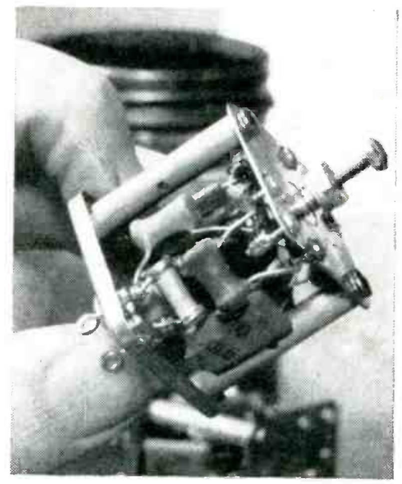
Readability
with a Mirror-Scale

Adaptability
with ½% resistors

Try This Volt-Ohm-Mil-Ammeter at your distributor's

TRIPLETT ELECTRICAL INSTRUMENT CO., BLUFFTON—OHIO molds in Raytheon's Brighton, Mass. plant. The leads then fall automatically into the correct positions for soldering when assembly workers place them inside a crowded chassis with tweezers. Preforming of leads in this manner eliminates the necessity of providing room for inserting pliers or fingers, and thus reduces the overall size of the product.

Ceramic molds were used for preforming because they could be duplicated in any quantity once the master was made. Individual machining of the required curved molds from steel would have proved much more costly. Each mold is cemented on a metal plate which in turn is fastened to an appropriately labeled plastic base.

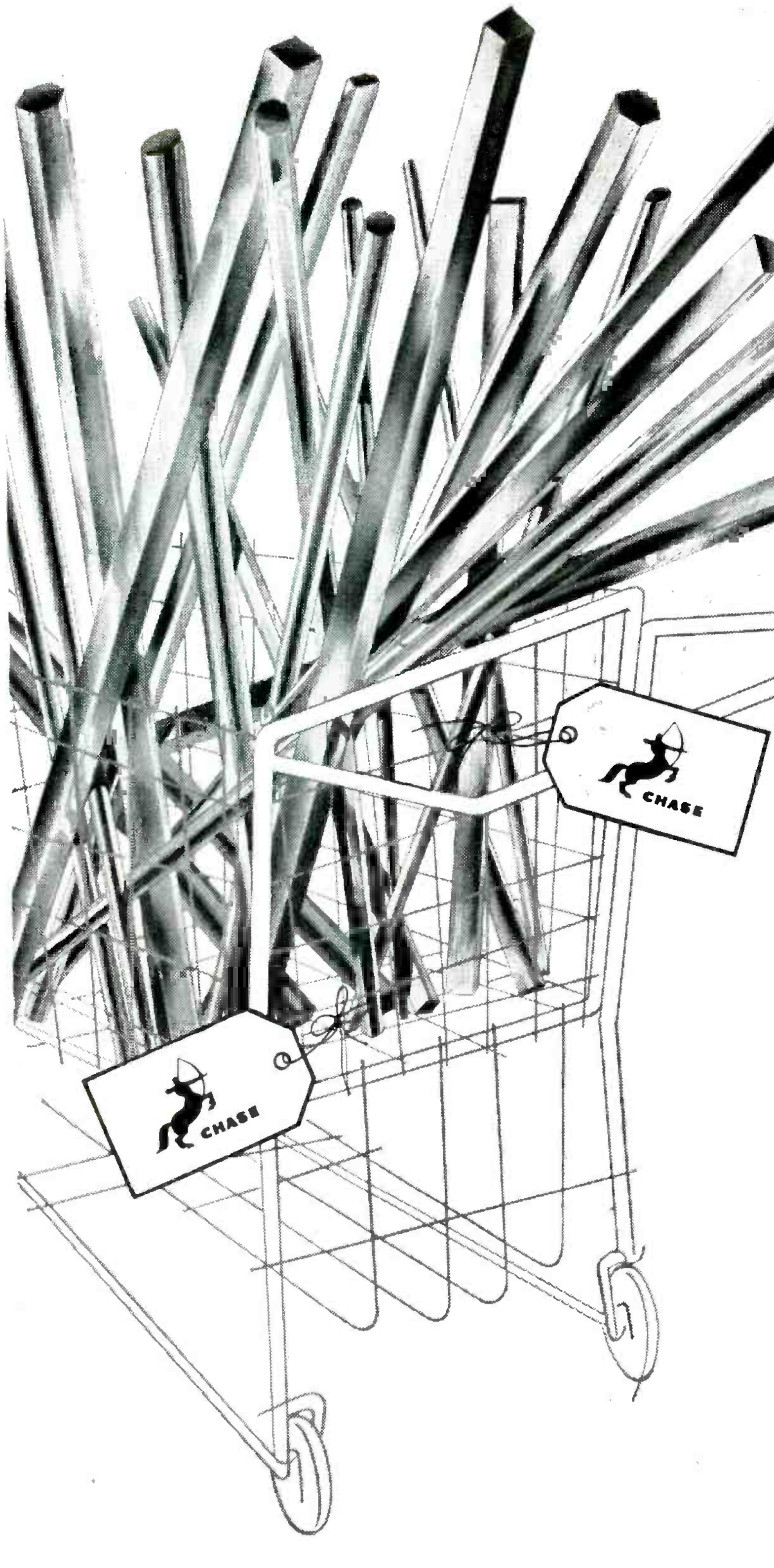


Example of subassembly requiring preformed leads on miniature components. This discriminator transformer is assembled with tweezers, needle-nose pliers, soldering pencils and additional special tools

Knob Springs Installed With Arbor Press

ALTHOUGH insertion of springs in television receiver tuning knobs is a relatively simple operation, repetition of this task hour after hour results in operator fatigue and a sore thumb. Changeover to an arbor press simplifies the operation, improving operator morale, speeding output and reducing rejects.

A fixture was made for the base of the press to hold the front face of the knob securely without scratching it. The operator places a knob in this fixture, drops a spring into the hole with her left



One-Stop shopping

for brass rod and bar

You can get rod or drawn bar of Chase Free-Cutting Brass, Copper or a wide variety of other copper alloys at one stop – *the Chase Warehouse nearest you!*

When you want free-cutting materials, it pays to buy Chase – for Chase rod and drawn bar yield the shorter chips that make for *easier machining, longer tool life*. They produce smooth, clean-surfaced products – less expensive to buff or polish before lacquering, enameling or plating.

And when it comes to re-ordering, remember that Chase alloys are uniform – repeat orders of the same alloy always have the same cutting characteristics.

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WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

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Boston	Detroit	Minneapolis	Providence	
Chicago	Houston	Newark	Rochester †	(† sales office only)
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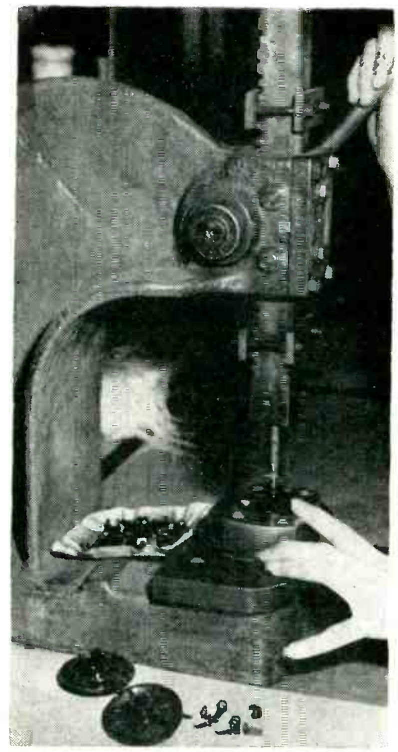
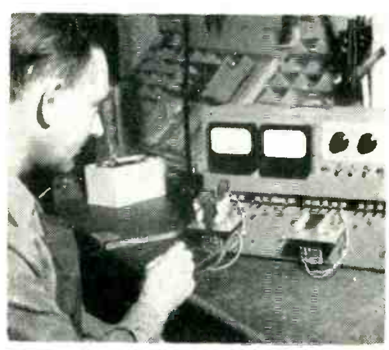


Using arbor press to force spring into tuning knob

hand, then operates the lever of the press with her right hand to drive the pin home. The end of the moving arbor is appropriately machined to do this without damaging the plastic knob.

Testing High-Voltage Power Supplies

POWER supplies used to provide the accelerating potentials for four different types of Tektronix cathode-ray oscilloscopes are production-tested with a single compact



Power supply tester in use at Portland, Oregon plant of Tektronix, Inc. Unit at right has its own leads. Unit at left has only terminals hence clip leads were attached to these for the test. Only one unit is tested at a time

the new cae oscilloscope (type 104)
performs the functions of several types

By using interchangeable D.C. Amplifier and Time Base Units, one CAE Oscilloscope performs the operations of several different types of oscilloscopes resulting in a considerable *saving in capital expenditure.*

Highly functional, it is constructed on the unitized principle and its unique system of controls makes it simple to operate with highly accurate results.

the cae
Oscilloscope (TYPE 104)

INTERCHANGEABLE AMPLIFIERS provide suitable combinations of—

- wide band, from D.C. up to 10 MC/S
- rise time down to 0.05 micro-seconds
- voltage gain up to 500,000
- inherent noise as low as 1 micro-volt

INTERCHANGEABLE TIME BASE UNITS provide suitable combinations of—

- sweep velocity 10 cm/micro-seconds to 5 cm/seconds
- triggered or continuous sweeps
- automatic synchronization
- linearity 1%
- voltage, frequency and time calibration accuracy 2%

Ask for Bulletin No. SIE-30101

For complete details of CAE Oscilloscope, Type 104, call or write the CAE office nearest you.

Canadian Aviation Electronics, Ltd.

8280 St. Lawrence Boulevard, Montreal

Toronto • Winnipeg • Vancouver

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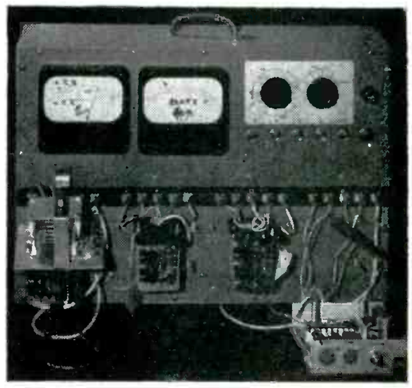


Closeup of tester, showing how four different types of power supplies for cathode-ray oscilloscopes are connected to the test positions. Meter at left reads output kilovoltage, and meter at right reads average oscillator current

test set having quick connectors. In practice, only one of the four test positions is used at a time, for checking a production run of one particular unit.

When changing to a different unit, the meters are switched to a different set of clips and the controls are reset for the required new test voltages and current ranges. Even though possible, testing of different units one after another would be confusing to the operator because each unit has different output voltages and loads the oscillators differently.

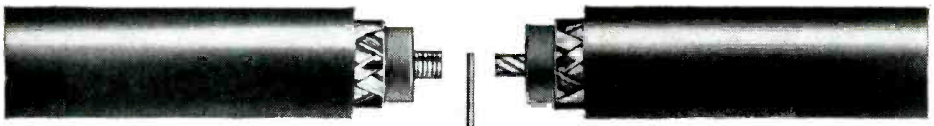
Use of Grayhill No. 2-0 panel mount test clips contributes to the high testing speed of less than one minute per unit.

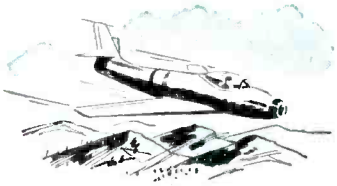
Some or all of the oscillator circuit components are mounted on the high-voltage unit. These are connected into the tester's oscillator tube circuit when the unit is being tested. Plate, screen and bias voltages are provided by the tester. Rectifier filament voltage for each high-voltage unit is supplied from a winding on its own transformer. Measurements are made of positive and negative d-c output voltages and average oscillator current.

Air-Operated Pot Jig

IN SUBASSEMBLY work involving assembly and soldering of leads and small parts on combination volume controls and on-off switches for a-m radios, an air-operated diaphragm is used to hold seven controls at a time in a wood jig.

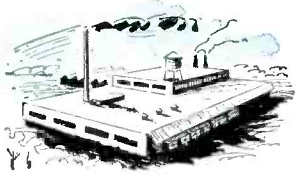
A flip of the foot pedal opens the





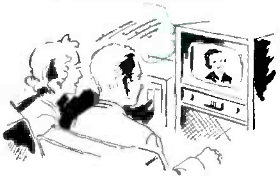
AVIATION

MARINE



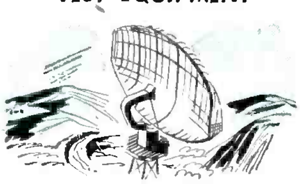
INDUSTRIAL

BROADCASTING



RADIO-TV LEAD-INS

TEST EQUIPMENT



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TRUSTWORTHY TRANSMISSION

For Every HF · VHF · UHF Application

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QUALITY-CONTROLLED

COAXIAL CABLES

Whatever your field of application . . . whatever your transmission line requirement . . . Federal is ready to serve you. If the cable you need doesn't exist, Federal will cooperate with you in developing and producing it in any quantity!

Federal offers you one of the nation's most diverse stocks of RG type cables—including the Federal-developed low-temperature, non-contaminating thermoplastic jacket.

Quality-controlled throughout the entire manufacturing process, Federal cables bring *trustworthy transmission* to every electronic application . . . *plus* top flexibility and superior resistance to abrasion, weathering and corrosion.

Before you specify cable—or complete cable assemblies—for any general or military application, get the facts and figures from Federal. *We have the answer or we can get it!*

FEDERAL HAS A NEW CABLE CATALOGUE

This new 28-page buying guide contains a world of up-to-date information on Federal's quality-controlled cables, plus numerous useful tables and diagrams. For your free copy, write to Federal today, Dept. D-715.

FEDERAL TELEPHONE & RADIO · FTR · DIVISION OF IT&T

Manufacturer of America's most complete line of solid dielectric cables

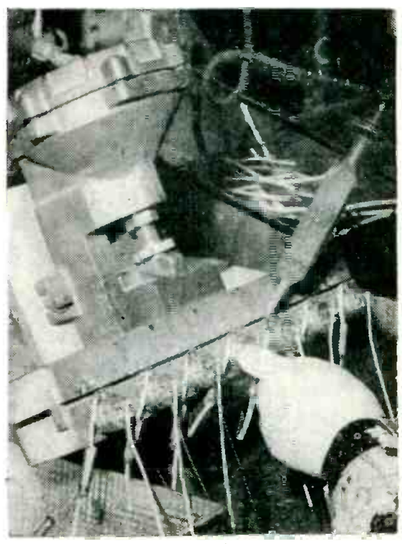
Federal Telephone and Radio Company

SELENIUM-INTELIN DEPARTMENT • 100 KINGSLAND ROAD, CLIFTON, N. J.

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

Foot-operated air valve controls opening and closing of jig for holding radio controls. Also showing is strap iron holder used throughout plant for keeping soldering-iron cord out of way

jig, allowing the operator to remove completed units and insert new controls. Another tap on the foot switch then moves the diaphragm downward, applying pressure to the upper wood block of the jig. The wood grips the threaded bushings of the controls to prevent them from turning, but does not damage the threads. This holding jig is in use at a large number of work positions in the Long Island City plant of Olympic Radio & Television, Inc.



Close-up of holding jig in use for subassembly work, showing how air unit (made by W. R. Brown, Chicago) applies pressure to upper block

FREQUENCY STANDARDS *Modular system*

DESIGNED AS A

The Type 2001-2 series provides frequencies from 30 to 30,000 cycles with an accuracy of .001% (at room temperatures) in units suitable for integration with instruments of your own design — or for panel rack mounting with your own power sources — or for line operation.

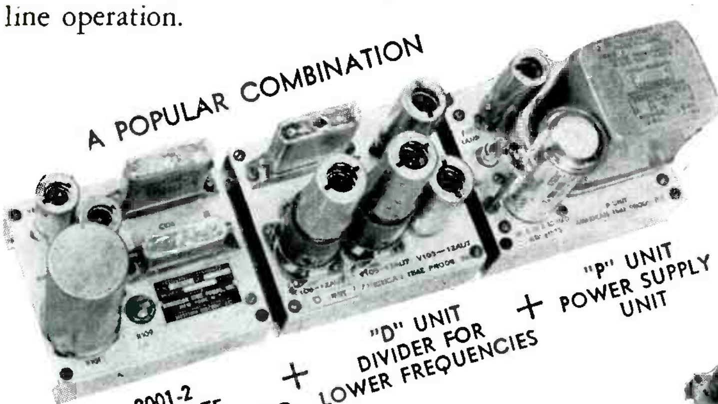
WHICH WILL MEET YOUR

CUSTOM NEEDS

FROM A COMBINATION OF

STOCK UNITS

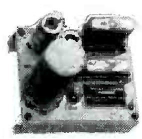
A POPULAR COMBINATION



2001-2 ACCURATE FREQUENCY STANDARD + "D" UNIT DIVIDER FOR LOWER FREQUENCIES + "P" UNIT POWER SUPPLY UNIT

TYPICAL COMBINATIONS

2001-2	2001-2 + M
2001-2 + L	2001-2 + M + P
2001-2 + L + P	2001-2 + L + P + R
2001-2 + H	2001-2 + H + P + R
2001-2 + H + P	2001-2 + M + P + R



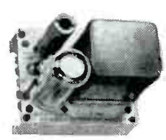
TYPE "2001-2" FREQUENCY STANDARD
Frequencies, 200 to 3,000 cycles. Output, approximate sine wave at 5 volts.

ACCESSORY UNITS

**"L" UNIT.
DIVIDER, (MULTI-VIBRATOR TYPE)**
Provides frequencies from 30 to 200, controlled by the 2001-2 unit. Output, approx. 5V. Approx. sine wave.

**"M" UNIT
AMPLIFIER**
Provides 2 watts at 6 and 110 volts.

**"D" UNIT.
DIVIDER, (COUNTER TYPE)**
Provides 40 to 200 cycles controlled by the 2001-2 unit. (fail safe)



**"P" UNIT
POWER SUPPLY**
Provides power for combinations of units illustrated, if other sources are inconvenient or not available.

**"H" UNIT
MULTIPLIER**
Provides frequencies from 3,000 to 30,000 cycles, controlled by the 2001-2 unit. Output, approximately 5 volts.

**"R" UNIT
PANEL MOUNTING**
Accommodates up to three units. Standard size is 8¾ inches high, 19 inches long.

For details, please request our "Type 2001-2" Booklet.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

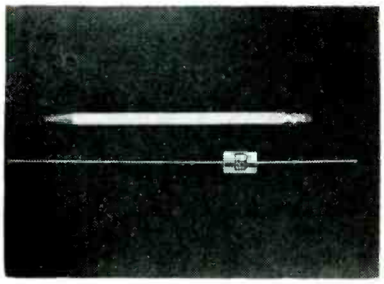
 Want more information? Use post card on last page.

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

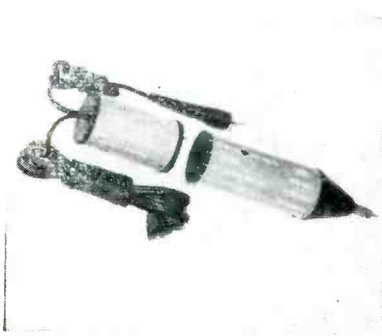
Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Fifty-Eight Trade Bulletins Reviewed

OTHER DEPARTMENTS
featured in this issue:



SELENIUM RECTIFIERS
are glass-encased

BRADLEY LABORATORIES, INC., New Haven, Conn., is producing a new series of glass-encased high-voltage selenium rectifiers, dubbed the SE6L. It is hermetically sealed in a $\frac{3}{8}$-in. diameter high-strength glass (pyrex) tube which has fewer high-voltage installation problems than the metal tube with glass-to-metal sealed end caps. The units are rated 1.5 milliamperes d-c and have maximum peak inverse ratings up to 6,000 volts. They meet government requirements for high-voltage hermetically sealed rectifiers.



POWER SUPPLY
for circuit analyzers

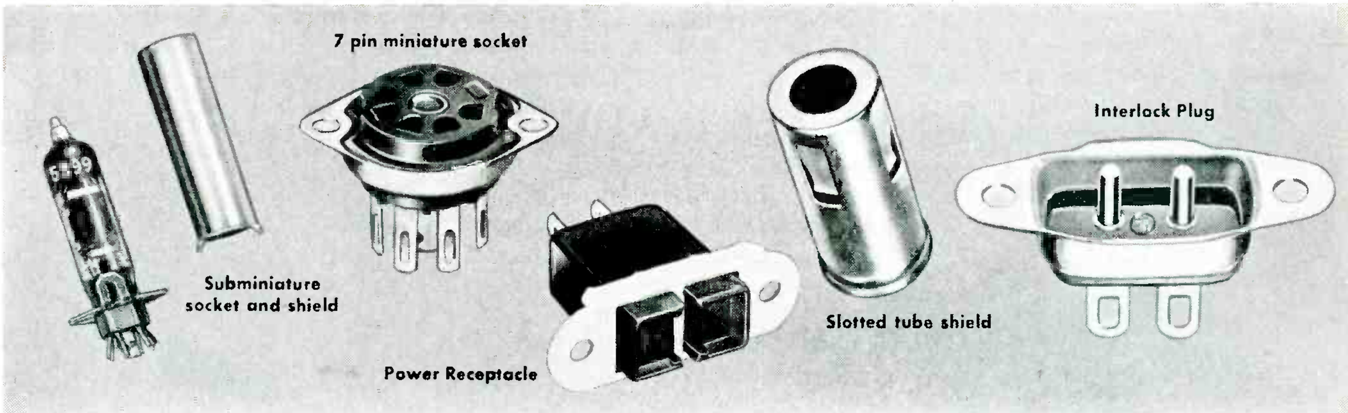
LEE ELECTRONIC LABS., INC., 233 Dudley St., Boston 19, Mass., have developed a new miniature electronic power supply, model PS-1 for use with their model E-C or E-A circuit analyzers. The new unit provides both a-c and d-c test voltages, permitting an extremely wide range of resistance and continuity tests and increases the sensitivity of the aforementioned models to over 200 megohms. It features a miniature selenium rectifier and dual-capacitor R-C filter network in a special circuit, which permits testing of capacitors for leakage with actual d-c voltages applied and quick indication of intermittently open capacitors with a-c applied. It will withstand direct short and all output terminals may be safely grounded without damage.

TRANSDUCERS
of the potentiometer type

RAHM INSTRUMENTS INC., 12 W. Broadway, New York 7, N. Y. The S series potentiometer pressure transducers include a number of instruments in the 0 to 5 and 0 to 30-psi range for the measurement of gage, differential or absolute pressure. The brush of a precision potentiometer is actuated by a change in pressure to produce a change in resistance-ratio or voltage. Small size is effected without sacrifice of resolution or linearity. All instruments in this series weigh 0.43 lb and are 2 in. in length and $2\frac{1}{4}$ in. in diameter. Instruments for operation to 285 C are available. Standard units for operation at normal ambient temperatures can be fluid filled.

MAGNETIC RECORDER
with slanted top design

AMPEX ELECTRIC CORP., 934 Charter St., Redwood City, Calif. Model 350 magnetic recorder for professional and semiprofessional use features a new cabinet design. Sloped at a 30-deg angle, the tape transport mechanism is within easy reach of an operator, sitting or standing. The electronic control panel, also slanted, is just in front of the tape transport. Since all operative units are contained in the upper portion of the console, the machine may be placed on a desk or table if the user does not desire to use the base which is furnished. Pushbutton control permits rapid shuttling between fast forward and rewind, facilitating rapid editing. A two-speed machine, it may be ob-



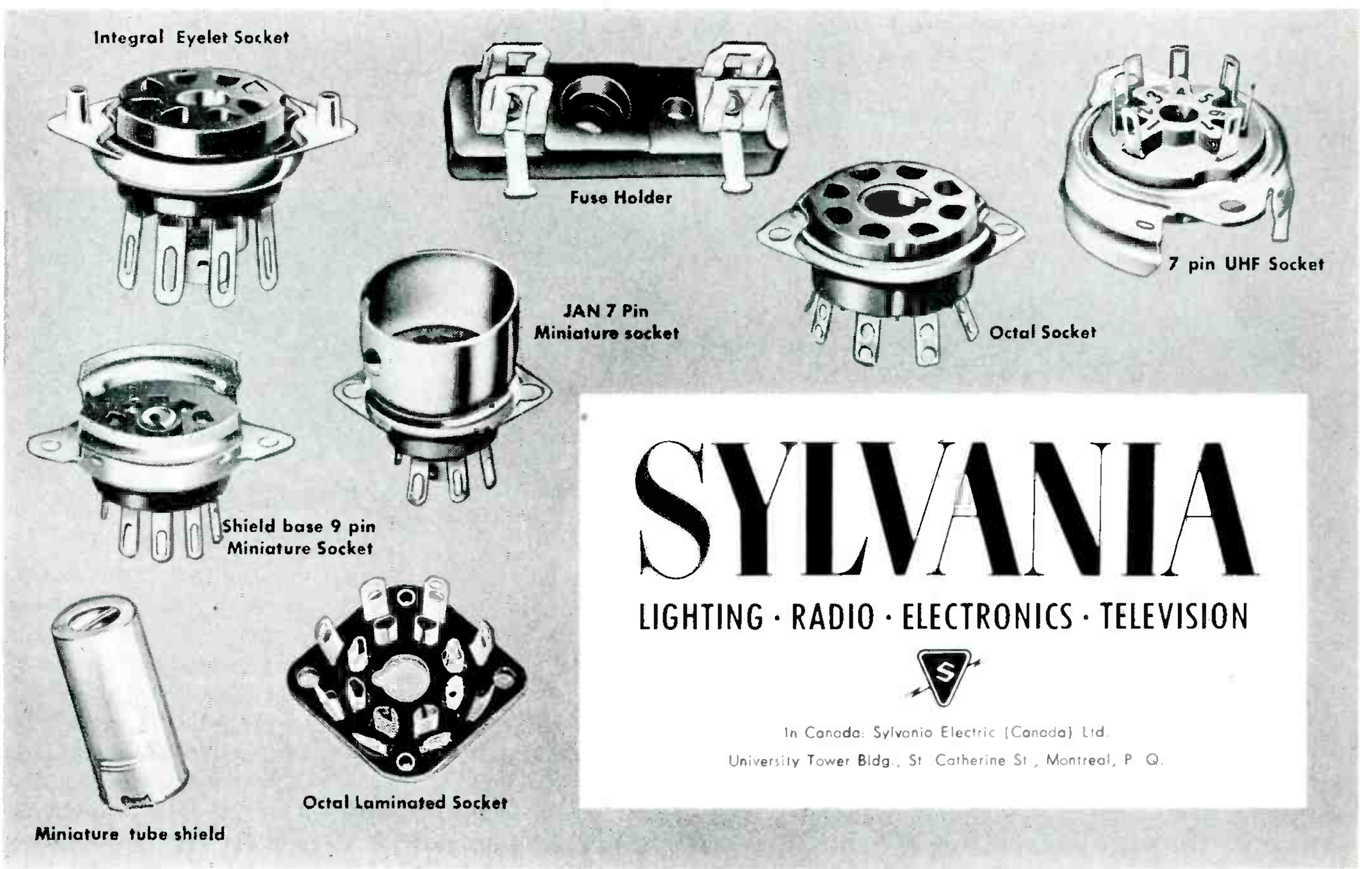
IMPROVED ELECTRONIC COMPONENTS FROM SYLVANIA

SYLVANIA's complete line of electronic components now includes tube sockets, shields, plugs and connectors . . . either standard or precision-made to your own specifications.

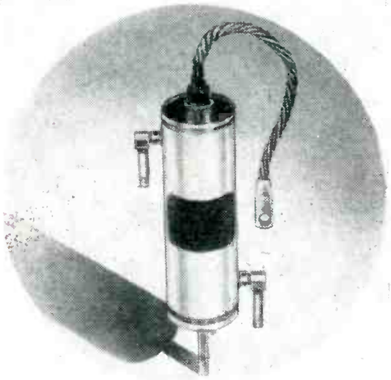
The tube socket line includes both molded and laminated types, supplied for either top or bottom mounting, a wide variety of saddles and with or without center shield and ground connections. Brass, phosphor bronze or beryllium copper contacts are either cadmium or silver plated. Socket insulators include general purpose phenolic, low-loss phenolic, ceramic or NEMA grade laminated phenolic.

Sylvania plugs and connectors are offered to meet every electronic designer's need.

For complete information on any of Sylvania's quality electronic components, write today to: Sylvania Electric Products Inc., Dept. 3A-1010, 1740 Broadway, New York 19, N. Y.

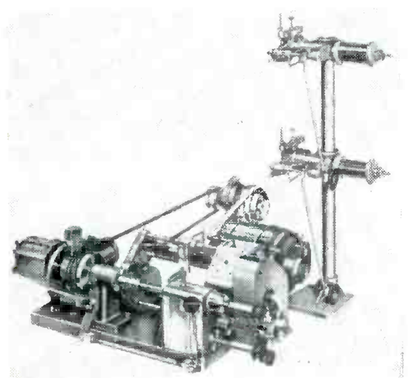


tained to operate at $3\frac{3}{4}$ and $7\frac{1}{2}$ ips, or at $7\frac{1}{2}$ and 15 ips. Frequency response to 15,000 cps is available at both the $7\frac{1}{2}$ and 15-in. speeds. At the $3\frac{3}{4}$-in. speed, response is flat from 50 to 7,500 cps.



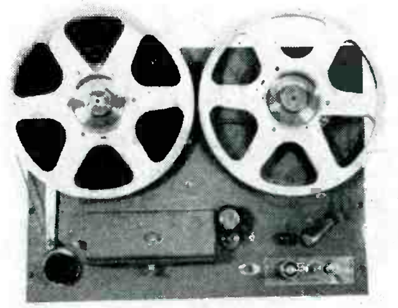
IGNITRON
for a-c control use

National Electronics, Inc., Geneva, Ill., has added a new class-B ignitron to its line of industrial tubes. The NL-5551 is a metal, water-cooled, mercury-pool tube designed especially for welder control and similar a-c control applications. Its rating is approximately equivalent to a 300-ampere magnetic contactor. The tube is a strong, compact design of stainless steel, seam-welded construction. The mercury-pool cathode permits the tube to handle extremely high currents on an intermittent basis.



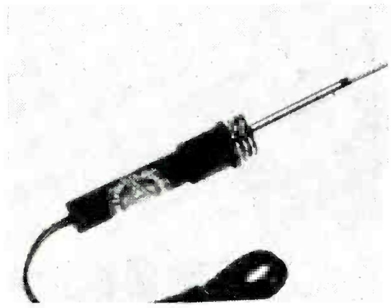
COIL WINDER
features dual head

British Industries Corp., 164 Duane St., New York 13, N. Y., has added a new AVO coil winding machine to the more than 30 models already available in the U. S. The Douglas and Macadie dual-head coil winder is designed for the winding of coils where the setup time is long compared to the actual winding time. While one coil is being wound, the other can be finished and replaced by a new bobbin ready to start another coil. This durable high-speed production machine features a predetermined revolution counter, magnetic clutch for positive control, lead-screw traverse, easily changed gears for quick setup, micrometer traverse adjustment, foot control and tension devices of an advanced design. One of the operating features of the coil winder is a rapid change of direction of the traverse at the end of each layer. This prevents any risk of the wire piling up against the cheeks of the coil. The winder will handle round, square or rectangular coils from $\frac{5}{16}$ in. to 4 in. in length and up to $2\frac{1}{4}$ in. diameter or diagonal. It will handle wires from 47 gage to 26 gage.



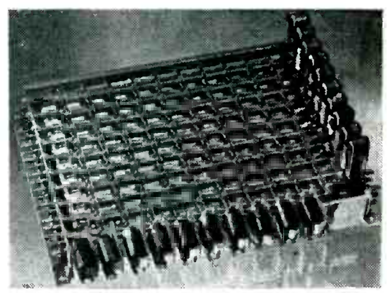
TAPE RECORDER
is self-contained unit

Presto Co., Paramus, N. J. Model RC-11 is a tape-transport mechanism of almost absolute accuracy, with separate heads for recording, playback and tape erasing. Built on a unitized construction principle it employs a capstan drive unit containing a precision motor, endless nylon belt, brass flywheel, capstan shaft, pressure pulley and solenoid. The entire unit is self-contained and instantly removable for maintenance or replacement. It accommodates reels up to $10\frac{1}{2}$-in. diameter and will record at $7\frac{1}{2}$ or 15 in. per second. Brakes and capstan pressure pulley are actuated by solenoids, making the unit ideal for remote control.



SOLDERING IRON
is extremely lightweight

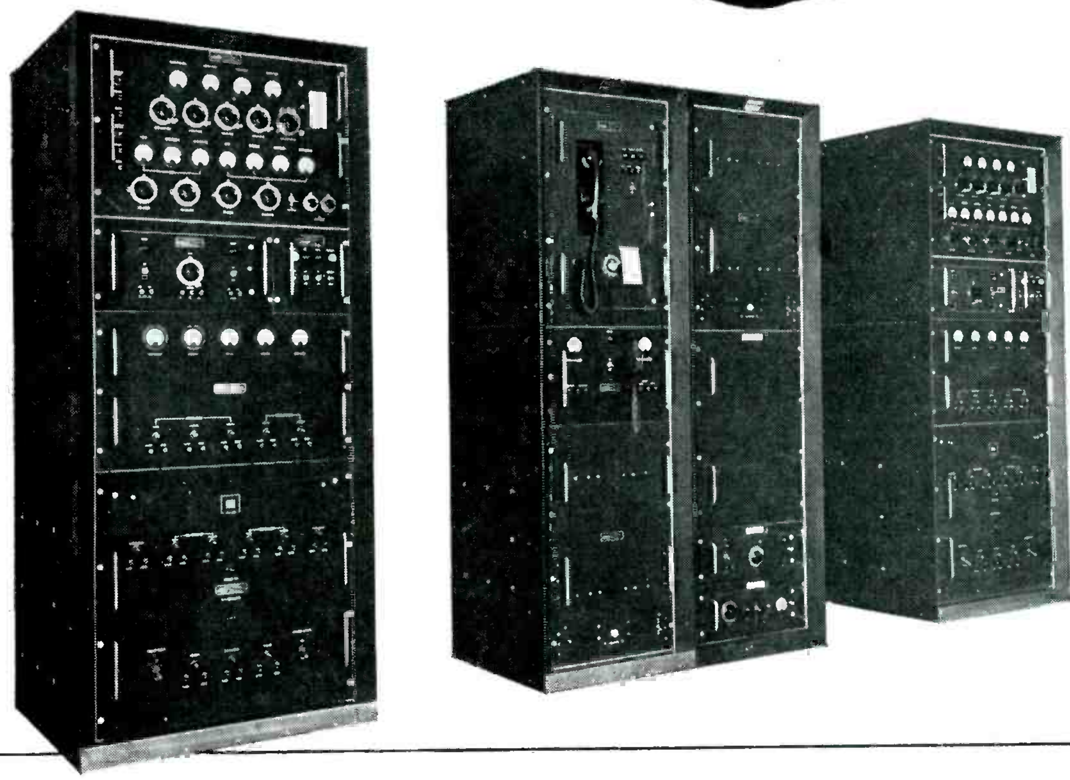
The Lenk Mfg. Co., 30-38 Cummington St., Boston 15, Mass., announces a new pencil-type electric soldering iron for industrial, professional and hobby use. The tool weighs 2 oz and is available in two popular wattage ratings—25 w and 40 w. The handle is made of plastic; the tip is $\frac{1}{8}$ in. in diameter; and the unit measures $7\frac{1}{2}$ in. overall. It is especially recommended for soldering electronic components, precision instruments, radio and tv parts on a continuous speedy production-line basis. Outstanding feature is light weight and perfect balance—both of which materially reduce worker fatigue.



CROSSBAR SWITCH
adaptable to many uses

James Cunningham, Son & Co., Inc., Rochester 8, N. Y., has announced a new type of crossbar switch adaptable to a wide range of uses in multiple switching of audio and video circuits, in computer systems and many other applications. The switch is especially distinguished by its ability to handle high frequencies, its extremely low

Now . . . The Most Compact and Only Complete VOR System



Another Lavoie First

SPECIFICATIONS:

Frequency Range: 112 to 118 megacycles

Frequency Control: Crystal accuracy 0.001%; crystal frequency 12.4444 to 13.1MC.

Power Output 200 watts; power in sidebands 25 watts.

Modulation: Speech 30% AM; Identification Code, 10% AM at 1020 cycles; Reference Signal, 10 KC subcarrier at 30%; frequency modulated ±480 cycles at 30 cycle rate. Equipment is capable of 85% modulation.

Power Requirements: 230 volts, 60 cycles single phase, maximum demand 6 kilowatts, normal demand 4 kilowatts, power factor approx. 85%.

Total Weight: 2250 pounds less antenna equipment.

Lavoie, and only Lavoie, manufactures a complete VOR System for short range aircraft navigation. By its use, accurate course, bearing and position are easily determined.

As perfected by Lavoie Laboratories, Inc., two fields are radiated by the system. One rotates at 30 revolutions per second; the other carries a reference 30 cycle signal in all directions. Only one small control panel in the control tower console, plus an extremely compact amplifier monitor are all that are required for complete, efficient transmitter control. The transmitter itself may be located up to 30 miles from the tower. All control functions, including voice modulation from the tower, are handled by one telephone pair.

Built to military standards of ruggedness and precision, the Lavoie VHF Omni Range system may be used with maximum efficiency in any part of the world. A mobile unit is also available.

We shall be glad to give you complete details on this unique, compact, thoroughly reliable Omnidirectional Radio Range System.

UHF

Lavoie Laboratories, Inc.
MORGANVILLE, NEW JERSEY

Designers and Manufacturers of Electronic Equipment

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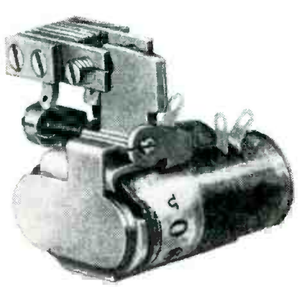
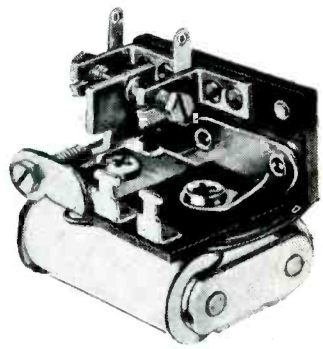
NOW WE ARE CROWING AND WITH GOOD CAWS...





The relay on the right may be recognized as a Sigma Type 5F. In 1943 we regarded it as quite an achievement. Over the intervening years it has done us yeoman service and kept a charmingly large segment of our customers in a state of dithers. (Sometimes because they couldn't get Type 5's, other times because they wished they hadn't!)

But we had come to feel it was, if not obsolete, at least no longer newsworthy, so we don't often speak of it in our advertising. Perhaps we were wrong, because we now observe the very creditable effort of an esteemed competitor (left above) to which he is devoting prominent attention in publicity. His specifications are good, too. 60,000 ohms winding resistance is offered publicly. (We do that sort of thing only on special request. We hate to encourage the philosophy leading to such a requirement.) Maximum sensitivity is given as 1 to 2 milliwatts. We assume they are being conservative because we feel the design is appropriate for ½ milliwatt sensitivity when well executed and well applied (not when used on an airplane!).

The competitor is to be complimented, too, for designing around our patent, a feat he has probably achieved at little or no sacrifice in most applications. We are flattered that he should think our patent strong enough to worry about.

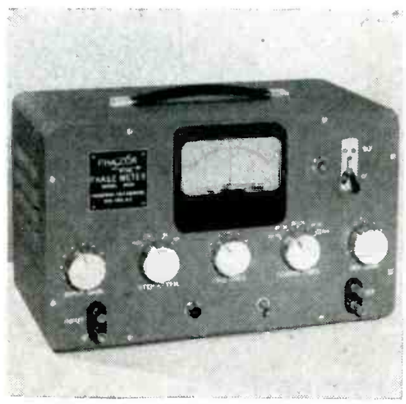
Maybe our venerable workhorse has more glamour than we thought.

SIGMA

SIGMA INSTRUMENTS, INC.

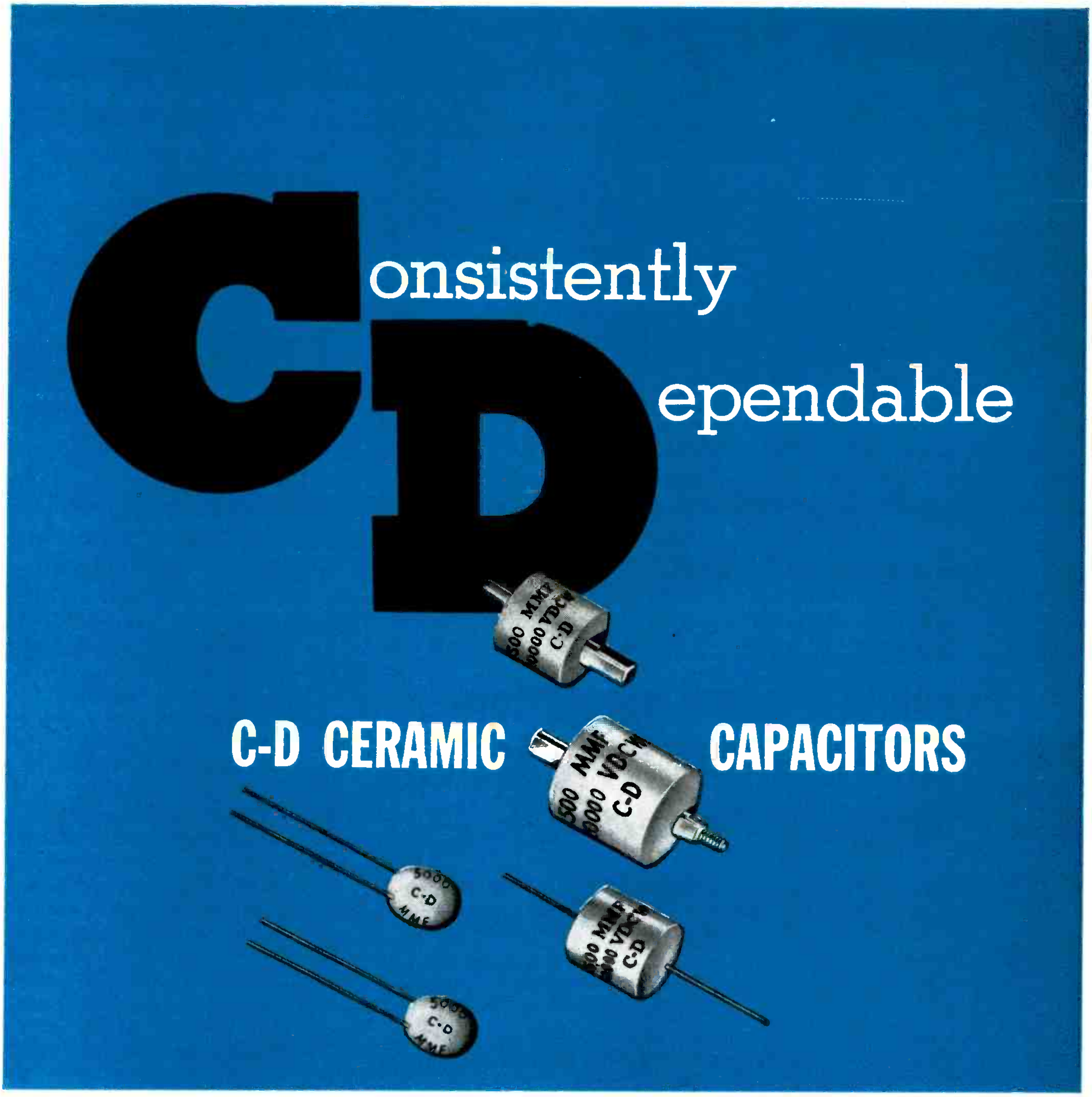
62 PEARL ST., SO. BRAINTREE, BOSTON 85, MASS.

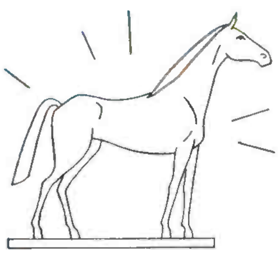
crosstalk level, its rapid operation and its compactness. It is available with 4 or 10 link levels, and either 10 or 25 line levels. Each circuit may have up to 3 conductors. Excellent transmission is achieved at frequencies as high as 70 mc. Bridging capacitance between adjacent conductors is 15 $\mu\mu$f. Crosstalk level between two circuits with common ground, and adjacent in both line and link levels, is down more than 65 db at 10 mc. The unit is particularly suitable for application to tv circuits for studio or master control, monitoring or other purposes. Computers, lab test apparatus, radar monitoring equipment and other devices requiring multiple switching in complex patterns and at high frequencies, also are uses to which the crossbar switch can be applied.



METER measures phase shift

INDUSTRIAL TEST EQUIPMENT CO., 55 E. 11th St., New York 3, N. Y. Model 200A Phazor phasemeter readily permits accurate phase-shift measurements even though the input signal is complicated by noise and harmonic voltages. The device is extremely useful in the measurement of phase shift in transformers, amplifiers, filters and phase-displacement networks. It can also be employed to measure either in-phase or quadrature voltage components. Self-calibrating action assures high accuracy. It measures 0 to 360 deg. Readings are not affected by noise and harmonics. Some other features are high sensitivity, broad frequency range, high input impedance, wide input voltage range and electronic limiting to prevent instrument





The ceramics with the "million dollar" body! Even the body is made by C-D, in the newest, most modern ceramic body plant in the world. You'll be as thoroughly "sold" on C-D ceramics as you are on C-D Dykanols*, micas and electrolytics. Write for Engineering Bulletins to: Dept. K-103, General Offices, Cornell-Dubilier Electric Corp., South Plainfield, New Jersey.

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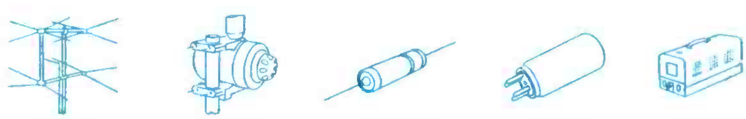
world's largest manufacturers of capacitors

*®



ANTENNAS ROTATORS CAPACITORS VIBRATORS CONVERTERS

SOUTH PLAINFIELD, N. J. • NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS. • PROVIDENCE, R. I. • INDIANAPOLIS, IND. • FUQUAY SPRINGS, N. C. • SUBSIDIARY, THE RADIART CORP., CLEVELAND, O.

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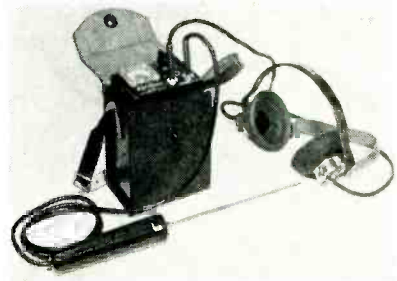
overload. Dimensions are 9 in. high × 15 in. wide × 8 in. deep.

DECADE INDUCTOR
with toroidal construction

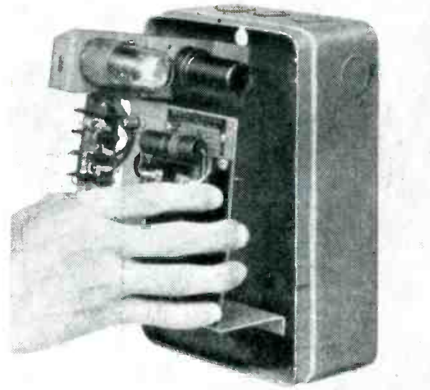
TOROCOIL CO., 1374 Mobile Court, St. Louis 10, Mo., has available a line of decade inductors that are particularly adaptable to design problems involving the need for precision, high-Q inductors such as wave filters, tuned circuits, and elements in oscillators and analyzers, where the advantage of a simple method for component substitution can be obtained over a wide range. The four basic decade steps: 1 to 10 mh, 10 to 100 mh, 100 to 1,000 mh and 1 to 10 henrys, are available as single units. Each range is encased in a heavy drawn metal container which protects it at all times from possible damage, and at the same time acts as an efficient electrostatic shield.

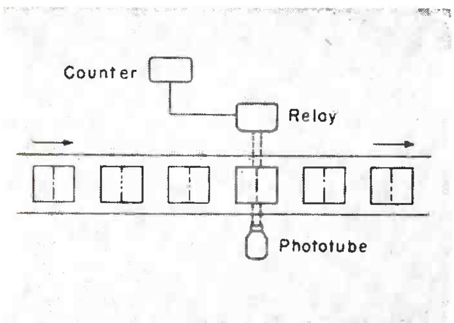


NOISE DETECTOR
has audio-video features

ANCO INSTRUMENT DIVISION, AMERICAN NAME PLATE & MFG. CO., 4254 W. Arthington St., Chicago 24, Ill., has introduced the Elec-Detec

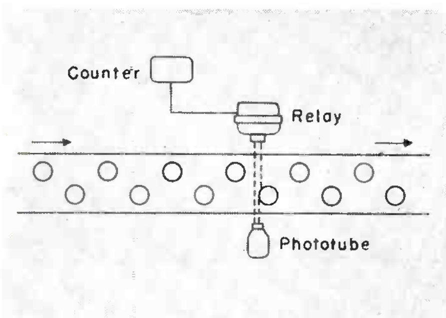
G-E Photoelectric Relays Sort, Count, Signal — Automatically





CR7505-K100
Simple, Inexpensive, Dependable

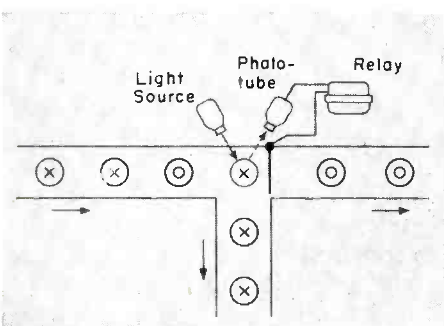
Ideal for applications not requiring extreme accuracy or extra high speeds, the K100 can relieve costly personnel for more productive jobs. A good example is the application at left, where this relay is being used to operate a counter on a conveyor line. The K100 is furnished in a sturdy NEMA Type I enclosure. *Bulletin GEA-3533D.*



CR7505-K201
High-quality, General-purpose Relay

The K201 photoelectric relay, shown at left counting small cans on a high-speed conveyor line, offers sufficient sensitivity and operating speed for most applications.

The K201 is available in either weather-resistant and dust-tight (NEMA III and V) or explosion-proof (NEMA VII) or water-tight (NEMA V). *Bulletin GEA-5920.*



CR7505-N210
High Speed, High Sensitivity

The N210 relay is an extremely sensitive device designed for operation at very high speeds.

In the example shown here, it is used on a conveyor to separate cans according to markings. It can also be used to sort unlabeled cans from correctly labeled ones. Available in same enclosure types as K201. *Bulletin GEA-5921.*

SPECIFICATIONS

Maximum operating speed:

K100: 150 per minute
K201: 450 per minute
N210: 600 per minute

Maximum operating distance:

K100: 30 feet
K201: 70 feet
N210: 210 feet

Sensitivity*:

(Minimum light intensity at phototube for successful operation)

K100: 40 fc.
K201: 3 fc.
N210: 1 fc.

* Depending on combination selected.

High contact rating

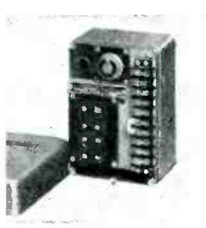
Can start f-hp motors directly, and operates all a-c motor starters through NEMA Size 4, without additional relay. Meets all NEMA standards.

ELECTRONIC TIMER CR7504-A142

Handles timing over three ranges. .06-1.2, .6-12, 6-120 seconds. Highly accurate, versatile. *Bulletin GEA-5255.*

ELECTRONIC RELAY CR7511-A126G2

A versatile new relay which operates wherever there is sufficient change in circuit resistance. *Bulletin GEA-5893.*



FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or authorized G-E distributor, or write General Electric Company, Section B 785-8, Schenectady 5, New York for the following bulletins:

- ☐ GEA-3533D, Photoelectric Relay K100
- ☐ GEA-5920, Photoelectric Relay K201
- ☐ GEA-5921, Photoelectric Relay N210
- ☐ GEA-5255B, Electronic Timer
- ☐ GEA-5893, Electronic Relay

NAME .... TITLE ....

COMPANY ....

ADDRESS ....

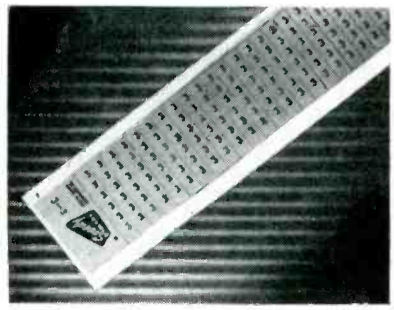
CITY .... STATE ....

ELECTRONIC DEVICES

GENERAL ELECTRIC

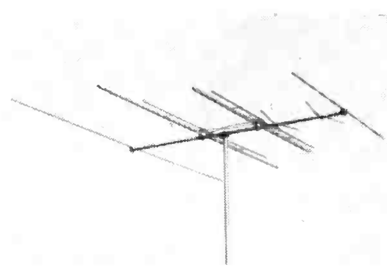
Want more information? Use post card on last page.

model V, a portable electronic instrument designed for locating noise sources in all types of mechanical equipment. The unit includes a milliammeter for checking sound impulses visually, in addition to the standard headphones for audible operation. The accurate performance of the new video unit is assured by the use of a highly stable germanium crystal diode in the circuit. This crystal serves to rectify the current to record the electrical impulses accurately on the d-c milliammeter, and to provide the wide frequency response required.



ADHESIVE MARKERS simplify identification

THE NORTHSHORE NAMEPLATE CO., Glenwood Landing, L. I., N. Y., announces a new line of Speedy Marx identification markers. Using an adhesive stock, these markers can be supplied in easy-to-read type styles, resulting in a simple and permanent marker for wire, transmission cable and other electronic products. Standard cards are available in black-and-white or in any regular NEMA colors. Special coating cards in any size, color or design are also available.



TV ANTENNA designed for fringe areas

WELLS & WINEGARD, TELEVISION ACCESSORY MFG., Burlington, Iowa,

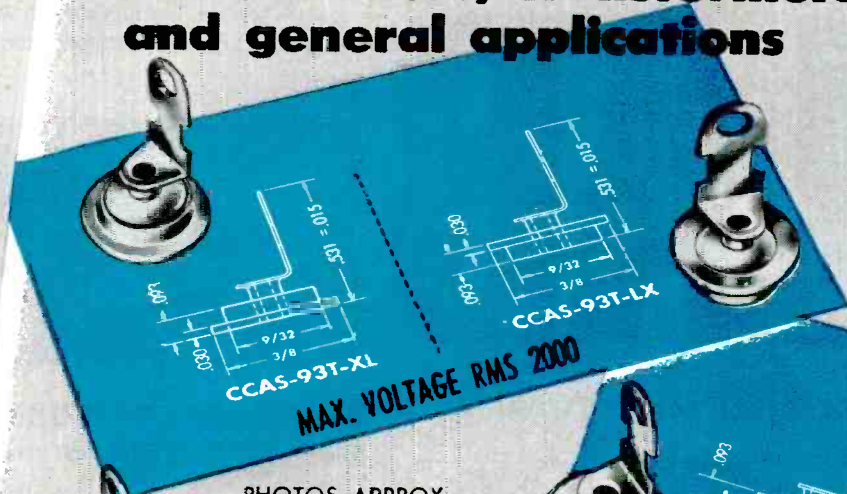
Standardized! To save you time and money–

E-I HERMETICALLY SEALED

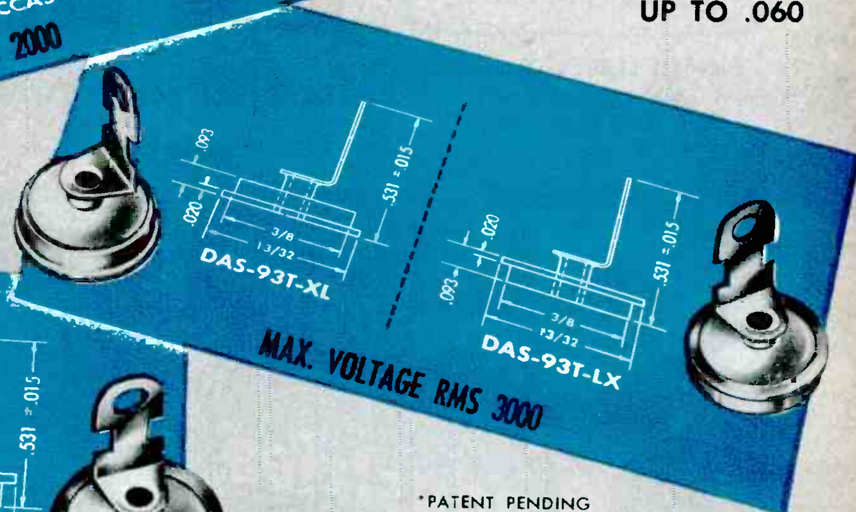
LUG-TYPE, LEAD-THRU INSULATORS

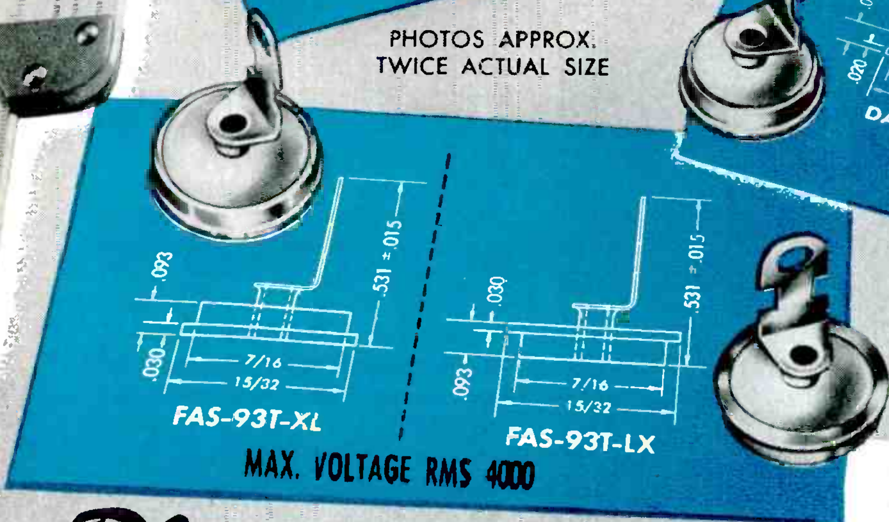
–for condensers, transformers and general applications

- RATINGS FROM 2000 TO 4000 VOLTS (rms.)
- COMPRESSION SEALED
- PRACTICALLY INDESTRUCTIBLE
- MOUNT FROM INSIDE OR OUTSIDE OF CAN
- LEAD THRU WIRES UP TO .060



PHOTOS APPROX. TWICE ACTUAL SIZE





*PATENT PENDING
ALL RIGHTS RESERVED

-*Plus* HUNDREDS OF STANDARD TERMINALS WITH MANY OPTIONAL FEATURES

Designers and engineers can rely on E-I for a quick, economical solution to practically any sealed terminal requirement. More than a dozen years of specialized manufacture assure performance that exceeds specifications. When unusual design requires custom engineered terminals these can be produced by E-I, at unit costs that reflect mass-production methods. Call or write for complete catalog.

E-I STANDARD TRANSISTOR CLOSURES

(SHOWN ACTUAL SIZE)

offering reduced size with soldering dimple, and hole for easy sealing. Available from stock TC-1C can, TB-1B base with long leads. Specify TB-1A for plug-in type. Samples on request. Production from stock.

DIVISION OF AMPEREX ELECTRONIC CORP.

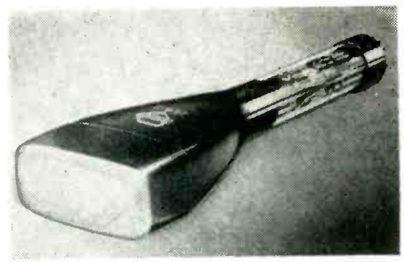
ELECTRICAL INDUSTRIES

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

EXPORT AGENTS

PHILIPS EXPORT CORP., 100 EAST 42nd STREET, NEW YORK 17, N. Y.

has added the model CP-1 Clipper to its antenna line. The Clipper, a high-gain fringe-area unit engineered for complete coverage of all vhf channels, offers high uniform gain, perfect 300-ohm match, one major forward lobe, a narrow beam to reduce ghosts and noise pickup and high signal-to-noise ratio. Good front-to-back ratio also eliminates troublesome cochannel interference. Other outstanding features are its light, rigid construction and easy assembly. The Clipper can be quickly installed to any height, and because of its compactness, offers unusually low wind resistance.



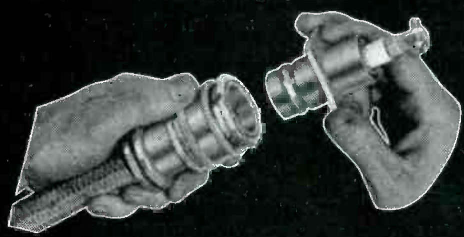
OSCILLOGRAPH TUBE
has 6 in. x 2 in. screen area

MULLARD LTD., Century House, Shaftesbury Ave., London WC2, England, has available the DG16-21 rectangular oscillograph tube. Although developed primarily for radar azimuth-trace applications, this tube should also find use in more conventional oscilloscopes where the packing factor in the horizontal plane is of importance. It has a screen area of 6 in. × 2 in. and is characterized by a high deflection sensitivity and small spot size.

DRUM CALCULATOR
for data processing

INTERNATIONAL BUSINESS MACHINES CORP., 590 Madison Ave.,

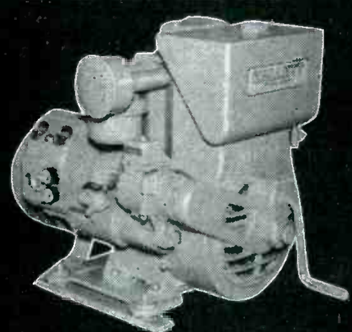
HALLETT



QUICK DISCONNECT COUPLINGS FOR COAXIAL CABLE USE

Investigate the advantages of compact, lightweight Hallett Quick Disconnect Couplings for coaxial cables, TV and radio installations, computers, etc. Manufactured to meet rigid military specifications and all vibration and thermal shock tests. Write for catalog and prices.

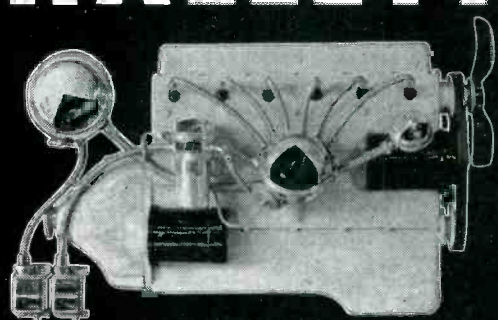
HALLETT



DIESEL ELECTRIC GENERATOR SETS

Hallett dependable full Diesel power from 2½ KW to 10 KW in both water and air cooled models for standby power, portable, mobile and stationary units — also available, bare engines with power take-offs for all power applications from 5 HP to 18 HP. Write for catalog concerning your power requirements.

HALLETT



RADIO INTERFERENCE REDUCTION AND CONTROL EQUIPMENT

Stock kits for most engines and tailor-made for special applications. Hallett radio interference reduction and control equipment is the standard of the industry — positively shields out all noise indefinitely. Manufactured in accordance with Government specifications. Technical data upon request.

HALLETT MANUFACTURING COMPANY

Main Plant: 1601 West Florence Avenue, Inglewood, California, Oregon 8-4751; District Sales Offices: Washington, D.C., 13th and E Streets, District 7-0217; Detroit, Mich., Book Tower Bldg., Woodward 1-9553; New York, N. Y., Grand Central Bldg., Murrayhill 3-4752; Chicago, Ill., 600 South Michigan Blvd., Wabash 2-1343

Gentlemen: Please send me more information concerning:

- [ ] Hallett Diesels
- [ ] Quick Disconnect Couplings for Coaxial Cable Use
- [ ] Radio Interference Reduction and Control Equipment

Name ____________________

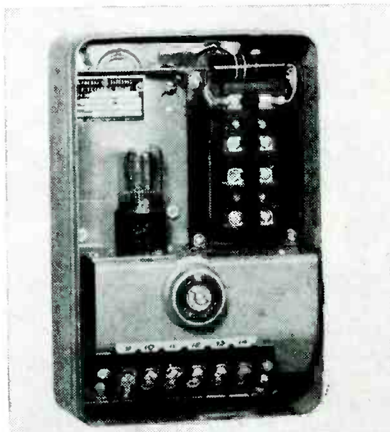
Firm Name ____________________

Address ____________________

City ____________ Zone ______ State ______

Want more information? Use post card on last page.

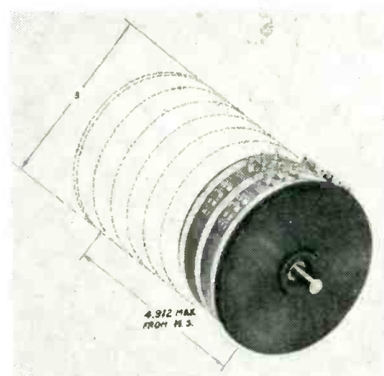
New York 22, N. Y., has introduced the magnetic drum calculator, a new machine that combines one of the advanced memory devices and the stored program concept of IBM's 701 with new high speed reading capacity in the conventional punched card equipment to achieve a powerful data processing machine for commercial and engineering requirements. In addition to its usefulness as an accounting and computing tool, the calculator will be a vital factor in familiarizing business and industry with the stored program principles fundamental to electronic data-processing equipment. A numeric decimal machine, it has up to 20,000 memory positions and can accept as many as 2,000 individual operating instructions to facilitate commercial and scientific computations. It consists of three units: a magnetic drum unit with electronic calculating components, an input and output unit, and a converter.



ELECTRONIC RELAY
is resistance sensitive

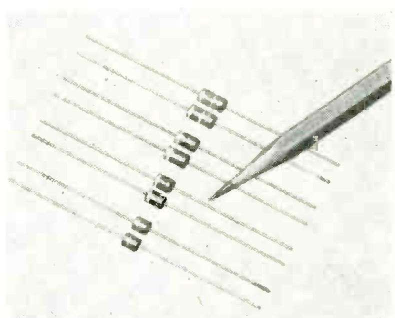
GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new electronic relay that is highly sensitive to resistance changes and can be varied by a stepless dial. It may be used to start or stop a fractional-hp motor directly when a contact-making ammeter, voltmeter or wattmeter reaches a required meter reading. Other uses include liquid-level control, sorting of small parts, and operating of lights, solenoids and contactors wherever there is sufficient change in the resistance of a circuit. Two spdt con-

tacts permit control of independent systems, and a simple jumper change sets the relay for normal or reversed operation. Selection of the most favorable relay operating point is facilitated through a sensitivity dial located on the front of the unit. The dial may be remotely controlled from as far away as 500 ft, and may be locked when set.



POTENTIOMETERS feature high precision

HELIPOT CORP., South Pasadena, Calif., is producing the model L series of 360 deg, continuous rotation, 3-in. o.d., high precision potentiometers. Variations on the basic design include the model L with bushing mounting and sleeve bearings, model LS with servo lid mounting and Oilite bearings, and model LSP with servo lid mounting and ball bearings. Models L and LS have standard linearities of ± 0.5 percent in resistance ranges from 10K to 100K ohms. Other versions with linearities as high as ± 0.1 percent (5K ohms and above) can be manufactured to order.



CAPACITORS for uhf applications

STACKPOLE CARBON CO., St. Marys, Pa., has added to its lines 39 new

PRECISION 60-CYCLE POWER SUPPLY

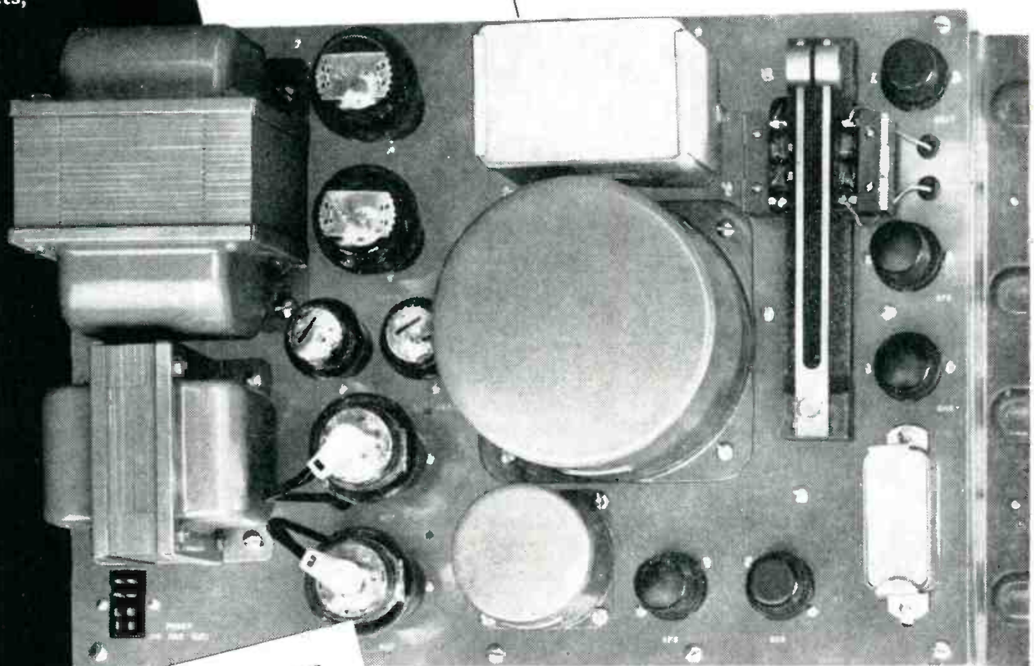
Accurate 60-cycle frequency stabilization with up to 70 watts power output is furnished by the Ampex 375. To provide frequencies other than 60 cycles, the power amplifier section may be independently driven by an external signal generator instead of by the built-in tuning fork oscillator.

The 375 was originally designed to provide the precise 60-cycle power required by Ampex tape recorders. Hence it is ideally suited to any application where constant speed of electric motors is a prime requisite. Typical of these are precision electric motor drives for turntables, stroboscopic timing devices, time bases, timekeeping, high-speed cameras, chronographs, astronomical units, geophysical units and viscometers.

AMPEX MODEL 375

GENERAL PERFORMANCE CHARACTERISTICS & SPECIFICATIONS

OUTPUT POWER:	70 watts
OUTPUT FREQUENCY:	Precise 60 cycles using built-in tuning fork oscillator (temperature coefficient 5 parts per million per degree Centigrade) 50 to 400 cycles using external signal oscillator
OUTPUT VOLTAGE:	0 to 135 volts, continuously adjustable
INPUT FREQUENCY:	50 to 400 cycles
INPUT VOLTAGE:	115 to 125 volts
INPUT POWER:	275 watts
DIMENSION & WEIGHT:	Standard 19-inch rack mounting Panel Height: 12¼ inches Weight: 60 pounds

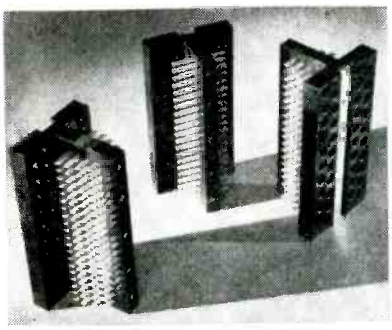


AMPEX
ELECTRIC CORPORATION

Write Dept. E-1038 today for further information

AMPEX ELECTRIC CORPORATION
934 CHARTER STREET • REDWOOD CITY, CALIF.

values in fixed composition capacitors (type GA). The complete range now includes 46 RTMA preferred values from 0.10 μμf to 10.0 μμf, in standard tolerances of 5, 10 and 20 percent. The many new values are designed to meet the growing need for inexpensive, low-value fixed composition capacitors for communications and uhf tv applications. The body of these tiny capacitors measures only 0.160 in. in diameter by 0.150 to 0.400 in. long depending on capacitance. Rated for a working voltage of 500 v d-c, the type GA capacitors are molded from titanium dioxide or other high dielectric-constant body material to provide insulation resistance in excess of 1,000 megohms. Temperature coefficient is less than ±2 percent of 20C value from −55C to +85C.

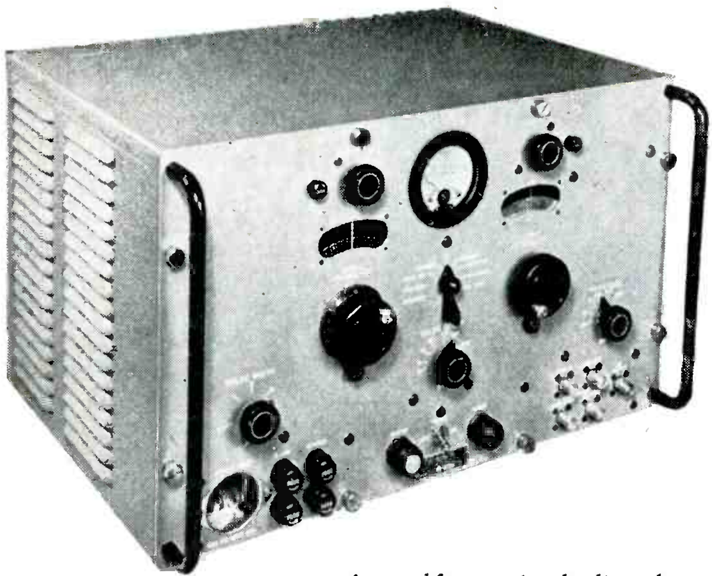


TERMINAL BLOCKS have phenolic structure

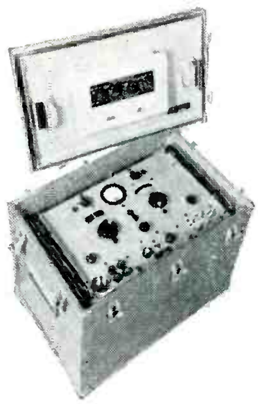
LENKURT ELECTRIC Co., County Road, San Carlos, Calif., has available phenolic terminal blocks for electronic and communications equipment. Four different arrangements are offered providing 40, 60, 80 or 100 pre-tinned, double-notched terminals securely fastened between phenolic strips. The terminal assembly is fastened to a base of the same material. Advantages provided by all phenolic block construction are excellent electrical characteristics, clean design, high structural stability and low water absorption. Specifications and prices are given in bulletin B1-P2.

MOLDING COMPOUND is moisture resistant

SANGAMO ELECTRIC Co., Marion, Ill., has developed Humiditite, a



TS-419/U SIGNAL GENERATOR



This compact portable Signal Generator is a self-contained, directly calibrated generator of continuous-wave or pulse modulated radio frequency signals. It is a reliable source of accurate signals for:

- testing radio and radar equipment in the frequency band from 900 to 2100 MC/S (single dial control directly calibrated to ± 1%),
- receiver measurements and other applications that require less than one milliwatt of CW or pulsed type r-f signals in this band,
- generating delayed and undelayed video pulse that can be used by external equipment,
- accurate determination of small increments of frequency, as required in certain types of selectivity and filter characteristics.

Specifications:

Frequency Range	900 to 2100 mc/sec in one band.
Frequency Stability	Warm up drift less than 0.2%; ambient drift less than 0.005% per °C.
Power Output	Zero dbm to −120 dbm continuously adjustable.
Output Impedance	50 ohms with VSWR of 2:1.
R. F. Pulse Shape	(a) Rise time: less than 0.5 microseconds. (b) Decay time: less than 0.9 microseconds. (c) Flatness: within 10% of amplitude of initial rise.
Modulation	(a) by external pulses, positive or negative. (b) by internal pulse generator. (c) by synchronization to an external pulse generator. (d) by synchronization to an external sine wave generator.
Power Requirement	115 V ± 10%, 50 to 1600 cycles, single phase, 200 watts.
Size	17⅜ inches wide, 10½ inches high, 12 inches deep.
Weight	43 pounds (less transit case).

We will gladly furnish all details regarding specifications, prices and delivery.

Write, wire or telephone for information.

NORTHEASTERN ENGINEERING INC

Manchester, New Hampshire

Telephone 2-6485

Want more information? Use post card on last page.

new molding compound for capacitors used where high moisture resistance is required. The standard moisture-resistance test described in MIL-C-5A (Proposed) Specification requires mica capacitors to offer at least 100 megohms of insulation resistance after ten 24-hour cycles in a humidity chamber at 90 to 95-percent relative humidity. Humiditite micas all tested in excess of 50,000 megohms of insulation resistance. Continued tests — beyond the requirements — proved them capable of withstanding from 21 to 52 cycles (from smallest sizes to the largest) before failure to measure 100 megohms. Engineering bulletin TS-111 contains complete information.

CAPACITOR
is adjustable ±1 percent

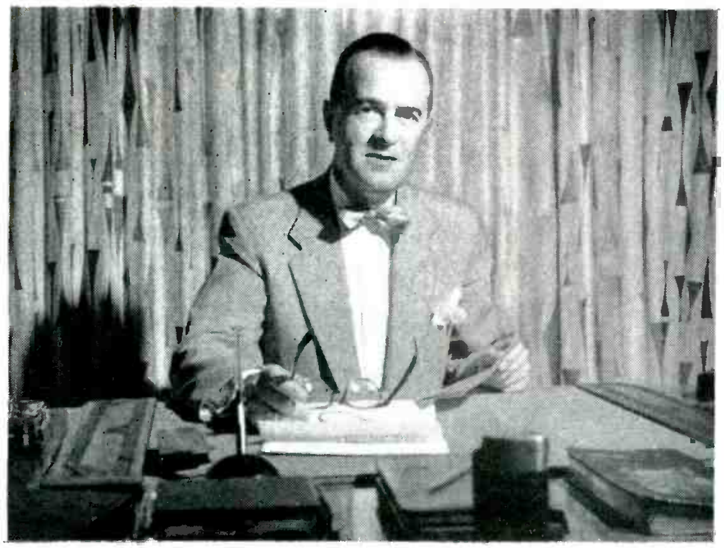
SOUTHERN ELECTRONICS CO., 239 W. Orange Grove Ave., Burbank, Calif., recently developed a capacitor that is being used in high accuracy computation work. Its dielectric material is polystyrene. Capacitance is adjustable ±1 percent from the mean value and is resettable to one part in 10,000. Its dielectric hysteresis, insulation resistance, dissipation factor and temperature coefficient are equal to the highest values obtainable in polystyrene. The 1-μf 330-v hermetically sealed unit measures 2 in. × 2 in. × 1 in.

SILICONE COATINGS
have high strength

MICA INSULATOR CO., Schenectady 1, N. Y., has available a new class

Meet the New President of Sealtron

This is the story of Bill Sage . . . pioneer of the hermetic seal.



William C. Sage

It all started with Pearl Harbor. Electronic equipment designed for temperate climates was rushed to the South Pacific, was put to the test of destructive humidity, fungus, temperature extremes – and failed! The country needed good hermetic sealing and needed it fast!

So, one night, Bill Sage got together with an old friend, an electronics manufacturer, and they thrashed out the knotty problem of providing practical air-tight, water-tight, moisture-tight, insulated terminals—to feed current into hermetically-sealed transformer "cans," sorely needed by the Armed Forces.

Combining his experience in the technical phases of glass making and his training in electrical engineering, Bill saw a way that glass might solve the problem. He worked long nights and before long was "cooking" America's first glass-to-low-carbon-steel hermetic seals, right in the oven of his kitchen stove.

These home-made seals were the forerunners of production-line versions that gave top sealing and insulating performance – stood up under severest tests. * Soon they were on the job out in the Pacific. Bill Sage was in the hermetic seal business for certain now, and he succeeded in helping establish a business that specialized in hermetic seal work.

The more he worked with seals, the more he realized their possibilities in electronics were *limitless*. One large company making complicated radar gear was having trouble soldering miniaturized terminals into a compact panel. Bill suggested using seals as feed-through and stand-off terminals and *further* suggested that Sealtron install the seals in the panel for them. After all, Sealtron technicians with their specialized experience in seal work could do the job faster and cheaper, could take a difficult production problem off their hands.

The manufacturer agreed—and the Sealtron Seal Assembly was born. Since then Sealtron has produced thousands upon thousands of such assemblies, large and small, simple and complex, for leading electronics manufacturers ** all over the country – and saved them countless man-hours and many dollars besides.

Another large radar manufacturer was having trouble with the "close-quarters" soldering of lead wires onto multiple header pins. Bill showed them how Sealtron could butt-weld flexible lead wires onto the pins for them, could save them valuable space with this less bulky connection. Now all they do is slip "spaghetti" sleeving right over the "built-in" flexible leads and connect directly into electronic assemblies.

Today, Bill Sage is realizing the dream that most of us have – he's the head of a Company that exists largely through his own efforts. That's something for Bill to be proud of. And rest assured we're mighty proud of Bill.

* Typical tests—
Pressure—up to 5000 lbs. per sq. inch without failing.
Thermal Shock—dry ice to boiling water.
Insulation—100,000 megohms after water immersion.

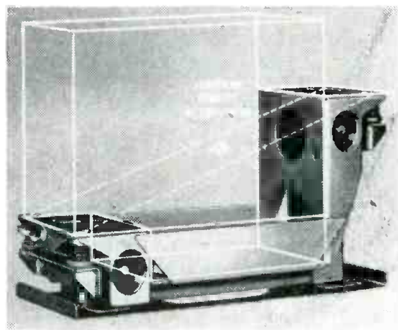
**Names on request.

SEALTRON

SEALTRON CORPORATION

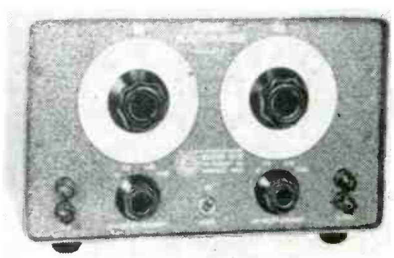
9701 READING ROAD, CINCINNATI 15, OHIO

H silicone-rubber-coated glass cloth insulation with unusually high dielectric strength and increased tensile strength. Both the electrical grade, E-944, and the mechanical grade, E-959, have a dielectric strength approximately twice that required by military specification MIL-C-2194A which requires the material to withstand at least 500 v per mil after conditioning of 96 hours at 25 C and 96-percent relative humidity. Both grades also possess excellent bending qualities due to a high tensile strength. Data sheets are available.



MOUNTING SYSTEM for vibration control

ROBINSON AVIATION INC., Teterboro, N. J., has designed a center-of-gravity type mounting system for use as vibration and shock control in combat aircraft. The MET-L-FLEX (fabricated steel wire) resilient cushions are located at the top and bottom of the the assembly in such a way that the diagonal plane between the top and bottom cushions passes through the center of gravity of the equipment. This provides maximum protection and stability.

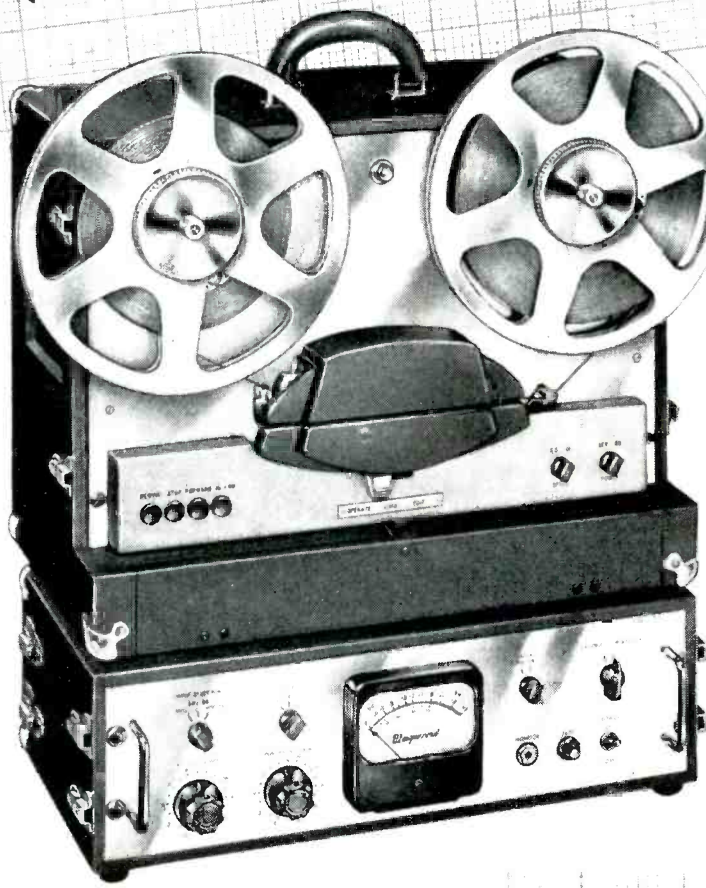


REJECTION FILTER for 20 cps to 200 kc

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39,

The NEW magnecord "M-80"

World's Most Versatile professional tape recorder



★ Slot-loading, easiest tape handling-editing.

★ Push button operation and full remote control.

★ 15,000 cps at 7½ inches

Check these outstanding new features!

- ★ 30-15,000 cps, ±2 db at 15" per sec.
- ★ 50-10,000 cps, ±2 db at 7½" per sec.
- ★ 50-15,000 cps, ±4 db at 7½" per sec.
- ★ Timing accuracy ±3 sec. in 30 min.
- ★ Signal-to-noise exceeds 58 db
- ★ Flutter less than 0.1% RMS at 15 ips.
- ★ Standard NARTB playback curve
- ★ Instant dual speed selection
- ★ Microphone and bridging inputs
- ★ Full or half track operation
- ★ Case, rack, or console mounting

See and operate the brillant new Magnecord M-80 at your dealer's, Look in the classified directory under "recorders".

The new M-80 Console
Amplifier and mechanical unit inverts for servicing. No mounting screws to remove.

Magnecord INC.

Dept. E-10 225 West Ohio Street,
Chicago 10, Illinois

Want more information? Use post card on last page.

Mass. Model 360-A adjustable rejection filter provides either a rejection band in which the gain falls at a rate of 24 db per octave or a sharp single-frequency null. A peaking factor is used to reduce the attenuation at the cutoff frequencies. Both the high and low cutoff frequencies are independently adjustable from 20 cps to 200 kc. Rejection bandwidth is thus continuously variable up to the maximum width covering the entire range from 20 cps to 200 kc. The sharp null may be obtained at any frequency from 100 cps to 50 kc. The unit is especially useful for any audio or ultrasonic work requiring selective amplification and for stabilization of a-c servos. The complete instrument weighs 14 lb.

SELENIUM RECTIFIER rated up to 130 v a-c

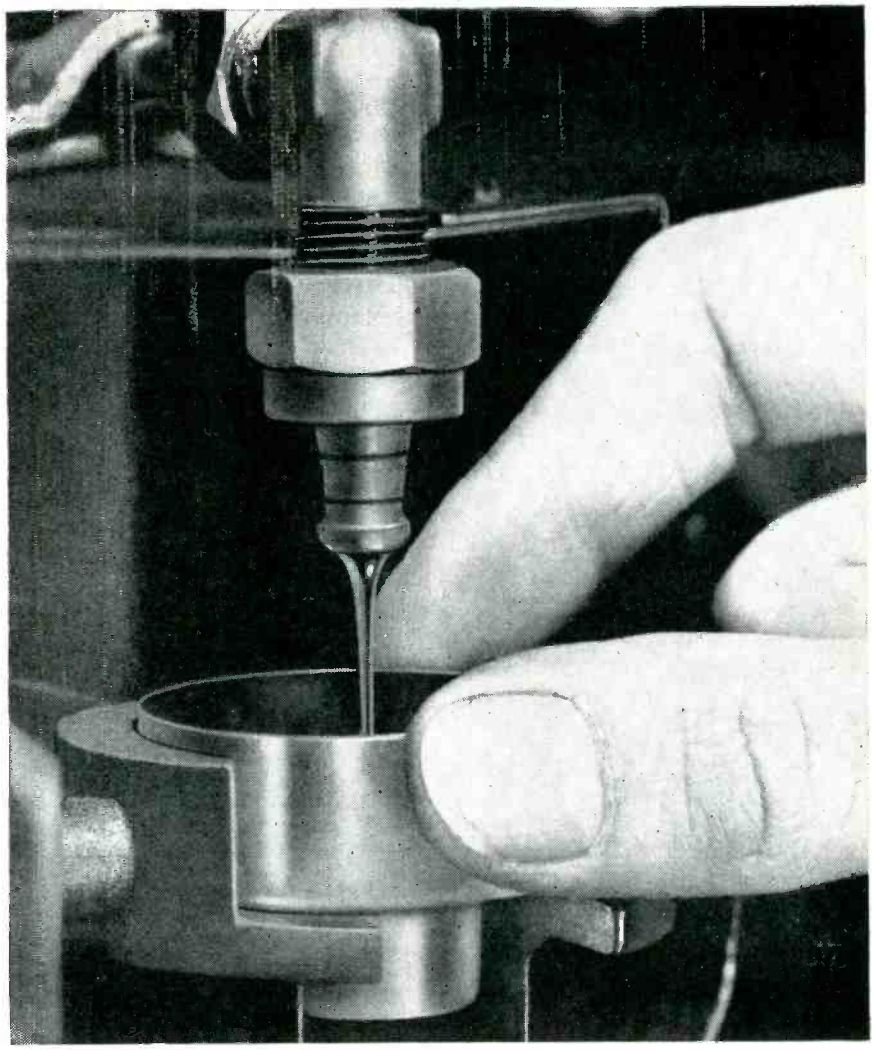
BRADLEY LABORATORIES, INC., New Haven, Conn., has announced a new series of hermetically sealed selenium rectifiers. The new series, designed SE3P, offers greater efficiency and much better heat dissipation than previous similar hermetically sealed units. Rated up to 130 v a-c, 12 milliamperes continuous d-c, the rectifier will meet JAN and MIL specifications for high temperature, vibration, shock and salt spray. SE3P's are designed for use in d-c relays, bias supply and surge suppressors. The unit measures $\frac{9}{16}$ in. in diameter and is $\frac{7}{8}$ in. long.

LEAKAGE TESTER is high-potential unit

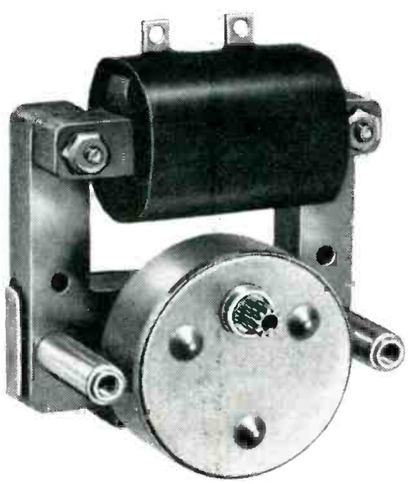
CINETECH CO., INC., 106 West End Ave., New York 23, N. Y., has

FILLING STATION

...FOR LONG-LIFE LUBRICATION



Telechron Synchronous Timing Motors



MODEL H-10. *Low-cost, light-duty motor capable of handling high momentary peak loads. Ideal for washing machines, dishwashers, refrigerators, and other appliance timer uses.*

Seal the oil in with the moving parts, and they'll both last longer. That's the simple reason behind the long, dependable life of Telechron Synchronous Timing Motors.

Into each motor goes a measured amount of special oil—carefully formulated for the particular service the motor is to perform. Then the unit is sealed. Dirt and dust can't get in. Lubricant is lifted by capillary action from the reservoir to all bearings, and flows continuously to all gears, efficiently . . . so efficiently, in fact, that many Telechron motors are still operating accurately and dependably after 20 years of continuous use.

There are other advantages, too, in Telechron Synchronous Timing Motors. Quick starting, due to the lightweight rotor. Power-line accuracy, because of true synchronous operation. Cool running, with the field coil isolated from the rotor unit. Altogether, a combination of worth-while features unique in the field of electric timing.

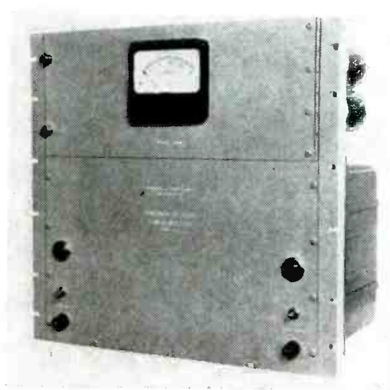
Telechron motors are available in a wide range of speeds and torque ratings, and for any standard AC power source. Get full details. Write Telechron Department, General Electric Co., 410 Homer Ave., Ashland, Mass.

Telechron®

MARK OF TIMING LEADERSHIP

Want more information? Use post card on last page

available a nondestructive device that will determine leakage at elevated potentials in delicate and expensive equipment. The instrument will indicate satisfactory performance when connected to an equivalent resistance of 100,000 to 110,000 ohms at one of three available voltage ranges—300, 1,000 and 1,500 v a-c. It will reject instantly without destructive effects to the equipment under test, when the equivalent resistance of the tested material is less than 100,000 ohms with high voltage applied. This action is so fast that complete safety to the equipment under test as well as to the operator is always assured because the high voltage normally present is immediately removed.

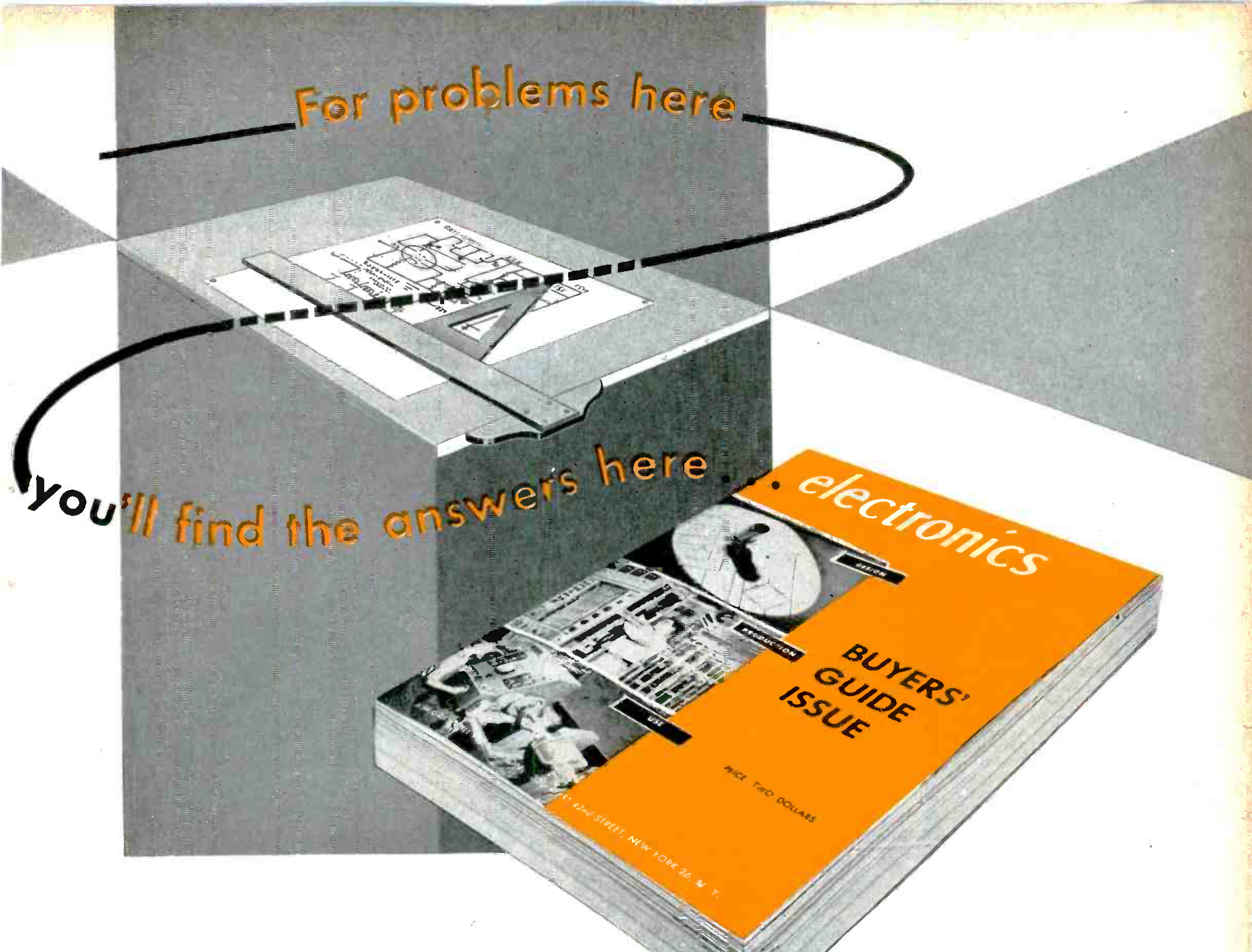


POWER SUPPLY
a variable frequency unit

INTERNATIONAL RESEARCH ASSOCIATES, 2221 Warwick Ave., Santa Monica, Calif. Model D-50 variable frequency power supply can furnish 500 w of power at 115 v a-c. Output voltage is adjustable by means of a level control from 0 to 125 v a-c. The frequency required can be supplied either by a tuning fork, if extreme accuracy is mandatory, or by a variable frequency audio oscillator capable of supplying 3v rms. The unit can be employed for continuous-duty cycles and for applications such as servo-spin tables or "G" tables.

C-R OSCILLOGRAPH
in rack-mounted version

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J. The type 304-AR rack-



It's become a habit . . . looking up product information in the ELECTRONICS BUYERS' GUIDE! The fact is, designers, engineers and specifiers reach for the GUIDE as they reach for their slide rule. They just naturally keep the GUIDE close by them as they work at their breadboards. Designing electronic equipment necessitates fitting in the correct component that is required in the circuitry. What they need is a ready source of information . . . product information that is essential in their work. That's why they always reach for the GUIDE.

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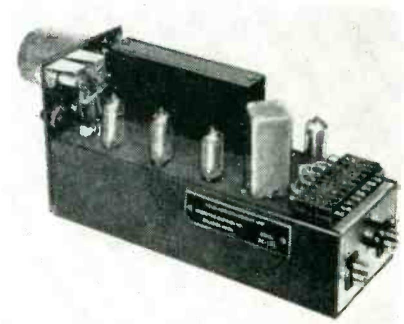
mounted version of the 304-A c-r oscillograph features the same built-in voltage calibration. The illuminated screen is calibrated by a pushbutton control on the operating panel which applies a standardizing potential to the screen. The oscillograph requires only $8\frac{3}{4}$ in. vertically in a standard relay rack. Voltage reading range on a 4-in. scale is from 0.10 v to 1,000 v, full scale. Frequency response is flat at d-c and extends to 300 kc, 50 percent down. Overall dimensions are: height, $8\frac{3}{4}$ in., width, 19 in., depth, $19\frac{1}{2}$ in. Weight is 50 lb.



MEMORY UNIT
in 1 plug-in type chassis

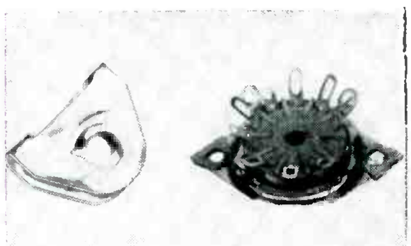
COMPUTER CONTROL CO., 106 Concord Ave., Belmont 78, Mass. Model 3C1–384 memory unit is composed of a solid acoustic delay line and associated circuitry. The unit is a complete package ready for installation in a computer. The design includes the entire memory circuit in one plug-in type chassis. The unit stores 384 bits at a pulse repetition rate of 1 mc. Input voltage requirement into write-erase gate is 10 v. The reshaped output signal level is 15 v into a 100-ohm impedance load. Carrier frequency is 20 mc. All circuits are degenerated, with reserve gain in the wide band i-f amplifier. There is a gain control for initial adjustment of the i-f stage. No tuning is necessary. The unit is especially fitted for airborne use and is insensitive to shock.

SHIELDED ROOMS
suppress r-f radiations

ACE ENGINEERING & MACHINE CO., 3644 N. Lawrence St., Philadelphia

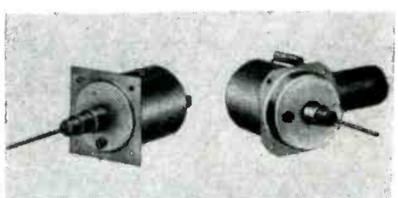
Want more information? Use post card on last page.

40, Pa., has announced a complete line of galvanized single-shielded enclosures for suppressing the r-f radiations of induction heating, dielectric sealing, diathermy, and other industrial and laboratory equipment. They provide more than 40 db attenuation from 14 kc to 400 mc. Up to 66 db attenuation at standard vhf-tv frequencies can be expected. The enclosures consist of a number of standard size panels rigidly bolted together from the inside. Each panel is a frame work of klin-dried, select white pine covered with a single layer of 22-mesh galvanized steel screening. The entire enclosure is easily erected, enlarged or dismantled in just a few hours.



SOCKET SADDLE NUTS give self-locking action

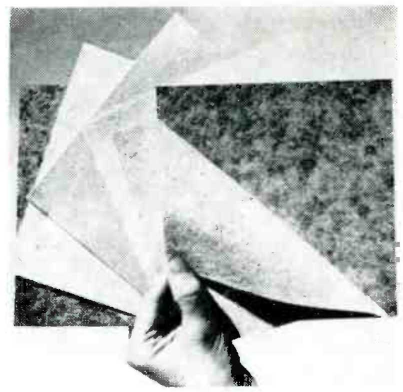
VECTOR ELECTRONIC CO., 3352 San Fernando Road, Los Angeles 65, Calif., has available a new U-nut that slips on the saddles of octal, loctal and miniature sockets. By its use a No. 4–40 mounting screw may be easily driven in without separately holding the nut. It is especially applicable to bottom-mounted sockets and is particularly useful for mounting turret-type sockets as illustrated. The nut is of the helical-depression type and provides self-locking action.



TUNED ELEMENTS available in two types

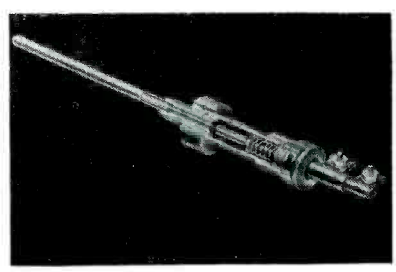
GRANCO PRODUCTS, INC., 36–17 20th Ave., Long Island City 5, N. Y., announces the availability of two

types of uhf coaxial tuned elements. Model UHO is an oscillator element with a built-in 6AF4 tube. Model UHR is a preselector element. Both models incorporate resonant-cavity tuning which features a moving plunger permitting coverage of the entire uhf-tv band. All elements are completely wired and tested.



INDUSTRIAL PAPERS
made of fibrous glass

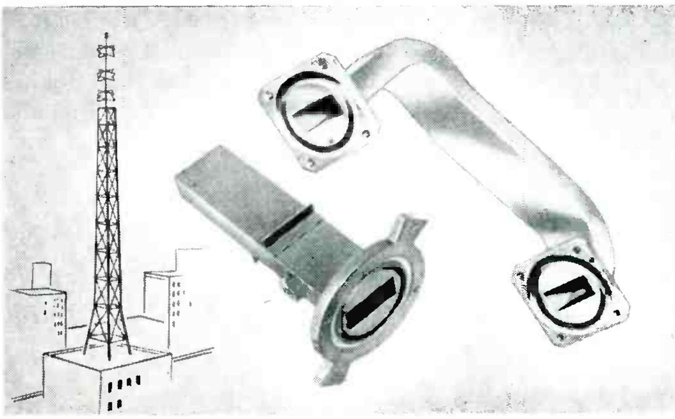
OWENS-CORNING FIBERGLAS CORP., Toledo 1, Ohio, manufactures a fibrous glass which, in its wool form, can be processed and made into incombustible, inorganic industrial papers for the filtration of hot and/or corrosive air, gases and liquids. The papers are also finding application as base sheets in specialty electrical laminates as gasketing material, and as plate separators in aircraft and other special batteries. In such applications, the inherent high temperature resistance and excellent electrical-chemical properties of the product are very desirable.



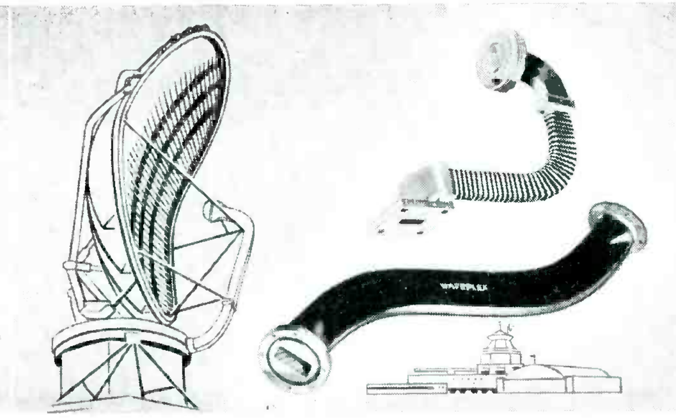
THERMAL SWITCH
for superhigh temperature

CONTROL PRODUCTS INC., Sussex St., Harrison, N. J. The ASA-21-2 is a 2-wire thermal switch designed

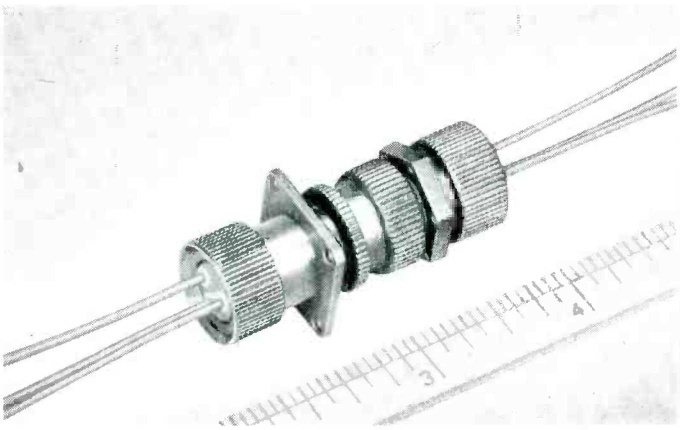
All these from one experienced source



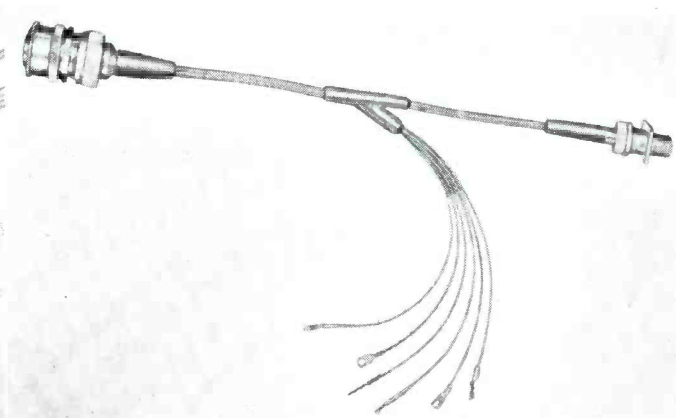
TITEFLEX DESIGNS AND MANUFACTURES— to customer specifications—rigid waveguides and combinations of rigid and flexible waveguides. Where there is, or should be, no movement, or where complicated accessories must be connected, Titeflex *rigid* waveguides are specially recommended.



WAVEFLEX® FLEXIBLE WAVEGUIDES are fabricated to retain critical dimensions — regardless of twisting or bending. Waveflex waveguides make assembly easy, improve design, compensate for expansion or movement. Rubber jacketing protects against weather, corrosion, physical abuse.



TITEFLEX CONNECTOR—lightweight, corrosion and moisture resistant with temperature ranges of —65°F. to +400°F. This connector's insulation properties will permit 3500 volts at sea level, 1200 volts at 50,000 feet altitude. Connector is available with 2 or 3 pins. 7 amperes. Weight ⅔ of ounce. Size 2" in length.



TITEFLEX CUSTOM WIRING SYSTEMS are corrosion resistant, moisture proof, pressure-tight and efficient at temperatures of — 65°F. to +400°F. Can be furnished with Titeflex or standard AN connectors for a wide range of service requirements. Can be sheathed with metal braids, fiber glass or nylon—and jacketed with silicone or other compounds.

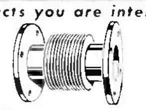
MORE THAN 37 YEARS of developmental experience make Titeflex a logical source of the components pictured on this page. We are currently in a position to supply connectors and wiring systems to makers of aviation and electronic equipment. If you have a problem requiring our unusual combination of products and engineering, let us quote on your requirements. The coupon will bring you information on our products.

Let Our Family of Products Help Yours

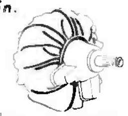
Titeflex

✓ *Check products you are interested in.*

☐ SEAMED AND SEAMLESS METAL HOSE

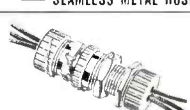


☐ PRECISION BELLOWS

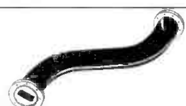


☐ IGNITION HARNESS

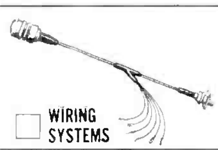
☐ IGNITION SHIELDING



☐ ELECTRICAL CONNECTORS



☐ RIGID AND FLEXIBLE WAVE GUIDES



☐ WIRING SYSTEMS

☐ FUSES

TITEFLEX, INC.
524 Frelinghuysen Ave
Newark 5, N.J.

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for extremely high temperature applications in jet engines, gas turbines, afterburner controls or wherever temperature warning is required to 2,000 F. It is a non-grounded switch and has maintained set calibration for 100 hours at 1,500 F with a variation of only 10 F. It will withstand any degree of overshoot or undershoot up to the ability of the metal to stand the temperature rise, and offers maximum vibration resistance. Contacts are welded on flexing arms for long life.

TAPE RECORDER
weighs only 19 lb

AMPLIFIER CORP. OF AMERICA, 398 Broadway, New York 13, N. Y., has available the Magnematic 110 v a-c portable tape recorder that weighs 19 lb and attains a frequency response of 50 to 15,000 cycles at 7½ ips. Completely operated by push-button control, it features solenoid operated clutch controlled capstan drive to start and stop tape travel within 1/20th of a second. It incorporates relay operated modified Geneva movement to control high speed rewind and 60 ips fast-forward functions. A built-in preamplifier provides for low level, low impedance microphone input.

COIL WINDERS
have variety of uses

REX RHEOSTAT CO., 3 Foxhurst Rd., Baldwin, L. I., N. Y. A line of automatic toroidal coil-winding machines designed and made in Germany is available in 4 sizes for a minimum inner

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diameter of $\frac{5}{16}$ in., $\frac{15}{32}$ in., $\frac{23}{32}$ in. and $\frac{13}{16}$ in. after winding. They are used for winding toroidal coils, filters, variable transformers, rheostats and potentiometers. Rings are revolved automatically through an adjustable gearing, and the feed is adjustable during operation. An adjustable brake is provided. Coils can be wound continuously around 360 deg or in sector forms.

SIGNAL BOOSTER
provides extra i-f stage

GRAYBURNE MFG. CO., INC., 4–6 Radford Place, Yonkers, N. Y., announces production of model TSB-1, an i-f signal booster for uhf and vhf. The unit provides an extra stage of i-f to amplify both uhf and vhf signals without switching. The booster, which is supplied in adaptor form, is installed in an existing tube socket and requires but one wire connection to ground. It is designed to improve performance in near fringe areas, increase picture brightness, amplify signals over 20 percent and clear snow effects.

MEGOHMMETER
tests leakage resistance

FREED TRANSFORMER CO., 1718 Weirfield St., Brooklyn 27, N. Y. Type 1020-B megohmmeter is a self contained and a-c operated instrument equally useful in the lab or for production testing of the leakage resistance of insulation materials, capacitors, cables, motors and transformer windings. Re-

N.L.Instr't

MEASURING INSTRUMENTS by New London

FM Signal Generator **100C**
25 to 216 mc (single range)

FM Signal Generator 100C uses a novel circuit with a variable permeability modulator and a single stage r-f.

There is no beating and no multiplication, eliminating spurious frequencies. Output is from 0.02 microvolts to 0.1 volts. Frequency deviation is from 0 to 250 kc.

FM Signal Generator **I-208-D**
1.9 to 4.5 mc and 19 to 45 mc

With a marker every 2 kc on the low band and every 20 kc on the high, the I-208-D has 1300 calibration points. This requires 25 feet of film—each individually calibrated. Accuracy is kept within 0.03%. Output voltage is from 0.2 microvolts to better than 0.6 volts.

Signal Generator and Power Meter **TS-155C/UP**
2700-3400 mc (S Band)

As a signal generator, the TS-155C/UP, with an output (50 ohms impedance) of -20 to -100 dbm, is widely used for testing radar receivers and transmitters. It can be pulse modulated internally or from an external trigger source.

As a power meter, the TS-155 measures power from +20 to +100 dbm (or up to 200 milliwatts).

Leakage is low—less than 95 dbm.

Panoramic Adapter **BC-1031**
250 kc to 470 kc

The Panoramic Adapter BC-1031 operates on an input frequency of 450 kc to 470 kc with a maximum sweep width of 200 kc.

Used extensively for rapid visual spectrum scanning, it also enables the operator to determine whether transmission is by cw, am, fm, or pulse modulated signals.

The BC-1031 is also used for deviation measurements of FM waves by the methods of dropouts.

Square Wave Generator **150A**
50 cycles to 1 mc

Square wave generator 150A provides waves at five spot frequencies from 50 cycles to 1 mc with a maximum rise time of 0.05 microseconds. Continuous frequency variation can be obtained by using an external frequency control capacitor. A pulse for oscilloscope syncronization is available.

Output is controllable from 0-20 volts peak to peak and is constant at all frequency settings.

for data on our
UHF TV Measuring Equipment

see page 450 of this magazine

WRITE FOR COMPLETE CATALOG OF OUR MEASURING EQUIPMENT

New London Instrument Company
NEW LONDON 1 - CONN.

sistance values are indicated directly on a 4-in. meter protected against overload. It is rapid and safe to use, with test voltage removed from terminals and capacitive component discharged to ground in all positions of multiplier switch. Low resistance in series with components under test provides very short charging time for even the very largest capacitors. Calibration position is provided to check accuracy of 500 v d-c potential. The 500-v test supply is electronically regulated. The megohmmeter's range is from 1 megohm to 2,000,000 megohms in six overlapping ranges selected by a multiplier switch. The unit weighs 18 lb, and measures $9\frac{1}{2} \times 10\frac{1}{2} \times 8$ in.

D-C POWER SUPPLY uses semiconductor diodes

ELECTRONIC RESEARCH ASSOCIATES, Box 29, Caldwell, N. J., announces a new dual tubeless regulated d-c supply especially designed for transistor applications. The new design utilizes semiconductor diodes in a bridge rectification circuit together with saturable reactors to provide for input line regulation. Good d-c regulation results from low diode voltage drop, coupled with the use of low-resistance filter components. Output No. 1, which is rated at 60 ma maximum can be adjusted for any of three ranges: 0 to 1, 0 to 10 or 0 to 100 v. Output No. 2, also rated at 60 ma maximum, yields an output of from 0 to 100 v d-c. Internal impedance is low, being approximately 100 ohms or less. Ripple measures less than 0.01 percent for an input variation of 95 to 125 v, 60 cycles. Maximum power consumption is 20 w. Dimensions are

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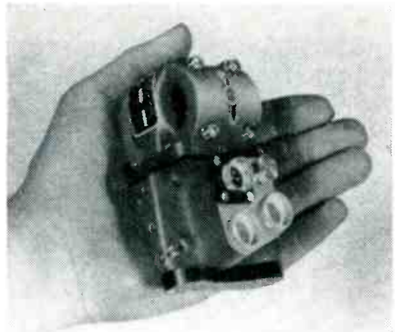
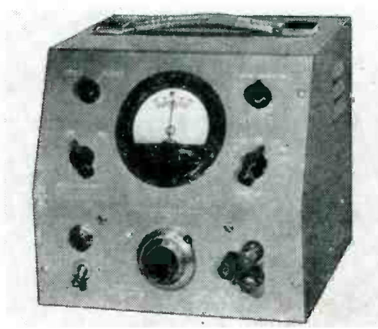
19 in. × 5¼ in., with a 7-in. dust cover depth. Weight is 24 lb.



TINY SERVOVALVE weighs 2.8 lb

MIDWESTERN GEOPHYSICAL LABORATORY, 3401 S. Harvard, Tulsa, Oklahoma. Model 4 miniature single-stage uncompensated servovalve was designed for use in hydraulic servosystems where fast response, reliability and small size are prime considerations. Due to its balanced symmetrical twin-piston design, it will operate smoothly under adverse vibration and lateral acceleration conditions. The valve has no external leakage (a small drain line returns leakage oil to the sump). Both pistons are readily accessible for mechanical actuation and may be utilized for safety limit stops in servosystems. The body and pistons are hardened, precision-lapped alloy steel which insures dependable servovalve operation under dirty oil conditions. The model 4 servovalve may be manifolded directly to the load actuator.



D-C VOLTMETER is lab standard unit

COMPUTER CORP. OF AMERICA, 149 Church St., New York 7, N. Y. Model PVM-4 laboratory standard d-c voltmeter features a resolution

Now... another R.R. JAN TYPE

1N34A

Germanium Diode for military use

with the PLUS factor of polarity at a glance or touch

To the list of Radio Receptor diodes that can be designated JAN type comes another important model — 1N34A. Built to the high standards of this designation, 1N34A as well as *all* Radio Receptor diodes gives you simplified polarity identification. The tapered case speeds up assembly, reduces possibility of error in connecting the diodes into the circuit, which all adds up to lowered production costs.

These JAN type diodes now available for prompt delivery	1N69	1N70
	1N81	*and now* 1N34A

Many other types of diodes are available too, including a range of computer diodes made to meet special requirements. Radio Receptor also makes Germanium Transistors and SELETRON Selenium Rectifiers. Our engineers will gladly study your problems without obligation and submit their recommendations.

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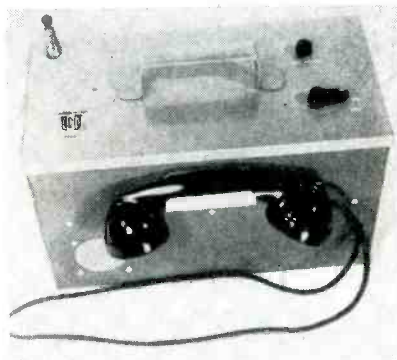
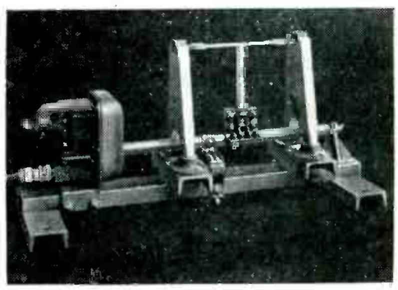
of better than 50 mv over the entire range of 0 to 600 v. The 0 to 10-v scale affords resolution of better than 5 mv in that range. Accuracy is better than 0.2 percent. Linearity is better than 0.1 percent. Input impedance is infinite. The unit is extremely rugged, completely protected against overload, and simple enough in operation to be equally suited to laboratory or production line use. It is expected that the PVM-4 will find wide application, particularly in the testing of power supply regulation, analog computer measurements, meter calibration, capacitor storage measurements and battery voltage measurements.



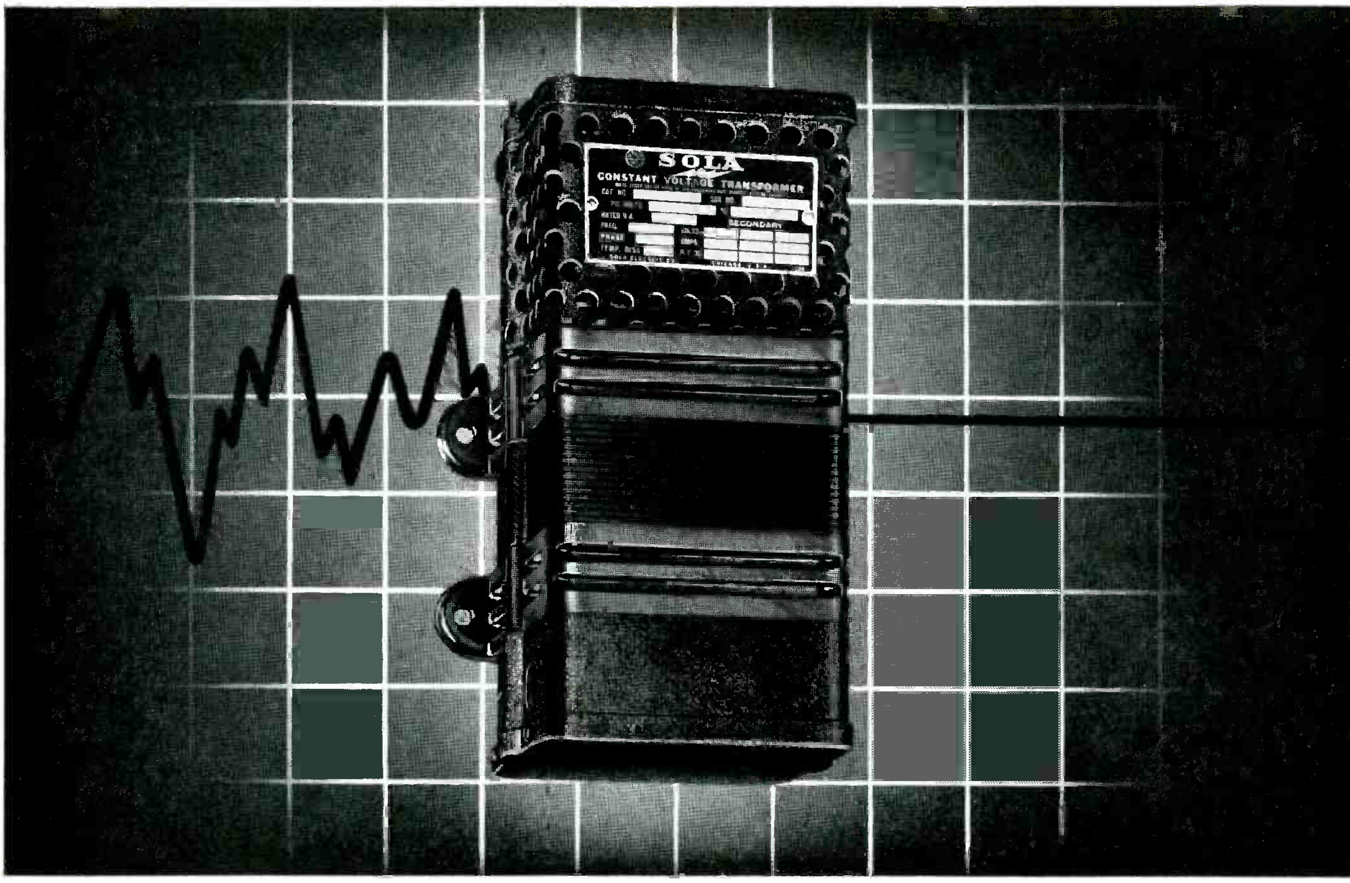
RADIOPHONE weighs only 14 lb

COMMUNICATION RESEARCH & DEVELOPMENT CO., INC., 9530 Aurora Ave., Seattle 3, Wash. Model B-3 emergency radiophone is completely self-contained and weighs only 14 lb. The set utilizes portable-radio batteries and can be supplied for any frequency from 2 to 30 mc with crystal control of both sending and receiving.



SHORTING SWITCH for transmission lines

TRYLON TOWER DIVISION, WIND TURBINE CO., West Chester, Pa., has introduced a new h-f shorting



Automatic, maintenance-free, instantaneous voltage stabilization

Static-magnetic constant voltage transformers are a practical and efficient solution for controlling input voltage to voltage-sensitive electrical and electronic equipment.

Sola Constant Voltage Transformers are widely used both as built-in components and as accessory units. They differ from regulators which depend solely upon saturation of core materials for their regulating action, or electronic types employing tubes. Sola Constant Voltage Transformers have the following characteristics:

1. Regulation within $\pm 1\%$, with primary voltage (transient or continuous) variations as great as 30%.
2. Response time less than 1½ cycles.
3. No moving or wearing mechanical parts, nor vacuum tubes; requires no manual adjustments.
4. Completely automatic, continuous regulation.
5. Self-protecting against short-circuits on output.
6. Current-limiting characteristics protects load equipment.
7. Can often be substituted in place of conventional non-regulating transformers.
8. Generally smaller than other types of regulators for similar duty.
9. Isolates the input and output circuits.

Forty-three Sola stock units are available in a wide variety of ratings, voltages and types. In addition, custom-designed units can be manufactured (in production quantities) to meet specific requirements.

The experience of the world's largest manufacturer of constant voltage transformers is available to you. We invite you to discuss your voltage stabilizing problems with a Sola Sales Engineer.

SOLA *Constant Voltage* **TRANSFORMERS**

WRITE FOR LITERATURE. Sola Constant Voltage Transformers are completely described in a 24 page manual. Write for a copy of D-CV-142 on your letterhead, please.

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Luminous Tube Signs
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PHILADELPHIA: Commercial Trust Bldg., RIttenhouse 6-4988 • *BOSTON: 272 Centre St., Newton 58, Mass., BIgelow 4-3354*
CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • *KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382* • *Reps. in Other Principal Cities*

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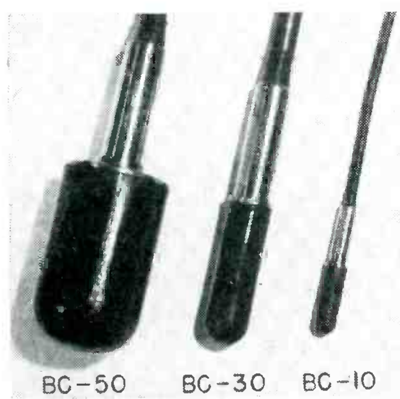
switch for two-wire open transmission lines having 12-in. spacing. Designed for flexible remote control in antenna "parks," the switch can be used for short circuiting two or more frequency tuning stubs; shorting transmission-line accept-reject circuits; or as a grounding device for transmission lines or other high-voltage a-c or d-c circuits. The switch causes a minimum of line disturbance in the open position and is conservatively rated to handle 30 kv wire-to-wire or 15 kv to ground. The heavy steatite-insulated shorting bar is controlled by a low-voltage d-c motor equipped with limit switches and an electromechanical brake that stops the motor instantly at the end of the stroke.

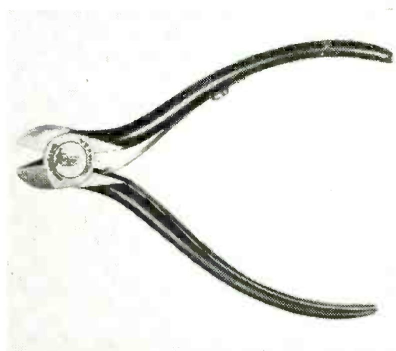


TRANSDUCERS
useful as pressure pickups

ATLANTIC RESEARCH CORP., Alexandria, Va., presents a new series of barium-titanite pressure transducers, models BC-10, BC-30, and BC-50, that are generally useful as transient pressure pickups in liquid and gaseous systems. The gages produce large voltage response (up to 0.6 v psi) flat over wide frequency ranges (3 cps to 75 kc, 1 cps to 40 kc and 0.5 cps to 30 kc, respectively). Sensitive elements of the instruments are hermetically sealed and covered with tough neoprene sheath. Construction eliminates possibility of water leakage. The d-c input resistances are maintained above 500 megohms. These models have withstood transient pressures of 10,000 psi and static pressures in excess of 5,000 psi. The gages are particularly suitable for undergroundunderwater explosion studies, sonar and geophysical exploration.

PRESSURE SWITCH
is 2½ in. in diameter

G. M. GIANNINI & CO., INC., 117 E. Colorado St., Pasadena 1, Calif. Model 44517 pressure switch, of very simple construction and 2½ in. in diameter, is comprised of a pressure responsive element which actuates a switch that can be set at the factory to a predetermined pressure. It can be used in applications that include control system actuation and pressure warning or shut-off devices. The unit will operate within a temperature variation of −54 to +71C and at altitudes up to 50,000 ft. It can withstand and operate under 0.032 in. double amplitude vibration from 10 to 55 cps. The switch section will handle 5 amperes at 125 or 250 v a-c and 3 amperes inductive motor load at 30 v d-c, sea level.



NEW PLIER
shears hardest wire

MATHIAS KLEIN & SONS, 3200 Belmont Ave., Chicago 18, Ill., offers a new kind of plier specially de-

for PROVEN RESULTS *specify*

McGRAW-HILL

Mailing Lists

You can save time, avoid needless expense, increase your results by having McGraw-Hill Lists do your mail advertising job!

Three quarters of a century of practical experience is made available to you when you turn your direct mail jobs over to McGraw-Hill. And these seventy-five years of leadership in the development and perfection of lists *assure you the maximum results at the lowest cost* per order or inquiry.

Those who are acquainted with mailing lists know that year-after-year acceptance of lists does not come by chance or luck. Accepted lists, like McGraw-Hill's, hold their places by merit alone. Nor does success one day guarantee success the next. Vigilant eyes must constantly add new names, delete, change, check, recheck, etc. Inferior lists are dropped as soon as shortcomings are noticed . . . "good lists" yield to better lists.

For seventy-five years expert list users have preferred McGraw-Hill by long odds. No matter how few names you use—whether your business is large or small—the best lists, McGraw-Hill Lists, are the most economical in the long run.

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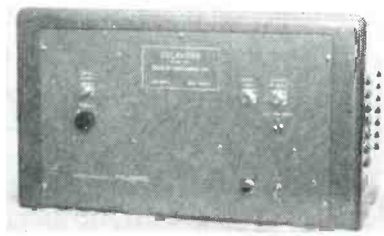
veloped for cutting tungsten filaments, music wire, springs and other hard wire. It operates on a shearing principle which eliminates the need for regular cutting knives. No adjustment is required even if accidentally nicked. A replaceable tempered steel spring keeps the plier in open position, ready for immediate use. Overall length is approximately 5½ in. Refer to No. 053-L for plier with leaf spring and 053 for plier without leaf spring.



HIGH-SPEED COUNTER
requires 100-mv input

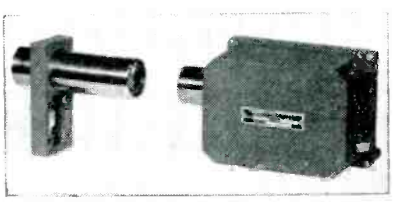
DECADE INSTRUMENTS CO., Box 153, Caldwell, N. J. The Decavider 100-1 is a precision high-speed counter for use in extending the range of standard 100,000-cycle counters to 1 mc. One of the new features consist of an output circuit providing square waves at one-tenth of the input frequency. Another output circuit furnishes sharp positive—or negative—going pulses having a rise time of 0.25 μsec at an amplitude of 40 v. Input requirements are 100 mv, 100 cycles to 1.2 mc. Dimensions of the unit are 18 in. wide x 10 in. high x 12 in. deep.

POWER SUPPLIES
for h-v r-f use

NEUTRONIC ASSOCIATES, 83–56 Vietor Ave., Elmhurst 73, N. Y., have added four new models to their line of high-voltage r-f power supplies. The new models are unusual in that they may be reversed in polarity by a conveniently located lever on the front panel. The reversible feature is useful where data are needed for both positive ground and negative ground hookups, or where quick reversing in polarity is desirable in the kilovolt range. A further advantage offered is the increased usefulness to the laboratory of a single power supply with both positive and negative output. The additions consist of two regulated and two unregulated bench type models.

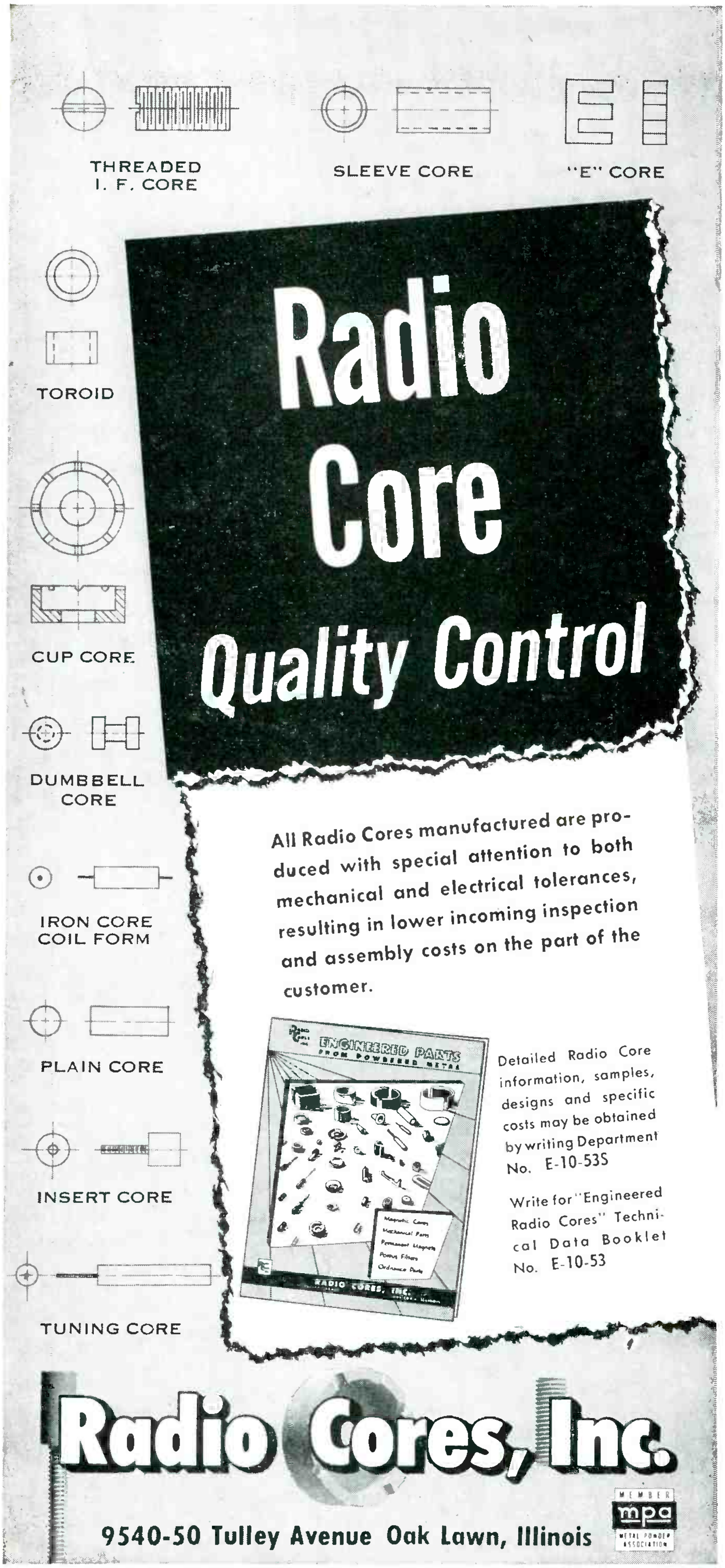
H-F ALTERNATOR
is a tiny, high-speed unit

D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif. Very high power outputs for their size and weight characterize a new line of miniaturized high-frequency alternators. Operating shaft speeds are from 10,000 to 50,000 rpm. The present line includes units with power output ratings from 125 to 4,000 w at 5,000 cps. As an example, the model A-17 illustrated is 2½ in. in diameter, weighs 22 oz, and delivers 350-w output at 5,000 cycles with a shaft speed of 25,000 rpm.



PHOTOELECTRIC UNIT
for plate-circuit control

The Autotron Co., Box 722-H, Danville, Ill. Actuation of electric



counters and other devices directly in the plate circuit instead of through the conventional plate-circuit relay is provided by an improved photoelectric unit called the Shadowswitch. Particularly in photoelectric counting, elimination of the conventional relay makes obtainable much higher counting speeds and increases the service life of counters. The amplifier is preadjusted to maximum sensitivity. Adjustments for specific applications are made with the light beam which can be focused for interruption by objects as small as $\frac{3}{16}$ in. in diameter. Even sharper focus is obtainable through use of an extra lens. The photoamplifier has positive lock tube shields and rubber base tube sockets. Maximum output of the plate circuit is 110 v d-c.

FREQUENCY STANDARD for the 200-11,000 mc range

PRESTO RECORDING CORP., P.O. Box 500, Paramus, N. J. Model 100 microwave secondary frequency standard provides a versatile instrument to generate accurate test signals over the range of 200 to approximately 11,000 mc. Accuracy is ± 0.005 percent. The unit delivers to the 50-ohm input of a typical microwave receiver an uninterrupted series of c-w signals spaced every 100 and 200 mc over the complete frequency range, and 50-mc marker output useful up to approximately 9,000 mc. Signals are all delivered simultaneously without any frequency tuning. The only variable adjustment on the front panel of the instrument is an output level control. Identification of signals in any 200-mc sector is accomplished by comparing their relative amplitudes since the amplitude of the 200-mc signals is greater than the 100-mc signals and the 100-mc output is greater than the 50-mc output.

MINIATURE GEARBOX designed for 300 to 1 ratio

BELOCK INSTRUMENT CORP., 13-11 111th St., College Point, N. Y. The new miniature gearbox features stainless steel construction and ball bearings used throughout. It is designed to meet aircraft vibration specifications and is built to take the Kearfott R-118-1B motor. It can be supplied with any potentiometer having a ⅛-in. shaft to form a packaged miniature servo system. Integrally cut cluster gears substantially reduce backlash to a minimum. The following data were taken while the unit was operating on standard 28-v aircraft supply: output torque, 8 in. oz with maximum backlash of 0.007 in. at the input; starting voltage, 1.5 v; and operation in temperatures from —65C to +125C. Life expectancy is 2,000 hr under normal applications and running conditions. The present design is for a 300-to-1 ratio.

POWER SUPPLY is voltage stabilized

POWER DESIGNS INC., 119-22 Atlantic Ave., Richmond Hill 19, N. Y. Model 351 voltage stabilized power supply is designed to furnish d-c power to equipment where unusually close performance tolerances, rapid recovery time and freedom from transient responses are required. Rated for 100-percent

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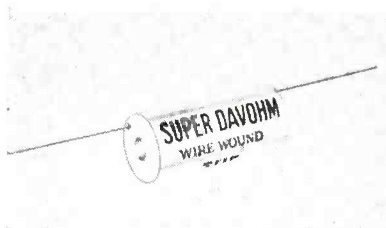
duty cycle, regulation is held to ±0.1 percent for line variations from 150 to 125 v, and load variations from 0 to maximum output current ratings. Ripple and noise level is less than 1 mv; internal impedance, less than 0.4 ohm; recovery time for instantaneous application of full load from a no load condition, less than 8 milliseconds; and stability, guaranteed to within 0.5 percent per day. Operating range is 150 to 350 v d-c with a load of 0 to 150 ma maximum.

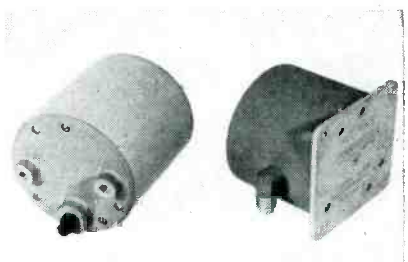
SOLID DELAY LINES
utilize fused quartz

LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass., has announced that its new solid delay lines are now available for applications such as video integration, computers and time markers. These ultrasonic delay lines utilize fused quartz as a delay medium. A delay time of 1 to 3,000 μsec can be provided with a high degree of accuracy. Frequency range specifications are from 5 to 100 mc. Spurious response is up to 60 db below desired signal. The delay lines are of minimum size and weight, and offer many advantages in obtaining precise delay intervals for pulse or modulated signals.



PRECISION RESISTOR
is noninductively wound

THE DAVEN CO., 191 Central Ave., Newark, N. J., has developed the type 1119 precision wire-wound resistor especially for application where a high value of resistance is necessary in a very small resistor size. The new resistor, although it measures only 21/64 in. diameter × 25/32 in. long, is available in values up to 1,000,000 ohms. This unit is rated at ¼ w and is noninductively wound. Standard resistance tolerance is ±1.0 percent; however it can be supplied in accuracies to ±0.05 percent. The unit is designed to withstand severe shock and vibration and will function satisfactorily under conditions of high humidity and extreme temperature changes.

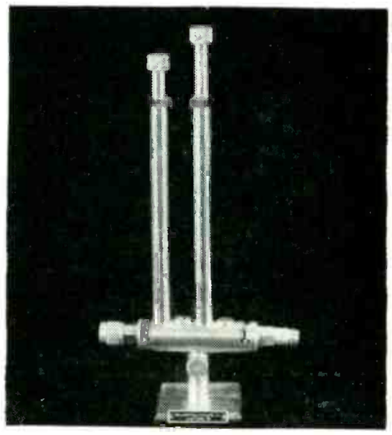


TRANSDUCERS
measure altitude, airspeed

RAHM INSTRUMENTS INC., 12 W Broadway, New York 7, N. Y., has available a series of potentiometer transducers for the measurement of altitude, rate-of-climb and airspeed, in which the brush of a precision potentiometer is actuated by a change in pressure to produce an output linear with altitude, rate-of-climb or airspeed. Indicators of the ratio type are available as monitors. The altitude transducer series covers the ranges from 0 to 70,000 ft; linearities of +0.5 percent over full range are standard. The airspeed transducer series in the 50 to 700 mph range exhibiting ±0.75-percent linearity and 0.25-percent resolution over full range are standard.

C-R OSCILLOSCOPE
for tv alignment

THE HICKOK ELECTRICAL INSTRUMENT Co., 10514 Dupont Ave., Cleveland 8, Ohio. Model 665 is a 5-in. cro with a frequency range from 0.5 cycle to 700 kc, down 3 db. It has excellent stability, no drift, less than 1-percent tilt, and less than 2-percent overshoot. The accelerating potential is 1,775 v and power consumption is 35 w. Square wave response is flat from 60 cps to 100 kc. A dual fuse is provided so that the B-plus line is entirely fused. The scope withstands shock, vibration and humidity, and has been designed with push-pull amplifiers with a vertical sensitivity of 0.020 mv per in. Horizontal sensitivity is 0.030 mv per in. Vertical-input impedance is 15 $\mu\mu$f, 2.2 megohms; horizontal impedance, 52 $\mu\mu$f, 0.1 megohm.



DOUBLE STUB TUNER
for coaxial lines

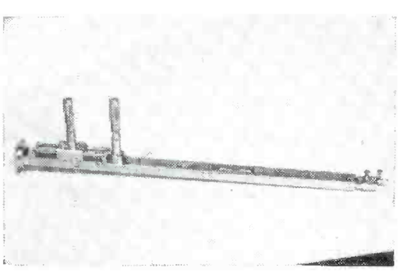
WEINSCHEL ENGINEERING & MFG. CORP., 10513 Metropolitan Ave., Kensington, Md. Model DS-109 coaxial double stub tuner is designed to match a wide range of impedances to a transmission line. This is done by adjusting the tuning elements to provide a variable shunt susceptance across the line. The unit comes with one male and one female type-N connector. The stand can be adjusted for use on lines from 2$\frac{5}{16}$ in. to 3¼ in. in height. The stubs have a travel length of 5$\frac{5}{16}$ in. giving the unit a frequency range of 1 to 10 kmc. The stubs have adjustable stops which can be locked for operation at a fixed frequency with a fixed load. A $\frac{5}{64}$-in. Allen wrench for a No. 8 screw is enclosed to lock adjustable stops.

ACCELEROMETERS
are potentiometer type

RAHM INSTRUMENTS INC., 12 W. Broadway, New York 7, N. Y. A line of linear acceleration transducers are potentiometer type instruments in which the brush of a precision potentiometer is actuated in response to linear acceleration. Special emphasis is placed on a number of low response instruments in the ±1 g to ±5 g range. Damping of all the instruments in this series is accomplished by means of an encapsulated fluid system. All units are 2.5 in. in diameter and between 3¼ in. and 3½ in. in length and weigh 1½ to 3 lb.

MICROPHONE SWIVEL
for desk or floor stand

ATLAS SOUND CORP., 1451 39th St., Brooklyn 18, N. Y. Model SW-1 Gyromatic swivel offers a great many applications in microphone positioning due to its ability to adjust to any angle with any microphone. It swivels through 360 deg and can be used on any desk stand or floor stand. It locks safely in any position by a turn of the locking knob. Length is 4½ in. Male and female threads are ⅝-27.



VSWR CALIBRATORS
for 8,500-9,600 mc range

TECHNICRAFT LABORATORIES, INC., Thomaston-Waterbury Road, Thomaston, Conn., has developed and

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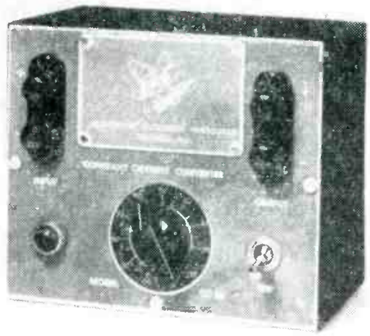
produced a new precision instrument for calibrating and checking waveguide vswr measuring equipment. Supplied calibrated for use over the frequency range of 8,500 to 9,600 mc, the device permits the operator to produce with micrometric accuracy known reflections and determine if the measuring equipment is giving true readings of vswr. Model C64G is currently available for use with test sets incorporating RG-52/U (WR-90) waveguide and, with the addition of a transformer, may also be used with RG-51/U (WR-112) waveguide.



CONVERTER
for transistor applications

Electronic Research Associates, Inc., Box 29, Caldwell, N. J., announces the model CC-60 constant-current converter. It is designed to convert a standard power supply into a constant-current generator for transistor and other applications where constant current is required. The converter is connected externally in series with the standard supply and no rewiring or other modifications are necessary. Substantially constant current is maintained independent of a wide range of load variation. Also, inverse current feedback is utilized which further increases the internal impedance and provides for long-term current stability. Input voltage to the unit can be fixed at any value in the 85 to 300-v range. Output constant current is continuously adjustable from 0 to 50 ma, the higher current being obtained at 300 v input. Current regulation is such that current variation is maintained within 2 percent for output voltage varia-

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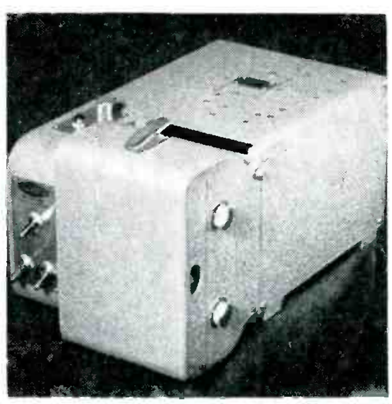
tion, 0 to 150 v. The unit is housed in a 4 in. x 5 in. x 6 in. cabinet and weighs about 3 lb.

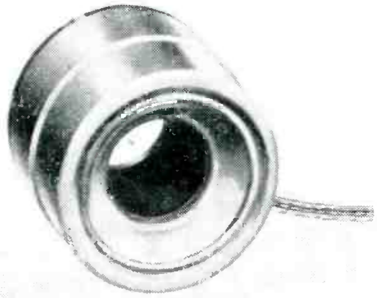
TRANSDUCER
is altitude controller

RAHM INSTRUMENTS INC., 12 W. Broadway, New York 7, N. Y. The altitude controller illustrated is a potentiometer type transducer in which the brush of a precision potentiometer is actuated by a pressure difference. Equal pressure is maintained on each side of the pressure sensitive diaphragm until a solenoid valve is closed entrapping a fixed reference pressure on one side of the diaphragm. The instrument then responds to and indicates differential changes from the reference pressure. Specifications and installation drawings are given in bulletin 653–6 now available.



OSCILLOGRAPH
for flight testing

MIDWESTERN GEOPHYSICAL LABORATORY, 3401 South Harvard, Tulsa, Oklahoma. Model 580 oscillograph was designed for dependable operation as a flight-test instrument, although it is equally useful in other field and lab applications. Among its more important features are: (1) 14 channels of separate data; (2) rigid cast aluminum alloy construction; (3) full-width timing lines at 0.01 sec with ±0.1 sec lines accentuated or 0.1 sec lines only; (4) shutter-type g proof precision timer; (5) trace identification (beam-interrupter type); and (6) record numbering. The oscillograph speeds may be varied through a wide range by a positive gear drive. The company offers a wide variety of precision galvanometers for use in this oscillograph which have undamped natural frequencies up to 3,500 cps.



TESTING YOKE eliminates down time

SYNTRONIC INSTRUMENTS, INC., 100 Industrial Road, Addison, Ill. Costly down time is completely eliminated in testing c-r tubes with the new magnetic deflection yoke now available. From 150,000 to 250,000 tubes may be continuously tested without yoke damage or failure. Three types, identical except in deflection angle, are available. Type Y29 has a deflection angle up to 50 deg, type Y29-2 up to 70 deg and type Y29-4 up to 90 deg. The three types are available in 8.5-mh, 13.5-mh and 24-mh horizontal impedances, and in 3-mh, 40-mh and 60-mh vertical impedances in any combination. Any $1\frac{1}{2}$ in. neck diameter c-r tube may be tested.

Literature

Relays and TV Deflection Yokes. Davis Electric Co., 230 N. Spring St., Cape Girardeau, Mo. An illustrated catalog of Decohm products is now available. The 8½ x 11-in. booklet is printed in three colors and lists complete technical data regarding the various molded-coil type open relays, hermetically sealed cannister type relays and tv deflection yokes. Information is included on the operating characteristics, range and sensitivity of the devices.

Magnetic Deflection Yokes. Syntronic Instruments, Inc., 100 Industrial Rd., Addison, Ill. Three new deflection yokes for military and oscilloscope applications are described in a new catalog page now available. Type Y15-5 is illustrated. Complete technical information is given, including dimensional drawing, electrical and mechanical data, and complete tables of push-pull and single-ended deflection coil data.

Servocalculator. Technology Instrument Corp. 531 Main St., Acton, Mass. Laboratory Report No. 7 features the theory and application of the Servocalculator. Derivation of Servocalculator scale, as well as examples of basic equation and its solution by the device are explained. Accuracy limitations are defined, with explanatory reference to treatment of functions with end resistance and changes of slope sign.

Transducers. Rahm Instruments Inc., 12 W. Broadway, New York 7, N. Y. Catalog 653 details a number of types of potentiometer transducers for the measurement of pressure, altitude, airspeed and acceleration. It gives an illustrated description, along with performance data and environmental data for each. The information contained therein may be augmented by a request for detailed specifications covering any instrument of the general types outlined.

Shop Equipment. The Industrial Bench & Equipment Mfg. Co., 98 South St., New Britain, Conn., has issued catalog No. 653 describing its steel shop equipment. The catalog features many new items in laminated wood top benches, smooth top steel benches, pressed steel bench legs, steel bench drawers, all steel work stands, all steel machine stands, steel tote boxes, welding benches, bench parts and accessories. Construction, sizes, styles and other data are included.

Voltage and Current Standard. Radiation, Inc., Melbourne, Florida. A single-page bulletin illustrates and describes the type M-DC-2 super-regulated voltage and current standard. The instrument discussed is designed for general laboratory and production use, and replaces the potentiometer and its accessories, such as galvanometers, standard cells, power supplies and precision resistors. Complete technical specifications are included.

TV Film Accessory Equipment. Radio Corp. of America, Camden, N. J. Catalog B.375 covers a line of Neumade film accessories designed and selected to accommodate practically every editing and film handling need of tv broadcasters for 16-mm programming. The new equipment listed includes film splicers, rewinds, viewers, measuring machines, editing tables, storage cabinets, reels and other handy accessories.

"Dag" Dispersions for Industry. Acheson Colloids Co., A Division of Acheson Industries, Inc., Port Huron, Mich. A 4-page folder lists 37 products of its current "dag" dispersions for industry. The tabulated data gives information on dispersed substance, carrier, solids content, particle size, consistency, density, diluent agitation before use and typical applications. The pamphlet is available upon request.

Transformer Catalog. Chicago Standard Transformer Corp., Elston & Addison, Chicago 18, Ill. A new 24-page booklet carries complete electrical and physical specifications on almost 500 transformers for radio, tv, high fidelity, amateur, military and other electronic applications. There are 25 new units listed, including 13 tv components and 5 transistor transformers. The tv section has been increased to 4 pages, listing 129 tv components. The high-fidelity section has been expanded to include the new miniature audio transformers and more detailed information on the Stancor-Williamson amplifier. A cross index chart between obsolete power transformers and the current 8400-series power transformers has been included.

Power-Line Carrier. Westinghouse Electric Corp., 2519 Wilkens Ave., Baltimore 3, Md. A 16-page booklet describes the new type FD power-line carrier equipment. The carrier assemblies most commonly used for such functions as relaying, telemetering, supervisory control, remote control, teletypewriter service and telephone service are described, with photographs of the assemblies. Such features of the equipment as crystal control, selectivity and sensitivity are discussed. Ask for booklet 84-000.

Electric Test Equipment. Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J. Catalog No. 19A is a 12-page electric test equipment booklet now being offered by the company. A large selection of electric test instruments for both laboratory and production applications are listed along with full specifications on each. In addition to the instruments, necessary accessories and test jigs are listed and described.

Ceramic Products. Stupakoff Ceramic & Mfg. Co., Latrobe, Pa. Bulletin 653 is a 4-page brochure on the company's products for the world of electronics. Included are photographs and descriptive details on: glass-to-metal seals, steatite and other ceramics, printed circuits and ceramic-metal assemblies. A section also is devoted to a description of the characteristics of Kovar glass-sealing alloy.

Electrolytic Capacitors. Astron Corp., 255 Grant Ave., East Newark, N. J., has announced availability of its new catalog supplement, AC-3A, for its expanded line of twist-prong electrolytic capacitors. The new supplement provides complete listings of catalog numbers, capacitance and voltage ratings, case sizes and list prices of all standard twist-prong capacitors to fulfill every radio and television replacement need.

Precision Potentiometers. The Gamewell Co., Newton Upper Falls 64, Mass. A new booklet describes the company's line of linear and nonlinear precision potentiometers. In addition to descriptions of standard products and condensed specifications, the booklet discusses windings available and contains a glossary of terms used by engineers working with potentiometers.

Magnetic Ferrites. Mullard Ltd., Century House, Shaftesbury Ave., London WC2, England, has issued a comprehensive source of reference on Ferroxcube magnetic ferrites. This 46-page publication should prove of considerable value to the equipment designer. It comprises five chapters. The first chapter gives an historical survey of magnetic ferrites followed by details of their physical structure. The second chapter deals with the electrical and magnetic properties of Ferroxcube. Subsequent chapters are devoted to the mechanical properties of the material, application data and standard core shapes and dimensions.

Electronic Control Equipment. Haledy Electronics Co., 57 William St., New York 5, N. Y., has available a new 4-page folder, No. 453, that describes and illustrates the use and application of controls for industrial and test equipment, featuring electronic counters, photoelectric equipment, relays, timers and liquid-level equipment.

Electronic Design & Production Facilities. Manson Laboratories, 207 Greenwich Ave., Stamford, Conn., have released an 8-page booklet describing their facilities devoted to special projects for the design and production of electronic and electromechanical instruments for laboratory and industrial use. A number of their products are illustrated, and pertinent data are given regarding their specifications and performance. Notable among the products described and illustrated are: regulated d-c power supplies and h-f pulse and multiple-pulse generators with a wide variety of characteristics; transmitting-tube checkers and modulators for testing magnetrons, pulse and microwave components at all power levels up to 40 megawatts peak power; and test equipment for the wire and cable industry.

Fiber Glass Yarns. Libbey-Owens-Ford Glass Co., Toledo 3, Ohio, has announced a new folder giving technical data on fiber glass yarns for electrical insulation. Tensile strength of the yarns described (250,000 lb per sq in.) permits tight, fast wire covering and coil taping even at extremely high operating temperatures. The folder contains complete information on standard packaging yarn specifications, and data on thermal conductivity, heat and acid resistance, moisture absorption, insulation resistance, dielectric strength, and cites numerous specific applications.

Transistor Bulletins. Electronic Research Associates, Inc., P.O. Box 29, Caldwell, N. J., offers a new bulletin on available types of transistors, manufacturers and other supplementary data. Also available is a several-page bulletin on the model TT-11 transistor tester. Data are also available on the model CC-60 constant current converter and the model-110 transistor power supply.

Electronic Load Weighing. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. How to weigh the contents of tanks, bins and hoppers electronically with type SR-4 load cells is explained in bulletin 4106, a new 8-page, illustrated brochure. The bulletin covers installation design considerations, such as mountings, temperature effects and vibrations; indicating and recording instruments; weighing accuracy; and the company's engineering services. A questionnaire designed to provide the data needed in specifying proper SR-4 weighing equipment is included.

Design Engineering. Designers for Industry, Inc., 2915 Detroit Ave., Cleveland 13, Ohio, has published a 4-page folder that describes the importance of designing industrial products for both function and appearance in meeting required standards of performance, size, weight and cost. It includes all the steps involved in design engineering, from preliminary design through the building and testing of prototypes. Three typical products are pictured with descriptions of design features, plus a partial listing of over 70 designed and commercially developed products.

Measurement Instruments. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio. "Instruments for Modern Measurements" is the title of a new 34-page book published in two colors. It illustrates and describes over 37 different instruments, especially engineered and produced for: electrical measurements, physical measurements, resistance-welding measurements, textile measurements, ultrasonic energy applications and electro-acoustical measurements. The booklet will be of special interest to research engineers, methods and production engineers, factory superintendents and other production and research executives.

Plastic Components. Tri-Point Mfg. & Development Co., 401 Grand St., Brooklyn 11, N. Y., offers a new 4-page brochure describing and illustrating the company's various types of plastic components. Plastics such as Teflon, Kel-F, Nylon, Formica, Rexolite, polystyrene, polyethylene and laminated phenolics are covered. The brochure tells how tolerances of 0.001 are held on production runs on components made in standard sizes or to specification.

Picture Tube Substitution. CBS-Hytron, Division of Columbia Broadcasting System, Inc., Danvers, Mass., has compiled a time-saving substitution chart for tv picture tubes. The chart includes all electromagnetically deflected tubes, regardless of make. An index leads to the proper substitution group listing all readily interchangeable types, and from this group one can pick an available type with the least number of necessary service adjustments. Outline and basing diagrams are included.

Amplifier Instruction Sheet. Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill. A revised edition of the Stancor Williamson amplifier instruction sheet has been issued. It is complete with performance curves, schematic, parts list, chassis layout and diagrams. The sheet notes that the excellent frequency-response curve recorded at the 8-watt level remains unchanged at the low level of 0.5 w, a factor frequently overlooked in amplifier evaluation. It points out that intermodulation distortion measures only 3 percent at 8-w output, and total harmonic distortion at 1,000 cycles is extremely low and may be considered nonexistent below the 10-w power level.

Mica Review. Mica Fabricators Association, 420 Lexington Ave., New York 17, N. Y., has published the first issue of the Mica Review. It is the intention of the members of the M.F.A. to include in the Review practical information for purchasing agents, engineers, and all those who handle the mineral mica. The Review will be concerned with only the two major types of mica —Muscovite and Phlogopite. The first issue discusses sources of supply, size, thickness and quality.

Taper Technique. Aircraft-Marine Products Inc., 2100 Paxton St., Harrisburg, Pa. An 8-page fully illustrated folder deals with new electronic uses for an old principle of mechanics. It covers a line of self-locking taper terminals that combine miniature size with remarkable electrical characteristics. Included are development information, test results, applications, specifications and catalog numbers for taper pins and taper tab receptacles.

Meter Calibrator. Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diego 10, Calif. A recent mailing piece illustrates and describes a meter calibrator that produces an absolutely calibrated d-c voltage, independent of input line voltage and output load variations. Included are an illustration, wiring diagram and complete technical specifications. The company invites you to write for a bulletin on this unit, as well as such other precision electronic instruments as a decade amplifier, Micro-Miker, super regulator and absolute d-c power supplies.

Instrumentation for Industry. Beckman Instruments, Inc., South Pasadena 1, Calif. The growing importance of instrumentation to nearly every modern industry, large or small, is dramatized by actual case histories appearing in the latest "Beckman Bulletin", a house organ. An instrument for analyzing flame color, for instance, enabled American Potash and Chemical Corp. to cut control time on its main product—potassium chloride—by a factor of eight. Another article summarizes the advantages found by a brewery in using a spectrophotometer for routine color control of beer. To find out about other applications ask for bulletin BB-11-59.

Engineering Reports. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y., has available a line of reports published quarterly designed for engineers, scientists and interested persons in industrial or educational organizations. The bulletins cover such subjects as frequency measurement devices, noise figure and some measurement aspects, microwave power measurements, metallized glass microwave attenuators, ridged waveguide, and a wideband sweep generator for both uhf and uhf tv. The bulletins are completely illustrated and give technical specifications. Write to the company and get your name on the mailing list.

Feed-Through Bushings. Thor Ceramics, Inc., 225 Belleville Ave., Bloomfield, N. J. A complete line of standard Steatite miniature feed-through bushings for efficient low and high-frequency equipment is illustrated and fully described in catalog bulletin No. 153. Complete with full engineering data, specifications and dimensional drawings, it covers the company's standard miniature feed-through bushings, made to conform to government and commercial specifications.

Tower Lighting. Crouse-Hinds Co., Syracuse 10, N. Y., has issued booklet 381-F, a 20-page publication entitled "Tower Lighting", that describes methods and materials necessary for installing obstruction lighting equipment on radio, tv and microwave relay towers. It includes layout drawings with complete bills of material for lighting towers of all heights. All information meets the requirements of the FCC and CAA. For example, a complete line of alarm relay equipment is available for remote indication of lamp failure as required by the FCC for unattended stations.

Tower Bulletin. Blaw-Knox Co., Farmers Bank Building, Pittsburgh 22, Pa., has published a 20-page bulletin, No. 2417, describing its a-m, f-m, tv, microwave, communications and radar towers. Various types of guyed and self-supporting towers are described. A photograph of the company's testing frame is shown. By use of this frame, any combination of loads representing wind and antenna load can be applied to a tower. Actual deflection and twist can be measured and tower tested to destruction if desired. The RETMA standard specifications are given in the bulletin.

Ground Station Receiver. Collins Radio Co., Cedar Rapids, Iowa, has issued a 2-page bulletin dealing with the 51N-2 ground station receiver, a unit that is engineered for unattended continuous airline duty and other applications calling for A1, A2 and A3 reception at any one frequency within the range of 2 to 24 mc. Included are illustrations, a complete description, technical specifications and information on operating conditions.

Frequency Meter. Nassau Research & Development Associates Inc., 66 Main St., Mineola, N. Y. A one-page brochure illustrates and describes the model 802 frequency meter designed for the 2,400 to 10,200-mc range. Accuracy of the unit discussed is 0.2 percent, and sensitivity is 10 mw to 5 w.

TV Transformer Replacement. Chicago Standard Transformer Corp., Addison and Elston, Chicago 18, Ill., has available the first edition of the 1953 Stancor tv transformer replacement guide. The 32-page reference book contains transformer replacement information on over 5,600 tv models and chassis. It covers 101 brands of tv sets, in alphabetical order, by model and chassis number. A special catalog section lists electrical and physical specifications on 125 Stancor tv replacement components.

Components and Products Catalog. Waldom Electronics, Inc., 911 North Larrabee St., Chicago 10, Ill. Catalog No. 5C3 lists more than 2,000 electronic components and Croname products. Included are tuner assemblies; mask, glass and escutcheon kits; title plates, dial and switch plates; knobs; instrument drives and dials; terminal lugs, cases and dial locks; terminal strips; pushbutton and control knobs; tv replacement items and accessories; sockets and shield bases and other components.

Titanium. Mallory-Sharon Titanium Corp., Niles, Ohio. A recent technical booklet, "Properties of Titanium and Titanium Alloys," provides current information on different production methods, general properties of various alloys, standard production classifications and testing procedures, and specific qualities of the five types of titanium and its alloys supplied by the company. Presently, titanium and its alloys are being used or considered as a replacement material for stainless steel and aluminum because of its high strength-to-weight ratio.

Locknuts and Collars. Standard Pressed Steel Co., Box No. 596, Jenkintown, Pa. Two four-page bulletins, one on Flexloc self-locking nuts and the other on Hallowell steel shaft collars, have been prepared. Both give information in text and illustrations on product properties and applications. The Flexloc locknuts described are one piece and all metal, do not have to seat to lock, and can be used as stop nuts because they will stay put at any point on a bolt or stud. Steel nuts are unaffected by temperatures up to 550 F, and corrosion-resisting steel nuts up to 750 deg. Sample applications are shown. The bulletin on steel collars lists the 42 standard sizes for shafts from 1/16 in. to 3 in. in diameter. It shows the Hallowell collar in use in various applications.

External Phasing Potentiometer. DeJur Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Bulletin 100 is a single-sheet publication illustrating and describing the series C-200 external phasing potentiometer. Eighteen features of the unit are outlined. Also included are dimensional diagrams and general specifications.

Technical Ceramics. American Lava Corp., Chattanooga 5, Tennessee. Bulletin No. 533 describes and illustrates technical ceramics for use in the electronic and electrical fields. The purpose of the 12-page primer is to tell some of the outstanding advantages of AlSiMag technical ceramics quickly and in nontechnical terms.

Hermetically Sealed Transistors. Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas. Two new production types of hermetically sealed, grown-junction transistors are covered in bulletin DL-S 310. It describes the types 200 and 201—both *npn* triodes with glass to metal hermetic sealing—which differ principally in collector resistance and amplification factor. The new bulletin contains two pages on the theory and application of junction transistors, as well as detailed specifications and curves on the company's units. Alpha (current amplification factor) is a guaranteed minimum of 0.90 in type-200 and 0.95 in type-201 transistors.

Electrical Insulating Materials. Insulation and Wires Inc., 3435 Chouteau Ave., St. Louis 3, Mo.,

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has available a 48-page catalog dealing with a wide line of electrical insulating materials. Over 225 items are indexed. Descriptions, specifications and prices are included. This catalog is published periodically and so kept up to date on prices.

Portable pH Meters. Beckman Instruments, Inc., South Pasadena 1, Calif., has released a 4-page folder designed to simplify the choice of pH equipment. Salient performance features and pictures distinguish the four pH meters in the series. They include a highly accurate instrument for laboratory and research studies; a line-operated model for routine measurements in the control laboratory; and two lightweight portables for plant and field applications. The booklet also lists typical industries where these instruments are used. Ask for bulletin 322–59.

UHF Transmitter. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. Bulletin No. TTD-T201 covers the company's 1-kw uhf tv transmitter. It outlines the design and operational features of the unit. Block diagrams, photos and graphs explain the basic circuitry of the visual and aural transmitters that make up the 1-kw transmitter. In addition, information required by FCC Form 301, Section V-C is provided for the convenience of station applicants.

Coaxial Cable. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 48-A is a 4-page folder illustrating and describing a $\frac{7}{8}$-in. diameter. semiflexible coaxial cable (type 737). It gives power ratings, mechanical and electrical characteristics, and a table of attenuation and efficiency. Included are a page of applications with typical bills of materials, installation information and an illustrated list of accessories.

Picture Tube Components. Sylvania Electric Products Inc., Towanda, Pa. Tungsten and chemical components for tv picture tubes are described in a 4-page booklet. Among the components described are screen phosphors, potassium silicate for screen settling, tungsten wire for cathode heaters, and triple carbonate cathode coatings. Also included is a description of stranded tungsten coils and filaments for vacuum metallizing. They are used in the aluminizing of picture tube screens.

Wire Identification. Alpha Wire Corp., 430 Broadway, New York 13, N. Y. One of the many new features contained in the 28-page catalog No. 53 is a 2-page identification chart for electronic wire and cable. It is designed to allow even the inexperienced to correlate positively and quickly an Alpha product from a vague general description.

Equipment Catalog. Perma-Power Co., 4727 North Damen Ave., Chicago 25, Ill., has published a 4-page, multicolored catalog on its complete line of electronic equipment. Items listed in the catalog include a new tv voltage regulator; a new model tv tube brightener; a tv insulated high-voltage grid cap assembly; a tv high-voltage spring clip assembly; a tv replacement socket; tv tube extensions; and the three battery eliminators—models A, B and E.

Remote Control Equipment. The Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y. A new 4-page 2-color bulletin describes the Multi-Gate remote supervisory control system designed for use by petroleum refineries, pipeline, railroads, power companies, and other organizations that have widespread physical facilities. The equipment described is designed for operation over wirelines, microwave, or radio lengths, or combinations of these to provide on-off control, switching or signaling at one or several remote points. Control of a given station or other remote point may be exercised from one or more control centers; and report back on the operations may likewise be obtained at any or all of the controlling stations.

Screen Rooms. Erik A. Lindgren & Associates, 4515–17 N. Ravenswood Ave., Chicago 40, Ill., has issued a pamphlet on its double-shielded type, heavy duty portable

Want more information? Use post card on last page.

construction screen rooms that feature minimum r-f interference. The illustrated brochure describes such features as easy assembly, leak-proof doors, ball bearing hinges, heavy-duty latches and floor panels that are faced with ¾-in. waterproof plywood and are laid over the double screened, sectional substructure. Complete specifications are included.

High-Temperature Alloy Fastenings. The H. M. Harper Co., Morton Grove, Ill. Bulletin HTA covers high-temperature alloys such as Refractaloy, Discaloy, Inconel, Hastelloy and Austenitic alloys, with a special section on titanium. This bulletin contains data on these superalloys, together with a section on the characteristics of high-temperature bolting. Tables give mechanical properties and chemical composition of various alloys and illustrate many types of fastenings produced from super alloys and titanium.

Public-Address Equipment. Newcomb Audio Products Co., 6824 Lexington Ave., Hollywood, Calif., announces a new 20-page catalog of public-address equipment. It contains illustrated information on all three lines of Newcomb amplifiers, portable systems and accessories, as well as rack and panel assemblies.

Electrical Insulation. L. Frank Markel & Sons, Norristown, Pa., have published a technical bulletin on improved types of a class H insulating tubing made of fiber glass base sleeving coated with Silicone rubber. It includes information on grades and electrical characteristics, thermal and chemical characteristics, flexibility, abrasion resistance, flammability, fungi resistance and sizes.

Carbon and Graphite Products. Stackpole Carbon Co., St. Marys, Pa. Standard and special carbon and graphite components and materials for chemical, electrical and mechanical applications are described in catalog 40A. Recently revised and enlarged, the 44-page catalog contains a wealth of data on carbon and graphite as applied to products ranging from battery and welding carbons to tube anodes, electrical contacts, bearing materials, seal rings, rail bonding molds, graphite for spectrographic analysis and many others. It is designed more as a guide to the many uses of carbon and graphite than as a restrictive listing of standard products. As a result, there is considerable engineering information on the physical and electrical properties of carbon and graphite as compared with metals and other refractory materials.

Beam Switching Tubes. Burroughs Adding Machine Co., Research Div., 511 N. Broad St., Philadelphia 23, Pa., has available the reprint of an article by one of its engineers dealing with multi-output beam switching tubes for computers and general purpose use. The booklet contains a well illustrated technical description along with a history of beam switching tubes.

Polyester Film. E. I. DuPont de Nemours & Co., Wilmington 98, Del., has issued a technical bulletin containing 14 pages of information on the physical, electrical and chemical properties of Mylar polyester film, and suggested applications. It is complete with charts, diagrams and tables. The electrical properties section covers such things as dielectric strength, insulation resistance, and volume and surface resistivity.

The Engineering Profession. Stevens Institute of Technology, Castle Point, Hoboken, N. J. An increasing interest in engineering, shown by high school students of late, has led to publication of a new booklet about the profession. Designed to answer questions about the work engineers do, the 16-page publication also discusses the scholastic attainments and special aptitudes which indicate whether a student should seek admission to an engineering college. The booklet, entitled "What's Engineering?", was written with an eye to aiding both students and counselors.

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

OTHER DEPARTMENTS featured in this issue:

Everitt To Receive IRE Medal Of Honor

WILLIAM L. EVERITT, Dean of the College of Engineering, University of Illinois, has been named to receive the Institute of Radio Engineer's medal of honor for 1954. The Institute gave the award "for his distinguished career as author, educator and scientist; for his contributions in establishing electronics and communications as a major branch of electrical engineering; for his unselfish service to his country; for his leadership in the affairs of the IRE."

Dr. Everitt had held teaching posts at Cornell University, University of Michigan and Ohio State University before coming to the University of Illinois in 1945 as head of the department of electrical engineering. He was appointed Dean of the College of Engineering in 1949.

In 1940 Everitt became a member of the Communications Section of the National Defense Research Committee and during World War II served as Director of Operational Research in the Office of the Chief Signal Officer. In 1950 he served as a member of the Senate Advisory Committee on Color Television. In April of this year, the IRE nominated him to serve on a committee of scientists formed to study the National Bureau of Standards.

The presentation of the medal of honor will be made during the annual banquet at the Waldorf-Astoria Hotel, New York, N. Y. on March 24, 1954 during the IRE National Convention.

RETMA Committee Chairmen Named

FOLLOWING THE ACTION of the Radio-Television Manufacturers Association in changing its name to the Radio-Electronics-Television Manufacturers Association and approving a reorganization plan which established a Radio-Television Industry Committee and an Electronics Industry Committee of the board of directors, board chairman Robert C. Sprague appointed the following committee chairmen:

F. R. Lack, vice-president of Western Electric Co., was appointed temporary chairman of the electronics industry committee and has designated himself as temporary chairman of the radio-television industry committee, pending election of permanent chairmen of both committees.

Leslie F. Muter of The Muter Co. was reappointed chairman of the annual awards committee. The committee has the responsibility for nominating the recipient of the RETMA medal of honor, presented annually to the person, company or organization which, in their opinion, has made the greatest contribution to the radio-television-electronics industry.

John B. Swan, Jr. of Philco Corp. and William L. Fogelson of P. R. Mallory & Co. were appointed chairman and vice-chairman respectively of RETMA's traffic committee.

The committee and its subcommittees will continue to work during the coming year to promote and protect the best interests of the industry in the field of traffic problems.

Paul V. Galvin of Motorola was reappointed chairman of RETMA's committee to survey subscription television. During the coming year, the committee will continue to study the nontechnical phases of subscription television with particular reference to its possible effects on the telecasting of sports, theatrical presentations and other

Elgin Watch Seeks Electronics Firms

Elgin National Watch Co. is actively seeking companies in the electronics and precision instrument fields with "a view to affiliation," J. G. Shennan, president, recently announced. Reasons why the 89-year-old company wishes to enter the electronics field are pointed out above by president Shennan who said the prime motives are need for higher return on capital and greater long-term stability. The company plans continued aggressive activity in its basic field of watchmaking


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entertainment activities.

H. A. Pope of National Union Radio Corp. was reappointed as chairman of the association's credit committee for the coming fiscal year. During the coming year the group will continue its active surveillance of the credit position of both manufacturers and distributors in the electronics field for circulation within the electronics industry.

Glen McDaniel, as general counsel of RETMA, was reappointed chairman of the association's legal committee for fiscal year 1953-54. During the coming year the committee will continue to watch state and local legislative proposals which affect the radio-tv electronics industry. It also will continue to work with the RETMA tax committee on current tax problems and to keep the association's members informed of various other legal matters of industry-wide interest.

A. M. Freeman of RCA Victor was reappointed chairman of the tax committee. The group will continue its work to keep the membership informed on current federal tax developments and to present the association's position on tax matters before appropriate federal agencies or the Congress.

W. R. G. Baker of GE was reappointed chairman of the television committee. The committee will continue to operate as the association's top policy group on television matters and formulate recommendations in this field for submission to the board of directors.

Frank W. Mansfield of Sylvania Electric was reappointed chairman of the industry statistics committee for the coming year.

Leslie E. Woods of Raytheon was reappointed chairman of the association's industrial relations committee for the ensuing year. One of RETMA's largest and most active groups, the committee is credited with many outstanding accomplishments in industrial and labor relations.

Harold J. Schulman of the Allen B. Du Mont Laboratories has been appointed chairman of the service committee. He succeeds R. J. Yeranko of Magnavox. The group has done much to improve service relations.

Quarles Appointed To Defense Post

DONALD A. QUARLES, vice-president of Western Electric Co and president of its subsidiary, Sandia Corp. of Albuquerque, New Mexico has been named by President Eisenhower as assistant secretary of defense, for research and development. He formerly served as chairman of joint RDB electronics committee.

Mr. Quarles graduated from Yale in 1916, was a graduate student at Columbia for the next four years after which he joined Bell Labs as an engineer. In 1948, he became vice-president of the company, leaving in 1952 to become vice-president of Western Electric.

Audio Convention Sets Technical Program

ARRANGEMENTS HAVE been completed for 28 papers to be delivered at the Audio Engineering Society's forthcoming Fifth Annual Convention and Audio Fair to be held in New York City October 14–17, 1953.

Three papers on loudspeakers will be delivered at the morning session on Oct. 14. In the afternoon audio-system design session, four papers will be delivered.

On Oct. 15, four papers on disc reproduction and others on new audio developments will be presented.

Friday, Oct. 16, amplifier circuit design and home music systems will be discussed.

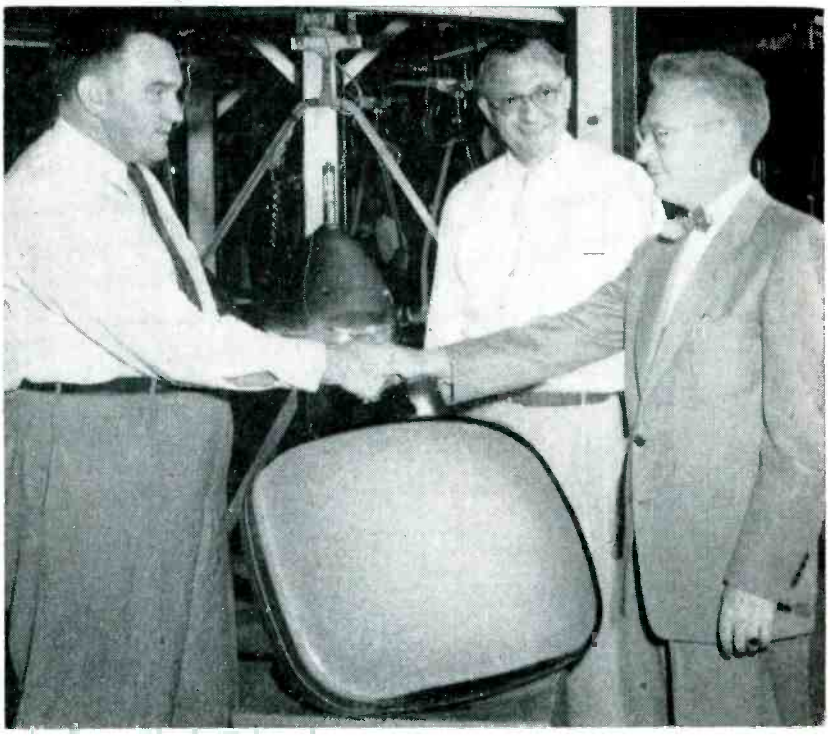
Multichannel sound reproduction papers will be given on Oct. 17.

Westinghouse Makes New Moves

WESTINGHOUSE ELECTRIC CORPORATION has purchased the large government-owned plant in Lansdowne, Md., which the company has operated under lease since its construction in 1942.

The plant is a large-scale producer of electronic equipment for the armed services and for indus-

Sylvania Has Produced Five Million TV Tubes



Mayor of Seneca Falls W. J. Cousin (right) congratulates Sylvania's division general manager, W. H. Lamb (left) on the production of the five-millionth picture tube to be made at the company's two picture tube plants in Seneca Falls, N. Y. and Ottawa, Ohio. Willis C. Toner, Seneca Falls plant manager (center), stands behind the 27-inch tube. The company also announced that another cathode-ray-tube plant will be built at Fullerton, Calif.

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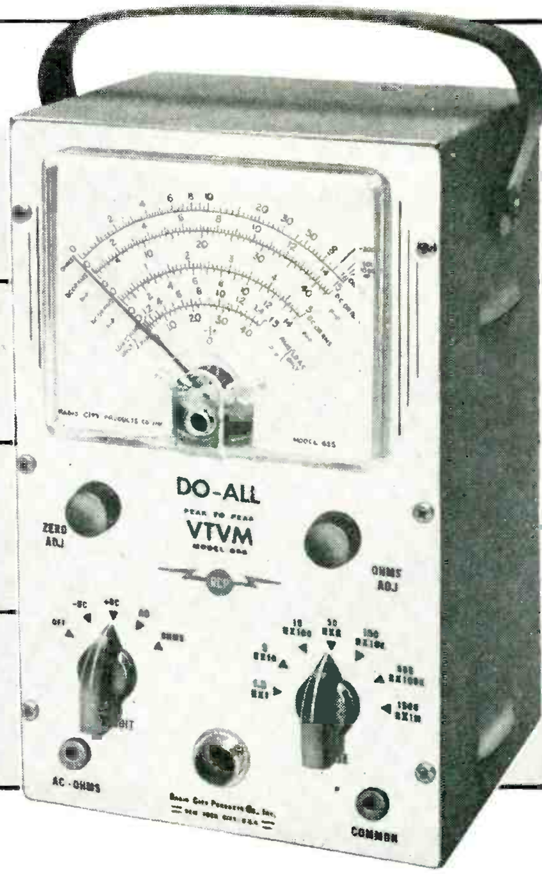

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. . . gives a true reading measurement of complex and sinusoidal voltages with necessary peak-to-peak or RMS value read directly, for the analysis of waveforms in video, sync and deflection circuits.

Now TV efficiency is given greater effectiveness because sets can be serviced as the manufacturers say—the peak-to-peak way. The combination of this P. to P. meter and service notes to match, take the guesswork out of service and speed up your service operation.

Versatility of measurement, built into each Model 655, serves a variety of industrial applications in the service of vibrator power supplies, AC generators and all equipment utilizing any type of waveform or DC.

Match the Model 655 with any peak-to-peak VTVM—You will find that comparable performance can only be found in much higher priced instruments. Of high impedance design, the Model 655 makes use of an electronic balanced push-pull circuit and peak-to-peak rectification. The result is an absence of circuit loading, waveform error or frequency distortion.

This handsome looking unit has a brushed aluminum panel, etched for durability and uses an attractive clear plastic meter. Comes complete with our new "RCP SOLDERLESS TEST LEADS" for operation on 105 to 125 V AC.

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- PEAK-TO-PEAK AC measurements of from .2 V to 4200 V on 7 ranges.
- AC RMS measurements of .1 V to 1500 V on 7 ranges.
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trial and commercial customers. The plant is now producing induction heating equipment, radio transmitters and certain radar components.

Increasing peacetime electronic demands on the plant's facilities was an important factor in the company's decision to buy the 60-acre installation. Westinghouse built the plant for the government during World War II to fill the urgent need for electronic equipment for defense. Recent peacetime demands for electronic equipment have caused that type of production at the plant to equal its military output. In view of the fact that this would have necessitated an eventual expansion of the plant's manufacturing capacity, Westinghouse decided to acquire the property.

In another move in the electronics division, Robert C. Cheek has been appointed to the newly-created post of assistant manager of engineering of the division, according to an announcement by F. S. Mabry, division engineering manager.

Prior to his present promotion, Cheek was assistant division sales manager. In his new capacity, he will supervise administrative and organizational activities under Mabry. He joined Westinghouse in 1939 and was a specialist in carrier and microwave applications. In 1949, he was named "outstanding young electrical engineer", by the Eta Kappa Nu national technical fraternity.

In the company's electronic tube division, Clarence M. Clark has been appointed manager of the division's plant at Bath, N. Y. He has been manager of accounting at the Elmira plant and joined the electronic tube division last May. Formerly with the company's special products division at Pittsburgh, Pa., he has been associated with Westinghouse for 27 years.

Rand Receives ARRL Merit Award

PHILIP S. RAND, a project engineer at the Remington-Rand Laboratory of Advanced Research at South Norwalk, Conn., was recipient of

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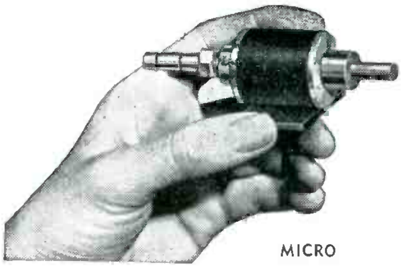
AIR CYLINDERS

Single Acting

and

Double Acting



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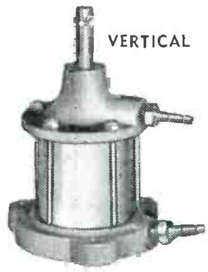
CLEVIS



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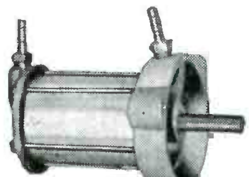
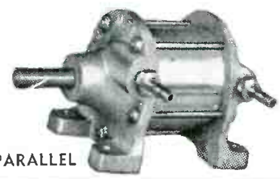


VERTICAL FACE



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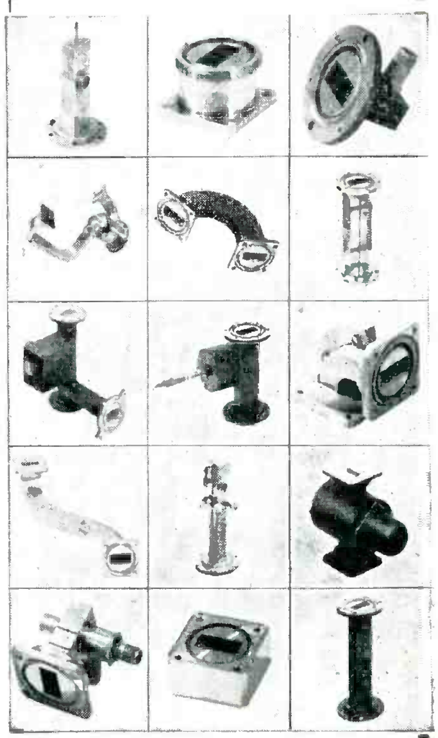

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the American Radio Relay League's merit award given at the Seventh ARRL National Convention in Houston, Texas. Goodwin L. Dosland, president of the ARRL, presented a plaque to Rand in recognition of his advancement of the welfare of amateur radio through outstanding leadership and technical accomplishment in reduction of tv interference.

Program Announced For Radio Fall Meeting

TECHNICAL PROGRAM of the Radio Fall Meeting sponsored by the RETMA engineering department, the RTMA of Canada and the IRE Professional Groups Committee has been established. The meeting will be held at the King Edward Hotel, Toronto, Ontario, Canada on October 26, 27 and 28.

Electronic Parts Show Elects Officers

HARRY A. EHLE of International Resistance Co. was elected president of the Radio Parts and Electronic Equipment Shows, sponsors of the Electronic Parts Show, at the annual meeting of the show board.

H. M. Carpenter of Thorow Distributors was chosen vice-president; Francis F. Florsheim, Columbia Wire and Supply Co., secretary; Bernard L. Cahn, Insuline Corp. of America, treasurer.

The 1954 show will be held at the Conrad Hilton Hotel in Chicago May 17 to May 20.

Air Materiel Command Reorganizes

AIR FORCE SECRETARY Harold E. Talbott announced that the Air Materiel Command, the U. S. Air Force's logistical arm, will eliminate seven of its subordinate headquarters by December 31, 1953.

Lieutenant General E. W. Rawlings, AMC's commander, said: "We have been making thorough studies of our operations and organization to comply with new Air Force programs. Consequently we have come up with this plan which not only will result in substantial

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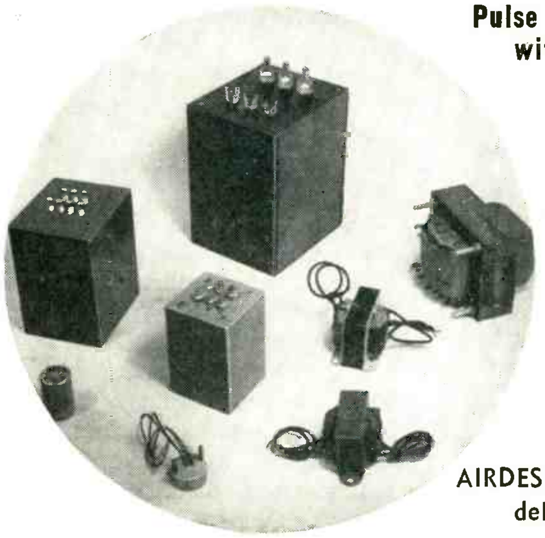

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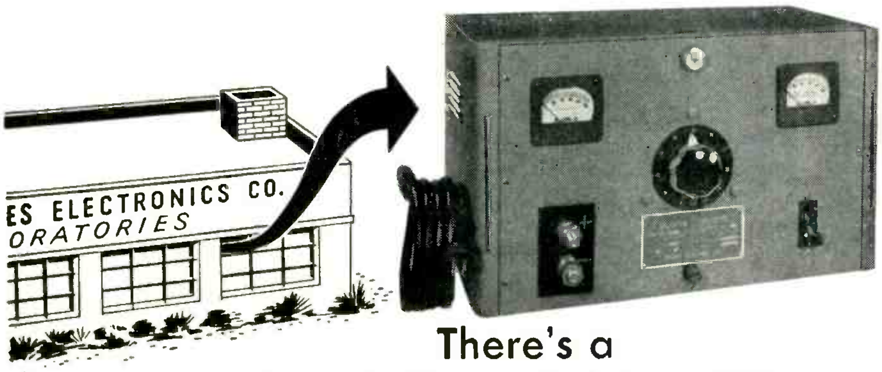

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Rapid Electric Co. makes Bench Selenium Rectifiers in 18 standard models--each covering a different DC output range and each completely portable. You buy the model that exactly fits your needs. If one of our standard models can't do the job, we can design and build special equipment that will.

ALL Rapid Rectifiers require no warmup, no maintenance, have long life even in continuous full load service, are easy to operate; with regulation, ripple and efficiency to meet your specifications. Cost is low, too—prices start at $79.50 with full controls.

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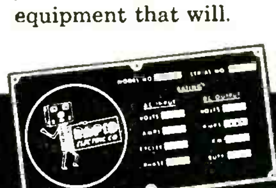

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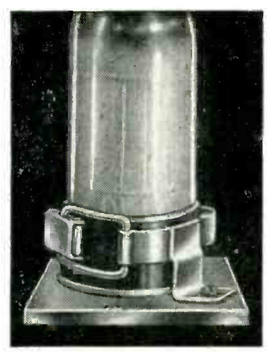

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There is a Birtcher Clamp ... *or one can be designed* ... for every tube you use or intend to use.

Regardless of the type tube or plug-in component your operation requires... and regardless of the vibration and impact to which it will be subjected... a Birtcher Tube Clamp will hold it securely and *rigidly* in place.

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savings of taxpayers' dollars but actually will increase our efficiency."

General Rawlings emphasized that the organizational change will have no effect upon the present method of contract placement.

The headquarters being eliminated are the six Air Procurement Districts. They are: Eastern APD, New York, N. Y.; Northeastern APD, Boston, Mass.; Central APD, Detroit, Mich.; Midcentral APD, Chicago, Ill.; Southern APD, Fort Worth, Tex. and Western APD, Los Angeles, Calif.

The seventh headquarters being eliminated is at Olmsted Air Force Base, Middletown, Pa., where the Middletown Air Materiel Area headquarters has been separate from the Olmsted base and Middletown depot organizations. These now will be consolidated into the Middletown AMA headquarters.

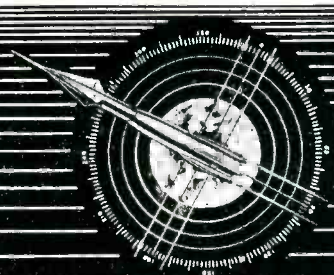
These six district headquarters, each assigned a geographical area, administer over 14,000 USAF contracts, with a $16.86 billion value, with industry. Under the reorganization, the field supervision of contract administration will be absorbed into AMC's eight Air Materiel Area organizations. The Air Regional Offices now will report to the AMA's rather than to the present Districts.

The AMA organizations will support all USAF bases, installations and activities (including overseas) within their areas in matters of supply and maintenance (overhaul and repair).

The eight Air Materiel Area headquarters now taking over supervision of contract administration are: Middletown AMA, Olmsted Air Force Base, Pa.; Mobile AMA, Brookley AFB, Okla.; San Antonio AMA, Kelly AFB, Tex.; Ogden AMA, Hill AFB, Utah; Sacramento AMA, Mc Clellan AFB, Calif.; and San Bernardino AMA, Norton AFB, Calif.

Otis Elevator Acquires TEMCO

OTIS ELEVATOR CO. has acquired the Transmitter Manufacturing Co. of New York which manufactures radio communication and electronic equipment for the U. S. Govern-



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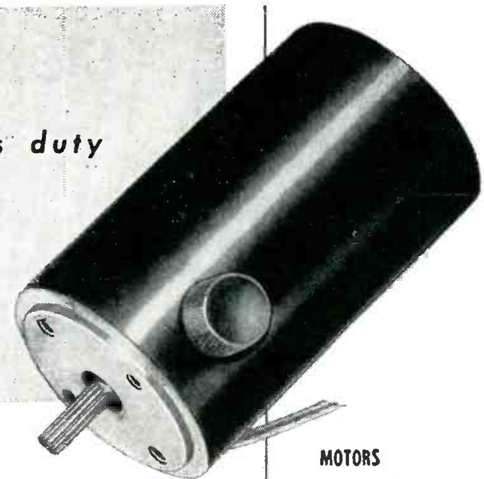

18 to 30 volts with or without brake . . .

- Ambient temperature: — 55° C to + 105° C.
- Size: 1.25 in. diameter, 2.18 in. long.
- Weighs 5.3 ounces . . . without brake.

We can manufacture these motors to meet your specifications. This particular motor is used on an actuator for aircraft use.

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SUB-MINIATURE weather-tested midgets

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5/16" DIA. x 3/8" LG.

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5/16" DIA. x 3/4" LG.

ASK FOR THE NEW RESISTOR HANDBOOK — Contains complete data on resistors for every purpose and their recommended applications. Please make request on company letterhead.

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COMMERCE AVENUE — IN RES CO — UNION NEW JERSEY

APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION

Morton B. Kahn

ment and industry.

At the same time, announcement was made of the establishment of the electronics division of Otis, of which Morton B. Kahn, president of TEMCO, will be manager. The electronics division will execute existing government contracts held by Otis for electronic bomber and navigational trainers and other contracts for electronic equipment under negotiation. In addition, it will carry on research and development work for Otis in the field of electronics. The electronics division will be located in Brooklyn, N. Y.

Mr. Kahn, who founded TEMCO in 1936, will continue as president. The company will remain in operation to complete its existing contracts.

IRC Builds Second North Carolina Plant

CONSTRUCTION OF A plant located in Boone, North Carolina has been started by the International Resistance Co. of Philadelphia. The plant, to be situated on a 20-acre tract recently purchased by IRC, will have 40,000 sq ft of work space. Building cost has been estimated at $400,000. Completion and actual production in the plant is expected by January 1, 1954.

Initially, IRC will employ approximately 200 persons. Eventually about 500 workers will be employed, of which 80 percent will be women. Various types of power wire-wound and precision resistors

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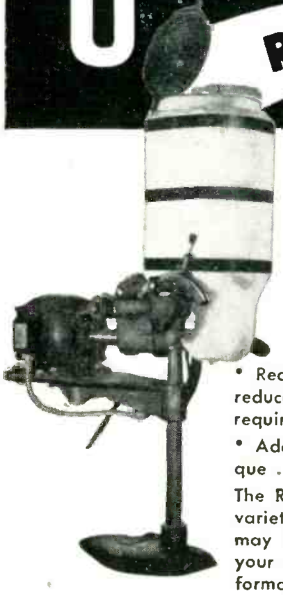

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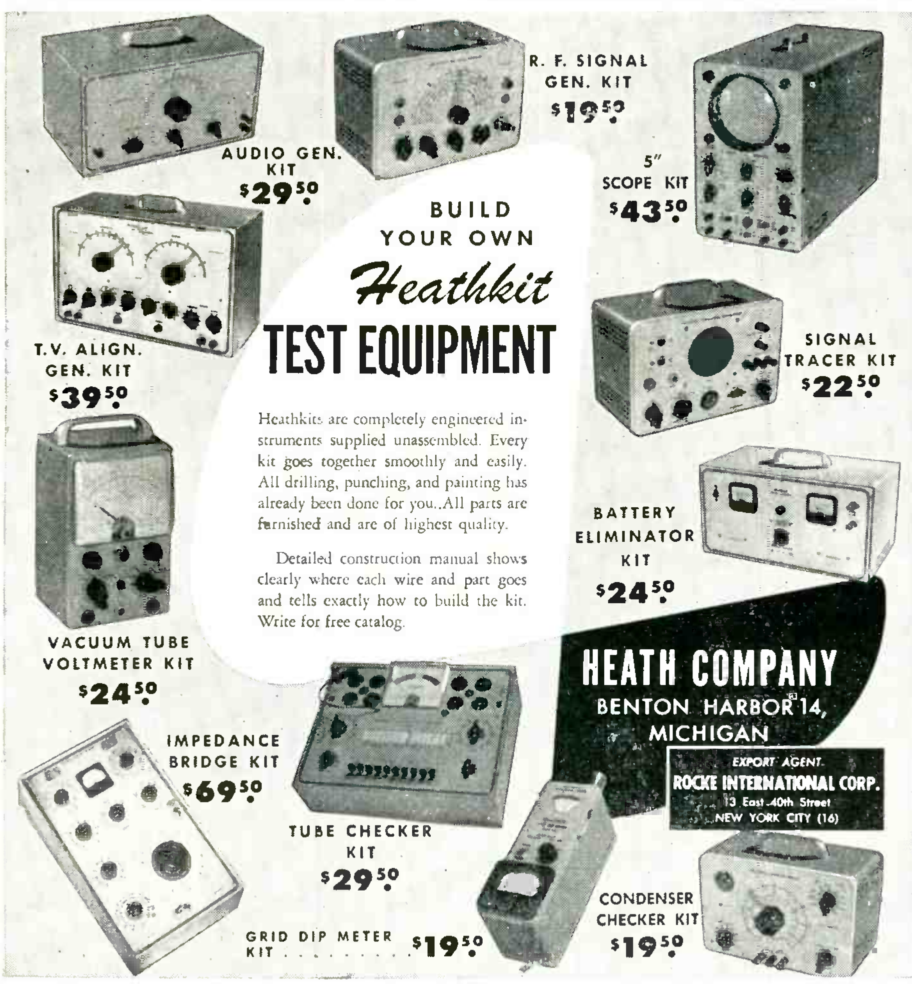

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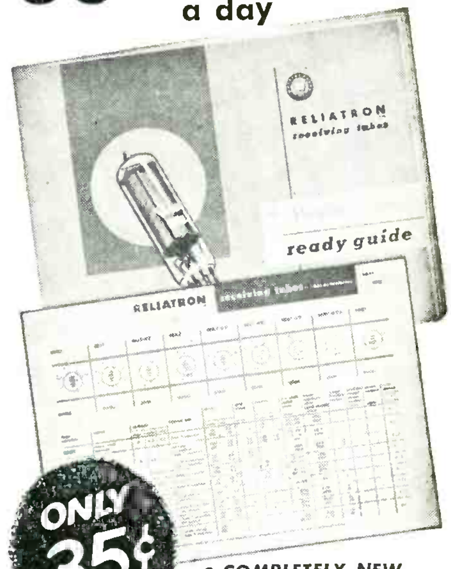

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This big new Westinghouse *Ready-Guide* is a completely new kind of handbook of receiving tube data. Designed to save time for busy servicemen and engineers. Eliminates "squinting" at tiny data listings.

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Just 9 tube types are listed on each 8½" x 11" page. Not 30 or 40 tiny type listings as in most condensed data books. Best of all, large clear base diagrams are located on the same page as ratings. Bothersome cross referencing, footnotes cut to the bone.

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This new Westinghouse Ready-Guide lists complete data on receiving tubes which account for more than 98% of tube usage. 48 pages. 385 pictures and diagrams. 342 types listed.

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will be produced in the new plant.

John Kane, who has been associated with IRC in Philadelphia for many years, has been appointed plant manager.

The plant is the second in North Carolina for the company. In March of this year, IRC started production of volume controls in its Asheville, N. C. plant.

Rectifier Corp. Opens Puerto Rican Plant

BEGINNING of operations in a new plant located in Fajardo, P. R. was announced by Rectifier Corp. The new company has been incorporated under the Island's laws to manufacture selenium rectifiers and related electronic equipment.

Lloyd J. Hughlett, president of the new company, announced that the plant's facilities have been organized to produce a complete line of radio stacks for radio and tv receivers and comparable equipment requiring current conversion. Markets will be on the mainland, Hughlett stated, and delivery from the Island to points on the Eastern seaboard and Midwest can be as rapid as from suppliers in the States.

Magnavox Elects Two New Vice-Presidents

John A. Rankin

ELECTION OF John A. Rankin and John S. Sturgeon as vice-presidents of the Magnavox Co. was announced by Frank Freimann, presi-

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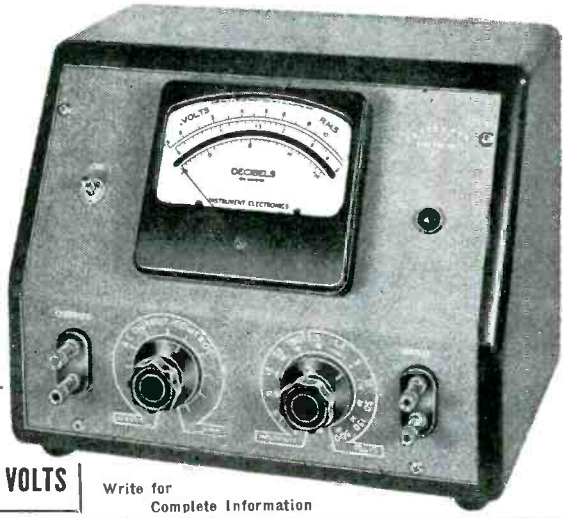

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45B	.0005-500	10C-250KC	5 Megohms 12 MMF	39 DB	NO	1600
47	.00005-500	15C- 30KC	1 Megohm 15 MMF	29 DB	10 DB	23000
47B	.00005-15	15C- 30KC	50 Megohms 15 MMF	27 DB	NO	23000
53	.00015-500	10C- 250KC	5 Megohms 12 MMF	35 DB	10 DB	5300

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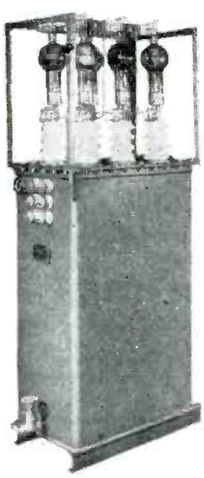

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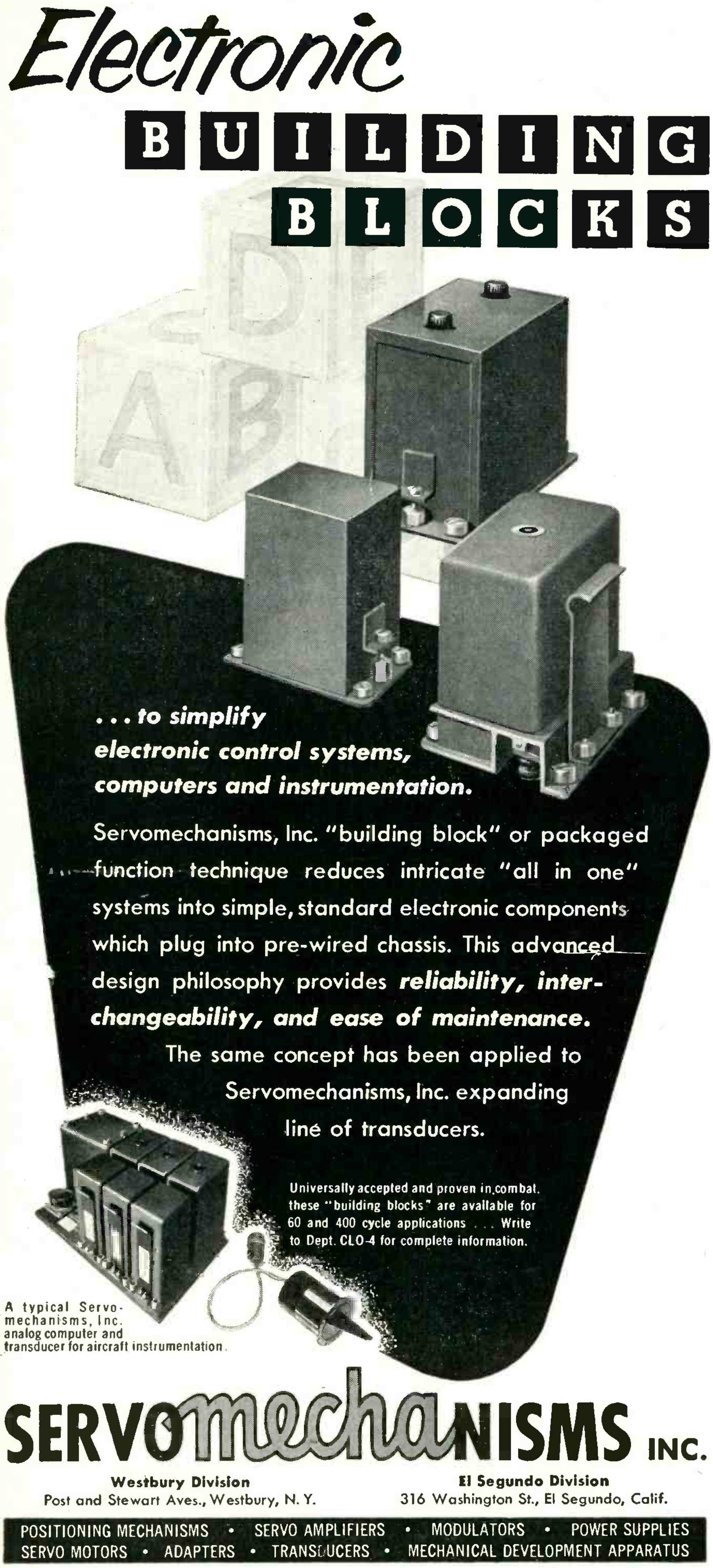

dent, late this summer.

Sturgeon is treasurer of the tv and radio-phonograph concern, while Rankin serves as director of engineering.

Sturgeon joined Magnavox in 1940 as comptroller and in 1949 was elected treasurer. Prior to that he served as senior accountant with Price, Waterhouse and Co. in Chicago for six years and in a similar capacity with Haskin and Sells.

Rankin joined Magnavox in 1951 as director of engineering. He is in charge of development, design and engineering for production of all civilian and military equipment.

Prior to joining Magnavox he served for a number of years as an executive engineer in the radio and electronics industry, including prominent positions with Belmont Radio Corp. and RCA.

The new vice-presidents will make their headquarters at the company's main office in Fort Wayne, Indiana.

LaPointe Buys Printed Circuit Company

LaPointe Electronics has purchased a 95 percent interest in Circuitron, manufacturer of printed circuits, it was announced by Jerome E. Respess, president. "By acquiring and managing Circuitron," Mr. Respess stated, "LaPointe is assured of a continuing supply of the printed circuits used in the Vee-D-X Mighty Match and other tv accessories. In addition, LaPointe will manufacture printed circuits for a wide variety of fields within the electronic industry."

Circuitron is being moved to Rockville, Conn. where it will take over space in another factory building near the main LaPointe plant. Initially, approximately 50 people will be employed to operate Circuitron, with aditional personnel being acquired as expansion continues.

GE Plans Increase In Aluminized TV Tubes

A FIFTY-PERCENT increase in its production of aluminized tv picture tubes is expected by GE when a multimillion-dollar retooling project, now under way at its Buffalo

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and Syracuse plants, is completed.

Almost three-quarters of GE picture-tube production then will be in the aluminized tubes, according to J. Milton Lang, general manager of the GE tube department.

Lang said increased production of the tubes is necessary because the company presently cannot meet the demand for them in both initial equipment and replacement use.

The retooling operation affected more than 60 percent of the Buffalo plant equipment, and about 90 percent of the Syracuse plant equipment. Work began early this year, and a major share of the project was completed at both plants during the two-week vacation shutdown early in July.

The tube department is also converting a former GE dishwasher plant at Scranton, Pa., for full-scale production of hydrogen-thyratron tubes for the nation's radar fence.

Clevite Elects Operations V-P

Herman L. Weckler

ELECTION OF Herman L. Weckler as vice-president, operations, of Clevite Corp. was announced by James L. Myers, president.

Weckler retired on April 30 from Chrysler Corp. where he was vice-president, general manager and a director for the past 13 years. In his new post he will have general responsibility for the operations of Clevite Corp's manufacturing and selling units including Cleveland Graphite Bronze Co., Brush Electronics Co., Harris Products Co.,

(Advertisement)

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1% accuracy — 0.2 microampere sensitivity — 100 watts load contact rating. These are some of the features you get in a nonindicating meter-relay like the one in the photo. It is a moving coil relay and it will do things you never expected without vacuum tubes.

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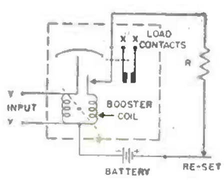
Factory adjustment is within 2% of the specified current or voltage for most units. It can be adjusted at installation to better than 1%. In fact, one customer (name on request) reports ¼% on a battery charger shutoff.

Sensitivity

Any setting between 0.2 microamperes and 50 amperes, or from .05 millivolts to 500 volts can be furnished. Higher ranges can be made with external multipliers. The sensitivity is adjustable at installation over a wide range to meet specific needs.

Contacts

S.P.S.T. or S.P.D.T. in several ratings. Normal contacts have ratings up to 100 DC milliamperes for "make" only. Heavy duty contacts are rated 1 ampere at 115 V. AC or 32 V. DC for "make" or "break." The diagram shows the internal arrangement and auxiliary equipment needed for the heavy duty contacts.



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Clevite Service and Clevite of Canada.

At Chrysler Mr. Weckler was made vice-president for labor relations in 1935, and the same year was also put in charge of the De Soto division. In 1940 he became vice-president, general manager and director of Chrysler Corp. During World War II he served in addition as president of the Dodge division.

Westinghouse Patents For Public Use

WESTINGHOUSE ELECTRIC CORP. recently turned over to U. S. Patent Office for public use 231 patents, primarily related to the electronics field. These patents may be used by anyone, without license or payment of royalties.

On the list are a number of patents dealing with electronic-discharge devices, transformers, amplifiers, resistors, rectifiers, circuit breakers and dynamo-electric machines.

A complete list of patents as well as a pamphlet with 609 patents previously available for free unrestricted use may be obtained without charge from the U. S. Patent Office, Washington 25, D. C.

Mullard Appoints Joint Lab Managers

P. E. TRIER and G. Knott have been appointed joint managers of the Mullard Research Laboratories in England.

Trier was engaged at the Admiralty Signal and Radar Establishment from 1941 until 1950. During the War he developed direction finding techniques in the meter and centimeter-wave regions. Later he was head of the vhf communications group. He joined Mullard in 1950 as head of the communications and radar division.

In his present appointment, Trier will direct the electronics laboratory and be responsible for work in the fields of communications, radar, special-circuit techniques, particle accelerators, special components and materials, tube applications, ultrasonics and metal physics. He will also act in the capacity of plant head.

Knott commenced his career as

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a physicist to the Calico Printers Association in 1935. From 1937 until 1940 he was engaged in research on x-ray crystallography at Cambridge University.

In 1940, he joined Mullard first as development engineer on transmitting tubes and later on vhf tubes. He was placed in charge of the Mullard vacuum physics laboratory when it was formed in 1946. He will continue to direct the work of this laboratory in his new appointment and will be responsible for vhf tubes, gas discharge tubes and photoelectric devices.

Minnesota Mining Buys Irvington Varnish

PURCHASE OF IRVINGTON Varnish and Insulator Co. of Irvington, N. J., by Minnesota Mining & Manufacturing Co. was announced.

Herbert P. Buetow, 3M president, said the directors of 3M have approved a \$7-million agreement by which Irvington becomes a division of 3M. Mr. Buetow said Irvington stockholders will receive 3M common stock and cash in exchange for their Irvington stock.

Buetow and Arthur E. Jones, Irvington president, said the move is a natural one in view of their respective interests in the field of electrical insulation.

"Like 3M, Irvington Varnish and Insulator Co. has had a long-term research program aimed at improving existing products and developing new products," Buetow said. "We think it is of tremendous importance to our company's continued growth to expand our services to the electronics industry. This industry is already one of the largest in America even though many phases of its development are just getting started."

According to president Buetow, 3M has no plans to change Irvington Varnish and Insulator's operating policies or its management team. Jones will continue as president of the division. All other officers and executives will continue in their present capacities.

Robert L. Westbee, who was recently elected a vice-president of 3M, will be responsible for liaison between the parent company and

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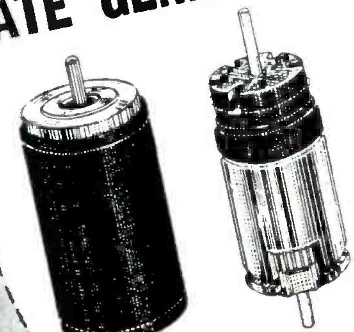

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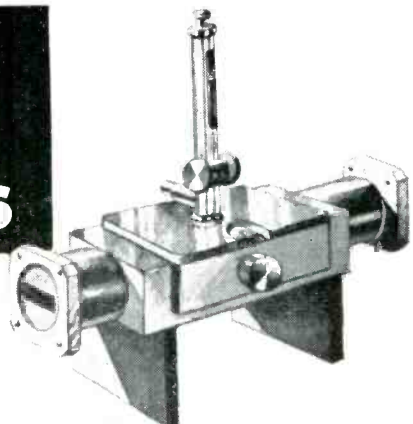

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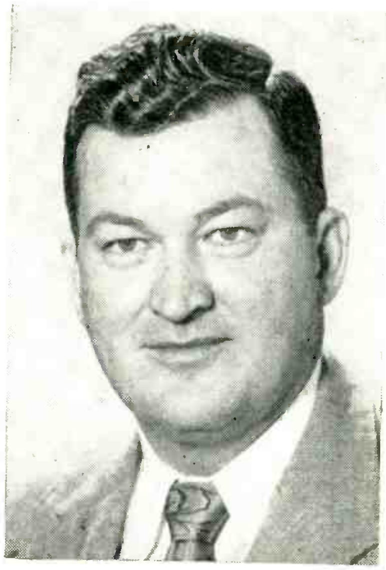

Robert L. Westbee

the new division. He heads 3M's newly created electrical products division. This new organization includes the electrical insulation and sound-recording tape division and the American Lava Corp. in addition to Irvington.

Mr. Westbee joined 3M as a technician in 1933, shortly after graduation from the University of Minnesota. In 1940 he was assigned to electrical-tape engineering. He was named sales manager of the electrical insulation and sound-recording tape division in 1944 and has been general manager of that division since 1948.

Paul D. Miles Rejoins FCC

PAUL D. MILES has been named engineering assistant to Rosel H. Hyde, chairman of the Federal Communications Commission.

Miles has rejoined the Commission staff after a leave of absence of more than five years, which enabled him to serve as a member of the International Frequency Registration Board (IFRB) of the International Telecommunication Union (ITU) with headquarters at Geneva, Switzerland.

From November 1945 to December 1947 he had been chief of the Frequency Allocation Service of the FCC's then Engineering Department. A graduate of the U.S. Naval Academy in 1927, Miles served in various Naval posts and

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A high pressure, quartz mercury arc lamp. It is ideally applicable for use with the microscope, polarimeter, spectrometer, and general laboratory applications.

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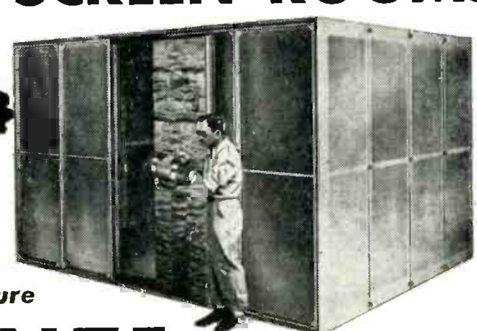

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then with Mackay Radio and Hearst Radio. Returning to the Navy in 1941 he became assistant chief and later chief of the Frequency Section of Naval Communications in the period to 1945. His naval service won him the Legion of Merit.

Answers From A Computer 500 Miles Away

A. W. Jacobsen, director of the Wayne University Computation Laboratory in Michigan, left, and Harry Huskey, technical director, watch as a test problem is fed to the teletype by research technician Gerald Licht. The message went instantly into the Burroughs Corp. electronic digital computer (right) in the firm's Philadelphia Research Laboratory where it solved the problem in seconds and sent the answer back to the teletype receiver at Wayne. Remote-control operation of the Burroughs computer will enable students attending a special two-week course on computers to gain practical experience in the use of giant calculators

Stanford Research Expands Air Lab

THE ENGINEERING DIVISION of Stanford Research Institute has revised and expanded the organization of its aircraft radiation systems laboratory.

Thomas H. Morrin, director of engineering research, has announced that expansion of industrial services in aircraft and communications programs has necessitated regrouping of related technical sections under a radio systems laboratory, by which name the new arrangement will be known.

Morrin has further announced that the broadened scope of research and development on the areas of radio communications at

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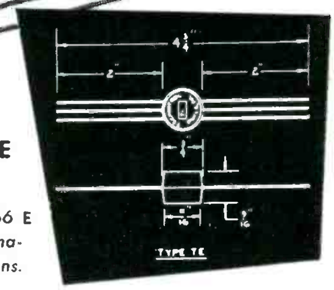

TYPE TE

Write for Bulletin 166 E for additional information and specifications.

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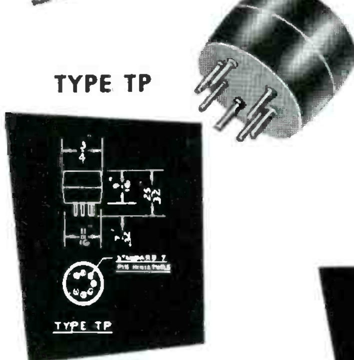

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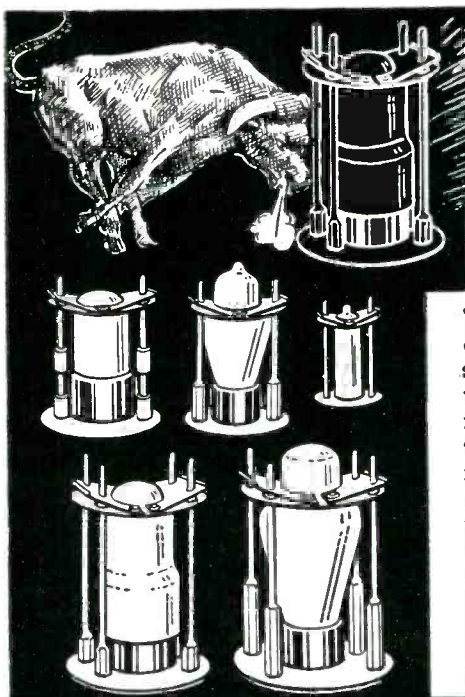

SHOCK PROOF

VACUUM TUBE RETAINERS

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Available for envelope types T7, T8, MT8, T9, T12, ST12, T12ZDL, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

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the Institute has made it desirable to change the name of the single sideband communications group to the communications group. Formerly a separate research section, the communications group will henceforth be a part of the radio systems laboratory.

Heading the new structure will be J. V. N. Granger, assistant chairman of the engineering department. Assistant head is John T. Bolljahn.

The groups now assigned to the radio systems laboratory are: communications, John F. Honey, head, and F. W. Clelland, supervisor; antenna research, J. T. Bolljahn, head; antenna development, Allen Ellis, head; airborne applications, D. R. Scheuch, head, Henry Blanchard, supervisor; microwave, Seymour Cohn, head.

Morrin has emphased that the revamped organization indicates no reduction in the scope of work for the aircraft industry.

Leeds & Northrup Elects New President

THE ELECTION OF I. Melville Stein as president of Leeds and Northrup Co. was announced by the board of directors. Stein, formerly executive vice-president, succeeds C. S. Redding who, after 14 years as president, becomes chairman of the board, a post that has been vacant since the death of Morris E. Leeds in 1952.

Other changes in management responsibilities also were announced. D. H. Schultz, who has been secretary and treasurer since 1940, succeeds Stein as executive vice-president while retaining the duties of treasurer. George W. Tall, Jr., vice-president, assumes the additional post of secretary.

Stein joined Leeds and Northrup as a salesman in 1919. During World War I he had been personal assistant to Thomas A. Edison when the inventor was chairman of the Naval Advisory Board. In 1928 he was appointed director of research at Leeds and Northrup. He was elected a vice-president in 1944, and in 1951 became executive vice-president.

Redding, now chairman of the board, first joined the company in

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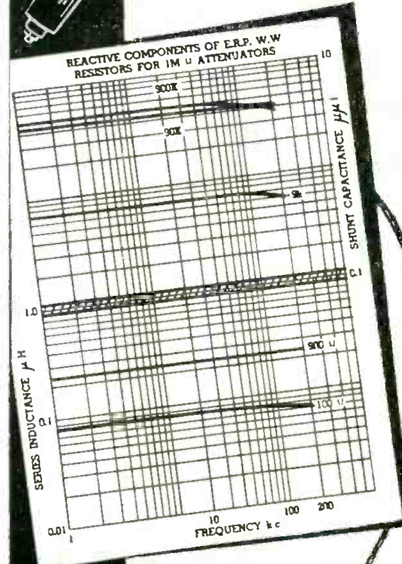
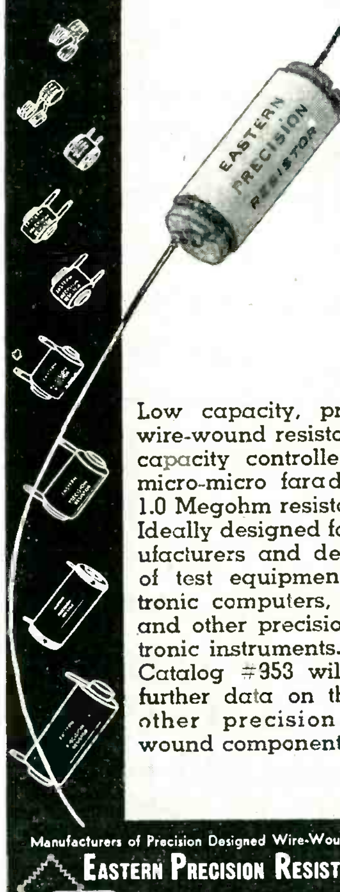
LOW CAPACITY PRECISION WIRE WOUND RESISTORS





Low capacity, precision wire-wound resistors with capacity controlled to .5 micro-micro farads on a 1.0 Megohm resistor. . . . . Ideally designed for manufacturers and designers of test equipment, electronic computers, meters, and other precision electronic instruments. Catalog #353 will bring further data on this and other precision wire-wound components.

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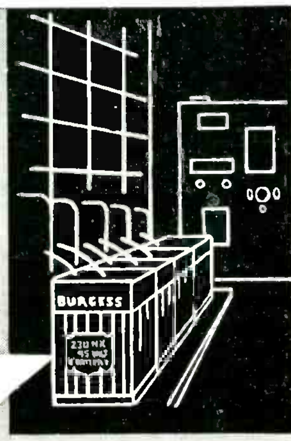
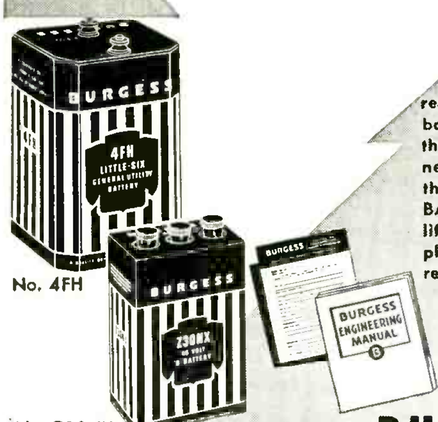


Independent surveys show 2 out of 3 engineers prefer BURGESS BATTERIES over other industrial dry batteries. There's an important reason for this popularity! BURGESS BATTERIES are backed by more years of engineering "know-how" than any other dry batteries. More and more engineers are switching to Burgess, exclusively, because they know what to expect from every BURGESS BATTERY they buy . . . top performance and long life. Whatever the application, Burgess is completely equipped to meet your exact, dry battery requirements.

Burgess provides its customers with a FREE engineering manual listing the complete line of BURGESS BATTERIES and specifications. Also a check sheet to enter new battery specifications. Write to Burgess for the name of your local distributor or, if you have a special application, write for the FREE check sheet.



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1901 as a draftsman. He rejoined the company in 1909, was appointed associate sales manager in 1917 and held successively more important executive posts in the company. He was elected president just before the company was plunged into the whirl of production for World War II. Under his leadership Leeds and Northrup made its contribution to the allied war effort, including the manufacture of thousands of precision instruments used in the atomic-bomb project.

GE Resumes Latin-American Broadcasts

ROBERT B. HANNA, manager of GE broadcasting stations, announced that programs beamed at Latin America will be resumed from GE shortwave station KGEI in San Francisco.

KGEI suspended broadcasting June 27 after the Federal government curtailed the Voice of America program. The station had been America's voice in Latin America and parts of the Far East for 11 years.

Programming is being resumed on a three-hours-a-day basis under the noncommercial sponsorship of GE, Hanna said. He added that the company decided to replace the former government-sponsored programs because of the continued need for good will and understanding among the peoples of the world.

GE started shortwave broadcasting from the San Francisco Bay area in 1939 at the Golden Gate International Exposition. KGEI was the first international broadcasting station west of the Mississippi. After two years at the exposition, KGEI's transmitter was moved to San Carlos, near San Francisco and was boosted in power to 50,000 watts.

JFD Appoints Carpenter And Hall

DOUGLAS CARPENTER has been named chief antenna development engineer of JFD Manufacturing Co. He is inaugurating an expanded engineering program at the company, incorporating new high-gain designs into its antenna line.

Carpenter previously served as

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MINIATURE 2-INPUT AUDIO MIXER

- Size—Only 2 1/16" x 1 13/16" x 1 1/16".
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LOW COST $7.95
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Part No. 310
"Mini-Mix"

Phone Jack inputs with Phone Plug output fitting standard jacks.

Ideal for use with Tape, Wire or Disc Recorders; Amplifiers, Musical Instruments, etc. Separate gain controls for mixing. Short lead lengths inside shielded housing minimizes "Stray Pickups". No bothersome projections. Gain control knobs located directly "in line" with inputs eliminates confusion in selection. Attractive brown finished case—nickel plated accessories. Write for details.

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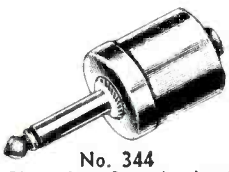
Big Time Savers

Simplify the connection of equipment having different type connectors.

7 Different "Adapters" Available

Complete description and dimensional drawings will be found in our Catalog No. S-52. Send for copy.



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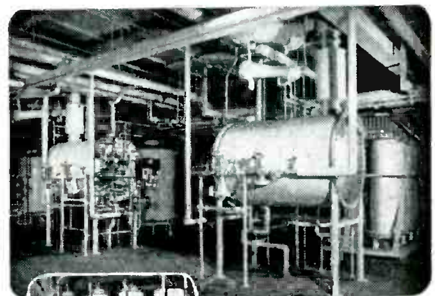
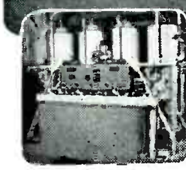
AVAILABLE AT ALL LEADING RADIO PARTS JOBBERS •

HOW Barnstead PURE WATER HELPS RCA





RCA requires Pure Water . . . copper-free to an extreme degree and free from organic impurities for trouble-free TV picture tubes. That is why RCA makes use of Barnstead 200 gph double-effect Stills in combination with Barnstead 1000 gph Demineralizers.

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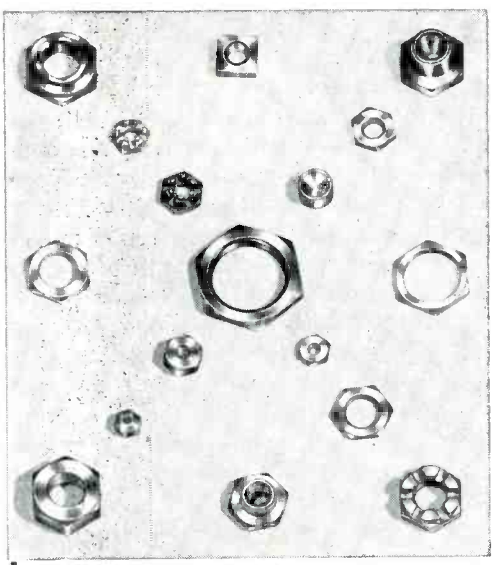
Get all 4 with WESTFIELD METAL PRODUCTS



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★ CAPACITY—From 3/16" hexagon to and including 1-1/16" hexagon across flats, from 1/16" thick to and including ¾" thick.

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Douglas Carpenter

chief engineer for the Vee-D-X division of La Pointe Electronics, the Summit Engineering Co. and McMurdo-Silver, all in Connecticut.

James Hall has been appointed associate antenna test engineer at JFD, assisting Carpenter in development and field testing of antennas. He was previously associated with the CAA and the aviation electronics operations of the U. S. Navy as a design and research engineer.

Battelle Names Stone And Moncreiff

JAMES STONE and Bruce Moncreiff have joined the staff of Battelle Institute, Columbus, Ohio.

Stone will conduct engineering research leading to the development of digital computing systems and components for the handling of both technological information and mathematical problems. Prior to joining Battelle, Stone was employed as an electronic development engineer at the Oak Ridge National Laboratory. It was while there that he developed what is now called the Oak Ridge National Laboratory reactor-controls computer—an analog-digital computer with special applications in the study of reactors.

Previously, he was senior electronics engineer on the NEPA project conducted by the Fairchild Engine and Airplane Corp. at Oak Ridge.

Moncreiff's principal interest at the Institute is in the development of information-handling devices

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NAVY TYPE

Shaw terminal blocks, produced to Navy specifications are now available from stock.

Supplied with complementary hardware if desired.

Shaw's reputation as an experienced custom molder assures you the highest quality precision-made terminal blocks.

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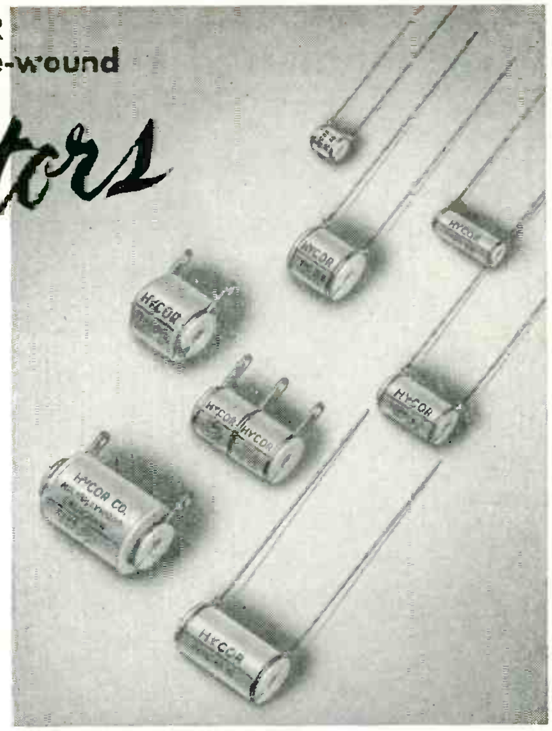
Precision Wire-wound

Resistors



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Our steady customers tell us that the formula works!

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New 800-2600 mcs FREQUENCY METERS
Lightweight — Portable Units

SPECIFICATIONS

1. **ACCURACY**
   Better than .05% from 20°F to 120°F
2. **SENSITIVITY**
   Usable indication with 1 milliwatt input
   Adjustable for higher levels
3. **INDICATOR**
   50 Microammeter
4. **INPUT**
   50 Ohm Type N Connector
5. **EXTERNAL DC OUTPUT**
   Pin Jacks
6. **EXCURSION OF MICROMETER**
   One-half inch
7. **MICROMETER SCALE**
   at 1000 Mc —
   1 Division equals 290 KC
   at 1400 Mc —
   1 Division equals 350 KC
   at 2000 Mc —
   1 Division equals 450 KC
   at 2600 Mc —
   1 Division equals 555 KC
8. **EXTERNAL SIZE**
   6½ x 9¾ x 7"
9. **WEIGHT**
   Four pounds

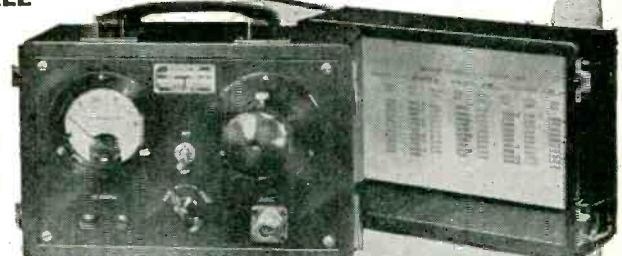
(Cavity units are also available for custom housing)

...For Field and Laboratory Use!

Models

FS-C-171-A	800-1200	MCS.
FS-C-172-A	1200-1600	MCS.
FS-C-173-A	1600-2250	MCS.
FS-C-174-A	1700-2600	MCS.

Units consist of cavity body, micrometer control, crystal, suitable connectors and calibration chart. Write for specifications and prices.



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and techniques for applying them to problems of business and industry. He comes to the center from the Prudential Insurance Co. of America where he was employed as senior methods analyst. While there, he supervised research aimed at finding applications for digital computers in the company's clerical operations. Prior to joining Prudential Moncreiff was engaged in operations planning at GE.

Noebels Heads Beckman Applications Division

Henry J. Noebels

APPOINTMENT OF Henry J. Noebels to head the applications engineering division of Beckman Instruments has been announced by W. H. Steinkamp, vice-president and general sales manager.

Mr. Noebels has been associated for the past eight years with the Heyden Chemical Co., in charge of the physical instrumental analytical research lab. He worked also as Adjunct-Professor of Analytical Instrumentation at the Newark, N. J. College of Engineering. His appointment follows a set-up in applications engineering activities at Beckman.

Motorola Establishes New Test Lab In Ohio

A NEW TEST LAB for Motorola products is being established at Loyal Oak, Ohio, it was announced by A. T. Alexander, national service

Engineering

WRITERS

ENGINEERS, E. E. or PHYSICS GRADUATES, for preparation of technical manuals . . .

HUGHES RESEARCH AND DEVELOPMENT LABORATORIES' *expanding program for production of radar, electronic digital computers, guided missiles and other military advanced electronic systems and devices requires the following:*

1 **ELECTRICAL ENGINEERING AND PHYSICS GRADUATES** to prepare operating, servicing and overhauling instructions for complex electronic equipment. Those with previous maintenance experience on military equipment preferred. Writers will participate in a three-month program in our technical training school to become familiar with the latest Hughes equipment prior to writing assignments.

2 **ENGINEERS EXPERIENCED** in the writing and preparation of maintenance manuals for electronic equipment or guided missiles. These specialists will work step-by-step with the people designing, developing and manufacturing the products involved. Experience in the writing of engineering reports is of value.

HOW TO APPLY

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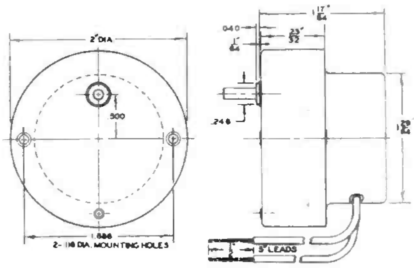
Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

SYNCHRONOUS MOTORS 2 INCHES IN DIAMETER



"CIRCLE B" TIMING MOTORS — Provide exceptional power. Up to 16 in. oz. torque continuous duty, and 84 in. oz. intermittent duty at 1 r.p.m. Compact — 2" diameter by 1 17/64" deep. Speeds from 1/6 r.p.m. to 1800 r.p.m. Operate in any position.

ELAPSED TIME INDICATORS — For industrial or laboratory applications. 2" diameter by 2⅛" deep.

LOW SPEED MOTORS — Ranging from 10 revolutions per hour to 1 revolution per month. 2" diameter by 1⅝" deep.

Bristol Motors are available for 24, 110, or 220 volts, 50-60 cycles. They are widely specified for timing devices, motion displays, defrosters, clocks, washers, ranges, dryers, time delay relays, general control equipment, and many other applications.

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CIRCLE B BRISTOL

BRISTOL MOTOR DIVISION

VOCALINE COMPANY OF AMERICA, INC.
254 Coulter St., Old Saybrook, Conn.

director. Although the site is especially suited to tv testing because of the number of vhf and uhf stations in the area, the company will also test its home and auto radios there.

Each week sets picked at random will be shipped to the Akron suburb to undergo quality-control checks. Arthur Pape of Motorola's service department will supervise testing operations. Up to the time of the move, testing was conducted in Lakewood, N. J.

RETMA Sets Plans For TV Service Course

TELEVISION TECHNICIANS in the New York area selected by the New York Trade School to participate in RETMA's first training course will learn modern service techniques by working on the latest tv sets and utilizing the most modern test equipment.

RETMA member companies have donated approximately $80,000 in money and equipment for the course. The pilot program is designed to develop an industry-approved upgrading course for tv service men to be used in trade and vocational schools throughout the country. It is expected that it will improve the technical proficiency and business technique of practicing tv servicemen.

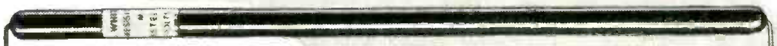
CBS-Columbia Names Three Engineers

LEOPOLD M. KAY, vice-president of engineering of CBS-Columbia, announced the appointments of Jerome Goldman, Eugene Lieberman and Robert S. Sterling to the company's engineering staff.

Goldman, who has been appointed senior electronic engineer on government equipment, was formerly associated with Tele King Corp., where he worked on uhf tuners. He also was an engineer with Western Electric Co. and with Techno Scientific Co.

Lieberman, who was named liaison engineer for the product engineering staff, will be in charge of coordinating activities between the engineering, production and quality-control departments. He was

The S. S. WHITE 80X HIGH VOLTAGE RESISTOR



(½ Actual Size)

4 watts • 100 to 100,000 megohms

Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage coefficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture - resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

WRITE FOR BULLETIN 4906

It gives complete information on S.S.White resistors. A free copy and price list will be sent on request. Send for a copy.

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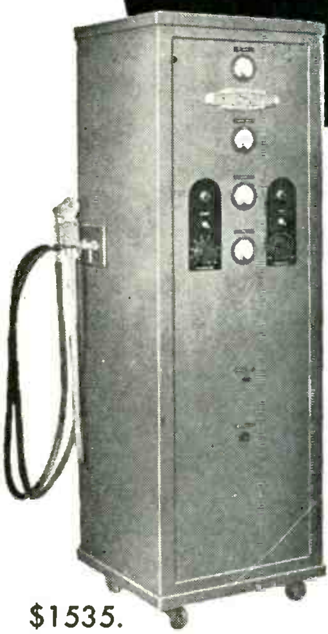

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Simple...Easy to Operate...Economical Standardization of Unit Makes This New Low Price Possible.

Maximum economies can be obtained only by use of correct frequency and power combinations when applying the techniques of induction heating to manufacturing processes.

It is significant that only Scientific Electric in the present market, can offer you a selection of frequencies depending on power required, in wide power range. 2-3½-5-6-7½-10-12½-15-18-25-40-60 KW (all units above 60 KW are considered custom built). This means that electronic heating equipment produced by Scientific Electric is tailored to your needs... fitted perfectly to the task entrusted to it, enabling you to keep your initial investment in equipment to a minimum while affording you all the proven advantages of electronic heating.

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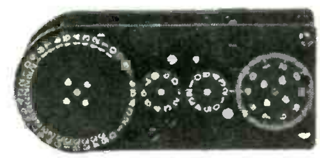
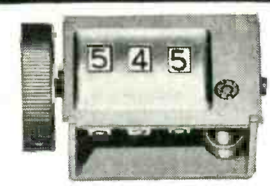
For RADAR, ELECTRONIC and INSTRUMENT APPLICATIONS

High speed, non-reset, direct reading counter to indicate increment of measurement in radar navigation instruments.

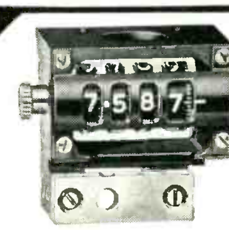


High speed degree-type counter to indicate degrees, minutes and tenths of minutes for navigating equipment.

"Y" 2-figure Rotary Counter used in navigating instruments.



Special counter for use on Tape Recorder to indicate the position of tape passing through the recorder.



Special high speed Y-type counter for Goniometer application.

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PRODUCTIMETERS SINCE 1879 *Count Everything* formerly with Emerson Radio in the test engineering department.

Mr. Sterling, who was appointed electronic engineer assigned to military equipment projects, formerly was with the Link Radio Corp. where he worked on communications equipment.

Commander Sergeant Joins Navy's Electronic Supply

Commander R. C. Sergeant

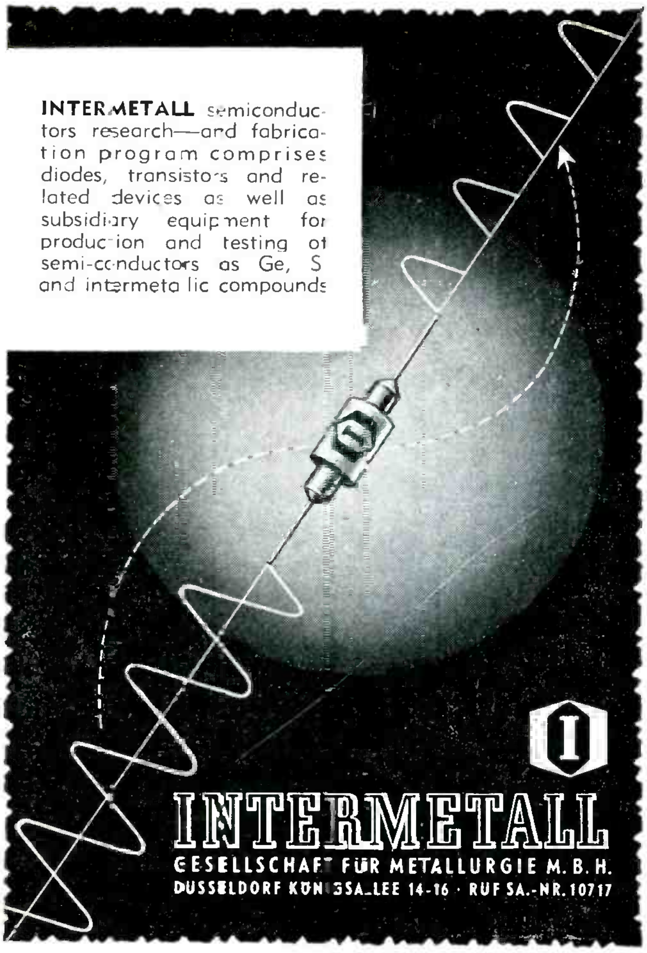
COMMANDER RUSSELL C. SERGEANT, USNR, has reported to the Navy's Electronic Supply Office, Great Lakes, Ill. to assume the position of technical division officer. His duties will include technical and engineering research relating to procurement, inventory control and distribution of electronic material. He will also serve as a liaison officer between the Navy and the electronics industry.

The Electronic Supply Office is the control point of the entire electronic supply system of the U.S. Navy.

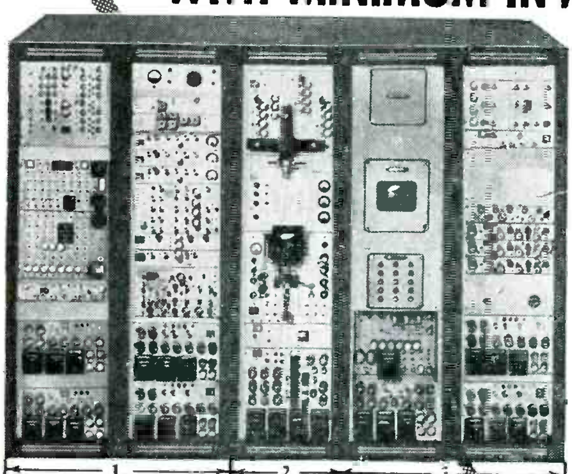
As a Signal Corps enlisted man in the 1920's Commander Sergeant was operator in charge of the Nome, Alaska radio station.

Before entering the Naval Service in 1940 he was employed by the Mackay Radio and Telegraph Co. for 14 years, first as a radio operator and later as radio supervisor of the San Francisco office.

During World War II, he served in the Aleutians, on the staff of



HOW TO INAUGURATE COLOR TV WITH MINIMUM INVESTMENT



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   Produces NTSC encoded signals from color bars.
2. **SUPPLEMENTAL EQUIPMENT**
   Creates accurately certified NTSC encoded pictures from color transparencies. Feeds phase equalized picture and sound transmitter.
3. **RECOMMENDED EQUIPMENT PLUS FULL FACILITIES**
   Transmits, receives, monitors and analyzes, composite NTSC color pictures.

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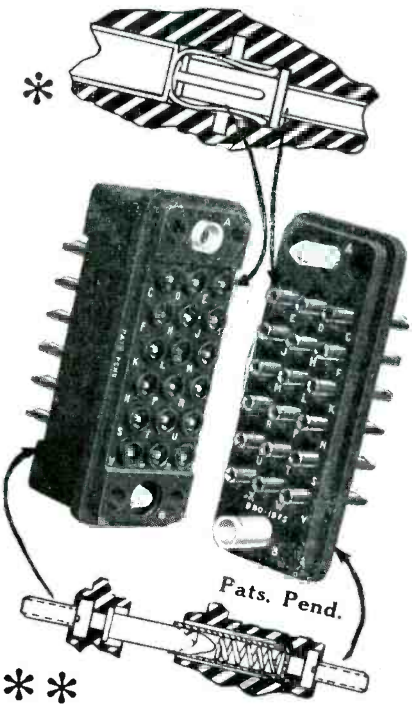
DOUBLE FEATURES Create demand for U.S.C. 980 Series-12-18-24-34 CONNECTORS



***Double wiping (internal & external) contacts assure positive contact under all conditions.**
****Spring loading on guide contacts reduces the separation force in disengagement of connectors. Also provides additional guide contact dependability.**

USC's complete engineering, tooling and production facilities are geared to produce quality connectors, allied components and assemblies.

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the Commander-in-Chief Pacific and in 1946 he reported to the Office of the Chief of Naval Operations where, for 7 years, he was engaged in the research and development of electronic countermeasures equipment.

For two and a half years, Commander Sergeant was chairman of the Panel on Electronic Warfare, under the Joint Chiefs of Staff.

Kimble Readies New TV Bulb Warehouse

SCHEDULED FOR COMPLETION this month, a new warehouse, to be used for storage of all-glass tv bulbs, is under construction at the Kimble Glass Co. plant in Columbus, Ohio. The one-story building will provide 200,000 sq ft of floor space.

Emerson Promotes Stanley Abrams

STANLEY L. ABRAMS, director of purchases of Emerson Radio, has been promoted to director of the Material Division, it was announced by Benjamin Abrams, Emerson's president.

The director of the newly created division will supervise overall logistics at Emerson and is charged with the duty of maintaining a constant and smooth flow of all materials throughout the organization. Included in the division will be the departments of expediting, inspection, stock control and production planning.

Mr. Abrams joined Emerson in 1946. In 1948 he was appointed manager of the purchasing division which post he held until January, 1952, when he was advanced to Emerson's director of purchases.

Robert J. Bahr, formerly manager of purchasing and traffic of GE's Electronics Division, has been named director of purchases succeeding Mr. Abrams.

Allied Radio Moves To New Building

THE ALLIED RADIO CORP. moved into its new $2-million building in Chicago. The two-story structure, with a total area of 147,000 sq ft, covers a square block in the geo-

Style 18 (Medium), 500 yd. spools, black or natural.

for lacings that stay put!

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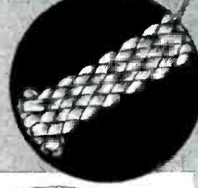

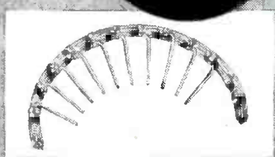

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**Patent Pending.*

R. F. WATTMETER ME-82/U

Model MM-625 Series 50 to more than 1000 MCS.

This series of instruments was designed to measure RF power up to 400 watts, and serve as an excellent dummy antenna load over the frequency range 50 to more than 1000 MCS in 52 ohm coaxial line circuits.

Some of the outstanding features are:

1. Directional coupler pick-up probe which eliminates high frequency resonant responses and errors due to slight deviations in the load impedance.
2. Rugged construction for field and laboratory use.
3. Hermetically sealed and ruggedized indicating instrument in accordance with specifications MIL-M-10304.
4. Two spare crystal rectifier supplied with each instrument.
5. Model MM-625 has recently been assigned the Armed Forces nomenclature ME-82/U.

SPECIFICATIONS

Impedance	52 Ohms
Frequency Range	50 to over 1000 MCS.
Maximum VSWR	1.2
RF Power Scale	
Model MM-625	120 watts
Model MM-626	40 watts
Model MM-627	400 watts
Accuracy	±5% of full scale
RF Connector	Type C (Adapters available for other types)
Size	6 x 7⅛ x 13-9/16
Weight	9½ lbs.

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graphic center of the city.

A. D. Davis, president, pointed out that the need for Allied's new facilities was dictated by the growth of the electronic parts industry. Shortly after World War II, the company carried about 8,000 separate stock items. Allied's 1954 catalog will list over 20,000 separate items. An increase of 25,000 items is anticipated within a few years.

Harvard Names F. V. Hunt

F. V. HUNT, Gordon McKay Professor of Applied Physics and wartime director of the Harvard Underwater Sound Laboratory, has been named Rumford Professor of Physics at Harvard University, Provost Paul H. Buck announced.

Hunt succeeds retiring Rumford Professor E. L. Chaffee in the 137-year-old chair. He will continue as Gordon McKay Professor of Applied Physics.

A member of the Harvard faculty since 1927, Hunt organized in 1941 and directed until 1946 the Harvard Underwater Sound Lab. which, operating with the Office of Scientific Research and Development, developed an efficient sonar system for detecting the presence of enemy submarines. For his part in the development of the bearing deviation indicator which enabled sonar operators to train their sound projectors on submarines with greater speed and accuracy and his work with acoustic torpedoes, he received a presidential Medal for Merit in 1947.

Since the war, Hunt has been continuing his acoustics research for the Navy and is a member of the National Research Council Committee on Undersea Warfare. During 1947-49 he served as chairman of the Panel on Acoustics of the Research and Development Board.

Philco International Promotes Jeffery

SYDNEY L. CAPELL, president of Philco International Corp., announced the promotion of W. H. Jeffery to vice-president and general manager of Philco Corp. of

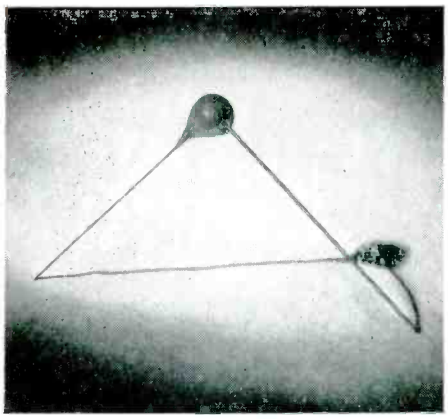
GOLD BONDED

Germanium Diodes

. . . designed for **Superior Service**

The smallest, most efficient and economical diodes commercially available, Transistor Products germanium diodes offer superior advantages in many applications.

All TP diodes have uniform characteristics and low shunt capacity; specific types meet highest forward current requirements and have a minimum voltage drop.



Transistor Products germanium diodes give dependable performance because they are designed and assembled for maximum mechanical strength. These diodes have the gold electrically bonded to the germanium — creating a welded alloy which meets shock resistance requirements. Only 3/16″ in diameter, they are compact and ideal for sub-miniature assembly. TP germanium diodes also have tinned copper leads which permit easier soldering in production lines.

For data sheets and complete information on Transistor Products diodes, transistors and transistor test set, write Dept. E10.

TP

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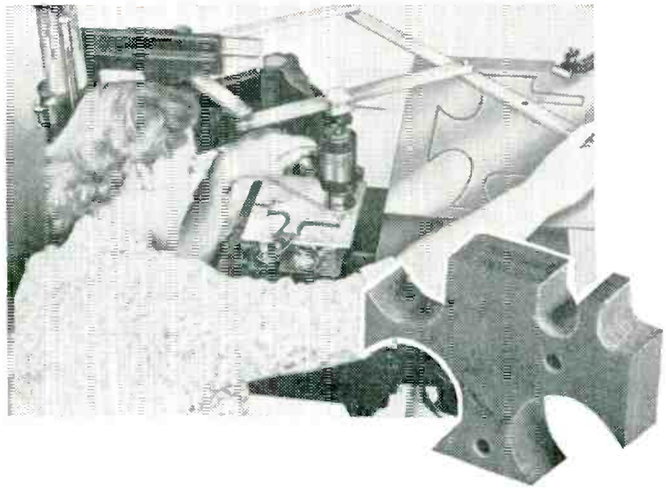

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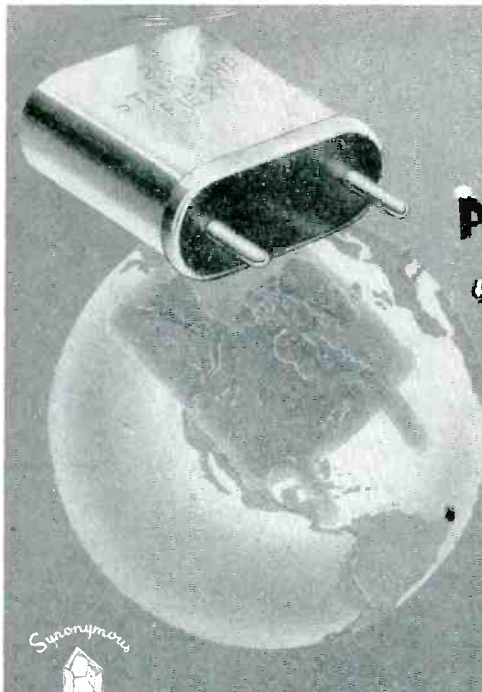

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In every corner of the globe . . . Standard Piezo Crystals are functioning with complete fidelity . . . just as faithfully as they did in their final, comprehensive inspection in our plant. Standard Piezo Crystals are truly masterpieces of precision . . . the rugged, *accurate* and *dependable* end-product of an exacting and vigorous system of manufacture, inspection and quality control. Quality is *standard* with Standard Piezo.

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Canada, located in Toronto.

This position was previously held by Mr. Capell who transferred from Toronto to Philadelphia to become president of Philco International and assume direction of all Philco manufacturing and sales activities outside the U. S. At that time, Mr. Jeffery was named general manager.

Mr. Jeffery has been associated with Philco of Canada since 1945, first as a division manager and later as general sales manager. Before joining Philco he was associated with British Columbia Power Corp. as sales engineer and with the Canadian National Steamship Co.

New Company Enters Electronics Industry

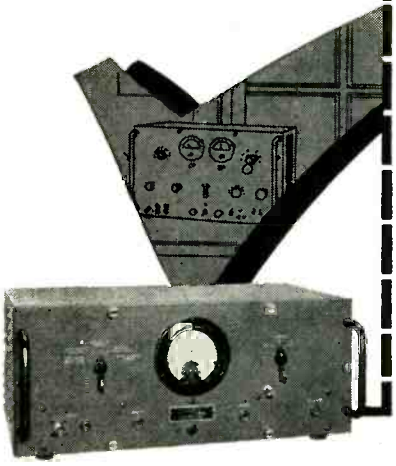
F. Gordon Schermerhorn

A NEW COMPONENT manufacturer, Bradford Components, has entered the electronics industry to develop and produce wire-wound precision resistors of low and medium power, wind precision coils and handle component subassemblies of all types.

The firm has a completely renovated plant of approximately 12,000 sq ft located in Bradford, Pa.

The company is headed by F. Gordon Schermerhorn, president, who has had many years of executive experience in the electronic-component manufacturing industry. For several years he was production manager and production-control manager of the Hi-Q division of the Aerovox Corp. Recently, as division manager of the Speer Resistor Corp., he was re-

H-16 CHECKS the CHECKER



ARC Type H-16 STANDARD COURSE-CHECKER

For Omni Signal Generators

▫ This newly developed instrument is a means for checking precisely the phase-accuracy of the modulation on VOR (Omnirange) Signal Generators. Now that the use of omnirange receivers and signal generators is so widespread, it is necessary to have a means of measuring the phase differences between the 30 cps envelope of the 9960 ± 480 cps reference modulation, and of the 30 cps variable modulation when that difference is required to be 0, 15, 180 or 195 degrees.

▪ An important feature of the H-16 is a built-in self-checking circuit to insure .1 degree accuracy. Errors may be read directly on a 3-inch meter, calibrated to read ± 4 degrees.

Write for detailed specifications

ARC

Dependable Airborne Electronic Equipment Since 1928

Aircraft Radio Corporation

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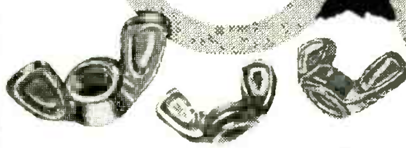
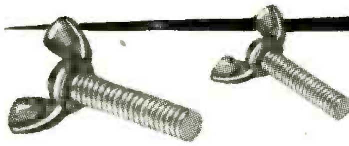
GRC ZINC ALLOY FASTENINGS



GRC WING NUTS
Exclusive, finger-grip design; easy to assemble, disassemble; brightly finished; clean threads.

GRC CAP NUTS
Die Cast, not turned! Free of tool marks, and cut-off burrs; class 2 threads tapped square with face of nut.



NEW! GRC WING SCREWS
A steel screw combined with GRC's attractive finger-grip wing-nut.

GRC SMALL TUBULAR RIVETS
Die cast, not headed! Closer tolerances, more uniform heads for greater riveting efficiency. Dia. up to 9/16"; lengths to 5/16".

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- DURABLE

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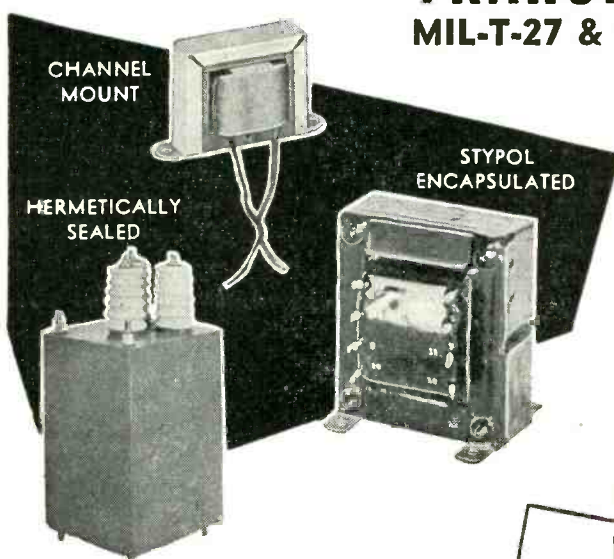

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sponsible for the completion and organization of their new composition-resistor manufacturing unit at Bradford, Pa.

The company's director of engineering is Lawrence Lopez, who has been associated with the electronic-component industry for over twenty years. He recently was project and development engineer in charge of coils and resistors for the Hi-Q division of the Aerovox Corp. Prior to that he was president and general manager of the R.K.L. Electro Winding Corp. at Delevan, N. Y. Before that he had many years of engineering and executive experience with such firms as General Winding Co. and Cornell-Dubilier Corp.

Albuquerque Set For TV Network Connection

DIRECT CONNECTIONS with national television networks and additional long-distance telephone facilities will be available to Albuquerque, N. M. by mid-1954, according to Wayne Coy, president and general manager of the Albuquerque Broadcasting Co., which owns and operates stations KOB and KOB-TV.

Making the new service possible is construction of AT&T's coaxial cable from Oklahoma City to Amarillo, and a microwave relay system from Amarillo to Albuquerque, and on to the Pacific Coast through Phoenix.

Albuquerque, which has been getting its TV shows on film for the last five years, with an average time lag of a week, will have three tv stations on the air when the new facilities are completed. KOB-TV will be affiliated with NBC and Du Mont; KOAT-TV, which plans to be on the air this fall, will be affiliated with ABC; and KGGM-TV, which has set a November opening date, is linked to CBS.

General Instrument Elects Hutchison

MALCOLM C. HUTCHISON has been elected a director of the General Instrument Corp., it was announced by Abraham Blumenkrantz, chairman of the board.

Hutchison is a former vice-presi-

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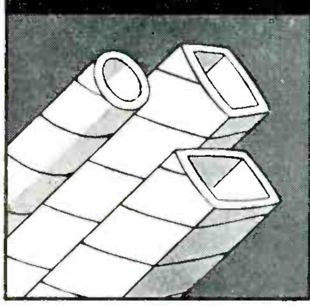

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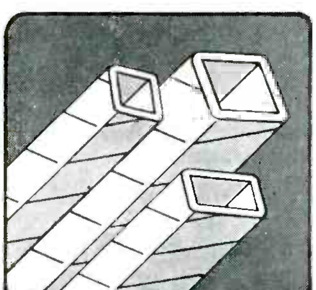
Standard-type PARAMOUNT paper tubes used for millions of coil forms and other applications. Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Red Rope, Acetate, or any combination wound on automatic machines. Any size from ½" to 30" long, from .450" to 25" I.P. Produced from wide range of stock arbors or specially engineered for you.



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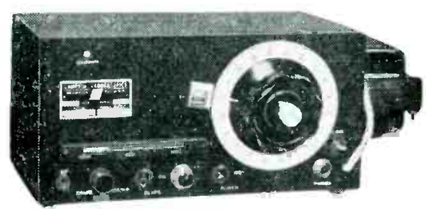
For Low-Cost Servicing of Mobile Radio Systems

Lampkin equipment gives you the lowest cost per channel, whether you supervise a large multiple-frequency system, or whether you service numerous smaller installations! Lampkin equipment measures center frequency and modulation deviation, to FCC specifications!

The Type 205 FM Modulation Meter For Multiple Mobile Frequencies.

The Type 205 FM Modulation Meter measures peak frequency swing due to voice modulation of FM transmitters, as required by the FCC. Indicates 0-25 KC. deviation. Instantly tunable to any frequency from 25 MC. to 200 MC. Simple to use. Direct reading. No charts. Price Net $240.00.

For Any Number of Frequencies, AM or FM. The Type 105-B Micrometer Frequency Meter



The Type 105-B Micrometer Frequency Meter measures center-frequency deviation on any number of transmitters, from 100 KC. to 175 MC.; also precisely simulates weak transmitter signals, for mobile receiver alignment, 20 MC. to 175 MC. Overall accuracy within 0.0025%, with spot check on WWV. Price $220.00., net.

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dent of the Irving Trust Co., from which he retired last May after more than 30 years service. He also is a director of the American Colortype Co., the Bankers Commercial Corp., the Longines-Wittnauer Watch Co. and Seeman Brothers, wholesale grocers.

Raytheon Wins Hearing-Aid Award

THE 1953 ENGINEERING award of the Society of Hearing-Aid Audiologists has been presented to Raytheon Manufacturing Co. The professional group, comprising some 500 dealers and consultants engaged in the hearing-aid business, made the award "in recognition of Raytheon's outstanding achievement in transistor design and production."

The company announced the availability of junction transistors for hearing aids in September 1952, began shipments in January of this year, and has since shipped well over 100,000 of them.

Greenhouse Joins Ferroxcube Corp.

HAROLD M. GREENHOUSE, formerly of the Ohio State University Research Foundation, has joined the research department of the Ferroxcube Corp. of America. Greenhouse will be employed in research on development of new types of ferrite magnetic materials, it was announced by W. W. Stifler, Jr., general manager.

Simpson Doubled Production Facilities

WITHIN the past year, facilities for the production of electrical testing equipment of the Simpson Electric Co. have doubled, according to Robert Brand, factory manager of the company's Chicago plant.

The company recently extended its Lac du Flambeau plant in Wisconsin, one of three now operated by the firm for the production of testing equipment.

At the plant, which is on the Lac du Flambeau reservation, home of the Lake Superior Chippewa indians, the company is uti-

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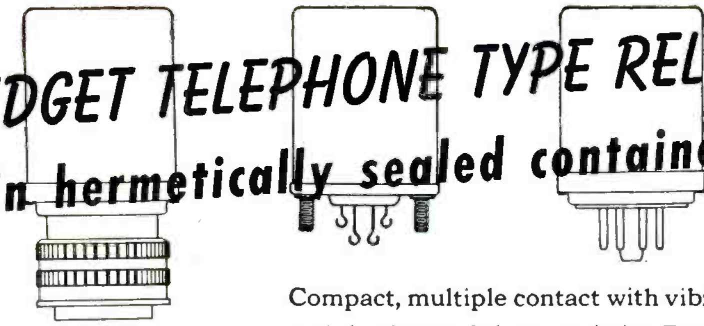
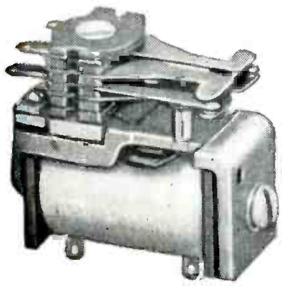
in hermetically sealed containers





Surface mounting, open type, Series 80 Relay — size: $1\frac{15}{32}$" l. x $\frac{5}{8}$" w. x $1\frac{25}{64}$" h.

Compact, multiple contact with vibration and shock-proof characteristics. Designed to meet various operating requirements typical of Armed Services applications.

Unique pile-up arrangement reduces width below the conventional relay, thereby reducing over-all space volume.

Coils are varnish-impregnated to resist high humidity conditions. All ferrous parts are treated to pass salt-spray tests.

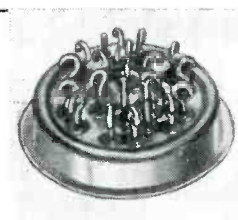
Engineering Representatives in Principal Cities

WRITE FOR BULLETIN *MTR-6*

Wheelock RELAYS
SIGNAL
ENGINEERING & MFG. CO.
154 WEST 14TH ST. NEW YORK 11, N.Y.

HERMETIC SEALS

- Vacuum Tight—Glass to Metal
- Standard Types from Stock
- Special Designs to Fit Your Product
- Write or Call for Full Information



MINIATURE 20 TIN HEADER

Sales Agency:
WESTERLUND & CO.
618 Calvert St. Baltimore, Md.

SCIENTIFIC ELECTRONIC LABS, INC.
866 Bergen St. Bigelow 8-6553 Newark 8, N. J.

$2\frac{3}{4}$ MILLION IN STOCK!

WHY EthoLoc* CABLE CLIPS?

1. Made of tough, durable Ethyl Cellulose plastic—no danger of shorts or grounds
2. Flexible and easy to apply—no sharp edges
3. Light in weight
4. Low in cost

15% reduction in prices on many popular sizes. We thank our customers for large volume that made price reductions possible.

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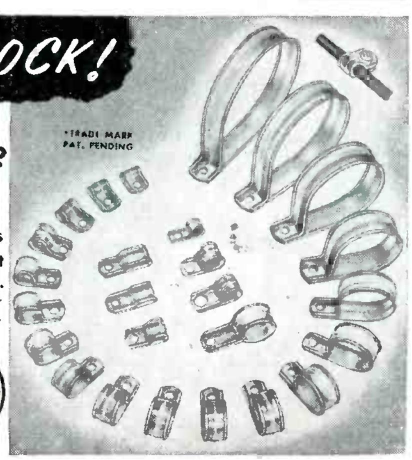
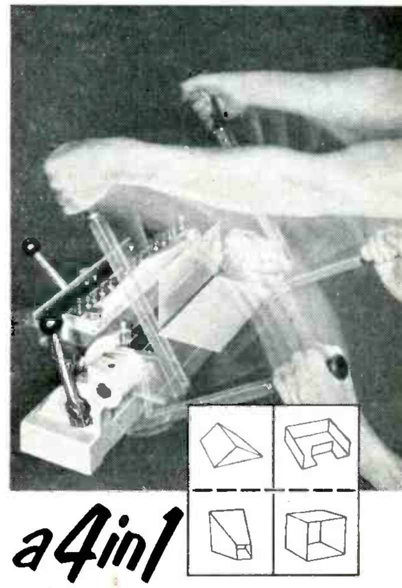
WECKESSER CO.
5267 N. Avondale Ave. • Chicago 30, Ill.

ALSO MFRS. OF ALL NYLON CABLE CLIPS





a 4 in 1 metal working tool!

di-acro* BOX FINGER BRAKE

Accurately, Easily, Quickly Form and Duplicate a Wide Variety of Shapes in Metal as Heavy as 16 Gauge—Widths up to 24" —with Versatile Di-Acro Brakes.

A number of forming jobs can be done with the Di-Acro Box Finger Brake, by simply adjusting or changing the type of mounting bar on the contact surface. Di-Acro Finger Brake is:

- **Box and Pan Brake** — when equipped with a complete set of Box Fingers.
- **Open End Brake** — when Open End Finger is installed in place of Box Fingers.
- **Bar Folder** — when an Acute Angle Bar replaces the Box Finger Bar mounting.
- **Standard Brake** — when a Forming Bar is mounted for heavy operations.

Di-Acro Standard and Radius Brakes are also available. Ten models in all.

*pronounced Die-ack-ro

WANT MORE INFORMATION?

Send for New 32-Page Catalog

Gives facts on Di-Acro Brakes and also both hand and power operated Di-Acro Benders, Notchers, Punch Presses, Rod Parters, Rollers and Shears. Mail your request today.

Creators of "Die-Less Duplicating"

O'NEIL-IRWIN MFG. CO.
321 Eighth Ave.
Lake City, Minn.

di-acro PRECISION METALWORKING MACHINES

lizing the dexterity of the Indians in mass-production techniques. About 95 percent of the plant's employees are native members of the Chippewa tribe on the reservation.

In appreciation for the opportunities given the Flambeau Indians, both Raymond Simpson, founder of the company, and Wallace Carroll, current president and owner of the firm, have been adopted as honorary members of the Tribe.

Corbett Retires From Sparks-Withington

William J. Corbett

WILLIAM J. CORBETT, vice-president of The Sparks-Withington Co., Jackson, Mich., was guest of honor at a dinner given by business associates and friends in Jackson on the occasion of his retirement from the company at the completion of 44 years service.

He was a member of the board of directors for 33 years and 28 years vice-president of The Sparks-Withington Co. He has been president of the firm's automotive division since 1938.

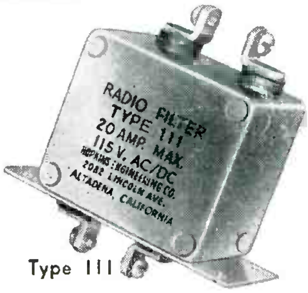
Machine Works Forms Electronic Division

HUFFORD MACHINE WORKS of El Segundo, Calif. has formed a new electronic division, according to J. A. Helget, president.

Located in a new 10,000 sq ft plant in Los Angeles, the new division will specialize in the development and production of d-c regulated and unregulated rectifier-type

DEPENDABLE *Miniature*

RADIO FILTERS



Type 111

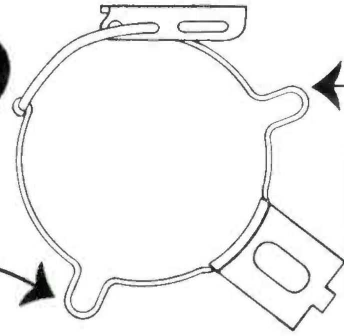
—Saves space !
—115 V ac/dc, 20 amp.
—Excellent attenuation
—Feed through installation
—Flange mounting bracket
—Corrosion & fungus resistant

If you have radio interference problems, write or wire us, TODAY !

HOPKINS *Engineering Co.*

FACTORY: 2082 Lincoln Ave., Altadena, Calif. *SYcamore 8-1185*
Offices in WASHINGTON, D. C. and DETROIT

WHAT CLAMP TO USE WHERE TOLERANCES ARE LARGE ?



AUGAT'S *NEW* TWO TENSION LOOP CLAMPS

Augat two-tension loop clamps are the long-sought answer for uses where tube base tolerances vary up to .040. The bands of these sturdy clamps are made of Beryllium copper, heat treated to retain original tension and nickel plated to withstand a 96 hour salt spray test with no adverse effect.

The remaining parts of Augat's two-tension loop clamps are made of 18% nickel silver.

Write today for catalog and samples.

AUGAT BROS. INC.

31 PERRY AVENUE • ATTLEBORO, MASS.

PHAZOR PHASE METER

Pat. Pend.

MODEL 200A

$349^{50} F.O.B. New York, N. Y.

Measures phase shift in transformers, amplifiers, filters, and phase displacement networks.

- Measures from 0 to 360 degrees.
- Readings not affected by noise and harmonics.
- Phase shifts of the order of .01 degree can be measured employing special circuit techniques.
- Measures in-phase and quadrature components separately.

SPECIFICATIONS

Accuracy—Basic accuracy plus or minus 2 degrees. Plus or minus 1 degree due to meter error.
Noise and Harmonic Rejection.......40 db. down
Sensitivity.......6 millivolts full scale
Maximum Input Voltage.......125 volts RMS
Peak Input Signal.......400 volts
Frequency Range.......20 to 20,000 cps.
Input Impedance
High Gain...2.0 megohm shunted by 25 mmfd.
Low Gain...2.5 megohm shunted by 10 mmfd.
Reference Input Impedance.......4000 ohms
Power Supply....105 to 125 volts, 60 cps., 25 watts
Dimensions—Length 15 in., Hgt. 9 in., Depth 8 in.
Weight.......25 pounds

INDUSTRIAL TEST EQUIPMENT CO.
55 EAST 11th ST., N. Y. 3 - Tel: GR. 3-4684

SECON

DEVELOPMENT and PRODUCTION METALLURGISTS

Fine wire and ribbon in base, rare, and precious metals, and alloys for new and highly engineered applications. In small units and sizes, and to close tolerances.

Further details on request.

SECON

SECON METALS CORPORATION
7 Intervale Street, White Plains, New York
WHite Plains 9-4757

power supplies, magnetic-amplifier controls, magnetic servo amplifiers and transformers.

Officers of the division are J. C. Washington, sales manager; B. J. McComb, chief engineer and J. R. Frost, in charge of government negotiations.

Du Mont To Sell Dage TV Equipment

THE TELEVISION TRANSMITTER DIVISION of Allen B. Du Mont Laboratories will sell the broadcast tv cameras and camera equipment of Dage Electronics Corp., it was announced by C. J. Harrison, marketing manager of the division.

Availability of the Dage equipment through Du Mont, Harrison said, will provide an extra service to station owners and applicants by supplementing Du Mont's own complete line of image-orthicon camera units with the lightweight, ultraportable and inexpensive Dage units which employ vidicon tubes.

Atomic Instrument Elects Collier

DONALD W. COLLIER, director of research for Thomas A. Edison, has been elected a director of the Atomic Instrument Co. of Boston, it was announced by L. W. Cronkhite, president.

As head of Edison Laboratory, Collier, 33-year-old research chemist, occupies the position created and held by the late Thomas A. Edison.

Sangamo And Southern Illinois Set Research

A new agreement between Southern Illinois University and the Capacitor Division of Sangamo Electric Co. will provide funds for a research program and scholarships for students majoring in physics.

The agreement calls for a joint research board including one University member and three members appointed by the manager of Sangamo's Capacitor Division. Sangamo will also supply financial aid, equipment, samples and technical information.

The new research unit will be

Mark your own symbols, numbers, lettering, on your small parts, tools, identification and name plates . . . easily, simply, quickly . . . tracing from a master with the GREEN ENGRAVER.

Widely used in electronic and plastic fields, in machine tool shops and wherever permanent marking is needed. The GREEN ENGRAVER engraves equally well on metals, plastic, wood, hard rubber and glass.

✓ Fact-filled folder on request . . . showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.

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Etching attachment and other special equipment for industrial uses are available.

Green Instrument Co.
INCORPORATED

363 PUTNAM AVE., CAMBRIDGE, MASS.

Visit us: National Instrument Exhibit, Booth 262

New Technitrol Variable Pulser

* Wide pulse repetition frequency range from 20 cps. to 2.0 mcs.
* Pulse rise and fall times are symmetrical at 0.05 μs.
* Duration of pulse variable from 0.2 μs to 5.0 μs in steps of 0.1 μs.
* Stable pulse duration controlled by electric delay lines.
* Low impedance output, amplitude continuously variable from 0 to 40 volts without distortion.
* Trigger pulse precedes output pulse.

This reliable and versatile instrument, developed for our own use, has wide possibilities for application in many laboratories.

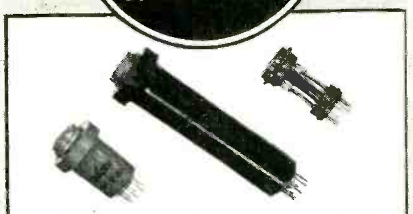
Write for Bulletin 186E.

TECHNITROL
ENGINEERING COMPANY
2751 N. 4th St., Phila. 33, Pa.

FOR EASY TUBE SIDE TESTS

Vector SOCKET-TURRETS

SAVE TIME EFFORT MANY USES



TEST ADAPTERS

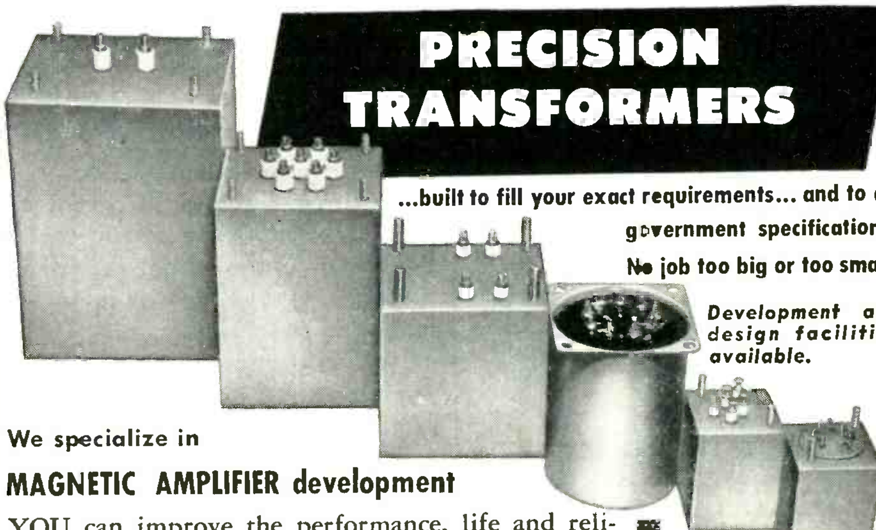
Vector Test Adapters are ideal for making measurements from the tube side of electronic equipment. The adapter is inserted between tube and socket, completing the circuit and providing test tabs. The short type (left) is most popular, but for some hard-to-reach locations a long type with shielded leads is available (center). For breaking circuits or changing connections the open "experimenter" type is useful (right). All types are available for octal, 7-pin miniature and 9-pin noval sockets. Kit T-789 combines the three short types in handy carrying case. Available at most distributors.

Send for catalog showing complete line of adapters, socket-turrets, plugs and plug-in units.

REPRESENTATIVES
B. B. Taylor Co.
241 Sunrise Highway, Rockville Centre, N. Y.
R. J. Magnuson
4258 West Irving Park Road, Chicago 41, Ill.
David H. Ross Company
534 El Camino Real, San Carlos, California

Vector Electronic Co.
3352 San Fernando Road, Los Angeles 65

PRECISION TRANSFORMERS



...built to fill your exact requirements... and to all government specifications. No job too big or too small.

Development and design facilities available.

We specialize in

MAGNETIC AMPLIFIER development

YOU can improve the performance, life and reliability of your circuits . . . eliminate costly equipment maintenance and replacement part costs by using ATLAS Magnetic Amplifiers for:

1. Low level amplification
2. Regulated DC power supplies
3. Motor drive controls
4. Thermocouple and photocell to relay applications

We welcome inquiries. Send sketches of your circuit and list desired performance characteristics . . . we'll do the rest.

CONSTRUCTION TYPES:

- **Hermetically sealed**
- **Fosterite**
- **Scotch Cast**
- **Open types**

ATLAS

ATLAS ENGINEERING CO., Inc.

3 EDGEWOOD ST., ROXBURY, MASS.

under the direction of Dr. Otis B. Young, who will be working under Dean Willis G. Swartz of the SIU Graduate School.

Ampex Electric No Longer Electric

AMPEX ELECTRIC CORP. of Redwood City, Calif. is now the Ampex Corp. George I. Long, general manager, explained that the board of directors changed the firm's name "because of the expanding scope of Ampex activities, which makes the term "electric" no longer descriptive of the company's business."

Heldor Moves To New Location

HELDOR MFG. CORP., maker of transformer cans, capacitor cans, component parts, and national sales agent for Heldor compression-type hermetic seal bushings and terminals, have announced the moving of their plant and offices to Patterson, N. J.

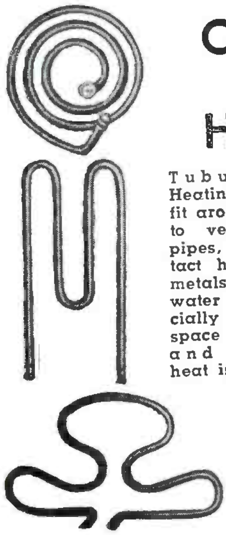
H. F. Elberfeld, president of Heldor, stated: "Our new plant provides more working space, better stock facilities, closer supervision of operations and quicker deliveries."

Keeping Cool At North American

Electronic brains under development in North American Aviation's electromechanical engineering department at Downey, Calif. undergo cold tests in the firm's weather laboratory. Company employee Mary Chastain removes a frosty electronic computer unit from the cold chamber where tests are made of advanced equipment being developed for a long-range guided-missile program

VULCAN

ELECTRIC HEATING UNITS



Coils of Heat

Tubular Electric Heating Units that fit around or clamp to vessels, tanks, pipes, etc. for contact heating of metals, oils, air and water . . . . especially where little space is available and considerable heat is needed.

Can be bent into almost any shape.

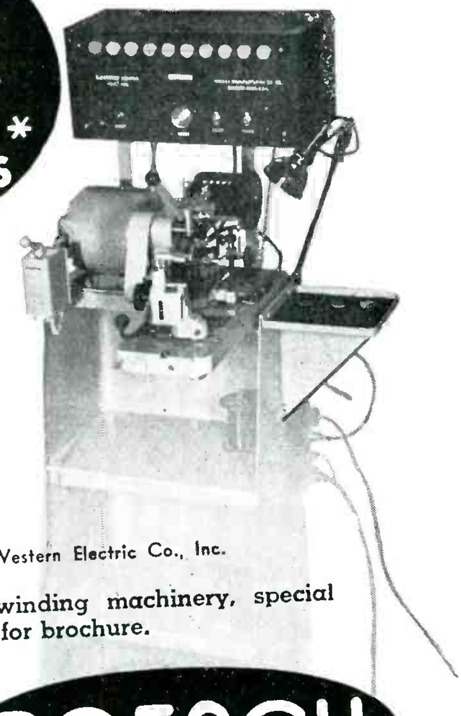
STANDARD SIZES

or made to your requirements.

VULCAN
ELECTRIC COMPANY
DANVERS 10, MASS

BOESCH

Semi Automatic Type Toroidal Coil WINDING MACHINES *



Designed primarily as a laboratory machine. This assembly has found extensive use as a production winder. Provides for the winding of a wide range of wire and coil sizes. Can be provided with variable speed control.

*Available to licensees of the Western Electric Co., Inc.

Designers and Builders of coil winding machinery, special machinery and equipment. Write for brochure.

WORLD'S MOST VERSATILE WINDING MACHINES

BOESCH
MANUFACTURING CO., INC.
DANBURY, CONN.

for the ELECTRONIC INDUSTRIES

Quality Ribbons STRIPS

MOLYBDENUM
TUNGSTEN
TANTALUM
FORMED PIECES

•

Your Special Metals Rolled to Thin Sizes & Close Tolerances

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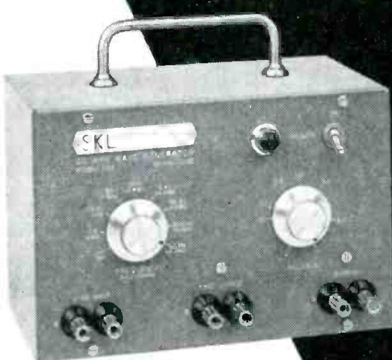
YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

H. CROSS CO.
15 BEEKMAN ST., N. Y. 38, N. Y.
WOrth 2-2044 and COrtlandt 7-0470

EXTREME FREQUENCY RANGE SQUARE WAVE GENERATOR



Features

- FREQUENCY RANGE = 0.5 CPS to 1 MEGACYCLE
- RISE TIME LESS THAN 30 MILLIMICROSECONDS
- MODERATELY PRICED
- SQUARE WAVEFORM
- LIGHTWEIGHT

Price $135

f.o.b. Cambridge

The new SKL Model 504 Square Wave Generator is a moderately priced, compact, lightweight, high quality laboratory instrument. A square waveform with very short rise time makes the SKL Model 504 Square Wave Generator useful in obtaining a rapid determination of the transient response of electrical networks.

Other features of the SKL Model 504 Square Wave Generator are: frequency range from 0.5 cps to 1 megacycle in eight steps; provision for the generation of a square wave of any intermediate frequency; a synchronizing pulse output and external sync input to permit use with auxiliary equipment; and a self-contained regulated power supply.

SKL SPENCER·KENNEDY LABORATORIES, INC.
186 MASSACHUSETTS AVE., CAMBRIDGE 39, MASS.

Want more information? Use post card on last page.

NEW BOOKS

Television and Radio Repairing

BY JOHN MARKUS. *McGraw-Hill Book Co., New York*, 556 *pages*, 1953, $7.95.

THERE is so much good practical information in this new book, that it is a little unfortunate the author thought it necessary to oversell and oversimplify the business of servicing television receivers.

The book supplies the first real comprehensive description of how to get started in the service business. Even though we must disagree with the opinion that one can start with a cash investment of less than a hundred dollars, if necessary, and his idyllic and hardly realistic description of what it means "to be your own boss" in the service business, we still feel that a beginning student can get a pretty good idea of the service business by reading this book carefully.

The basic premise of the author is that a student with average intelligence can learn to handle up to 75 percent of the repair jobs that come to the average radio and television shop. While the exact percentage may be a little high, there is no doubt that the application of the knowledge found in the book's pages will enable a serious student to start right in handling service work.

This book can fill a practical need in new television areas or in existing areas where there just are not enough good servicemen to go around. For the good of the industry, though, it is hoped that most readers of this book will continue on with further studies, since this book doesn't get into circuit theory with any depth at all. A serviceman cannot be considered competent in his field until he knows quite a bit more about radio or television than is available in the text.

We believe that the book does accomplish its stated goal. It gives practical how-to-do information that can be applied to actual receivers right from the start. A serious-minded, ambitious student should be encouraged by the progress he makes as he applies the sug-

WEBBER
TRADE MARK REGISTERED

TEST CHAMBER
WITH HIGH-TEMPERATURE, LOW-TEMPERATURE AND HUMIDITY

★ This Webber test unit, designed for production and experimental testing, has a temperature range from +250°F., to −100°F. The pull-down to −100°F., is achieved in 45 minutes, and can be cycled from −100°F., to +250°F., in 30 minutes. 95% relative humidity is provided at temperatures between 75°F., and 95°F. Vacuum equipment can be added to simulate high altitudes. The test chamber, provided with a moisture-proof light for illumination, is 4½ cubic feet, 20 inches high, 20 inches wide, 20 inches deep. High and low temperatures are governed by a temperature controller with scale range from −200°F., to +400°F., with a 3 degree control point differential, 1½ degrees plus and minus. The humidity is regulated by a wet and dry bulb controller. Unit size is 60" long, 45" wide, 74" high. Apertures in left side of cabinet provide for electrical cables to energize equipment being tested. Webber offers a complete line of test units for various applications.

Write for more complete information

INDUSTRIAL FREEZER DIVISION
WEBBER MANUFACTURING COMPANY, INC.
(Formerly Webber Appliance Co., Inc.)
2745 MADISON AVENUE · INDIANAPOLIS 3, INDIANA

Every DANO Coil is Custom-Made

In electronic equipment success or failure is often determined by coil function. Every Dano coil is made to customer requirements and is delivered to you fit as a fiddle and ready to serve you and your products with perfect, trouble-free performance.

Send us samples or specifications with quantity requirements for our recommendations. No obligation!

- Form Wound
- Paper Section
- Acetate Bobbin
- Molded Coils
- Bakelite Bobbin
- Cotton Interweave
- Coils for High Temperature Application

Also, Transformers Made To Order

DANO

THE DANO ELECTRIC CO.
MAIN ST., WINSTED, CONN.

NO HEAT is required for BARCO
Metal Degreaser Fluid

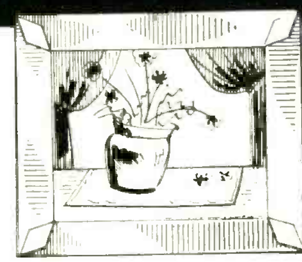
.... for Electronic and Allied Industry

Removes all oil, grease, waxes, etc.
Does **NOT** burn. No heat required. Non-corrosive.
Used by leading electronic and Television manufactures for production and maintenance.

SAFE-UNDERWRITERS LAB. APPROVED.
Write for full information TODAY!

BARCO CHEMICAL PRODUCTS CO.
701-703 S. LA SALLE   Chicago 5, Illinois

Two Pictures . . . ONE IS ART



Oster

Thousands of paintings have been put on canvas, but only the select few have the lasting quality of great art.

We're not artists, but we do know something about quality. Osters have produced top-notch products for over a quarter of a century. We have a group of well-trained, conscientious engineers who will design and produce what you want in

BLOWERS • MOTORS • ACTUATORS SERVOS • SYNCHROS

You'll find we're as precise as the old masters about the quality of our product.

You Can Depend on SAFER Flight . . . EXTRA Fight with OSTER Products

JOHN OSTER
MANUFACTURING COMPANY
AVIATION DIVISION
RACINE, WISCONSIN

Corrections of Product Listings for the 1953-1954 Electronics Buyers' Guide

The additions and corrections listed below apply to the current issue of the GUIDE.

ALTEC LANSING CORP.
9356 Santa Monica Blvd.,
Beverly Hills, Calif.
MICROPHONES—Condenser,
not MICROPHONES—Carbon

THE LENK MFG. CO.
30-38 Cummington St.
Boston 15, Mass.
Listing under SOLENOIDS is incorrect. Listed under IRONS—Soldering only.

FEDERAL TEL. & RADIO CORP.
88 Kingsland Rd., Clifton, N. J.
(Additions as follows:)
AMPLIFIERS—Magnetic
AMPLIFIERS—Servo
CONTROLS—Temperature, Electronic
COUNTERS—Photoelectric
REGULATORS—Voltage Regulator and Stabilizer

J-B-T INSTRUMENTS, INC.
431 Chapel St., New Haven 8, Conn.
(Addition as follows:)
SWITCHES—Toggle and Pushbutton

ERIK A. LINDGREN & ASSOC.
4515 N. Ravenswood Ave.,
Chicago 40, Ill. (Addition as follows:)
ROOMS—Screen

MINNESOTA MINING & MFG. CO.
900 Fauquier Ave., St. Paul 6, Minn.
(Additions as follows:)
INSULATION PARTS
TAPES—Insulating

POLARAD ELECTRONICS CORP.
100 Metropolitan Ave.,
Brooklyn 11, N. Y. (Addition as follows:)
RECEIVERS—Microwave

STAR EXPANSION PRODUCTS CO.
147 Cedar St., New York 6, N. Y.
(Addition as follows:)
STRAIGHTENERS—Pin, Tube

★ ★ ★ ★ ★

Bold facing and advertising page number are omitted in the following:

WEINSCHEL ENGINEERING CO., INC.
10511 Metropolitan Ave.,
Kensington, Md. Advertising Page 36
ATTENUATORS—Microwave Coaxial Fixed
ATTENUATORS—Microwave Step
OSCILLATORS—Audio Frequency

★ ★ ★ ★ ★

In the following, the correct advertising page should be page 344, not 334:

REON RESISTOR CORP.
117 Stanley Ave., Yonkers, N. Y.
RESISTORS
Wire Wound
12. 2 Watts and under
13. 4 to 35 Watts
17. Precision Low Voltage
18. Precision High Voltage
19. Rf non-inductive
RESISTORS—Sub-Miniature

★ ★ ★ ★ ★

ABC **electronics** ABP
BUYERS' GUIDE
A McGRAW-HILL PUBLICATION, 330 WEST 42nd ST. NEW YORK 36, N. Y.

gested techniques found in each chapter.

The book starts out by describing how you get started in servicing, what tools you need and how to make a service call. It describes briefly how television and radio sets work, including a brief discourse on electricity and magnetism.

Then the book shows you how to use a multimeter and, in three chapters, covers the subject of tube testing and replacing.

The beginner is taught how to solder, and how to test and replace the various components found in modern receivers. The chapter on phono pickups and needles is extremely valuable because this information is rarely found in such detail in servicing texts.

Chapters on repairing cabinets, and the installation and repair of radio and television antennas complete the book.

The text is very clear and easy reading. Paragraph headings, ample photographs, and review questions after each chapter add to the instructional value of the text.

Summing up the review, we find that despite some of the distortions and over simplification mentioned earlier, a beginner will be able to pick up from this book lots of good practical information he will need in servicing—information that might otherwise take months of practical experience and guidance to acquire.

HAROLD J. SCHULMAN,
Allen B. Du Mont Labs., Inc.

Introduction to Solid State Physics

BY CHARLES KITTEL. *John Wiley & Sons, Inc., New York.* 396 *pages,* 1953, $7.00.

IN RECENT years the attention of engineers and scientists has been focused more and more sharply on the study of solid-state physics. While results have not been so spectacular or so influential in world affairs as those in nuclear physics, they are of particular interest in the field of electronics.

Early in World War II, when need for a thorough understanding of the crystal detector arose, specialists in solid-state physics were able to clarify experimental data

AGASTAT

light . . . versatile

TIME DELAY RELAYS

AGASTATS are used by Onan to prevent starting of their standby plant on momentary power failure, to prevent stopping of the plant until power has returned for a given time, and on some lugging presses that operate over a million times a year. Onan reports several years of service with a minimum of attention.

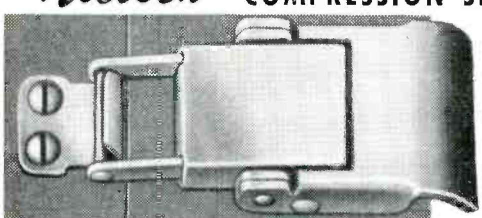
AGASTATS are solenoid actuated and pneumatically timed. They are light, compact, dustproof and can be furnished to operate mounted in any position. There is an AGASTAT model that is right for your needs.

Write for Bulletin
Dept. A2-104

AGA

Division of Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth 3, New Jersey

"Nielsen" COMPRESSION SPRING DRAW PULL CATCHES WITH SPRINGS CONCEALED



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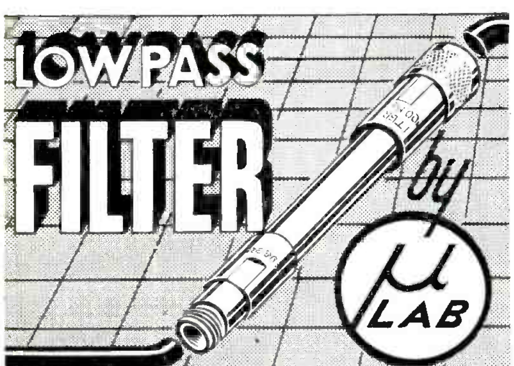

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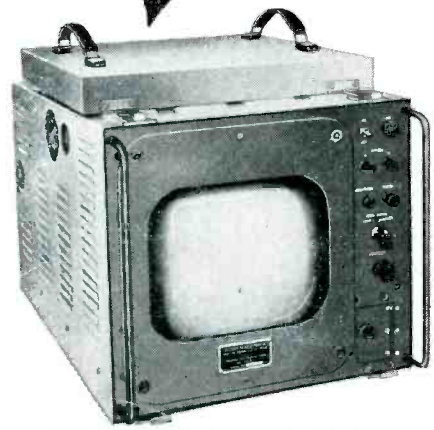

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Kinescope (Aluminized back)	12KP4A
Retrace Time	4.2 microseconds
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Weight	60 lbs.
Size	19"x19"x20"
Tube Complement	3-1X2A; 1-5R4GY; 2-6AC7; 1-6AH6; 1-6BG6; 1-6BL7GT; 1-6CD6; 7-6SN7; 1-6X5; 1-12KP4A

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so completely that engineers were able to produce these devices in required quantities. The transistor, announced five years ago, provided an even greater impetus for becoming better acquainted with many of the concepts of solid-state physics, without which an understanding of transistor action cannot be had.

Interest on the part of electronics engineers in solid-state physics is not, of course, confined to its bearing on semiconductor devices such as crystal diodes and transistors. The electron theory of matter, especially as it relates to metals and insulators, electron emission, and the phosphors used in fluorescent lamps and cathode-ray tubes, is basic to much of our work in electronics. It has, in fact, been proposed by people in the field that semiconductor engineering be established as a recognized profession.

Professor Kittel's book is intended, presumably, to provide a working knowledge of the concepts in that branch of science we now call solid-state physics. For a reasonably complete understanding of the material, a knowledge of physics and mathematics beyond the first few years of college work is required. The book is, in fact, intended for senior and first-year graduate students in physics and chemistry. Electrical engineers will be able to study it with profit if they are already familiar with some concepts in modern physics such as the Bohr atom model and the wave equation for free particles.

The book contains five chapters on such topics as general properties, lattice characteristics, and thermal properties of solids; six on electric and magnetic properties including superconductivity; and five more on topics of special importance in electron devices, including the electron theory of metals, semiconductors, and the highly interesting and important effects of imperfections in solids.

Arrangement of the material in the book is admirable. The principles of solid-state physics are not easily made clear, and the result achieved in producing a text book on so difficult a subject is

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largely a matter for the reader to decide for himself. In this reviewer's opinion, Professor Kittel has done an excellent job of orderly, logical exposition; his book is certain to be widely used.—G. D. O'NEILL, *Sylvania Electric Products Inc., Bayside, N. Y.*

Microwave Spectroscopy

BY WALTER GORDY, WILLIAM V. SMITH AND RALPH F. TRAMBARULO. *John Wiley and Sons, Inc., New York,* 1953, 446 *pages*, $8.00.

THE ANNOUNCED scope, and approach, of this first book on microwave spectroscopy are indeed ambitious. The wonder is that it comes so close to attaining its objective. The subject matter runs the gamut from mechanical recorders to the physics of spectroscopy, all in quite condensed form. The reader is duly warned concerning what is to come by a statement in the preface, "It is readily apparent to anyone who reads this book that microwave spectroscopy is not a single subject but rather a common method which can be applied to the study of various problems in physics, chemistry, electronics, and even astronomy."

The tremendous range of subject matter makes imperative a condensed style of presentation and places a premium on conciseness; yet the book neither looks, nor reads, like a handbook. Because page space is so important some readers will wonder about necessity for including certain items.

For example, the statement on page 11 that, "Commercially available recorders such as the Brown, the Leeds and Northrup Speedomax, and Esterline and Angus are satisfactory," while quite likely correct, somehow adds little to an understanding of the problems of spectroscopy—but does use space. Much of page 29 is used to show a dimensioned sketch of a magic tee, a standard microwave component, which immediately becomes nearly useless because iris thickness dimensions are omitted. The original source is given but a comparison soon reveals that certain dimensions differ by the waveguide wall thickness—a formidable discrepancy at K-band.

Occasionally certain parts in the microwave and electronic sections are emphasized in a way which almost seems to promise striking results which then are not forthcoming. For example, small but important space is used on page 11 to call attention to the relation between spectrograph sensitivity and bandwidth appearing later (Eq. 1.32, 1.33) on page 64. Inspection of the two equations indicates the not entirely unexpected dependency of the sensitivity on the square root of bandwidth.

Statements like, "Seldom are all components of the absorption line moved completely out of the range of the source frequency during a period of modulation," (page 64) should perhaps be revised to make life a little easier for the reader. Then sometimes, in attempting to be brief, unwarranted generalizations appear. To illustrate, (page 80 in section 1.6b) the statement concerning the spacing of side frequencies from the integral harmonic frequency is not general. It can be true but only in particular cases. Such particular systems require harmonic generators with input-output characteristics such that the predominant output term is the first order side frequency of the harmonic. In addition this predominance must be maintained in the detection system which follows. Another small example of larger implication is in the last paragraph on page 3. A system of time as defined by a spectral line probably does wend its way toward infinity with more uniformity than in a system defined in more conventional astronomical fashion. However, it is a little hard to see why it should be that time intervals defined by the first system should necessarily be more "accurate" when the particular use for the interval so defined is completely unspecified, especially when intervals defined by the older system are presumably simultaneously available to all users of such information. A simple statement that time defined by a spectral line progresses more uniformly than time defined by astronomical methods, might lead to more agreement.

These cited cases are random

and isolated but typical of others. The objections are relatively minor. The book contains a tremendous amount of preponderantly well presented information. The style, because of the scope of the effort, is somewhat dogmatic, but the statements are well buttressed and fortified by an excellent bibliography which in itself would almost justify the appearance of this book.
—L. E. NORTON, *RCA Laboratories Division, Radio Corporation of America, Princeton, N. J.*

Treatise on the Theory of Antenna Systems with Complete or Partial Rotational Symmetry

("Bidrag til teorien for antennesystemer med hel eller delvis rotationssymmetri") BY H. LOTTRUP KNUDSEN, *228 pages + figures, I Kommission Hos Teknisk Forlag, Copenhagen,* 1953.

THIS BOOK, written in Danish, is the most complete treatise published to date on antenna systems possessing rotational symmetry. Radially oriented dipoles arranged like the spokes of a wheel, tangentially oriented dipoles forming the equivalent of a loop, and obliquely oriented dipoles situated in planes tangential to a circular cylinder are some of the forms analyzed. Cases are treated where the elements are all in the same phase and also where the phase increases progressively around the array. In general, the pattern is expressed by a principal term which is independent of the number of elements and correction terms which are a function of the number. Turnstile and helical antennas are included in the discussion and one chapter is devoted to supergain.

The book is restricted to antennas, such as mentioned above, possessing at least partial rotational symmetry and the author has combined, with numerous references to the literature, the results of many investigators and has integrated them with contributions of his own. The book includes a 7-page summary in English. It is illustrated with many antenna patterns and contains an extensive bibliography. The author, H. Lottrup Knudsen, is lecturer at the Royal

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Technical University of Denmark in Copenhagen.—JOHN D. KRAUS, *Ohio State University, Columbus, Ohio.*

Complex Analysis

BY LARS V. AHLFORS. *McGraw-Hill Book Co., New York*, 1953, 247 *pages*, \$5.00.

THIS BOOK was written for use as a text in the first year graduate course in complex variables which is given at most universities. It is the reviewer's opinion that the author has in fact largely succeeded in creating a text which is concise, rigorous, teachable and authoritative, and inasmuch as a real need exists for a text at this level, this one appears certain to enjoy wide use.

Although the author writes for the mathematician, geometric visualization is stressed in the hope that the reader's intuitive grasp of the matter is developed even though he might not follow the proofs in detail. The author's approach may be a bit abstract for the tastes of most engineers working in applied mathematics. Moreover, most of the results which are of importance in applied mathematics may be found stated elsewhere without rigorous proofs.

In the first chapter, the arithmetic operations satisfied by the complex numbers are introduced and an outline of the justification of the process is presented (i.e., a proof of the existence of the complex-number field). This is followed by the geometric representation of complex numbers. The author is careful to point out that while a geometric argument cannot replace an analytic proof, still geometry is a useful tool for guiding the intuition. This tool is then applied to lead the discussion through the spherical representation (Reimann sphere) and the linear transformations.

The second chapter is devoted to the concept of a complex function as a mapping from one complex plane to another. After a tentative definition of analytic functions, the elementary functions are discussed. Only those topological concepts necessary for function theory are then introduced. Based on those concepts arbitrary analytic functions are presented, concluding with a discussion of elementary Reimann surfaces.

The third chapter covers complex integration. The author considers his delay in introducing integration (until the student has mastered the mappings of the previous chapter) an essential feature of the book. Cauchy's theorem is proved in great generality. The notions of removable singularities, Taylor expansions, zeros and poles, and exact differentials are also introduced. The chapter ends with a discussion of the calculus of residues including an excellent section on the evaluation of real integrals.

The fourth chapter deals with infinite sequences and associated ideas including topics such as uniform convergence, power series, partial fractions, and infinite products. The Reimann mapping theorem ends the chapter.

The fifth chapter is devoted to harmonic functions. These are defined and some of their properties (e.g. maximum principle, Poisson's formula, Harnack's principle, Jensen's formula, the symmetry principle) are proved. The Dirichlet problem is solved by the use of subharmonic functions (Perron's method). Finally, by use of the notion of harmonic measure, mappings of multiple-valued functions are discussed.

The last chapter covers the theory of multiple-valued functions. By the notion of analytic continuation, the general analytic function is defined. From this follows a definition of a Reimann surface and the monodromy theorem. The algebraic functions are studied. The book ends with a discussion of linear differential equations.—S. G. KNEALE *and* G. W. PRESTON, *Philco Corporation, Philadelphia, Pa.*

Applied Electricity

BY H. COTTON. *The Industrial Press, New York,* 480 p, 1953, $4.50.

THE FIRST edition of this book, introduced in England in 1951, is now revised and somewhat increased in scope, and made available for American use. It is a primary book, aimed at technical schools or as a first course in colleges, and deals with the elements and machinery of direct and alter-

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nating currents. Since some of the concepts introduced are not explained (integrals and differentials for example) a teacher or previous knowledge of these tools would be required.

The fundamentals are composed of chapters on the electric circuit, magnetism, electrostatics, conduction in electrolytes and thermo-electricity. Then follow chapters on d-c machines, a-c currents and circuits, resonance, polyphase circuits, transformers, alternators, synchronous and induction motors, electronics (32 pages), illumination, measuring instruments and a final section on units and dimensions.

The text is easy to read; there are numerous examples worked out in detail and a great many problems with answers. By the chapter headings it is seen that it deals mostly with fundamentals and with power equipment rather than with electronics. While the slant is definitely English, it would be useful in an American technical school. —K. H.

Design of Machine Elements

By M. F. Spotts. *Prentice-Hall, Inc., New York*, 1953, 496 *pages*, $9.65.

In the preface, the author states that this book was designed to provide an introduction to the design of machine elements in a comprehensible manner. These aims have, in general, been carried out with admirable results.

When first published in 1948, this book was enthusiastically received. Now the author has gone over his entire book to make it even more comprehensible, more approachable, more flexible than before. He has done this by introducing many additional topics and by going into greater detail than previously. Sufficient definition has been incorporated to acquaint all interested readers with a perspective of each major step.

"Design of Machine Elements", as the title indicates, does not deal with the broader aspects of the design of complete machines, but explains the fundamental principles required for the correct design of the separate elements which compose the machine. If a complete

machine is to be designed, the text will serve as a reference work or source book for information on the various elements.

The chapter headings are as follows: 1. Fundamental Principles; 2. Working Stresses; 3. Theory of Torsion; 4. Springs; 5. Screws; 6. Belts, Clutches, Brakes; 7. Welded and Riveted Connections; 8. Lubrication; 9. Ball and Roller Bearings; 10. Spur Gears; 11. Bevel, Worm and Helical Gears; 12. Miscellaneous Machine Elements; 13. Dimensioning and Details; and 14. Engineering Materials.

The well-known basic theories of design are clearly presented, as now being employed. Mathematical derivations are given in full, but have been simplified wherever possible. Tables are included giving the properties of engineering materials as determined by laboratory tests; however, design data usually obtained from catalogs and handbooks have been omitted. The text contains many illustrative examples, problems and solutions. Each chapter is concluded with a brief bibliography for those who may wish to pursue the study of the various machine elements more extensively. Engineers and designers in industry will find this book to be of value as a reference.

Professor Spotts has had many years of experience in teaching machine design, and he has also spent years as a practising engineer in industry. Author of numerous articles on this subject, he is Professor of Mechanical Engineering, The Technological Institute, Northwestern University, Evanston, Illinois.—EUGENE J. MARTIN, *Physics Laboratories, Sylvania Electric Products Inc., Bayside, New York*

THUMBNAIL REVIEWS

ASTM Standards on Electrical Insulating Materials. ASTM, 1916 Race St., Philadelphia 3, Pa., 590 pages, 1953, $5.25. The 1953 edition containing standards, test methods, specifications and appendices. Printed on Bible paper and with heavy paper cover.

Measurement of Linear and Non-linear Distortion in Electrodynamic Speakers, by Fritz Ingerslev, I Kommission Hos Teknisk Forlag, Copenhagen, 1953 266 pages. In Danish but with a 13-page summary in English.

BACKTALK

QRA

DEAR SIRS:

IN YOUR July issue you carried a story (p 10) on the first share-time authorization for television operation, that of Stations KMBY-TV and KSBW-TV in Monterey and Salinas, California. As consulting engineer for these two stations, I would like to compliment you on the article. It is regretted, however, that the call letters for the Monterey station were erroneously shown as WMBY-TV.

Construction of these stations is now proceeding and they are expected to be in operation at an early date.

ROBERT L. HAMMETT
Consulting Radio Engineer
San Francisco, California

Loaded

DEAR SIRS:

I HAVE read the article in the July, 1953, issue of ELECTRONICS, "How to Design Small Boat Antennas" by Elbert Robberson, and found it very interesting.

We are in agreement with Robberson's comments and conclusions. However we feel that enough emphasis was not placed on the conclusions relative to the gains to be made by locating the loading coil near the base of the antenna.

From our work in the field of high-Q loading coils for the 75-meter (and 40, 20, 11, etc.) mobile radio amateurs we have come to the conclusion that the amateurs, and some others, have been taking the term center-loading a bit too literally. It becomes obvious that with amateur mobile antennas in the range of 100 to 130 inches in total length, with a loading coil placed at the exact center, the top section will have too little capacitance to tune the coil properly. Also the coil will have more turns, reducing the gain made in resistance loss by moving the coil half way up the whip.

Physically, an efficient loading coil is much more easily mounted at or near the bottom of the antenna where it will ride much better and probably result in the antenna being in tune a higher percentage of the time while the vehicle is in motion. Practically, it also looks better at the base.

All of the above observations are confirmed by our results with a high-Q loading coil we manufacture. On average amateur mobile antennas we recommend the placing of the loading coil not over 24 inches above the spring mount.

If we insist on the principle of center loading, we should also consider that in the base-loaded whip, with the coil replacing a section of the whip, the ball joint, the spring mount and the bottom of the coil itself are active radiators.

H. CHARLES KAETEL
K-W Engineering Works
3145-A North 48th Street
Milwaukee, Wisconsin

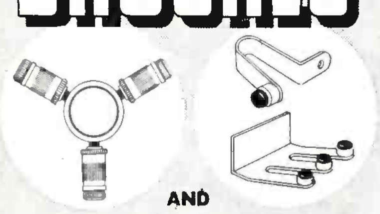
Hidden Treasure

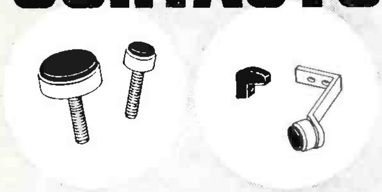
DEAR SIRS:

YOU HAVE been recommended to us as the best source from which to obtain the names of firms in the U. S. that manufacture electronic equipments for the detection of minerals and metals. Our chief interest is to locate hidden treasures buried in Paraguay after the 1865-1870 war against the Triple Alliance, in which at least 800,000 people died. Most of the private and public money, jewels etc. were buried.

We have already contacted some manufacturers in the U. S. We have their literature and some of their instruments. However, each instrument has advantages and disadvantages for our purpose. We are still looking for something *better* and more modern, regardless of cost.

Under these circumstances, we have no doubt that you can investigate this matter and put us in direct communication with firms or persons whom you think may be able to submit to us an instrument we could use for our investigations. No doubt that after the various experiences of the late war, mine detectors have been improved and new methods are now available. One commercial instrument seems different from other equipments. It uses a galvanometer instead of a milliammeter and earphones and works with a high-frequency oscillator. However, the manufacturers





mention that their latest model has many improvements, but have published no new literature since 1934.

If you are in a position to obtain any information as to the firm manufacturing or selling this equipment, we will appreciate your information. We are sure that you must know about several new inventions that could be used in the field in which we are interested. Having explained to you our requirements we trust you will be of help to us.

JOHN H. G. BALDWIN
General Manager
Promocion
Asuncion, Paraguay

More Treasure

DEAR SIRS:

I HAVE HAD the pleasure of reading your magazine ELECTRONICS in the American Section of the Melbourne Public Library, and I was interested in the wide field of your activities, regarding electronics.

The nature of my inquiry is one regarding an electrical or magnetic appliance that will locate buried treasure (gold, silver, etc., approximately 300 tons) buried about 8 feet under the earth in a chamber built of stone, containing boxes, which were placed therein about 155 years ago.

I would not like a heavy instrument, because the country to be surveyed is very rough and steep in places; therefore the lighter the instrument the better. I would be glad to hear from you or any of your readers who might be able to help me.

N. DALTON
Victoria, Australia

(Editor's Note: The above are typical of the many letters received at this office enlisting our help in finding a good treasure finder. Almost without exception the writers appear to have definite treasures in mind, and cost seems to be of little importance, since a successful instrument would pay for itself many times over.

We have asked Curt Schafer who has had wide experience in the field of detecting buried objects, to explain briefly the situation in this country as he sees it, in the hope that his observations will be of

value to other readers in their quest for hidden riches.)

Expert Advice

DEAR SIRS:

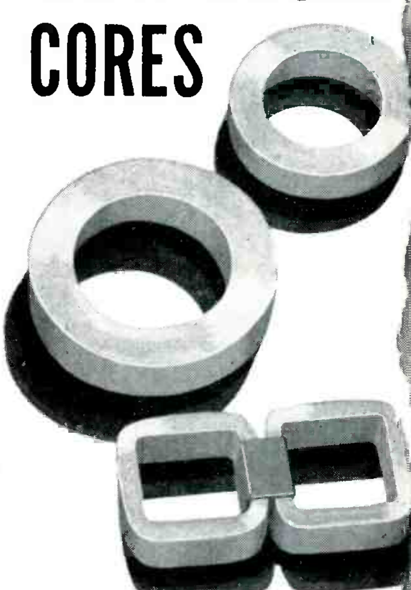
IT IS certainly a privilege to have the opportunity to comment on such fascinating letters as the above. At the same time, it is difficult to relinquish the luxury of daydreaming about buried gold long enough to gather some pertinent observations on the subject.

There are two primary requirements for treasure locators: sensitivity and stability. The equipment must have good sensitivity or it is useless; but sensitivity without stability is an abomination. There are secondary requirements, such as portability, ease of maintenance, overall weight, and the ability to discriminate between ferrous and nonferrous metals. The last feature is important, for it will save digging up tons and tons of scrap iron.

The writer has personally tested several treasure and pipe locators during the past few months. In each case the instrument was compared directly to the SCR-625 land mine detector which was purchased (new) from a surplus outlet store. The SCR-625 located a buried U. S. silver dollar at a distance of 22 inches; a 6x6x⅛-in. copper plate at a distance of 38 inches; and a standard 11x17x2-in. steel radio chassis at a distance of 5 feet. No commercial treasure or pipe locator tested was able to even approach this sensitivity in the case of the dollar or the copper plate; only one model did better in the case of the steel chassis, detecting it at a distance of 73 inches.

The SCR-625 was originally designed to give the maximum possible sensitivity that its use over the slightly magnetic soil of Long Island would permit. It is highly recommmended as a treasure locator (although commercial models are lighter in weight).

If the magnetic permeability of the soil in Paraguay is low, a more sensitive device than the SCR-625 would be useful. The mine detector written up in ELECTRONICS for January 1946 ("Vehicular-Mounted Mine Detector", by Dall, Lebourg and Miller) was supplied to the



U. S. War Department as mine detector set AN/VRS-1, and it is described in War Department Technical Manual TM-11-1138. Increased sensitivity was obtained by increased oscillator output, made practical by the fact that the batteries could be carried in a jeep instead of on a soldier's back. Two other very important features were the automatic drift stabilizing system which saves rebalancing every fifteen minutes or so, and a phase selective circuit which permits the detector to be made responsive to either ferrous or nonferrous metals, but not to both.

The sensitivity of any metal detector is inversely proportional to the sixth power of the distance between the radiating and the detector coils when this distance is measured via the object to be detected. Hence it is readily seen that the sensitivity falls off very rapidly as the distance is increased. The sensitivity could be regained, for objects at a greater depth, by increasing both the oscillator power and the amplifier gain, if the magnetic permeability and resistivity of the soil permitted. This is not always practical, however, for the point is sometimes reached at which the detector gives a continuous indication due to the presence of the ground itself, for almost all soil, sand, and rock show some magnetic susceptibility.

For those seeking custom-designed equipment, Electro-Mechanical Research, Inc., in Ridgefield, Connecticut, has done some fine work in the design of metal and ore locators. We believe that an excellent treasure locator could be built by combining the best features of the SCR-625 and the AN/VRS-1; it could be carried by two persons, one handling the search coil and the other carrying the electronic gear and batteries. We feel that it would be wise to get a good engineering firm to design and build a treasure locator, taking into account the magnetic permeability and resistivity of the soil and rocks in the area where the instrument will be used.

CURTISS R. SCHAFER
*Chief Engineer,
Electronics Division,
The Aerotec Corporation,
Greenwich, Connecticut*

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376	402	426	492	516	444	464	6470		2065		2532	5
377	403	427	493	518	445	465	6497	9	2105		2545	
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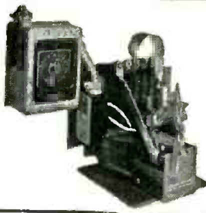

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WELDERS FOR SPOT & WIRE BUTT
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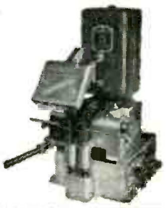
ELECTRONIC EQUIPMENT, VACUUM PUMPS, Etc.
Wet Glass SLICING & CUTTING MACHINES for Lab Use
TRANSFORMERS, SPECIAL & STANDARD TYPES
EISLER ENGINEERING CO., INC.
751 So. 13th St. Newark 3, N. J.



Have you problems in
Metal to Glass Seals?
NAME IT ... WE'LL MAKE IT!
TERMINALS
HEADERS
END SEALS ... SPECIAL ITEMS
QUALITY PRODUCTS CO.
387 Charles St., Providence, R. I.

Shorted Turn Indicator
Sensitive, rugged, non-shocking for unmounted coils; $15D. f.o.b. HUNTINGTON BEACH, CALIF.
KARTRON

WALKIE-RECORDALL 8 lb. miniature BATTERY RECORDER-PLAYBACK
Continuous, permanent, indexed recording, up to 4 hrs., only 3¢ hr. Instantaneous, permanent playback. Picks up sound up to 60 ft. Records conferences, lectures, dictation, 2-way phone & sales talks; while walking, riding or flying. Records in close briefcase with "hidden mike"! Write for Detailed Literature.
MILES REPRODUCER CO., INC.
812 BROADWAY Dept. E-10 NEW YORK 3, N. Y.

SEARCHLIGHT SECTION

(Continued on the opposite page)

ENGINEER ... WAITING ...

THE OPPORTUNITY OF A LIFETIME FOR QUALIFIED MAN WITH A GOOD SOUND PRODUCT

We are AAA-1 manufacturers of electro-mechanical components, located in NYC.; interested in expanding our operations into diversified branches of the electro-mechanical and electronic components field.

IF YOU ARE ABLE TO ORGANIZE AND SETUP AN OPERATION IN YOUR OWN SPECIALTY

we will give you control of a separate division of our company, created and staffed to fill your own specifications.

... **YOU** will have complete backing and cooperation
... **YOU** will earn and enjoy the highest remuneration possible, receiving the prevailing salary scale plus an attractive profit-sharing arrangement.

If you have a product you think we can use—if you want a chance to make your skill and "know-how" pay off—please write us giving a complete outline of your experience and the product you have in mind. Your reply will be held in strictest confidence. Box E 1094, 221 W. 41 St., N. Y. 36.

GENERAL MAGNETICS INC.
has openings for
ELECTRICAL ENGINEERS

With at least three years experience in design and development of MAGNETIC SERVO AMPLIFIERS and Voltage Regulators.

A chance to grow with a young and progressive company. Salary and advancement commensurate with ability. State education, experience and salary requirements.

Address all inquiries to:

GENERAL MAGNETICS INC.
135 Bloomfield Ave. Bloomfield, N. J.

ENGINEERS:

TV COLOR TUBE OPPORTUNITIES

Leading Tube Manufacturer has several engineering positions opening in the West in design and development on color picture tubes. Write giving full resume to

P-9080, Electronics
68 Post St., San Francisco 4, Calif.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

ELECTRONICS ENGINEERS and Physicists interested in Research and Development on trigger circuits and high speed sweeps. Opportunity to do original work on transducer applications to specialized problems in shocks and detonations. P-8766, Electronics.

SELLING OPPORTUNITY OFFERED

ESTABLISHED TRANSFORMER company seeks additional representation for line of commercial and military power and electronic transformers. Especially interested in Eastern U. S. RW-9070, Electronics.

SELLING OPPORTUNITIES WANTED

SALES ENGINEERING—College training, with 15 years varied experience in communications—electronics. Presently employed as chief engineer regional broadcast station. Desire to represent reputable company in Southern territory, preferably Ky.-Tenn. area. RA-8933, Electronics.

THE REDUCED Government Budget will require intensive representation in Washington to retain your position or gain new business. I can represent one additional electronic account. RA-9181, Electronics.

BUSINESS OPPORTUNITIES

Patent Newest Development in Rotary Generators direct current (Modulus). No brushes no collector slip-ring. Owner will sell, apply Carnus 6033 Hutchinson Montreal, Canada.

Manufacturing facility. Tools & equipment of Electronic Mfg. shop available for cash, or interest in established enterprise. List on request. West Coast only. BO-9034, Electronics, 68 Post St., San Francisco 4, Calif.

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ELECTRONICS TECHNICIAN would like to manufacture small items or parts. Willing to buy special shop equipment. CW-9187, Electronics.

ADD'L LINES WANTED
by
MFR'S. REPRESENTATIVE
actively covering
CALIFORNIA, ARIZONA, NEV.

Specialize in electronic components & instruments

EXCELLENT ESTABLISHED SALES CONTACTS

Write
RA-9164, Electronics
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ENGINEERS, PHYSICISTS, and APPLIED MATHEMATICIANS NEEDED

for Research and Development Programs

Design of electronic instrumentation for underwater ordnance, including high gain amplifiers, conventional filters, power amplifiers, oscillators and detectors in the ultra sonic range.

Transducer design, fundamental problems in underwater acoustics involving transmission, attenuation, reflection, etc. Problems in sound control and noise reduction.

Mathematical treatment of original scientific research problems in the fields of hydrodynamics, acoustics, electronics, mechanics, network theory, servomechanisms, communication and information theory, and operations research.

Excellent Opportunities for Graduate Study

Liberal Vacation Policies — Excellent Working Conditions

Write Personnel Director

ORDNANCE RESEARCH LABORATORY
THE PENNSYLVANIA STATE COLLEGE

P. O. Box 30 — State College, Pennsylvania

ELECTRONIC DEVELOPMENT IS MOVING WEST*

ENGINEERS—Take this opportunity to join the staff of a Western electronics pioneer & leader.

Creative ability finds expression with us!

- **RESEARCH**
- **DEVELOPMENT**
- **PRODUCTION**

Broad project variety in special receivers, transmitters & other devices. Advanced design techniques.

* Figures show 20% U. S. activity in So. California

Relocation expenses—excellent working conditions—Central location. Scheduled reviews & advances. Fine insurance plan. Move should not disturb urgent military projects.

Send complete resume with income history & requirements to engineering employment mgr.

Hoffman LABORATORIES, Inc.

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(A Subsidiary of Hoffman Radio Corp.)

SALES ENGINEER
Powdered Metals

Contact and sell electronics, metallurgical, and allied industries. B.S. in E.E. Knowledge of electronic design, and sales experience preferred. Salary $5,200 and up according to experience.

P-9192, Electronics
330 W. 42 St., New York 36, N. Y.

ELECTRICAL SALES & ENGINEERING REPRESENTATIVE

Nationally known California Corporation desires sales engineering representative for Eastern U. S. with sound background in general electrical insulation field, to promote sale of new line of yarns and textile materials for high temperature application. Must have car and be free to travel. Salary and expenses.

RW-8960, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

FIELD ENGINEERS

Pacific Division, Bendix Aviation Corporation, needs electronic field engineers to form a new Field Engineering Group offering excellent opportunities for growth. The job requires supervision of installation and maintenance, and instruction in the operation of Bendix airborne radar at aircraft plants and Air Force Bases within U. S. limits.

Positions are open at several levels, and inquiries are also invited from recent graduates. Salaries based on ability, experience, and education. Travel allowance in addition to salary.

Address inquiries to W. S. Leitch, Chief Electronics Engineer, 11600 Sherman Way, North Hollywood, California.

Additional Employment Advertising on pages 458, 460 thru 467 & 494

Want more information? Use post card on last page.

HAVE YOU EVER THOUGHT OF A GENERAL MOTORS' CAREER?

AC QUALITY PRODUCTS

ENGINEERS
Electronic
Servo

DESIGNERS
Electro-
Mechanical

RIGHT now we have unusually attractive project assignments at our Milwaukee plant for high caliber engineers. Some of the necessary qualifications are—experience in research, analysis, and/or design and development . . . in any of these fields:

AIRBORNE INSTRUMENTATION
SERVO-MECHANISMS
COMPUTERS
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These will be permanent positions inasmuch as our operations consist of extensive manufacturing as well as development programs. At AC SPARK PLUG you will be part of a steadily expanding division of G.M.C.—a division with over 20 years' experience in the instrument field. With us you profit from "small-company" advancement opportunities plus "large-company" employee benefits. ADVANCEMENT FROM WITHIN is a fact, not a phrase. Let your next step be a letter to

SUPERVISOR OF EMPLOYMENT

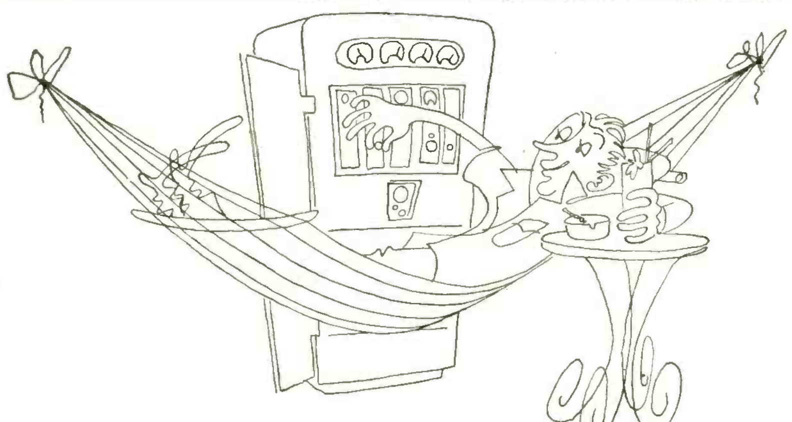
FIELD ENGINEERS

Assignment—you will assist in the installation, operation, and maintenance of our equipment at aircraft plants and Air Force bases. The work will include liaison between AC and the customer, training of customer personnel, analysis of problems, and recommendations for improvements. Many of these outstanding openings are one-year overseas assignments.

Your Background—your educational background can be in any of the fields of AE, EE, ME, Physics, or equivalent. To be successful in these positions you should have a definite interest in people as individuals and be willing to relocate to field assignments. Single men given preference.

Training—our theoretical and applied in-plant training (here in Milwaukee) will prepare you for these assignments. In addition to your salary, you will receive a field allowance—and a substantial bonus if selected for overseas assignment . . . if you're looking for an opportunity with a "present" and a *future* write us for further facts.

AC Spark Plug Division • GENERAL MOTORS CORPORATION
1925 E. KENILWORTH PL. MILWAUKEE 2, WIS.



Pleasant Working Conditions

So we're exaggerating a little! If you want to get technical about it (and you probably do) your life at our company won't be quite this cushy. We can promise this though—even the sky's not the limit for future opportunity. You work with a congenial group of engineers. People will listen to your ideas. The boss's door is always open. ***Who you are***—You're an Electronic or Mechanical Engineer. You're experienced in air communication and navigation circuitry and development. You have worked with low or high frequency circuits, instrumentation, component utilization or associated problems. ***What you do now***—Simple! Just contact:

Arthur E. Harrison, Vice President, Engineering
wilcox Electric Company, Inc.
Fourteenth & Chestnut, Kansas City 27, Mo.

ENGINEERS

SYSTEMS
RADAR
SERVO
COMPUTER

BACKGROUND: Responsible positions open for top level development and project engineers with practical and research experience in:

Advanced Electronic Circuits and Systems
Microwave Radar
Microwave Receivers and Transmitters

Also Engineering Design and Analysis relating to fields such as:—

Analogue and Digital Computers
Servomechanisms
Communications
Navigation
Fire Control

MAXSON

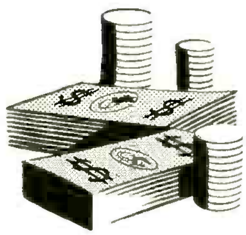
Requirements emphasize advanced analytical and/or management experience on highly complex electronic and electro-mechanical systems.

Kindly send resume and salary requirements to

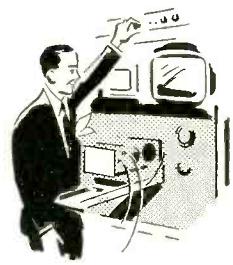
The W. L. MAXSON Corp.
460 W. 34th ST., NEW YORK 1, N.Y.

What means most to an Engineer?

PROFESSIONAL RECOGNITION



GOOD SALARY



UNEXCELLED FACILITIES

SUBURBAN LIVING

A Career at RCA offers all Four!

RCA offers opportunities now—real career opportunities—for qualified ELECTRONIC, COMPUTER, ELECTRICAL, MECHANICAL and COMMUNICATIONS ENGINEERS . . . PHYSICISTS . . . METALLURGISTS . . . PHYSICAL CHEMISTS . . . CERAMISTS . . . GLASS TECHNOLOGISTS.

Positions are open in research, development, design and application. Long range work in many fields is being carried on both for commercial developments and military projects for war and peace.

At RCA you'll work in an exciting professional atmosphere, with technical and laboratory facilities unsurpassed anywhere in the radio-electronic industry. You are in close and constant association with leading scientists and engineers. Individual accomplishment is not only recognized, it is sought out. Delightful suburban living is easily available for your family. And there's ample opportunity for income and position advancement.

Plus, Company-paid hospitalization for you and your family . . . accident and life insurance . . . progressive retirement plan . . . fine recreational program . . . modern tuition-refund plan at recognized universities for advanced study.

Join the team at RCA, world leader in electronic development, first in radio, first in recorded music, first in television. Rest easy in the knowledge that your future is secure, the rewards many and varied.

Positions Open In: **RESEARCH—DEVELOPMENT—DESIGN—APPLICATION**

in any of the following fields:

RADAR—Circuitry—Antenna Design—Servo Systems—Information Display Systems—Gear Trains—Stable Elements—Intricate Mechanisms

COMPUTERS—Digital and Analog—Systems Planning—Storage Technique—Circuitry—Servo Mechanisms—Assembly Design—High Speed Intricate Mechanisms

COMMUNICATIONS — Microwave — Aviation — Mobile—Specialized Military Systems

MISSILE GUIDANCE—Systems Planning and Design—Radar and Fire Control—Servo Mechanisms—Vibration and Shock Problems

NAVIGATIONAL AIDS—Loran—Shoran—Altimeters—Airborne Radar

TELEVISION DEVELOPMENT—Receivers—Transmitters and Studio Equipment

COMPONENT PARTS—Transformer—Coil—Relay—Capacitor—Switch—Motor—Resistor

ELECTRONIC TUBE DEVELOPMENT—Receiving—Transmitting—Cathode-Ray—Phototubes and Magnetrons

ELECTRONIC EQUIPMENT FIELD ENGINEERS — Specialists for domestic and overseas assignment on military electronic communications and detection gear.

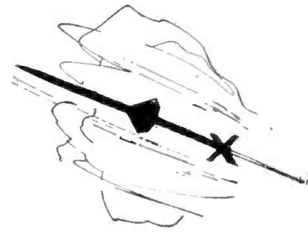
Personal interviews arranged in your city.
Please send a complete resume of your education and experience to:

MR. ROBERT E. McQUISTON, Manager
Specialized Employment Division, Dept. 200J
Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

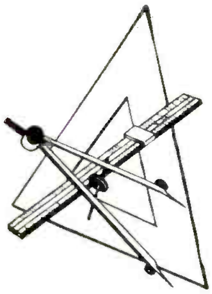
RADIO CORPORATION of AMERICA

Want more information? Use post card on last page.

Help Build Tomorrow's World TODAY!

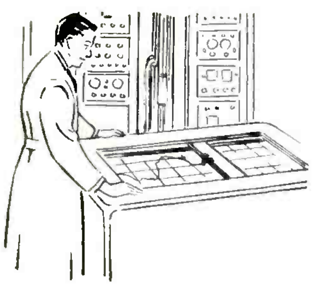


GOODYEAR AIRCRAFT CORPORATION, pioneer and leader in lighter-than-air craft, offers you a new employment opportunity with a well-established and fast-growing company where "careers are planned."



DESIGN AND DEVELOPMENT engineering opportunities are available for capable and imaginative men and women in the field of airships, aircraft and aircraft components.

RESEARCH AND DEVELOPMENT projects — missiles, electric and electronics systems, servomechanisms, new special devices, fiber resin laminates — all present an urgent need for engineers with fresh talent, aptitude and ambition.



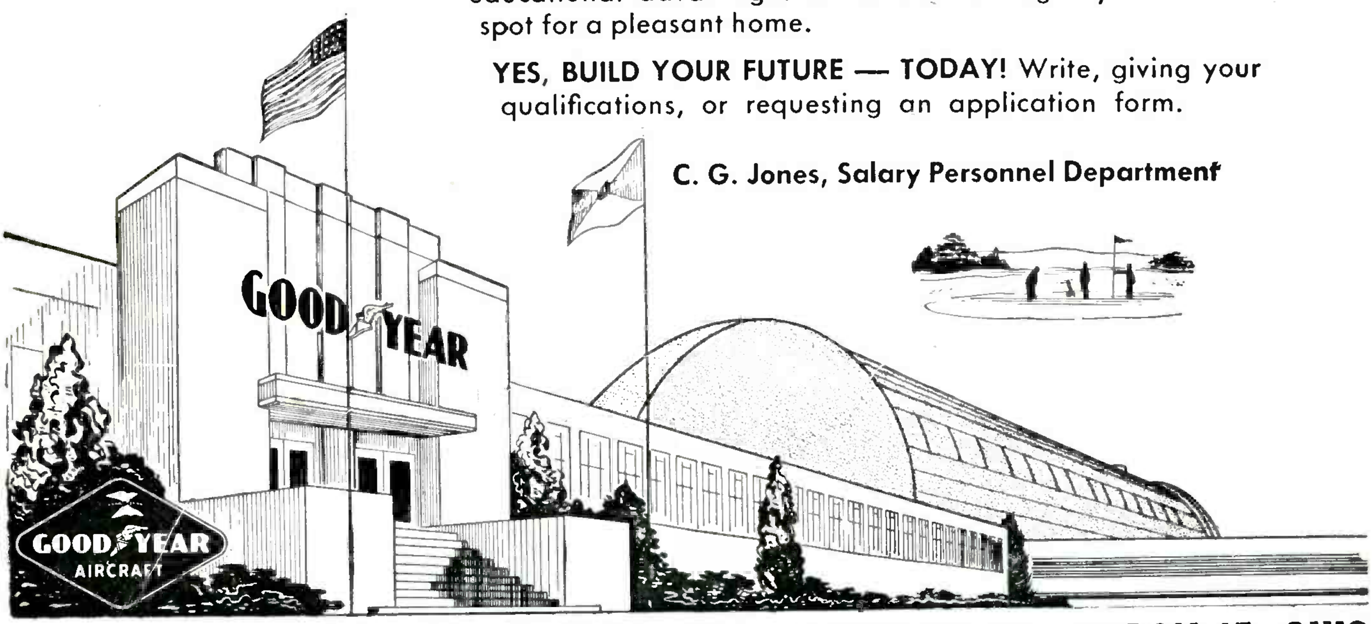
POSITIONS ARE OPEN at several levels in various fields with salaries based on education, ability and experience.

Physicists	Civil engineers
Mechanical engineers	Electrical engineers
Aeronautical engineers	Technical editors
Welding engineers	Technical illustrators

AKRON, THE HOME OF GOODYEAR AIRCRAFT, is located in the lake region of northeastern Ohio. Cosmopolitan living, year-round sports and recreation, cultural and educational advantages make this thriving city an ideal spot for a pleasant home.

YES, BUILD YOUR FUTURE — TODAY! Write, giving your qualifications, or requesting an application form.

C. G. Jones, Salary Personnel Department



GOODYEAR AIRCRAFT CORPORATION, 1210 MASSILLON RD., AKRON 15, OHIO

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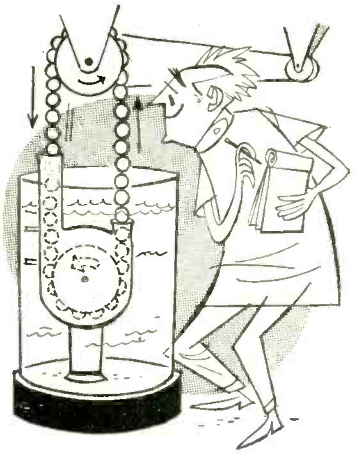


Hydrobuoyant Spheremotor

A chain of flexibly coupled, hollow rubber spheres loop over drive pulley and through air-filled "J" chamber. Underwater end of "J" chamber forms water seal as spheres go through aperture. Neglecting friction: Will this machine operate? If so, which way does it go?*

Design, development engineers...

Like to solve interesting problems?

Most engineers do—of the off-beat variety like the one above as well as the more practical ones you're always running into at Honeywell.

Right now we need a

FLIGHT
CONTROL ENGINEER,

a systems, analysis or component design man, with experience in calibrators, recorders, amplifiers, computing receivers or circuits.

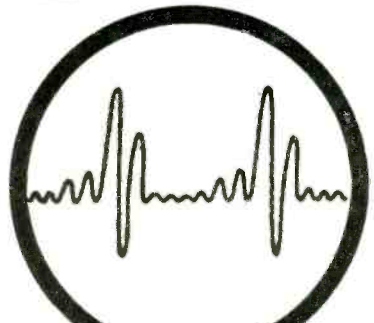
Honeywell offers this man professional engineering assignments, creative opportunities, a fine place to work and many benefits.

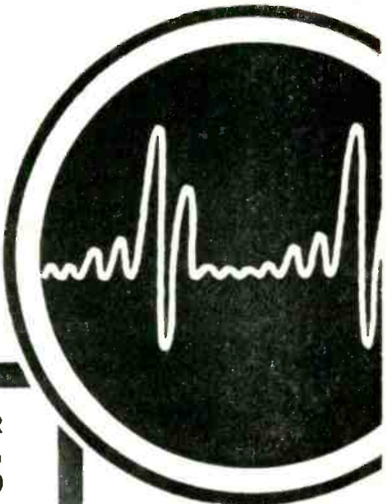
Write J. A. Johnson, Engineering Placement Director, Dept. EL-10-189, Honeywell, Minneapolis 8, Minnesota. Learn in detail about the interesting opportunities at Honeywell. Ask for our book, "Emphasis on Research."

*Mathematical solution to above problem on request.

MINNEAPOLIS
Honeywell

First in Controls





SPECIAL OPPORTUNITIES FOR

SENIOR ENGINEERS

Convair in beautiful, sunshiny San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in commercial aircraft, military aircraft, missiles, engineering research and electronics development. Positions open in these specialized fields:

Electrical Design	Servo-mechanisms
Mechanical Design	Aerodynamics
Structural Design	Thermodynamics
Structures	Operation Analysis
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Generous travel allowances to those accepted. For free brochure, write Mr. H. T. Brooks, Engineering Dept. 900

CONVAIR
IN BEAUTIFUL
SAN DIEGO

3302 PACIFIC HIWAY
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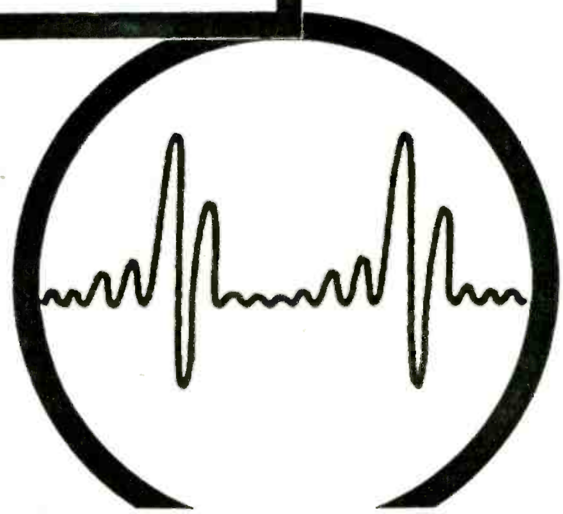

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Capehart

DIVISION OF IT&T

announces, with pride, new facilities which provide truly unexcelled opportunities for professional growth in Electronics.

Research, Development, and Production Engineers are needed to staff our growing operations in Radar and Pulse Systems, Microwaves, Guided Missle Guidance Systems, Antennas, Radio, Television, Computers, Vacuum Tubes, Servomechanisms, Solid State Physics, etc.

These positions are enhanced by an easy, relaxed, continuous welcome in one of America's most pleasant Communities.

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TO

EMPLOYMENT DIRECTOR

CAPEHART-FARNSWORTH

FT. WAYNE 1, INDIANA

WANTED

ENGINEER WITH EXPERIENCE IN

VHF OR UHF

Interesting creative work with the most resourceful and progressive firm in the field of television equipment.

This position is permanent. It will offer every opportunity for unlimited advancement and for developing a successful career. The plant is now housed in a newly-acquired larger building, only 22 miles from downtown New York City. The surroundings and atmosphere are stimulating and congenial.

Attractive Salary

Write stating qualifications.

BLONDER-TONGUE LABORATORIES
526-536 NORTH AVENUE
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ELECTRONIC ENGINEERS
&
TELEVISION ENGINEERS

The Standard Coil Products Co., Inc., a leading electronics manufacturer, has started operations at their new plant located in North Dighton. Applications are now being accepted for experienced personnel in the above mentioned classifications, preferably with experience in UHF—VHF tuners, I. F. strips, high voltage and fly-back coils and test equipment design. Excellent opportunity with our fast growing organization which is not dependent upon defense contracts. Plant pleasantly located in small New England town near Providence and Boston. Good housing and schools. In resume state salary requirements and send to Personnel Manager.

STANDARD COIL PRODUCTS CO., INC.

SPRING STREET, NORTH DIGHTON, MASS.

LOS ALAMOS requires

ELECTRONICS ENGINEERS

for design and development work. B.S.E.E. or Physcis with progressive and independent experience in the field. Write John A. Stevenson

Los Alamos Scientific Laboratory
of the
University of California
Los Alamos New Mexico

ELECTRONIC ENGINEERS

FOR DESIGN & DEVELOPMENT WORK IN
RADAR
COMPUTERS
DIGITAL TECHNIQUES

with a young progressive company, send resumé of experience and education, with salary requirements, to

Electronic Engineering Company
of California
180 SOUTH ALVARADO STREET LOS ANGELES 4, CALIFORNIA
DUNKIRK 2-7353

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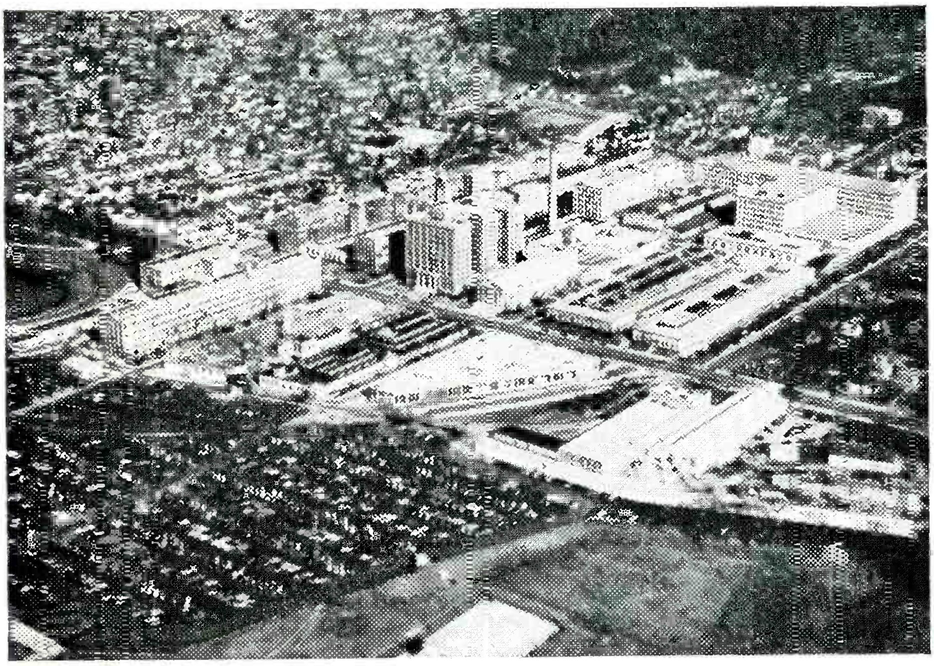
Exceptional Opportunities for...



electrical engineers
mechanical engineers
mechanical designers

•

in the field of electronic computers and associated equipment for use in business machines.

Write, giving education and experience to Employment Manager.

Reply to Department A.

THE NATIONAL CASH REGISTER COMPANY, Dayton 9, Ohio

ENGINEERS AND PHYSICISTS
BS–MS–Ph.D:

Responsible positions in mechanical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years' experience in experimental research design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential.

Ind. Rel. Manager
Research & Development Dept.

PHILLIPS PETROLEUM COMPANY
Bartlesville • Oklahoma

Bell Telephone Laboratories

has career openings for experienced

electrical engineers
mechanical engineers
physicists

For work on Guided Missiles, Radar, Fire Control and Underwater Systems in New Jersey *(20 miles from New York City).*

The company that has pioneered many of the major developments in the fields of communications and electronics now offers you an opportunity to join its staff. Here you will gain invaluable experience and great satisfaction through the challenging diversified nature of the work. To qualify, you must be a college graduate (preferably not over 40 years of age) with related experience of the following types:

Systems Engineering	Systems Development
Analysis	Fundamental Development
Coordination	Circuit Design
Evaluation	Mechanical Design
Planning	Equipment Development
Studies	Field Testing

Write, giving full details of education and experience to:

BELL TELEPHONE LABORATORIES Inc.
Employment Director, Box 2, New York 14, N. Y.

Additional Position Vacant Advertising on page 494

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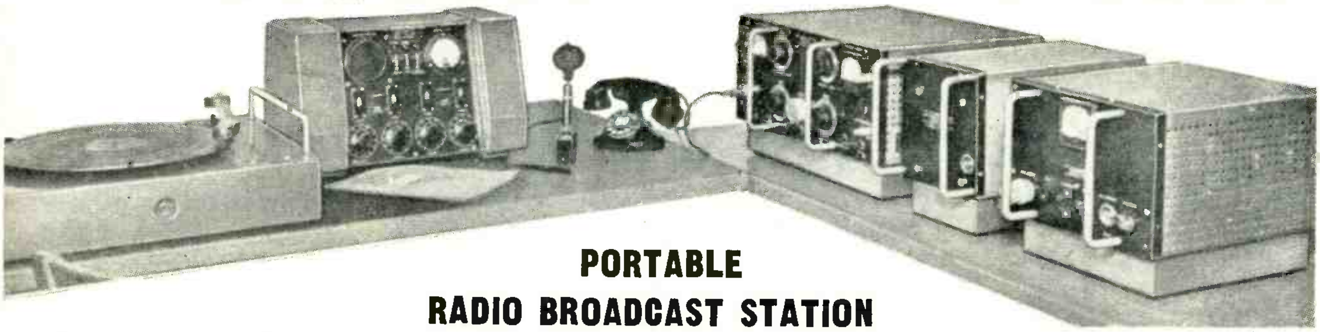
THE **BIGGEST** AND THE **BEST**



PORTABLE
RADIO BROADCAST STATION
50 WATTS OUTPUT, COMPLETE WITH ALL ACCESSORIES

NEW, UNUSED equipment, designed for Psychological Warfare (Propaganda) and Armed Forces Radio—Troop entertainment, this equipment will meet FCC specs for carrier stability (crystal-controlled) and fidelity. *Freq. Range* is 1,100 to 1,500 KC, and design provides either crystal control or VFO. *Modulation* is 100% using a special hi-efficiency circuit. *Operation* is from 90 to 240 Volts, 50/60 cycles AC, and total drain at full modulation —725 watts. *Audio Response* is within 1 db from 100 to 5,000 cps, and distortion less than 5% rms at 100% modulation. Design provides for use with quarter-wave antenna against ground, with loading coil of sufficient inductance included within transmitter to permit use of smaller antenna where conditions do not allow proper size. THE EQUIPMENT SUPPLIED FORMS A COMPLETE MOBILE OR PORTABLE BROADCAST STATION, except for AC Power. The following are the various units supplied, with net weights and dimensions:

LIST OF MATERIAL PER SET

Qty.	Item	H.	W.	D.	Wt. (lb.)
1	Radio Broadcast Transmitter TWT PB-50A	11¼	18¾	17⅞	49½
1	Transmitter Power Supply, Type PB-50	10½	12½	16	89¼
1	Pressure Cooling and Voltage Selector Unit, Type B2.	11⅞	9	17⅞	54¼
1	Control Console Mixer, Type 2C4	11	18	9⅜	35
1	Phonograph Turntable, Type T2, two-speed 33⅓ & 78 RPM	6¾	20¼	18	20
2	Dynamic microphones, cables, connectors	....	....	....	....
1	Set of operating tubes for all units	....	....	....	....
9	Connecting cables for all units	....	....	....	....
1	Auxiliary Antenna Kit, Type 10B	12	12	3	20
1	Set of spare operating tubes for all units	....	....	....	....
1	Set of spare parts	....	....	....	....
1	Kit of small tools for maintenance	....	....	....	....
1	Technical manual, TM 11-825, Portable Radio Broadcast Transmitter TWT PB-50A	....	....	....	....
5	Armored Trunks for Transporting	20	28¾	12½	32½

The five armored trunks are supplied as part of the equipment. They serve as carrying cases, with the various units packed.

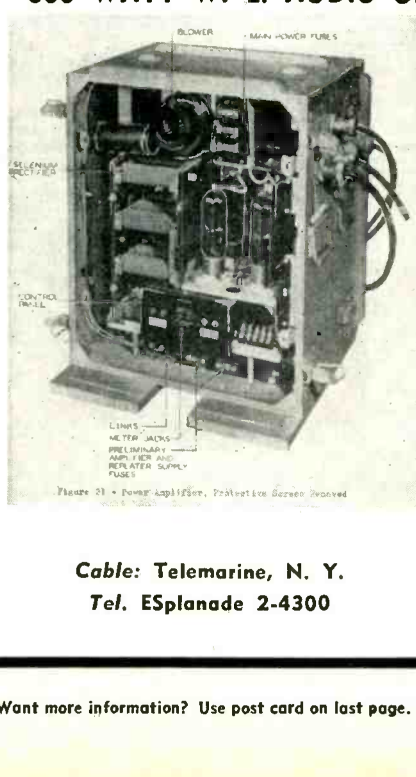
PRICE, PER COMPLETE SET AS LISTED ABOVE, NEW—UNUSED.. $1,100.00

TRANSMITTERS—RECEIVERS ETC.

TDQ VHF 100-156 MC. 50W. AM X-mttr for 110 V. 50/60 C. AC.
BC-797 VHF 110-126 MC. 50W. AM Output for 110 V. 50/60 C. AC.
SCR-510/610. FM Trans-Receiver, 20 to 28 and 28 to 37 mc respectively. With PE-117 or 120 Vibrator Power Supply and other accessories.
SCR-619. FM Trans-Receiver, 27 to 38.9 mc, complete with all accessories. NEW units.
SCR-522 VHF, 4-Channel, 100-156 MC Trans-Recvg. Eqt. for Plane or Ground Communications.
SCR-511. Walky-Talky, 3-6 MC, Crystal Controlled Trans-Rcvg. with Plug-In Units for Freq. Changing.
BC-611 and **MAB** HANDY and WALKIE-TALKIES.
SCR-284 Field Radio Equipment, A1, A3 emission. Complete with all Accessories.
BC-221 Frequency Meters, Excellent condition. Complete with crystal and matching Calibration Book.
BC-312/342 Receivers. Like New Units.
BEACHMASTER 250 & 500 WATT SOUND SYSTEMS for Airports, Shipyards, Amusement Parks, Civilian Defense, Etc. **Write for Prices and Literature.**
TCS X-mttr-Receivers for Ship or Shore.
TBK HF 500W, 2-20 Mc. Transmitter with MG, Starter, and Spares.
TAJ 500 W. Output, 175-550 Kc. with M.G. for AC or DC operation.
TAQ, Same as TAJ above but 1,000/1,500 W. output, with MG.
TBL 350 W. Output, A1, A3, I.F. & H.F. for AC or DC operation.
APN-4 Loran Eqpt. R-9A/APN-4 Receivers and 1D-6A & 6B Indicators, with tubes, crystal, etc. Reconditioned to like-new. **WRITE FOR PRICES.**
GO-9 100/125 W. IF, HF Ship or Aircraft Transmitter, A1 and A2 Emission. All New with Spares.
ATD Aircraft Transmitters. 50 W. A1 & A3. 1.5 to 9.05 MC. NEW.
GP-7 Aircraft Transmitters.
ZB-3 ILAS Eqpt.
SCR-283 Rcvg. & X-mttng Eqpt. Complete.
RT-3/ARN-1 Altimeter.
RADIOSONDES AN/AMQ-1A to D. New.
PE-75U Gas Engine Generators. NEW. w/Spares.
T-21/GR-3-C Sound Ranging Microphones for locating Artillery Fire.
NAA Underwater Beacon Equipment.
BD-57-B Switchboards, telephone.
HS-23, 33 Headphones.
AN-CRT-1A Sonobuoys.
DZ-2 DIRECTION-FINDERS, Aircraft or Marine, 15 to 1750 KC in 6 bands, for 24/28 V.D.C. operation. With 34" or 55" Loop Extension Shaft. Complete. NEW eqpt. with Dynamotor, Loop Extension Shaft and Control, Cables, Instruction Manual, etc., all export packed in 2 cases per set.
WRITE FOR PRICES

EXTRA
PE-104 POWER SUPPLIES for Receiver of SCR-284, NEW, with Spare Vibrator. Export-Packed. Large Quantity Available. *WRITE FOR PRICES.*

600 WATT W. E. AUDIO OR SUPERSONIC POWER AMP.



NEW, Western Electric Audio Power Amplifiers in wooden transportable case, 600 watts max. output, for use as PA amplifier, modulators, or use **as 400 to 1200 cycle power source to test servos, radar, test eqpt., etc., requiring 110 V., 400 to 1200 cycles AC** up to 600 watts. Requires 40 watts max. to drive to full output. Less than 10% total harmonics in output. Input imped. 250/500 ohms; Output imped. 15 to 18 ohms. Uses 4- 805's (supplied) in push-pull parallel. H.V. Power Supply uses selenium rectifiers (no tubes) and motor blower for forced-air cooling. Operates from 115, 3-Phase, 60 cycles, or 208V., 4-wire (3-phase) 60 cycles AC. Rugged design and construction. Freq. response 200-6000 cycles (amplifier only) substantially linear. **Easily converted to Supersonic Driver & Amplifier for testing, operating magneto-striction units, by changing input & output transformers (20 to 25 KC available. AC additional cost).** Dim: 21" x 24" x 28" overall. NEW, UNUSED eqpt

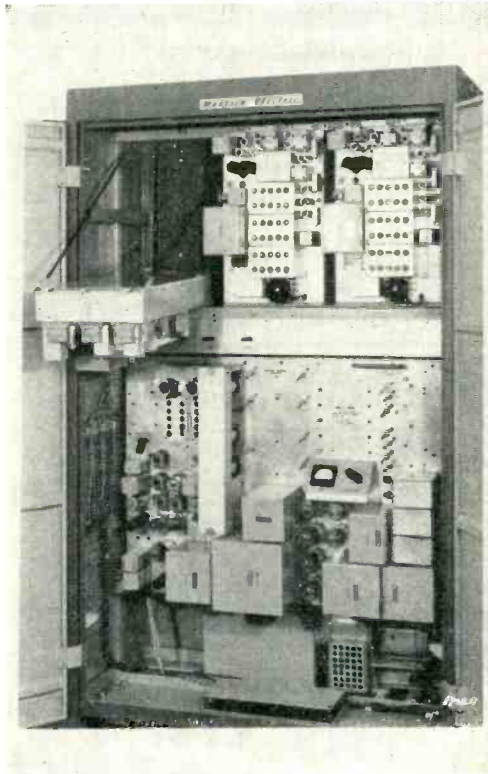
PRICE, EACH **$385.00**
Driver Amprifier, WE, for above, with tubes **$175.00**
Speaker 12 units. PM horn type, in 2 sections, shock and blast proof, with 6 lb. #5 alnico slugs **$215.00**
20-25KC (Tunable) Input & Output Transformers, for conversion of above, for 600W. Output. **PAIR** **$120.00**

Cable: Telemarine, N. Y.
Tel. ESplanade 2-4300

TELEMARINE
3040 W. 21st
B'KLYN 24,

IN SURPLUS COMMUNICATIONS EQPT!

WESTERN ELECTRIC 250/350 WATTS RADIOTELEPHONE EQPT.



★ Provides Complete 2-Way Long or Short Distance Radiotelephone Communication
★ Frequency Range—2 to 20 MC
★ 30 Channels Transmit & Receive. All Crystal Controlled
★ Monitors 3 Separate Channels Simultaneously
★ Voice-Operated Carrier Control or Push-To-Talk, as Desired
★ Motor-Driven Channel Switching Controlled by Channel Selector
★ Highest Degree of Construction, Salt Air Corrosion Resistant, Hermetically Sealed Transformers, Etc.

The Model 248A Radiotelephone Equipment was developed at Bell Telephone Laboratories to furnish powerful, dependable radiotelephone communication, especially on the high seas. It is ideal for ship installation, and fixed-radio installation, since its design and construction are of the highest possible degree.

Each 248A Equipment consist of: 1-48A Radiotelephone Transmitter; 1-48A Radio Receiver (cabinet has provision for a total of 3 receivers, the 48A Receiver provides 10 channels in the 2-6 MC range; a 48B Receiver provides 10 channels in the 4 to 20 MC range, available at additional cost. The 2nd and 3rd receiver may be either a 48A or 48B, available at extra cost); 1-43A Control Unit (may be installed remotely); and, 1-104A Antenna Tuning Unit (medium frequency). A 104B Antenna Unit with whip antenna for the higher frequency, is available at additional cost.

The 48A Radiotelephone Transmitter provides 30 channels of transmission, all crystal controlled, and is rated at 250 watts output. However, a Western Electric Modification Kit is supplied with each, which will increase the power to 300/350 watts. Features of this transmitter include automatic variable-gain audio amplifier; sidetone (hearing of one's own voice in the telephone receiver); interlock safety relays; provision for Selective Ringer installation within cabinet (up to 3 units, 1 for each receiver) for automatic selective calling; motor driven switches for channel selection, controlled by the 43A Remote Control Unit which incorporates a telephone handset, monitoring loudspeaker; ventilating fan for cooling and providing filtered air within cabinet; hinged transmitter and individual receivers for easy access to parts, etc.

Operation of this equipment is from 115 V., 50/60 cycles AC.

This equipment is NOT GOVERNMENT SURPLUS, and is NEW—UNUSED. Additional accessories and full spares also available. Priced far below original selling price!!

WRITE FOR DESCRIPTIVE LITERATURE AND PRICES.

W. E. MODEL 107A SELECTIVE RINGER

Latest design W.E. Selective Ringer, for use with any size Ship-to-Shore Radiotelephone. Operates from radiotelephone's receiver to ring bell when shore telephone operator has call for you. Compact, easily installed. Dim. 15⅞" L. x 8½" H. x 5⅛" W. Nt. Wt. 18 lbs. NEW EQPT., with instruction book.
PRICE, EACH **$135.00**

SCR-296-A SHORE RADAR

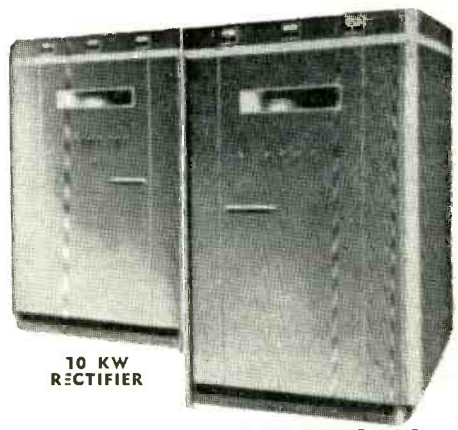
Designed to determine accurately range and azimuth of surface craft and to furnish this information for fire (shore battery) control purposes. It is a fixed radar installation with following Specs:
Range — 100,000 yards max., Min. 500 yards.
Accuracy — plus or minus 20 yards (max. range).
Azimuth — 360 degrees. **Peak Power** 40 KW.
Indicators—5" Class A scope for Range; 3" for Azimuth.
Frequency—700 MC (43 centimeters).
Operation—120 V. 60 cycles A.C.
Excellent, like new material, complete with all amplidynes, servos, synchros, concentric transmission line and plumbing, tubes, spare parts, etc., in 29 cases per set. **WRITE FOR PRICES**, or further details.

GE 10 KW FM POWER AMPLIFIERS and RECTIFIERS

BRAND NEW, not war surplus, 10 KW FM Power Amplifiers with associated separate Power Rectifiers, designed for boosting low power FM broadcasting stations. Can be used for increasing power of television stations (sound portion), or by changing L and C can be converted to power amplifier on other frequencies. Present range 88-108 MC. Rectifier Power Supply delivers approximately 5,000 V. at 18.4 KVA. Operates from 220 V., 50/60 Cycles, 3 phase AC. Power Amplifier uses 2 GL5518 (not supplied) forced-air cooled GE high efficiency tubes. Includes internal blower system, reflectometer amplifier (with tubes) and GL-8008 rectifier tubes. Beautifully constructed, new equipment at terrific price savings!

PRICE, Type BF-3-A 10 KW RF FM Amplifier and Separate Rectifier, less RF Final Tubes **$4,000.00**

RECTIFIER ONLY, if desired. **WRITE FOR PRICE.**



10 KW RECTIFIER

10 KW POWER AMP.

SPECIAL!!

PE-218D Inverters, 25-28 V. DC Input; 115 V., 380-500 cycles output at 1500 VA. NEW UNITS. **OUR PRICE, EACH $19.95**

EXPORTERS, GOVERNMENT AGENCIES, INDUSTRIALS!

We have a large stock of Transmitters, Receivers, Walkie-Talkies, VHF Equipment, Ship & Shore Communications, FM Broadcast Stations, Radar, Accessories, etc. Write and tell us of your requirements. Descriptive literature and prices available upon request.

COMMUNICATIONS CO.

STREET
NEW YORK,

All Prices F.O.B. N.Y.C.

All Material Offered Subject to Prior Sale

Want more information? Use post card on last page.

Reliance Specials

SOUND POWERED HANDSET

Brand New

TS-10 Type—includes 5 ft. cord, USES NO BATTERIES OR EXTERNAL POWER SOURCE
PAIR—$18.95

SOUND POWERED HEAD & CHEST SET

Navy Type M Head and Chest Set. Brand New For Work Requiring Free Use of Hands. Heavy Duty—Consists of Headset with 2 Phones and Chest Mike. Includes 20 Ft. Rubber Cord .... EACH $14.88

TELEPHONE FIELD WIRE

W-110-B

½ MILE COIL.... $7.95
1 MILE REEL.... $14.95

HAYDON TIMING MOTOR

1 R.P.M. 115 V., 60 Cycle.. $1.95

TIMING MOTOR

8 RPM 115 V 60 cyc
E. Ingraham Co.

$1.79

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A.C. Fully cased Plugs into octal socket $5.50

TIME DELAY RELAY

Raytheon CPX 24166
1 Min. Delay. 115 V., 60 Cycle

2½ second recycling time spring return • Microswitch contact, 10A • Holds ON as long as power is supplied • Fully Cased •
ONLY $6.50

JONES BARRIERS STRIPS

2—140Y	$0.17	3—141W....	$0.27	8—141 ¾W	$0.64
3—140 ¾W	.21	4—141	.24	9—141	.48
6—140	.28	5—141	.29	9—141Y	.71
10—140W	.59	5—141 ¾W	.41	3—142	.24
10—140 ¾W	.59	7—141 ¾W	.56	2—150	.43
13—141 ¾W	.27	8—141	.44	3—150	.60

Brand New Meters—Guaranteed

0-10 ma. D.C. 3½" $3.95
0-1 Ma D.C. 3½" Dejur (Scale Reads 0.4 KV) $5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V $1.70
Half Wave 100 Ma 115V .... .91

3 AG FUSES

Amp.	Per 100	Amp.	Per 100	Amp	Per 100
⅛	$4.00	¾	$4.00	8	$3.00
⅜	4.00	1	3.00	10	3.00
½	4.00	4	3.00	15	3.00
		5	3.00		

3 AG FUSE HOLDERS (Finger) 25¢

RESISTORS

Type EB	½W	10%	6¢ ea.	$4.00 per C
EB	½W	5%	12¢ ea.	8.00 per C
Type GB	1W	10%	9¢ ea.	7.00 per C
GB	1W	5%	18¢ ea.	14.00 per C
Type HB	2W	10%	12¢ ea.	9.00 per C
HB	2W	5%	24¢ ea.	18.00 per C

AVAILABLE IN ALL STANDARD RMA VALUES

POSTAGE STAMP MICAS
AVAILABLE IN ALL STANDARD RMA VALUES
PRICE SCHEDULE

5 mmf to 910 mmf .... 5¢
.001 to .0013 mfd .... 8¢
.0015 to .0056 mfd .... 15¢
.0062 to .0091 mfd .... 20¢
.01 mfd. .... 28¢

SILVER MICA—POSTAGE STAMP
AVAILABLE IN ALL STANDARD RMA VALUES
PRICE SCHEDULE

10 mmf to 910 mmf .... 10¢
.001 mfd to .002 mfd .... 20¢
.0022 mfd to .0091 mfd .... 50¢
.01 mfd. .... 95¢

ASSORTMENTS

GEARS—100 SMALL GEARS, BUSHINGS & SHAFTS. $6.50
RESISTORS—200 ½ WATT ALL INSULATED AMERICAN MADE $2.50
HARDWARE—5 lbs. BOLTS—NUTS—LUGS—WASHERS ETC $2.00

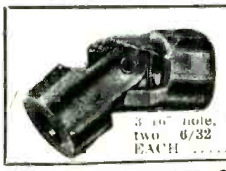
PULSE TRANSFORMERS

UTAH—9262 9278 9289 9318 9340 9350
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9800, KS9862, KS13161
GENERAL ELECTRIC—80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

AN CONNECTORS

See Our Ad February, 1953 Electronics
PHONE! WIRE! WRITE! YOUR NEEDS

TERMS — Cash with Order or 25% Deposit — Balance C.O.D. Net 10 Days to Rated Accounts. All Prices are Net F.O.B. Our Warehouse.

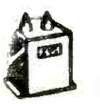


UNIVERSAL JOINTS ALUMINUM

¼" hole, ½" O.D. 1-⅛" long with two 6/32 tapped set-screw holes EACH 85¢
3/16" hole, ⅝" O.D. 1-⅛" long with two 6/32 tapped set-screw holes EACH .... 80¢

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
5.2	50	$0.89	0.5	3,000	$2.40
6	400	.85	2	3,000	4.50
3 x 3	400	1.00	2	4,000	7.95
4	500	.85	0.01	5,000	.95
1	600	.55	1	5,000	4.88
0.5–0.5	600	.40	0.03–0.03	6,000	1.50
2	600	.75	1	6,000	9.95
4	600	1.75	0.02–0.02	7,000	1.55
8	600	1.85	0.1	7,000	1.79
10	600	3.25	0.1-0.1	7,000	5.95
4 x 3	600	2.50	0.1	7,500	2.25
8–8	600	1.95	0.075–0.075	8,000	6.50
1	800	.60	0.15–0.15	8,000	6.95
1	1,000	.69	0.25	20,000	19.95
2	1,000	.95			
3	1,000	1.70			
1	1,500	1.45			
0.02	2,000	.65			
0.1–0.1	2,000	1.30			
0.1–0.5	2,000	.95			
0.5	2,000	1.65			
3	2,000	3.75			
8	2,000	7.95			
0.25	3,000	2.25			



1 mfd
6,000
V.D.C.
G.E.
$9.95

OIL FILLED AC CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
7.5	220	$2.00	15	440	$6.25
20	220	4.95	1	660	2.95
1	236	.49	2.9	660	4.35
4	236	1.60	3	660	4.45
8	236	1.95	4	660	4.95
3	330	1.45	5	660	5.45
4	330	2.25	6	660	5.95
20	330	6.75	8	660	7.50
25	330	7.50	0.2	750	.69
4.4	375	2.15			

COAXIAL CABLE CONNECTORS

A full line of jan approved connectors in stock

83-1AC	$0.42	PL-274	$1.10	UG-88/U	$ .90
83-1AP	.30	PL-275	2.10	UG-89/U	1.10
83-1BC	.35	SO-239	.40	UG-102/U	.80
83-1F	1.10	UG-13/U	1.70	UG-103/U	.68
83-1H	.12	UG-18B/U	1.05	UG-104/U	1.40
83-1HP	.22	UG-20B/U	1.60	UG-105/U	1.50
83-1J	.73	UG-21/U	.85	UG-106/U	.15
83-1R	.40	UG-21B/U	1.00	UG-107B/U	2.75
83-1RTY	.65	UG-21C/U	1.05	UG-146/U	2.00
83-1SP	.45	UG-21D/U	1.45	UG-167/U	3.75
83-1SPN	.50	UG-22/U	1.30	UG-175/U	.12
83-1T	1.30	UG-22A/U	1.60	UG-176/U	.12
83-2AP	1.95	UG-22B/U	1.20	UG-185/U	.95
83-2J	2.10	UG-23/U	1.20	UG-196/U	1.65
83-2R	1.65	UG-23B/U	1.50	UG-203/U	.65
83-22AP	1.40	UG-23C/U	1.10	UG-224/U	1.15
83-22F	2.10	UG-24/U	1.30	UG-255/U	1.95
83-22J	1.40	UG-27/U	1.25	UG-260/U	.85
83-22R	.68	UG-27A/U	2.25	UG-261/U	1.10
83-22SP	.80	UG-27B/U	2.95	UG-262/U	1.10
83-22T	1.95	UG-28A/U	2.95	UG-273/U	1.45
83-168	.12	UG-29B/U	1.75	UG-274/U	2.30
83-185	.12	UG-30/U	2.30	UG-290/U	.90
CW-123A/U	.45	UG-57B/U	1.85	UG-291/U	.95
M-358	1.30	UG-58/U	.70	UG-306/U	2.65
M-359	.30	UG-58A/U	.90	UG-414/U	1.95
M-359A	.65	UG-59A/U	1.90	UG-499/U	1.25
PL-258	.75	UG-88/U	1.75	UG-625/U	1.35
PL-259	.45	UG-85/U	1.65		
PL-259A	.50	UG-87/U	1.40		

NEW COAXIAL CABLES Jan approved

	Price per 1000 ft.		Price per 1000 ft.
RG5/U*	$140.00	RG 22/U*	$150.00
RG6/U	180.00	RG 22A/U	285.00
RG7/U*	85.00	RG 24/U	675.00
RG8/U*	100.00	RG 26/U	475.00
RG9/U*	250.00	RG 29/U*	50.00
RG9A/U	275.00	RG 34/U*	300.00
RG10/U	240.00	RG 35/U	900.00
RG11/U*	100.00	RG 41/U*	295.00
RG11A/U*	150.00	RG 54A/U	97.00
RG 12/U	240.00	RG 55/U*	110.00
RG 13/U*	216.00	RG 57/U*	325.00
RG 17/U	650.00	RG 58/U*	60.00
RG 18/U	900.00	RG 58A/U*	70.00
RG 19/U	1250.00	RG 59/U*	55.00
RG 20/U	1450.00	RG 62/U*	75.00
RG 21/U*	220.00	RG 77/U*	100.00

Add 25 % for orders less than 500 feet.
* No minimum order—other 250 minimum.

NEW RG-8/U Unmarked 100 Ft. Coil..Special $5.95

SELSYN MOTORS

Army Ordnance Type C-78248 115V. 60 Cy. Transmitter. Approx. 3-⅜" dia. x 5-⅜" L. Like new..EACH $27.50

SELSYN MOTORS

50 V. 50 Cy. High Torque. Connect in Series For Use On 110 V. 60 Cy. Approx. 3-⅜" dia. x 5-⅜" L. Like New .... ONLY $12.95 PAIR

DIFFERENTIAL

Used $4.95
115 V., 60 Cycle #C78249
New $9.95

3⅜" dia. x 5⅜" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted) $5.50
Mounting Brackets—Bakelite for selsyns, and differentials shown above .... 35¢ pair

PRECISION RESISTORS
(WIRE WOUND SPOOL TYPE)

½ watt one percent tolerance WW3 or Equal 35¢ ea

.250	7.4	16 37	105 8	400	4451	25K
.334	9 1	20	123.8	414.3	5000	30K
.502	10 48	25		705	6500	32.89K
.557	10 84	30	130	723	7000	33K
.627	11.1	46	147.5	750	7500	33.3K
.760	11.25	50	180	855	8000	35.89K
1	11.74	52	210	2193	8500	36K
1 01	12.32	55 1	220.4	2200	8800	37K
1.53	13	62.54	235	2250	14 82K	47K
2	13.02	75	260	2500	15K	50K
2 04	13 15	79.81	270	2850	15.75K	59K
2.5	13.52	87	298.3	3427	16.7K	59.15K
3 5	13.89	97.8	301.8	4000	17K	79.01K
5.26	14.98	100	366.6	4300	20K	125K

1 watt one percent tolerance WW4 or Equal 45¢ ea

.861	3.39	20	270	2000	7000	50K
1.01	5.1	28	425	2200	8000	55K
2.55	5.21	38	1250	3300	9000	80K
2.58	12	50	1750	6000	20K	

1 watt one percent tolerance WW4 or Equal 60¢ ea.
100K 128K 150K 240K 320K 500K 600K
120K 130K

1 watt WW5 or Equal 65¢ ea.
84K-2% 522K-1% 645K 1% 700K-1% 1 meg–5%

1 MEGOHM 1 WATT 1% $1.50

TYPE "J" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
100	SS*	2.5K	SS	100K	7/16
150	SS	3.0K	⅜	200K	SS
150	SS*	4.0K	⅜	250K	5/8
500	1/4	15K	⅜	250K	SS
1.0K	9 16	25K	SS	1.0 Meg	1/4
1.5K	5/16	75K	SS		
2.0K	1/4	100K	⅜		

SS: Screw-driver slot.
*: Split locking bushing.

$1.25 EACH

TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
10K-10K	5/16	30K-10K	⅜†	90K-3K	¼
15K-15K	SS	†With switch.			

PRICE—$2.50 EACH

High Current Filament Transformer

Amertran type W Pri. 105-125 V. 60 cy. 1 Phase—Sec. 5V. 190 amps.—.97 KVA 35 KV. RMS Insul. Test 7x10x12; Wt. 80 lbs. Ideal For Use As Arc Welder.
SPECIAL $29.50 ea.

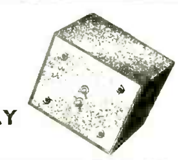
Kenyon S-14940 S.C. #2Z9943-1073 Pri. 105-125 V. 60 Cy. Sec. 5V. 115 Amps .... $19.50 ea.
Kenyon S-13377 S.C. #2Z9943-7 Pri. 115 V. 60 Cy. Sec. 5V, 60 Amps. .... $15.25 ea.

RAYTHEON PLATE TRANSFORMER

TYPE U8355A

PRI. 110V/220V/440V/60 cy.
SEC #1 300V @ 4 AMPS. SEC. #2 300V @ 4 AMPS.
1780 RMS TEST. 9¾"x9½"x8½" HIGH... $19.95

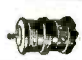
Choke
10 hy
400 MA
90 OHMS
HERMETICALLY SEALED



$4.88

2J1G1 SELSYNS $8.50

400 CYCLE BRAND NEW



400 CYCLE INVERTERS

Leland Electric Co.

#10800 in; 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF $29.50

Minimum Orders $3 Get on our Mailing List

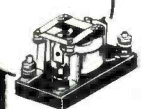
RELIANCE MERCHANDIZING CO.

Arch St., Cor. Croskey Phila. 3, Pa. Telephone Rittenhouse 6-4927

AIRCRAFT SOLENOID CONTACTORS

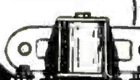
18 to 29 VDC Double Make Contacts

B2 & B2A



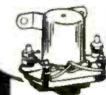
25-Amp Contacts Continuous; 50-Amp Surge; SPST: Spec. #94-32185D; 160 ohm; 6.5 oz approx
Guardian 34420 (B2) #R375 $[illegible]
Guardian 33557 (B2A) #R376 $2.25
G. E. CR2791A102A10 (B2A) #R377 .... $2.25
Struthers Dunn 61HXX100 (B2A) #R378 .... $2.25
Cutler Hammer 6041H60A (B2) #R379 .... $1.95
Square "D" Class 9350 (B2A) #R380 .... $2.25
RBM B2A #R381 .... $2.25
Ward Leonard B2 #382 $1.95
RBM B2 #383 .... $1.95
Allen Bradley B2A #R384 $2.95
Leach 1227-24 (B2A) #R385 $2.25

B4 & B4A



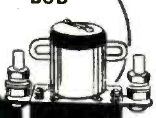
200-Amp Contacts, Continuous, 800-Amp Surge, SPST: SPEC. 94-32324C; AN-R-20A; 70 ohms
Square "D" B4 #R386 .. $4.95
Autolite B4 #R174 .... $3.95
Autolite B4A #R387 .... $4.95
Cutler Hammer 6041H17C; B4 #R388 .... $4.95

B5, B5A, B5B



50-Amp Contacts; Continuous; 100-Amp Surge; SPST: Spec. #94-32351-B; 100 ohm
Allen Bradley X91419 (B5A) #R105 .... $2.50
Hart 692R4 (B5A) #R389 $2.50
Square "D" B5A #R25 .. $2.50
Cutler Hammer 6041H2A (B5) #R390 .... $2.00
Cutler Hammer 6041H2B (B5A) #R24 .... $2.50
Cutler Hammer 6041H79A (1204-1 or B5B) #R294 $3.50
Leach 7064-278 (1204-1 or B5B) #R391 .... $3.50

B6B

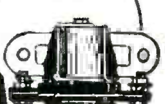


100-Amp Contacts; Continuous; Spec. 94-32352: SPST
Allen Bradley X95545; 65 ohm: Identical to NAF 1204-2 (A-BX95395) except coil connection screws inverted; #R606 .... $4.25

B7A & B7B

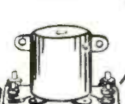
200-Amp Contacts; Continuous; 800-Amp Surge
Arrow, H & H 39169; Spec. 94-32353; SPST; B7A; 10/110 ohm; #R320 .... $4.95
Guardian 1204-3; 10/110 ohm; #R321 .... $4.95
Allen Bradley X95396; NAF 1204-3; 60 ohms; #R322 $4.95

B8



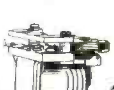
200-Amp Contacts, 1000-Amp Surge; 10 ohm 8-28VDC; Intermittent Duty; Spec. 32424; SPST
Autolite B8: #R128 .... $2.95
Guardian 34056 #R129 .. $3.95
Hart 694R15A #R601 ... $3.50
Cutler Hammer 6041H139A #R130 .... $4.95
Leach 7210-24 #R602 ... $3.95

NAF



15-Amp Inductive; SPDT: Time Delay 0.050 sec (slow make); Spec. #32429; 180 ohms 7½ oz approx
Leach 2069-147 #R323 .. $2.25
Guardian 34464 #R324 .. $2.25

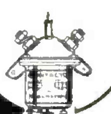
B9



200-Amp Contacts; 18-29 V; Spec. 94-32183; SPST
Eclipse C1-73110-521-1; 80 ohm; #R325 .... $4.95

200-Amp Contacts; 8-28V DC Intermittent Duty
Spec. #94-32181; SPST; Eclipse D1-66198-518-2; 6 ohms; #R126 .... $4.95
Cutler Hammer 6041H61A; 50 ohms; #R292 .... $4.95

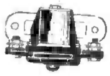
C1



1204-1 (B5B): 50-Amp Contacts: Spec. 569a: SPST
Cutler Hammer 6041H79A; 150 ohms; #R294 .... $3.50
Leach 7064-278; 150 ohms; #R326 .... $3.50

D1

1204-2 (B6B) 100-Amp Contacts; Spec. 569a; SPST
Allen Bradley X95395; 65 ohms; Identical to B6B (A-B X95545) except coil connecting screws inverted; #R327 $4.25
1204-3 (B7B) 200-Amp Contacts; Spec. M569a; SPST
Allen Bradley X95396; 60 ohms; #R329 .... $4.95
Cutler Hammer 6041H81A; 65 ohms; #R295 .... $4.95
11181-1; 25-Amp Contacts; Spec. S85D; SPST
Struthers Dunn CX1535; 24VDC; 240 ohms; #R604 $2.95



CUTLER-HAMMER

AIRCRAFT & COMMERCIAL D-C CONTACTORS

C-H No.	AAF or NAF	COIL Volts D.C.	COIL Ohms	CONTACTS Circuit	CONTACTS Amps	Stock No.	Price Ea.
6041H2A	B5	24	100	SPST	50	R298	2.50
6041H2B	B5A	24	100	SPST	50	R24	2.75
6041H6A	——	24	100	SPST	50	R288	2.75
6041H12A	——	24	65	SPST	100	R421	3.50
6041H17C	B4	24	65	SPST	200	R289	4.95
6041H36A	A3	12	17	SPST	200	R121	[illegible]
6041H50A	——	12	17	DPST	50	R290	3.50
6041H54A	——	24	100	SPDT	50	R299	3.95
6041H60A	B2	24	160	SPST	25	R291	1.95
6041H61A	D1	24	50	SPST	200	R292	4.95
6041H63B	——	24	50	SPST	100	R293	3.95
6041H79A	B5B 1204-1	18–29	150	SPST	50	R294	3.50
6041H81A	B7B 1204-3	18–29	65	SPST	200	R295	4.95
6041H84A	——	12	25	No Contacts		R296	1.75
6041H139A	B8	10–24	10	SPST	200	R130	4.95
6041H158A	——	12	25	SPST	50	R428	2.75
6041H169A	3350-2	24	100	SPST	50	R297	3.95
9565H2B	——	24	25	SPST	50	R300	6.95

MAGNECON CONTACTORS

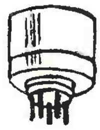
200 Amp Contacts SPST, Double Make

Holding Current Automatically Cut by 90%

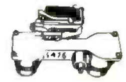
305381-2, 36VDC, 14 ohm Start, 140 ohm Hold. #R589 .... $4.95
305381-3, 72 VDC, 60 ohm Start, 600 ohm Hold. #R590 .... $5.50
305281-4, 120VDC, 200 ohm Start, 2000 ohm Hold. #R591 .... $5.95

LEACH CONTACTORS

Leach No.	AAF or NAF	COIL Volts D.C.	COIL Ohms	CONTACTS Circuit	CONTACTS Amps	Stock No.	Price Ea.
1227–24	B2A	18–29	160	SPST Slow Make	25	R385	2.25
2069–147	B9	18–29	180	SPDT	15	R323	2.25
5023CG17	——	24	100	SPDT	60	R282	5.00
5030	——	12	7	SPST	60	R700	3.95
5030CSP	——	12	25	SPST	50	R125	2.95
5031LA	——	12	25	SPST	100	R707	3.50
5035	——	12	7	SPST	60	R713	3.50
5035CS	——	12	25	SPST	60	R714	3.50
5035–3	——	12	7	SPST	60	R703	3.50
5037	——	12	25	SPST	50	R705	3.50
5050	——	24	25	SPST	40	R701	3.50
5051GM	——	24	40	SPST	65	R708	3.50
5053SM	——	24	10	SPDT	100	R712	4.50
5055	——	24	25	SPST	40	R704	3.50
5057	——	24	105	SPST	30	R706	3.50
5058	——	24	10	SPST	200	R709	7.95
5058CDWG17	—	24	140	SPST	200	R710	7.95
5058–1G17	——	24	10	SPST	200	R711	7.95
7064–12C	——	12	40	SPST	75	R702	3.50
7064–278	NAF1204–1 B5B	18–29	100	SPST	50	R391	3.50
7210–24	B8	18–29	66	SPST	200	R602	3.95

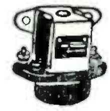


ARC 3 & ARC 5 RELAYS



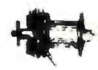
23025 RBM 48VDC; SPDT; 8000 ohm; 6 ma; #R428 $2.50
55251 (K403, K405) Telechron; 24VDC; SPST; n.o. (1A); 300 ohm; #R174 .... $1.25
55340 (K203) Price; 24VDC; SPST n.o., (1A); 300 ohm; #R170 .... $1.25
55342 (K206, K213) Telechron: 24VDC; (2A's);(1C); 300 ohm; Anti-Capacity Arms; Low Loss Bakelite Insulation; #R171 .... $1.75
55476 (K101) Clare; 12-24VDC; Co-Axial Antenna Relay; SPDT (1C); 275 ohms; #R421 .... $9.95
55526 (K109, K116) Cook; 24VDC; (1A, 1C); 300 ohm; Ceramic Insulation; #R107 .... $1.75
55528 (K107) G. E.; 12VDC; 6PST n.o., (6A's); 150 ohm; #R426 .... $2.00
55531 (K106) Cook; 12-24VDC; (2A's, 2C's); 150 ohm; #R405 .... $1.95
55585 (K103) G. E.; 12-24VDC; Sealed Plug-in-Relay; SPDT (1C); 2500 ohm; #R419 .... $4.95
55589 (K102) G. E.; 12-24VDC; DPST n.o. (2A); 280 ohm; #R245 .... $1.75
55836 (K406) G. E.; 24VDC; SPDT; 250 ohm; #R402 .... $1.50
55837 (K401, K402) G. E.; 24VDC; Double Make (2A); 300 ohm; #R108G $1.25
55837 (K401, K402) RBM; Same as #R108G; #R108R $1.50
55837 (K401, K402) Allied; Same as #R108G; #R108 .... $1.75
23012-0 RBM; 24VDC; SPDT; 250 ohms; #R172 $1.50
6385 ARC: 12-24VDC; SPST n.o. (1A), 10 Amp Contacts; 200 ohm; #R213 .... $2.00
7251 ARC; 24VDC; SPDT; (1C); 300 ohm; #R406 $1.50
7252 ARC; 24VDC; DPST n.o. (2A); 300 ohm; #R354 $1.50
7735 ARC: 24VDC; Antenna Relay; SPDT (1C); 200 ohm; #R799 .... $3.95

OTHER CONTACTORS



Mfgr. & No.	COIL Volts D.C.	COIL Ohms	CONTACTS Circuit	CONTACTS Amps	Stock No.	Price Ea
RBM 118083	24	153	SPST	60	R715	2.50
RBM 117083	24	10	SPST	60	R716	2.50
RBM 120083	32	178	SPST	60	R717	2.50
RBM 119083	32	272	SPST	60	R718	2.50
RBM BN5	24	200	SPST	50	R224	2.50
Guardian 79733	24	65	SPDT	60	R131	3.00
Guardian 34585	24 ea	2x24	2xSPDT	2x75	R223	9.95

Dual Electrical Latching



G.E. CR2792B118A3	24	150	SPST	50	R23[illegible]	2.95
G.E. CR2792D116W2	12	30	SPST	100	R719	5.50
G.E. CR2800–384A3	24	50	SPST	200	R720	5.95
G.E. CR9533K100A2	24	240	2B; 1A 2 Switchettes; extra long throw	15	R132	9.95
G.E.M29J682-1	10–12	30	No Contacts		R167	1.25
EPCO S47D	12	35	SPST	50	R122	2.50
A-B X86382	24	40	SPST	100	R722	3.50
Autolite	12	17	SPST	50	R74	2.50
Allied AN1332	24	175	SPST	75	R436	3.95
Allied AN1328	6	14.2	SPST	75	R721	4.50

ACCESSORIES FOR TELEPHONE TYPE RELAYS

Clare CR1 Molded Bakelite Cover #CR1 ...... .90
Clare BR2 Long Relay Bracket #BR2 ...... .20
Clare BR4 Short Relay Bracket #BR4 ...... .15

CARBON MONOXIDE DETECTOR SIGNAL ASSEMBLY

MINE SAFETY APPLIANCES CO. Type K-1 and K1-N—Manufacturer's Part No. SK 1557 and SK 1557-1—Spec. No. 27493

NEW! REG. PRICE $300

89.00 each — **3 for $250.00** — **10 for $825.00**

TERMS:—All prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order.

Delivery From Stock While They Last!

Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

Universal general corp.

Want more information? Use post card on last page.

BENDIX AIRCRAFT TYPE GENERATOR

Bendix-Eclipse Aviation; Type 1235 . . . Counter-clockwise rotation. Speed 2500-4500 RPM; 28.5 VDC @ 15 A. A. Two-Brush ball bearing generator suitable for any application where 28 volt output is required. Field and armature taps for adjustment of voltage from 12 to 28 volts........**NEW $15.00**

G. E. GENERATORS

General Electric Type 5-ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia...**$99.50 ea.**

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle..............**$30.00 ea.**

Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor. **$25.00 ea.**

Arma Resolver Type 213014; equal in size to size 5 synchro; 55-60 cycle; single phase primary, 2 phase secondary...........**$79.50**

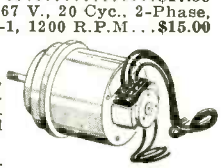
VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D..................**$17.50**

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D **$17.50**

A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M...**$15.00**

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.

Quantities Available.

REPEATERS ....**$20.00 ea.**

TRANSMITTERS ....**$20.00 ea.**

AUTOSYN MOTOR TYPE 1

115 VAC; 60 cycle; 1-phase; DR. # CB 4279 Foot Mounted; Mfg. Bendix Aviation Corp. **$22.50 ea.**

SELSYN GENERATOR

General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle..................**$22.50 ea.**

SYNCHROS

AUTOSYN MTR. KOLLSMAN Type #403; 32 VAC; 60 cycle; single phase.......**$22.50**

AUTOSYN MTR. BENDIX Type #851; 32 VAC; 60 cycle; single phase.........**$22.50**

SYNCHRO TRANSMITTER. KEARFOTT Type R-212-1A-A Rotor; 26 Volts; single phase; Stator; 11.8 Volts; 3-phase; 400 cycle **$25.00**

MICROSYN UNIT, Type 1C-006-A...**$35.00**

IF Special Repeater (115V-400 Cy.) **$15.00 ea.**

2J1F 3 Generator (115-400 cyc.)..**$10.00 ea.**

5CT Control Transformer: 90-50 Volt; 60 Cy. ....**$50.00 ea.**

5F Motor (115/90Volt—60 cyc.)......**$50.00**

5G Generator (115/90 v.—60 cy.)..**$50.00 ea.**

5/DG Differential Generator (90-94 volts—400 cyc.) ....**$30.00 ea.**

TRANSMITTER, BENDIX C-78248; 115 Volt, 60 Cycle ....**$25.00 ea.**

Differential—C-78249; 115 V., 60 Cy...**$5.00**

5N MOTOR (115 Volts/60 Cycle).....**$22.50**

REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle ....**$37.50 ea.**

REPEATER, AC synchronous 115 V., 60 cycle, C-78863 ....**$15.00 ea.**

REPEATER, DIEHL MFG. No. FJE 22-2; 115 Volt; 400 Cy.; Secondary 90 V....**$27.50**

7G Synchro Generator (115/90 volt; 60 cycle) **$75.00**

6G Synchro Generator (115/90 volt; 60 cycle) **$60.00**

6DG Synchro Differential Generator (90/90 volt; 60 cycle) **$60.00**

2-JF5-J Selsyn Control Transformer: 105-55 Volts; 60 Cycle **$50.00**

5JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle **$50.00**

2J1F1 GENERATOR: 115—57.5 Volt; 400 cycle ....**$12.50 ea.**

2J1H1 DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle...........**$12.50 ea.**

2J1G1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle..............**$7.50 ea.**

PIONEER TORQUE UNITS

TYPE 12606-1-A: Contain CK5 Motor coupled to output shaft through 125.1 gear reduction train. Output shaft coupled to autosyn, follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15.1..........**$70.00 ea.**

TYPE 12604-3-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn ....**$70.00 ea.**

TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train...................**$70.00 ea.**

Immediate Delivery

ALL EQUIPMENT FULLY GUARANTEED

All prices net FOB Pasadena, Calif.

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input**: 28.5 VDC; 12 amp. ....**$69.50 ea.**

PIONEER 12126

OUTPUT: 10 VAC; 10V AMP; FREQ 400 cycle; 3-phase .60 P.F. INPUT: 28 VDC; 1.25 AMPS. ....**$29.95 ea.**

PIONEER 12117

OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase **INPUT**: 24 VDC; 1 amp. **$25.00 ea.**

ALTERNATOR, CARTER

Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC. 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm. **$49.50 ea.**

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. **INPUT**: 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5. **BRAND NEW** ....**$39.95 ea.**

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 RPM; **Input**: 13.5 VDC; 29 amp. **$69.50**

MG-0-75 ONAN

Navy Type PU/11 . . . **Output**: 115 VAC; 480 cyc.; single phase; 5.3 amp and 26 VDC @ 3.8 amp. **Input**: 115/230 VAC; 60 cyc.; single phase **$225.00**

MG 153 HOLTZER-CABOT

Input: 24 V, DC, 52 amps; **Output** :115 volts —400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated ....**$95.00 ea.**

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps. 400 cycle single phase, 141 VA. **Input**: 20-30 VDC, 18-12 amps. Voltage and frequency regulated ....**$89.50 ea.**

12116-2-A PIONEER

Output: 115 VAC; 400 cyc.; single phase; 45 amp. **Input**: 24 VDC 5 amp....**$90.00 ea.**

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF, and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input**: 27.5 VDC, 60 amps. cont. duty, 6000 RPM. Voltage and Frequency regulated.......**$195.00**

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input**: 27.5 DC; 12.5 amp; Cont. Duty ....**$90.00 ea.**

PIONEER 10042-1-A

DC INPUT 14 Volts; **OUTPUT**: 110 Volts; 400 Cycle 1-Phase; 50 Watt..........**$90.00**

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle; .40 PF. **Input**: 27.5 Volts DC; 18 amps; cont. duty, voltage and freq. regulated **$95.00**

PIONEER AUTOSYNS

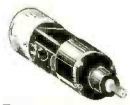
AY-1	26 Volt—400 Cycle		**$6.95**
AY-5	26 Volt—400 Cycle		**$7.95**
AY27D			**$12.50**
AY6—26 Volt—400 cyc			**$4.95 ea.**
AY30D—26 Volt—400 cyc			**$25.00 ea.**
AY14D			**$10.00**
AY34			**$20.00**
AY20—26 Volt—400 cyc			**$12.50 ea.**

PORTABLE GAMMA SURVEY METER

Model 247B: For detecting and measuring higher intensities of Gamma radiations while obtaining discrimination against other radiations. Range switch permits selection on scales of zero to 50, zero to 500, zero to 5000, and zero to 50,000 milliroetgens/hour (MR/HR). Entirely self-contained, the unit consists of a watertight aluminum case with sealed detector assembly, hermetically sealed meter, vacuum tubes and circuit components with power supply of 1-45V dry battery and 1-300V dry battery. Dimensions are 10-¾" wide; 12-59/64" high; weight 12-¾" lbs. incl. batteries. Mfg. Victoreen Instrument Co. Original A.E.C. cost over $300. Buy it at a tremendous savings.

Brand New **$89.50**

ALNICO FIELD MOTORS



(Approx. size overall . . . 3¾" x 1¼" diameter)

DELCO TYPE #5069600: 27.5 volts DC; 250 RPM **$19.95**

PM Motors Delco Type #5069371: 27.5 volts: DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125" **$15.00**

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

AC CONTROL MOTOR

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 2; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝" ....**$15.00 ea.**

400 CYCLE MOTORS

PIONEER: TYPE CK5 2 Phase; 400 cycles **$25.00 ea.**

EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle **$17.50 ea.**

AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03 ....**$10.00 ea.**

EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM ....**$12.50 ea.**

EASTERN AIR DEVICES, TYPE J31B: 115 V. 400-1200 Cycle. Single Phase **$12.50 ea.**

AIRESEARCH: AC induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps. ....**$79.50 ea.**

AIREARCH: AC Induction. 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps. **$25.00**

Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 phase Kearfott Co., Inc. ....**$17.50 ea.**

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear

SMALL DC MOTORS

DELCO #5072000: 27.5 VDC; 11.75 rpm **$15.00**

DELCO #5068750: constant speed: 27 VDC; 160 RPM; built-in reduction gears and governor ....**$17.50 ea.**

J. OSTER: series reversible motor: 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps;

SPERRY #806069: approx. size 1⅝" x 3½" **$7.50 ea.**

(Approx. size....4" long x 1½" dial.)

General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM. shunt wound; 4 leads; reversible..**$15.00 ea.**

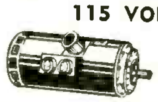
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque, 12 DC, 50 RPM, 1.02 amp. **$15.00 ea.**

General Electric Type 5BA10AJ52C: 27 volts, DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$15.00 ea.**

GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64, 160 r.p.m.; 65 amp; 12 oz.-in. torque; 27V DC ....**$19.95 ea.**

2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp. **$35.00**

115 VOLT GENERATORS



Brand new Eclipse generators: 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited **$29.95**

MICROPOSITIONER

Barber Colman AYLZ 2133-I Polarized D.C. Relay: Double Coil Differential sensitive, Alnico P. M. Polarized field. 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc. ......**$12.50 ea.**

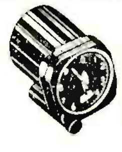
BLOWER

Eastern Air Devices, Type J31B; 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R #2 blower; approx. 22 cu. ft./min. **$15.00**

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL, 17CFM, complete with capacitor. New ....**$12.50 ea.**

SENSITIVE ALTIMETERS



Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required ..**$12.95 ea.**

C and H Sales Company

BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

A LEADING SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY -- FULLY GUARANTEED

A. C. SYNCHRONOUS MOTORS

110 Vt. 60 Cycle

- HAYDON TYPE 1600, 1/240 RPM
- HAYDON TYPE 1600, 1/60 RPM
- HAYDON TYPE 1600, 4/5 RPM
- HAYDON TYPE 1600, 1 RPM
- HAYDON TYPE 1600, 1 1/5 RPM
- TELECHRON TYPE B3, 2 RPM
- TELECHRON TYPE BC, 60 RPM
- HOLTER CABOT, TYPE RBC 2505, 2 RPM, 60 oz. 1 in. torque.

SERVO MOTORS

- PIONEER TYPE CK1, 2 ϕ 400 CYCLE
- PIONEER TYPE 10047-2-A, 2 ϕ, 400 CYCLE, with 40:1 reduction gear.

D. C. MOTORS

- BODINE NFHG-12, 27 VTS., governor controlled, constant speed 3600 RPM, 1/30 HP.
- DELCO TYPE 5068750, 27 VTS., 160 RPM, built in brake.
- DUMORE, TYPE EIY2PB, 24 VTS., 5 AMP., .05 HP., 200 RPM.
- GENERAL ELECTRIC, TYPE 5BA10AJ18D, 27 VTS., 110 RPM, 1 oz. 1 ft. torque.
- GENERAL ELECTRIC, TYPE 5BA10AJ37C, 27 VTS., 250 RPM, 8 oz. 1 in. torque
- BARBER COLMAN ACTUATOR TYPE AYLC 5091, 27 VTS., .7 amp., 1 RPM, 500 in. lbs. torque.
- WHITE ROGER ACTUATOR TYPE 6905, 12 VT., 1.3 amp., 1½ RPM, 75 in. lbs. torque.

AMPLIDYNE AND MOTOR

- AMPLIDYNE, GEN. ELEC. 5AM31NJ18A input 27 vts., at 44 amp. output 60 vts. at 8.8 amp., 530 watts.
- MOTOR, GEN. ELEC. 5BA50LJ22, armature 60 vts. at 8.3 amp., field 27 vts. at 2.9 amp. ½ HP., 4000 RPM.

PIONEER AUTOSYNS 400 CYCLE

- TYPE AY1, AY5, AY14G, AY14D, AY20, AY27D, AY38D, AY54D.
- PIONEER AUTOSYN POSITION.
- INDICATORS & TRANSMITTERS.
- TYPE 5907-17, single, Ind. dial graduated 0 to 360°, 26 vts., 400 cycle.
- TYPE 6007-39, dual Ind., dial graduated 0 to 360°, 26 vts., 400 cycle.
- TYPE 4550-2-A, Transmitter, 2:1 gear ratio 26 vts., 400 cycle.

INVERTERS

- WINCHARGER CORP. PU 16/AP, MG750, input 24 vts. 60 amps. outputs 115 vts., 400 cycle, 6.5 amp., 1 phase.
- HOLTZER CABOT, TYPE 149F, input 24 vts. at 36 amps., output 26 vts. at 250 V.A. and 115 vts. at 500 V.A., both 400 cycle, 1 phase.
- PIONEER TYPE 12117, input 12 vts., output 26 vts. at 6 V.A., 400 cycle.
- PIONEER TYPE 12117, input 24 vts., output 26 vts. at 6 V.A., 400 cycle.
- WINCHARGER CORP., PU/7, MG2500 input 24 vts. at 160 amp., output 115 vts. at 21.6 amp., 400 cycle, 1 phase.
- GENERAL ELECTRIC, TYPE 5D21NJ3A, input 24 vts. at 35 amps., output 115 vts. at 485 V.A., 400 cycle, 1 phase.
- LELAND, PE 218, input 24 vts. at 90 amps. output 115 vts. at 1.5 K.V.A., 400 cycle, 1 phase.
- LELAND, TYPE D.A. input 28 vts., at 12 amp. output 115 vts. at 115 V.A., 400 cycle, 3 phase.

ENGINE HOUR METER

- JOHN W. HOBBS, MODEL MI-277 records time up to 1000 hours, and repeats, operates from 20 to 30 volts.

VOLTAGE REGULATOR

- LELAND ELEC. CO. TYPE B, CARBON PILE. Input 21 to 30 volts D.C. regulated output 18.25 vts. at 5 amp.
- WESTERN ELEC. TYPE BC937B, input 110 to 120 volts, 400 cycle. Output variation 0 to 7.2 ohms at 5 to 2.75 amps.
- WESTERN ELEC. TRANSTAT, input 115 vts., 400 cycle output adjustable from 92 to 115 vts., rating .5 K.V.A.
- AMERICAN TRANS. CO., Transtat input 115 vts., 400 cycle output 75 to 120 vts. or 0 to 45 volts, rating .72 K.V.A.

SYNCHROS

- 1 F SPECIAL REPEATER 115 vts. 400 cycle.
- 2J1F1 GENERATOR, 115 vts. 400 cycle.
- 2J1F3 GENERATOR, 115 vts. 400 cycle.
- 2J1G1 CONTROL TRANSFORMER 57.5 vts. 400 cycle.
- 2J1H1 DIFFERENTIAL GEN. 57.5/57.5 vts. 400 cycle.
- 5G GENERATOR, 115 vts. 60 cycle.
- 5DG DIFFERENTIAL GEN. 90/90 vts. 60 cycle.
- 5HCT CONTROL TRAN. 90/55 vts. 60 cycle.
- 5CT CONTROL TRAN. 90/55 vts. 60 cycle.
- 5SDG DIFFERENTIAL GEN. 90/90 vts. 400 cycle.

ALL PRICES F. O. B. GREAT NECK N. Y.

TACHOMETER GENERATOR & INDICATOR

- GENERAL ELECTRIC, GEN, TYPE AN5531-1, Pad mounting 3 phase variable frequency output.
- GENERAL ELECTRIC, GEN. TYPE AN5531-2, Screw mounting 3 phase variable frequency output.
- GENERAL ELECTRIC, IND. 8DJ13AAA, works in conjunction with above generators, range 0 to 3500 RPM.

D. C. ALNICO FIELD MOTOR

- DIEHL TYPE FD6-23, 27 vts. 10,000 RPM.

GENERAL ELECTRIC D. C. SELSYNS

- 8TJ9-PAB TRANSMITTER 24 VTS.
- 8TJ11- INDICATOR, dial 0 to 360°, 24 vts.

RECTIFIER POWER SUPPLY

- HAMMETT ELECTRIC MFG. CO. MODEL SPS-130. Input voltage 208 or 230 volts, 60 cycle, 3 phase, 21 amps. Output 28 volts at 130 amps. continuous duty, 8 point tap switch, voltmeter ammeter, thermo reset all on front panel.

MISCELLANEOUS

- PIONEER MAGNETIC AMPLIFIER ASSEMBLY Saturable reactor type, designed to supply variable voltage to a servo motor such as CK1, CK2, CK5 or 10047.
- SPERRY A5 CONTROL UNIT, part No. 644836.
- SPERRY A5 AZIMUTH FOLLOW-UP AMPLIFIER, part No. 656030.
- SPERRY A5 DIRECTIONAL GYRO, part No. 656029, 115 vt. 400 cycle, 3 phase.
- SPERRY A5 PILOT DIRECTION INDICATOR, part No. 645262 contains AY 20.
- ALLEN CALCULATOR, TYPE C1, TURN & BANK IND., part No. 21500, 28 vts. D. C.
- TYPE C1, AUTO-PILOT FORMATION STICK, part No. G1080A3.
- PIONEER GYRO FLUX GATE AMPLIFIER, Type 12076-1-A, 115 vt. 400 cycle.

INSTRUMENT ASSOCIATES

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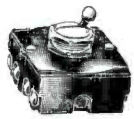
HEAVY DUTY SWITCHES



H&H 4.P.D.T. Toggle Switch. 5 AMP. @ 250 Volt. 10 Amp. @ 125 Volt. Single 3/4" hole mount. Ball handle.
Stock No. 6203A — Price Each **$1.95**

CUTLER HAMMER TYPE 8905K628

4 Pole D.T. Neutral Center Toggle Switch. Luminous Tip—Bat Handle. 2 Hole Mg.
Stock No. 6291A — Price Each **$1.95**

TOGGLE SWITCH

CUTLER HAMMER #8803K5
SPST BAT HANDLE, SINGLE HOLE MTG.
STOCK NO. 6423A — Price Each **$.35**

SWEEP CAPACITOR

5-10 MMFD. Sweep Generator Capacitor. Has cylindrical silver plated rotor, concentric to silver plated stator plates. Rotor has high speed ball bearings. Completely enclosed in moulded bakelite housing. Ideal for motor driven sweep generators.
Stock No. 6276A — Price Each **$2.00**

HIGH VOLTAGE TRANSFORMER

21,000 volt 100MA. Half Wave oil filled. Maloney Electric Co.
Stock No. 5728A — Price Each **$300.00**

PLATE TRANSFORMER

Thordarson Tru-Fidelity Plate Transformer. Primary 208-210-220-230-240 Volts 60 Cycle. Secondary 3310 V.C.T. @ .86 Amps. 10,000 Volt insulation. Brand new—limited quantity.
Stock No. 6399 — Price Each **$60.00**

FILTER REACTORS

4 Henry @ 1.75 Amps. Thordarson Tru-Fidelity. 15,000 Volt Test. 10 Ohms D.C.
Stock No. 6400A — Price Each **$35.00**

Swinging Choke. Thordarson Tru-Fidelity. 10-20 Henry @ 500 to 50 M.A. 7500 Volt Test. 55 Ohms D.C.
Stock No. 6401A — Price Each **$20.00**

SCOPE TRANSFORMERS

2500 Volt @ 1.6 M.A. Secondary. 115 Volt 60 Cycle Primary. Insulated for 7500 Volts. Open strap mounting 3 5/8" centers. Mfg. by Thordarson.
Stock No. 6387A — Price Each **$1.50**

FILAMENT TRANSFORMER

20 VOLTS TAPPED AT 14 VOLTS @ 20 AMPS. PRIMARY TAPPED IN 5 VOLT STEPS FROM 210 TO 240 VOLTS 50-60 CYCLE STANCOR SS10696. 4" x 5" x 5" HIGH.
Stock No. 6292A — Price Each **$4.95**

MIL—T—27 FILAMENT TRANSFORMER

PRIMARY: 107.5; 112.5; 117.5; 122.5; 215; 225; 235 and 245 Volts 50/60 cycle SECONDARY: 6.3 Volts @ 5.3 AMPS and 6.3 Volts @ 3 AMPS. Ceramic bushings with solder lug terminals. Rated for continuous duty under Mil-T-27. Class "A" Grade I specs. Hermetically sealed case, 2 3/4" x 3 1/4" x 3 1/8" high.
Stock No. 6284A — Price Each **$35.00**

RESISTORS PRODUCTION QUANTITIES

in stock of late carbon and wire wound resistors. 1/2—10 watt sizes, savings 10—25%.

Large Quantities such as

Pieces				
150,000	220 ohm	1/2 Watt	20%	IRC
500,000	100 ohm	1 Watt	10%	IRC
1,000,000	220 ohm	1 Watt	10%	IRC
100,000	390 ohm	1 Watt	10%	IRC
150,000	1000 ohm	1 Watt	10%	IRC
75,000	6.8 megohm	1 Watt	10%	IRC
100,000	100 ohm	2 Watt	10%	St'CPole
100,000	4700 ohm	2 Watt	10%	St'CPole
50,000	2200 ohm	2 Watt	20%	St'CPole
60,000	470 ohm	4 Watt W/W	10%	Cl'Rstat
90,000	13000 ohm	10 Watt W/W	15%	Cl'Rstat

Send us your requirements.

STANDARD BRAND RESISTORS

10 ohm	1/2 Watt	10%
100 ohm	1/2 Watt	10%
6.8 megohm	1/2 Watt	20%
820 ohm	1 Watt	5%
4300 ohm	1 Watt	5%
30,000 ohm	1 Watt	5%
62,000 ohm	1 Watt	5%
300,000 ohm	1 Watt	10%
12 megohm	2 Watt	10%
18 megohm	2 Watt	10%
22 ohm	2 Watt	20%
22 ohm	2 Watt	20%
6800 ohm	2 Watt	20%
15,000 ohm	2 Watt	20%

HI—VOLTAGE RESISTORS

10 meg	MVX-1	1 Watt	15%	IRC
12 meg	MVX-1	1 Watt	15%	IRC
15 meg	BBF	1 Watt	15%	RPC
25 meg	MVX-2	2 Watt	15%	IRC
200 meg	BBR	3 Watt	15%	RPC

TYPE "J" POTENTIOMETERS

500 Ohm—2 Watt Type J Pot. 3/8" Long Shaft. 1/4" long Bushing. Complete with Knob.
Stock No. A6123 — Price Each **49¢**

100 ohm Type I with 3/8" bushing and locking nut. Screw-driver slot.
Stock No. 6270A — Price Each **$.49**

LAB. POTENTIOMETERS

MODEL 260. 6 Watt 20,000 OHM Laboratory. Potentiometer. Resistance tolerance plus or minus 5%. Five finger bronze wiper. Bakelite shaft 3/8" Diam. x 1 1/4" Long.
Stock No. 6277A — Price Each **$1.50**

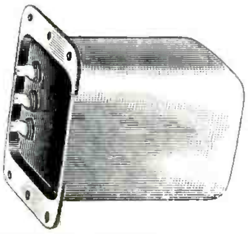
MALLORY M200R

200 ohm 4 watt Rheostat
Stock No. 6137A — $25.00 per 100 — Price Each **30¢**

SIGNAL CORPS & NAVY TRANSFORMERS

Over 200,000 transformers, chokes etc. For Signal Corps and Navy Equipment. Send us your requirements, or ask for our catalog listing by Signal Corps Numbers. DON'T DELAY!

THORDARSON AUDIO PASS FILTERS



Band pass 800 to 1200 cycles Input 10000 ohms —Output 25000 Ohms Level 10DB

Stock No. T48500 — Price 5.50 ea.

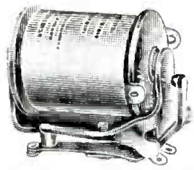
THORDSON BAND PASS FILTERS

600 ohms to 600 ohms
1700 cycles to 3300 cycles
Attenuation 25 DB at 1450 cycles or 50 DC at 4880 cycles.
Size: 6" x 6 5/8" x 5"
Stock No. 5897A — Price Each **$8.00**

LOW PASS FILTER

500 Ohm to 500 Ohm. 200 to 2000 Cycles. Sig. Corps No. 3Z1891—1.2. P/O R/19A—TRC-1.
Stock No. 6413A — Price Each **$3.00**

SENSITIVE RELAYS



MIDGET TYPE RELAYS
Automatic Electric Type R-45. 6500 ohm Coils
Normally open contacts except as noted.

Stock No.	Contents	M. A.	Price Each
102152	S.P.S.T.	2.0	$1.25
102249	2.P.S.T.*	4.5	1.50
102264	3.P.S.T.	6.0	2.00

* 1 Norm. open-1 Norm. closed.

Same type and style as above, but has 24 V.A.C. coil. Intermittent duty. Will operate on 6 V.D.C. Continuous duty. Contacts: S.P.S.T.-N.O. and S.P.D.T.
Stock No. 102248A — Price Each **$1.25**

304TL's EIMAC JAN 304TL's INDIVIDUALLY BOXED $10.95

RADAR ANTENNA

NAVY TYPE CBM 66AFT-1 Antenna Assembly. Part of SF-1 Radar Equipment, has two selsyns 115V 60 cycle—MK1 MOD. 4 type 5G MFG. by Bendix and 2-115VDC fractional motors, complete assembly with cover.
$150.00 each

TINNED WIRE

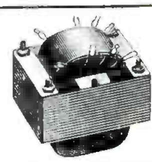
1/4 lb. spools of No. 20 solid tinned wire. Individually boxed.
Stock No. 6391A — Case of 100 at $20.00 — Price Each **25¢**

6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.4 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Horizontal Half Shell Mounting. 2 1/2" x 2 13/16" Mounting Centers. 2 13/16" x 3 3/8" Core Size. 2 1/2" above Chassis. Soder Lug Terminals—All Terminals Marked.



Stock No. 5254A — Price Each **$2.65**

TERMS:

Open Accounts to rated or Acceptable reference accounts. Others pre-payment of 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

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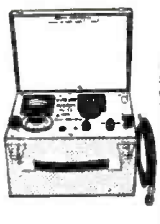
Micro-Wave Lavoie Freq. Meter 375 to 725 MCS

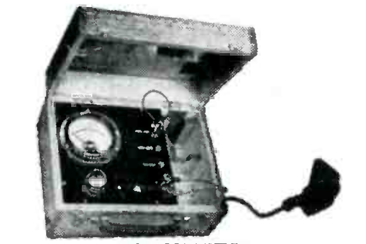


Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0.5 MIN. time witch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tutbes. Less batteries.

Full data on request
$79.50

HIGH VOLTAGE OIL CAPACITORS

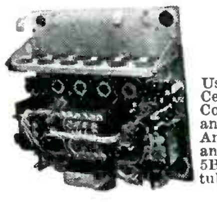
.001 MFD 50,000V DC	$37.50
.01 MFD 5,000V DC	$2.95
.02 MFD 8,000V DC	$9.50
.025 MFD 50,000V DC	$45.00
.025/.025 MFD 50,000V DC	$59.50
.1 MFD 500V DC	$ .95
.1 MFD 3,000V DC	$2.95
.135 MFD 7,500V DC	$6.95
.15 MFD 12,000V DC	$7.50
.2 MFD 50,000V DC	$67.50
.25 MFD 15,000V DC	$19.50
.25 MFD 20,000V DC	$26.50
.25 MFD 50,000V DC	$72.50
1. MFD 7,500V DC	$12.50
1. MFD 15,000V DC	$49.95
2. MFD 6,000V DC	$14.50



FLUXMETER

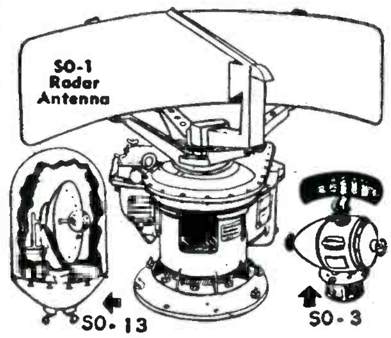
Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at....$29.50

G.E. Servo Amplifier



Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A. New less tubes. $29.50

RADAR EQUIPMENT



RADAR ANTENNAS

Type SO-1 (10CM) assembly with reflector, waveguide nozzle, drive motor. New...........$279.50
Type SO-3 (3 CM.) Surface Search type with reflector, drive motor, etc., but less plumbing. New in original cases $189.50
Type SO-13. (10CM.) Assembly with 24" dish, dipole, drive motor, gearing. New........$149.50
Also in stock — spare reflectors, nozzles, probes, right angle bends for SO-1 antennas.

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil $3.00

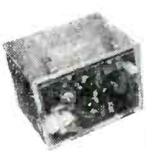
HIGH POT TRANSFORMER

High Voltage Trans. Westinghouse Pri: 115, 60 cy., Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up. C. T. ungrounded....................$29.50

Telrad Frequency Standard

Complete self contained, dual 100/1000 kc crystal, multivibrator and harmonic amplifier. Calibrates with WWV and provides 1000, 100, and 10 kc check points from 100 to 45,000 kc. 115V. 60 cycle. New with instructions. $29.50

TS-47/APR Test Oscillator



Provides calibrated CW, mod. or pulse signal source from 40 to 500 mc. Operates on 80, 115 or 230 V. from 50 to 2600 cy. or battery supply. New with tech. manual. $265.00

INVERTERS

Onan M-G.-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26V DC at 4 amps. New..............$295.00
Onan M-G.-075. Navy type PU/11 Input: 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 5.3 amps. and 26 VDC @ 3.8 Amps. New...........$225.00
Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output: 80V. 800 cy. 1 Ph., 485VA. New....$22.50
G.E. J8169172. Input: 28DC. Output: 115, 400 cy., 1 Ph. 1.5KVA. New........................$32.50
G.E. 5AS1315511A. Model 218J. Input: 28 DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New $89.50
Holtzer-Cabot M.G. 164. Input: 440, 3 Ph., 60 cy., Output: 70V, 146 cy. 3 Ph., 0.140KVA. New.$67.50
Elcor. 74DC to 110AC, 60 cy., 1 Ph. at 2.4 Amps. New $39.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130DC. Output: either 26DC at 20 amps. or 13DC at 40 amps. Radio filtered and complete with line switch. New $89.50
Type PE94CM. For SCR-522. Brand new in overseas cases. Has wide band input and output filters. $19.50

AMPLIDYNES

G.E. 5AM21JJ7. Input: 27VDC. Output: 60VDC. 150 Watts, 4600 RPM. Type MG-27-B. New..$34.50
Edison 5AM31NJ18A. Input: 27VDC. 44 Amps. 8300RPM. Output: 60VDC at 8.8 Amps. 530 Watts. New $12.50
G.E. 5AM31NJ9A. 530 Watts. 7500 RPM. Input: 27VDC. Output: 60VDC. Weight 34½ lbs....$29.50

SMALL D.C. MOTORS

G.E. 5BA50LJ2A. Armature 27VDC at 8.3 Amps. Field 60VDC at 2.3A RPM 4000. H.P. 0.5. New $27.50
Oster E-7-5. 27.5DC. 1/20HP, 3600RPM. Shunt Wound. New $9.50
Dumore Co. type ELBG. 24VDC. 40-1 gear ratio. For type B-4 Intervalometer. New............$6.75
G.E. 5BBY47AB12. ¼ H.P. Perm. Mag.—1 amp. 250V. 1725 RPM. New $22.50

400 CY. BLOWERS

Westinghouse. Type FL. 115V, 400 cy., 6,700 RPM. Airflow 17C.F.M. New $6.75

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New $22.50
Armor. Synchro Differential Generator. Type 6DG. New $60.00
Hobart Mfg. Co. Synchro Differential Synchro Type XIX 115V. 60 cy. New....................$9.50

STEP BY STEP MOTOR

Bendix—Type CAL 14810 (MK1 Mod 0). 70 Volts DC input $16.50

REPAIR PARTS FOR BC-348 RECEIVERS (H, K, L, R, Only)

Also BC 224 Models F. K., Coils for ant., r.f., det., osc., I.F., c.w. osc., xtal filters, 4 gang cond., front panels, dial assemblies, vol. conts., etc. Write for complete list and free diagram.

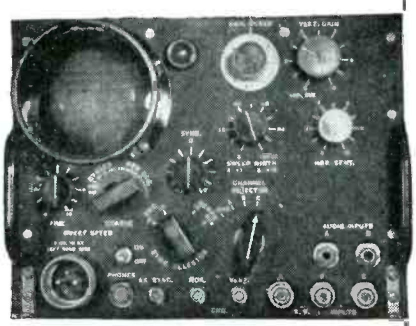
SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, P.E. 94CM dynamotor. Brand new equipment with instruction manuals.

MULTI-CONDUCTOR CABLE

CO-215. Stock 3E2215. Bulk 9 conductor No. 20 A.W.G. Stranded tinned copper plastic insulated, color coded, tinned copper braided shield. Flamenol jacketed. Made by G.E. Available 1000, 1500, 2000 ft. reels. Price............................$.15 Ft.

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

Price........................$245.00

Gov't Cost $1800.00.
AN/APA-10 80 Page Tech Manual...........$2.75

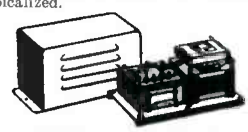
TRANSMITTING MICA CAPACITORS

LARGE QUANTITIES IN STOCK
WRITE FOR LIST

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed Prices Subject to Change

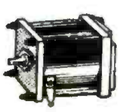
RAYTHEON VOLTAGE REGULATORS

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V. 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6½" H x 8¾" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.



PRICE—NEW $16.75

SWEEP GENERATOR CAPACITOR



High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new.

Price $2.25

ELECTRONICRAFT
INC.

27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

Want more information? Use post card on last page.

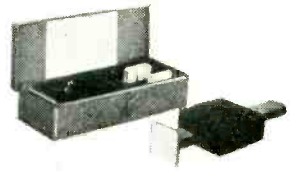
Weston HIGH QUALITY TEST EQUIPMENT

WL-117 WAVEMETER

A precision wavemeter having a range from 2400 mc to 3400 mc with an accuracy of better than 0.1% over the entire range. The resonant cavity has a Q of not less than 1000 and normally from 1000 to 2000. The unit, supplied with a pickup dipole interconnecting cable and adapters, may also be used for relative field strength measurements.
PRICE: $390.00

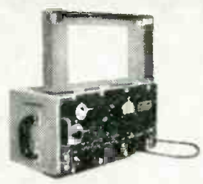
WL-62 ECHO BOX

A portable ringing cavity for microwave research; the unit has a frequency range from 9320 to 9420 mc, with a Q of 50,000 to 80,000. The echo box is used for relative power measurements, spectrum analysis, frequency checks, tests for unstable operation and a host of other applications in the laboratory.
PRICE: $550.00



WL-108 TERMINATION

This 1" x ½" waveguide hi-power load is capable of dissipating a peak power of 200 kilowatts and an average power of 150 watts. The VSWR is less than 1.10 over the entire frequency range of 9300 to 9450 mc. All accessories including carrying case and coupling adapters are supplied with the unit.
PRICE: $90.00



WL-13 SIGNAL GENERATOR

A versatile x-band signal generator providing a source of pulsed or CW power and having provisions for square-wave and sawtooth modulation. Accurate monitoring of the RF output is accomplished with a thermistor bridge and a calibrated attenuator. The power supply is electronically regulated to insure stable operation of the 723A/B Klystron oscillator.
PRICE: $1275.00

WL-89 VOLTAGE DIVIDER

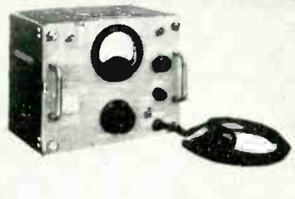
An indispensable aid in high power radar and transmitter measurements this unit has provisions for 100:1 and 10:1 voltage division. It can be used with an oscilloscope to measure video pulses between 200 and 20,000 volts in high-impedance circuits. The ratio accuracy is within +15% and transmission is within 2 db from 150 cycles to 5 megacycles.
PRICE: $45.00

WL-102 PULSE GENERATOR

Equivalent to the TS-102/AP Range Calibrator, this crystal controlled pulse generator produces a square-topped, 50 volt synchronizing pulse of .8 microseconds at a prf of 400, 800, 1600 or 2000 cps. and a triangular marker pulse of 0.4 microseconds duration at a prf corresponding to a pulse-echo distance of 1500 ft. The phase between the marker and sync. pulses is continuously variable from —180 to +180 degrees.
PRICE: $550.00

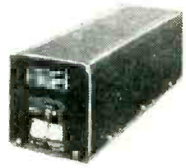
WL-125 POWER METER

This instrument is a compact, battery operated thermistor bridge designed to measure power in the range of 2400 to 3335 mc., and having a full-scale sensitivity of 2 milliwatts. Among other applications, it can be used to measure antenna patterns, check standing wave ratio and determine average or peak powers. A complete set of accessories, including a 10 db and 16 db attenuator pad for measuring higher power levels, are supplied with the unit.
PRICE: $390.00



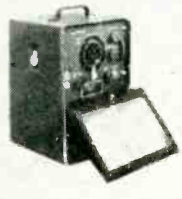
SG-8/U NOISE GENERATOR

This popular model, employing a 5722 temperature limited diode as the R.F. noise source, can be used as an absolute means of receiver noise measurements as well as for fundamental studies. The normal input impedance is 270 ohms but a 50 ohm adaptor is supplied with the unit as a standard accessory.
PRICE: $290.00



WL-90 DUMMY LOAD

Provides a 50 ohm termination in the form of a 50 to 1 ratio voltage divider for making over-all performance tests on radar units such as the AN/APQ-7, 13, 13A, 23 and a host of other equipments in this frequency and power range. The 49 and 1 ohm resistor elements are carbon coated ceramic rods in helium filled glass tubes and are capable of dissipating up to 500 watts at a peak voltage of 5000 volts.

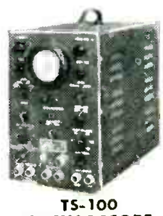


BC-221 FREQUENCY METER

This universally used and time-tested instrument is a precision meter designed to measure or radiate R.F. impulses between 125 and 20,000 KC. The overall accuracy of the unit is 0.034% over the entire operating range. It is portable and completely self contained or, if desired, it can be obtained with a power supply for 115 volt operation.

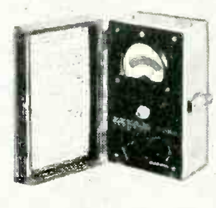
PRICE:

Without Modulation	$125.00
With Modulation	165.00
115v Power Supply	35.00



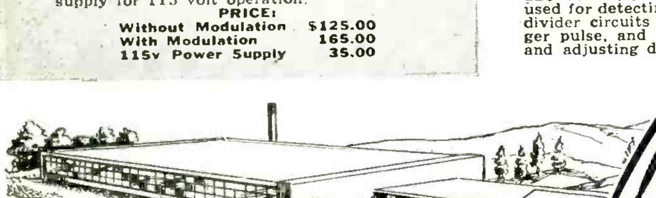
TS-100 OSCILLOSCOPE

This instrument can be used with a linear sweep as a general purpose test oscilloscope or it can be used with a circular sweep as a precision range calibrator. It has a PRF rate of 300 to 1500 per second. Trigger input — 15 volts at 100 volts per microsecond rise. Trigger output — 120 volts (+ 20 volts). It can be used for detecting "jitter" in trigger divider circuits and modulator trigger pulse, and also for determining and adjusting division rate.
PRICE: $550,00



WL-268B/U CRYSTAL RECTIFIER TEST SET

A combination ohmmeter-ammeter designed to measure the electrical characteristics of microwave crystal rectifiers such as the 1N21 and 1N23 series. The instrument is completely self contained and requires only a single 1½ or 2-volts cell for operating power.
PRICE: $53.75



Weston LABORATORIES, INC.
HARVARD, MASS.
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Cable: WESLAB

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COMMUNICATIONS EQUIPMENT CO.

MICROWAVE PLUMBING

"S Band," RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors .... $22.50 EACH
DIRECTIONAL COUPLER. Broadband type "N" Coupling. 20 db. with std. flanges, Navy #CABV 47AAN-2 .... $37.50
LHTR, LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc Tr. Cavity and Type N CPLG, To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $49.50
BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice. each $47.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $45.00
RT-39 APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR, cavity compl. recvr. & 30 MC IF strip using 60K5 (2C40, 2C43, 1B27 lineup) w/Tubes.
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28 .... $4.00
WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOR" ADAPTER CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50
OAJ ECHO BOX, 10 CM TUNABLE $22.50
HOLMDELL-TO-TYPE "N" Male Adapters, W.E. #D167284 .... $2.75
I.F. AMP. STRIP: 30 MC. 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—with video detector. A.F.C. less tubes $24.50
POLYROD ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50
ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50
"E" or "H" PLANE BENDS, 90 deg. less flanges $7.50

7/8" RIGID COAX—3/8" I. C.

ROTARY JOINT. Stub-supported, UG 46/UG 45 fittings $27.50
10 CM STABILIZER Cavity, tunable, standard UG46 UG 45 fittings $45.00
RG 44/U RIGID COAX, stub support, 5 ft. sections, with UG46/UG45 connectors $12.50
RT ANGLES for above $2.50
RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00
SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00
RT. ANGLE BEND 15" L. OA $3.50
FLEXIBLE SECTION. 15 L. Male to female ... $4.25
7/8" RIGID COAX. BULKHEAD FEED-THRU . $14.00
MIXER ASSY. "Pencil" Type for "SO" Radars. Complete with crystal and 2-type "N" output connectors $12.50

MICROWAVE MIXER

CV-12/APR-6: Waveguide/mixer unit, 4000-6000 mc. Designed for use with microwave receiver. Has pick up loop for coupling to lighthouse cavity local oscillator. RF input is to 1" x 2" waveguide (contact flange). Output (thru 1n21 xtl.) is from standard 50-ohm coax connector. Brand new, complete with crystal. As shown $35.00

APS-2 SPARE PLUMBING

Z-601C: Elevation Joint $9.50
Z-601B: Transmission Line from El. Jt. to antenna feed $4.50
Z-601A: Antenna and Dipole feed assy $12.50
Z-601E: Azimuth Rotating Joint $15.00
Z-911: Long Rt. Angle Bend, 90 Deg $4.50
Z-910: Short Rt. Angle Bend with pressure fitting $3.50

X Band— RG 52/U WAVEGUIDE

VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks. Mounted ½ Wave apart $8.50
UG 40A/U Broadband Choke Flanges $1.65
1" x ½" waveguide in 5' lengths, UG 39 flanges to UG40 cover .... **per length $7.50**
Rotating-joints supplied either with or without deck mounting. With UG40 flanges .... **each, $17.50**
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section 15 lb. gauge and press nipple $10.00
Pressure Gauge, 15 lbs. $2.50
Directional Coupler, UG-40/U Take off 20 db. . $17.50
TR-ATR Duplexer section for above $8.50
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50
Waveguide Section 2½ ft. long silver plated with choke flange $5.75
Rotary joint choke to choke with deck mounting $17.50
90 degree elbows. "E" or "H" plane 2½" radius $12.50
45 degree twist $8.00
Microwave Receiver, 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits. 6 I.F. Stages give approximately 120 DV gain at a bandwidth of 1.7 MC. Video Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00
ADAPTER. waveguide to type "N", UG 81/U. p/o TS 12, TS-13, Etc. $27.50
ADAPTER, UG-163/U round cover to special btl. Flange for TS-45, etc. .... $2.50 ea.

APS-15 SPARE WAVEGUIDE PARTS

CU-73/APS-15A, SCS #2Z3265-73 right angle bend. E plane, 6½" x 10", with directional coupler on 6½" arm, type "N" takeoff 20 db coupling ... $12.50 each
Z-607 Dwg. Symbol. Approx. 150 degree bend with 90 deg. twist. One end pick-up loop with press. fitting $6.50
Z-614: Philco 756-1142, CG124/APS-15A. Wave-selector: approx. 16" L. with 15 deg. bend at center (E-plane) 20 db coupling $12.50
Philco 348-1425, 180 deg. bend. with pressure fitting $4.50
Z-609, Philco 348-1629, 13½" run, with bend & 90 deg. twist (on 3½" section) $6.75
Z-606: 8" run with 30 deg. bend (E-plane) one end $4.50
Philco 348-1427 E plane bend 11" x 6½" $6.50
CG1/APS-3 Philco 358-5212. S-curve 16" L with round contact flanges $5.75

WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.65	UG 52A/U	$3.40

K Band RG 53/U WAVEGUIDE

APS-34 Rotating joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, choke to cover $12.00
Mitered Elbow, cover to cover $4.00
TR-ATR-Section Choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
APS-34 K-Band Pillbox Antenna $22.50
Slotted Section, with Carriage & Probe $45.00

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 0.5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-'72's, 1-'73. New .... Less Cover—$135
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Energy 0.018 Joules $49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers, 115 v. 400 cycle input. New with all tubes $49.50

PULSE TRANSFORMERS

GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms
Pulse length: 1.0/5 usec @ 635/120 PPS.
Pk. Power Out: 1,740 KW
Biflar: 1.5 amps (as shown) $62.50

GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Biflar rated at 1.3 Amp. Fitted with magnetron well $39.50
K-2745. Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Biflar: 1.3 Amp. Has "built-in" magnetron well $42.50
K-2461A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Biflar: 1.3 Amp. Fitted with magnetron well .. $39.75
UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $7.50
UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg $7.50
68G711: Ratio: 4:1 6.7 Ohms, Pri: 0.23 Ohms sec. $4.50
TR1049: Ratio: 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75
K-901695-501: Ratio 1:1. Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95
Ray UX 7896—Pulse Output Pri. 5v. sec. 41v $7.50
Ray UX 8442—Pulse inversion—40v + 40v $7.50
PHILCO 352-7250. 352-7251. 352-7287
RAYTHEON: UX8693. UX5986 .... $5 ea.
W.E.: D-166310. D-166638. KS 9800. KS9948.
UTAH #9262, with Cracked Beads, but will operate at full rated capacity $5.00
UX 8693 (SCS #2Z9627-54); 3 Wdgs, 32 turns #18 wire. DCR is: .362/.372/.4 ohms. Total voltage 2500 vdc. $5.00
D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ*-13 .... $12.50

PULSE NETWORKS

15A—1.400-50: 15 KV, "A" CKT. 1 microsec. 400 PPS, 50 ohms imp. $37.50
G.E. #3E (3-84-810) 8-2.24-405) 50P4T: 3KV "E" CKT Dual Unit: Unit 1, 3 sections. 0.84 Microsec. 810 PPS, 50 ohms imp.: Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp. $6.50
7-5E3-1-200-67P. 7.5 KV "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance 3 sections $7.50
7-5E4-16-60, 67P. 7.5 KV "E" Circuit. 4 sections 16 microsec. 60 PPS. 67 ohms impedance $15.00
7-5E3-3-200-67P. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS, ohms imp. 3 sections $12.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32-40H @ .08A. 30.700V Corona Test, 21KV Test. $37.50
G.E. 25E5-1-350-50 P2T. "E" CKT, 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance $69.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR. 9000 Vac test $14.95
G.E. 6E3-5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections $7.50

THERMISTORS

D-164699	Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F, Coefficient: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC ...	$2.50
D-167332	Bead Type, DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC	1.50
D-167613	Disk Type DCR: 355 Ohms @ 75 Deg. F. P.M. 2.5%, 1 Watt	1.50
D-166228	Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F 2590 Ohms @ 100°F, 1640 Ohms @ 120°F	1.50

MICROWAVE ANTENNA EQUIPMENT

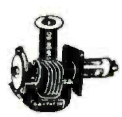
AT49/APR—Broadband Conical. 300-3300 MC Type N Feed $12.50
AS-31/APN-7: 10 cm Polyrod in Lucite Ball. Type N Fitting Coax Feed $22.50
Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $100.00
Dipole for above $12.00
TDY "JAM" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New $150.00
Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal 33 deg. in vertical planes $35.00
Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50
AS14A/AP, 10 CM pick up dipole assy, complete w/length of coax and "N" connectors $3.50
AS46A/APG-4 Yagi Antenna, 5 element array ... $22.50
30" Parabolic Reflector Spun Aluminum dish $4.85
APS-34 Pillbox Antenna, waveguide input: 24.000-27000 MC $22.50

RADAR ANTENNAS

AS-12/APS-3	AS-125/APR
AS-17/APS-2	AS-217/APG-15
AS-13/APG-2	AT49/APR
AS69/APT	AS14/AP

MAGNETRONS

Type	Price	Type	Price
2J21	$ 8.75	2J39	$24.50
2J22	7.50	2J49	59.50
2J27	19.95	2J61	34.50
2J31	24.50	2J62	34.50
2J32	28.50	2J31	85.00
2J37	12.50	725-A	Write
2J38	16.50	730-A	24.50



QK 60, 61, 62—$85 ea.

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
723A/B	19.50	417-A (Sperry)	17.50

SELSYNS

115 VAC 60 CYCLES 1 PHASE
1—Transmitter #C-78248
1—Differential #C-78249
Per Set **$24.50**
Transmitter Units Only .... $17.50 ea.

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of .001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 3.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Req'd. Brand New, Complete with schematic and all tubes $375.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. ALL MDSE SUBJECT TO PRIOR SALE AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

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MOBILES! C. D. MEN! CAP!!

IDEAL DYNAMOTOR—CONVERTS EASILY TO SUPPLY UNIT DELIVERING

12 Volt Input—
610 V @ 150 MA
325 V @ 125 MA

OR

6 Volt Input
300 V @ 90 MA
160 V @ 110 MA

Brand New with Conversion Data.......... $3.75

SELENIUM RECTIFIERS

Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$8.50
2 Amps.	2.20	4.20	5.40	10.50
2½ Amps.	.....	.....	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	44.95
12 Amps.	8.50	16.25	20.50	49.00
20 Amps.	13.25	25.50	38.00	79.50
24 Amps.	16.25	32.50	45.00	90.00
30 Amps.	20.00	38.50	.....	.....
36 Amps.	25.00	48.50	.....	.....

UNDERWATER MICROPHONES

Originally designed for use in harbor defense equipment, these amazing hydrophones may be coupled to any hi-gain audio amplifier. For listening to undersea sounds such as schools of fish, shrimp, lobster, etc. Ideal for fishermen, explorers, students. Available in two models described below:

JR HYDROPHONE: Consists of a mosaic of 7 crystals encased in a rubber sheath approx. 4" diam and 4' long. Directivity is essentially horizontal. A matching transformer is "built-in", permitting use of long cable runs without loss.............. $24.50

M-1 HYDROPHONE: A lattice of 3 crystals encased in a rubber disk approx. 1 inch thick and 6 inches diameter. Directivity is essentially vertical (downward). Complete with amphenol fitting. $27.50

SUPERSONIC OSCILLATOR

For experimenters, teachers, technicians. Delivers 30 watts of R.F. Tunable from 17-27KCS. Originally designed as driver unit for 500 watt Sonar set. Operates from 115 V, 60 cycles. Brand New, Rack Panel Size. Complete with all tubes.. $119.25

APN-3 SPARE PARTS

K-901684-501: SCS #229632.306, Trans.......... $2.49
K-901689-501: SCS #229631.238, Trans.......... 2.45
K-901692-503: SCS #229617-70, Xfmr. Fil....... 2.49
K-901699-501: SCS #229617-68, Fil. Xfmr....... 3.45
K-901698-501: SCS #229618-38, Plate Xfmr...... 4.29
K-901695-501: SCS #229627-19, Pulse Xfmr...... 3.50

DYNAMOTORS

ALL BRAND NEW—ORIGINAL PACKING

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
BD 69††	14	2.8	220	.08	$12.95
O-402†	13.5	12.2A	300	.200	
			8.8VAC		12.50
SP 175	18	3.2	450	.06	4.49
PE 86	28	1.25	250	.060	4.25
DM 416	14	6.2	330	.170	6.75
DM 33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 PACK	12	9.4	275	.110	8.95
			500	.050	
OA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
5053	28	14	250	.060	3.95
PE 73 CM**	28	19	1000	.350	**

* Replacement for PE 94.
** Price sent on request.
†† Less Filter.
† Used, Excellent.

INVERTERS

PE-218-H: Input: 25/28 vdc, 92 amp. Output: 115 v. 350/500 cy 1500 volt-amperes. New.......... $44.50
PE-206: Input: 28 vdc, 38 amps. Output: 80 v. 800 cy. 500 volt-amps. Dim: 13x5½"x10½". New.. $22.50
NAVY CQR-211095: Input 22-30 VDC/75-60A. OUTPUT: 115V/400 CY. 1 KVA/8.7A. RPM: 4800. With coupling provision for motor. Brand New. Original packing.......................... $150.00

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CT-766 300-0-300V/120MA, 2 x 5V/3A, 2.5V/5A.. $3.95
CT-129 550-0-550V @ 150 MA, 6.3V/4A, 2.5VCT/5A............ 5.79
CT-013 450-0-450V @ 200 MA, 10V/1.5A, 2.5V/3.5A 5V/3A............ 6.95
CT-15A 550VCT .085A 6.3V/.6A, 6.3V/1.8A........ 2.85
CT-164 4200V. .002A/12KV Test, 5VCT/3A/12KV Test. 6.3V/0.6A/5400V Test........ 12.95
CT-341 1050 10MA,—625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A............ 9.95
CR 825 360VCT .340A 6.3VCT/3.6, 6.3VCT/3A..... 3.95
CT-626 1500V .160A 2.5/12, 30/.100..... 9.95
CT-071 110V .200A 33/.200, 5V/10, 2.5/10............ 4.95
CT-367 580VCT .050 A 5VCT/3A........ 2.25
CT-403 350VCT .026 A 5V/3A............ 2.75
CT-931 585VCT .086 A 5V/3A, 6.3V/6A.... 4.25
CT-456 390VCT 80 MA 6.3V/1.3A, 5V/3A.. 3.45
CT-531 585VCT 86 MA 5V/3A, 6. V/6A.... 4.95
CT-442 525VCT 75 MA 5V/2A, 1 CT/2A, 50V/200 MA..... 3.85
CT-720 550-0-550V/250 MA, 6.3V 1.8A............ 8.95
CT-43A 600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A 6.49
CT7-501 650VCT/200MA, 6.3V/8A, 6.3V/5A........ 6.49
CT-444 230-0-230V/.085A, 5V/3A, 6V/2.5A....... 3.49

Filament Transformers—115V50-60 cps Input

Item	Rating	Each
FT-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A	2.79
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A. 16 KV TEST	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5AV/.5A, 7V/7A	2.19
FT-899	2x5V A 5A, 29KV Test	24.50

Special Fil. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STF-370	220/440	3x2.5V/5A, 3KV Test 2.5V/15A	6.95
STF-11A	220V	2x40V/.05A, 2x5V/6A 12.6V/1A	4.49
STF-608	220V	24V/0.6A, 5V/3A, 6.3V/1A, 6.3V/1A	3.45

TRANSFORMER SPECIAL

#766: Primary: 115 V. 60 cy. 1ϕ. Secondary: 200-0-300 V @ 120 MA. D.C., 2.5V WDGS @ 3 A ea. Also 2.5 VCT @ 5 A. Ruggedized. Herm. Sealed. Size: 4¾" H x 3⅜" x 4½". 11 Solder Tmls. M.F.D. W.E $3.95

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A, P/O ID-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
K59584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V0.9A, 6.3V 25. A 6.3V/.06A, 5V/CA	6.95
352-7070	2x2.5V/2.5A(2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .005A	7.45
352-7196	1140/1.25MA.2.5V/1.75A,2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA,4.5V/3A,6.3VCT/20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5V/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48352	700VCT/806MA5V/3A, 6V/1.75A	4.25
352-7098	2500V/MA, 300, VCT, 135MA	5.95
KS 9336	1100V 50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 63.V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
352-7069	2-2.5V Wdgs. at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V/1.75A, 5V/3A, 6.5V/6A, 6.5V/1.2A, P/O BC800	
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V/.6A, P/O BC-929	6.45
O163253	5200V/.002A, 2.5V/5A	5.35
M-7471957	2.5V/20A, 12KV Test	4.85
352-7179	250V/100MA, 6.5V/12ACT 5V/2A	3.45

"SEA-DOG" CONVERTER

Designed for Buships, this rugged, compact dynamotor is rated as follows:
INPUT: 115 VDC—6 AMPS
OUTPUT: 13 VDC at 40 AMPS
—OR—26 VDC at 20 AMPS
Brand, Spanking, New; Original Packing.................... $89.50

VOLTAGE REGULATORS

CARBON—PILE TYPES

LELAND TYPE "A": Coil: 245 ohms. Current 108-110 MA. Reg. Resistance: 1.5-2.5 ohms with 1.2-3.3 Amps. for 80 V.

LELAND TYPE "B": Volts In: 21-30 V. Volts Out: 18-25 V DC. at 5 A.

LELAND TYPE "C": Spec: VR 9000—2 C. Input: 22-30 VDC. Coil: 300 MA. Output: 19 V @ 5.7 A.

WEBSTER: 35x025: Philco 451-1035 Input: 21-30 V. D.C. Output: 18 VDC/4.75 A.

Price, Any Model....... $2.25 ea.

GN 35 HAND GENERATORS

BRAND NEW, IN ORIGINAL CARTONS. WILL DELIVER 8 V @ 2.5A AND 325-365 V @ 100 MA OR 10 V 1.25A AND 380-420 V @ 70 MA. LESS HAND CRANKS. A GREAT VALUE $17.50

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TEST OSCILLATOR TS-47/APR

A. Function: The oscillator provides a calibrated high-frequency source for testing receivers. Unit can be operated from either an a-c or a d-c power source.

B. Electrical Characteristics:
Frequency Range: Two bands, 40 to 115 mc and 115 to 500 mc.
Signal Output: Sine wave of 1,000 cps modulated 50 percent, or a 70-microsecond pulse with prf of 500 cps.

C. Specifications:
A-c Operation: 80, 115, or 230 volts at 50 to 2,600 cycles.
D-c Operation: 6.3 volts at 0.30 ampere (dial light off) and 202.5 volts at 0.016 ampere. Dial light draws 0.25 ampere. Four 1-½-volt and three 67.5-volt dry batteries are required.
Tube Complement
2 tubes 9002
1 tube 6X5GT

D. Signal Corps Stock No. 3F3910-47

Price, New.............. $265

HIGH-POWER GEAR

TRANSTAT:

Type TH45BG: Input 130/260V. 50-60 cy. 1 ph. Output Range: 0-260V, 45A. Max. 11.7 KVA two-unit bank, parallel connected. Completely enclosed in cabinet with handwheel atop. Brand New.... $235.00

CIRCUIT BREAKER:

ITE Model KJ. Will handle 600 VAC at 115A. Break time adjustable from instant. to 10 minute. Break amperes adjustable from 115A to 1000% overload. Brand New.............. $15.00

ALTERNATOR:

Louis-Allis Co. Type "AL", 198-C. Output 110/220V—1 ph. 60 cy. .9 P.F. 1200 RPM, completely self-regulating with built-in exciter. Brand new, original crates........... $795.00

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2K28	31.50
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3C45	14.95
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815	3.75
829B	11.75
832	7.25
832A	8.25
833A	39.50
845	5.40
866A	1.40
869B	69.75
872A	3.25
884	1.80
931A	5.25
958A	.75
959	2.95
1603	5.15
1624	1.40
5516	5.25
5643	7.25
5651	2.65
5654	1.95
5670	4.00
5672	1.40
5676	3.30
5687	3.95
5691	7.65
5692	7.65
5693	6.50
5702	2.95
5703	1.89
5704	2.40
5718	6.50
5719	8.65
5726	1.69
5814	2.75
5876	16.50
6005	4.35
8005	6.40
8020	1.10
8025	4.75
9001	1.40
9003	1.50
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1N21B	2.75
1N21C	20.00
1N23	1.10
1N23B	3.25
1N26	7.45
1N34	.62
1N34A	.85
1N38	1.25
1N38A	1.10

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Brand New W.E.
Tuneable 400-600 MC, 450KW output, 15KV plate, AV filament . . . P.O.R.

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TS36/AP X Band Power Meter
TS-45/APM-3 X Band Signal Generator 300.00
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TS-56/AP L Band Slotted Line
TS-59/APN Altimeter Test Set
TS-61/AP S Band Echo Box
TS-62/AP X Band Echo Box
TS69/AP Frequency Meter 400-1000MC
TS-76/APM-3 Wave Guide Kit for TS-45
TS-89/AP Voltage Divider
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS146/UP X-Band Test Set
TS147 X Band Signal Generator
TS-148 X Band Spectrum Analyzer
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TS174/AP Freq. Meter
TS175 Freq. Meter
TS-250/APN Test Set for Altimeter
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A high precision navigation and bombing equipment for use in aircraft or ships. Used with AN/CPN-2 ground beacons. Complete sets available: indicator, computer, comparator etc. Mfg: RCA. Write

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SCR-536 HANDIE TALKIE . . $200.00 pr.
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SCR-619 ARMY FIELD RADIO 27-38.9 mc. Xtal Control 6-12v D.C. Input. **POR**
SCR-718A, B, C, High Alt. Altimeter 0-50,000 ft. 2 ranges 110v 400-2600 cyc. **$575.00**
AN/ARC-1 Transceiver 100-156 mc xtal controlled 10CH. 24v 20 and 50 CH. available **$750.00**
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APT-4 RADAR JAMMER TRANSMITTER 165-780 mc. 110v. 400cyc. . . . **P.O.R.**
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AN/TPQ-2 K-BAND GROUND RADAR
Very late moodel set. Used to plat trajectary of artillary and mortar shells and ta enable counter battery fire with extreme accuracy. This Radar is so accurate and sensitive it will pick up movements of personnel on the battlefield. It can also be used to measure height of cloud cover for weather forecasting. Mfg: WESTERN ELECTRIC. Write

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AN/APR-5 Receiver 1000-3100 mc. 10 mc. IF. bandwidth. 30MC IF 110v 60 cyc Input **$475.00**
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BC-639 100-156 MC VHF Receiver with PWR Supply 110v 60 cyc . . . . **P.O.R**
AN/APN-9 LORAN RECEIVER Airborne Navigation Equipment . . . . . . **P.O.R.**
BC-348 Receiver 28v Freq. Range 1.7-18 mc **$150.00**
BC-348R or Q Receiver 28v late model. **$190.00**

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TS-250 ALTIMETER TEST SET
Can be used with APN-1, SCR-718 or most any airborne altimeter. Operates 24 v. D.C. Brand new Mfg'r. . . . . P.O.R.

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AN/APS-10 LIGHTWEIGHT SEARCH AND NAVIGATION RADAR. Freq. 9375 mc. Range approx. 90 miles. 110v 400 cyc. 5" P.P.I. . . . . **POR**
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UPN-2 S Band Radar Beacon. Has range 35 miles, used to send coded signals to Radars. 110v 60 cyc Input. **$350.00**
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SO-8 MARINE RADAR S-BAND . . **$2000**
SO-13 MARINE RADAR S-BAND **$2250**

SCR 291A
Long range automatic direction finder. Used to take bearings on aircraft, ships, etc. Freq. range 1.5-30MC. input 110v 60 cycle. Coomplete sets available including receiver, indicator, antennaes, cables, etc. Write

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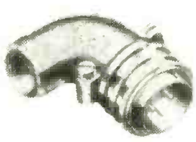

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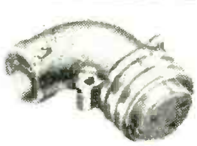

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OIL . . . CONDENSER SPECIALS . . . MICA

6 mfd—150 V . . . . $.35
Three term. dual 3mfd. oil cond. complete with brackets, measuring 4¼"x 1¾"x1". Ideal for audio crossover networks.

2 x 1 mfd—230 VAC . . . $.49
2 S.T. Bathtub

7 mfd—600 V $1.45
By leading mfg. 2⅛"x3¾"x1¾"

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Dual 2mfd section; 4 glasseal term. Standard dimensions.

OVER 16,000 SOLD

10 mfd—600 V . . . . $.98
Three term. bot. mtg. channel type. Dims. 3¾"x2½"x2". Two 5 mfd. sections rated 400 V at 72 deg "C". 1800-V test. Meets commercial specs. for 600 V operation up to 40 degs "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large qua. available **$.89**

12 mfd—450 V . . . . $.69
Rectangular case—Electrolytic

.00025 mfd—1200 V . . . $.19
Trans. Mica Type #4. 10% disc lots of 100.

.03 mfd—600 V . . . . . . $.55
Trans. Mica Type #9.

8 mfd—500 V $1.35

3 x .1 mfd—600 V . . . . $.42
Avox #618 Channel, 3 Terms, bot. mntg.

Mfd	Volts	Price	Mfd	Volts	Price
.0016	15KV	5.75	2	3000V	5.80
.005-.005-			2	4000V	7.95
.01	10KV	4.75	2	5000V	12.50
.01	10KV	4.75	2	6000V	19.95
.012	25KV	22.50	2	12.5KV	P.U.R.
.02	10KV	5.25	2	32KV	P.U.R.
.02	20KV	17.90	2-2	600V	1.25
.025-.025-			3	600V	.59
	50KV	55.00	3	4000V	P.U.R.
.03	16KV	15.95	3-3	150V	.35
.05	5KV	2.49	3-3-3	400V	1.05
.05	7500V	2.95	4	600V	1.25
.08	12.5KV	15.95	4	600VTLAD	1.40
.1	1500V	.59	4	1000V	1.95
.1	2000V	.49	4	1500V	2.65
.1	2500V	1.39	4	2000V	4.85
.1	3000V	1.89	4	2500V	5.95
.1	5000V	1.95	4	3000V	7.55
.1	7500V	1.75	4	4000V	P.U.R.
.1	7500V	3.50	4	5000V	P.U.R.
.1	10KV	9.50	4-4-4	600V	2.40
.1	10KV	12.95	5	330VAC	1.75
.1	12KV	14.95	5	600V	1.75
.1	12KV	14.95	5	1000V	1.99
.1	15KV	16.95	5	1500V	2.98
.125	27.5KV	P.U.R.	6	330VAC	1.75
.1-.1	7500V	3.50	6	600V	1.85
.15-.15	8000V	1.95	6	1000V	2.49
.2	10KV	10.95	6	1500V	3.65
.2	15KV	17.95	6	2000V	3.95
.25	2000V	1.35	7	600V	1.45
.25	3000V	2.05	7	800V	1.99
.25	6000V	1.75	7	1000V	2.49
.25	15KV	15.95	8	500V	1.35
.25	20KV	19.95	8	600V	1.49-2.25
.25	50KV	85.00	8	660VAC	3.50
.3	2000V	1.45	8	1000V	3.25
.4	10KV	14.95	8	1500V	4.65
.5	1500V	1.20	8	2000V	7.25
.5	2000V	1.85	8-8	600V	1.75
.5	2500V	2.20	8-8-8	500V	2.25
.5	3000V	2.39	10	600V	2.75
.5	4000V	3.15	10	660VAC	5.90
.5	5000V	4.15	10	1000V	4.55
.5-.1	2000V	.90	10	1500V	6.25
.5-.5	600V	.69	10	6000V	P.U.R.
.5-.5	1000V	.69	12	1000V	4.95
.5	25KV	55.50	12	2000V	6.95
1	400V	.45	15	330VAC	3.95
1	500V	.59	15	440VAC	4.95
1	1000V	.69	15	1000V	5.35
1	1500V	1.35	15	1500V	6.35
1	2000V	1.95	17	25V	.69
1	2500V	2.50	20	330VAC	4.69
1	3000V	3.50	30	330VAC	5.25
1	5000V	5.25	50	330VAC	6.29
1	6000V	8.98			
1	7000V	12.00			
1	10KV	P.U.R.			
1	15KV	P.U.R.			
1	16KV	P.U.R.			
1	20KV	P.U.R.			
1	25KV	P.U.R.			
2	600V	.59-.79			
2	1000V*	.85			
2	1000V TLA	1.29			
2	1500V	1.69			
2	2000V	2.80			
2	2500V	3.95			

TRANS. MICA CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.000024	2500	.23	.002	5000	2.98
.00003	2000	.65	.002	6000	3.50
.000047	2500	.29	.0024	5000	2.35
.00005	1200	.32	.0025	1200	.42
.00005	2500	.32	.0025	6000	3.50
.00008	1200	.29	*.003	6000	PUR
.00009	3000	.69	*.003	6000	4.95
.0001	600	.22	.0035	2500	.69
.0001	1200	.30	.004	2500	.82
.0001	2500	.33	.0045	600	.30
.0001	3000	.89	.005	600	.35
.0001	5000	1.75	.005	1200	.45
.00015	5000	1.95	.005	2500	.85
*.0002	15KV	PUR	.006	600	.30
.00025	600	.29	.006	1200	.52
.00025	1200	.33	.0068	1200	.65
.00025	5000	2.05	.008	600	.32
.00027	2500	.41	.01	600	.38
.0004	2500	.47	.01	1200	.69
*.0005	20KV	PUR	.01	2500	.85
.001	600	.28	*.01	15KV	PUR
.001	1200	.32	.015	2500	.99
.001	2500	.49	.0125	6000	6.25
*.001	6000	3.25	.02	600	.21
*.001	20KV	PUR	.02	600	.50
.001	4500	1.25	.02	1200	.85
.0015	5000	2.25	.02	2000	1.25
.0015	6000	3.65	.03	1200	.77
.002	600	.27	.033	600	.69
.002	1200	.40			
.002	2500	.65			

* Donates Pillar Type.

BATHTUB CONDS.

Mfd	Volts	Price	Mfd	Volts	Price
.01-.01	600	$.25	3x.25	600	.65
.02-.02	600	.25	.25	1000	.48
.04-.04	600	.25	.5	400	.15
.05	600	.20	.5	400	.37
.05-.05	600	.25	.5	600	.47
.08-.08	600	.25	.5	1000	.52
.1	600	.39	2x.5	600	.59
.1	1000	.42	3x.5	600	.69
.1	1200	.45	1	200	.25
.1-.1	400	.29	1	300	.30
.1-.1	600	.39	1	400	.45
.1-.1	1000	.51	1	600	.59
3x.1	600	.40	1-1	600	.85
.2	1000	.21	2	400	.60
.25	800	.19	2	600	.91
.25	400	.30	4	100	.40
.25	600	.41			
.25-.25	600	.49			

Sp. Bathtub Kit 15 @ 1.00

Available in Other Sizes

CHANNEL CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.025	600	$.19	.25	600	.48
.05	1000*	.22	.4	600	.30
2x.05	600	.30	.5	400*	.21
.1	500	.28	.5	500*	.33
.1	600	.32	.5	600	.49
.1	2500	1.25	2x.5	600	.59
2x.1	400	.34	.5-.1	600	.39
2x.1	600	.40	1	400	.50
3x.1	400	.40	1	500	.58
3x.1	600	.41	1	500*	.58
3x.1	1000	.52	1	600	.63
.25	400V	.34			
.25	600V	.39			

* Top Terms.

METAL TUBULAR OIL CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.0025	400	$.10			.16
.005	600	.14	.05	1000V	.19
.01	300	.09	.1	400V	.17
.01	600	.15	.1	600V	.20
.01	2000	.19	.25	600V	.18
.02	400	.14	.5	600V	1.19
.03	400V	.15			
.05	200V	.07			

Quans. of 100, 10% disc.

MICA CONDENSERS

5, 6, 8, 10, 15, 25, 30, 34, 39, 50, 70, 75, 100, 140, 150, 185, 200, 230, 240, 250, 300, 350, 390, 400, 470, 500, 510, 600, 650, 700, 750, 1000, 1200, 1250, 1400, 1500, 2000, 2200, 2400, 3000, 3300, 3700, 3900, 4000, 4700, 5000, 5100, 6000, 6200, 6500, 6900, 7500, 7950, 7960, 8000, 9100 & 10,000 MMfd.

PRICE SCHEDULE

5 to 750 mmfd . . . . 5¢
1000 to 1500 mmfd . . . . 6¢
2000 to 5100 mmfd . . . . 10¢
9100 to 10000 mmfd . . . . 26¢

Special Mica Kit—100 @ $3.50

SILVER MICA CONDENSERS

7, 24, 25, 33, 50, 60, 75, 95, 100, 120, 150, 170, 200, 270, 300, 330, 390, 400, 450, 500, 750, 800, 1000, 1400, 1450, 1700, & 2500 mmfd.

7 to 95 mmfd . . . . 8¢
1000 to 1700 mmfd . . . . 14¢
100 to 800 mmfd . . . . 9¢
2500 mmfd . . . . 16¢

Special S. Mica Kit—100 @ $6.50

POWER RESISTORS

10 Watts—2, 3, & 25 ohm Variable.@ $.09
10 Watts—100, 750, 1750, 2000, 3000, 5000 ohm . . . . . . @ $.14
20 Watts—5000 ohm . . . . @ $.19
50 Watts—10 ohm Variable . . . . . @ $.39
50 Watts—25, 50, 100, 150, 200, 250, 300, 400, 500, 750, 1000, 1500, 2000, 2500, 4000, 5000, 6000, 7500, 8000, 10,000 12,000, 15,000, 20,000, 25,000, 35,000, 50,000 & 100,000 . . . . . @ $.50
78 Watts—400, 630, 800, 1200, 2000, 2500, 3100, 6300, 8000, 12,000, 20,000, 25,000 & 31,000 . . . . . . @ $.58

MANY OTHER VALUES AVAILABLE INQUIRIES SOLICITED

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3 Hen.	1.30 amp	$9.50
5 Hen.	2 amp	P.U.R.
5 Hen.	165 ma	.89
8 Hen.	150 ma	.98
20 Hen.	300 ma	10.50
5-25 Hen.	200 ma	3.25
50 Hen.	125 ma	2.35
Prim. 115V., Sec. 6.3V @ 6A		2.25
Prim. 117.5V—Sec. #1, 4V @ 16A Sec. #2, 2.5V @ 1.75A		
Herm. Sealed		2.15

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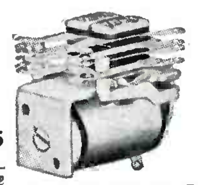
26.5 VDC midget
425 ohm $2.95



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RELAY 3 PDT 24 vdc 250 ohm Clare Type K	$ 2.75
CONNECTOR 15 pin Amphenol #26-151	.69
S BAND CONVERTER Navy CG-46ABW	89.50
ISOLATION XFORMER 35 watts 115v. & 6.3	2.45
SYNCHRO MOTOR 1 FS 115/90 v 400 cycles	14.95
MOTOR 400-1800 cyc 115v EAD J31C	9.95
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LINK MOBILE XMTRS #25UFM 30-40 MC.	59.50
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J Pot 1 meg w/switch audio taper	1.39
CHOKE 2H 70 ma. 100 ohm wgt 5.5 oz.	.29
TOGGLE switch spst C.H. #8280	.23

CONDENSERS in stock: bathtubs from .02 400v to 2 mfd—600v, upright oils (CP65 pyranols, YAB, etc) from 3x.1-600v to 1 mfd 600v. Large oils from .1-7500v to 1 mfd-2,000v. Also mica, silver mica, compression trimmers, ceramics, air variables. Detailed listing available.

PL-144, SO-124, PL-68, AN-3106-10s-2s, 83-1H. 300-500 cycle 1400 watt/variable freq. electronic generator, 220v 60 cy. input. CML #1400
2% .002 Silver Mica—3AG fuses—Switches—J Pots

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SEARCH RECEIVER—ARD-2

Frequency range 80 to 3000 Mcs.

Measures RF signals from 80 to 3000 Mcs and pulse rates from 50 to 8000 cycles.

The ARD-2 can be used as a Direction Finder to locate signals, or as a frequency meter, by VISUAL and AURAL indicators, provide Originally designed and used by USN aircraft. Ideally suited for military, laboratory and general purpose use.

Equipment consists of the following:

ANTENNA DETECTOR-CMD-66AFH — Has variable length antennas, diode detector and silver plated tuning stub with calibrated scale.

AMPLIFIER CMD-50ADC — has three stage pulse amplifier, a trigger circuit, a pulse rate counter circuit and audio amplifier, visual signal indicator, rectifier power supply which is operative on 115 Volts AC 60 to 2400 cycles current, regulated.

TEST OSCILLATOR-CMD-60ABG—has cavity frequency of 400 cycles with selection of four pulse repetition rates.

ALL CABLES AND FITTINGS, ACCESSORIES AND SHOCK MOUNTED RACK for immediate installation, plus two Technical Manuals.

SPARE PARTS—Steel chest includes spares for components and two extra sets of spare tubes: Guaranteed NEW.

All the above in original export packed cases. Wt.: 113-lbs.

Price each $375.00

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C1A	6.25	3B24W	6.75	6BM6	52.50	276A	6.50	700D	12.50	815	4.50
1B22	1.75	3B25	3.50	6C21	16.75	282A	10.25	701A	4.50	829A	6.75
1B23	6.00	3B26	2.75	6CF	12.75	283A	3.25	702A	2.00	829B	9.00
1B24	7.75	3B28	4.50	7BP7	3.75	304TH	6.75	705A	1.00	830B	2.00
1B32	1.50	3C23	6.75	9LP7	3.50	304TL	5.00	706AY	22.50	832	6.00
1B35	8.00	3C24	1.00	12DP7	12.50	307A	2.75	706FY	30.00	832A	7.50
1C21	2.00	3C31	2.50	12GP7	15.50	310A	3.50	706GY	30.00	833A	30.00
2AP1	6.75	3DP1	3.00	FG-17	3.00	311A	3.25	707A	4.00	836	3.00
2C39A	12.50	3EP1	3.50	RX-21	7.50	313C	2.25	707B	9.50	837	1.00
2C40	6.25	3GP1	3.00	RK-23	2.25	323A	11.25	708A	2.75	838	3.00
2C43	10.50	3JP12	15.00	RK-62	2.00	323B	9.75	709A	2.75	846	85.00
2C44	1.00	3KP1	9.75	RK-73	1.00	328A	4.25	715A	3.00	849	18.50
2D21	1.00	4C22	7.50	75T	5.00	329A	6.00	715B	4.50	860	2.25
2E22	1.75	4C27	12.75	FG-95	16.50	348A	6.50	715C	15.75	861	10.00
2J22	5.25	4J34	112.50	F-128A	38.50	350A	4.25	719A	18.25	866A	1.00
2J26	13.50	4J35	150.00	F-129B	90.00	352A	7.50	721A	1.50	878	1.25
2J27	9.75	5BP1	3.50	VT-158	38.75	353A	3.25	723A/B	13.50	884	1.00
2J31	20.25	5BP4	3.50	FG-172	18.75	354A	15.00	724A	1.75	869B	55.00
2J32	22.50	5C30	3.00	FG-190	7.75	355A	15.00	724B	2.25	892R	257.25
2J33	20.25	5CP1	4.25	204A	28.75	375A	10.50	725A	4.25	902-P1	4.25
2J34	18.75	5D21	13.75	F-207	180.00	394A	2.50	726A	8.75	923	1.00
2J38	9.00	5FP7	1.25	212E	25.50	417A	6.00	726B	40.00	927	1.00
2J50	15.75	5FP14	12.25	WL-218	28.75	434A	12.00	726C	60.00	931A	3.75
2J55	50.00	5JP1	16.75	F-232CH	180.00	446A	1.00	728CY	25.00	CK-1006	1.50
2J56	112.50	5JP4	16.75	250R	6.00	446B	3.00	728DY	25.00	1624	1.00
2J61	30.00	5JP11	16.75	250TH	13.50	450TL	40.00	728EY	25.00	2050	1.25
2K25	20.50	5J23	30.00	250TL	8.50	GL-451	3.00	728GY	25.00	ZB-3200	150.00
2K41	93.75	5J30	29.50	253A	11.75	464A	6.00	803	2.50	8012	1.50
2X2A	1.25	5LP1	13.00	264C	3.00	527	8.75	807	1.25	8013	2.00
3AP1	5.00	5R4GY	1.00	267B	7.00	631-P1	3.75	808	1.50	8020	1.00
3BP1	3.75	C6A	4.50	271A	6.50	WL-530	12.75	811	2.25	8025	3.50
3B24	4.25	6BL6	52.50	274B	2.25	700A	12.50	814	2.50	PD-8365	50.00

- *Receiving tube listings—upon request*
- *Usual terms apply*

western engineers

- *Unconditional guarantee extended*
- *Subject to prior disposition*

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

CARRIER EQUIPMENT

Western Electric CF-1A 4-channel carrier telephone terminals.
EE-101-A 2-channel 1000/20 cycle carrier ringers.
CF D-B 4-channel carrier pilot regulated telephone terminals complete with four channels 1000/20 cycle ringing.
CF D-B 4-channel pilot regulated telephone repeaters.
C-42-A V. F. telegraph in from 2- to 12-channel terminals.
FMC 1 or 2 channels carrier telephone terminals, automatic regulation, duplex signaling each channel. Carrier frequencies above 35 KC. Ideal for adding channels above type "C".
Complete engineering and installation services offered.

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SIGMA 4F 8000 OHM RELAYS

All New, Contract Termination Material—Production Quantities Available

Special Low Price—3 for $10.25—10 for $32.50—100 for $300.00
Super-Sensitive BK-35 Type Relays, 10,000 ohm at ½ ma, 5PDT $4.95

HERE IS ANOTHER GOOD NUMBER

Type DYR-6011, Dual .1 mfd 600 VDC, 3 Side Terminals Bathtub Capacitor
100,000 Clean New Units Available—Priced at 17½¢ for Quick Sale

Note: at this price you can use them as is, tie both sections together for approx. .25 mfd capacity or use as single .1 mfd unit.

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Type	Our Price	Type	Our Price	Type	Our Price	Type	Our Price	Type	Our Price
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1R5	.57	6AL5	.49	6K8G	.80	12SQ7	.56	808	1.75
1S4	.69	6AQ5	.50	6SG7	.60	35Z4GT	.59	830B	2.40
1T4	.61	6AX4GT	.90	6SK7 Met	.58	35Z5GT	.40	864	.20
1A5GT	.62	6B8G	.70	6SH7	.60	50L6GT	.50	866A	1.10
1B3GT	.93	6B8	.75	6SK7GT	.55	42	.60	9002	.80
1U5	.60	6BE6	.52	6SN7GT	.60	2E22	1.90	9004	.38
2X2	.56	6BQ6GT	1.00	6SS7	.80	5CP1	5.00	9006	.35
5T4	1.59	6C6	.59	6X5GT	.50	5BP1	4.00	2050	1.50
5U4G	.50	6H6 Met	.54	7Q7	.60	100TH	6.00		
6AB7	.80	6J5 Met	.50	12AU7	.65	357A	7.00		
6AC7	.80	6J5GT	.40	12SK7 Met	.50	803	2.50		

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100th List $18.50
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Purchasing Agents: NOTE: all tubes are New, Standard Brands, Packed in original cartons. Immediate delivery. Terms 25% with order, balance C.O.D. Minimum order: Transmitting tubes $25.00, Receiving tubes— 50 per type, or multiples of 50. Discounts on large orders. State quantity. Call or write today for detailed price list.

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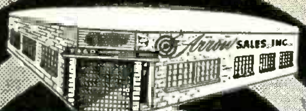

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MILITARY ELECTRONICS

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High powered crystal controlled, long-range transmitter. Frequency range: 300-600 Kc and 2.9-15 MC. Eight separate channels are provided. New. Send for complete literature P.U.R.

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MD22/UPN2
RC-1841FF
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TS-159/TPX

Can be used as frequency meter. 150–200 MC. Separate 30 MC. output. Unit is crystal controlled. 2" meter has two scales: 0–50 and 0–500 VDC. Operates from 110 V. 400 cyc. Easily converted to 110 V. 60 cyc. Complete, new, with schematic. Only **$69.50**

Test Equipment

Complete Line

DuMont 224-A Oscilloscope
1–77 Hickok Tube Checker
1–208 FM Signal Generator
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1-198
BC-638
BC-1255
CWI-60ABJ
1E-36
1-95
1-96-A
1-122
1-130A
1-139
1-145
1-212
1-222
TS-3A/AP
TS10A/APN
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TS-12 Spare Parts Kit
TS16/APN
TS19/APQ
HEWLETT-PACKARD #205
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TS34/AP
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TS36/AP
TS-45A APM-3
TS-59/APN
TS61/AP
TS89
TS92
TS100/AP
TS-102
TS111/CP
TS-118/AP
TS126
TS127/U
TS131
TS-148/UP
TS-173/UR
TS-174/UR
TS175/UR
TS182/UP
TS184A/AP
TS204/AP
TS-218
TS251
TS323/UP
1-146
TS-268/U
Boonton Mod. 78B Sig. Gen.
Boonton Type 102FSig.Gen.
LAD Sig. Gen
LAE-2
LAVOIE Freq Meter: 300-600 Mc.
TS-56A/AP
I-100 ADF Test Set

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ARC-1
ARC-3
R-4/ARR-2
ID-6/APN-4
MP-10G
BC-640
RM-26
SCR-540
SCR-561 Equip.
PE-125AX
R-9/APN-4
BC-733-D
R-57/ARN
BC-788-A-AM-C
BC-639
SCR-284
MN-26 Complete Installation
RTA/1B
SCR-422
TA2J-24
R-28/ARC-5
T-23/ARC-5
R-89/ARN
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RM-25
SCR-536
Motorola Model Fstr-250
EE 89 phone amplifier

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New in original cartons. Complete. Consists of all accessories, plus AS-27A, R89B/ARN-5 and BC-733D. Modified to flag alarm.

TBS 4 & 5, NEW, COMPLETE

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SA-22 ANT. LOAD
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C-87 CONTROL BOX

AN/APG-13A RADAR

Absolutely complete, brand new

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RTA-1B
BC-1016
APA-6 INDICATOR
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HS-33 HEAD SETS, NEW
MG-149F & H
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APS-2, 3, & 15 Components
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SCR-510
SCR-522
MG-153

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SCR-720
SO-7
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SCR-269
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Altimeter equipment—complete

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CFI UNITS 1-152
ART-13
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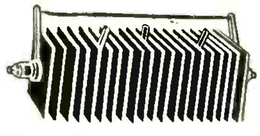
SELENIUM RECTIFIERS



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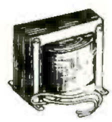
D.C. AMPS.	0–26 VAC 0–20 VDC	0–52 VAC 0–40 VDC	0–130 VAC 0–100 VDC	0–156 VAC 0–120 VDC
.5	$2.75	$5.10	$9.85	$11.40
1.0	3.65	6.85	15.50	18.15
1.5	3.90	7.35	16.20	18.90
2.5	5.55	10.10	20.50	23.95
4.0	7.45	13.95	29.65	36.00
6.0	8.00	14.65	30.40	37.00
8.0	9.65	18.20	42.00	49.60
12.0	10.25	19.05	43.85	51.80
15.0	17.40	32.80	....	....
22.5	18.20	34.30	....	....

RECTIFIER TRANSFORMERS

All Primaries Tapped
110-125 Vac 60 Cycles



SEC. VOLTS	AMPS	PRICE
18 VAC tapped at 9V.	10	$9.95
	35	35.00
	70	60.00
36 VAC	2	$5.95
	5	7.80
	10	12.95
	20	28.50
	35	45.00

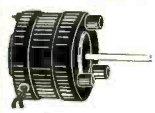
HI-AMP CHOKES

5 AMPS	.03 HY	.2 OHM	$7.95
10 AMPS	.015 HY	.06 OHM	13.95
20 AMPS	.007 HY	.03 OHM	28.50

FILTER CAPACITORS

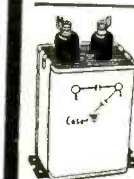
W.V. D.C.	Cap. Mfd	Price	W.V. D.C.	Cap. Mfd	Price
12	3000	$1.50	50	500	.95
15	1000	.75	50	1000	1.95
15	2000	1.25	50	2000	3.50
15	4000	2.50	150	200	1.75
18	1000	.90	200	500	3.25
18	2000	1.45	200	1200	6.50
25	1000	1.50			
35	2000	2.00			
35	3000	2.25			

MOTOR SPECIAL



Diehl Cat #FB2101-6 115 Va 60 Cycles 0.4 Amps. 1800 RPM 4-Pole Shaded Type. Shaft ¼" x 1" Long. Ball Bearing. Cast Frame. Shpg. Wt. 6 Lbs. Brand New............ $4.50

OIL CAPACITOR



2 x .15 MFD 8000 V.D.C. Us both section in parallel for .3 MFD or in series for .075 MFD. Ca 26F381..................... .99
Lots of six in orig. carton...... $5.00

MISCELLANEOUS

Grain-O-Wheat bulbs, type 319A, 3volts Doz. $1.00
Selenium Rect., Bridge, 36VAC-28VDC 2 Amp.. 4.95
Circuit Brkr, 10 Amp, thermal, push-to-reset..... .40
Guardian Relay, 250 Amp. Type B 8........... 2.50
Thordarson Choke 10 Hys. 55 Ma. Fully Cased.. .65
Fuse, 1/40 Amp. 8AG................... Doz. .50
Oil Capacitor, 8 MFD 660VAC KGM6080...... 3.00
Phase Inverter, FTR MC-413-A w/tubes....... 3.00
Oil Capacitor, .5 MFD 400 VDC, Rect. Case.... .10
Shaft Coupling, ceramic, ¼" to ¼"........... .15

FILTER CHOKE

50 Hys. 40 ma. 1780v. RMS Test. Raytheon Type U7402. Dimen. 3½" x 3½" x 3¼". Shpg. weight 6 lbs......... $1.5

Minimum order $5.00. All prices are FOB shipping point. Send check or MO. We will ship transportation charges collect. Rated concern send P.O., Terms Net 10 days.

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63 WEST BROADWAY
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24 HOUR DELIVERY FROM STOCK!

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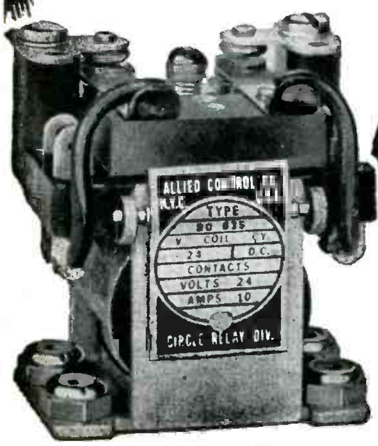
Our stock of more than a million relays — in over a thousand different types — is the world's largest. Don't delay your production for want of large or small quantities of relays of any type.

Telephone, wire or write for quotations.



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1953 RELAY SALES CATALOG

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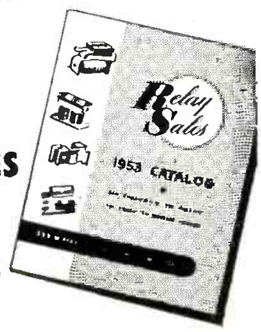
Be sure to send for your copy



Relay Sales

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833 W. CHICAGO AVE.
DEPT. 4, CHICAGO 22, ILL.

POWER RHEOSTATS

ohms	W	Ea.	ohms	W	Ea.	ohms	W	Ea.
.1	150	4.89	50	50	2.10	500	100	3.60
.5	25	1.98	60	25	1.86	500	150	4.63
.5	50	2.34	75	25	1.86	500	300	6.93
.5	150	4.89	75	50	2.10	750	25	1.86
1	50	2.34	75	75	3.25	750	150	4.90
2	50	2.34	80	50	2.10	1000	25	2.10
2	100	3.86	100	25	1.86	1000	50	2.22
2	300	6.93	100	50	2.10	1200	225	6.41
3	100	3.86	100	100	3.60	1200	300	6.93
3	225	6.41	125	25	1.86	1250	50	2.22
5	25	1.86	150	50	2.10	1250	150	4.90
5	50	2.10	175	25	1.86	1500	25	2.10
5	100	3.86	185	25	1.86	1500	50	2.22
5	150	4.63	200	25	1.86	1600	50	2.22
6	25	1.86	200	100	3.60	1800	150	5.15
6	50	2.10	200	150	4.63	2000	25	2.10
6	75	3.25	225	50	2.10	2000	50	2.22
7	25	1.86	250	25	1.86	2250	150	5.15
7.5	75	3.25	250	50	2.10	2500	50	2.22
7.5	225	6.41	300	50	2.10	2500	100	3.71
8	50	2.10	300	75	3.25	2500	150	5.15
10	25	1.86	300	100	3.60	3000	25	2.22
10	50	2.10	350	25	1.86	3000	100	3.71
10	100	3.60	350	100	3.60	5000	25	2.22
12	25	1.86	350	150	4.63	5000	50	2.34
12	50	2.10	370	25	1.86	7500	50	2.34
15	25	1.86	378	150	4.63	7500	100	4.40
15	75	3.25	400	25	1.86	10000	50	2.50
15	100	3.60	400	75	3.25	10000	100	4.75
20	50	2.10	500	25	1.86	15000	25	2.75
22	50	2.10	500	50	2.10	20000	150	6.98
25	25	1.86	500	75	3.25			
50	25	1.86						

Specify Type Shaft Required—1/8" S5 or Knob Type
(Special Prices to Quantity Users)

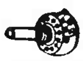
HIGH POWER TR. MICA

G-1 TYP		.0005	10KV	.006	10KV
.0001	6KV	.00065	10KV	.015	7KV
.00015	6KV	.001	10KV	.25	1.6KV
.0002	6KV	.002	10KV	**G-4 TYPE**	
.0004	6KV	.03	2KV	.00025	30KV
.0008	6KV	.045	2KV	.0006	35KV
.001	6KV	**G-3 TYPE**		.0025	25KV
.01	4KV	.0001	20KV	.0039	20KV
.032	2KV	.00015	20KV	.0075	15KV
.04	1KV	.00025	20KV	.01	15KV
.051	1.5KV	.0004	20KV	.01083	12KV
.08	1.5KV	.00045	15KV	.03	8KV
.09	1.5KV	.00047	20KV	.056	5KV
G-2 TYPE		.0005	20KV	**OTHERS**	
.0001	10KV	.00095	5KV	.000155	30KV
.00015	10KV	.001	20KV	.0004	30KV
.0002	10KV	.0012	20KV	.000533	30KV
.0003	10KV	.00124	15KV	.001	30KV
.000375	10KV	.0015	20KV	.007	15KV
.004	5KV	.0051	10KV	(Many Others)	

TRANSMITTING MICAS TYPE "4" and "9"

mfd.	wv	type	ea.	mfd.	wv	type	ea.
.0001	600	4	.36	.0015	600	4	.36
.003	600	4	.36	.00162	600	4	.42
.00005	600	4	.29	.002	600	4	.39
.00005	2500	9	.57	.002	1200	4	.72
.0001	600	4	.29	.0025	600	4	.39
.0001	2500	9	.57	.003	600	4	.43
.00015	600	4	.36	.004	600	4	.45
.0002	600	4	.29	.005	1200	9	.99
.00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.86
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	600	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.08
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

Many other sizes in stock



TYPE "J" POTENTIOMETERS

TYPE "J" $1.25			TYPE "JL" $1.50	TYPE "JJ" $2.95
ohms	ohms	ohms	ohms	ohms
150*	4000†	80K†	500-500*†	130K-130K*
200†	5000*†	100K*†	600-600†	150K-150K†
200*	6500*†	125K*	1500-1500*	100K-200K†
300†	9000†	150K†	2000-2000*†	250K-250†
400*†	10K*†	165K†	2000-50K*	300K-300K†
500*†	12K†	250K*	2200-25K	350K-350K*
600†	15K*†	300K†	5000-35K†	2meg-2meg†
650*†	20K*†	400K*	25K-10K† sw	25K-25K*†
750†	25K*†	1meg*	2000-20K†	10K-10K*†
1000*	30K*†	1meg†	25K-10K†	1meg-1meg†
1400†	50K*†	2meg*†	7K-1meg†	5K-5K*†
1500*†	60K*	3meg*	300K-5K†	400K-400K†
2000*†	75K†		25K-400K†	500K-500K†
			1meg-500K†	50K-50K*†

Type "JJJ" $4.95

20K-200K-20K†	750K-750K-750K†
45K-27K-2.5K 1/4 sh	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

(*) 1/2" screwdriver slotted shaft. (†) Knob type shaft. (*†) Both types.

Many other Hard-To-Get items available for Immediate delivery from our large inventory. Send us your requirements and let us quote.

New MICA listing now ready.

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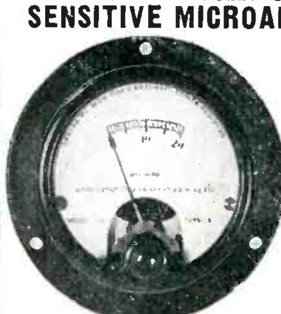

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$9.95 FOBNY EACH

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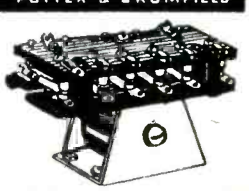

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1N27	8.00
1N28	4.25
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1N34A	.71
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1N38	1.10
1N40	11.50
1N41	12.00
1N43	1.75
1N44	1.50
1N48	.62
1N51	.50
1N52	1.37
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OA2	1.00
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1B22	2.50
1B23	7.00
1B24	12.00
1B26	3.50
1B27	13.00
1B29	2.75
1B32	3.25
1B35	9.00
1B42	9.00
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C1B	8.00
1P21	28.00
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2B22	1.90
2C26A	.60
2C34	.60
2C39	20.00
2C39A	21.00
2C40	10.00
2C43	17.50
2C44	1.50
2C46	30.00
2C50	9.00
2C51	5.00
2C53	13.00
2D21	1.50
2E22	2.50
2E24	3.00
2E26	3.40
2E27	3.50
2E36	3.50
2J21A	10.50
2J22	10.50
2J26	15.00
2J27	20.00
2J31	30.00
2J32	26.00
2733	25.00
2J34	25.20
2J36	110.00
2J37	15.00
2J38	24.00
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2K25	28.00
2K26	100.00
2K28	33.00
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2K39	100.00
2K41	150.00
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3A5	1.10
3B22	3.50
3B24	5.50
3B24W	8.50
3B25	6.50
3B26	6.00
3B27	4.50
3B28	4.50
3C21	5.00
3C24	1.50
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3C33	21.00
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4-250A	38.00
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4B25	8.50
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4C27	38.00
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249B	7.00
249C	7.00
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250R	20.00
250TH	20.00
250TL	20.00
252A	28.00
253A	20.00
255B	130.00
258B	10.00
304TH	9.00
304TL	9.50
307A	4.00
316A	2.50
319A	21.00
323B	11.00
327A	4.00
328A	8.00
329A	8.50
332A	45.00
350A	8.00
350B	8.00
355A	21.00
357A	19.00

371A	.85
371B	.85
388A	3.00
393A	12.00
394A	4.00
407A	5.50
408A	3.00
417A	12.00
434A	20.00
446A	2.50
450TH	50.00
450TL	50.00
451	10.00
468	26.00
471A	3.00
502	73.00
527	15.00
530	16.00
532A	3.50
375A	21.00
600	7.00
602	9.00
604	7.75
614	7.50
700A	24.00
700B	24.00
700C	26.00
701A	5.80
703A	5.50
705A	1.90
707B	16.00
708A	5.50
714AY	16.00
715A	6.00
715B	9.00
715C	29.00
717A	1.20
719A	28.00
721A	4.00
721B	6.00
723A/B	20.00
724A	3.00
724B	2.00
725A	10.00
726A	14.00
726B	49.00
726C	69.00

730A	35.00
731A	4.50
801	2.10
802	4.00
803	4.00
804	16.00
805	3.00
807	1.65
807W	11.50
808	2.25
809	3.50
810	11.50
811	2.95
811A	3.75
812	3.50
813	11.50
814	3.75
815	4.50
816	1.50
826	1.50
828	12.00
829B	12.75
830B	4.50
832	7.00
832A	9.50
833A	41.00
834	13.00
836	3.50
837	1.45
838	3.95
843	1.25
845	7.00
851	55.00
852	19.00
860	3.25
861	26.00
864	.40
866A	1.65
869B	60.00
872A	3.50
876	1.35
878	1.75
884	1.58
885	1.75
931A	5.00
954	.45
955	.67

956	7.55
957	.35
958	.95
958A	1.00
1612	2.00
1613	.80
1616	1.50
1619	.40
1620	6.00
1622	2.25
1624	1.50
1625	.30
1626	.25
1630	.85
1631	1.40
1632	.75
1633	1.00
1641	2.25
1665	1.30
2050	1.50
2051	.80
5516	7.20
5527	46.00
5545	31.50
5559	18.50
5560	27.00
5563	44.00
5581	2.25
5582	2.65
5585	150.00
5633	11.00
5634	11.50
5635	12.75
5636	8.00
5638	10.50
5645	12.85
5651	2.50
5654	2.80
5657	200.00
5672	1.40
5675	17.00
5676	1.30
5678	1.20
5679	1.25
5683	9.50
5686	4.50
5687	4.00

5702	4.45
5703	1.90
5704	2.75
5718	8.50
5719	11.00
5720	18.75
5722	6.25
5725	3.90
5726	2.00
5734	16.00
5751	3.25
5763	1.50
5814	2.50
5829	3.80
5840	9.00
5863	14.00
5879	1.65
5881	3.00
6005	3.25
7193	.65
8005	6.75
8008	7.10
8012	2.00
8013A	5.00
8014A	70.00
8019	4.00
8020	2.25
8025	4.50
9001	1.20
9002	.90
9003	1.30
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ALL TYPES of COILS and PILE-UPS

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CLARE TYPE C STANDARD SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	1A	4 MA	$2.25 ea.
2)	6500 ohms	1C	2 MA	3.00 ea.
3)	6500 ohms	1B-1C	3.5 MA	2.75 ea.
4)	6500 ohms	2A	4 MA	3.00 ea.
5)	6500 ohms	4A	4 MA	3.00 ea.
6)	6500 ohms	3A-1B	4 MA	3.00 ea.
7)	6500 ohms	5A	5 MA	3.25 ea.

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
5)	3600 ohms	1C	6 MA	2.00 ea.
6)	4850 ohms	1A	5 MA	2.00 ea.
7)	3300 ohms	(None)	ACTUATOR	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V.	$2.50 ea.
2)	400 ohms	1A	12 or 24V.	1.65 ea.

CONTACT SYMBOLS

A=Norm. Open B=Norm. Closed C=S.P.D.T.

G.E. Relays #CR2791-B109P36 Coil—10,000 ohms Contacts 1A, 1B Operates on 8 MA....Price $1.65
Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma Price—$2.75 ea.
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SIGMA TYPE 5F SENSITIVE RELAYS. Has two 70 ohm coils. Contacts—SPDT...Price—$3.00 ea.

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3)	.001 MFD	1200v.	DCW	.35 ea.

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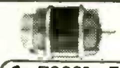

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Type MS Henschel 115V 60 Cy.	22.50
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1N Mtr. - 115/90V - 60 Cy.	45.00
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2J1G1 Gen. 57.5/57.5V - 400 Cy.	5.75
2J1H1 Dif. Gen. 57.5 - 400 Cy.	12.50
2JD5J1 Mtr. - 220V - 60 Cy.	50.00
2J5A-2 Gen. - 115/105V - 60 Cy.	25.00
2J-5F1 Cont. Tr. 105/55V-60 Cy.	45.00
2J5L1 Cont. Tr. 105/55V-60 Cy.	45.00
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In: 28V DC 52A
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115V 400 Cy. 750 VA ThP..$125.00

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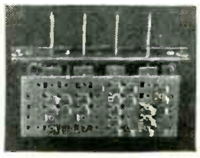

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TRANSFORMERS: (Power) 115V. 400cy. Pri. 27V, 4.3 amp; Sec. 6.3V, 2.9 amp; Sec. 1.25V, .20 amp. Sec. Sig. Corp. #2Z9613-112 WE #KS-8984....$1.25

TRIMMERS: 2-7 MMFD, Tubular, Ceramic, Centralab type #829....$38.00/M

TRIMMERS: 1-4 MMFD, Tubular, Ceramic, Centralab type #829....$28.00/M

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OD3/VR150	.85	RK60/1641	1.75
1B22	1.75	211/VT4C	.49
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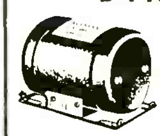

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4B26	11.00	394A	4.50	1620	6.50
4B28	6.25	417A	17.50	1622	2.25
4B32	11.00	446A	3.75	1623	4.00
4C35	32.50	446B	16.75	1625	.49
4E27	22.50	446D	16.75	1626	.49
4E27A	35.50	450TH	55.00	1629	.49
4J31	135.00	450TL	55.00	1630	.85
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5FP7	2.50	615	1.75	1851	1.95
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5JP1	27.50	KU628	32.50	2051	1.15
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5R4WGY	3.25	672A	34.50	5651	3.35
5UP11	22.50	GL675		5654	4.00
6AJ5	2.55	705A	2.35	5659	4.15
6AK5	1.30	706AY	59.50	5660	3.75
6AN5	3.15	706DY	58.50	5661	3.75
6AR6	3.35	706GY	59.50	5663	2.00
6AS6	2.95	707A	18.25	5664	3.30
6AS7	4.50	707B	19.25	5670	4.25
6BG7	1.80	708A	4.75	5691	8.45
6BM6	75.00	709A	3.85	5692	8.45
C6J	7.95	713	1.98	5693	6.95
6C21	29.50	714AY	12.50	5732	
6J4	6.95	715	5.00	5749	3.95
6K4	4.50	715A	5.75	5751	3.75
7BP7	8.95	715B	12.50	5783	1.65
9LP7	37.50	715C	24.50	5803/VX-34	5.25
10Y	.65	717A	1.75	5814	3.95
12DP7	17.50	718BY	79.50	5838	4.75
12GP7	17.50	719A	42.50	5871	3.35
12HP7	17.50	720CY	65.00	5931/5U4WG	4.95
CA13	.70	721A	4.50	X6089	1.75
15E	1.85	723AB	22.50	UX6653	1.25
15R	1.05	724A	2.75	7193/2C22	.49
FG17	5.25	724B	3.15	8002R	105.00
RK20A	9.95	725A	9.50	8011	1.00
24G	1.85	726A	14.50	8012	3.00
25T	9.00	726C	75.00	8013	3.35
FG-27A	23.00	SN729	3.25	8013A	5.50
28D7	2.35	730A	28.95	8020	2.15
FG32	15.00	WL762	45.00	8025	5.45
FG33	23.00	801A	.85	9001	1.25
FK34	85.00	802	4.20	9002	.95
35T	9.00	803	5.00	9003	1.55
35TG	9.00	804	16.50	9004	.65
35TIG	9.00	805	4.95	9005	2.25
CE36C	1.75	806	17.50	9006	.45
RK39	14.50	807	1.65	AX9903	
EF50	1.30	808	6.95		
53A	5.95	809	3.50		
FG57	14.95	810	11.00		
58A	1.35	811	2.95		
QK59	65.00	812	4.75		

These listings represent only a small portion of our tremendous Electronic inventories. If your requirements are not listed, write and allow us to quote you accordingly. Prices subject to change without notice. Terms: Rated firms net 10 days, Non-rated 25% with order balance COD. FOB Boston. Minimum order $10. Merchandise Fully Guaranteed.

ELECTRO Sales Company Inc. ESCO

50 EASTERN AVE., BOSTON 13, MASS. CAPITOL 7-3456

INDEX SEARCHLIGHT

OCTOBER, 1953

This index is published as a convenience to the readers. Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

TO THE ADVERTISERS

OCTOBER, 1953

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

Want more information? Use post card on last page.

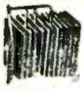
FEDERAL "ITT" SELENIUM BATTERY CHARGER RECTIFIER

10-0-10 Volts (CT) 100 Amp (Fan-Cooled), Replace Your Old inefficient Sulphide Rect. with the New Selenium Types. **SPECIAL**..$11.98

SELENIUM RECTIFIERS

1/2 WAVE FOR RADIO & TV

CURRENT (Cont.)	LIST PRICE	"TAB" PRICE	QTY 12 FOR
65MA @ 130V	$1.50	$0.59	$6.48
75MA @ 130V	1.85	.69	7.58
100MA @ 130V	2.05	.79	8.68
150MA @ 130V	2.25	.99	10.78
200MA @ 130V	3.15	1.39	14.98
300MA @ 130V	3.30	1.49	15.98
400MA @ 130V	4.25	1.89	20.38
500MA @ 130V	4.40	1.98	21.28
230MA @ 18V	1.40	.59	5.98
230MA @ 36V	2.25	.89	8.38
250MA @ 300V	6.95	1.39	14.98



SELENIUM RECTIFIERS

We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$7.50
2 Amp	2.20	3.60	5.40	10.50
4 Amp	4.25	7.95	12.95	25.25
6 Amp	4.75	9.00	13.50	33.00
10 Amp	6.75	12.75	20.00	40.00
12 Amp	8.50	16.25	25.50	45.00
20 Amp	13.25	25.50	39.00	79.50
24 Amp	16.25	32.50	45.00	90.00

Full Wave Rect & Trans. 115V/60cy inputs.
up to 14VDC at 12 amps..............$23.98
up to 28VDC at 12 amps..............31.98
up to 28VDC at 48 amps..............120.00
C "TAB" fast delivery SPECIALS

RECTIFIER XFMRS

PRIMARY 115V 60 cyc
SECONDARY 0-9-12-18-21-36V
CONT. CURRENT { 4 amp..........$8.75
12 amp..........16.75
24 amp..........35.75 }
30-32-34-36v. 48 A..........59.75
18 Volt 2 amp..........1.98

RECTIFIER CHOKES

4 Amp	.07 Hy	.6 Ohm	$7.95
12 Amp	.01 Hy	.1 Ohm	14.95
24 Amp	.004 Hy	.025 Ohm	23.95

"TAB" THAT'S A BUY

RHEOSTAT SALE

15 ohm 25W w/knob..........$1.49; 2 for $2.49
60 ohm 50W w/knob..........2.25; 2 for 3.98
100 ohm 50W Model K..........1.98; 2 for 3.50
200 ohm 25 Model D..........1.49; 2 for 2.49
300 ohm 225W Model P..........2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft, 25 watt..........79c; 3 for 2.00

• • SPECIALS • • Powerstats & Test Equipment

Type 20/0–135V/3Amp/ (N)$10.98
Type 116U/0–135V/7.5 Amp/(N)..........16.98
Type 116 As above, except cased (N)..........20.49
Type 1126/0–135V/15 Amp/(LN)..........41.98
Type 1226/0–270V/9 Amp/(LN)..........41.98
3000 BU/0–135V/30 Amp/4KV/(N)..........48.00
3020 BU/0–270V/18 Amp/4.9KV/(N)..........48.00
GR 50A/0–135V/45 Amp/5KV/(LN)..........100.00
GR 50B/0–270V/31 Amp/7KV/(LN)..........100.00
GE ST4A Sweep Generator (N)..........300.00
GE ST5A Marker Generator (N)..........325.00
GE ST2A Oscilloscope (N)..........275.00
(N) NEW & (LN) LIKE NEW

CONDENSER SPECIALS 2 MFD 330 VAC

1000 VDC STD MFGR **25¢** LOTS OF 10

Smaller Quantities Each..........49c: 3 for $1.25
2MFD 600VDC W/MTG Clamp..........3 for $1.50

DC POWER-SUPPLY

0 to 12VDC/2 AMP Variable DC supply—inpt 115v/60 cy. Usable LAB supply, filament D.C. plating, battery charging, model railroad includes voltage or speed control and center off reversing sw. Ideal for two "HO" loco's..........$10.95; 2 for $20.00

TACHOMETER GENERATOR

GENERAL ELECTRIC
PART #2CM5-AAK-20
MARK V STUD MTG
NEW..........$3.98; 2 for $7

KITS AND COMPONENTS

Oil Condensers Assorted..........5 for $1.25
Electrolytics Assorted..........5 for 1.25
Silver & Mica Cndsrs..........15 for 1.25
Controls, Popular Values..........5 for 1.25
Resistors, ½ & 1W..........100 for 1.25
Vitreous W W Resistors..........8 for 1.25
Sockets, Asstd. 8, 7, 5, 4P..........12 for 1.25
Iron Core Slug & Screw..........50 for 1.25
Knobs, Asstd. w/Insert..........10 for 1.25

"TAB" Special — YOU PICK 'EM **$1.00** Lots of 5

866A KIT AND XFORMER

2 Tubes, Sckts, xfmr 115v 60cyc Inp, outpt. 2.5vct, 10A/Hv insul. **SPECIAL**..........$4.98

DIODE PROBE TUBE

Unexcelled for **No-Loss VHF** testing. Ultra sensitive subminiature-envelope. New, w/data VR92..........25c; 5 for $1.

OIL CONDENSER SPECIAL

DUAL 8MFD 600 VDC **$2.25**
FITS STD 4 PRONG SOCKET
4 HOLE FLANGE MTG

"LAST MINUTE SPECIALS"

Helipot 50K ohm 10 Turn 0.5% 50KAJZ..$8.95
Attenuator 7470 & 1063 ohm 12 step..........3.49
Daven Attenuator T323G dual 600 ohm, 20 step 1½ DB per/step..........10.98
Eveready 6V Hotshot 1461 Battery..........98
Vector Turret Socket 8N9T & Base Shld..........2 for .98
Lacing cord #6 **Waxed for cabling**..........1.39
Lacing cord #12 Waxed, linen..........1.89
K. Miller stripper #100 & cutter..........89
Clock radio 5 tube famous make..........16.95
Carbide drills for TV/Ant ¼, ⅜, ½"..3 for 3.89
Hytron adapter SH27, 28, 29 Asst....3 for 5.00
Line filter F/5 AR for AN/ARC5 installation, used, as-is..........1.98

"TABS" NEW TRANSFORMER STOCK

2.5VCT/10A 12.5KVINS Kenyon $6.98; 3 for $19.
778VCT/200MA, 5V/3A, 6.3VCT/5A Thordarson..........$5.98; 3 for $16.
800VCT/150MA Stancor..........$5.98; 3 for $16;
850VCT/148MA 5V/3A, 6.3V/5A, 6.3V/3A..$6.49
2500VDC 200MA KIT, Transformers Power & Bridge Filaments & 4/866's Special..........$23.00
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A....$2.49

TRANSFORMERS

All 115 V 60 Cyc Input TV & CR Pwr Xmfr up to 20" tubes. Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL Tubes, PL & Fil wndgs 300 VDC/275Ma Full-Wave.; 6.4V/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core. Oil Impreg. $6.49; Two for..........$12.49
1000VCT/45MA, 795VCT/80 MA, 360VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/.3A CSD HVINS CAN BE USED 2X RATING RAYTHEON, HYPERSIL CORE..........$4.98
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT..........$5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS..........$2.25
780VCT/250MA, 5V/6A, 12.6V/5.5A..........$7.95
770VCT/200MA, 5V/6A, 12.6V/5.5A..........$6.95
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4/scope..........$3.69
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price..........$3.98; Two for..........$7.25
700VCT/100MA, 2X6.3V/1.5A, 5V/2A, Isolation Winding 120MA..........$3.49
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A..$4.39
420VCT/90MA, 6.3V/1.9A, W/imputs 6, 12, 24, 115VDC & 115 & 230 VAC..........$1.49

FILTER CHOKES

12Hy/80ma/3KVins..........2.25
10Hy/75ma..........1.25
10Hy/125ma/UTC/Csd/H'sld/1 KVins..........1.49
50Hy/125ma/Csd/H'Sld..........2.89
12Hy/300ma/5KVins..........4.95
20Hy/300ma or 15Hy/400ma/12KVins Kenyon..........8.95
13.5Hy/1Amp/17KVins/Raytheon..........39.95
Dual 2 Hy/300ma USN..........95c; 2 for 1.49
6Hy 175ma 250 Ohm..........$1.49; 2 for 2.49
10 Hy 100ma Freed..........1.39

FILAMENT TRANS.

6.3V/2AMP $1.08: Two for..........$1.98
2.5V/2A @ 79c, 2 for **$1.49**, 10 for..........6.49
2.5VCT/10A 5KVINS..........3.59
5VCT 100/12KV INSUL G.E...........8.25
7.5VCT 12A CSD KENYON 15 KVINS....10.95
24V/1.25A CSD @ $1.98 Two for..........3.49
2X12V/2A or 24V/2A @ $3.89 Two for..........6.98

TUBES

"TAB" Tested & Guaranteed

PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.95
OA3/VR75	1.04
OB2	1.37
OB3/VR90	1.09
OC3/VR105	1.15
OD3/VR150	.90
1B3/8016	.81
1B21/471A	2.85
1B22	2.20
1B23	9.90
1B24	9.45
1B26	2.45
1B27	12.75
1B32/532A	3.90
1B35	9.15
1B37	16.98
1B38	29.95
1B41	49.95
1B42	18.00
1B46	1.98
1B53	49.95
1B56	38.50
1B58	175.00
1B60	69.75
1B63	50.00
1B63A	75.00
1L4	.69
1L6	.98
1P21	33.00
1V2	.70
1X2A	1.29
2C36	27.00
2C39	21.00
2C39A	29.50
2C40	7.29
2C43	17.75
2C43/464A	9.43
2C44	1.20
2C51	5.49

2D21	1.26
2E31	1.49
2E36	1.49
2E43	1.49
2G21	1.49
2J21	27.00
2J31A	79.95
2J32	37.00
2J33	27.00
2J34	27.00
2J36	108.00
2J37	12.70
2J38	11.75
2J39	44.00
2J42	187.00
2J48	24.25
2J49	67.25
2J50	21.25
2J52	249.50
2J55	85.00
2J56	119.00
2J61	49.95
2J62	49.45
2K22	39.45
2K23	39.45
2K25	28.49
2K25/723AB	24.90
2K26	29.00
2K33	259.00
2K35	389.95
2K41	126.00
2K42	145.00
2K48	120.00
2X2	.49
3B22	2.70
3B23/RK22	4.95
3B24	8.93
3B25	4.50
3B26	8.25

3B28	7.90
3C22	89.00
3C23	9.90
3C31/C1B	3.45
3C33	14.98
3C45	14.95
3D6/1299	.69
3D21A	8.95
3D22	13.95
3D23	4.90
3E29	14.95
4C35	19.95
FL5BHD	16.98
5C21/C6J	9.89
5C22	39.85
5C30/C5B	3.95
5D21	19.50
5D23/RK65	36.50
5J29	12.40
5R4GY	1.55
5R4GYW	1.75
5T4	2.49
5U4G	.69
5V4G	1.10
6AG5	.79
6AG7	1.39
6AH5G	1.49
6AH6	1.22
6AJ5	1.40
6AK5	.74
6AK5W	2.98
6AK6	1.05
6AL5	.54
6AL7GT	1.29
6AN5	2.90
6AQ5	.55
6AQ5W	3.98

6AQ6	.81
6AQ7GT	1.29
6AR5	.79
6AR6	2.98
6AS5	.79
6AS6	2.43
6AS7G	4.65
6AT6	.63
6AU5GT	1.10
6AU6	.59
6AV5GT	1.29
6AV6	.49
6AW6	1.89
6B4G	1.23
6BA6	.63
6BA7	1.27
6BC5	.63
6BC7	1.23
6BD5GT	1.65
6BD6	.83
6BE6	.59
6BF5	.98
6BF6	.65
6BF7	2.55
6BG6G	1.39
6BG7	1.98
6BH6	.63
6BJ6	.69
6BK7	2.15
6BL7GT	1.45
6BN6	1.79
6BN7	1.69
6BQ6GT	1.20
6BQ7	1.65
6BY5G	1.95
6C21	29.45
6CB6	.69
6CD6G	1.69
6D4	2.70

C6J/5C21	9.89
6J4	6.66
6J5GT	.47
6J6	.63
6K4A	6.45
6L6	2.09
6L6G	1.35
6L6GA	1.35
6L6GAY	2.29
6SA7GT	.63
6SC7	.90
6SD7GT	.80
6SF5	.77
6SF7	.73
6SG7	.72
6SH7	.61
6SJ7	.70
6SK7GT	.69
6SL7GT	.69
6SN7GT	.70
6SQ7GT	.63
6SR7	.65
6SS7	.75
6ST7	.98
6V6	1.39
6V6GT	.57
6W4GT	.57
12AK5	1.98
12AL5	.75
12AT6	.89
12AT7	.81
12AU6	.72
12AU7	.63
12AV6	.49
12AV7	.98
12AW6	1.79
12AX4GT	1.20
12AX7	.79
12AY7	2.79

12AZ7	1.49
12BA6	.59
12BA7	.79
12BD6	1.23
12BE6	.59
12BF6	.85
12BH7	1.29
12BY7	1.35
12BZ7	1.25
12SA7GT	.69
12SC7	.80
12SF5GT	.72
12SF7GT	.4
12SG7	.83
12SH7	.63
12SJ7GT	.59
12SK7	.72
12SL7GT	.65
12SN7GT	.75
12SQ7GT	.63
12SR7	.63
FG17	3.95
19T8	1.09
19V8	1.62
24G/3C24	1.90
25BQ6GT	1.19
25L6GT	.69
25Z5	.79
25Z6GT	.99
FG27A	8.70
28D7	1.95
FG32/5558	13.85
35Z5GT	.59
50L6GT	.69
RK61/XFG1	2.65
80	.69
81	1.69
82	1.19
82V	1.39
83	1.45
83V	1.79
84/6Z4	.99
FG95/5560	24.85
FG98	19.35
100TH	7.93

FG104	37.98
FG105	17.64
117L/M7GT	1.59
117N7GT	2.49
117Z6GT	1.19
117Z7GT	1.49
F123A	7.90
VT127A	3.90
VXR130	4.50
CV148	4.98
FG166	49.00
FG172	29.00
211/VT4C	1.25
RX215	9.95
250TH	18.97
250TL	17.75
304TH	8.90
304TL	8.90
371B	2.93
388A	1.49
WL417A	8.95
417A/5842	18.50
GL434A	12.69
446A	1.05
446B	3.89
450TH	49.97
450TL	52.00
460/HF200	15.95
GL471A	2.69
CK501X	1.26
CK501AX	2.20
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK506AX	1.49
CK509AX	1.79
CK512AX	1.45
CK522AX	1.29
CK525AX	1.29
CK526AX	1.49
CK528AX	1.49
CK529AX	1.79
GL530	22.00
CK531DX	1.89
53	6.98

CK532DX	1.89
WL532	3.98
CK533AX	1.29
CK534AX	.99
CK536AX	.99
CK537AX	3.04
CK538DX	.98
CK539DX	2.19
CK541DX	1.99
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK547DX	1.98
CK571AX/5886	2.49
CK573AX/6029	3.49
WL579	10.49
WL579B	12.98
WL652	65.00
WL673	117.00
WL676	39.95
703A	4.75
705A	1.98
707A	7.90
707B	13.50
715A	6.00
715B	11.90
715C	24.00
717A	.90
718BY	48.45
718CY	48.45
719A	28.50
721A	2.49
722A/287	2.45
723A	11.95
723A/B	25.00
724A	3.95
724B	3.45
725A	8.49
726A	21.97
726B	45.00
726C	79.95
801A	.45
803	3.89

805	3.90
807	1.65
808	2.59
809	2.43
810	9.95
811	2.90
812	2.70
813	12.49
814	3.95
815	5.97
816	1.29
826	.95
829	11.49
829B	12.45
832	8.97
832A	9.65
833A	39.45
836	5.95
837	1.45
849	29.45
860	4.90
865	1.29
866A	1.50
872A	3.29
917	2.59
925	1.69
927/CE25	1.49
CK1005	.85
CK1027	2.98
5635	11.57
5637	6.53
5640	11.57
5641	7.52
5643	11.57
5644	11.57
5646	11.57
5651	2.35
5654	2.79
RK5657	350.00
5663	1.85
5670	5.30
CK5672	1.29
CK5678	1.89
5687	5.49
CK5702	3.49

CK5703	1.29
5812	2.99
5814	3.64
5840	12.34
8020	1.25

Xtal Diodes

1N21A	$1.55
1N21B	2.89
1N22	1.25
1N23	1.35
1N23A	2.20
1N23B	2.25
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.90
1N35	1.65
1N38	1.43
1N38A	1.29
1N41	8.95
1N42	16.95
1N43	1.73
1N44	1.24
1N45	1.45
1N46	.69
1N47	4.00
1N48	.55
1N51	.45
1N52	1.39
1N54	.89
1N54A	1.15
1N55	3.10
1N57	.89
1N58	1.19
1N58A	1.15
1N60	.60
1N61	2.07
1N63/K63	2.49
1N64	.69
1N69	.98
1N86	1.15
1N87	1.15
1N88	1.15

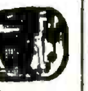
RELAY SPECIAL

SPST Mini Size 115VAC 3A CTS..........98c; 3 for $2.75
SPDT Mini Size 115VAC 3A CTS....$1.39; 3 for $3.75
SPNO 115VAC/15A CTS S'Dunn....$1.98; 2 for $3.50
DPDT & SPNO 12 VDC/10A CTS..........$2.25; 2 for $3.75
DPDT Clare SK5010, Octal Base, 18-28V 2A Contacts, Nitrogen Sld. New Stock..........$2.98

METER BUYS

0-30 VDC "AN" $1.98: 2 for $3.25
0-60 ADC "AN" Type Mtg Less Shunt..........2.95; 2 for 5.00
0-15 VAC GE 2½ Rnd 800cy 1.29
0-150 VAC/Wstghs/2½ Rnd 3.49
0-150 VAC/25-125cy/3½" Square RA35/Wstgh..........5.98
0-1/MADC Wstghs 3½" Sq RA35 LN..........6.49
0-50 Microamps Weston 301 3½" Sq..........13.98
0-500 MADC/2½"; Rnd Triplett 221T..........4.98
VU-20 + 3 Weston 301 3" Sq. L.P. **$41**..........14.98
0-120 MA RF 3½" Rnd Weston 301..........12.98

INFRARED SNOOPERSCOPE



SEE IN DARK TUBE
Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin/in. Complete data & tube..........ea. $4.98; 2 for $9.49
Snooperscope Pwr Supply **1800VDC/35MA**, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram **115V/60cy** Operation..........$6.98

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 oz Designed Portable Equip. Models...98c: 4 for $3
Four 36V BATTERIES w/acid *..........3.35
2V 20AH Willard PLUS 2V. Vibrator..........2.98
2V 20AH Batt. W/Vib. & Acid *..........3.59
6V/6AH Willard NT6/BB214U..........2.98
6V/6AH Batt. W/Acid *..........3.25
6V/40AH Willard..........6.98
6V/40AH Batt. W/Acid *..........9.25
4V/16AH Gould..........2.89
* Acid is shipped in Bottles. R'Exp only.

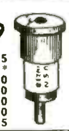
ELECTROLYTIC CONDENSER KIT

POPULAR VALUES **25¢** EA
LOTS OF 15
A handy assortment for the Serviceman
15 ASSORTED CNDSRS, ONLY $3.75

PRECISION RESISTORS

2 MILLION IN STOCK
GUARANTEED 1% TOLERANCE
ORDER ANY VALUE YOU NEED
.42 to 970K OHM..........35c; 10 for $3.29
1MEG & UP..........70c; 10 for $6.49

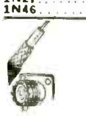
CRYSTAL DIODES



IN23B Sylvania **$1.89** Lots of 10
Smaller Quantity, Unit Price $2.25

1N21..........85c; 6 for $ 4.00
1N21A..........$1.55; 5 for $ 7.00
1N21B..........$2.89; 4 for $10.00
1N27..........$1.55; 5 for $ 7.00
1N46..........69c; 5 for $ 3.25

"AN" CONNECTORS



REDUCED UP TO **90%** OFF LIST
EXTRA 10% QUANTITIES OF 100

AN3102-10S-2P	23c	AN3108-22-4S	$1.32
AN3101-12S-3S	52c	AN3102-22-4S	89c
AN3102-12-5P	29c	AN3102-36-9S	2.95
AN3102-14S-5P	45c	AN3057-4	25c
AN3108-14S-7S	69c	AN3057-12	30c
AN3108-16S-4P	67c	GK-C8-21 1/2B	1.15
AN3062-20	55c	GK-9-32S	66c
AN3102-20-26P	72c		

Others in Stock, Write for Qty Price

YOU PICK THEM 39¢ Lots of 10 WHILE THEY LAST

ELECTROLYTIC CONDENSERS

20MF/25VDC	2X15MF/350VDC
20MF/450VDC	2X20MF/25V, 30MF/450V
25MF/300VDC	40MF/250V, 20MF/25V
50MF/350VDC	3X100MF/35VDC
100MF/25VDC	30/15/10MF/250VDC

ALL SIZES & TYPES NEW STOCK

TEST CORDS

15 Foot Extension Cord, Hvy Duty, SJ Rubber Covered Insulation, as Shown....98c
4 Foot Instrument Test Leads, High Quality Red & Black. Per Pair..........59c; 2 for 98c
TV Cheater Cord Approx 32"..25c; 5 for $1.00

OIL CONDENSER SPECIAL

10 MFD 600 VDC **$1.75 ea**
LOTS OF 3
CASE SIZE 4¼H—3¾W—1½"D
"TAB" Special Qty. Less than 3.....ea. $1.98

SELSYNS

2J1H1 GE Selsyns..........Each $8.98
2J1F3 GE Brand New 115V/400 cy. ea..........9.75
C78248 Sync. Trans. 115/60 cy **30.00**; 2 for **55.00**
C78249 Sync. Diff. 115V/60 cy **12.95**; 2 for **25.00**
Sync. Repeater 115/60 cy Type 11-4..2 for **99.00**
Bendix Autosyns AY1 & AY5..........2 for **6.95**
Bendix AY20 New Orig Crtns..........**12.98**
OTHER TYPES IN STOCK

DYNAMOTORS

INPT 6VDC, Output 200V/100ma, or 12/24V Output 500V/50ma 'P' Magnt. As Illustrated.. **6.95**
INPT 28VDC/1.4A Output 250V/60ma..........**3.69**
DA3A 28V/10.5A out 300VDC/260ma 150VDC/10ma. 14.5vdc/5amp..........**6.75**
PE94 Plate Supp., Uses DA3A (SCR522)....**8.98**

LINEAR SAWTOOTH DC POTENTIOMETER KS15138

Electric power is supplied through 2 fixed taps 180° apart. 2 rotating taps, and take off brushes are provided for output voltage. Varying position of the brushes, varies the output voltage in accordance with a linear sawtooth wave. Special **$3.95**
WRITE FOR ADDITIONAL INFO

CU-24/ART 13 LOADING CONDENSERS

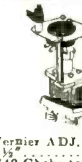
Three 25MMF 10,000V condensers P/o ART13 XMTTR. NEW..........$2.49

GENUINE SWEDISH STEEL SAWS

FIRST QUALITY

STOCK NUMBER	SIZE	TEETH PER/IN.	REG. PRICE	"TAB" PRICE
TAB-20-10	20"	10 PT	$9.00	$3.95
TAB-24-10	24"	10 PT	9.75	4.15
TAB-24-8	24"	8 PT	9.75	4.15
TAB-26-8	26"	8 PT	10.85	4.25
TAB-26-6	26"	6 PT	10.85	4.25
TAB-26-10	26"	10 PT	10.85	4.25
TAB-28-8	28"	8 PT	10.85	4.35
TAB-28-6	28"	6 PT	11.50	4.70
TAB-30-6	30"	6 PT	11.00	4.50

MICROWAVE



Klystron Mts Assy (723AB) & Coupling to 2 Type "N" Co-Ax Fittings. As Shown **$9.98: 2 for $18.00**
1 Microsecond Delay Line "**Millen**" **$2.95; 4 for $10.00**
Microwave Lighthouse Assy —P/O RT39 APG5 & 15. osc and Tr Cavities. Tunes 24-2700 MC. **SPECIAL $20.00; 2 for $36.00**
Variable Attenuator 3CM Vernier ADJ. RND Choke to Straight Flange 1" x ½"..........$39.95
X Band Adaptor UG39 to UG40 Choke to Plane Flange Sperry Lab Dsgn..........$1.69; 4 for $6.00
X Band Straight Wave Guide Per/Ft..........$2.00

PULSE TRANSFORMERS

Pulse Shaping Xfmr Raytheon UX12819 1 MU Sec. 2000 CY. $5.00
PULSE-XFMR 1000 Pulse Per Sec. 5 Watt, TR1025 P/O LU-3 Test Equipment..........$7.98
7.5 KV Pulse, Pri 4 KV, 50-1000 ohm imped. Permalloy Core Weco D-163247..........$12.00
Fuse is 3AG Size. Operates up to 24 Volts. Please State Amps (current) desired.

CIRCUIT BREAKER FUSES

PUSH TO RESET
Amps 3-5-7-10-15-20 Ea. **27c**
4 for $1.; 25 for $5.; 100 for $18.
Circuit Breaker Fuse W/2 Mounting Clips 39c; 3 for....$1.00; 20 for....$5.98; 100 for....$25.

● THAT'S A BUY **"TAB"** A BUY ●

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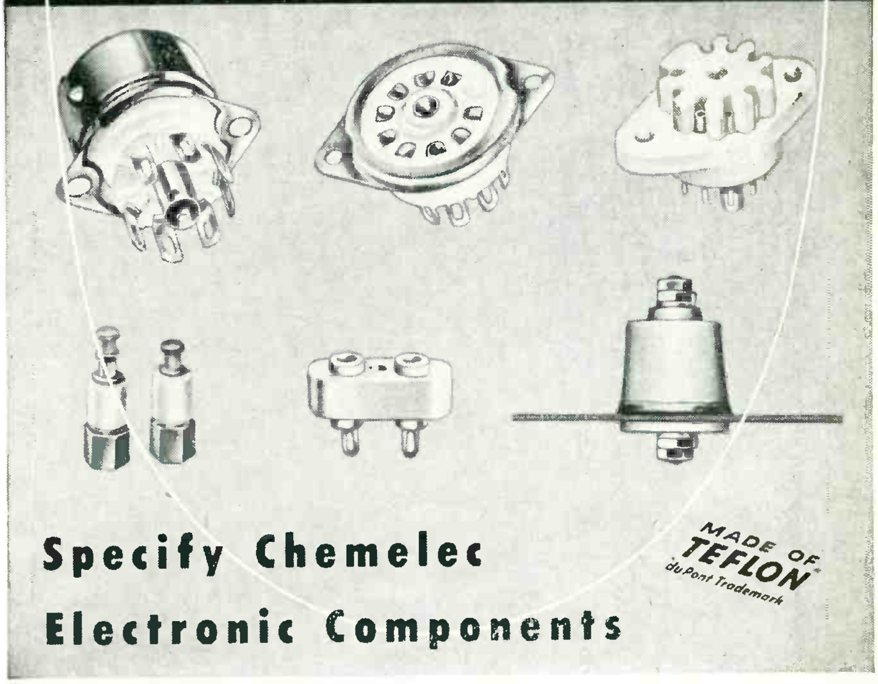

Chemelec High Performance Electronic Components include a complete line of Teflon-insulated 7 and 9-pin Miniature Tube Sockets, 9-pin Connectors, Crystal Sockets, Stand-off Insulators, Feed Through Insulators and Terminals.

All provide the same high performance which this superior insulating material assures. Surface resistivity 3.5 x 10^{13} ohms. Loss factor less than 0.0005. Dielectric constant 2.0 (60 cycles to 30,000 megacycles). Serviceable at —110° F. to 500° F. Won't carbonize under arcing. Zero water absorption by ASTM Test. Unaffected by extreme humidity. Won't DC plate. Chemically inert, non-gassing, immune to corrosive atmospheres, fungus, oil, solvents. Non-flammable, tough, resilient, withstands and absorbs mechanical shock and vibration.

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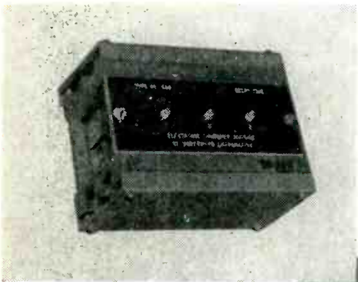

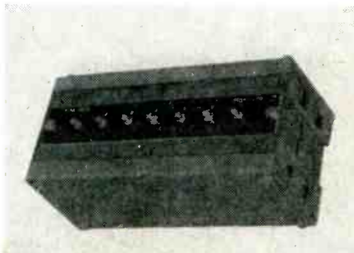

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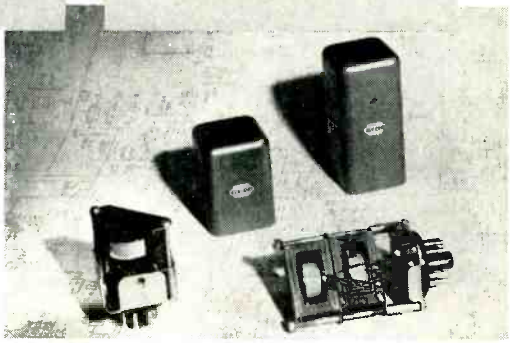

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Today, *only Daven* uses a stranded lead wire to connect the resistance wire to the solder terminal of the Super Davohm Precision Wire Wound Resistor.

As a result, no matter how much strain, stress, heat or pressure is applied to the solder terminal, no accompanying shock is put upon the fine resistance wire itself, but is absorbed by the heavy lead wire without adversely affecting the resistor in any way.

Therefore, Super Davohm Resistors are substantially more rugged than conventional resistors and are able to withstand unusual vibration, rough treatment and abnormal shocks.

This exclusive Daven feature, plus the many other quality aspects of Super Davohm Precision Wire Wound Resistors, makes Daven the leader in the resistor field.

The Super Davohm line includes resistors made in accordance with MIL-R-93A specifications, as well as sub-miniature units to give you the most complete selection of resistors available anywhere. Deliveries can be made to meet your requirements.

Write for assistance with your problems, and ask for a copy of Daven's complete, new brochure on Super Davohm Precision Wire Wound Resistors.

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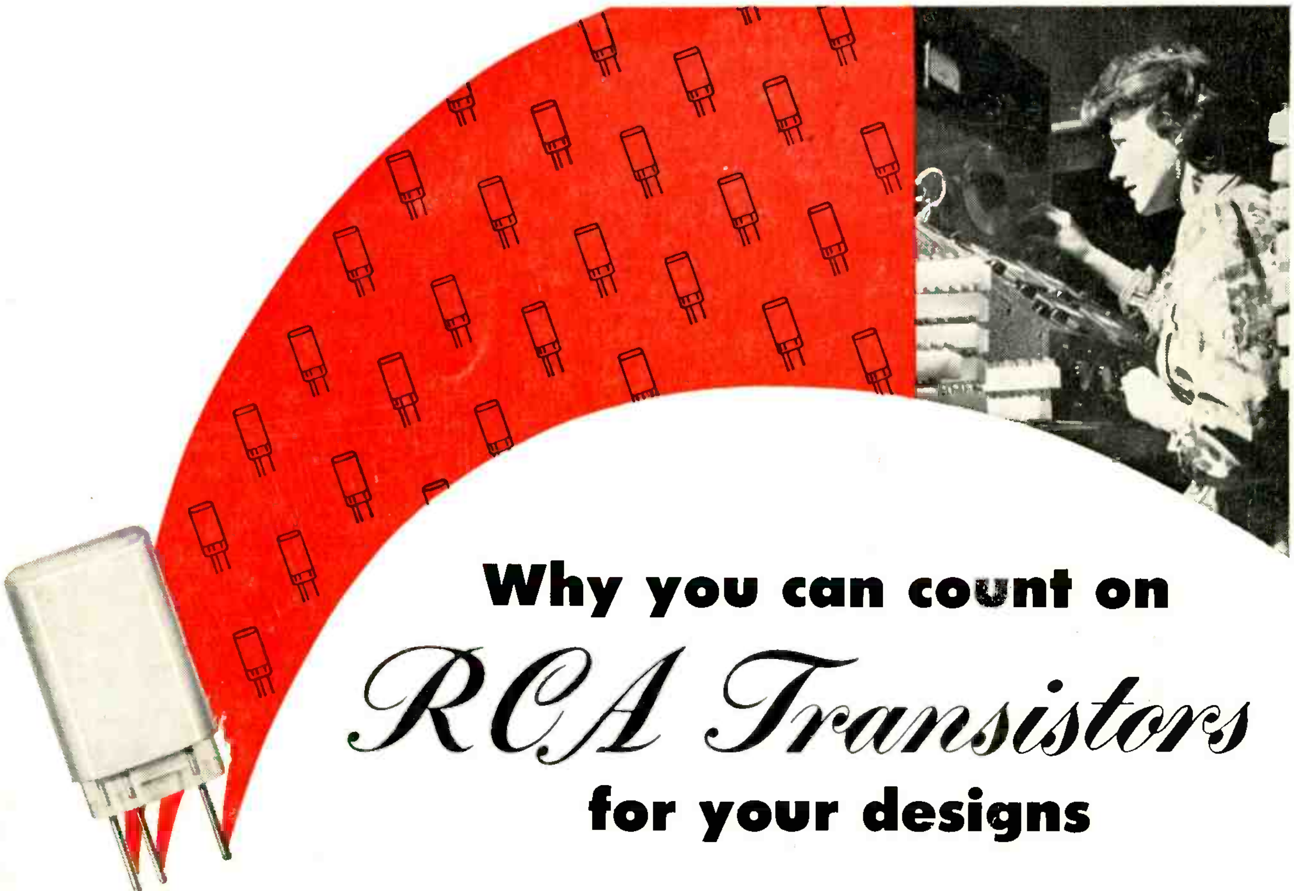

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To achieve this goal, RCA is gearing transistor production to the progress being made in developing new manufacturing techniques and improved methods of production control.

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APPLICATION GUIDE FOR RCA TRANSISTORS

RCA Type	Max. Ratings—Absolute Values		Characteristics at Ambient Temp. of 25°C			
	Collector Dissipation (mw)	Ambient Temperature (°C)	Power Gain (db)	Frequency for Alpha Cutoff (Mc)	Approx. Useful Power Output at 50 Mc (mw)	Current Amp. Factor (approx.)
RCA-2N32 Point-contact type—for pulse or switching applications	50	40	21*	2.7#	—	2.2†
RCA-2N33 Point-contact type—for oscillator applications up to 50 Mc	30	40	—	—	1.0	—
RCA-2N34 Junction p-n-p type—for low power, af amplifier applications	50	50	40**	—	—	40††
RCA-2N35 Junction n-p-n type—for low power, af amplifier applications	50	50	40**	—	—	40††

* With collector load resistance of 10000 ohms, signal-source impedance of 500 ohms, and signal frequency of 5000 cps.

†† Between Base Connection and Collector.

\# Measured at a point 3db down from its low-frequency value (100KC). Cutoff frequency is defined as the frequency at which the current amplification factor has dropped to 0.7 of its low-frequency value.

** With collector load resistance of 30000 ohms, signal-source impedance of 500 ohms, and signal frequency of 5000 cps.

† Between Emitter and Collector.

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