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electronics

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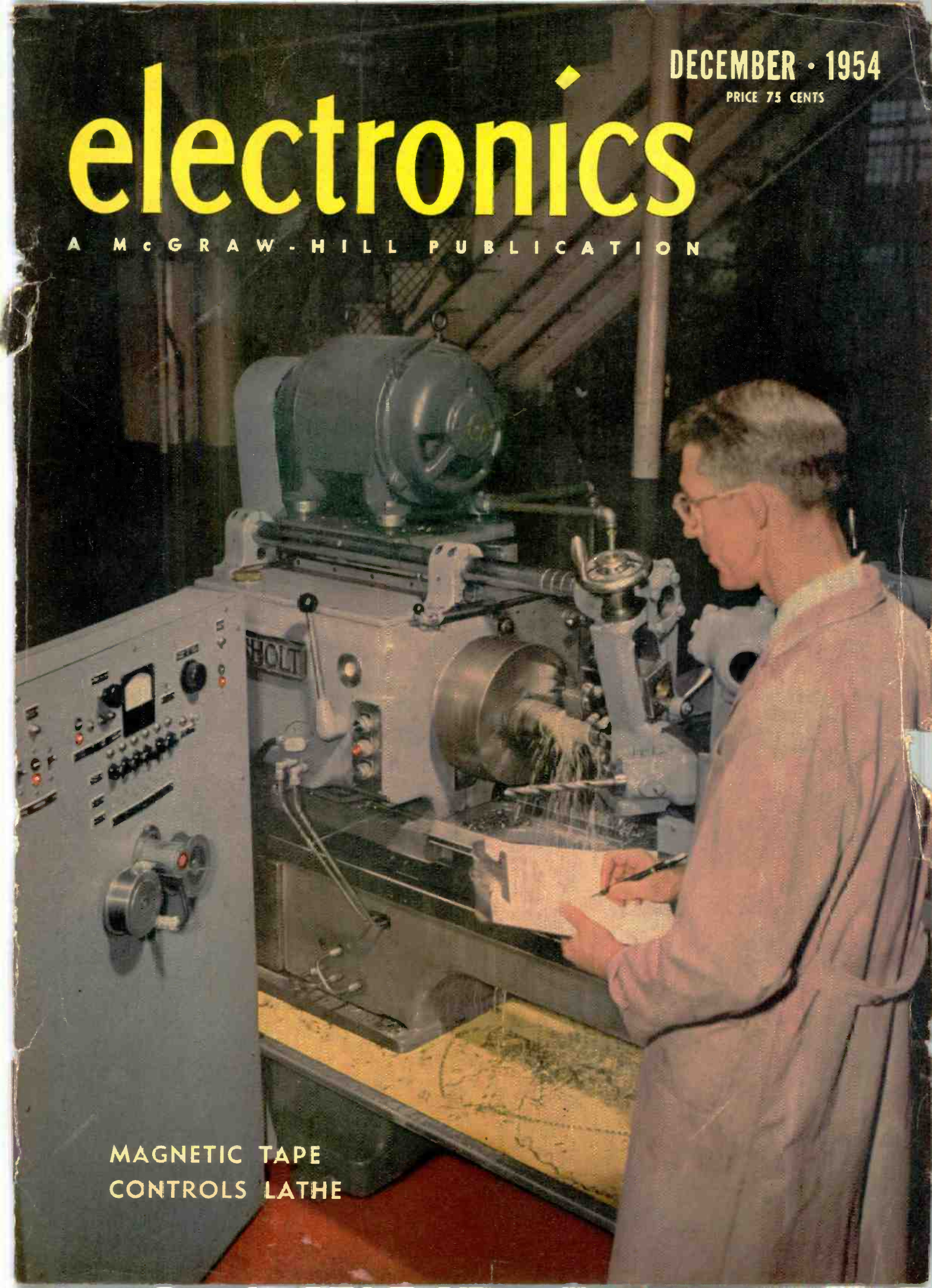


MAGNETIC TAPE
CONTROLS LATHE

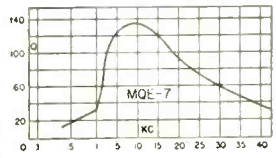
LARGEST PRODUCERS IN THIS FIELD FOR TWO DECADES...

HIGH Q INDUCTORS
FOR EVERY APPLICATION

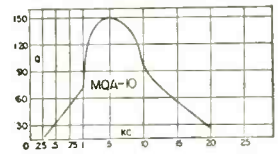
FROM STOCK... ITEMS BELOW AND 650 OTHERS IN OUR CATALOGUE B.

MQ Series Compact Hermetic Toroid Inductors

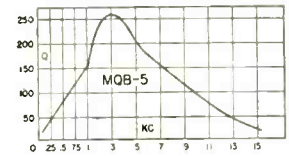
The MQ permalloy dust toroids combine the highest Q in their class with minimum size. Stability is excellent under varying voltage, temperature, frequency and vibration conditions. High permeability case plus uniform winding affords shielding of approximately 80 db.



MQE
15 stock values
from 7 Mhy.
to 2.8 Hy.



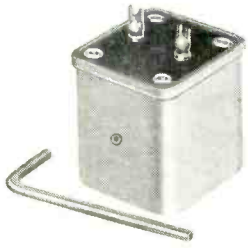
MQA
19 stock values
from 7 Mhy.
to 22 Hy.



MQB
12 stock values
from 10 Mhy.
to 25 Hy.

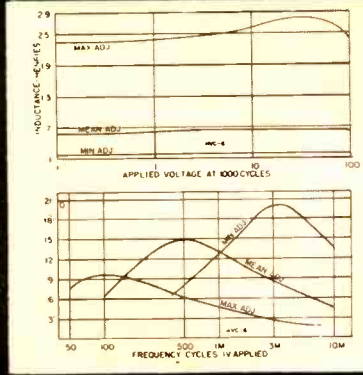
MQ drawn case structure.

	Length	Width	Height
MQE	1/2	1-1/16	1-7/32
MQA	11/16	1-9/32	1-23/32
MQB	1-5/16	2-9/16	2-13/16



VIC case structure

Length	Width	Height
1-1/4	1-11/32	1-7/16



Type	Mean Hys.	Type	Mean Hys.
VIC-1	.0085	VIC-12	1.3
VIC-2	.013	VIC-13	2.2
VIC-3	.021	VIC-14	3.4
VIC-4	.034	VIC-15	5.4
VIC-5	.053	VIC-16	8.5
VIC-6	.084	VIC-17	13.
VIC-7	.13	VIC-18	21.
VIC-8	.21	VIC-19	33.
VIC-9	.34	VIC-20	52.
VIC-10	.54	VIC-21	83.
VIC-11	.85	VIC-22	130.

VIC Variable Inductors

The VIC Inductors have represented an ideal solution to the problem of tuned audio circuits. A set screw in the side of the case permits adjustment of the inductance from +85% to −45% of the mean value. Setting is positive.

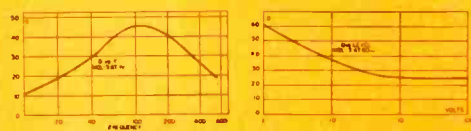
Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

MQL Low Frequency High Q Coils

The MQL series of high Q coils employ special laminated Hipermalloy cores to provide very high Q at low frequencies with exceptional stability for changes of voltage, frequency, and temperature. Two identical windings permit series, parallel, or transformer type connections.

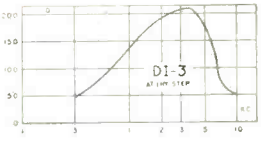
MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.

MQL case
1-13/16 dia. X 2-1/2" H.



DI Inductance Decades

These decades set new standards of Q, stability, frequency range and convenience. Inductance values laboratory adjusted to better than 1%. Units housed in a compact die cast case with sloping panel ideal for laboratory use.



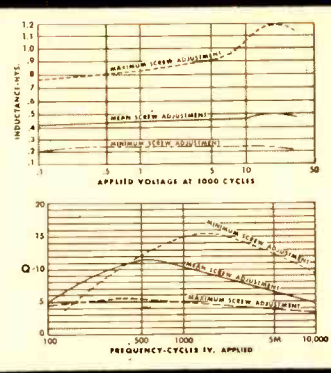
DI-1	Ten 10 Mhy. steps.
DI-2	Ten 100 Mhy. steps.
DI-3	Ten 1 Hy. steps.
DI-4	Ten 10 Hy. steps.

DI DECADE

Length	4½"
Width	4⅜"
Height	2⅜"

HVC Hermetic Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27 . . . extremely compact . . . wider inductance range . . . higher Q . . . lower and higher frequencies . . . superior voltage and temperature stability.



Type No.	Min. Hys.	Mean Hys.	Max. Hys.
HVC-1	.002	.006	.02
HVC-2	.005	.015	.05
HVC-3	.011	.040	.11
HVC-4	.03	.1	.3
HVC-5	.07	.25	.7
HVC-6	.2	.6	2
HVC-7	.5	1.5	5
HVC-8	1.1	4.0	11
HVC-9	3.0	10	30
HVC-10	7.0	25	70
HVC-11	20	60	200
HVC-12	50	150	500

HVC case structure.

Width	Length	Height
25/32	1-1/8	1-7/32

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electronics

DECEMBER • 1954
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PUBLICATION

MAGNETIC TAPE CONTROLS LATHE—Multitrack tape on control panel acts through Maico Co.'s Factrol servo system to control spindle speeds, saddle and tool positions and tape rewind on Gisholt lathe. Details on p 144.... *COVER*

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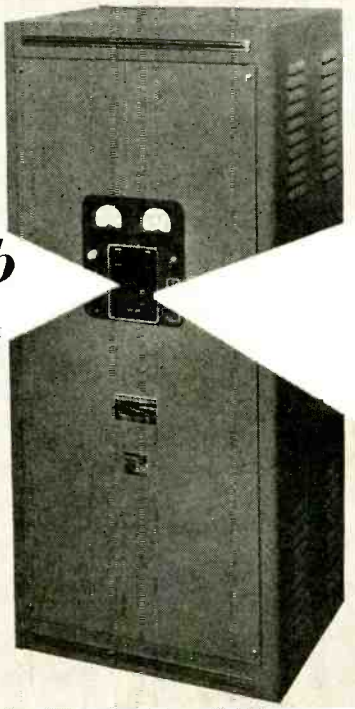

100-300VDC at 1-10 amps
(model SR2)
5-135VDC at 1-10 amps
(model SR100)
5-30VDC at 3-30 amps
(model SR30)
with ±0.25% regulation accuracy!

The Sorensen Nobatron-Ranger is essentially an adaptation of the proved Nobatron circuit**, with the added feature of continuously adjustable output voltage over a wide range. This makes the RANGER an exceptionally good investment for the many laboratories and test installations where a multi-purpose DC source can be used to advantage.

ELECTRICAL CHARACTERISTICS

Input voltage range	95-130VAC, 1Ø, 50-60~ for models SR30 and SR100 190-260VAC, 1Ø, 50-60~ for model SR2
Output voltage and load range	5-30VDC at 3-30 amps in model SR30 5-135VDC at 1-10 amps in model SR100 100-300VDC at 1-10 amps in model SR2
Regulation accuracy	±0.25% at any output voltage setting with an input between 105 and 125VAC. The accuracy will be slightly less at the extreme value of the input.
Ripple	1% RMS max. of output setting

All RANGERS are 22" wide by 17¼" deep by 47¼" high. They are self contained in handsome cabinets, equipped with casters for easy mobility. Meters are furnished as standard equipment, and there is adequate protection against overload, overvoltage, and tube filament failure.

Write for further information, and for your free copy of the new Sorensen general catalog, to Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, please correspond directly with Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

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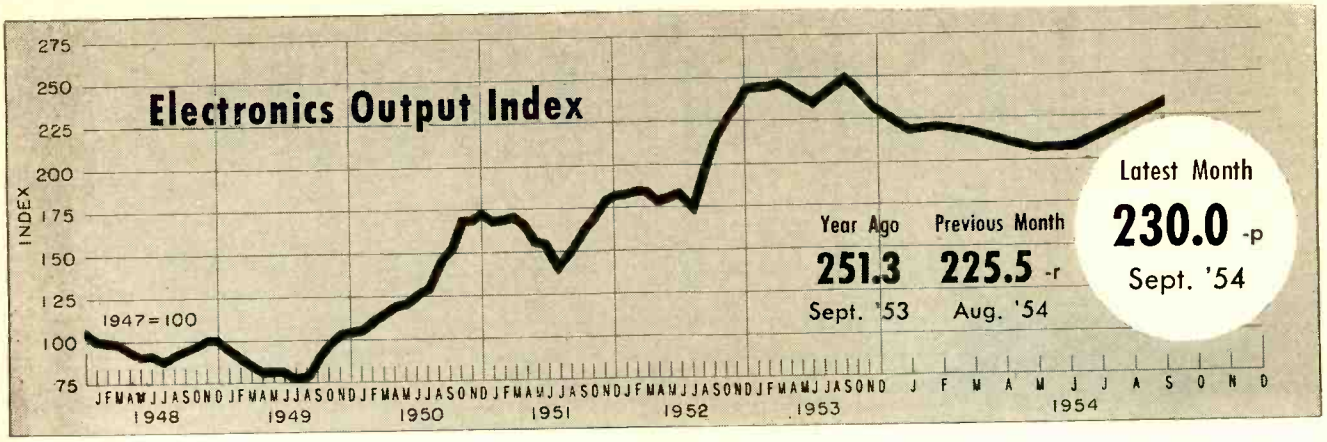


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month Sept. '54	Previous Month Aug. '54	Year Ago Sept. '53
Television sets, total	947,796	633,387	770,085
With UHF	136,613	93,404	193,212
Color sets	14,538*	N.R.	———
Radio sets, total	932,323	785,499	1,216,525
With F-M	17,644	15,936	39,873
Home sets	352,499	280,607	529,427
Clock radios	207,226	155,171	182,417
Portable sets	76,271	74,713	147,355
Auto sets	296,327	275,008	357,326

RECEIVER SALES

(Source: RETMA)	Sept. '54	Aug. '54	Sept. '53
Television sets, units	986,136	484,533	753,953
Radio sets (except auto)	763,589	447,025	650,898

RECEIVING TUBE SALES

(Source: RETMA)	Sept. '54	Aug. '54	Sept. '53
Receiv. tubes, total units	40,966,063	35,167,272	38,929,539
Receiv. tubes, value	$28,953,592	$24,002,391	$27,401,566
Picture tubes, total units	1,149,791	855,191	875,712
Picture tubes, value	$23,892,469	$17,941,034	$20,524,677

SEMICONDUCTOR SALES

	Aug. '54	July '54	Aug. '53
Germanium diodes / Silicon diodes	1,156,114	608,446	836,334

INDUSTRIAL TUBE SALES

Quarterly Figures

(Source: NEMA)	Latest Quarter 2nd '54	Previous Quarter 1st '54	Year Ago 2nd '53
Vacuum (non-receiving)	$9,851,020	$8,971,335	$10,400,000
Gas or vapor	$3,987,036	$4,589,239	$3,300,000
Phototubes	N.R.	N.R.	$700,000
Magnetrons and velocity modulation tubes	$16,429,553	$16,135,274	$10,500,000
Gaps and T/R boxes	$1,914,313	$1,517,426	$1,700,000

TV AUDIENCE

(Source: NBC Research Dept.)	Latest Month Oct. '54	Previous Month Sept. '54	Year Ago Oct. '53
TV Homes, total	31,674,000	31,274,000	25,690,000

BROADCAST STATIONS

(Source: FCC)	Oct. '54	Sept. '54	Oct. '53
TV stations on air	431	428	315
TV stations CPs—not on air	147	150	230
TV stations—applications*	167	167	424
A-M stations on air	2,627	2,616	2,497
A-M stations CPs—not on air	126	121	106
A-M stations—applications*	137	137	187
F-M stations on air	558	559	566
F-M stations CPs—not on air	10	14	20
F-M stations—applications*	2	2	5

* in hearing

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Oct. '54	Sept. '54	Oct. '53
Aeronautical	39,900	40,695	42,427
Marine	47,882	47,360	42,931
Police, fire, etc.	16,308	16,109	14,094
Industrial	22,339	22,132	18,868
Land transportation	7,012	6,982	6,201
Amateur	123,163	121,762	113,909
Citizens radio	8,229	8,143	3,987
Disaster	306	305	251
Experimental	607	600	476
Common carrier	1,730	1,699	1,327

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Aug. '54	July '54	Aug. '53
Prod. workers, comm. equip.	357,800-p	340,400-r	424,800
Av. wkly. earnings, comm.	$69.03 -p	$67.64 -r	$67.73
Av. wkly. earnings, radio	$67.83 -p	$67.20 -r	$65.36
Av. wkly. hours, comm.	39.9 -p	39.1 -r	40.8
Av. wkly. hours, radio	39.9 -p	39.3 -r	40.1

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Oct. '54	Sept. '54	Oct. '53
Radio-tv & electronics	360.4	349.4	272.1
Radio broadcasters	400.7	381.6	272.2

p—provisional; r—revised
N.R.—not reported
*9 mos.

FIGURES OF THE YEAR

	TOTALS FOR FIRST NINE MONTHS 1954	1953	Percent Change	1953 Total
Television set production	4,733,315	5,524,370	—14.3	7,214,787
Radio set production	7,042,442	10,149,163	—30.6	13,368,556
Television set sales	4,645,063	4,300,360	+ 8.0	6,375,279
Radio set sales (except auto)	4,032,704	4,526,186	—10.9	7,064,485
Receiving tube sales	266,050,907	347,152,450	—23.3	437,091,555
Cathode-ray tube sales	6,476,566	7,552,862	—14.3	7,582,835

INDUSTRY REPORT

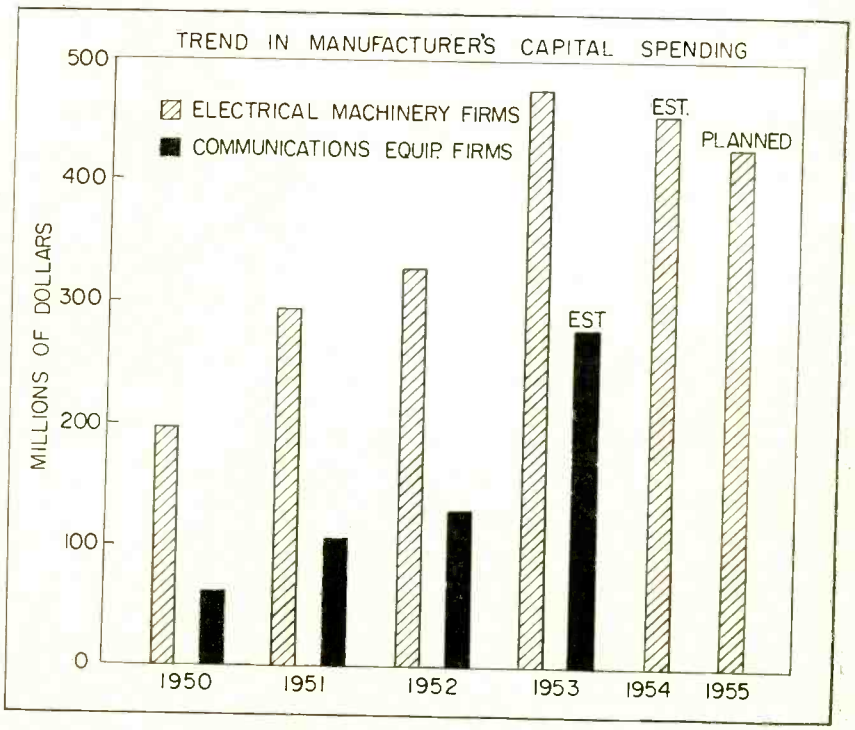
Control Board Planned To End Airport Delays

WHEN developed as an operating unit, the mock-up board shown may eliminate much of the paperwork of air traffic control. The board is under development at Bell Labs for the CAA.

The plane's location, determined from radar contact, is pinpointed on the lower board—a ppi-type of display with an airlane map overlay. Altitude information, transmitted from the plane by voice radio, is inserted manually and causes a second pip to appear on the upper board.

► **Flight Plans**—When the dark line or cursor lines up the plane's position and altitude pips, information such as identity, type, destination and ETA can be flashed on the tote board in the center. This information may be derived either from teleprinter reports or from flight plans stored in a magnetic-drum calculator.

Full-scale mock-up of proposed air traffic control board demonstrates operation



Industry Maps Capital Spending

Firms in the electronics field may spend somewhat less next year to enlarge facilities

LEVELING out of electronics manufacturers' expenditures for new plants and equipment in 1955 is indicated in the results of a survey of American industry's preliminary plans for capital spending in 1955 by the McGraw-Hill department of economics. According to the survey, manufacturing companies in the electrical machinery field, which include electronics firms, will spend about $30 million less in 1955 or $431 million compared to $461 million in 1954, a six-percent drop. The estimated amount spent this year was $20 million less than was spent in 1953, a drop of four percent.

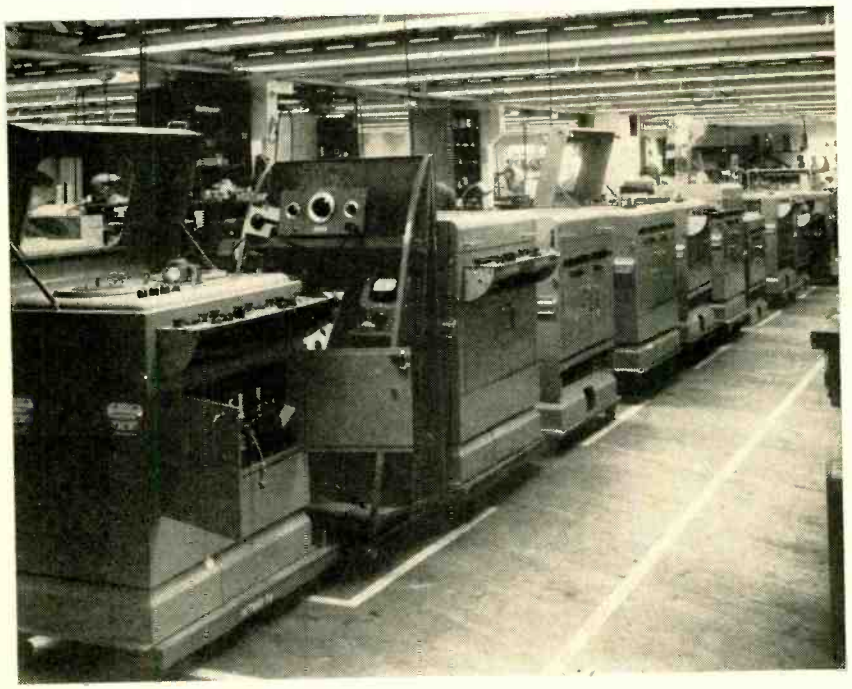
► **Chart**—As can be seen in the graph, the portion of electrical machinery capital expenditures accounted for by communications equipment firms is large and has averaged about 39 percent of the total. Thus they have accounted for much of the rise in this classification of expenditures for new plant and equipment and have probably been responsible for lessening the foreseen decline.

► **Status**—The survey shows that U. S. manufacturers as a whole have preliminary plans to spend about 7 percent less for new plants and equipment in 1955 than in 1954. However, the range in planned expenditures is wide extending from a 23 percent increase for stone, clay and glass firms to a 48 percent decrease for beverage manufacturers.

► **Future**—According to the survey, most firms in the electrical

machinery field expect capital spending in 1956 to remain about the same as for 1955. A total of 66 percent of the electrical firms surveyed indicated that their preliminary investment plans were about the same as for 1955. About 21 percent of the firms expected their investment to go down and 13 percent planned higher expenditures for plant expansion.

Although plans for 1956 are highly tentative, past surveys have indicated that companies are inclined to underestimate their capital spending for more than one year in advance. Thus the prospects are favorable for capital spending in the industry at a level at least as high in 1956 as in 1955.



DATA tape machines roll off Ampex production line as . . .

Magnetic Tape Hits High Level

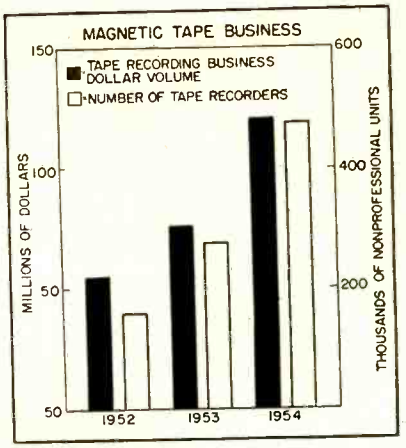
Volume in all phases of the field hits record highs as more companies enter the market

THE magnetic tape business has increased an estimated 60 percent this year and firms in the field see further future gains in the making.

▶ **Growth**—As shown in the chart, the estimated volume of business done in the tape recording field this year tops the $120 million mark. This includes sales of tape, tape machines of all types and related accessories and represents a $45 million increase over last year's business.

Biggest portion of the volume this year is accounted for by nonprofessional or home recording. It is estimated that about 450,000 home units will be sold this year for a dollar volume of over $76 million. In the professional field, about 20,000 units are expected to be sold for a dollar volume in the neighborhood of $30 million.

▶ **Tape**—Recording tape alone has become a volume business. Minnesota Mining and Manufacturing estimates that over $9 million in tape will be sold by tape makers this year compared to $8 million last year. The biggest market for tape is represented by the professional field which includes broadcasting, motion pictures and phonograph record companies.



The instrumentation field is growing in importance and it is estimated that now about 5 percent of total magnetic tape volume is used in this field. Major use in instrumentation is in telemetering aircraft and guided missiles.

▶ **Companies**—In the past year, nearly 75 manufacturing companies have entered some phase of the magnetic recording field. Growth in the number of tape and equipment makers is indicated by Armour Research Foundation of the Illinois Institute of Technology which owns more than 250 patents relating to magnetic recording equipment and sound recording tape. It lists 64 companies throughout the world that are now licensed to use ARF magnetic recording patents compared to about 25 before 1952.

Defense Business Upswing Continues

Contracts for electronics in the third quarter are nearly double last year's

RISING trend in military contract awards evident in the second quarter of 1954 (ELECTRONICS, p 10, Aug. 1954) continued in the third quarter. As shown in the chart, p 8, about $83 million was spent in contracts compared to $46 million in the third quarter of 1953. Although this total is a substantial drop from second quarter

(Continued on page 8)

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These improved Sylvania tubes are manufactured and quality controlled for highest dependability. Now for the first time they enable circuit engineers to meet precisely the ever-widening range of today's application requirements.

5675 a low Mu tube for CW operation to 3000 cycles as an amplifier, oscillator, or frequency multiplier in either lumped, constant, or external cavity-type circuits. Delivers 300 mw average power at 1700 megacycles.

5794 designed for continuous wave operation, this tube oscillates inside a cavity tuned to a fixed frequency of 1680 megacycles. This low Mu tube with its special heater at 5.2 volts is capable of delivering a power of 300 milliwatts.

5876 is a high Mu triode designed for continuous wave operation up to 3000 megacycles in either lumped, constant, or external cavity-type circuits.

5893 for pulse operation to 3400 megacycles. Will deliver .750 KW peak minimum at maximum frequency with .001 duty cycle.

6263 a low Mu high power tube for application as an amplifier, oscillator to 1700 megacycles. Plate input power is 22 watts and plate dissipation is 13 watts.

6264 a medium Mu frequency multiplier version of the 6263 with the same plate characteristics.

The attached coupon brings you full engineering data and characteristics of Sylvania's complete pencil tube line.

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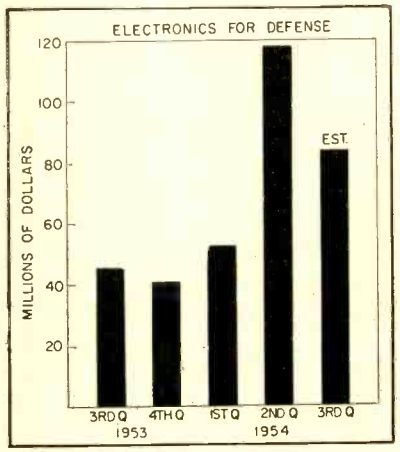
spending, it is still nearly twice that spent in the third quarter of 1953.

► **Breakdown**—The amount spent by the military on electronics may be actually 4 or 5 times as much as indicated by Pentagon breakdowns shown in the chart because contracts for equipment such as ships, planes and missiles include money for associated electronic equipment.

Increased contract awards for these items also mean more business for electronics manufacturers. Estimates of defense contracts for these equipments in the third quarter are $1.2 billion for aircraft, $292 million for ships and $44 million for guided missiles. If

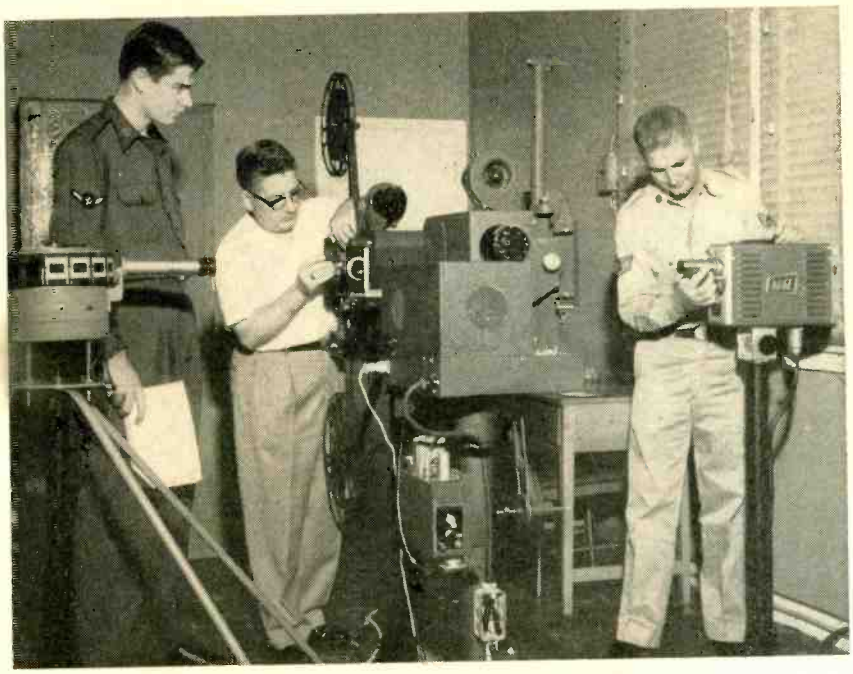


only 10 percent of these total contracts go for electronic equipment, it will mean an additional $150 million in business for the field.

The importance of electronics, dollarwise, in military end equipment is indicated in recent contract awards. The Navy recently awarded one electronics manufacturer a $24.6-million contract for sonar detection devices. Two recent contracts for guided missiles have meant over $200 million in business for electronics firms.

► **Subcontractors**—There will be substantial new business for small electronics subcontractors as a result of the increased spending.

Air Force, in a sampling of its electronics subcontractors made last year, found that between 40 to 54 percent of the dollar value of electronic prime contracts were going to subcontractors.



AIR Transport Station in Azores installs tv equipment while . . .

Military Telecasting Increases

Air Force personnel buy second low-power television station for entertainment use

PLANS to provide television entertainment to military personnel in areas in the U. S. and abroad where regular telecasting is unavailable are being stepped up in the Armed Forces. Dage division of Thompson Products recently supplied a $50,000 system for the U. S. military air transport station on Terceira Island in the Azores. It is the second tv system supplied to the military for entertainment use. A $34,000 station supplied by RCA is presently operating at the Air Force base in Limestone, Maine.

Both stations are owned and operated by military personnel and were purchased with PX and movie proceeds or welfare funds.

► **Equipment**—Both of the Air Force stations have low power ratings. The Azores station equipment includes a Dage dual Vidicon chain, a 50-watt Gates transmitter and two Holmes 16-mm tv projectors and other studio equipment. The transmitter's peak visual output of 50 watts is fed into a simple ring-type antenna with a gain of approximately 0.8.

► **Policy**—According to the Air Force, such military tv stations will be operated only in areas where it is not possible to receive tv programs from commercial outlets. The stations will be located primarily in bases where dependents of personnel also live.

It has been indicated that if the present stations prove successful, the Armed Forces will standardize on the type of equipment used.

Electronics Business Picks Up

Although some segments of the industry are behind last year, all exceed 1952 business

ELECTRONICS manufacturers are keeping company with U. S. industry as a whole in the upsurge in business that took shape as the last quarter of 1954 got underway. Although total output as measured by the *Electronics Output Index* is considered likely to remain below

(Continued on page 10)

only Sprague makes them all!

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Looking for tantalum electrolytic capacitors? You'll save time and trouble by checking Sprague's complete selection *first*. Sprague makes more types of tantalum capacitors than *any other manufacturer*.

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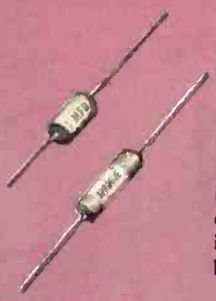
There's a complete range of sizes and ratings available in Tantalex capacitors . . . from the ultra-miniature 10 mf, 4 volt unit in a case only ⅛" in diameter by 5/16" long . . . to the 7 mf, 630 volt unit in a case 1⅛" in diameter by 2 19/32" long. As for case styles, Sprague makes them all, from tiny tubular and cup units to the large cylindrical types.

For complete details relating to your miniaturization or high temperature problems, write Sprague Electric Co., 35 Marshall St., North Adams, Mass.

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of tantalum capacitors.



NEW! TYPE 101D for low-cost transistor circuitry

Especially useful for filter, coupling, and by-pass applications in transistor electronics, these foil type miniature Tantalex capacitors were intended for use in hearing aids, pocket radios, and similar uses. Operating temperature range is —20 to +65°C. Request Engineering Bulletin 353.

NEW! TYPE 102D for −55°C to +85°C operation for military use

Here are tubular capacitors hermetically sealed in cases of silver plated copper. Intended for applications from 3 to 150 vdc, their small capacitance drop-off at extremely low temperatures, extremely low leakage current, and low power factor are of particular interest. Request Engineering Bulletin 351.

NEW! TYPE 103D ultra-miniature capacitors for transistor circuitry

Only ⅛" in diameter, and from 5/16" to ½" in length, these are the smallest electrolytics made. Providing relatively large values of capacitance in the very minimum of space in bypass, coupling, and filter applications, they are ideally suited for transistor hearing aids and military amplifiers in which small size is all-important.
Request Engineering Bulletin 352.

NEW! TYPE 104D miniature "cup" capacitor for military use

These low-voltage units consist of a sintered porous tantalum anode housed in a miniature silver thimble, which serves as both cathode and container for the electrolyte. Volume is less than 1/10 cubic inch; operating temperature range —55 to +85°C, and up to 100°C with a voltage derating of 15%. Request Engineering Bulletin 354.

TYPE 100D for −55 to +125°C operation for military use

These hermetically sealed capacitors are available in voltage ratings up to 630 volts at 85°C or 560 volts at 125°C. They are of the sintered porous tantalum anode type, with internal construction to withstand high g shock, severe vibration, and thermal cycling. Request Engineering Bulletin 350A.

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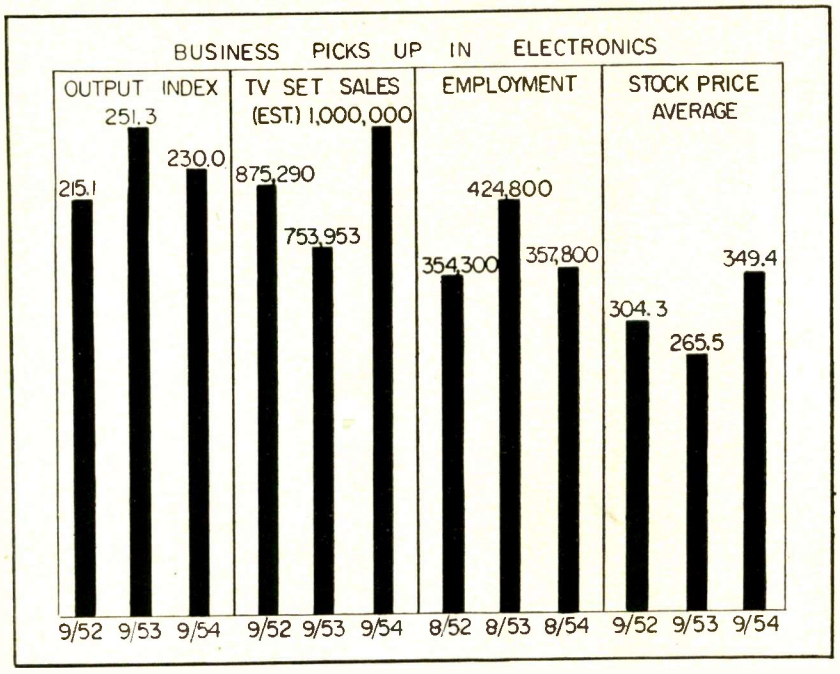


last year's records, indications are that output in the last three months will exceed that of 1953's last quarter.

► **Chart**—As shown in the graph, the *Electronics Output Index* took a decided rise in September of 18 points, far above the output for September, 1952. The provisional figure of 230.0 may be revised even higher now that final tv production figures are in.

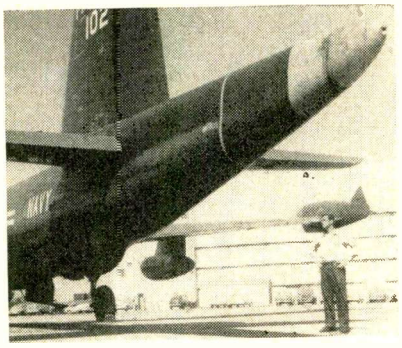
RETMA has announced that nearly one million tv receivers were produced in September to establish a new high in monthly output for the product. During the five-week period production totaled 947,796 units compared with 633,387 produced in August and 770,085 sets manufactured in September of 1953. The previous record high was established in December, 1952 when 921,086 sets were manufactured in a statistical period which extended over six weeks.

Television set retail sales have also increased to a record volume, as shown in the chart. During the month of September 986,136 tv sets were sold, exceeding the month's total in 1953 and 1952 and bringing this year's nine-months total to approximately 4.6 million units.

► **Employment**—Mirroring the industry's increased output are figures on production worker employment. Even though latest reports cover August figures, the upswing is apparent. Employment of production workers reached 357,800 in the month, compared to 354,300 in August of 1952. With the high output of nearly one-million tv sets in September, it is likely that employment totals have increased substantially.

► **Future** — Financial observers point out that the stock market has provided some indication of the future business prospects for an industry. If that holds true for present electronics stock price averages, the industry can look forward to increasing business next year.

Tail Tattles On Subs



Protuberance resembling a giant wasp's stinger that appears on this Navy Neptune contains a magnetic airborne detector which spots submarines by registering disturbances in the earth's magnetic field

Business Sizes Up Electronic Computers

Users and prospects foresee expanding future for office equipment but urge careful study

MORE than a quarter century ago, Bell System executives gave the green light to automatic dialing when studies predicted a future dearth of telephone operators. General business stands at the same threshold. Management men realize the tempo and complexity of modern business must one day outstrip pencil-pushing methods.

The question is, "How soon will my office have to go electronic?" This past month several management specialists offered varying opinions:

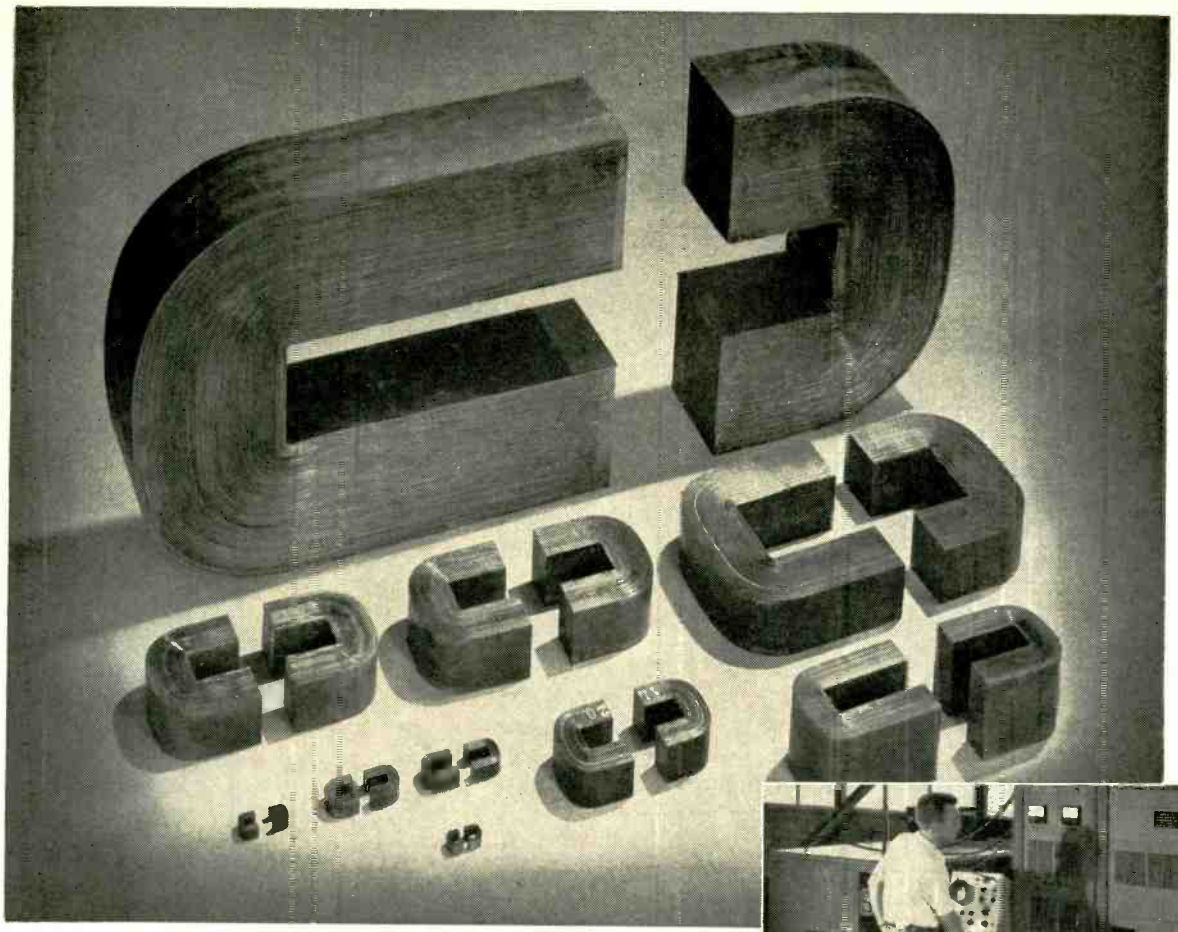
► Electronic computers are destined to be recognized as the most powerful management tool yet developed—predicted W. W. Smith, senior procedures analyst for General Electric's major appliance division. He indicated that GE was saving $100,000 annually through assembly-line studies at Appliance Park.

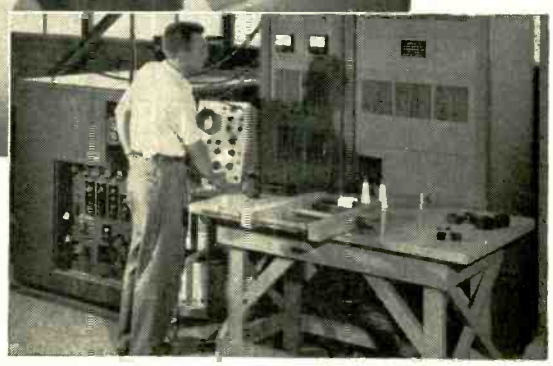
► The complete automatic office made up of only sexless and shapeless machinery will never come even if large-scale electronic systems become common in offices—asserted J. D. Elliott, superintendent of customer billing for Detroit Edison.

► Large companies that do not enter into an electronic program voluntarily in the very near future will be forced into it when they are no longer able to meet the low cost of operation and prompt service provided their competitors—said A. C. Vanselow, Franklin Life Insurance Co.'s assistant v-p in charge of planning. He announced that computer techniques were saving his company $425,000 annually in salaries.

► Business still has a long way to go in learning how to plan the

(Continued on page 12)





Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

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The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

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efficient use of computers—stated E. F. Cooley, associate director of methods research, Prudential Life Insurance Co. of America.

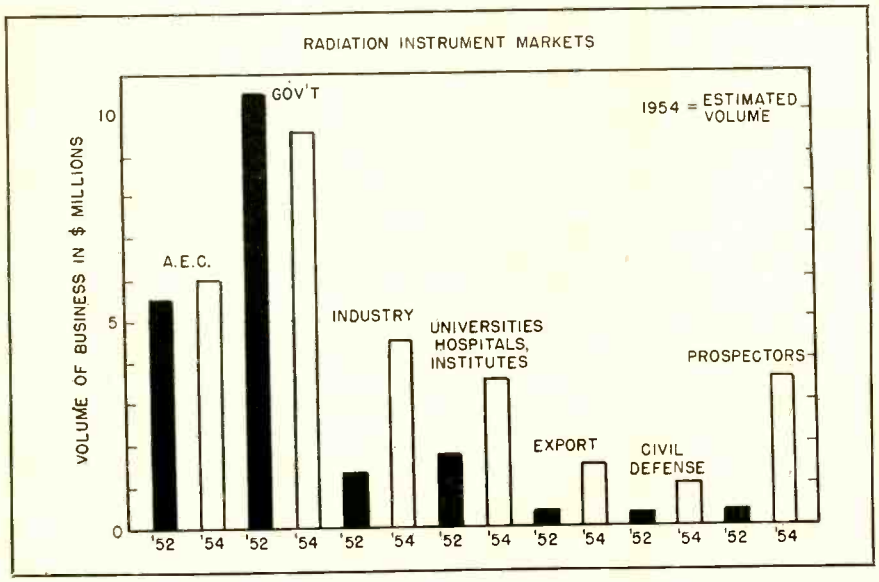
▶**Computing Center**—Computer manufacturers indicated that use of computing-center facilities is one way to approach the electronic office. Reasons for patronizing the centers include: learning the advantages of computer operation to justify buying or renting one, help during peak-load times and carrying out projects left in the bottom-left desk drawer for want of free time.

▶**Procedures Study**—Systems and procedures experts agree that all large-scale business should investigate use of computers in their operations. Even if a computer is not indicated, the study should reveal some worth-while ways to streamline operations for efficiency and economy.

▶**New Equipment**—Integrated data processing, as announced by a maker of business forms, refers to a system of machines talking to machines through the common language of punched paper tape. This system is designed to tie existing business and communications equipment in with electronic computers in a complete system.

National Cash Register recently demonstrated a medium-sized computer selling for $89,500 to $140,000, depending on the precise application. Basically a scientific calculator, it occupies two free-standing cabinets and control console.

A smaller computer, about the size of a standard office desk has been introduced by Burroughs. It sells for $32,500.

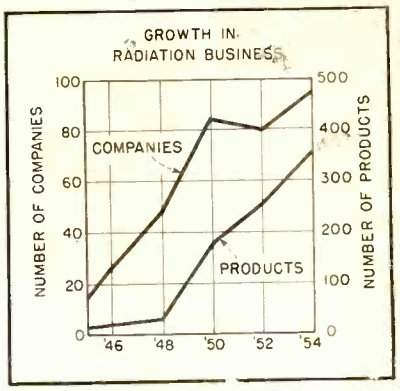


Atom Sparks Instrument Sales

Expanding use of the atom provides $50 million in potential markets by 1960

INSTRUMENTATION for nuclear energy operations has been a steadily growing business since the beginning of the atomic energy program and is expected to continue its expansion. The field comprised three companies manufacturing nuclear instruments in 1943 and has expanded to 96 companies in ten years. Their business volume for 1953 is estimated at $25 million. By 1960 this volume is expected to reach $50 million.

Most of these companies are small—85 percent are doing business in the neighborhood of $300,000 or less. Only six of these nuclear instrument companies are known to have volumes greater than $1 million.



▶**Markets**—In addition to the growing new instrument market, there is a large market in replacements. The Atomic Energy Commission reports that 25 percent of its annual instrumentation cost is for improved instruments. The AEC's estimate of $6 million in expenditures for nuclear instrumentation in 1953 is expected to reach a level of $12 million by 1960. This provides a potential market of $45 million over the next five years.

Over 5,000 new medical users of radioisotopes are expected to enter the field in the next five years. The instrumentation required by these and present users provides a five-year market of $20 million. Civil defense requirements for the same period are estimated to be 50,000 survey meters and over 1,500,000 dosimeters at a cost of over $30 million.

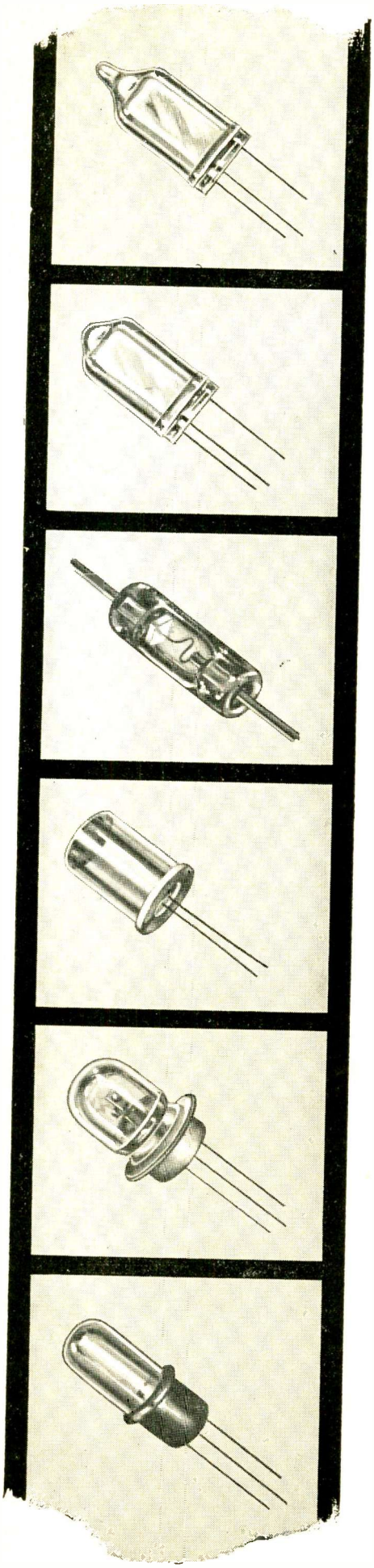
New York Surveys Its Electronics Industry

MANUFACTURE of electronic equipment is steadily expanding in New York State. New plants have been built by firms such as GE, Sonotone, Westinghouse, Sylvania, CBS-Hytron, IBM and Remington Rand.

The Empire State produces a significant share of the national electronic output, according to a study by the New York State Department of Commerce.

▶**Workers**—The state has occupied an important position in the industry's production and employment for a number of years. Be-

(Continued on page 14)



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With Kahle machinery and methods you can obtain high speed, low speed, or laboratory production to meet any encapsulation production requirements.

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tween 1939 and 1947, the number of production workers manufacturing radios, television sets and related electronic products increased 341 percent in the state, compared with a national gain of 213 percent.

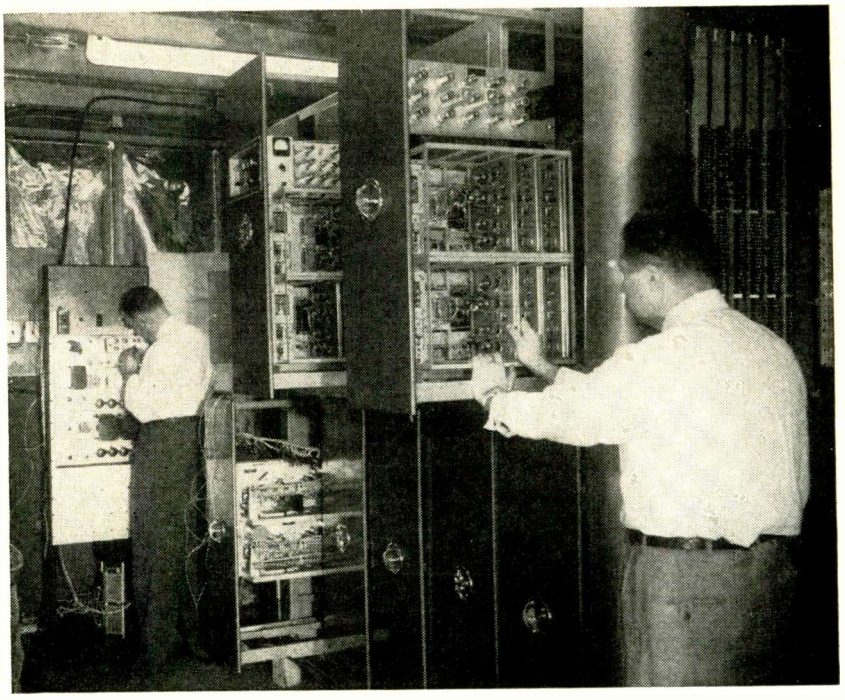
While nation-wide employment in the field gained little from 1947 to 1950, the increase in New York was 20 percent, according to the Department. In electronics, peak employment was reached in October of last year when 73,000 workers were employed. Approximately one-fifth of the nation's workers in the industry are employed in New York State.

► **Where**—Over one-third of the industry's workers in the state are employed in New York City plants. Other concentrations are to be found on Long Island and in Syracuse, Rochester, Poughkeepsie and Buffalo. Many small enterprises have been set up in Westchester County, outside of New York City.

A number of the plants recently established or under construction have been located in areas where the industry has not previously been important. For example, GE has enlarged its Utica factory and is also operating in Johnson City. Westinghouse has completed large plants at Bath and Horseheads. Sylvania has opened new facilities at Batavia and many small enterprises have been set up throughout the Hudson River Valley.

► **Why**—Among the reasons for the State's position in the industry is its immediately available mass consumer and industrial markets. In addition, a technical labor supply has developed in the state and there are more than 90 commercial laboratories that conduct research in electronics.

The Department points out that an estimated 30 to 40 million people make up the consumer market and the industrial Northeast is the location of some of the nation's largest manufacturers. Access to these markets has been improved through New York State's highway building program which is expected to open new markets and building sites to state's growing electronics industry.



DATA recording system is designed and built by The Austin Co. as . . .

Plant Builders Look To Electronics

AN industrial plant construction firm is in the electronics manufacturing business and there are signs that others may soon join the industry either through acquisition of existing electronic companies or the establishment of electronics divisions. One of the main reasons for construction company interest in electronics is the increasing use of specialized electronic automatic production equipment in plants being built.

► **Firm**—Although there are several construction firms engaged in building electronically instrumented plants, the Austin Company is actually producing electronic equipment. The company, through its special devices division, has manufactured and sold a wide variety of electronic devices. The division's sales volume exceeded $3 million last year. It has built and sold several computers to industry, mainly to machine tool builders, and eighteen $75,000 data recording machines like the one shown.

Although most of the division's sales have been to the military, an increasing number of devices are being sold to industry. Some business has come from the electronics industry as a result of the company's many plant building contacts with the field. The firm estimates that it has built approximately 60 percent of the buildings for tv stations now on the air and a large number of electronics production plants.

► **Equipment**—The range and extent to which Austin is already in the electronics business can be seen in the following list of some of the systems that have been designed and built by its special devices division: color-tv tape recorder, analog and digital computers, radiation detection devices, electronic color scanners, sonar devices and automatic data processing and recording systems.

Printed circuits are used extensively by the company in its data processing equipment. One recent installation is a computer for an aircraft engine manufacturer to control the machine cutting of jet turbine blades. It is from the automatic production field, that The Austin Co. expects a large share of its future business.

(Continued on page 16)

Barry Engineers Report on Design Methods

Technical articles written by Barry engineers over the past several years on the protection of electronic apparatus against damage by vibration and shock are now available. The information presented covers both the theoretical and the practical aspects of shock and vibration protection—for aircraft, naval, mobile, and industrial equipment.

Engineers who wish copies of these reports may obtain them by asking for them by number; requests should be addressed to Mr. A. S. Chivers, Barry Corporation, Watertown, Mass.

Designing for Shock Resistance
By Charles E. Crede and Miguel C. Junger. Reprinted from "Machine Design", Jan. 1951.
Bulletin R-511

Shock Testing of Airborne Equipment
By Charles E. Crede. Reprinted from "Tele-Tech", July-August 1951. Bulletin R-518

How to Evaluate Shock Tests
By Charles E. Crede. Reprinted from "Machine Design", Dec. 1951. Bulletin R-521

Toned-Down Noise Tunes Up Operation
By Charles E. Crede. Reprinted from "Steel", Feb. 25, 1952.
Bulletin R-523

Mounting Keeps Vibration in its Place
By William C. Gallmeyer. Reprinted from "Steel", May 18, 1953. Bulletin R-535

Shock or Vibration Isolators?
By J. Markowitz. Reprinted from "Product Engineering" June, 1953. Bulletin R-536

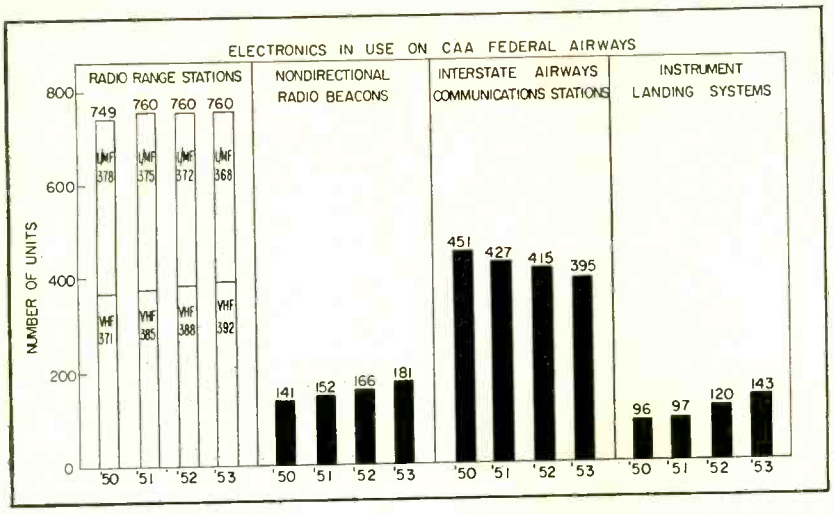
Mock-ups for Vibration and Shock Testing
By Charles E. Crede. Reprinted from "Product Engineering" July, 1953. Bulletin R-537

Vibration Isolators speed up plant changes
By Harold Wrigley. Reprinted from "Plant Engineering" Jan. 1954. Bulletin R-541

The Role of Shock Testing Machines in Design
By Charles E. Crede. Reprinted from "Mechanical Engineering" July, 1954. Bulletin R-544

Vibration and Shock Isolators
By Charles E. Crede. Reprinted from "Machine Design", August 1954. Bulletin R-546

Machine Mobility
By E. A. Johnson. Reprinted from "Automation", September, 1954.
Bulletin R-547



CAA Takes On More Electronics

Installation of newer aids for civil air navigation increases. Budget for '55 rises

SPENDING by the government for civil-aviation electronic aids represents substantial business for some manufacturers. This can be seen in the table below of CAA appropriations for electronics in the fiscal years indicated. Funds do not include money for relocation of facilities.

► **Gear**—As shown in the graph, vhf radio-range stations are gradually replacing low and medium-frequency radio-range stations. The number of nondirectional radio beacons is also increasing steadily. A decrease in interstate airways communications stations has been evident since 1950. In 1949 there were 464 such stations but as aircraft radio equipment has improved the need for these stations has decreased so that at the beginning of 1954 there were only 395.

Biggest increase percentagewise in CAA aids to navigation was in instrument landing systems with a total of 23 installed last year bringing the total to 143. Precision approach radar remained at 10 while airport surveillance radar increased from 10 to 17 systems during the year.

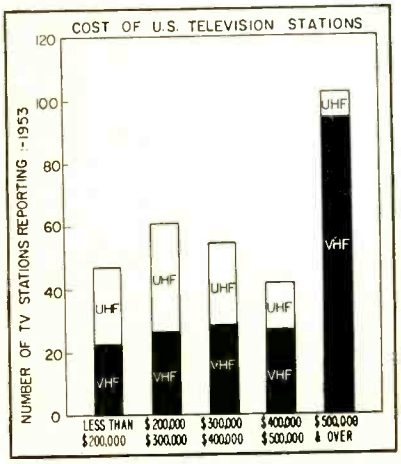
► **Future**—According to CAA, the vhf omnirange (VOR) gear with its complementary unit, distance measuring equipment, is meeting the need for greater reliability and utility in navigation. Progress in the installation of this equipment is indicated by the fact that a total of 454 DME's will be installed by CAA by June 30, 1955 although not all of them will be operating. There are at present 230 units in operational use, 34 operating "off and on" and 186 "under test" leaving 4 DME's not yet assigned.

► **Abroad**—Recommended by International Civil Aviation Organization (ICAO) is the establishment of Consol beacon stations at Iceland, Southern Greenland, the Azores, Newfoundland, Labrador, Nantucket and Atlantic City.

Consol, developed by the British from the German wartime Sonne system, is attractive in that it has a daytime range of 1,000 miles and requires only a low-frequency receiver and a watch with a second hand to provide navigational information. Four transmitting stations are presently operating in Europe.

The United States, which would bear the lion's share of the financial burden in erecting and operating such facilities, is inclined to accept Consol as an interim navigational aid. Two developmental stations are to be operated soon at Nantucket and Atlantic City.

Item	1953 No.	1953 Amt.	1954 No.	1954 Amt.	1955 No.	1955 Amt.	Total No.	Total Amt.
VOR	...	.....	7	$679,897	24	$2,495,908	31	$3,175,805
Remote comm	1	$58,893	...	.....	8	331,321	9	390,214
Stations towers	23	856,446	33	1,781,864	1	31,689	57	2,669,999
Radar control rooms	...	.....	...	.....	1	24,351	1	24,351
Air-ground station	1	27,579	...	.....	...	.....	1	27,579
Remote transmitter	...	.....	2	118,100	...	.....	2	118,100
100 wpm telecomm	...	2,015,019	...	.....	...	.....	...	2,015,019
VHF, A/G comm	265	517,617	...	.....	...	.....	265	517,617
Totals		$3,475,554		$2,579,861		$2,883,269		$8,938,684



FCC Reports On TV Broadcasters' Profits

Final figures for 1953 show that tv revenues increased 33 percent

DESPITE wide variations in individual station income, the final tv broadcast financial data for 1953, recently released by FCC, shows that tv broadcasters as a whole enjoyed record sales and profits last year. Total tv broadcast revenues for the field in 1953 were $432.7 million, 33 percent above 1952's $324.2 million. This includes revenues from the sale of time, talent and program material to advertisers. Net income before Federal income tax for the broadcasters, comprised of 4 tv networks and 334 tv stations, was $68.0 million or almost 23 percent above 1952's $55.5 million.

(Continued on page 18)

Basic

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For High Performance at Moderate Cost

The G-R UNIT INSTRUMENT line, started some years ago, offers the educational laboratory a wide variety of basic instrumentation with high-grade performance.

The G-R Unit Instrument idea is the economical design of single instruments incorporating one basic function with simple, rugged and compact construction; all unnecessary refinements are omitted in the interest of maximum performance at minimum price; no concessions are made in either electrical characteristics or reliability.

The unit instruments plug into one another, connect to one another or can be used with each other or auxiliary accessories to form assemblies and systems for a wide variety of specific measurements.

Separate, plug-in Unit power supplies are available for those instruments not having built-in power sources.

For complete descriptions of these and other G-R Unit Instruments, write for the UNIT INSTRUMENT Bulletin

UNIT INSTRUMENTS

RANGE	TYPE NO.	PRICE
OSCILLATORS		
500 kc to 50 Mc	1211-A	$295.00
50 Mc to 250 Mc	1215-A	190.00
65 Mc to 500 Mc	1208-A	190.00
250 Mc to 920 Mc	1209-A	235.00
10-100-1,000 kc and harmonics to 1,000 Mc	1213-A	130.00
400 c and 1,000 c	1214-A (Built-In Power Supply)	66.00
AMPLIFIERS		
Wide Range 3 w: 20 c to 50 kc 1.5 w: 10 c to 100 kc 0.5 w: 250 kc	1206-B	85.00
30 Mc IF Amplifier Bandwidth: 0.7 Mc—3 db down 9.5 Mc—60 db down	1216-A (Built-In Power Supply)	365.00
NULL DETECTOR		
20 c to 5 Mc— On-scale Range 120 db	1212-A	145.00
PULSE GENERATOR		
Durations: Continuous 0.2 to 60,000 μsec	1217-A	225.00
POWER SUPPLIES		
★ NOTE: The Type 1203-A Unit Power Supply will furnish power for all of the above, except Types 1214-A and 1216-A which have built-in supplies.		
OUTPUT: a-c 6.3 v, 3 a max. d-c 300 v, 50 ma max.	1203-A	40.00
OUTPUT: a-c 6.3 v, 3 a max. d-c 0 to 300 v, 100 ma max. no-load: 400 v	1204-B	90.00

We sell direct. Prices shown are NET, f.o.b. Cambridge or W. Concord, Mass.

One of the Newest and Most Popular G-R Instruments . . .

Type 1217-A Unit Pulser . . $225.00
(shown with 1203-A Unit Power Supply)

Pulse Durations: 0.2 to 60,000 μsec
Rise Time: 0.05 μsec with minimum overshoot
Repetition Rates: 30 c to 100 kc in 12 steps
Variable Amplitude: 0 to 20 v, open circuit

Output Impedance: 200 ohms for plus pulses, 1500 for negative
External Synchronization: pulses or sine waves can be used for continuous locking from 15 c to 100 kc
Sync Signal for Scope: leads pulse by 1/10 μsec —leading edge will be visible in scope
Power Supply: Plug-in Type 1203-A: **$40.00**

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STROBOSCOPES
TV & BROADCAST MONITORS
U-H-F MEASURING EQUIPMENT
UNIT INSTRUMENTS
VARIACS®
V-T VOLTMETERS
WAVE ANALYZERS
WAVE FILTERS

▶**Networks**—Revenues of the tv networks including their 16 owned and operated stations in 1953 totaled $231.7 million compared to $170.3 million in 1952. This left a net profit before federal income taxes for the networks of $18 million compared to $9.9 million in 1952. The tv profit of $18 million was almost double the $9.4 million received from a-m radio in 1953.

▶**Stations**—Of the 108 prefreeze stations, including network owned and operated stations, 97 reported profitable operations for 1953 compared to 94 in 1952. Thirteen of the 97 reported profits before Federal income tax between $1 million and $1.5 million and 13 others had profits of more than $1.5 million.

There were 11 prefreeze stations with losses last year compared to 14 in 1952. Eight were located in New York and Los Angeles, the two 7-stations markets in the U.S. Of the 11 stations, 6 had losses of less than $200,000, 1 had a loss between $200,000 and $400,000 and 4 had losses of $400,000 to $800,000.

▶**Freeze**—A total of 240 post-freeze stations had commenced commercial operations by the end of 1953. Reports from 226 of these stations showed that 114 vhf stations had total revenues of $16.1 million, expenses of $20.3 million and a loss of $4.2 million.

A total of 112 uhf stations reported revenues of $10.4 million, expenses of $16.7 million and a loss of $6.3 million. The average post-freeze station had been in operation less than five months at the end of 1953.

▶**Equipment**—A total of $233.1 million had been invested by 325 stations at the end of 1953 in tangible broadcast property which includes land, building and equipment. Of this amount, $71.6 million was invested by networks and their 16 owned and operated stations; $87.4 million by 91 prefreeze stations; $40.9 million by 109 post-freeze vhf stations and $33.2 million 109 post-freeze uhf stations.

As shown in the chart on p 16, 104 stations, including 21 post-freeze vhf and 8 post-freeze uhf reported an investment in tangible broadcast property of $500,000 and over; 47 stations including 21 post-freeze vhf and 24 uhf reported an investment of less than $200,000. As can be seen, the largest number of uhf stations, 35, have invested between $200,000 and $300,000 for station property while most vhf stations have invested $500,000 and over.

Radar Brain Subdues Railway Jolts

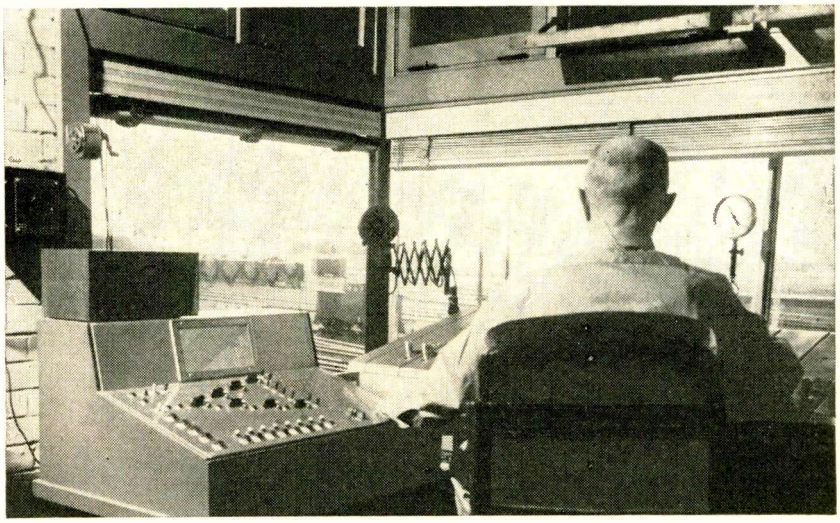
Automatic yardmaster can cut freight damage costs by controlling car speed

DAMAGE CLAIMS paid last year by American railroads for freight loss amounted to more than $111 million. A considerable fraction of this sum resulted from current practice in train make-up yards. Here, a string of cars for various destinations is pushed up over a hump or artificial hill and each car is cut loose to coast onto an appropriate classification track. In the old days, a brakeman rode the car, slowing it down expertly with the hand-brakewheel just before it coupled onto the train being made up.

Nowadays, a towerman operates a series of electropneumatic car retarders that grip the wheels and slow the car. But once a car has passed beyond control of the retarders it may travel so slowly it doesn't couple or it may smack into its neighbor with consequent damage to itself or its contents.

▶**Automatic Judgment**—Union Pacific and Reeves Instrument engineers have recently combined radar, a computer and the remotely controlled car retarder into a sure-fire control that will permit automatic humping of 4,000 freight cars in 24 hours. Whether the car is to roll two-thirds of a mile or a few hundred feet, the electronic computer sets the retarders so that coupling is at a speed no greater than three miles an hour.

The radar speed meter senses a car's progress and the computer sends the retarders instructions for light or heavy braking. Switching instructions for as many as 120 cars can also be fed into the computer by the yardmaster as soon as he receives a teleprinted listing of the makeup of a train and destination of each car.



Electropneumatic car retarders are remotely controlled from this yardmaster's tower above Union Pacific North Platte, Neb., yards. Human judgment as to proper speed of car is removed by computer (not shown) that is fed radar information and directions as to which classification track the rolling freight car must enter

(Continued on page 20)

low microphonics?

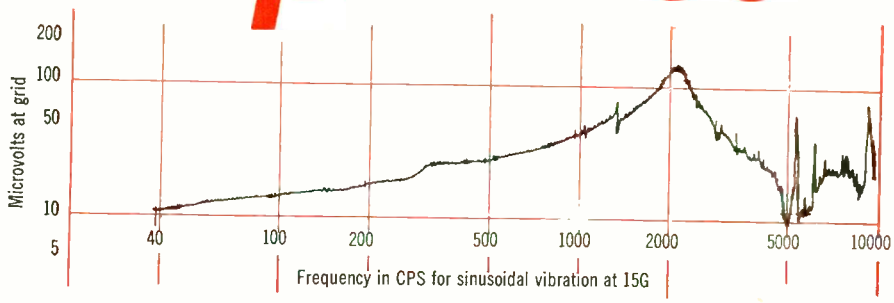
THIS IS IT!

RAYTHEON

CK6533

a new guided missile

RELIABLE SUBMINIATURE TRIODE



Pictured is the vibration output voltage of a typical CK6533 tube over a wide frequency range, in terms of microvolts at the grid when the tube is vibrated at 15G and operated at Ep = 120V, Rk = 1500 ohms.

The CK6533 is designed and manufactured to meet the latest military specifications for guided missile application.

Mutual conductance is 1750 umhos.
Amplification factor is 53.
Plate current is 0.9 ma.

superior stability?

for DC AMPLIFIER and COMPUTER service

RAYTHEON

CK5755

RELIABLE TWIN TRIODE

THIS IS IT!

electrical **stability**
mechanical **stability**
low microphonic output
low grid current
fine **balance** between sections

These characteristics are *designed into* the CK5755, making it the ideal tube for precision DC amplifiers, computers, highly stable regulated power supplies and many other critical applications.

Grid current		10^{-9} amp. maximum
Plate current balance (Eic-E2c)	(typically 0.05V)	0.3V maximum
Plate current drift (Ec after 5 min.)		2.0mV maximum
Plate current drift (Ec after 16 hours)		5.0mV maximum
Mechanical stability (Ec after 400-600G shock)		25.0mV maximum

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Excellence in Electronics

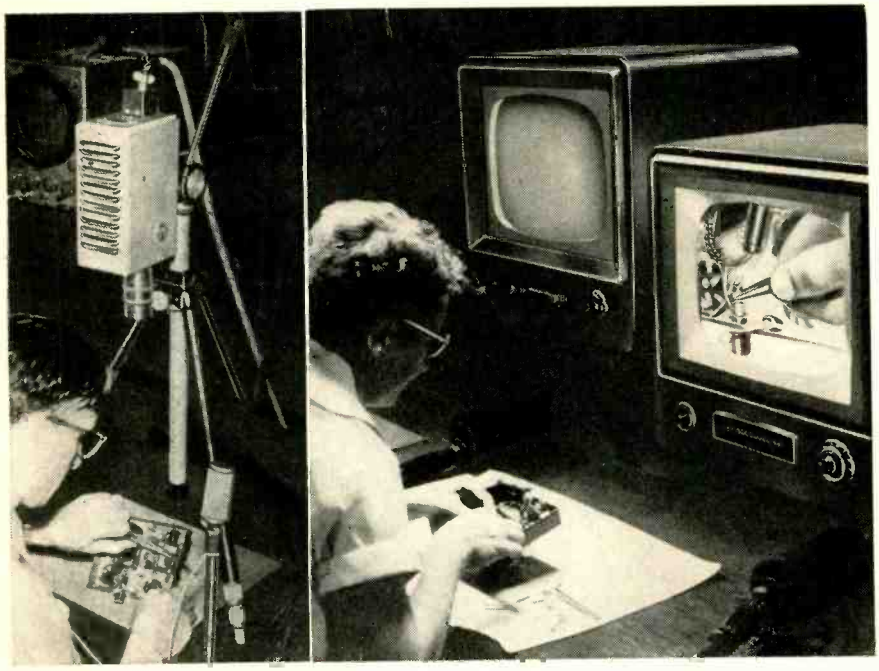
RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500

For application information write or call the Home Office or: 4935 West Fullerton Avenue, Chicago 39, Illinois, NAtional 2-2770
589 Fifth Avenue, New York 17, New York, PLaza 9-3900 • 622 South La Brea Ave., Los Angeles 36, California, WEbster 8-2851

RAYTHEON *MAKES* ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES



CAMERA aimed at specialist feeds monitor receivers on assembly line when . . .

Industrial TV Cuts Training Time

Operators follow the leader by watching screens of tv sets and listening to his instructions

TO MEET a rush deadline, ten identical electronic assemblies were produced simultaneously in a few hours by workers with no previous instruction on that job. An emergency proved the usefulness of industrial television equipment in producing small quantities of electronic equipment in minimum time, with no preliminary worker instruction, no instruction sheets and no training time whatsoever for the particular job. The Radio Corporation of America needed ten identical assemblies of new theater sound control circuits to meet rush deadlines for openings in theaters.

► **How It Was Done**—Camera on tripod was placed right on top of a bench, aimed downward at the hands of a specialist who knew how to do the job. Alongside of him on a stand was the microphone. The camera fed video signals to ten 17-inch tv sets, each in front of an assembly worker. Each duplicated the actions of the specialist by watching his hands on the screen and listening to his instructions, so that all ten theater sound system control units were put together simultaneously in a few hours.

► **Potentialities** — The technique appears applicable to almost any type of intricate electronic assembly job, because the tv camera gets a much better view of the expert's work than could even be obtained by looking right over his shoulder. For small runs, where the quantity needed is equal to or less than the number of workers and monitor sets, just one run cleans it up.

► **Quantity Production** — Larger jobs can be handled with two or three runs by the specialist. For still larger quantities, the system can be used as an efficient training medium combined with immediate production, so that a line gets up to speed almost immediately in situations where simultaneous assembly is feasible. As yet it does not seem likely that industrial television can be adapted to sequential assembly lines, where each production worker is doing a different task.

Financial Roundup

SURVEY of the profit reports of 21 radio, tv and electrical equipment firms by the National City Bank of New York for the first nine months of this year shows that total net profits of these companies are 15 percent above those for the same period in 1953. Total net profit of $277.5 million was reported by 21 companies for the period, compared to $241.6 million for the same period in 1953.

Following are the net profits of 19 firms in the electronics field for the fiscal periods indicated:

Company	Net Profit 1954	1953
AMF 9m	$2,832,000	$3,324,000
AT&T 12m	466,040,000	403,688,160
Bendix Av. 9m.	17,901,493	12,618,552
Clarostat 6m	68,182	
Clevite 9m	1,980,501	2,771,221
Daystrom 6m	757,813	488,475
T. A. Edison 9m	500,873	977,847
GE 9m	140,691,000	116,386,000
Gen. Prec. Equip. 9m	3,602,640	2,283,830
Hoffman Radio 9m	1,139,421	1,115,533
IBM 9m	33,575,088	24,092,078
Minnesota Mining 9m	17,594,981	13,708,826
Pyramid Electric 6m	313,568	138,433
RCA 9m	27,557,000	25,152,000
Stromberg-Carlson 9m	1,316,204	1,328,391
Sylvania 9m	6,166,226	7,562,941
Thompson Products 9m	8,812,107	7,463,109
Tung Sol 9m	1,478,493	1,423,284
Westinghouse 9m	62,644,000	53,219,000

► **Securities** — Tung-Sol Electric filed with SEC covering 100,000 shares of convertible preferred stock, $50 par value. Proceeds of the sale will be used for general corporate purposes. Since January of 1952 the company has spent $4 million in improving and expanding manufacturing facilities and expects to spend approximately $5 million for expansion over the next two years. Plans are to use about $2.5 million of the amount to provide production facilities for color-tv picture tubes.

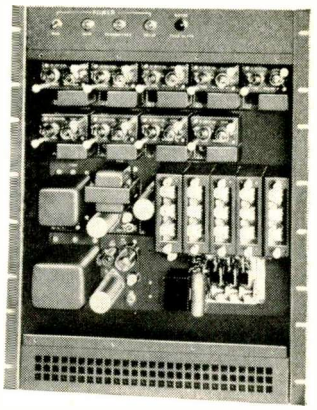
Daystrom purchased 22,713 shares of the capital stock of Weston Instrument at $25 per share. Acquisition of these shares gives Daystrom voting control of 49.5 percent of Weston stock. Daystrom now holds outright 95,892 shares of Weston and has voting rights to an additional 116,000 shares under an agreement with an investment group.

(Continued on page 22)

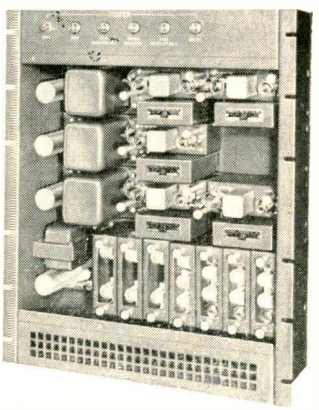
MULTI-GATE®—A Proven Data Transmission "Pipeline"

for C* OC

CENTRALIZED OPERATIONS CONTROL



Multi-Gate Transmitter



Multi-Gate Receiver

Control Engineers tell us the most important part of any remote supervisory control system is the "pipeline"—the means by which data is sent from control point "A" to operating point "B". And these same control engineers tell us our MULTI-GATE Systems have proven themselves as compact, efficient, and dependable "pipelines."

The MULTI-GATE system provides complete "on-off" or "raise-lower" control and report-back indication of practically an unlimited number of remote switches for valves, pumps, lights, power transfer and other functions, as well as alarm indication. Pipelines, refineries, chemical plants, railroads, public utilities and many other industries are finding MULTI-GATE an efficient, money-saving tool. All their control operations can be performed over a single communications circuit.

When used with telemetering equipment, *simultaneous control and remote metering* of such quantities as flow, temperature, pressure and electrical quantities are available over the same circuit—radio, microwave, wire or carrier—because all operations are performed by audio tones.

The transmitter and receiver terminals pictured at the right are typical of Hammarlund MULTI-GATE equipment. These units, designed for a 42 function system (21 "on-off" operations), take little space and are readily accessible when mounted in a standard 19-inch rack.

For details write The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N.Y. Ask for Bulletin 125.

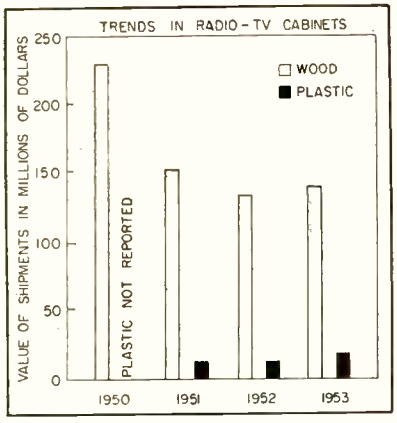
C* OC
CENTRALIZED OPERATIONS CONTROL
(trademarks pending)

Hammarlund's systems for completely controlling and metering of any number of remote functions from central operation points for efficiency, speed and economy.

HAMMARLUND
Since 1910

Beckman Instruments registered with SEC covering 150,000 shares of its $1 par common stock at a price to be related to market price when it is offered. Net proceeds will be applied as follows: $1 million for the retirement in full of all short-term unsecured notes. The balance is to added to general funds some of which may be used for the possible purchase of certain assets of Specialized Instruments Corp. and of Spinco Co., both in Belmont, Calif.

Square Root Industries filed with SEC covering 1 million shares of common stock (par 10 cents) to be offered at 30 cents per share. Net proceeds will be used to increase working capital.



Radio-TV Cabinet Business Changes

SALES trend as indicated in the chart, shows the dip in the value of shipments in 1952 for both plastic and wood cabinets. But both types regained lost ground in 1953 as set production increased.

► **Wood**—Over 4.7 million tv cabinets and 7.0 million radio housings were used in the first 9 months of this year. Most radio cabinets were made of plastic while wood is most popular for tv. Hardboard made of pressed wood fibers has steadily increased its share of the wood tv cabinet business in the past few years, because of lower cost and a short supply of veneers.

The plastic cabinet market reached an all-time high in 1953.

MEETINGS

NOV. 28–DEC. 3: 1954 Annual Meeting, ASME, Hotels McAlpin & Governor Clinton, New York, N. Y.

NOV. 29–DEC. 2: First International Automation Exposition, 244th Coast Artillery Armory, New York, N. Y.

NOV. 30–DEC. 2: First Electronic Computer Clinic, 244th Regiment Armory, New York, N. Y.

DEC. 8–10: Eastern Joint Computer Conference & Exhibition, Bellevue-Stratford Hotel, Philadelphia, Sponsors, IRE, AIEE, ACM.

DEC. 28–29: Fourth Conference on Scientific Manpower sponsored by the National Science Foundation, National Research Council, Engineering Manpower Commission, Scientific Manpower Commission and American Association for the Advancement of Science, Berkeley, Calif.

JAN. 12–15, 1955: World Symposium On Applied Solar Energy, Westward Ho Hotel, Phoenix, Ariz.

JAN. 17–19, 1955: Fourth Biennial Conference On High Frequency Measurements, IRE, AIEE, URSI, NBS, Washington, D. C.

JAN. 20–21, 1955: RETMA Symposium On Printed Circuits, University of Pennsylvania Auditorium, Philadelphia, Pa.

FEB. 10–12, 1955: Seventh Annual Conference and Electronics Show, Southwestern region of IRE, Baker Hotel, Dallas, Texas.

FEB. 10–13, 1955: Los Angeles Audio Fair, Hotel Alexandria, Los Angeles.

FEB. 20–28, 1955: Institute of Surplus Dealers' Fourth Annual Trade Show and Convention, 212th AAA Armory, New York, N. Y.

FEB. 1955: Western Computer Conference, California, sponsored by IRE, AIEE and ACM.

MARCH 21–24, 1955: 1955 IRE National Convention, Waldorf Astoria Hotel & Kingsbridge Armory, New York, N. Y.

MAY 2–5, 1955: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.

MAY 6, 1955: American Association of Spectrographers Sixth Annual Conference, Chicago, Ill.

MAY 16–19, 1955: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

Industry Shorts

► **First** uhf-tv application and grant by FCC to station intending not to originate its own programs was made to Cascade Broadcasting Co. of Yakima, Wash. Station will rebroadcast pictures and sound from KIMA-TV, 60 miles distant.

► **Interim** use of tv frequencies between 680 and 890 mc has been proposed by AT&T for telephone and international tv service between Florida and Cuba. Comments pro and con must be filed with the Commission by Dec. 3.

► **New** monthly publication, "U. S. Government Research Reports" indexes U. S. and foreign research projects by industry classification is available from Superintendent of Documents, Washington 25, D. C., $6.00 per year.

► **National** Lumber Manufacturers Association is reported to be considering whether to seek a special FCC hearing on diathermy regulations because of effects on woodworking companies that use electronic gluing machines.

► **Reduction** of $50 a pound has been made in the price of Du Pont's pure silicon bringing its cost down to $380 a pound.

► **Date** for filing formal comments on FCC rules governing restricted radiation devices has been extended to February 3, 1955 by the Commission.

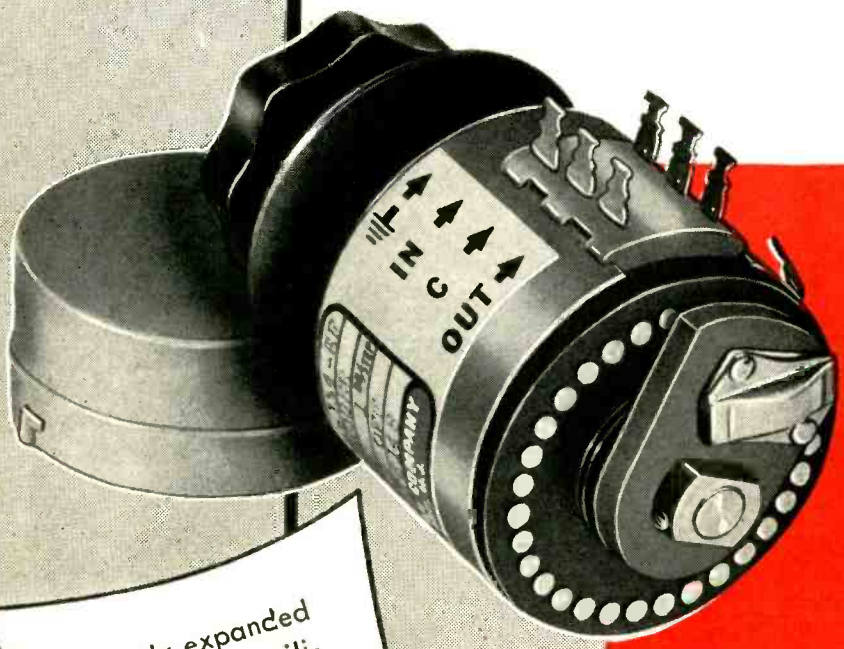
► **More** powerful image tube which operates at 20,000 volts as compared with the previous 4,000-volt tube is being used in a new sniperscope developed by the Army.

► **Japanese** portables made by Matsushita Electric of Osaka that feature a single earphone in addition to a regular loudspeaker, are on the U. S. market.

THESE ARE THE

REASONS

WHY DAVEN IS THE LEADER IN THE AUDIO ATTENUATOR FIELD



LA-130 Series,
Ladder Network
30 Steps, 1 3/4 Diameter

1. "KNEE-ACTION" ROTOR . . . gives positive contact and low contact resistance under all conditions.
2. BRASS CASE OF 2-PIECE CONSTRUCTION . . . gives excellent shielding and allows more compact equipment design.
3. "LOCK-TITE" DUST COVER . . . designed to withstand severe vibration and at the same time allow easy accessibility.
4. ENCLOSED ROLLER-TYPE DETENT MECHANISM . . . gives positive indexing, but does not increase depth of unit.
5. LOW-LOSS MOLDED TERMINAL BOARD . . . has high resistance to leakage.

Greatly expanded production facilities enable Daven to make delivery from stock on a large number of standard attenuator types.

Write for complete catalog data.

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WORLD'S LARGEST MANUFACTURER OF ATTENUATORS

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The Reader AUDITED PAID ABC CIRCULATION *His Mark*

THE ABC SYMBOL, which appears at the head of this page, is your brand—the reader's brand—on this magazine. It stands for Audit Bureau of Circulations. It means that this magazine will stay in business only so long as it continues to serve its readers to their satisfaction.

That Bureau—known for short as ABC—is a voluntary, nonprofit, cooperative association founded in 1914 by a group of publishers, advertisers and advertising agencies who wanted to establish and maintain higher standards of publishing practices than then prevailed. Its primary and specific purpose was to set up yardsticks to appraise circulation values and to verify the claims of publishers as to their circulations. For the buyer of advertising space this provides an effective means to take some of the guesswork out of buying and to reconcile the conflicting claims of competing publishers. BUSINESS WEEK magazine has aptly described ABC as "the publisher's conscience—and cop."

BUT IN DOING that job, ABC performs another function of high importance to the readers of ABC member publications. It provides a constant pressure on the publishers to keep alive in their staffs a sense of primary responsibility to their readers. That is because the most simple and direct method of making a publication responsible to its readers is to place upon it a purchase price, whether by subscription or newsstand purchase. The right to purchase or to refrain from purchasing a publication gives to the reader and to no one else the power to pass effective judgment on the publisher's success in serving the reading public. Each paid publication will grow or languish, will prosper or fail, in proportion as it wins or loses the following of thousands or millions of readers. The readers, by their patronage, record their judgments as to whether the publisher and his publication are measuring up to their responsibility to them.

And that is where the ABC comes into the reader's picture. The newspaper or magazine that carries the ABC symbol on its masthead must in the first place be a paid circulation publication. Moreover, it must conform to the high standards set up by the Bureau as to terms of payment and accounting methods. And again it must open all of its books to the auditors of the Bureau on demand.

SINCE THE INFORMATION thus determined by thorough and impartial audit is periodically made public through the ABC statements and audit reports, it is constantly available to and universally used by advertisers who are considering the purchase of space in an ABC publication. These reports show the circulation trend, as verified and certified by ABC, and thus put the advertisers in a position to know whether or not the publisher is rendering satisfactory service to his readers.

Thus the publisher who submits his publication to the supervision and discipline of ABC affirms in the strongest possible manner that he recognizes his primary obligation is to his readers and that he owes his standing to a voluntary demand by those readers. It follows that the editors of ABC publications must be exceptionally alert to the desires of their readers and responsive to their needs, since any decline in circulation will soon show up in the ABC statements and audit reports.

THAT IS WHY we describe the ABC symbol as the reader's brand. It shows that a publication must be primarily responsive to him and that he holds in his own hands its success or failure. And that ABC symbol is not only a constant reminder to him of that fact, but also an equally constant reminder to all concerned that the reader's willingness to pay for the ABC publication is the acid test of its value to him and to the advertiser.

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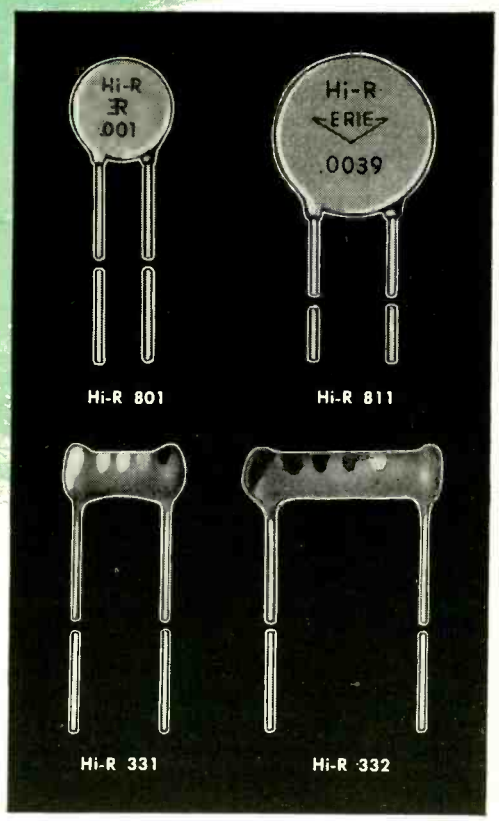
HI-RELIABILITY CERAMICONS®

with a failure potential approaching

only **1 part in 10,000!**



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This "Hi-R" Premium Line includes Temperature Compensating and Hi-K Types in both Disc and Tubular Ceramicon Styles. It has been designed for manufacturers of highly complex military and commercial electronic equipment where continuous operation is essential.

Produced of the very best material, under ideal conditions, and thoroughly tested to insure the required reliability, these Custom Designed Ceramic Capacitors offer:

- Extreme moisture resistance
- Stability maintained throughout life
- Unequalled low failure rate
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400 CYCLE CHOPPER

PROVEN PERFORMANCE in large volume production is your best guarantee of quality!

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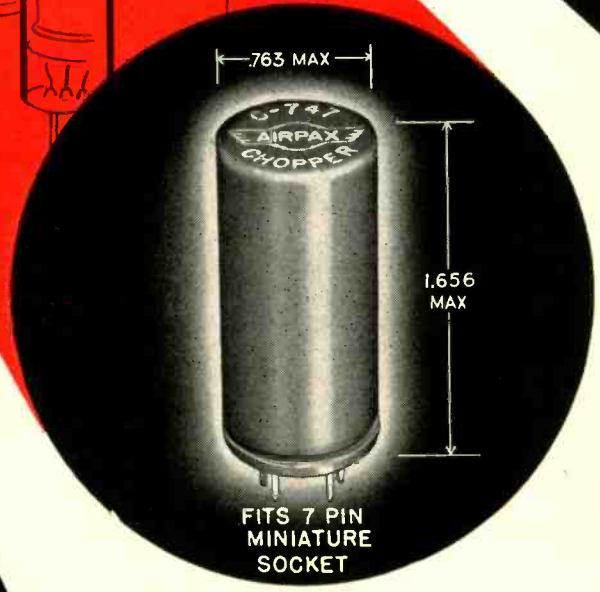

Weighs less than 1 oz.

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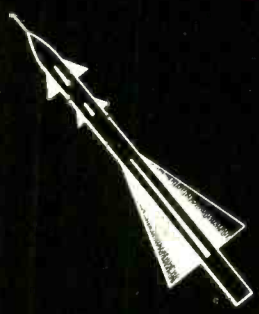
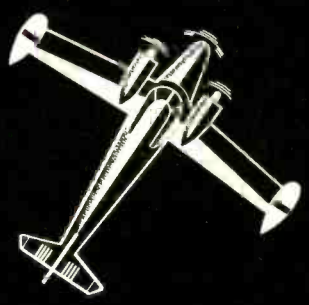
A NEW 400 CYCLE VIBRATOR

Model A 500, Completely New, Completely Different, Opens New Fields of Performance Offers a High Order of Reliability with the Big Saving of Weight Space and Cost Resulting From High Frequency Operation

Reliable Short Duty Performance of as High as 200 Watts From One Vibrator!

Continuous Duty Performance of up to 30 Watts for a Safe 500 Hours!





Hermetically Sealed, Provides an Efficient Source of 400 Cycle Power to Handle Small Motors, Gyros and Selsyns

Provides Ideal Source of Power For Mobile Applications. Reliability Plus a Very Small Power Supply

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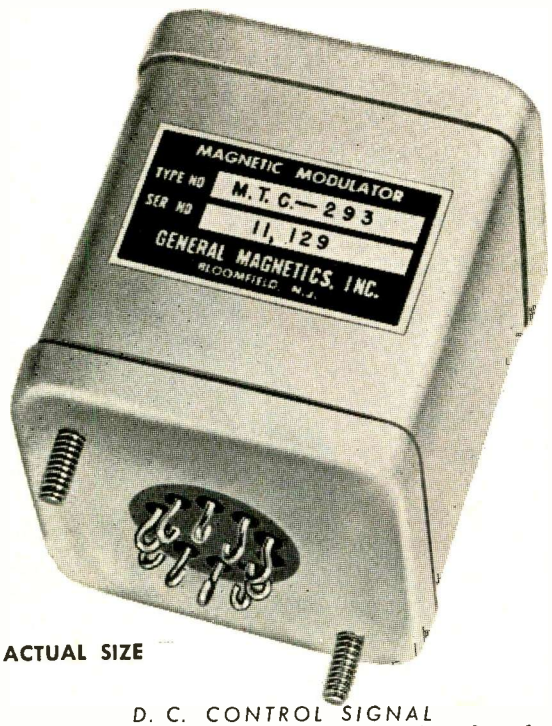
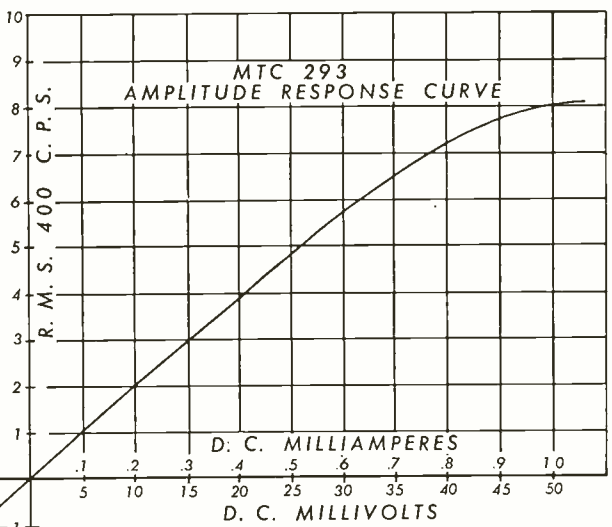
GENERAL MAGNETICS INC. Introduces to the Temperature Control Field MTC 293

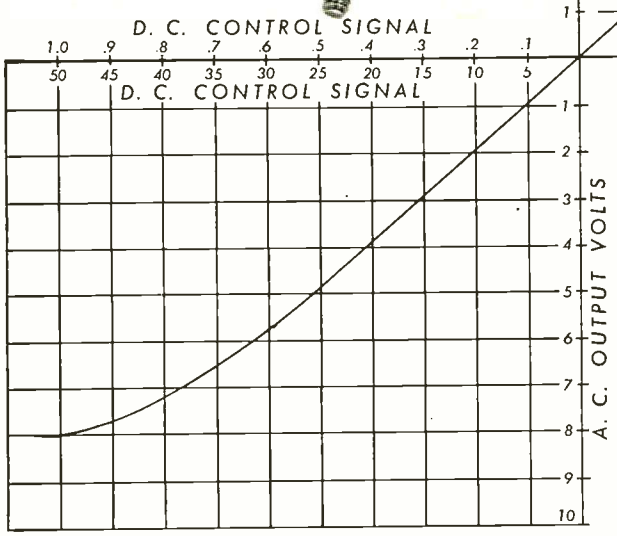
MAGNETIC THERMOCOUPLE CONVERTER-AMPLIFIER



ACTUAL SIZE

THE GENERAL MAGNETICS THERMOCOUPLE CONVERTER IS DESIGNED TO CONVERT AND AMPLIFY LOW LEVEL DUAL POLARITY DC SIGNALS INTO 400 CYCLE SINUSOIDAL AC VOLTAGES OF CORRESPONDING AMPLITUDE AND PHASE SENSE.





We specialize in control systems and magnetic amplifier components for Automatic Flight Control — Analog Computers — Fire Control and Armament — Guided Missiles — Nuclear Applications — Magnetic Voltage Regulators and Power Supplies.

- Input Signal Resolution — Less than 5 microvolts
- Greater Stability with Temperature
- Higher Gain
- Extremely Low Hysteresis
- Negligible Time Delay
- Clean Output Wave Form
- No Moving Parts or Contacts to Fail
- Practically Unlimited Life
- Operation in Temperature Ambients from −70°C to + 200° C
- No Internal Rectifiers
- High Shock and Vibration Resistant

SPECIFICATIONS

1. Excitation: 12 V. RMS ± 10% @ 400 CPS ± 10%
2. AC input impedance — About 2500 Ohms
3. Output Impedance — About 10,000 Ohms
4. No load voltage gain — 250
5. Output at null: 30MV max. RMS (Composed of even and odd harmonics)
6. Output phase: 0 or 180° ± 10°
7. Harmonic distortion in signal range: About 15%
8. Overall dimension 1⅞" x 1⅞" x 2" high

Write on your letterhead for further details

GENERAL GM INC. MAGNETICS

MAGNETIC MODULATORS AND AMPLIFIERS — VOLTAGE REGULATORS — CONTROL SYSTEMS

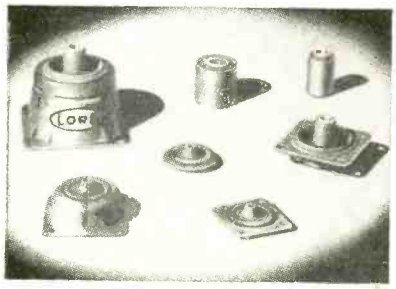
135 Bloomfield Ave., Bloomfield, N. J.

ADVERTISEMENT

Lord Vibration Control Mountings . . . The Most Effective Protection For Electronic Equipment

In the rapidly advancing field of electronics, the control of destructive vibration and isolation of damaging shock are prime factors in the consideration of design engineers. Lord, Headquarters for Vibration Control, is constantly working with electronics engineers to improve the methods for protecting sensitive mechanisms.

For instance, Varo Static Converters which change alternating to direct current for aircraft with less than 1% voltage ripple are protected against shock and vibration by Lord Mountings. High fidelity Audio frequency electronic equipment such as Collins Radio Company manufactures is protected from vibration and shock through the use of Lord Mountings. The 212A-1 Broadcast Station Speech Input Console by Collins requires 28 Lord square Plate Form Mountings to protect each amplifier stage individually. This prevents mechanical interaction between stages and lessens acoustical feed-back effects.

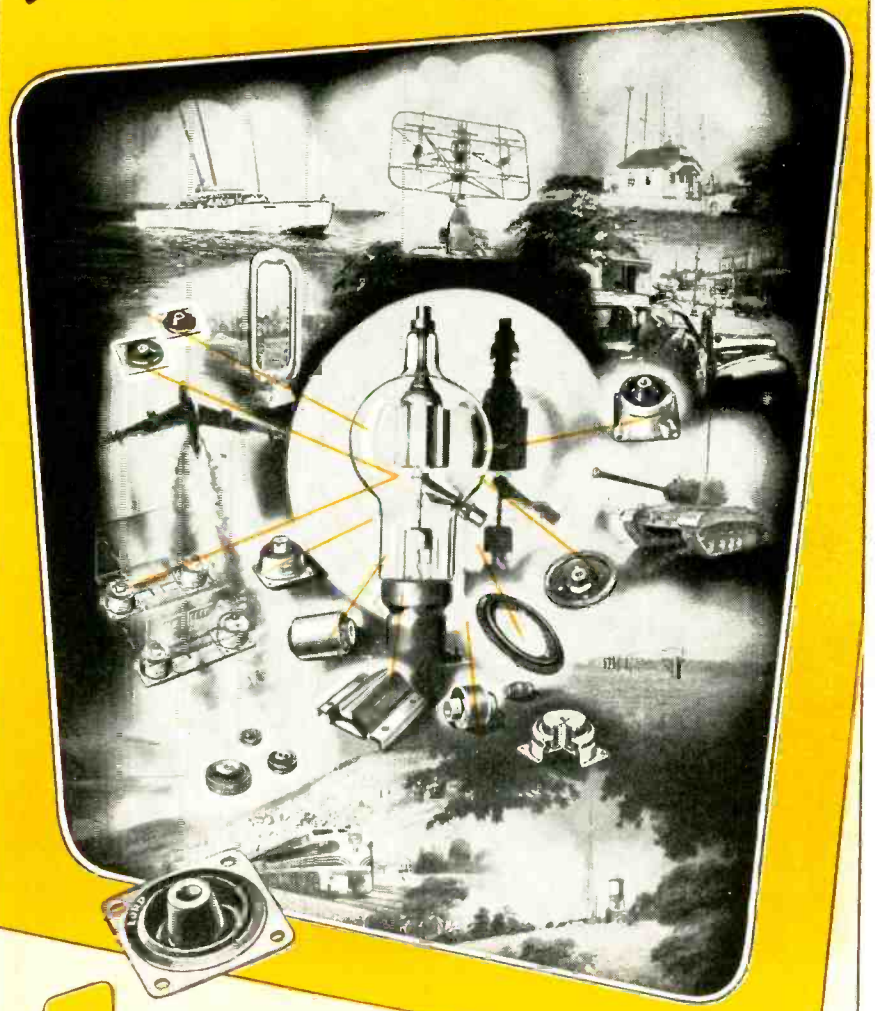


Again the Agnew Spark Plug Welder by Agnew Electric Company uses Lord Mountings to support the electronic weld timers to prolong the useful service life of Mercury Vapor Tubes.

Lord Mountings, which you see illustrated in the accompanying advertisement, are used in a wide diversity of applications to protect electronic equipment and sensitive instruments. Business machines and such sensitive mechanisms, the accuracy of which must be perfect, are improved in operation and protected from damaging vibration and shock by Lord Mountings.

The Lord Manufacturing Company, Erie, Pa., offers a vast reservoir of recorded experience in the solution of vibration and shock problems. Your request for help on your own problem is welcomed.

LORD MOUNTINGS PROTECT INSTRUMENTS *and* ELECTRONIC EQUIPMENT *from* VIBRATION *and* SHOCK DAMAGE • • •



VIBRATION and shock are natural enemies of electronic equipment and precision instruments . . . To control the damage which these enemies can do, Lord Vibration Control Mountings and Bonded Rubber Parts are used to very profitable advantage. More than a quarter century's experience in dealing with vibration and shock is yours when you take advantage of Lord engineering assistance. The result of such consultation is full protection for electronic units and sensitive instruments by correctly designed and precisely manufactured Lord Mountings and Bonded-Rubber parts.

DETROIT 2, MICHIGAN — 311 Curtis Building
LOS ANGELES 28, CALIFORNIA — 7046 Hollywood Blvd.
CHICAGO 11, ILLINOIS — 520 N. Michigan Ave.
CLEVELAND 15, OHIO — 811 Hanna Building
PHILADELPHIA 7, PENNSYLVANIA — 725 Widener Building
NEW YORK 20, NEW YORK — 630 Fifth Avenue Rockefeller Center
DALLAS, TEXAS — 313 Fidelity Union Life Building
DAYTON 2, OHIO — 410 West First Street

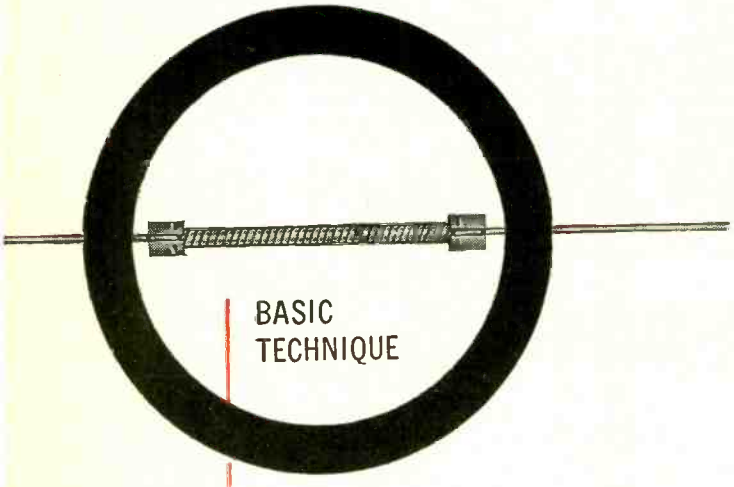
LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for **VIBRATION CONTROL**

Precision, high-speed winding equipment for IRC elements

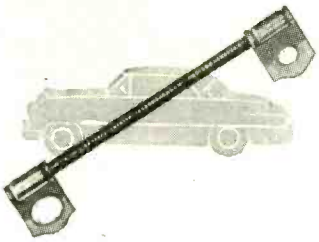
ONLY IRC WINDING SKILL OFFERS



BASIC TECHNIQUE

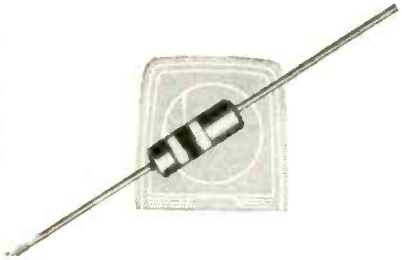
Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

If you seek savings in component costs, IRC's winding skill may serve your need. IRC's mastery of winding wire elements dates back more than 25 years. Today, it provides a wide variety of unique units that offer realistic possibilities for savings. Cost-conscious IRC engineers will glady analyze your requirements.



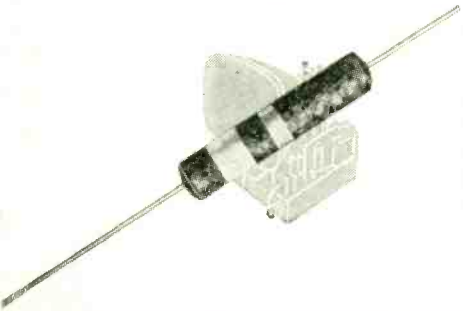
14c savings per car

Type AW Wire Wound resistors save automobile manufacturers an average of 14c per car. For quantity requirements, these low-cost windings can be made specially to suit individual designs. This adaptability has proved profitable to numerous appliance manufacturers.



low cost—low wattage

Type BW insulated wire wounds offer excellent stability in low ranges—at low prices. Leading instrument manufacturers attest to their superiority. ½, 1 and 2 watt sizes are equivalent to Jan types RU-3, RU-4 and RU-6.



50% savings

IRC Insulated Chokes offer savings up to 50% over ordinary types. Available in two sizes, they are fully protected against humidity, abrasion, assembly damage and danger of shorting to chassis. A favorite source of savings for TV and radio set manufacturers.

THESE SAVINGS

inexpensive solution

4-watt Insulated Power Wire Wounds with axial leads can save several cents over conventional power resistors. Inorganic core and high-temperature plastic housing allow safe operation up to 165° C. Widely used in toys, juke boxes and amusement devices.

NEW *encapsulated* precision resistors

Type WW15M—MIL-R-93A Style RB15

Type WW16M—MIL-R-93A Style RB16

Type WW17M—MIL-R-93A Style RB17

Type WW18M—MIL-R-93A Style RB18

Type WW19M—MIL-R-93A Style RB19

- **Epoxy Resin Compound Used For Both Winding Form and Seal.**
- **Exclusive Molding Process Avoids Air Pockets And Assures Uniform Distribution Of Resin.**
- **Exceed MIL-R-93A Specifications In 1%, 0.5%, 0.25%, 0.1% Tolerances.**

SEND COUPON FOR DATA BULLETIN

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

Wherever the Circuit Says—

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INTERNATIONAL RESISTANCE CO.

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

In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send Technical Bulletins on: ☐ Encapsulated Precision Wire Wounds; ☐ Insulated Chokes; ☐ BW Resistors; ☐ 4-Watt Power Resistors.

Name_____

Title_____

Company_____

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KEPCO

VOLTAGE REGULATED POWER SUPPLIES

MODEL 615

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-600	0-300 Ma.	0.5%	5 Mv.
2	0-150 Bias	0-5 Ma.	*	5 Mv.
3	6.3 AC	10 Amp.	†	

MODEL 815

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-600	0-200 Ma.	0.5%	5 Mv.
2	0-150 Bias	0-5 Ma.	*	5 Mv.
3	6.3 AC	10 Amp.	†	

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

30 MODELS

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An Announcement

of the Utmost Importance to Engineers Doing Research and Design Work in the Entire Audio Frequency Range.

BURNELL

Burnell and Co., Inc.

is proud to announce the development of *an entirely new product*—

ROTOROID®

a Variable Toroidal Inductor (patent applied for)

ROTOROID will prove to be a valuable aid in the solution of many engineering problems—in research and design—and opens new possibilities for production which were previously impractical or impossible.

ROTOROID Now 4:1

- . . . is a continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft.
- . . . employs no mechanical resistance contacts and is therefore free of noise and wear.
- . . . requires no DC saturating currents and thereby eliminates the need for circuitry.
- . . . is applicable over the entire audio range (from approximately 300 cps). ROTOROID is not limited to any stock value of nominal inductance. It is available in any value of inductance now available in regular toroids.
- . . . is hermetically sealed and is virtually vibration and shock-proof, can be chassis or panel mounted.

An outstanding feature of ROTOROID is that, at maximum inductance, it provides the full Q of the toroid it contains. Thus, the user is at once able to take advantage of the high Q characteristics of toroids while at the same time having available a variable inductor not previously available in a toroid.

Applications: Virtually unlimited. Just a few of the many possible uses of ROTOROID are:

- **Tunable Audio Oscillators**
- **Variable Z Devices**
- **Servo Systems**
- **Telemetering**
- **Adjustable Selective Networks**
- **Variable Phase Shift Networks**
- **Variable Filters**
- **Electro-Mechanical Control Systems**

Availability: Immediately available: ROTOROIDS VTI-A and VTI-B which are equivalent in electrical characteristics to Burnell toroids TC-16 and TC-3 in cases 2¼" in diameter, 3-1/16" long. Soon to be available: two miniature types, VTI-C and VTI-D, equivalent to Burnell toroids TCO and TC-6.

Now Available

Write Department C for further information.

Burnell & Co., Inc.

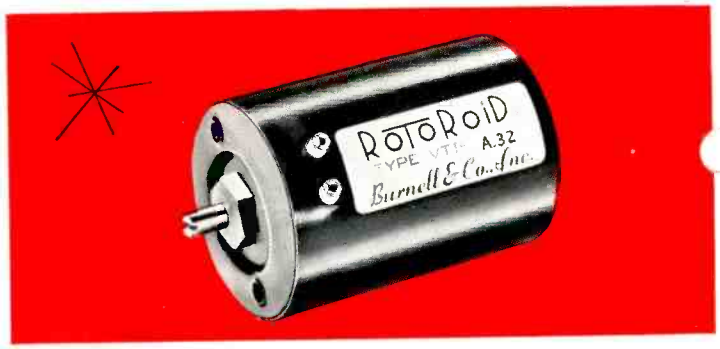
Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

FIRST IN TOROIDS AND RELATED NETWORKS

3 BIG REASONS

to check BURNELL first!



ROTOROIDS® A continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft. Write for new brochure which gives complete technical data.

TOROIDS Combining the advantages of toroidal type winding with the molybdenum permalloy dust core and other specially selected materials, these toroids provide higher Q than any other structure. They also provide greater stability of inductance vs. temperature and level in a smaller space. Their self-shielding properties permit compact assemblies of coils with a minimum of deleterious effects. Supplied to an inductance accuracy of 1%. Available in standard, miniature and sub-miniature sizes. Also in a wide variety of finishes, including ***for the first time toroids molded in a new special material.***

TELEMETERING FILTERS
Band pass filters available for every channel ranging from 400 to 70,000 cycles for band width between 15 - 40%. Low pass filters available for operation in either unbalanced or balanced line, and range in cut off frequency from 6 up to 10,500 cycles. Also, miniaturized filters that do not sacrifice attenuation characteristics, save up to 80% space.

3 EXTRA REASONS TO CHECK BURNELL FIRST!

- Proven Top Quality
- Competitive Prices
- Prompt Deliveries

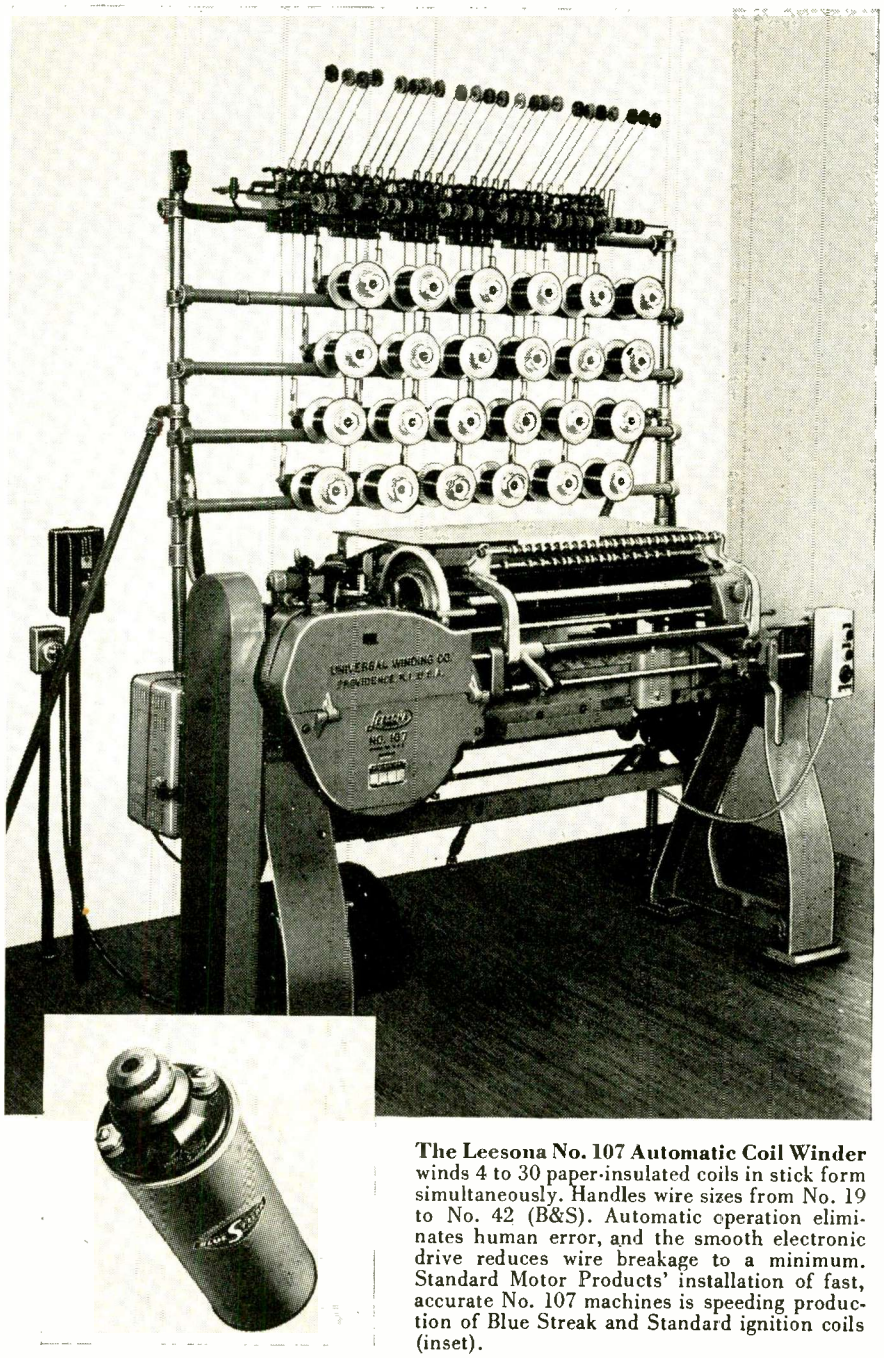
Write Department C for Catalog 102A

BURNELL & CO., INC.
Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

FIRST IN TOROIDS AND RELATED NETWORKS

New Coil Winders Aid Production Flow



The Leesona No. 107 Automatic Coil Winder winds 4 to 30 paper-insulated coils in stick form simultaneously. Handles wire sizes from No. 19 to No. 42 (B&S). Automatic operation eliminates human error, and the smooth electronic drive reduces wire breakage to a minimum. Standard Motor Products' installation of fast, accurate No. 107 machines is speeding production of Blue Streak and Standard ignition coils (inset).

Standard Motor Products Inc. uses Leesona No. 107 Automatic Coil Winders to integrate production output

Once again Leesona Coil Winders prove their ability to deliver faster, more efficient performance.

Here is what H. A. Rosenstein, V.P., of Standard Motor Products Inc., Long Island City, N. Y., has to say about their No. 107 Coil Winders:

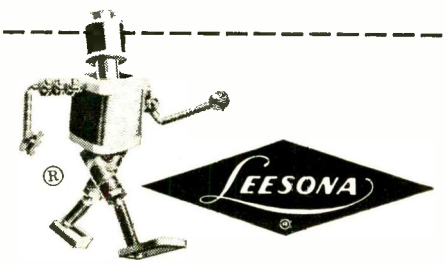
"Perfect timing with our production schedule has been achieved by the installation of Leesona No. 107 Automatic Coil Winders for winding our ignition secondaries. Results have lived up to every expectation. The new Leesona No. 107 Machines are great performers. Their automatic operation gives us exactly the precision accuracy we want — plus perfect coordination with our general production flow."

Reports like this are familiar stories wherever plants have modernized with Leesona No. 107 Coil Winders. And they give you a good idea of how these advanced machines can benefit your own coil winding operations.

Get All The Facts

on the Leesona No. 107 Coil Winder. Send the coupon for a new, illustrated bulletin describing how every feature is designed to produce compact, uniform paper-insulated coils — in fastest time — with minimum operator attention — at lowest cost.

Read how you can step up your coil winding production to new, profit-boosting efficiency — with the machine that's the last word in automatic coil winder design. The coupon also lists other helpful coil winding information. Why not check and mail it today?



FOR WINDING COILS
IN QUANTITY... ACCURATELY
...AUTOMATICALLY... USE
UNIVERSAL WINDING MACHINES

UNIVERSAL WINDING COMPANY

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Please send me

- ☐ Bulletin on the Leesona No. 107 Automatic Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

Name.....Title.....

Company.....

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Want more information? Use post card on last page.

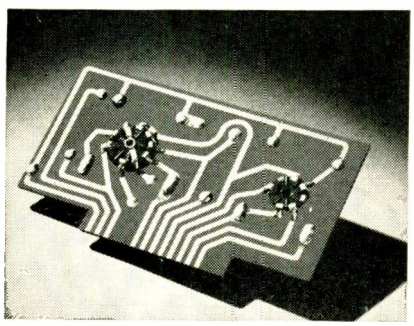
Get better printed circuits . . . lower costs . . . fewer rejects

with NEW C-D-F METAL CLADS

All manufacturers of metal clad stock for printed circuitry have made considerable progress in improving their product—a material with a metal foil surface bonded to a nonconducting base. How this has been done by one leading manufacturer, the Continental-Diamond Fibre Company, illustrates some of the problems involved in buying this type of material and in understanding its design potentials.

C-D-F CONSOLIDATED GRADES

At first, small test lots of Dilecto laminated plastic with copper surfaces were made. Almost every core material was used. Finally the number of practical grades for printed circuit work narrowed down to these few grades which retained to a large degree the inherent electrical qualities of their base material and resin at high temperatures:

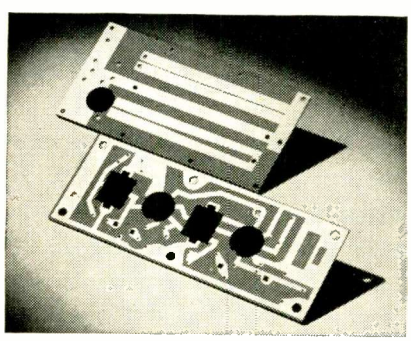


COPPER CLAD GRADE XXXP-26

A laminate with excellent electrical and mechanical properties. High moisture resistance and dimensional stability. Recommended for applications where high heat and high insulation resistance plus low dielectric loss under high humidity is needed. Low cold flow characteristics. Can be hot punched to ⅛″. Good flexural strength. Natural green color.

This is one of the *improved C-D-F Dilecto laminates.* Advances in resins and manufacturing techniques makes this grade almost homogeneous, with improved impregnation of the filler. Thorough impregnation eliminates entrapped moisture and air, giving greater moisture resistance and better dielectric properties.

Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a *uniform* metal clad material, like this C-D-F grade, becomes vital.



COPPER CLAD GRADE XXXP-24

Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.

COPPER CLAD GRADES GB-112S AND GB-261S

These silicone grades use a glass fabric laminate with a copper foil surface on one or both sides. Recommended where high heat resistance and low dielectric loss properties are required. For certain tuners and inductances the low dielectric loss factor of this grade makes its higher cost acceptable. A continuous filament (Grade GB-112S) is used for thicknesses 1/32 to 1/16″. A staple filament (Grade GB-261S) is used for thicknesses over 1/16″.

COPPER CLAD GRADE GB-116T

A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

C-D-F INCREASED BOND STRENGTH

By developing a special thermo-setting adhesive particularly suited for metal clads, C-D-F was able to increase the bond strength of their laminates considerably above their original figures. Bond or peel strength, the amount of pull required to separate the foil from the core material, is one of the most important physical properties. Therefore, the purchaser should compare his source of supply with these C-D-F average test values:

BONDING STRENGTH—FOIL TO LAMINATE

MATERIAL	Average or Typical Value Lbs. pull per 1″ width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014″ copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028″ copper	7 to 9
GB-116T plus 0.0014″ copper	5 to 12
GB-112S plus 0.0014″ copper	6 to 8
GB-261S plus 0.0014″ copper	7 to 10

These values are based on tests at prevailing room temperature (20-30°C.)

C-D-F INCREASED HEAT RESISTANCE

Special efforts by C-D-F technicians to increase the heat resistance of all C-D-F Metal Clads have resulted in certain special grade variations able to withstand higher soldering temperatures without damage. As production methods change, C-D-F offers materials to meet your requirements.

NOW . . . HOW ABOUT YOUR STORY?

Notice how we have talked about C-D-F and what we have done to improve quality and uniformity of metal clad products. Much of this has been accomplished with the guidance and cooperation of leading users of printed circuit stock. No one company knows all the answers . . . but C-D-F, a big reliable source of supply, can help you get better printed circuits . . . lower costs . . . fewer rejects. Look up the address of your nearest C-D-F sales engineer in Sweets Design File, write us for samples you can test in the lab and on the production line, technical bulletins, help on your specific project. We want to work with you!

CDF Continental-Diamond Fibre

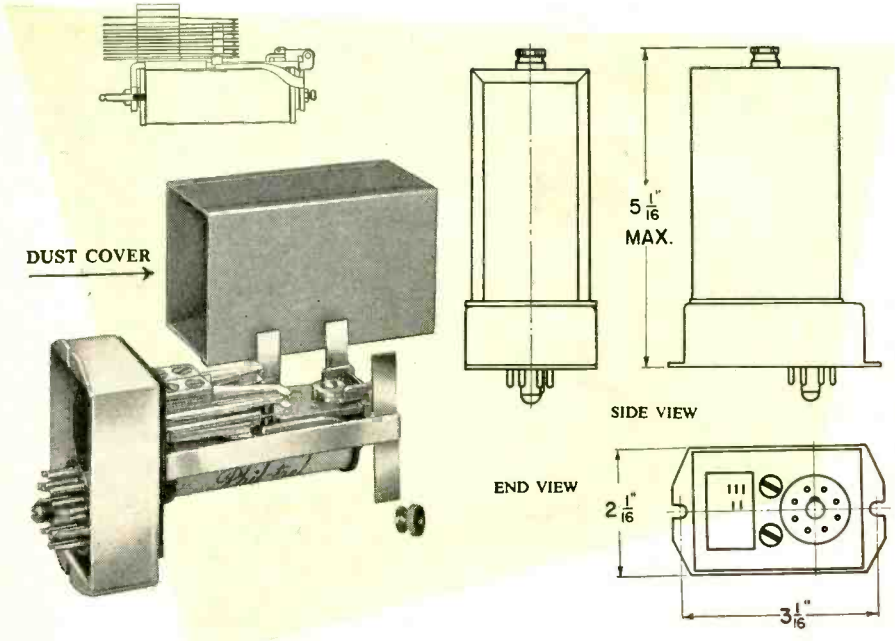
CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 16, DELAWARE

Phil-trol Data

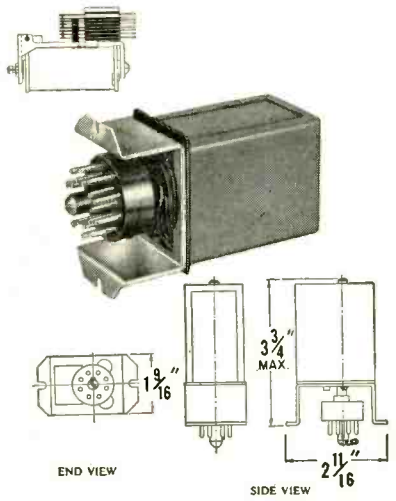
Standard Plug-In and Dust Covered Relays Now Available in Three General Types

Lock Base Holds Relay Structure Firm Removing Stress From Plug

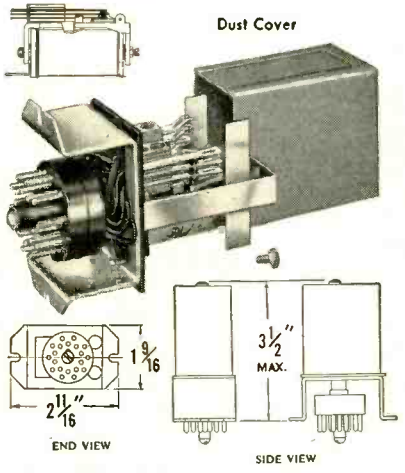
The almost universal demand for a relay having the plug-in feature and a well secured dust cover has created need for the following design. This design is now available in the three basic multiple-contact relays illustrated—namely, types 2, 6, and 8. This design consists of a plug-in arrangement having many different combinations of plugs, from 4 to 20 circuits per relay, and is equipped with a bracket, which itself is secured by two screws, thus removing the stress from the conducting plug. The cover assembly itself is fitted over a bracket, which is so designed as to protect the contacts of the relay, eliminating the possibility of damage to contact springs when the cover is either removed or replaced. The cover is held on by means of a knurled nut or screw, and is securely held against a rubber gasket. This method assures maximum protection from dust and dirt and provides uniformity of mounting.



The **Phil-trol type 2QA (Quick Acting) relay,** is commonly known as the standard telephone type, providing fast closing and opening of a maximum number of circuits. Its long-coil construction permits the use of high resistance coils. The time delay models, known as types 2SO (slow-operate), and 2SR (slow-release), are also available, providing time delays of as much as .010 second operate and .500 second release. This plug-in cover arrangement is also available for the 2AC relay.



The **Phil-trol type 6QA relay** is extremely efficient, more compact than the type 2QA, and has similar performance characteristics.



The **Phil-trol type 8QA relay** is one of our latest newly developed relays. It is equipped with special features which make it extremely fast operating. It is equipped with twin contacts for maximum reliability of contact closure, and has an extremely long life expectancy.

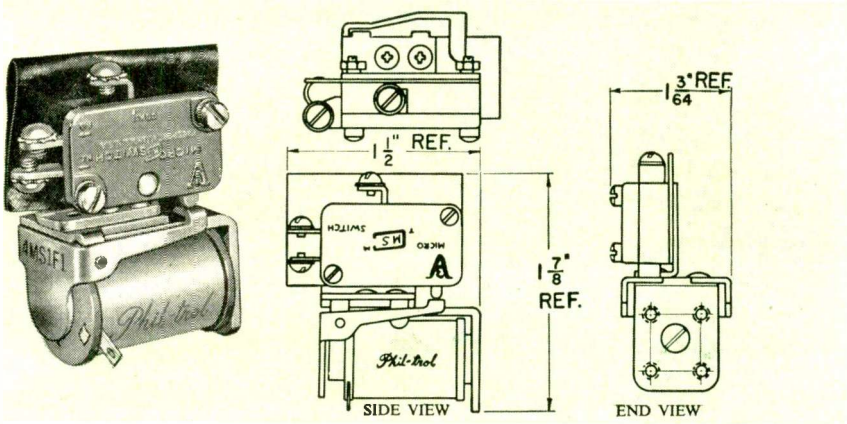
Phillips Control Corporation JOLIET, ILLINOIS
A THOR CORPORATION SUBSIDIARY

Want more information? Use post card on last page.

for Relay Users

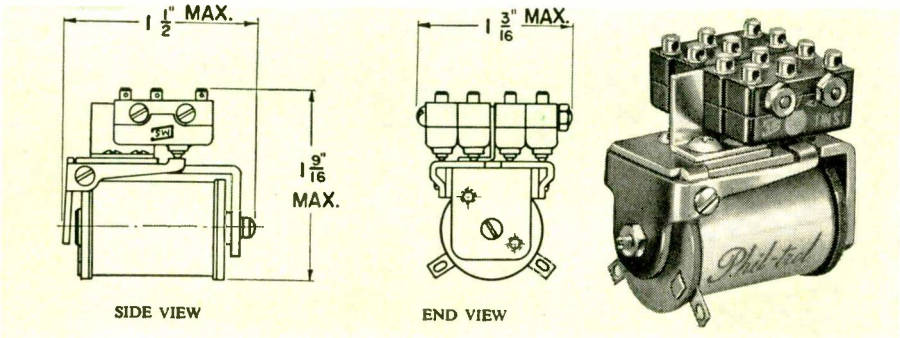
New Phil-trol Miniature Micro Switch Relays Now Available

Compact snap-action contacts of the miniature variety are utilized in the new Type 4MS and 4BMS series relays.



TYPE 4MS RELAY ASSEMBLY

This assembly, at left above, features a fast, light weight, highly sensitive and low cost miniature unit, with Micro Switch style V3-101, operating on approximately 1 watt power input. It may be engineered to operate on as little as .005 amps. Available SPDT or DPDT. Contact terminals are of screw type.



TYPE 4BMS RELAY ASSEMBLY

This sub-miniature unit provides for as many as four miniature Micro Switches on one relay. (4PDT) Type 1SM1, rated at 5 amps., 250V A.C. is used. Stud terminal connections are provided.

Phil-trol Sales-Engineering Offices

COAST-TO-COAST

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Joliet, Illinois.
Tel: JOliet 3-3431

CALIFORNIA, Los Angeles 36,
5410 Wilshire Blvd.
Tel: WEbster 3-6405

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180 University Ave.
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Let Phil-trol Progress Help Solve Your Relay Problems

Plants at Joliet, Illinois, Santa Monica, California, and Santurce, Puerto Rico

PHILLIPS CONTROL CORP., Dept. E, 10, Joliet, Ill.

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The Magnetics, Inc. "Performance-Guarantee" on molybdenum permalloy Powder Cores is a revolutionary concept in the communications and electronics industries, and opens the way to substantial savings in your production and assembly operations. The guarantee of performance *to your specifications* is your assurance that these Powder Cores are standardized to meet your circuit requirements.

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Keep in Mind These Advantages of Powder Cores . . .

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Write us . . . on your company letterhead . . . we'll be delighted to send you literature, delighted to answer specific questions. No obligation, of course. . . .

*Manufactured under a license agreement with Western Electric Co.

MAGNETICS inc.

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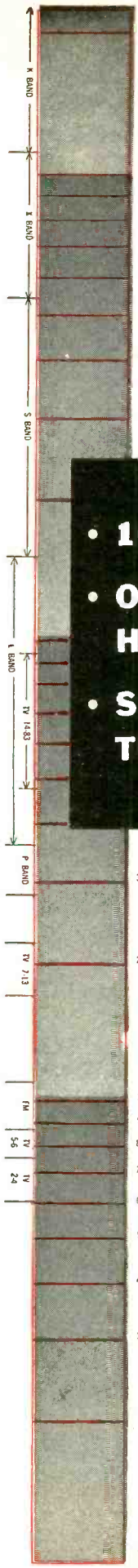

NEW! PORTABLE DIRECT READING SPECTRUM ANALYZER

- 10 TO 22,000 MCS
- ONLY 3 R. F. HEADS
- SINGLE DIAL TUNING

Now, a new Polarad spectrum analyzer only 21 inches high that covers the entire frequency range 10 to 22,000 mcs with but 3 interchangeable R—F tuning heads. The model TSA operates simply—single dial frequency control—with utmost frequency stability. It provides highest accuracy, and reliability for observation and true evaluation of performance over the entire R—F spectrum—saving engineering manhours.

This instrument is designed for maximum utility and versatility in the laboratory and on the production line providing an easy-to-read 5 inch CRT display of the R—F spectrum.

The model TSA Spectrum Analyzer has these exclusive Polarad design and operating features:

- Single frequency control with direct reading dial. No klystron modes to set. Tuning dial accuracy 1%.
- Only three interchangeable R—F tuning units for the entire frequency range 10 to 22,000 mcs.
- Temperature compensation of Klystron Oscillator.
- Swept IF provides 250 kc to 25 mc display independent of R—F frequency setting.
- Internal R—F attenuator.
- Frequency marker for measuring frequency differences from 100 kc to 25 mc.

Write today to your nearest Polarad representative, or directly to the factory for complete information.

Model No.	Equipment
Model TSA	Spectrum Display and Power Supply
Model STU-1	R-F Tuning Unit 10-1,000 mc.
Model STU-2	R-F Tuning Unit 910-4,560 mc.
Model STU-3	R-F Tuning Unit 4,370-22,000 mc.

SPECIFICATIONS:

Frequency Range:
10 mc to 22,000 mc

Frequency Accuracy:
1%

Resolution:
20 kc

Frequency Dispersion:
Electronically controlled, continuously adjustable from 50 kc/in. to 7 mc/in.

Input Impedance:
50 ohms

Over-all Gain:
120 db

Attenuation:
RF....Internal: 120 db continuously variable
IF....60 db continuously variable

Input Power:
400 watts

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NEW SODEREZE!*

- **Instant Soldering Without Stripping**
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- **Excellent Flexibility and Toughness**

New Sodereze represents a spectacular advance in ready-to-solder magnet wire. It's a new and typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, save time, reduce overall costs and satisfy a variety of different operating conditions. The versatility and outstanding properties of New Sodereze not only permit its use wherever solderable wire has been *proved* practical and dependable but suggest its application in unlimited other electronic and electrical fields to replace conventional wires.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer.

*SODEREZE is a Phelps Dodge Trademark.

PHELPS DODGE COPPER PRODUCTS CORPORATION

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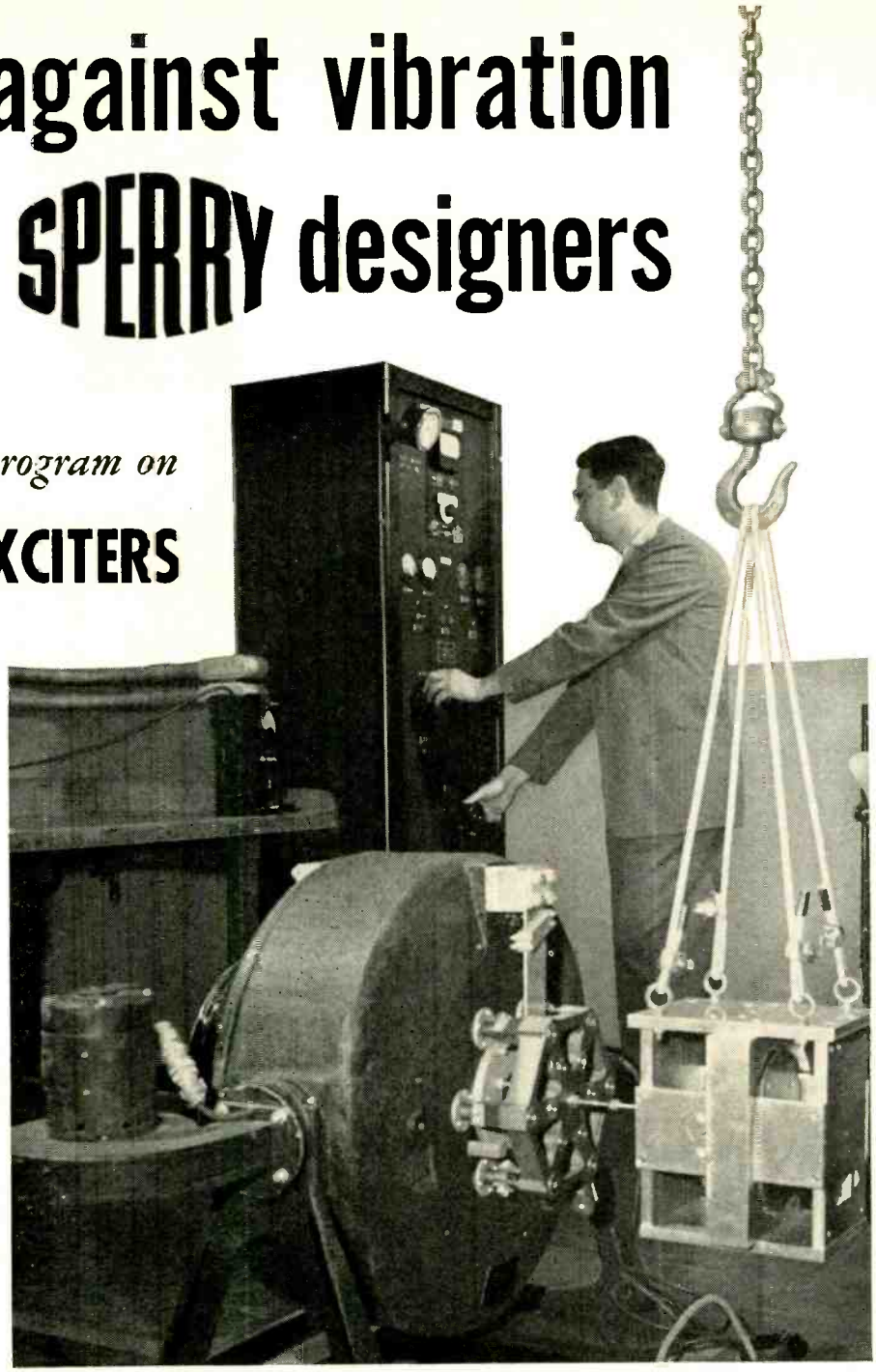
Durability against vibration assured by SPERRY designers

. . . with a shake-testing program on

MB VIBRATION EXCITERS



In a Vibration Test Section of Sperry Gyroscope Company, an MB Vibration Exciter Model C-5 is being used to fulfill requirements of MIL-E-5272 and other specification tests.

COMPANIES quick to take advantage of newest techniques for development and testing are generally also those known for outstanding products. Such a concern is the Sperry Gyroscope Company. It maintains well-equipped vibration testing laboratories where searching tests are performed on all designs subjected to vibration in service. Vibration is ruled out as a trouble-maker in vital products and components.

VIBRATION TESTING SPEEDS DATA

With vibration now recognized as an archenemy of product life and performance, it pays to learn early in the game whether corrections in design are needed. MB Shakers can help *you* to do just that. In a few short hours, the equipment can reproduce the ravages of *years* of vibratory service conditions. Within minutes, it can show you visually the vibratory response of a product to a whole range of frequencies.

The result: *savings in engineering time and work, and a better product.*

WHY MB VIBRATION EXCITERS?

Engineered by vibration specialists to deliver maximum performance, MB Shakers can be counted on for pure table motion and dependable operation to full rated capacity. Moreover, MB's line of vibration testing "tools" is complete—from small specialized-duty shakers to the largest in existence today; also automatic cycling systems, vibration pickups, meters and other accessories.

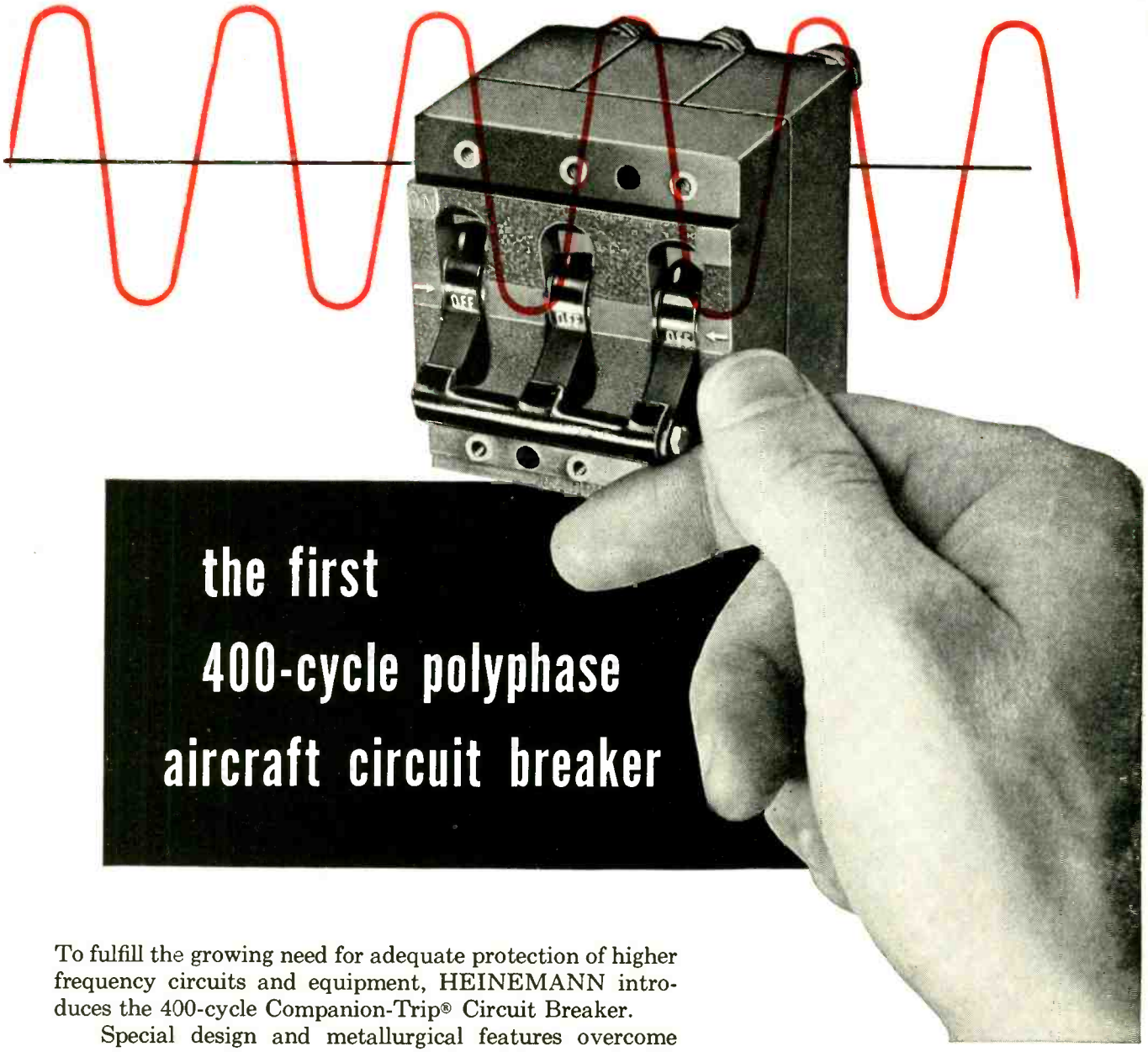
Like so many well known companies, why not make MB *your* headquarters on vibration?

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-5.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION . . . TO *EXCITE* IT . . . TO *MEASURE* IT

ANNOUNCING...



To fulfill the growing need for adequate protection of higher frequency circuits and equipment, HEINEMANN introduces the 400-cycle Companion-Trip® Circuit Breaker.

Special design and metallurgical features overcome previous limitations, and Companion-Trip—a new principle—provides complete phase isolation.

The new aircraft type circuit breaker is hydraulic-magnetic, of course. Current carrying capacity and set tripping points are completely unaffected by ambient temperature.

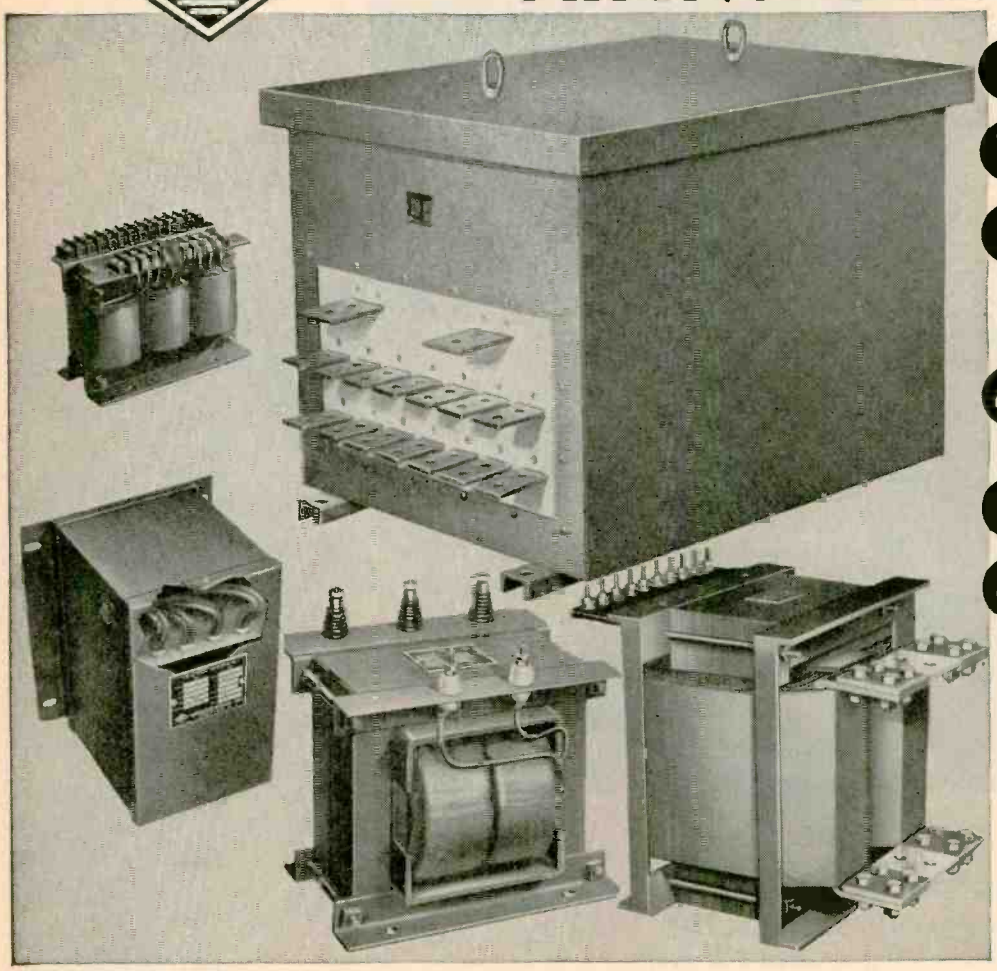
Moreover, a selection of time delay response curves permits overload protection to be fitted to the precise requirements of your equipment.

For complete information, request Bulletin T-3301.

HEINEMANN Circuit breakers

HEINEMANN ELECTRIC COMPANY
97 Plum Street • Trenton 2, New Jersey

SIX GOOD REASONS for the superior performance -OF- NOTHELFER TRANSFORMERS



1. All coils vacuum pressure impregnated.
2. All connections over 5 Amperes silver soldered.
3. Grain Oriented Steel in sizes above 1 KVA, and conservative copper assures high efficiency and low losses.
4. All units individually tested to assure quality performance.
5. Only the highest quality materials used.
6. We sincerely believe NWL Transformers are superior, and we have built our business on this policy.

TRANSFORMERS FOR:

Heating, Testing, Power, Electronic, Electric Furnace, Special Welding, Phase Changing, Precipitation, Controlling, Research, Lighting, Industrial, Measuring, Signaling, High and Low Voltage.

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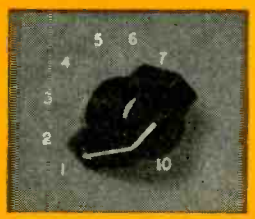
Manufacturers of Electrical Transformers— Testing Equipment

MEMBER

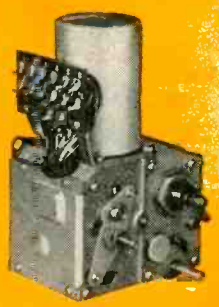
In automatic positioning

Collins AUTOTUNE* leads the field

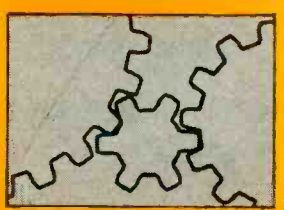
Select the channel



to Activate Autotune



Your Mechanism is Positioned



The Collins AUTOTUNE* is the standard of the world in automatic positioning systems. Its superior performance has been proven for both remotely and locally controlling automatic tuning of high quality military and commercial communication equipment. Collins AUTOTUNE is also applied to many other equipments which require precision positioning.

The system can be actuated by either a remote or local selector switch having one position for each selector channel. Settings on any selector channel can be changed in a few seconds, giving the operator complete re-set control.

Standard AUTOTUNE heads — both Single-turn and Multi-turn — are available to industry. The Type 496A packaged unit illustrated is an example of a particularly compact AUTOTUNE system for use where minimum weight and space allocations exist. It has a re-set accuracy of 0.05 angular degrees which means approximately **1/10,000 inch** on a quarter inch diameter shaft.

Write for complete information, or advise us of your design problems. We are confident that we can supply an AUTOTUNE to meet your positioning requirements.

*Registered U. S. Patent Office

COLLINS RADIO COMPANY
Cedar Rapids, Iowa,

261 Madison Avenue, NEW YORK 16
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2700 West Olive Avenue, BURBANK
Collins Radio Company of Canada Ltd.
74 Sparks Street, OTTAWA, ONTARIO

COLLINS

Send this coupon for a fully descriptive, 16-page brochure on Collins AUTOTUNES.

COLLINS RADIO COMPANY
855 35th St. NE, Cedar Rapids, Iowa

Gentlemen: Please send me your 16-page brochure on Collins Autotunes.

Name _____

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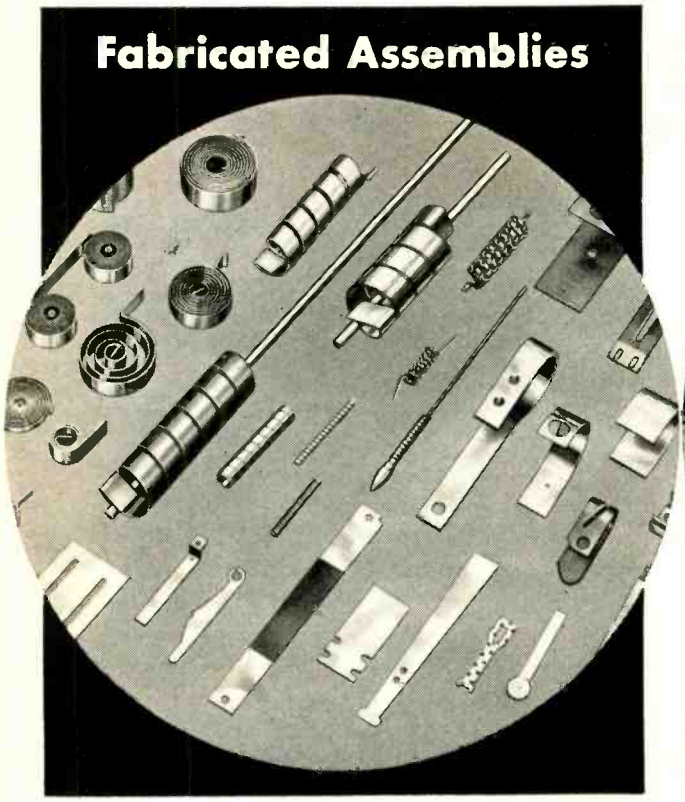
In Any Form



General Plate
TRUFLEX® Thermostat Metals
Give Accurate
Temperature Response . . . Cut Costs

General Plate *Truflex* Thermostat Metals provide a sure way to get reliable performance and at the same time cut costs of products requiring temperature control, indication or compensation.

Advanced General Plate production methods coupled with the best equipment available insure close tolerances on all properties and dimensions. This maintains positive consistency in thermal, mechanical, and electrical performance. With no variation from lot to lot rejects are eliminated, costly adjustments are minimized.

General Plate *Truflex* fabricated assemblies are engineered and manufactured to your specifications, ready for installation into your products. They eliminate costly fabrication problems . . . needless special equipment . . . experimental work and expensive calibration.

However, if you prefer to make your own assemblies, General Plate *Truflex* Thermostat Metals are available as strip in extra long coils or flat cut lengths manufactured to your material specifications.

Write for information and engineering assistance.

You can profit by using General Plate Composite Metals!

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GENERAL PLATE DIVISION
312 FOREST STREET, ATTLEBORO, MASS.

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to see why leading industries specify ADLAKE Mercury Relays wherever sensitivity and dependability are vital!

Type 5000 Adlake Relay

ADLAKE Mercury Relays have won their place by *proven dependability* in jobs which conventional relays can do in an uncertain manner at best. For instance, they have proved their ability to stand up under the most adverse conditions of temperature and moisture . . . normal line voltage fluctuations or ambient temperatures from −38.8° to +200° F. have no material effect on their time-delay characteristics.

What's more, every ADLAKE Relay is hermetically sealed . . . absolutely maintenance-free . . . always silent and chatterless. And ADLAKE'S mercury-to-mercury contact provides an ideal snap action.

Yes, wherever sensitivity and dependability are required, ADLAKE Mercury Relays can do the job best! Send for the ADLAKE Relay catalog today . . . no obligation, of course. The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana. In Canada, address Powerlite Devices, Ltd., Toronto.

EVERY ADLAKE RELAY GIVES YOU THESE PLUS FEATURES:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

SILENT AND CHATTERLESS • REQUIRES NO MAINTENANCE • ABSOLUTELY SAFE

MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking.
And every ADLAKE Relay is tested—*and guaranteed*—to meet specifications!

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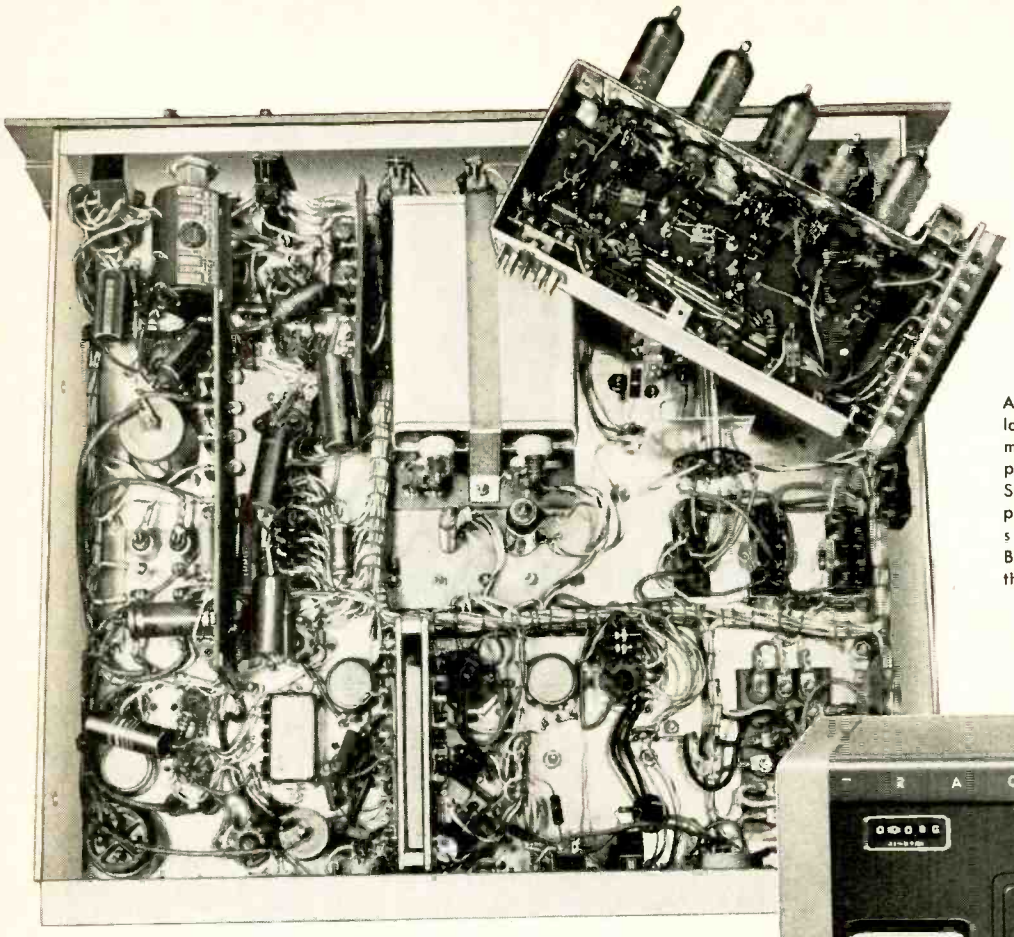
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Want more information? Use post card on last page.



At left—Plug-in unit of Tracerlab Superscaler mounted on a miniature chassis. It can be plugged into the front of the Superscaler. Various types of plug-in units are available for special electronic functions. Bradleyunits are standard in this Superscaler assembly.

Tracerlab Superscaler

equipped with

Bradleyunits and Bradleyometers for maximum dependability

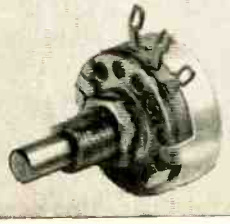
The Tracerlab Superscaler is a fast-counting instrument for Geiger, proportional, or scintillation pulses, featuring both preset count and preset time operation.

Bradleyometers are used in this Superscaler for dependable potentiometer adjustments. The resistor element is molded to satisfy any resistance-rotation curve. Variations in temperature and humidity do not affect its performance.

Bradleyunits are stable fixed resistors entirely free from erratic variations in resistance, and they have never been found to open circuit in service. The leads are differentially tempered to prevent sharp bends at the resistor body. After carrying full load at 70 C ambient for 1000 hours, the resistance change is less than 6 per cent.

For quality in fixed and adjustable composition resistors, follow the example of leading electronic equipment manufacturers—standardize on Allen-Bradley components. Write for descriptive engineering bulletins, today.

BRADLEYUNITS are available in standard RETMA values in ½ and 2 watt sizes from 10 ohms to 22 megohms; in the 1 watt size from 2.7 ohms to 22 megohms. Allen-Bradley resistors do not use "wax impregnation" to pass salt-water immersion tests.



BRADLEYOMETERS can be supplied as single units or in dual and triple construction. Built-in line switch can be provided. Corrosion-resistant metal used throughout. No riveted, welded, or soldered connections.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

DU PONT
Better Things for Better Living . . . through Chemistry

ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

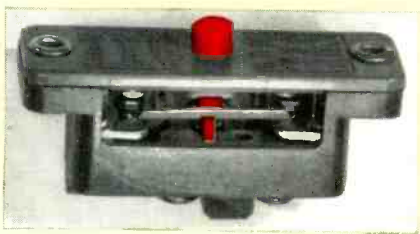
NO. 6 1954

Properties of Du Pont TEFLON® Make It Ideal Insulation for Electrical Equipment

Du Pont "Zytel" nylon resin gives improved switch performance

Snap switches for machine tools and basic contact mechanisms on industrial instruments often have buttons and stems molded of "Zytel" nylon resin. This engineering material is used to obtain more efficient production and better performance.

Du Pont "Zytel" is tough and resilient, and resists abrasion. It makes possible the maintenance of critical dimensions. This is particularly important in the manufacture of such parts as timing relays for resistance welding machines, which control the duration of current flow and electrode motion.



These switches feature one-piece buttons and stems of molded Du Pont "Zytel" nylon resin.

The lightness of weight and remarkable strength of "Zytel" in thin sections are important factors in such applications. Mass production by injection molding is economical. One molded part often replaces a complex assembly of many parts.

Perhaps "Zytel" nylon resin can help solve one of *your* design problems. For further information about this or any other Du Pont engineering resin material, clip and mail the coupon on the reverse side.

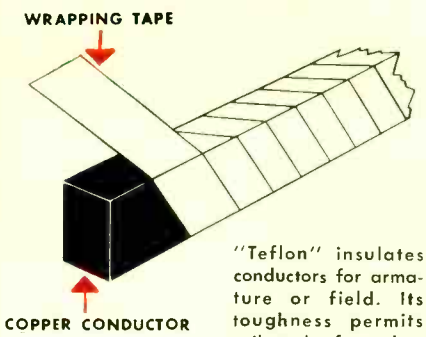
"Zytel" is the new trade-mark for Du Pont nylon resin.

Dielectric and thermal advantages of "Teflon" are unmatched by any other single material

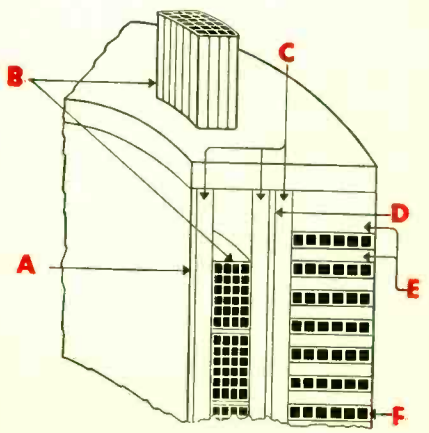
Du Pont "Teflon" tetrafluoroethylene resin is used for insulation in power distribution equipment because of its unusual combination of properties. In tape form, as wire coating, or molded part, "Teflon" withstands hot-spot temperatures, to 500°F. It is not affected by weather or moisture (zero water absorption by ASTM test D570-42). "Teflon" has a power factor of less than .0005 for the tested range of 60 cycles to 10^8 cycles. A part molded of "Teflon", when exposed to an arc, leaves no carbonized path.

In addition, "Teflon" has high short-time dielectric strength—with values ranging from 1000 to 2000 volts per mil, depending on thickness. (Recommended working stresses: 50 to 100 volts per mil.) And it is inert to all chemicals normally found in industry.

"Teflon" is tough and flexible over a wide temperature range, from —450°F. to 500°F. "Teflon" can take a lot of abuse, both during assembly and in use. Parts will not crack if dropped. Cable insulation resists damage from vibration and bending. And tape of "Teflon" conforms easily to sharp corners and odd shapes.



"Teflon" insulates conductors for armature or field. Its toughness permits coils to be formed to shape after taping.



Conductor and layer insulation of "Teflon" in power distribution coils: (A) core insulating barrier (laminate of "Teflon" and glass fiber); (B) low-voltage winding (glass fiber coated with "Teflon"); (C) axial spacers; (D) high-low insulating barrier (laminate of "Teflon" and glass fiber); (E) radial spacers; (F) high-voltage winding (glass fiber coated with "Teflon").

You will find "Teflon" performing with outstanding success . . . not only on power distribution equipment, but in these and other applications as well:

FOR MOTORS AND GENERATORS

The unusual advantages of "Teflon" become apparent when temperatures are too high or atmospheres are too corrosive for other dielectrics. Tape of "Teflon" is particularly suitable for armature or

(Continued, column 3, back side)

OVER

DU PONT
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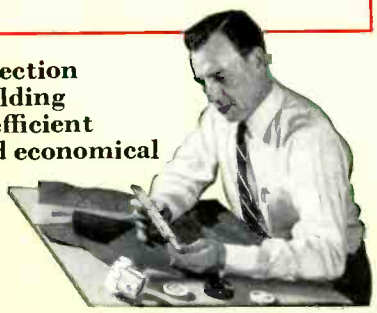
ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 6 — 1954

POINTERS ON PROCESSING

Injection molding is efficient and economical



Injection molding, as a method of mass-producing parts made of Du Pont engineering resin materials, has been developed mainly within the past ten or fifteen years. And new improved techniques have accompanied that development.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"** nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

Injection molding offers the advantages of high production rates, low unit cost, and usually does away with finishing operations. One important saving which has been effected by injection molding occurs when the molded piece replaces an assembly of two, three or more parts.

HIGH PRODUCTION RATE

Multi-cavity dies have been made which produce hundreds of identical pieces at a time. Molding time and cycle vary, of course, with the size of the part and its shape. The injection molding process is versatile, and is used to produce a wide variety of quality parts, rapidly and economically.

LOW UNIT COST

Another positive value of injection-molded parts is the low cost of fabrication per part. While the initial cost of the mold itself is high, a mass-production operation makes the cost per piece low. In addition, loss of molding material is generally low.

NO FINISHING OPERATIONS

With good molding techniques, pieces can be injection-molded to close tolerances. In many cases, molded pieces require no finishing operations. Thus, large savings in time and expense can often be realized.

SIMPLIFIED DESIGNS

The versatility of injection molding often permits design simplification. Du Pont "Zytel" nylon, for example, can be injection-molded into intricate shapes, as well as around metal inserts. Du Pont "Alathon" polyethylene resin and "Lucite" acrylic resin can also be successfully injection-molded into a variety of useful forms. For more information about Du Pont engineering resin materials and how they are being used in industry, clip the coupon.

Du Pont "Teflon"

(continued from other side)

field conductor insulation, coil wrapping, slot lining, lead insulation, and coil separation.

FOR TRANSFORMERS

"Teflon" makes it possible for transformers to operate at hot-spot temperatures as high as 500°F. "Teflon" is used in transformers for conductor, layer, and ground insulation, and for coil separation. At the present time it is used commercially in electronic transformers and experimentally in distribution and power units.

FOR CAPACITORS

Where high ambient temperatures and minimum power loss are essential, "Teflon" gives outstanding service. It is used as the dielectric in many wrapped capacitors.

FOR ELECTRONICS EQUIPMENT

Under conditions of ultra-high frequencies, heavy moisture and concentrated heat, "Teflon" assures efficient operation. Here it takes the form of tape, molded component, or extruded insulation.

Can "Teflon" help you with your design problems? The properties discussed above show why no other single material can match it. And the coupon on the left will bring you whatever further information you need about "Teflon" or any of the other versatile engineering resin materials made by Du Pont.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Polychemicals Department
Room 2212, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for*

NAME_____ TITLE_____

COMPANY_____

STREET ADDRESS_____

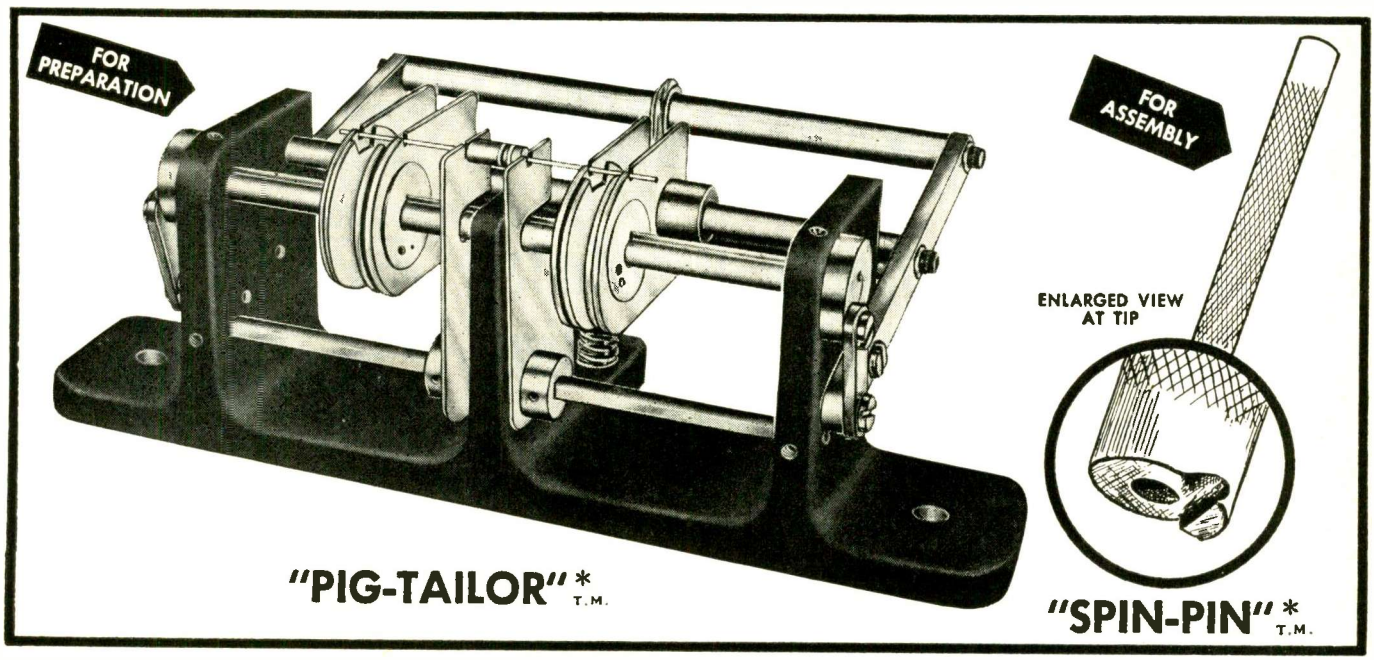
CITY_____ STATE_____

TYPE OF BUSINESS_____

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
**"Zytel" is the new trade-mark for Du Pont nylon resin.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters!
2. Long-nose pliers!
3. Operator judgment!
4. 90% operator training time!
5. Broken components!
6. Broken leads!
7. Short circuits from clippings!
8. 65% chassis handling!
9. Excessive lead tautness!
10. Haphazard assembly methods!

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. E-12

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DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
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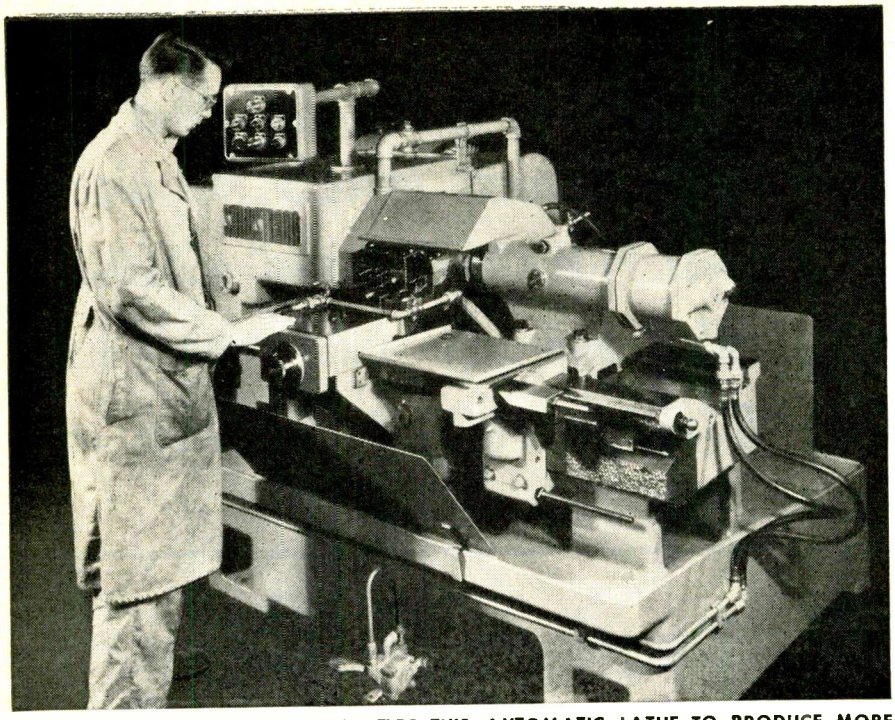
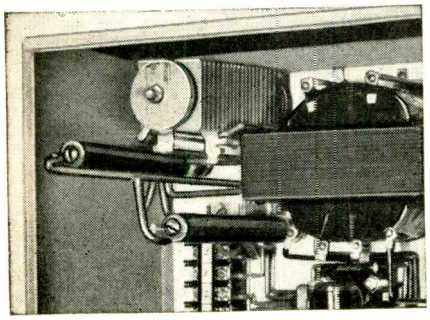


FASTER STARTING AND STOPPING HELPS THIS AUTOMATIC LATHE TO PRODUCE MORE

General Electric Selenium Rectifiers Help Make This Lathe More Productive

Speeding up starting and stopping operations has increased the productivity of many of today's finest machine tools. In the Sunstrand automatic lathe pictured above, an electric brake and clutch combination starts and stops the machine spindle. Another electric brake provides a fast stop when the tool carriage is advanced to the work, or backed off to the unloading position.

D-C POWER to operate the electric brakes and clutch on this lathe is supplied by General Electric selenium rectifiers shown in the smaller photograph. Their high quality (see C.E. Hamann's article at right) makes G-E selenium rectifiers ideal for almost all machine tool applications.



D-C POWER for the lathe's clutch and brakes comes from this selenium rectifier.

TOP PERFORMANCE of G-E selenium rectifiers is the result of a unique "evaporation" process and careful inspection and testing. Besides providing stacks with exceptionally low forward voltage drop and low reverse leakage, this process assures greater uniformity of these characteristics among different stacks. These qualities last in service. On test in the laboratory, and on-the-job in almost every field of application, G-E selenium rectifiers are demonstrating their extremely slow aging.

OTHER APPLICATIONS for G-E selenium rectifiers include supplying power to operate d-c relays in various control circuits and as components in electronic equipment. A complete range of ratings is available in either open stacks or various types of sealed cases to meet special operating conditions. Contact your nearest G-E Apparatus Sales Office for complete information, or write Section 461-33, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

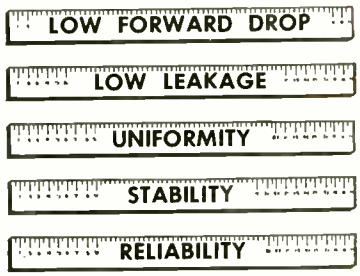
METALLIC RECTIFIER FACTS FOR ENGINEERS

Quality

by C. E. Hamann

One of the most overworked terms used in the selenium rectifier industry is "high quality." Every manufacturer claims "high quality" for his product. Every user wants "high quality" in the selenium components he buys because the quality of the end device can be no higher than that of the components assembled into it.

There are many yardsticks for measuring the quality of a selenium stack. Electrical characteristics, for example: low forward drop and low reverse leakage. Often one is sacrificed in favor of the other.



Which "yardstick" measures quality?

Real quality insures that both the forward and the reverse characteristics are good.

Uniformity of characteristics is another yardstick. If the characteristics vary from stack to stack the performance of the end equipment will be questionable.

Stability is another important standard in determining quality. The initial characteristics must be good, but they must stay good and not deteriorate with time and use.

Reliability is still another measure of quality. No matter how liberal the manufacturers replacement policy, frequent failures in the field are costly to the equipment manufacturer, and annoying to the equipment user.

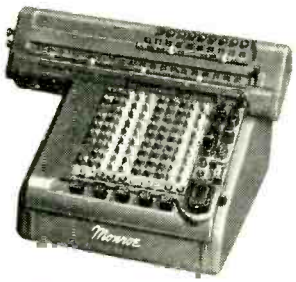
All of these yardsticks must be considered carefully in determining quality. To really earn the title of "high quality" a selenium stack must measure up to a high standard of performance by every one of these yardsticks.

C. E. Hamann

General Electric Company

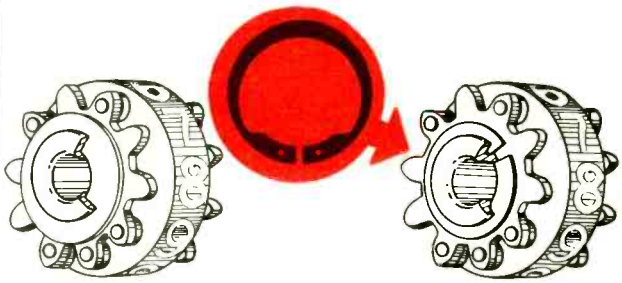
Waldes Truarc rings replace old-fashioned fasteners . . . save assembly time...end scrap loss...increase operating efficiency

This is the Monroe Calculator



...precision-engineered business machine made even more efficient, and less costly to manufacture through the use of Waldes Truarc Retaining Rings.

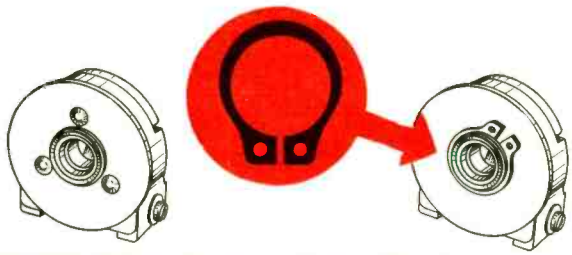
Multiplier Dial Assembly



Old Way. One-piece assembly was spun together. Spinning operation was costly, resulted in high scrap loss.

Truarc Way. Two-piece assembly is held together by one Truarc Ring (series 5108). Rejects: practically zero.

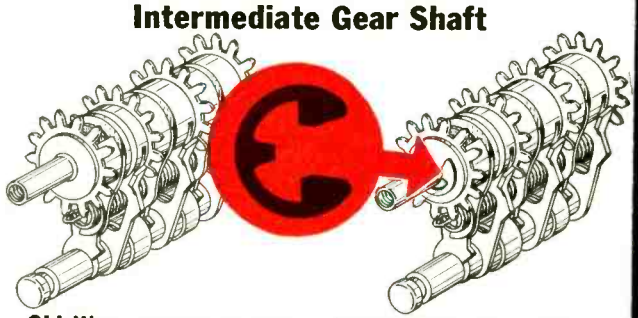
Electric Motor Governor



Old Way. Collector Disc assembly was formerly riveted, requiring skilled labor. Riveted Collector Disc could not be removed in the field.

Truarc Way. Truarc Ring (series 5100) replaces rivets, saves labor, material...improves Collector action. Collector Disc is easily replaced.

Intermediate Gear Shaft



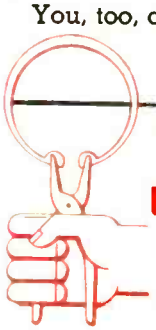
Old Way. Washer riveted on end of assembly for zoning control. Costly, troublesome, hard to obtain critical zoning required.

Truarc Way. Truarc E-Ring (series 5133) cuts assembly time, virtually eliminates rejects and final assembly and zoning problems.

Monroe Calculating Machine Company, Orange, N. J. uses various types and sizes of Waldes Truarc Retaining Rings. Use of Truarc has helped eliminate scrap losses, saved on material and labor, and resulted in increased operating and servicing efficiency of the product. Monroe plans to use Truarc Rings for every possible fastening operation on their entire line!

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

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



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; 2,441,646; 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

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

E126

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

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

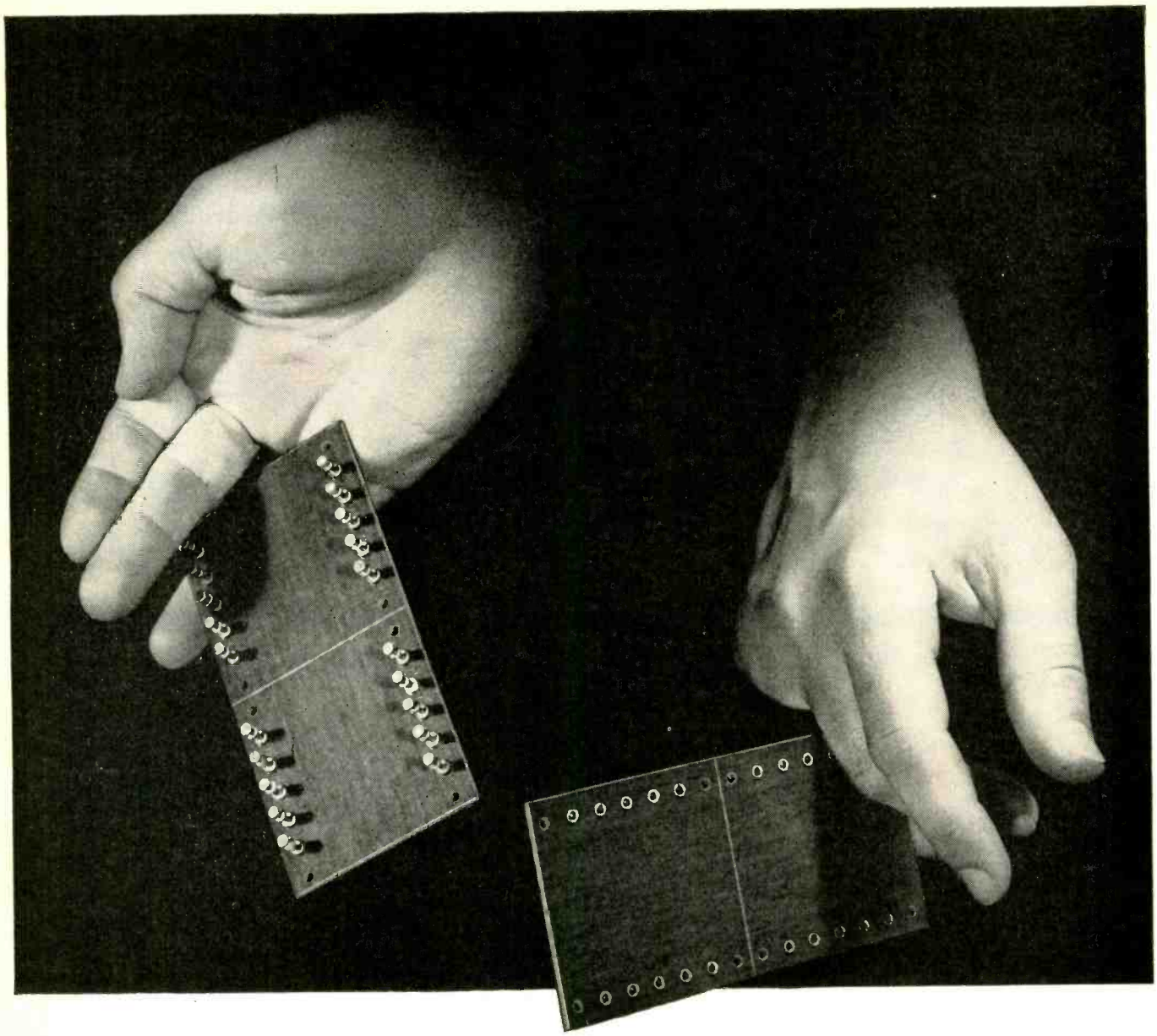
Name .....

Title .....

Company .....

Business Address .....

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



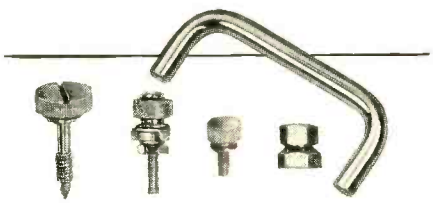
No cracks, please

You'll find no radial cracks in C.T.C. terminal boards, or "cracked" rivet shanks on terminals. And there's a good reason for this.

Our swaging machines use tools that we designed ourselves in order to prevent just such damage. Terminals are fastened securely — *and carefully*. You benefit from a board that has no "weak spots" — that can give you the service you have a right to expect. And, of course, you also benefit from all the other quality control details that enable us to offer our customers *guaranteed* components — custom or standard. Coatings are smoothly applied — no wrinkles, no heavy deposits. C.T.C. terminals are made from certified stock that is free from defects. And the terminals themselves are guaranteed, even to the thickness of the coatings.

This C.T.C. quality control is given to all C.T.C. products including insulated terminals, coil forms, coils, swagers, terminals and capacitors. For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Terminal Board Data. C.T.C. makes both standard boards and to your own specifications. Standard boards in cotton fabric phenolic, nylon phenolic or grade L-5 silicone impregnated ceramic. Custom made in cloth, paper phenolic, melamine, epoxy or silicone fibreglas laminates, imprinted as required and lacquered or varnished to specifications MIL-V-173 and JAN-T-152.



A wide variety of hardware is available at C.T.C. — all of it quality controlled and guaranteed for durability. This hardware includes terminal board brackets, standoff mounts, spacers, tube clamps, panel screws, thumb screws, dial locks, shaft locks, handles and handle ferrules.

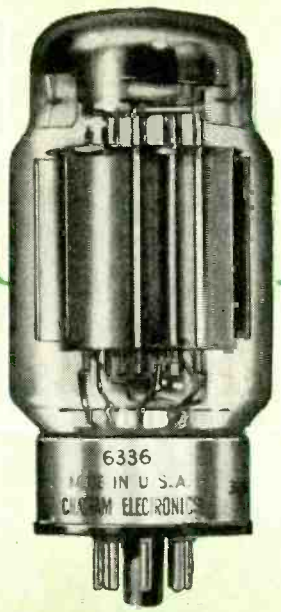
CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

3 twin power triodes

...for voltage regulation

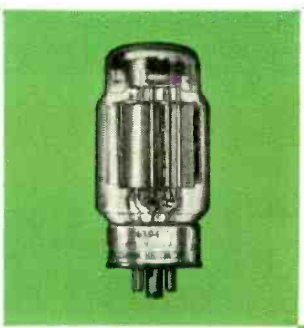


CHATHAM
TYPE 6336
NEW TWIN TRIODE FEATURING HIGH PLATE DISSIPATION

The new Chatham Type 6336 is a twin power triode with special suitability for voltage regulating applications. Used as a series tube, it will pass a minimum of 150 milliamperes per section with 40 volts, D.C. plate voltage. Special features include a hard glass envelope, an 8-pin button stem with Jumbo Octal Base.

CHARACTERISTICS *(PER SECTION)*

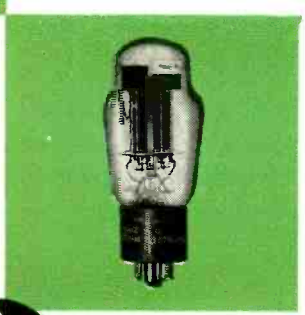
- **PLATE DISSIPATION: 30 WATTS**
- **AMPLIFICATION FACTOR: 2.7**
- **TRANSCONDUCTANCE: 11,000 MICROHMS**
- **PLATE RESISTANCE: 250 OHMS**
- **HEATER REQUIREMENTS: 6.3 V., 4.75 AMPS.**



TYPE 6394
TWIN TRIODE
Similar to Type 6336 in every respect except for Heater Requirements which are 26.5 volts, 1.25 amps.

The tubes shown are typical items from the complete Chatham line of general and special purpose tubes. Included in this line are Amplifiers, Mercury and Inert Gas Rectifiers, also Mercury, Inert Gas and Hydrogen Thyratrons.

Most Chatham tubes are available directly from stock and can be supplied promptly. Chatham also designs, develops and manufactures special tubes to exact customer specifications—inquiries are invited.



CHATHAM TYPE 6AS7G IMPROVED TWIN POWER TRIODE—

This Chatham Twin Triode is built to close tolerance — features plate current and GM characteristics held within ±10%, very low microphonics, improved triode balance, absence of grid current and greatly reduced plate current drift. Plate current is 125 milliamperes at 40 volts, D.C. plate voltage. The characteristics of this tube recommend it especially for voltage regulation circuits. Base is Medium Shell Octal.

CHARACTERISTICS: *(PER SECTION)*

- Plate Dissipation: 13 Watts
- Amplification Factor: 2.0
- Transconductance: 7,000 Microhms
- Plate Resistance: 280 Ohms
- Heater Requirements: 6.3 Volts 2.5 Amps.

CHATHAM ELECTRONICS CORP.

Executive and General Offices: LIVINGSTON, NEW JERSEY
Plants and Laboratories: NEWARK and LIVINGSTON, NEW JERSEY

Want more information? Use post card on last page.

He's using the telephone that lends an extra hand

"Sure . . . I'm looking up the figures right now!" From busy executives to clerks, people in business can work more easily and efficiently with Bell's new Distant Talking Telephone. Small white rectangle is the loudspeaker.

For people who want to keep *both* hands free when they telephone, Bell Telephone Laboratories engineers have devised a new telephone with a sensitive microphone in its base.

To use it, simply press a button. The microphone picks up your voice and sends it on its way. Your party's voice comes to you through a small loudspeaker. Both hands are left free.

The volume can be adjusted to suit yourself. If privacy is needed, you simply lift the handset; this shuts off the microphone and loudspeaker and you talk just as you would on a regular telephone.

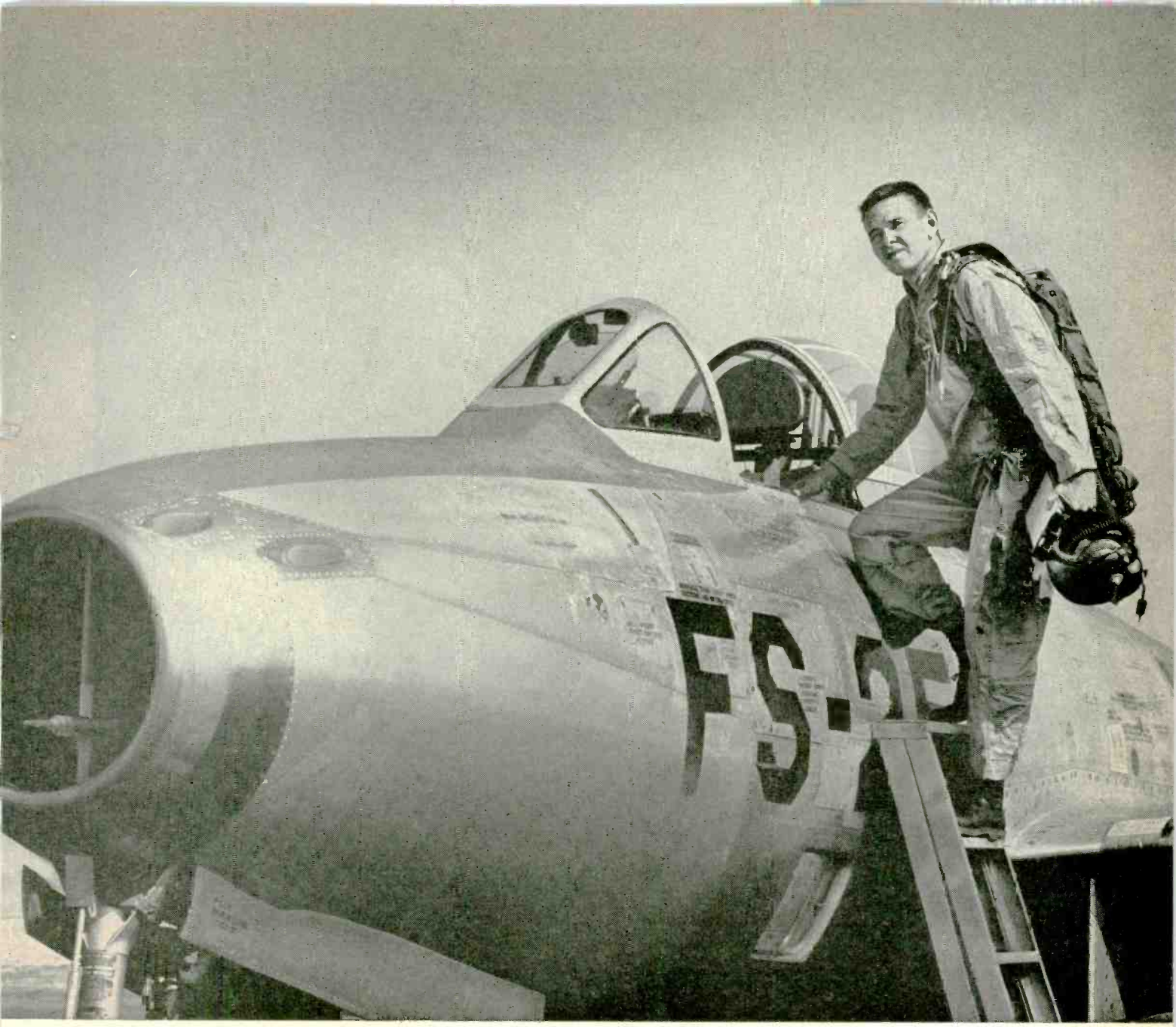
This new development of Bell Laboratories increases the number of ways your local Bell telephone company can serve in businesses and homes.

Pencil points to microphone in base of new telephone. Left-hand button controls volume, center one turns set "on" and lights up while in use. The third is an "off" button.

Bell Telephone Laboratories

Improving telephone service for America provides careers for creative men in scientific and technical fields.

Want more information? Use post card on last page.

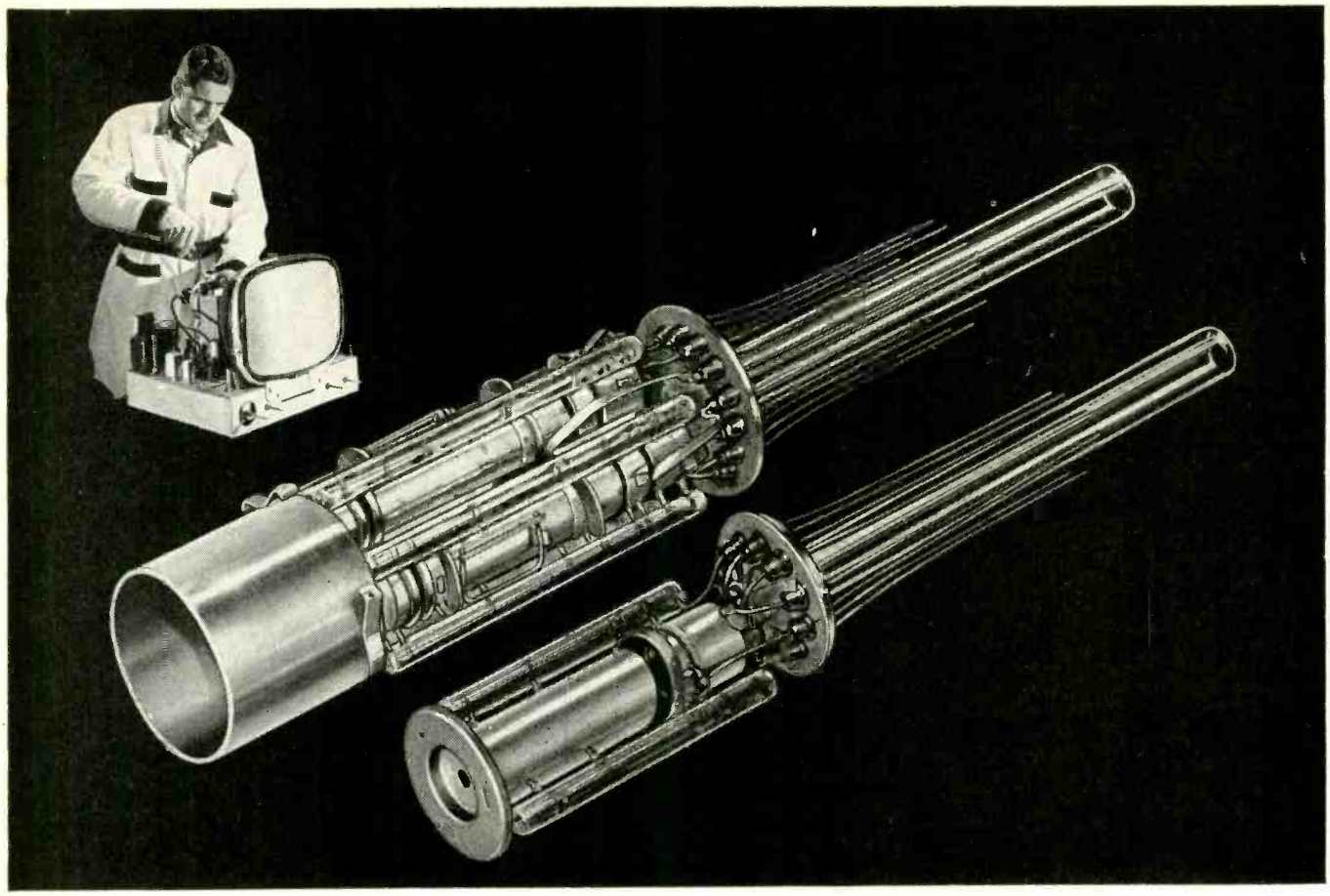


This is a Lear engineer designing a new autopilot

JOHN HARPER, B.S.E. (University of Michigan), is one of *ten* Lear engineers qualified and actively flying as jet pilots. But please note that these ten engineers are engaged *primarily* in the design, development, and perfection of automatic flight control systems, using their jet piloting skills only as an *engineering* tool.

At Lear, first-hand *in-flight* analysis is an integral part of development. As a result of this program, continuously checking theory against performance, Lear is exceptionally equipped to offer the most advanced solutions to the challenging and ever-changing problems of automatic flight stabilization.

LEAR



Miniature TV Tri-color cathode gun solves designer's dilemma

Sometime this year, a fortunate few thousand TViewers who can pay the freight will relax at home and watch their favorite stars cavort in color. Back of each screen is a triumph of engineering magic—a tri-color cathode ray gun, actually 3 cathodes—one for each primary color.

To bring color TV within pocketbook range of all of us, the heart of future guns will be a miniaturized version of the present disc cathode. The tubular nickel shank of this new disc cathode has been shortened from .312" to .220" and the outside diameter decreased from .121" to .090", resulting in a number of improvements adding to the efficiency of the assembly.

Cathode surface area is reduced. Smaller and shorter heaters used. Less power required (300-450 milliamps instead of the 600 required in older guns).

Lower heat radiation, due to less power, offers a constant heat as well as a cooler continual operation.

A smaller shank and cap which will not dish-in offers better transmission of electrons to the TV screen.

Smaller guns permit a more compactly assembled 3-gun unit. By moving guns closer together, the deflection of the electron beams is more closely controlled.

Miniaturization of the guns means a smaller neck on the finished TV tube. The 3-barrel color tubes take little more space than black and white types, and vital space is conserved for set manufacturers.

The advantages of the present larger disc cathode for monochrome guns—wide choice of material for cap and shank; close "E" dimension control—are also incorporated in the new design.

If you're interested in more information on materials used in the new disc cathode, and details on Nickel and Nickel Alloy Tubing, mail coupon today for a blueprint and Data Memo 5 and 19. There's no obligation.

Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.
Electronics Division.

Please send ☐ Blueprint ☐ Data Memo 5 and 19 on Superior Nickel and Nickel Alloy Tubing.

Name_____

Company_____

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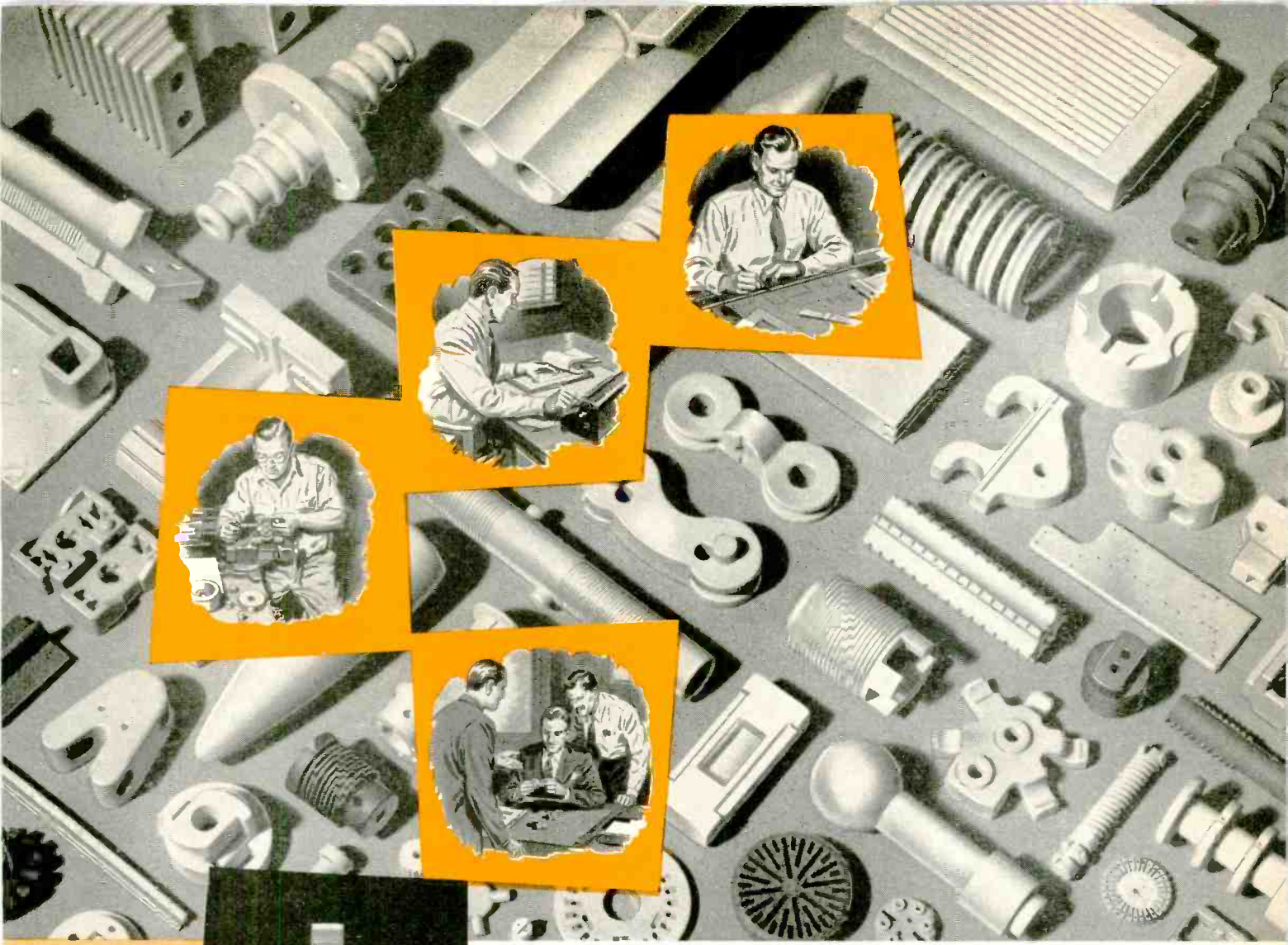
Superior Tube

The big name in small tubing

All analyses .010" to ⅝" O.D.
Certain analyses in light walls up to 2½" O.D.



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(another AlSiMag Extra)

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Careful study of designs by our engineering staff (with more than 50 years of specialized experience) often results in recommendations which mean — **Savings** in manufacturing costs, **Savings** in speed and ease of assembly, **Savings** through improved performance, **Savings** from combining two or more parts for still greater economy.

Our Sample Order Department can quickly make up pieces to any new design that looks promising and let you test them thoroughly. When the final design has been decided upon, parts can be produced to specification in volume to match your requirements.

A blueprint or sample of your present part with outline of operating requirements will bring prompt action . . . which may save you lots of money.

53RD YEAR OF CERAMIC LEADERSHIP

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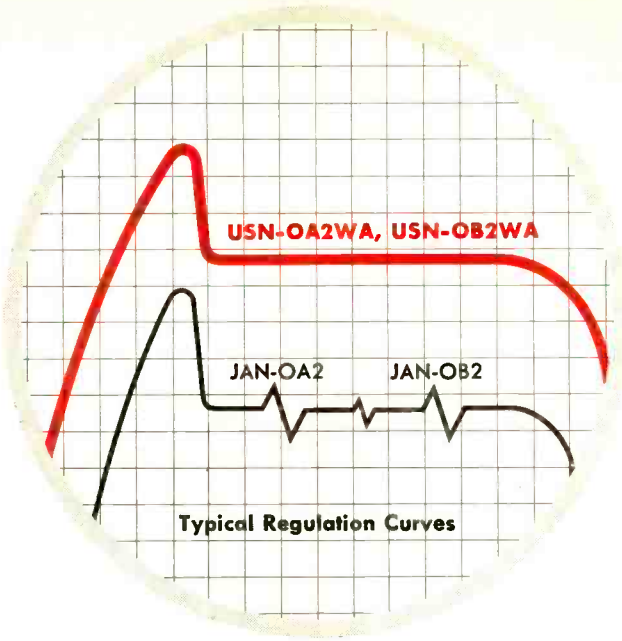
NOW...VR TUBES WITHOUT "PIPS"!

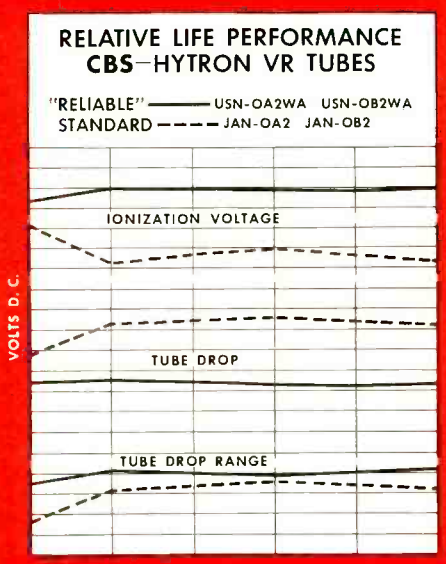
...for Stable Voltage Reference

NEW "RELIABLE"...DUAL-PURPOSE CBS-HYTRON USN-OA2WA USN-OB2WA*

CBS-Hytron, the leader in VR tubes, has solved the "unsolvable" VR-tube problem. Has taken those annoying "pips" (sudden discrete voltage shifts) out of two new CBS-Hytron VR developments: The dual-purpose USN-OA2WA and USN-OB2WA. Both are superior, "reliable" voltage regulators. Both also achieve stable voltage-reference performance.

These new tubes are directly interchangeable with the JAN-OA2 and JAN-OB2. But they are manufactured and tested to new, more rigid U. S. N. Bureau of Ships specifications. USN-OA2WA and USN-OB2WA are designed for dependability under severe environmental conditions . . . and for a wide range of applications. Improved construction and tight quality control offer many advantages. Check features, curves, and construction of these versatile tubes.

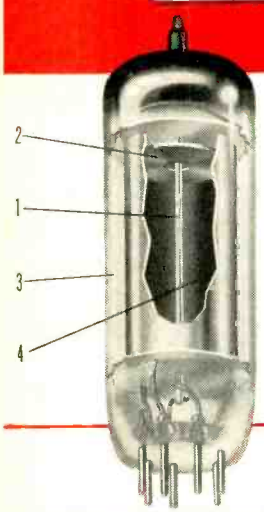




** Improved tubes, tested to U. S. N. specifications, not to be confused with earlier JAN "reliable" versions.*

CHECK THESE FEATURES

1. Flat, smooth voltage-current characteristic.
2. Greatly improved voltage repeatability.
3. Stable electrical characteristics.
4. Tested under severe conditions of shock, vibration, temperature, and altitude.



IMPROVED CONSTRUCTION USN-OB2WA

Note these improvements: 1. New, simplified aluminum-rod anode. 2. New disc-type starting electrode, to minimize gap-spacing variations and give more uniform starting voltage. (In USN-OA2WA, this electrode is located at bottom of mount assembly.) 3. New gas fill with neon body and low argon content. 4. New composite nickel-aluminum cathode work surface. Improvements 3 and 4 make possible operation at 150°C . . . and stable voltage-reference applications.

FREE DATA for both USN-OA2WA and USN-OB2WA. Write for Bulletin E-235.

CBS-HYTRON Main Office: Danvers, Mass.

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Send for this *Free* SAMPLE FOLDER...

Contains 25 different Test Samples of high-dielectric INSULATING TUBING and SLEEVING

INCLUDES SAMPLES AND DESCRIPTIONS OF THE FOLLOWING...

VARGLAS SILICONE Class H insulating materials were pioneered by our Laboratory. Retain flexibility, electrical properties and mechanical strength in temperatures ranging from —85°F. to 500°F. Available in tubing, sleeving, lead wire, tying cord.

PERMAFIL-IMPREGNATED VARGLAS TUBING Fiberglas braid coated with General Electric's Permafil resin. Extremely tough, resistant to solvents and elevated temperatures, highly flexible. Can be bent or twisted with little or no loss of dielectric strength. Coils and standard 36" lengths.

VARGLAS SLEEVING AND TUBING Numerous types and grades—including synthetic-treated, varnished, lacquered, saturated, litewall and others.

VARGLAS NON-FRAY SLEEVING Fiberglas braid normalized to remove all organic impurities. It will withstand temperatures up to 1200°F. Recommended where dielectric properties are not paramount. Three types available.

VARFLO TUBING AND SLEEVING Vinyl-coated Fiberglas in full range of sizes, colors and grades. Extremely flexible with excellent heat aging qualities. Low priced.

VARFLEX COTTON TUBING AND SLEEVING Varnish or lacquer impregnated — for applications where MIL-I-3190 Class A materials are specified. All NEMA grades.

SYNTHOLVAR EXTRUDED TUBING Made in various standard formulations of vinyl polymers. Has high dielectric and tensile strength—will not support combustion nor absorb moisture. Type EG Approved under MIL-I-631A. Several others to meet special requirements.

NEW! VARGLAS SILICONE RUBBER SLEEVING AND TUBING—the culmination of 5 years of research—for applications requiring extraordinary flexibility. Details on request.

Varflex CORPORATION

Makers of Electrical Insulating Tubing and Sleeving

MAIL COUPON TODAY FOR SAMPLES!

VARFLEX CORPORATION,
506 W. Court St., Rome, N. Y.

Please send me free folder containing samples of your electrical sleeving and tubing.

I am particularly interested in insulation for:

NAME.....

COMPANY.....

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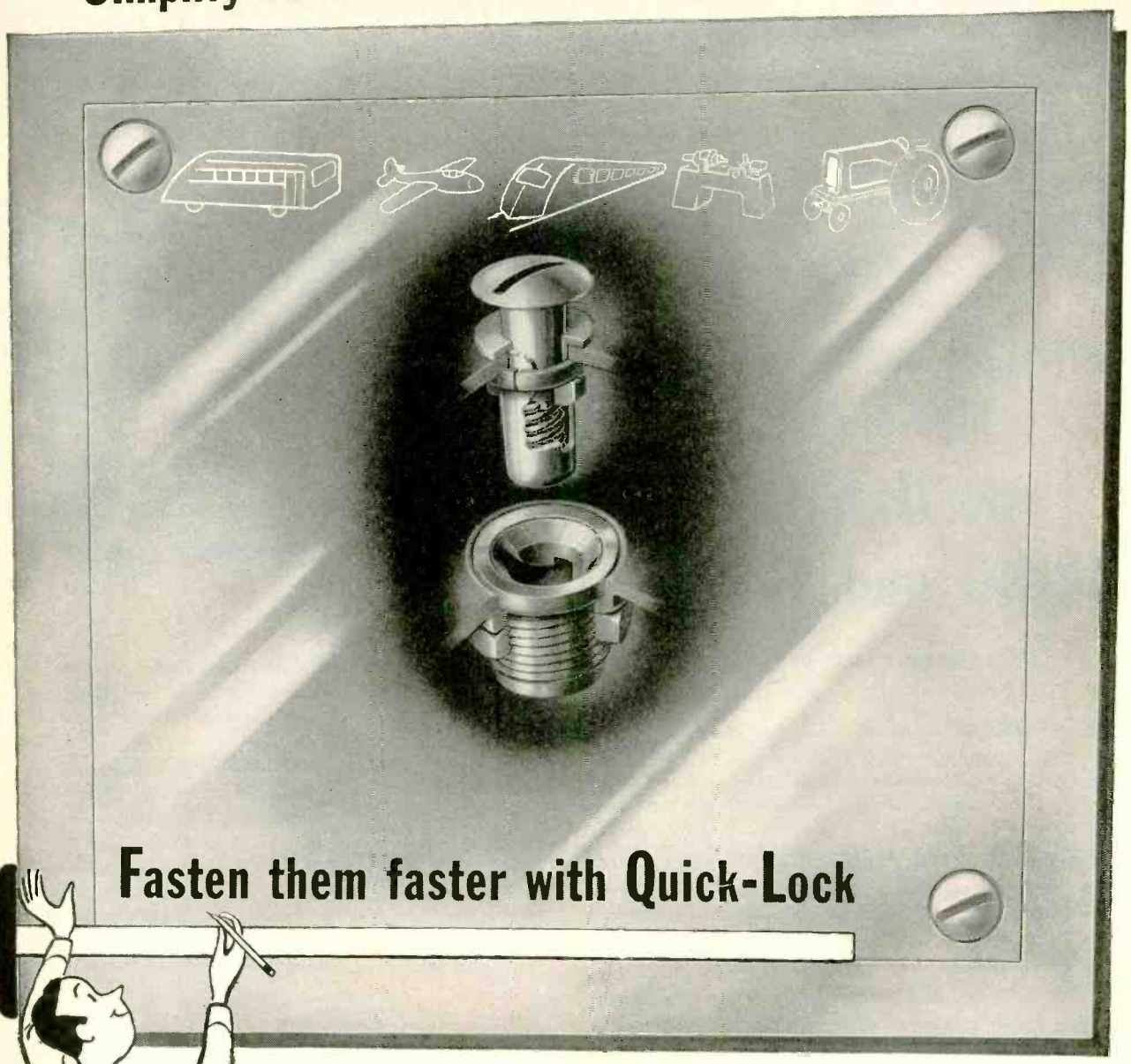
CITY.....ZONE.....STATE.....

Simplify Your Access Panel and Door Assemblies...



Fasten them faster with Quick-Lock

Fastening removable access doors and panels need not be a laborious and costly production or assembly operation—not if they're fastened with QUICK-LOCK.

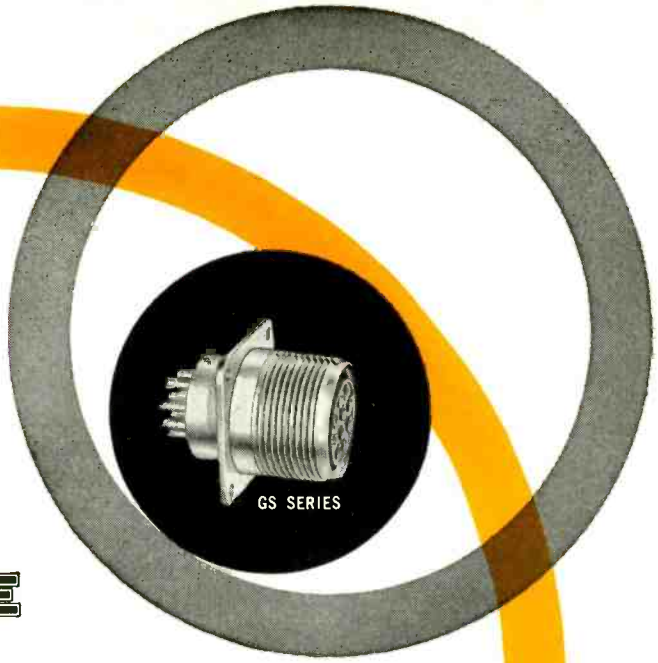
Designed for simple installation, QUICK-LOCK requires no special tools. It speeds up mounting and demounting detachable panels with only a 90° turn required to lock and unlock it *in a jiffy*.

The flexible mounting and tapered stud makes QUICK-LOCK ideal for assembling curved sheets and insures a tight fit when locked. Stud is self-ejecting when unlocked. Minimum deflection is assured—only initial loads are carried by the helical spring. Solid supports take up increased loads.

Industrial and agricultural equipment manufacturers would do well to analyze the cost-saving features of QUICK-LOCK's simple design. A good way would be to call in a Simmons Engineer and discuss the economy of a QUICK-LOCK installation as compared to your present fastening method. Why not send for him today?

SIMMONS FASTENERS

SIMMONS FASTENER CORPORATION • 1750 NORTH BROADWAY, ALBANY 1, N. Y.



for **TRUE**

HERMETIC

SEALING

Canseals *by cannon*

Hermetically-sealed multi-contact Canseal connectors made by Cannon are really rugged! And . . . they are the only connectors that give you **true hermetic sealing under adverse pressure and atmospheric changes.** Here's why . . .

Cannon pioneered the first successful hermetically-sealed connector more than six years ago . . . since then has continously refined and increased the line. All have special steel contacts. Glass insulation . . . **fused to both contacts and shell for a perfect permanent seal** . . . is stronger than steel, withstands temperatures to 1000° F, and permits the use of the **highest conductive steel** contacts compatible with any glass fusing operation.

Available in a wide variety of insert layouts for control, relay, power, and instrument applications in Series GS (AN type), KH, RKH, U, DAH, BFH, TBFH, DBH, DCH, KH30 standard, miniature and sub-miniature sizes. Also, special mounting flanges and brazing service to help you obtain a strong and leakproof overall assembly.

CANNON PLUGS

first in connectors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KH SERIES

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Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
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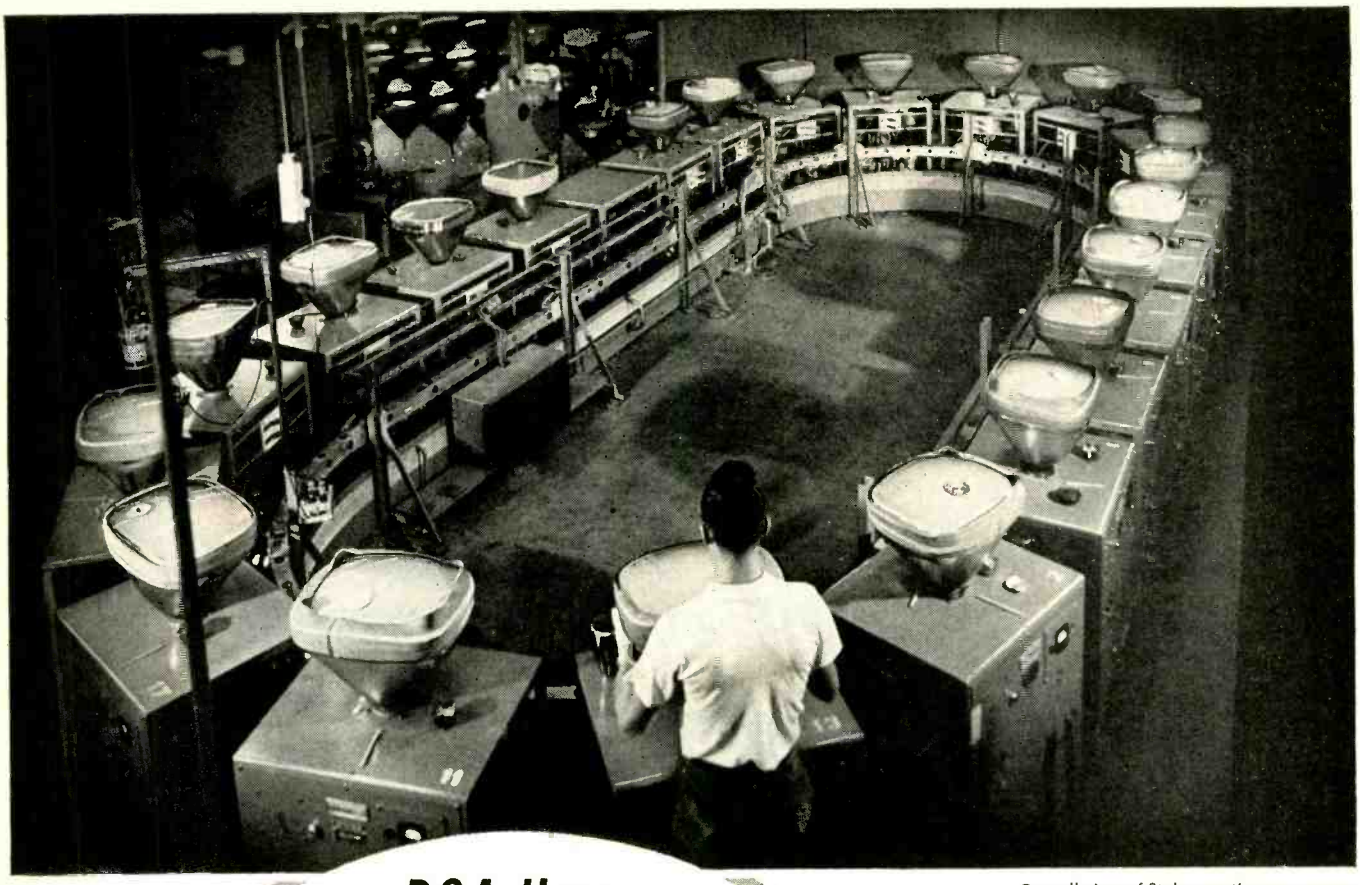

Overall view of Stokes continuous vacuum metallizing dolly system for aluminizing TV tubes at RCA's Marion, Indiana, plant. Operator is required only to load and unload tubes from the carts.

RCA Uses Stokes Vacuum Equipment for Aluminizing TV Tubes

The new Stokes installation at RCA's Marion, Indiana, plant is a valveless, rugged system capable of aluminizing up to 120 TV picture tubes per hour. Low in operating cost, it is by far the least complex continuous aluminizing system available. It is designed without timers, gadgets or intricate accessories, any of which could fail and stall production. The system is so free of vibration that a five-cent piece can be balanced on the dollies while they are in motion.

Operation is simplicity itself: the operator loads one tube to a cart; pressure is automatically reduced to the required vacuum, the filament is automatically flashed and the completed metallized tube delivered to the operator's station.

For metallizing COLOR or BLACK AND WHITE TV tubes, Stokes designs and installs automatic or semi-automatic in-line systems or stationary units, in standard designs or to customer's requirements.

Send for a NEW 28-page technical brochure on vacuum metallizing.

F. J. Stokes Machine Company
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...and of course it uses Midland CRYSTALS

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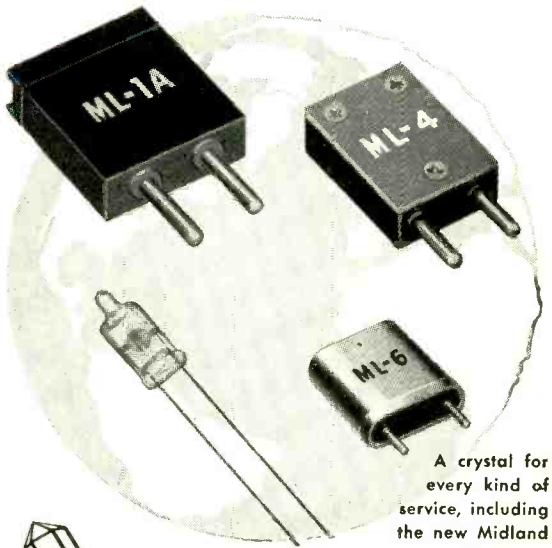
Midland employs the finest technical skill and production facilities in the industry to make sure you'll get completely dependable crystal quality and performance.



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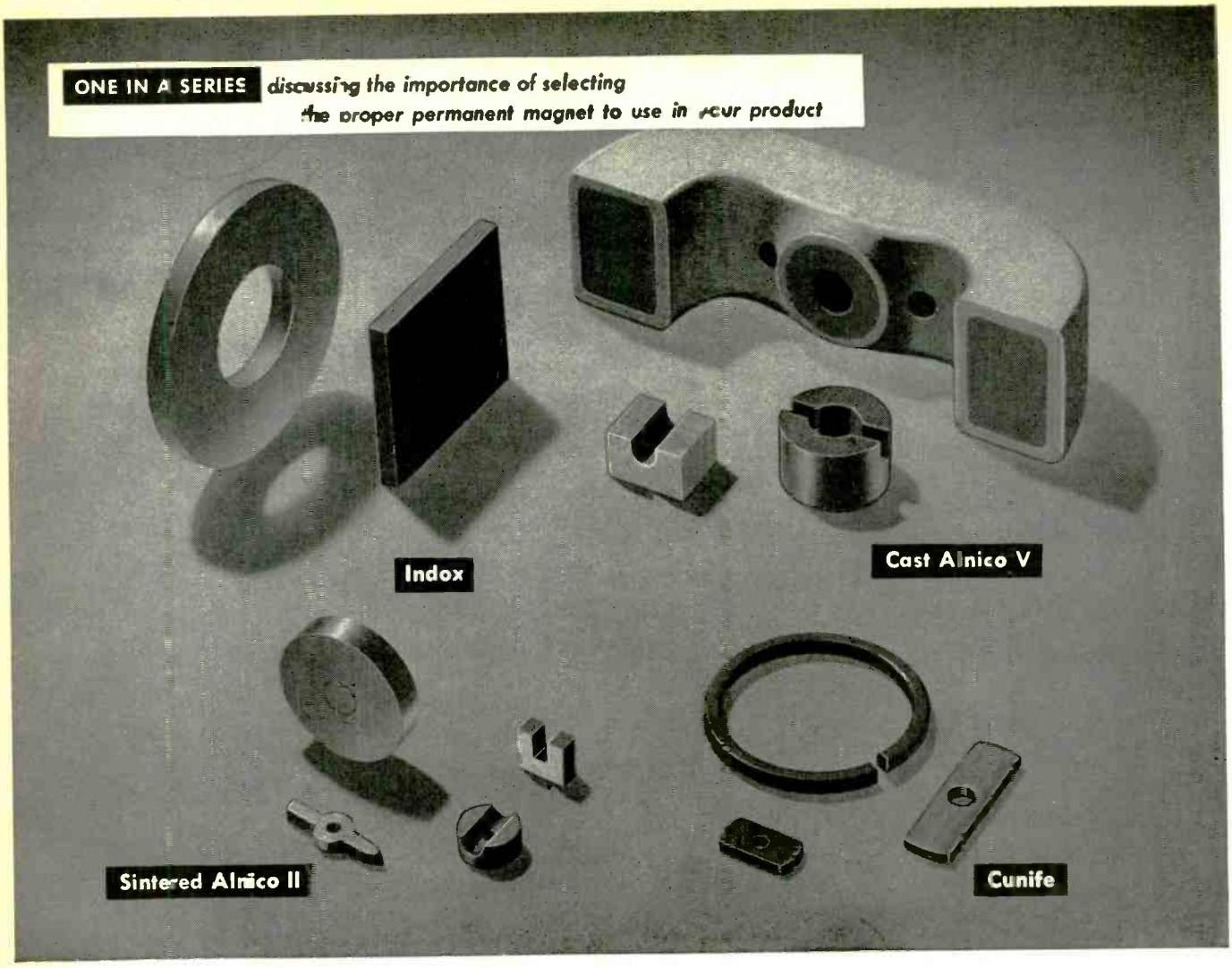

How the Right* Permanent Magnet Material Can Benefit Your Product

Of the many permanent magnet materials available—a few of which are shown above—only *one* will permit your product to *function best at the lowest possible cost.*

Which one is it? To help you answer that question properly is part of our job. As specialists in permanent magnets, we have helped to provide manufacturers with the answers for over 35,000 applications. The case of the telephone equipment manufacturer is typical. Perhaps we can assist you, too.

There is no charge . . . or obligation . . . for this service. Just write us, today, giving the details of your particular design problem. Or, ask for our Engineering Design Manual No. 4-A12. We'll be glad to provide both.

A Typical Case

. . . Is that of a prominent telephone equipment manufacturer who changed from a chrome steel magnet to the use of Alnico III in his polarized relay. The results:

- **70% Savings in initial cost**
- **Simplified design**
- **Reduced weight**
- **Flux increase of 27% —improved performance**
- **Saving in space**
- **Less maintenance**

** The one which will permit your product to function best at the lowest possible cost.*

THE INDIANA STEEL PRODUCTS COMPANY • Valparaiso, Indiana

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INDIANA PERMANENT MAGNETS

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LET G-E TUBE SERVICE INCREASE YOUR SHARE OF A FAST-GROWING COMPUTER MARKET

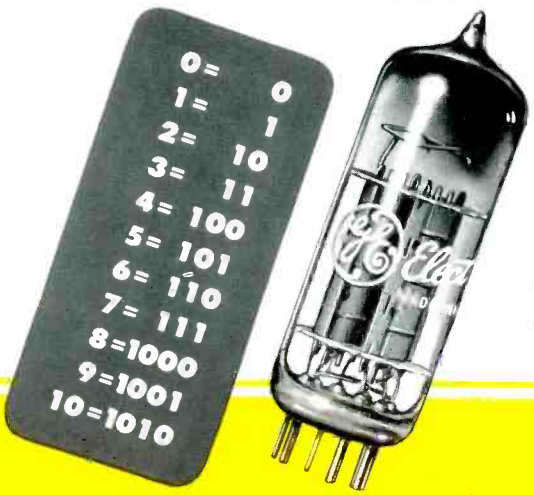
Estimates say that the computer market—business, military, and research—will triple in the next five years. Here are substantial sales and profits for computer builders who can meet their customers' demands for fast, efficient equipment.

G.E. offers experience and facilities to strengthen your competitive position . . . will analyze your circuit in terms of its specific tube requirements, and select the right types to give you optimum performance. You will receive every help in actually testing G-E tubes in your computer, from the time the latter is still in the "breadboard" stage.

Special computer tubes were pioneered by General Electric. G.E. is their largest builder. In line with performance requirements that become steadily more advanced, G.E. is devoting extensive research and development to still newer tubes for tomorrow's circuits—types that will be available for *you* when you need them.

G.E. offers you close cooperation at the tube-design level . . . application help by experienced tube engineers . . . local-laboratory help in checking tube performance in your circuits . . . fast order and delivery service from G-E tube warehouses coast-to-coast.

Most important of all, General Electric has ready . . . now . . . a line of special computer tubes for your immediate needs. They are described on the next page.



Ready now

5 SPECIAL G-E TUBES FOR COMPUTERS... DESIGNED FOR HIGH-SPEED CIRCUITS

Others soon!

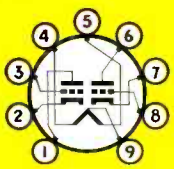
ALSO: 5 important reasons why these G-E computer tubes all do an efficient job . . . reliably:

- **High-perveance design.**
- **Low heater power requirement.**
- **Balanced, sharp cut-off characteristics.**
- **Cathodes specially designed for on-off dependability.**
- **Life-tested under cut-off conditions.**

GL-6463

9-pin high-capacity twin triode for extra-fast computers. Especially suited to frequency-divider circuits.

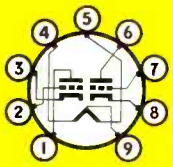
Max cathode current, per section	28 ma
Max dissipation, per plate	4 w
Max tube dissipation	7 w
Grid voltage required to cut off plate current	—11 v
Heater current	.6 amp



GL-6211

9-pin medium-mu twin triode for binary-counter or amplifier applications.

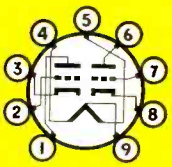
Max cathode current, per section	14 ma
Max dissipation, per plate	1 w
Max tube dissipation	2 w
Grid voltage required to cut off plate current	—10 v
Heater current	.3 amp



GL-5965

9-pin twin triode for high-speed computer use as binary-counter or amplifier tube.

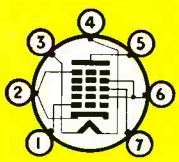
Max cathode current, per section	15 ma
Max dissipation, per plate	2.2 w
Max tube dissipation	4 w
Grid voltage required to cut off plate current	—5.5 v
Heater current	.45 amp



GL-5915-A

Dual-control heptode, for use primarily as a coincidence-gating tube.

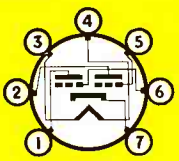
Max cathode current	20 ma
Grid voltage required to cut off plate current	—10 v
Typical plate current in gating service ("on" condition)	5.8 ma



GL-5844

Medium-mu twin triode, for use as counter or amplifier tube in moderately high-speed computers.

Max cathode current, per section	9 ma
Max dissipation, per plate	.5 w
Max tube dissipation	1 w
Grid voltage required to cut off plate current	—10 v
Heater current	.3 amp



Get complete information! Write to *Tube Department, General Electric Company, Schenectady 5, New York.*

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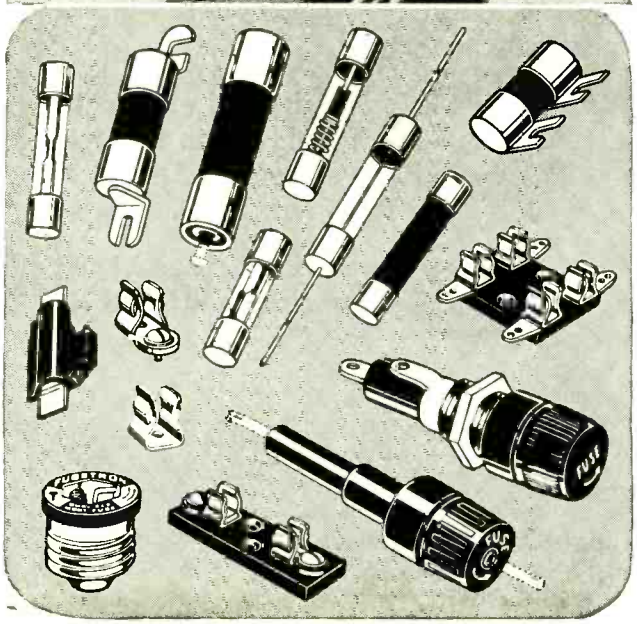

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Manufacturers and service organizations in increasing numbers are standardizing on BUSS fuses because . . . they know, from their own experience, that BUSS fuses give dependable electrical protection under all service conditions.

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To make sure that BUSS fuses maintain their 40 year old reputation for highest quality, every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

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When designing new devices that require electrical protection you can save engineering time by turning to BUSS. Our fuse research laboratory and its staff of fuse engineers can help you save time and money in determining the right fuse or fuse mounting for the job . . . and if possible, ones already available in local wholesalers' stocks.

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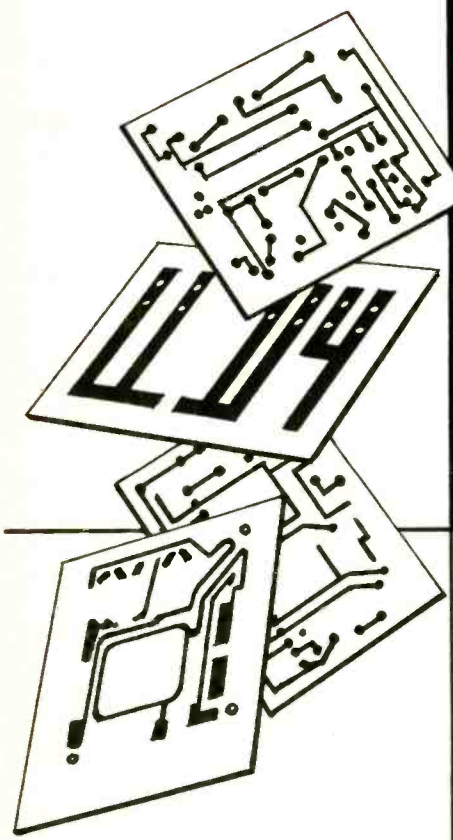

For printed circuits, the important consideration is the laminate base since other characteristics are often similar. In buying printed circuits, therefore, it pays to insist on the best —INSUROK T-725 or T-812—because of their outstanding electrical properties which remain remarkably stable under repeated temperature and humidity cycling.

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Experienced Richardson engineers will gladly assist you in the selection and application of copper-clad INSUROK . . . write or phone your nearest Richardson sales office today.

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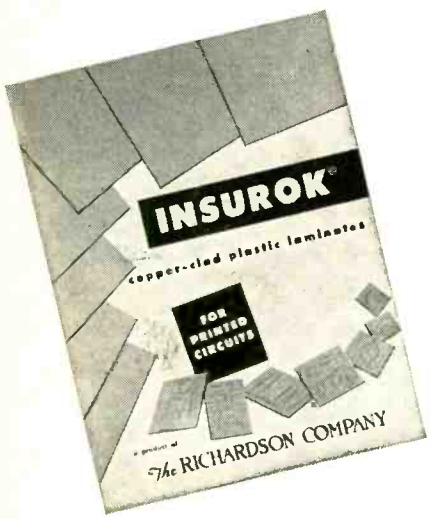

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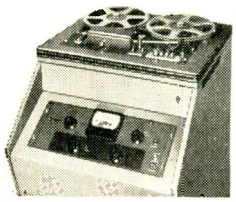
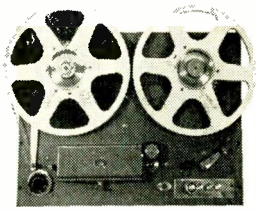
What's your choice in fine tape equipment?



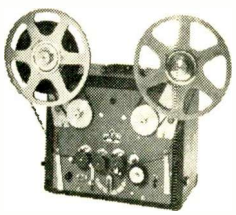
NEW PRESTO SR-11

Complete studio console tape recorder. Never before so much quality, operational ease and value at such a modest price. Embodies the famous PRESTO R-11 tape mechanism, matching amplifier – power supply in sturdy well-designed console cabinet. Three motors for complete flexibility; 15" and 7½" per sec. speeds.



PRESTO R-11

A tape recording mechanism of truly modern design in engineering and operation. Mechanism includes three-head assembly, solenoid operated brakes and employs the exclusive Capstan drive unit. Tape reels mounted directly on heavy-duty torque motors.

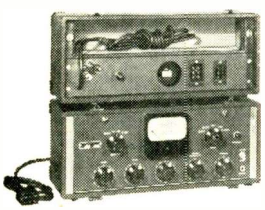


PRESTO R-7

Rugged, portable tape recorder with separate recording, reproduction, and erasing heads. Built around a sturdy, three-motor drive eliminating friction clutch, the RC-7 contains the same high-quality components found in PRESTO'S fine studio equipment. Heavy-duty construction throughout.

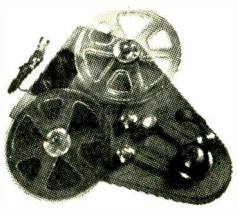
PRESTO PB-17A

Reliable, long-playing tape reproducing mechanism. Automatically reversible for continuous playback for background music in eight hour cycles. Frequency response uniform from 50 to 8000 cps. Tape speed: 3¾" per sec. Reels up to 14" diam. (4800' of tape) with dual track.



PRESTO 900-A

Precision tape amplifier for portable use or rack mounting. Composed of individual record and reproduce (monitor) amplifiers on a common chassis; separate power supply; three-microphone input, 250 ohm low level mixer; illuminated V.U. meter. Output of reproduce amplifier, 500 ohms, plus 20 db maximum. May be used with any model PRESTO tape recorder.

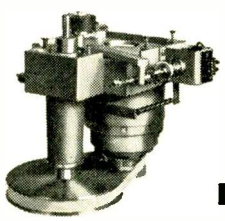


PRESTO TL-10

Turntable-driven tape reproducer. Unique, low-cost unit that adapts any 16" turntable for reproduction of tape at 7½"/sec. or 15"/sec. with exceptional accuracy. No pre-amplifier required; plugs into standard studio speed input equipment.

PRESTO A-920

More compact than the 900-A. In carrying case or for rack mounting. Consists of microphone preamp, a reproduce preamp, power amplifier and power supply – all on a common chassis. Two small speakers mounted behind front panel for playback. Single mike input: 250 ohms. Playback output: 15 ohms, 10 watts.



PRESTO CDR-200 CAPSTAN DRIVE UNIT

Heart of all Presto tape recorders and reproducers. Motor, capstan and flywheel, pressure pulley and pressure pulley solenoid are mounted on independent cast aluminum chassis. Positive, very quiet tape drive with minimum of parts.

Behind every piece of tape equipment are these PRESTO "extras"— painstaking craftsmanship, years of experience... quality control...and advanced production facilities that guarantee instruments of absolute precision and lifelong dependability.

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☐ R-11 Tape Transport ☐ TL-10 Tape Reproducer
☐ R-7 Tape Recorder ☐ A-920 Tape Amplifier
☐ 900-A Tape Amplifier ☐ CDR-200 Capstan Drive

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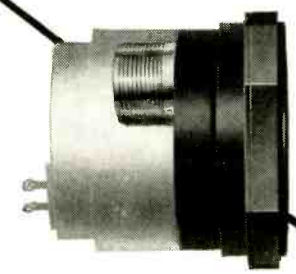

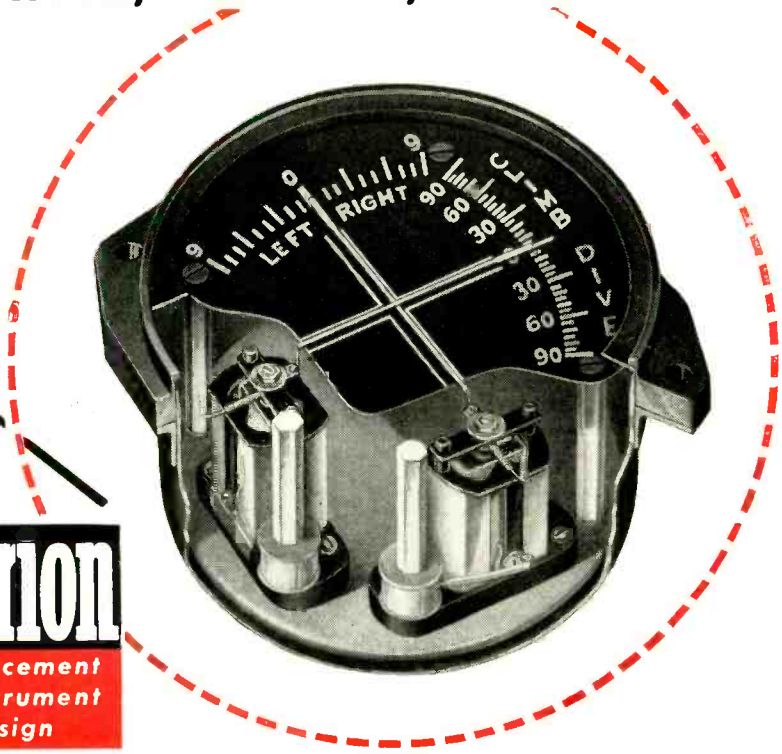

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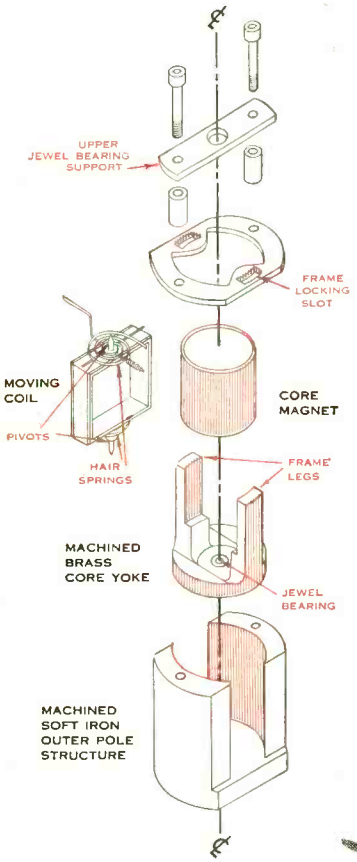
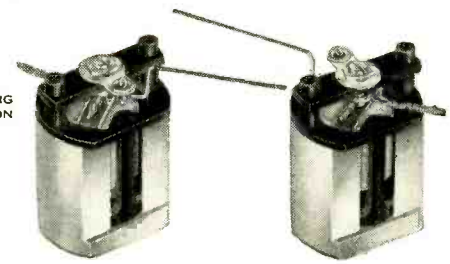
advancement in instrument design



EXPLODED DIAGRAM SHOWING INTERLOCKING CONSTRUCTION
Marion coaxial mechanism

A new AN type multi-element aircraft instrument, incorporating recently developed Marion Coaxial Mechanisms, has greater durability and performance stability than many existing instruments of much greater size and weight. Applications of the new instrument, available with two, three or four elements, include ammeters, voltmeters, temperature indicators and radio navigational instruments. They meet the requirements of Army-Navy Aeronautical Design Standard AND10401 for 2¾" dial instruments.

The Coaxial Mechanism making these improvements possible represents a new Marion concept in the mechanical design of moving coil mechanisms. The Coaxial assembly provides a self-shielded magnetic field of great strength, uniformity and stability. Ruggedness and stability are inherent in the basic simplicity of the design. Only two fasteners hold the rigid, interlocked assembly together. All critical dimensions are machined from a common center (the bearing axis), facilitating precise alignment of parts.



MECHANISMS BY MARION

The Coaxial Mechanism typifies the way each Mechanism by Marion is designed to meet the particular requirements of a specific application — and to provide substantially improved performance, with large reductions in cube and weight. They are not adaptations or variations of standard, conventional mechanisms.

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401 Canal Street, Manchester, New Hampshire

*Trade Mark Patents Pending

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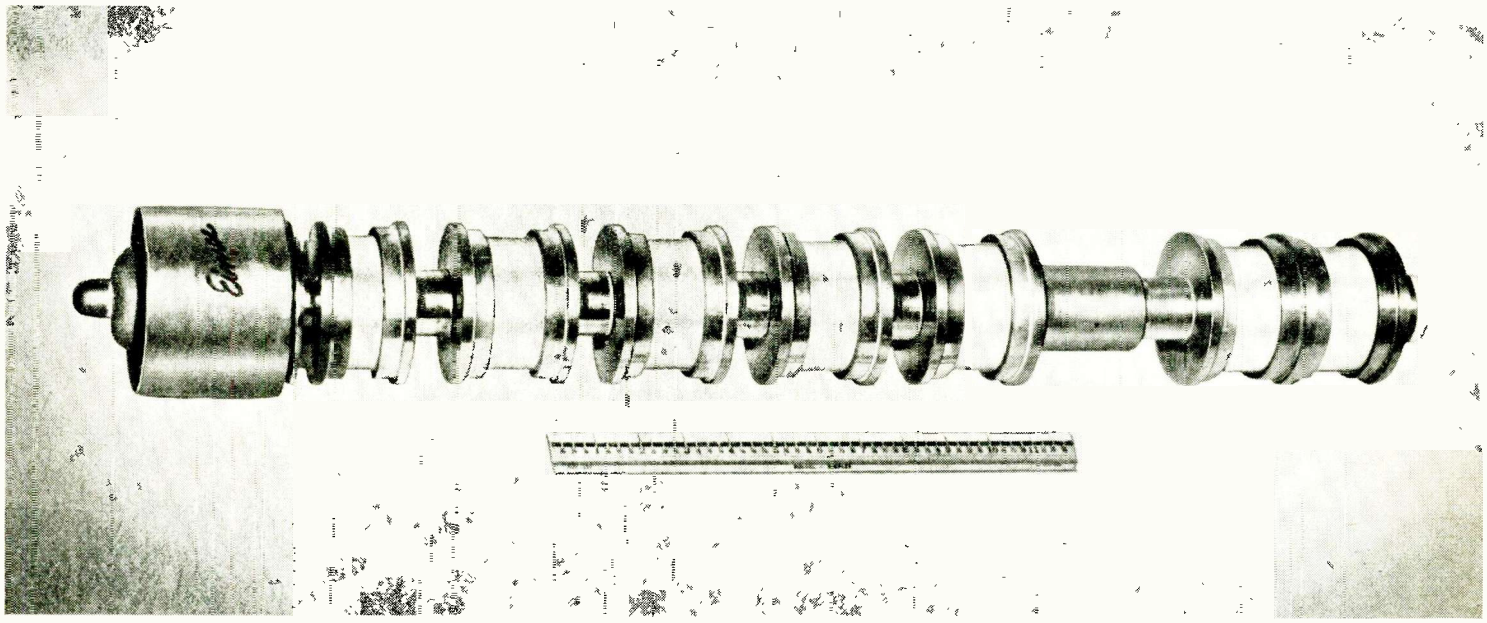
Eimac Klystron Report

X566

20kw modulating anode pulse klystron

- **High power gain of 53db**
- **UHF operation — 960-1400mc**



EIMAC X566 UHF klystrons have consistently obtained peak pulse power outputs of more than 20kw with over 40% efficiency at 960-1400mc. Many times more powerful than any other tube intended for similar operation, such as aircraft navigational aid Distance Measuring Equipment, the air-cooled X566 requires only 100 milliwatts driving power for a 20kw output — a power gain of 53db with bandwidth adequate for most pulse applications. Of special significance is the high average power capability of one kilowatt, allowing the duty cycle to be raised to 5% with a 20kw peak output, or 10% with 10kw output, and so on. Outstanding pulse capabilities of the X566 are made possible through the use of the Eimac modulating anode — an insulated anode between the cathode and drift tube section — permitting the klystron to be pulse modulated with low pulsing power. In Eimac high power amplifier klystrons using ceramic and copper construction, the resonant cavities are completed outside the vacuum system, which is left free of RF tuning devices — permitting easy wide range tuning and uncomplicated input and output coupling adjustment. This simplicity of design and rugged construction minimize replacement costs as well as making the Eimac X566 suitable for mass production techniques.

The X566, another Eimac high power klystron achievement, is now available with circuit components for experimental purposes.

- *For additional information, contact our Technical Services Department.*

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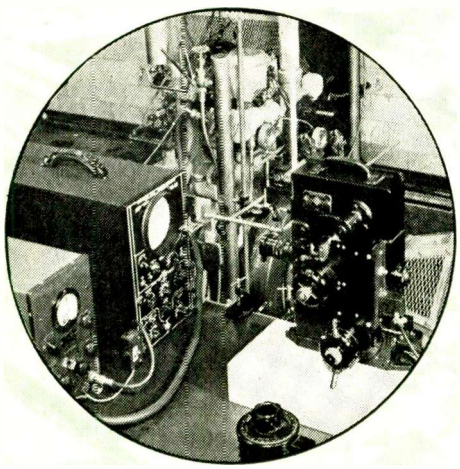
THE WORLD'S LARGEST MANUFACTURER OF TRANSMITTING TUBES



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Bring Industrial Applications to the Foreground

Technological developments in electronic circuitry, components and equipment, the result of the national defense effort, are now being applied to industrial electronic controls.

The use of electronic controls possesses the greatest growth possibilities in this fast growing electronic business. There are countless applications in every type of manufacturing . . . metal working, food processing, candy making, cosmetics, glass, chemical, automotive, aircraft, to mention a few that utilize electronic controls and new equipment.

But the saturation point is as yet completely out of sight.

Alert manufacturers, to insure their share of this vast market, are telling their product story in ELECTRONICS. Whether they make components or complete equipment, they are reaching the men who are responsible throughout industry for recommending and selecting electronic controls for industry. These men are the subscriber-readers of ELECTRONICS. In the sales pages of ELECTRONICS, manufacturers reach the men who control an unlimited market with ALL industry as its future!

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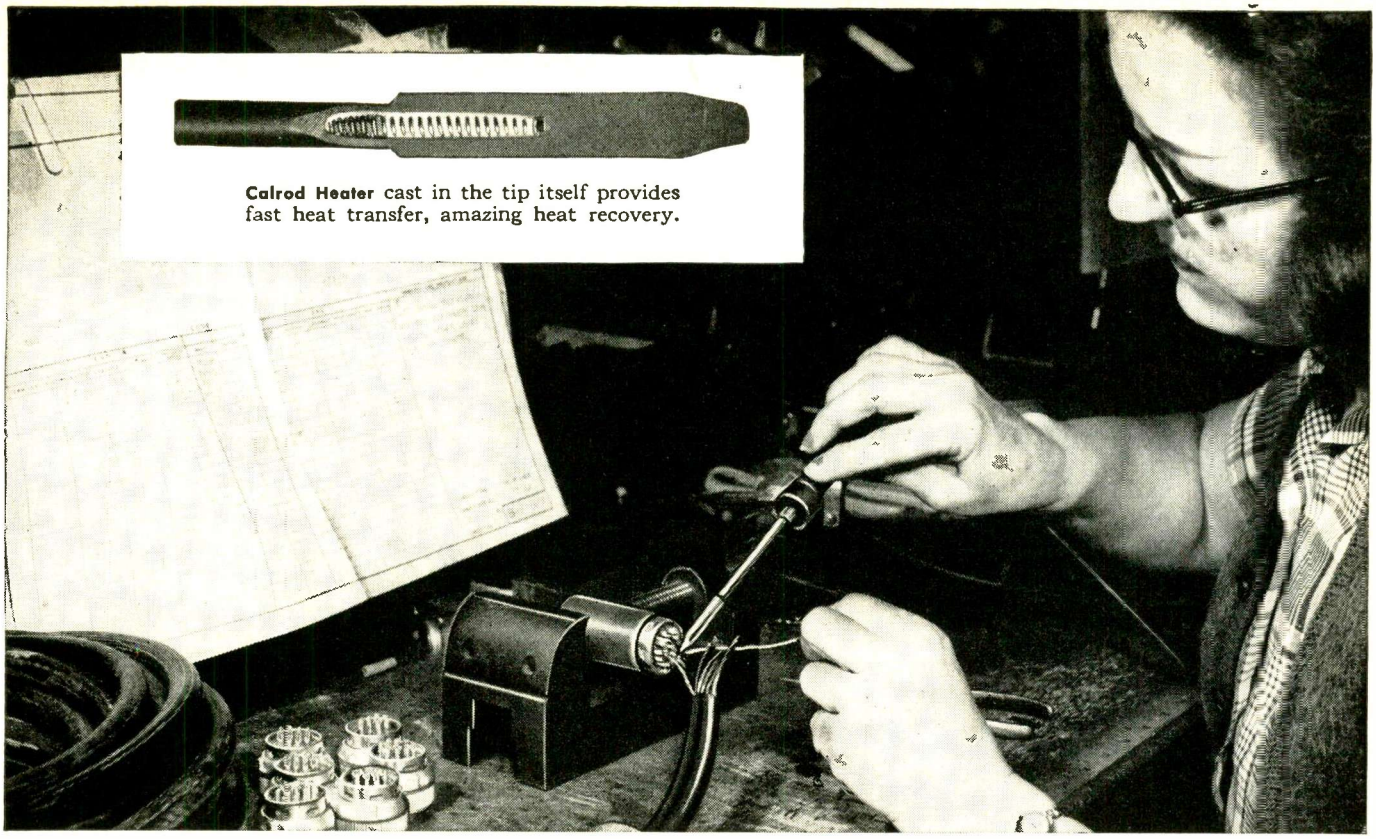
New York 36, N. Y.

Want more information? Use post card on last page.



Calrod Heater cast in the tip itself provides fast heat transfer, amazing heat recovery.

MIDGET'S SMALL-DIAMETER TIP with Calrod* heater cast in (see inset) is required here for close-quarter soldering. Fourteen delicate connections are soldered easily and quickly with the General Electric Midget iron. Three tip sizes are available.

Five Reasons why this Company is sold on the G-E Midget Soldering Iron

A. E. FINGERHUT, PLANT SUPT., PICKER X-RAY CORP., SAYS:
"We use General Electric soldering irons one-hundred percent. For close quarter soldering of electronic and x-ray components, we use the G-E Midget and we're completely sold on it."

1. "We're saving the replacement costs." Since switching to the G-E Midget five years ago, Picker X-Ray hasn't had a heating element burn out. That's because the Midget offers a long-life Calrod heater installed in the tip.

2. "We're saving maintenance time." Because the G-E Midget is equipped with a durable Ironclad tip, Picker X-Ray operators have eliminated tip filing. As a result, the company saves twenty to thirty minutes per day per operator in maintenance time. A Midget iron equipped with an Ironclad tip will give service up to *ten times longer* than irons equipped with ordinary tips.

3. "We're realizing increased production." Weighing only as much as a pack of cigarettes, the G-E Midget helps boost Picker X-Ray's production because operator fatigue is reduced.

4. "We're cutting damage costs." Small diameter tips, $\frac{1}{4}$ in., $\frac{1}{8}$ in., $\frac{3}{16}$ in. available with the Midget enable Picker X-Ray operators to solder small connections without burning adjacent wire insulation.

5. "We're getting the right amount of heat." Too much heat from a soldering iron causes varying quality in soldered components. Picker X-Ray finds that the G-E Midget produces the right amount of heat for soldering delicate connections.

Picker X-Ray's experience shows how you can profit by using the G-E Midget soldering iron for precision soldering. And to meet *any* of your soldering requirements, General Electric offers twenty-four different irons with ratings from 25 to 1250 watts. Contact your General Electric Sales Office today for more information. And for a free bulletin on industrial soldering irons, mail the coupon below.

*Reg. trade-mark of General Electric Co.

Sect. F720-139, General Electric Co., Schenectady 5, N. Y.
Please send me Bulletin GEA-4519D, Industrial Soldering Irons.

Name.....

Company.....

Address.....

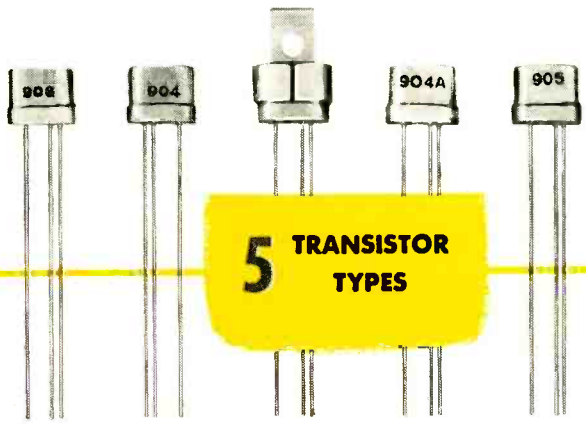
City..... **State**.....

GENERAL ELECTRIC

silicon

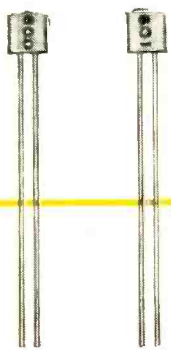
semiconductor devices available now in production quantities

HIGH VOLUME PRODUCTION of *silicon* semiconductor devices enables Texas Instruments to offer you an enlarged line of five types of silicon transistors and two types of silicon junction diodes . . . all available for immediate delivery in production quantities!



5 TRANSISTOR TYPES

SILICON TRANSISTORS-produced commercially by and available *only* from Texas Instruments – are now available with alpha (current amplification factor) to over 0.975 and with alpha cutoff frequency to over 8 megacycles . . . stable to 150° Centigrade (302° F)!

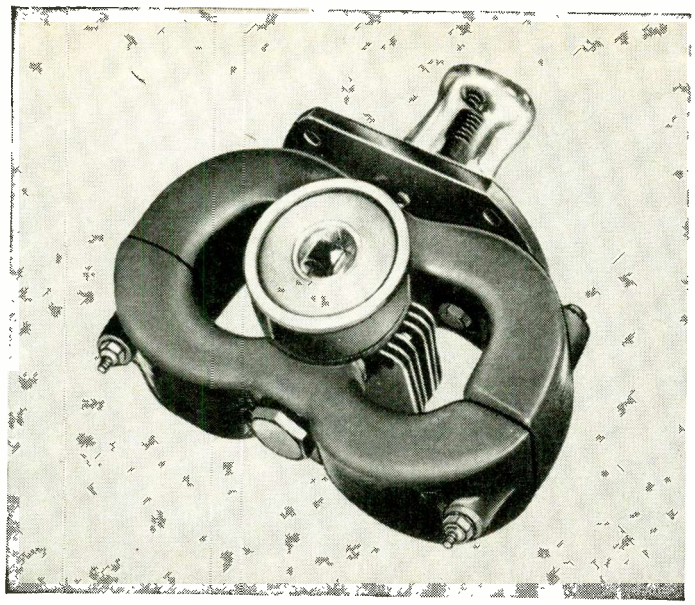


2 JUNCTION DIODE TYPES

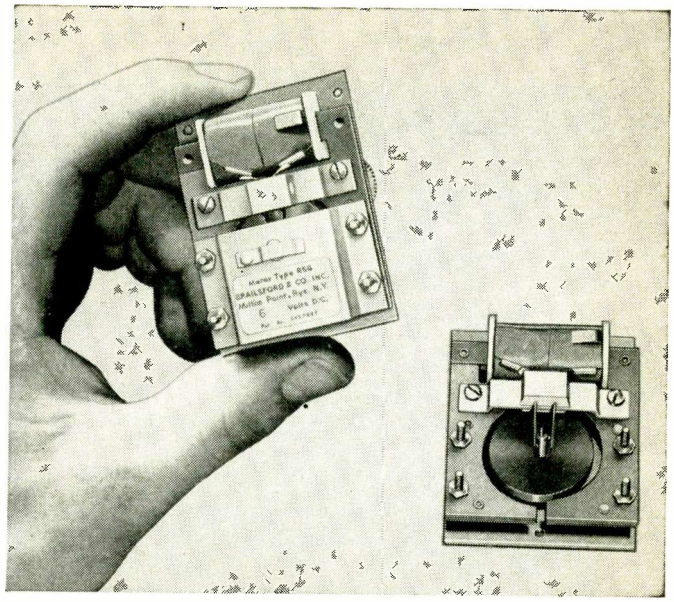
SILICON JUNCTION DIODES are also manufactured by Texas Instruments from grown single crystals and feature back currents as low as 0.001 microamp and safe operation to 150° Centigrade! All TI semiconductor devices – *silicon* or germanium; diodes, triodes and tetrodes – are made with glass-to-metal hermetic seals.

WRITE FOR LITERATURE on semiconductor devices in the widest range available today!

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS



Search Radar Magnetron Tube. Two large Carboloy Alnico permanent magnets supply the electron beam control in this Raytheon magnetron. They help reduce size and weight, with no decrease in performance.



Miniature Electric Motor. Tiny, powerful Carboloy permanent magnet replaces wound electromagnet as rotor. The magnet's self-contained power supply reduces battery drain, requires less power.

Permanent magnets provide an economical way to convert electrical energy to mechanical motion

Carboloy® Alnico permanent magnets provide a low-cost means of simplifying design and reducing size in motors, radar magnetron tubes and hundreds of other products.

In the motor above, a tiny Carboloy permanent magnet rotor supplies the motor action; in the magnetron tube, two large Carboloy permanent magnets provide electron beam control. Both are examples of permanent magnets' inherent ability to convert electrical energy to mechanical motion. Thousands of other products utilize Carboloy permanent magnets' other basic functions (see below) . . . and realize substantial cost and design savings.

Permanent magnets supply a uniform source of stable, low-cost energy; help eliminate coils, wire and other operating parts. They are available cast, or sintered where closer tolerances and more complex shapes are required.

"Designing-in" permanent magnets will improve your product. Specially trained Carboloy Magnet Engineers will work with you in both design and application. Send coupon today, for complete information and technical literature.

Basic functions of permanent magnets

1 Convert electrical energy to mechanical motion
- Eddy Current Braking
- Instrument Action
- Motor Action
- Acoustic Action
- Electron Beam Control

2 Convert mechanical motion to electrical energy
- Generator Action
- Magneto Action
- Sound Pick-up

3 Convert mechanical energy to thermal energy
- Control of Torque

4 Mechanical Holding
- Snap Action
- Separation
- Holding and Lifting

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11139 E. 8 Mile Ave., Detroit 32, Michigan

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

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

I would like the following:

Information on permanent magnets in _____

☐ Permanent Magnet Design Manual, PM-101

☐ Permanent Magnet Standard Stock Catalog, PM-100

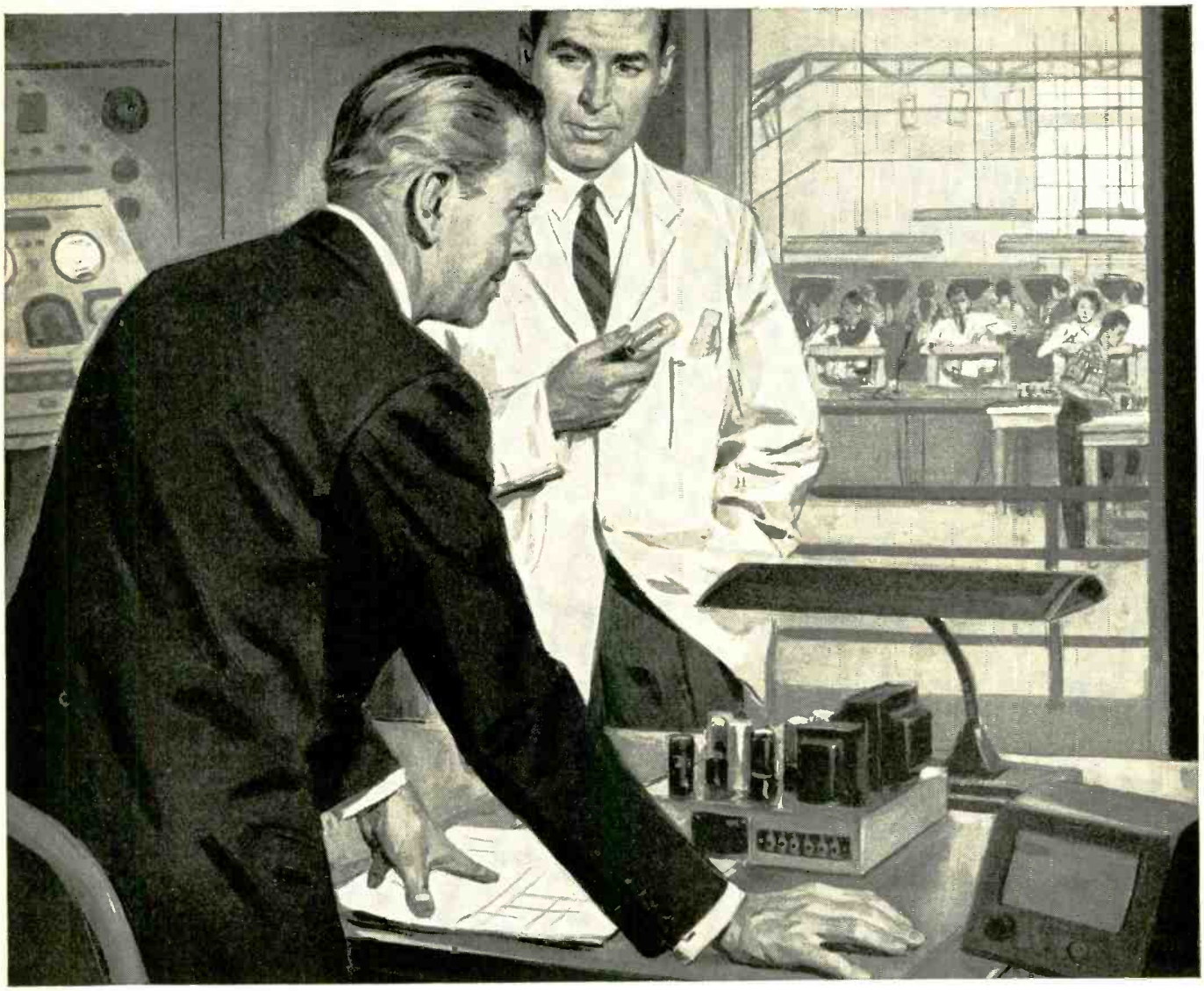
Name _____ Position _____

Company _____

Address _____

City _____ Zone _____ State _____

Protect yourself from production delays



Ship American Airlines AIRFREIGHT

American Specializes In Fast Shipments

To be sure parts come in on time, specify delivery by American Airlines Airfreight. With fast and frequent service to all twenty-three leading industrial states, American has space for you at the right places. This means direct one-carrier service, prompt forwarding and dependable on-time deliveries.

It means, too, that you can reduce your inventory requirements; make quicker engineering modifications without obsoleting huge stocks of component parts. Because with suppliers only hours away by air, you can maintain production with much less depth in stock. American Airlines, Inc., Cargo Sales Division, 100 Park Ave., N. Y. C. 17.

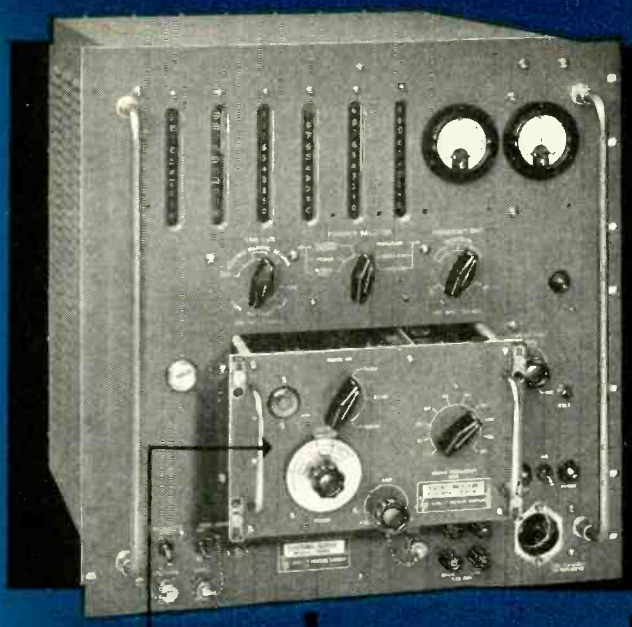
AMERICAN AIRFREIGHT ALSO LEADS IN

COVERAGE – American serves more leading industrial centers in the United States than any other airline.

CAPACITY – American has the greatest cargo capacity of any airline with the right space at the right places.

EXPERIENCE – first with scheduled airfreight service, American has the experience to provide expert handling.

America's Leading Airline **AMERICAN AIRLINES** INC.



Frequency 10 cps to 220 mc
Interval 1 μsec to 100 days
Period 0 cps to 10 kc

measured instantly, automatically, directly by the revolutionary new...

-hp- 525A
Frequency Converter

-hp- 525B
Frequency Converter

-hp- 526A
Video Amplifier

-hp- 526B
Time Interval Unit

-hp- 524B ELECTRONIC COUNTER

Why buy more instrumentation than you need? The new all-purpose -*hp*- 524B Electronic Counter with Plug-In Units gives you *precisely* the frequency, time interval or period measuring coverage you want now. Later, you can add other inexpensive plug-in units to double or triple the usefulness of the Counter.

Model 524B offers direct, instantaneous, automatic readings requiring no calculation, interpolation or complex instrument set-up. It has high sensitivity, high impedance, and its operation is so simple and dependable it can be used readily by non-technical personnel. Resolution is 0.1 μsec, and accuracy is 1/1,000,000 ± 1 count. Construction throughout is of highest quality components in a compact militarized design.

The new Counter with Plug-In Units gives you more range, more convenience, smaller size and lower cost than any commercial instrument combination ever offered. With this one compact equipment, you readily measure transmitter and crystal oscillator frequencies, time intervals, pulse lengths, repetition rates, frequency drift; make high accuracy ballistics time measurements or high resolution tachometry measurements, or use as a precision frequency standard giving convenience and flexibility not provided in the usual primary standard.

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

BASIC COUNTER

The basic -*hp*- 524B Counter unit measures frequency from 10 cps to 10 mc with accuracy of ± 1 count ± stability, reading direct in kc; or measures period from 0 cps to 10 kc with accuracy of ± 0.3% reading direct in seconds, milliseconds or microseconds. Eight-place registration, short term stability 1/1,000,000, display time variable 0.1 to 10 seconds. $1,890.00

COUNTER WITH PLUG-IN UNITS

-hp- 525A Frequency Converter extends Counter's range to 100 mc, maintains accuracy, and increases Counter's video sensitivity to 0.1 volts through basic 10 cps to 10 mc range. $225.00

-hp- 525B Frequency Converter like 525A but extends Counter's range from 100 to 220 mc at 0.25 volts sensitivity. $225.00

-hp- 526A Video Amplifier increases Counter sensitivity between 10 cps and 10 mc to 10 millivolts for low level frequency measurement. $125.00

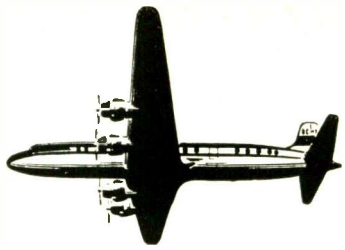
-hp- 526B Time Interval Unit measures interval 1.0 μsec to 100 days with accuracy of 0.1 μsec ± 0.001%, reading direct in seconds, milliseconds or microseconds. Start, stop triggering in common or separate channels, through positive or negative going waves. $150.00 (Plug-in units supplied in aluminum storage case).

Request complete details today from your -hp- Field Representative, or write direct

HEWLETT-PACKARD COMPANY
2998A Page Mill Road • Palo Alto, California, U. S. A.

hp INSTRUMENTS | COMPLETE COVERAGE

AEROCOM'S 1046 H. F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY

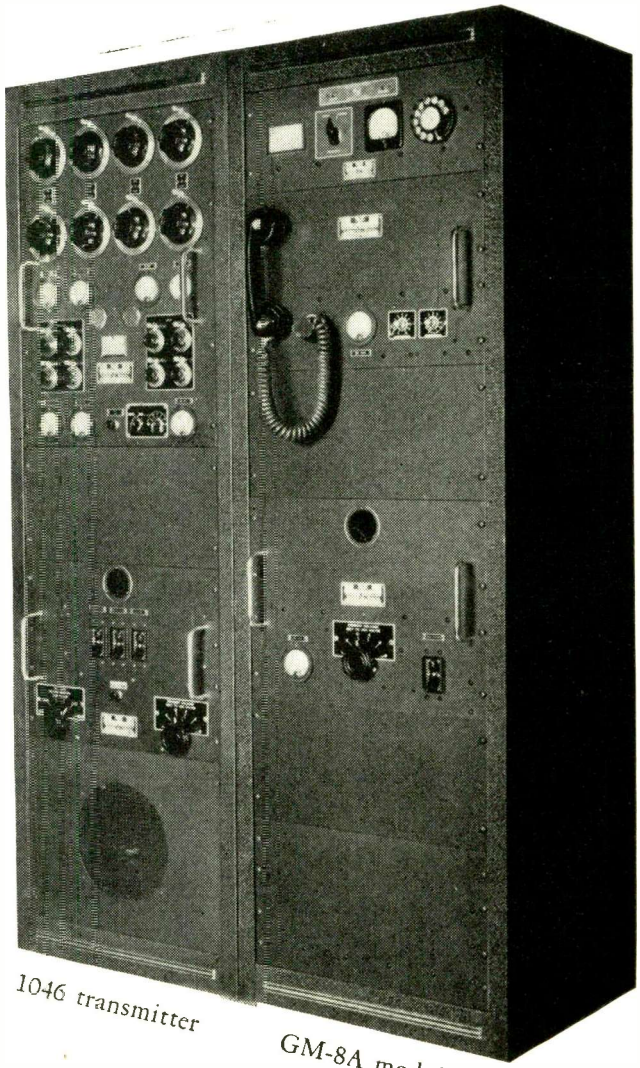
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to + 50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator . . . new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

AER -O- COM

3090 S.W. 37th AVENUE MIAMI 33, FLORIDA

TUNG-SOL

6550

BEAM POWER AMPLIFIER

HIGH POWER CAPABILITIES (Up to 100 watts output in pairs) **LOW DISTORTION OUTPUT • EXTREMELY UNIFORM CHARACTERISTICS • LONG LIFE**

first in its power range . . designed specifically for audio service

The Tung-Sol 6550 is a brand new and direct approach to the high power design requirements of high fidelity audio amplifiers. For outputs up to 100 watts, two 6550's in push-pull will provide the same power now attained in most existing designs by the use of four or more tubes. In addition to greater audio output, use of the new 6550 results in simplified electrical balance, reduced maintenance and lower cost. The Tung-Sol 6550 is not directly interchangeable with the 616, 5881 or KT66 class of tubes. With proper circuitry, however, the 6550 will provide full power output with approximately the same grid voltage drive as the smaller tubes. The 6550 is produced under laboratory conditions with exhaustive quality control to assure premium performance and long life.

Rugged Construction — *The advanced design features which have made the Tung-Sol 5881 so extremely reliable are embodied in the 6550.*

1. Glass button stem construction is strong and compact and provides a rugged support for the tube structure.
2. Micanol wafer and metal shell base provides full lifetime electrical insulation and greater mechanical strength.
3. Cathode materials of exceptional stability give more uniform emission with greater life expectancy. Cathode is not poisoned by inactivity during standby periods.
4. Maximum control of grid emission achieved by gold plating and carbonizing.
5. Triple gettering promotes long, gas-free life. Getters are confined by a spray shield to prevent mica contamination.
6. Life tests are made under severe overload conditions to assure adequate safety factor.

MECHANICAL DATA

Coated Unipotential Cathode	
Outline Drawing	Bulb—Short St-16
Base	Large Wafer Octal 8-Pin Mical with Metal Sleeve B8-86
Maximum Diameter	2 1/16"
Maximum Overall Length	4 3/4"
Maximum Seated Height	4 3/16"
Pin Connections	Retma Basing 7S
Pin 1—Base Shell	Pin 5—Grid No. 1
Pin 2—Heater	Pin 7—Heater
Pin 3—Plate	Pin 8—Cathode and
Pin 4—Grid No. 2	Grid No. 3
Mounting Position	Any

ELECTRICAL DATA

(INTERPRETED ACCORDING TO RETMA DESIGN CENTER SYSTEM)

DIRECT INTERELECTRODE CAPACITANCES — *No Shield*

Grid #1 to Plate	0.85 μμf
Input	14.0 μμf
Output	12.0 μμf

RATINGS

Heater Voltage (AC or DC)	6.3 ±10% VOLTS
Maximum DC Plate Voltage	600 VOLTS
Maximum Plate Voltage (Triode Connection)	450 VOLTS
Maximum Plate Dissipation (Triode Connection)	40 WATTS
Maximum DC Grid #2 Voltage	400 VOLTS
Maximum Grid #1 Voltage	—300 to 0 VOLTS
Maximum Plate Dissipation	35 WATTS
Maximum Grid #2 Dissipation	6.0 WATTS
Maximum DC Cathode Current	175 MA.
Maximum Heater-Cathode Voltage	
Heater Positive (Peak) (DC not to exceed 100V)	+200 VOLTS
Heater Negative (Peak or DC)	—300 VOLTS
Maximum Grid #1 Circuit Resistance (Fixed Bias)	50 KILOHMS
Maximum Grid #1 Circuit Resistance (Self Bias)	250 KILOHMS
Maximum Bulb Temperature	250 °C

HEATER CHARACTERISTICS

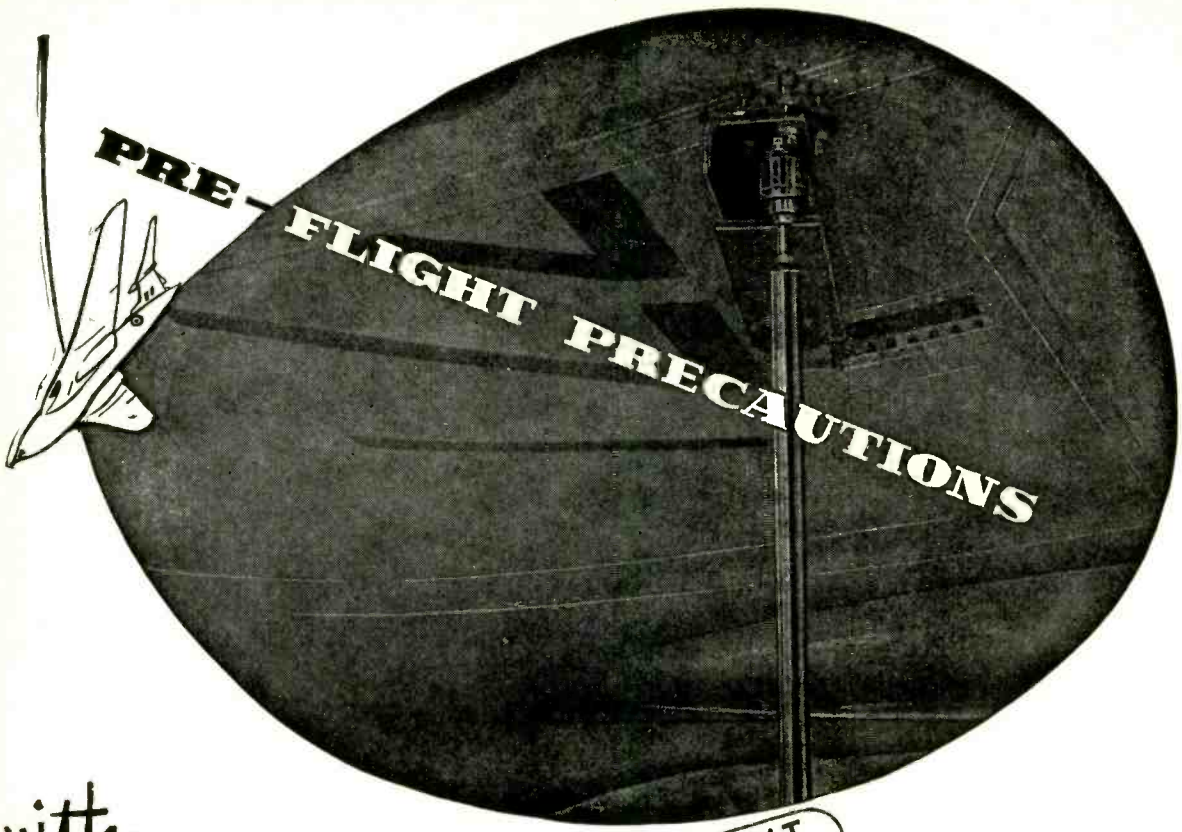
Heater Voltage	6.3 VOLTS
Heater Current	1.8 AMP.

The TUNG-SOL engineering which has produced the 6550 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Technical data sheets, or circuitry suggestions for the 6550 may be obtained by writing to Tung-Sol Commercial Engineering Department.

TUNG-SOL ELECTRIC INC., Newark 4, New Jersey — Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Seattle

TUNG-SOL makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

TUNG-SOL®
ELECTRON TUBES



with GOODMANS PERMANENT MAGNET SHAKERS

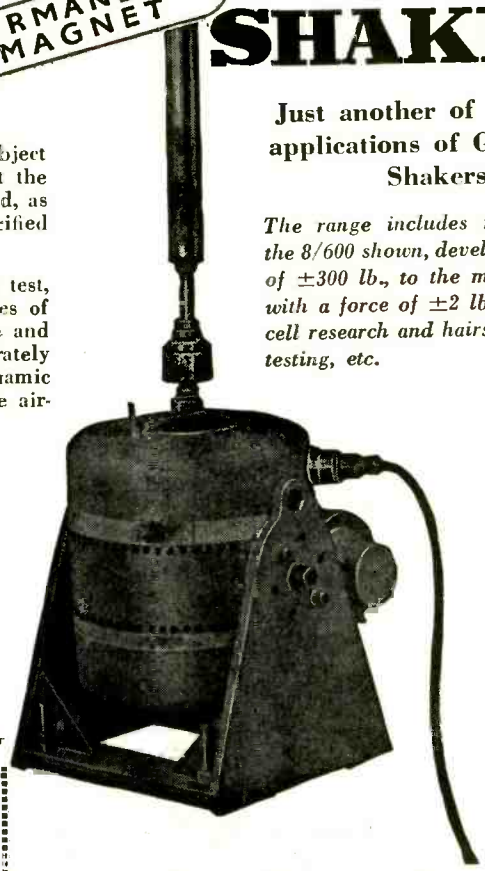
The flight characteristics of a newly designed aeroplane are the subject of lengthy calculations before the first prototype is built. Whilst the mathematical calculations are themselves accurate, they are based, as in all design work, on several assumptions which have to be verified by a series of pre-flight tests.

One of these essential investigations is the Ground Resonance test, the purpose of which is to determine the various complex modes of vibration of the airframe structure. The frequency of the mode and the dynamic response at remote parts of the aircraft must be accurately determined. The information obtained together with the aerodynamic derivatives is used in predicting the critical 'flutter' speed of the aircraft. The illustration shows one of the two Goodmans Model 8/600 Shakers which were used to excite the Handley Page 'Victor' for this very important test.

For wide frequency range vibration testing and dynamic response investigations, Goodmans Shakers are an obvious choice. These units require no field excitation and provide a faithful reproduction of the input wave form. Industrial applications of controlled vibration are continually increasing; maybe it can serve you—in which case our unique experience is at your service.

Just another of the wide applications of Goodmans Shakers

The range includes models from the 8/600 shown, developing a force of ±300 lb., to the midget model, with a force of ±2 lb., for optical cell research and hairspring torque testing, etc.



MAIL THIS COUPON

TO GOODMANS INDUSTRIES LIMITED
AXIOM WORKS, WEMBLEY, MIDDX., ENGLAND

Please mail me your catalogue and technical data sheets in connection with your PERMANENT MAGNET Shakers.

NAME .....

COMPANY .....

CITY ..... ZONE ..... STATE ..... E/U

GOODMANS INDUSTRIES LTD.

AXIOM WORKS • WEMBLEY • MIDDX • ENGLAND

Cables: ***GOODAXIOM WEMBLEY, MIDDX.***

THIS IS IT!

This is the actual size of the newest, smallest Blue Jacket — ready now to help solve your production problems!

NEW...a 3-watt Blue Jacket®
miniaturized axial-lead wire-wound resistor

This power-type wire wound axial-lead Blue Jacket is hardly larger than a match head *but it performs like a giant!* It's a rugged vitreous-enamel coated job—and like the entire Blue Jacket family, it is built to withstand severest humidity performance requirements.

Blue Jackets are ideal for dip-soldered sub-assemblies . . . for point-to-point wiring . . . for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
151E	3	17/32	13/64	6,000 Ω
27E	5	1 1/8	3/16	30,000 Ω
28E	10	1 7/8	1/4	50,000 Ω

Standard Resistance Tolerance: ±5%

WRITE FOR ENGINEERING BULLETIN NO. 111B

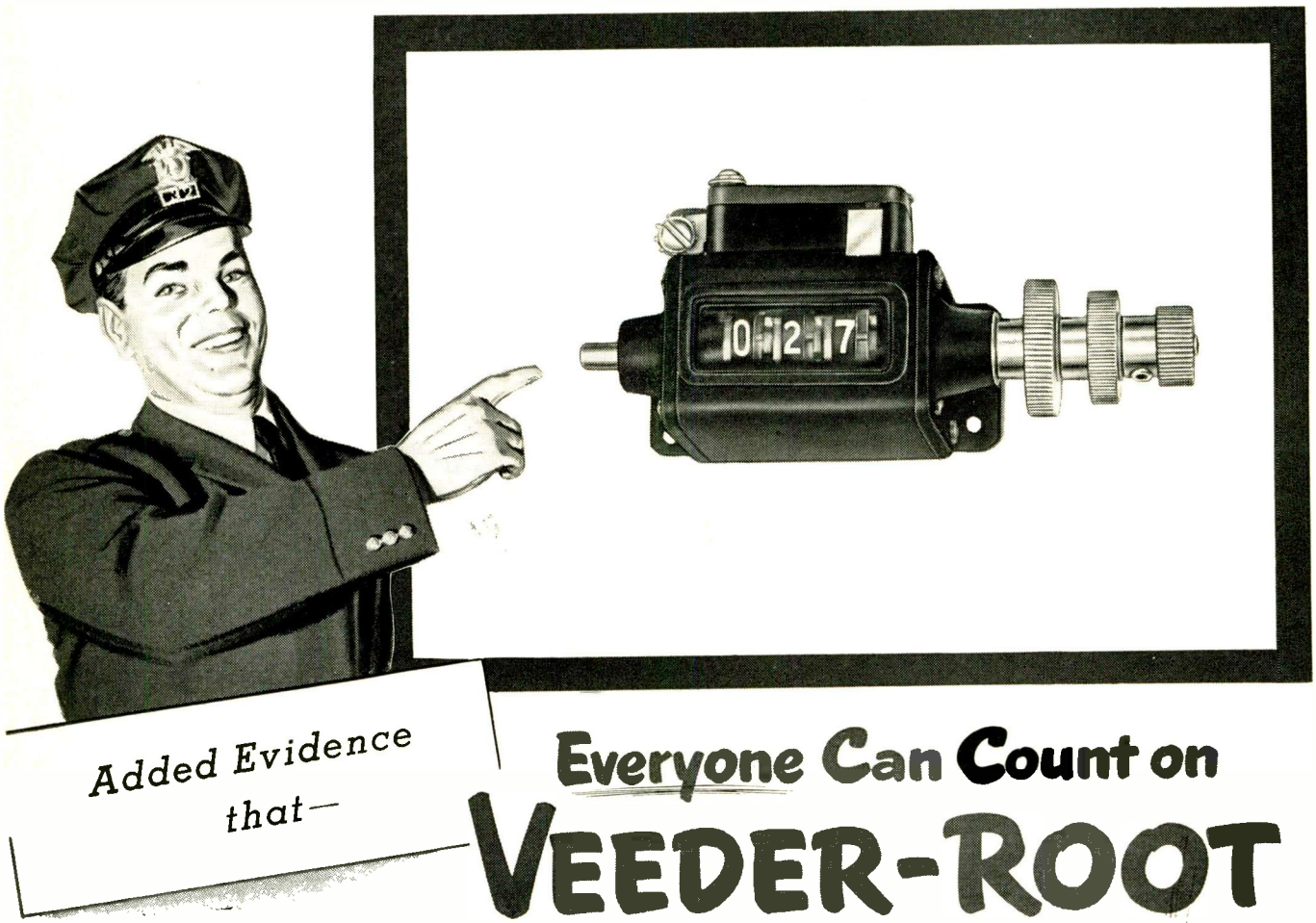
SPRAGUE

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.

Here's a New

"TRAFFIC COP"

for short high-speed runs



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

This new small Predetermining Ratchet Counter is set for any run up to 1,000 counts, pieces or other units by the three knurled setting knobs. Then it subtracts to zero, and at that point actuates a contact to light a light, ring a bell or stop the machine. Compact and easy to reset, this counter makes an attractive new selling feature when built into a machine as a standard integral part. And it's just one of scores of standard and special Veeder-Root Counters for every mechanical and electrical application in any field from atomics to automation. What would *you* like to count? Let Veeder-Root figure out how to do it. Write:

VEEDER-ROOT INCORPORATED
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Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
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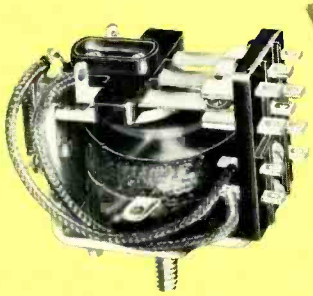
Offices and Agents in Principal Cities

® **"The Name that Counts"**

Relay problem—answer— HIGH QUALITY AT LOW COST

Potter & Brumfield's New KA • AB • GA Relays



GENERAL PURPOSE SERIES KA

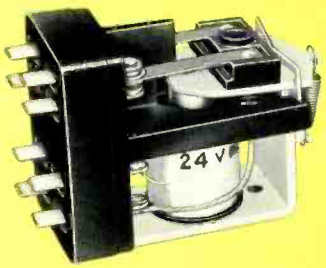
Designed for current or voltage actuation. Small overall size, high capacity and many contact combinations make KA series universal in application.

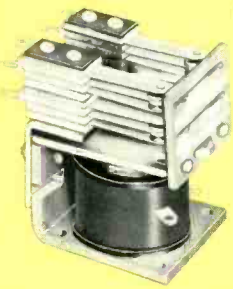
Contact capacity up to 10 amperes
Contact arrangements up to 3 form C (3PDT)
Winding to 18000 ohms, 1½ to 230V AC or 110V DC
Maximum sensitivity 10 MA
Available open or hermetically sealed
Meets U. L. insulation requirements (Min. 1/8" through air, 1/4" over surface)
Dimensions open relay 1" x 1¾" x 1⅛" high

APPLIANCE SERIES AB

The AB relay is primarily designed for appliance applications to eliminate noisy and troublesome clapper or solenoid type contactors

One piece reinforced molded phenolic base
No contact bounce capacity up to 20 amps
Meets underwriter's creepage specifications
Coils available to 230V AC or 110V DC
Clip on solderless or screw terminals
Dimensions 1⅜" x 2⅞" x 1⅞" high mounting single 8-32 screw





MULTIPLE LEAF SERIES GA

The GA series permits a wide range of contact combinations for multiple circuit switching of power loads.

Contact arrangements up to 4 form C (4PDT)
Contacts of various materials up to 10 ampere rating
Patented unique variable magnetic gap structure
Available with four different types of mounting arrangements
Dimensions 1" x 1 11/16" x 1 13/16" high

SAMPLES AVAILABLE FOR IMMEDIATE SHIPMENT . . . QUOTATIONS ON REQUEST

POTTER & BRUMFIELD
PRINCETON INDIANA
Subsidiary of AMF New York, N. Y.

EXPORT: 13 East 40th Street, New York, New York
Sales Offices in Principal U. S. and Canadian Cities

Potter & Brumfield

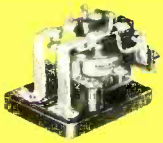
Standard Relays

offer you many advantages

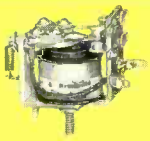
The extensive line of Potter & Brumfield Standard Relays will meet the circuit requirements of a wide variety of applications. Wherever a P & B standard or slightly modified version can be used to solve your problem you gain these important advantages.

1. **Proven Design**—P & B Standard Relays are the result of more than 20 years experience in relay design and have been completely proven under all kinds of operating conditions. You are assured of long, trouble-free, dependable performance.
2. **Lower Cost**—These relays are already tooled. They are manufactured in production quantities. You gain substantial advantages in costs.
3. **Fast Delivery**—Orders for standard relays can be filled from stock or with a minimum delay.
4. **Sold through Distributors**—Popular types available through P & B franchised Electronic Parts Distributors located in all principal cities.

A FEW OF THE MORE THAN 110 P&B STANDARD RELAY STRUCTURES

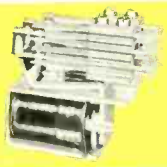


POWER RELAYS Two series—heavy and medium duty. For across the line power circuits, high current or high voltage switching. From SPST to 3PDT.



GENERAL PURPOSE RELAYS For applications where space and weight are important. Withstand high shock and vibration. Fram SPST to 3PDT.

MULTIPLE CONTACT RELAYS Longer coil gives power to actuate additional contacts and maintain 15 grams pressure. From SPST to 4PDT.



MULTIPLE LEAF RELAYS For temperature, indicating or protective circuits. Heavy, tin-coated phosphor bronze contact springs. From SPST to 4PDT.

LATCHING RELAYS Compact—high utility switching. Coils operate on AC or DC. Voltage or current. From SPST to 4PDT.

PLATE CIRCUIT RELAYS Actuate on a few milliwatts. Easy to adjust. Small—rugged—low in cost. From SPST to DPDT.

IMPULSE RELAYS Automatic stop prevents backlash or overtravel. Precise switching regardless of operating speed. DPDT or 4PDT.

TELEPHONE RELAYS Four series meet practically all telephone type relay requirements. Short armature movement, long armature arm. Many contact combinations.

MOTOR STARTING RELAYS Voltage controlled to insure throwout of starting winding when motor reaches rated speed. Fast acting double break.

HEAVY-DUTY SHOCK-PROOF RELAYS Can be mounted in any position. Particularly resistant to vibration and shock. From SPST to DPDT.

SUPER SENSITIVE RELAYS Operate on less than 10 MW. Dual coils, 10G vibration resistance. Wide versatility. One Form C-SPDT.

400 CYCLE AC RELAYS 15 gram or higher contact pressure. Withstand better than 10G shock. Heavy cast mounting foot. One form A to 2 form C.

SUPER MIDGET RELAYS Tiny and rugged—plug in—one form C. High degree of resistance to vibration and shock.

SUBMINIATURE SENSITIVE RELAYS Standard 7 pin plug-in. Ruggedized for vibration and shock. Operating power 25MW. Contact load 2 amps.

MINIATURE DC POWER CONTACTOR High current contact capacity and rugged construction. Contact pressure approx. 250 grams. SPST-NO-DM.

ALL P & B STANDARD RELAYS CAN BE SUPPLIED WITH DUST COVERS OR HERMETICALLY SEALED CANS WITH EITHER SOLDER OR PLUG-IN HEADERS

Write home office in Princeton or phone your local P & B Sales Office for new Engineering Guide describing our wide line of basic relay structures, housings and enclosures. Samples, recommendations and quotations promptly furnished on special applications.

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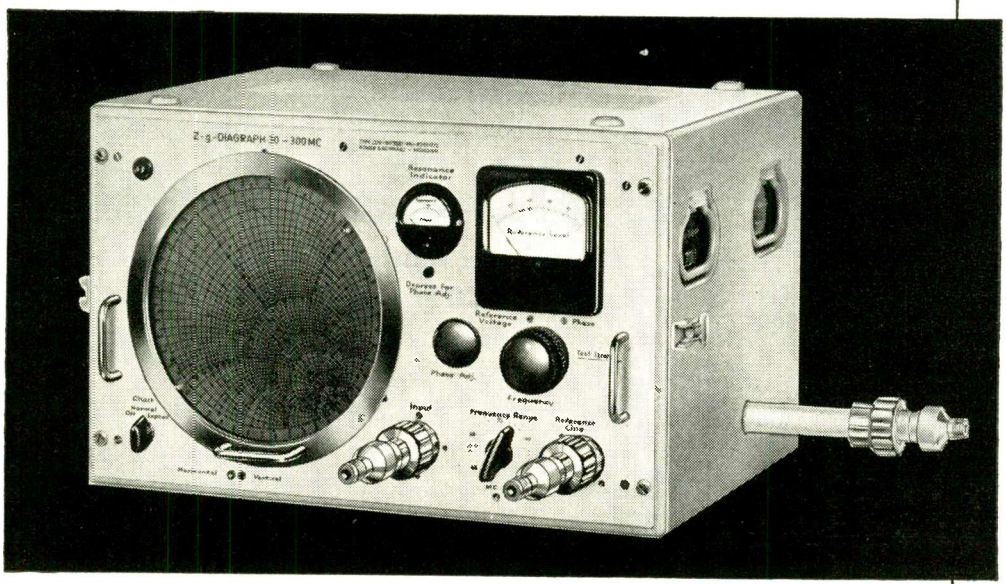
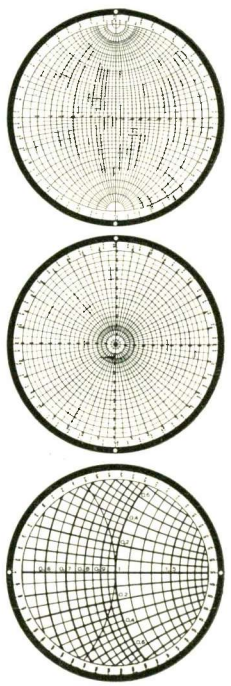
Z-g DIAGRAPH





Eliminates complex, time-consuming calculations... all measurements read from interchangeable charts

The Z-g Diagraph, by Rhode and Schwarz—one of West Germany's leading instrument makers—is probably the most unusual device ever developed for fast, high-accuracy impedance and admittance measurements.

The Diagraph indicates results directly on a Smith, or similar, chart. It can obtain an entire broad-band characteristic in a few minutes . . . present it visually . . . without tedious calculating.

Separate, quickly-interchangeable charts permit measuring of reflection coefficient, resistance and reactance (Smith Chart), or magnitude and phase angle of an unknown impedance. Either can be used without recalibration or change in test set-up.

The transmission characteristic of a four-terminal network, such as a filter or attenuator, can also be read directly. The latter feature permits the Diagraph to be used for measuring the phase angle between two voltages of unequal amplitude but of the same frequency.

For further information on the performance and versatility of the Z-g Diagraph, mail the coupon to Federal's Instrument Division.

SPECIFICATIONS:

Frequency Range: Type ZDU . . . 30 to 300 mc.; Type ZDD . . . 300 to 2400 mc.

Characteristic Impedance: 50 ohms.

Measuring Range: Impedance . . . 1 to 2500 ohms; Phase . . . 0 to 360°; Attenuation . . . 0 to 30 db.

Accuracy: Amplitude . . . ±3%; Phase . . . ±1.5°.

Terminals: Type N.

Power Supply: 115 volts (or 220 volts), 50 to 60 cycles.

Weight: 135 lbs.

Price: $5,950 net, FOB, Clifton, N. J.

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for today... and for *many* tomorrows

What do you need in an oscilloscope now?

Is it here in one of these oscilloscope and plug-in combinations? What will you need tomorrow — next month — next year? Isn't it likely that you'll find it here, also?

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Tektronix is working on that, too! New plug-in units now in development will help you accomplish even more with a single oscilloscope — and help you keep that oscilloscope working for you far longer.

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TYPE 531 — $995 plus price of desired plug-in units.

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Prices f.o.b. Portland (Beaverton), Oregon

Your Tektronix Field Engineer or Representative will gladly arrange a demonstration at your convenience . . . call him today.

Tektronix Model 531 and 535 OSCILLOSCOPE CHARACTERISTICS

Advanced Cathode-Ray Tube
Entirely new Tektronix crt provides full 6cm x 10cm undistorted viewing area . . . 50% more vertical deflection than previous high-voltage tubes. 10kv accelerating potential permits single-sweep photography at the fastest sweep speed.

Wide Range of Triggered Sweeps
0.02 μsec/cm to 12 sec/cm, continuously variable. 24 calibrated sweeps from 0.1 μsec/cm to 5 sec/cm, accurate within 3%. Accurate 5-x magnification.

Wide-band Output Amplifier
DC-coupled amplifier designed for use with all Type 53-series Plug-in Units.

Balanced Delay Network
0.25 μsec signal delay in vertical amplifier.

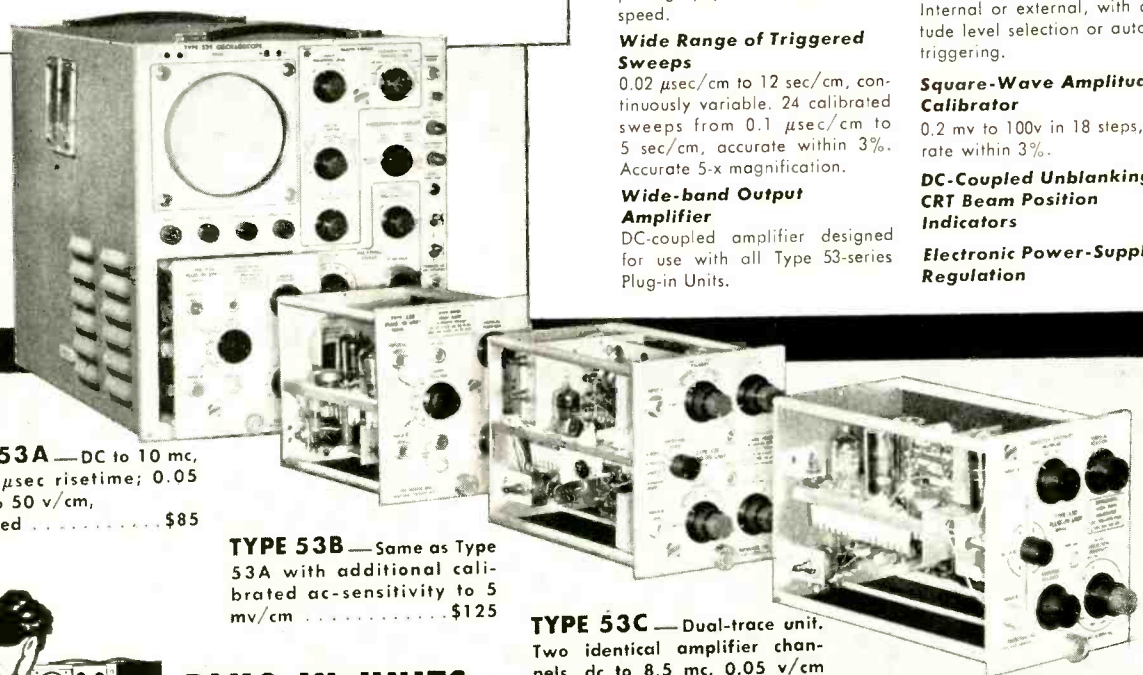
Sensitive Horizontal Amplifier
0.2 v/cm to 20 v/cm sensitivity.

Versatile Triggering
Internal or external, with amplitude level selection or automatic triggering.

Square-Wave Amplitude Calibrator
0.2 mv to 100v in 18 steps, accurate within 3%.

DC-Coupled Unblanking CRT Beam Position Indicators

Electronic Power-Supply Regulation

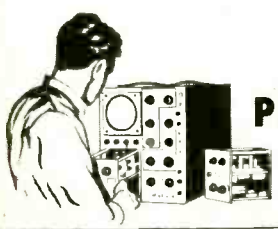


TYPE 53A — DC to 10 mc, 0.035 μsec risetime; 0.05 v/cm to 50 v/cm, calibrated $85

TYPE 53B — Same as Type 53A with additional calibrated ac-sensitivity to 5 mv/cm $125

TYPE 53C — Dual-trace unit. Two identical amplifier channels, dc to 8.5 mc, 0.05 v/cm to 50 v/cm. Electronic switching triggered by oscilloscope sweep . . . or free running at about 100 kc $275

TYPE 53D — Differential input, high gain. DC to 350 kc at 1 mv/cm — passband increasing to 2 mc at 50 mv/cm. Full range 1 mv/cm to 125 v/cm, $145



PLUG-IN UNITS

New booklet describing phase-angle measurements with the Type 535 and Type 53C now available. Write for free copy.

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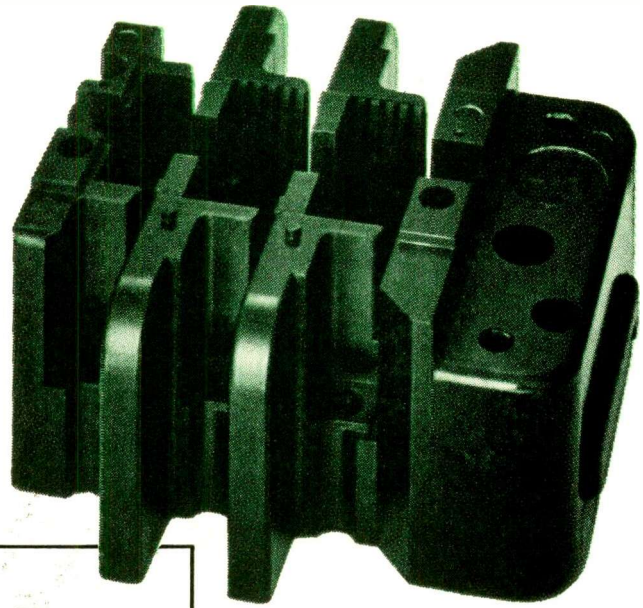
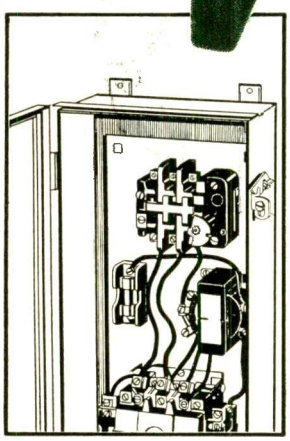
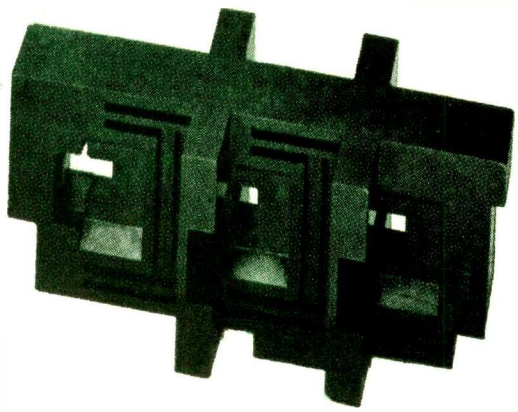
How would you handle this electrical parts problem?







Combination starter, containing parts molded of Monsanto's Resinox 3700 thermosetting material, manufactured by Arrow-Hart & Hegeman Electrical Co.

Arrow-Hart solved it with new RESINOX 3700

Arrow-Hart & Hegeman Electrical Company of Hartford, Conn. needed a strong, stable, electrical-grade material with high arc-resistance for important parts of their combination starter shown here. They specified Monsanto's new thermosetting molding powder, Resinox 3700. Result: Complete satisfaction!

Resinox 3700 is the ideal all-around material for magneto ignition, motor control and electronic circuits, and other electrical applications.

1. **It combines high arc-resistance with outstanding dimensional stability. Eliminates undesirable after-shrinkage.**
2. **It has excellent moldability and relatively good impact resistance, plus good transfer molding properties.**
3. **It offers superior heat resistance.**

Perhaps Resinox 3700 is exactly what *you* need to solve an electrical equipment problem. Write today for full information!

Resinox: Reg. U. S. Pat. Off.

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MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2507, Springfield 2, Mass. Please send me complete information on Monsanto's new Resinox 3700 arc-resistant material.

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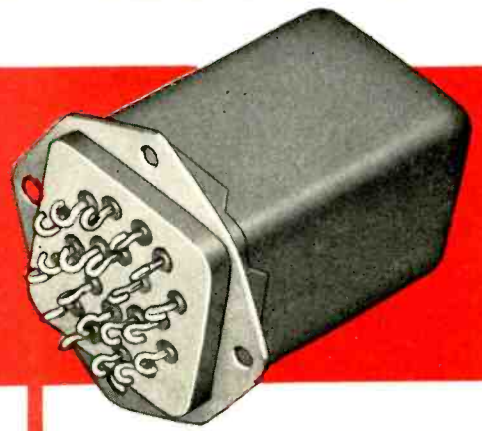
Presenting THE NEW 5-AMPERE SUB-MINIATURE 6-Pole, Double Throw GUARDIAN® Series 2005 RELAY



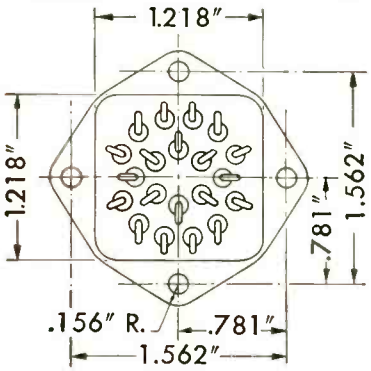
Hermetically Sealed

★It's here—a truly great achievement in *sub-miniature* control engineering and hermetic sealing—the new Guardian Series 2005 Relay. And here are the features that design engineers evaluate so highly: (A) de-gassed construction materials prevent contact contamination; (B) extremely high contact pressure in both energized and de-energized positions insures reliable operation at both low and maximum current ratings; (C) internal wiring, limited to two connections from coil terminals to header pins, virtually eliminates breakage of leads. It's easy to see—this new Guardian Series 2005 hermetically sealed sub-miniature relay can equip your product to prevent rejects and reduce service calls. Prompt quotations gladly given upon request.

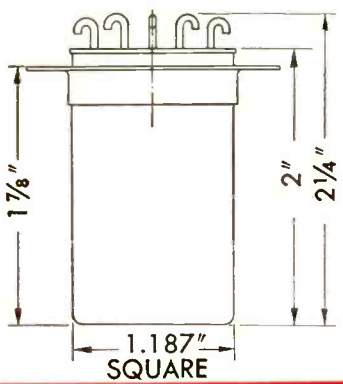
CHARACTERISTICS:

- Unit meets all requirements of Military Specifications MIL-R-5757-B, Class A and MIL-R-6106-A, Class A.
- Built to withstand 100 G shock. Vibration resistance is 10 G minimum from 75 to 2000 cycles per second in all mounting planes.
- All contacts rated at 5 Amperes, 24 to 30 Volt, Direct Current, resistive load. Nominal coil voltage is 24 to 30 Volts. Unit operates satisfactorily on as low as 16 volts at 25° C., ambient temperature.
- Fine silver contact materials insure extremely low contact resistance.
- Class B relays, per Military Specification MIL-R-5757-B and as in other specifications, such as MIL-R-6106-A, also available upon request.

Guardian Series 2005 Relay



(4) MTG. HOLES .144″ DIA.



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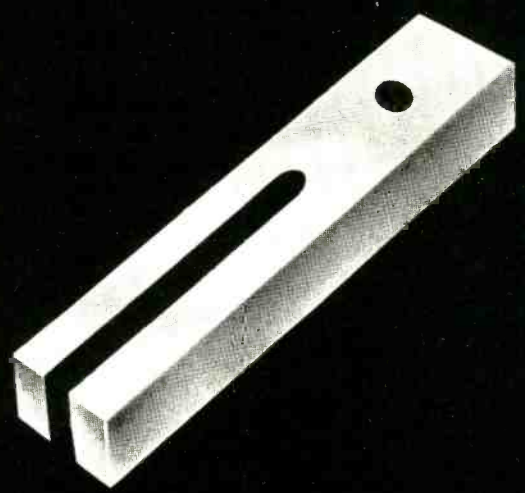
Tuning Fork Resonators, the ultimate in precision audio frequency control . . .



. . . phone or write

for complete information regarding component type **Tuning Fork Resonators,** or variously packaged **Tuning Fork Frequency Standards.**

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- **8 Range Voltmeters** *
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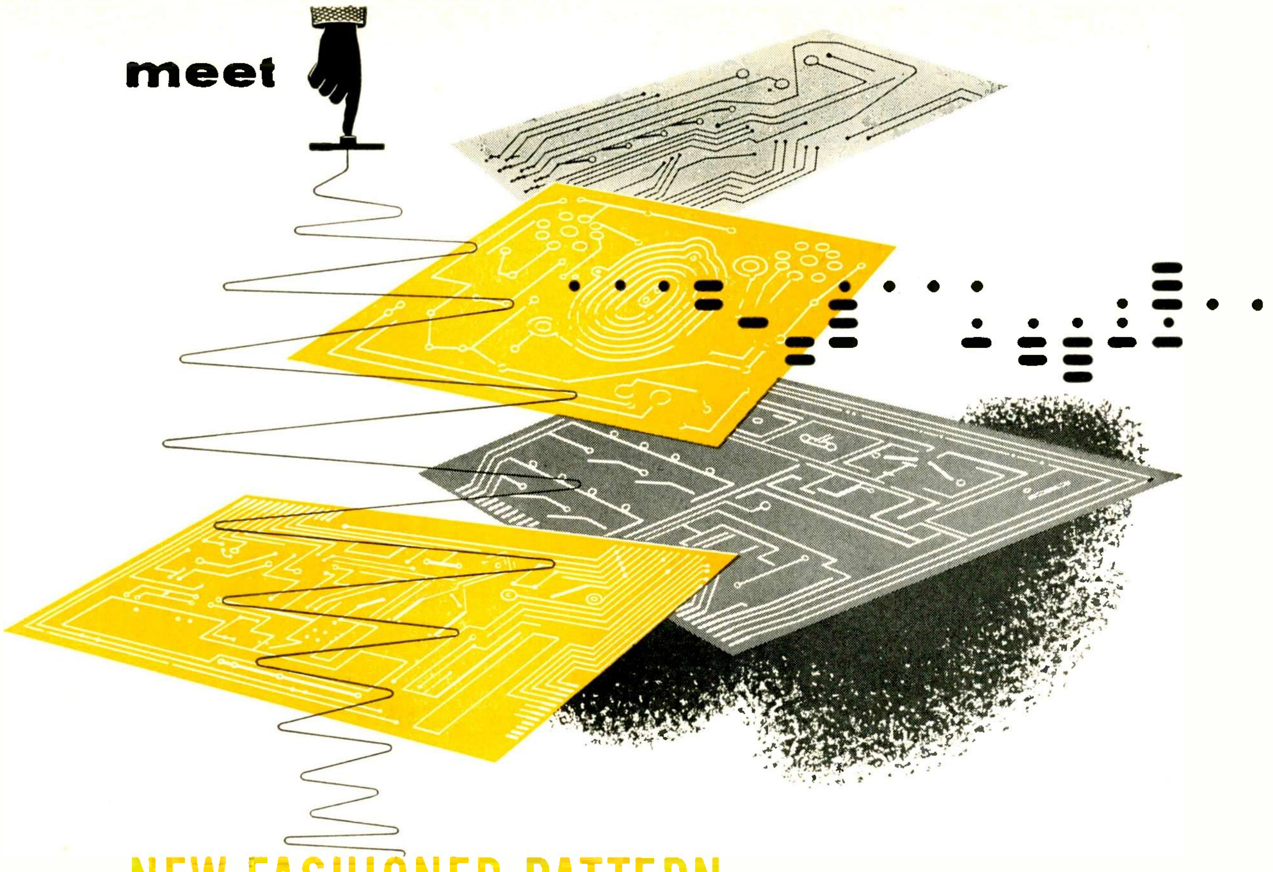
Providing unequaled scale visibility due to wrap-around windows, the same rated accuracy of 0.5% and the same efficient shielding of all other instruments in this famous line, these three new additions make the 901 group the most comprehensive line of precision portables available. Complete specifications and prices available in bulletin form, or from the WESTON representative in your vicinity . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON
Instruments



a NEW-FASHIONED PATTERN for automation!

Automation is a sought-for goal today—but, for the electrical and electronic manufacturer, hand wiring and assembly are the stumbling blocks in its achievement. But now a bright entrant in the field, *printed circuitry*, overcomes this obstacle—and provides other equally great gains in addition!

Complicated manual wiring is replaced by a pattern of conductors, coils, resistors, and other components "printed" on a sheet of laminated plastic. Low in cost, uniform in performance, and free of wiring "bugs," such assemblies are speedily mass-produced. Labor costs are drastically cut two ways—far fewer personnel are needed, and lesser-skilled workers can easily assemble (and service) complex devices with less chance of error. Since exact wiring duplication is achieved, inspection is greatly simplified. Assemblies grow small in size, overhead is reduced, less floor space is needed . . . the whole problem takes a big "easy-does-it" step toward complete automation.

National Vulcanized Fibre Co. is a pace-setter in the development of foil-clad laminates —the basic materials for most printed circuitry. Copper-Clad Phenolite—by National— is recognized as the standard by fabricators everywhere. For Phenolite is a high-quality base laminate that can be *engineered* to fit *your* conditions. It has the high insulation resistance, low electrical loss, and low moisture absorption required in the *right* base material for printed circuits. It is light in weight, easily punched and worked, and withstands effects of the various circuit-printing processes.

No matter which method you use to produce printed circuits, Phenolite clad laminates are the ideal base materials. Whether clad with metal foils, or non-metallic materials (such as rubber, vulcanized fibre, etc.) there is a Phenolite laminate for *your* particular job. Ask any of our district offices or Wilmington headquarters for details.

***HERE'S HELP FOR YOU**—our new, fact-filled, 12-page bulletin entitled "Mechanize Your Wiring With Copper-Clad Phenolite." Contains full information and application data on Copper-Clad Phenolite and other metal and non-metal clads. Write for it today! Address Dept. AF-12.*

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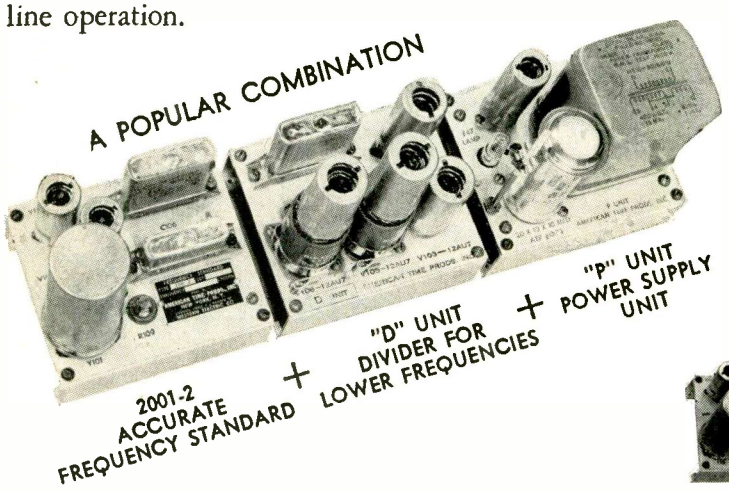
DESIGNED AS A *Modular system*

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.



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FROM A COMBINATION OF

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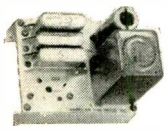
TYPICAL COMBINATIONS

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

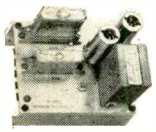
TYPE "2001-2"
FREQUENCY STANDARD
Frequencies, 200 to 3,000 cycles. Output, approximate sine wave at 5 volts.

ACCESSORY UNITS

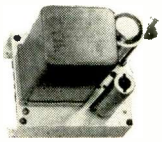


"L" UNIT.
DIVIDER, (MULTI-VIBRATOR TYPE)
Provides frequencies from 30 to 200, controlled by the 2001-2 unit.
Output, approx. 5V. Approx. sine wave.

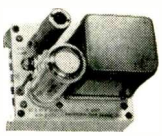
"D" UNIT.
DIVIDER, (COUNTER TYPE)
Provides 40 to 200 cycles controlled by the 2001-2 unit. (fail safe)



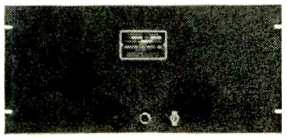
"H" UNIT
MULTIPLIER
Provides frequencies from 3,000 to 30,000 cycles, controlled by the 2001-2 unit. Output, approximately 5 volts.



"M" UNIT
AMPLIFIER
Provides 2 watts at 6 and 110 volts.



"P" UNIT
POWER SUPPLY
Provides power for combinations of units illustrated, if other sources are inconvenient or not available.



"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.

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GOLD BONDED SUBMINIATURE GLASS DIODES

designed for specific applications

HIGH INVERSE VOLTAGE TYPES

The 1N55B with a 150 volt rating, and the T5G with a 100 volt rating are particularly suitable for circuits where high voltages are encountered.

HIGH TEMPERATURE TYPES

The T18G and 1N198 diodes are rated, specified, and 100% tested for operation at 75°C. They are specifically intended for use where high inverse resistance and reliable performance is required at elevated ambient temperatures.

HIGH CONDUCTANCE TYPES

For applications requiring high forward conductance, types such as the T7G and T25G with over 200 ma at + 1 volt provide improved circuit performance.

HIGH RESISTANCE TYPES

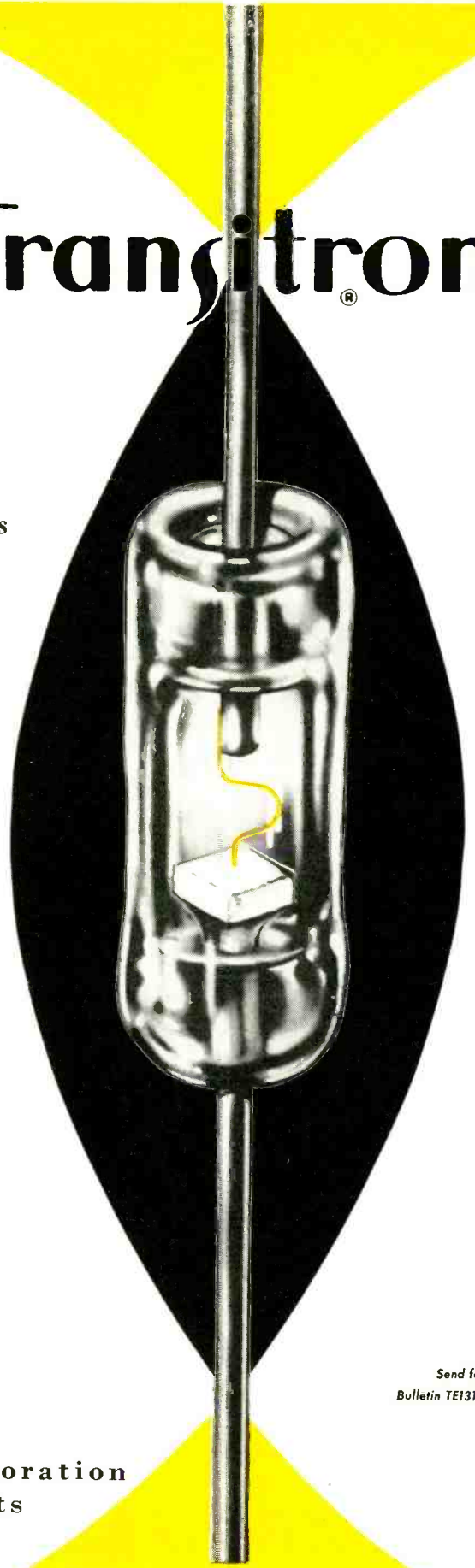
The T8G and T9G offer several megohms inverse resistance and are ideal for critical circuits requiring a minimum of diode loading.

COMPUTER TYPES

Specified for recovery time, the T16G, T17G, 1N191, and 1N192 are suited for critical pulse circuitry. Types T7G, T6G, and T25G have been designed especially for fast core switching.

JAN TYPES

The 1N126, 1N127, 1N128, and 1N198 are designed and tested to meet all requirements of MIL-E-1B.



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RESOLVER

Ketay offers a complete range of sizes and types of rotating components . . . synchros, servo motors, and resolvers. Specifications for 116 of them are contained in an illustrated brochure, available upon request.

Ketay leadership is the result of sound, imaginative engineering. From the design of a specialized component to the fabrication of complete systems, Ketay engineers create the "standards of tomorrow".

Costs, quality, and stringent delivery schedules, are best controlled when critical manufacturing is done "on the premises" . . . under close supervision. Ketay plants are fully equipped with modern machines and equipment. This Heald Boremetic Department is but one of many such divisions at Ketay.

Ke

. . . leader in the development and manufacture of Synchros, Servo Motors, Resolvers, Amplifiers, Airborne instruments, and Automatic Controls.

Ketay leadership is the result of a combination of research, experience, and outstanding manufacturing facilities. Some of these facilities are pictured here.

Ketay has produced many *firsts* in automatic controls. For example, in Synchros, Ketay was first to produce miniaturized Synchros so remarkable for their high accuracy and unmatched reliability. Ketay was *first* to produce high temperature and corrosion resistant Synchros.

Today, Ketay produces literally hundreds of different

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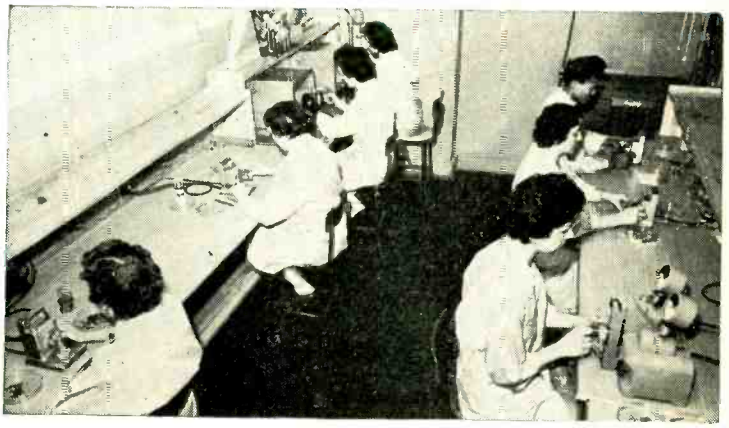
tay



Inspection of all parts, sub-assemblies, as well as completed instruments, is a fetish at Ketay. For instance, all bearings are inspected with specially developed equipment in air conditioned work space. This is just one of the many techniques that assure maximum performance when Ketay units are specified.

electro-mechanical devices some of which are illustrated on these pages. Currently, original Ketay developments are providing instrument performance far above present standards—many of which were set by earlier Ketay developments.

Ketay successfully applies its production facilities and experienced research personnel to specific problems for the leaders in automatic control.

Your interest will be well served by learning fully of the products and services you may obtain from Ketay.

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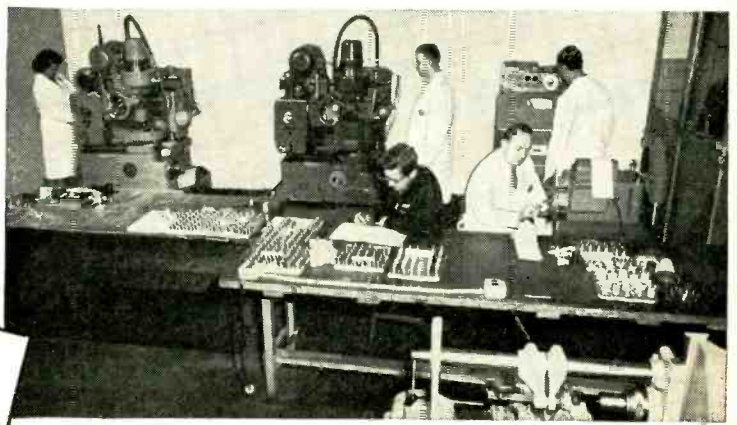
Research & Development Division

Write, today, for descriptive specifications of those types of Ketay instruments which may be applied to your designs.



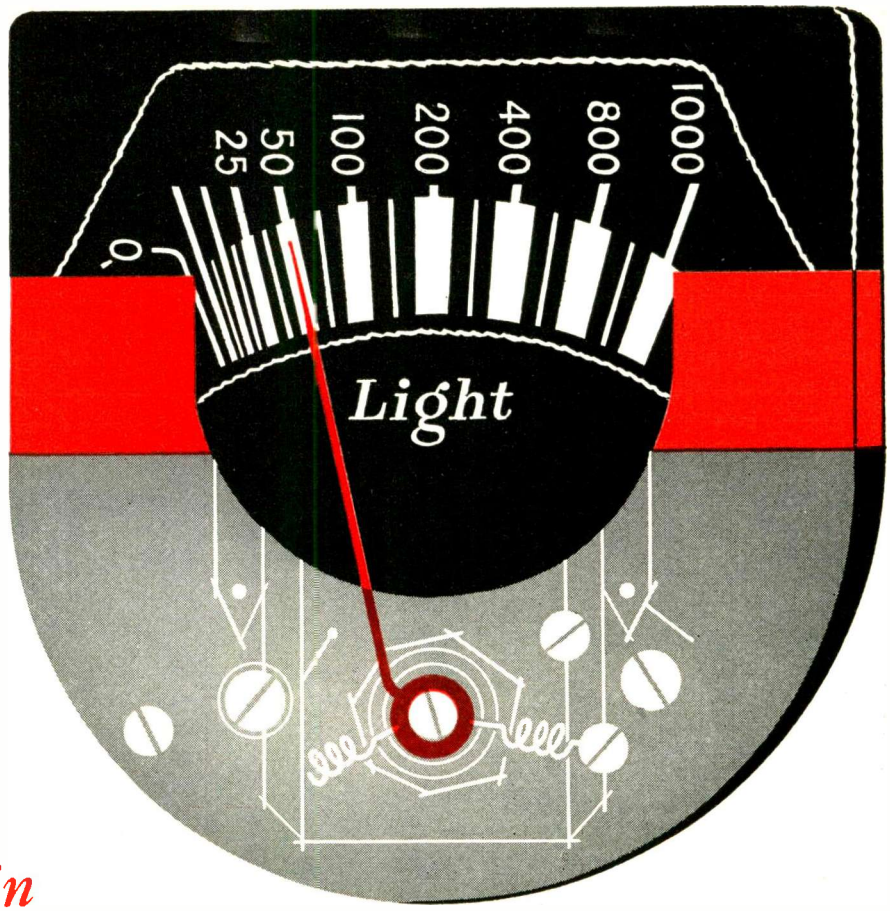
Precision of manufacture is vital in every Ketay unit. To assure continuing reliability for its products, Ketay employs the very latest facilities and techniques. Typical is this "gear room" where modern gear cutting machinery produces gears to the finest of tolerances.

TACHOMETER GENERATOR

PANCAKE SYNCHRO GYRO PICKOFF

SYNCHRO OVERLOAD TRANSFORMER

Many specialized units have been designed by Ketay engineers and are in quantity production. Custom engineered units for specific application are also available.



...in exposure meters too,

CRUCIBLE PERMANENT MAGNETS

afford maximum energy... minimum size

It's a fact, Crucible alnico magnets have a *consistently higher* energy product . . . which means more energy from a smaller magnet.

That's why, ever since alnico alloys were developed, Crucible has been producing them for leading manufacturers of voltmeters, watt-hour meters, exposure meters and magnet-equipped devices of all kinds.

Our twenty-years of magnet experience is backed by over a half-century of fine specialty steelmaking. You'll find that whenever you have a magnet application it will pay you to *call Crucible.*

CRUCIBLE first name in special purpose steels

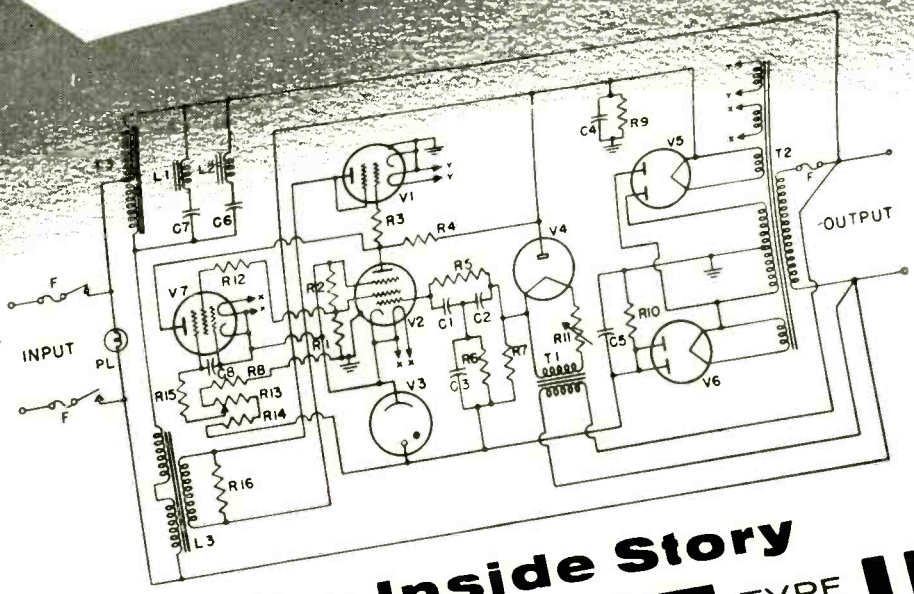
54 years of Fine steelmaking

ALNICO PERMANENT MAGNETS

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

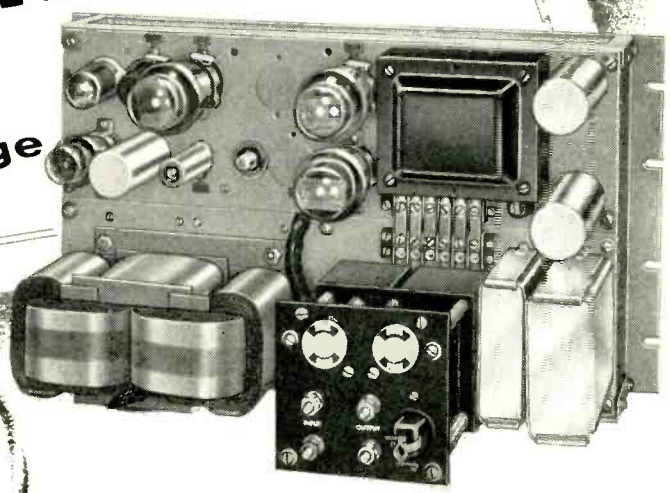
STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.



The Inside Story STABILINE TYPE IE

Instantaneous Electronic Automatic Voltage Regulators



STABILINE Type IE5101R. Rated 95-135 Volts, 60 cycles input; 115 volts, 1.0 KVA output.

- **Instantaneous Correction**
- **Excellent Regulation and Stabilization**
- **Minimum Waveform Distortion**
- **Wide Input Range**
- **Adjustable Output Voltage**
- **Insensitivity to Frequency Changes**

The circuit diagram shows how the error detector, the amplifier and power control circuit are combined in a STABILINE Type IE to deliver stabilized and regulated a-c voltage.

You will find a combination of circuit simplicity and mechanical ruggedness in STABILINE Automatic Voltage Regulators Type IE. Send us the details of your specific requirements or use the coupon below. Numerous models are offered in capacities from 0.25 to 5.0 KVA.

Visit Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY

212 Clarke Ave., Bristol, Conn.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
212 Clarke Ave., Bristol, Conn.

Please send Bulletin S351 on STABILINE Automatic Voltage Regulators.

Name.....

Position.....

Company Name.....

Company Address.....

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

Want more information? Use post card on last page.

SENSITIVE RELAYS

by Iron Fireman

EXCEED MILITARY SPECS!

At last! A sensitive relay which not only meets but actually exceeds the stiff requirements of military use. For example...

0—500 cps at 10 g's

Ability to perform dependably under severe vibration conditions is an outstanding characteristic of this relay.

-55° C to +110° C

Reliable operation is achieved under widely varying changes in ambient temperatures.

Quarter-million cycles

The life of this relay has consistantly been demonstrated to be in excess of 250,000 cycles of operation.

In ALL respects, Iron Fireman sensitive relays meet or exceed the requirements of MIL-E-5272 and MIL-R-5757B specifications.

Model No. MSR-300

(actual size $1\frac{15}{16}$" high, 1" wide)

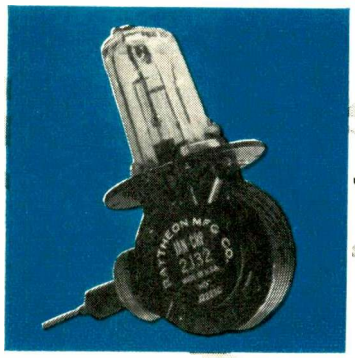
This small current-sensitive DPDT relay operates positively where very little power is available, such as in vacuum tube circuits. Available in models with coil resistance ranging from 150 ohms to 11,000 ohms, it is especially designed for dependable performance under adverse conditions of vibration, shock and temperature. A variety of header arrangements can be supplied.

For more information on Sensitive Relays as well as High Speed Relays, write now to:

®Iron Fireman Electronics DIVISION

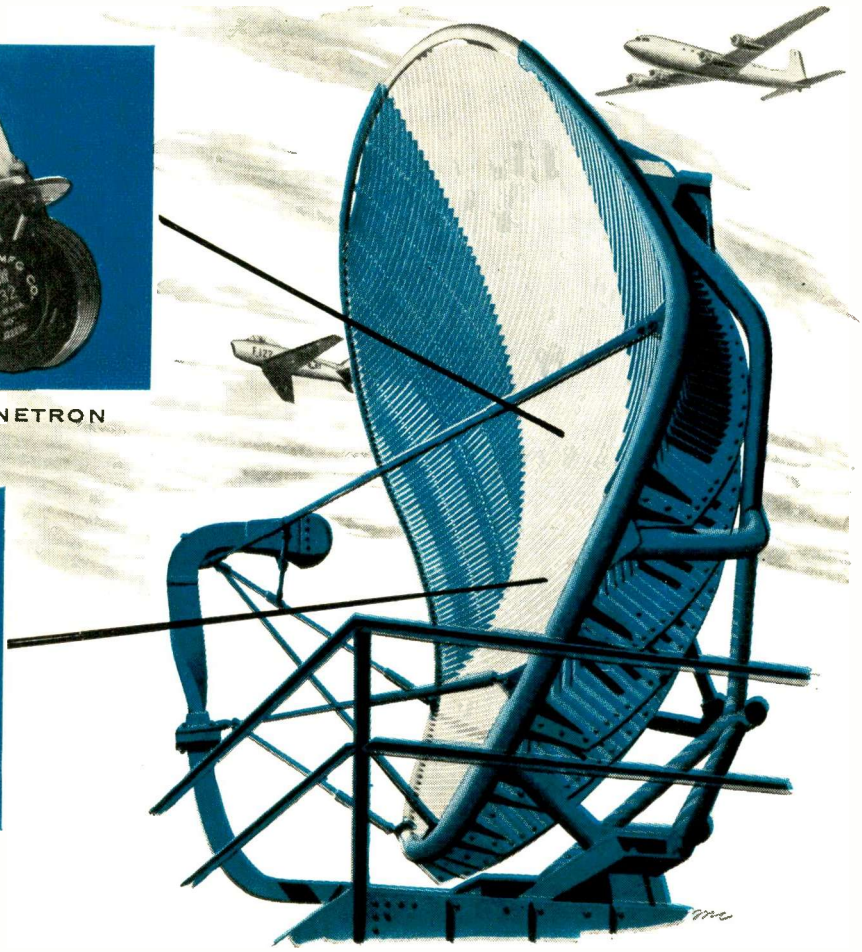
2800 S. E. 9TH AVENUE, PORTLAND 2, OREGON

Want more information? Use post card on last page.



2J32 MAGNETRON

2K28 KLYSTRON



HELPING ESTABLISH RELIABILITY RECORDS

Raytheon Magnetrons and Klystrons in proved Gilfillan ASR-1 Radar

Civil Aeronautics Administration reports record-breaking reliability of Gilfillan airport surveillance radar. Boston International Airport had 8,760 hours continuous performance with only 7⅓ hours involuntary outage—less than 1/10 of 1%—from their Gilfillan installation.

Condensed Typical Operating Data							
	Power Output	Frequency Range, mc	Reflector Voltage	Resonator Voltage	Maximum Temp. Coef.	Tuning	Cavity
2K28	140 mw	1200-3750	—140 v. to —300 v.	300 v.	±.15	Mech. Inductive	Ext.
	Power Output	Frequency Range, mc	Anode kv	Anode Amps.	Pulse Width	P.R.R.	
2J32	285 kw min.	2780-2820 Fixed freq.	20	30	1 μsec	1,000	

Check these performance records of Raytheon tubes in the Gilfillan ASR-1. Average life, 2J32 Magnetron: 4,000 hours. Average life, 2K28 Klystron: 2,500 hours.

Your microwave and radar equipment offers extra reliability when you specify Raytheon Magnetrons and Klystrons. Use these rugged, reliable tubes in your present and proposed systems. Contact Power Tube Sales to take advantage of Raytheon's Application Engineer Service, without obligation. Write for free Tube Data Booklets.

RAYTHEON *Excellence in Electronics*

RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Section PL06, Waltham 54, Massachusetts

PERHAPS YOUR TIMER WILL BE THE 661st

How do you know we can supply you with the timer that will do your job best? Because we have 19 years of experience in developing new timers to meet our customers widely varied requirements. If one of our standard timers won't do it–or one of the 660 combinations we have thus far developed from our 17 basic units–our engineers will develop the 661st combination, for your specific needs.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

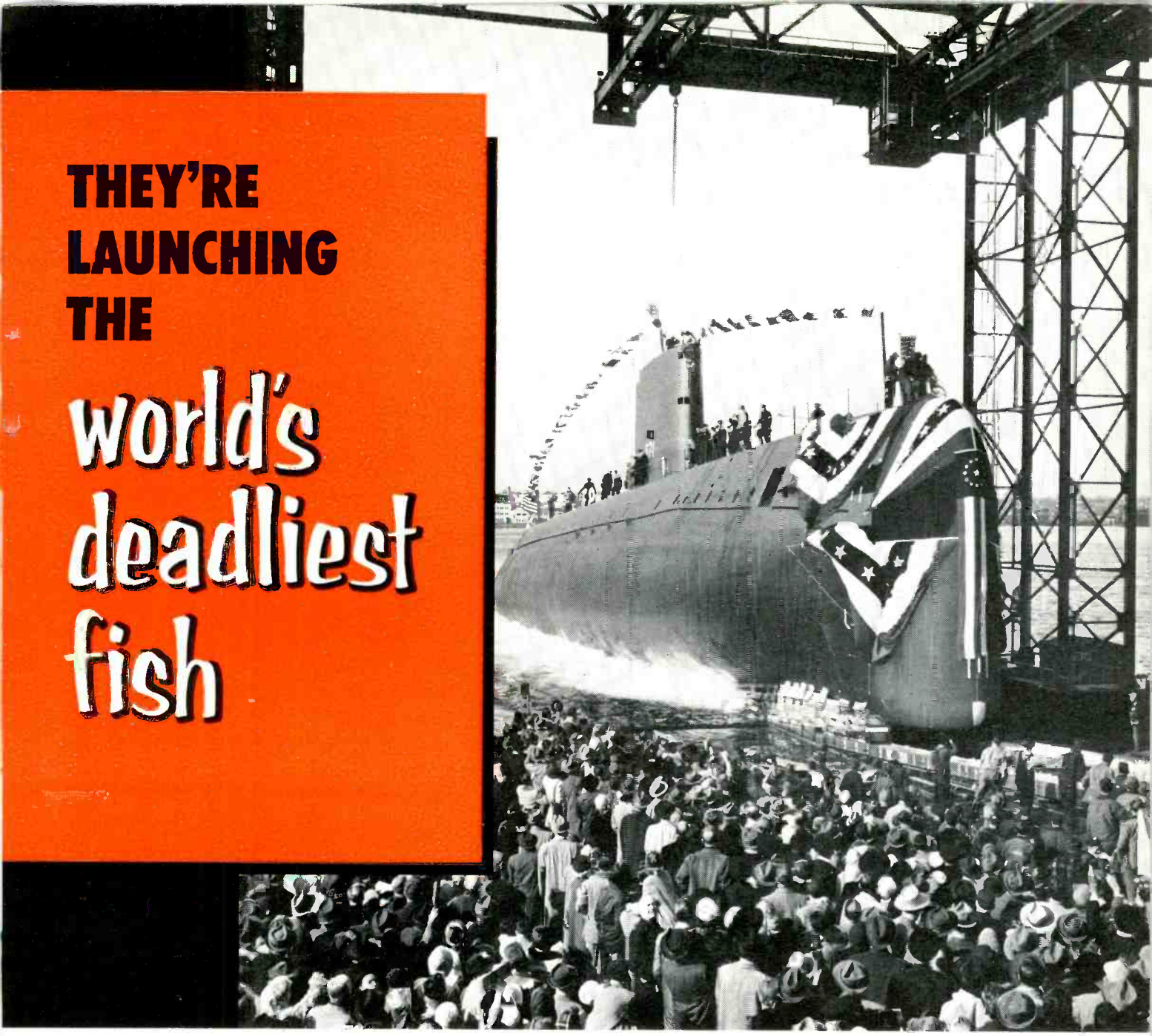
And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries–and of good deliveries even on special orders. Automation? We're in it up to our ears...just put your problem up to one of our timer specialists. Your inquiries will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

131 OGDEN STREET, NEWARK 4, N. J.

THEY'RE LAUNCHING THE world's deadliest fish



It's the revolutionary *U.S.S. Nautilus,* world's first atomic-powered submarine and fastest recruit ever to join America's underseas fleet.

Built by the Electric Boat Division of the General Dynamics Corporation, the *Nautilus* can travel around the world completely submerged, surface to attack the enemy, then dive under water to race away at a speed that defies pursuit.

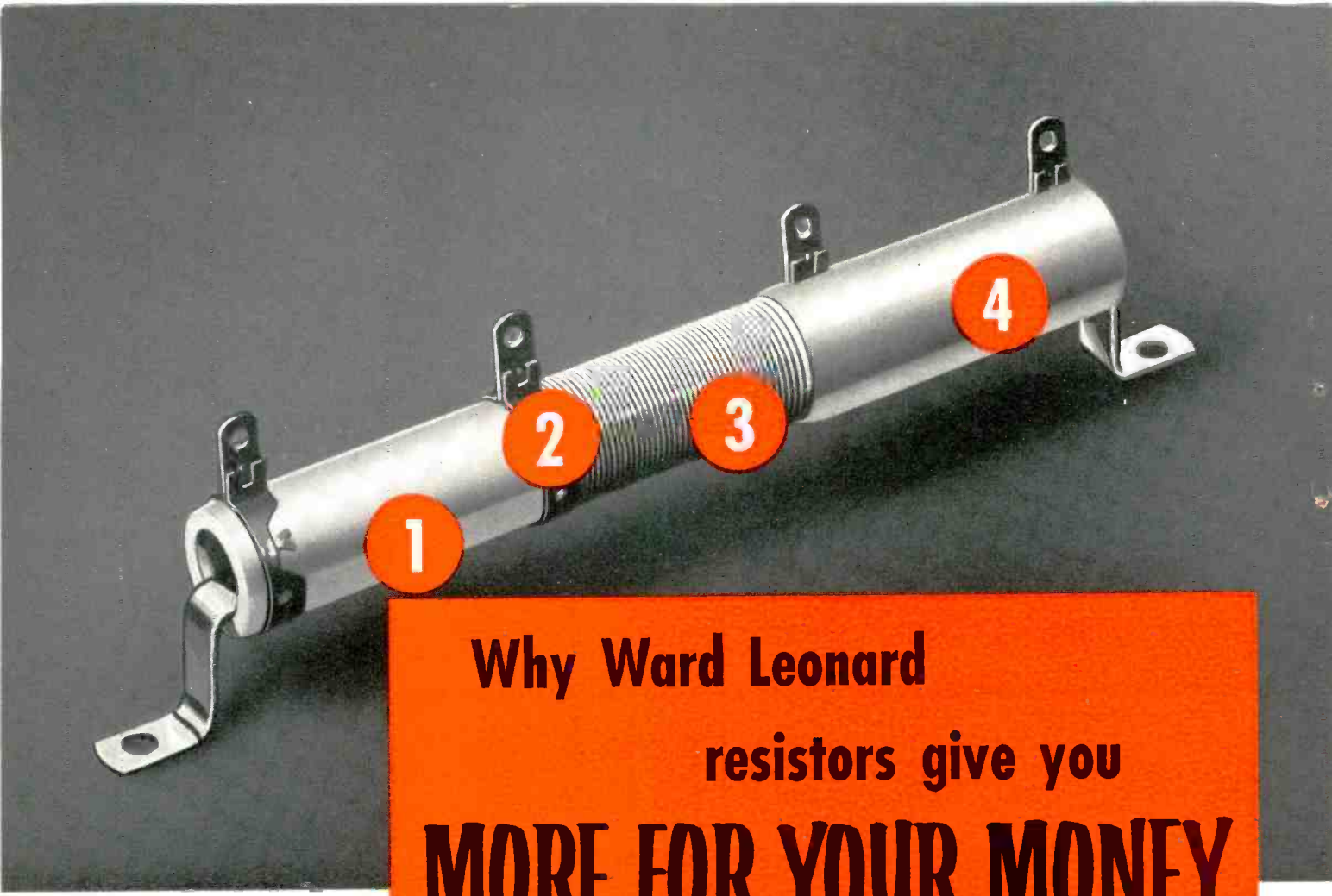
Naturally, every component of the *Nautilus*, down to the last bolt, had to meet tough specifications. They weren't too tough, however, for the Ward Leonard electric control components and equipment installed.

Point is, when you want truly dependable performance from an electric control – whether it's for an atomic sub, an electronic computer or a traffic light – take your pick from the complete Ward Leonard line. And check the other side of this page for the story behind the fine reputation of Ward Leonard resistors.

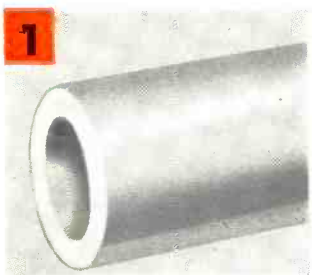
4.8

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

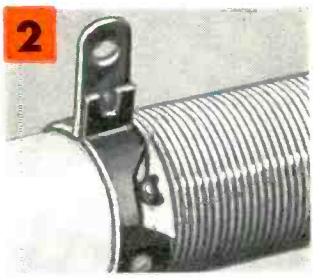
Result-Engineered Controls Since 1892



Why Ward Leonard resistors give you MORE FOR YOUR MONEY

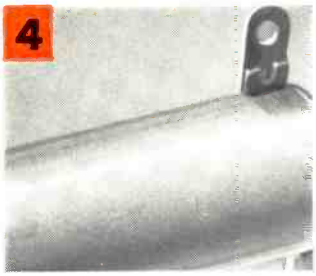


RESISTOR CORE. Ward Leonard's own manufactured cores are perfectly smooth, cylindrical ceramic bodies of high density, low porosity, and high dielectric strength. The ceramic material has been selected so that its thermal coefficient of expansion is correlated to that of the other components.



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 firmly clamped to the core, then specially silver-brazed for lasting contact.

RESISTANCE WIRE. All wire is drawn to our own specifications for each particular resistor type. It's 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.



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.

Our new 64-page Catalog 15 tells you more about the Vitrohm line of power resistors. It also includes many helpful charts and data. Write for it today to Ward Leonard Electric Company, 500 South Street, Mount Vernon, New York.

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

Why we choose WINCO® DYNAMOTORS

"Precision airborne communication equipment must have a dynamotor of consistently reliable quality . . . that's why we specify Winco."

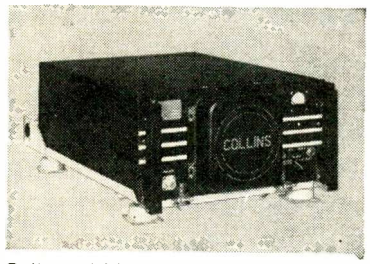
says Mr. Paul Wulfsberg,
Ass't. Director Engineering and Research

COLLINS RADIO CO.

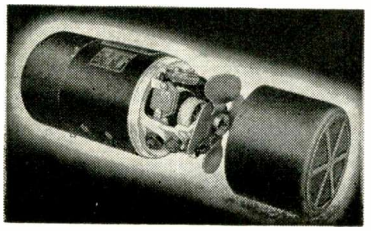
Cedar Rapids, Iowa.

WINCO DYNAMOTORS are manufactured on a wide range of rugged frames that allow for broad design applications. Winco engineers have a decade of experience in successfully designing dynamotors to rigid military and commercial specifications. They tackle each power conversion and/or supply problem individually, either modifying a standard Winco machine, or designing a special unit to meet your exact requirements. Winco specialists then plan its manufacture on a production basis to keep costs down and final performance quality at its best.

Winco dynamotors are lightweight, compact and totally enclosed and ventilated. Precise static and dynamic balance is assured by the most modern machines — each dynamotor is thoroughly tested with periodically calibrated precision meters.



Collins 18S Transmitter/Receiver, used for reliable HF communications in major air-lines and executive aircraft uses a Winco-Engineered Frame 51 Dynamotor.



SEND THIS COUPON TODAY for complete information on how Winco can supply you with reliable, efficient dynamotors and power supplies produced in volume at low cost.

WINCO® **POWER** for the Nation's Mobile Communications

WINCHARGER CORPORATION

Sioux City 2, Iowa
Subsidiary of **ZENITH** Radio Corporation

To Wincharger Corp., Sioux City 2, Iowa.
Send me the facts on Winco Dynamotors and Power Supplies

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Company _____

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Coupon No. 163

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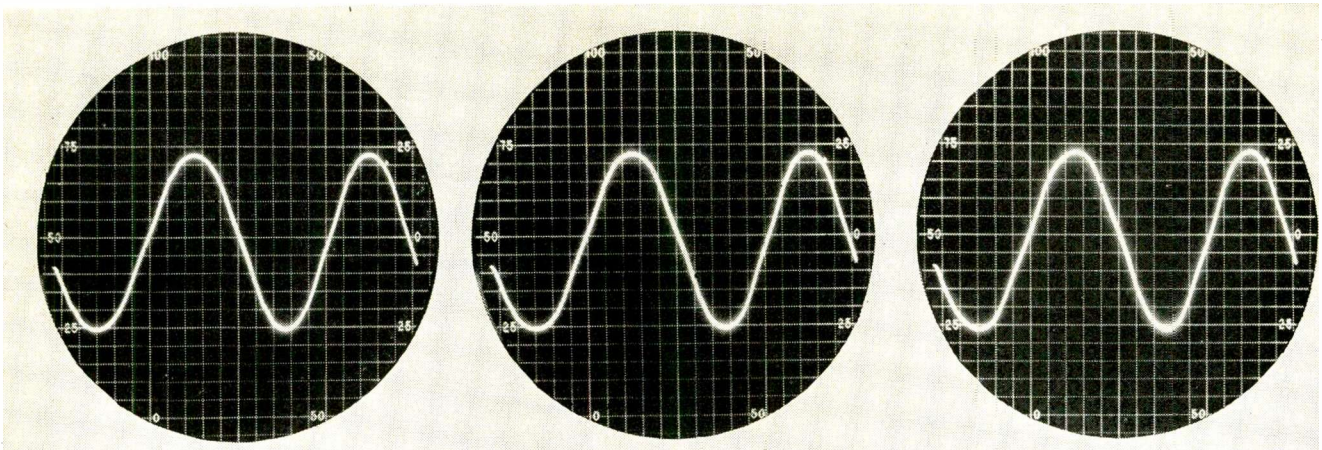


UNRETOUCHED OSCILLOGRAMS OF OUTPUT VOLTAGE: 1000va Sola Harmonic-Neutralized Constant Voltage Transformer operating from 110v input and correcting output to 115v with less than 3% harmonic distortion. "Commercial sine wave" is maintained regardless of load capacity served.

±1% static magnetic voltage regulation with less than 3% harmonic distortion

Static magnetic voltage regulation with all its advantages —automatic, continuous operation; instantaneous response; no maintenance; self-protection against short circuits; and input-output circuit isolation — has harmonics in its output voltage. In the case of the Sola Standard CV Regulator, harmonic distortion is held within an average of only 14% at full load. However, even 14% is excessive on some applications.

Sola Harmonic-Neutralized Constant Voltage Transformers have the characteristics of the Standard Sola CV Stabilizer *plus* the added advantage of less than 3% harmonic distortion in the output voltage wave.

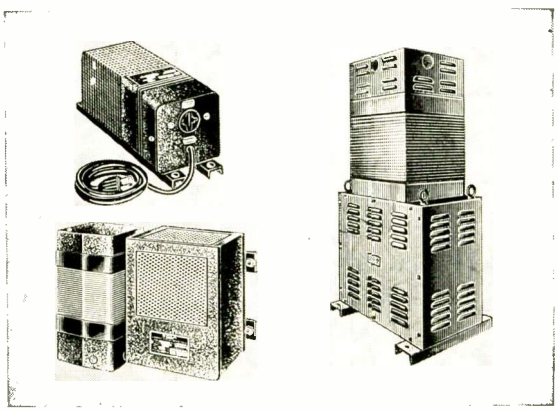
Sola sinusoidal output stabilizers are ideal for the most exacting applications. They are widely used to provide stabilized undistorted voltage for instruments, production control components, and communication gear. They are especially suitable for input to a rectifier when close regulation of the dc output is required.

Six standard ratings from 60 to 2,000va are immediately available from your electronic distributor's stock. Custom-built designs with ratings from 30 to 15,000va can be ordered in production quantities. A Sola sales engineer will be happy to discuss your specific requirements.

***TYPICAL HARMONIC ANALYSES, TYPE CVH CONSTANT VOLTAGE TRANSFORMER**

	Input Volts	Output Volts	3rd	5th	7th
Full Load	115	115.0	0.77%	1.20%	0.34%
50% Load	115	116.1	1.00	0.70	0.55
No Load	115	116.2	0.65	0.36	0.60

**On production units, the lowest residual harmonic content may occur anywhere between full load and no load.*



TYPICAL MECHANICAL STRUCTURES: The two stabilizers on the left are stock units, the transformer on the right is a "special" in the 7,500va size range.

SOLA *Constant Voltage* **TRANSFORMERS**

WRITE FOR BULLETIN 7L-CV-200 FOR COMPLETE DATA

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *BOSTON:* 272 Centre Street, Newton 58, Massachusetts • *NEW YORK 35:* 103 East 125th Street • *LOS ANGELES 26:* 2025 Sunset Boulevard • *PHILADELPHIA:* Commercial Trust Building • *CLEVELAND 15:* 1836 Euclid Avenue • *KANSAS CITY 2, MISSOURI:* 406 West 34th Street • *Representatives in Other Principal Cities*

ADVANCED CAPACITOR DESIGN

...Especially adaptable to your own requirements and specifications

Good-ALL CAPACITORS

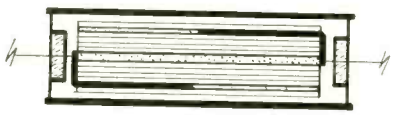
MYLAR* Dielectric

METAL ENCLOSED

Hermetically Sealed, Miracle X Impregnated.

Types 612 and 613 extended foil construction

612 One End Grounded • 613 Both Ends Insulated



Types 614 and 615 tab construction

614 One End Grounded • 615 Both Ends Insulated

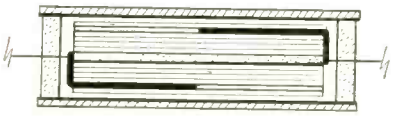
This MIFILM capacitor is unaffected by severe climatic changes—retains extreme high insulation resistance over complete temperature range of −65° C to +150° C. SUBMINIATURE SIZES OVER THE ENTIRE CAPACITANCE AND VOLTAGE RANGE. Special sizes can be made to withstand even higher temperatures. Tolerances as low as ± ½ of 1%. Special shapes available to meet your space requirements.

MYLAR* Dielectric

Commercial Type Construction

Enclosed in thermo-setting plastic impregnated tube or ceramic case.

Type 620 extended foil construction



Type 621 tab construction

A high quality, lower cost capacitor with the same excellent properties obtained in our hermetically sealed metal enclosed Mifilm Capacitor. Miracle X Impregnated (high temperature synthetic oil). Marbelite plastic end seal. Excellent humidity resistance. High insulation resistance. Low capacitance change with temperature. Operating temperature −65° C to +125° C. Power factor less than .5%.

*Du Pont trade-mark for its Polyster film.

We custom-build to your specified sizes. Our engineers are always ready to work with you on any capacitor problem. We invite sample orders for your evaluation. Write for complete catalog covering these any many other types of Good-All long life capacitors.

Good-ALL CAPACITORS

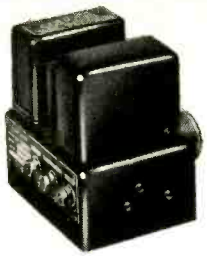
SO SUPERIOR they are being specified and used extensively by Electronics, Radio and TV Manufacturers throughout America.

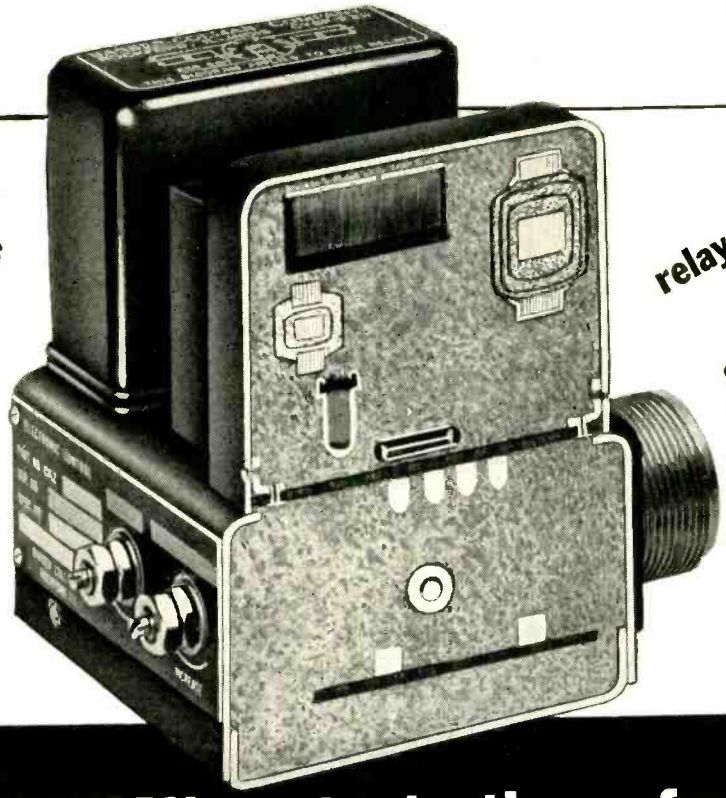
GOOD-ALL ELECTRIC MFG. CO.

114 West First Street • Good-All Building • Ogallala, Nebraska

Phone 112 or 113

What's inside this Aircraft Temperature Control?...





resistors

transformers

potentiometers

capacitors

relays

sub-miniature vacuum tubes

radio noise filter

BARBER-COLMAN protects these from shock, vibration, humidity with NOPCO® LOCKFOAM

Barber-Colman Company, Rockford, Ill., is well known for its varied line of aircraft temperature and positioning control systems, actuators, air valves, and other accessory equipment. In designing the electronic temperature control shown here, they required a potting material to protect the fragile components and the connecting wiring. It was necessary that the material be both light and strong, have good electrical insulation properties, and be impervious to salt spray and humidity. Curing temperature was not to exceed 250° F., and after curing had to withstand ambient temperatures up to 220° F.

Their search for the right material ended when they tried one of the 50 different formulations of Nopco Lockfoam. "By using Nopco Lockfoam as the potting material," states Barber-Colman, "we were able to meet environmental operating requirements with an economy in manufacturing and assembly time."

These properties of Nopco Lockfoam are finding new applications almost daily—and they are by no means limited to electronics or aviation. Since Nopco Lockfoam is poured-in-place, it exactly fills the configurations you wish to fill. It is consistent and reproducible.

One of the many formulations of Nopco Lockfoam may be the means of improving some product of yours, or even of bringing into being a product that so far exists only on your drafting board. Send for the free informative booklet today.

Plastics Division

NOPCO CHEMICAL COMPANY

Harrison, New Jersey

4858 Valley Blvd., Los Angeles 32, Calif.

NOPCO REG. U.S. PAT. OFF. EVOLVED THRU RESEARCH

FIRST–

high voltage mica capacitors.

FIRST–

super-power tank circuit mica capacitors.

In harness racing as in capacitors you pick the leader by looking at the record. That's why at Cornell-Dubilier, we're mighty proud of our record of new capacitor designs, consistent dependability and outstanding field performance —a record no other company can even come close to approaching. That's the record of

C-D...45 YEARS OF FAMOUS FIRSTS

Typical of these "Famous Firsts" are the examples shown here ... just three of the hundreds of money-saving answers in capacitors a C-D engineer can show you. Write to Cornell-Dubilier Electric Corp., Dept. K-124, South Plainfield, N. J.

FIRST–

carrier current coupling capacitors.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

EDO

finest name in

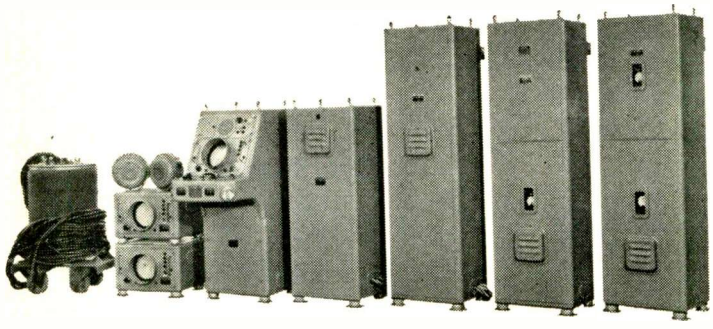
SONAR

Ingenuity of design, proven performance and superior range with accuracy are the main reasons why EDO is now regarded and recognized as the outstanding leader in the development of echo-ranging equipment.

From deep depth sounders for navigation, survey, and ocean bottom exploration to a wide variety of under water detection systems, Edo equipment has made its mark and proven its superiority.

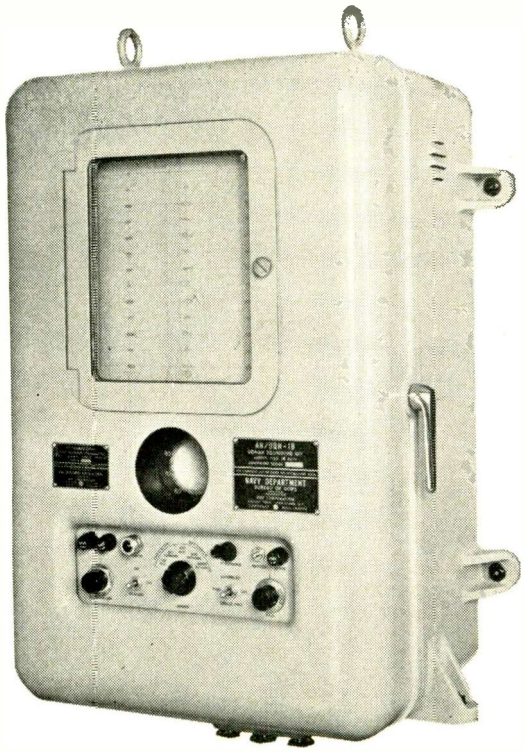
That's why when you see the Edo flying fish emblem on a sonar equipment you can confidently recognize it as a product of brilliant engineering and masterful workmanship—reliable beyond question.

Just off the press! "The Story of Edo"—24 page book describing Edo's diversified facilities and the company's 29-year old history. Send for your copy today.

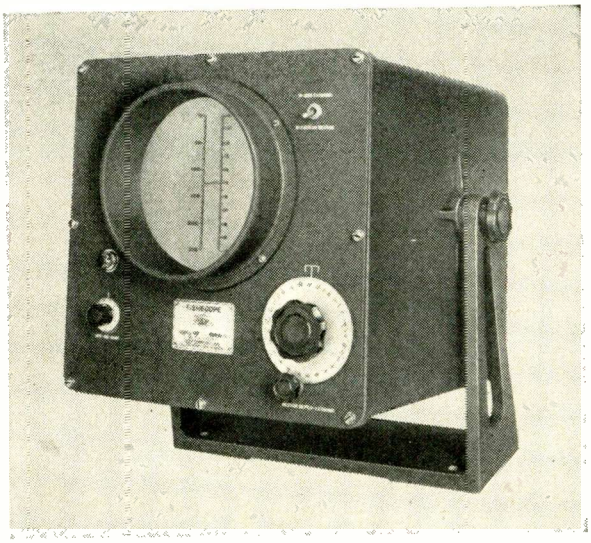


EDO SCANNING SONAR a typical example of a complex naval sonar system, developed and built for the U. S. Navy by Edo.

A FEW OF MANY EDO SONAR EQUIPMENTS FOR COMMERCIAL AND NAVAL USE



0 TO 6000 FATHOM DEEP DEPTH SOUNDER in wide use with U. S. Navy (AN/UQN-1b) now available commercially (Model 185). Gives clear indication of depth on cathode-ray tube in two scales: 0 – 100 feet; 0 – 100 fathoms. Records continuously in three scales: 0–600 feet; 0–600 fathoms; 0–6000 fathoms. The finest deep depth sounder available. For complete details send for Model 185 brochure.



EDO FISHSCOPE. Most advanced fish finding device available today. Spots fish on cathode-ray tube in 0 – 250 fathom range, then magnifies any 10-fathom sector 25 times for clearer view. Commercial fishing boats equipped with the Fishscope report better than average hauls in far less time thanks to this Edo development. For full details send for Fishscope brochure.

EDO CORPORATION • COLLEGE POINT, L. I., N. Y. Since 1925

New time-saving AMF Everlock pre-assembled screws and lockwashers. In types, sizes and materials to meet your needs.

fasten it and forget it...

Specify

Another AMF Product

Everlock
INDUSTRIAL FASTENERS

Tight, vibration-proof fastenings—*for the life of your product.*

New AMF Everlock pre-assembled screws and lockwashers give you both . . . fast, one-operation application and vibration-proof tightness. Everlock washers, with the exclusive alternating chisel edges, actually bite into the surface of both screw and part. Even under the most punishing vibration, Everlock fasteners stay secure—for *good!*

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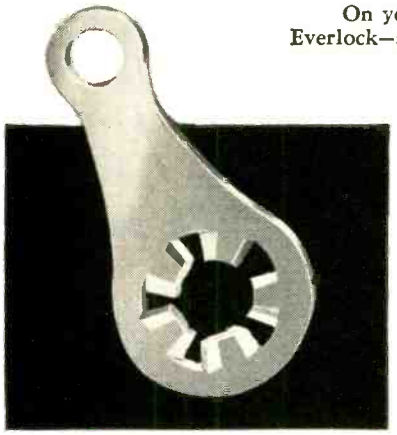

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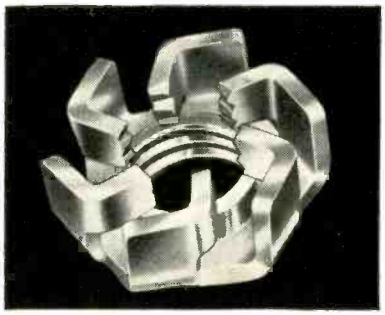

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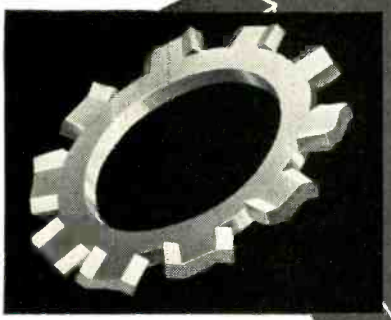

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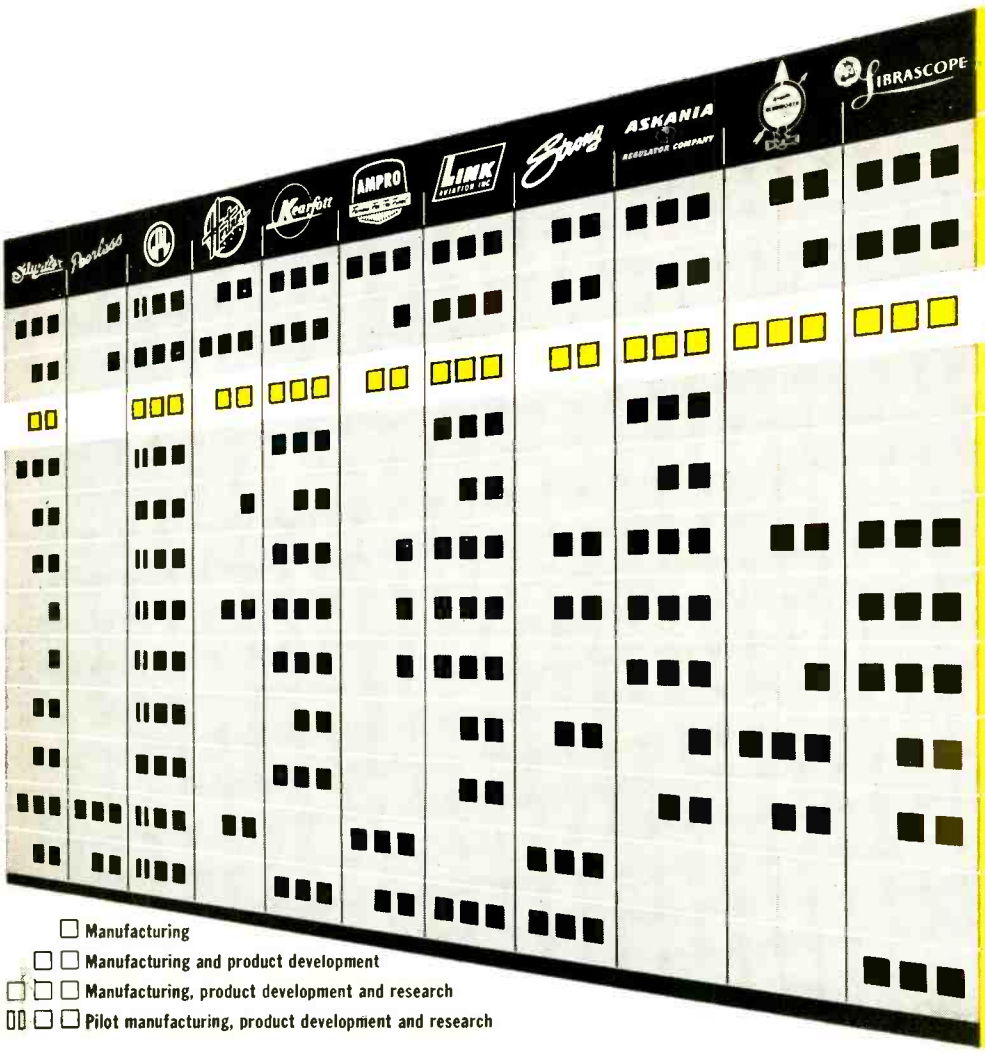
GPL SERVES INDUSTRY THROUGH *coordinated* CAPACITIES



- PRECISION MECHANICS and CERAMICS
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One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

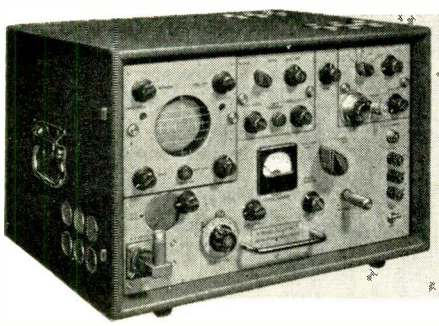
precision technology

GPE Coordinated Precision Technology is the basic GPE operating policy which inter-relates the research, development and manufacturing facilities, techniques and capabilities of the producing companies of General Precision Equipment Corporation. Thus each company's specialization in its particular areas of competence is supplemented by the application of the resources of the other companies, wherever relevant. A diversified line of advanced precision equipment of superior design and performance has resulted from this application of the newest and most advanced techniques possessed among the companies in every technical capacity.

e.g. in ELECTRONICS

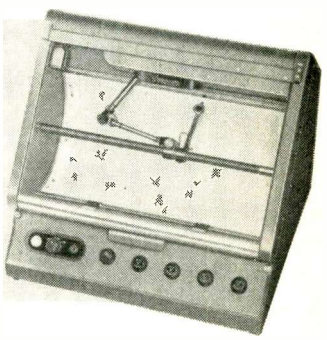
Ten of the GPE Producing Companies work in this important field. These companies were "born in electronics" and pioneered in its development before the word was coined. Their work covers every phase of electronics and GPE coordination relates each new electronic problem to the specialized knowledge and experience which is most valuable. This secures the optimum solution for the customer with minimum expenditure of time and money.

GPE Producing Companies have been responsible for the research, development and manufacture of a wide range of electronic precision components, equipment and systems, including Theatre Sound Systems, Sonar Equipments, Flight Simulators, Industrial Control Systems, Analogue Computers, Digital Computers and Components, Industrial and Studio Television, Navigation Systems—both airborne and marine. GPE systems, in most instances, are advanced concepts, often employing components specifically developed for the purpose by one of the GPE companies. Of the great number, two are shown.



Kearfott X-band Test Set, frequency range 8,500 to 10,000 MC; a unique all-purpose portable radar test set, comprising a power monitor, spectrum analyzer, wavemeter and signal generator which supplies an accurately calibrated signal of known level with variable amplitude and pulse-width combinations. Also provides FM, square wave and CW output.

Librascope X-Y Plotter and Recorder; automatically displays data derived from punch cards, mechanical or electronic computers or sensing elements; features rapid graphic 2-axis display with provision for 10-fold scale expansion and zero suppression. Used in aero-dynamic and electronic research, as well as in mass data reduction systems for business and industry.



Most advanced technological products which utilize electronics also call for other advanced technological skills. Though space allows only for an outline of GPE's work in electronics, both the capacities chart on the facing page and most of the products mentioned above serve to suggest the broad coordination of technical capacities in all fields which exists as a result of GPE Coordinated Precision Technology.

Address inquiries to: **GENERAL PRECISION EQUIPMENT CORPORATION**
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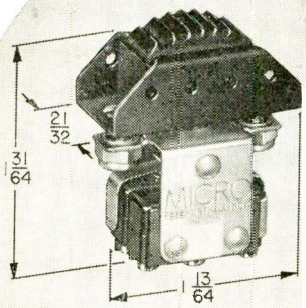
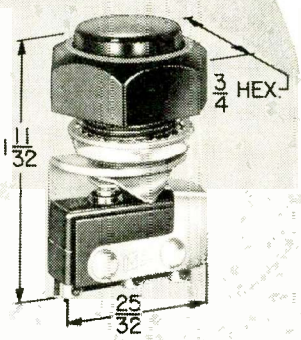
MICRO SWITCH Precision Switches

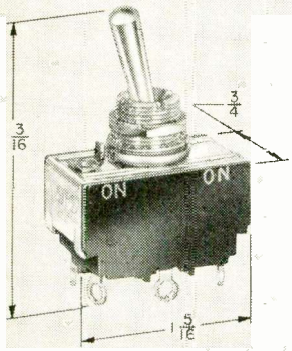
A PRINCIPLE OF GOOD DESIGN



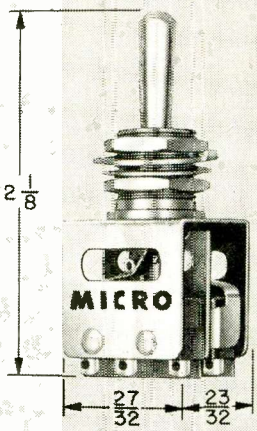
A Slide Button Switch



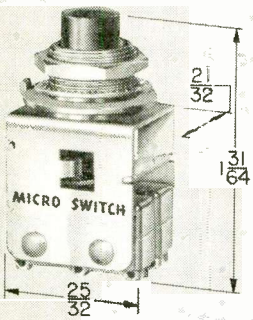
B Push Button Assembly



C Sealed Toggle Switch

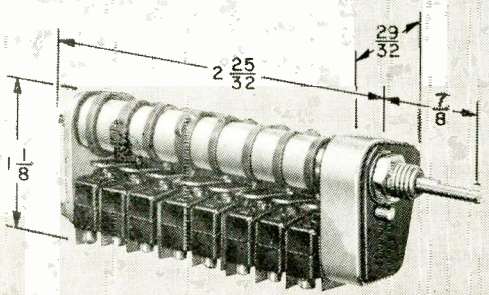


D Toggle Switch Assembly



E Push Button Assembly

F Rotary Selector Switch



Why

electronic designers turn to MICRO SWITCH for manually operated switch components

• Wide variety • Small size
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MICRO SWITCH precision switches shown here are typical of hundreds of switches developed to meet the specific requirements of the electronics industry. Whether your requirement is for a slide switch, a push switch, a toggle switch, or a rotary selector switch, consultation with MICRO SWITCH engineers can save you time and money.

A **Slide Button Switch.** Designed for two-circuit control. Two subminiature switches mounted in a three-position, maintained contact, slide-button assembly. Both switches can be wired normally-open, both normally-closed, or one in each position.

B **Push Button Assembly.** For panel mounting with push-button plunger mechanism sealed at the panel, thereby protecting subminiature switch on inside of panel. Extremely small—complete assembly weighs only .04 lb. Operating force may be from 3 to 6 lbs.

C **Sealed Toggle Switch.** Supplied with external panel seal and internal bushing seal below the bat handle. Has bushing for panel mounting and may be equipped with keying tab where desired.

D **Toggle Switch Assembly.** For panel mounting and provides control of as many as 4 circuits. One of two single-pole, double-throw subminiature switches is actuated in each extreme toggle position. Require minimum space behind mounting panel.

E **Push Button Assembly.** Composed of two single-pole, double-throw subminiature switches. Switch provides an improved "feel" and simultaneous make and break of the two circuits.

F **Rotary Selector Switch.** Uses from 2 to 8 single-pole, double-throw subminiature switches to control multiple circuits. It permits 2 to 8 switching positions with spring or manual return to neutral position.

For complete information on these switches —or the complete MICRO SWITCH *line call your nearest* MICRO SWITCH *branch office. Why not do it NOW?*

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

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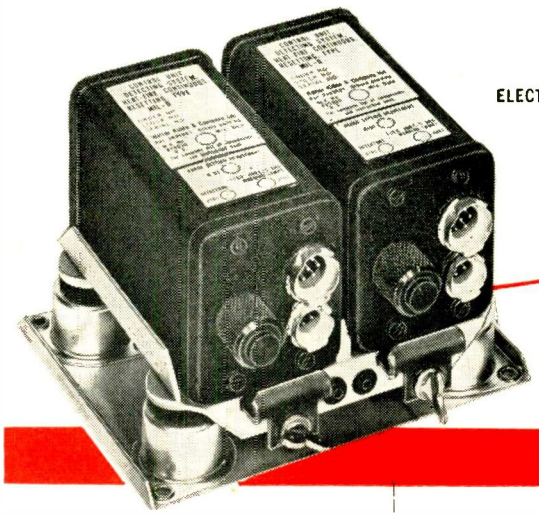
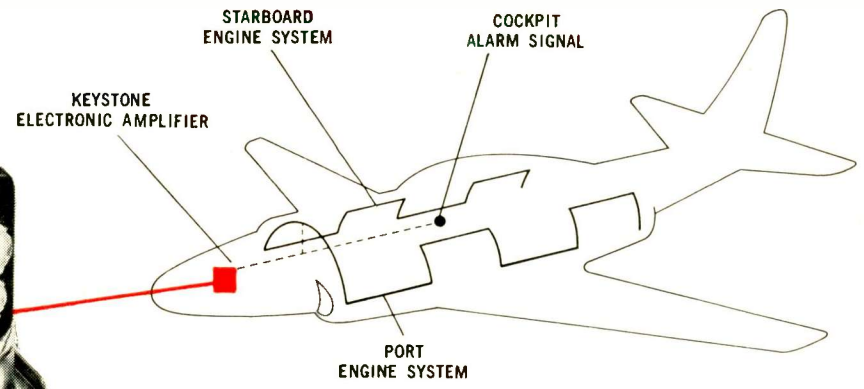
H HONEYWELL

POWER PACKAGE

for fire detectors





Outline of typical continuous element system

Keystone electronic amplifiers power fire detection system in latest jet fighters

These twin Keystone amplifiers power the continuous resetting fire detection system supplied by Walter Kidde & Company, Inc., for the nation's newest jet aircraft.

Units for each engine provide constant power through the flexible sensing element, which gives immediate warning of fire in any engine zone.

These special purpose, Kidde-designed electronic amplifiers were produced by Keystone to meet military specification MIL-D-7872, and to operate under extreme vibration and temperature changes. Rigid production control and exhaustive testing assure dependable performance, long life.

This unit is typical of the special electronic and magnetic amplifiers produced by Keystone to meet unusual requirements in military and commercial installations. New applications are constantly making more demands on control and power systems – require new and unique amplifiers to solve individual problems. Whatever your particular need, Keystone can furnish exactly the right amplifier to meet your specifications . . . from design and development through production.

Find out how Keystone can cut your engineering and production time and costs – send an outline of your amplifier needs to the Engineering Department today. If your application involves magnetic amplifiers, send for the handy *Keystone Magnetic Amplifier Reply Sheet*, a quick data sheet which helps Keystone engineers recommend the necessary amplifier promptly and accurately.

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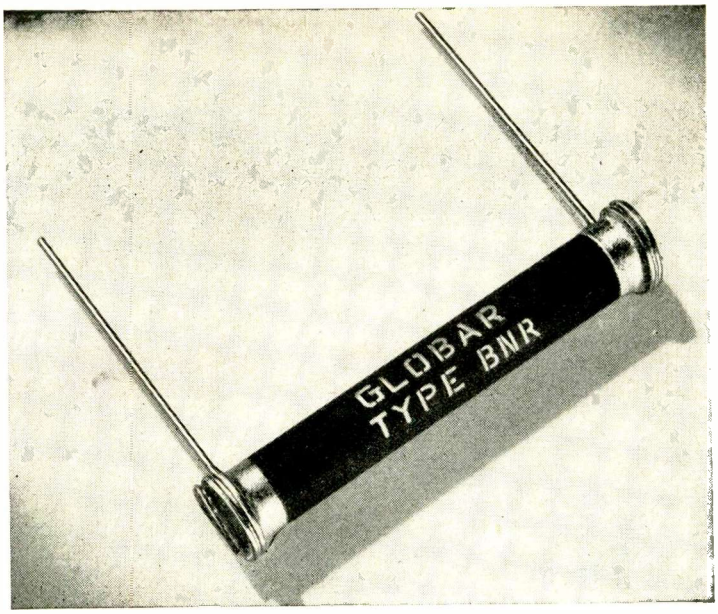
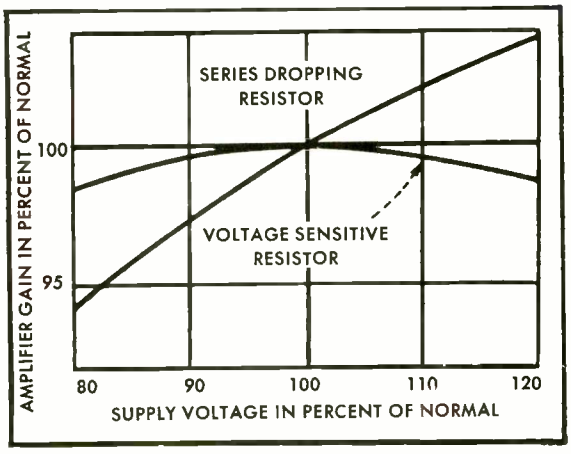
Stabilize Amplifier Gain with

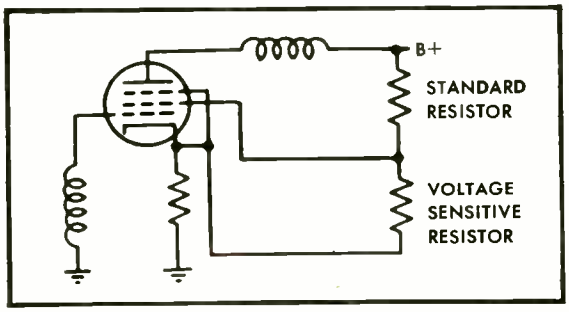
GLOBAR® TYPE BNR VARISTORS





Variation of gain with supply voltage for 12SK7 pentode in circuit using linear resistors and voltage sensitive (non-linear) resistors.

Circuit using voltage-sensitive resistors has voltage divider returned to ground through cathode resistor.



Varying supply voltages need *not* affect performance of pentode amplifiers. A GLOBAR® Type BNR Voltage Sensitive Resistor in the low potential section of the voltage divider—returned to ground through the cathode resistor, as shown in this circuit for a 12SK7—effectively limits gain fluctuations to within ±0.2% when supply voltage varies from −10% to +10%. The same supply variation in a conventional circuit, with a regular series dropping resistor, results in fluctuations up to ±2.5%... more than 12 times as great.

GLOBAR BNR varistors give similar stabilization with nearly all r-f pentodes—and some beam pentodes. Our engineers will work with you on any voltage stabilization problem you have... without obligation. Write Dept. EL 87-43, The Carborundum Company, Niagara Falls, New York.

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PRODUCT	APPLICATIONS
Television Receivers, Cathode-ray Oscilloscopes	Automatic picture-width control; surge limitation to protect tubes.
Communications Equipment	Automatic signal-strength control; surge limitation to protect tubes.
Relays, Solenoids, Vibrating Contact Devices, etc.	Reducing surge voltage peaks to limit arcing, insulation stresses.
Small Motors	Surge limitation to reduce arcing of contact points.
Low voltage devices	Spark reduction to lower interference on radio and television.
Electronic circuits	Voltage stabilization; surge limitation; generation of unusual wave shapes, harmonics; DC control of AC resistance; volume compression.

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Ceramic Resistors

VOLTAGE SENSITIVE • CONVENTIONAL • TEMPERATURE SENSITIVE

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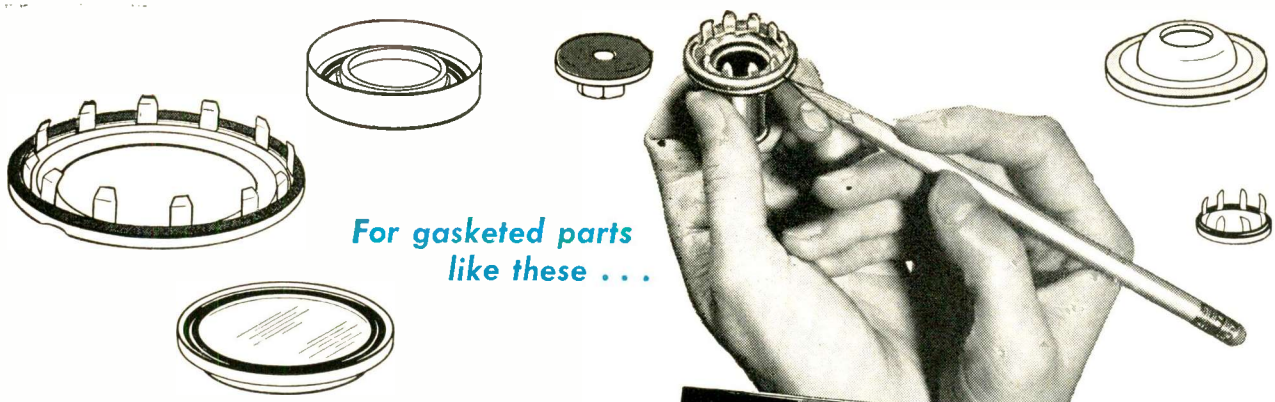

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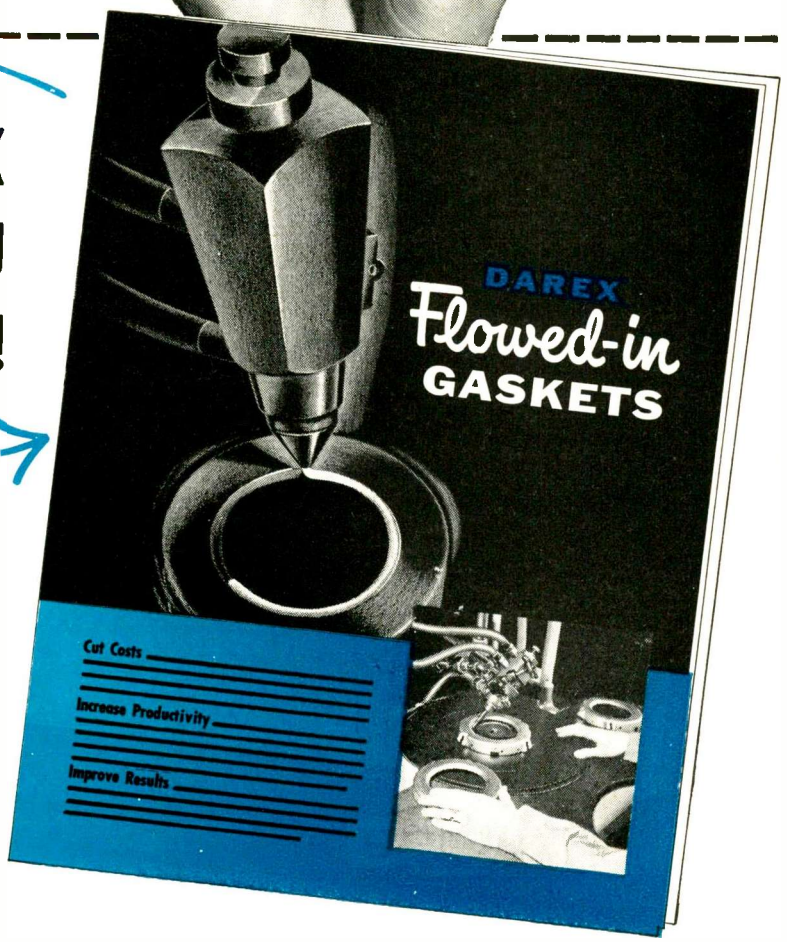

There's something new in electronics this year . . .

IT'S THE DAREX Flowed-in GASKET PROCESS!

And this fact-filled brochure gives you the whole Flowed-in Gasket Story. Here are a few samples of the things you'll read in this informative new book:

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Using the DAREX Flowed-in Gasket Process, a major electronics manufacturer is saving $50,000 per year in labor and materials on a single gasketing operation. As a result of this striking cost reduction, the firm has recommended the DAREX Process for several more gasketing operations.

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The Flowed-in Gasket Process is a new application of a method of sealing developed by Dewey and Almy researchers over 30 years ago, and successfully used in food container manufacture ever since.

The DAREX Flowed-in Gasket Process is more than a sealing compound . . . more than a machine . . . more than an engineering service . . . *it's a complete Process!* So when you switch to Flowed-in Gaskets, you get all three.

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Cambridge 40, Mass.

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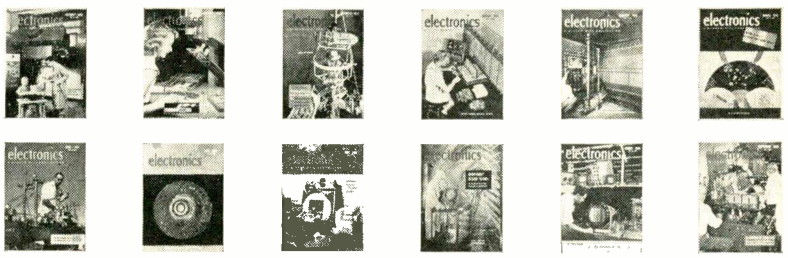

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1 Electronics Buyers' Guide

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These important purchasing influences of the electronic industry have, throughout the years, grown accustomed to using the ELECTRONICS BUYERS' GUIDE as their sole product reference source . . . for fourteen years they have relied on the "Guide" for its complete, accurate and up-to-date information, serving them year upon year in the exacting manner they require. These technicians of the industry *choose* and *use* the "Guide" as their Breadboard Blue Book . . . that's why manufacturers with electronic products to sell get more results from their advertising dollars by doing a complete year 'round product selling job in 13 issues of ELECTRONICS.

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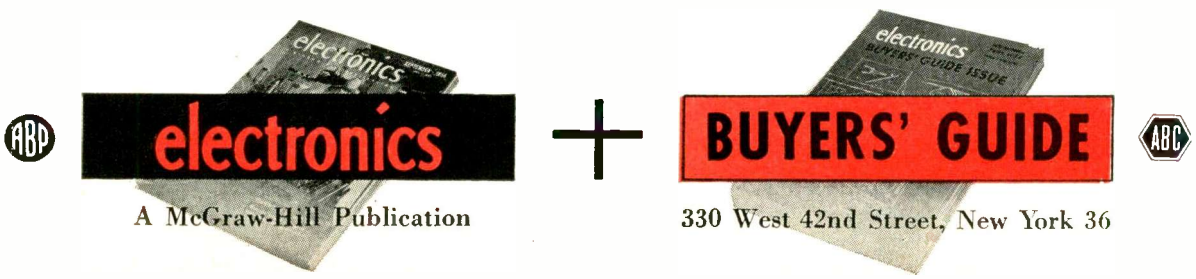

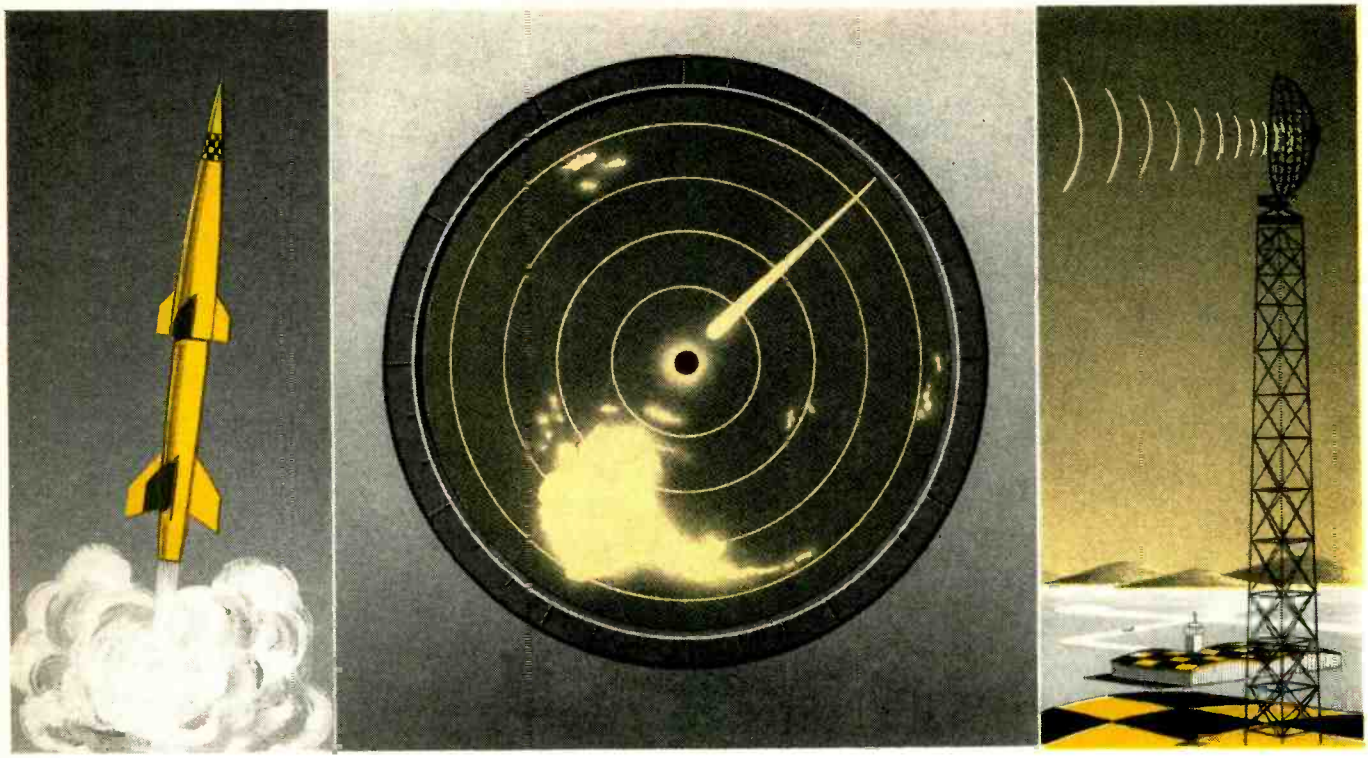

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VARIAN'S NEW VA-94

TYPICAL OPERATION

Frequency	*16.5 kmc*
Resonator Voltage	*300 v*
Resonator Current	*38 ma*
Reflector Voltage	*− 150 v*
Power Output (VSWR < 1.1)	*40 mw*
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Varian now offers the most advanced reflex klystron ever developed for airborne radar local oscillator and beacon service. *The VA-94* provides a minimum power output of 20 mw throughout its range of 16 to 17 kmc . . . to give you absolutely reliable operation at any altitude without pressurization.

Exclusive Varian features include a unique brazed-on external tuning cavity . . . to assure you of excellent frequency stability, extremely low microphonics, slow tuning rate and long tuning life. Its single screw tuner adapts easily to motor tuning. The VA-94 weighs only four ounces and mates directly with standard waveguide flanges.

FOR EXPERIMENTAL APPLICATIONS . . . SPECIFY THE VERSATILE NEW VA-92. Varian's VA-92 meets all reflex oscillator requirements in the frequency range 14 to 17.5 kmc . . . is especially suitable for signal generators and laboratory testing. It gives you the ease of tuning, ruggedness and reliable performance that has made Varian klystrons the first choice among microwave engineers. Special features include linear reflector voltage tracking, wide tuning range and high altitude operation without pressurization.

FOR OTHER K-BAND APPLICATIONS . . . SPECIFY V-39, V-40 AND VA-96.

FOR COMPLETE SPECIFICATIONS and technical data on the outstanding new VA-94, and other Varian klystrons, contact our Application Engineering Department.

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Want more information? Use post card on last page.

Next Steps in Atomic Progress... A Challenge to American Industry

The purpose of this editorial is to throw light on the significance for American industry of recent changes in the statutes that control the development of atomic energy.

The need for clear light on the meaning of this new legislation is made more urgent by the political confusion and distortion that marked its course through Congress. The politically inspired charges of "giveaway" that delayed its passage — charges that were almost totally unrelated to the legislation itself — helped to obscure the vital importance of the step finally taken by Congress.

In sober, post-Congressional fact, the principal significance of the new atomic legislation is that it extends to private enterprise responsibility for the development of peaceful uses of atomic energy, whereas heretofore this responsibility has rested in a tight government monopoly. **And this extension is made on terms that emphasize the responsibility far more than they open any opportunity for economic gain in fulfilling it.** The revised Atomic Energy Act provides that:

1. Industry may now own and operate its own nuclear reactors, under license from the Atomic Energy Commission. And it may build and sell nuclear reactors for export.

2. Industry may use — but not own — nuclear materials at the discretion of the Atomic Energy Commission.

3. The Atomic Energy Commission will make available to industry scientific knowledge that may be useful in developing peaceful applications of nuclear energy.

4. For the first time, industry will have the right to patent inventions in the field of nonmilitary nuclear energy. However, "basic" discoveries must be made available to all companies in the field for a period of five years, after which they, too, will revert to normal patent status.

Two Kinds of Know-How

These provisions, despite the imposed limitations, represent the first positive step toward development of nuclear energy for peaceful applications in the United States. Potentially useful knowledge, previously locked in the minds of government scientists, will now be available to all those who are willing and able to put it to work for the good of mankind.

The advantages to be gained from enlisting the talents of American industry in the development of peaceful atomic applications are imposing. As *The* (London) *Economist*, Europe's leading economic journal, recently remarked, "The atomic scientists are in a position to surmise how atomic energy can be applied... but they lack the specialized knowledge of engineering design and operating technique just as industry itself lacks atomic knowledge." Now the engineers of private industry need no longer lack the atomic knowledge, and there is granted to them at least a restricted freedom to apply it to the solution of their engineering and operating problems.

But the new opportunity for private industry to find constructive uses for the science of nucleonics carries with it a grave responsibility. These uses must be so developed that they will benefit the people of all the free nations. It is essential that the United States, which pioneered in developing lethal uses for atomic fission, demonstrate to the world our paramount interest in its peaceful application. It would be a moral set-back to the free world almost beyond calculation if the Communists should be able to offer to the poorer nations of the world the benefit of low cost atomic power—provided by Communist technicians—while we concentrate primarily on building our stockpile of atomic and hydrogen bombs.

Race For a Peaceful Victory

Most of the experts are agreed that it may be many years—perhaps ten, fifteen or more—before the cost of electricity from atomic fission can be reduced to a level that will make it competitive with conventionally produced power in most regions of the United States. But most of the world is not nearly so fortunate as we are in power resources. Electricity, even at a cost far higher than the average that prevails in the United States, would be a blessing in many countries, and the nation that provides the technology to bring it into being will score a great moral victory.

The useful potential of nuclear energy is not restricted to the generation of electric power—although twenty years from now this use will be highly important to the power industry of the United States. Even with the limited research that has been done in this field thus far, the use of radioisotopes—the radioactive products of atomic reactors—is saving American industry an estimated $100 million a year. Commissioner Campbell of the AEC, who made this estimate, believes that these savings may well reach $1 billion a year within ten years. Radioisotopes are already at work in industries ranging all the way from paper manufacturing, where they measure paper thickness, to pipeline transportation, where they mark the dividing lines between shipments of different products (at an estimated saving of $500,000 a year). Medical applications of these same radioisotopes hold promise of longer and more comfortable lives for those who are stricken by cancer and other diseases.

Above All a Challenge

The new Atomic Energy Act is a crucial stride toward the day when all these benefits—and undoubtedly others not yet revealed by research—will be realized. But it is a step that is essentially permissive. It still leaves it to private industry for the most part to decide what is to be done and how soon.

The new act is thus, above all, a challenge. It confers on private industry the responsibility to assume a leading role in the development of peaceful uses for nuclear energy, a step long urged by NUCLEONICS, a McGraw-Hill magazine devoted to atomic energy. To achieve a success in this task that will measure up to the requirement of the national interest, this development must command all the resources and ingenuity that private enterprise can apply—and do so without promise of glittering prizes surely to be won. **But now that the responsibility has been defined and the challenge offered, American industry will, we believe, measure up to its grave and mighty import.**

"Retains Flexibility - Resists Abrasion"

says Redmond Company of TEMFLEX* 105 Tubing

In making the field connections for the unique TRI-FLUX shaded pole micromotors built by Redmond Company, Inc., Owosso, Mich., a 1¼" length of Irvington's Temflex 105 Tubing is slipped over the lead from one field coil, and the lead is twisted together with the connection from the next field coil. Twisted wires are then welded and bent back, and the Temflex tubing drawn over the welded joint. The entire field is then varnished and baked.

In addition to abrasion resistance and retained flexibility, "resistance to baking heat and high dielectric strength are other reasons for using this material," says Redmond about this flexible plastic tubing. Temflex 105 also carries Underwriters' Laboratories approval for continuous operation in air at 105° C. — and for 90° C. operation *in oil*.

Temflex 105 Tubing is produced by Irvington's Plastics Division in all standard colors, to fit all standard wire sizes. It's identified by the continuously printed name on the tubing surface — look for it when you buy high-temperature tubing. Send for literature and samples.

Look to
IRVINGTON
for Insulation Leadership
INSULATING VARNISHES
VARNISHED CAMBRIC
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INSULATING TUBING
CLASS "H" INSULATION

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DIVISION OF MINNESOTA MINING & MANUFACTURING COMPANY

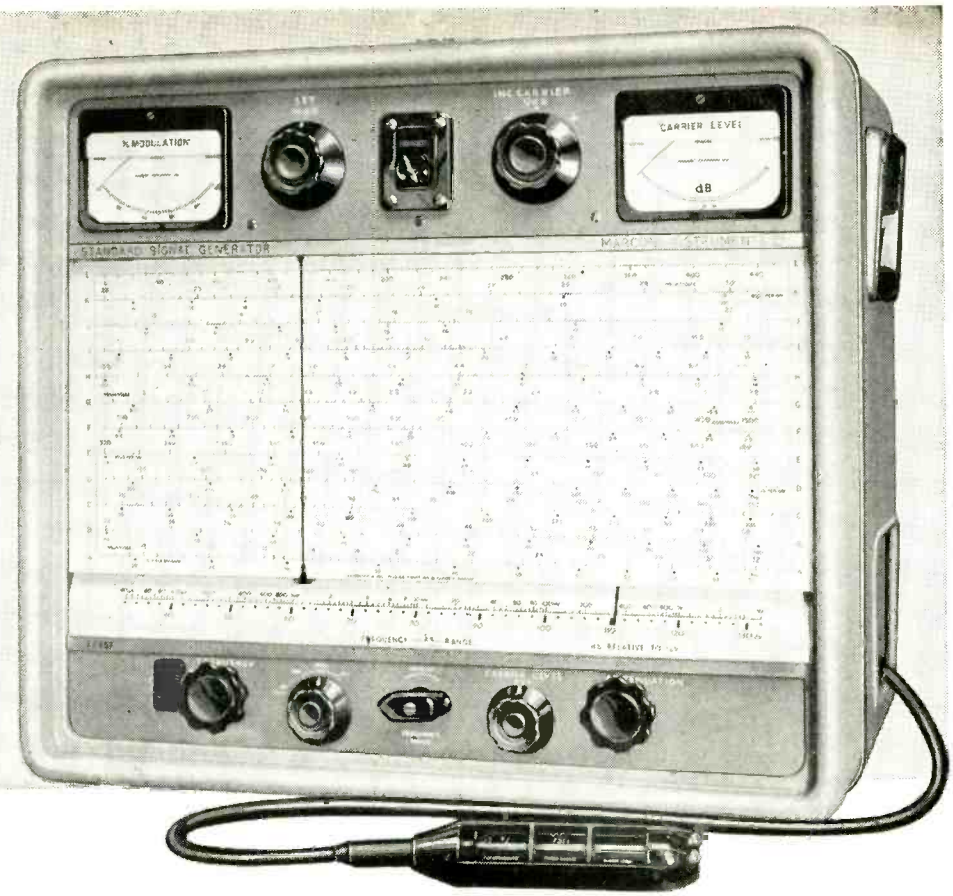
11 ARGYLE TERRACE, IRVINGTON 11, N. J. • PLANTS: IRVINGTON, N. J.; MONROVIA, CALIF.; HAMILTON, ONTARIO, CANADA

UNDISTORTED 100% MODULATION AM *WITHOUT* FM

WITH THE

STANDARD SIGNAL GENERATOR

TYPE TF867



EXCELLENT amplitude modulation is an outstanding feature — a.m. accompanied by unmeasurable f.m. Other features include :

Wide Range: 15 kc to 30 mc on 15 ft. high-discrimination full-vision scale.

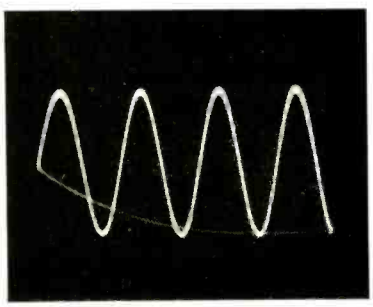
Crystal Accuracy: 0.01% with built-in 1 mc harmonic source.

High Output: 4 volts down to 0.4 microvolts.

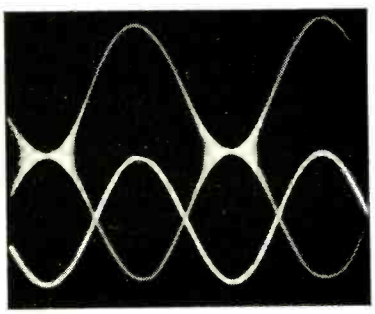
Flexible Modulation: Internal 400 and 1,000 cps, external 50-10,000 cps within a db.

Also incorporated : Automatic level control, overall negative feed-back from r.f. output to modulation input, modulation monitoring by dual-rectification and variable impedance termination with animated diagram.

A signal generator also ideal as a video oscillator for wide-band television systems.



15 kc Unmodulated Carrier showing good waveform.



320 kc Carrier modulated at 400 cps— audio source on lower trace shows fidelity.

TEST OSCILLOGRAMS

Full data and prices of any of the items listed below will be mailed immediately on request.

STANDARD SIGNAL GENERATOR TF 867 · FM/AM SIGNAL GENERATOR TF 995
UNIVERSAL BRIDGE TF 868 · FM DEVIATION METER TF 934
VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

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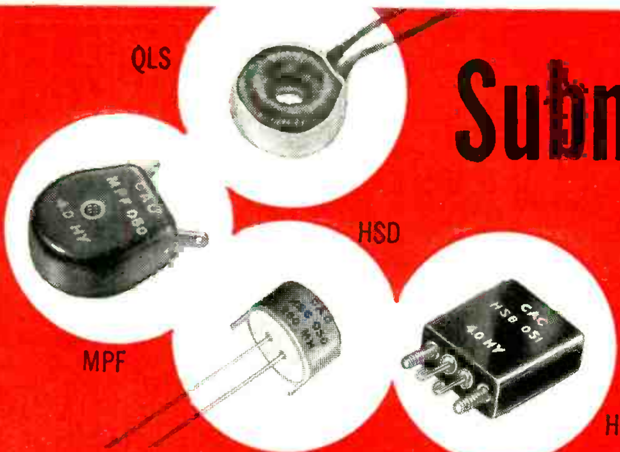

HIGH PRODUCTION
PROTOTYPES
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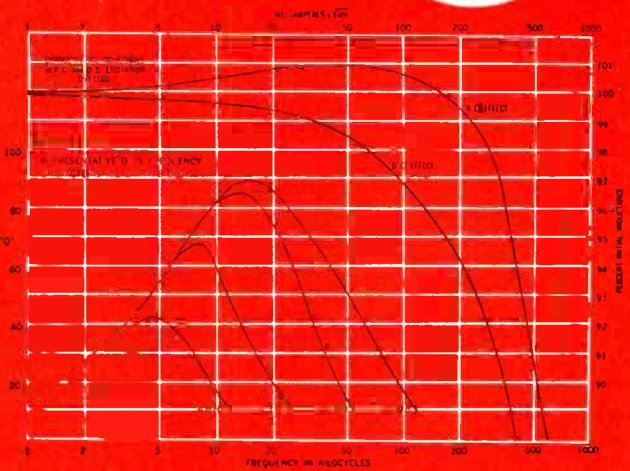
C-A-C



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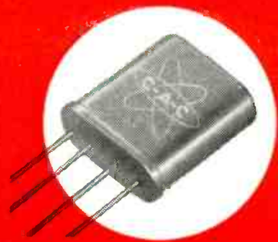
Consistent with advanced engineering in subminiaturization, CAC offers transistor transformers in hermetically sealed cases, molded or cast type construction—designed to meet military requirements—temperatures (−) 55° C to (+) 105° C. Enclosed magnetic field afforded by toroidal form. Frequencies and impedances to your specifications . . . utilize our advanced engineering and modern high speed production facilities. See your CAC representative now.

TYPICAL PULSE TRANSFORMER

IMPEDANCE RATIO	RISE TIME (MICRO SEC)	WIDTH (50% PEAK)	DROOP % PEAK	−OVERSHOOT % OF + PEAK	INPUT PULSE TIME MICRO SEC	RING
200/800	[illegible]	[illegible]	10.4	0	8	3
700/2800*	[illegible]	[illegible]	[illegible]	4.1	8	2.5
5000/2000	1.3	8.0	10.0	20.0	8	0

*Nominal Design



A TYPICAL PULSE TRANSFORMER—ONE OF MANY CUSTOM DESIGNS DEVELOPED BY CAC ENGINEERS — HIGHLY STABLE TOROIDAL UNITS — EXHIBIT EXCELLENT CHARACTERISTICS

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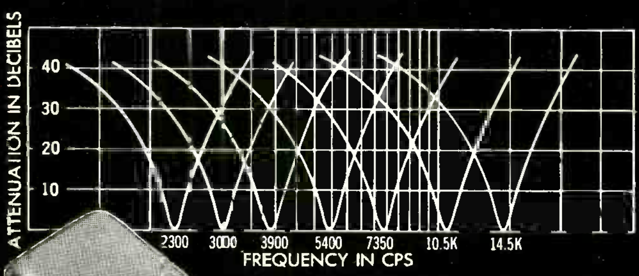

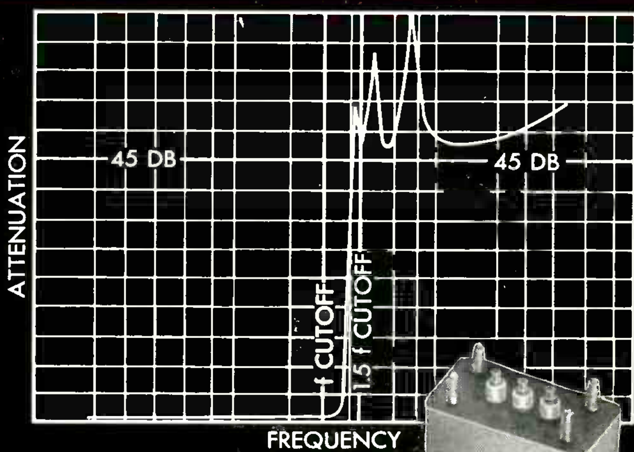

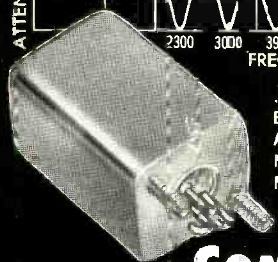

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C-A-C

STANDARD LOW PASS SERIES – DESIGNED & PACKAGED TO MIL T27 SPECIFICATIONS – OFFERS OVER 45 db ABOVE f_2 (f_2 = 1.5 f_1). HERMETIC SEALED – STUD MOUNTED – TEFLON TYPE TERMINALS. CIGARETTE SIZE PACKAGE. 3, 6, 10 & 15 KC STD. UNITS. ALSO AVAILABLE IN SUBMINIATURE VERSION.

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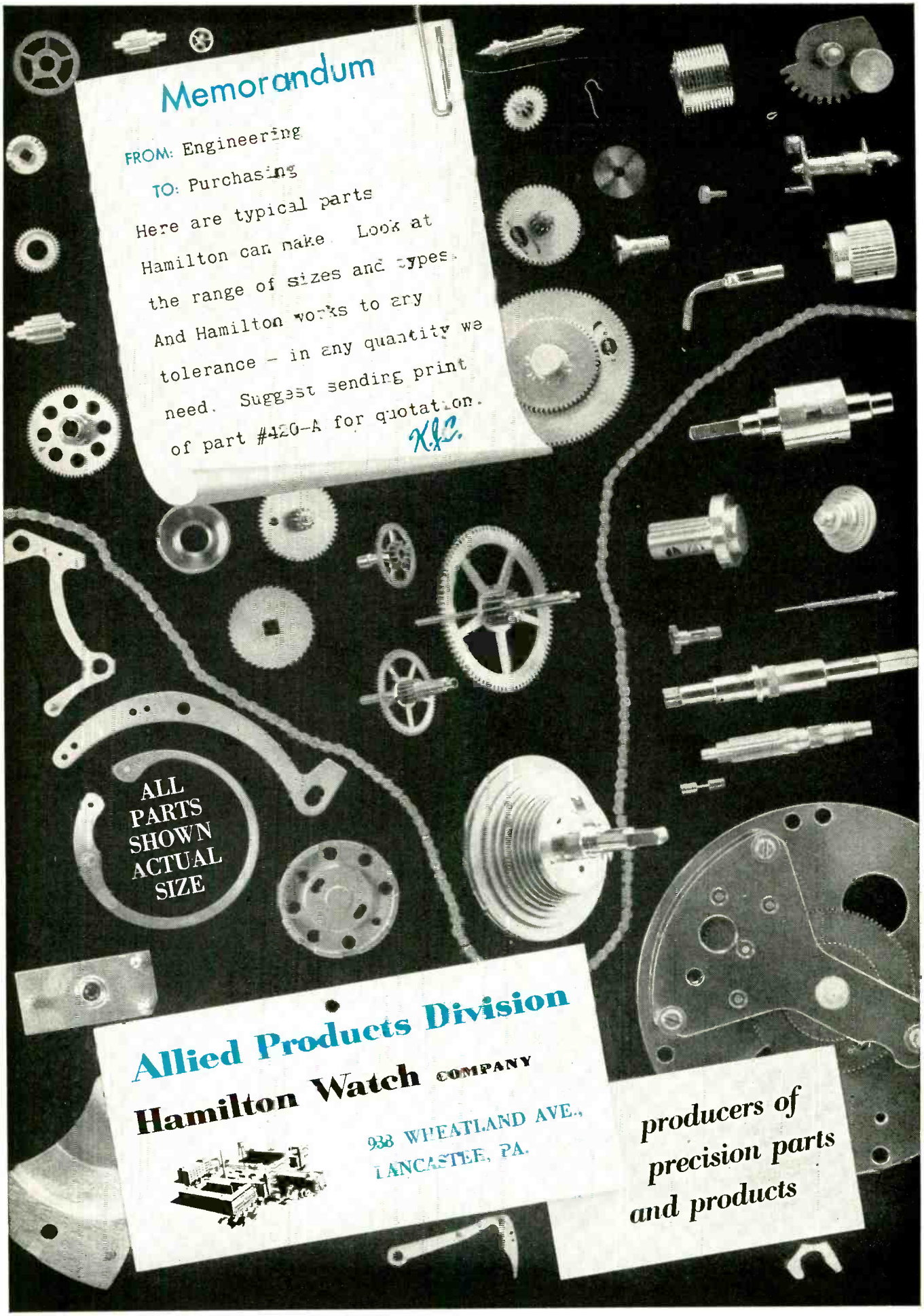
Want more information? Use post card on last page.


Memorandum
FROM: Engineering
TO: Purchasing
Here are typical parts
Hamilton can make. Look at
the range of sizes and types.
And Hamilton works to any
tolerance – in any quantity we
need. Suggest sending print
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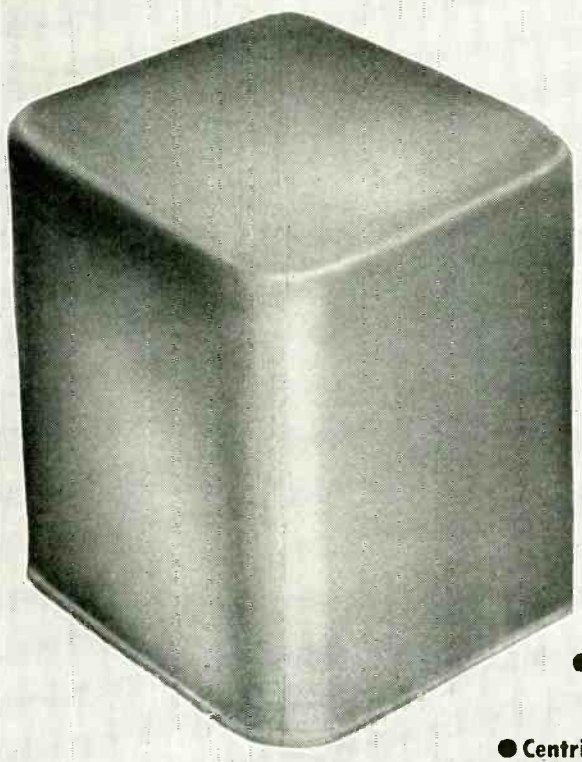
NOW- Heldor

QUALITY, SERVICE and ECONOMY in DRAWN CANS



Now you can forget about drawn can problems. HELDOR — the first name in fabricated cans — will produce drawn cans with inside fitting covers in *all* 22 sizes (AF through NB) to meet the latest MIL-T-27 specifications as well as to customers' requirements.

Tools are being rushed to completion. Presses are installed and waiting. Soon . . . consistent, TOP QUALITY drawn cans and covers will be made available to the electronic industry. On March 1, 1955 production on these cans will start to roll out of the HELDOR plant. Orders accepted now for custom-size drawn cans for earlier delivery.

We're all set NOW to save you money! Send us your specs or prints on your drawn can requirements today! **Write for complete information!**

Don't forget . . . you can effect major economies on any or all of Heldor's products and services listed below.

Other Heldor Products:

- Compression-type and new NON-TWIST, Hermetic Seal Lock-in Terminals
- Fabricated Cans & Covers and related precision metal products.
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- A Complete, hermetic seal Assembly Service!
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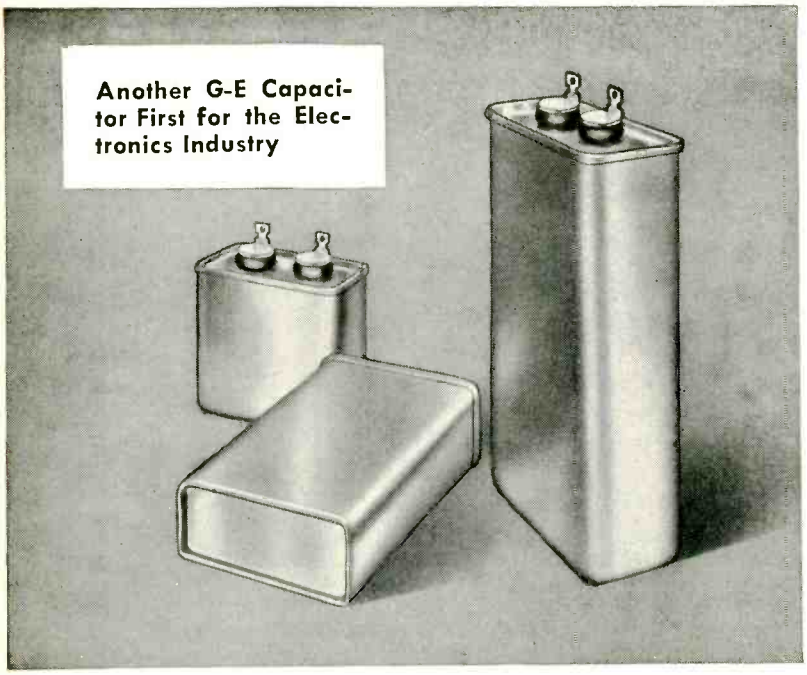
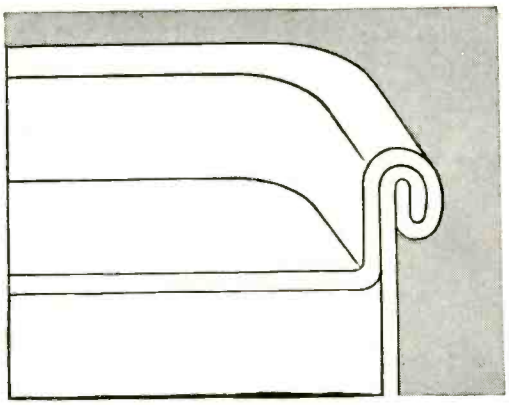
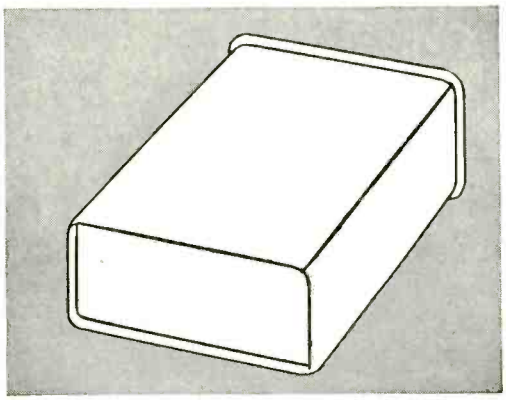


DRAWN-RECTANGULAR CASE has no soldered seams, does not depend on solder for mechanical strength and effective sealing.



SOLDERLESS DOUBLE-ROLLED COVER SEAM makes a mechanically strong, hermetic seal.



BOTTOM OF CASE IS INDENTED to permit mounting in inverted position.

new . . . G-E CAPACITORS IN DRAWN-RECTANGULAR CASES

- **Solderless, double-rolled cover seam**
- **Seamless case with standard dimensions**

General Electric is now producing fixed paper-dielectric capacitors in seamless, solderless cases with standard dimensions that comply with or exceed MIL specifications. For complete information contact your G-E Apparatus Sales Office or write for Bulletin GEC-809A to Section 442-24, General Electric Co., Schenectady 5, N. Y.

Progress Is Our Most Important Product

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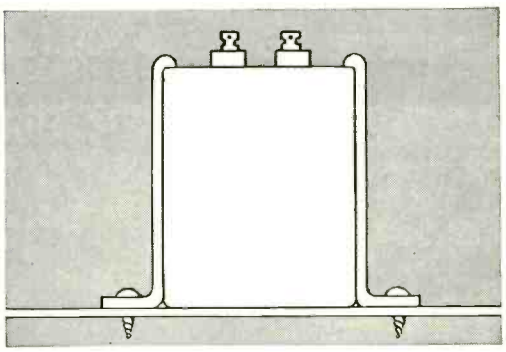
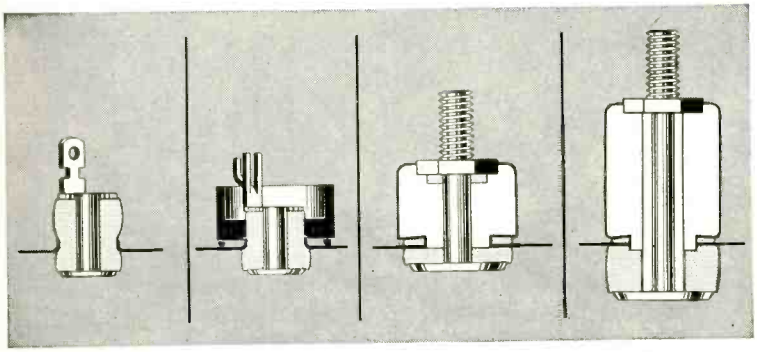
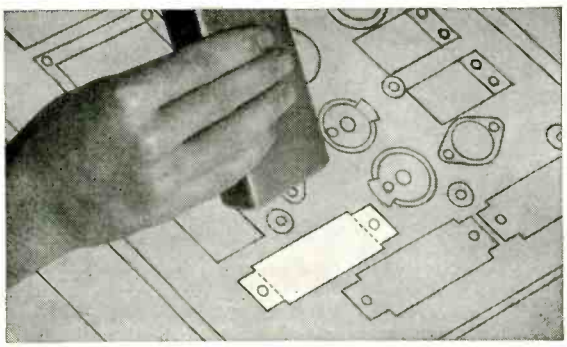


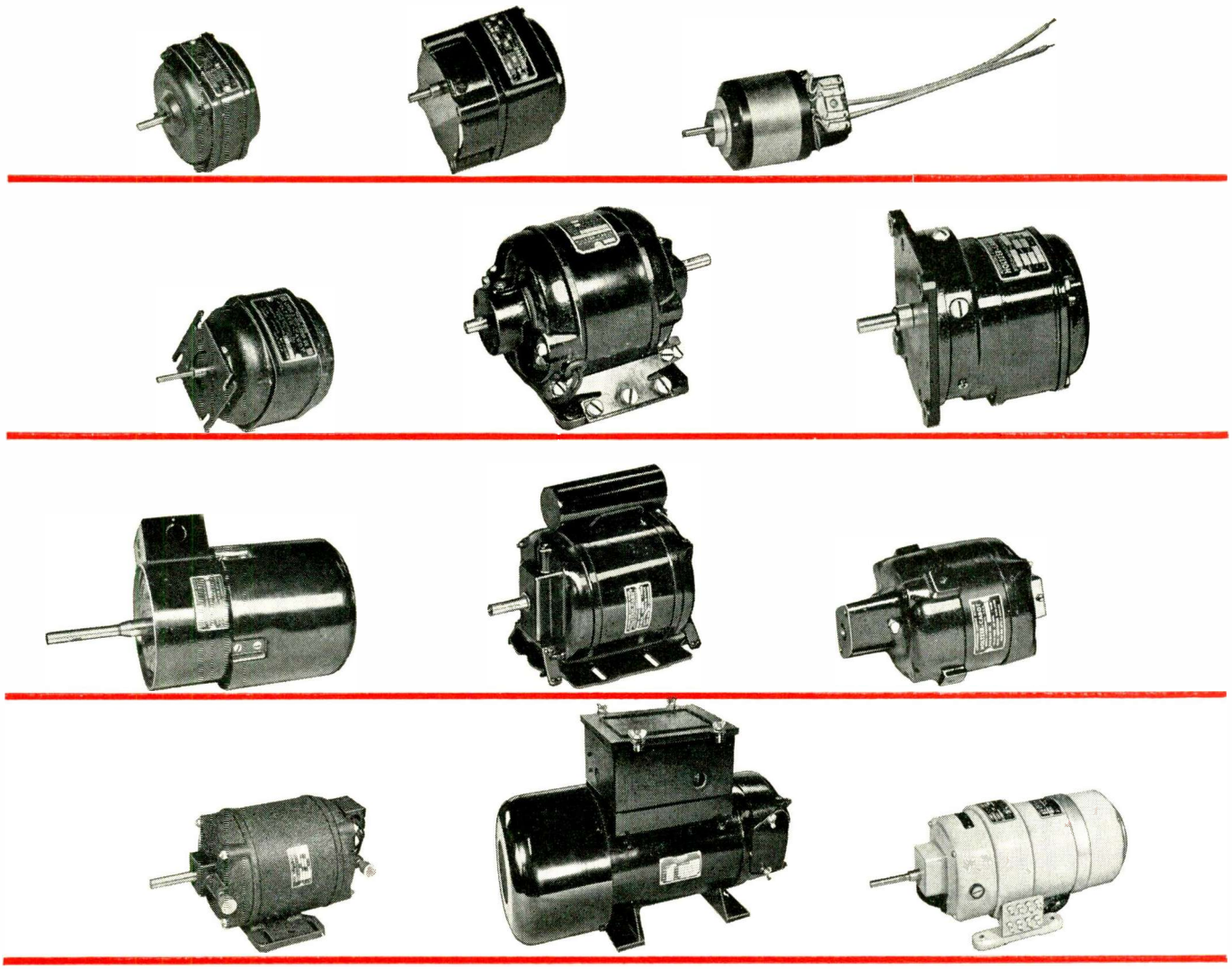
UPRIGHT OR INVERTED MOUNTING is possible using either spade lug, or footed brackets (above)

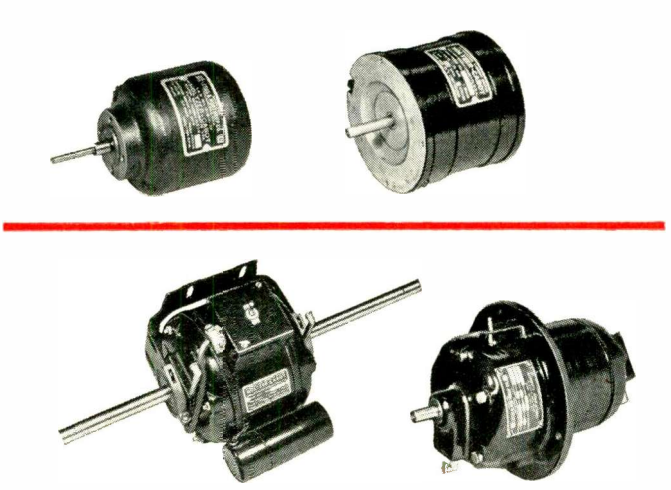


FOUR BUSHINGS STYLES are available for applications below 2000 volts d-c, special skirted bushings for higher voltages.



STANDARD CASE SIZES are interchangeable, making it unnecessary to change drawings or circuit layouts.





N.B. — The different mechanical designs shown were selected from one day's quantity production.

each of these HOLTZER-CABOT motors solved a special problem!

Holtzer-Cabot specializes in motor and generator design, and is tooled to produce both AC and DC motors and generators, in a wide range of frames, with unlimited varieties of mechanical and electrical features.

Quality motors correctly designed result in lowest ultimate cost.

Bring your small-motor application problem to Holtzer-Cabot. Our experience in developing custom-built motors assures you of a prompt and expert solution.

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POWER: PULSE and CW—5μW to 5W average
FREQUENCY: 20MC — 10,000MC
ACCURACY: ±5% Absolute at all ranges, frequencies, temperatures

- **INDICATIONS:** Direct Reading
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- **R-F COMPONENTS:** 3, 6, 10 and 20db Attenuators, Bolometer Mount and Elements, R-F Cable
- **BOLOMETER:** Broadband, High Overload Capacity
- **PLUMBING:** 3/8" and 7/8" 50-ohm Coaxial
- **POWER SOURCE:** 115VAC ±15%, 50-1000 cps
- **CONSTRUCTION:** Rugged, meets all JAN, MIL requirements

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DC VOLTMETERS

For most applications these rugged portable, self-contained nulling voltmeters replace a potentiometer, voltbox, galvanometer and standard cell combination. They are suitable for laboratory use, production line testing and field service.

Model LVM-5

Voltage Range:	0-100 Volts DC
Resolution: At least	50 microvolts between 0 and 1 volt
	500 microvolts between 1 and 10 volts
	5 millivolts between 10 and 100 volts
Absolute Accuracy:	± 0.1% of reading
Input Impedance:	Infinite at null

Model PVM-4

Voltage Range:	0-600 Volts DC
Resolution: At least	5 millivolts between 0 and 10 volts
	50 millivolts between 10 and 600 volts
Absolute Accuracy:	± 0.1% of reading
Input Impedance:	Infinite at null

The Model LVM-5 may also be used as a deflection potentiometer, a sensitive null indicator and a precision millimicroammeter. Write for catalog PL which describes these instruments completely. Address Dept. E-12

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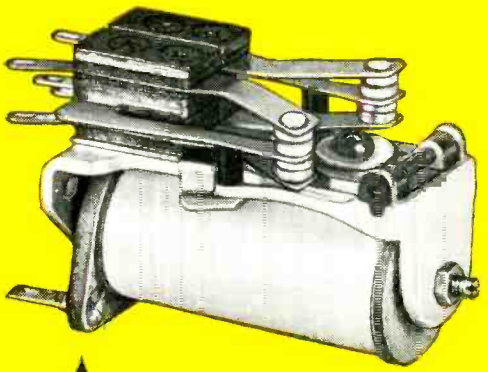
New variety of CLARE Type J Relay provides a power relay as sensitive and accurate as telephone-type relay



The new CLARE Type J Relay has all the advantages of the small size, light weight and sturdy construction which makes the standard Type J Relay so popular with designers of electrical and electronic equipment.

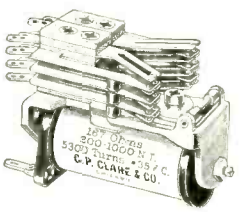
Increased current carrying capacity is provided by the use of Code 18 (Silver) heavy duty contacts which are riveted to the springs. A combination of the standard Type J twin contacts and the new heavy duty contacts is also available.

Nominal rating of this new Type J Relay is: 10 amperes, 115 volts a-c (resistive); 10 amperes, 27½ volts d-c. The relay is 2¼" long, 1⅛" wide and 1⅜" high with two Form C contacts.

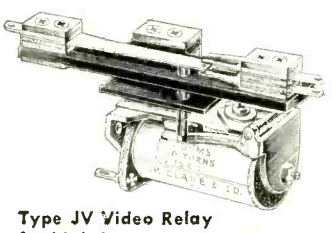
Long life and increased adjustment stability is provided by a new hinge-type armature. The new heavy-duty yoke has a stainless steel pivot pin with a large bearing surface which turns in precisely reamed bearings of nonferrous material.

1. Handles inrush current of 50 amperes for 50,000 operations —rating of 10 amperes, 27½ volts d-c.

2. Has exceeded 500,000 operations on motor load of 6 amperes—inrush current of 15 amperes—at 70,000 feet altitude.



Standard Type J Relay with independent twin contacts

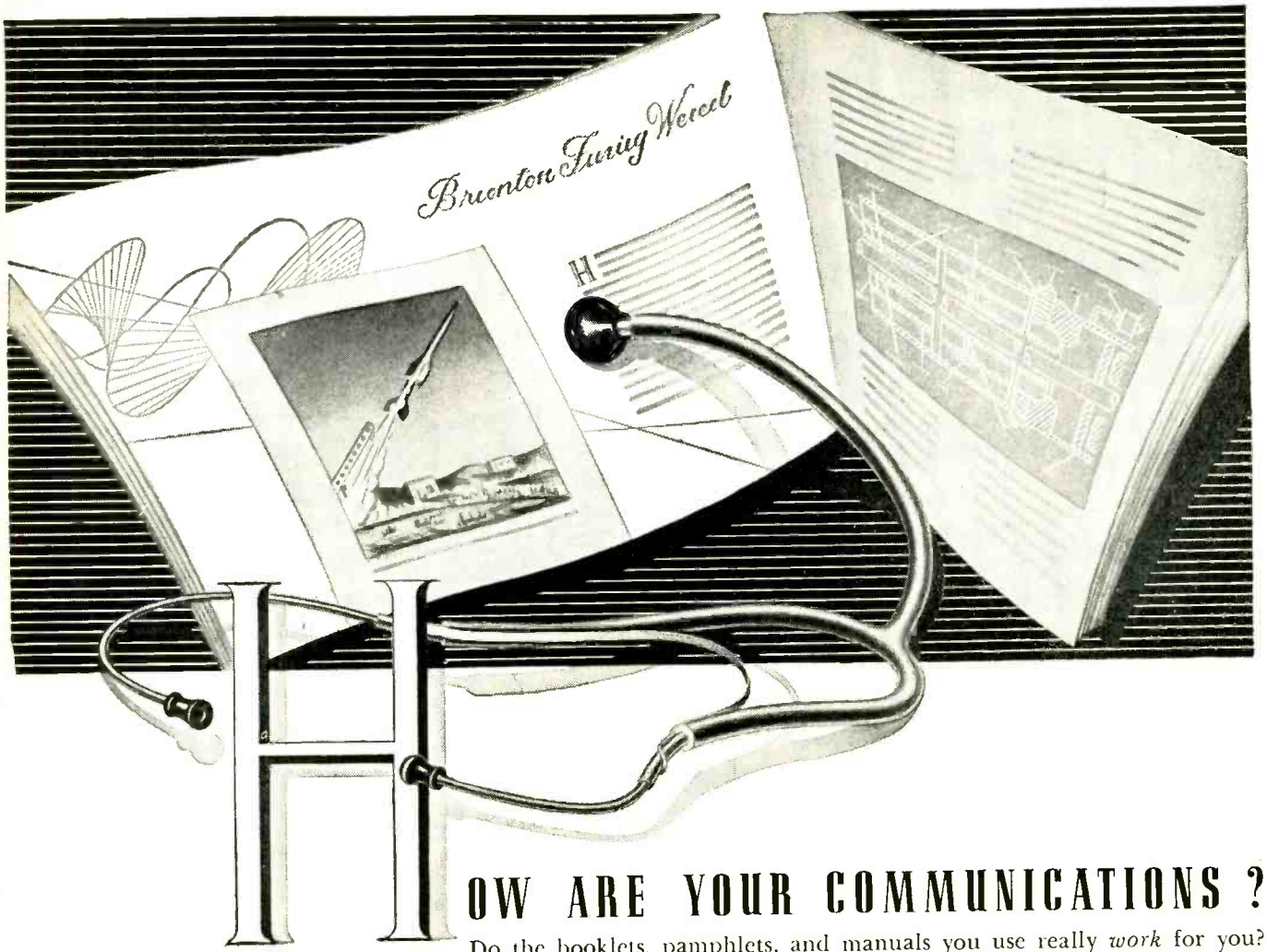


Type JV Video Relay for high frequency currents

For complete information write for CLARE *Bulletin No. 119. For information on other variations of the Type J Relay send for our Engineering Data Book. Address: C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address:* CLARELAY.

CLARE RELAYS

FIRST in the industrial field



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*PATENTS PENDING

HIGH TEMP PLASTIC!

NEW ETC-7 (POLYESTER RESIN) USED ON ILLUSTRATED PART FOR HIGH TEMPERATURE OPERATION

—for high temp applications!

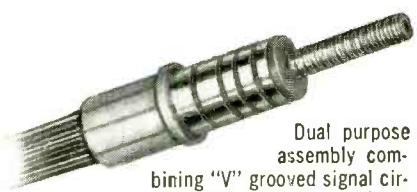
HARD GOLD RINGS!

24 KT. SOLID GOLD RINGS — ENTIRE RING THICKNESS ELECTRODEPOSITED UNIFORM HARDNESS, 90 to 100 BRINNELL.*

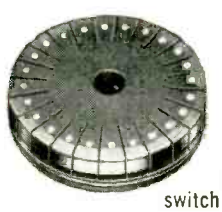
COURTESY LEAR, INC.
— these two features were incorporated in the assembly illustrated above, having 45 rings, dia. .180", ring width .020", barrier width .010". Overall length, less leads 1.763".

Electro Tec Corp., in its constant endeavor to keep pace with the most exacting requirements, has developed these new processes and products. They provide flawless performance under conditions far exceeding the capabilities of other types of construction. Where high temperature is involved, the superiority of these assemblies is so marked, that acceptance has been industry-wide. At the same time, an increasing number of users are specifying these assemblies for the ultimate in dependability under normal operating conditions. Inquiries will receive prompt attention; no obligation.

← 72 rings on integral support — no accumulated tolerances — fulfills electrical, minimum weight and space requirements.



Dual purpose assembly combining "V" grooved signal circuits and wide power rings.



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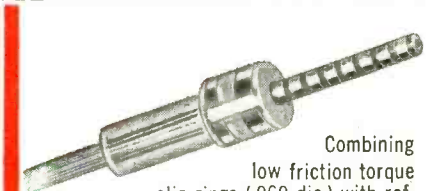

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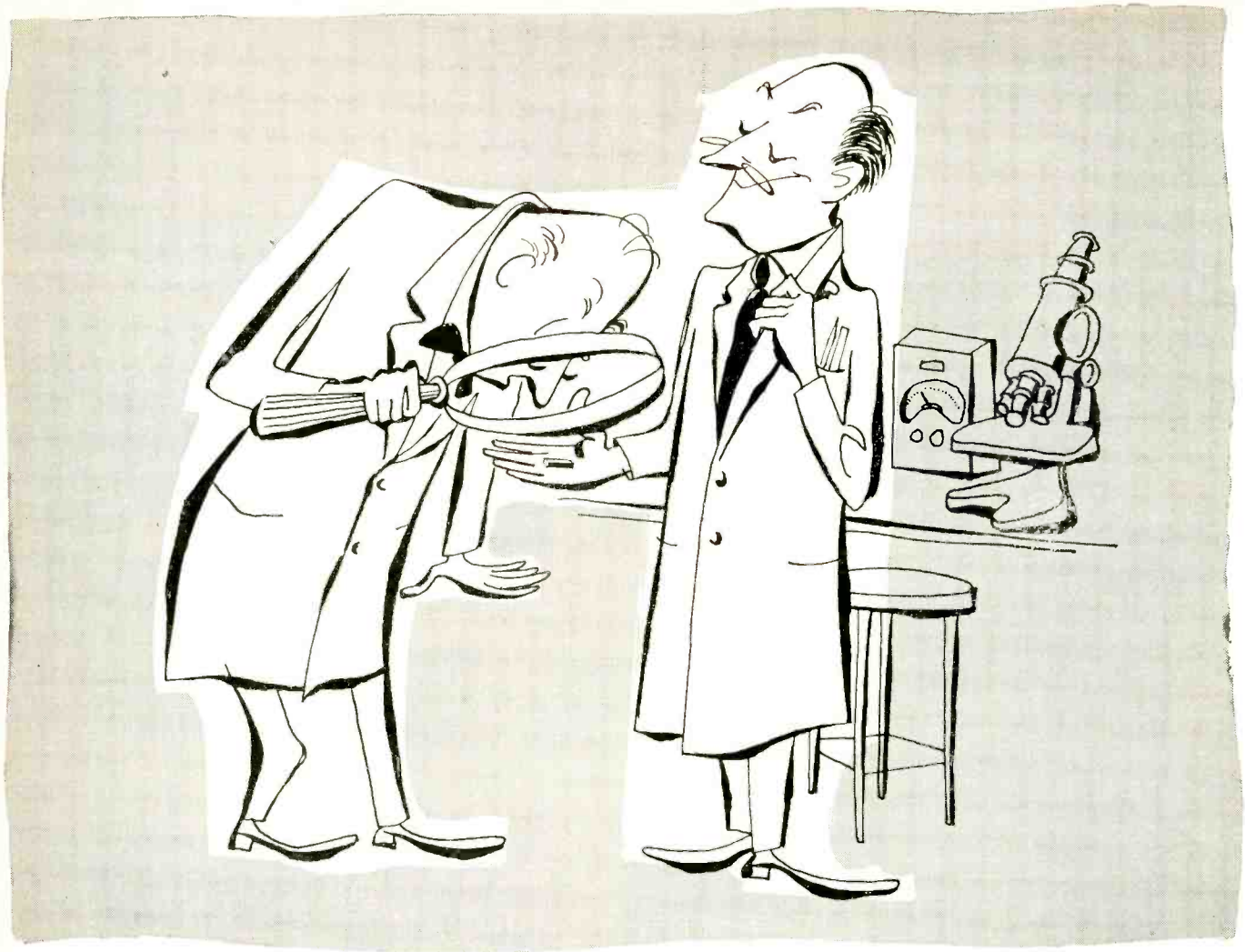

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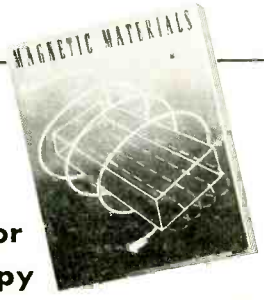

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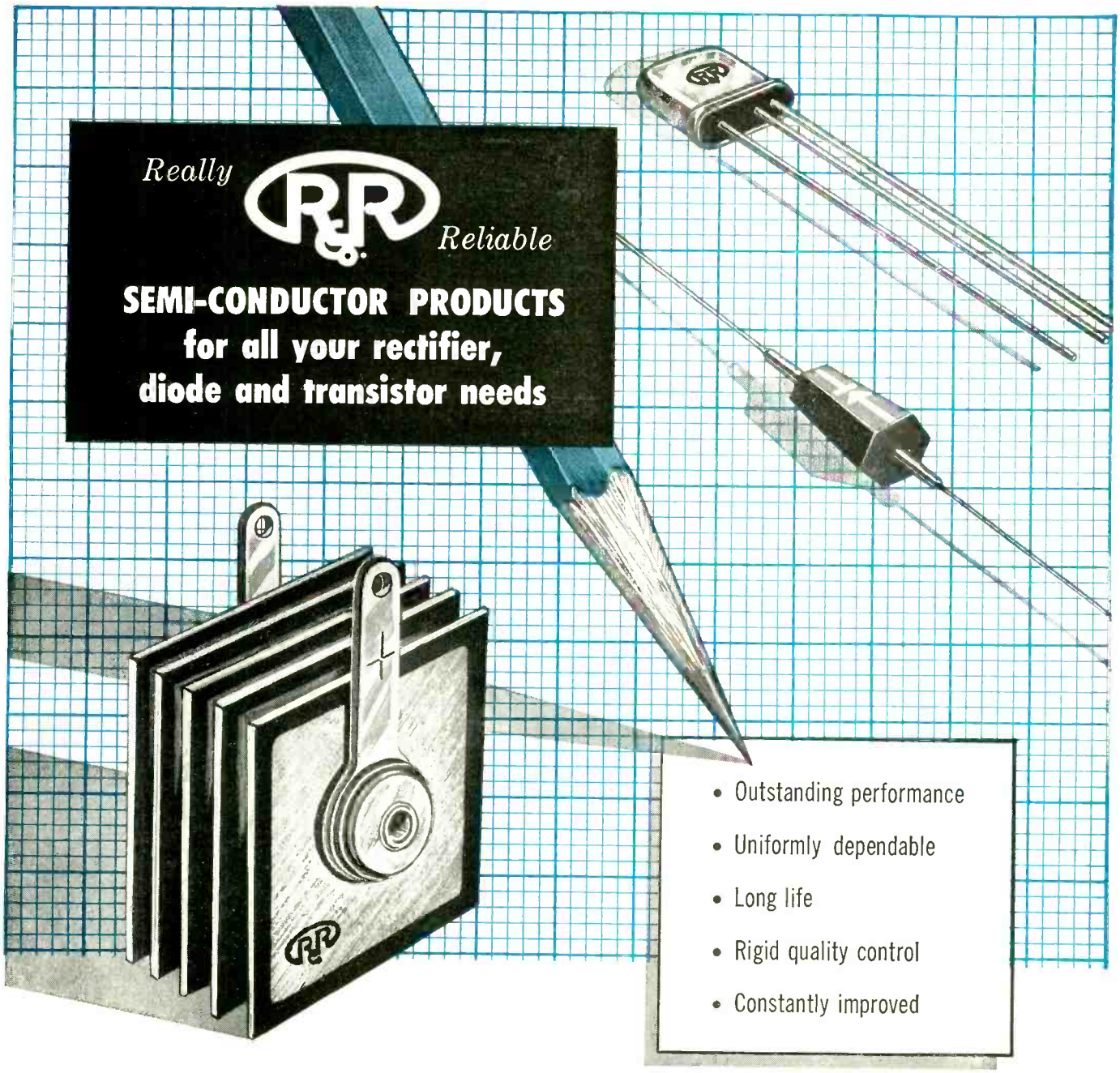

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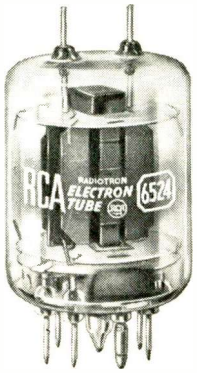

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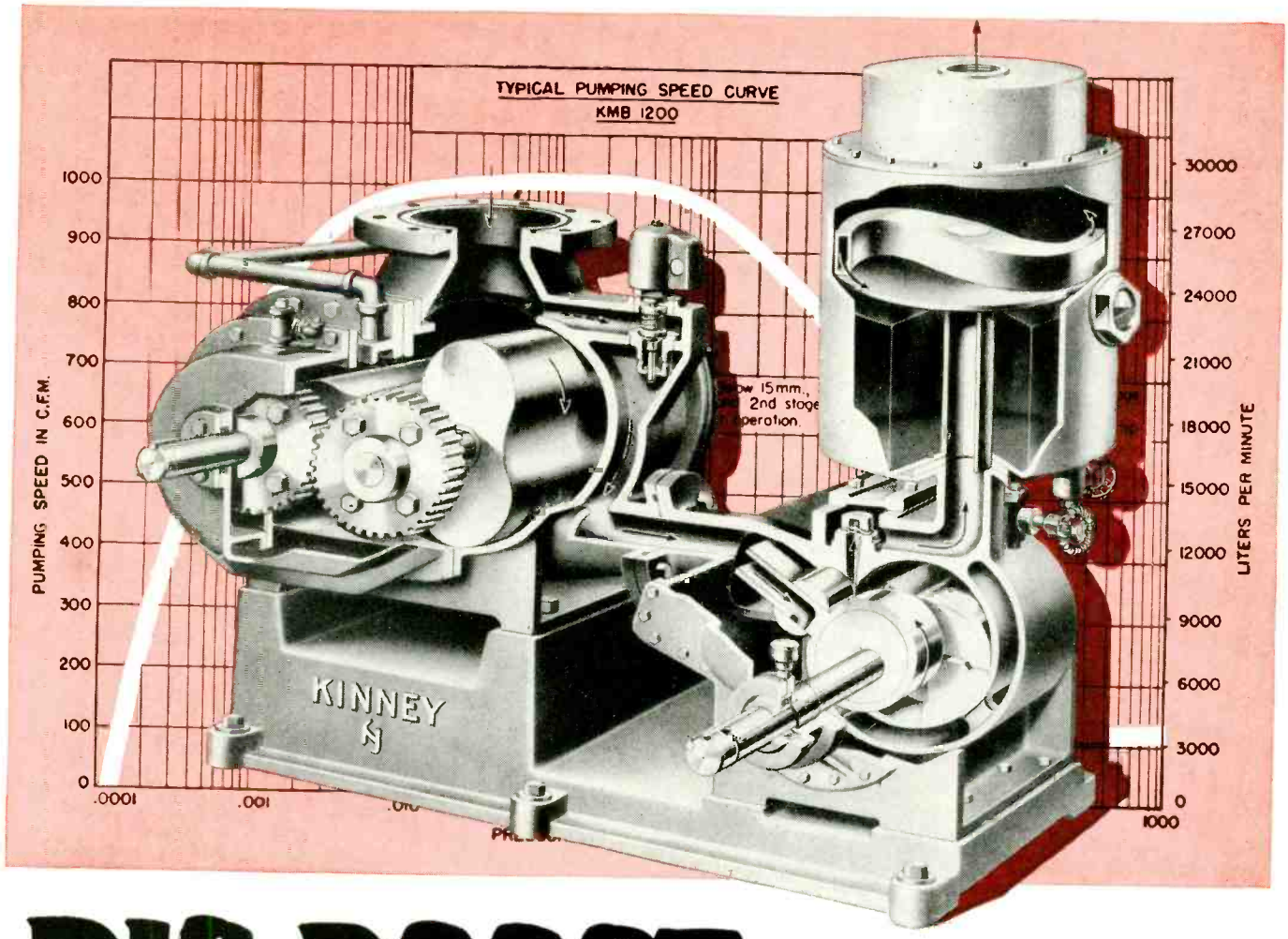

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electronics

W. W. MacDONALD, Editor

DECEMBER • 1954

CROSS TALK

► **MANAGEMENT TREND . . .** We've been out in the field almost continuously for the past two months, talking to a wide variety of people at such places as the Instrument Show, the National Electronics Conference, AIEE's Fall Meeting and RETMA-IRE'S Radio Fall Meeting. Business is good, and most of the men to whom we have talked think it will be as good or better in 1955, but they also think there may be less spread between gross sales and net profit because of rising costs.

This conviction is causing management generally to take a close look at operating expenses, not with the idea of reducing expenditures considered necessary for the encouragement of additional volume but to weed out any nice but not strictly necessary expenses that may have crept in during the lush post-war period. Some long-range projects may suffer but, in the main, the objective is to effect economies by eliminating non-essential routine.

► **BUSINESS MACHINES . . .** Data processing equipment is rapidly becoming one of the most important branches of the electronics industry. The promotional spotlight is currently playing brightly on the adaptation of such equipment to business offices. Over 100 big companies are known to be studying its possible use for the handling of such things as financial statistics, payrolls and stock records, and even to illuminate the road over which future sales efforts might go.

Certainly much of the technology by which data processing equipment can be adapted to general business use is known, so we are inclined to agree with those who think that this application of electronics may some day be as important as applications out in the manufacturing plant itself. But a word of caution seems advisable. Like industrial electronics, business electronics will take time to sell; it will be hard to devise universally useful packages, even for similar businesses, so pushbutton offices are not right around the corner.

► **TRANSISTOR AVAILABILITY . . .** A major manufacturer has the circuit and pre-production model for a practical transistorized portable radio worked out. He thinks he could sell it, even at twice the price of conventional portables, because in addition to battery economy this particular design also offers superior sensitivity and other performance advantages.

So far, this manufacturer has not found it possible to buy the transistors he needs for even pilot-plant quantities, although they are going into military devices and hearing aids. He says he can buy good low-gain transistors suitable for general use in quantity and at a reasonable price but has not so far found a source for types capable of delivering 30 db or more at the required radio frequencies. These, he says, seem to be available only in laboratory quantities, and at laboratory prices.

► **COLOR COMPLICATION . . .** With just a few exceptions, manufacturers have not yet taken the color-television plunge, and it now seems unlikely that many will do so much before the end of next year at the earliest.

Designers are developing their own pet circuits to simplify sets that meet NTSC signal standards, and much has already been accomplished in the direction of cost-reducing simplification. But the cost of the picture tube remains very high, preventing the suggested list price of receivers from going down to about the $500 mark, where many merchandisers think it must go before color can be widely sold to the mass market.

► **LAPEL RELIEF . . .** In this, the heavy season for conventions and committee meetings, we note with interest the use of identification badges that stick to the lapel rather than being fastened to it with a marlinspike. The precise nature of the stickum is unknown to us but the stuff holds, yet you can remove a dogtag with a slight pull and none of the nap from your best suit comes with it.

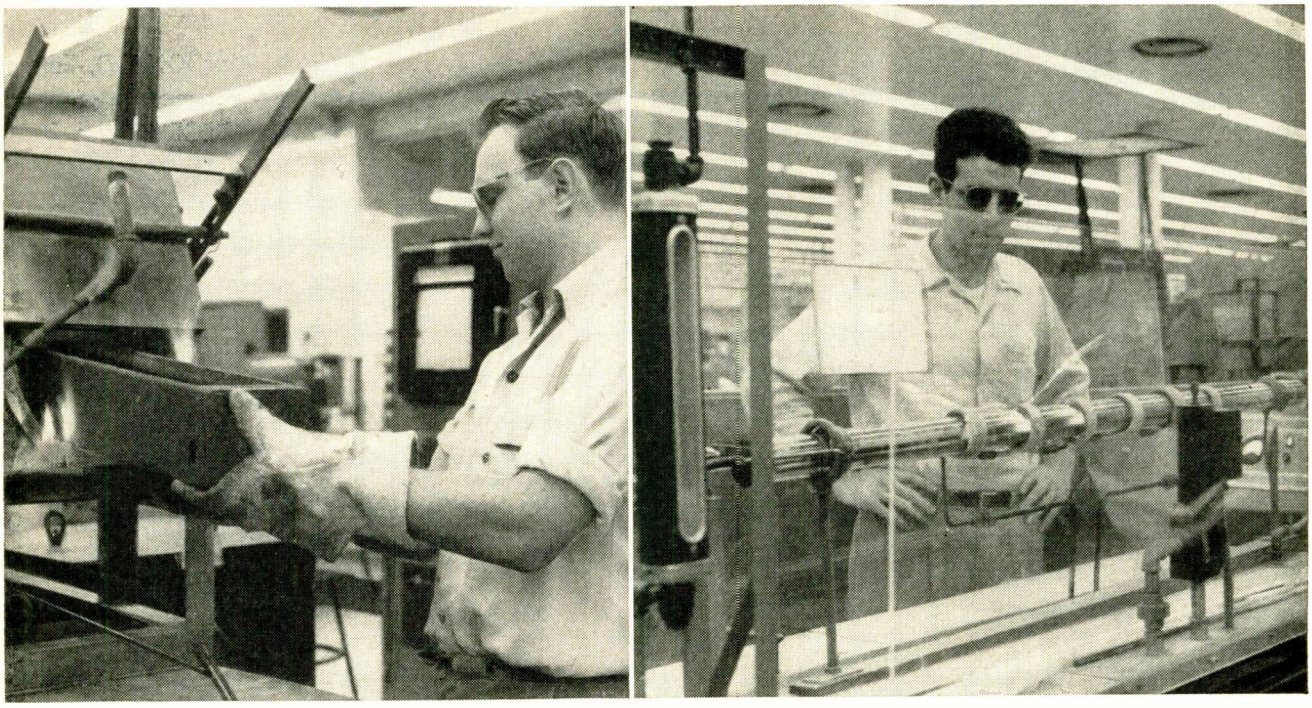

FIG. 1—Reduction of germanium dioxide is accomplished under hydrogen atmosphere in 600-C electric furnace (left). Temperature is then raised to 1,000 C to produce ingot. Zone melting (right) provides high-purity germanium. Six induction-heating coils melt germanium in long graphite boat

By FRANK H. BOWER

Manufacturing Development Engineer
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Allentown, Pennsylvania

Manufacturing Grown

Step-by-step procedure for making grown junction germanium transistors is described. Details are given on critical processes such as growing and doping monocrystalline germanium, locating the junction and attaching the base lead

GROWN JUNCTION *npn* transistor triodes begin as germanium dioxide, an expensive white powder of high purity. The first operation, at left of Fig. 1, involves removal of the oxygen from the germanium dioxide at 600 C, accomplished in a hydrogen-filled furnace. The temperature is then raised to 1,000 C for several hours (936 C is the melting point of germanium) producing a metallic ingot. The impurity content of the germanium must now be reduced until less than one atom of impurity is present for every 10^{10} germanium atoms.

The concentration of impurity in the reduced ingot is measured by the resistivity of the material and is usually found to be between 2 and 6 ohm-cm. For junction transistors, however, material of greater than 20 ohm-cm resistivity is required and 40 ohm-cm is preferred. At 27 C an intrinsic germanium bar would measure about 47 ohm-cm.[1]

Zone Melting

The reduced ingot in a graphite boat is placed in a zone-melting furnace such as that shown at right in Fig. 1. This furnace has a one-pound capacity; larger units are used for actual production runs. It is an inert-gas-filled quartz tube which has a pull mechanism to draw the boat slowly and smoothly from one end to the other. An associated r-f generator supplies power to six work coils located at intervals along the tube. As the boat traverses the tube, it is heated intensely within the field of each coil and a molten zone is produced. After several hours the boat reaches the end of the tube. Since the impurities tend to remain in

STEPS IN MANUFACTURE

- Reduction of germanium dioxide and refining of the metal.
- Production of single-crystal germanium having minute amounts of doping alloys accurately distributed both in location and concentration within it.
- Shaping of a small bar of single-crystal germanium containing a back-to-back junction at its center.
- Performing cleaning, assembly and chemical operations necessary to attach the three electrodes to the bar; cleaning and protection of the bar's surface; and housing the assembled bar in a sealed structure with access leads for external circuits.
- Electrically testing for acceptance according to the unit's d-c and low-frequency a-c operating characteristics, frequency response, temperature characteristic, stability and characteristic input and output impedances

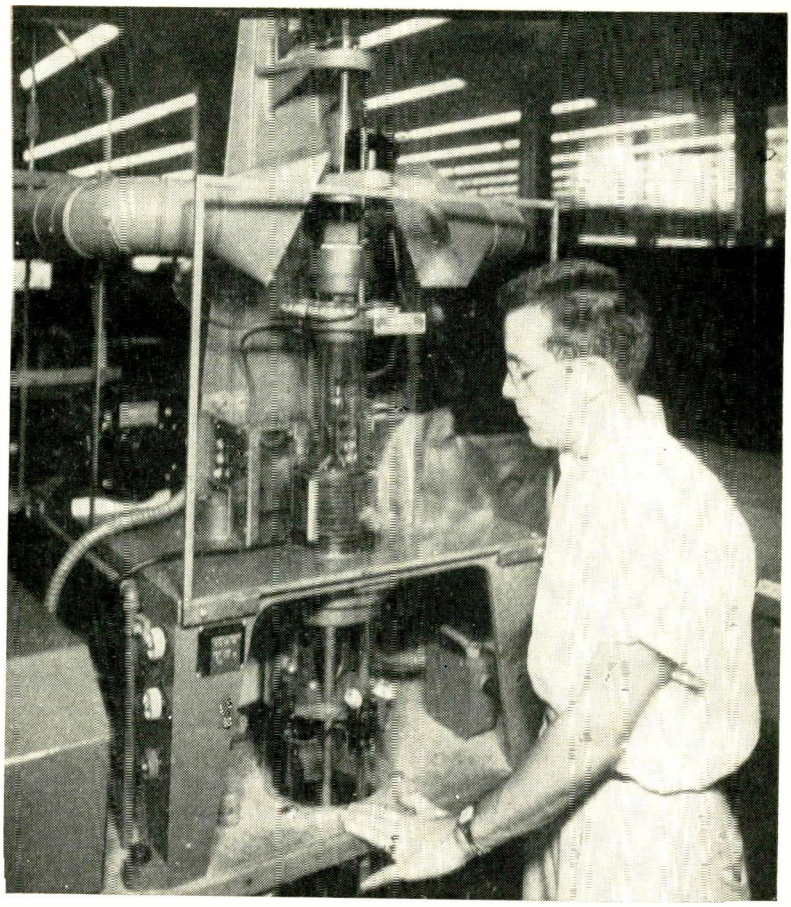

FIG. 2—Vertical crystal growing produces *npn*-type crystal. Grower has just completed its cycle and crystal is shown lifted from crucible to cool

Junction Transistors

the liquid germanium, the six melting zones have literally swept impurities to the rear end of the ingot. This portion is the last to solidify and is below 20 ohm-cm in resistivity. It is cropped and along with other similarly cropped ends again refined by the same process.[2,3] The purified material measures between 20 ohm-cm and intrinsic and is suitable for the next operation.

Crystal Growing Apparatus

The elimination of grain boundaries and the high degree of crystalline perfection of a germanium single crystal are highly favorable to the unimpeded flow of carrier holes and electrons in the solid. Therefore the growing of large single crystals is a requisite

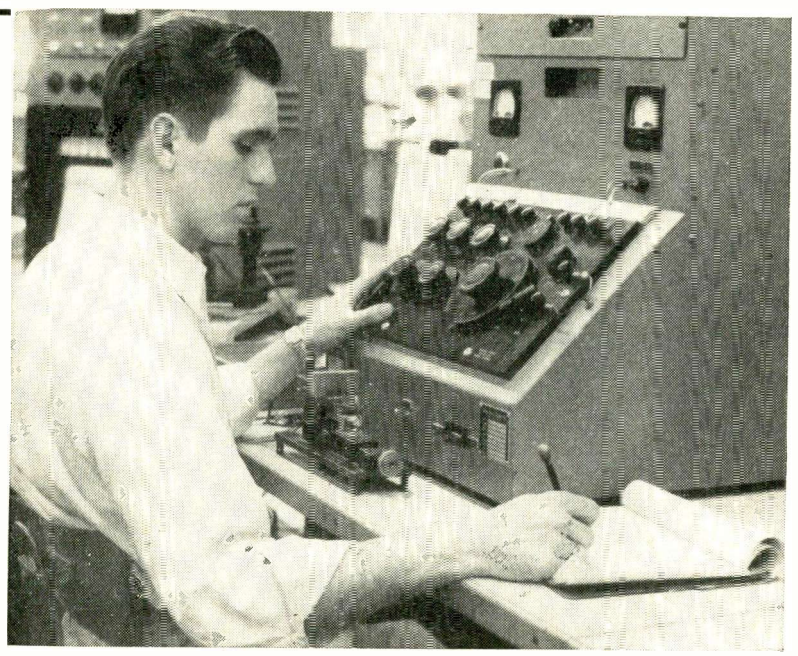

FIG. 3—Checking grown crystal for width of p-layer and resistivity of n-regions. Operator is performing a four-probe resistivity measurement

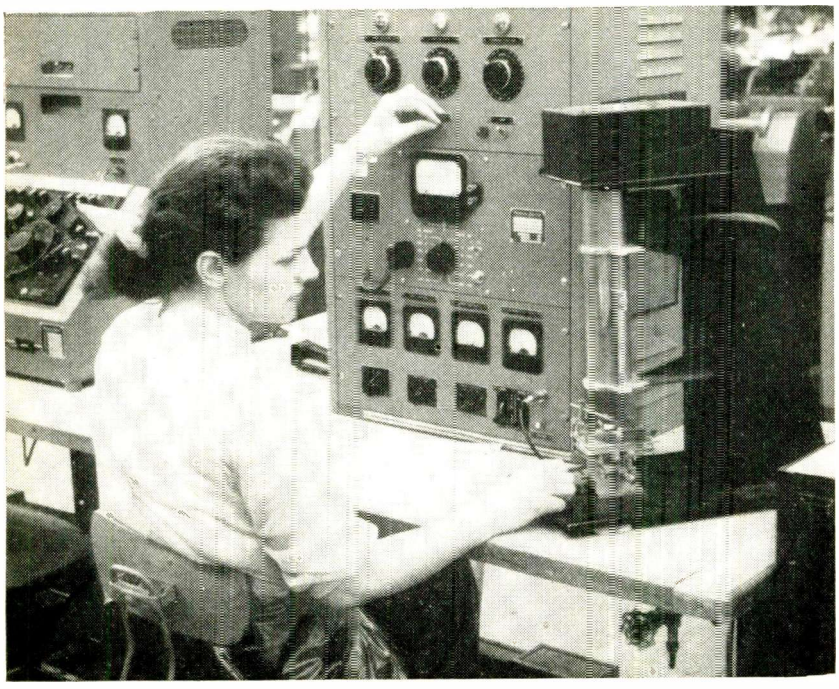

FIG. 4—Measuring minority carrier lifetime. Energy is applied to specimen in form of modulated light beam

for basic material for high quality transistors.[4]

By cooling very slowly the grains formed in the solid may be made larger than if the metal were rapidly solidified. If one of these larger grains is cut from the specimen and touched to a molten surface of the same metal, a single crystal can be grown as the temperature is slowly lowered and the crystal withdrawn. This growing process is referred to as vertical crystal growing.

Only the heart of the complete crystal grower is shown in Fig. 2; the complete unit includes temperature control equipment, an r-f power generator, the growing chamber and associated mechanical and atmosphere control apparatus.

Heating is accomplished by an r-f induction coil surrounding and concentric with a germanium-charged crucible. Controlled variations in power input to the coil accurately set the temperature of the germanium with minimum thermal inertia. A graphite container is used so that inductive coupling may be obtained to heat the crucible and melt the germanium despite the fact that at low or room temperatures germanium is a poor conductor. A low-conductivity water-filled cooling chamber surrounds the inside quartz tube and is formed by a second annular cylinder of Pyrex glass outside the r-f coil. This provides a heat sink for radiated heat and aids in reducing the thermal inertia of the temperature control system.

With germanium in the molten state, it is imperative that no unintended contaminants enter solution and that oxidation of both the melt and crucible be prevented. The inner quartz tube serves as an envelope for a controlled inert or reducing atmosphere such as helium or hydrogen.

Crystal Growing

The growing of a single *n*-crystal is begun with a measured charge of zone-purified germanium which has been acid etched, rinsed and dried.[5] It is placed in the graphite crucible of the crystal grower and rapidly melted by heating a few hundred degrees above the melting point (936 C) for about 5 minutes. The temperature is then lowered to a few degrees above the melting point and a single crystal seed of germanium on a rotating vertical pulling shaft is slowly lowered until it dips into the molten charge. A short period of time is allotted for thermal equilibrium to be attained followed by a slow and steady withdrawal of the seed. As the seed is gradually pulled upward, temperature and pull rate are again adjusted so that germanium grows onto the seed to form a crystal of a desired cross sectional area.

When a definite cross sectional

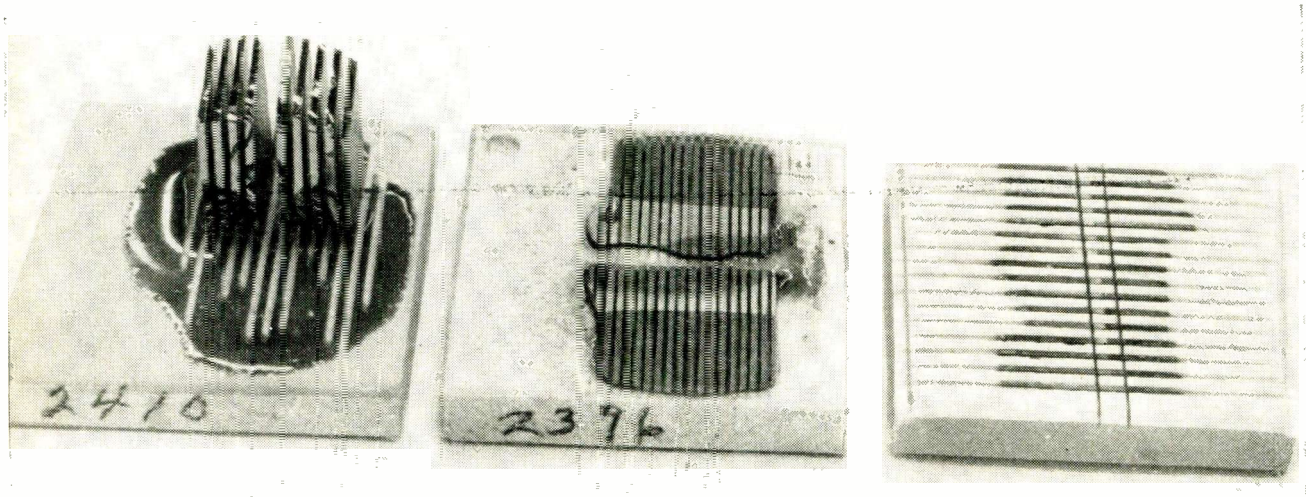

FIG. 5—Cutting operations produce transistor bars from single crystal. Slices are first made perpendicular to junction plane (left). These slices are gang sawed into bars (center). Electrolytic etching makes junction visible for centering between trimming saws (right)

size of the crystal is attained, the growing of the main body is begun. To accomplish this, temperature and pull rate are readjusted automatically causing the crystal to grow straight, vertical sides.

The seed is rotated to produce a symmetrical crystal. The rotation also produces a continuous agitation which distributes the calculated quantities of doping alloy more uniformily through the melt. If agitation and controlled growth rate were not employed, the crystal would solidify from a melt of rapidly increasing alloy concentration and exhibit an undesirable gradient throughout its length.[6] Frequently, a small amplitude vibration is also applied to the crystal during the growing process to achieve better distribution of the doping alloy.

Doping

Growing single crystals with *p-n* junctions requires additional apparatus for controlled addition of minute amounts of doping materials such as gallium and arsenic. In producing *npn* junction transistors, the pulling of the crystal is the same as described, except that apparatus for dropping pellets of desired doping alloys is used. The pellets are barely visible to the naked eye and are dropped through tubes which may be seen in the photograph (Fig. 2).

The first *n*-type region is grown until it is the proper length. Then a charge of gallium-alloy pellets is dropped into the melt and diffuses rapidly. It overcomes the weak concentration of *n*-dope (arsenic) already in the melt and the growing crystal picks up gallium atoms in its structure giving it *p*-type characteristics.

Within a specified period of time the doping apparatus releases a charge of concentrated arsenic *n*-dope and this overcomes the domination of the gallium concentration reverting the melt to strong *n*-type. The growth cycle is continued until this heavily doped second section of *n*-material has grown on the crystal. In this manner, a narrow *p*-layer sandwiched between two *n*-regions is produced.

Crystal Inspection

The finished *npn* crystal is evaluated for width of the *p*-layer and resistivity of the *n*-regions by measurements of voltage profile and resistivity. The latter are made by a method illustrated in Fig. 3 using four probes.[7] The probes are placed on a flat surface of the crystal and a current is passed through the two outer electrodes and the floating potential is measured across the inner pair. This method is used to overcome the rectifying properties of metal-semiconductor contacts and the adverse influence of minority carrier injection at current-carrying contacts.

In addition, the lifetime of minority carriers[8] (holes) in the lightly doped *n*-region is measured, Fig. 4, and a visual inspection is made to assure that twinning and lineage have not occurred to destroy the proper alignment of the atoms within the crystal.

Sawing and Cleaning

After the single germanium junction crystal has been grown, the crystal is mounted on a ceramic plate and cut longitudinally into thin *npn* slabs (Fig. 5, left). A diamond saw cuts the hard and brittle germanium and the valuable germanium sawdust is recovered in special filters. The slabs are removed from the ceramic plates and a lapping machine such as that shown in Fig. 6 (left) finishes the cuts to close tolerances.

After a selective etching process that renders the junction visible, the slabs are mounted and cut as shown in Fig. 5 (center) in a second sawing operation. Figure 6 (right) illustrates the actual cutting operation. The bars produced are approximately 1/32 in. square in cross section each having a visible *npn* junction perpendicular to its length. The alignment of bars for trimming is illustrated in Fig. 5 (right) and the final trimming cut produces the basic *npn* bar about $\frac{1}{8}$ in. long.

Assembly

Assembly may be done under microscopes and in controlled low-humidity enclosures. All handling of the germanium is performed with great care so that the material is clean and uncontaminated. Oxide and films which can form on the surface of the material play significant roles in the ultimately

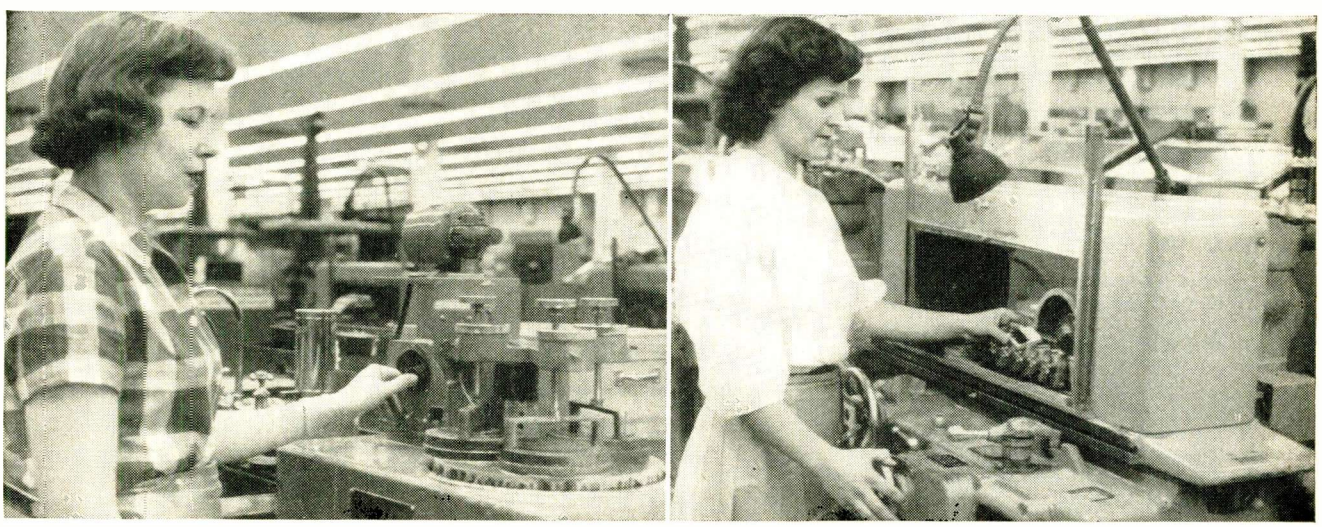

FIG. 6—After first cutting operation the slices are lapped to close tolerance (left). Semiautomatic saw trims bars (right). Machine incorporates provisions for recovering valuable germanium chips

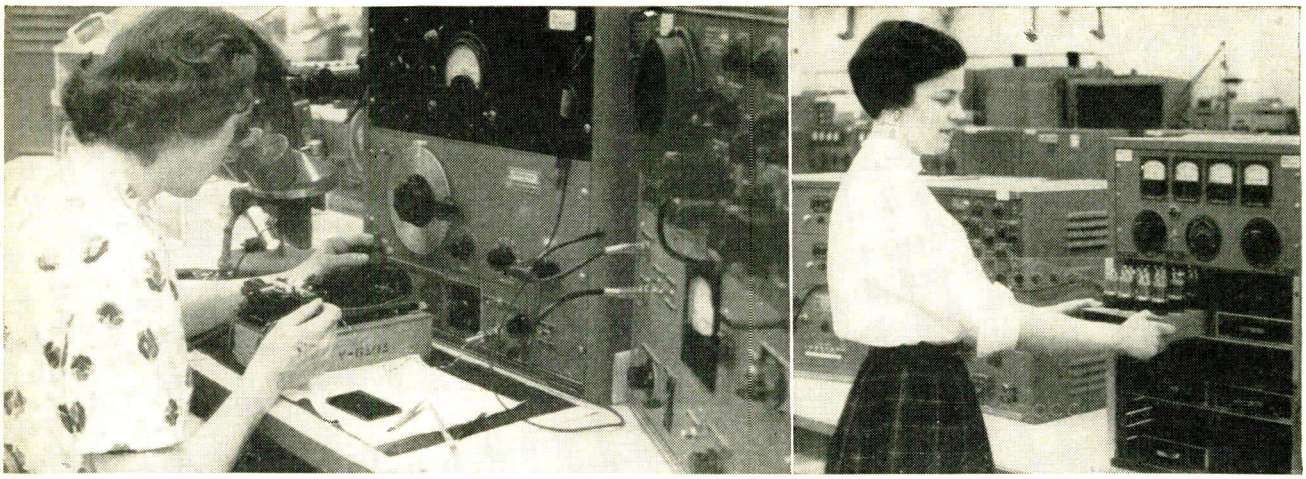

FIG. 7—Bonding base lead (left) involves welding fine gold wire to 0.002-in. p-region. Operator probes junction with micromanipulator while checking transistor characteristics on oscilloscope. Trays of completed transistors (right) are loaded into racks for 24-hour aging

attainable characteristics of the finished transistors.[9]

The inspected bar is mounted on a glass-and-metal header which makes ohmic contact to the ends of the bar giving rigid mounting and external electrical connection to the emitter and collector. After cleaning, an electrolytic etching operation is performed with a weak solution of potassium hydroxide in water as the electrolyte to remove the surface debris caused by the mechanical operations of sawing and lapping. In a period of one to two minutes, depending on the setting of current density, the bar surface is brought to a high polish without the need for masking and without the use of strong chemical etches. Then the current-voltage characteristics of the device are observed on an oscilloscope. From this point on, the device is protected from moisture by processing in a controlled low-humidity atmosphere.

Base Lead

A third lead must now be attached to the thin *p*-region of the bar. This operation is illustrated in Fig. 7 (left). The equipment for location of the base connection supplies operating biases and an input and output circuit to the transistor assembly so that when the base lead probe is bearing on the *p*-region, the transistor is operating as an amplifier. The circuit is arranged so that the small 10-kc input signal and the amplified output signal are presented on the oscilloscope in an envelope pattern characteristic of most of the electrical parameters of the assembly under test. When the maximum gain point has been located, the gallium-doped gold wire probe is bonded to the *p*-region by passing a welding current through the contact. By observing the positioning through a 30-power microscope and watching the oscilloscope pattern, the bonding of a 0.002-in. diameter wire to an equally thin *p*-layer is readily accomplished. The gold wire is then attached to the third header lead and makes the base connection available for external contact.

A protective coating is applied to the internal bar assembly and it is hermetically sealed into a can in a dry atmosphere. The seal is made by soldering, using a few seconds application of r-f power to the header skirt which causes localized heating to soldering temperature.

After 24 hours of power aging (Fig. 7, right), the transistor is cycled twice from room temperature to 60 C to stabilize its characteristics. The final testing consists of measuring the 11 electrical parameters listed in Table I.

For assistance in preparing this material, acknowledgement is made to T. F. Briody and J. C. Yastrzab.

Table I—Key Electrical Parameters in Transistor Testing

(1) I_{co1}, collector current at zero emitter current and collector voltage of +4.5 v with respect to the base ($V_c = +4.5$ v)
(2) I_{co2}, the same current measured at $V_c = +10$ v
(3) I_{co3}, the same current measured at $V_c = +30$ v
(4) $1 + H_{21}$, parameter H_{21} is equal to the absolute value of α, the short-circuit current multiplication ratio
(5) $1 + H_{21}$, same as in (1) but measured at 60 C
(6) H_{12}, open-circuit feedback voltage ratio, approximately equal to base resistance r_b divided by collector resistance r_c
(7) H_{22}, admittance between collector and base, approximately equal to the reciprocal of the collector resistance r_c
(8) H_{11}, short-circuit input impedance, approximately equal to the emitter resistance r_e
(9) f_{co}, alpha cutoff frequency measured as the frequency at which alpha has dropped 3 db from its low-frequency value
(10) C_c, collector to base capacitance in $\mu\mu f$ measured at a collector voltage of +4.5 v and zero emitter current.
(11) N_f, noise figure at 1,000 cps for 150-cps bandwidth

* Tests conducted at room temperature unless otherwise noted.

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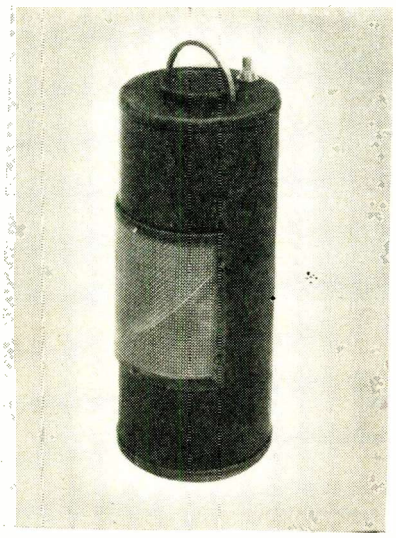

FIG. 3—Latest version uses miniature motor to scan area of interest. It hooks on belt and weighs only 1¾ pounds

quency of which is in the region 7 to 8 kc. Oscillograms of these clicks suggest that their waveforms are not unlike those produced in the projector just described, although intensity is many time greater.

This information reopened the question of whether or not sonar methods might be made to yield enough information for genuine obstacle avoidance. It was therefore decided to construct a projector utilizing automatic scanning. Two models have thus far been built. The latest, shown in Fig. 3, has a diameter of 3⅝ inches and a length of 8¼ inches. The transducers in each case are crystal sound-cells.

Paraboloidal horns are fastened to the top cap of the box and open vertically downward. The sound beam is reflected horizontally out through the opening in the side of the cylinder by the aluminum ellipse, which can be seen through this opening. The ellipse (oriented at 45 deg from the vertical) is mounted on a vertical shaft that is driven by a small motor in the lower section of the cylinder.

In the first model, the reflecting ellipse rotated at about 1 rps and thus the sound beam emerged from the projector only about half the time. Angular width of the opening in the side of the cylinder is 120 deg. In the latest model, the ellipse is made to execute an angular oscillation with an amplitude of 60 deg and a period of 0.7 sec by means of a mechanism comprising a Scotch crosshead and a rack and pinion assembly. Thus the beam continually emerges from the projector with a sinusoidal right-and-left scanning motion.

Motor-Driven Scanner

In both models the motor is a permanent-magnet rotor type with make-and-break contacts actuated by the rotor shaft. The electrical pulses for exciting the transducer are supplied from the motor field coil at each break of the contacts. The transducer is tuned to resonance at approximately 10 kc by shunting it with a 50-mh choke.

This parallel-resonant circuit is coupled to the motor coil through a small capacitor to reduce the amount of low-frequency energy in the exciting pulses. Pulse amplitude from the second model is somewhat greater than that from the projector of Fig. 1. Recent developments have improved pulses.

Experience with this form of projector confirms the supposition that automatic scanning provides a gain in the information obtainable from the device. A scan rate of 0.7 to 1 sec is difficult to maintain manually and this rate has been estimated as about the optimum on the basis of a number of considerations. The later model is provided with a hook for attachment to belt or clothing, so that both hands of the user can be free. Weight of this model is 1¾ lb. With this arrangement, it is conceivable that, at least in thinly settled areas, the blind might use a cane for the detection of step-downs or drops, while using the sound projector for obstacle avoidance.

Projectors of this kind are still inadequate for obstacle avoidance under many conditions, particularly in noisy and congested areas. If the intensity of the projected sound were increased to make it comparable with that of the oil birds' sounds, the noise would be so great that the user would become far too conspicuous.

However, it is probable that intensities of that order would be needed to assure the detection of all obstacles, because of the primarily specular character of sound reflections from most surfaces. Even then, high levels of ambient noise could seriously interfere with obstacle detection and avoidance.

Since step-downs or drops can only be detected optically, or with a material probe such as a cane, it is highly probable that the eventual general-purpose travel aid for the blind will be entirely optical. However, the inherent simplicity, low cost and ruggedness of sound projectors still justify their consideration for use under very simple travel conditions, such as those encountered in rural areas.

CHRONOLOGY OF SONIC BLIND AIDS

1941—D. R. Griffin[1] shows that bats make use of ultrasonic echo-location for obstacle avoidance in flight, and have nerve mechanism (like radar t-r switch) to "short-circuit" ear while high-intensity sound pulse is being emitted.

1944—K. M. Dallenbach and M. Supa[2] demonstrate that obstacle sense of the blind lies in ability to interpret sound echoes (above 8 kc) from large objects.

1944—Griffin's metallic snapper in paraboloid is used to train blinded veterans. W. Etkin, CCNY, and others at Haskins Laboratories, New York City, experiment with electrically driven sound sources.

1947 to 1951—V. Twersky,[3] Witcher[4] and R. L. Beurle[5] use tones or pulses at 8 to 12 kc projected by electromechanical transducer from paraboloid to minimize direct pickup and enhance reflections from obstacles.

1953—Griffin[6] shows that South American oil birds fly in absolute darkness of large caves by the aid of very intense, sharp, metallic-sounding clicks about 8 kc

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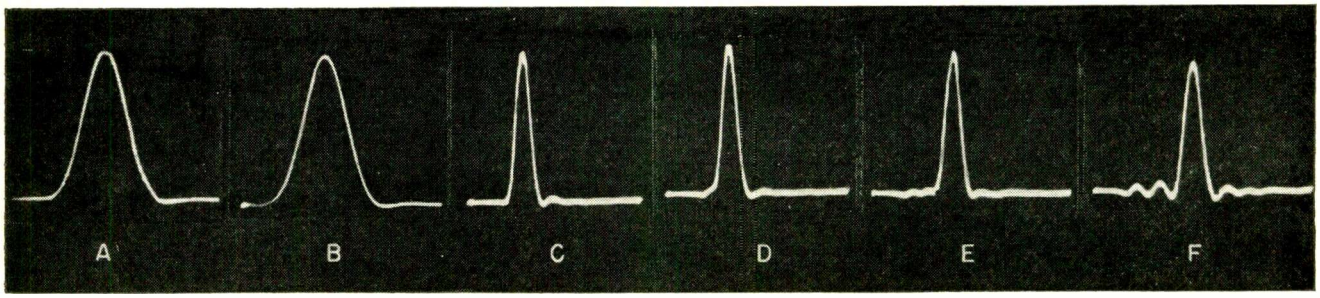

Sine-Squared Pulses

Flaws in television systems show up better when a sine-squared pulse is applied than when square waves are used for checking. Broadcast engineers will find the techniques described useful in lining up transmitters and studio gear for color

By RALPH C. KENNEDY

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USE of a sine-squared test pulse subjects a television system to a more realistic test than does a square wave because the camera signal from a sharp vertical black-to-white transition follows a sine-squared curve.[2]

Furthermore, a sine-squared pulse provides a more rigorous test for ringing than a square wave. Overshoot, when a sine-squared pulse is passed through an ideal bandwidth-limited system, is 13 percent as against 8.9 percent for a square wave.

When ideally limited, the pulse appears as a $(\sin x)/x$ function. The pulse spectrum is such that the component energies at the nominal high-frequency limit are down 6 db in power and have zero value at twice the nominal high-frequency limit.[3,4] Since the pulse conforms to these values within about ±1 percent, there is available in the sine-squared pulse a mathematical function readily reproducible and suitable for all types of analysis and synthesis.

Test Interpretation

A system's response characteristic is appraised by the pulse duration and amplitude. The area under the pulse remains constant so that bandwidth limitation most frequently causes only a decrease in pulse height and an increase in pulse width. Furthermore, the phase characteristic is readily evaluated by the symmetry or lack of it about the pulse axis. A $(\sin x)/x$ function is perfectly symmetrical about the pulse axis. Any departure from this ideal condition by the system phase characteristic most frequently causes only dissymmetry to occur. If time of transmission through a system is faster at high frequencies than at low frequencies, ripples appear prior to the pulse while the converse causes ripples following the pulse.

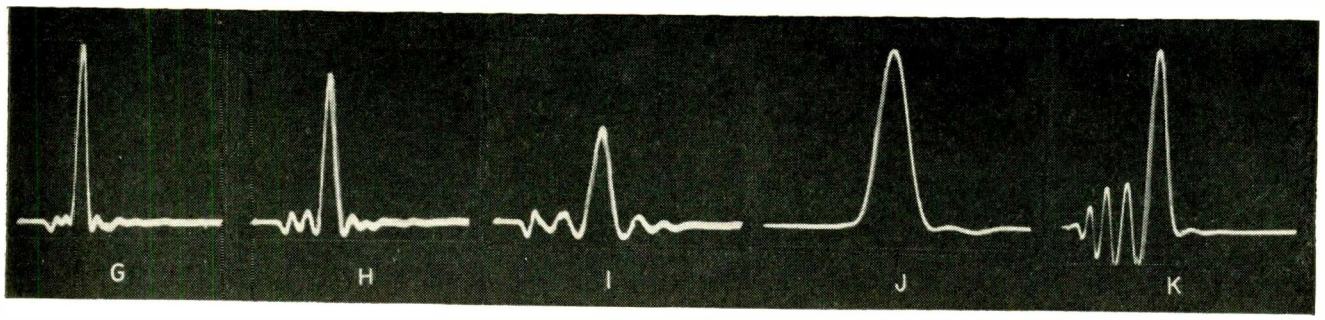
Since the pulse consists of frequency components up to twice the nominal high-frequency limit, the pulse appraises only a certain portion of the spectrum. This dictates the use of two pulses for testing 4-mc television circuits—one having 0.25-μsec half-amplitude duration which contains energy 6 db down at 2 mc and no energy at 4 mc and a second of 0.125-μsec half-amplitude duration which correspondingly is 6 db down at 4 mc and zero at 8 mc.

By combining a low-frequency square wave having sine-squared transitions with the above two pulses, a system can be thoroughly checked throughout the total pass band. The use of a calibrated oscilloscope scale based on a rating factor[5] enables the observer imme-

SINE-SQUARED TEST PULSE

A pulse having the shape of the curve $y = \sin^2 x$ has been used to check distortion in television links in England and on the continent for a number of years.[1] However, little use of this test pulse has been made in the U. S.

The CCIF (Comite Consultatif International Telephonique) in 1951 provisionally adopted the following specification for this test pulse: (1) the prf shall be at the line frequency and (2) the half-amplitude duration of the pulse shall equal half the period of the system's nominal bandwidth. Thus for a system 6 db down in power at 4.5 mc, the half-amplitude pulse duration is 0.111 μsec



Test Color-TV Systems

diately to determine the go or no-go characteristics of the system.

Equipment

Figure 1 illustrates the equipment setup for generating test pulses. The input pulse amplifier is a twin triode. It accepts the horizontal-blanking signal and provides a sharply differentiated, large-amplitude negative pulse to drive the twin-triode cathode-coupled multivibrator that delays the sine-squared pulse 20 or 30 μsec and delivers a large-amplitude negative pulse to the pulse shaper.

The pulse shaper is a pentode amplifier that increases pulse rise time and inverts the negative pulse. The trigger circuit is transformer coupled to a conventional blocking oscillator that creates large amplitude short-duration pulses, which are shaped in the filters.

Waveforms (A) to (B) show two test pulses having half-amplitude durations of 0.34 and 0.11 μsec respectively. These test pulses were put through a series of low-pass linear-phase-shift filters[6,7] and a lossless nonlinear-phase network.[8]

The low-pass filters have characteristics such that their response is down 3 db at 6.0, 4.0, 2.3 and 1.67 mc. Waveforms (C) to (F) show the effect the filters have on the 0.34-μsec pulse. Decreasing pulse height and increasing width are evident in (E) and (F) while the symmetry in (F) occurs as the pulse begins to assume a $(\sin x)/x$ form. Since the 0.34-μsec pulse has essentially no energy above 3 mc, the 6 and 4-mc filters have no effect on pulse height or duration as is evident in (C) and (D).

Filter Effects

Waveforms (G) through (I) show the effect of the 6, 4, and 2.3-mc filters on the 0.11-μsec pulse. The phase characteristic of both the 6 and 4-mc filters is not as good as it is in the 2.3-mc filter.

Waveforms (J) and (K) display the effect produced on the pulse by a lossless nonlinear-phase network. The network used was designed to produce the NTSC envelope-delay characteristics for color tv transmitters. The requirement is that the envelope delay remain constant from 50 kc to 3 mc and then decrease linearly to 4.18 mc so that it is 0.17 μsec at a frequency of 3.579 mc.

Distortion

Little effect should be produced on the 0.34-μsec pulse as is evident in (J). However, the 0.11-μsec pulse is distorted as seen in (K). Furthermore, the slight ripple in (J) follows the main pulse whereas it precedes the pulses in (K).

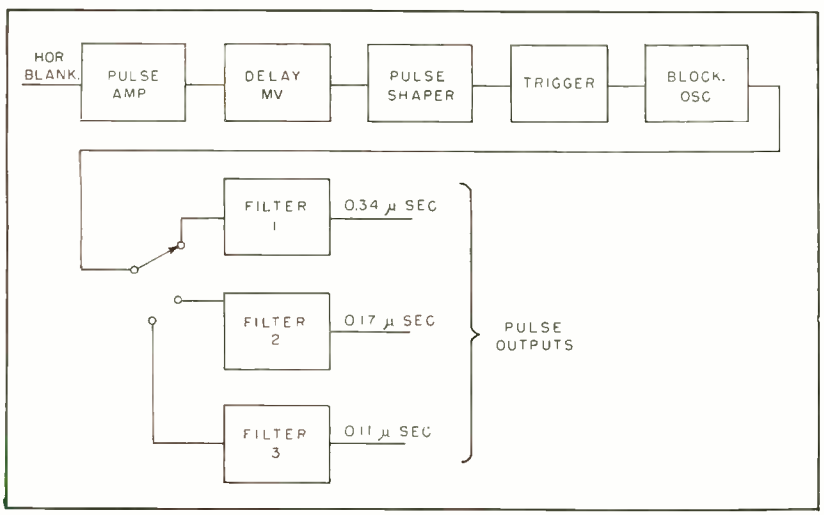


FIG. 1—Equipment setup for generating sine-squared pulses

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High-Frequency Coils

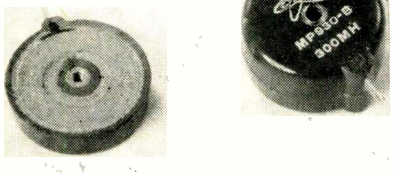

FIG. 1—Center-threaded brass insert of toroid allows coils to be stacked without applying mounting pressure to plastic case or coil assembly

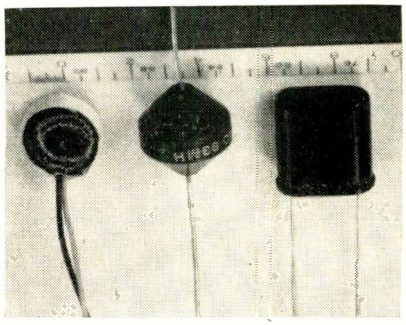

FIG. 2—Open toroid unit is recommended for high-temperature operation; pigtail unit has an inductance of 93 mh; hermetically sealed unit is small

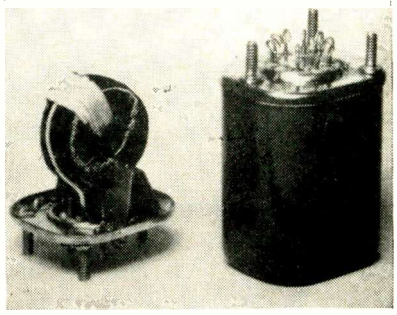

FIG. 3—High-frequency controllable inductor is wound on toroidal core and hermetically sealed in case that serves as magnetic shield

Ferrite and powdered-iron cores in varied shapes give new high-frequency inductors and transformers the versatility and compactness of low-frequency units. Toroidal construction finds greater use. Metallized glass inductors give stability and ruggedness

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Two of the more significant recent advances in high-frequency inductors are the extension of saturable reactor and magnetic amplifier techniques and the introduction of new materials for coil forms. The former advance includes ferrites, used as cores for inductors operating to about 100 mc; the latter includes glass and other low-loss materials, used as forms at higher frequencies.

High-frequency inductors are superficially simple, being wire wound on a form. Wire is available from innumerable producers and various materials are made as tubes suitable for coil forms. Winding is a relatively simple process. Thus many equipment manufacturers wind their own inductors and from such unsophisticated beginnings evolve special materials, techniques and designs. There seems to be more variety—and more manufacturers—of high-frequency inductors than of any other component. Units range from a few μμh for use at hundreds of megacycles to a hundred henrys or so for use at hundreds of cycles. This range necessitates variety.

Toroids and Filters

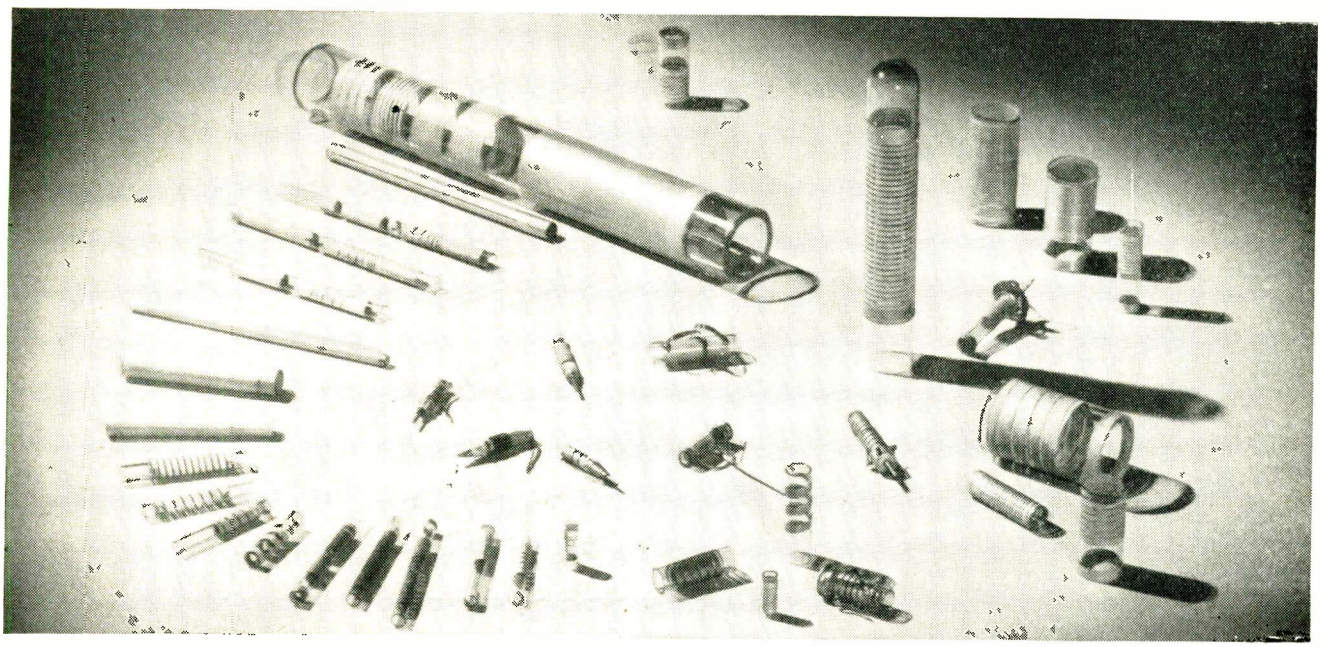
From audio frequencies to a few megacycles, torodial coils are often preferred for their self-shielding. For example, Burnell & Co. specializes in winding transformers, filters and mutual-inductance delay lines on molybdenum-Permalloy dust-core toroids. One more recent innovation is a set of plug-in decade precision toroids ranging in steps of 1, 2, 3, 4 and 8 in each decade from 1 mh to 180 h. Terminals are on the axis and serve to mount one unit on another to produce the desired inductance; this is especially useful during circuit development from 100 to 10,000 cps.

Many firms custom-engineer their inductors and transformers. Raytheon Manufacturing Co. winds ultrasonic and other special units to order. On the other hand, companies such as Freed Transformer carry a wide range of inductors and filters as catalog items, including miniature transistor transformers.

High-temperature operation of core inductors is ultimately limited by Curie temperature (as low as about 100C for ferrites of high initial permeability, to about 800C for iron). At Tri-Dex Electronics, Teflon and ceramic insulation are used with metal bobbins where possible for high heat conductivity; such bobbins are attached directly to heat sinks for operation above 180C. The Arnold Engineering Co. furnishes powdered Permalloy toroids stabilized to provide a permeability constant within ±0.1 percent over a specified temperature range.

These examples are by way of pointing out that a high-frequency inductor must be engineered for adaptability or tailored to its use. Refinements come from design,

Use New Core Materials



Highly stable inductances are formed by metallizing windings on glass forms. Pitch of spiral can be varied to shape tuning curve of variable units with slug tuning. Transformers can be made by winding ordinary wire on metallized glass forms

choice of materials and techniques such as handling fine wire.

Advances in manufacturing techniques have lowered unit costs. Communication Accessories Co. uses toroidal winding machines with speeds of 2,500 to 3,000 turns per minute, compared with 500 tpm used formerly, to wind the coil on the powdered-iron core whose cross-section is shown in Fig. 1.

Polyester and alkyd compounds seal units and yet add little to their overall size. Such inductors operate over a temperature range of −40C to +85C; in this range the frequency drift of a telemetering filter may be less than 0.5 percent, for example. In response to the demand for components compatible with transistors, manufacturers are developing such subminiature inductors as those in Fig. 2.

Saturable Reactors

Automatic voltage-stabilizing inductors, variable and saturable regulators and magnetic amplifiers, which are common components at power frequencies, are being extended in operation up to tens of megacycles. Controllable inductors are used in tunable filters, variable delay lines, switches and modulators. In the Increductor (trade name of CGS Laboratories) of Fig. 3, current through one or more control windings determines the magnetic state of the core to control the effective inductance of a signal winding. The windings and core are arranged to cancel inductive coupling.

At zero control current, the signal winding of a controllable inductor has its maximum inductance; this is about 66 microhenrys for the unit whose characteristics are plotted in Fig. 4. At full rated control current of 100 ma the inductance of this unit is reduced to less than a microhenry. The relation between control current and inductance is given by the stationary scales at the top and bottom of Fig. 4. The scales are aligned for monotonically increasing control current. Because of hysteresis, the inductance is slightly different when reached by decreasing the current.

Loss relative to reactance varies with frequency and inductance as shown by the constant-Q contours of Fig. 4.

Most controllable reactors have larger temperature coefficients than linear components, although there is generally a control current at which temperature coefficient of in-

Previous Articles in Series

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Part II: New Variable Capacitors Extend Tuning Range, p 130, Aug. 1954
Part III: Fixed Resistors Show Stability Improvements, p 132, Sept. 1954
Part IV: Precision Potentiometers Use New Materials, p 144, Oct. 1954
Part V: Iron-Core Transformers Run Smaller and Hotter, p 136, Nov. 1954

COMPONENT DESIGN TRENDS

- Self-shielding molybdenum-Permalloy dust-core toroids can be stacked for decade inductors
- Combining Teflon and ceramic insulation with heat-conducting metal bobbins permits operation above 180C
- New toroidal winding machines run at speeds up to 3,000 tpm
- Metallized glass construction permits economical production of variable-pitch units giving special tuning characteristics

ductance is zero from −50C to +80C. Typical values of temperature coefficient are 0.1 percent to 0.5 percent.

Up to 10 mc, ratios of maximum to minimum inductance in the hundreds are feasible; to 50 mc, ratios in the order of 30 to 100 are achieved; at higher frequencies the ratio of maximum to minimum inductance is less than 2. Up to 50 mc, the peak Q ranges from a few hundred down to 40; at 100 mc it is between 10 and 50. Control power is usually 0.1 to 100 milliwatts, and rarely over a watt, yet r-f outputs to 300 watts can be controlled between 20 and 40 mc. Special units can operate to 250 mc. Maximum inductance can exceed 100 henrys. Standard units respond to a 1,000-cps sawtooth control current; special units respond to control currents varying at megacycle rates. In a representative application, the frequency of an oscillator shifted 25 percent per ma of control current in the region of zero temperature coefficient.

To counteract the decrease in variation due to remanent magnetism, the Vari-L Co. shunts the toroid with a permanent magnet in addition to control windings. The permanent magnet provides a bias field with a stability that would be difficult to achieve by a bias current in a separate winding and without continuous expenditure of power. The magnet can be rotated with a screwdriver adjustment to trim the starting inductance or the shape of the characteristic curve.

Ferrite Cores

Ferrites, which are crystals commonly formed from NiO, ZnO, and Fe_2O_3 (but which may also contain copper, iron, lithium, magnesium, manganese or cadmium), are the core materials used in more recently developed high-frequency inductors. At lower frequencies, grain-oriented tape-wound iron cores are used, but even in thin insulated laminations they introduce too much eddy current loss for general use above a few hundred kilocycles.

Ferrites are being applied to variable inductors, high-frequency saturable reactors, magnetic amplifiers, pulse transformers, resonant reactors, flyback inductances and, usually in toroids, to a wide variety of filters—lower sideband, band-pass, low-pass, high-pass, traps (band rejection), telemetering and interstage. They are well suited to antenna coil cores, television components and miniature transformers, especially for ultrasonics and for tv deflection and impedance matching.

Magnetostrictive effect is a function of composition. It can be made zero if undesired, or accentuated to provide electromechanical transducers. Composition also affects Q and Curie temperature.

Antenna Transformer

By way of illustrating the performance of contemporary r-f transformers, the response of a Polycoupler (CGS Laboratories) antenna transformer is presented in Fig. 5. This unit, utilizing a core material adapted for the application, couples a balanced rhombic antenna with a mean impedance of 600 ohms to a 75-ohm feeder line; it can handle up to six receivers in parallel with negligible cross coupling. Although rated for operation from 2 to 20 mc, the curves are plotted over the full range of measurements as made by two independent users.

Different test equipment was used in the two measurements whose results are combined in Fig. 5; the methods were substantially the same, however. A signal generator fed the coupler through a simulated 600-ohm impedance. Three different loads were used one at a time in each case: 100, 75 and 50 ohms. Because of individual differences in the test setups, the data are presented as a scatter diagram. At the low-frequency end, response fell off as the load resistance increased; at the high-frequency end, response fell off abruptly as the load resistance decreased.

Metallized Glass Inductors

Metallized glass inductors are filling various needs because of their drift stability, ruggedness and adaptability to production-line fabrication. Low coefficient of thermal expansion for the coil form coupled with low temperature coefficient of dielectric constant (substantially constant up to 100C) result in an extremely low tempera-

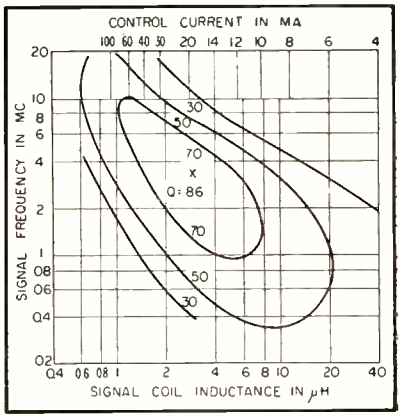


FIG. 4—Representative Q plot of controllable inductor shows Q as function of inductance (related to control current) and of frequency

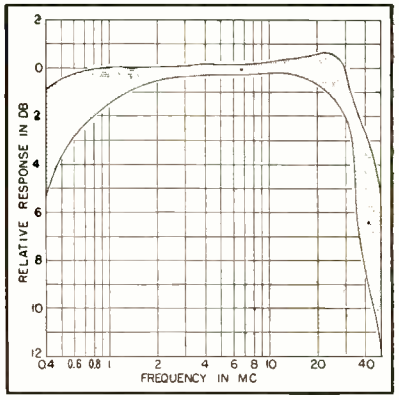


FIG. 5—Data from two independent tests of an antenna transformer are presented as a scatter diagram

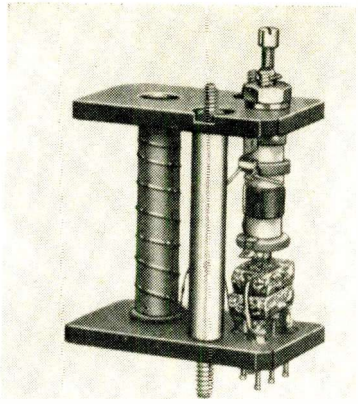
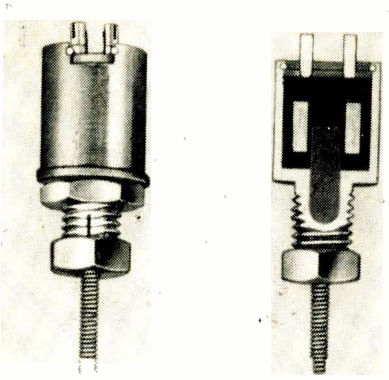


FIG. 6—For quality control, L, C and Q of this r-f assembly are measured



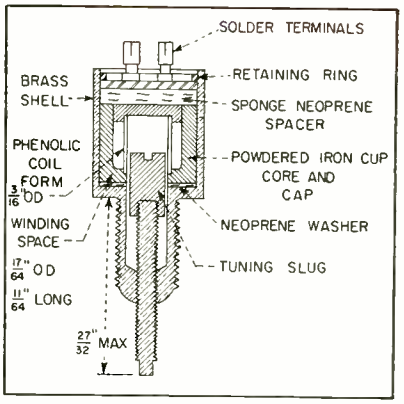


FIG. 7—Miniature slug-tuned and shielded r-f coil form is 7/16 inch in diameter and extends 5/8 inch below chassis when mounted with screw above chassis

ture coefficient of inductance, approximately 7×10^{-6} per degree C for Corning Glass units without cores. In these inductors, the conductors are fired on the coil forms, and consequently the units can be calibrated and accurately duplicated. Values of Q are in general lower than for comparable wire-wound units. At 20 tpi the average Q for a typical inductor is about 120. However, in designs where the unit behaves more as a distributed circuit element than a lumped constant, quality may be described better in terms of d-c resistance, which is usually low.

As illustrative values (for a variable inductor tuned by a slug over the f-m band from 87 to 109 mc), apparent inductance at 100 mc is 0.07 μh, distributed capacitance without core is 0.6 μμf, with core full in it is 1.1 μμf, minimum Q at 108 mc without slug is 150 and temperature coefficient of inductance without core is $+6 \times 10^{-6}$ per degree C at 100 mc, using the recommended low-loss ceramic core.

At Corning, such units are fabricated by firing silver onto the low-loss glass form; the silver is then copper-plated and, if desired, a coating of flash tinning is applied to protect the conductor from oxidation. Average total thickness of metal is 0.0010 to 0.0015 inch. Such metallized inductors are used from 30 to 1,000 mc; production units are used in low-frequency, f-m and uhf applications.

Bifilar inductances for transformers can be supplied with fixed pitches. Conductor width and gap width can be varied to meet particular requirements, although experience to date at Corning has been that gap width can be fixed in any one design; minimum practical gap width is 0.020 inch, and gaps up to 0.125 inch have been produced. A maximum of 20 tpi seems practical.

Space limitations and required coupling coefficients may preclude metallized glass transformers. One alternative is a metallized inductor in the tuned circuit of an oscillator with a wire-wound tickler cemented onto the glass form.

A related component is the metallized coil form for delay lines. This form consists usually of from 12 to 30 metallized axial strips running the length of the form (1.5 to 6 inches) separated by an 0.004 ±0.001-inch gap. A ⅛-inch ring at one end joins the strips. The form is about ¼ inch in outside diameter. A distributed-constant delay line is formed by winding a wire coil on the form.

R-F Coils and Transformers

Typical of r-f inductors is the tuner-buffer assembly of Fig. 6, produced by I-T-E Circuit Breaker Co. The wire coil is wound on a ceramic form, which may be treated with silicone. These forms are available in a wide variety of sizes with and without tuning slugs. To minimize the capacitance of terminals for such forms, Cambridge Thermionic Corp., for example, mounts them on silicone fiber-glass collars.

The unit of Fig. 7 illustrates, in unusually compact form, the principal features of r-f coil construction. The coil is wound on a phenolic form, providing a winding length of 11/64 inch, and is surrounded by a powdered-iron cup core that shields the unit magnetically yet leaves the center available for a powdered-iron tuning slug that is driven by a threaded shaft. Composition of the cup core and slug depends on intended frequency; the recommended range is from 200 kc up. A brass shell provides electrical and mechanical shielding, and a compression locknut on a split mounting stud holds the slug in its set position. Inductance values to 1.5 mh with Q's below a hundred are obtained; maximum size of wire is No. 22. Because of the shielding and the compact, fairly shockproof construction, these coils can be mounted close together as in miniaturized i-f strips.

Where losses or high-voltage creepage are critical factors, air-wound inductors such as those built by Barker and Williamson are used. Applications range from miniature units for portable vhf transmitters to tank circuits for long-wave communication transmitters.

Until recently pulse transformers have been exclusively a customer-tailored component. For example, Engineering Research Associates developed a transformer for 0.1 to 0.5-μsec pulses with three windings having turns ratios of 2:1:1 and a characteristic impedance referred to the high-turn winding of 1,300 ohms. Recently PCA Electronics announced a line of stock units. Standard units provide a pulse width from 0.1 to 16 μsec and rise times from 0.01 to 1.2 μsec with a drop of 10 to 15 percent in blocking oscillators. As with other high-frequency cores, ferrite cores have contributed significantly to recent advances.

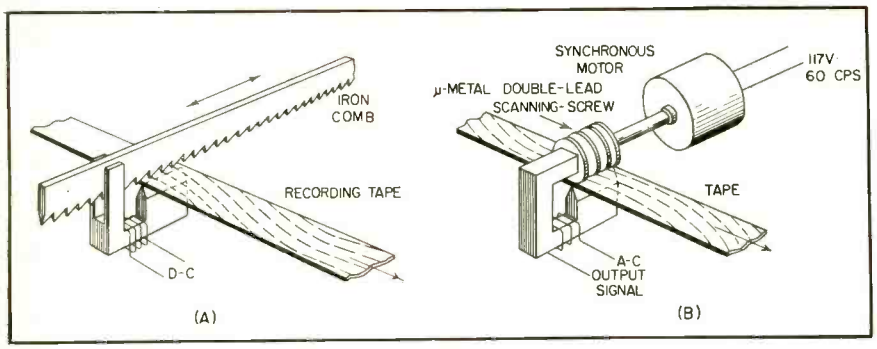


FIG. 1—Comb-shaped recording head coupled to cutting tool produces master tape for control (A); screw serves as playback head for producing control signal (B)

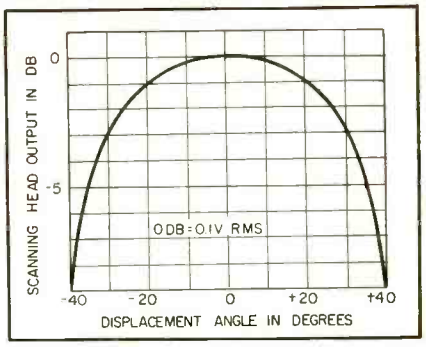
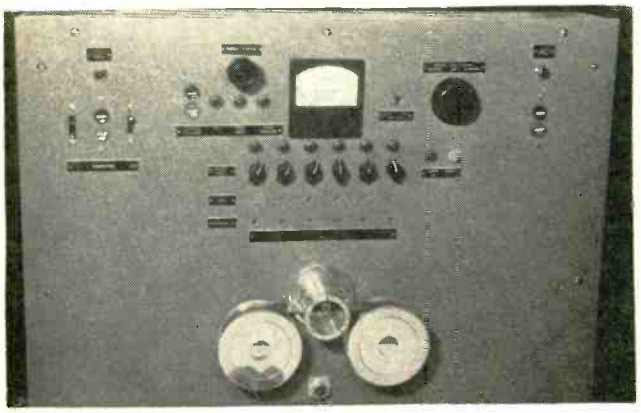
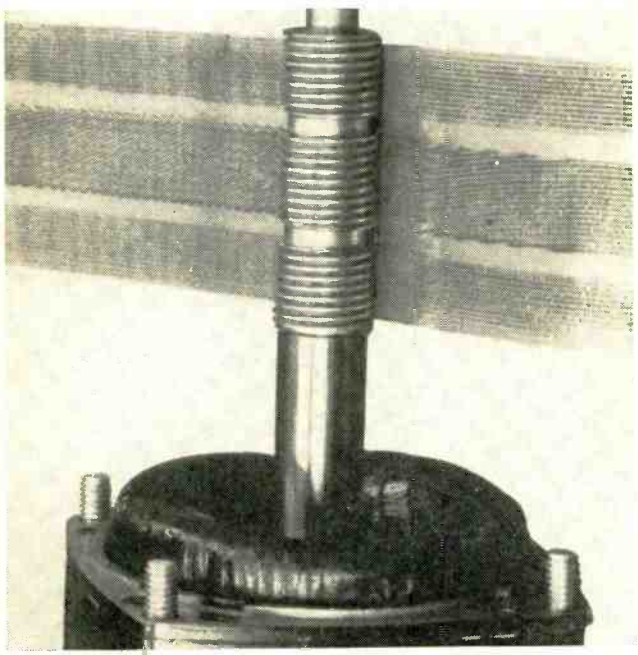
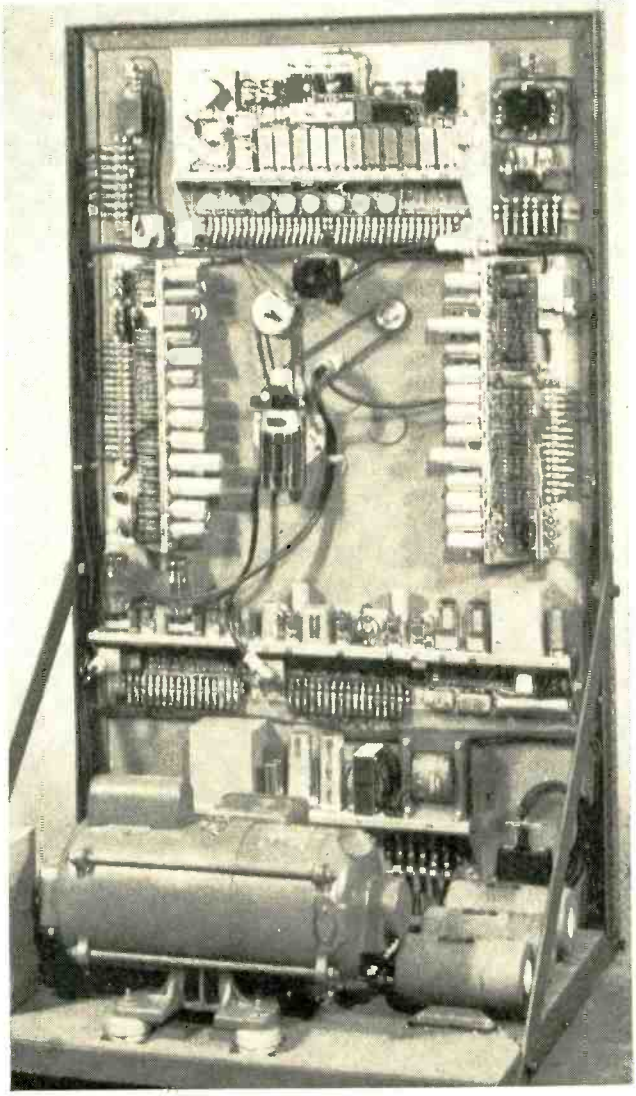


FIG. 2—Scanning-head response with zero tape velocity

Magnetic Tape Controls







THE FRONT COVER—Control panel at upper left shows tape running through primary frequency generator. Mu-metal rotor, below, reads three-channel tape which has been immersed in a solution of finely powdered iron particles to show magnetization. Rear view of the complete electronic control is shown at right

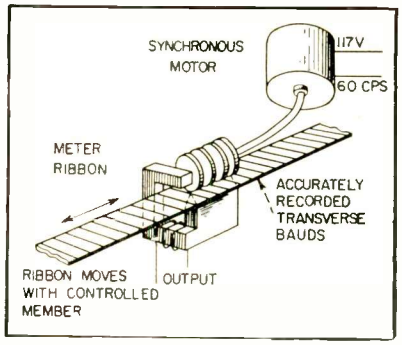


FIG. 3—Secondary signal generator detects position of controlled member

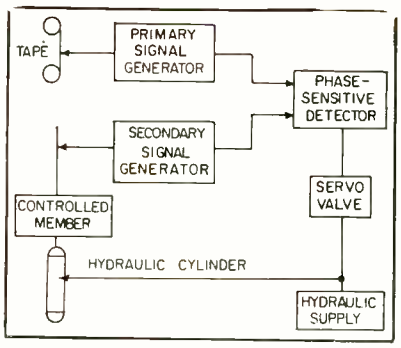
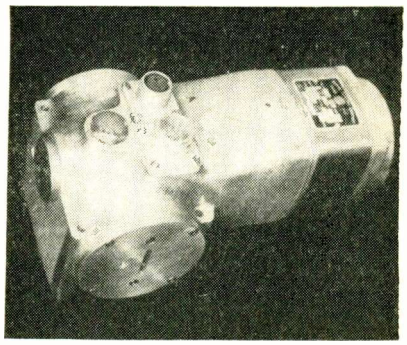


FIG. 4—Block diagram of single-dimension Factrol system



Secondary signal generator has slot on face for tape entry

Machine Tools

By JOHN W. HOGAN

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Minneapolis, Minn.

Cutter displacements are accurately recorded as separate tracks on magnetic tape by moving comb linked to cutter by thyratron or other servo drive. Segments of rotating screw act as scanning devices to pick up multi-channel control information during playback

AUTOMATIC machine control incorporating a simple and accurate magnetic recording and playback technique is necessary to realize a unit that can be accepted by industry. In the Factrol system developed for large machine tools, programming information is recorded on a strip of tape. When completed, the tape contains all control signals necessary to start and stop spindle-drive motors, control spindle speeds if multiple tools are used, provide continuous speed control if maximum cutting rates are desired and provide precise displacement control of one or more cutting tools, grinders, drills or cutting torches. Tape signals to control automatic rewind of tape and other auxiliary functions are also recorded.

Basically, a phase-detection system of magnetic-tape playback is provided in conjunction with a conventional hydraulic, Amplidyne or thyratron servo drive. Plastic-backed oxide tape or steel ribbon provides an inexpensive, durable storage medium which is instantaneously ready for playback. It can be recorded, duplicated or erased for reuse by relatively inexperienced personnel. The single tape provides multiple control tracks for several auxiliary functions as well as the actual tool-displacement control.

The displacement control signal is the part of the recorded information that forms the input to the servo unit and is the most important track or channel on the tape. It is effectively a cam signal because it acts as an integral part of a system that performs the same function as a mechanical cam-controlled machine tool.

Record and Playback

The controlled displacement or cam motion to be reproduced is recorded on the medium by the mechanism shown in Fig. 1A. As the medium is drawn through the transverse magnetizing head, the desired displacement is recorded by moving a comb in the indicated direction. Total displacement is limited only by the physical length of the comb, since an equal number of recorded lines enter and leave the tape as the comb is moved. The polarity and direction of the magnetization are through the thickness of the tape.

Playback of the tape is accomplished by the scanning head shown in Fig. 1B. The rotary pickup, a part of the magnetic circuit, has a pitch equal to the distance between adjacent teeth on the recording comb. As the rotary pickup revolves, it alternately provides a path of relatively high and low reluctance for the magnetizing pattern on the tape. The resultant generated sinusoidal emf provides the basic control signal for the system. In practice the scanning screw is double-lead and is driven by a miniature 3,600-rpm synchronous motor, resulting in a base frequency of 120 cycles per second. Since the head provides a signal without tape motion, the system does not require tape velocity to maintain locked-in control.

If the tape is moving and displacement velocity is present, the frequency output of the playback head will be increased or decreased, depending upon the relative direction between displacement and scanning-screw motion. In practice, the tape velocity and displacement angle are limited so that the constant-velocity frequencies lie between 60 and 180 cycles per second. The displacement-angle tangent is limited to one-half and tape velocity to six inches per second. This

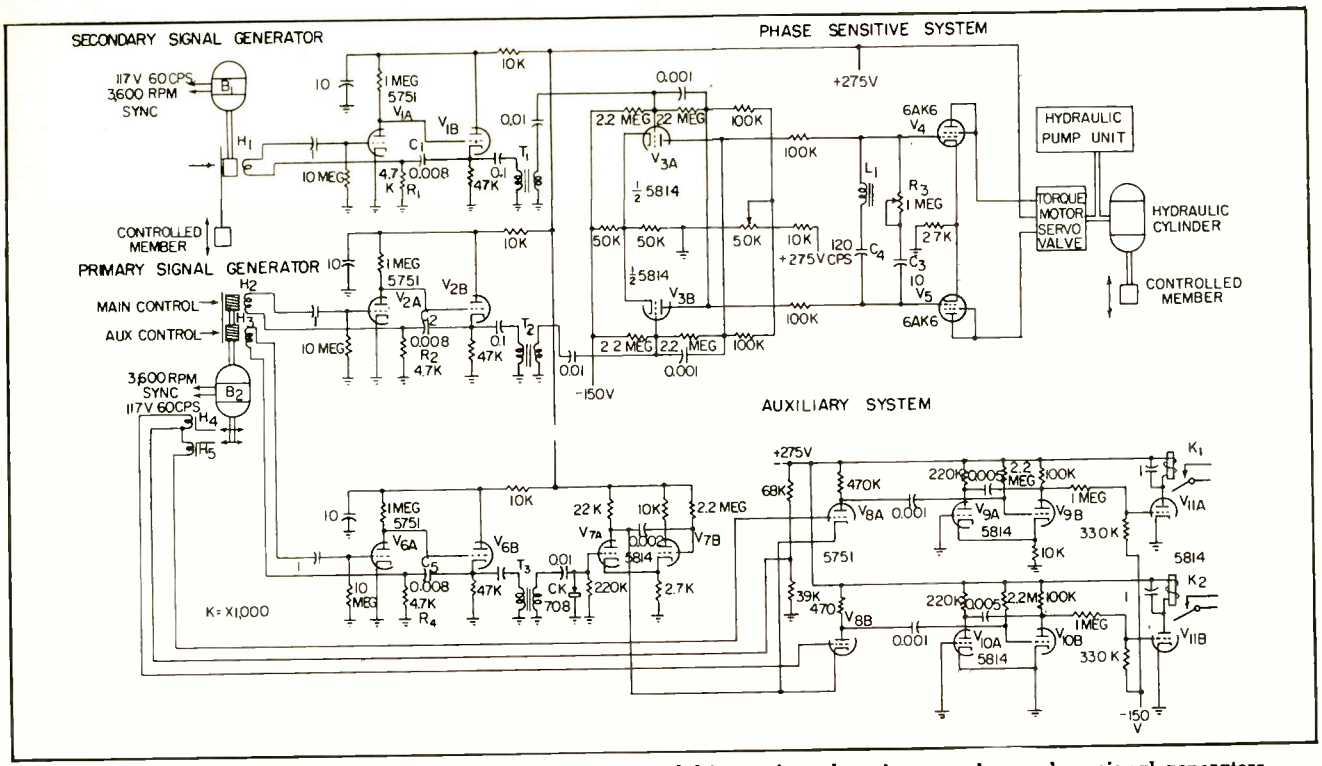


FIG. 5—Circuit diagram of single-dimension system showing sinusoidal inputs from the primary and secondary signal generators

results in a maximum displacement velocity of three inches per second.

Equalization

An unusual equalization problem presents itself in amplifying the scanning-screw signal. The displacement angle produces an amplitude response versus angle as shown in Fig. 2. This is accompanied by negligible phase shift. A second source of amplitude deviation is due to the conventional 6 db per octave change when the tape velocity includes displacement velocity. In practice, conventional feedback equalization is used to correct the second source of deviation. This provides a minimum of phase shift error under all dynamic conditions.

The output of the pickup head is approximately 0.100 volt rms maximum and the dynamic range (above erased tape) is between 50 and 60 db. The signal contains less than 2-percent total harmonic distortion. One interesting feature of this head is the fact that the gap spacing between the rotating member and the pickup lip is not critical. Since the magnetic circuit is a simple series path, the vertical position of the tape in the gap will result in only second-order changes in output.

Two pickup-head assemblies are used in a single-dimension system. One, the primary signal generator, reads the recorded control signal from the tape, along with any auxiliary control signals. The second unit, the secondary signal generator, detects the position of the controlled member (lathe carriage or milling machine table) by reading the phase of equally spaced bauds recorded on a steel tape called a meter ribbon, shown in Fig. 3. Magnetically, it operates the same as the primary generator except that the axis of the scanning screw is parallel to the length of the meter ribbon. The meter ribbon, when put in place on the carriage, saddle or milling table, becomes a permanent installation. It functions as the accurate comparison link in the servo loop.

Much care is taken to magnetize this tape under uniform ambient temperature conditions, at a temperature that will be a mean value of that encountered in the ultimate location of the machine tool.

Servo System

A single-dimension system is shown in block and schematic form in Fig. 4 and 5. The primary signal generator reads the control-signal tape. The secondary signal generator gives a reading proportional to the actual position of the controlled member. The outputs of these two units are presented to a phase-sensitive detector and then to a torque motor which controls a hydraulic cylinder to complete the loop.

The sinusoidal signals from the primary and secondary signal generators are amplified by V_1 and V_2 and equalized by networks R_1 C_1 and R_2 C_2. The signals are then shaped by saturating-core transformers T_1 and T_2 and used to trigger a dual-entry Eccles-Jordan circuit which serves as a phase comparator. The plates of V_3 are adjusted so that the nonconducting and conducting plate voltages will be equally above and below ground potential.

When duty cycles are equal (resulting from 180-deg phase-displaced input pulses) the average d-c voltage at each plate will be zero. The circuit is direct-coupled push-pull into drivers V_4 and V_5 and into the differentially connected torque motor. Integrating network R_3 C_3 permits more loop gain as the rate-of-error signal change decreases. The hydraulic servo valve used with the equipment has

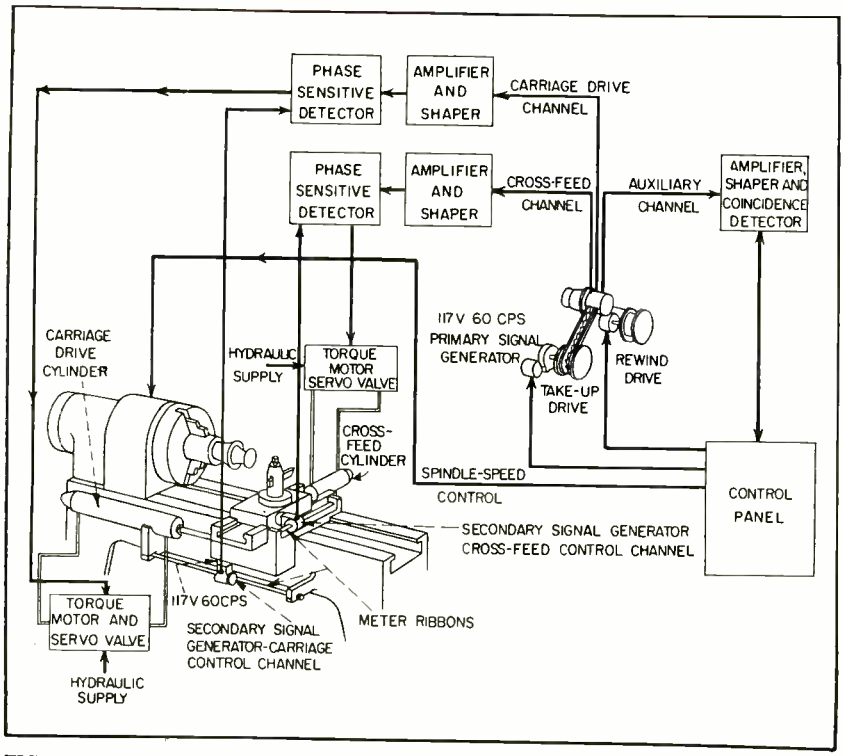


FIG. 6—Simplified diagram of two-dimensional control system applied to a lathe

response characteristics above 100 cycles per second, hence the L_1 C_4 network is added for 120-cps fundamental suppression. An error signal of only three degrees provides full power to the torque motors.

Pulse techniques have been employed in the phase detector to avoid effects of tube aging and low-level transient noise conditions. As a secondary advantage, the output of this type of detector is linear from +180 electrical degrees to −180 electrical degrees.

Auxiliary System

The auxiliary pickup head, an integral part of the primary signal generator, is identical with the main signal pickup. The auxiliary signals consist of the conventional parallel-line traces on the tape. However, they occupy only discrete phase-angle positions depending upon the desired number of auxiliary positions.

By a system of coincidence gates, operated by the auxiliary track in conjunction with a pulse-tooth pickup-head group, it is possible to include as many as six auxiliary controls with only one track channel. This operation can be understood by again referring to Fig. 5. When the magnetized insert falls beneath H_4, a positive pulse is injected into the grid of V_{8B}. At a time 180 mechanical degrees or 1/120th second later, a magnetized insert falls beneath H_5 and a corresponding positive pulse is injected into the grid of V_{8A}.

The signal from auxiliary head H_3 is amplified by V_6 and equalized by network R_4 C_5. It is then shaped and made to trigger one-shot multivibrator V_7. The normally nonconducting plate of V_{7A} is direct-connected to the cathodes of gate V_8. When the auxiliary signal is in time coincidence with either H_4 or H_5, the gate has an output which triggers the associated one-shot multivibrator V_9 or V_{10}. This in turn operates an appropriate relay, K_1 or K_2. Thus the relays individually stay closed as long as the auxiliary signal remains in phase coincidence with the appropriate pulse.

Operation

The technique under discussion offers a simple means of dynamic control without need for data conversion to digital or other pulse techniques. The latter approach invariably requires continuous tape motion or start-stop circuitry to avoid displacement error in the record. The system described has continuous closed-loop control, even when the tape is stopped. Thus, the tape can be stopped during certain operations, such as when a drill automatically positioned by the system is drilling through work and requires dwell time.

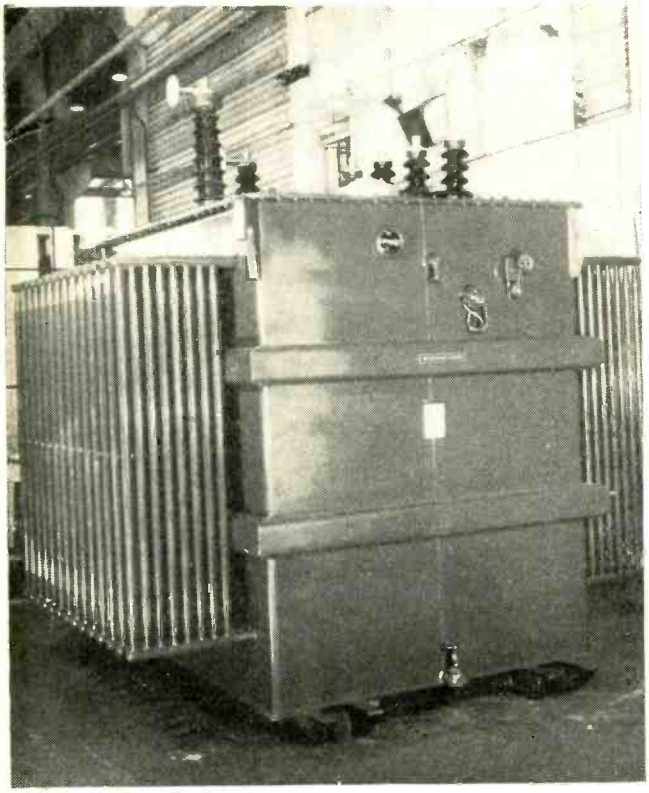
To conserve tape, the maximum displacement angle is usually used. The maximum angle tangent is 0.5; thus, 30 feet of tape gives a displacement total of 15 feet when meter ribbon pitch equals control-tape pitch.

Additional tape is required for acceleration. The recording process automatically provides constant acceleration (or uniformly increasing velocity) until the maximum displacement angle is reached.

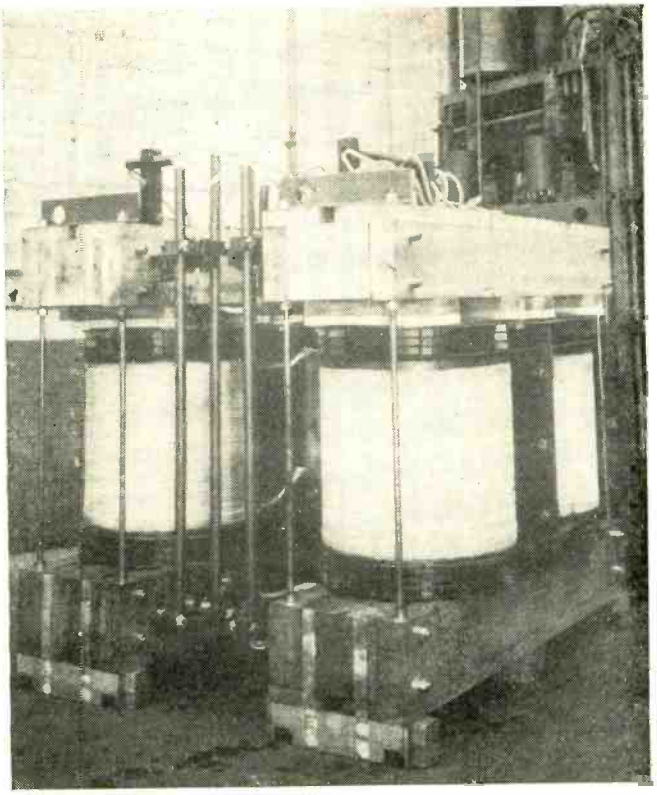
Occasionally the pitch of the recorded bauds on the meter ribbon is changed to a number greater or less than the pitch on the control tape. The resolutional accuracy of the system, as well as the ratio of tape length to controlled member displacement, is a function of this pitch ratio. With a pitch ratio of one to one, the overall accuracy from record to controlled member is better than ±0.001 inch.

Controlled-member velocity is usually varied by changing the speed of the control tape. For multidimensional work and contour control it is often desirable to control member velocity by displacement-angle variation. Also, in multidimensional control, one primary signal generator with multiple pickup coils is used and all dimensional-control channels recorded on one control tape. The width of any control channel is six parallel traces of 0.050-inch pitch for a total of 0.3 inch. To reduce crosstalk, 0.10-inch separation is used between adjacent channels. An individual secondary signal generator is used for each independent dimension control.

The author acknowledges the invaluable assistance given by system inventor Eric Neergaard and his assistant H. Trechsel; J. F. Dundovic of Maico, who contributed heavily on development; the Maico engineering staff; S. Jatras and personnel of the Midwestern Geophysical Laboratories; and D. A. Gerard of DAG Tool and Engineering.



Single-phase saturable reactor rated at 7,500 kva



Core of saturable reactor used for vlf antenna tuning

Keying VLF Transmitters

Rapid keying of high-power Navy transmitters operating on 15 to 35-kc carriers made possible with frequency modulation. High-Q antenna is kept resonant to driving frequency by means of a saturable reactor. Teleprinter signals transmitted at 19 kc with powers of 450 kw using 100-cycle shift are successfully received at 5,000 miles

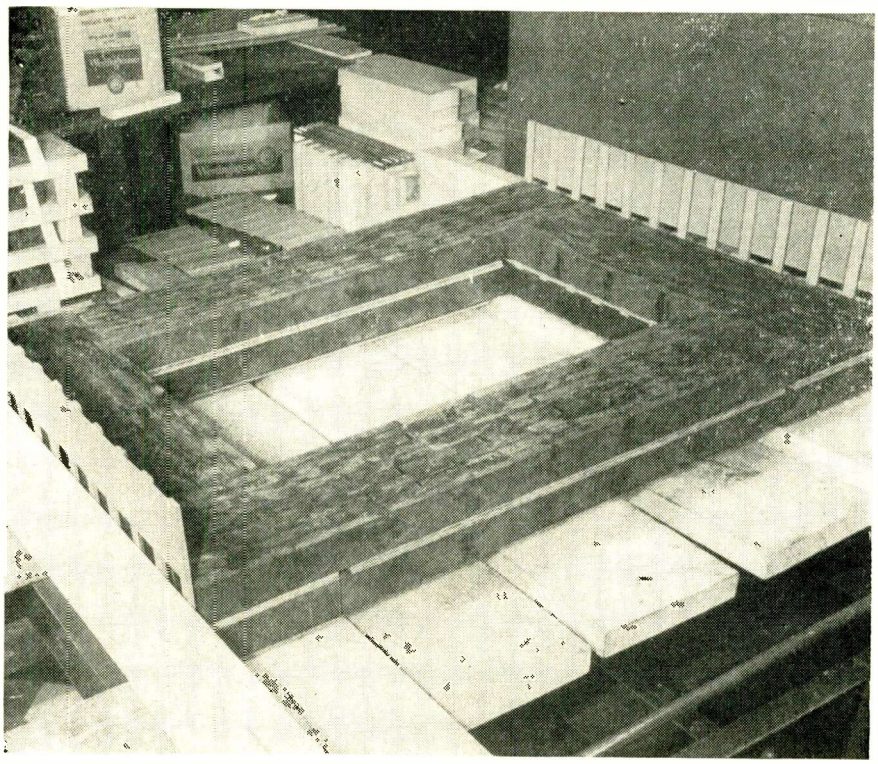
COMMUNICATIONS with naval ships at sea and submarines running under the surface at distances up to several thousand miles must be maintained on a 24-hour-per-day basis. Such rigorous conditions can best be fulfilled with high-power, very low-frequency transmitters, operating from strategic positions around the world. These transmitters are capable of delivering from 250 to 1,000 kw of r-f power into antennas designed to radiate in the 15 to 35-kc radio frequency spectrum.

Practical antennas employed in this service are electrically short and therefore exhibit a very high Q. As a result, the speed of on-off keying is seriously restricted. No attempts have been made in the past to frequency-shift key the transmitters because of the severe distortions produced by the limited bandwidth of the antenna resonant circuit.

High-Q Antenna

The problem of adapting high-speed communication to vlf transmitters has been solved by employing a frequency-modulated transmitter followed by an antenna whose resonant frequency is kept tuned to the instantaneous driving frequency. As expected, varying the resonant frequency of a high-power, high-Q antenna in synchronism with the instantaneous driving frequency proved to be a major task. It was accomplished, however, with a variable reactance in the form of a saturable reactor. With the reactance tapped across the tuned antenna circuit and the appropriate signals applied to its control windings, the desired antenna resonant frequency shift can be obtained.

The equivalent circuit for the antenna and associated tuning elements employed in vlf stations is shown in Fig. 1. In the frequency range of 15 to 35 kc, reactances in this type antenna frequently run as high as 450 ohms. On the other hand, resistance values are only 1 or 2 ohms. Thus, for developed powers in the order of 500 kw, voltages are obtained in hundreds of



Slabs of a special ferrite magnetic material are used to build up the core

at High Speed

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Transformer Division
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kilovolts and currents are generated in hundreds of amperes.

Double-Ended Tuning

Voltages applied to single ended antennas are limited to between 250 and 300 kv by the formation of corona discharges. For this reason the antenna circuit of Fig. 2 is often employed. This multiple tuning system increases the amount of antenna current flowing, for a given voltage, over a single-tuned system of the same size. The effect is accomplished by having two vertical downleads tuned by two separate inductances.

Thus, half of the antenna's total capacitance is tuned to resonance by one tuning coil having twice the inductance of the tuning coil in the single-tuned system. The other half of the antenna is tuned by the other inductance and the two halves operate in parallel. It is only necessary to couple the transmitter to one of the inductances since the second section is excited because of its proximity to the first section.

Such an antenna has been installed at Naval Radio Station NSS at Annapolis, Maryland. It was on this antenna that all of the field tests of this communications system have been conducted. The characteristics of the antenna are shown in Fig. 3. Examination of these curves reveal that the Q of the antenna varies from 800 to 150 over the 15 to 35-kc frequency range. The resulting bandwidth varies from 18 to 230 cycles. Thus, at the lower radio frequencies, the transient response time is such that serious distortion would occur at signaling speeds associated with machine keying.

No advantage is gained in this respect from frequency modulation when operated in the conventional manner. Even with low-frequency shifts, the signal would be subjected to serious amplitude distortions and phase shifts. To be compatible with high-speed operation, Q values have to be much lower, a condition that is incompatible with efficient operation at high power levels.

F-M and Variable Circuit

The new system avoids the dilemma by utilizing frequency modulation and an antenna circuit having variable circuit elements. Since the objectionable distortion arises from temporary discrepancies between tuning frequency and instantaneous signal frequency, it is possible to avoid them simply by varying the resonant frequency of the tuned antenna circuit in synchronism with the instantaneous f-m driving signal.

At first the proposal seems to violate a principle that decrees the rate for transmitting information through a channel of given bandwidth is limited by that bandwidth. However, further investigation reveals that in this system, intelligence is transmitted only after advance information has been received at the control element. Thus, the signal can hardly be considered independent intelligence within the meaning of the theorem.

Having accepted and proved these concepts, the problem became one of supplying a device capable of tuning a high-voltage, high-power antenna in synchronism with a frequency-modulated signal. The device requires response times compatible with the frequency of the signaling equipments. It is desirable also that both the power necessary to control the device and the power dissipated in the device be held to conservative values.

Saturable Reactor

A saturable reactor employed as shown in Fig. 4 meets the neces-

sary requirements. The reactor is tapped across a portion of the loading inductance normally used in the antenna circuit. Direct control current is supplied to the reactor in accordance with the keying signals supplied to the frequency-determining circuits of the transmitter. It is thus possible to vary the reactance of the antenna circuit with sufficient accuracy to transmit intelligence. Distortions are held within acceptable limits.

Antenna Efficiency

The reactor used for this purpose has sufficient sensitivity and a low enough loss factor that it can be placed in the high-power antenna circuit without reducing the efficiency of the antenna beyond acceptable proportions. In fact, under the most unfavorable conditions possible in 500-kw operation, it is calculated that not more than 20 kw will be lost because of the addition of the reactor. This loss is encountered under conditions of the full 100-cycle shift employed by the system.

Success of this system depends to a large extent on the satisfactory performance of the saturable reactor. Careful consideration was therefore given to the design and construction of the 7,500-kva reactor employed.

Any iron-core device capable of handling 7,500 kva and dissipating over 20 kw without means of external cooling is necessarily large. This reactor is rated at 7,500 kva, single phase, 15,000 to 34,000 cycles, 75,000 volts. It is oil-insulated, self-cooled and suitable for outdoor operation. To facilitate moving, it is mounted on a structural steel base equipped with wheels having a standard railroad gage. The unit weighs 46,000 pounds and measures 10 by 12 by 12 feet.

Construction

To obtain the desired electrical characteristics it was necessary to use two sets of cores and coils for each unit. The magnetic circuit is rectangular in shape, built up of slabs of a special ferrite magnetic material.

Each ferrite slab is separated from the adjacent one by pressboard duct spacers to permit the free circulation of oil through the core for cooling.

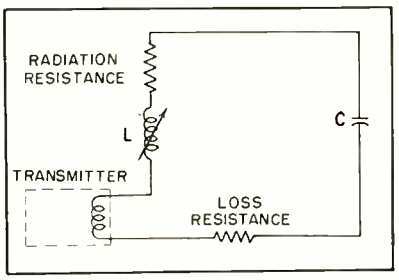


FIG. 1—Equivalent circuit of vlf antenna and tuning network with single-ended tuning

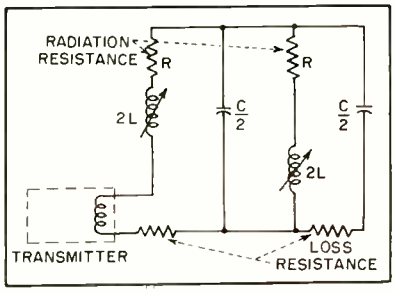


FIG. 2—Tuning network with double-ended tuning and equivalent circuit of vlf antenna

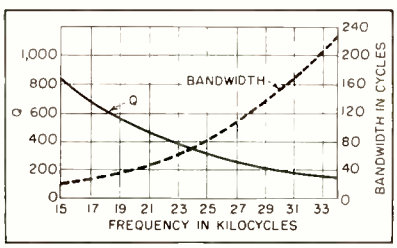


FIG. 3—Curves plotted for vlf antenna and tuning network with double-ended tuning

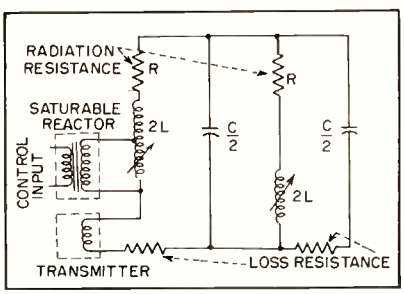


FIG. 4—Equivalent circuit of vlf antenna and tuning network with saturable-reactor tuning element attached

Each of these slabs is made up of Ferroxcube blocks approximately 2.8 by 1.1 by 6.9 inches, all laid and cemented together similar to a brick building. There are more than 2,000 bricks used in each core. Each brick has its surfaces carefully ground to reduce the effective gap length and keep reluctance to a minimum. Special jigs were required to construct the saturable reactor core.

Coil Design

The high voltage and frequency at which this reactor must operate necessitated a special coil design. The coils are wound with a relatively few number of turns of a very low-loss Litz cable, consisting of 4,500 strands of 0.005-inch diameter copper wire, each insulated from the other and twisted into a transposed cable. The coils are cylindrical, with an inner and an outer coil on each leg of the core. Cooling ducts are dispersed through the coil to permit the free circulation of oil.

To keep stray eddy current losses to a minimum, no magnetic materials were used in the core and coil structure. The complete core assembly was given several dips in a thermosetting varnish and baked, bonding the complete structure into one solid mass.

Cable Connections

Making electrical connections and splices in the Litz cable required a special technique. Conventional methods of brazing or soldering could not be used because of the small diameter of each strand of the cable and the fact that each strand is individually insulated with varnish. First, the number of connections necessary was kept to a minimum by continuing the cable in the coil directly to the final destination.

For the few connections that were necessary the following procedure was followed: each cable end was wrapped tightly with a fine bare copper wire and sweated together with solder; the cable was then cut off with a hack saw through the sweated end; the two ends to be joined were then telescoped into a copper ferrule with the two raw ends butted together; the joint was soldered by pouring molten metal through a hole at the center of the ferrule.

Insulation and Shielding

A special low-capacitance design of high-voltage bushing was developed to insulate the high-voltage lead from the cover. At the voltage and frequency at which the reactor

operates, the dielectric loss in commonly used materials (such as wet process porcelain, micarta papers and some press boards) is so high that the internal heat developed would destroy them. Combinations of low power factor press board separated by oil ducts are assembled inside a porcelain weather housing. Shielding is placed at the high stress points to help distribute the dielectric stresses and remove the porcelain from the electrostatic field.

When operating under rated conditions of 75,000 volts at 100 amperes, at a frequency of 18 kc, the flux density in the core is approximately 800 gauss. The permeability of the unit measured on the assembled core with zero d-c control current approaches 1,200.

To obtain a 100-cycle variation in the antenna resonant frequency at 18 kc, a control current change of 100 amperes is required. This change is effected at an absolute current level of from 25 amperes to 125 amperes.

Special modulation equipment is required to produce control currents of the order required. Design of this equipment is determined to a large degree by two major factors. The first is the efficiency problem encountered when direct currents must be amplified to large values. For the second, fast changes in current must be produced in an inductance. This response time must be decreased to allow keying at reasonable speeds.

Modulation Equipment

Both of these problems are overcome by the modulation equipment shown in Fig. 5. Efficient d-c amplification is made possible by a subcarrier amplifying chain followed by a rectifier in the power output stages. Response time is reduced to satisfactory levels by a pulse injection system that acts to increase the rise and decay time of the d-c control signals. Having produced current signals in the control winding of the reactor in accordance with the keying signals, it follows that an inductance change of the same form will occur at the output of the secondary windings of the reactor.

It can be shown that a shift of the same shape will result in the resonant frequency of the antenna circuit. Since the keying signal for the transmitter frequency-shift circuits is taken as a sample of the current in the control windings of the reactor, the shift of frequency of the transmitter will correspond in shape to the shift in antenna resonant frequency. By properly adjusting the amplitudes of the signals involved, both amplitude and shape of each frequency variation can be made to correspond.

Subcarrier

Referring to the subcarrier signal chain shown in the top line in the block diagram of Fig. 5, operation can be described as follows:

The 1,800-cycle subcarrier signal is generated in the oscillator stage and then modulated approximately 70 percent by the keying impulses, usually teleprinter signals. This 1,800-cycle wave, now modulated in accordance with the keying signals, is amplified by the power amplifier, transformed to low impedance, rectified by dry-disk rectifiers and appears as a large d-c signal variable in amplitude. Except for rise and decay times, the d-c signal is a reproduction of the original keying signal.

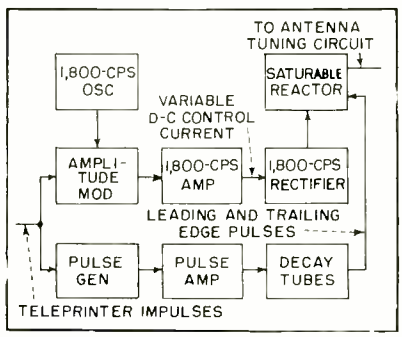


FIG. 5—Block diagram of the reactor modulator unit

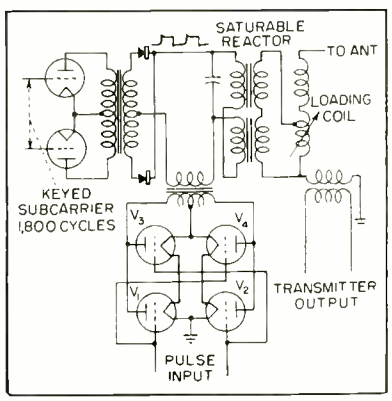


FIG. 6—Circuit for reactor modulator pulse injector with pulse decay tubes

Pulse Injection

Since the exception to the exact duplication of the keying signal (slower rise and decay time) is unacceptable for satisfactory operation of the system, the pulse chain shown in the lower half of the block diagram of Fig. 5 is employed. This portion of the modulation device provides pulses at the leading and trailing edges of the keying impulses or characters, which result in current signals of adequate rise and decay time to be supplied to the control circuit of the saturable reactor.

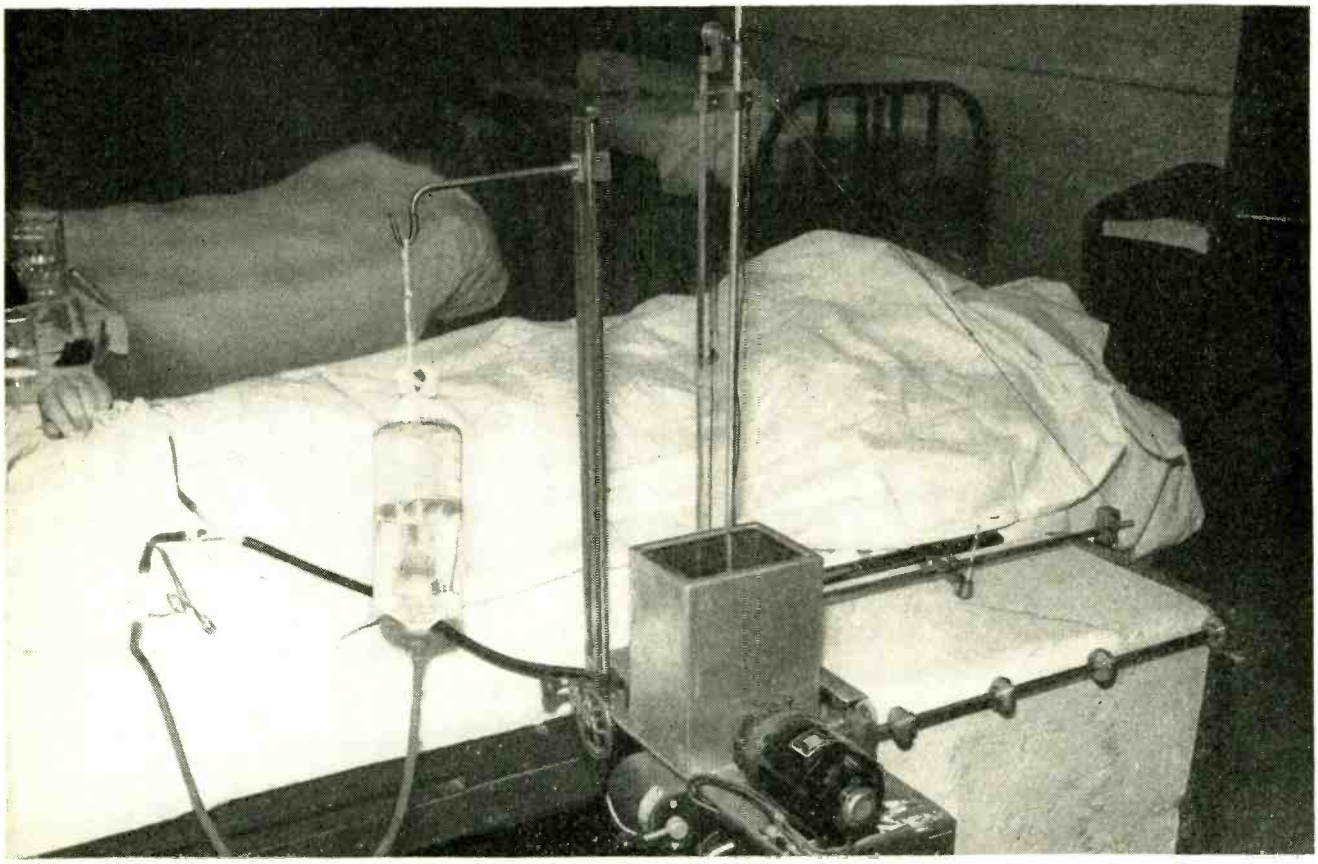
The type of circuit employed in the final stages of the modulation unit appears in simplified form in Fig. 6. The d-c control circuit of the saturable reactor is shown inserted in series with the secondary winding of a pulse transformer. Tubes V_1 and V_2 inject the pulse voltages necessary to effect the rapid current changes required to follow the beginning impulses accurately.

The addition of decay tubes V_3 and V_4 provides a low-resistance path for the circulating current in the primary of the transformer, which further serves to improve the control wave shape. By use of this system it is possible to effect the 100-ampere control current change with less than 10 kilowatts of power.

Performance

Successful teleprinter transmissions were made at 19 kc using approximately 100-cycle shift and 450-kw maximum transmitter output. These signals were received and copied at various receiver stations varying in distance from the transmitter from 35 miles to over 5,000 miles.

The results of these tests demonstrated that this system of high-speed communication is basically sound. By applying such techniques to existing installations, the efficiency of vlf communications can be greatly increased at a cost far below the initial cost of the transmitting equipment now in service.



Apparatus records changes in patient's biliary system pressure. Recordings are directly in centimeters of water

Manometer Recorder for

Servomechanism helps medical researchers determine effects of various drugs on patients. Motor-driven ball-point pen records variations in manometer water level as pressure changes in bile-duct system. Recording technique is applicable to industrial uses

PAIN as a result of improper functioning of the gall bladder and associated ducts is not uncommon. The study of pressures existing in this system and their possible modification by drugs often used to treat this pain offer valuable information to the clinician.

Bile is formed in the liver, stored in the gall bladder and delivered to the small intestine through the common bile duct. The sphincter of Oddi located at the junction of the common bile duct and the small intestine acts as a valve to control the flow of bile. Its contraction is highly variable and its change in contraction as a result of drug action is of considerable interest.

Although the biliary system is ordinarily inaccessible, when a gall bladder is removed surgically and a T-tube introduced for drainage, it is possible to measure pressure changes in the system. It is also possible under these circumstances to increase the ductal pressure by the addition of physiological salt solution and thus to determine the amount of pressure necessary to overcome the contraction of the sphincter of Oddi. These pressure changes may be measured most easily with a water manometer, as shown in Fig. 1. The problem remains to record the level of the water manometer as a permanent record of pressure changes. This could be done photographically by recording its lens-like action, but expensive paper and development of a large record are required. To eliminate the photographic process it was decided to use ordinary white paper in a roll 18-inches wide and a moving ball-point pen driven by a motor in a simple servomechanism.

System Operation

As diagramed in Fig. 2 the motor is controlled by a follower device which consists of a lead weight suspended in the manometer tube with a contacting needle beneath it. The weight is suspended by a fine gold chain to provide sufficient flexibility. The chain passes over a pulley

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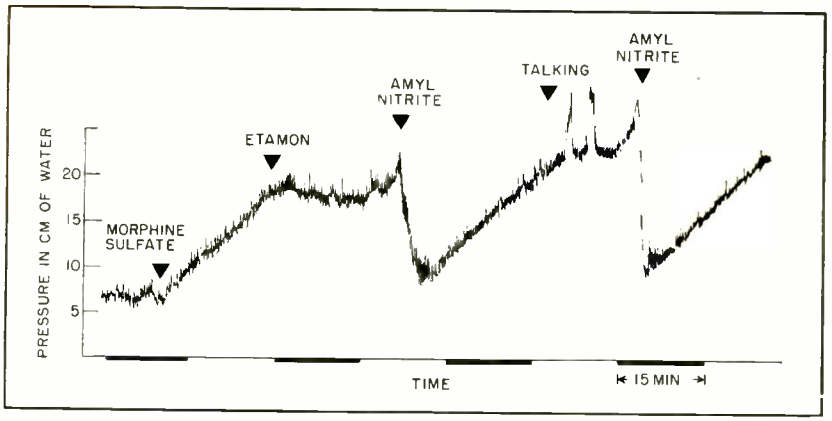

Typical recording shows effects of intravenous injections of morphine sulfate and etamon. The amyl nitrite is administered by inhalation. Effect of talking is reflected in increased intraductal pressure

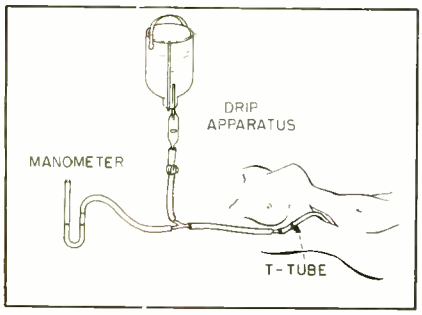

FIG. 1—Setup for measuring biliary pressure changes

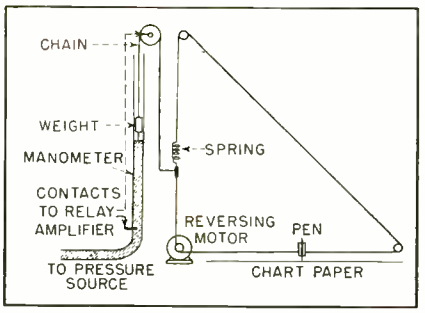

FIG. 2—Schematic representation of apparatus in photograph

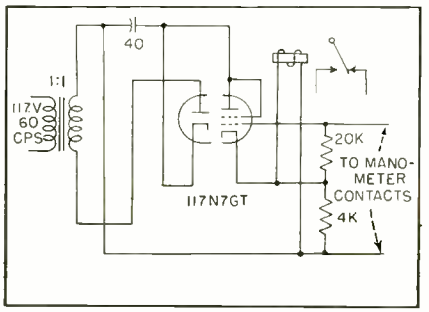

FIG. 3—One-tube amplifier controls motor-reversing relay

Physiological Pressures

and is attached to a cord driven by a reversible motor, which controls the positions of both a pen passing horizontally over the recording paper and of the lead weight suspended in the manometer tube. The direction of motor rotation is changed by the relay in the cathode circuit of the amplifier in Fig. 3.

The relay is actuated by the presence or absence of a contact between the surface of the liquid in the manometer tube and the tip of the needle. If contact is made, the motor is energized to lift the weight and if broken, energized to lower the weight. This action provides a continuous small oscillation above and below the actual pressure.

The movements of the electrode are directly reflected, centimeter by centimeter, by the pen—giving a record of the height of the water column without further calibration.

There is no definite on and off electrical contact of the electrode and water column when the inside of the tube becomes wet, even if antiwetting agents are used on the glass. There is instead a small differential in resistance, that is not sufficient to operate an ordinary type of relay which when closed tends to remain closed. To operate with this small differential, a galvanometer of the type used in electroencephalographs was converted into a heavy meter-type contactor by the addition of tungsten contacts, which operate as a reversing switch.

To permit placing the apparatus at the proper level with respect to a patient lying in bed, the entire mechanism is mounted on a column, the height of which can be controlled by a threaded shaft obtained from an automobile jack. The lower end of this shaft has attached to it a worm gear which is coupled to a worm on the shaft of a small reversible motor. The motor is controlled by a switch, raising or lowering the entire instrument to the desired position. A microswitch is so connected that the movement is stopped at a predetermined limit.

Although designed particularly for gall-bladder pressure recording, the instrument is also adaptable to recording venous or similar physiological pressures. It has the advantage of comparative simplicity, uses ordinary paper, produces a large record and insures complete stability of pressure recordings. The recordings are obtained directly in centimeters of water without need of calibration.

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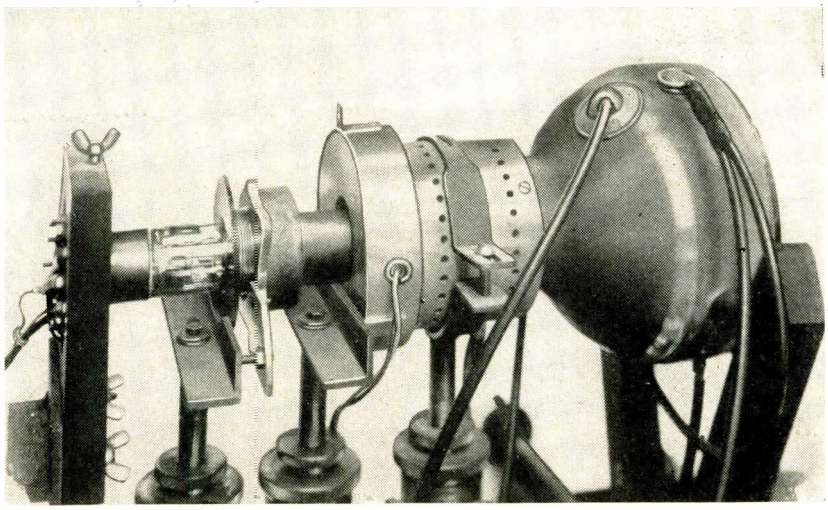

Tube assembly showing focus magnet and focus and deflection coils

Dark-Trace Display Tube

Special electron optical design causes dark-trace crt to have writing speed better than three times previously available. Analysis of dark-trace tube writing-speed qualities presented as function of electron gun and screen characteristics, with experimental proof

DARK-TRACE tubes have certain inherent advantages over bright display tubes which make their use desirable for information displays. These advantages are: the ability to integrate visually, to retain information for extended periods of time and to present optimum contrast with high ambient illumination. The daylight viewing characteristic of dark-trace tubes, in conjunction with the storage characteristic, explains the interest in these tubes.

One limit to the utilization of the dark-trace tube in the past has been the low information-display rate. A tube is described herein which greatly increases the display rate. It incorporates a special electron optical system, which reduces the deflection defocusing encountered when high beam currents are employed.

Analysis

After basic analysis of the problem of the low information-display rate of dark-trace tubes, it was found that an appreciable improvement was required. A study of the characteristics affecting the writing speed revealed that changes in the accelerating potential, the beam current or the screen sensitivity would influence the writing speed of the tube.

A possible solution to the problem was to increase the accelerating potential. However, limitations to this technique were immediately apparent. The magnitude of the possible increase in the writing speed due to increased potential would be limited. In addition, the insulation and corona problems associated with potentials higher than fifteen kilovolts limit any proposed tube's application.

Based on the relationship between contrast and the charge density deposited on the dark-trace tube screen, an analysis was prepared and experimental verification obtained of the relationship of writing speed, beam current and spot size.[1,2,3] The formulation arrived at was

$$W = KI/s \qquad (1)$$

where W is writing speed, I is beam current incident on the screen, s is spot size and K is a constant determined by the screen sensitivity. This equation led to the information display rate, which is equal to the writing speed divided by the spot size

$$F = W/s = KI/s^2 \qquad (2)$$

where F is the information display rate. This is a more accurate formulation for comparing different tubes since it is actually the maximum number of digits of information that can be displayed per unit time.

An increase in the writing speed could be attained by increasing the factor K in Eq. 1. This, however, would involve a modification in the basic screen material, entailing a long study of the crystal state of the screen material and the effect of the variations in the composition of the screen material on the formation of the F centers. Available information indicates that an increase in the sensitivity of pure potassium-chloride screens would

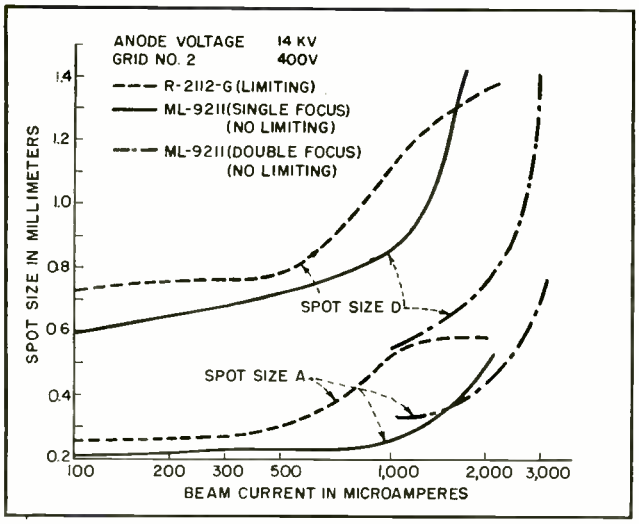

FIG. 1—Spot-size characteristics of R-2112-G and ML-9211

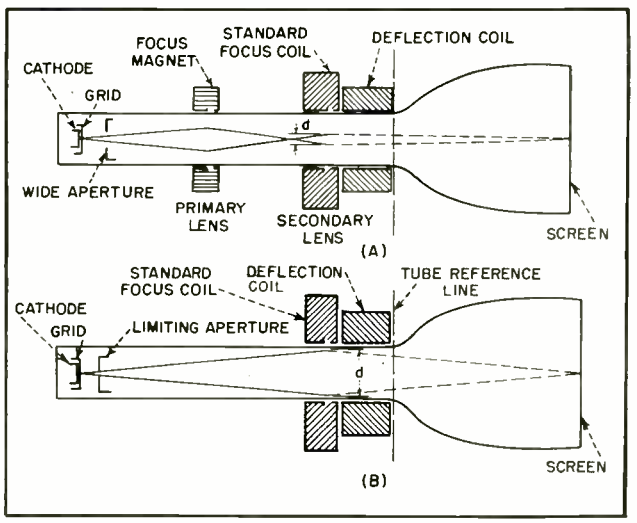

FIG. 2—Beam diameter in double (A) and single-focus (B) tubes

Has High Writing Speed

be very difficult and here again, the possible increase would probably not be sufficient to warrant the effort.

The remaining factor in the writing-speed equation, the ratio of beam current to spot size, showed the most promise. Our objective, therefore, has been to increase the ratio of the screen current of a dark-trace tube to the spot size while maintaining satisfactory resolution.

Tube Description

To attain the desired objective, a dark-trace tube (ML-9211) was constructed containing a wide-aperture tetrode gun and a low-heat-capacity mica-supported screen. The gun is capable of approximately ten-milliamperes emission through the wide aperture.

This tube was studied to determine if it satisfied the basic requirement of the problem, an improvement in the writing speed. The vertical-deflection waveform was a sawtooth and the horizontal waveform a sinusoid. The frequency of the sinusoid was increased until the trace just disappeared at the vertical centerline. The writing speed was then calculated by measuring the width of the raster, noting the frequency of the sinusoid and substituting these values into the formula

$$W = 2\pi fa \qquad (3)$$

where W is writing speed in centimeters per second, f is frequency of the sinusoid in cycles per second and a is amplitude in centimeters. The small vertical velocity component can be neglected.

The results of this study were not completely satisfactory. The writing speed, at one-milliampere beam current, was 7.1 kilometers per second as compared to a previously determined value of five kilometers per second for the standard R-2112-G tube, or an increase of about 40 percent.

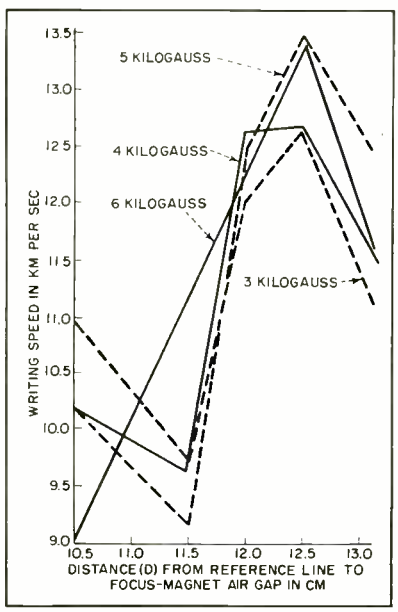

FIG. 3—Variation of writing speed with D at various values of flux density of the ML-9211 double-focus tube

An increase in the beam current beyond one milliampere was accompanied by increased deflection defocusing. To obtain a quantitative measure of this phenomenon the spot size was measured as the beam current was increased. It was found that a comparison of the standard spot size A[4] of the shrinking raster method (the line width at the center of the raster), with spot size D produced a measure of the deflection defocusing. Spot size D is defined as the line width determined by shrinking a fifty-line raster until the top two lines merged. Results of these measurements, shown in Fig. 1, and spot size measurements of the R-2112-G confirmed the observation that the increasing spot size of the ML-9211 restricted it to operation with beam currents of one milliampere or less. The criterion for this limit was taken to be a spot size of one millimeter, which is comparable to that of the P-7 cascade screens currently in use.

Electron Optics

It has been found that the basic cause of the deflection defocusing

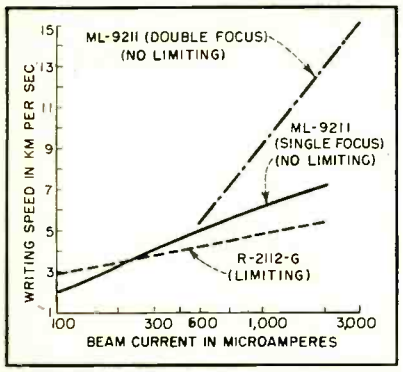

FIG. 4—Writing speed with 14-kv anode voltage and 400-v grid No. 2 voltage

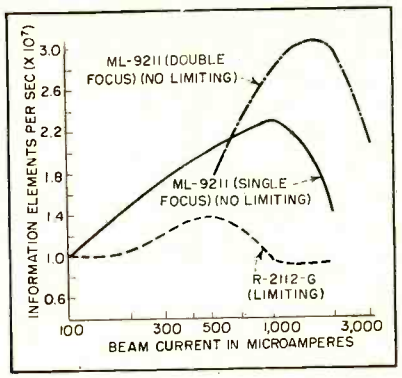

FIG. 5—Information display rate of various tubes

encountered is the large diameter of the electron beam in the field of the deflection coils.[5] With this as a guide, a lens system was designed to reduce the beam diameter entering the field of the deflection coils.

The lens system is shown in Fig. 2A. It is composed of a primary, short focal-length lens and a secondary, long focal-length lens. The primary lens, placed on the neck of the tube just forward of the gun structure, converges the beam at a point just before the field of the secondary lens. The secondary lens, in turn, refocuses the beam at the screen. Comparing this system to the conventional focus lens, shown in Fig. 2B, the diameter of the beam, d, has been reduced by producing an effective point electron source much closer to the focus coil.

The primary lens field, calculated from the geometric character of the tube employed, is approximately four kilogauss as measured in the air gap with a kilogauss meter. Since this field magnitude can not be produced by a practical electromagnetic lens, an Alnico-V magnet was magnetized to a stable condition having a variation of from three to six kilogauss by mechanical variation of the air-gap dimension.

The secondary lens is a standard 2D2 electromagnetic focus coil.

Initial attempts to employ the system indicated a substantial reduction of the deflection defocusing found at two-milliamperes beam current. The position and field strength of the primary lens were then varied to determine the optimum operating conditions. The graph of the results, Fig. 3, indicates the position and field for minimum deflection defocusing to be at 12.5 centimeters from the tube reference line and a field strength of five kilogauss. These values were found to yield good results for all beam currents employed.

Results

The results of the various spot-size determinations are summarized in graphical form in Fig. 1. It will be noted that, while the ML-9211 and the R-2112-G have equivalent spot sizes A and D for beam currents up to nine-hundred microamperes, the ML-9211 has much more severe deflection defocusing for higher beam currents. The aperture limiting of the R-2112-G is apparent when compared to the ML-9211 at these higher beam currents. The improvements obtained with the two-lens focusing system are verified by the displacement of the spot-size curves of the ML-9211 employing the system. The curves are displaced appreciably in the direction of higher beam current. The spot size A is maintained below 0.5 millimeter while the spot size D is practical for beam currents up to and including two and a half milliamperes.

The results of the writing-speed measurements are shown in Fig. 4. The R-2112-G is capable of a usable writing speed as fast as five kilometers per second. The ML-9211, employing the conventional focus system, attains a maximum of seven kilometers per second, while the two-lens focus system raises this value to fifteen kilometers per second. Thus the combination of the ML-9211 and the two-lens system provides a considerable improvement as compared with the R-2112-G. The final figure attained is an improvement of more than three-hundred percent.

The information-display rate shown in Fig. 5, which provides a good figure of merit, varies from a maximum of 1.37×10^7 elements per second at 500-microamperes beam current for the R-2112-G to 2.30×10^7 elements per sceond at 1,000 microamperes for the ML-9211 and to approximately 3.05×10^7 elements per second at 1,800 microamperes for the ML-9211 with the two-lens system. This is an improvement of 124 percent.

Applications

In oscillography it will be possible to obtain recordings of faster nonperiodic phenomena than could previously be recorded. The two-lens system insures that the trace will be sharp and clear and enables display of more rapid phenomena.

For radar applications the dark-trace tube now comes closer to having the high writing speed characteristics of bright-trace tubes, with the additional advantages of the scotophor. With its integration abilities and daylight viewing, it can prove most useful in the fields of signal-to-noise enhancement, where signal retention is required.

The two-lens focusing system itself is applicable to any cathode ray tube which is to be operated at high beam currents. It is useful where extremely small spot size is required and aperture limiting is not feasible. It may enable construction of shorter cathode ray tubes for television by reducing the deflection defocusing found when wide deflection angles are used.

The authors express their appreciation to F. Holborn for his kind cooperation and to D. H. Andrews and F. R. Darne without whose encouragement this work would not have been possible.

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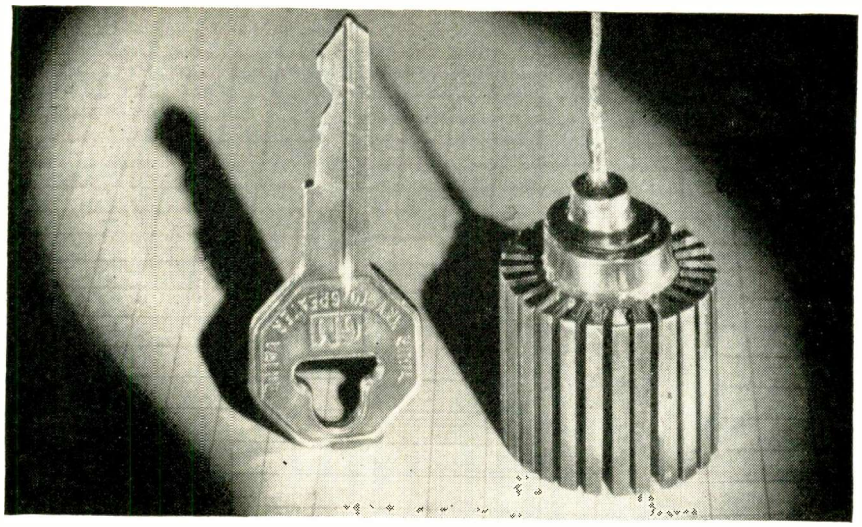

New rectifier, shown approximately actual size, is 1 inch in diameter and about 1 inch high. Slots in copper mount aid cooling by natural convection or forced air

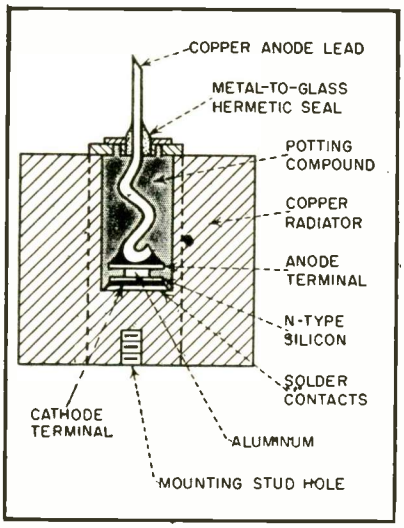

FIG. 1—Cross-section of rectifier. Junction area of silicon is 0.05 square inch

Silicon Power Rectifier Handles 1,200 Watts

Larger junction area in new fused-junction silicon rectifier permits radical miniaturization of high-power rectifiers because efficiency approaches 98 percent and remaining heat loss is readily dissipated through copper mount. Air cooling doubles power rating

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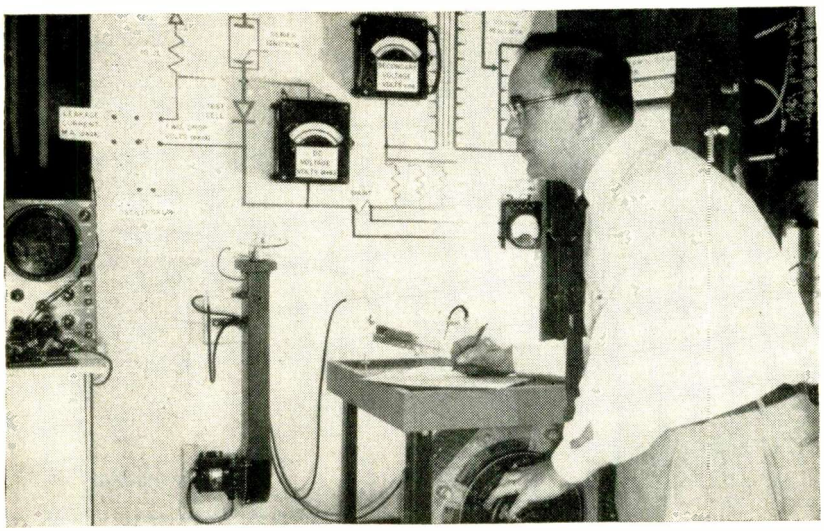
NEWLY DEVELOPED silicon power rectifiers have a junction area of 0.05 sq cm, as compared to 0.00005 to 0.0005 sq cm for older types of *p-n* junction silicon rectifiers. The new fused-junction units are prepared with *n*-type single-crystal silicon having an electrical resistivity in the order of 1 to 5 ohm-centimeters. Aluminum is used as the *p*-type impurity element which is fused to the silicon to produce the *p-n* rectifying junction. The units are assembled with suitable anode and cathode terminals and then encapsulated in heat exchangers, as illustrated in Fig. 1.

The heat exchanger consists of a finned copper radiator which serves as one electrode of the rectifying cell. The other electrode is a wire lead that emerges from the top of the radiator through a metal-to-glass bushing that hermetically seals the rectifier. A suitable potting agent fills the cavity between rectifier and top of the heat exchanger, and electrically insulates the rectifier terminals.

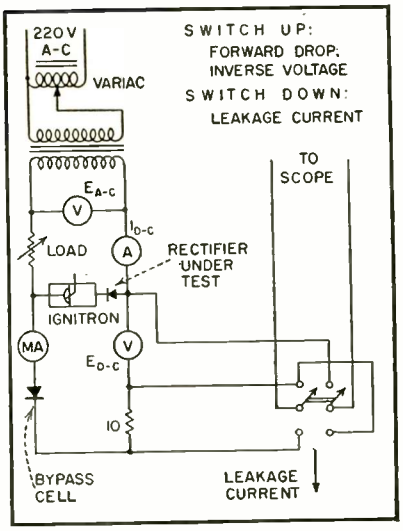
D-C Characteristics

The curves in Fig. 2 present the d-c characteristics of a typical silicon power rectifier having a *p-n* junction area of 0.05 sq cm. Reverse and forward characteristics of an older silicon rectifier with an extremely small *p-n* junction area (0.00007 sq cm) have been added in Fig. 2A for comparison. The small-area junction rectifier has an extremely sharp reverse breakdown voltage curve, whereas the power rectifier curve has a more gradual bend or soft knee. Also, the leakage current at relatively low values of voltage is high in comparison with small-area junctions. For example, at about 30 v the leakage current is 1 ma for the large junction, as compared to 0.05 μa for the small junction.

Despite the inferior reverse characteristics, the larger-area junctions have leakage currents which are sufficiently low for the majority of power applications (about four times lower than those obtained on germanium rectifiers of comparable area when operated at the same inverse voltage). This is true despite at least a 100C increase in operating temperature for the silicon



Single-phase half-wave test setup for silicon power rectifier, using forced-air cooling. Rectifier is mounted on top of duct running up from blower on panel



Test circuit, showing use of series ignitron for limiting inverse voltage

power rectifiers during tests.

The forward d-c characteristics of the 0.05-sq-cm junctions are quite good. At 1 v, for example, the forward current is 10 amp, which corresponds to a current density of 200 amp per sq cm. For power applications, low values of forward drop are quite important since the bulk of the heat developed in the junction is produced by the forward rather than reverse characteristics.

Another important feature of a silicon power rectifier is the relatively high rectification ratio obtainable. For the unit of Fig. 2A the rectification ratio at 1 v is 5.9 million at room temperature, which is similar to the values obtained for small-area junctions. However, the high rectification ratio is obtained because the forward current density a 1 v is improved to a greater extent than the leakage current is adversely affected by increasing the junction area.

Temperature affects leakage current of silicon power rectifiers appreciably, as shown in Fig. 2B. At low values of voltage, leakage current increases as test temperature increases. At high voltages, however, the curves for various test temperatures cross and leakage values become lower at higher test temperatures. Stated in another way, higher values of breakdown voltages are obtained as test temperatures are increased.

Figure 2B also illustrates that the forward voltage drop is lower at higher test temperatures. The effect of temperature on forward drop is apparently greater at low values of forward current. For a forward drop of 0.5 v, for example, the forward current changes from 0.045 ma at −50C to 0.2 amp at 200C—a change of almost four orders of magnitude. At 1 v forward drop, the corresponding change is from 1.5 to 3 amp or less than one order of magnitude.

The effect of temperature on rectification ratio for the application of 1 volt in both the forward and reverse directions is indicated in Fig. 2C for a typical 0.05-sq-cm silicon power rectifier. At room temperature, the forward-to-reverse current ratio is in the order of 0.5 million. This value decreases to 13,000 at 150C and to 3,000 at 200C. The increase in leakage current with temperature is primarily responsible for the drop in rectification ratio. Rectification ratios much higher than these, in the order of 6 million at room temperature, have been obtained as indicated in Fig. 2A.

A-C Characteristics

The current-carrying ability of the encapsulated rectifiers was de-

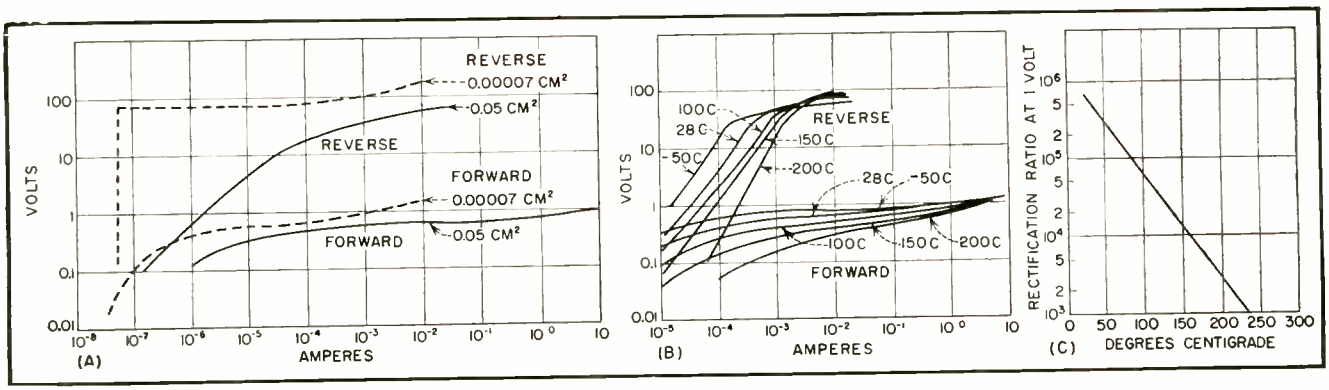


FIG. 2—Curves showing d-c forward and reverse characteristics of typical silicon power rectifier at room temperature, and effect of temperature on these characteristics and on rectification ratio. Dashed curves apply to older unit

termined by noting how the peak values of forward voltage drop and leakage current varied as the load current was increased, both for natural and forced-air cooling.

Results obtained for a rectifier operated at a peak inverse voltage of 100 volts are shown in Fig. 3. For natural convection cooling, the forward drop and leakage curves vary almost linearly with load current until the latter exceeds about 6 amp average. At this point, the peak leakage current has reached 10 ma and is rising sharply, more so than the forward voltage drop. It appears that the heat-dissipating ability of the copper radiator is decreasing, so that higher load currents result in rapidly increasing leakage current. For natural cooling, therefore, the silicon power rectifier can safely handle a load current of 6.5 amp average at 100 v peak inverse. For single-phase half-wave circuits this corresponds to 10.2 amperes rms, which for the 0.05-sq-cm junction area indicates a current density of about 200 amp rms per sq cm. The rms power output of the rectifier under these conditions is $10.2 \times 50 = 510$ watts.

For forced-air cooling, the slope of the forward drop curve is somewhat lower than before and remains essentially linear up to 15-amp load current. The peak leakage current is affected to a greater extent than forward drop by forced air cooling. Its initial value is appreciably reduced, and the curve has essentially a zero slope until quite high values of load current are reached. At a load current of 15.25 amp, corresponding to 20 ma peak leakage current, the upper limit of heat-dissipating ability of the copper radiator is being approached for forced-air cooling.

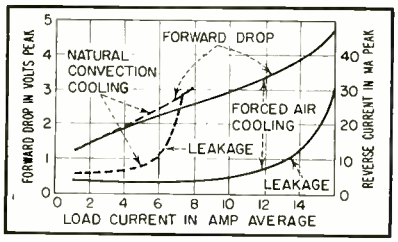


FIG. 3—Forward and reverse single-phase half-wave a-c characteristics with resistive load and peak inverse voltage of 100 volts

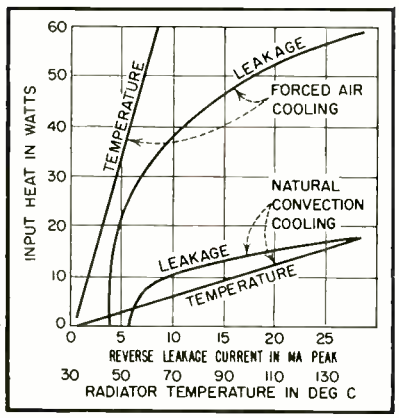


FIG. 4—Effect of external cooling on heat dissipation, cell temperature and leakage current

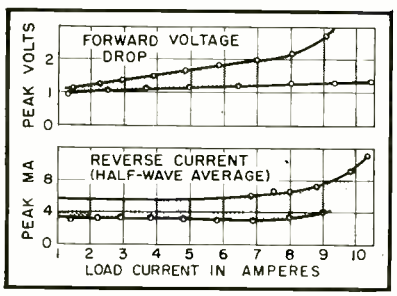


FIG. 5—Range of a-c characteristics of 0.05-sq-cm silicon power rectifiers when used with resistive load at 50 volts peak inverse in single-phase half-wave circuit for typical electronic application

If a load current of 15 amp average is taken as the safe upper limit for forced-air cooling, the encapsulated silicon power rectifier can safely handle 24 amp rms or about 480 amp rms per sq cm. The rms power output of the rectifier is then $24 \times 50 = 1{,}200$ watts. Forced air cooling thus doubles the power-handling ability of the new silicon rectifiers.

The power-dissipating ability of the copper radiator may be seen more clearly in Fig. 4. Here the heat input to the copper radiator, as determined by the product of rms forward drop and load current, is plotted against leakage current and radiator temperature. For natural convection cooling, the heat input is about 10 watts when the leakage current begins to rise rapidly. The corresponding point for forced-air cooling is around 50 watts. The radiator temperatures for these particular heat inputs are only 70C and 60C respectively, and are rising linearly with heat input. Thus, for natural convection cooling the rectifier operates at a power efficiency of about 98 percent. For forced-air cooling the operating efficiency is 96 percent.

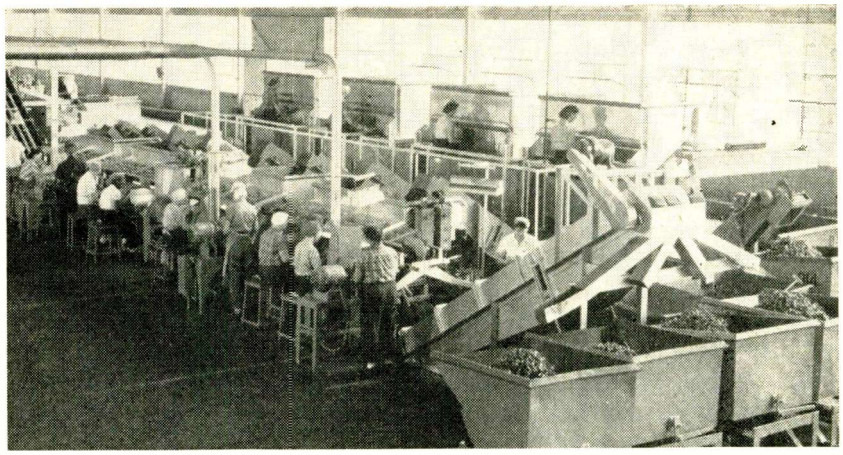
A different encapsulated rectifier was tested at 70 instead of 100 v peak inverse. At this lower voltage the rectifier could safely handle 470 watts with natural cooling and 1,540 watts with forced-air cooling.

Silicon rectifiers appear capable of handling quite high leakage currents before failing. In this respect, instead of failing suddenly as do germanium rectifiers, they give sufficient warning time which permits power reduction. Radiator temperatures as high as 230C have been reached.

Figure 5 shows the range for forward and reverse a-c characteristics obtained for a number of experimental silicon power rectifiers tested at 50 volts peak inverse using normal convection cooling. The peak leakage current remains fairly constant for individual rectifiers within the range of 3 to 7 ma for load currents up to about 9 amp average. For the same load current, the range of peak forward voltage drops is 1.3 to 2.7 v.

POTENTIAL APPLICATIONS

- In aircraft electronic power supplies, where ruggedness and ability to operate at temperatures up to 400F combine with greatly reduced space and weight as features
- In motors, generators and motor-generator sets, where compactness and ruggedness permit mounting directly on the rotor to replace the commutator for changing a-c to d-c
- In radio and television power supplies, where small size permits reducing chassis size
- In computers, to reduce space occupied by power supplies
- In all types of power supplies for transmitters, to replace rectifier tubes
- In all rectifier applications where efficiencies up to 98 percent—about 10 percent higher than the best motor-generator sets—are advantageous along with miniaturization



Four hardness testers in background test entire output of production line. Acceptable rocker arms are dropped onto conveyor belt and distributed into hoppers

Hardness Tester

By MILTON J. DIAMOND

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MEASURING hardness of small parts in large quantity production by the usual Brinell method requires grinding a flat area for the test and then measuring depth of penetration of a steel ball. On small parts it is often difficult to find sufficient area for Brinell testing without making the part unusable. To reduce time and material losses in measuring hardness of rocker arms for automobile engines an electronic hardness tester has been developed based on the magnetic retentivity of the Arma-Steel material used in the rocker arms.

In the early development of the tester, experimental work was done using permeability as a basis for measuring hardness but the results were inconsistent. Further work showed that magnetic retentivity was a function of hardness and could be used as a nondestructive means of hardness testing.

The tester, shown in block form in Fig. 1, tests hardness by measuring the field produced by a magnetized part as it drops through a set of coils.

The rocker arms drop through a plastic tube. Falling through the initiating coil, the part actuates a timer turning on the magnetizing coil. As the part reaches the magnetizing coil the field pulls it to the magnetic center and the arm is held there for a one-third second magnetizing period.

At the end of this time, the arm drops by free-fall through two pickup coils, each coil controlling the accept-reject switch through its own amplifier system. Sensitivity controls set the upper and lower values of retentivity that will trigger the amplifiers. Accepted rocker arms are demagnetized as they pass into the accept bin.

Circuit Operation

The circuit of the complete tester is shown in Fig. 2. The signal produced by the part passing through the initiating coil sets the main timer for the magnetizing cycle. This timer closes relays 1 and 2, placing 110 volts on the grid of coil-control thyratrons V_1 and V_2. The thyratrons, operating in a full-wave rectifier circuit, supply 125 v d-c to the coil for $\frac{1}{3}$ sec.

A relay connected to the output of the timer disables the initiating-switch circuit during this period to prevent repeating of the cycle. A time delay relay disconnects the plate supply to the accept-reject control thyratrons V_3 and V_6 during the magnetizing period to prevent the field of the magnetizing coil from producing a false triggering signal through the pickup coils.

At the end of the magnetizing cycle the part drops through two pickup coils generating a voltage in each coil that is a function of hardness or retentivity. The coil signals are amplified in the hard- and soft-side amplifiers.

Normal position for the accept-reject control is in the reject position. Bias on the hard-side amplifier is set so that thyratron V_3 will fire only when the part is above the upper hardness limit. A rocker arm that is too hard will fire the hard-side thyratron first since the hard-side pick-up coil is placed above the soft-side pickup coil. Tube V_3 operates a relay, opening the plate supply of the thyratron V_6 making it impossible for the soft-side amplifier to trigger the accept-reject control. The control remains in its normal position and the rocker arm goes to the reject side.

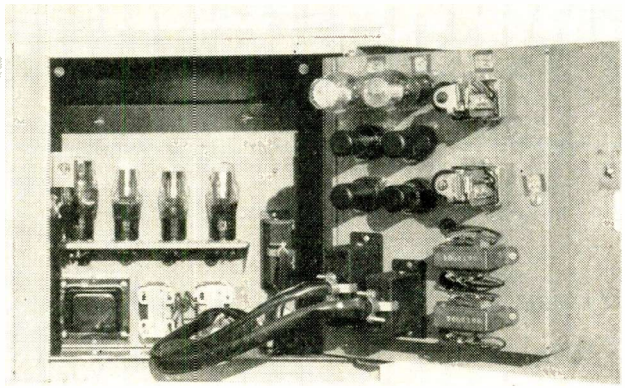
Bias of thyratron V_6 on the soft-side amplifier is adjusted so that it will be triggered by a part having a hardness above the lower acceptable limit. When V_6 fires, it operates relay 4 setting the accept-reject control to the accept position. A rocker arm that is too soft will not produce a signal large enough to fire the thyratron and the part will go to the reject side.

Construction

Construction of the amplifiers is straightforward, using large-valued coupling capacitors to pass the low-frequency pulse, about 15 cps, produced by the parts falling through the coils.

Shielding of the amplifiers was necessary to eliminate the effect of stray magnetic fields. Power is obtained from a regulated source. A separate supply for the magnetizing coil has a time-delay relay to prevent application of B+ to the tubes until after warm-up.

Another time-delay unit discon-



Amplifiers and thyratron controls for hardness tester are mounted on door of cabinet. Power supply for entire unit is at rear of box

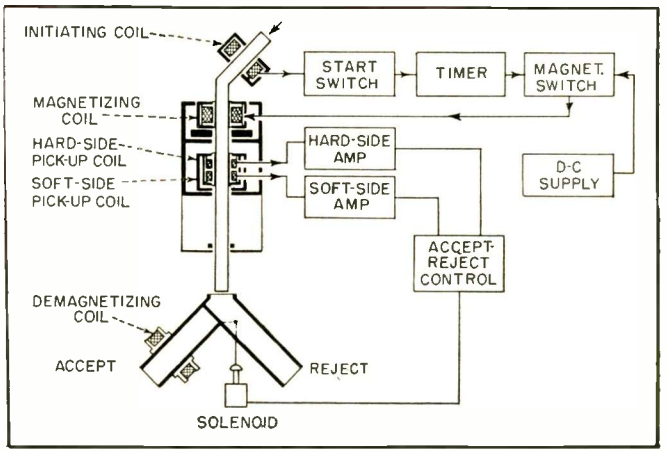


FIG 1—Magnetized parts falling through pickup coils triggers accept-reject control if part falls within preset hardness range

Sorts Auto Engine Parts

Automatic sorter measures hardness of steel rocker arms for automobile engines at rate of 3,000 pieces per hour. Nondestructive test using magnetic retentivity provides 100-percent inspection, rejecting parts having hardness above or below preselected levels

nects the power to the accept-reject solenoid after a short period. This prevents coil burnout if the unit is left in the accept position.

Setting Up

The hardness tester is set up by the use of rocker arms previously selected for hardness by the Brinell method. A set of test rocker arms consists of a pair at the soft end of the range and a pair at the hard end of the range. One of each pair is 0.1-mm Brinell hardness within the allowable range and the other is 0.1 mm out of the range. The sensitivity controls of each amplifier are adjusted so that the two arms within the range are passed and the two outside the range are rejected.

A set of test rocker arms is kept for each type of arm in production.

When changing from one type of rocker arm to another, only a few minutes are required to make the necessary adjustments.

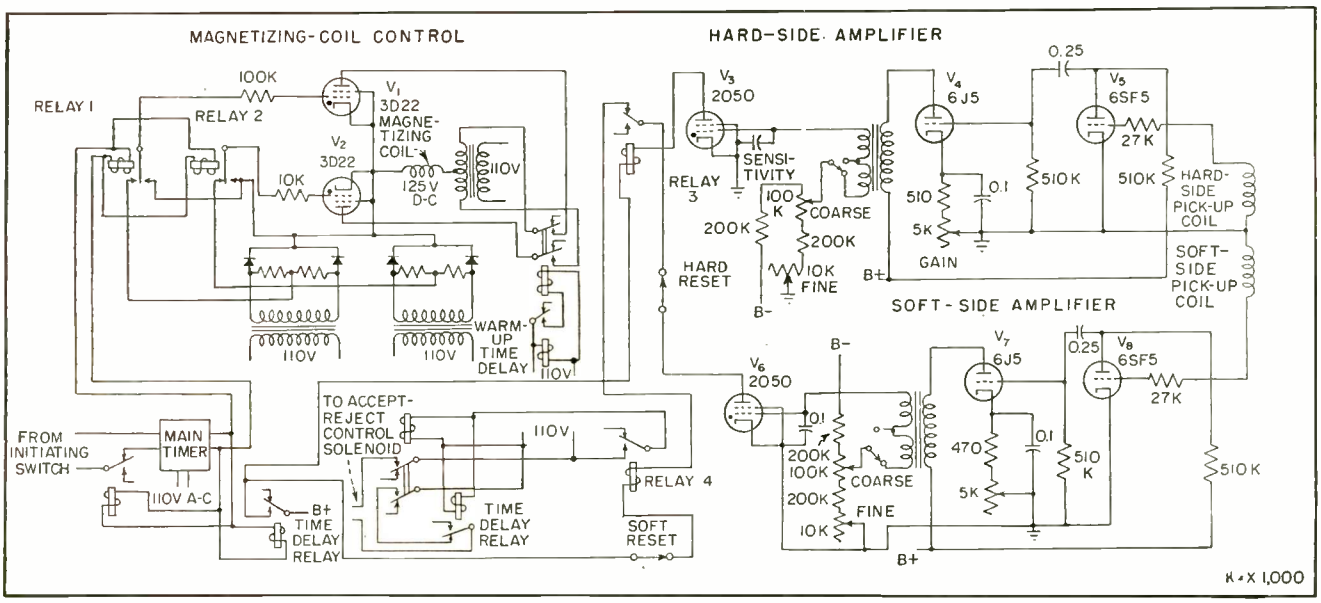


FIG. 2—Parts above lower hardness level will trigger soft-side amplifier to accept. Parts harder than upper level trigger hard-side amplifier which disables output thyratron of soft-side unit

Direct VSWR Readings

Rapid check on operation of radio and radar transmission systems can be made using a simple instrument that presents the quotient of incident and reflected power on a meter reading directly in voltage standing-wave ratio. In laboratory service, the device complements slotted-line measurements

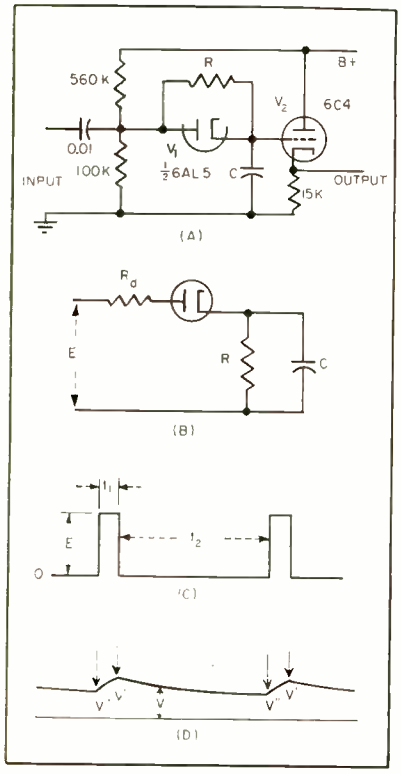


FIG. 1—Partial stretcher circuit (A) with cathode-follower output, basic stretching diode circuit (B) with applied pulse (C) and output waveforms (D)

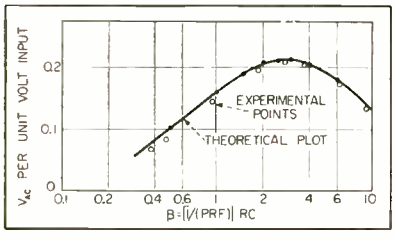


FIG. 2—Experimental verification of derived relation between a-c component and applied pulse for a partial stretcher circuit used in measurements

DIRECT INDICATION of voltage standing-wave ratio can be shown with the instrument to be described that samples incident and reflected signals simultaneously. Their quotient is read directly as vswr. Readings are independent of incident power variations. The only adjustments insure that internal amplifiers are not overloaded.

Besides the vswr indicator, a bi-directional coupler and r-f detectors are required. Little emphasis is placed here on directional couplers since they are adequately treated in the literature. The detectors used are of importance only in that they offer significant nonlinearity errors at small signal amplitudes.

Prior art has established techniques that are generally tedious but sufficiently accurate. The slotted line is a most accurate and versatile instrument. High precision slotted lines are expensive and require many accessories. Directional couplers and reflectometers[1] have been improved to the point where they compete with slotted lines in cost and accuracy. Great interest in impedance bridges[2, 3] has been augmented by the desire to circumvent the slotted line.

Reflectometer Techniques

Two accepted reflectometer techniques are used for rapidly obtaining vswr readings. One method employs feedback that keeps the incident power on a transmission system constant and the reflected power is a measure of the reflection coefficient[4] or vswr.

Practically, the incident power level does not stay constant in an r-f transmitter. As an alternative, by setting the incident level reading to unity on a meter and then switching to the reflected signal, the vswr or reflection coefficient can be obtained directly.[5, 6]

An earlier paper[7] described an electronic ratio meter and its application to the measurement of reflection coefficients. An extension and improvement of the earlier techniques to pulse-modulated systems, such as radar, is considered below.

Diode Nonlinearity

When the r-f signal is a typical radar output consisting of pulses of short duty cycle, the nonlinearity of the diode can be minimized only by working with large signals so the nonlinear region is a small percentage of the total swing. In addition, an averaging type of ratio meter cannot be used, since the large pulses (of small average value) cannot be accommodated in conventional amplifier circuits.

Techniques that stretch the pulse, to increase its average value, are required. Another serious consideration of pulse operation is that crystal diodes fail as detectors. The crystal diode is essentially a low-level device and most successfully used as a square-law detector. When large pulses are applied to crystals, they saturate and hence distort by virtually clipping the signal. Besides, they conduct significantly in the reverse direction.

There is, however, a small linear

in Pulsed R-F Systems

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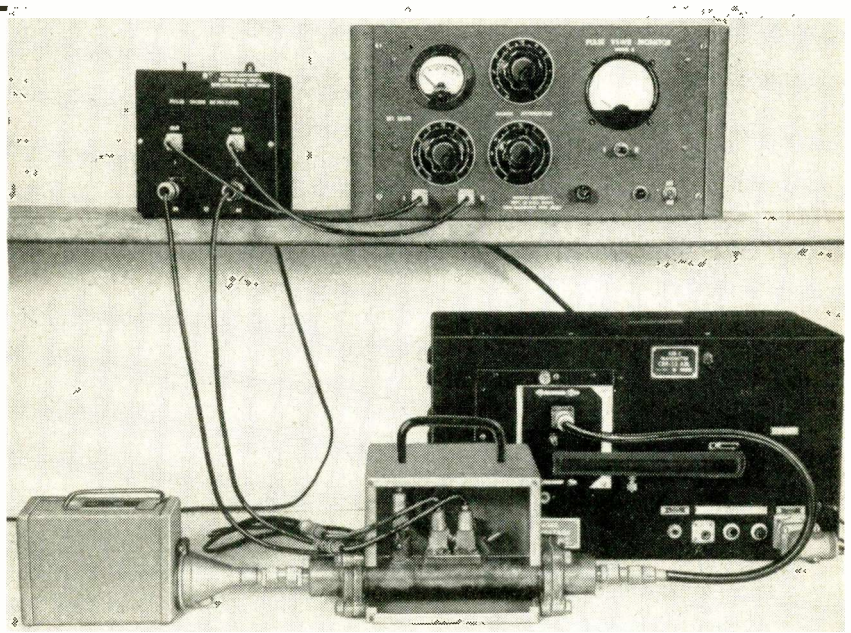

Pulse monitor (upper right) is fed by diode detectors (left) from bidirectional coupler (below). Radar transmitter is in background and terminating load at lower left

region dangerously close to the burnout point that can be obtained in certain selected crystals. This region is completely impractical for present considerations but may be a necessity for high-frequency detector designs. Thermionic diodes were alone considered in the developed vswr indicator. They have all the desirable characteristics exclusive of frequency range. The type 6173 pulse diode was chosen because of its high peak current rating (1,000 ma) and high useful frequency, 3,300 mc. The tube is a pencil variety and can be conveniently mounted coaxially. With identical mounts, it is reasonable to assume that these diodes can be used up to their resonant frequencies in ratio measurements.

Pulse Stretching

A technique was developed to measure pulse ratios by incompletely stretching the pulses and directly deriving an a-c exciting signal for the ratio meter. Equations of the diode charging circuit indicate the methods employed. A typical partial stretcher circuit is shown in Fig. 1A. The symbols and circuit used from which waveforms were derived are shown in Fig. 1. Voltage V' is the voltage after the pulse application and voltage V'' is that after the time corresponding to a pulse-space period t_2. The important equations are

$$V' = E\,(1 - e^{-\alpha}) \,/\, [1 - e^{-(\alpha+\beta)}]$$

and

$$V'' = E\,(1 - e^{-\alpha}) \,/\, [e^{+\beta} - e^{-\alpha}]$$

where $\alpha = t_1/RC$, the charging parameter and $\beta = t_2/RC$, the discharging parameter. The capacitor can stay charged to the peak value $V' = E$ only if $\beta = 0$ (no discharge). For any value of β greater than zero there is some error. If the charging circuit has no resistance (α = infinity), then

$$V' = E$$

and

$$V'' = E_e{}^{-\beta}$$

Therefore, capacitor C charges up to voltage E and will discharge according to the equation

$$V = E_e{}^{-t/RC}$$

If it is assumed that the pulse width is negligible in the averaging process and that α is extremely large, the average value of the voltage across the load is

$$V_{AV} = \frac{E}{t_2} \int_0^{t_2} e^{-t/RC}\, dt$$

where

$$t_2 = 1/PRF$$

which results in

$$V_{AV} = (E/\beta)\,(1 - e^{-\beta})$$

The average value can vary between the maximum limit E (when β = zero) to zero (β = infinity) and is lost in passing through an RC coupling network. The a-c value of the output signal, as would be read by an averaging instrument, is

$$V_{AC} = \frac{2E}{\beta}\left[1 - \frac{1 - e^{-\beta}}{\beta} + \frac{1 - e^{-\beta}}{\beta}\ \ln\left(\frac{1 - e^{-\beta}}{\beta}\right)\right] \qquad (1)$$

This equation indicates that the ripple riding on top of the stretched pulse is proportional to the pulse amplitude and it can be used as a design equation. If, for example, $\beta = 1$ then

$$V_{AC} = 0.168E$$

Decreasing β will decrease the available a-c component as the pulse stretches to pure d-c as shown in Fig. 2. Increasing β will increase the available a-c until some maximum value is reached after which the pulse becomes exceedingly narrow and the a-c component is again reduced. These a-c components can be applied directly to the ratio meter and although a certain amount of the pulse amplitude is lost, the proportionality is preserved so that ratio measurements are accurate.

Complete VSWR Meter

As shown in Eq. 1, there is an a-c component associated with a

Table I—Measured VSWR versus Outside Standards

Experimental Supplied By		Measured Using Monitor
3.8	RADC	3.6
3.1		3.2
2.7		2.75
2.35		2.35
1.93		2.0
1.73		1.87
1.65		1.62
1.50		1.50
1.35		1.33
1.40		1.35
1.50		1.39
1.90		1.76
2.35		2.30
1.04		1.043
1.04	Manufacturer	1.035
1.07		1.025
1.10		1.058
1.16		1.088
1.20		1.103
1.26		1.14

partially stretched pulse that is essentially an exponential decay. This a-c component is directly related to the original pulse but modified by a cumbersome factor that is a function of the pulse repetition period divided by the discharge constant β.

Since the reflected and incident signals are of the same shape, ratios of the partially stretched pulses are a true indication of the reflection coefficient. These a-c signals can be applied directly to the ratio meter.

The a-c component derived from a partial stretcher per unit input volt is shown in Fig. 2. The solid points are calculated from the equation and the circled points are those obtained experimentally from a circuit having $R = 2.2$ megohms and $C = 240$ μμf, shown in Fig. 1A. The a-c value is the full rectified value and the gain of the cathode follower and meter calibration have been taken into account. Large values of β correspond to small stretching, whereas small values of β correspond to large stretching, or waveforms that are essentially triangular.

Peak a-c output is in the vicinity of $\beta = 3$ and beyond this value the peak-to-average value of the decaying exponential may be great enough to overdrive the ratio-meter amplifiers. Smaller values of β correspond to safer operation, but unfortunately small signal outputs. A safe design center point is $\beta = 1$ and a stretcher is practically useful between $\beta = 3$ and $\beta = \frac{1}{3}$. In the instrument described, a value of RC equal to 1.82 megohms × 1,000 μμf was used for a repetition rate of 550 pps at $\beta = 1$. Hence the practical range would be from 200 pps to 1,500 pps. Any range can be accommodated by the proper choice of R and C.

Significant nonlinearity occurs at about 1.5 volts pulse amplitude. The output is smaller than expected and results essentially from high forward resistance of the diode at these small amplitudes limiting the voltage to which the capacitor can charge. This nonlinearity makes loads of small vswr appear optimistic.

Monitor Circuit

The circuit of the pulse vswr monitor using the partial stretcher principle is shown in Fig. 3. It consists of two partial stretcher channels driving a general-purpose ratio meter, the indicator of which is calibrated in vswr. To obtain a vswr calibration for the basic ratio meter movement, it is necessary to convert the basic ratio or reflection coefficient into the corresponding vswr value.

Inserting a fixed attenuation into the incident channel establishes the scale range. The two ranges shown in Fig. 4 are considered satisfactory. The range of 1.1 to 4.0 requires an attenuation of 15.7 db in the incident channel and the 1.02-to-1.3 range requires 28.9 db. If the coupling coefficients of the bidirectional coupler are not equal, proper equalization can be made in the channel attenuator, providing it is made variable.

It is common to have the reflected signal coupling greater than the incident coupling. For example, a coupler may couple to the incident signal by 10.4 db less than to the reflected. The attenuation setting should therefore be reduced by this amount in setting up the range as follows:

Range	DB
1.1 to 4.0	15.7 − 10.4 = 5.3 db
1.02 to 1.3	28.9 − 10.4 = 18.5 db

Any coupler can be accommodated by this flexible arrangement. Precision attenuators are inserted between the stretcher and the ratio meter. An incident signal passing through the upper channel is first partially stretched and then passed through an attenuator (ganged to an identical attenuator in the reflected channel) to limit overloading of the ratio meter. After the level-setting attenuators, a coarse and a fine attenuator are cascaded in the incident channel for range selection. Assuming a bidirectional coupler of equal incident and reflected coupling is available, this attenuator is set as described above. If the bidirectional coupler has unequal coupling, the attenuation can be reduced as indicated.

The ratio meter consists of a 12AX7 triode driving a type 5687 output stage. Since the feedback cathode resistors are nearly 35 ohms, approximately 30 millivolts average will cause one milliampere

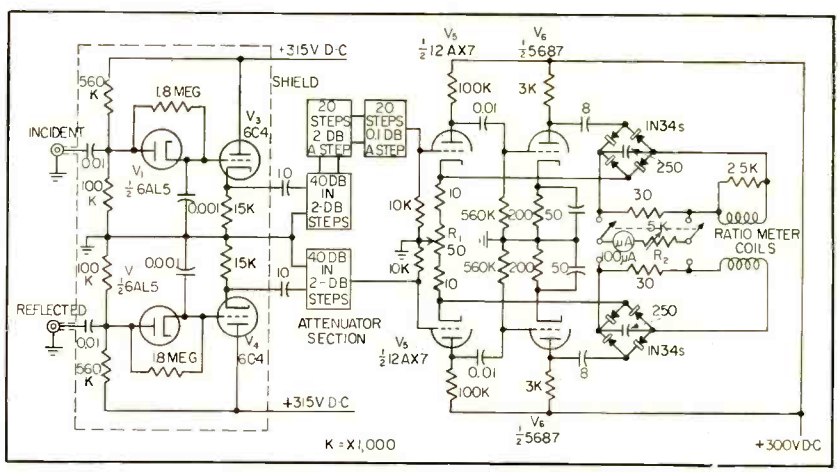

FIG. 3—Complete circuit diagram for the vswr meter that uses special panel-type ratio-meter movement for direct indication

of ratio-meter current. The overload indicator is a 100-μa meter connected as a voltmeter to monitor the current passing through a 30-ohm precision resistor. It is set by R_2 so that 15 ma of ratio meter coil current corresponds to full-scale deflection. The average input signal for 15-ma output current is closely 450 mv. About 15 db feedback is included in each ratio-meter channel.

Operating Procedure

In setting up the vswr meter, certain initial balancing adjustments must be made. The peak detector unit is connected to the incident and reflected channels but the input is derived from a single source, such as the incident signal of the directional coupler. With r-f on and with no attenuation in the range switch, both channels should be identical except for deviations in the detectors and stretchers.

These deviations can be compensated by balancing the ratio meter through potentiometer R_1. A center marker on the ratio meter scale indicates the equal-signal condition. This equalization procedure insures that each channel is identical from the r-f end to the direct current in the ratio-meter coils.

The r-f inputs can then be disconnected from the single r-f source and connected to the incident and reflected signals. If a bidirectional coupler of equal nominal coupling is used. this balancing procedure can be carried out with a good open circuit or short-circuit on the line. Similarly, if a coupler is provided with known incident and reflected coupling, the range attenuator can be set to equalize the coupling and allow balancing under an open-circuit or short-circuit condition.

The latter two methods assume that the load can be disconnected and that an appropriate open circuit or short-circuit is available. In general, it is necessary to inject equal signals into the ratio meter for the initial setup. It is also desirable that the diodes in the partial stretchers and in the r-f detector experience comparable r-f amplitudes.

Upon equalizing the ratio-meter channels, the monitor is ready for operation. The range switch setting must be chosen based on the bidirectional coupler coefficients previously discussed. The only other control that must be set during operation is the level-setting ganged attenuator. By referring to the overload indicator and switching between incident and reflected, the level can be set for both readings on scale.

Since the ratio meter will never pass currents greater than the approximate ratio of 3.6-to-1, it is always possible to obtain I and R readings that are on scale. The level indicator region below 10 (corresponding to 1.5 ma) is a region of error since the ratio-meter coil currents are of insufficient strength completely to nullify the spring-restoring forces. This region should be avoided if sufficient signal strength is available.

Calibrating Technique

To evaluate the vswr indicator, standard loads of known vswr were prepared. A simple mount that can be easily machined from 1 × 1 in. brass stock was made. Two-watt Allen-Bradley composition resistors are mounted coaxially and terminate in a type N fitting. These loads were calibrated by the Rome Air Development RADC Standards Laboratory at low power levels and considered as standards.

Six more commercial loads with vswr values between 1.04 and 1.26 were obtained. This assortment of loads was used in the test evaluation of the instrument developed.

With these standard loads, a series of measurements was obtained. A modified ASB-5 radar unit having a pulse width of 0.7 μsec at 500 mc was employed. The test set-up is shown in the photograph. The diode detectors exhibited a cross-coupling of approximately 0.3 percent and theoretically would limit the lowest measurable vswr to 1.006. However, this low vswr is not accommodated by the meter, which would under all circumstances be in gross error since the reflected diode's nonlinearity would be excessive.

Measured Comparison

Values in Table I were obtained by setting up the ratio meter under open-circuit conditions. The slight deviation in coupling (0.3 db) of the commercial bidirectional coupler is therefore equalized.

These results compare favorably with the RADC Standards Laboratory measurements. Some of the small discrepancies may result from aging of the resistors or peculiarities of pulse operation.

Larger errors were observed for the manufactured loads. The one-watt rating of these loads was insufficient, so that measurements had to be made immediately after the application of r-f power. One typical 60-ohm load changed 3 ohms after 2 minutes of exposure to r-f power with average value approximately 2 watts. Repeated use of these loads may have permanently changed their characteristics. Also, reflected signals become small at small vswr values and introduce serious nonlinearity errors.

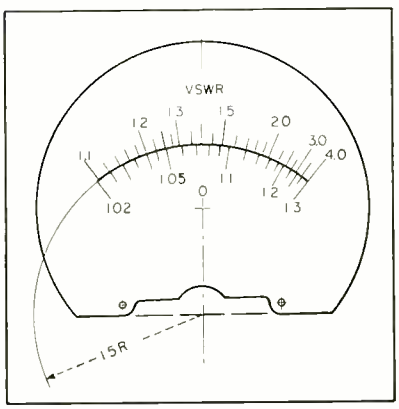

FIG. 4—Meter calibration shows two scales used. Zero centering is provided for initial adjustment

The authors thank the Rome Air Development Center, Griffiss Air Force Base, sponsors of this work under contract AF28(099)-33. The capable assistance of William C. Schaal, Research Assistant, is appreciated.

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Predicted-Wave

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Collins Radio Co.
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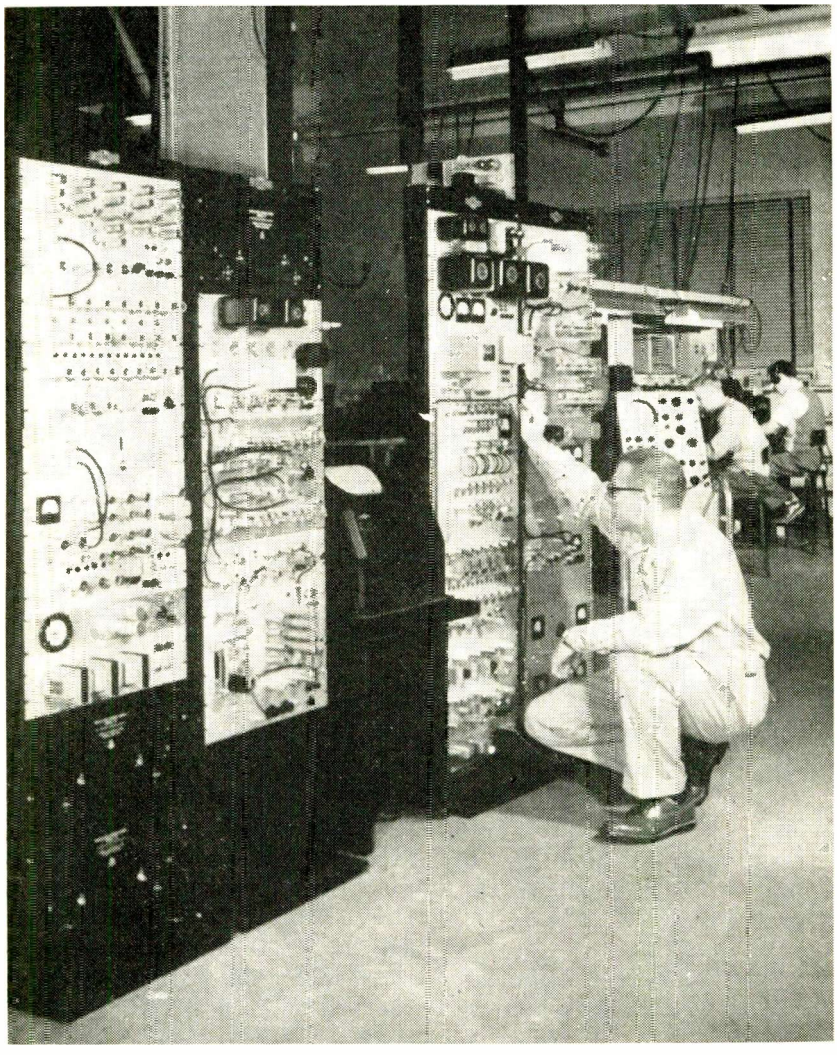
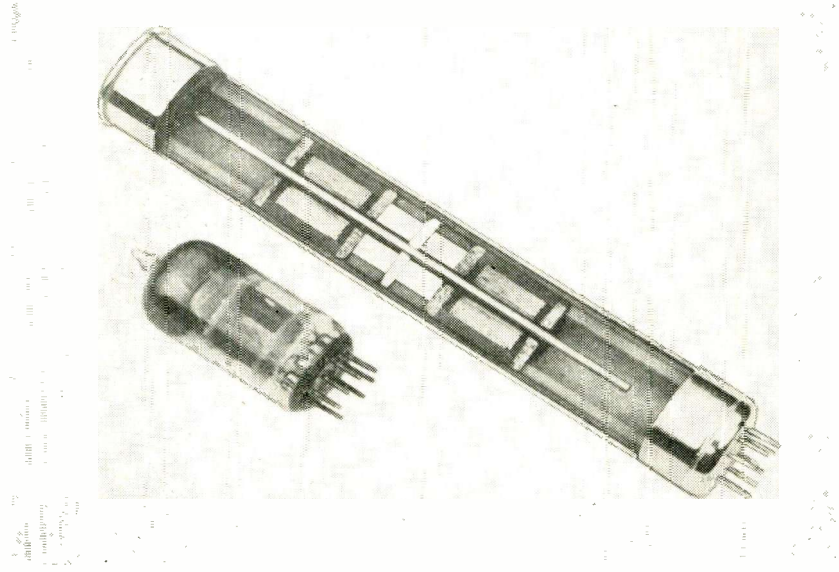


Laboratory prototype of 100-watt transmitter and complete receiver necessary to convert signals to teleprinter page copy



Cutaway view of the magnetostrictive resonator compared to tube size

CURRENT PRACTICE in frequency-modulated radiotelegraphy requires use of frequency-measuring techniques for conversion of the received signal to a form suitable for operation of land-line telegraph equipment. Usual circuits include band-pass filtering (in the receiver i-f amplifier), a limiting amplifier and a discriminator. Refinement of these methods does not necessarily lead to the best use of received signal energy. The predicted-wave system to be described transmits a frequency-shifted signal similar in form to that currently used. However, the intelligence is obtained from this signal by methods leading to greater utilization of the received signal energy.

Predicted-wave detection circuits measure pulse amplitudes at the two alternate frequencies of the frequency-shifted wave by accumulating over each pulse period the signal and noise from each of the two frequency channels in a pair of high-Q resonators. If the largest amplitude is measured in the mark channel, a mark is transmitted to the page printer. When the largest amplitude is measured in a space channel, a space is transmitted. This circuitry performs the same function as the limiting amplifier, discriminator and keying relay chain used in fsk, but is less affected by noise and interference.

Sync Signal

The radio-frequency wave emitted from a predicted-wave transmitter differs from the usual frequency-shifted telegraph signal in that a third frequency midway between the mark and space frequency is used to provide automatic synchronization. Time and frequency relations used in the pre-

Radio Teleprinter

New radiotelegraph system, using diversity reception and magnetostrictive resonators for accumulating mark and space information, employs synchronizing pulse on center frequency. Characters are delivered in less time than start-stop type and have 8.5-db advantage at the 0.1-percent error-rate level

dicted-wave system are shown in Fig. 1. The synchronous signal includes a set of five pulses, each placed on either the mark or space frequency (each spaced 360 cycles from center), followed by a synchronizing pulse of equal duration occurring on center frequency at all times. The first pulse of the group of seven is used for the blank recognition function of the page-printer start pulse.

Minimum, maximum and normal timing for a conventional start-stop telegraph system are shown at the top of Fig. 1. The start-stop signal is characterized by a start pulse, which releases a timing sequence and places the following five signals in a mechanical storage that identifies one of 32 characters. The last information-carrying pulse is followed by a stop pulse approximately 1½ times as long as the first six pulses. The timing of the predicted-wave synchronous system has been chosen to deliver a character in slightly less time than the minimum required for the start-stop system. This means that a start-stop line feeding the synchronous system always lags and a storage of two-character capacity is all that is required to join the two systems.

Transmitting Equipment

A block diagram of the transmitting equipment is shown in Fig. 2A. Start-stop signals from a non-synchronous line are fed to a two-character electronic storage code converter using hard vacuum tubes. Binary information, coded as shown in Fig 1, is read out of the code converter at a synchronous rate controlled by the time-base unit. The synchronous timing is so chosen that the read-out rate is slightly faster than the fastest start-stop input signals. With an average keyboard or tape reader, the code converter will transmit about one blank in every 23 characters.

All timing signals are derived from a magnetostrictive oscillator operating at 23,040 cycles. Frequency-dividing circuits reduce this to 360 cycles for use in the frequency-shift circuits and to 45 cycles for pulse timing. The integral relation between the pulse timing rate and frequency shift results in minimum crosstalk between mark, space and synchronizing channels.

The frequency-shift generator accepts synchronous binary information from the code converter and delivers a frequency-shift-keyed output at 23,400 cycles for mark, 22,680 cycles for space and 23,040 cycles for synchronization (every seventh pulse). Both data and sync pulses are of 1/45-second duration.

The mark and space signals are obtained by modulating the 23,040-cps signal from the same source in a doubly balanced modulator. Band-pass filters select the mark and space frequencies and three gates are synchronously keyed to

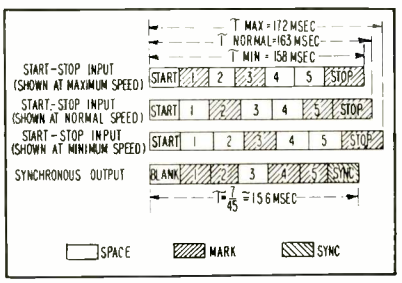


FIG. 1—Time and frequency relations for start-stop and synchronous teleprinter systems. Blank-recognition and center-frequency sync pulses characterize the newer system

yield an output at the mark or space frequency for the data, or on center frequency every seventh pulse for synchronization.

The output of the frequency-shift generator is translated to a nominal 250 kc in the heterodyne unit and further heterodyned and amplified in the exciter unit to a 100-watt output level at operating frequency.

Receiving Equipment

Receiving equipment is shown in block form in Fig. 2B. Signals from a pair of diversity antennas are heterodyned to a nominal 250 kc in a pair of crystal-controlled receivers operated from a common oscillator and using a common avc system. The chassis containing the automatic-frequency-control and oscillator circuits includes a crystal oscillator with suitable multipliers for excitation of the receiver mixers.

A pair of narrow-band discriminators at the mark and space frequencies of 23,400 cycles and 22,680 cycles are used to control the frequency of the heterodyne oscillator converting the 250-kc signal to the 23-kc range. This system forms an automatic frequency control capable of adjusting the received signal over a range of approximately 200 cycles. The avc and synchronizing chassis uses three band-pass filters, each approximately 200 cycles wide, to provide separate outputs for the mark, space and synchronizing channels. The mark and space outputs are added to provide a signal that drops to zero during the time of arrival of the synchronizing pulse. The synchronizing filter yields the inverse of this signal. The envelope of the added outputs from the mark and space filters

is subtracted from the envelope of the synchronizing filter and the difference voltage is half-wave rectified and limited.

Multipath synchronizing signals smaller in amplitude than the desired synchronizing signal are discriminated against in this circuit.

Magnetostriction Timer

An oscillator controlled by a magnetostrictive resonator like that in the photograph is used as a source of timing information in the receiver. The output frequency of this oscillator is divided to provide a signal at 45 cycles to be compared with the received synchronizing pulse in a product detector. The output of the product detector drives a servomotor that corrects the phase of the 45-cycle signal and the frequency of the magnetostrictive oscillator to synchronize the receiving time base with the incoming signal.

Automatic-gain-control information is obtained by adding the outputs of mark, space and synchronizing filters.

The intermediate-frequency outputs from the two diversity receivers are fed to the detector and diversity-selector unit. The output of each receiver is fed to a pair of magnetostrictive resonators, one at the mark frequency of 23,400 cycles and one at the space frequency of 22,680 cycles. Each resonator is damped to zero energy level at intervals of 1/45 second, corresponding to the transition times of the incoming signal. The damping is achieved by applying strong inverse feedback around the resonator for approximately one millisecond. Since the resonator is freed of stored energy and input-signal history by the damping pulse, it is possible to integrate the incoming signal over the necessary 1/45-second period preceding the following damping operation.

The resonator consists of a nickel-iron alloy rod a half wavelength long at operating frequency and supported at its center by staking into a brass disk. Ring-shaped biasing magnets are located on either side of the support disk and provide a permanent field through the rod. Multiturn driving and pick-off coils are located on either side of the magnets and are connected to the terminals of the 9-pin miniature plug. A resonator of this type operates in the vicinity of 20 kc with a Q of about 2,000 providing excellent frequency stability.

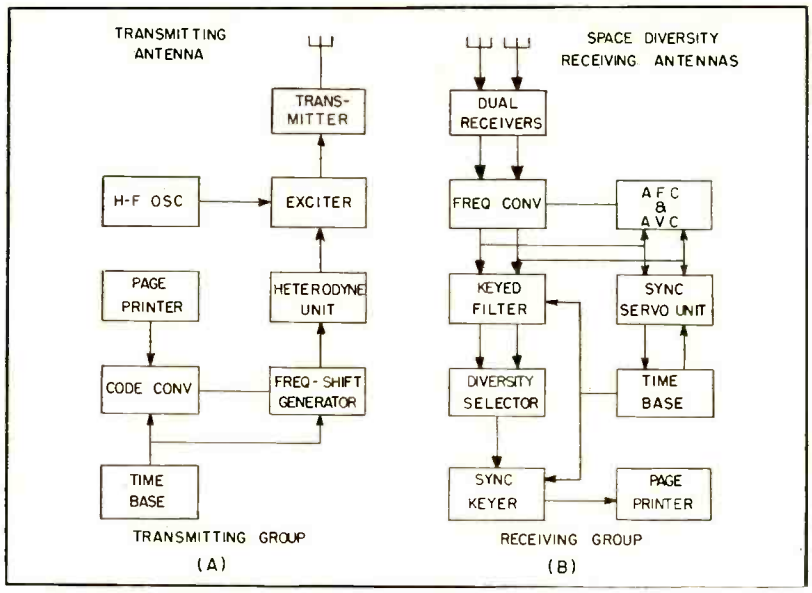


FIG. 2—Elements of the predicted-wave transmitter (A) and receiver (B) used to obtain more reliable communications

Keyed Filters

A circuit diagram of one of the four identical keyed filters used in the detector and diversity-selector chassis is shown in Fig. 3. A timing impulse occurring at received-pulse transition times derived from the time base unit is stretched to approximately one millisecond and delivered to the grid of tube V_{1A} in the form of a positive pulse. Current flowing in the cathode circuit of V_{1A} causes the cathode of V_{1B} to become positive, cutting off the tube.

Conduction in V_{1A} also causes its plate voltage to drop, which in turn causes the grid of V_{2A} to go negative. This causes cutoff in tube V_{2A} and thence conduction in V_{2B}. Thus during the one-millisecond damping interval, tube V_{1B} is cut off and V_{2B} conducts, while during the remaining 21.2 milliseconds of the pulse period, tube V_{1B} conducts and V_{2B} is cut off. The 20-kc outputs of tubes V_{1B} and V_{2B} are added and amplified in V_{3A} to drive the magnetostrictive resonator.

Output of the resonator is amplified in V_{3B} and fed back through a 0.01-μf capacitor and potentiometer to the grid of V_{2B}, thus establishing a high-gain feedback circuit during the one-millisecond damping period. This feedback is negative and rapidly quenches all vibrations in the resonator. Output of the resonator is also fed through a decoupling 33,000-ohm resistor to the grid of V_{1B} to provide a positive feedback of lower gain during the 21.2-millisecond period when the resonator is accumulating signals from the receiver output.

Diversity Accumulation

Four of these keyed-filter circuits are used. They are actuated in synchronism by the common timing signal. One circuit using a resonator tuned to mark frequency and another for space frequency are driven from the output of one of the two diversity receivers. A parallel arrangement is used for the output of the other diversity receiver. Tube V_4 operates as an amplifier to yield an output proportional to the output of the resonator. Diode diversity-selection circuits following the four outputs select the strongest of the four and produce a mark output if the strongest occurs in one of the two mark resonators or a space output if the strongest occurs in one of the two space resonators.

The keyed filter yields an output dependent upon the frequency of an input sine wave. Measurements of the output amplitude as a func-

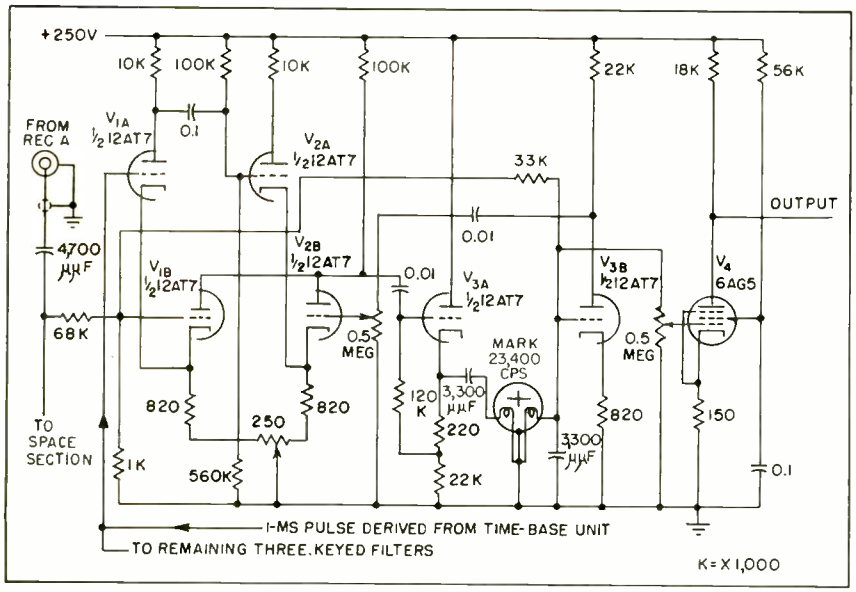


FIG. 3—Keyed-filter circuit employing magnetostrictive device is heart of new receiving technique

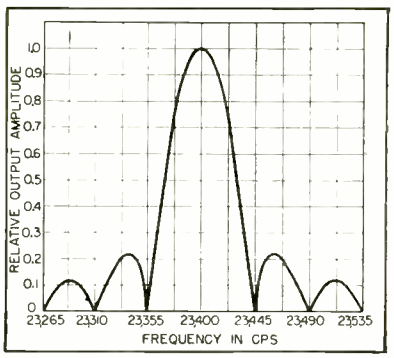


FIG. 4—Keyed-filter response shows high-amplitude response at resonance resulting from positive feedback

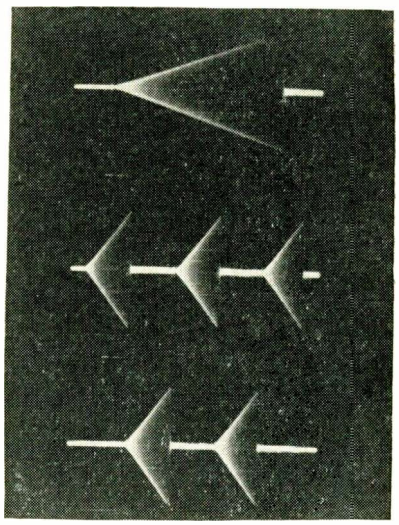


FIG. 5—Oscillograms of keyed-filter action, showing buildup (top) resulting from accumulation of pulses (bottom) and unaffected by undesired pulses (center). Rapid damping is indicated

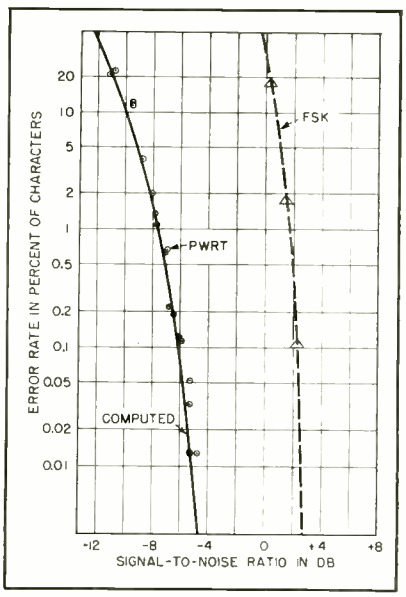


FIG. 6—Error-rate versus predetection signal-to-noise ratio. Experimental data obtained at 60-wpm for frequency-shift (right) and new system (left)

tion of frequency input are shown graphically in Fig. 4. The positive feedback existing during the 21.2-millisecond pulse period is adjusted to give an essentially infinite effective Q for the resonator.

Thus an incoming sine wave exactly at resonator frequency is accumulated there much as a direct current is accumulated in a perfect capacitor. Figure 5 illustrates this accumulation photographically. The waveform shown at the top is at the output of a keyed filter in which the resonator, on mark frequency, is driven from a signal of alternate marks (bottom) and spaces (middle). Linear buildup during the 21.2-millisecond driving period and the rapid damping are easily identified.

Performance Characteristics

Error rate versus signal-to-noise ratio measurements for the predicted-wave system are shown in Fig. 6. The circles represent points obtained by counting the number of page-printer errors obtained in a period of approximately 20 minutes. The signal-to-noise ratio was obtained by measuring the noise and signal power in the 3,100-cycle i-f band of one receiver. Noise was supplied by a gas-tube noise generator and i-f power levels were measured with the aid of a bolometer.

An error rate of one-tenth of one percent was obtained with signals 6 db under the noise level in the i-f band. The solid line was computed from the formula

$$P_e = \frac{1}{\sqrt{2}} \epsilon \exp\left(-S^2 / 4a^2\right)$$

where S^2 is the energy of the received signal pulse and a^2 is the noise energy of $\frac{1}{2}$-cycle band integrated for one second.

For comparison purposes similar measurements were made on a start-stop frequency-shift-keyed system of conventional design. The converter used employed a prelimiting bandpass filter 1,500-cycles wide followed by a limiting amplifier and a linear discriminator. Both the converter and the telegraph printer used for this test were adjusted for optimum performance immediately before the measurements were made. Three points were obtained, each having an operating period of approximately 20 minutes. A comparison of the two curves shows that at the one-tenth-percent error-rate level the predicted-wave system has an 8.5-db advantage over the frequency-shift system.

The ability of the predicted-wave system to utilize signals of lower quality makes it particularly valuable for use with scatter propagation.

The author acknowledges the aid of Earl Heald and George Grondin who assisted in the preparation of this article.

Pulling-Figure Tester for

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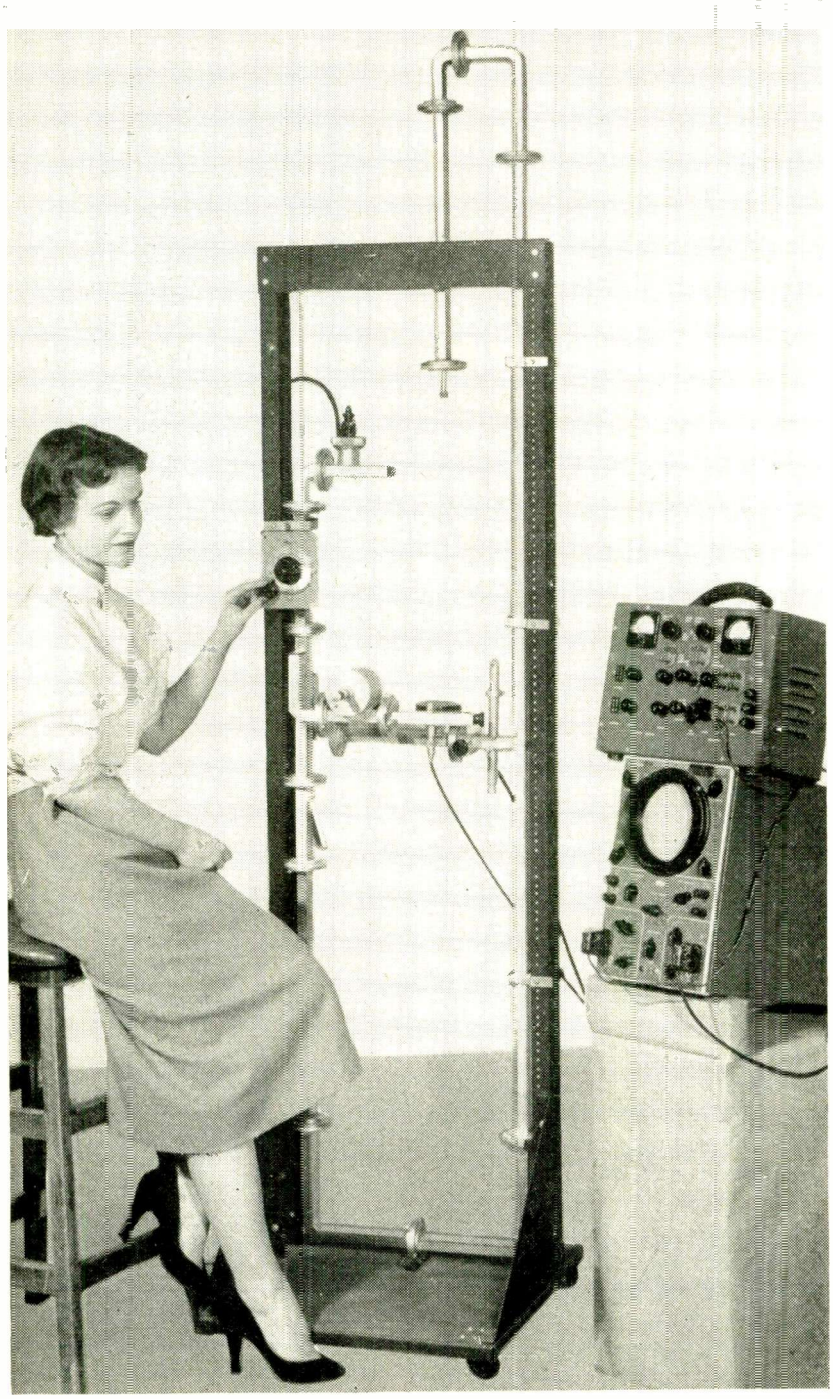

Complete pulling-figure tester in operation as used to measure the pulling-figure of reflex klystrons. Technique applicable to other oscillators

MICROWAVE TRANSMITTERS frequently consist of an oscillator directly feeding an antenna with no buffer amplifier stages to provide isolation. This is due to the fact that suitable microwave amplifiers have only recently been developed and that microwave oscillators are capable of delivering sufficient power in many cases to eliminate the need for amplifiers.

This lack of oscillator isolation results in the antenna load affecting oscillator characteristics. The load may alter the frequency of oscillation, cause distortion in frequency-modulated oscillators and even make it impossible to tune the oscillator to certain frequencies.

A need existed for a means of measuring oscillator sensitivity to load effects and for a means of describing this sensitivity quantitatively. To accomplish this the pulling-figure characteristic was devised and may be defined as the difference between the highest and lowest frequencies which result when a specified load variation is presented to the oscillator. The dynamic method of pulling-figure measurement yields accurate results in a fraction of the time required for the conventional method.

Static P-F Measurement

Figure 1 is the diagram of a typical test circuit for measuring static pulling figure. The power and frequency monitor are used to adjust the operating conditions of the oscillator. A fixed standing wave of 1.5 is obtained from a step reflector and terminating matched pad. The standing wave is passed through all possible phases by means of a matched phase shifter. An alternate method is to use a matched variable attenuator to limit the vswr fol-

Microwave Oscillators

Production-line measurements of klystron and magnetron oscillator sensitivity are made quickly and accurately by unskilled operator with new dynamic tester that is independent of warmup for oscillator drift and requires no critical adjustments

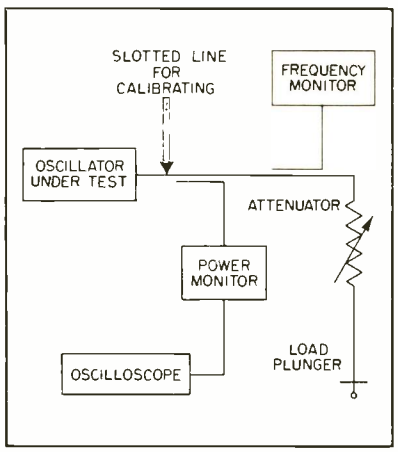

FIG. 1—Typical test circuit for measuring static pulling figure. Matched variable attenuator limits the vswr. Movable shorting plunger acts as a phase shifter

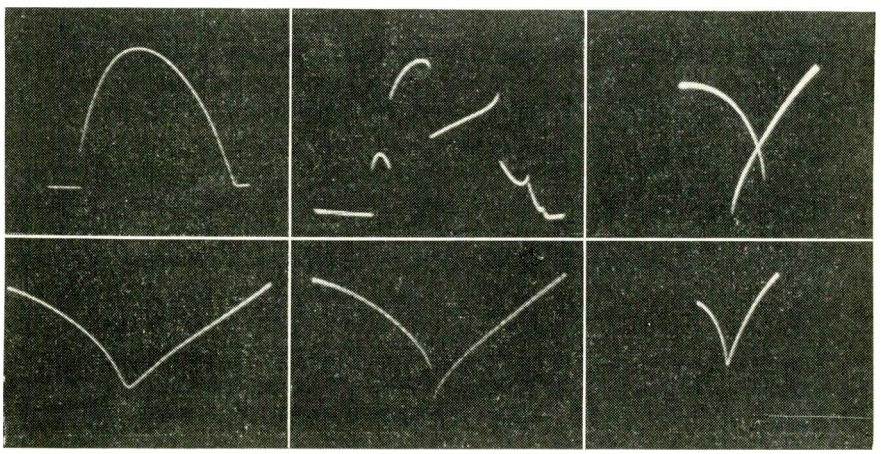

FIG. 2—Power output of reflex klystron, showing normal mode looking into a matched line at 7,500 mc, top left, same mode with several db padding, center. Center curve is magnified at right. In determining pulling figure, patterns show too little, bottom left, too much, center and proper amount, right, of attenuation added

lowed by a movable shorting plunger that acts as a phase shifter. The frequency may be observed as the phase shifter is moved and the two frequency extremes recorded.

There are several difficulties in using this sort of instrumentation. An inherent problem exists in that the change in frequency is ordinarily about one thousandth of the oscillator frequency, thus limiting measurement accuracy. A heterodyne circuit can compensate for this deficiency but does not solve the basic problem of drift in the oscillator being tested.

The power supplies must be highly stabilized and the temperature of the oscillator must be controlled. This demands a warmup time and some kind of controlled-temperature chamber if utmost accuracy is desired.[1]

Analysis Of Dynamic Pulling Figure

Since the pulling figure states quantitatively the frequency sensitivity of an oscillator to reflections from the load, effects of load on oscillator frequency should be considered. In its simplest form a microwave oscillator can be considered as an energized tuned circuit. Viewed from the oscillator, the load may have some reactance depending on the termination of the waveguide which the oscillator is feeding. This reactance appears in parallel with the oscillator tuned circuit and causes a shift in resonant frequency from that which occurs from a non-reactive load.

A discontinuity in the freqency and power characteristics may occur when the length of waveguide between the oscillator and the mismatched waveguide termination is larger than a few wavelengths. Cause of this discontinuity is the variation of the input impedance of the waveguide with frequency so as to permit the oscillator to have more than one stable frequency of operation. This phenomenon is known as the long-line effect.[1-5]

An equation has been derived for the minimum vswr in the waveguide load which will cause such a discontinuity to occur.[2] This equation is solved for the pulling figure of the oscillator

$$\text{pulling figure} = \frac{1}{1.19\,KD(\text{vswr}^2 - 1)} \qquad (1)$$

where λ_g = wavelength in guide, D = distance, source to sink, in same units as λ_g, and

$$K = \frac{2\pi}{\lambda_g^2}\,\frac{d\lambda_g}{df} \qquad (2)$$

Figure 2 shows a series of oscillographs of a discontinuity in the power output characteristics of an overcoupled reflex klystron having a pulling figure of 15 mc at 7,500 mc. This includes an oscillograph in which the attenuator has been adjusted to reduce the vswr to the minimum value which could produce the discontinuity. When this condition is reached the attenuator dial is read and the pulling figure found from a calibration curve. A similar series is shown in Fig. 3 for a degree of coupling suitable for microwave transmitters. The pulling figure here is 6 mc at a

frequency of 6,800 megacycles.

A careful check was made to determine experimentally the difference between the dynamic pulling figure and its static value. Results were found to be the same for values of pulling figure below 10 mc at a frequency of 6,750 mc. However, for values of pulling figure above 10 mc the dynamic method gave values about 10 percent higher than the static method. The reason for this difference is that the static method depends on the tube characteristics over the entire frequency range through which it is pulled by the load, whereas the dynamic method depends only on the slope of the tube characteristic at the frequency of measurement as shown in Fig. 4.

To evaluate K accurately, Eq. 1 is rearranged. For the rectangular TE_1 mode and width a

$$\lambda_g^2 = \frac{\lambda^2}{1 - (\lambda/2a)^2} \qquad (3)$$

replacing λ with c/f and differentiating

$$\frac{d\lambda_g}{df} = -\frac{cf}{\left[f^2 - \frac{c^2}{4a^2}\right]^{1/2}} \qquad (4)$$

Substituting in Eq. 2, and also substituting $2\pi f = \omega$, yields

$$K = \frac{\omega}{c[f^2 - c^2/4a^2]^{1/2}} \qquad (5)$$

For example, at 6,300 mc, $K = 2.868 \times 10^{-10}$ sec. per cm. This value substituted in Eq. 1 gives an accurate pulling-figure calibration.

Dynamic Measurement

Basically, the same equipment shown in Fig. 1 will measure the dynamic pulling figure without tracking wavemeters and without attention to warmup or oscillator drift. The distance between source and sink is purposely made sizeable (10 or 20 feet for frequencies of several kmc) to increase the load effect on the oscillator.

The ordinarily smooth mode shown in Fig. 5 of a 2K25 reflex klystron as distorted by a reflection which, although only on the order of vswr of 1.2, is seen to result in serious pulling for the 130 feet of transmission line.

Measurement consists of adjusting the attenuator until a mode discontinuity appears on the oscilloscope. The movable load-shorting plunger is moved to center this discontinuity in the region of interest, such as the center of klystron mode. The attenuator dial may be calibrated directly in dynamic pulling figure for any one carrier frequency or, its reading may be converted to dynamic pulling figure by means of a graph. In this apparatus the oscillator is frequency modulated from any convenient source such as a 60-cycle sine wave and is deviated a few megacycles in order to observe the top of the klystron mode on the oscilloscope. In all microwave oscillators with which this arrangement has been used the warmup time can be practically neglected, and frequency need be set only approximately. Remaining oscillator adjustments need be set only to the accuracy required for visual observation on the oscilloscope. This elimination of critical adjustments makes the procedure suitable for production quality control.

The pulling-figure tester is also useful in the design of oscillator-waveguide couplers or starting sections. It facilitates measurement of the effect of any pertinent parameters on the pulling figure of the combination. For example, the effect of varying the position of the shorting plunger in a Shepherd-type klystron coupler may be quickly determined by measurement of pulling-figure versus plunger position. Because the power output, f-m sensitivity and long-line distortion are related to the pulling figure, such a tester is used extensively in microwave-transmitter design.

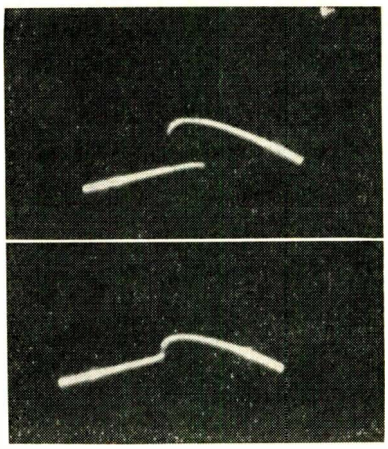

FIG. 3—Mode of 5976H klystron at 6,800 mc with attenuation set for excessive pulling (top) and (bottom) attenuation set for measuring pf

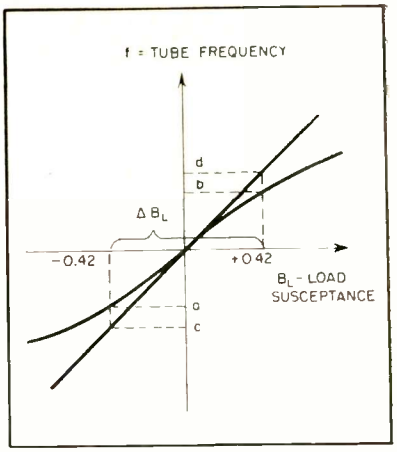

FIG. 4—Change in load susceptance due to a 1.5 vswr; Δf_{a-b} is pulling figure for static method; Δf_{c-d} is pulling figure for dynamic method

Quality control of klystrons ordinarily consists of applying standard voltages and then measuring the resulting currents and microwave properties at several frequencies across the intended frequency band. These properties are ordinarily pulling figure, power output, modulation sensitivity and distortion. For convenience, the pulling-figure tester includes adapters for the other tests.

Power is determined by the thermistor head plus an automatic power bridge. Wavemeters are used in the measurement of modulation sensitivity in cases where only a few measurements are to be made. For frequent measurement of modulation sensitivity, and also for measurement of distortion, a microwave superheterodyne receiver is used. For this purpose a directional coupler is connected in the equipment which in the photograph is capped with a pair of dust shields. For superheterodyne measurements, a local-oscillator assembly is connected to one flange of this directional coupler and a mixer assembly is connected to the other flange.

Dynamic Tester Calibration

Measurements require temporarily installing a slotted line between any convenient oscillator and the attenuator, Fig. 1. For each frequency band, the attenuator is varied in steps of about one db and the standing-wave ratio is recorded versus the attenuator dial reading.

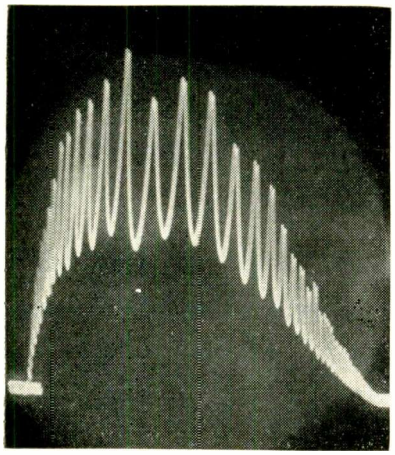

FIG. 5—Mode of klystron with mismatched load. Abscissa shows repeller voltage, and ordinate r-f power output

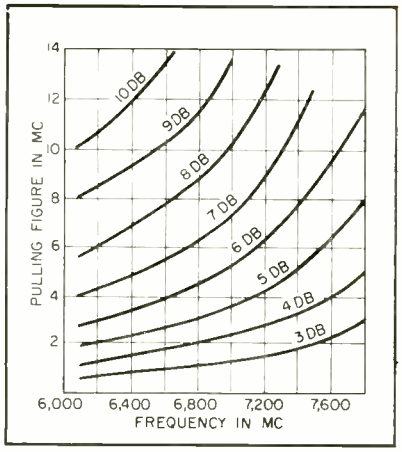

FIG. 6—Graphical calibration of dynamic pulling-figure tester for different attenuator settings

The attenuator should be fairly well matched so that any one position gives a constant standing-wave ratio regardless of variations in the position of the load plunger. A family of curves is then drawn for pulling-figure versus attenuator-setting for various carrier frequencies. These are computed from Eq. 1 with the aid of Eq. 5 in which K is a constant for a particular waveguide installation and frequency. If modulation is present each sideband will yield a particular phase of reflected wave which gives a modulation distortion.

Other Oscillators

While the discussion on dynamic pulling figure measurement has been restricted to the reflex klystron oscillator, it should be equally applicable to other oscillators since the manner in which the load affects frequency is similar for many oscillators. For example, the equation showing how load susceptance alters oscillator frequency is the same for the klystron[3] and magnetron,[4] namely $2C\Delta\omega + B_L = 0$ where B_L = load susceptance, ω = angular velocity and C = equivalent capacitance of the frequency-determining circuit.

Dynamic pulling-figure measurements have been made on tubes that were designed to be operated c-w and f-m. Using a small amount of f-m is helpful in observing the critical discontinuity. To use the dynamic pulling-figure method with pulse modulation, the pulse duration would have to be long enough to allow the transients on the transmission line to die out, because the analysis used for this method is based on steady-state impedance concepts.

Application

Several subsidiary definitions of pulling figure are useful in analysis or specifications. Some oscillators have a coupling adjustment such as the plunger used with a probe-coupled reflex klystron. In this case certain available degrees of coupling are of interest and may be specified by the pulling figure. Normal pulling figure is that obtained with the oscillator and its coupling adjustment tuned for maximum power output. This is the adjustment most ordinarily obtained in the field tuning of a finished design.

Maximum pulling figure is that obtained when the coupling adjustment is varied through a range to maximize the pulling figure regardless of its influence on other tube parameters. If overcoupling occurs, there will be proportionately-reduced power output. This figure is useful as an indication of how much pulling might be obtained in practice from maladjustment of the controls or it may be an indication of the maximum available modulation sensitivity.

Thus far pulling figure has been considered in units of reciprocal time (megacycles) for a microwave oscillator. For analytic work there is some value to the dimensionless relative pulling figure which is the ratio of dynamic pulling figure to carrier frequency. Present reflex klystrons ordinarily have a relative normal pulling figure of about 0.0005 to 0.001 (0.1 percent, or perhaps 1.0 per 1,000). This may be a useful figure in distortion analysis because it accounts for the carrier frequency.

The Tester

The tester shown in the photograph is used to measure the pulling figure of reflex klystrons operating across the frequency band of RG50/U waveguide supporting a TE_{10} mode of transmission. The length of waveguide is 15 feet from reference point (probe) of klystron to midpoint of load plunger travel. For purposes of standardization and interchange of oscillator tube samples this dimension has been adopted by several laboratories.

The calibration graph is shown in Fig. 6. Any other installation in this frequency band would have a calibration graph closely duplicating this one, provided the length of waveguide and the impedance match of the attenuator is the same. The attenuator shown has its dial calibrated directly in decibels. A more perfectly matched attenuator would be better for this purpose.

The range ordinarily found useful is from 3 to 10 db, this range being small enough that a reasonable broadband impedance match may be obtained. These values allow testing a range of pulling figure from 1 to 14 mc, using vswr's from 1.2 to 2.5. The vswr's in this range are easily measured and cause distinct discontinuities in the klystron characteristics. Values beyond 15 mc pulling figure are not calibrated in this usage and are recorded as 15 plus.

The authors wish to acknowledge and thank Richard E. Wells for his contributions to the development of this equipment.

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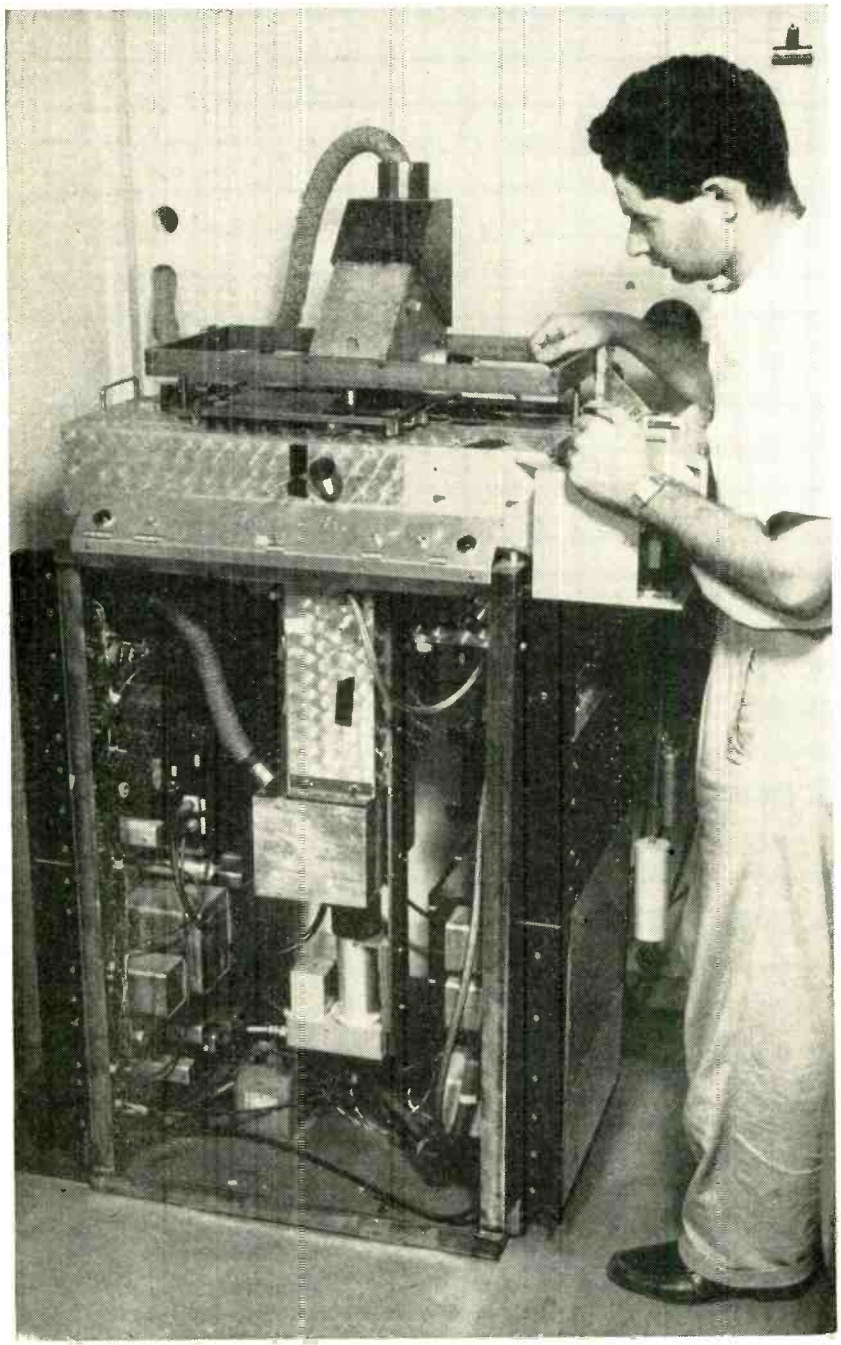
Microphotometer Scans

Intensity variations of light that produced spectrogram are automatically plotted in absolute values by comparing densities on spectrogram with those on a standard. Output may be recorded photographically or on an electronic pen recorder



Microphotometer undergoing adjustment. Light from lamphouse at top of unit is brought down through microscope objective onto subject spectrogram, which lies on horiontal carriage. Carriage housing contains rotating mirrors and optics

A RECENTLY CONSTRUCTED microphotometer scans the photograph of a line spectrum and records the intensity of the light that produced the spectrogram. It differs from typical microphotometers in that the latter record the photographic density on the spectrograms. Line profiles can be plotted from their readings only after a point-by-point comparison of microphotometer tracings with photographic characteristic curves for the spectrogram.

The microphotometer to be described automatically considers the characteristic curve at each wavelength by comparing the densities on the subject spectrogram with those on a standardizing spectrogram. In this regard it resembles the Williams-Hiltner microphotometer. It differs in a number of important features, however, which make it potentially a much faster instrument. These differences also eliminate the tendency of the Williams-Hiltner microphotometer to oscillate when hunting for a null position and the introduction of plateaus into line profiles owing to pinhole or dust streaks in the standardizing spectra.

Principles of Operation

The high-speed comparison of the two spectrograms is effected by a rapidly rotating mirror, which sweeps the standardizing spectrum, and by a Kerr cell driven at a radio frequency, which permits light alternately from the standardizing spectrogram and from the subject spectrogram to strike a multiplier phototube.

Figure 1 shows a section of a typical spectrogram to be analyzed and its corresponding standardiz-

Spectrum Photographs

By D. E. BILLINGS, R. H. COOPER, J. W. EVANS and R. H. LEE

Harvard University and University of Colorado
High Altitude Observatory
Boulder, Colorado

ing spectrogram. The two spectra have been photographed in the same spectrograph. The standardizing spectrum is that of an incandescent source, photographed when a wedge of continuously varying density was placed over the collimator slit.

The spectrograms are mounted side by side on the movable carriage of the microphotometer as shown in Fig. 2 so that corresponding wavelengths on the two spectrograms are illuminated by the microphotometer lamp.

As mirror M rotates, rectangle R in Fig. 1 sweeps across the film in direction X, as indicated in Fig. 2. The subsequent optical and electronic system responds at the instant when the light beams passing through R and rectangle B in Fig. 1 are of equal intensity and records the distance X of R from the edge of the film. As the carriage moves, carrying the two spectrograms in the direction of dispersion (Y of Fig. 2), the succession of values of X gives the locus of points on the standard spectrogram that have the same density as the points B of corresponding wavelength on the spectrogram being analyzed.

In Fig. 2, the various light beams are indicated by dotted lines, while the optics that direct these beams are for the most part omitted.

Beam S_1B illuminates a narrow rectangular portion B of the unknown spectrogram. In normal operation the carriage moves, carrying the two films parallel to the dispersion of the spectrogram. Thus the intensity of beam BC is varied by the variations in density of the spectrogram with wavelength.

Beam S_1A illuminates strip A of the standard spectrogram at the same wavelength as B on the unknown spectrogram. The illuminated strip A extends the full width of the standard spectrogram, as shown in Fig. 1. The concave mirror D throws an image of R, a small portion of A, upon the slit P. The distance of R from the edge of the spectrogram is determined by the position of the rotating eight-sided mirror M. Thus as M rotates, the standard spectrogram is scanned normal to dispersion.

Beams AC and BC are united as they emerge from the calcite C. The former is the ordinary ray in the calcite and the latter the extraordinary ray so that the two will be plane-polarized at 90 degrees to each other.

Behind the calcite is a unit consisting of a quarter-wave plate, a solid Kerr cell to which an r-f voltage is applied and a Polaroid filter. The optical axes of the quarter-wave plate, Kerr cell and Polaroid are so oriented that the unit transmits the ordinary ray from the calcite when the voltage on the Kerr cell is of one polarity and the extraordinary ray when the voltage polarity is reversed. Consequently the output of the multiplier phototube has an alternating component except when the density of the portion of A being scanned is equal to the density at B. This alternating component changes phase as the rotating mirror passes the portion of A of density equal to that at B.

The alternating component of the multiplier phototube output, after amplification, is transmitted to a phase-sensitive detector. The output voltage of the detector changes polarity abruptly as the input signal changes phase at the instant the densities at R and A are equal.

Recording

An electronic pen recorder coupled directly to the phase-sensitive detector records intensity as a function of wavelength. The deflection of the recorder is essentially proportional to the time interval between the null instant and the passage of the mirror sweep off the standardizing film.

Because of the geometry of the rotating mirror system, this deflec-

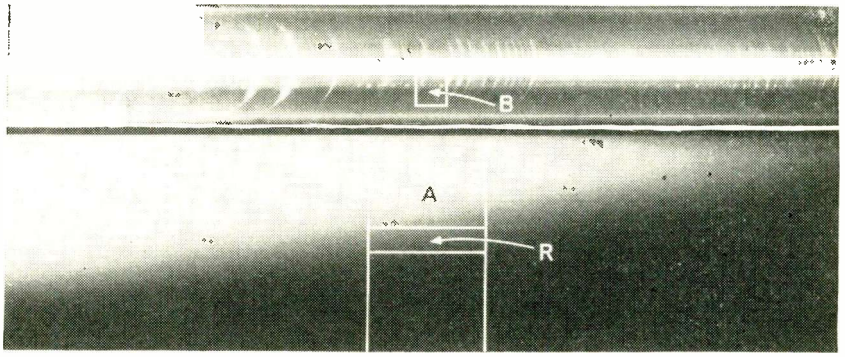


FIG. 1—Section of spectrogram under analysis (above) and its associated standardizing spectrogram. Small rectangle B is scanning slit and large rectangle A is portion of spectrogram being illuminated from microphotometer lamp. Rectangle R is portion of A that is being scanned at a particular instant by rotating mirror. The test section is from an ultraviolet flash spectrogram of the solar chromosphere taken during the total solar eclipse at Khartoum, Sudan on Feb. 25, 1952

tion is not strictly a linear function of X. Also, the deflection is somewhat dependent on the density of the film as well as the position of null on the standard film. These two difficulties are overcome by a calibration based on tracings along the direction of dispersion of a second standardizing film identical to the one in the standardizing spectrogram position.

Operation of the microphotometer with an electronic pen recorder has the advantage that the operator can observe line profiles as they are traced.

To utilize the intrinsic speed of microphotometer an alternative photographic recording system has been devised. This system has been operated for preliminary tests; a brighter source of light is needed, as described below, to make it fully successful. Operation of the photographic recording system is likewise shown in Fig. 2.

The phase-sensitive detector operates a pulse generator at the instant the two densities are equal. The pulse generator applies a high voltage pulse to Kerr cell K, which, lying between two crossed Polaroids P_1 and P_2, operates as an electro-optical shutter. Thus, at the moment the densities are equal, a light pulse passes from source S_2 to the rotating mirror M', which is on the same shaft as M. The position of M' determines the position of the pulse on the recording film. By making optical system $M'D'P'$ a duplicate of MDP, nonlinearities between scan and record are eliminated.

Because the angular aperture of the recording optical system is limited by the Kerr cell and the size of a rotating mirror face and also because of the short time in which a recorded dot must register on the film, a bright light source, S_2, must be used. From preliminary tests of the photographic recording system, it was concluded that a source of approximately five times the brightness of a two-watt zirconium arc is necessary to attain the proper brightness.

Circuits

The electronic system determines the instant at which two beams of light are equal and converts this information to a form suitable for operating either of the two forms of recorders. The two beams are sampled at a rate of 804 kc by the light-modulating action of the Kerr-cell electro-optical shutter. The Kerr cell is driven by the oscillator and power amplifier shown in Fig. 3. The circuit is conventional except for the 5687 clamp tube that provides a gradual increase in the voltage applied to the Kerr cell. The delay of several seconds between the switching on of the oscillator and the application of full voltage (2,200 volts rms) protects the cell from thermal shock.

The light modulated at the 804-kc rate falls on a 5819 multiplier phototube (Fig. 4), which is connected so the dynode voltage de-

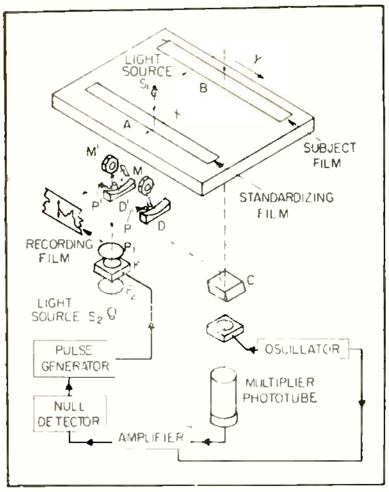


FIG. 2—Simplified circuit diagram of microphotometer

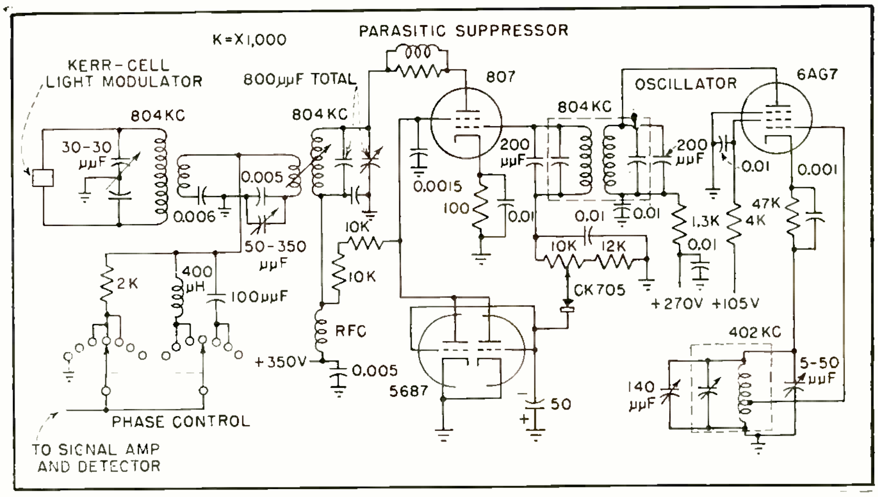


FIG. 3—Output of 6AG7 oscillator-doubler tube is transformer-coupled to 807 class-C amplifier that drives Kerr-cell light modulator

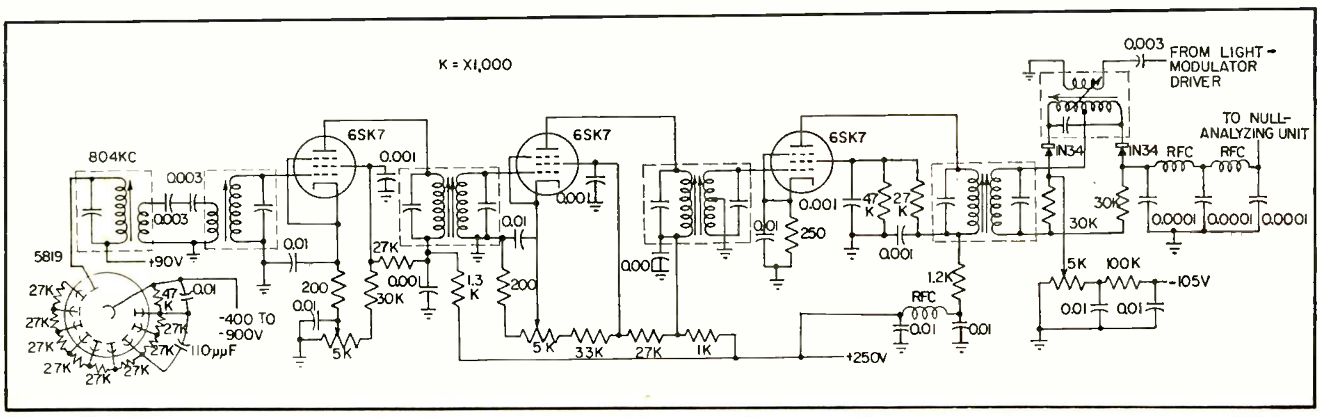


FIG. 4—Signal from multiplier phototube is amplified by 804-kc signal amplifier and fed to twin-1N34 phase detector

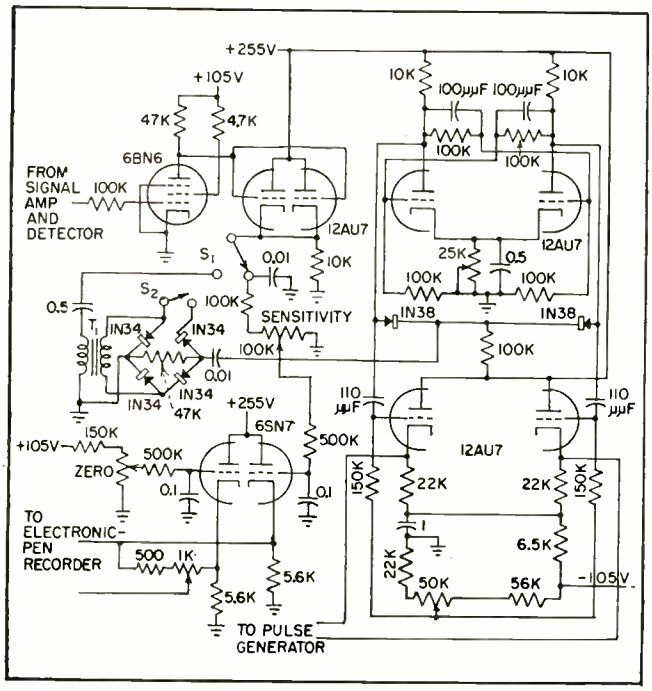


FIG. 5—Null-analyzing unit has clipper, flip-flop multivibrator and cathode follower circuits. Flip-flop stage routes pulses to alternate thyratron channels in pulse generator

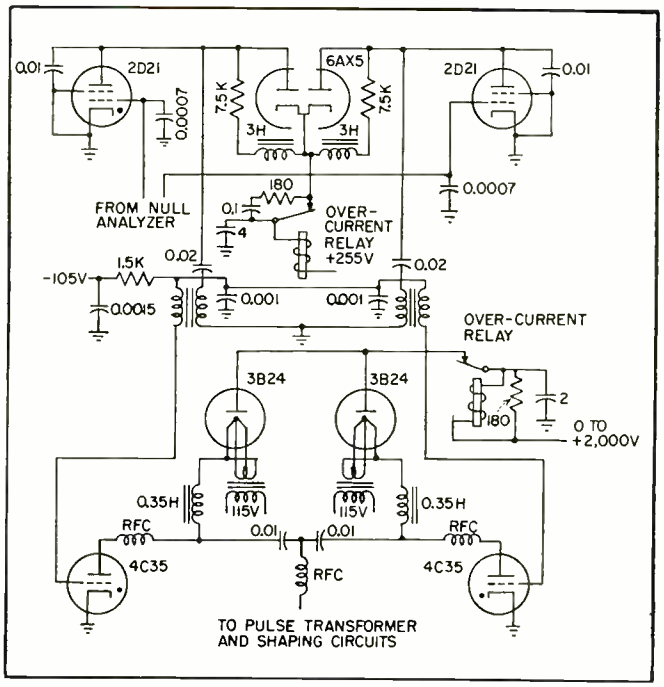


FIG. 6—Each of high-level pulse generators employs 2D21 thyratron to trigger 4C35 thyratrons. Both sides of system discharge through same transformer

creases with increasing light intensity, after a certain intensity is reached, thereby protecting the tube when no density is present in either of the optical systems.

The anode load for the 5819 is a resonant circuit with a low-impedance output for coupling through coaxial cable to the 804-kc signal amplifier. This amplifier is similar to a conventional three-stage i-f amplifier, except that its output is coupled to a phase-sensitive detector. The detector takes its reference voltage from the same source that drives the original light modulator, so the output of the detector is proportional to the light beam unbalance and the sign of the output indicates the direction of the error. This relation holds true only for a limited range on either side of the null, since the amplifier and detector saturate at large signal levels. The resulting difference in potential between the two rectifier cathodes, biased to a suitable value, is passed to the null analyzing circuit shown Fig. 5.

Null Analyzer

The 6BN6 gated-beam tube in Fig. 5, changes abruptly from nonconducting to conducting when the voltage of the control grid passes through a critical value. By proper bias of the d-c signal from the detector, the tube changes from nonconducting to conducting when the a-c component of the multiplier-phototube current changes phase. Hence, if the rotating mirror is sweeping the standard film from dark to transparent side, the tube becomes conducting at the moment the density of the swept portion of the standardizing film becomes equal to that of the subject film and remains conducting until the mirror sweeps off the standardizing film. The width of the resulting pulse is therefore a direct measurement of the intensity of the light causing the density on the subject film.

For electronic pen recording the d-c output of the 12AU7 cathode-follower is averaged by an R-C circuit, then supplied to the recorder by the 6SN7 differential cathode-follower.

Most of the circuits shown in Fig. 5 as well as the circuits of Fig. 6 and 7 are used in the high-speed photographic recording system.

When S_1 is thrown in the left position, the square wave output of the 12AU7 cathode-follower is differentiated by the primary of T_1 and its coupling capacitor so that positive pulses are generated in the primary winding corresponding to an increase in voltage at the cathode-follower output and negative pulses, corresponding to a decrease.

Densitometer Operation

For normal operation as a densitometer, switch S_2 is left open and the 1N34 diodes are connected to T_1 in such a manner that only the pulses corresponding to negative pulses in the primary appear at the output, where they are still negative. These nulls are recorded only when the density being scanned by the rotating mirror is changing in one sense. Accordingly, all true nulls, but only half of the false nulls (caused by noise) are recorded.

These negative pulses control the bistable 12AU7 multivibrator causing it to change its state each time a negative pulse is received. The multivibrator routes pulses alternately through the 4C35 thyratron channels in the pulse generator (Fig. 6), to get pulses closer together in time than would otherwise be possible. The deionization time of the thyratrons and the charging time of the pulse capacitors are the limiting factors.

The output of each side of the bistable multivibrator is differentiated and passed through the 12AU7 cathode-follower to the 2D21 thyratrons in Fig. 6. These thyratrons

act as pulse amplifiers to provide a pulse of sufficient amplitude to trigger the 4C35 thryatrons.

The over-current relays associated with the pulse capacitor-charging circuits are necessary because certain signal and noise combinations can cause any of the thyratrons to go into continuous conduction. If this happens, the average current through the relay increases and the B+ supply is opened momentarily, permitting the thyratron to deionize.

At the output of the 4C35 thyratrons, the alternate pulse channels are recombined by permitting both tubes to discharge their associated capacitors through the same pulse transformer.

Gating Pulses

The secondary of the pulse transformer (Fig. 7) applies a 15-kilovolt pulse to a second Kerr-cell electro-optical shutter operating as a conventional shutter and admitting a pulse of light to the same rotating system that caused the null. The position at which the light falls upon the recording camera film is therefore determined by the angular position of the rotating mirror at the time the two light beams become equal.

The 300-kva pulse transformer used was more than adequate for this application since it has a short rise time and pulse duration. Therefore a 1-mh choke and a 500-μμf capacitor were added in series with the secondary winding of the transformer to increase the pulse duration and to remove the steep wavefront before it is applied to the electro-optical shutter. It was necessary to increase the pulse duration to admit enough light to the recording film and to reduce heating in the electro-optical shutter by reducing the peak current.

The 705A and 3B24 diodes remove the positive overshoot on the pulse, so that the pulse applied to the electro-optical shutter approximates a negative half-cycle of a sine wave with a duration of about 5 microseconds and a peak amplitude up to 15 kv. The capacitor voltage divider and test point provide a means of observing the pulse on an oscillograph.

When the instrument is to be used as an isophotometer, S_2 in Fig. 5 is closed, permitting a negative pulse to be sent to the bistable multivibrator in Fig. 6 each time the phase-sensitive detector passes through a null, regardless of direction.

Since the frequencies involved in this instrument are in a range where radio interference could result if r-f leakage were permitted, fairly elaborate filtering and shielding are necessary. Stray pickup within the instrument is greatly reduced by the same precaution.

Isophotometer Use

The High Altitude Observatory microphotometer, is designed to have an alternative use as an isophotometer. When used as an isophotometer the photograph to be analyzed is scanned by the rotating mirror. Thus it is placed in the

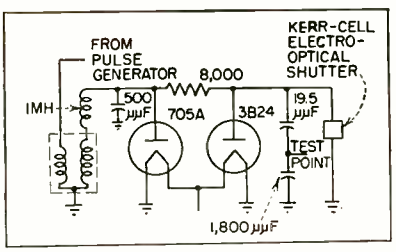


FIG. 7—Secondary of pulse transformer applies 15-kv pulse to Kerr-cell electro-optical shutter

position on the carriage that is occupied during microphotometry by the standardizing spectrum. A step on a comparison wedge (which does not move with the carriage) replaces the subject spectrum between the microscope objectives. Thus the phase-sensitive detector responds whenever the rotating mirror scan crosses the same density on the photograph as that between the microscope objectives.

If the photographic recording system is being used, a succession of exposed points on the recording film identify an isophotal contour. This method of tracing isophotes has two distinct advantages; the complete contour is traced in a single scan and if the contour runs off the film, the instrument automatically picks it up again at the appropriate point rather than hunting and perhaps finding a different contour. The pen recording system does not give an isophotal contour. However, the area under the curve which it traces is proportional to the area within the contour.

Application

The microphotometer, using Esterline Angus recording, has been in operation for about six months. Its most extensive use during that time has been in the analysis of the Balmer and Paschen lines and the Balmer continuum in the flash spectra of the solar chromosphere, taken at Khartoum during the solar eclipse of February 25, 1952. Since these lines occupy a rather limited portion of the spectrograms, the speed of the electrical recorder has been adequate for their analysis. It is anticipated, however, that if it is attempted to catalog the intensities, in energy units, of all the several thousand lines appearing on the eclipse plates, it will be necessary to bring the photographic recording into use.

The microphotometer is also being used for standardization of the line intensity readings of the coronal spectrograms which are taken daily at Climax, Colorado. During the several months of rather intensive use, the instrument has demonstrated a high degree of stability and has required negligible servicing by the operator.

As the instrument now operates, the rotating mirror turns at 400 scans per second and the comparison Kerr cell is driven at 800 kc. The carriage speeds are 0.015, 0.068, 0.13 and 1 mm per sec. The three lower speeds are used with the electronic-pen recorder, the choice of speed depending on the gradient of the line profiles. The 1 mm per sec carriage speed is primarily for use with the photographic recorder.

The authors thank the Naval Research Laboratory and the Office of Naval Research for their support of the design and construction of this instrument. Thanks are also due to W. O. Roberts for assistance in the design of the microphotometer and to the Mount Sopris Instrument Co. for aid in many phases of its development.

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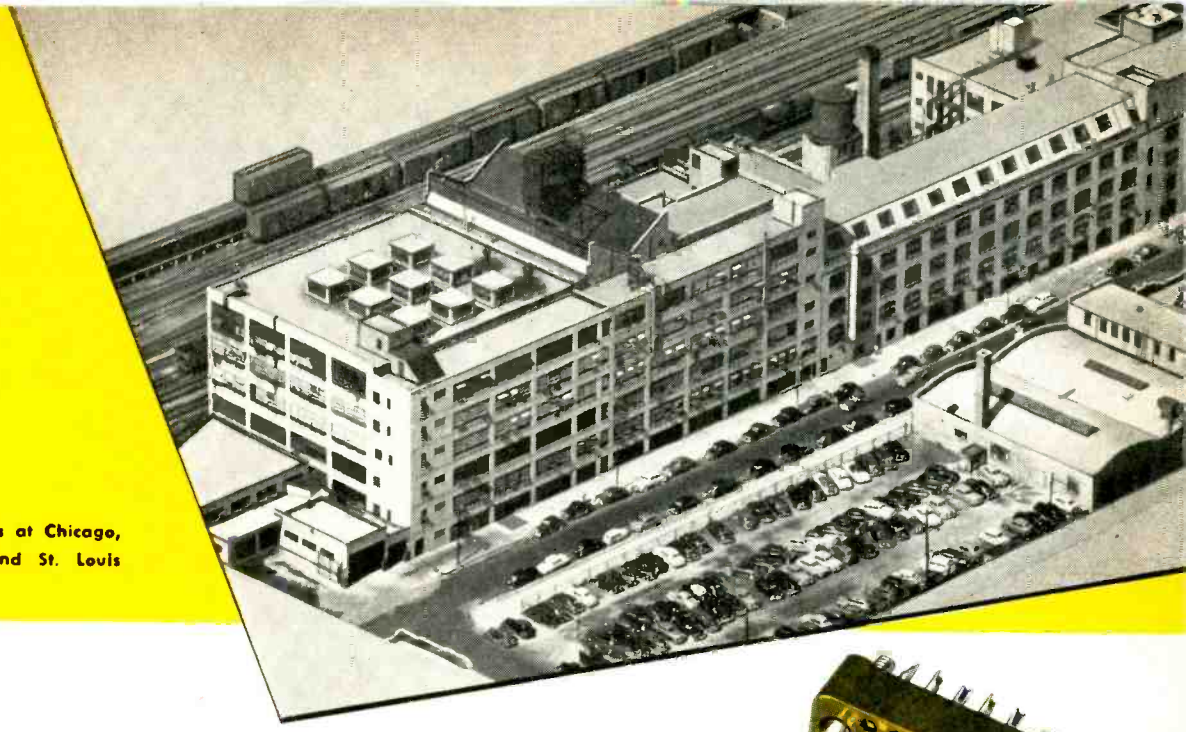

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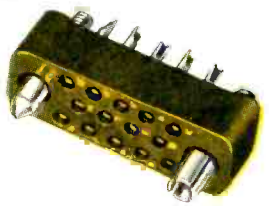

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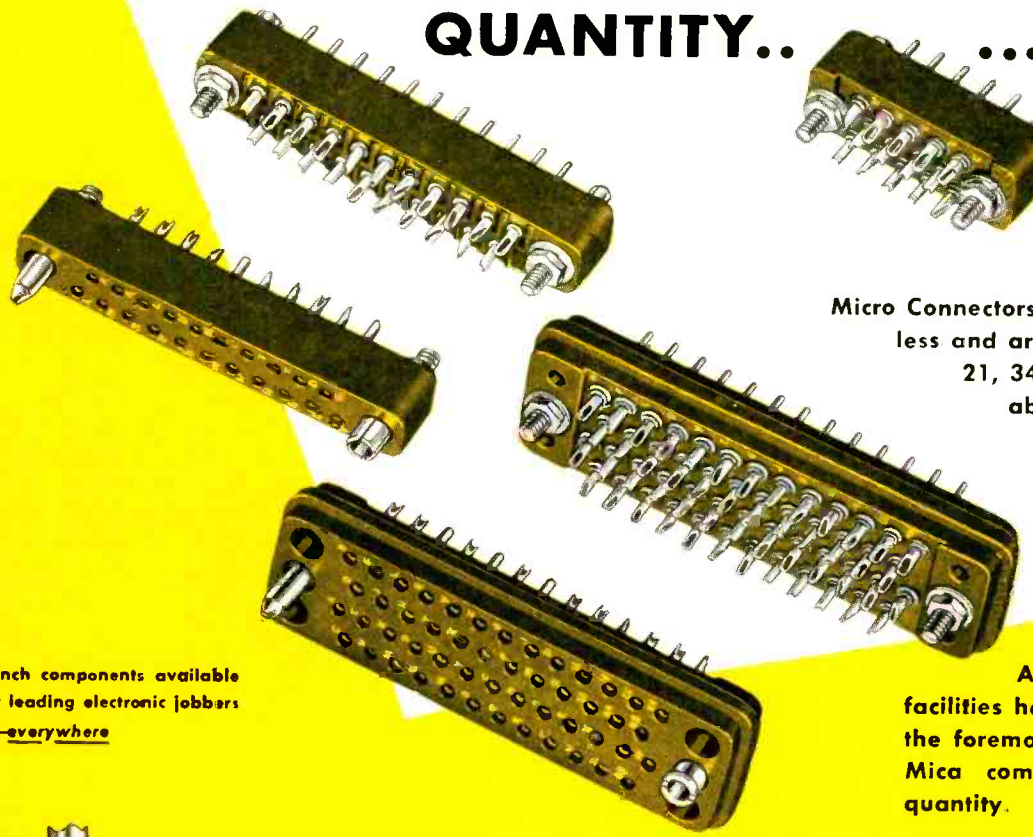

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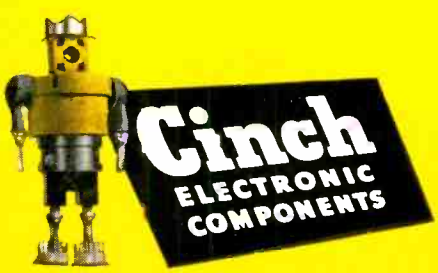

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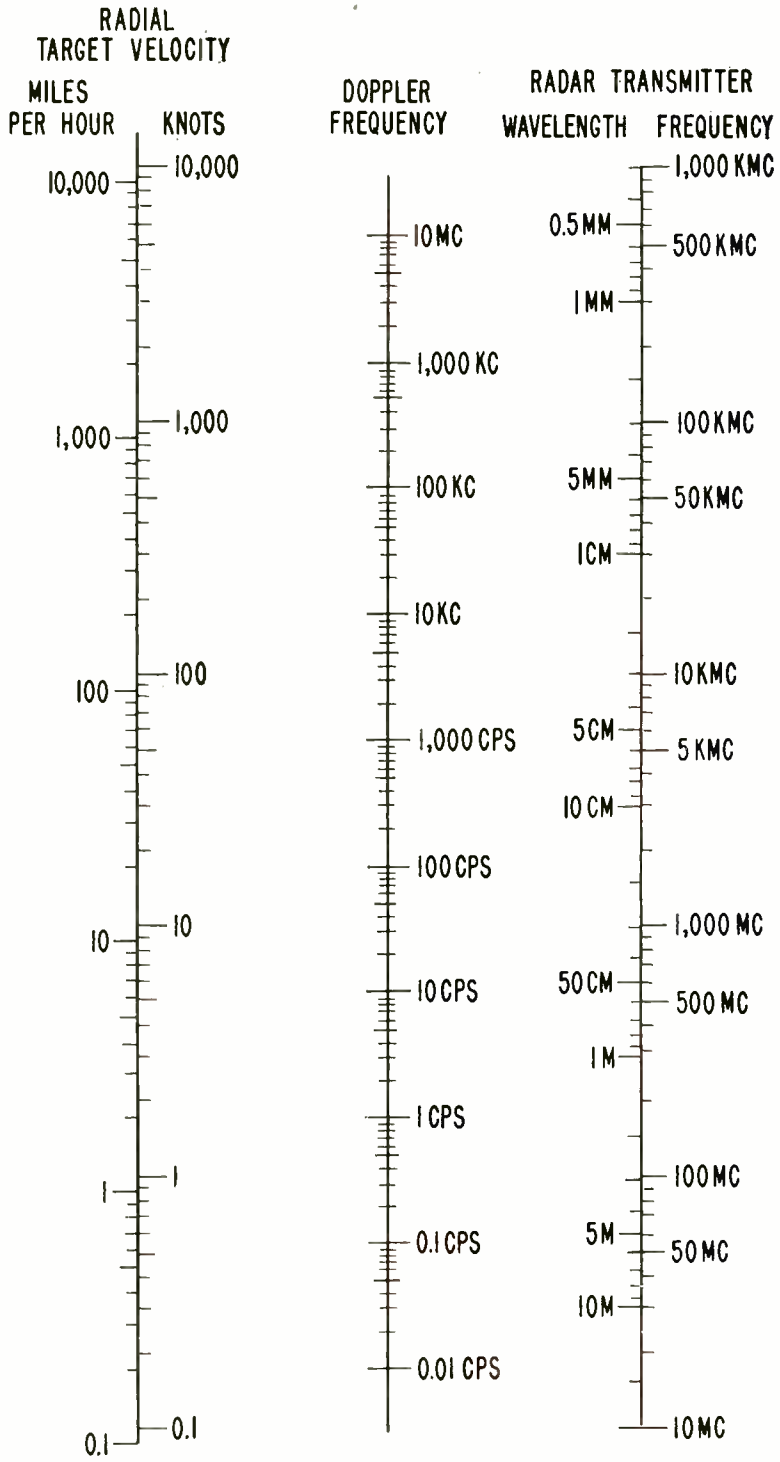
Radar Doppler Nomograph

Relates Doppler frequency, radar transmitter frequency or wavelength and radial velocity of target in miles per hour or knots, as aid in design of c-w or coherent pulsed radars capable of separating moving targets and suppressing clutter



By ALLEN H. SCHOOLEY

Naval Research Laboratory
Washington, D. C.

RADAR targets having a radial velocity component, either toward or away from the radar, give a returned signal frequency that is higher or lower respectively than that of the transmitted signal. This difference or Doppler frequency is important to designers and users of radars.

To make practical use of Doppler information, it is convenient to refer to the adjacent nomograph which is based on the relationship $f_d = 2|V|f_t/c$, where f_d is the Doppler frequency in cps, $|V|$ is the absolute value of the radial component of target velocity relative to the radar in miles per hour, f_t is the transmitted frequency in cps and c is equal to 6.7×10^8 miles per hour, which is the speed of electromagnetic wave propagation.

A straightedge laid across the nomograph gives the Doppler frequency for any radar frequency from 10 mc to 1,000 kmc.

As an example, determine the Doppler frequency of a target traveling 100 knots directly towards (or away from) a 10-centimeter radar. Starting at the 100-knot point on the left scale of the nomograph, draw a straight line to the 10-centimeter point on the right scale. Read 1,000 cps at the point where the line crosses the center scale. Similarly, a 1,000-knot radial velocity target would produce a 10-kc Doppler signal.

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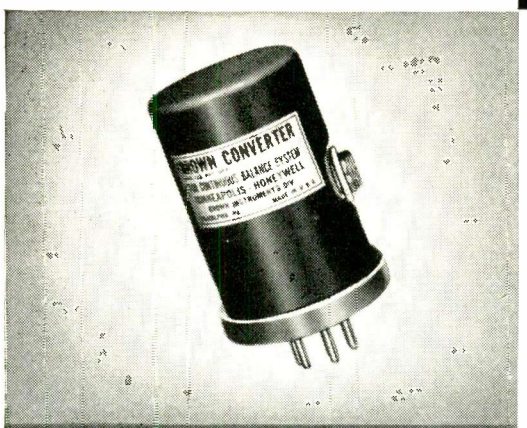

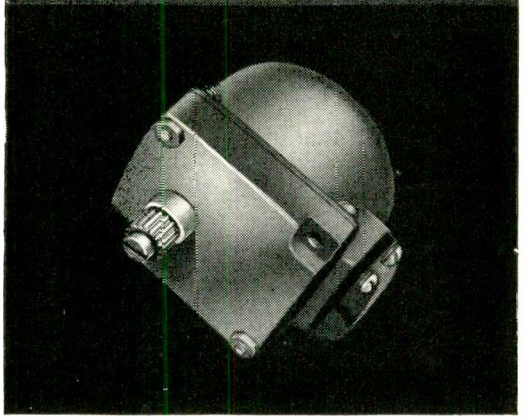

● converters

Compact, durable; proved by years of service in *ElectroniK* recorders. Convert low power d-c signals to alternating voltages for nominal frequencies of 25, 40, 60 or 400 cycles, as specified. Useful for null detection or error voltage measurement. Refinements in design give low phase angle lag and extremely long life. Ask for Data Sheets 10.21-1 and 10.20-5.

● amplifiers

For use with converter and balancing motor, for null detection and error signal correction. See Data Sheets 10.20-3b and 10.20-4.

Amplifier No.	Input Impedance (ohms)	Sensitivity* (volts)	Overall Voltage Gain
357504-20	80,000	3×10^{-6}	1×10^{6}
357504-21	80,000	1×10^{-6}	3×10^{6}
357504-5	400	4×10^{-6}	1×10^{6}
356899	2,200	$.05 \times 10^{-6}$	40×10^{6}

*Approximate sensitivity, when used with motors listed below.

● balancing motors: 2-phase induction, reversing

Totally enclosed, self lubricated. High torque at low speeds. See Data Sheet No. 10.20-2c.

Ratings for 115 volt, 60 cycle operation†				
Shaft Speed, rpm	27	54	162	333
Maximum Torque, inch-ounces	85	43	19	11
Intermittent Rated Torque, inch-ounces	30	15	5	4
Maximum Power, inch-ounces per minute	5850 at 14-16 rpm	5800 at 30-32 rpm	7550 at 92 rpm	8750 at 190 rpm
Power Required, all speeds	Line Field, 11 watts Amplifier Field, 2.5 watts			

†Motors for 25 and 40 cycle service are also available. Above motors may be used on 50 cycles.

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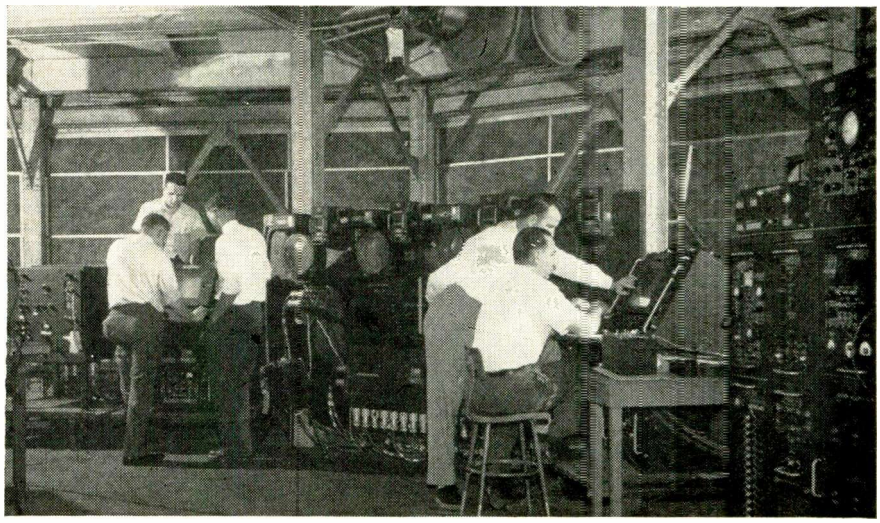


Radar Height Finder Fills Balloon

New Air Force height-finder built by GE has three times the range of previous equipments. It is adapted to Arctic climates by dome-shaped covering made of woven-glass fabric impregnated with a rubber compound. The balloon-like radome (left) is supported by about a half pound per square inch air pressure and can withstand winds up to 125 miles an hour. Entrance to the radome is through an air lock. Radar data from height and search radars is fed to control center (right) from whence it is relayed to fighter bases. Fluorescent tubes a hundred feet away can be lighted from the radio energy

Transistor Audio Source

AUDIO OSCILLATOR producing 2 volts across 600 ohms at frequencies of either 400 or 1,000 cycles is said to be the first commercial test equipment to use a transistor. It is manufactured by General Radio Co.

Designed as a self-contained audio calibration device, the oscillator uses a *pnp* junction transistor in a Hartley circuit. The inductor is an iron-core coil with an air gap. The coil is divided to obtain proper d-c operating voltages for the transistor, but a large bypass capacitor connects the sections in series for audio currents. The tuning capacitor is connected across the full coil for 400-cycle operation. It is switched across only a part for operation at 1,000 cycles.

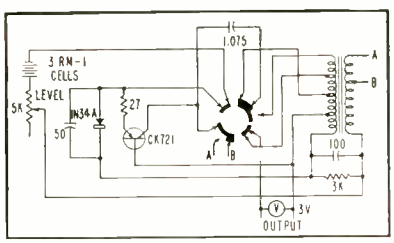
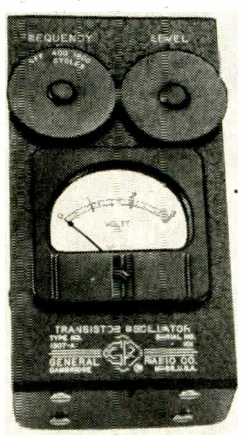


FIG. 1—Circuit diagram shows output winding coupled to inductor

In the circuit, the emitter of the transistor corresponds to the cathode of a vacuum tube; the base, to the grid; and the collector, to the



Commercial transistor oscillator produces two audio frequencies

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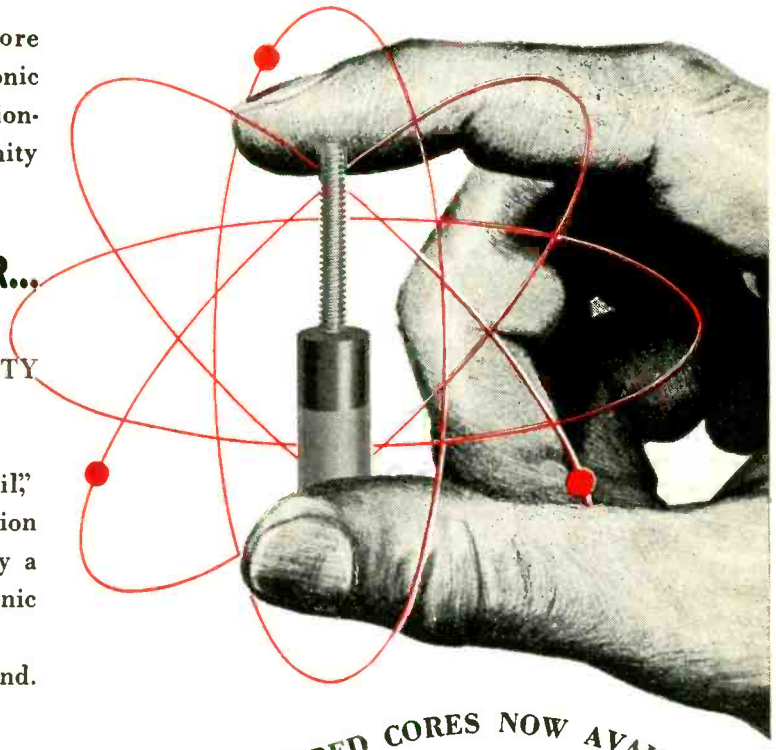

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plate. The main tuned circuit for 400-cycle operation is connected between base and collector and the emitter is connected to the coil at a point between those two elements.

A germanium diode sets bias voltage for the base. Operating characteristics of the diode approximate those of the emitter-base junction of the transistor so oscillations will start for a wider range of temperature, battery voltage and transistors than would be possible with a linear resistor in the bias circuit.

The rectifier-type voltmeter is used to indicate output voltage.

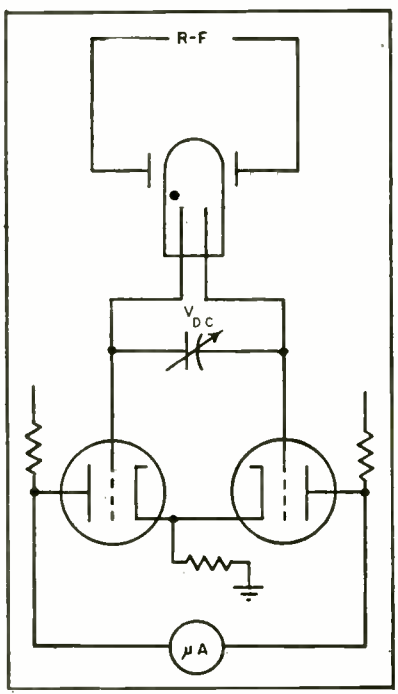
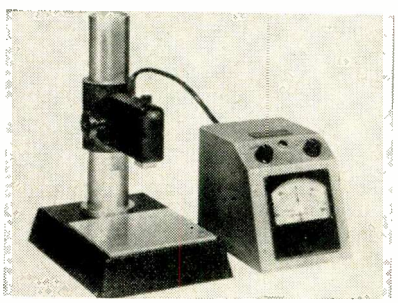


FIG. 1—Simplified circuit of the comparator micrometer using the gas-tube transducer

Ionization Transducer Micrometer

DISPLACEMENT from 0.000001 to 0.0002 inch using a new capacitance principle can be measured in a newly developed comparator micrometer. Full-scale deflection of its indicating meter registers plus or minus 20 microinches.

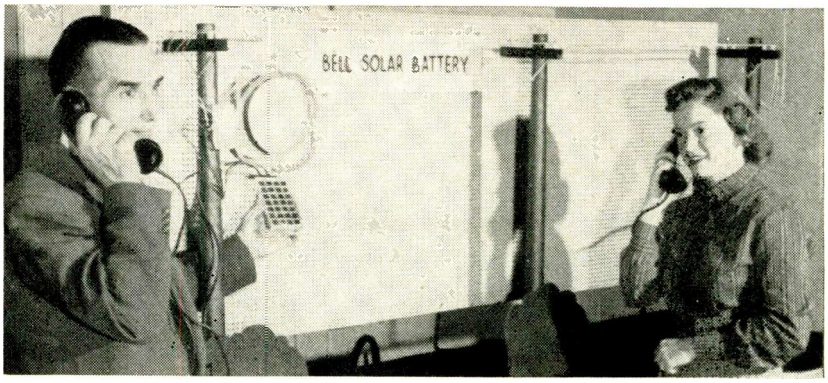
Conversion of capacitance variation to electrical signal is accomplished through a new type of transducer element using the circuit shown in Fig. 1. The ionization transducer is a small glass capsule filled with noble gases under reduced pressure and excited by a regulated r-f source. The direct current developed by the transducer is applied to a differential circuit. The indicating microammeter gives 400 microamperes deflection for each volt of input signal.



Commercial version of the micrometer giving measurements to a millionth of an inch without physical contact

Basic principle of the transducer element was discovered by Kurt S. Lion, now associate professor of Biophysics at Massachusetts Institute of Technology, Cambridge, Mass. He exposed a gas-discharge vessel containing two electrodes to a radio-frequency electric field existing between the plates of a capacitor. It was found that a relatively high direct voltage resulted between the two electrodes. Magnitude of the voltage varied between minus 60 and plus 60 volts as a function of the position of the vessel in the electric field. Symmetry in the vicinity of the electrodes leads to zero output voltage, while any slight asymmetry, owing to an unbalanced field or other cause, produces output voltage.

Systems have been built whereby



Gerald L. Pearson, a coinventor of the Bell solar battery holds the new version of the silicon device with which eight percent efficiency has been obtained

Solar Battery Improved

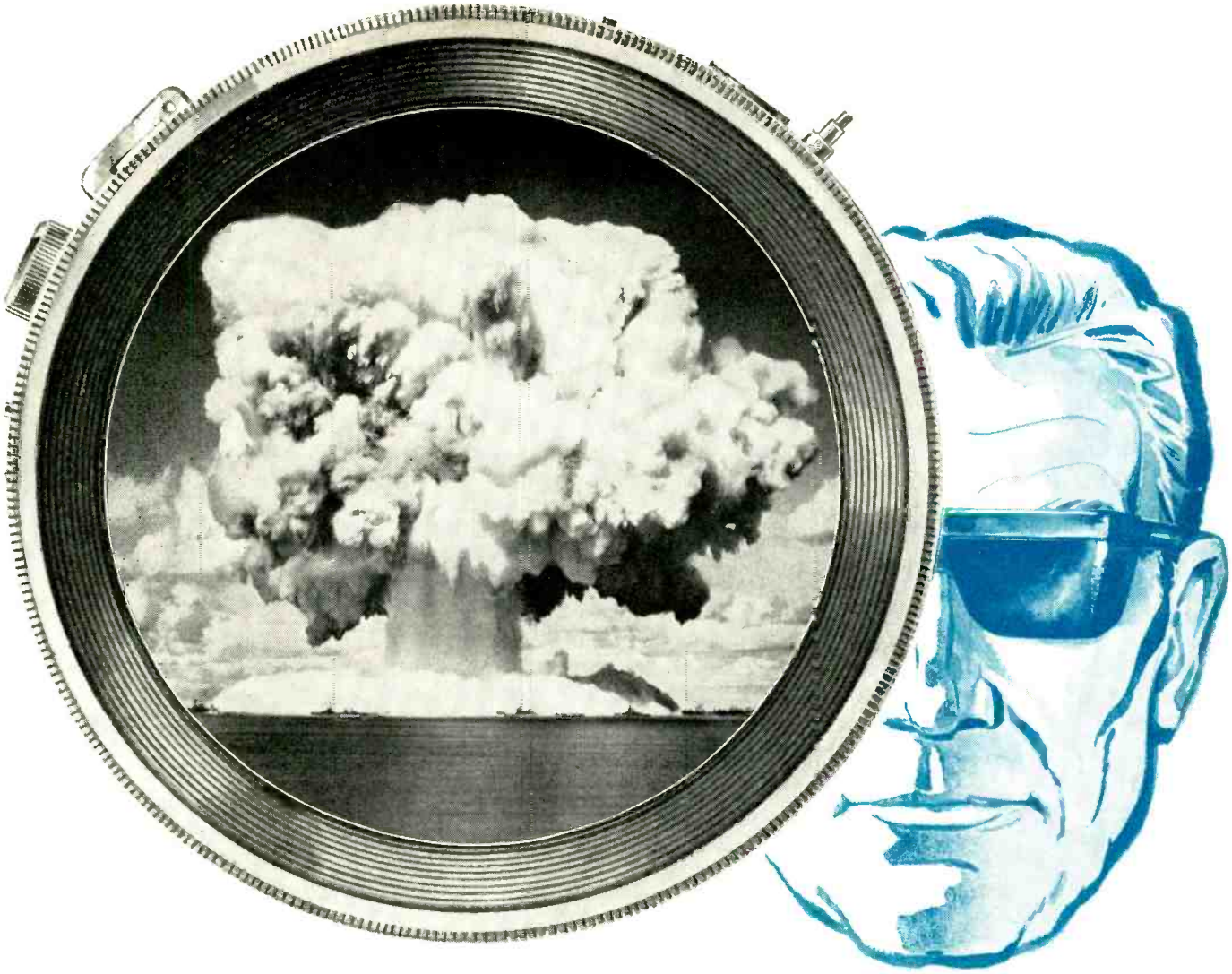
SOLAR BATTERIES operating at an efficiency of six percent were demonstrated at Bell Telephone Laboratories (ELECTRONICS, p 196, June 1954). More recently an increase in efficiency of a third was announced. Experimental cells now yield a record eight-percent efficiency, comparable to that of steam and gasoline engines.

While goals of 10 to 15 percent are yet to be attained, the value of eight percent is ten to fifteen times better than the efficiencies of the best photovoltaic devices available. Maximum theoretical efficiency is estimated at 22 percent.

Factors limiting the efficiency include losses of radiant energy by reflection from the silicon surface as well as those within the cell itself.

Technique for production of experimental silicon *p-n* junction devices is controlled introduction of a foreign element into a microscopic layer near the surface of a thin slice of arsenic-doped silicon.

Treatment under gas at high temperatures permits the introduction of minute traces of impurities into the atomic structure at the surface. Introduced at a precise rate and under carefully controlled conditions, the impurities reach a depth less than ten-thousandth inch.



how to stop an h-blast

WANTED: a camera to stop the action of a nuclear explosion at a pre-selected microsecond, with high quality image-definition . . . that was the problem handed by the AEC and its Los Alamos Scientific Laboratory to the Boston firm of Edgerton, Germeshausen & Grier, Inc. EG&G solved it by inventing the non-mechanical Rapatronic shutter . . . employing the Faraday Effect of magnetically rotating the plane of polarized light as it traverses an optical element . . . and relying on HELIPOT* precision potentiometers and DUODIAL* turns-counting dials for sensitivity setting and calibration.

A light-pulse from the blast falls on a photocell . . . generates a signal that passes through a variable time-delay to trigger a condenser-discharge circuit . . . releasing energy which surges through a coil wound around a lead-glass lens. The resulting magnetic field rotates polarized light from the blast as it passes through the lens . . . effecting a one-microsecond exposure.

Sensitivity of the photocell circuit is controlled by a standard-linearity Model A 10-turn HELIPOT, calibrated with a Model RB DUODIAL. Time-delay from photocell pick-up to shutter operation . . . continuously variable from 0 to 100 microseconds . . . is controlled by a Model A 10-turn HELIPOT of 0.1% linearity, calibrated with a Model W10 DUODIAL.

The coil of the HELIPOT is wound with more than 10,000 turns of resistance wire . . . the DUODIAL is settable to a fraction of any of its thousand scale-divisions . . . and the Rapatronic shutter can be tripped at any preselected fraction of a microsecond.

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a movement of the discharge tube in the high-frequency field of 1/1,000 mm produces an output voltage of greater than two volts.

Inside Speech Clipper

By Ed. C. Miller
Inland Broadcast Co.
Weiser, Idaho

Conventional methods of speech clipping use biased diodes to clip off the positive and negative peaks that exceed the bias voltages. Such a circuit is shown in Fig. 1A. The output waveform is very nearly a square wave and as such contains a multitude of harmonics, besides the applied frequency.

A low-pass filter is inserted after the clipper to reduce the undesired high-frequency harmonics that would create unnecessary sidebands or splatter. In this outside type of clipper, the body or inside of the applied signal is passed and the peaks are removed.

Figure 1B illustrates a clipper circuit that takes out the inside of the signal and leaves the outside portions joined to form a continuous wave. The diodes are used as clamper tubes and clipping takes place in the triodes, by grid-current limiting in V_1 and by cutoff of V_2. During the first positive half-cycle of signal, R_2 is shorted to ground by V_4, causing C_2 to become charged to the extent of the positive signal voltage.

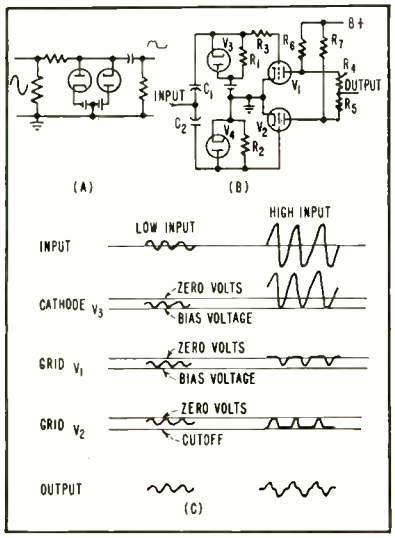


FIG. 1—Clipper circuit (A) removes waveform peaks. Circuit (B) passes positive and negative peaks of wave and rejoins them as shown in (C)

After the positive crest of the first half-cycle of input is reached and it begins to go in a negative direction, V_4 will no longer conduct. Resistor R_2 is sufficiently large so C_2 will not discharge appreciably during the remainder of the cycle. Signal at the grid of V_2 is the same as the input, except that its positive maximum is zero volts and it extends in a negative direction. If the input is great enough, V_2 will be cut off during a certain portion of the cycle. The same action is accomplished with V_3, only it clamps the signal at its negative maximum to the bias voltage, with the audio-frequency voltage extending in a positive direction. When the bias voltage is exceeded, grid current will flow in V_1 and clipping of a positive portion will occur. Combining the outputs of V_1 and V_2 results in an output wave that has the center portion removed.

Waveforms are shown in Fig. 1C that are present at various points in the circuit of Fig. 1B. At low signal inputs, V_1 and V_2 function as parallel Class-A amplifiers and as the input increases the mode of operation of these tubes changes. At extremely high inputs, V_1 continues as a Class-A amplifier, but introduces grid-current limiting through R_2. Tube V_2 operates Class-C, its grid being driven in excess of cutoff.

For easiest design, V_1 and V_2 should be the same type, and assuming such is the case, the clipping level of each tube should be made the same so the output waveform will be symmetrical. To do this, the grid bias of V_1 must be just slightly less than cutoff.

If it were in excess of cutoff, both the positive and negative peaks would be clipped in V_1. From a practical standpoint, perfect symmetry cannot be attained in the grid circuits alone, but can be recovered in the plate circuit by making R_4 and R_5 of unequal values.

The complete inside clipper is shown in the photograph and in Fig. 2. A pentode amplifier precedes the clipper to allow the use of a high-impedance crystal or dynamic microphone and the output is attenuated to the output of a microphone, so it can be inserted into any speech equipment with low-level high-impedance input.

In Fig. 2, no diode is used across the grid resistor of V_{3B}. Because current drain is negligible, the grid of V_{3B} performs the functions of the diode V_4 in Fig. 2. The network

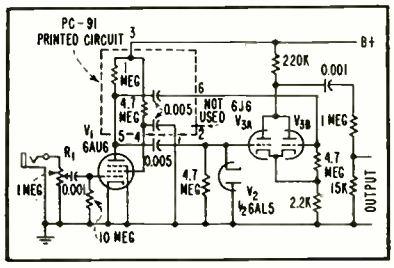
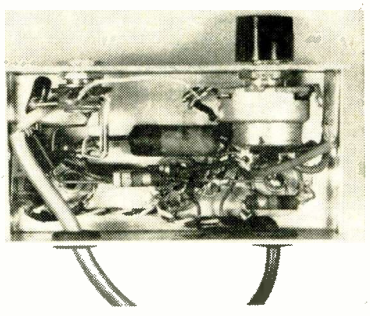


FIG. 2—Complete clipper circuit uses pentode preamplifier to provide high-impedance input

of mixing resistors shown in Fig. 2, is replaced by a single plate resistor. This can be done because at low inputs, both sections of V_2 operate in parallel as previously described. Whenever one section is following the signal contour beyond the clipping point the other section is either saturated or beyond cutoff and will therefore not affect the total plate current of the two triodes.

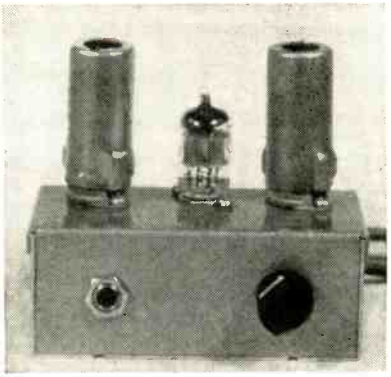
For simplicity and to prevent the normal aging of the tube from adversely affecting the circuit operation, cathode bias is used on V_1, instead of the battery bias shown in Fig. 1B. Cathode bias does not permit the output to be held absolutely constant from the clip level on. But it does remain nearly constant, so this minor disadvantage is outweighed by its reduction of the sharpness of the cutoff or clipping. This reduces the harmonic content of the clipper output to basically third harmonics and minimizes the filtering re-



Clipper uses printed coupling circuit to reduce space requirements

quired. In most transmitters, no additional filter is needed except perhaps a capacitor across the modulation-transformer winding.

A printed circuit is used for coupling from the pentode stage to the clampers. The 6AL5 tube could be replaced with a germanium diode and the 12AU7 inserted after the preamplifier in an amplifier already in use, or the entire unit could be built on the same chassis with the rest of the speech amplifier. The



Poteniometer on clipper chassis controls clipping level

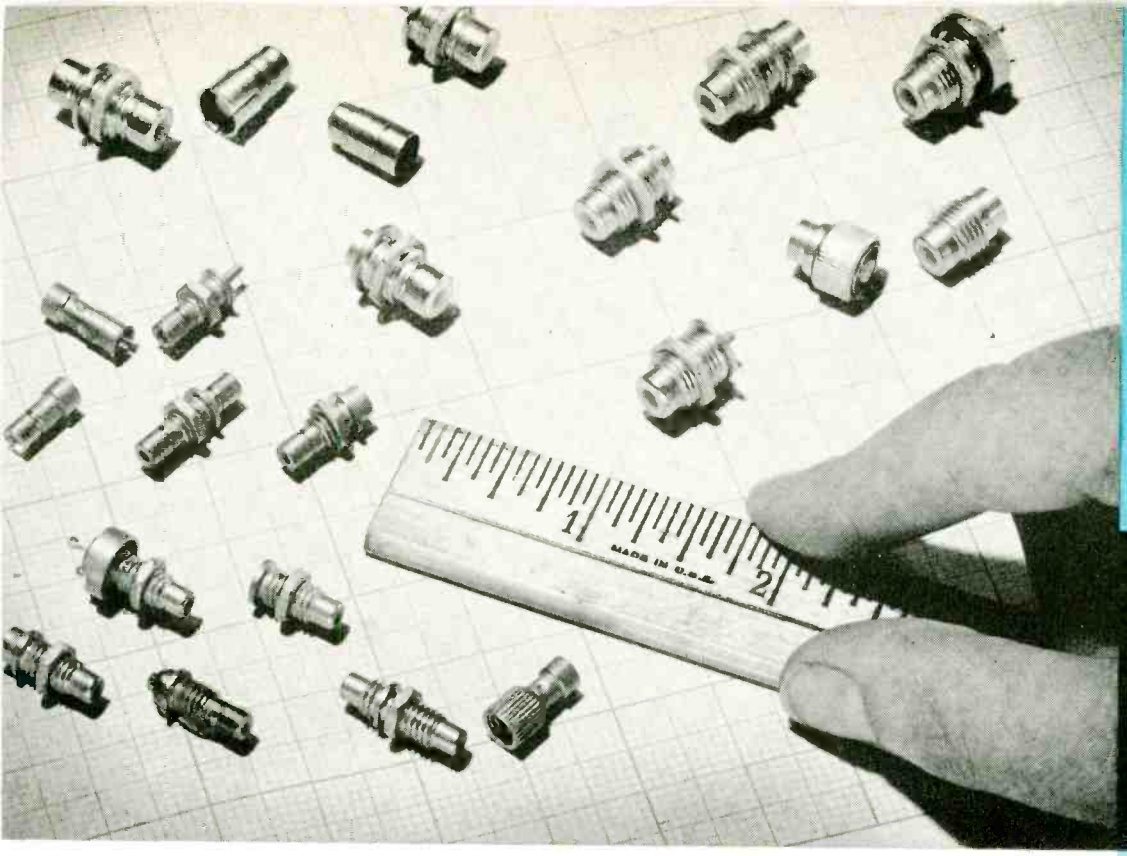
separate chassis was used in the present instance to allow its use with one of several transmitters.

Adjustment of the inside clipper is the same as any clipper circuit. The master gain control on the speech amplifier or modulator is adjusted to give the desired percentage of modulation with a high degree of clipping. Then R_1, the input potentiometer, is set such that clipping just begins at normal voice levels. If a sine-wave audio oscillator or generator is used to adjust the modulation percentage (and this is recommended,) 95 percent modulation at 20 db of clipping is suggested. Then with the audio oscillator disconnected and a microphone inserted in the clipper input, R_1 is set such that a high level of peak modulation is obtained during all of the transmissions.

Transistors Use Emitter-Coupled Feedback

By Frank C. Alexander, Jr.
Gulf Research and Development Co. Pittsburgh, Pa.

A large family of cathode-coupled vacuum-tube circuits has grown up in the technology during the past fifteen years. This article describes



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A complete line of 50 and 75 ohm RF connectors, so small that all of the twenty-two connectors in the series easily fit in the palm of your hand!—the ruler certainly tells the story of the amazing new AMPHENOL ***subminax*** RF connectors! A result of the continuing AMPHENOL development work in the field of miniaturization, the new ***subminax*** connectors have all the dependable features of their older, larger brothers compressed into a fraction of the space usually demanded in RF connectors!

The ***subminax*** line is exceptionally complete. Connectors are available in both screw-on and push-on types in either 50 or 75 ohms. In each design there is a plug, jack, receptacle, jack bulkhead and feed through. In addition, *hermetically sealed* receptacles are available in the 50 ohm and 75 ohm screw-on connectors. Construction? ***Subminax*** connectors have machined brass bodies with a tough and shining gold-plated finish.

Although ***subminax*** cable assemblies are available directly from AMPHENOL, assembly at your plant is both easy and practical. Inexpensive and easy-to-use *hand crimpers* are available along with the necessary lengths of AMPHENOL Miniature Coaxial Cable.

50 ohm Push-on

Part No.	Description
27-1	Plug
27-2	Jack
27-3	Receptacle
27-4	Jack Bulkhead
27-5	Feed Through

50 ohm Screw-on

Part No.	Description
27-5	Plug
27-8	Jack
27-9	Receptacle
27-10	Jack Bulkhead
27-11	Feed Through
27-12	Receptacle Hermetically Sealed

75 ohm Push-on

Part No.	Description
27-13	Plug
27-14	Jack
27-15	Receptacle
27-16	Jack Bulkhead
27-17	Feed Through

75 ohm Screw-on

Part No.	Description
27-19	Plug
27-20	Jack
27-21	Receptacle
27-22	Jack Bulkhead
27-23	Feed Through
27-24	Receptacle Hermetically Sealed

MINIATURE COAXIAL CABLE

Three types of miniature coaxial cable are available from AMPHENOL for making *subminax* assemblies. These are 50 ohm and 75 ohm polyethylene dielectric with black vinyl jacket cable and a 50 ohm Kel-F dielectric and Kel-F jacket cable.

Part No.	RG-/U No.	Impedance	Description
21-596	—	50 ohm	Kel-F
21-597	—	75 ohm	Poly.
21-598	174	50 ohm	Poly.

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some analogous transistor circuits that have been built and tested. They all use readily-available junction-transistor types.

Circuits have been built using both CK-722 *pnp* transistors and TI-201 *npn* transistors. The *npn* units are more expensive, but permit operation to higher frequencies.

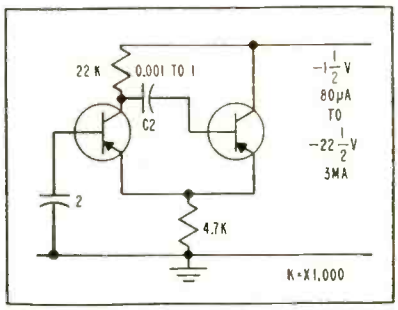

FIG. 1—Two-transistor free-running multivibrator uses a minimum of parts

Figure 1 shows a two-transistor free-running multivibrator using only two capacitors and two resistors. The prf was varied from 6 per sec to 6,000 per sec by varying C_2 from 1 μf to 0.001 μf.

A monostable one-shot multivibrator with rise time of 2 μsec, a minimum pulse width of 5 μsec and a maximum pulse width of several seconds depending on C_2 is shown in Fig. 2. A trigger of 0.03-volt amplitude and 1-μsec duration is required.

Figure 3 shows a two-terminal oscillator. This has been operated

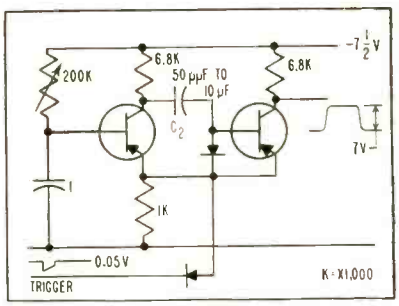

FIG. 2—One-shot multivibrator produces pulses with 2-μsec rise time

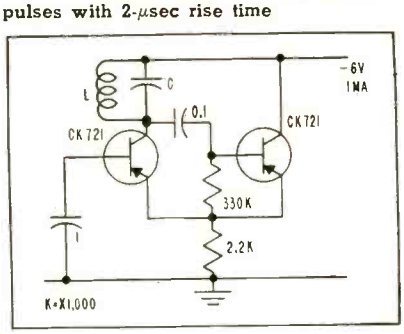

FIG. 3—Two-terminal oscillator circuit will operate to 500 kc

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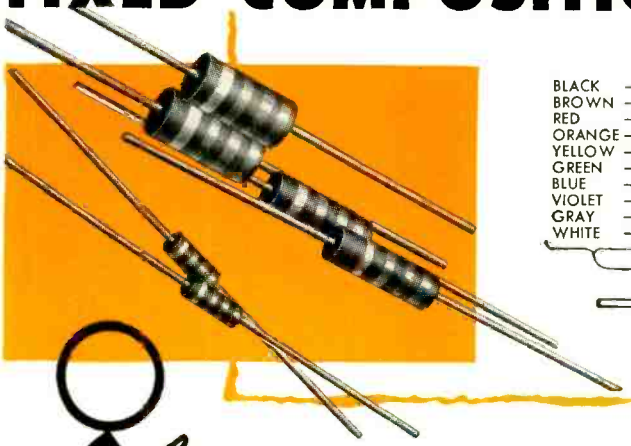

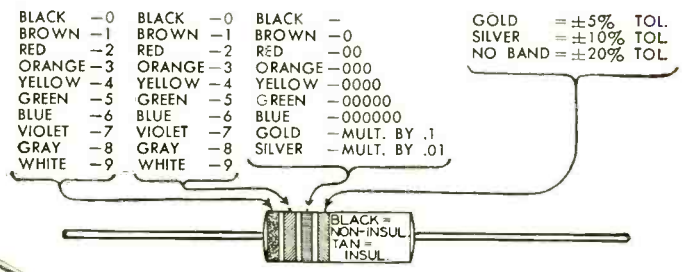

These standard resistance ratings have been carefully selected to cover every circuit requirement while avoiding costly and unnecessary overlapping of values. All Stackpole ½-, 1-, and 2-watt resistors are regularly supplied in each of the ranges and tolerances indicated. Through this standardization you are assured of maximum quality and faster deliveries plus easier stocking of resistors for you.

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These 269 RETMA Values Meet Every Modern Circuit Need!

±20%	±10%	±5%	±20%	±10%	±5%	±20%	±10%	±5%	±20%	±10%	±5%
10	10	10		390	390	15000	15000	15000		560000	560000
		11			430			16000			620000
	12	12	470	470	470		18000	18000	680000	680000	680000
		13			510			20000			750000
15	15	15		560	560	22000	22000	22000		820000	820000
		16			620			24000			910000
	18	18	680	680	680		27000	27000	1.0 Meg	1.0 Meg	1.0 Meg
		20			750			30000			1.1 Meg
22	22	22		820	820	33000	33000	33000		1.2 Meg	1.2 Meg
		24			910			36000			1.3 Meg
	27	27	1000	1000	1000		39000	39000	1.5 Meg	1.5 Meg	1.5 Meg
		30			1100			43000			1.6 Meg
33	33	33		1200	1200	47000	47000	47000		1.8 Meg	1.8 Meg
		36			1300			51000			2.0 Meg
	39	39	1500	1500	1500		56000	56000	2.2 Meg	2.2 Meg	2.2 Meg
		43			1600			62000			2.4 Meg
47	47	47		1800	1800	68000	68000	68000		2.7 Meg	2.7 Meg
		51			2000			75000			3.0 Meg
	56	56	2200	2200	2200		82000	82000	3.3 Meg	3.3 Meg	3.3 Meg
		62			2400			91000			3.6 Meg
68	68	68		2700	2700	100000	100000	100000		3.9 Meg	3.9 Meg
		75			3000			110000			4.3 Meg
	82	82	3300	3300	3300		120000	120000	4.7 Meg	4.7 Meg	4.7 Meg
		91			3600			130000			5.1 Meg
100	100	100		3900	3900	150000	150000	150000		5.6 Meg	5.6 Meg
		110			4300			160000			6.2 Meg
	120	120	4700	4700	4700		180000	180000	6.8 Meg	6.8 Meg	6.8 Meg
		130			5100			200000			7.5 Meg
150	150	150		5600	5600	220000	220000	220000		8.2 Meg	8.2 Meg
		160			6200			240000			9.1 Meg
	180	180	6800	6800	6800		270000	270000	10.0 Meg	10.0 Meg	10.0 Meg
		200			7500			300000			11.0 Meg
220	220	220		8200	8200	330000	330000	330000		12.0 Meg	12.0 Meg
		240			9100			360000			13.0 Meg
	270	270	10000	10000	10000		390000	390000	15.0 Meg	15.0 Meg	15.0 Meg
		300			11000			430000			16.0 Meg
330	330	330		12000	12000	470000	470000	470000		18.0 Meg	18.0 Meg
		360			13000			510000			20.0 Meg
									22.0 Meg	22.0 Meg	22.0 Meg

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to 500 kc with *pnp* transistors. The use of *npn* transistors permits operation to 1.5 megacycles.

A series-resonant crystal oscillator operating to 500 kc is shown in Fig. 4. This circuit is ideal for light crystal loading. It has been used with 98.324-kc. crystals as a

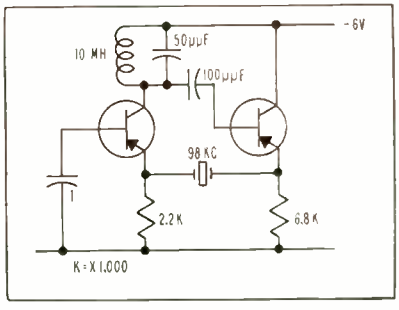

FIG. 4—Crystal oscillator circuit used in radiolocation work

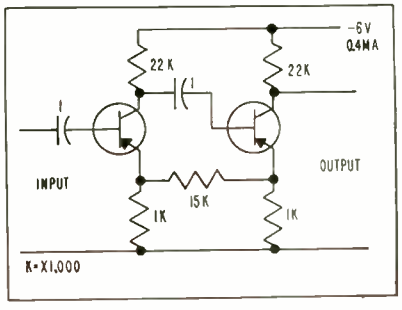

FIG. 5—Audio amplifier obtains current stabilization by series emitter resistors

5,000-ft range calibrator in radiolocation work.

The audio amplifier of Fig. 5 features transistor-current stabilization with series emitter resistors. Positive feedback is used to obviate the requirement for large bypass capacitors across the emitter resistors.

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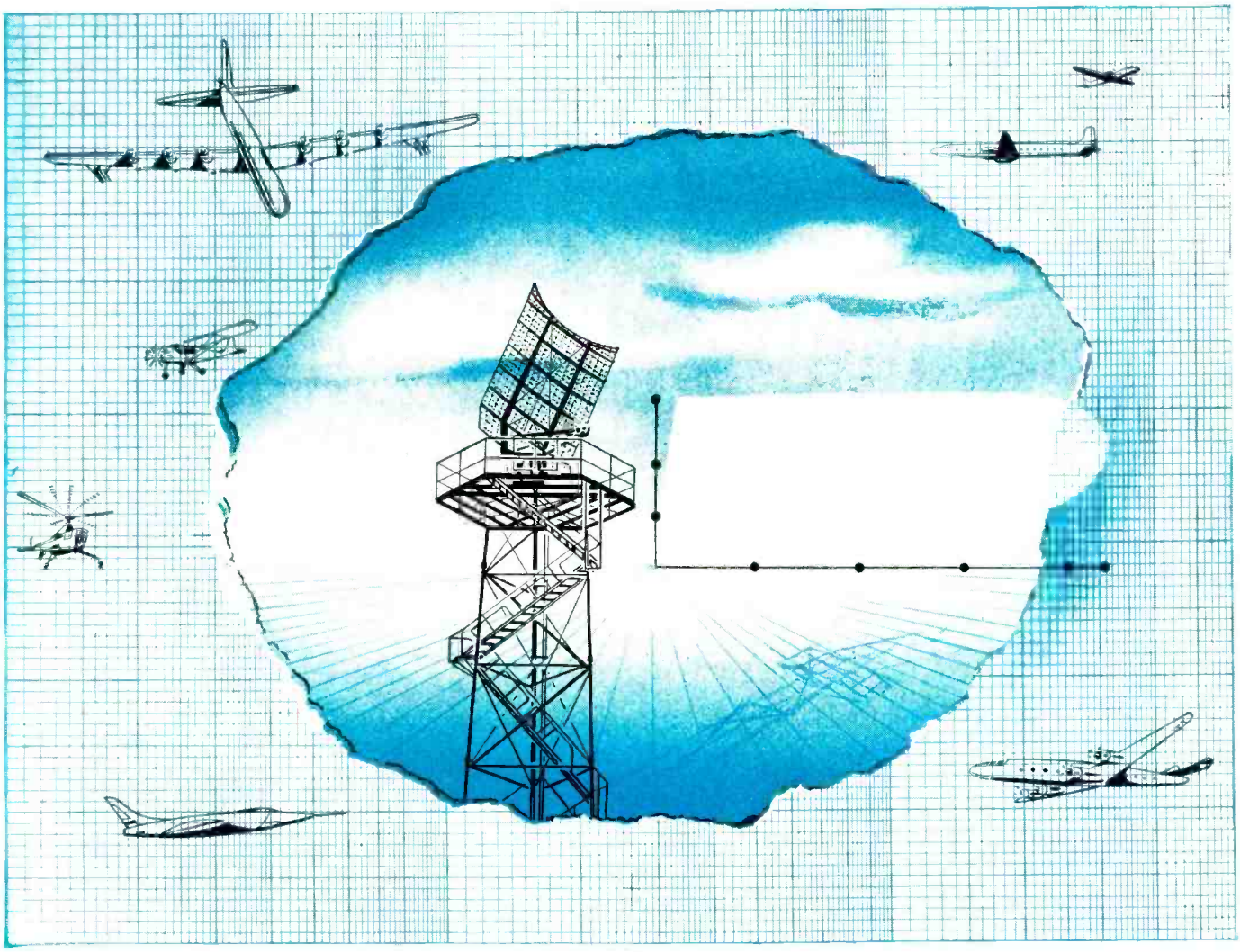
(1) Peter G. Sulzer, Cathode-coupled Negative Resistance Circuit, *Proc IRE*, 36, p 1,034, Aug. 1948.
(2) Frank C. Alexander, Jr., A Cathode-coupled Oscillator, *QST*, 30, No. 9, p 69, Sept. 1946.
(3) F. Butler, Cathode Coupled Oscillators, *Wireless Engineer*, 21, No. 254, p 521, Nov. 1944.

Thyratron Peak Voltmeter

BY J. P. C. MCMATH

Assoc. Prof. in EE
University of Manitoba
Winnipeg, Canada

MEASUREMENT of positive or negative peak values of steady-state alternating voltages, recurrent pulses or any transient voltage can be made with the simple instrument described below. It is not suitable



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for the measurement of single transients that are not repeated. For example, lightning surges are not measurable, except possibly to indicate a surge voltage in excess of some preset magnitude.

The basic principle of using the firing voltage of a calibrated thyratron for surge voltage measurement is not new.[1,2] However, the particular method of varying the screen grid potential of a type 2050 thyratron to control its firing point greatly simplifies the apparatus design as compared with that required when three-electrode tubes such as the type 884 are used. The addition of a phase inverter to permit convenient measurement of surges of either polarity does not seem to be in wide use.

Operation

Referring to Fig. 1, the input is applied by means of a resistance potential divider and switch to the control grid lead of V_1. The divider values may be modified as required, and any suitable form of divider used. The input capacitor C_1 was used to block direct voltage from

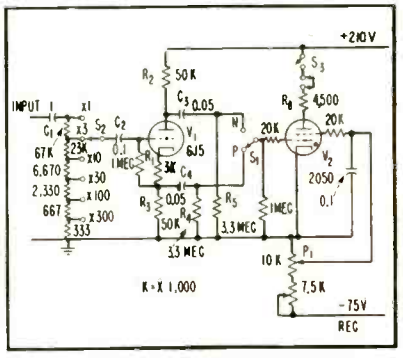

FIG. 1—Calibrated thyratron firing voltage used for surge voltage measurement

the input, and in many cases would not be necessary. If used, it must be capable of withstanding the maximum voltage to be measured.

Where large divider ratios are used and fast transients are to be measured a capacitive divider, omitting C_2, or a capacitance-compensated resistive divider would be preferable. Tube V_1 is the familiar split-load or cathodyne phase inverter, possessing the merits of simplicity, relative independence from the effects of variations in tube characteristics and good frequency response.[3]

The signal polarity at P will be the same as that of the input; and

at N, it will be opposite. Since the thyratron requires a positive voltage at its control grid for firing, when switch S_1 is in position P, positive peaks will be measured and when in position N, negative peaks. The screen grid voltage of V_2 is adjustable from zero to about minus 45 volts by means of P_1 which should be wire-wound and preferably linear.

Its dial can be calibrated in terms of peak voltage input to V_1, the calibration being very nearly linear as shown by the dashed curve of input voltage against critical screen grid voltage in Fig. 2. In order that a

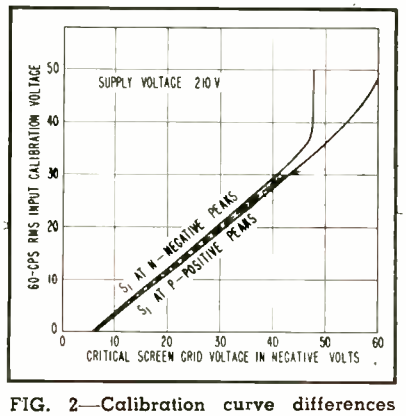

FIG. 2—Calibration curve differences due to imperfect matching of resistors

single calibration may apply for either positive or negative voltages, resistors R_2 and R_3 and also R_4 and R_5 must be closely matched pairs. The internal impedance of the power supply must be negligible or adequately bypassed, and C_3 and C_4 must have negligible leakage.

This last requirement is particularly important, owing to the considerable difference in d-c voltage between anode and cathode of V_1. Any leakage will cause considerable and probably erratic differences in the calibrations for positive or negative inputs. Only high grade mica capacitors of ample voltage rating should be used. Switch S_3 interrupts the anode current and so resets the thyratron. Resistor R_8 limits the anode current to a safe and convenient value.

For most purposes the tube glow is sufficient indication of firing; however, a pilot lamp, buzzer or relay could be inserted between S_3 and R_8. Variation of the anode supply voltage from 200 to 220 volts has negligible effect on the calibration, except for very small input signals. The negative supply to the

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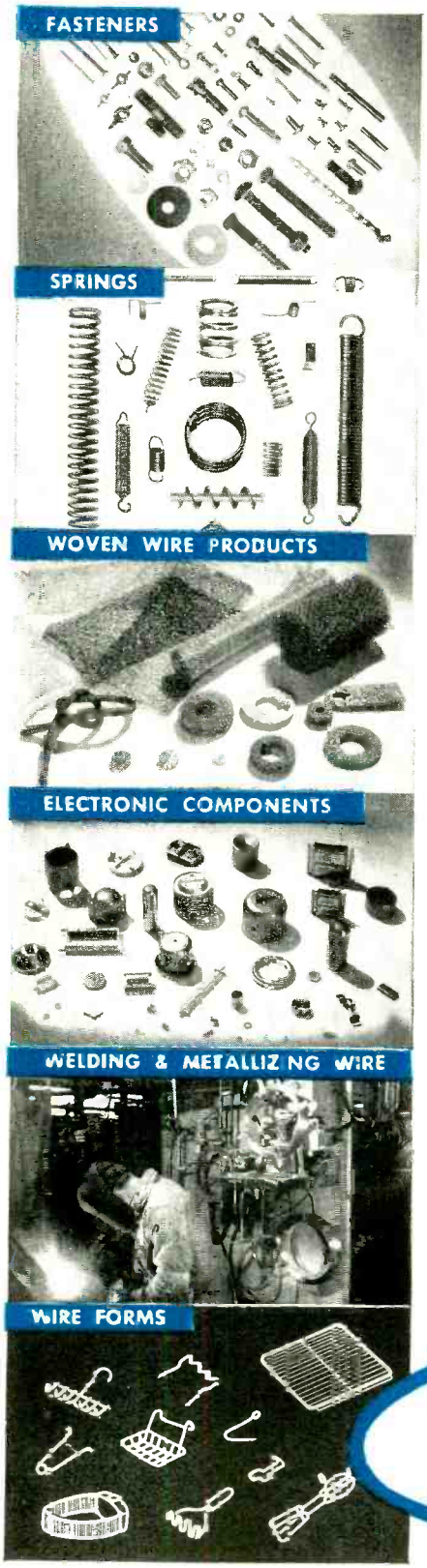

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shield grid should be regulated, as variations would directly affect the calibration. An OA3/VR75 tube was found adequate.

In use, S_2 and P_1 are adjusted until the input signal just triggers the thyratron. Its magnitude is then obtained from the dial calibration on P_1 multiplied by the ratio setting of S_2.

The calibration curves of Fig. 2 were obtained using a 60-cycle sinusoidal input voltage. The small difference between the curves for positive and negative peaks is due to imperfect matching of resistors R_2 and R_3, also R_4 and R_5 in the experimental model. Slight leakage in C_3 and C_4 may also have been a contributing factor to the curve differences.

When paper capacitors were used in these locations, a much greater difference between the curves was obtained. The upturn in the curve for negative peaks at large signal inputs results from plate current cutoff in the phase inverter section. For practical use the scale of ordinates would be converted to equivalent peak volts. It is suggested the input voltage at the grid of V_1 be limited to approximately 40 volts peak.

In slightly more primitive form, this instrument has given excellent results in measuring the magnitude of troublesome switching transients that occurred on a 125-volt battery-fed power control system. These transients were much too fast to be seen with available oscilloscopes.

References

(1) H. J. Reich, "Theory and Applications of Electron Tubes", p 611.

(2) T. Offenbacher, Electronic Device Indicates Peak Transient Voltages, *Electrical World*, p 80, May 1945.

(3) G. E. Jones, Jr., An Analysis of the Split Load Phase Inverter, *Audio Engineering*, p 16, Dec. 1951.

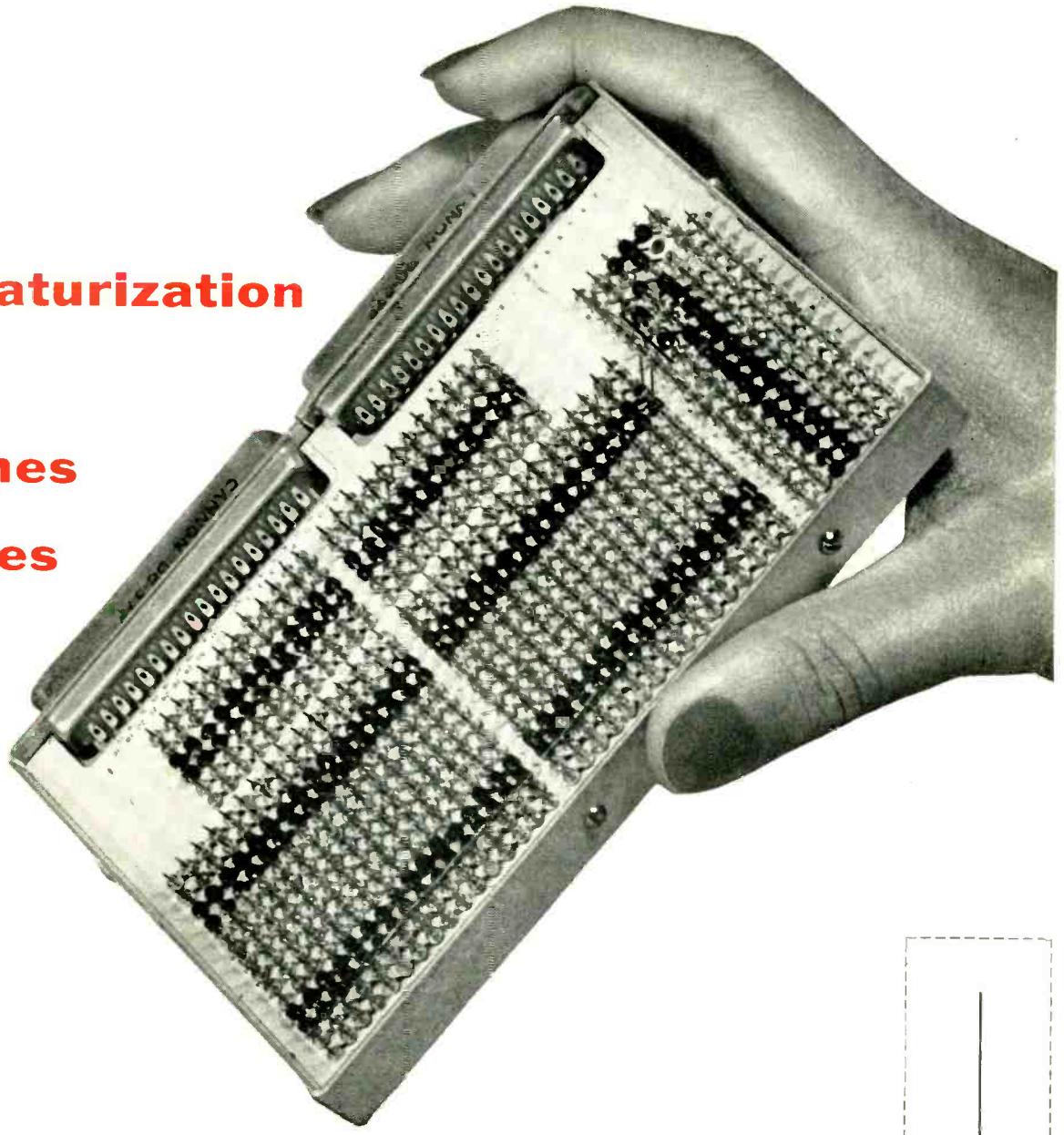
Low-Frequency Phase-Shift Modulator

By W. F. Coombs

Electrical Engineer
University of Rochester
Rochester, N. Y.

Producing about 150 degrees of phase shift in a 60-cps waveform the phase modulator described in this article requires about 3 volts

Miniaturization with Hughes Diodes



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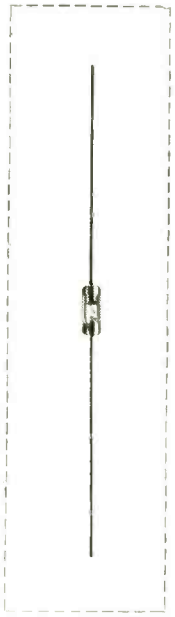

*Actual size, diode body: 0.265 by 0.130 inches, maximum.

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d-c input control signal. The basic circuit is the phase-shift bridge shown in Fig. 1. Output voltage E_{cd} of such a bridge is equal in amplitude to the applied sinusoid E_{ab} and lags it by a phase angle $-2 \tan^{-1} \omega CR$.

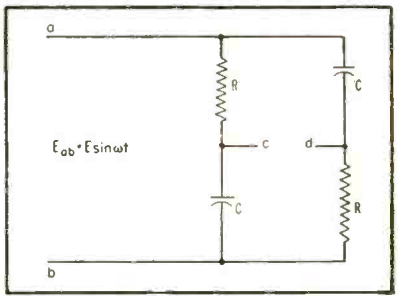


FIG. 1—Basic bridge circuit used in phase-shift modulator

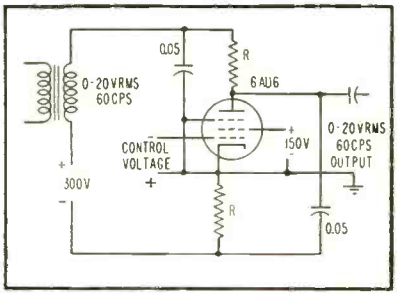
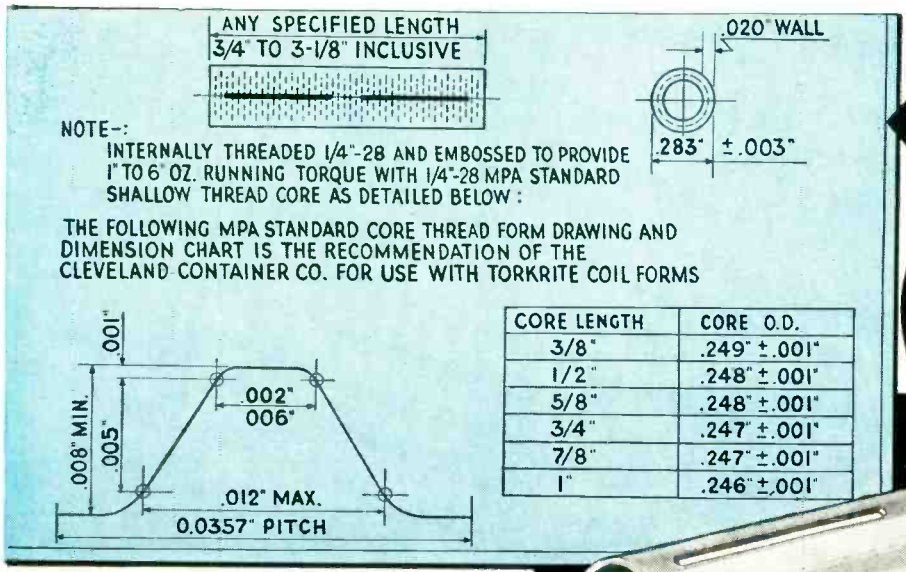


FIG. 2—Phase modulator provides up to 150-deg phase shift in 60-cps waveform

The circuit of Fig. 2 is the modified version of this bridge. The values of components are chosen for 60-cps operation. Resistors R are Carborundum type BNR. These resistors vary as a function of the voltage across them approximately as the voltage to the -3.5 power.

A pentode was chosen to present a high-resistance load to the bridge and to provide a control element for the direct-current flowing in the resistors. The pentode is ideal for control in this circuit since the plate current is almost independent of plate voltage over the range of operation. Because of the nonlinear relation between resistance and voltage across the resistors it was expected that for small distortion the peak-to-peak a-c component across the resistor should not exceed approximately 20 percent of the d-c value. However, some correction is obtained because the distortion across each resistor partially cancels in the output.

In practice the 6AU6 tube was found to be a good choice for the load. The variation in resistance

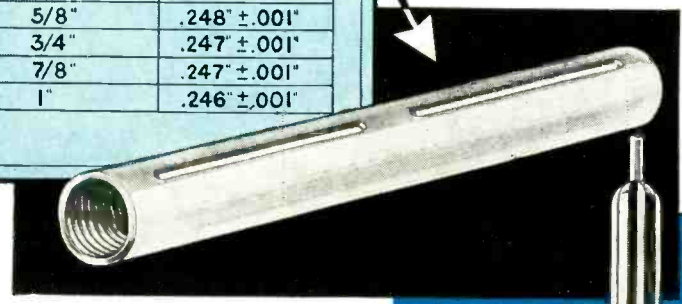


CORE LENGTH	CORE O.D.
3/8"	.249" ±.001"
1/2"	.248" ±.001"
5/8"	.248" ±.001"
3/4"	.247" ±.001"
7/8"	.247" ±.001"
1"	.246" ±.001"

DESIGN

PRODUCT

APPLICATION



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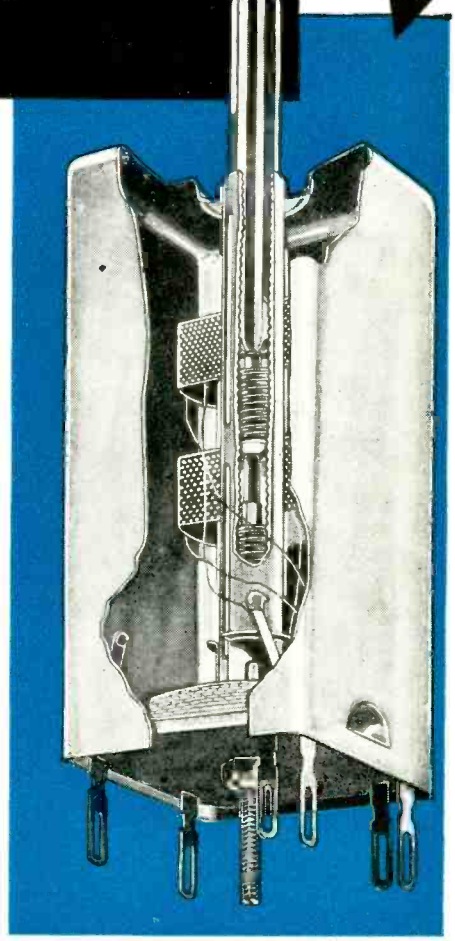

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obtained was from about 50,000 ohms to 1 megohm for a current variation from 0.02 to 2.50 milliamperes through the tube. Actual phase-shift versus control-grid bias is plotted in Fig. 3. The input volt-

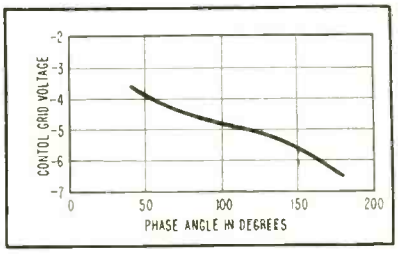

FIG. 3—Modulator phase shift versus control-grid voltage

age (equal to the output) can be as much as 20 volts rms before distortion is noticeable. If distortion can be tolerated, considerably higher outputs can be obtained. For outputs up to 20 volts rms the phase-shift versus control-voltage plot is independent of amplitude.

This particular circuit was designed for use in a grid-controlled thyratron power supply, but it should be useful in other systems. The equivalent shunt capacitance of the BNR resistors used is about 50 $\mu\mu$f which does limit their use in high-frequency applications. The bridge in practical use should be operated into a cathode follower or some equally high-impedance load.

The author wishes to thank the Carborundum Company, K. Enslein and L. W. Coulter for their assistance and helpful suggestions.

BIBLIOGRAPHY

"Characteristics and Methods of Calculating Applications of Type BNR Resistors", Carborundum Company, Globar Division, Application Engineering Bulletin GR2.

Continuous Phase Shifter

BY RANALD O. WHITAKER
Silvis, Ill.

STUDY OF PHASE SHIFTS assumes importance in work with amplifiers for servo systems using 60-cycle two-phase motors. The study can be simplified by a phase-shifter giving a 60-cycle signal of constant amplitude but phased to the line

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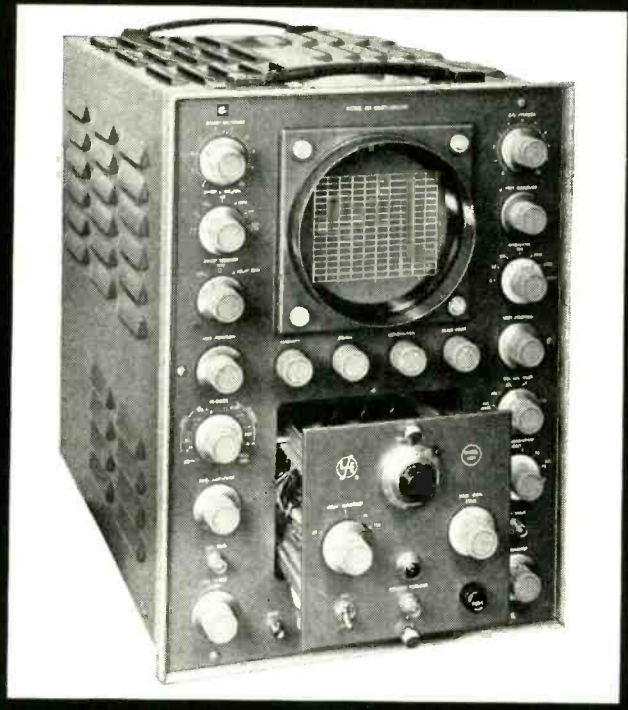

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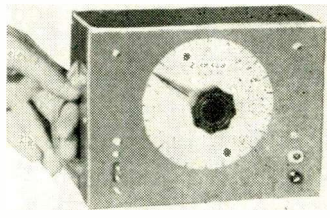
In this circuit $E_1 = E_2 = E \sin \omega t$ and L, R_1 and C are chosen with respect to R_2 and R_3 so that $V_{wx} = 2V_k \cos(\omega t + \alpha)$, and $V_{yz} = 2V_k \sin(\omega t + \alpha)$. Potentiometers R_2 and R_3 consist of rectangular cards



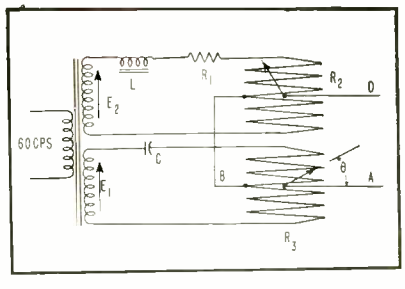
Lightweight, portable device for servo testing

on which resistance wire is uniformly wound top to bottom. Contact arms are pivoted at the centers of the cards and ganged to each other in positions 90 deg apart so that $V_{AB} = V_k \cos(\omega t + \alpha) \sin \theta$, and $V_{BD} = V_k \sin(\omega t + \alpha) \sin(\theta + 90°) = V_k \sin(\omega t + \alpha) \cos \theta$. $V_{AD} = V_{AB} + V_{BD} = V_k [\cos(\omega t + \alpha) \sin \theta + \sin(\omega t + \alpha) \cos \theta] = V_k \sin(\omega t + \alpha + \theta)$.

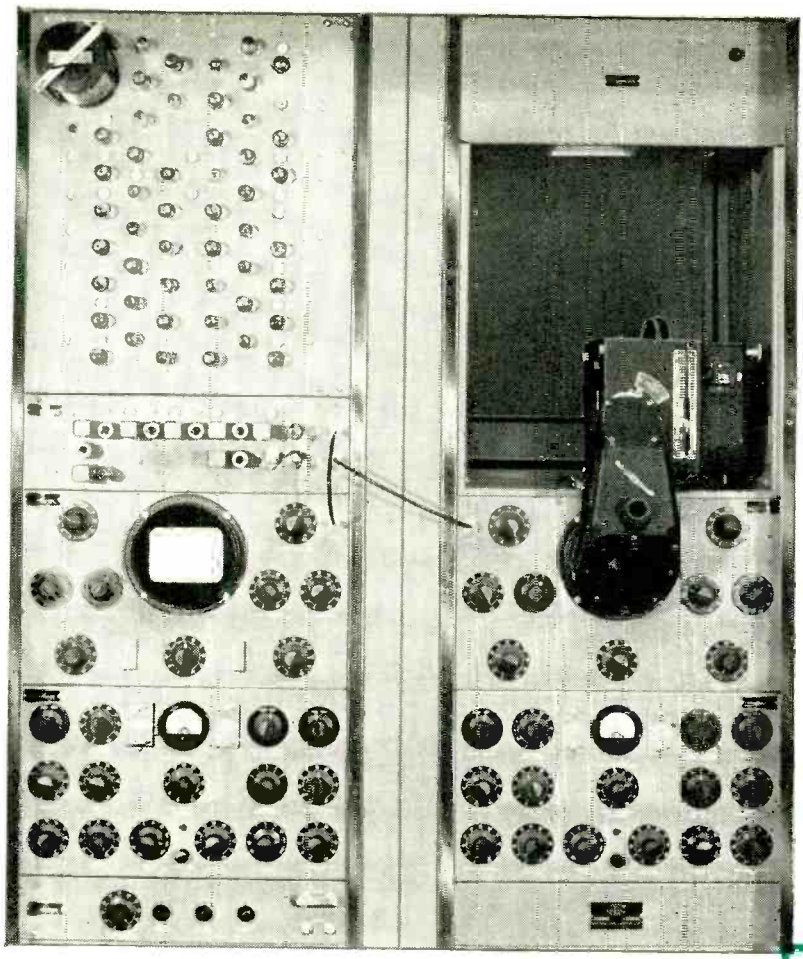
Hence, output is of constant amplitude and varies from phase of input in a linear manner with rotation of ganged arms.

Output impedance varies slightly over the range, but does not have the wide variation of the conventional R-C phase-shifter.

Harmonic content of the input signal causes the output waveform to be distorted—since the inductive half of the circuit tends to attenuate harmonics in the output,



Phase shifter uses two cards wound with resistance wire as R_2 and R_3 Potentiometer arms, mounted in center of card, are ganged and displaced from each other by 90 deg



500 mc recording receiver, front section

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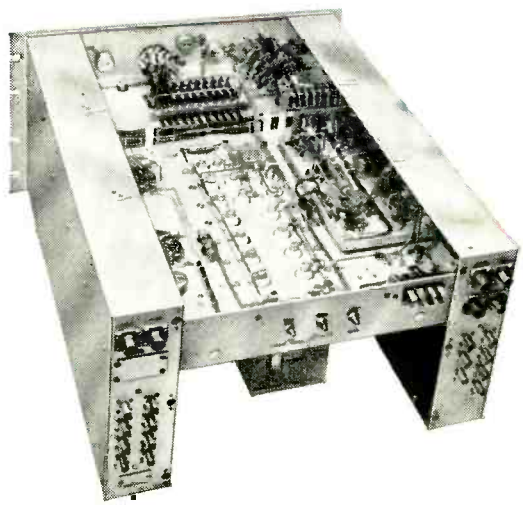
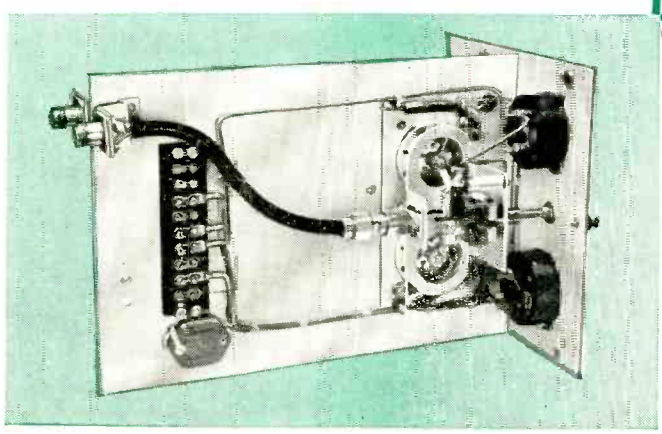


Sweep generator, bottom view



150 mc output amplifier, bottom view

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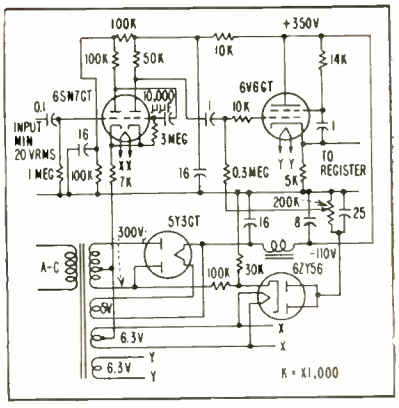
while the capacitive half tends to accentuate them. Should this prove excessive, R_1 should be removed from the inductive half of the circuit and placed in the capacitive half. This will permit the major portion of the phase shift to be made in the inductive half, requiring a larger inductor, which will in turn attenuate harmonics further. Similarly, a larger capacitor will be required in the capacitive half resulting in less accentuation of harmonics in that portion of the circuit.

The inductor and capacitor may be so chosen that R_1 need not be included. Design of a specific circuit must take into consideration the secondary impedance of the transformer. The author found cut-and-try to result in earlier completion of the unit. Similar units may be designed for use at other frequencies.

Mechanical Register Amplifier

COUNTING relatively low-speed impulses is often most economically performed with a mechanical register. The advantage of hard-tube transducers between output circuit and the counter mechanism has already been described (ELECTRONICS, p 186, Sept. 1954). A circuit antedating the referenced article is shown in the drawing.

This circuit has been evolved specifically for use with the LKB-Produkter mechanical register that counts up to 300 impulses a second. At this speed, input current must average about 40 milliamperes. Other circuits can be used provided



Circuit used to drive mechanical register from 20-volt source

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the pulse duration and amplitude are similar. Resistance of the register is approximately 700 ohms. The circuit can be used with similar devices.

The type 6V6 cathode follower output tube puts out pulses in usable form that is independent of input voltage, provided input to the circuit is no less than 20 volts rms.

Information on this circuit has been made available through the courtesy of Tracerlab, Boston, Mass., distributors of the Swedish mechanical register described.

Selective A-F Transistor Amplifier

By D. Bier and S. Rosen
Tel-Aviv, Israel

Good stability and selectivity are obtained with the amplifier circuit shown in Fig. 1, using a single junction transistor. Negative feedback for all frequencies is provided by a resistor in the emitter circuit. Positive feedback at one frequency is provided by a tuned transformer. Voltage gain is 76 and current drain is about 100 microamperes at 4.5 volts.

The tuned transformer has the following parameters: L_1 = 18 mh, Q = 80, 460 turns, L_2 = 0.1 mh, 25 turns, wound of 0.2-mm enamel-covered copper wire on an Arnold toroidal core having an outer diameter of 1.35 in., inner diameter 0.92 in. and a height 0.35 in.

The frequency of the circuit (10 kc) is determined mainly by L_1 and C_2 for the values given. Positive feedback is applied through L_2 and is limited by R_3 to avoid oscillations. Resistor R_2 provides negative feedback and determines the selectivity of the circuit.

With the components shown the

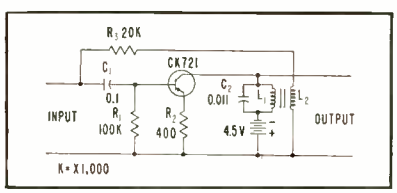

FIG. 1—Positive feedback is supplied by tuned circuit in collector of selective a-f amplifier

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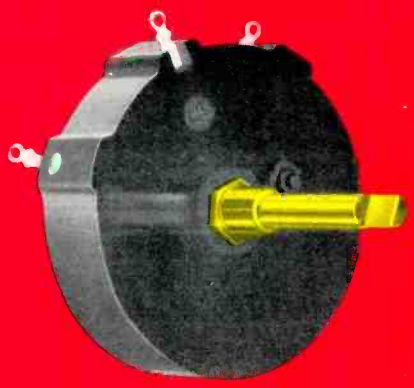

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1 1/8" diameter composition control for applications where ratings up to 3/4 watt required. CTS type 35.

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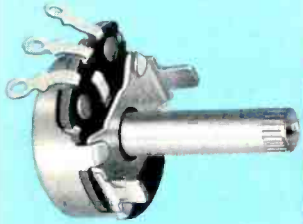
Ear mounted composition control. Simply twist two ears for rigid mounting. Eliminates bushing and mounting hardware. Available with shafts for knob operation or for preset applications with insulated or metal shaft. CTS type P45 with metal shaft illustrated.



Ear mounted two watt wirewound available with or without center tap. CTS type P-254 with tap illustrated.

Four watt wirewound control available with or without center tap. CTS type 27 with tap illustrated.

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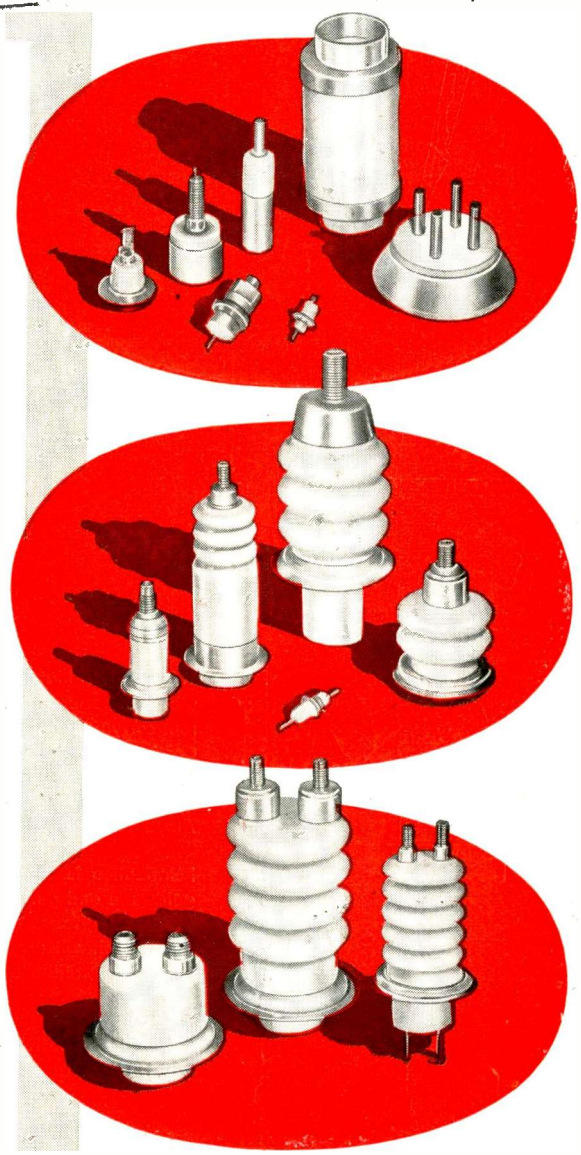

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selectivity obtained was ± 150 cps between the 3-db points 10 kc being the mid-frequency. Input level is 1 mv. Values of R_2 and R_3 are not critical and may be slightly reduced to increase the gain.

A 3-stage transistor selective a-f amplifier using this circuit is shown in Fig. 2. Coupling between the first and second transistor is achieved by a transformer with step-down im-

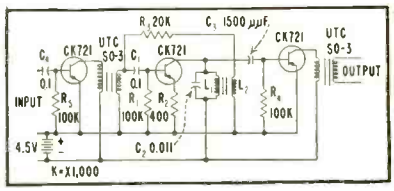

FIG. 2—Three-stage transistor amplifier provides a gain of 6,000 at 10 kc

pedance ratio of 10,000 to 200 ohms, which matches the collector impedance of the first CK 721 transistor to the base impedance of a few hundred ohms in the second transistor.

Coupling to the third stage by C_3, provides impedance transformation from the preceding collector. This transformation may be seen from the fact that the series circuit made up of coupling capacitor and base resistance may be considered as an equivalent parallel circuit having a much higher resistance. The equivalent parallel capacitance is included in the tuned circuit.

After introducing C_3, C_2 will require a slight readjustment to resonate at 10 kc. Overall voltage gain of circuit is 6,000. Input level is 0.5 mv.

Simple Remote Control

REMOTE CONTROL by means of adjustable level d-c potential applied to a two-wire telephone line can be accomplished using a standard telephone dial to interrupt or pulse the steady state potential.

Experimental equipment developed at the Naval Research Laboratory at the request of the Bureau of Ships for airport traffic control uses two small adapter units and a reactance-tube assembly.

Amplifiers and metering circuits in the remote unit amplify and indicate the power level of audio signals returned over the same line from the local station. The local

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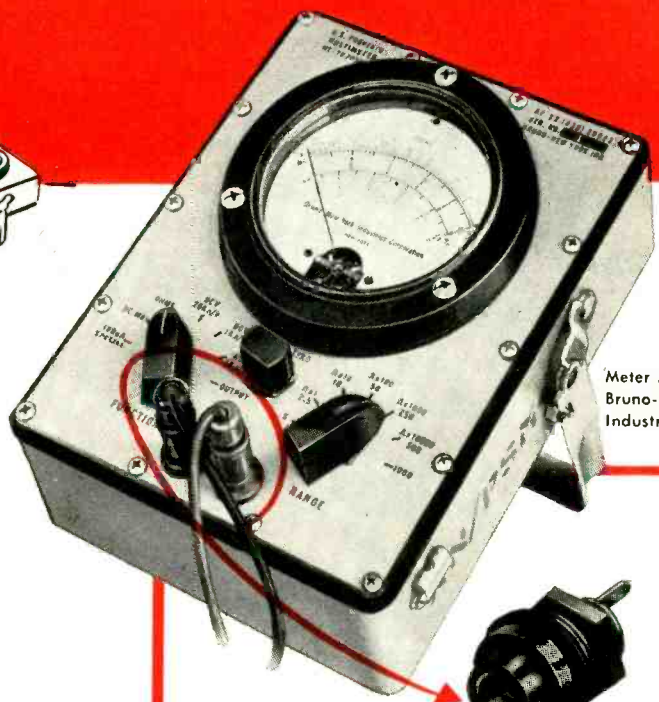
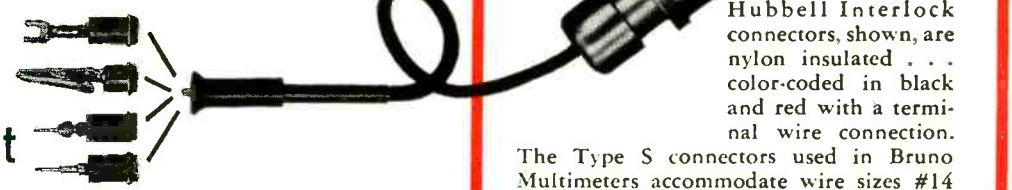


Meter Mfrd. by Bruno-New York Industries Corp.

Another Hubbell Interlock Development!

4 in 1 Test Prod Kit



This complete 10-piece kit, consisting of two prod couplers, one black and one red, and two each of four basic attachments, makes it possible to change from one tip to another without changing the entire test lead. Wired with Interlock Type S Plugs for a perfect, low contact resistance connection at the meter, Hubbell's versatile test kit gives an accurate reading every time. Basic attachments are: Phone Tip, Phono Needle, Alligator Clip and Spade Terminal. Extra attachments also available in black or red.

Hubbell Interlock connectors, shown, are nylon insulated . . . color-coded in black and red with a terminal wire connection. The Type S connectors used in Bruno Multimeters accommodate wire sizes #14 to #18 with 15 amps. capacity.

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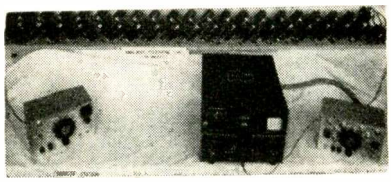


Local station at right can be used to control simple functions of receiver (center) or control can be shifted to remote station (left). Lumped-constant simulated wire line is shown above

unit actuates a stepping switch in synchronism with d-c control pulses. Various preset receiver gain levels and several on-off functions can be remotely selected through the local stepping switch.

The reactance tube is connected across the first conversion oscillator tank circuit of the receiver and is controlled by the absolute level of steady-state d-c voltage impressed on the line by the remote unit. This feature makes it possible to effect fine tuning of the signal to which the local receiver is adjusted.

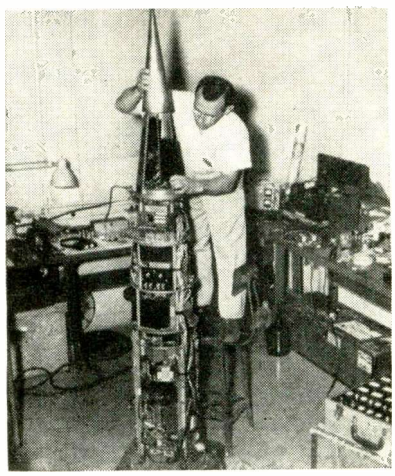
PERTINENT PATENTS

By NORMAN L. CHALFIN

Hughes Aircraft Co.
Culver City, Calif.

PATENT REVIEWS this month include an electron accelerator, miniaturized bandpass filter and an elec-

Rocket Probe



Electronic instrumentation used to obtain upper-atmosphere information is compactly assembled in cylindrical unit that forms rocket head. Instruments have been carried as high as 90 miles above Holloman Air Development Center using this technique

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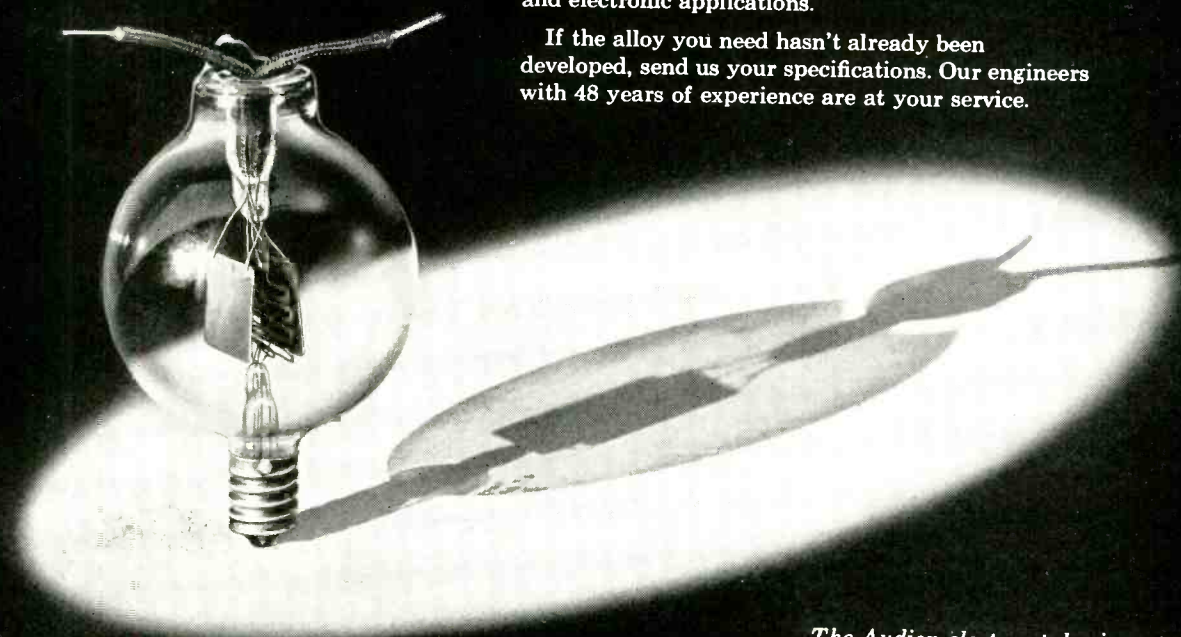

The Audion electron tube, invented by Lee de Forest in 1906

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Electron Accelerator

Novel electron sources have figured in recently issued patents. One in particular awarded to K. Gund, H. Berger, M. M. Scheer and R. Schittenhelm of Erlangen, Germany, is for an electron accelerator. The patent is No. 2,637,818.

The invention is shown in Fig. 1. Radiation output end of the device

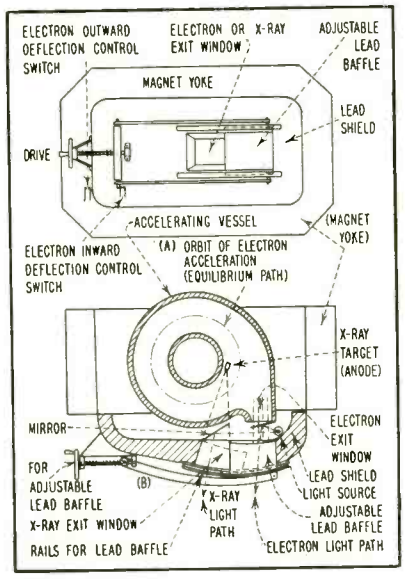

FIG. 1—Radiation output (A) and internal structure (B)

is shown at (A); Fig. 1B shows the internal structure.

Within the accelerator structure, the electrons are accelerated in an equilibrium orbit. Upon actuation of an appropriate switch the beam of electrons may be deflected inwardly or outwardly with respect to the orbit.

Inward deflection results in accelerated electrons striking the target anode to produce X rays. Outward deflection results in electron emission through an electron exit window. Either X ray or electron radiation may be selected by the switching devices. A lead baffle may be moved into place to cut off one or the other as needed.

The accelerator of this invention is used in medical therapeutic work where either X radiation or electron radiation is required.

A light source impinging upon mirrors whose surfaces are opaque and reflective to light but transparent to X rays or electron streams is used to show which of the radia-

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Band-Pass Filter

A band-pass filter organization that can be incorporated into miniaturized assemblies is the subject of patent 2,668,882 awarded to M. Morrison of Upper Montclair, N. J. The title of the patent is simply "Amplifier".

The circuit of Morrison's assembly is shown in Fig. 2. Figure 3 shows the band-pass characteristics of the amplifier. Curve *C* represents the characteristic when the tank and both input and output are tuned to the center frequency. Curve *D* shows response when the tank is tuned to center frequency and the input and output are tuned to a lower frequency. It can be seen that there is greater symmetry in curve *D*. The inventor claims that the lower in frequency one tunes input and output away from center the more symmetrical are the skirts of the band-pass characteristic.

The filter proper shown at the left in Fig. 2 comprises a dust core toroidal high-Q tank coil, a tuning

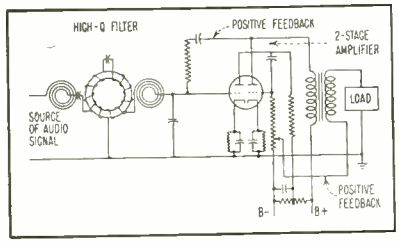


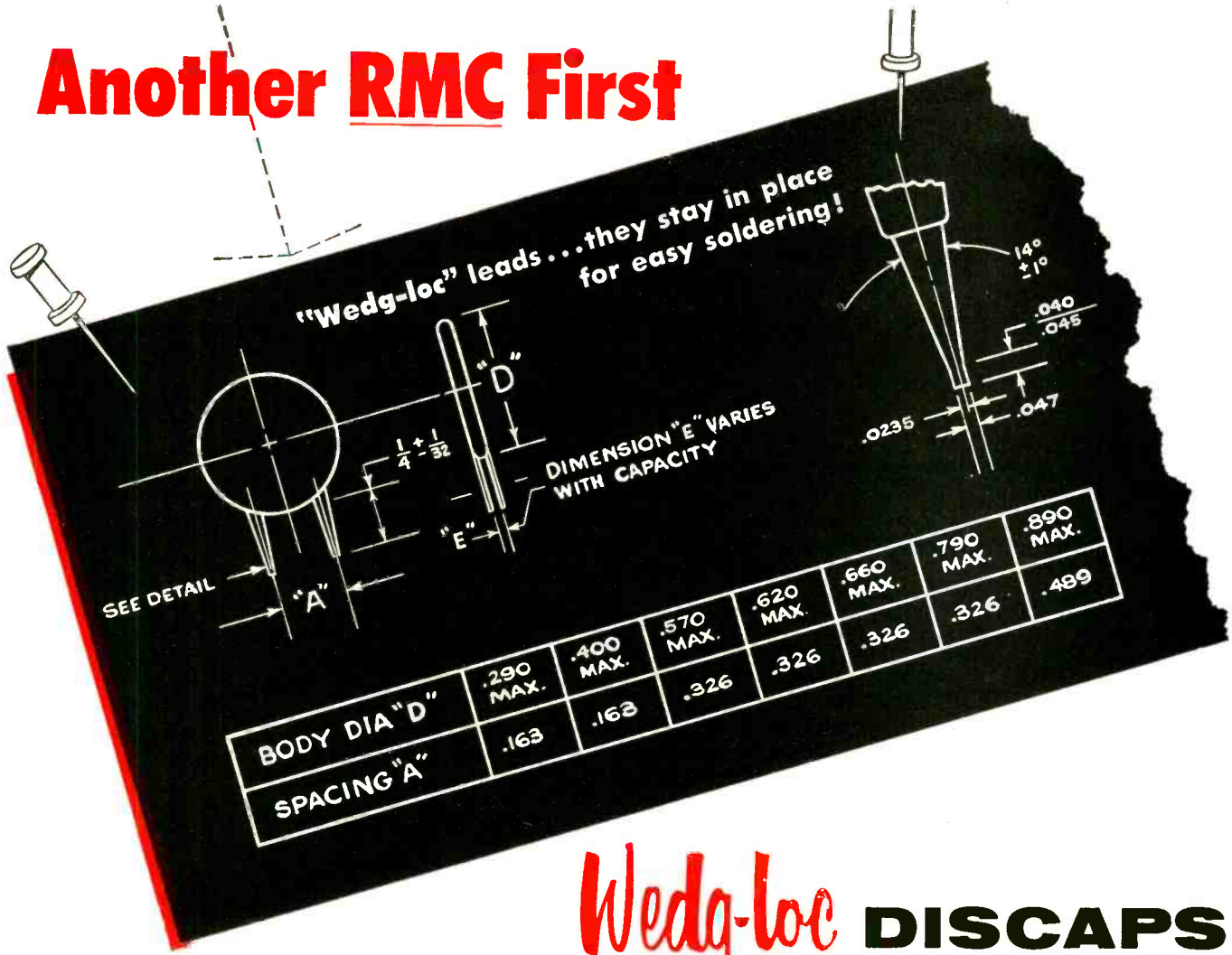
FIG. 2—Circuit of miniaturized band-pass filter

capacitor and input and output air-wound inductors. The inventor claims to obtain as much as 10 times the voltage across this circuit as in conventional circuits.

The two-stage amplifier at the right has a positive feedback path from output to input stages and another positive feedback path from the secondary of the output transformer to the grid of the output stage. Physically all of the resistor and capacitor components of the amplifier are located around the twin-triode amplifier tube.

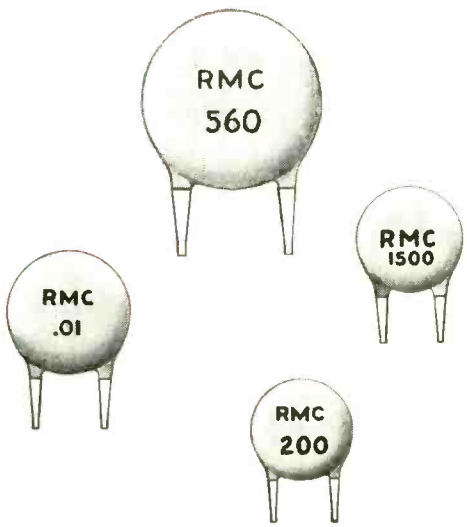
The feedback of energy from amplifier to filter compensates for some of the normal filter dissipation losses. So long as the feedback does not equal the total filter dissipation losses, oscillations will not

Another RMC First



BODY DIA "D"	.290 MAX.	.400 MAX.	.570 MAX.	.620 MAX.	.660 MAX.	.790 MAX.	.890 MAX.
SPACING "A"	.163	.168	.326	.326	.326	.326	.489

Wedg-loc DISCAPS
for printed wire circuits



The exclusive wedge design of the leads on these new DISCAPS lock them securely in place on printed circuit assemblies prior to the soldering operation. The "Wedg-loc" leads eliminate the possibility of the capacitors becoming loose or falling out. Application of "Wedg-loc" lead DISCAPS to your printed circuits will cut production time, reduce costs, and insure the uniformity of your soldered connection.

"Wedg-loc" DISCAPS are available in capacities between 2 MMF and 10,000 MMF in temperature compensating, by-pass, and stable capacity types with lead spacing as shown above. Electrical specifications and tolerances are the same as standard wire lead DISCAPS. Your inquiry is invited.

ANOTHER NEW DEVELOPMENT FROM THE RMC TECHNICAL CERAMIC LABORATORY

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be sustained and so the system will be stable after removal of input energy from the source. The feedback path to the grid leak of the output stage is stabilized by the grid conduction voltage, which limits the feedback current.

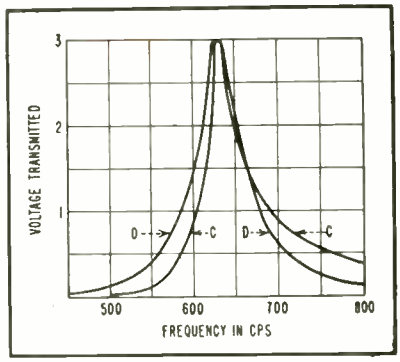

FIG. 3—Band-pass characteristics with tuning to center frequency C and input and output tuned to lower frequency D

The inventor claims that he has developed herein a filter that attains results only obtainable with much larger and costlier filters in the prior art. The difficulty in the past, he points out has been due to much larger amount of stored energy present in multiple section filters. The single storage circuit of this invention lessens the difficulty.

The patent states that in a single-core storage unit, less core material is required for the same inductance, for two reasons; first, the same core is used for all the turns of the reactance and second, the inductance of a coil on a single core is proportional to the square of the number of total turns employed. That means, if four separate coils are used for a filter midsection, not only are four separate cores required, but also four times the total number of turns.

For example, if N turns are required on a certain size single core to obtain a given inductance, this inductance is proportional to N^2. If these N turns are equally distributed among four cores (as is common practice for a midsection) the inductance of each coil will be proportional to $(N/4)^2$ and of the four coils will be $4(N/4)^2$ which is equal to $N^2/4$ or one fourth that of the single-core coil, which single coil results in a higher Q (more sharply defined cutoff characteristics) and less stored energy (faster modulation-frequency response

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under transient working).

A further filter improvement can be made, if and when desired, under transient operation, by embodying the following discovery in filter terminal resistances, which may be included in the terminal reactors when indicated.

It is believed that this discovery can be taught by use of simpler filter circuits than that illustrated in Fig. 2 because the mathematical theory of such a circuit involves complex algebra and the disclosure desired to be made, can be taught easily by a simple procedure.

Referring to Fig. 4A, there is shown a conventional single-stage high-pass filter. Conventional filter theory assumes the flow energy in

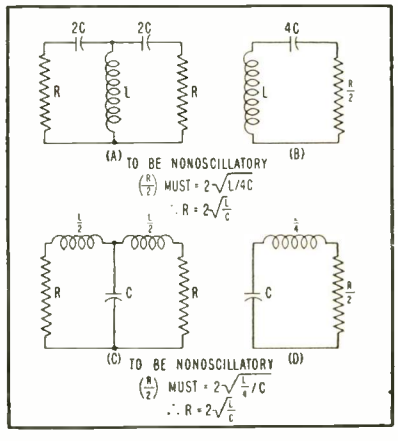


FIG. 4—Development of filter described in text

such a filter is always in one direction at a time, that is, it flows from left to right or from right to left. On this basis it is shown that if no reflections are to occur at the filter ends (which is merely another way of saying that the filter will not sustain oscillations of its own accord or that it is a nonoscillatory system), the terminal resistances must each equal the characteristic impedance of the system or $R = (L/C)^{1/2}$.

While most treatments of the subject do not point out that the result is arrived at on a basis of the steady-state analysis of the network, that is the case. It is known that this result has certain frequency limitations attached to it, but it is the basis of a good working rule for steady-state filter operation.

Referring again to Fig. 4A, if a rectangular pulse-modulated wave

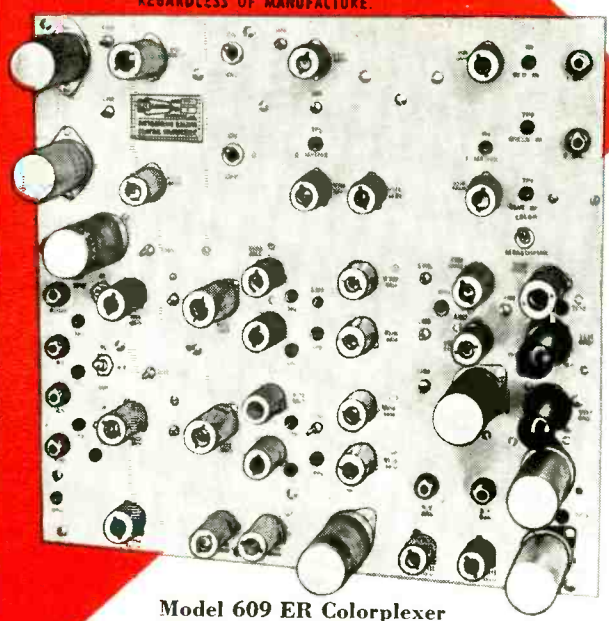
SOLVED! COLOR TV DRIFT PROBLEMS IN COLORPLEXING EQUIPMENT

TELECHROME SHOWS THE WAY

TELECHROME INCORPORATED

AUTOMATIC BALANCE CONTROL

Model 617 BR
Automatic Balance Control
for ALL COLORPLEXERS
REGARDLESS OF MANUFACTURE.



Model 609 ER Colorplexer
with Built-in Balance Control

ALL COLORPLEXERS DRIFT

One of the most difficult problems with which the color TV broadcaster is faced is that of drift in the modulator sections of the colorplexer. ALL COLORPLEXERS DRIFT, some more than others, but—

On the average, colorplexers require at least two hours of warm-up time and must be re-balanced a few times during a normal day's operation. Unbalance causes color receivers to "see" the wrong colors. TELECHROME'S new Model 617-BR Automatic Balance Control completely eliminates drift problems and works with ALL TYPES OF COLORPLEXERS REGARDLESS OF MANUFACTURE.

ELIMINATES DRIFT PROBLEMS

An ingenious circuit locks the entire color encoding equipment in balance within 20 seconds after being turned on. Thereafter balance is held, even after weeks of operation.

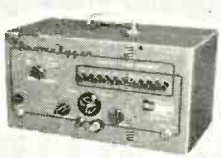
The Automatic Balance Control holds balance even under conditions where ordinary colorplexers would go completely out of control—tubes may be replaced, room temperature conditions may be varied, line voltages may be changed, manual controls may be turned, tube types may be substituted—NONE of these conditions affects the colorplexer kept under control by the TELECHROME Model 617-BR Automatic Balance Control! WARM-UP TIME IS UNNECESSARY; this alone saves many engineering hours per week. And need for stand-by personnel to reset balance is eliminated.

A memory system is incorporated so that interruptions in signals or switching transients will not interfere with the operation of the correction circuits.

NEW AUTOMATIC BALANCE CONTROL COLORPLEXER

The Model 609-ER Colorplexer is the ONLY unit engineered to incorporate Automatic Balance Control in order to eliminate chroma unbalance components in a color signal and to keep the colorplexer in balance at all times. This new Colorplexer design completely eliminates the necessity for manual adjustment of balance controls.

DELIVERY 30 DAYS



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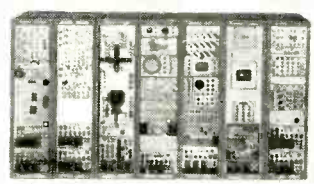

Full facilities
Transmits,
receives,
monitors,
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color pictures

Literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request.

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such as that in Fig. 5A is injected into one terminal resistance the LC of the circuit has to fill up before the steady-state transmission voltage value shows up at the other terminal resistance of the filter. This is illustrated by the form of the tracing of the envelope in (B) during the crescent interval. While

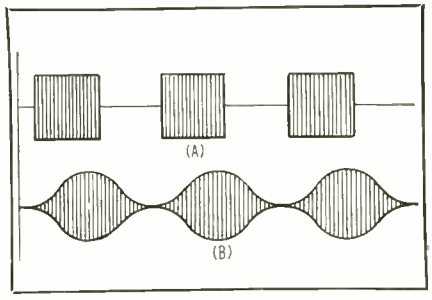

FIG. 5—Input waveforms (A) and output (B)

the curves in Fig. 5 are taken from the operation of the band-pass filter of Fig. 2, they can also be used as illustrating certain operations in filters having only high-pass or low-pass characteristics.

If the filter in Fig. 4A has its input energy interrupted when the LC of the circuit is full of stored energy, the flow of energy ceases to move in one direction. Because of the removal of opposing voltage at the input end, the stored energy moves toward that end as well as toward the output end. This means that when the input voltage is removed from the circuit, after steady-state operation is attained, circuit (A) operates exactly as circuit (B) of the same figure, which is its exact equivalent.

Circuit (B) is the familiar closed circuit system containing capacitance, inductance and resistance in series, represented by the differential equation

$$\frac{1}{c}\int idt + L\frac{di}{dt} + Ri = 0$$

It is well known that for a circuit represented by this equation to be nonoscillatory, R must have a value not less than that represented by the following relation:

$$0 = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

or

$$R = 2\sqrt{L/C}$$

This double value of R, when the energy is flowing in two directions, provides the same resistance fac-

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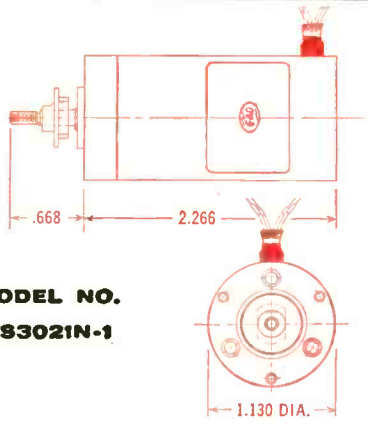

MODEL NO.
GS3021N-1

CHARACTERISTICS

Input Voltage	115	Stall Torque	7 oz. in.
Phase	2	Rated Torque	3 oz. in.
Frequency	400 cycles	Size	1 1/8" dia.
No Load Speed	180 rpm		2 17/64" long
Full Load Speed	135 rpm	Gear Reduction	28.4
Rotor Inertia	1.25 gm. cm²	Weight	4 1/2 oz.
		Duty	Continuous

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ing the double flow of the stored energy that the single R provides for the unidirectional flow of energy, because of the resistance being in parallel relation during double flow.

The same reasoning can be applied to a low-pass filter, as indicated in Fig. 4C, as well as to band-pass filters.

This means that if a filter functions under steady-state working in nonoscillatory operation with terminal resistances each equal to R; for such a filter to function under transitory-state working in nonoscillatory operation, the terminal resistances must at least equal $2R$.

Referring again to Fig. 2 this means that, if and when desired, the nonoscillatory response of such a circuit can be materially improved by considerably increasing the resistance of the terminal half-sections, over and above that resistance that is equal to the characteristic impedance of the network.

Photoelectric Switcher

J. A. Rajchman has been awarded patent 2,667,599 for an "Electronic Switching Device". The patent is assigned to RCA.

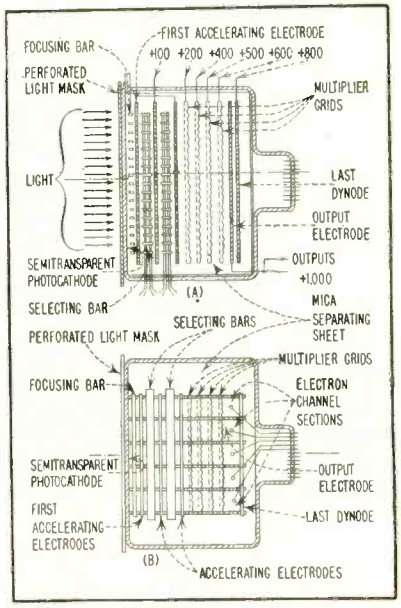
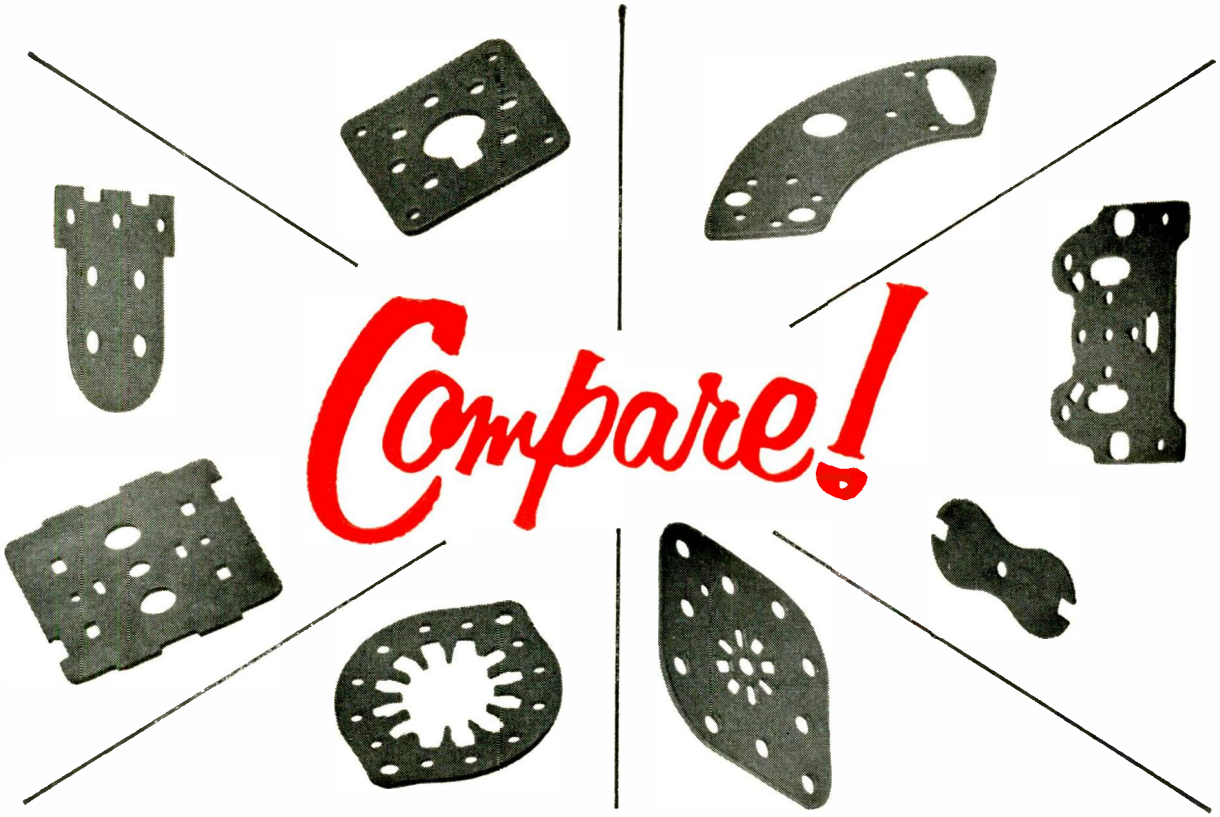


FIG. 6—Structure of the switching tube shows side (A) and top (B)

The structure of the switching tube is shown in Fig. 6. Figure 7 is a schematic of the device, which is a photoelectric type of electron multiplier.

Light entering the tube through



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WATER ABSORPTION, (%)
Precond. E-1/105
Cond DI-24/23

1/16" thick	0.57
1/8" thick	0.37

SPECIFIC GRAVITY

1/16" thick	1.33
1/8" thick	1.33

FLEXURAL STRENGTH, (psi)
Tested flatwise, Cond. A

1/8" thick	cut lengthwise	21,000
	cut crosswise	16,900

DISSIPATION FACTOR AT 1 MEGACYCLE

1/8" thick	Cond. A	.0314
	Cond. D-24/23	.0316

DIELECTRIC CONSTANT AT 1 MEGACYCLE

1/8" thick	Cond. A	4.42
	Cond. D-24/23	4.63

DIELECTRIC BREAKDOWN, (Kv.)
Parallel to lamination, S/S
Cond. D-48/50

1/16" thick	68.8+
1/8" thick	68.0+

PUNCHING QUALITY

1/16" thick	Heated 1 min.	Good
	Heated 2 min.	Good
	Heated 3 min.	Good

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a perforated light mask impinges upon a photocathode. The perforations on the mask are prearranged according to some switching code. There is a plurality of columns and rows of electron multiplier channels each associated with one end of the

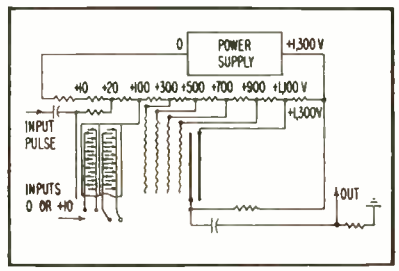

FIG. 7—Circuit of electron multiplier

mask, so that where there is a perforation in the mask, that area of the photocathode emits electrons into its associated electron-multiplier channel.

Selecting conductors are provided for each row of electron channels to select and maintain one row open to the passage of electrons. A separate target is provided for each column of electron channels. The position of perforations on the mask determine which of the electron channels in a row opened by the selector electrodes will have photoemitted electrons in it. There will be an output voltage at the target electrode connected with the selected column and row. The switching pattern may be changed by changing the pattern of the perforations.

A variation of the device not shown in the figures incorporates a horizontally and vertically selective grid structure instead of the light mask to actuate the electron channels and select those to be open or closed.

The device is used not only as a switching device but may be used as an encoder or decoder for computing machines. A given signal pattern may be applied to the selecting bars and be encoded in accordance with the mask pattern. Similarly a given signal code may be applied to the selecting bars to be decoded in accordance with the mask perforations. The switching tube may be used in this way to read perforated tapes or punched cards.

The number of the channels that may be included in one switching tube is not limited by anything but physical size requirements.

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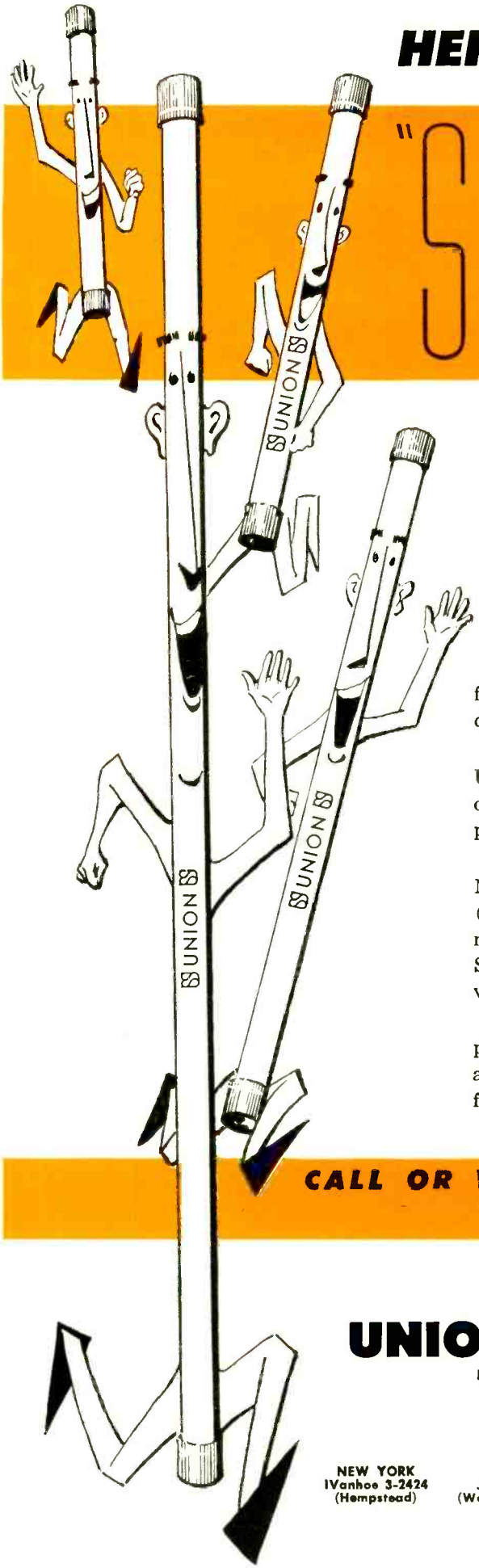
"Selenium Slims"



New HI-VOLTAGE SELENIUM RECTIFIERS for the price of vacuum tube circuits!

The long wait is over. Now you can design with reliable, trouble-free high-voltage selenium rectifiers at a price competitive with ordinary, power-hungry vacuum tube circuits.

The secret lies in a new production method worked out by Union Switch & Signal engineers, the original developers of copper-oxide rectifiers back in 1926. Cells can now be produced with greater precision and at a *lower cost* than ever before.

These are tubular rectifiers designed to fit standard fuse clips. Maximum RMS input voltage ratings vary from 13 to 3380 volts (with capacitive input filter.) Maximum DC current rating is 2.5 ma., though other current ratings can be supplied on special order. Stacks may be combined in series, as full-wave bridge circuits, or as voltage doublers.

These new rectifiers will reduce the cost, the weight and the power consumption of any high-voltage, low-current circuit. In addition, they give you the priceless advantage of rugged, trouble-free operation.

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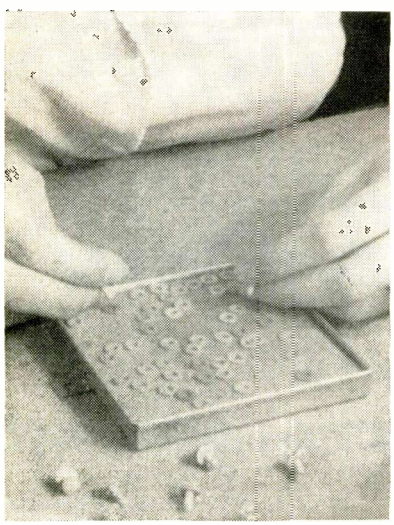
Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue

Sponge Rubber Pad Aids Pickup of Washers

Placing washers on bolts two at a time with aid of sponge rubber pad



Method of mounting pad in metal frame

ASSEMBLY of telephone relays at the Liverpool, England plant of the Automatic Telephone & Electric Company Limited has been facilitated by a simple device for pairing bolts and washers.

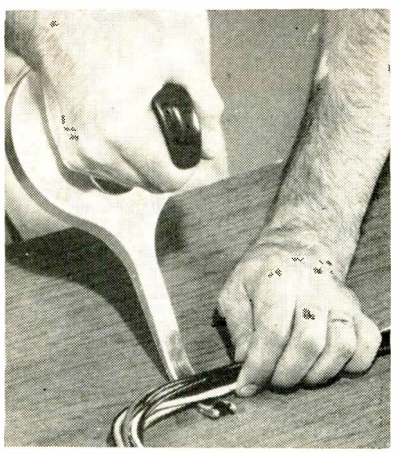
About a hundred washers are spread out in front of the assembler on a pad of ¼-inch-thick sponge rubber. She can then pick up the washers quickly and neatly by pressing the threaded end of each bolt through a washer into the rubber. This quickly gives a stock of bolts and washers to be used in the next assembly operation. The operation is more speedy and certain than the former method, in which a washer was picked up from a tray with one hand and a bolt with the other. Only one hand is required in the new method, or alternatively, twice the work can be done by using two hands simultaneously as shown in the illustrations.

Taping Gun Speeds Wrapping of Harnesses

ELECTRICAL harness wrapping can be speeded up from two to ten times by using plastic tape dispensed by a new taping gun marketed by Minnesota Mining and Manufacturing Co., St. Paul, Minn. for use with ⅜-inch Scotch No. 33 plastic electrical tape. The lightweight gun makes it possible to bundle the wires and cut the tape in a single easy motion taking approximately one second.

As first step in using gun, end of tape protruding from curved tip is pressed over wiring

In use, the tape protruding from the end of the gun is stuck to the wires by the thumb, threaded around the bundle by the curved tip, and then cut with a touch of a thumb button. The end of the tape is pressed down to complete the



Second, tip of gun is pushed under cable to draw tape underneath

S'matter, Swami, won't it work?

Near-sighted or not, our snake charmer friend should know he can get more out of a wire if it has a well soldered connection. How do we know that? Well, making the right kind of flux core solder for every application has been Kester's sole business for more than 50 years. There's no mystery about Kester Solder, no secret ingredients either. With Kester, quality is the paramount feature . . . the same today as it's always been.

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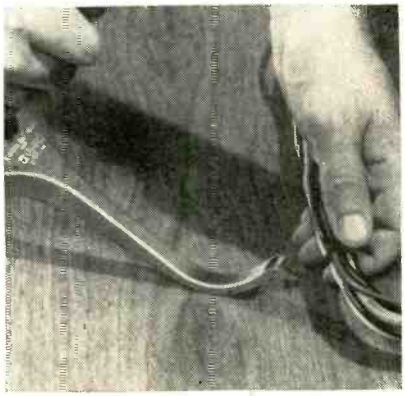
Third, operator presses button on grip to actuate spring steel cutting blade that cuts tape, then pulls gun out

wrap for holding the wires together securely.

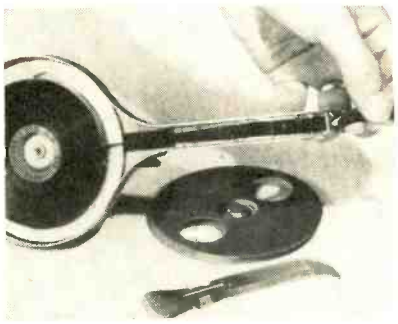
The slender 10½-inch curved tip serves as a convenient needle to thread the tape around wires on a cable layout board or in spots which would be difficult to reach.

With the exception of the grip and cutting button, which are molded from high-impact styrene plastic, the taping gun is of steel.

Advantages of plastic tape for electrical harness wrapping, as compared to previous methods using twine, include drastically reduced time and cost, elimination of any danger of cutting the insulation and freedom from attack by fungus—especially important where warm, moist conditions prevail.

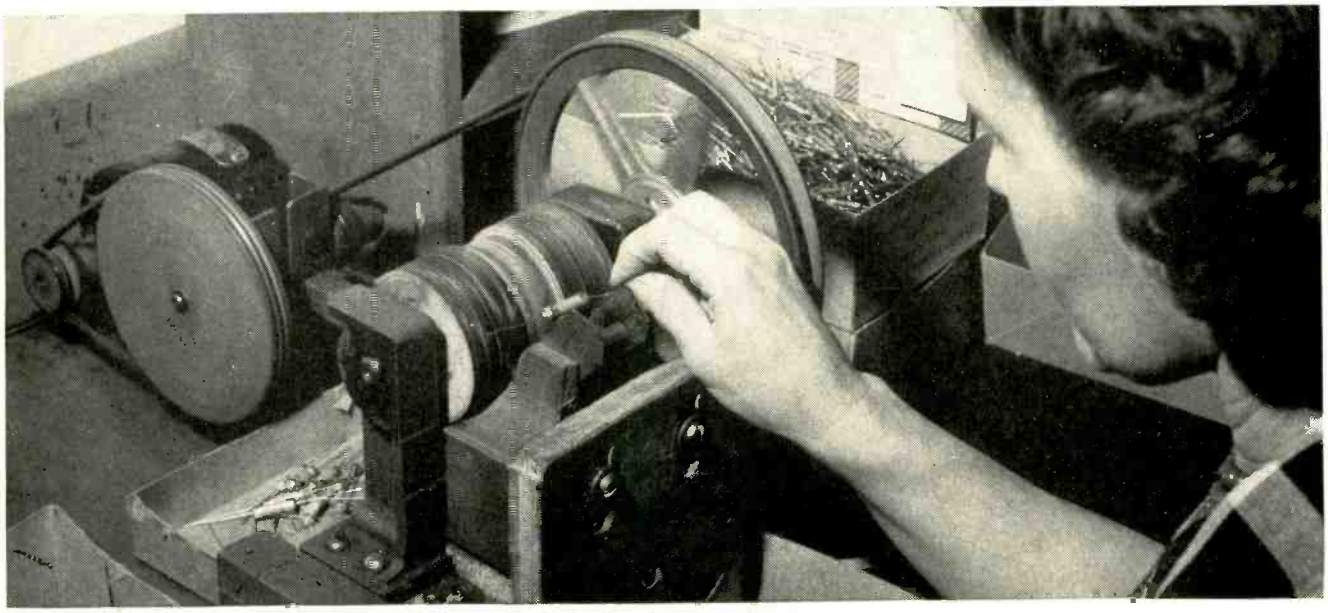


Final operation involves pressing down loose end of tape



Taping gun is loaded by removing revolving plate with coin or screwdriver and inserting 36-yard roll of tape, then threading tape down tip and under roller. Below is removable cover for bottom side of tip

Motor-Driven Roller Straightens Axial Leads of Resistors



Method of dropping resistors into lead-straightening fixture. Resistors pass under roller and drop into box at rear

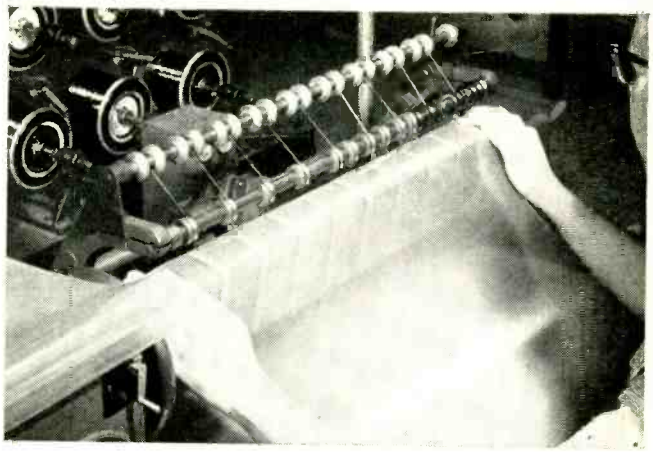
A SIMPLE rubber-faced roller rotating in close proximity to a curved slide provides a quick and inexpensive means of straightening the axial leads of deposited carbon resistors after their manufacture in the Kansas City, Mo. plant of Electra Mfg. Co., Resistor Division.

The operator merely drops resistors one after another between the slide and the roller, with the body of the resistor positioned between two vertical metal plates so that it lines up with a recess in the roller and does not get crushed. The leads are straightened as they are rotated against the wood slide by the rubber face of the rotating roller.

Cathode Tabbing Machine

THE OPERATION of welding a flat nickel ribbon to a tubular cathode sleeve for type 12AT7 tubes is performed automatically at high speed on a special welding machine in Tung-Sol's Bloomfield, N. J. plant. The welded ribbon serves as a lead or tab for connecting the cathode to the wire lead coming through the tube stem.

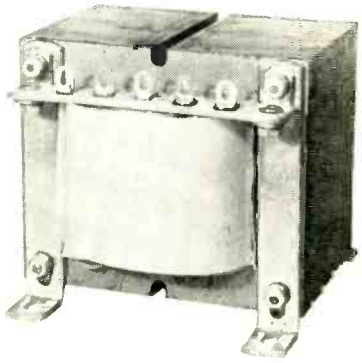
The operator pushes the sleeves up to a stop near the rotary loading wheel. When they get close enough, a permanent magnet under the loading table pulls the sleeves into the wheel one at a time. Spring-loaded jaws in the wheel are opened by a cam at the loading position, and the sleeve is then transported to the welding position. Here an



Operator of a Universal winding machine using Natvar Silicone-Coated Fiberglas for interwinding and layer insulation of a Freed multiple wound class H transformer.

FREED CLASS H TRANSFORMERS

are insulated with NATVAR Silicone-Coated FIBERGLAS



In spite of its weight, only 23 lbs., this class H unit delivers 2 kva. A unit of the same size with class A insulation would have an output of only 0.5 kva. Interwinding, interlayer and outside wrapper are of Natvar Silicone-Coated Fiberglas for maximum reliability.

FREED TRANSFORMER COMPANY, pioneer in the field of radio and electronics, designs and manufactures test instruments, transformers, reactors and filters of high reliability, including an extensive line of components built to meet MIL-T-27.

One of the significant developments in military apparatus is the saving of space and weight through use of new materials which permit operation at higher temperatures with no sacrifice of reliability. For these applications, Class H insulation must be used.

Freed uses Natvar Silicone-Coated Fiberglas to insulate Class H transformers because of its consistently good electrical and physical properties. All Natvar flexible insulations are dependably uniform, no matter when or where purchased. They are available either from your wholesaler's stock or direct from our own.

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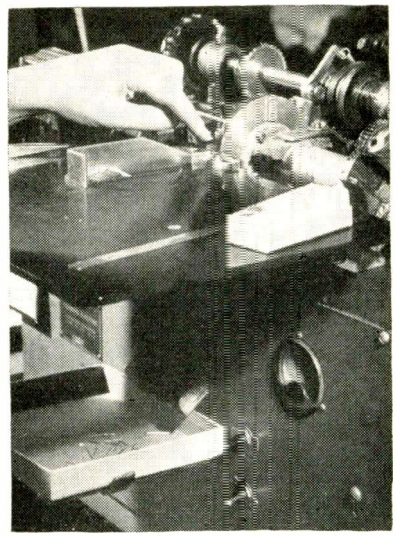
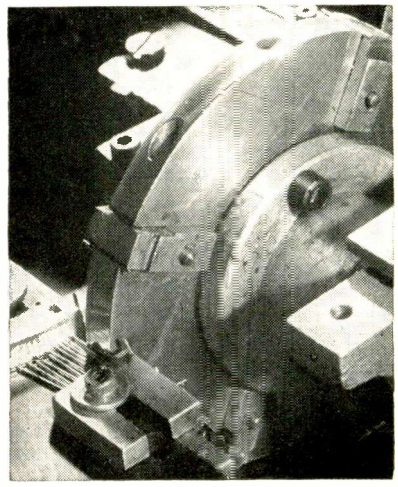


Automatic cathode tabbing machine. Operator has just pushed a sleeve up against a stop, from where it is pulled into the loading wheel by a magnet



Loading wheel of machine. Welding position is under wheel and hence not visible

anvil moves under the sleeve, the wire ribbon is fed over the top of the sleeve from its supply spool, and a welding electrode moves down over the ribbon to make the weld. The tabbed cathodes then drop down a chute to a box on a stand under the loading table. A Geneva cam mechanism provides the required dwell time at the welding and loading positions.

Sluggish Solder

ONE problem in normal dip-pot soldering is metallic contamination of the solder due to solvent action of the molten solder on the metal being dipped. Solvent action is, of course, a normal and necessary reaction without which soldering could not take place. In the case of steel

PERFECTING

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RHEOSTATS

● During the past two years we have re-designed and rebuilt into our rheostats tremendous improvements.

And we offer now *only one quality*—the best we can build. And that "best" is designed to comply with current standards of:

(a) Military Specifications JAN-R-22.
(b) Underwriters' Laboratories
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Furthermore that "best" is offered to all industrial users as well.

Mechanically the improved features include:

● **Unequalled perfection in our "buss-bar" type brush control, which automatically adjusts tension to complete, continuous contact with the entire winding surface.**

● **Positive, smoothly-controlled spring action which eliminates all strains tending to bind shaft in the bushing.**

● **Greater flexibility —no risk of backlash.**

All models are of course completely bonded with our new high-temperature-enamel;—thermo-shock-proof; more resistant to heat; increased safety factor; higher terminal strength.

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parts or assemblies, solder contamination due to solvent action is generally inconsequential because steel is relatively insoluble in solder. With such metals as brass and copper, however, there is rapid contamination of the solder bath due to the ready solubility of zinc and copper in liquid solder.

When molten solder finally becomes sluggish and unworkable due to metallic contamination, it should be replaced with fresh, pure solder, according to Kester Solder Co. It is fruitless and economically wasteful to add pure tin or pure solder to the bath in an attempt to compensate for metallic contamination.

Wafer Coil Technique Mechanizes Production of Transformers

By Albert Zack

Project Engineer, Transformer Development
Sylvania Electric Products Inc.
Ipswich, Mass.

Development of automatic assembly methods for transformers was initiated as a development project by Wright Air Development Center to prevent a bottleneck in times of emergency, as well as to improve uniformity and reduce costs of these components. During the investigation, the idea was conceived that wound laminated foil or rolled sheet material when sliced or cut into cross-sectional wafers would produce individual coils with close spacing and self-termination. The wafer slices have been constructed with spacings of 0.0002 inch and

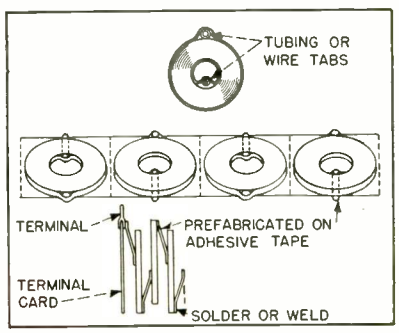

FIG. 1—Method of using adhesive tape for assembling individual wafer coils (top) to achieve insulation and interconnection of layers. Tape is cut at dotted lines and assembled, after which jumper leads are soldered to terminals of adjacent wafers and last wafer is soldered to terminal card having lead for external connection

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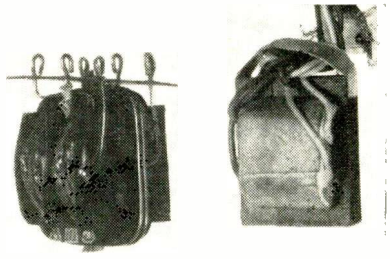
conductor areas measuring 0.0009 × 0.00017 inch (equivalent to No. 48 wire). Thus a great density of turns can be packed into a small area and a wide range of wire sizes can be obtained by simply varying the wafer thickness during slicing.

Audio transformers using aluminum-foil wafer coils have been constructed which are physically the same size as conventional units. Further reduction in size can probably be made by using copper foil which at present is not commercially available in 0.0002 inch thickness. Electrically, the frequency response and other characteristics of conventional and wafer-



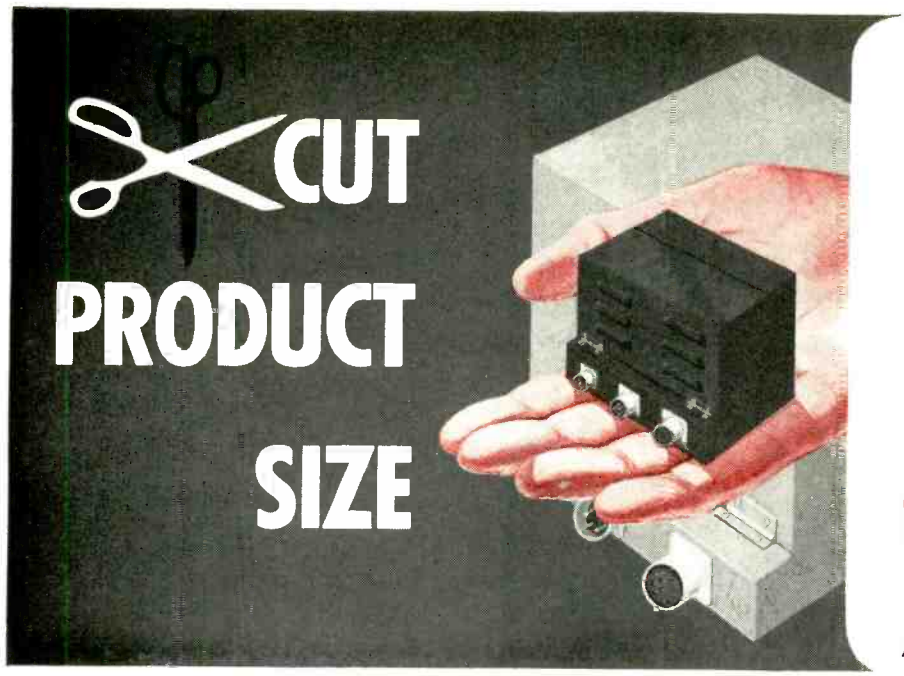
Miniature output transformers as made with wafer coil technique (left) and conventional coils

type coils are essentially the same.

Wafer coil construction begins with winding wide metal foil into a roll. The foil is previously coated with an adhesive-type insulator or a spacer is used to separate the turns. Terminal tabs in the form of tubes or tinned copper foil are attached by soldering or folding at the beginning and finish of the winding, or the foil itself is folded into a terminal tab.

The wound roll is next sliced into wafers, the thickness depending upon the cross-section desired for the conductor. For instance, if a conductor equivalent to No. 44 wire is needed and 0.00017-inch foil is used, the wafer thickness needed is approximately 0.017 inch. Slicing is done on a lathe-type cutter, using either a straight blade or a rotating circular blade. If necessary, the wafers are given a quick etch to remove any burrs or sharp edges, then insulated by spraying and mounted on a tape for assembly.

One method of assembling the wafers is shown in Fig. 1. Each start tab is connected to a preformed terminal on a carrying tape. This brings the inside connection to the outside terminal tab of the



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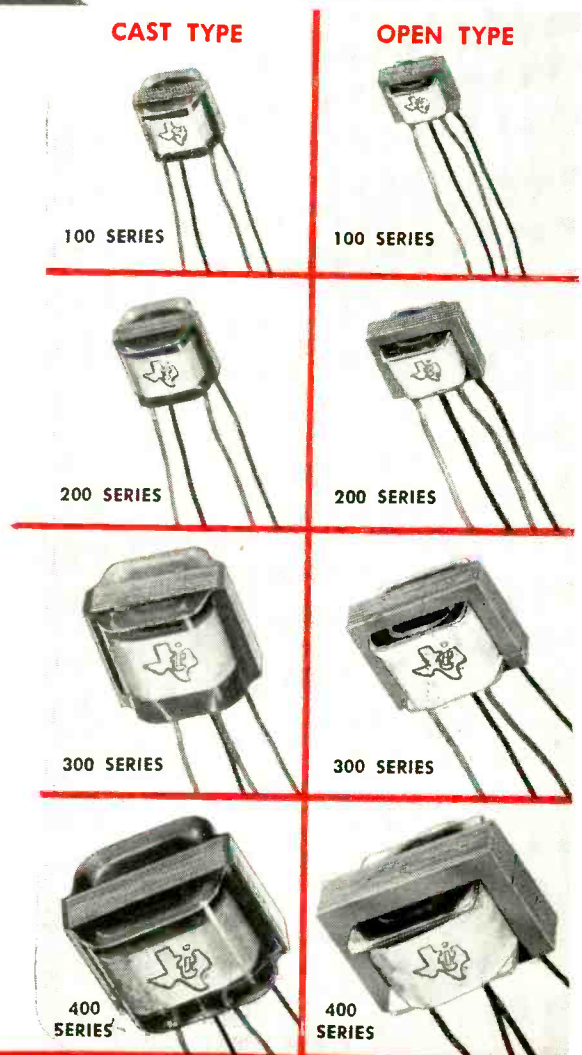
Input, interstage, choke, and output types are available in four size series ranging from less than 3/8 inch cubed (one milliwatt output) to slightly less than one inch cubed (over 100 milliwatts). Each series is manufactured in both open and cast construction, making a total of 16 basic types . . . 32 models. Designed for use in the audio and ultrasonic frequencies, these subminiatures will operate over a temperature range of —25° C to 100° C, with the cast units being particularly resistant to moisture and other environmental contamination. For your special applications, our engineers will design models to your detailed specifications.

Write for literature! Let our sales and design engineers help you with your specific transformer, magnetic amplifier or pulse network problems.



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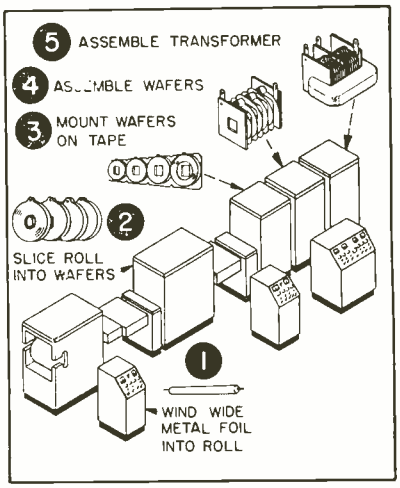
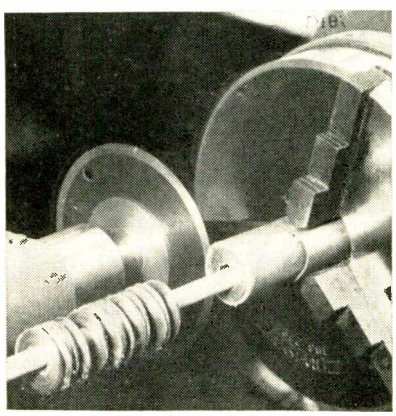


FIG. 2—Concept of complete mechanized setup for producing transformers using wafer coils

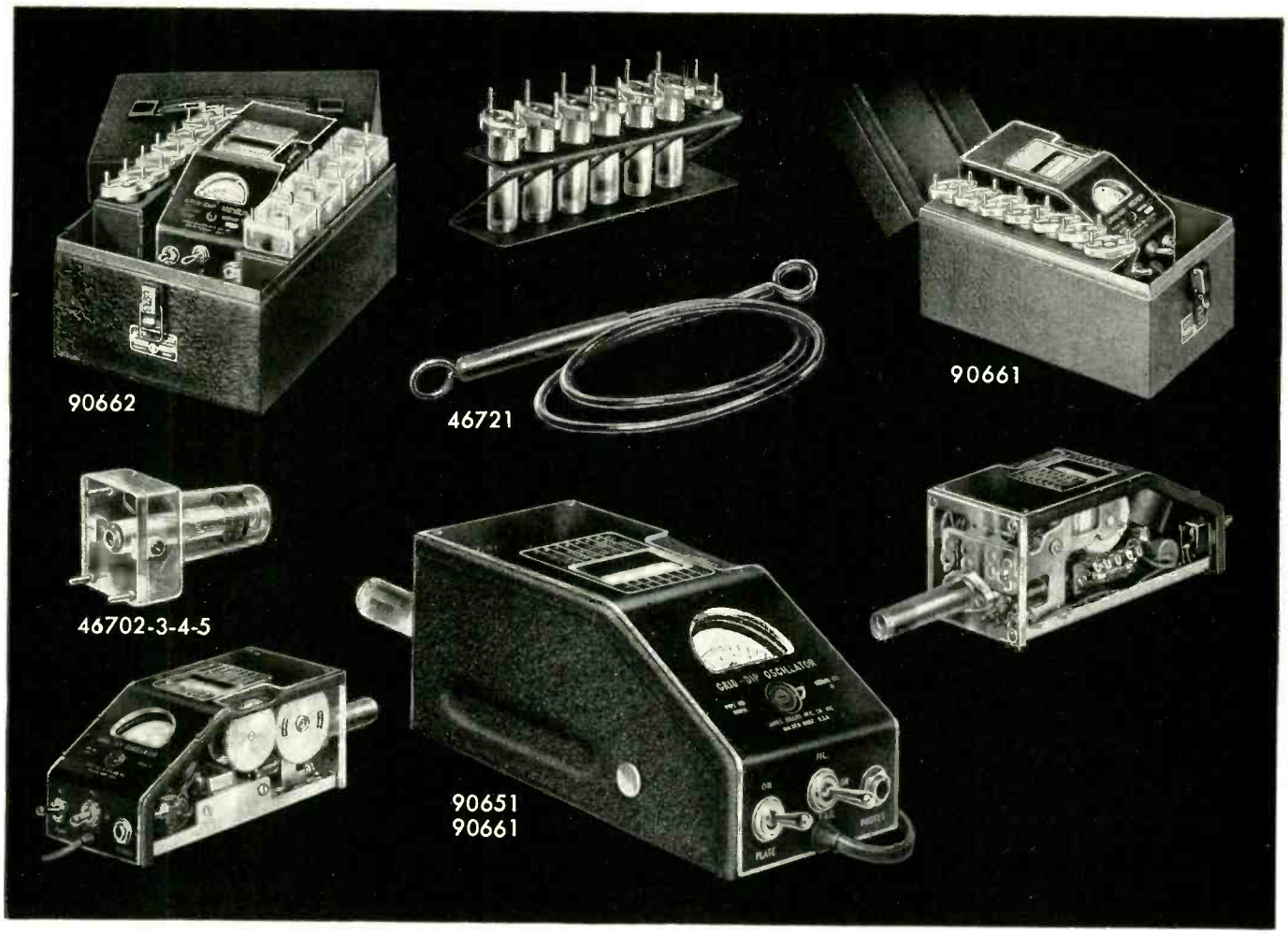
next following wafer, thus putting the coils electrically in series. As many wafers are used as are necessary to provide the proper number of turns. The first and last wafer are connected to preformed terminal cards which match the wafers and provide an outside connection to the coil. The assembled primary and secondary coils are then placed on a core and the unit is ready for final processing.

Essentials for an automatic assembly system are shown in Fig. 2. Construction of the wafers is separated into winding, slicing and prefabrication. Automatic winding can be accomplished on a bed-type winder similar to those common in the metal foil industry. This machine automatically coats and winds the foil and forms or fastens the terminal tabs at an estimated rate of twenty rolls per hour or the equivalent of 2,000 average units per hour.

The wound rolls are ejected into a magazine which feeds them into



Use of rotary blade for slicing wafers from foil roll in chuck



Designed for Application

Grid Dip Meters

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use with a range from 225 kc. to 300 mc. incorporates features desired for both industrial and laboratory application, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range o 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe.

These instruments are complete with a built-in transformer type A.C. power supply and internal terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 205° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Gride Dip Meters may be used as:

1. A grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

Size of Grid Dip Meter only (less probe): 7 in. x 3 3/16 in. x 3 3/8 in.

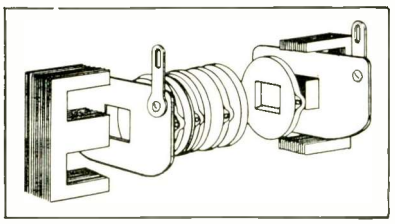
JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.

a slicing machine. The slicing machine automatically cuts each roll into wafers which are collected by a vacuum or pressure system. Controls on this machine will be used to vary the wafer thickness as needed.

The wafers next move through an etch spray and wash and then a spray for insulation. In one method, the wafers are placed on a prefabricated tape and connected to terminals on the tape by spot welding. The wafer tape is then fed



Wafer coil assembly fits conventional laminated iron-core structure

into an assembly point which places each wafer on an assembly arbor, starting and finishing with a rigid terminal card. From this point, the assembled coil is passed through a solder dip to connect the outside terminals and then is assembled to the core.

For r-f applications, larger spacings and low-loss dielectrics must be utilized to obtain high Q. Tuning can be accomplished by physical movement of the wafers to change mutual inductance, variation of capacitance between wafers, moving powdered-iron wafers or moving conventional powdered-iron slugs. Dip-coating the wafers in resins loaded with iron powder provides a complete coating of core material around the wafer. The wafers can be mounted on a printed-circuit chassis in much the same manner as flat disk capacitors.

Resistor Strip Fixture

SMALL resistor subassemblies used in strip transmitters for Motorola 30-watt mobile communication equipment are assembled four at a time with the aid of a special fixture. The operator loads the insulating panels into recesses in the plate of the fixture, brings down a clamping bar to lock the panels in position and proceeds with assembly. A knurled nut on the right-hand pivot shaft holds the rotating

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company DECEMBER 1954

Insulator of KEL-F® Plastic Doubles as Vital Structural Part in Severe 250°F Water-Immersion Service

Perfect electrical insulation and maintenance of critical spacing of electrodes are provided by this spacer of KEL-F polymer plastic. Even under constant immersion in water at 250°F, insulation remains high, precision tolerances and dimensions of the spacer-insulator are maintained.

Excellent mechanical properties of this fluorocarbon plastic dielectric under extremes of temperature and stress permit the critical spacer to be used under heavy spring loading without deformation or failure. Accurately machined grooves in the plastic hold O rings to prevent liquid leakage.

McNab Incorporated, New York City, machines the spacers from rod extruded from unplasticized KEL-F polymer by the Resistoflex Corporation, Belleville, N. J. Spacers are used in special conductivity cell-valve units manufactured by the McNab company for use in marine and industrial installations producing potable water.

For further information ask for Application Report E-131

Insulated Union of KEL-F® Plastic Carries 400 psi Gas Safely Through 10 Kv Potential in Atom Research

A hollow threaded stud of KEL-F plastic, one of the best "tough" dielectrics, maintains a gas-tight connection and effectively insulates the line in a high potential field. The plastic union is also required to hold a high vacuum when used in the nuclear research device.

Used to carry a gas with an extremely high diffusion rate, the fluorocarbon plastic's non-porosity effectively blocks leakage.

The novel coupling was devised by the Brookhaven National Laboratory, Upton, N. Y. and machined from rod extruded from KEL-F polymer Grade 300 by the Plax Corporation, Hartford, Connecticut.

For further information ask for Application Report E-132

(SEE REVERSE SIDE)

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CONTINUED FROM PRECEDING PAGE

Dome of KEL-F® Plastic Pressurizes Airborne Radar Antenna in Minus 85°F —Plus 160°F... Cuts Power Losses

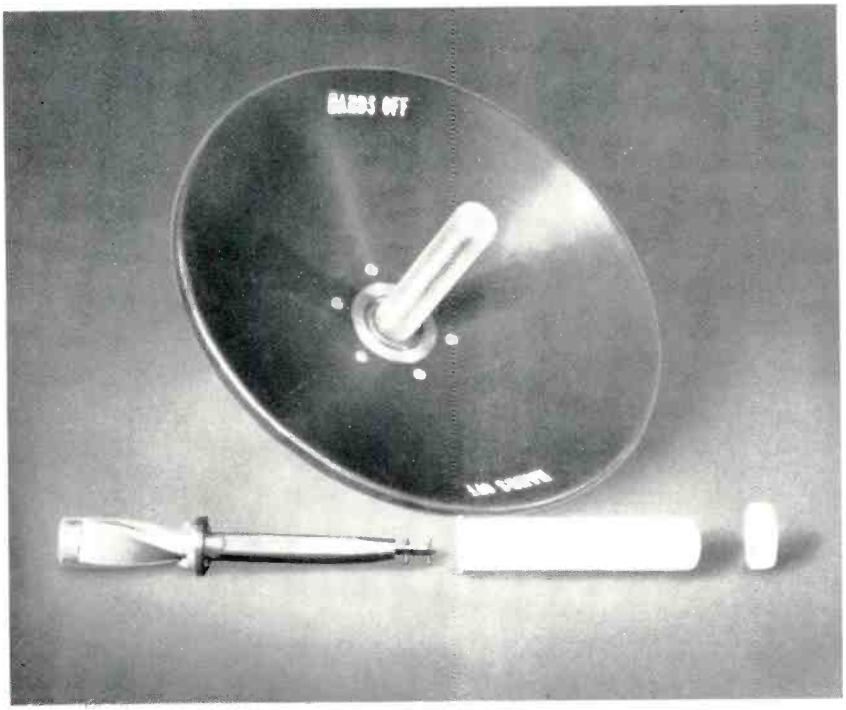
A "test tube" and machined lock nut —both made from KEL-F polymer— help maintain this radar "horn" under 15 psi positive pressure and prevent power breakdown even at high altitudes. Tough, but resilient, they are undamaged by accidental blows, vibration or exposure.

The fluorocarbon plastic remains transparent to high frequency pulses indefinitely. Zero water absorbing and non-wetting, interference from high humidity or fungus is cut.

Rigid but not brittle, the plastic tube and lock nut are readily installed and removed for servicing without danger of breakage or chipping.

Fluoro Plastics, Inc., custom molders of Philadelphia, Pa., compression-mold these new radar domes from unplasticized KEL-F polymer Grade 300. The molded tubes are ready for use without machining. The lock nut is machined from rod stock by the radar manufacturer.

For further information ask for Application Report E-133



Molders & Fabricators of the Month

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

Auburn Button Works, Inc.
Auburn, N. Y.
Injection molding

Bacon Industries, Inc.
Watertown, Mass.
Compression & transfer molding
Gaskets & O rings

Elco Corporation
Philadelphia, Pa.
Injection molding
Electronic tube sockets

Electronic Mechanics Inc.
Clifton, N. J.
Extrusion, injection, compression & transfer molding
Forming
Rod, tube & sheet
Coil forms & tube sockets
Diaphragms & gaskets

A. Gusmer, Inc.
Stalpic Division
Woodbridge, N. J.
Corrosion control
Dispersion application

Recent Significant KEL-F Polymer Developments...

Lip seals for liquid oxygen and other liquefied gas equipment operating at low temperatures are molded now of KEL-F plastic. Resiliency at subzero temperatures, dimensional stability and chemical inertness overcome shortcomings of other gasket and sealing materials used.

Liquid level gauges now have their glasses protected by a thin sheet of KEL-F plastic. Remaining transparent indefinitely in spite of contact with highly corrosive chemicals such as HF, the plastic sheets act as their own gaskets.

Miniature coil forms are molded of KEL-F plastic for use in electronic devices operating at elevated temperatures. Types include special models with metal inserts.

Quality test for use by the manufacturer of trifluorochloroethylene polymer parts (the "Z.S.T." test) has been developed and field-tested by Kellogg. Test is simple, requires no special training. Equipment is automatic, eliminates the human error factor in test results.

OFF THE PRESS...
Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

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

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"... cost of the projector will be returned within a three-month period"

CUTLER-HAMMER MOTOR CONTROL C-H

Tool and Die Dept.

SUBJECT: Report of Savings through use of KODAK CONTOUR PROJECTOR in Tool Inspection

1-This report covers the period from June 1 through 30.

2-During this period, a Kodak Contour Projector was used to check circular form tools; flat drills, taps, and special cutters received from suppliers; and board samples.

3-The following table summarizes direct labor savings in man hours effected by replacing manual inspection with inspection on the Contour Projector. Time required for manual inspection is estimated on the basis of past experience with these parts.

Parts Checked	Direct Labor, Manual Insp.	Direct Labor, Optical Insp.	Savings (In man hrs.)
Circular form tools	350 hours	50 hours	300 hours
Flat drills, taps, special cutters	375 hours	65 hours	310 hours
Board samples	250 hours	90 hours	160 hours
		Total man hours saved	770

4-Without savings cited here, three additional men would have been required for these inspections. In addition, use of the Contour Projector has reduced the possibility of error and resulted in more consistent checking.

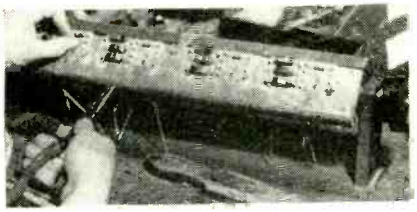
5-RECOMMENDATION: Based on the knowledge that these savings can be duplicated each month with present tool room volume, purchase of a second Kodak Contour Projector is recommended. This opinion recognizes the fact we are now checking with one machine only about 40% of all work suitable for the projector. Assuming man hour savings equal to those already effected, cost of the projector will be returned in direct labor savings within a three-month period.

Such reports by users of the Kodak Contour Projector are typical. To find out more about how optical gaging speeds inspection, improves accuracy, write for a copy of the illustrated booklet "The Kodak Contour Projector."

EASTMAN KODAK COMPANY, Special Products Sales Division, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak TRADE-MARK

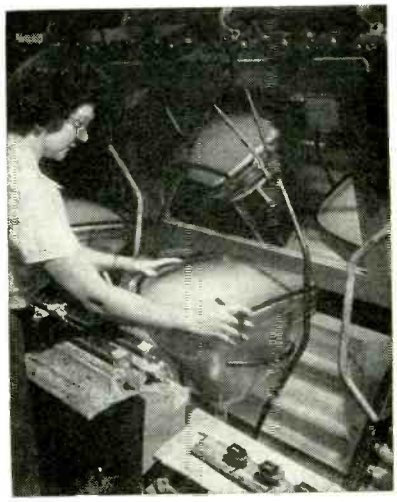


Resistor subassembly fixture

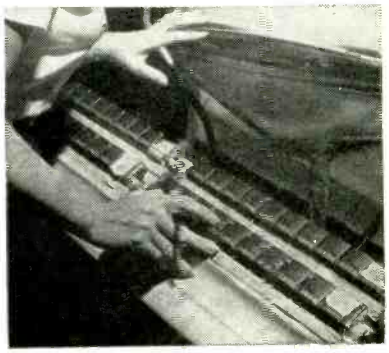
fixture at the desired angle for optimum efficiency. After resistors have been mounted, wire leads are pushed through panel holes one by one from the top and their ends are twisted around the terminals.

Running-Count Tabulation of Picture-Tube Flaws

AT THE screen inspection station on the conveyorized processing line for picture tubes in General Electric's tube plant at Electronics Park, Syracuse, N. Y., minor holes or other flaws in the fluorescent screen coating are cause for rejection. A high-intensity light source made up of banks of four-foot fluorescent lamps below the tubes makes screen defects readily noted. Bulbs re-



Overhead conveyor moves tubes slowly over fluorescent lamp bank at inspection position



Details of totalizing counters for types of flaws

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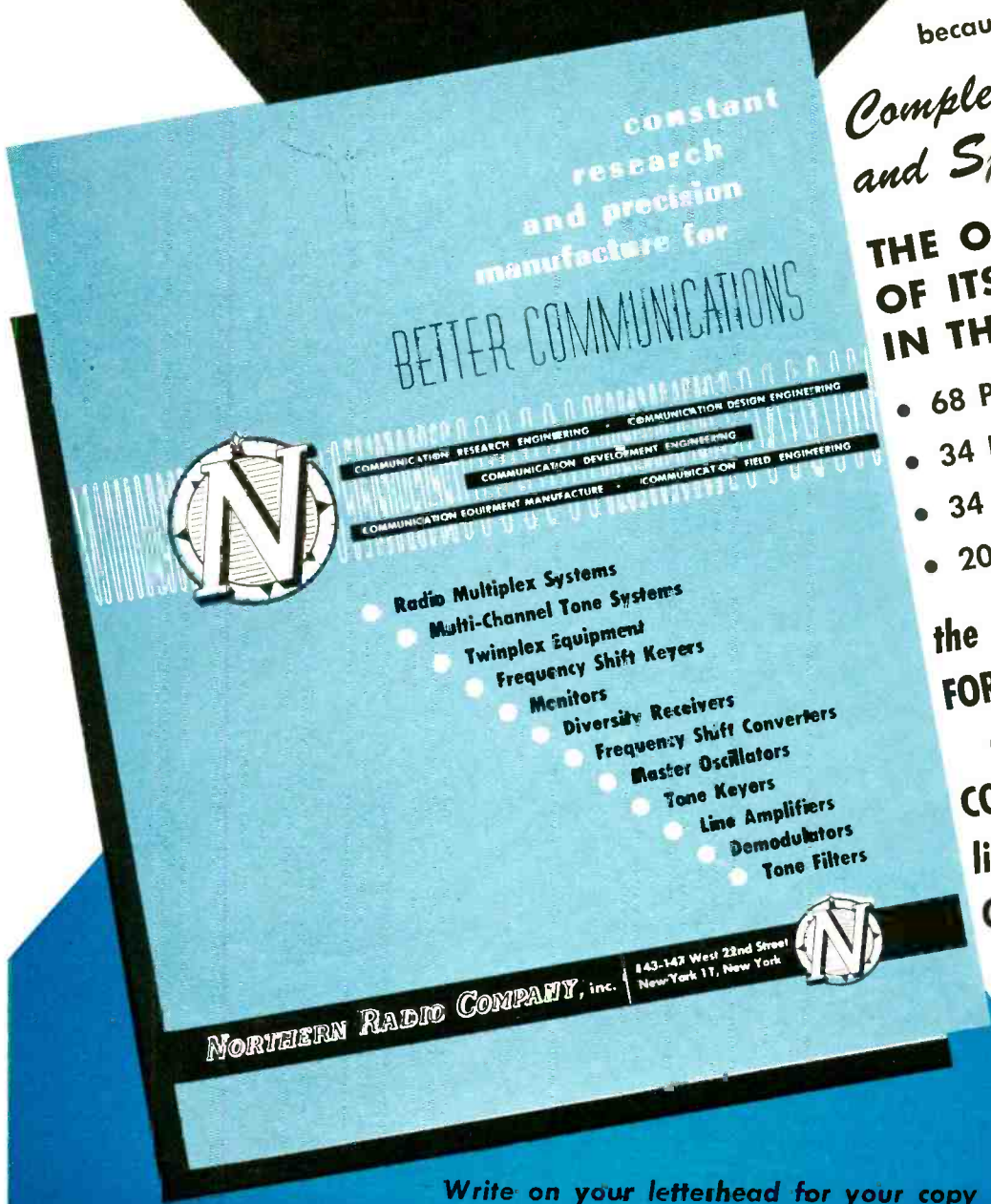

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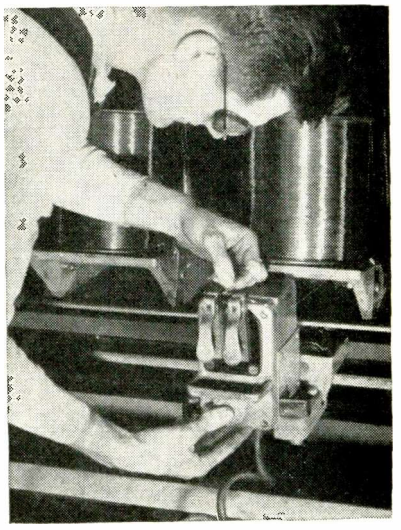
Pace-Setters in Quality Communication Equipment

jected at this station are returned to be washed out and rescreened.

A running record of rejects and reasons for rejection is kept on grouped banks of mechanical counters placed conveniently below the operator's hands. Coded identification symbols are written on strips of tape below the counters to identify the type of flaw represented by each counter. The counters are so designed that they advance one count when the top of the counter housing is pressed; the action resembles that of a pushbutton.

Brazing Unit for Wire-Electrotinning Machine

SIMULTANEOUS electrotinning of 50 strands of copper wire at high speed is achieved with minimum stoppage in Western Electric's Tonawanda plant by employing a brazing unit to braze one end of the wire from a full spool to the inside end of a spool that is about to run out. The wire is then automatically transferred from the empty spool to the next full spool without stopping the machine.



Pressing button to initate brazing with portable unit that slides on rail running the length of the spool-supporting rack for the electrotinning machine

The brazing unit slides on a rail and is connected to a power outlet through a coiled rubber-covered line cord which eliminates the need for trolley duct. Spring-mounted pulleys absorb the shock involved in starting the unwinding of a loaded spool during switchover.

Electrobrazing is achieved by placing one wire end under one

ANNOUNCING ANOTHER NEW AMPEX

but this time it's a superb amplifier-speaker

It's a 25 pound portable amplifier-speaker that matches the Ampex 600 tape recorder in appearance **and in quality, too!** The new Ampex 620 has FLAT ACOUSTIC RESPONSE from 60 to 10,000 cycles. This would be a great achievement in a speaker of any size, but in a 25-pound portable it's truly exceptional — in the Ampex tradition.

A quality demonstrator to sell broadcast time Program samples or auditions can now be demonstrated with a new impact and clarity that will make prospective time buyers sit up and take notice. The Ampex 620 can be carried anywhere. It has ample power for a group hearing in office, conference room or small auditorium.

A speaker to monitor with greater sensitivity The Ampex 620 is an extra sensitive monitoring unit usable anywhere inside the studio and outside with portable recorders as well. It will give operating personnel a much better indication of recording and broadcast quality than the usual monitor speaker. This can help forestall criticism from the growing percentage of your audience who listen through high quality amplifiers and speakers.

AMPEX 620 PORTABLE AMPLIFIER-SPEAKER
Connects with your studio console — or reproduces directly from tape recorders, turntables or pre-amplified microphones. The Ampex 620 is a perfectly integrated design including a 10-watt amplifier, loudspeaker, reciprocal network, level control, equalization control and acoustically correct enclosure. By standard test procedures **in air** it has low distortion and an acoustic response curve that is essentially flat from 65 to 10,000 cycles. Price is $149.50 complete.

AMPEX 600 PORTABLE TAPE RECORDER
Like the great Ampex studio tape recorders the 600 is the best of its kind. It weighs only 28 pounds, yet the Ampex 600 can serve every broadcast station need. For auditions and demonstrations it is the perfect sound source for the Ampex 620 amplifier-speaker. Prices: $498 unmounted, $545 in portable case.

For full description and specifications write Dept. E-1977

Signature of Perfection in Sound

Distributors in principal cities (see classified section of your telephone directory under "Recording Equipment.") Distributed in Canada by Canadian General Electric Company.

AMPEX CORPORATION

934 CHARTER STREET
REDWOOD CITY, CALIF.

spring clamp electrode and placing the other wire end in the other electrode clamp, in such a way that the wires butt together under slight pressure. The operator then presses a button to send current through the joint for the brazing operation.

Checking Perpendicularity of C-R Traces

By IRWIN S. LANDOW
Cathode Ray, Storage and Phototube Section
U. S. Naval Material Laboratory

CURRENT DEVELOPMENT of electrostatic cathode-ray tubes for military and commercial applications requires that the angle of intersection of the vertical and horizontal traces shall not differ from 90 deg by more than ±1 deg. Previously a tube was acceptable if the deviation from normality of the traces was not greater than ±3 deg. Quality control of these improved tubes requires that this characteristic be measured with a high order of precision.

This article describes an instrument which satisfies this specification and has the additional advantage that the measurement does not require the simultaneous display of the traces or the location of the point of intersection of the traces.

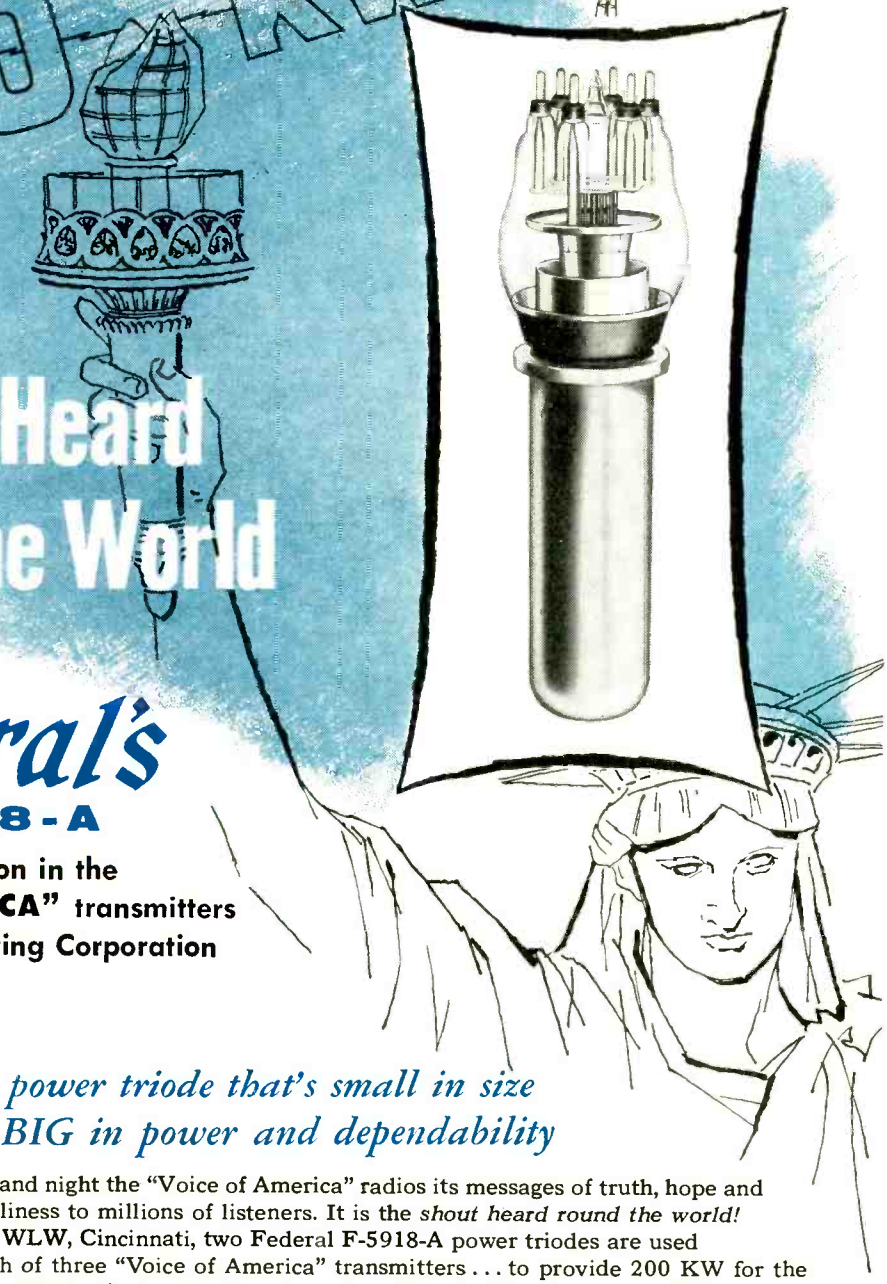
The instrument comprises a Plexiglas disk 7 inches in diameter and ¼ inch thick with cross-hairs scribed at right angles on the front and back faces. The corresponding cross-hairs are aligned with mirror symmetry in order to eliminate

Operator measuring angle between traces

200 KW

FOR THE

Shout Heard Round the World



Federal's F-5918-A

Serves with distinction in the "VOICE OF AMERICA" transmitters of Crosley Broadcasting Corporation

Prime Features of the F-5918-A

Heavy Wall Anode provides improved heat dissipation . . . allows conservative plate dissipation ratings.

Kovar Grid, Filament and Anode Seals increase ruggedness . . . for industrial and other applications.

Specially-treated Grid permits high heat dissipation . . . has recuperating power, which prevents destruction by momentary overload.

Low Grid-plate Interelectrode Capacity allows easy neutralization at frequencies up to 22 mc.

Thoriated Tungsten Filament results in reduced operating temperature of all tube parts.

Full Voltage safely applied to cold filament . . . no step-starting or high reactance transformers needed.

The power triode that's small in size but BIG in power and dependability

DAY and night the "Voice of America" radios its messages of truth, hope and friendliness to millions of listeners. It is the *shout heard round the world!*

AT WLW, Cincinnati, two Federal F-5918-A power triodes are used in each of three "Voice of America" transmitters . . . to provide 200 KW for the steady stream of programs broadcast from this vital link in the vast "VOA" chain.

"We find these tubes very satisfactory for the international band," says Crosley Broadcasting Corporation. "They are stable in operation . . . easy to neutralize up to our highest frequency of 21.65 mc without using grounded grid operation."

Federal's F-5918-A is amazingly rugged . . . providing maximum dependability. Its thoriated tungsten filament results in longer life . . . lower costs. Each tube delivers *more* output (100 KW) with *less than half* the filament power required by pure tungsten types.

The F-5918-A also is particularly suitable for 100 KW induction or dielectric heaters. An air-cooled version of this rugged performer is available in Federal's F-5919.

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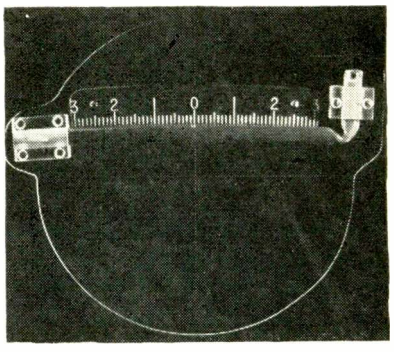
For Complete Technical Data on Federal's F-5918-A write today to Dept. K-613



Instrument for measuring angle between traces on cathode-ray tube screen

parallax. A clinometer is mounted on the Plexiglas disk for measuring angles of inclination. It consists of a spirit level and a circular scale graduated in tenths of a degree within the interval of ±3 deg. By means of a reservoir of air at one end of the glass tube, the size of the air bubble may be adjusted. For this application the radius of curvature of the glass bulb is approximately 10 feet. The large radius of curvature of the glass bulb permits the required instrumental precision.

In order to measure the angle between the traces, the cathode-ray tube is initially operated with one focused line trace almost horizontal. The horizontal cross-hair on the Plexiglas disk is aligned with the trace and the clinometer reading recorded. The deflection voltage is now applied to the second pair of plates of the cathode-ray tube and the clinometer reading is recorded when the vertical cross-hair is aligned with this trace. The algebraic difference between the two clinometer readings is the deviation from 90 deg of the angle between the traces.

Winding Frame Grids for Ruggedized Tubes

By Robert E. Booth
and
Richard C. White
Sylvania Electric Products Inc.

Conventional siderod grids are inadequate for many high-performance tubes because comparatively heavy lateral wires must be used to achieve needed strength. As the wire approaches 0.0005 inch in diameter, siderod grids not only suffer seriously from lack of strength, but also are difficult to manufac-

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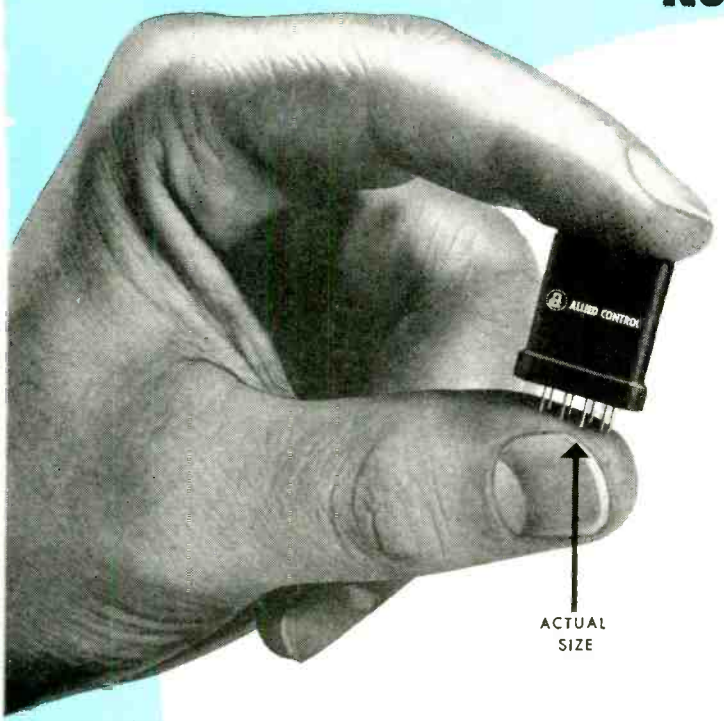
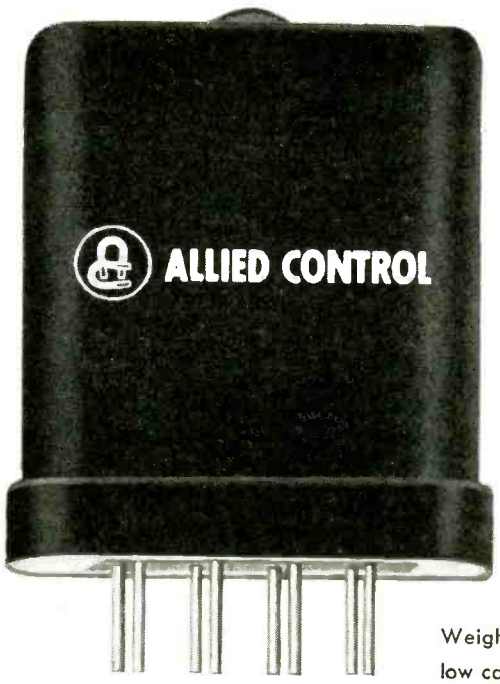
Now Double Pole Double Throw with Increased Ratings





Weighs 0.33 oz.—has low capacity for RF switching. Applicable to printed circuits.

TYPE KH-6D

ELECTRICAL SPECIFICATIONS

CONTACTS: Double pole double throw rated at 0.5 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms standard

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10 G up to 500 cycles

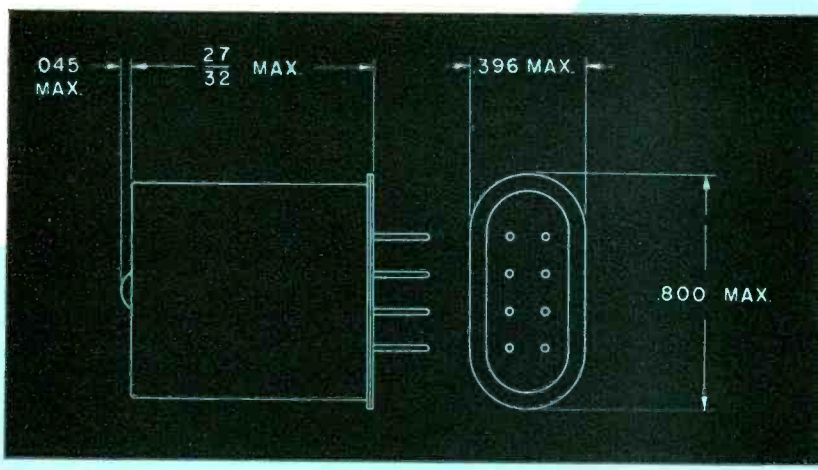
SHOCK: 100 G plus (operating)

SPEED OF OPERATION: 2 milliseconds at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 350 volts rms at 80,000 feet

TERMINAL TYPES: Printed circuit, solder terminals and plug-in

CAPACITY: N. O. contact to case 0.6 mmf.



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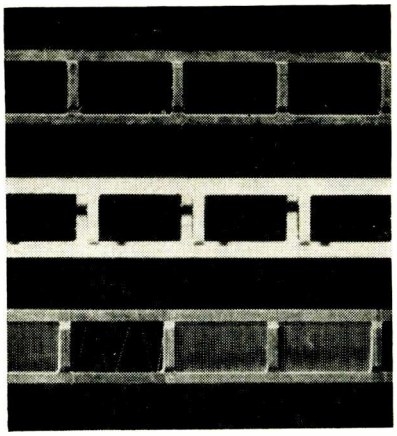


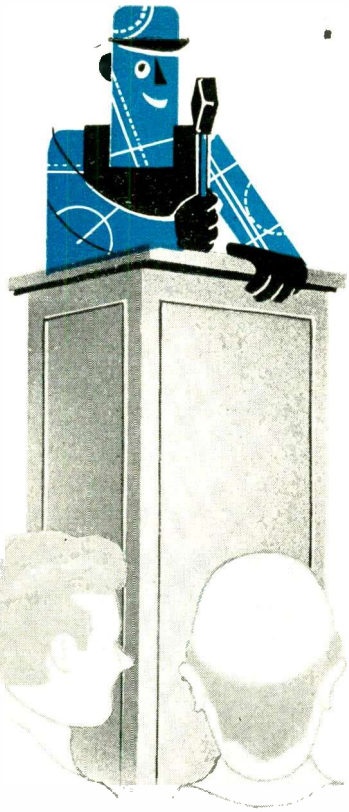
Steps in production of frame grids. The frame is first stamped, then two frames are assembled back to back so laterals may be wound and brazed into place

ture. Normal methods of lateral wire placement, by nicking and swaging the siderod material, are difficult to employ without breaking the lateral wire or producing an erratic pitch. Lack of adequate control of lateral-wire springback when the grids are released from the mandrel also contributes to nonuniformity.

The frame grid, developed as part of a U. S. Navy contract, provides a satisfactory answer to these problems. It is readily adaptable to automatic production techniques and can be fabricated at a rate approaching that of conventional siderod grids, at only slightly higher cost. It relies on a rigid frame for its strength and stiffness, and therefore extremely small-diameter lateral wires wound with a small, accurately controlled pitch can be used to provide the current control necessary for better tube performance.

The lateral wires are brazed to a rigid frame, the thickness of which determines the minor dimension of the grid. Thus frame grids can be made more nearly identical, and the spacing between grid and emitter can be controlled with greater ease. As a result, tube shrinkage can be greatly reduced for given testing limits, or the testing limits can be tightened appreciably to give the necessary improvements in reliability and uniformity.

The frame grid has rugged features that are especially desirable when tubes must be capable of giving good performance under conditions of severe shock and vibration. This is particularly true in the case



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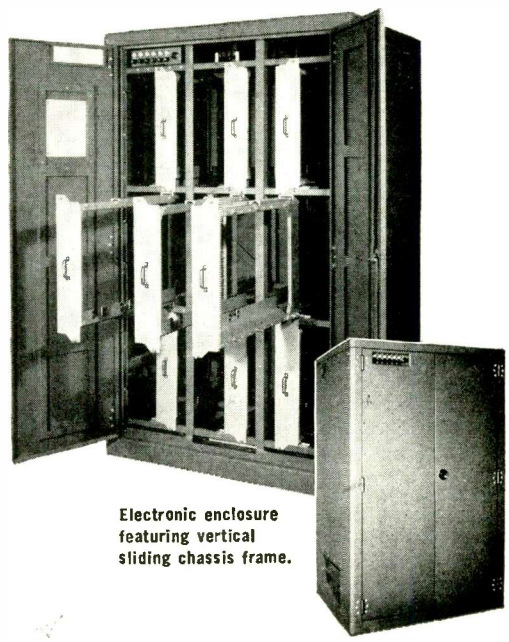

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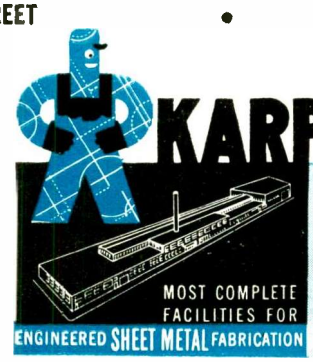

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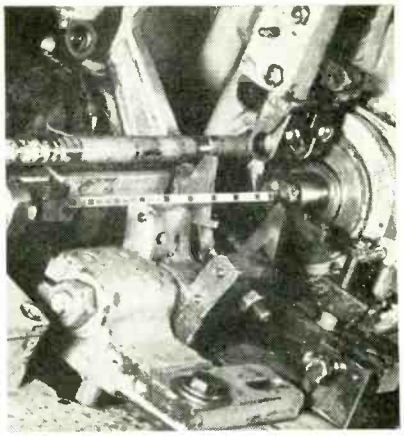
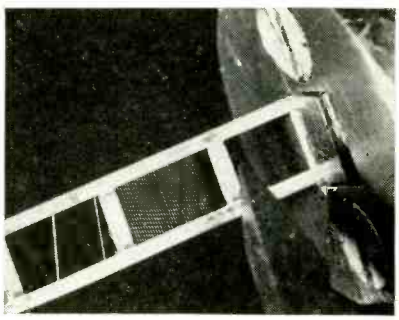


Frame grid strip being wound on slightly modified standard grid lathe



Strip emerging from pressure mandrel, showing the skip-wound portion between grids. Wire here is 0.0005-inch tungsten, wound at 210 turns per inch

of subminiature tubes. Ruggedness is also desirable in the process of tube assembly since, in being welded, grids may be subjected to possible twisting, a major cause of lateral distortion and siderod bowing that frequently leads to short-circuits or cutoff difficulties in finished tubes.

Fabrication of Frame Grids

Molybdenum was selected as the frame material because of its high modulus of elasticity and high-temperature strength. Also, its thermal expansion coefficient, which is important in brazing, is comparable with that of the tungsten laterals.

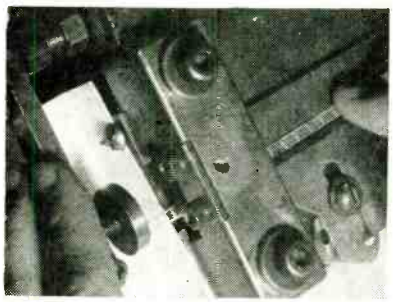
The first operation in preparing the frame grid is to punch and form the material into strips of frames. These are then cleaned and gold-plated. Two strips are placed back to back with the cross bars lined up and are drawn through a pressure mandrel on the grid machine by the lead screw.

The lateral wire is wound on the frame at the desired pitch as the frame emerges from the mandrel. No nicking or swaging is necessary

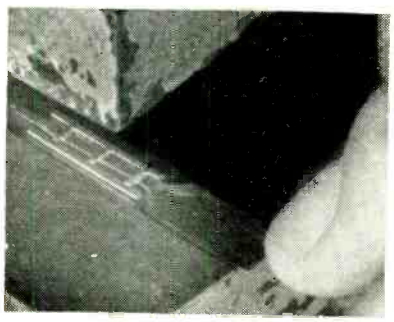
because the tension on the laterals is sufficient to hold the frame strips together and the laterals temporarily in place. By means of a cam, sections of the frame are skipped in the winding to provide free, unwound legs for mounting the grid into the mica support.

The wound strips are placed in a wide V-shaped slotted rack and fired in a hydrogen furnace to braze the laterals to the frame. The gold plating on the frame serves as the brazing material. It was found possible to straighten the strips by cold stretching them after brazing.

Brazed strips are cut into individual grids and the loose turns



Cutting operation, showing positioning of brazed strip in cutter



Lateral tensioning operation. Pressure is applied to the crossbars, which are offset for that purpose as well as for filament clearance

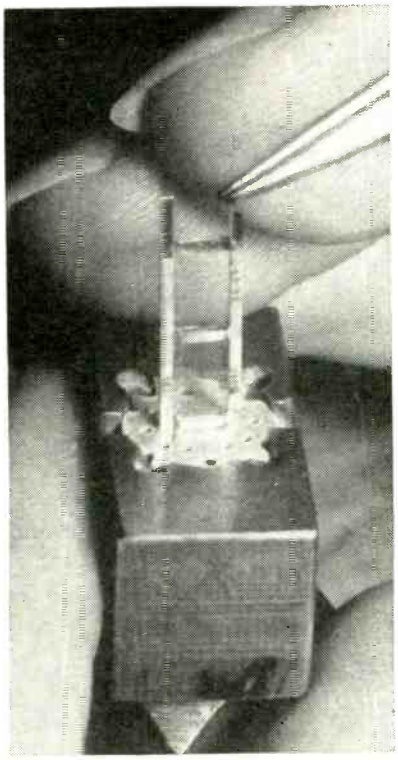
occurring in the skip-wound portion are peeled off the frame. If the laterals still exhibit loose tension after stretching and brazing, they can be tightened by exerting pressure on the crossbars of the frame, which have been offset for that purpose as well as for providing clearance for the filament assembly.

Since tensioning can be accomplished after winding and brazing, it is not necessary to control the winding and brazing to a fine degree. This, of course, is a saving in setup time on the grid machine and is an important factor governing production costs.

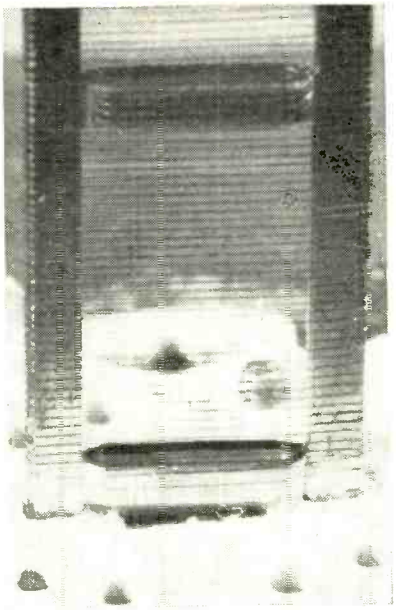
The completed grids are next in-

spected and trayed. Finally, the trayed grids are sealed in plastic bags to prevent the accumulation of small dust particles on the lateral wires.

The resultant frame grid has perfectly plane surfaces and a very uniform pitch. Controlling the thickness of the frame material to insure accurate, close tolerances of the grid minor dimension is much simpler than determining the uncontrolled, allowable lateral-wire



Frame grid being mounted in a mica support

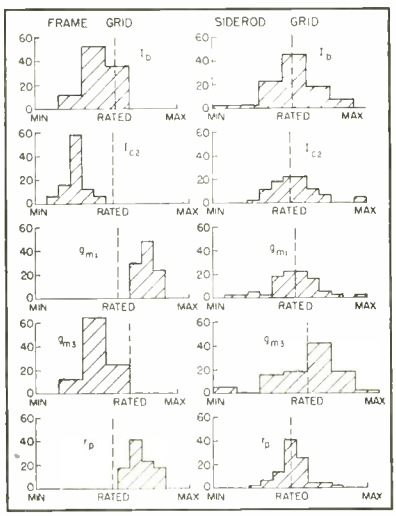


Crossbars prevent end lateral jamming during assembly

springback of conventional grids.

Frame grids will withstand almost any rough handling short of jabbing an object through the laterals. Even then, the laterals are not appreciably dislocated unless they are broken. The crossbars prevent jamming of the end laterals during assembly, virtually eliminating potential shorts and cutoff shrinkage.

Grids have been wound successfully with 0.00034-inch tungsten lateral wire at 472 turns per inch



Spread in characteristics of tubes having frame and siderod grids. Frequency of occurrence in percent of total tubes is plotted against five different tube characteristics

on standard grid lathes with excellent results. It is believed that 0.0002-inch wire could be wound safely, although no attempt has been made to do so.

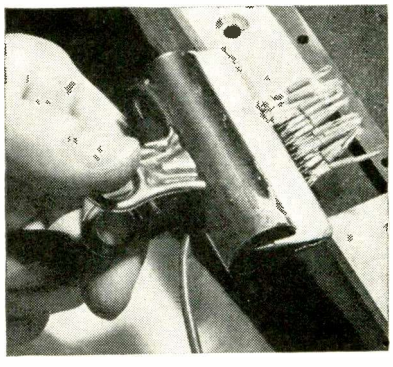
Conclusion

The advantages of a frame grid that can be adapted to automatic mass-production techniques are numerous. Its contribution to the manufacture of higher-performance tubes with more-uniform electrical characteristics is clearly shown by the narrower range of characteristics exhibited by the tubes incorporating it. It provides the most reliable method, to date, for the fabrication of grids with closely-spaced, extremely small lateral wires. Its strength and rigidity alleviate handling problems in tube assembly and are beneficial in the construction of ruggedized tubes, particularly those required by the Armed Services. Finally, although the manufacturing cost of frame

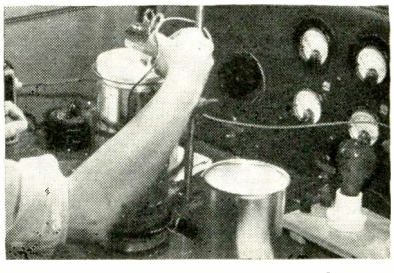
grids is at present higher than that of conventional siderod grids, the number of tubes rejected for mechanical and electrical defects should be considerably lower.

Cataphoretic Coating for Heater Bends

TO COAT the exposed peaks or bends in heaters for vacuum tubes after they have been folded, the heaters are picked up in batches of a dozen or more with a large spring-type paper clip and treated in a cataphoresis process developed in the Bloomfield, N. J. plant of Tung-Sol



Method of picking up heaters with clamp-type electrode after aligning them with the aid of bars arranged on bench



Holding batch of heaters in cataphoretic coating solution

Electric Inc. The paper clip is connected to the negative terminal of a Variac-controlled d-c power supply delivering 10 volts at about 100 ma. The clip is held for 2½ seconds over an aluminum container serving as the positive electrode and containing a special electrolyte obtained from Electron Tube Coil Co. Only the ends of the heater are immersed; these pick up solids of aluminum hydroxide and aluminum oxide from the solution.

The solution is stirred continuously by a paddle-shaped Alnico magnet inside, driven magnetically by another magnet on the shaft of a small a-c motor in the stand under the container. Speed of stirring is

controlled by a rheostat in the motor circuit. This magnetic stirrer is available from Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

A signaling timer connected into the plating circuit cuts off plating current in 2½ seconds. A lamp in series with the timer and bath indicates to the operator that the coating process on a batch has been completed.

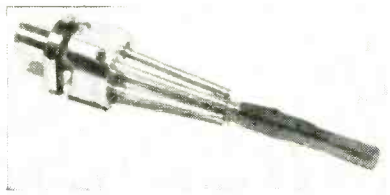
Furnace Sample Holder

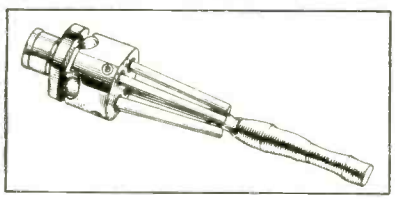
By J. SOLED and A. MACDONALD
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

IN THE DEVELOPMENT of the floating zone technique for the recrystallization of silicon, a need arose for a small metal sample holder. Tungsten was selected as the material for the supporting fingers because they often approach close to the induction coil. In preliminary resistance heating, the fingers also act as conductors for the current.

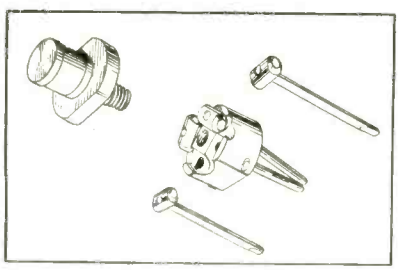
In the design evolved for the purpose, set screws pressing against each of the four tungsten fingers lock the irregularly shaped sample in place. The radial movement of each tungsten finger is obtained by a T-bar pivot construction.

Stainless steel was used for all parts except the fingers, which are of 0.90-inch-diameter ground tung-





Sample holder with silicon in tungsten fingers



Parts of holder, showing T bar sockets

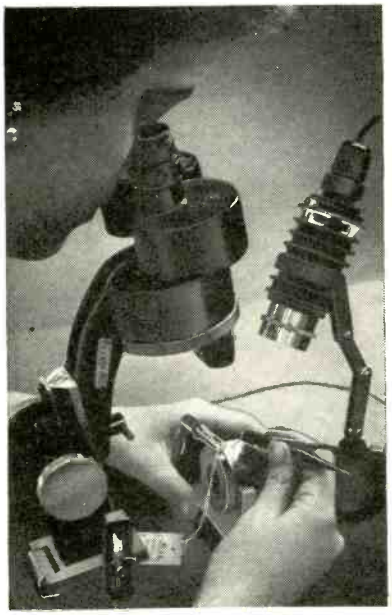
sten rod 1½ inches long. The body of the holder is ¾ inch in diameter and the pivots are made of $\frac{3}{16}$-inch-diameter rod.

Some of the characteristics of this design are open construction which is desirable for high-vacuum applications, ease of assembly which facilitates cleaning of parts and metal-to-metal contact of the components which improves cooling of the tungsten fingers.

The feature of grasping an irregular sample by adjustable fingers could be used in other applications such as surface analysis. The fingers may be of varying lengths and may alternatively be constructed of nonmetallic materials, such as quartz.

Spot Welder Makes Tap on Single Turn of Wire

IN SPOT-WELDING tap connections at Helipot Corp., South Pasadena, California, skilled workers use binocular microscopes in conjunction with a new technique in spot welding the very fine electrical connections. This technique assures that tap connections are attached to a single turn only of the resistance wire, rather than to several adjacent turns as is often the case with conventional methods. Thus the high resolution, important



Setup for welding wire lead for tap to single turn of resistance wire inside housing, by working through drilled hole in housing while observing operation through microscope. Lead is held in tweezer-type welding electrode

to the proper functioning of a precision potentiometer, is not reduced. None of the wire turns adjacent to the one tapped are shorted out.

Buffing Picture Tubes

SCRATCH marks on the faces of television picture tubes are removed economically, quickly and with no operator fatigue by using a Stow B50 flexible shaft machine in the plant of CBS-Hytron. This transmits one horsepower to the buffing pad while the motor rests on a bracket up out of the way. A half-inch flexible shaft six feet long, with a five-to-one reduction angle head gives a buffing speed of 690 rpm. The machine is made by Stow Manufacturing Co., Binghamton, New York.

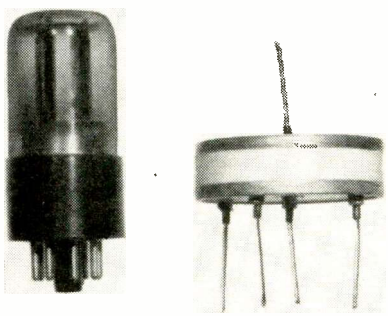
Buffing face of picture tube to remove scratches

Ceramic Twin-Triode Pumping Technique

NEW high-reliability developmental ceramic tubes comparable to the 6SN7 are sealed without using exhaust tubulations, in a Government-sponsored Eimac program concentrating on smaller tubes. An end disk of the tube is automatically brazed to the ceramic envelope inside the vacuum chamber after

pumpdown with heavy-duty pumps.

From appearance, it is difficult to recognize the resulting design as a vacuum tube. The flat cylindrical shape resembles more that of a pill box. Flexible leads are provided because the inherent reliability is expected to permit soldering the tube permanently into a circuit. The tube is at present still in a pioneering stage at the San Bruno, Calif. plant of Eitel-McCullough, but the



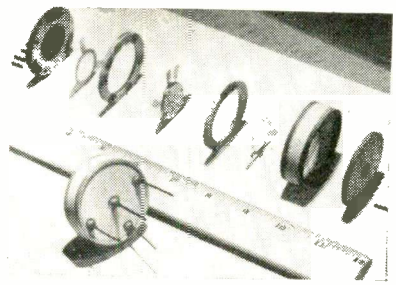
Comparison of conventional 6SN7 twin-triode with ceramic equivalent

ideas embodied in its design are believed to be fundamentally sound.

In the new ceramic twin-triode, ceramic end disks comprise the anodes. Grids and cathode are separated by ceramic spacer rings, all assembled in stacked relationship in a confining ceramic envelope cylinder. The grids are made by a photographic electroforming process for accurate high-speed production. The cathode button contains a packaged heater which is a structurally integral part of the unit. Since the heater is integrally formed, it cannot move or vibrate. All of the parts, including the electrode supports, are brazed solidly in position. Spot welds have been eliminated.

The stacked construction was selected because it permits assembly without requiring skilled operators. It is also ideal for automatic machine assembly operations, that also being one of the objectives of our program.

The stacked construction illustrated is a basic design, adaptable for a variety of tube types. Eliminating the grids gives a twin-diode. Inserting more grids gives a twin-tetrode. While a twin structure has been illustrated, this stacked structure is adaptable for the commoner single-unit tubes such as diodes and triodes. In some



Exploded view of ceramic twin-triode. From left to right, parts are anode disk, frame grid, ceramic spacer, cathode, ceramic spacer, frame grid, ceramic envelope and other anode disk. Base of complete tube shows in foreground

designs the disk at one end of the tube supports the cathode and the disk at the other end forms the anode, thus providing a simple diode. This basic diode may then be expanded into a triode, tetrode or pentode simply by stacking in the requisite number of grids. Certain tube parts, not unlike building blocks, are therefore common to a variety of tube types.

The proposed method of pumping these tubes is of interest. There is no exhaust tubulation on the tube. All parts are assembled and brazed together except one of the end wall disks. The exhaust then takes place in a vacuum chamber, while the end disk is held separated from the main body of the tube, providing a wide opening for withdrawal of gas. Exhaust problems associated with restricted pumping tubulations are thus avoided. As a final step, the end disk is lowered and brazed in place while the tube is still in the vacuum chamber. Many tubes can be exhausted simultaneously in this manner.

Bakeout and exhaust at 650 C is permitted because of the absence of glass and other low melting point materials. Flash getters are eliminated.

Induction Bonding Cuts Cost of Stripping Stranded Wire

NEWLY developed induction heating units for bonding stranded wire during the cutting and stripping operation have been studied by engineers of The William Brand & Co., Willimantic, Conn.

After induction heating and prior to the cut and strip operation, it is

important to quench the plastic with a wet sponge or some similar cooling method to obtain a clean strip. It is also important to use die type cutting blades and not V type since the latter has a tendency to destroy the bond by untwisting action.

Consistent bonding can be obtained, but the tin coating flows into the interstices of the stranded wire (which is necessary to obtain the bond). Even with double-dipped tinned wires, in general it is necessary to dip-solder the cut and stripped wires to obtain a good soldered termination because there is insufficient tin remaining. Despite this, the machine is a significant cost reducer in eliminating twisting before soldering and in easing the problem of handling cut and stripped wires without danger of flaring the conductor.

In those operations where it has been found that induction heating bonded well and yet retained sufficient tin without the need to solder-dip, it was noted that:

(1) The dial setting should be advanced only to the point where the tin coating is grayish or similar to a tarnished silver appearance. The dial should not be advanced to the point where the tin coating becomes dark.

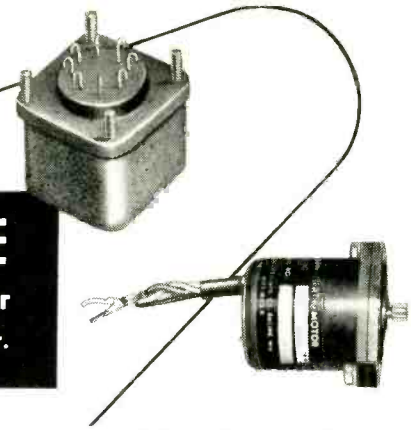
(2) The termination operation should be done within 6 to 8 hours after the cut and strip operation.

(3) The traditional aspiration to have a bright tinned appearance of the stripped wire prior to termination will have to be discarded. It has been noted that with the grayish or tarnished silver-like finish it is still possible to get a good termination without solder dip.

(4) Though double tinning is not an industry standard and might present procurement problems, it does seem to indicate some slight advantage over the single or standard tin coating. Double tinning also presents the disadvantage of higher cost than standard coating.

(5) Double or heavy tinned stranded wire shows more consistently favorable performance.

Close control of the extrusion process in insulating the wire is an extremely important factor contributing to successful use of this induction bonding technique.



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NEW PRODUCTS

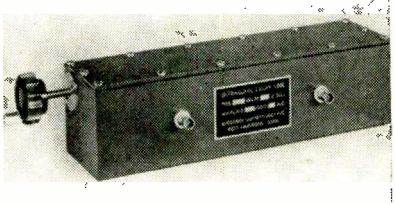
Edited by WILLIAM P. O'BRIEN

67 New Products and 25 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS featured in this issue:

DELAY LINE
has wide variation range

ANDERSEN LABORATORIES, INC., 39 Talcott Rd., West Hartford, Conn. In the delay line illustrated continuous variation of delay time is effected by rotary motion of a shaft. Variation can be as wide as 4 to 1 (as for instance, from 10 to 40 μsec) with practical extremes being 2.5 to 5 μsec and 20 to 75 μsec. Special features include wide



range, high stability (short-time jitter nonexistent) smooth, positive action, ruggedness and dependability. Carrier frequency is 15 mc; bandwidth, 3 mc; attenuation, 48 db; and dynamic range, 25 db. Complete details are given in bulletin 227.

NONMAGNETIC RELAY
has many applications

MULLENBACH ELECTRICAL MFG. CO., 2300 E. 27th St., Los Angeles 58, Calif. The Capaswitch is a sensitive, nonmagnetic relay utilizing an entirely new actuating principle. In place of the electromagnetic coil of ordinary relays, it uses an electrostrictive capacitive unit to cause transfer of the contacts. The Capaswitch invites a multitude of applications, some of which may require unusual circuitry. Consultation with the company's application engineers is welcomed. Nominal working voltage is 150 v d-c; maximum operating voltage, 175 v d-c, and Capaswitch test voltage, 500 v d-c. Contacts are spdt, 1 ampere at 125 v a-c (resistive load). Life expectancy is 300,000 operations minimum at rated contact load. A 4-page folder gives chief features, complete specifications, a dimensional drawing, 9 of its applications and a special circuit.

MILLIVOLT METERS
for aviation research

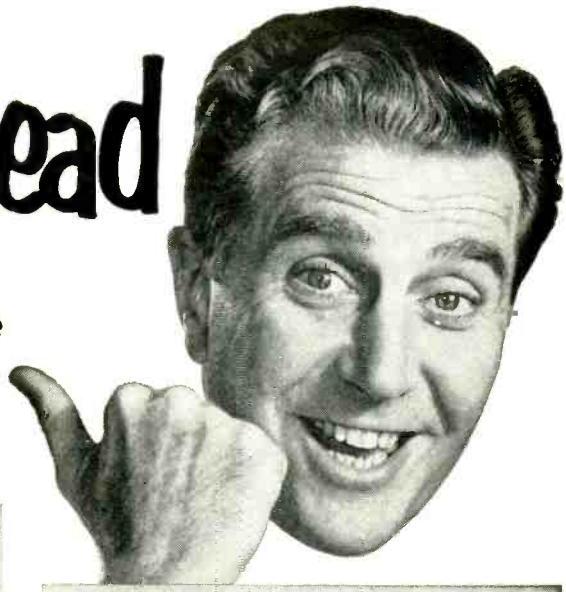
MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y., has developed a new series of d-c millivolt meters covering a voltage range of 100 μv to 1 kv, at 6 megohms input impedance on the low ranges and 60 megohms on all ranges above 1 v full scale. They contain an accurately-tuned 120-cps d-c modulator which is driven from its own highly stable 60-cps R-C tuned oscillator. The MV-17CP unit illustrated is designed for 400-cycle operation. The meters are available as portable models

and in rack-mounted form, also with or without facilities for operation as highly stable d-c amplifiers. In the latter case they have a gain of 1,500 and a d-c drift of less than 50 μv referred to the input circuit over long periods of time. They may be used over a wide power supply frequency range extending from 40 to 500 cps.

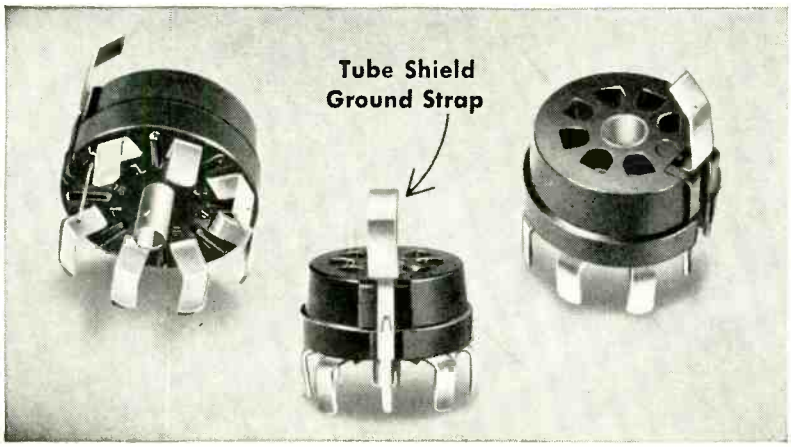
C-BAND WAVEMETER
covers 3,500-6,500 mc range

AMERAC, INC., 116 Topsfield Rd., Wenham, Mass. Model 230 C-band wavemeter is a coaxial-line type

Big Savings Ahead

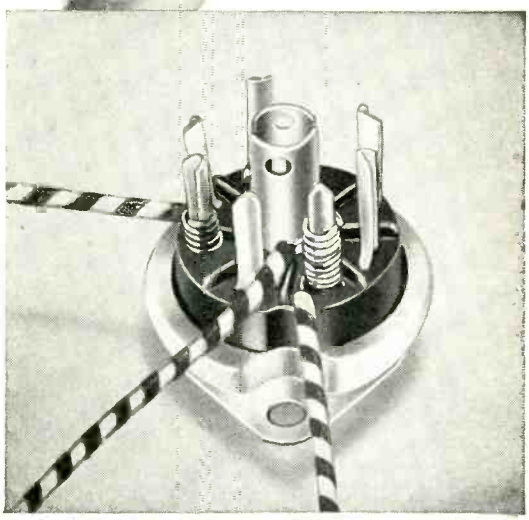


2 New SYLVANIA SOCKETS save Assembly Time... Cut Costs ...Improve Performance!



1. New Sylvania 7-pin Miniature Printed-circuit Sockets. Contacts and center shield are shaped so that sockets can be stacked one upon another for automatic feeding and assembly. Small slots are used on the circuit board to receive the contacts, resulting in stronger chassis construction. Only one socket assembly need be stocked since terminals can be interconnected by printing the circuit on the chassis board rather than using a metallic connector on the socket itself.

Insulator is molded of general-purpose or low-loss phenolic. Contacts are brass or phosphor bronze, plated to suit your specification. Supplied with or without center shield. Now available in 7-pin construction with 9-pin miniature and other types to follow. Tube Shield Ground Strap can also be furnished.



2. New Sylvania Solderless-type Sockets for wire-wrapped connections are now being made in all 7 and 9-pin miniature sizes. Contacts are shaped to provide reliable connections with the use of present wire-wrapping tools.

For full information *concerning these or other Sylvania parts, or special quality components engineered to your own specifications, write to Dept. 4A-1612, Sylvania today.*

See the full story of Sylvania's Fabricating Services in Sweet's Catalog—Product Design File. Look for 1b/Sy

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Building, St. Catherine Street, Montreal, P. Q.

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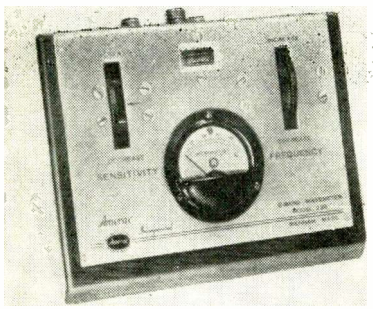
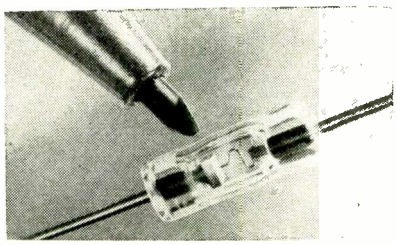


instrument covering the frequency range from 3,500 to 6,500 mc, by either the transmission or absorption method. Among its features are: (1) a precision-ground lead screw, which helps give a high accuracy of measurement; (2) a cavity body made from a solid block, precision-machined to close tolerances, giving extreme mechanical stability; (3) the use of Invar in the line displacement portion, affording a high frequency stability throughout the temperature range of 10 C to 40 C; and (4) tri-plating of all r-f surfaces. Power-handling capability by absorption method is from 0.5 mw to 1 w maximum; by transmission method, from 1 mw to 25 w (peak power). Approximate loaded Q is 2,500. Net weight of the unit is 4¾ lb.

GERMANIUM DIODES

with tiny gold junction

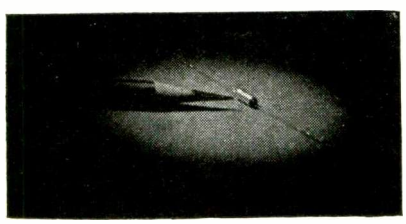
HUGHES AIRCRAFT CO., Florence Ave. at Teale St., Culver City, Calif., has available a new line of subminiature germanium diodes employing a miniature gold junction. Their high forward conductance with high back resistance properties make them particularly



suitable for such applications as magnetic amplifier circuits, clamps, d-c restorers and logical gates. They are manufactured with a fusion-sealed, one-piece glass body, impervious to external contaminating agents. Actual size of the diode body is 0.265 in. long × 0.130 in. wide, maximum. Dumet leads are tinned, easy to solder or spot-weld.

TINY ELECTROLYTICS

use tantalum as anode

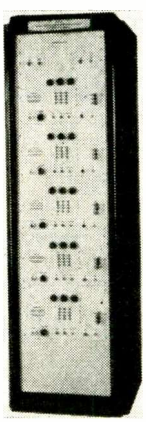


SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. The Tantalex capacitors are ideal for low voltage applications where they provide relatively large values of capacitance in a minimum of space. Use of tantalum as the anode gives them unusual stability of performance. Only ⅛ in. in diameter × $\frac{5}{16}$ in. long, they are ideal for bypass, coupling and filter applications in low voltage transistor circuits. Other uses include transistor hearing aids and military amplifiers. Operating temperature range is −20 to +65 C, with outstanding resistance to severe humidity.

INTERVAL GENERATOR

for research and testing

POTTER INSTRUMENT CO., INC., 115 Cutter Mill Rd., Great Neck, N. Y. Model 3157 multiple-sequence megacycle preset interval generator provides a convenient means of generating a series of preset time delays adjustable in increments of 1 μsec. Typical applications include multiple-sequence control of high-speed camera systems and radiographic units for use in firing ranges and destructive testing facilities. The system includes a 1-mc crystal-controlled master oscillator that feeds one or more preset counters capable of producing an output pulse any desired number of



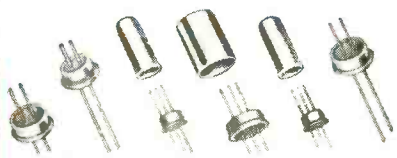
counts (microseconds) after application of a start pulse. Each counter is set to the desired number of microseconds (up to 999) by means of front panel selector switches. For sequential intervals or extended delays, the output of one counter may be used to start another. Provisions are made for using the equipment as a multiple-channel interval timer. The model illustrated has five separate timing channels.

TRANSDUCERS

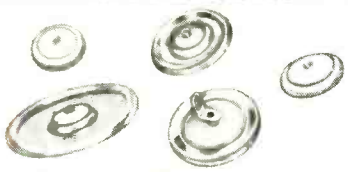
for sensing linear motion

MINATRON CORP., 14 Cliveden Place, Belle Mead, N. J. A new line of linear motion displacement transducers, featuring minimum size and high sensitivity, is now available in

Let E-I eliminate your HERMETIC SEALING PROBLEMS

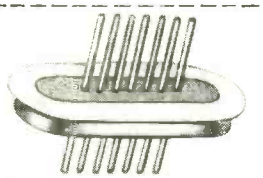


1. Transistor and diode assemblies available with cans

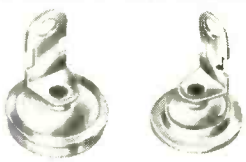


2. Stra n-free end seals for condeners, resistcrs, tubular assemblies

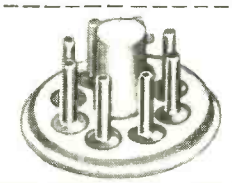
3. Single wire compression type miniature sealed terminals



4. Miniature sealed header with cushioned glass construction



5. Lug type, lead thru insulators for voltages from 2,000 to 4,000 (rms.)



6. Octal headers with solid metal blanks for high mechanical strength

7. Super durable compression headers offer maximum shock resistance

E-I Standardization Rigidly Controls Quality... Lowers Costs... Speeds Deliveries

Precision quality hermetically sealed terminals and miniature closures are mass produced by EI in hundreds of standardized designs. Economical standard catalog items are available in a wide range of types offering electrical and mechanical characteristics that solve all but the most unusual circuit requirements. Where applications require modifications or completely new custom components, these can be supplied quickly and economically in reasonable quantities.

- ✓ MINIATURIZATION
- ✓ CUSHIONED GLASS CONSTRUCTION
- ✓ MAXIMUM RIGIDITY
- ✓ VACUUM TIGHT SEALING
- ✓ HIGH DIELECTRIC STRENGTH
- ✓ VIBRATION RESISTANT
- ✓ SUPER DURABILITY
- ✓ DESIGN STANDARDIZATION
- ✓ FAST DELIVERY IN QUANTITY

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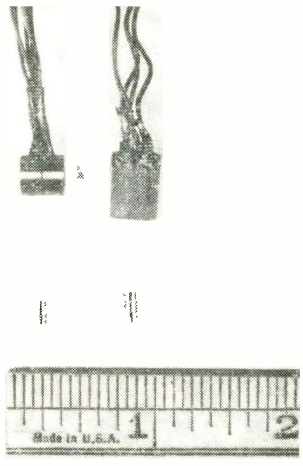
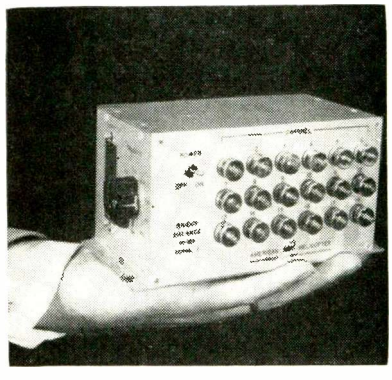


32 models with linear displacement ranges from 0.003 in. to 2 in. Lyn-A-Syn transducers are highly accurate and sensitive inductive components for precise sensing of rectilinear motion. Operation of the units is based on the linear change in flux linkage between the primary coil and secondary coils with displacement of the high-permeability metal core. The large range of available models allows the systems engineer to select units designed for power frequency or medium audio-frequency operation, and at input voltages of 0.5 to 10 v. Physical size of the Lyn-A-Syn models ranges from 15/64 in. o.d. × 15/64 in. long for the 0.003-in. linear displacement unit to ¾ in. o.d. × 9½ in. long for the 2-in. linear displacement unit. The photograph shows a 0.005-in. magnetically shielded unit, and a 0.010 standard miniature model.



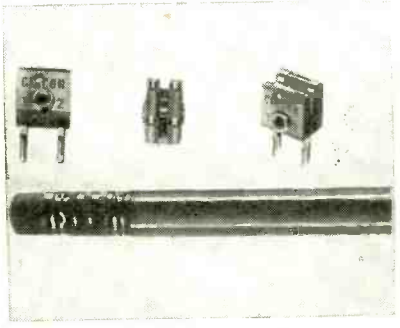
BRIDGE BALANCE has 18 channels

AMERICAN HELICOPTER, Div. of Fairchild Engine and Airplane Corp., 1800 Rosecrans Ave., Manhattan Beach, Calif. Model BP-18A is an 18-channel bridge balance

with provisions for controlling the electrical balance, sensitivity and calibration of resistance bridge sensing devices, such as strain gages, accelerometers and pressure pickups. It weighs only 2.4 lb. and its overall dimensions are 7⅛ in. × 3½ in. × 3½ in. Ten-turn potentiometers with shaft locks are employed for circuit balancing. Calibration resistors are accurate to within ±0.1 percent, operating over a −40 F to 200 F temperature range with a temperature coefficient of 0.00002 per deg C. Model BP-18A is ideally suited for use in aircraft and guided missiles flight instrumentation as well as a laboratory instrument.

VOLTAGE REGULATOR
for aircraft systems

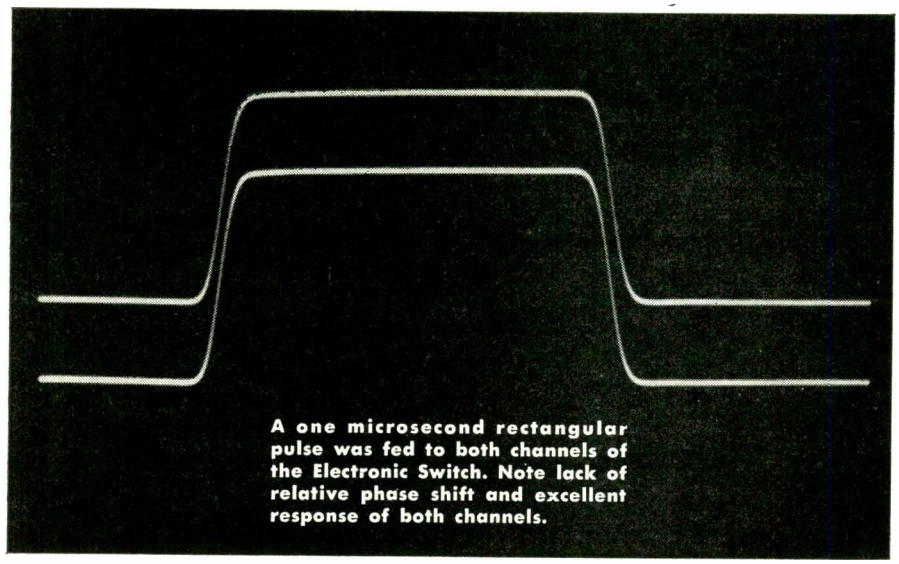
RHEEM MFG. CO., 9236 East Hall Rd., Downey, Calif. The REL-11 subminiature voltage regulator is designed for missile or aircraft instrumentation systems. It regulates within 0.1 percent for load variations of ± 25 percent and input variations of ± 20 percent. The output is 100 to 150 v d-c at 100 ma. Dimensions are 4.7 in. × 2.8 in. × 1.3 in., and it weighs 7 oz. The voltage regulator functions to specifications and is completely reliable while subjected to severe environmental conditions.



TINY CONNECTOR
for printed circuit use

CIRCON COMPONENT CO., 17544 Raymer St., Northbridge, Calif. The SM4F116 subminiature multiple circuit connector weighs less than 0.8 gram (about 1/40 oz) and is less than 0.03 cu in. in volume. It is usable in both printed circuit and

Convert to Dual Channel Operation in the Range of DC to 15 MC



A one microsecond rectangular pulse was fed to both channels of the Electronic Switch. Note lack of relative phase shift and excellent response of both channels.

... using any Single-Channel Oscillograph with the

NEW DU MONT TYPE 330 ELECTRONIC SWITCH

The new Du Mont Type 330 Electronic Switch is a self-contained accessory for oscillography that permits . . .

1. Converting *any* single-beam oscillograph into a dual-channel instrument.
2. Adding a channel to any multi-channel instrument.
3. As a chopper, converting an a-c oscillograph for d-c measurement.

Within the range of DC to 15 MC, the Type 330 is limited only by the characteristics of the cathode-ray oscillograph being used.

This is the answer to those studies requiring comparison between two or more functions. Maximum time shift between the channels of the Type 330 is within one millimicrosecond. Both channels may be adjusted for unity gain making it a simple matter to superimpose two phenomena for very precise time, phase or amplitude comparison.

Three free-running switching rates, 1KC, 10KC and 100KC, or triggered operation allow selection for best presentation on the cathode-ray oscillograph. The Type 330 can be connected into a test setup or disconnected as the need arises.

MAJOR SPECIFICATIONS

SIGNAL CHANNELS

I. Sinusoidal Frequency Response: with an output load of 60 uuf, either channel, flat to d.c. and down not more than 3 db at 15 mc.

II. Amplifier Rise Time: with external load of 60 uuf, no greater than 0.022 usec.

III. Variable Attenuator: Each channel has two series stepped attenuators with attenuation ratios of 1, 2, 4, 10, 20, 40, 100, 200, and 400; accuracy of attenuators ± 2%.

IV. Output: Level is zero volts d.c. with no signal or positioning voltage; positioning controls provide ±1 volt of d.c. positioning voltage.

SWITCHING

I. Recurrent: Free-running, fixed frequencies of approximately 1 KC, 10 KC and 100 KC; Triggered, rate may be triggered at 0 to 100 KC rates.

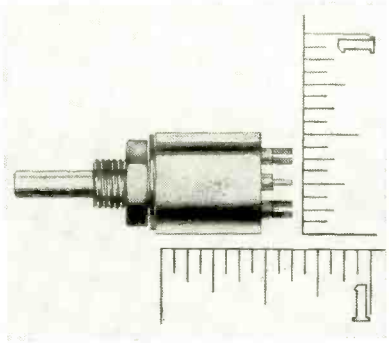
PRICE **$295**

WRITE FOR COMPLETE INFORMATION

DU MONT

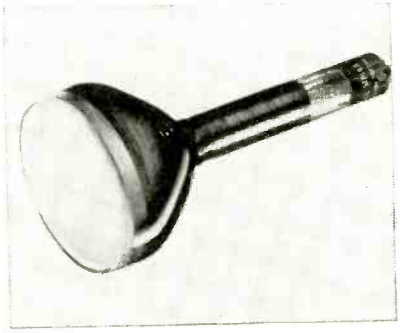
ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
760 BLOOMFIELD AVENUE • CLIFTON, N. J.

conventional cabling applications. This 4-contact connector permits side-by-side and end-to-end mounting of any desired combination with a rated maximum load of one ampere per contact. The open-end feature allows accomodation of straight edges of any size printed circuit without special shapes or fabrication. It will connect independently to both sides of a circuit and is particularly adaptable to transistor circuits.



TINY PRECISION POTS
are wire-wound units

ACE ELECTRONICS ASSOCIATES, 125 Rogers Ave., Somerville 44, Mass. Model No. 500 Acepot is a new standard in subminiature wire-wound precision potentiometers. The unit illustrated features $\frac{1}{2}$-in. diameter, special precision winding equipment and assembly process, use of new materials and techniques for the lowest dielectric constant and power factor; extremely low torque; and availability in threaded bushing, servo or tapped hole mountings.



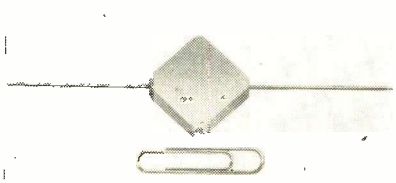
FIVE-INCH CRT
for radar applications

GENERAL ELECTRIC Co., Syracuse, N. Y., has announced a new 5-in. cathode-ray tube for radar applica-

tions. It has a high-resolution electron gun providing an exceptionally narrow trace on the screen. The tube, type GL-5FP14-A, has a maximum line width limit specification of 0.25 mm. The decrease in line width, or spot size, means that target identification will be aided considerably. The tube is all-glass, employs magnetic focus and deflection, has a 53-deg deflection angle, and has a medium-long persistence phosphor. Typical operating conditions are: anode voltage, 5,000 v d-c; grid No. 2 voltage, 250 v d-c; grid No. 1 voltage (for visual extinction of focused undeflected spot), −25 to −70 v d-c; spot position, 9 mm; typical line width A, 0.009 in.

R-F POWER AMPLIFIER
for missiles and aircraft

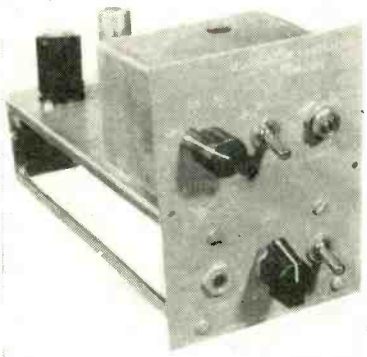
RHEEM MFG. CO., 9236 East Hall Rd., Downey, Calif. The miniature r-f power amplifier, REL-09, is currently being used in missile and aircraft instrumentation systems. The unit utilizes an Amperex 6360 tube, tunes from 215 to 235 mc, provides 10-w output and weighs only 12 oz. Operating voltages are: B + 250 v d-c; filaments, 6.3 or 12.6 v, and bias −45 v d-c. The unit will function properly and be completely reliable when subjected to severe environmental conditions.



TOROID COIL
encased in epoxy plastic

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif., is producing a new postage-stamp toroid coil consisting of a subminiature molybdenum permalloy toroid core with a winding having a residual hole as small as 1/16 in. Windings are impregnated with a special compound and the finished coil is encased in a tough epoxy

plastic. Tinned No. 20 Awg wire leads are provided and the coil may be handled and mounted in the manner of its counterpart, the postage-stamp mica capacitor. Dimensions are $\frac{13}{16}$ in. × $\frac{13}{16}$ in. × $\frac{3}{8}$ in. thick. It is available in any inductance up to 1 henry. Useful frequency range covers 1,500 cps to 150 kc, dependent upon the inductance value. The unit can withstand temperatures from −55 C to +125 C, plus extreme environmental conditions. These coils are also available in the unencapsulated form with the winding ends exposed for making direct connections. Unencapsulated dimensions are only $\frac{5}{8}$ in. o.d. × $\frac{5}{32}$ in. thick.



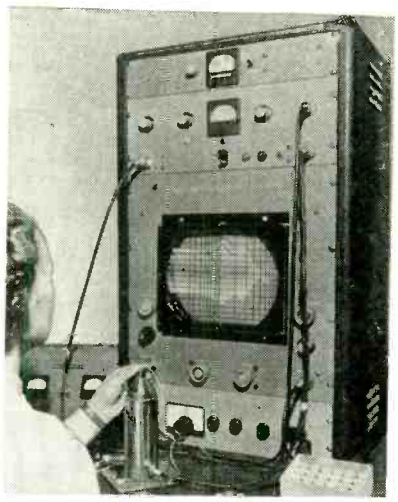
AMPLITUDE MODULATOR
for use with magnetic tape

ALLEGANY INSTRUMENT CO., 1000 Oldtown Road, Cumberland, Md., announces a new amplitude modulator for use with magnetic tape in the frequency range of d-c to 5 kc which is amplitude modulated by 50 kc. This signal in turn modulates the tape and has the advantage of greatly reduced cost over f-m systems. Input sensitivity is 1 mv.

MODULATOR
for microwave spectroscopy

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. The Stark modulator provides a referenced high voltage, and a variable frequency square wave to be applied to the waveguide electrode containing gas under test. The square-wave modulation facilitates the viewing of the Stark effect in microwave spectroscopy by

supplying a high voltage waveshape capable of working into a capacitive load which is presented by the Stark cell. The output level is continuously variable from 10 v to 1,000 v peak to ground over the frequency range of 50 to 30,000 cps and is monitored by a 2-percent-accuracy direct-reading voltmeter. Either sine-wave or pulse input may be utilized in driving the modulator.



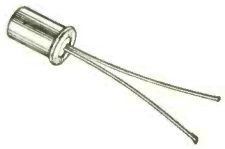
A-F CURVE TRACER
features 12-in. crt

MAICO CO., Minneapolis, Minn., has introduced a new audio-frequency curve tracer that can cut testing time in half. It features a giant 12-in. c-r tube instead of the 5-in. tube in common use. The device is used for research, quality control and production line testing of receiver, loudspeakers, microphones, filters, transformers and other partial or completed audio assemblies. Chief advantage of the curve tracer is the extra ease of visibility, enabling the operator to get a fast, accurate picture of the frequency response of the unit under test.

PICTURE TUBE
with 17-in., 90-deg deflection

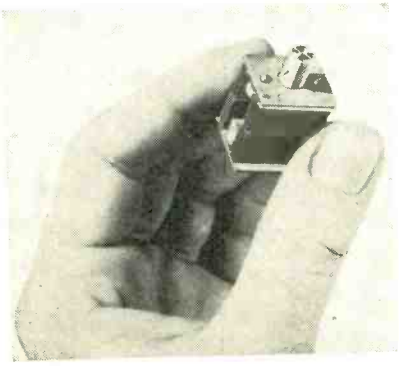
WESTINGHOUSE ELECTRONIC TUBE DIV., Box 284, Elmira, N. Y., has available a new 17-in. tv picture tube. An improved bulb design permits 90-deg deflection and a weight reduction of 5½ lb with a resulting overall length reduction of approximately 3 in., compared to previous

17-in. models. Two new tube types (17ATP4 and 17ATP4-A), are available. Both are electrostatic focus, directly viewed picture tubes of rectangular glass construction. Both tubes have external conductive coatings. The 17ATP4-A has an aluminized screen for increased picture brightness.



SILICON DIODES
use *p-n* junction structure

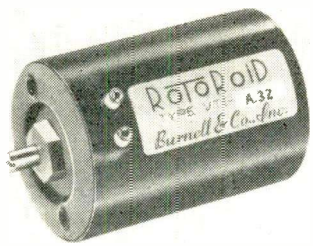
NATIONAL SEMI-CONDUCTOR PRODUCTS, Evanston, Ill., has available a line of silicon diodes employing a *p-n* junction structure. They are characterized by excellent stability, extremely low reverse current, moderate to heavy forward conductance and a sharply defined low impedance breakdown region in the reverse direction which occurs at a particular applied voltage termed the Zener voltage. Internal contacting is a shock tested alloyed junction that will withstand military as well as commercial usage.



VARIABLE CAPACITOR
for tiny receivers

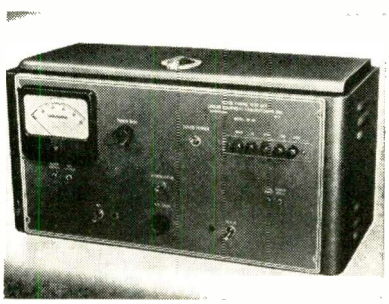
MCCOY ELECTRONICS Co., Mt. Holly Springs, Pa., has developed a Mini-Dual variable capacitor for subminiature receivers and subminiature transmitters. Dimensions, exclusive of shaft, are $\frac{13}{16}$ in. $\times \frac{11}{16}$ in. $\times 1\frac{1}{16}$ in. Capacitance range is up to 385 μμf per section, with at least 10 to 1 ratio from maximum

to minimum. Both rotors and both stators are isolated for flexibility of circuitry. Other specifications include: shaft diameter, $\frac{3}{16}$ in. or $\frac{1}{4}$ in.; standard shaft length, $\frac{3}{8}$ in.; weight, only $\frac{1}{2}$ oz.



TOROIDAL INDUCTOR
is continuously variable

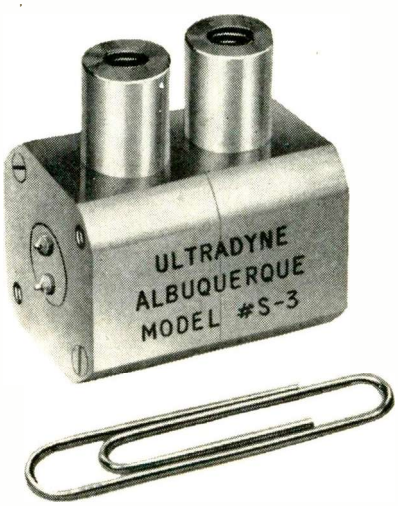
BURNELL & CO., INC., 45 Warburton Ave., Yonkers 2, N. Y. The RotoRoid continuously variable toroidal inductor is stepless and employs no mechanical resistance contacts and is therefore free of noise and wear. It provides a 3 to 1 range of maximum-to-minimum inductance in 180-deg rotation of a shaft, and at maximum inductance provides the full Q of the toroid it contains. RotoRoids are hermetically sealed and are virtually vibration and shock proof. They can be chassis or panel mounted. Uses include tunable audio oscillators, variable impedance devices, adjustable selective networks, variable phase shift networks, variable filters, servo systems and telemetering.



TEST SET
for noise figure measuring

LINEAR EQUIPMENT LABORATORIES, INC., Brightwater Place, Massapequa, L. I., N. Y. Model HF-20 noise figure test set comprises a wideband amplifier, built-in 3-db attenuation network, detector and output

indicator, and necessary electronically regulated power for both amplifier and most tuners. Introduction of attenuation does not affect selectivity. It permits uniform, consistent measurements of noise factor, and observation of tuner r-f selectivity.

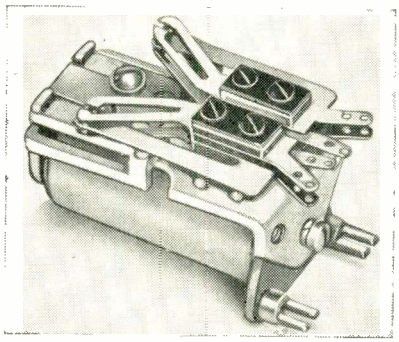


PRESSURE TRANSDUCER
has 50-μsec rise time

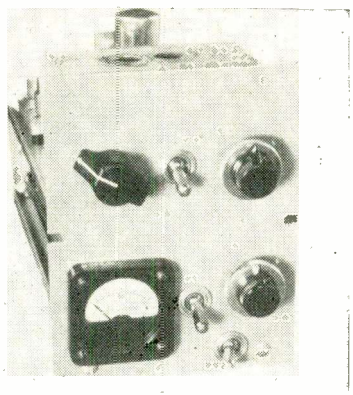
ULTRADYNE ENGINEERING LABS., INC., P. O. Box 8007, Albuquerque, New Mexico. Model S-3 pressure transducer operates on the variable reluctance principle and is suitable for use with a wide variety of recording and telemetering systems. It is especially suited for transient and h-f pressure measurements. The gage has such features as 50-μsec rise time, 1-percent or less nonlinearity, 0.1 to 0.4-percent hysteresis, 0.03-percent-per-g acceleration sensitivity and 0.01-percent-per-deg F zero shift with temperature. It weighs 2 oz and is $\frac{3}{4}$ in. × $\frac{3}{4}$ in. × $1\frac{1}{16}$ in. in size.

TINY RELAY
with bifurcated contacts

MAGNECRAFT ELECTRIC CO., 1448 W. Van Buren St., Chicago 7, Ill., announces development of miniature relays with bifurcated (twin) contacts for reliable switching of extremely low voltage and low current. Flexibility of the long bifurcated contact springs enables the twin points to make contact inde-



pendently, thus permitting one point to make contact, even when the other is blocked by dust or grit. Bifurcated contacts are available with series 22 relays, for a-c or d-c, in open types, as well as with a wide selection of hermetically sealed and dust-tight enclosures. Literature is available on request.



D-C AMPLIFIER
used with oscillographs

ALLEGANY INSTRUMENT CO., 1000 Oldtown Road, Cumberland, Md. Model 306 d-c amplifier is designed for use with galvanometer oscillographs. These amplifiers employ electronic inversion of d-c and subsequent amplification on a-c amplifiers. They may be employed either for strain gage or thermocouple work. Packaging is for 19-in. rack. Power unit may be supplied for either 24 v d-c or 110 v, 50 cycle.

SSB FILTER
is fixed tuned and compact

BURNELL & CO., INC., Yonkers 2, N. Y. The S-16000 single sideband filter is designed for use in applications where upper sideband

operation is preferred. It may be installed in any existing amateur receiver or in a new design. It also can be used for reception not only of ssb but of regular a-m signals. The new filter uses toroidal coils of high Q instead of costly crystal elements, to provide a narrow-band sharp cutoff response which insures maximum intelligibility and maximum signal strength. It is fixed tuned, requires no adjustment, and is compact, hermetically sealed, rugged and trouble-free. Price is $40. These filters are designed to be used in a 50-kc second i-f amplifier. With normal tuning, sidebands as much as 3,000 cps above the carrier are passed with not more than 3-db attenuation, the carrier is attenuated 15 db, and the sidebands 200 cps or more below the carrier are attenuated at least 30 db.

POTENTIOMETER
and millivolt source

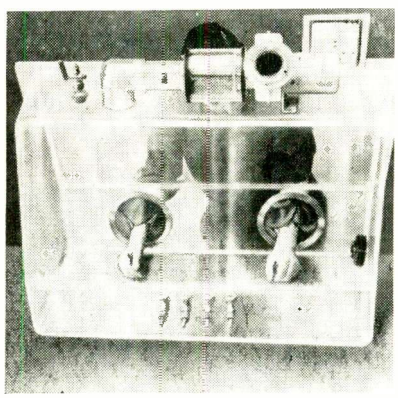
ALLEGANY INSTRUMENT CO., 1000 Oldtown Road, Cumberland, Md. Model P-55 is a miniaturized potentiometer and millivolt source. Small size and light weight make it truly a portable instrument. The input is dual, with an internal switch. The overall range is 0 to 50 mv and the smallest reading is 0.01 mv. Battery life is guaranteed to be two years.

THYRATRON
has high control ratio

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y.,

Want more information? Use post card on last page.

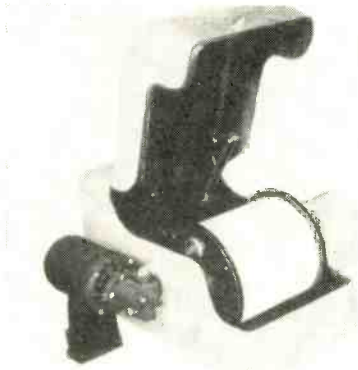
has broadened its line of thyratron tubes with the addition of type AX5727, a ruggedized version of the standard type 2D21. The AX-5727 is designed for relay and servo-control applications where reliability of operation and mechanical ruggedness are important. It is an inert gas filled thyratron with negative control characteristics. It has a high control ratio, which is stable over a wide temperature range, and features low grid-anode capacitance and low grid current. The heater-cathode construction is made to withstand the rigorous requirements of intermittent operation.



DRY BOX
for lab and industry

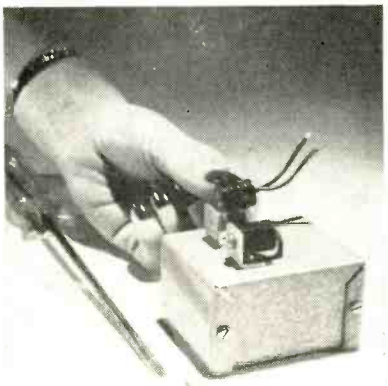
P. M. LENNARD CO., INC., 671 Bergen St., Brooklyn 38, N. Y. Illustrated is a rear view of the new low cost 15-lb portable controlled-atmosphere dry box showing the new sealproof hand entry diaphragms. The box can be hermetically sealed in 30 seconds. A relative humidity electronic circuit controls r-h to a constant 1.0 percent. It is made of heat, chemical

resistant transparent plastic, and mass produced with standard air-lock, filter system to control dust to 1 micron, glove assembly, and the like.



DRUM CAMERA
with 2,400-ips film speed

ALLEGANY INSTRUMENT CO., 1000 Oldtown Rd., Cumberland, Md., announces a new series of rotating drum cameras having 6-in. and 12-in. diameter drums. A film speed of 2,400 ips is available in the model 912. This instrument may be used for multichannel recording at cro's, the movement of a spot of light reflected from the mirror of a string galvanometer or a Bourdon tube. The movement of objects in motion may also be recorded.



POWER TRANSISTOR
for any l-f circuit

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh 30, Pa. A combination of mounting and physical design has made possible the 1-w rating of this new ger-

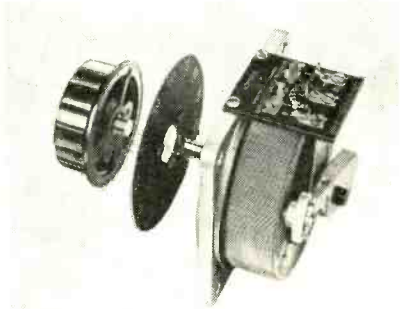
manium power transistor. The black, ribbed surface provides cooling capacity for the 1-w collector dissipation rating. Additional cooling is accomplished by fastening the unit in thermal contact with the chassis as shown. The new pnp-type transistor (2N71) will be applicable to any low-frequency circuit, such as class A amplifiers, where output power is desired.

SATURABLE REACTORS
for use in computers

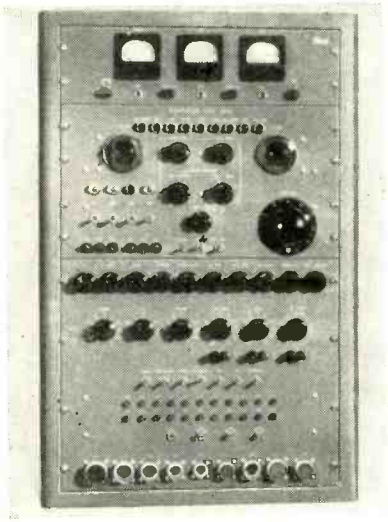
SNYDER LABORATORIES, 601 Chapel Ave., Merchantville 10, N. J., announce a series of Magnestats, small saturable reactors to control pulse or sine wave power ranging from microwatts to deciwatts at frequencies from 100 kc to 20 mc. They are as stable as transformers, do not depend on resonance, and the control and the controlled circuits are electrically independent. Magnestats are made for use in computers and similar complex systems as amplifiers, gates, flip-flops, switches and arithmetic elements. For example, type AH25 is an amplifier which operates on 15-mc power. It will drive two other similar amplifiers with a signal rise time of less than 0.5 μsec.

AUTOTRANSFORMERS
for 350 to 1,200-cps use

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Higher power frequencies, used in aeronautical and marine equipment, call for voltage controls designed specifically for the requirements of



these services. The types M-2 and M-5 Variac autotransformers are rated at 2 and 5 amperes respectively for 115-v, 350 to 1,200-cycle input. Output range is 0 to 115 or 0 to 135 v depending on connections. For 0 to 115-v connection maximum output currents are 3 and 7.5 amperes. Two-gang and three-gang assemblies for multiple-circuit as well as 3-phase controls are available in addition to single units, and special requirements can also be considered where standard models are unsuitable.



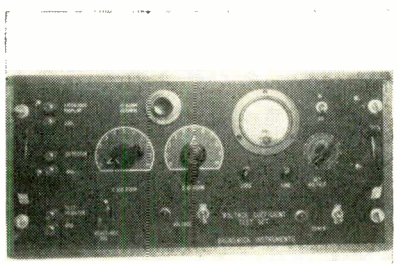
COMPUTER TEST UNIT
for flight data

CAL-TRONICS CORP., 11307 Hindry Ave., Los Angeles 45, Calif., has designed and manufactured the flight data computer test unit illustrated. It gives a detailed test of every individual circuit and provides means for a complete alignment simulating all other units of a radar fire control system. The unit is used for production, hangar

and flight-line tests of a complex airborne analog ballistics computer. Full information may be found in bulletin CT-54.

R-F FILTER
for screen rooms

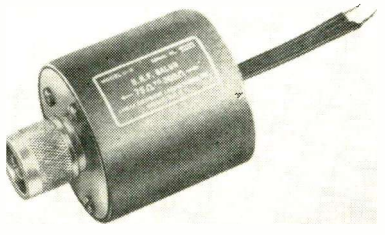
MICAMOLD RADIO CORP., 1087 Flushing Ave., Brooklyn 37, N. Y., is manufacturing a radio interference filter for use in the power feed lines entering shielded enclosures or screened rooms. This r-f filter is rated at 100 amperes up to 600 v d-c or 250 v a-c at frequencies from 0 to 400 cycles. Maximum attenuation is provided from 10 kc through 1,000 mc and beyond. From less than 100 kc up to 1,000 mc the attenuation exceeds 100 db; at 14 kc it is about 40 db.



TEST SET
measures voltage coefficient

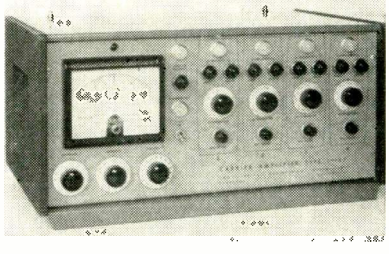
BRUNSWICK INSTRUMENTS, P. O. Box 813, New Brunswick, N. J., has available a test set that provides a rapid and reliable measurement of the voltage coefficient for composition resistors and will find application in the study of resistor materials and geometry, contact behavior and semiconductor phenomena. The unit can be used for inspection and quality control of resistors and similar components. The instrument operates on the principle that the nonohmic nature of a material or resistor (that is

voltage coefficient), will result in the generation of current harmonics when an alternating voltage is applied. The apparatus applies an adjustable voltage to both a specimen under test and a standard variable linear resistor. The measured harmonics can be directly correlated to voltage coefficient.



UHF-VHF BALUNS
in four new types

LINEAR EQUIPMENT LABORATORIES, INC., Brightwater Place, Massapequa, L. I., N. Y. New additions to the company's line of baluns now extend the range covered. Model V-6A is designed to match an unbalanced 50-ohm source to a balanced 300-ohm load with negligible loss and good balance efficiency over the frequency range from 50 to 220 mc. The V-6B is similar, but designed for a source impedance of 75 ohms. Model U-2A matches a 50-ohm unbalanced source to a balanced 300-ohm load over a frequency range from 450 to 900 mc. The U-2 is similar, but designed for a source impedance of 75 ohms.



CARRIER AMPLIFIER
is ± 1 percent accurate

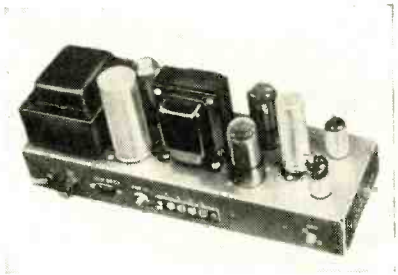
CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif., has introduced a 4-channel carrier amplifier which has a flat frequency response from 0 to

3,000 cycles. The type 1-127 amplifier is particularly useful in the aircraft and guided missile fields for reproducing outputs of resistance or reluctance type transducers in the frequency range of 0 to 3,000 cycles. The instrument contains a regulated power supply, a 20-kc oscillator, 4-carrier amplifiers with associated bridge balancing and demodulator circuits, control and metering system and a calibrating system. For nominal amplifier sensitivity, a 1-mv modulation signal causes full-scale output of ±50 ma. The amplifier is provided with a gain control to adjust for full scale when an input of 1 mv is applied with any source impedance from 60 to 1,000 ohms. Amplified accuracy is ±1 percent for modulating frequencies from 0 to 3,000 cycles.

POWER SUPPLY
has outstanding stability

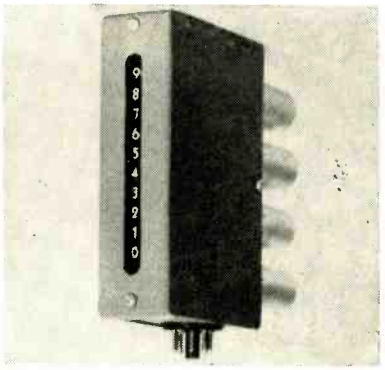
KEITHLEY INSTRUMENTS, 3868 Carnegie Ave., Cleveland, Ohio. Model 2204A regulated voltage supply offers outstanding stability, compact size and a wide range of test potentials. Line regulation of the new supply is within 0.01 percent; output, zero to 1 ma. Six taps of 500, 250, 100, 50, 25 and 10 v are furnished, accurate within 2 percent. In addition, the potential can be continuously varied from 5 to 500 v. A polarity switch is provided, so that the test voltage can be either positive or negative. Also included is a zero-output switch, permitting connections to be made while the instrument is on, and facilitating the timing of measurements. The new supply is used in measuring

ultrahigh resistances, furnishing excitation voltage to photocells and ion chambers, and supplying a buck-out potential for precise voltage measurements by the null method. It is also useful separately as a stable test potential in checking d-c amplifier gains and in calibrating meters.



TEN-WATT AMPLIFIER
for high fidelity

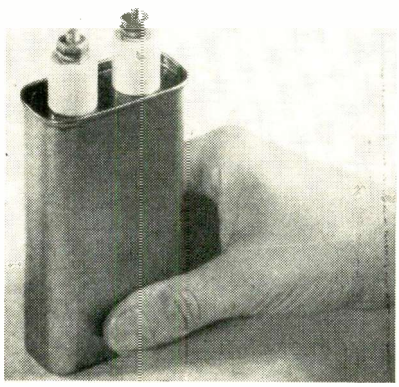
FREED-EISEMANN, 200 Hudson St., New York 13, N. Y., has produced a new 10-w amplifier for high-fidelity reproduction. Model 910 Williamson type linear amplifier features a frequency response of 20 to 30,000 cycles at ± 1 db. The total harmonic distortion is less than 0.5 percent at full rated output. Hum and noise level is 80 db below the rated output. Specially designed output transformers are constructed with grain oriented steel laminations and interleaved windings. The model 910 chassis measures only 13 in. × 4¼ in. × 5⅝ in.



DECIMAL COUNTERS
available in two types

ADVANCE ELECTRONICS CO., INC., 451 Highland Ave., Passaic, N. J., has available types 100A and 100B decimal counting units. They are

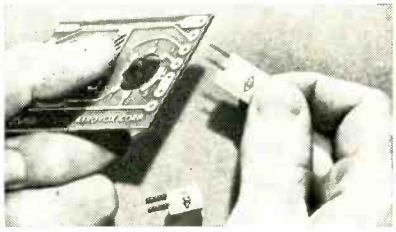
direct-reading plug-in electronic counters. Each unit counts the number of input pulses from 0 to 9; the 10th pulse resets the counter to 0 and at the same time produces an output pulse. The number of pulses applied to the input is indicated by the illumination of one of the ten neon bulbs installed behind a numbered plastic front panel. To increase counting capacity a number of these decimal counters may be connected in cascade with the output of one unit fed to the input of the next unit. Type 100A is used for counting from 40 kc to 0 cps. The 100B is used for counting from 100 kc to 0 cps. Both have identical power requirements, 6.3 v at 1.2 amperes and 300 v at 15 ma. Input signal for both must be at least 100 v; rise time, 1 μsec or shorter; and duration, 2 μsec or longer. Resolution time is 5 μsec for both types. Arrangement is provided for zero reset. Output pulses of either type are adequate to trigger another type 100A.



CAPACITORS
in drawn rectangular cases

GENERAL ELECTRIC CO., Hudson Falls, N. Y., has announced new fixed paper-dielectric capacitors in drawn rectangular cases, which are designed to give greater protection against leakage than fabricated cases. Elimination of soldered seams in the drawn can provides the added protection. These capacitors for motor, industrial control, filter, luminous-tube transformer, and other a-c or d-c applications were previously available in drawn cases, but only in oval styles. Features of the new capacitors include welded bushing studs, welded taps, high-

purity aluminum foil, low-loss Kraft paper, and Pyranol dielectric. The new units are available in capacitance ratings of 0.05 μf to 16 μf and voltage ratings of 400 v to 12,500 v d-c and 236 to 660 v a-c.



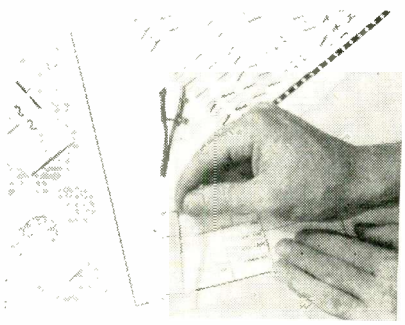
PRECISION RESISTOR
for automation purposes

CINEMA ENGINEERING CO., Division Aerovox, Burbank, Calif. The series PW precision wire-wound resistors are designed especially for printed wiring assembly technique and automation. Entirely encapsulated in an epoxy resin, they meet requirements of humidity protection and aging presently met only by resistors under MIL-R-93A. Simplification in design is featured in both subminiature and larger models. One feature is a key moulded along the length of the resistor to allow for the necessary indexing and registration on the printed wiring. Other outstanding technical points include the latest in low temperature wire and very light weight, with the smallest resistor having a weight of but 1 gram, capable of dissipating 0.1 w. Other units vary in weight to 1 oz., capable of dissipating 1 w.

CAPACITORS
are h-v glass-cased type

GUDEMAN CO., 340 W. Huron St., Chicago 10, Ill., offers a new hermetically-sealed h-v d-c glass cased

GC type line of paper dielectric capacitors. The GC line has improved electrical characteristics, is smaller in size and lighter in weight than present conventional types. Reduction in size and weight is primarily a function of the high dielectric strength characteristic of impregnant No. 258 and the high creepage path proferred by thermal glass tubing. Operating temperature range of GC 45 series and GC 46 series is from −55 C to + 105 C No voltage derating is necessary up to 85 C. At 105 C, the maximum applied voltage recommended for continuous operation is 75 percent of the rated voltage. Insulation resistance at 25 C is 10,000 megohm-μf minimum but need not exceed 20,000 megohms. At 85 C, insulation resistance is 100 megohms-μf minimum but need not exceed 1,000 megohms. At 105 C, insulation resistance is 30 megohms-μf minimum but need not exceed 300 megohms.



DRAFTING AIDS
save time and effort

JOHNSON RESEARCH CORP., Bethpage, L. I., N. Y., has developed improved title blocks, technical symbols, etc., for use by engineers and draftsmen on drawings and tracings. They are known to industry as Transeals, a thin transparent printed plastic sheet with a pressure-sensitive adhesive coating that is protected by a removable waxed paper sheet. Transeals eliminate rubber stamps and the time-consuming hand lettering, symbol drawing and ruling usually required for engineering drawings on paper, vellum or cloth. Furnished for application to either the reverse side or the face of drawings, Transeals are easily applied by slight hand pressure without the use of

heat, and can be conveniently stored for future use. The company will set type, rule lines, and prepare all kinds of symbols according to individual customer's specifications. Samples will be sent on requests written on a company letterhead.

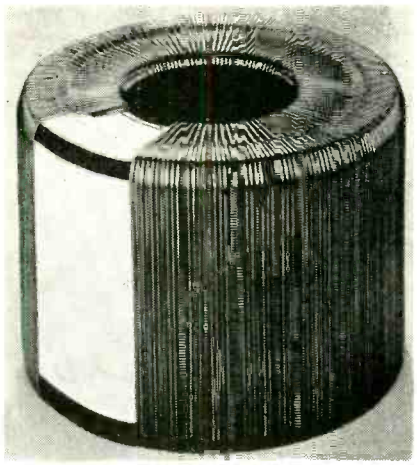
AMPLIFIER PENTODES
for high-fidelity audio

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., has announced two new amplifier pentodes designed especially for high-fidelity audio sound systems. Type 6CA7 (25-w plate dissipation) and type EL84 (12-w plate dissipation) are designed to deliver high power without drawing control grid current.

D-C SUPPLY
is a tubeless unit

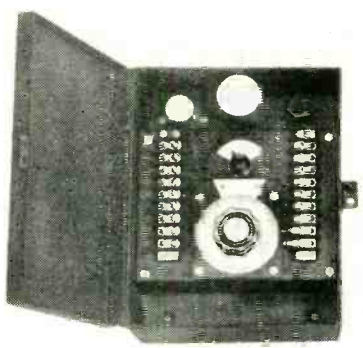
SORENSON & CO., INC., 375 Fairfield Ave., Stamford, Conn. Model MA65 magnetic amplifier d-c supply is compact, inexpensive, tubeless, designed particularly for telephone and telegraph systems, radio and tv applications. Input is 105 to 125 v a-c, single phase, 60 cycle. Out-

put is 6 v d-c, adjustable ± 10 percent. Load range is 0 to 5 amperes. Ripple is 1 percent maximum.



BANKED WINDING
for variable transformers

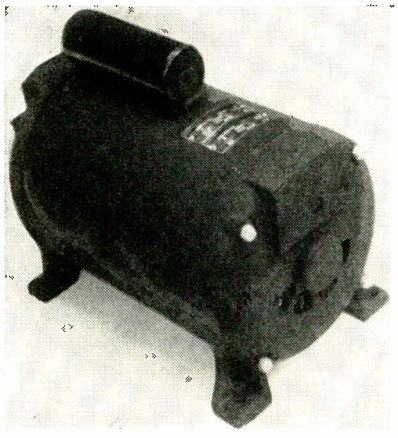
REX RHEOSTAT CO., 3 Foxhurst Rd., Baldwin, L. I., N. Y. An attachment for automatic toroidal winding machines is now available to wind variable transformer cores with banked winding without using knurled guiding plates.



ELECTRONIC TIMER
with 1-percent accuracy

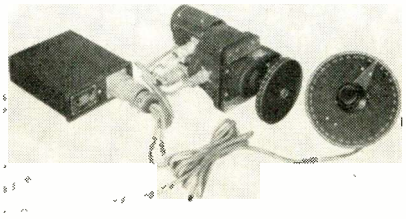
FERRARA, INC., 8106 W. Nine Mile Road, Oak Park 37, Mich., announces a new precision general purpose electronic timer with 1-percent accuracy for interval timing, timed delay, repeat cycling, programming or pulsing. Because of unique circuit design the T2 timer is designed for use on process timing, sequence control of automated equipment, induction heating equipment, conveyors, machine tools, injection molding machines,

and packaging and filling machinery. Features include: 3 time ranges of 0.1 to 1 sec, 1 to 10 sec, and 10 to 100 sec; a direct-reading time dial; and 2 spdt load contacts with 8-ampere rating. A 4-page technical brochure is available.



MOTOR-ALTERNATOR
is highly portable

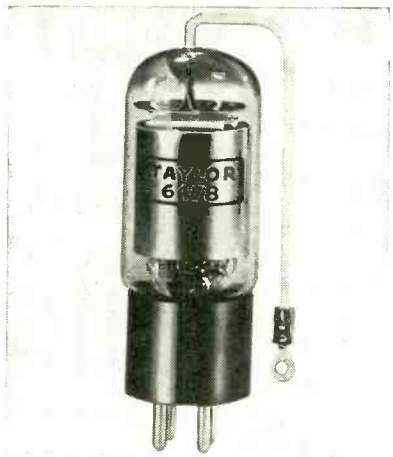
ELECTRIC MOTORS AND SPECIALTIES, INC., King and Hamsher Sts., Garrett, Ind. Model SA-40 is a 420-cps synchronous motor-alternator. It features two-bearing construction and 60-lb weight for high portability. Applications include lab test equipment, servos, electronic controls, indicating systems, photographic devices, recorders, actuators and computers.



REMOTE POSITIONER
extends servo usefulness

LEAR, INC., Grand Rapids 2, Mich. The Electrolink remote positioning system extends the useful power range of electric servomechanisms in both the aviation and industrial fields. Because of relative control inefficiency and high weight per-unit-power, electric servos have hitherto been limited to low-power applications whenever h-f response

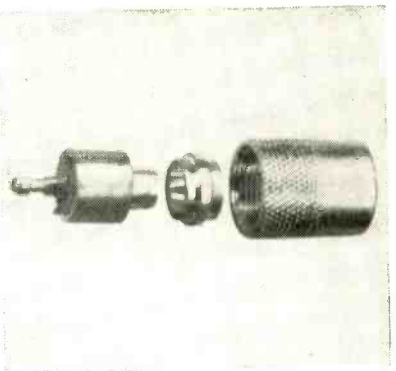
was required. For remote control systems requiring higher torque output, it had been necessary to rely on hydraulic servomechanisms. The Electrolink brings the advantages of electric servo operation to many remote positioning applications previously considered beyond the scope of such systems. The three components of the remote positioner are an electric amplifier, a transmitter autosyn and a magnetic-powder-clutch servo-drive with integral receiver autosyn. Power required is 115 v, single-phase, 400-cycle; and 28 v d-c. All components meet applicable USAF and Navy specifications for airborne use. Accuracy is within 0.25 deg for most loads, with h-f response retained over the entire output range. The system of contrarotating magnetic powder clutches is the key to the high positioning speed and accuracy of the Electrolink.



XENON THYRATRON
for airborne operation

TAYLOR TUBES, INC., 2312 Wabansia Ave., Chicago 47, Ill. The 6478 xenon thyratron meets the exacting electrical and mechanical requirements for reliable airborne operation at high altitudes. Its small size and flexible anode lead make it ideal for applications where space is limited. The tube has a maximum operating voltage of 1,500 v a-c. Continuous anode current is 1.5 amperes and the continuously recurring peak anode current is 20 amperes. Filament current is 7 amperes at 2.5 v. The type 6478 features a maximum deionization

time of 80 μsec. Ambient temperature limits are −75 C to + 85 C. Maximum cathode warmup time is 15 sec. Hard glass construction makes the tube applicable in high shock installations. Maximum physical dimensions are 4⅞ in. long, 1⅝ in. in diameter. The anode lead has a maximum length of 4½ in. with a closed No. 6 lug.



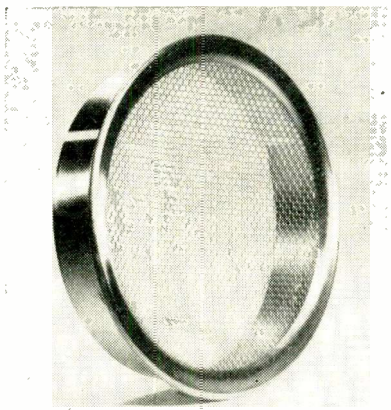
COAX CONNECTOR
is completely solderless

ENTRON, INC., 4902 Lawrence St., Bladensburg, Md. A new coaxial cable connector offers several features that recommend its incorporation in communications and tv equipment. Of interest to designers particularly is its electrical reliability, high mechanical strength and effective shielding, the latter obtained by a radial grounding contact. Quickly and easily installed, completely solderless, it offers as a principal feature time-saving efficiency.

MARINE RECEIVER
has improved selectivity

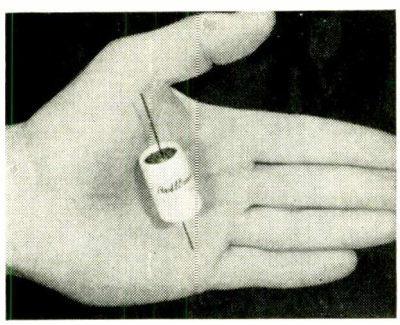
MARINE DIVISION OF MACKAY RADIO AND TELEGRAPH CO., INC., an associate of American Cable & Radio Corp., 67 Broad St., New York 4, N. Y., has available a general-purpose, 5-band superheterodyne communication receiver covering the frequency ranges from 35 to 500 kc and 1.9 to 24 mc. Its ultra-sharp selectivity enhances reception of c-w signals in the presence of intense static and interfering transmissions. Type 3007-A marine receiver is entirely self-contained with panel-mounted loudspeaker.

It is designed to operate from 115 v, either a-c or d-c. The double-conversion oscillators are thoroughly shielded to reduce radiation of energy from the receiver antenna well below the permissible maximum specified by the FCC.



COPPER LOUVERS
available in many designs

MIDGET LOUVER CO., Norwalk, Conn., has introduced a new line of copper louvers as an addition to its line of push-in type, circular aluminum louvers. They are available in 1, 1½, 2, 2½, 3, 4 and 6-in. sizes. They should interest manufacturers of electronic equipment where midget louvers provide ventilation and moisture-vapor control for instrument and other type casings. Installed on radio transmission sets they prevent picture interference on adjacent tv receivers.



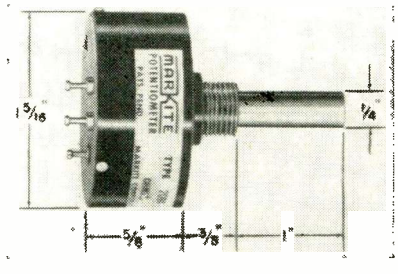
THERMAL TIME DELAY
is tiny and inexpensive

BELLTRON MFG. CO. INC., 6th and Fulton St., Elizabeth, N. J. The miniature thermal time delay illustrated is meant to fill the gap where a very low-cost time-delay unit is

desired and where ambient thermal and humidity conditions are not beyond average. It is designed around a radically new and different heater element permitting an overall body size ⅜ in. diameter × 1¼ in. long. Its appearance is similar to that of a paper-wound capacitor. Cost is no more than for a standard capacitor of similar size. Factory-set time delays, from 2 to 60 sec, can be supplied with operating voltages of 6.3 v to 110 v a-c or d-c. Standard contacts are rated at 2 to 5 amperes with higher ratings available on special order. It has spst circuits only—normally closed or normally open. The heater element can be had in parallel with contacts, as illustrated, or a 3-wire model can be supplied for separate heater connection.

TV PICTURE TUBE
for compact receiver design

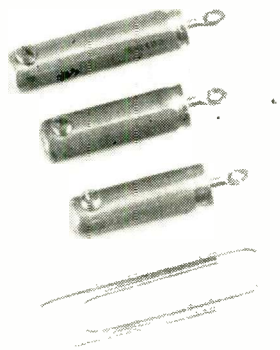
SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., has announced a new, 90-deg magnetic deflection, 17-in., glass tv picture tube, with an overall length of only 15⅝ in. The 17AVP4 is an all-glass, rectangular type with a grey spherical face. It is not aluminized. The tube is electrostatically focused and requires a single field ion trap magnet. It is supplied with external conductive coating. Its length, 3¾ in. shorter than previous 17-in. types, makes the tube well suited to compact receiver designs.



POTENTIOMETER
features high resolution

THE MARKITE CORP., 155 Waverly Place, New York, N. Y. Type 2094 rotational potentiometer is designed for applications where long life, substantially infinite resolution and

low noise under extreme vibration and acceleration are essential. It carries a life guarantee of 5 million revolutions at 600 rpm or less. The active element is a solid resistance track of conductive plastic which is integrally co-molded to terminals, taps and a rigid supporting phenolic insulator plastic. Standard resistance values of 2,000 to 100,000 ohms with linearity of ± 1.0 percent or ± 0.5 percent are available.



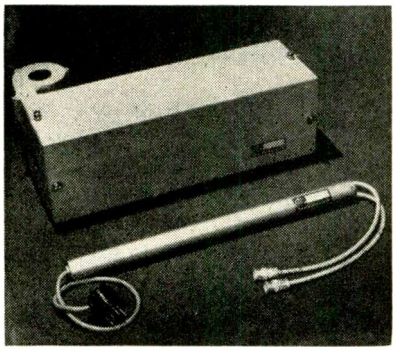
SEALED THERMOSTAT
has fast response time

CHATHAM CONTROLS CORP., 110 Summit Ave., Chatham, N. J., announces an adjustable hermetically-sealed thermostat that is rugged, exceptionally small in size and has extremely fast response time. Sealed in a brass tube with a glass-to-metal base, this thermostat can be used as a nonhermetic unit and still be completely resistant to corrosion, fumes and dirt. Three models are available, all ¼ in. in diameter, featuring different lengths, depending on internal construction. These lengths vary from $\frac{33}{32}$ in. to $\frac{15}{16}$ in. exclusive of terminal. Temperature ranges from −65 C to + 150 C and have 0.5 deg or less temperature differential at the thermostat. Non-inductive load up to 5 amperes at 27.5 d-c may be handled. Its 110-v rating is 0.5 ampere.

TIME CALIBRATOR
is compact and portable

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J. Type 300 compact, portable, crystal-controlled time calibrator is designed to check a great variety of instruments that employ time bases,

or incorporate timing functions. A 10-mc sine wave, and five sharply peaked pulse outputs having repetition rates variable in decade steps from 1 μsec to 10 millisec are provided by the instrument. The accuracy at any repetition rate selected is within 0.1 percent. Either 3-v positive or 30-v negative pulse outputs may be selected. Synchronizing signals of 100 cps, and 1, 10, and 100 kc rates are also available at front-panel jacks enabling accurate triggering of oscillographs or other devices at desired rates regardless of timing pulse-rate selected. In addition, the type 300 serves as a shaper for external signals, transforming signals of any wave shape, fed to the unit, into sharp pulses at the same frequency. Calibration pulses may be thus obtained from external frequency standards in the range of 100 cps to 1 mc.



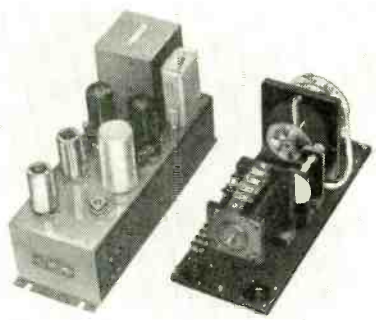
T-W AMPLIFIER TUBE
for S-band medium power use

HUGGINS LABORATORIES, INC., 711 Hamilton Ave., Menlo Park, Calif., has announced a new broadband S-band medium power amplifier developed to deliver 1-w output with 1-mw input from 2 to 4 kmc without resorting to any electrical or mechanical tuning procedures. The tube finds its greatest application where wide bandwidth and medium power output are required. These applications include use as a power amplifier to raise the output of milliwatt signal generators in microwave measurement techniques and as a driver amplifier in system applications. With the addition of a grid it becomes useful as a medium power modulator. Approximate operating characteris-

tics over this band are 30-db gain, 1-w output, and 25-db noise figure. It requires a 600-gauss field and a 1,200-v regulated power supply.

SSB FILTER
priced at $195

KAY ELECTRIC CO., Pine Brook, N. J. For generation of ssb tv signals the company offers a vestigial sideband filter, which, used in conjunction with their Mega-Pix or with any other tv r-f carrier generator, passes upper and rejects lower sideband of any one vhf tv channel. It is known as the Telefilter and has the following features: flatness—better than ±7 percent over the 4.5-mc band; lower sideband discrimination—adjacent sound, 20 db down; adjacent picture, 35 db down; insertion loss—less than 10 db; characteristic impedance—nominal 75 ohms. It is available for any single channel from 2 to 13, inclusive. Price is $195.



SERVO MULTIPLIER
driven by d-c data

INDUSTRIAL CONTROL CO., Wyandanch, L. I., N. Y. The SL-1053 is a high-precision servo multiplier operating from the 60-cps line. Its basic action is to convert a d-c input variable into a shaft rotation. A precision potentiometer, driven by

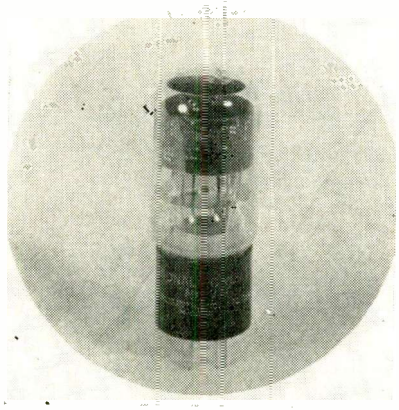
this shaft, performs the computation. Three 2-megohm summing inputs are provided to accommodate 1, 2 or 3 input variables. Overall accuracy is 0.3 percent; full-scale travel under 0.5 sec; response extends to 10 cps; and input zero drift is negligible. The SL-1053 finds wide application in research and development laboratories. It has been especially designed as a building block for the control equipment in automatic factories, in process control installation, nuclear energy reactor control and monitoring, and other industrial control applications.

T-W TUBES
for microwave radio use

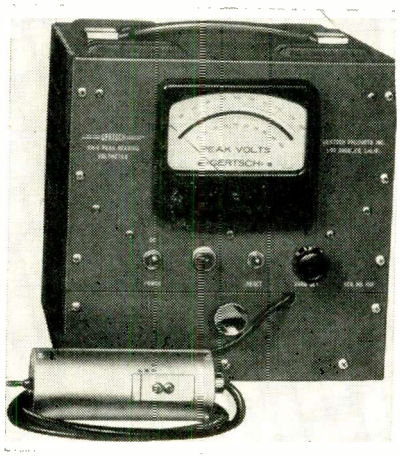
RADIO CORP. OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y., has developed two new types of low-noise traveling-wave tubes which promise greater efficiency, range and sensitivity in microwave radio applications. The t-w tubes are an S-band type, for use in the input stage of microwave receivers and amplifiers operating over a frequency range from 2,700 to 3,500 mc, and a C-band type, for use in microwave relay applications covering the frequency range from 5,900 to 6,900 mc. Their low noise advantages result from utilization of a novel three-region velocity-jump electron gun which de-amplifies shot noises in the tubes. The S-band tube will operate in a solenoid with a noise figure less than 10 db for a gain of 20 db; the C-band type, which utilizes a waveguide feeds, has a noise figure of only 12 db, with a 20-db gain.

THYRATRON TUBE
for industrial control

NATIONAL ELECTRONICS, INC., Geneva, Ill., has announced a new single-end thyratron. This tube, designated as the NL-716, is rated at 1 ampere d-c and 8 amperes peak current. It is designed especially for motor speed control and low current regulated voltage supplies. The NL-716 is gas and mercury filled for quick-starting and long



life. Its constant characteristics through wide temperature ranges and long life make it particularly valuable for industrial control applications. Other ratings are: filament voltage, 2.5 v; filament current, 6.3 amperes; peak forward and peak inverse voltage, 1,250 v.



VTVM
for short duty cycle pulses

GERTSCH PRODUCTS, INC., 11846 Mississippi Ave., Los Angeles 25, Calif. A portable, true-peak reading vtvm is capable of measuring pulses with very short duty cycles. Designed to operate over a wide bandwidth—50 cps to over 100 mc—the model VM-1 may be used to measure positive peak, negative peak, or the peak-to-peak voltage of a waveform. Voltage range of the VM-1 is 100 v full scale, with multipliers available to 30 kv, designed to permit rapid selection of voltage ranges. Actual measuring elements are housed in a probe. The circuitry in the VM-1 consists of a pair of diodes, housed in the probe, arranged so they give a positive d-c output voltage equal to the peak

positive, peak negative, or peak-to-peak voltage being measured. This voltage is fed to a stabilized feedback amplifier utilizing an electrometer tube which drives the indicating meter. All critical voltages are regulated.

Literature

Large Screen Oscilloscopes. Electromec, Inc., 3200 North San Fernando Blvd., Burbank, Calif. A 4-page folder covers the company's large-screen oscilloscopes. Included are illustrations and descriptions of the 21-in. and 17-in. types. Important features and specifications are given.

Tube Clamping Shields. International Research Corp., 177 W. Magnolia Blvd., Burbank, Calif., has available a complete 2-color catalog on miniature and subminiature electron tube clamping shields. A wide range of tube shield types and sizes are illustrated and keyed to appropriate dimensional engineering drawings. The catalog gives information on pure silver, Beryllium copper, alluminum alloy and special-purpose tube shields. Contents also include complete facts on the company's new low-cost series 100 and 200 tube clamp shields designed for use under average to high tube operating temperatures in most commercial applications.

Phase Meter. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y. A single-sheet bulletin illustrates and describes the model 200A Phazor phase meter, an instrument that is useful wherever precision phase measurements are necessary. The brochure lists applications, principle of operation, features and specifications.

Tubular Capacitors. Corson Electric Mfg. Corp., 540–39th St., Union City, N. J. The complete line of type G-6 tubular, glass-cased, plastic dielectric capacitors is described in the new catalog sheet just issued. Ratings listed range from 0.01 μf at 600 v through 0.0015 μf at 60,000 v. The units described are partic-

ularly useful where space is at a premium and for handling high voltages at high temperatures in d-c and low-frequency a-c circuits.

Compass System. Collins Radio Co., Cedar Rapids, Iowa. An 8-page folder covers the MC-101 compass system. Included are modern aircraft data requirements. Power requirements, installation information, dimensional diagrams, specifications and a block diagram are available.

Uranium Prospecting Instruments. El-Tronics Inc., Fifth and Noble Sts., Philadelphia 23, Pa. A 4-page folder covers a new line of Geiger counters designed primarily for prospecting applications. Illustrated descriptions and prices are are given for 9 different instruments.

Components Catalog. Herman H. Smith Inc., 2326 Nostrand Ave., Bklyn 10, N. Y., has issued 24-page reference book listing a complete line of plugs, jacks, connectors, switches, terminals, and hundreds of vitally needed electronic components and accessories. Exhaustive schematic dimensional diagrams throughout the book make this an important guide for the engineer as well as the purchasing agent. Catalog 55 lists some 50 new items including linen and nylon cable, nylon plastic cable clamps and Vibrex panel fasteners.

Facilities Folder. The Johns-Harford Tool Co., Inc., 390 Capitol Ave., Hartford, Conn., announce publication of a facilities folder and equipment lists covering their extensive precision contract manufacturing facilities. The company specializes in experimental and short run production work of extremely close tolerances and in the manufacture of precision components or subassemblies for instruments, turbo-jet engines, automotive, aircraft, electronic and other mechanisms.

Circuit Assembler. U.M.&F. Mfg. Corp., 10929 Van Owen St., North Hollywood, Calif. A single-sheet bulletin illustrates the See Zak circuit assembler for simplifying breadboard problems. All parts of

an introductory kit selling for $12 are pictured and numbered. Some of the advantages of the circuit assembler are listed.

Block Unitized Pulse Instruments. Electro-Pulse, Inc., 11811 Major St., Culver City, Calif., has available a general catalog on block unitized pulse instruments, and brochures on the model 2120A pulse generator, and model 2140A double pulse generator. Illustration descriptions, chief features and applications are included.

H-V Glass-Cased Capacitors. The Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A new 4-page catalog describes hermetically sealed h-v glass cased GC type paper dielectric d-c capacitors. Operating temperature of the units covered in bulletin GC-1 ranges from −55 C to +105 C. Data include explanation of catalog numbers, high altitude application, lead specifications, ripple voltage and complete engineering specifications. Illustrations consists of GC-45 series, GC46 series, dimensional drawings, and typical performance curves for power vs temperature, insulation resistance vs temperature and change of capacitance vs temperature.

H-F Generators. Electronic Processes Corp., 1078 San Antonio Road, Los Altos, Calif. Details on a new convertible Electrotherm high-frequency generator primarily designed for plastic welding and packaging machinery are given in a new leaflet, form G-554. The convertible feature of the generator described permits rapid conversion between two input power ratings of 2,000 and 4,000 d-c watts. Besides illustrating the unit, the leaflet includes application notes concerning the various welding length limitations related to power ratings; shows construction details of the sliding-drawer arrangement for subassemblies which permits convertibility and also facilitates service and maintenance. Specifications are tabulated to cover operating frequency, line power requirements, weights and dimensions.

Germanium p-n Junction Photo Diode. Transistor Products, Inc., 241 Crescent St., Waltham 54,

Mass. Form No. DS-54-1B covers the type 1N188 germanium *p-n* junction photo diode. The device described and illustrated is designed for use as a light detector in devices requiring high sensitivity particularly in the near infrared region. Mechanical specifications, electrical data and a typical characteristics chart are included.

Electronic Filters. Communication Accessories Co., Hickman Mills, Missouri, has available new technical data on its electronic filters. The information is largely on additions to the company's standard line of electronic filters. The literature illustrates the new units and describes the electrical characteristics, complete with response curves, physical sizes and mounting dimensions.

System Analysis with the Complex Plane Analyzer. Technology Instrument Corp., 531 Main St., Acton, Mass. Laboratory Report No. 11 discusses a simple network example and is the first in a series of 3 articles on system analysis with the complex plane analyzer. Articles two and three in this series discuss the complex plane analyzer and its methods of use and closed-loop systems, root locus and their relation to the complex plane analyzer. These will be available in the near future. They may be had for the writing.

Instrument Calibration Standard. Radio Frequency Laboratories, Inc., Boonton, N. J., has published a folder illustrating and describing the model 829 instrument calibration standard. Included is information on accuracy, reliability, operating procedure, accessory equipment and net price. Some typical instruments that can be calibrated with this equipment are listed.

Kits and Wired Instruments. Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y., has published its 1955 catalog describing and illustrating 38 kits and 42 factory-wired instruments. To enable the reader more readily and fully to understand the function and application of each instrument, the descriptions for each model are carefully analyzed into features,

specifications and applications. The catalog also describes the company's engineering laboratories, quality control department and other important facilities.

Systems Engineering. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Custom Engineering of electronic instrumentation tailored to specific industrial, scientific and military needs is the subject of a recently announced 16-page brochure. Case histories of typical instrumentation systems, applications, biophiles on key personnel, description of service facilities and methods of planning used to solve customer problems are features highlighted in the new publication. Write for bulletin CEC-1304.

Test Equipment. Radio City Products Co., Inc., Easton, Pa., announces a new multicolor brochure describing and illustrating the company's complete line of test equipment. It includes testers for color tv as well as black-and-white, together with many instruments for tube testing and servicing all radio and tv receivers. It also covers instruments for industrial applications in the electronic and related industries.

Vertical Subminiature Tube Holders. Atlas E-E Corp., Bedford Airport, Bedford, Mass., has available a bulletin describing a new line of precisely engineered vertical subminiature tube holders especially designed for application in printed circuitry and similar limited-space conditions, where it is necessary to hold tubes and components securely against shock and vibration. The tube holders discussed will hold up under 5-g vibration at 500 cycles.

Thermosetting Laminated Plastics. Synthane Corp., Oaks, Pa., has compiled a tabulation of the latest military and government specifications for NEMA grades of thermosetting laminated plastics has been compiled in chart form. The chart also describes the composition of the 24 grades of tubing, rods and sheet stock covered. The information contained in the government specification chart has proved particularly helpful to manufacturers of government-purchased equip-

ment, designers, engineers and purchasing men.

Voltage Regulator. Leach Corp., 4441 Santa Fe Ave., Los Angeles 58, Calif. A 4-page, 2-color bulletin No. T-8400 fully describes and illustrates a new type all static voltage regulator for 400-cycle a-c machines, named the INETRX400. The unit described is constructed of long-life magnetic amplifiers, rectifiers and resistors. The bulletin presents detailed specifications on construction, installation and operating characteristics. Included are photographs of oscillograms showing voltage recovery and stability, and output voltage waveform.

Sealed Panel Meter. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-color, 2-page engineering data sheet on round model 150 panel meter gives detailed specifications, actual size illustrations, outline drawings and ordering information.

Printed Circuit Data. Photocircuits Corp., Glen Cove, N. Y., has available eight technical bulletins, P-1 through P-8, dealing with various aspects of printed circuitry. Topics covered are: printed circuit design for ease in fabrication; base materials for printed circuitry; plating and plated holes; etched or plated conductor characteristics; printed components for etched circuits; printed circuit switch plates and commutator disks printed circuitry assembly and dip soldering; and printed wiring layout and design. Also available is an 8-page brochure covering printed circuits and allied electronic subassemblies. This lists special applications, tips for the designer, and outlines the company's facilities for technical services.

Bobbinless Precision Resistors. Monson Mfg. Corp., 6059 W. Belmont Ave., Chicago 34, Ill., has released a catalog page picturing and describing its new line of lower cost, smaller size bobbinless noninductive precision wire type resistors. Complete data include tolerances, sealing of ceramic tubes, resistance wire, terminals, and a table listing typical sizes and resistances available.

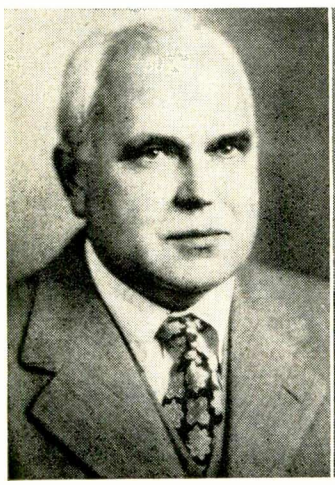
PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Engineers receive awards from technical societies . . . Electronic manufacturers promote engineers and management executives . . . New plant expansions are announced . . .

OTHER DEPARTMENTS featured in this issue:

IRE Names Annual Award Winners For 1955



Harald T. Friis

Arthur V. Loughren

Bernard Salzberg

Harold B. Law

HARALD T. FRIIS, director of radio research of Bell Telephone Laboratories, will receive the IRE Medal of Honor, the highest technical award in the radio engineering profession at the Institute's national convention next March in New York City. The award will be given "For his outstanding technical contributions in the expansion of the useful spectrum of radio frequencies, and for the inspiration and leadership he has given to young engineers."

The Morris Liebmann Memorial Prize, awarded annually to an IRE member who has made a recent important contribution to the radio engineering art, will be given to Arthur V. Loughren, director of research of Hazeltine Corp., "For his leadership and technical contributions in the formulation of the signal specification for compatible color television."

Bernard Salzberg of the Naval Research Laboratory will receive the Harry Diamond Memorial Award, which is given to persons in government service for outstanding work in radio and electronics. The award will be presented "For his contributions in the fields of electron tubes, circuits, and military electronics."

The Vladimir K. Zworykin Telesion Prize Award goes to Harold B. Law of RCA Laboratories Division for his contributions to the shadow-mask tri-color tv picture tube.

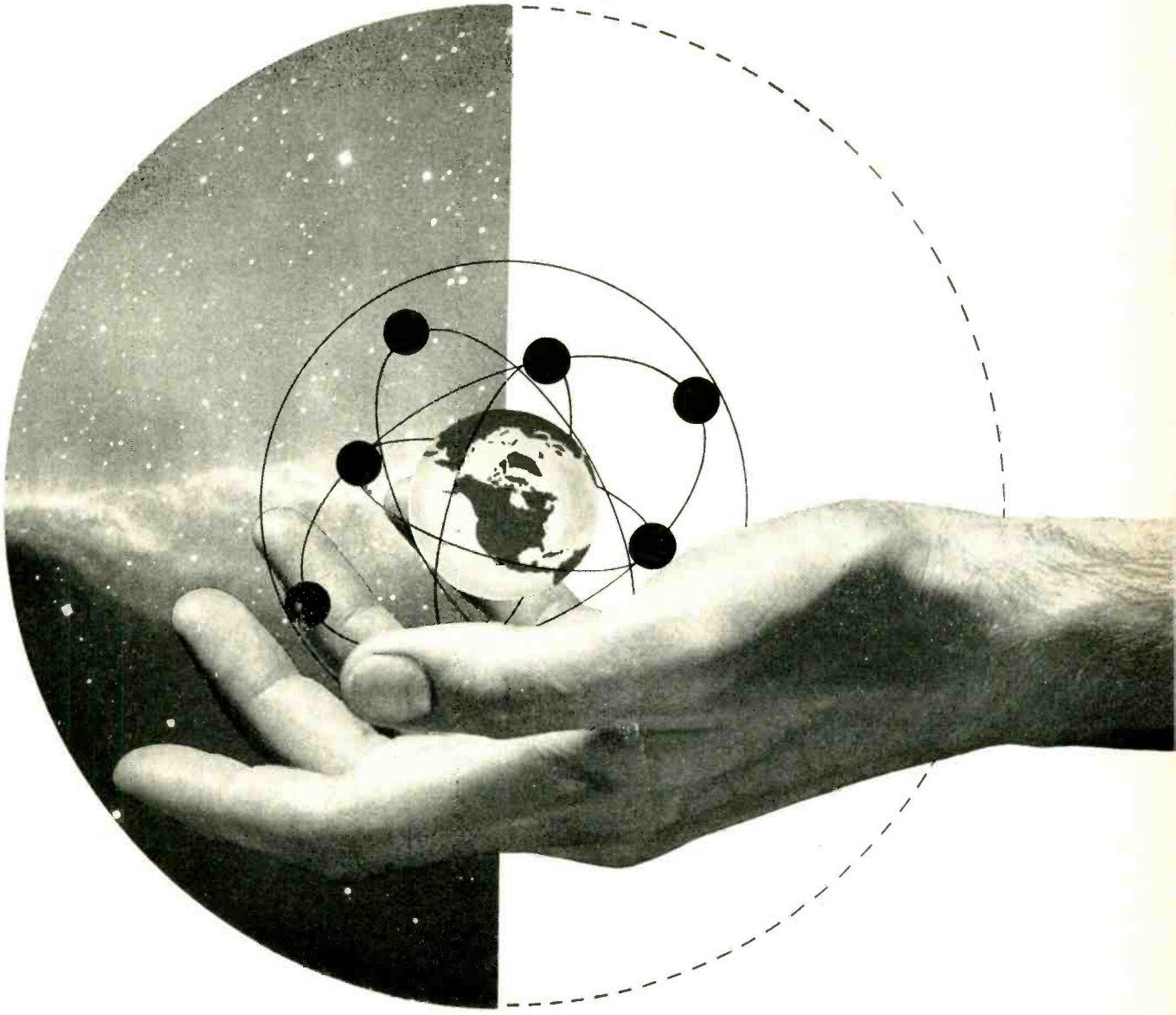
MIT Plans Karl Compton Laboratories

THE KARL TAYLOR COMPTON LABORATORIES for Nuclear Science and Electronics will be built at MIT as a memorial to the Institute's late chairman, Dr. Karl Taylor Compton.

Plans for a $3 million building are being made and a fund of $3,000,000 will be provided for unrestricted support of the Institute's work in these fields.

The proposed laboratory building will comprise about 125,000 sq ft of floor area, designed especially for M.I.T.'s work in nuclear science, nuclear engineering, electronics and related activities under the departments of physics, electrical engineering and chemical engineering.

James R. Killian, president of MIT, said in announcing the Institute's plans . . . "Developments in electronics over the last twenty-five years have amply demonstrated the far-reaching impact of physical science on our economy, our health and our security. In large measure, continued Dr. Killian, electronics is still in its infancy in terms of its potential



brand new world

As a major development in its program of advanced design, Martin has expanded its operations into the field of atomic power.

This means that a top team of scientists, physicists and engineers is now ready at Martin to carry on a strategic long-range program in the application of nuclear energy to weapons systems development.

Yesterday, Martin took the lead in recognizing the importance of electronics, integrating this new science into its operations with engineering and development facilities second to none in the industry.

Today, the horizonless science of nuclear power has been added—again ahead of the calendar.

And tomorrow you can expect Martin to develop techniques for harnessing the potential of each new science to come.

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value to the United States and to the whole world."

The Research Laboratory of Electronics, which will share the new facilities of the Karl Taylor Compton Laboratories, was founded at M.I.T. just after World War II. It now has 245 staff members—including faculty and graduate students—and a total research and teaching budget of about $1,500,000 yearly.

Audio Society Honors Engineers

AT THE AUDIO ENGINEERING SOCIETY annual banquet in New York City the Society's John H. Potts Award for outstanding achievement in audio engineering was bestowed upon Joseph P. Maxfield of Espanola, New Mexico. Maxfield was honored for his contributions in the field of audio engineering, including the development of electrical recording and reproducing systems for phonograph transcription and sound picture applications. His pioneering work led to important improvement in the fields of studio, theatre, industrial and military acoustics. Maxfield was associated with the Bell System throughout most of his career.

The Award for service to the Society was given to John D. Colvin, director of engineering of Gates Radio Co., who was previously chief audio engineer with the American Broadcasting Company.

Frederick V. Hunt, Rumford professor of physics and Gordon McKay professor of applied physics at Harvard University, received the Society's Emile Berliner Award. The latter is bestowed annually for outstanding developmental work in audio engineering. Dr. Hunt was given the award in recognition of his analysis of tracing distortion in disc reproduction, his work on underwater sound systems and his studies in acoustical measurement techniques.

The Society gave an honorary membership to Harold S. Black of Bell Telephone Laboratories for his work in development of stabilized feedback amplifiers.

Elgin Watch Company Enters Electronics

ELGIN NATIONAL WATCH CO., of Elgin, Ill. has purchased Neomatic of Los Angeles, Calif. as part of its diversification program in the fields of electronic components and automatic production instruments.

Founder and former president of Neomatic, T. Ross Welch, will direct research and engineering and William M. Brandes, vice president of Elgin in charge of manufacturing, will become president. Welch was instrumental in his company's development of sub-miniature relay switches and holds many patents in the field.

Neomatic grossed $500,000 in sales last year and employs approximately 100 people.

Magnecord Buys Davies Laboratories

MAGNECORD purchased all of the outstanding stock of Davies Laboratories of Riverdale, Md. Gomer L. Davies, president and founder of the firm bearing his name, was elected to the Magnecord seven man

RETMA Board Of Directors And Officers For 1954-55

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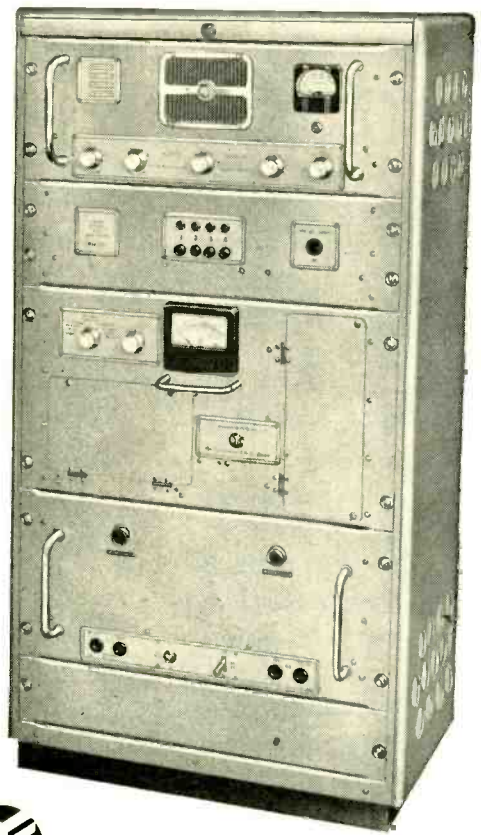

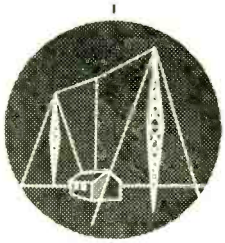

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Gomer L. Davies

board of directors.

The firm will continue as a wholly-owned Magnecord subsidiary under the dircetion of Davies and no immediate change in management personnel is contemplated. Both companies will retain their corporate entities.

Davies Laboratories had 63,000 shares outstanding which were exchanged for a total of 10,512 shares of Magnecord stock. At the time of the purchase Magnecord had 26,732 shares of stock outstanding against an authorized issuance of 200,000 shares.

In addition to the exchange of stock, purchase terms included a five year contract for Davies, at an undisclosed figure, and his election to the company's board of directors. The Magnecord charter authorizes a maximum board of eleven directors.

The engineering and research staffs of the subsidiary will be increased by at least 50 percent as soon as additional production space is acquired.

Willys Motors Plans Laboratory

WILLYS MOTORS, wholly-owned subsidiary of Kaiser Motors Co., is planning a new research and development laboratory devoted to electronics at Stanford University.

It will be a 12,000 sq ft building on 3¼ acres of land in the Stanford industrial tract adjacent to the GE microwave laboratory now under construction.

The laboratory will be devoted to development of new types of radar,

television, and other electronic equipment.

Cost of the building and land is expected to be $250,000. Plans are to lease the property from the university.

Mort Frank, an executive of the Kaiser organization, will be manager of the laboratory. Director of research will be Ross Aiken, previously with the University of California radiation laboratory.

RETMA Honors Loughren for Color TV Work

ARTHUR V. LOUGHREN, vice-president in charge of research of the Hazeltine Corp., was cited by the engineering department of RETMA for outstanding service to the television industry.

Loughren, who also is executive vice-president of Hazeltine Research of Chicago, was presented a plaque at the annual Radio Fall Meetings.

The award, made for Loughren's contributions to color television circuitry, was presented by W. R. G. Baker, vice-president of GE and general manager of the Electronics Division, who received the association's first award in 1941 for his work in the development of black-and-white television standards.

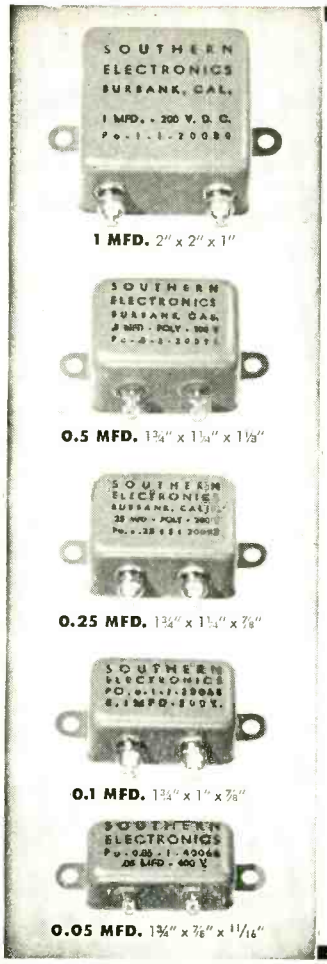
Loughren became an associate member of the IRE in 1924, a member in 1929, a senior member in 1943 and a fellow since 1944. He was elected a director in 1952.

Through the years, he has been active on a number of IRE and RETMA committees. He is presently chairman of the Joint Technical Advisory Committee of IRE and RETMA and chairman of the RETMA Television Systems Committee.

Signal Corps Names Research Chief

EDWARD L. NELSON, technical director of the Signal Corps engineering laboratories at Fort Monmouth, N. J., has been appointed scientific chief of research and development for the Army Signal Corps.

Nelson will be responsible for the technical direction of research and



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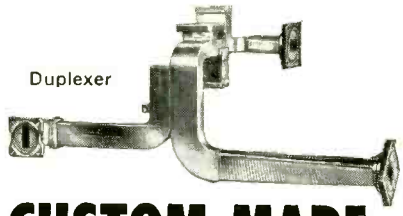

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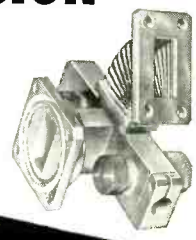

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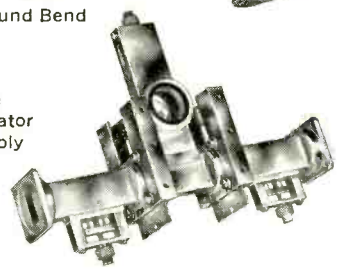

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development for the Corps.

Prior to his appointment at Fort Monmouth, he was with Bell Telephone Laboratories in New York City engaged in the development and design of military weapons systems and equipment under Army and Navy contracts.

Hoffman Plans TV Plant Expansion

HOFFMAN RADIO plans to begin construction on a $1.5 million television manufacturing plant shortly after the first of the year in El Monte, Calif. The 200,000 sq ft facility will have 170,000 sq ft of production space and the remainder for offices, cafeteria, and building services. When the plant is completed, around May 1, 1955, Hoffman expects to combine production from two plants at the new location.

Engineers Receive 1954 SMPTE Awards

THE SOCIETY of Motion Picture and Television Engineers awarded the 1954 David Sarnoff Gold Medal Award to Ray D. Kell for his pioneering achievements in the development of all-electronic television and important contributions to color television, including its adaptation to the limits of a 6-megacycle channel. Lorin D. Grignon received the 1954 Samuel L. Warner Memorial Gold Medal Award.

Kell is a member of the television research staff of RCA Laboratories. He has been a leading participant in television develop-

Ray D. Kell

ment during the past 27 years and has to his credit more than 36 inventions in the field of television and communication. He joined RCA in 1930. The Sarnoff Award was established to give recognition to technical contributions to the art of television and is awarded primarily for achievements within the last five years. In 1953 it was presented to A. V. Loughren of the Hazeltine Corp.

Grignon received the Warner Award for work over a ten-year period in the development of systems and techniques for the application of stereophonic sound to motion pictures. He is a development engineer in the research department of Twentieth Century Fox. The 1954 Warner Medal recognizes Grignon's specific contributions to Cinemascope, particularly, "the application of stereophonic sound, standardization of the release film, application of magnetic sound recording for release prints, supervision of magnetic striping and printing equipment, and preparation of engineering data for release throughout the world".

Garstang Joins Allen-Bradley Radio

WILLIAM W. GARSTANG has been appointed chief engineer of the radio division of Allen-Bradley Co., manufacturers of radio, television, and electronic components.

Prior to joining Allen-Bradley Company, he was vice-president in charge of manufacturing at the Chicago plants of Raytheon. Previous to that he was president of

Electronic Laboratories Inc. of Indianapolis. Several patents have been issued to him covering the design and manufacture of vibrator-type rectifiers for radio apparatus.

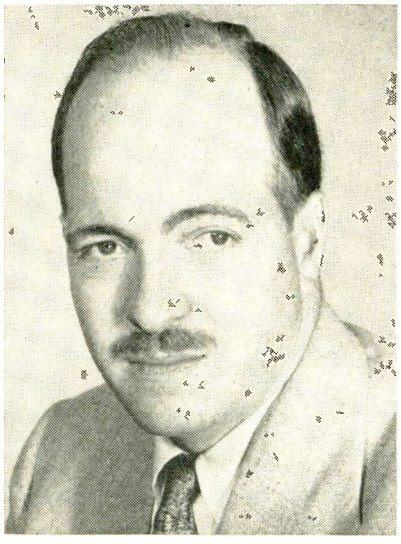
Admiral Expands TV Set Plant

CONSTRUCTION has started on the fourth addition, since 1946, to Admiral's television plant in Harvard, Illinois. The 65,000 sq ft addition will increase the total plant area to over 187,000 sq ft.

Of the 65,000 sq ft to be added, approximately 45,000 sq ft will consist of a warehouse addition. The remaining 20,000 sq ft will be devoted to an extension of production facilities.

GE Microwave Lab Appoints Personnel

JAMES W. NELSON, JR. has been named as manager for advanced tube development at the GE Microwave Lab in Palo Alto, Calif. George C. Trotter was appointed manager of auxiliary operations.



James W. Nelson

The new GE laboratory will concentrate on developing and exploring the application of new types of microwave electron tubes which the company believes will revolutionize the broadcast, communications and radar industries over the next ten years.

Operations will soon be housed in an ultramodern building under construction in the industrial and

technical center being developed by Stanford University in Palo Alto.

Nelson has been associated with GE since 1946 when he became a radar development engineer for the Company at Syracuse, N. Y.

In 1951, Nelson was appointed manager of application engineering for military electronics equipment, a position he held until early this year when he was named a joint project leader on color television receiver development.

Trotter, who joined GE in 1948, was sales manager for U. S. Air Force equipment made by the GE Heavy Military Electronic Equipment Department at Syracuse, N. Y., prior to his new appointment.

Guided Missile Scientists Join Ramo-Wooldridge

Left to right: J. C. Fletcher, M. U. Clauser, L. G. Dunn

TWO MORE missile scientists have joined the newly formed guided missile research division of Ramo-Wooldridge, Los Angeles affiliate of Thompson Products.

In addition to Louis G. Dunn, who is now associate director of the new division, Milton U. Clauser has been appointed director of the aeronautics and structures staff of the division. He was formerly head of the School of Aeronautics of Purdue University. Prior to 1950 he was with Douglas Aircraft Co.

James C. Fletcher has been appointed director of the guidance and control staff of the division. He was formerly with Hughes Aircraft where he headed theory and analysis for the Falcon, the Air

Force air-to-air guided missile.

During the coming year, according to D. E. Wooldridge, president, the company's guided missile research and development commitments call for an expenditure of nine million dollars. A building program will provide the new division with laboratory and office facilities of approximately 100,000 sq ft by mid 1955.

The new facilities will have an electronic computing center equipped with $1.5 million of digital and analogue computers to facilitate theoretical work.

Simon Ramo, executive vice-president of the company, will also serve as director of the new Guided Missile Research Division. He will be assisted in over-all technical direction by R. P. Johnson, vice-president for research and development. He was formerly director of research and development at Hughes Aircraft and before that, deputy director of the research division of the Atomic Energy Commission.

American Bosch Arma Promotes Foss

CLIFTON T. FOSS has been appointed assistant general manager of Arma Division of American Bosch Arma Corp. Foss continues as vice-president of engineering of the division. He joined Arma 21 years ago as a development engineer.

Litton Buys West Coast Companies

LITTON INDUSTRIES has purchased controlling interest in West Coast Electronics Co. of Los Angeles, manufacturer of electronic mobile communication equipment and com-

ponents. It also acquired Digital Control Systems of La Jolla, Calif. West Coast will continue to operate under its own name with a new president, Bruce A. Worcester, formerly a management executive of Litton Industries.

Howard P. Gates, Jr., was appointed vice-president of engineering and Howard G. Grove, vice-president in charge of military liaison and field service of West Coast.

Gates was formerly head of the communications and navigation section of Hughes Aircraft Co. Prior to his appointment, he served as head of communications and navigation section at Litton Industries.

Grove, a founder of West Coast eight years ago, had been active in Southern California radio, serving as Dean of the Radio Institute of California from 1935 to 1937. Later he was associated with Cound Products Corp. and Pacific Aviation as plant manager.

IRC Acquires Van Dyke Instruments

VAN DYKE INSTRUMENTS has been purchased by International Resistance for an undisclosed sum.

Van Dyke Instruments produces precision potentiometers required for guided missiles, electronic equipment vital to automation and atomic installations and other related devices.

Van Dyke Instruments will be operated by its present management as an IRC wholly-owned subsidiary.

RCA Names Engstrom, Hillier, Color Staff

ELMER W. ENGSTROM has been elected as a member of the board of directors of RCA. His election fills a vacancy caused by the retirement from the Board of Walter A. Buck.

Dr. Engstrom, who became executive vice president, research and engineering, on June 4, 1954, has broad responsibility for all research and engineering activities of RCA. In addition, he is head of RCA Laboratories and a member of the board of directors of RCA Victor of Canada.

He joined RCA in 1930. First

as an engineer and then as a research administrator, he has had a pioneering role in the development of radio, sound motion picture apparatus, the general science of electronics, and both black-and-white and color television.

James Hillier, pioneer in the development and use of the electron microscope, has joined the research and engineering staff of the Corporation as an administrative engineer.

James Hillier

Dr. Hillier, who has been director of the research department of Melpar, a subsidiary of Westinghouse Air Brake, was associated with RCA Laboratories from 1940 to 1953, first as a research physicist and later as supervisor of fundamental electron microscope research.

In the RCA Tube Division a separate operations staff was appointed for administration of all activities connected with the engineering and manufacturing of color television picture tubes at its Lancaster, Pa., plant.

The staff will function under the supervision of Harry R. Seelen who recently was appointed manager of a newly created color kinescope operations department. The new department divides Lancaster activities into two separate plant operations: one devoted exclusively to color kinescopes; the other to black-and-white kinescopes and other types of cathode-ray and power tubes.

Appointed to the color staff are: Donald O. Corvey, manager, purchasing; S. M. Hartman, manager, equipment development; Homer L. May, manager, planning and controls; C. Price Smith, manager, engineering and Rex E. McNickle,

administrator, quality control.

Kenneth M. McLaughlin, formerly manager of transistor manufacturing at the Harrison, N. J., plant, has been appointed manager of the Lancaster color kinescope plant. Earl M. Wood continues as manager of the Lancaster cathode-ray and power tube plant.

Librascope Opens New Plant

LIBRASCOPE, a subsidiary of General Precision Equipment Corp., has dedicated a new $500,000 plant addition at its Glendale, Calif. facility.

The new 55,000 sq ft building brings Librascope's total floor space to 160,000. It will house administrative offices, engineering and an electronics laboratory.

The firm manufactures electronic computers and controls for both military and commercial applications.

Farnsworth Electronics Promotes Engineers

WALTER G. HAWKINS of Farnsworth Electronics has been appointed manager of missile and radar development and Vinton D. Carver was named manager of product engineering.

Hawkins has been associated with the company for three and a half years in charge of guided missile development.

Before joining the firm, he was active in development of radar and missile equipment at Hughes Aircraft; Hazeltine Electronics and Sperry Gyroscope.

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McGRAW-HILL FOR BUSINESS

McGRAW-HILL PUBLICATIONS

W. G. Hawkins

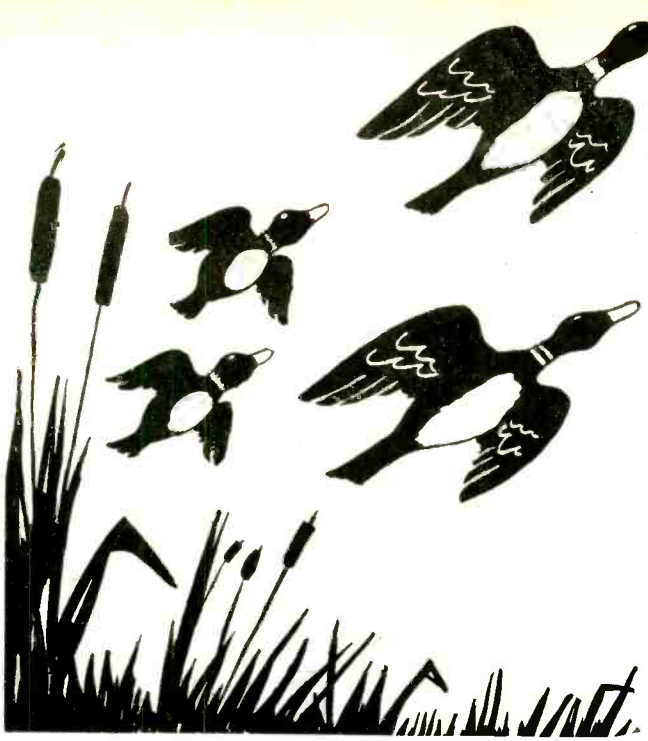
in March, 1953 as chief mechanical engineer in the technical products division. He was subsequently named chief mechanical engineer of research and development and held that position until this appointment. Prior to his association with Capehart he was with the Argonne National Laboratory and Tennessee Eastman.

V. D. Carver

In addition to these appointments, Donald R. Rasley continues as chief engineer of the radar department and William W. Harger was appointed chief engineer of the missile department.

Rasley has been with the company for thirteen years having started as a junior engineer in 1941. Since that time, he has been associated with the company in radar development and has been chief engineer of that activity since 1953.

Harger started with the company in March, 1946 as a junior engineer. He has been active in the company's missile development and prior to his present appointment, he was



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section head, missile guidance and assistant chief engineer of the guided missiles department.

Sylvania Appoints New Radio-TV Head

Howard E. Riordon

HOWARD E. RIORDON has been appointed general manager of the Radio and Television Division of Sylvania Electric.

Riordon, who has held executive posts with Sylvania and subsidiary and predecessor companies for the past 23 years, succeeds John K. McDonough, who recently resigned from the company.

Elected president of Sylvania Electric of Puerto Rico, a subsidiary manufacturing company, in August, 1953, Riordon served in Puerto Rico until his new appointment.

Leverenz To Receive Brown Medal

A FRANK P. BROWN MEDAL will be awarded to Humboldt W. Leverenz, director of the physical and chemical research laboratory of RCA Laboratories, by Franklin Institute for his contributions to the development of the fluorescent lamp, principally by the invention of reliable, efficient and versatile phosphors.

Ultraviolet radiation produced by electric energy of the fluorescent lamp cannot pass through ordinary glass, but must be converted to visible light by a phosphor coating on the inside of the tube. Mr. Leverenz' research on luminescent materials was of considerable import to the evolution of fluorescent light-

ing techniques.

Joining RCA in 1931 as a chemico-physicist, he was in charge of research on electronically active solids from 1942 until being named to his present post this year.

IBM Promotes Top Engineers

RALPH L. PALMER was appointed director of engineering of IBM. He formerly was manager of the company's engineering laboratory at Poughkeepsie, N. Y.

Ralph L. Palmer

Other appointments include those of John C. Abrams as director of laboratory operations, Jerrier A. Haddad as director of advanced machine development and James J. Troy as director of product design. Horace S. Beattie has been named manager of the company's Poughkeepsie laboratory and Francis E. Hamilton has been made manager of the Endicott, N. Y. laboratory.

Abrams was previously assistant to the IBM director of engineering,

John C. Abrams

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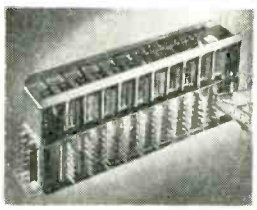

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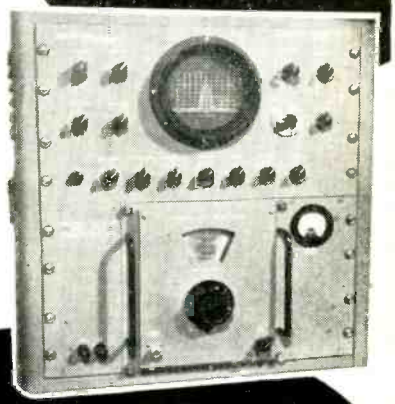

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- Panoramic Sonic Analyzer
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10 South Second Avenue, Mount Vernon, N. Y.
MOunt Vernon 4-3970

Haddad was manager of the company's engineering laboratory at Endicott, N. Y. and Troy was assistant manager of engineering at Endicott responsible for component and advanced machine development. Beattie was manager of advanced machine development at Poughkeepsie in 1952. Hamilton was a development engineer in the Endicott laboratory.

Appointments to key positions in its plant now under construction in Kingston, N. Y. were also made by IBM. Richard J. Whalen has been appointed superintendent; Carroll F. Lynch has been named production engineer; George S. Vermilyea, manufacturing engineer; Paul F. Heitz, quality control manager and Frank G. Paul, production manager.

Whalen, who was formerly in charge of manufacturing planning for a defense contract, joined IBM in 1946. Lynch was a production engineer on Project High, an IBM defense project, prior to his present promotion.

Vermilyea was in charge of tool engineering and test engineering for Project High, Heitz was quality manager of defense contracts. Paul was manager in charge of toll recorder manufacturing until his appointment to the Kingston plant.

Seneca Falls Machine Goes Electronic

SENECA FALLS MACHINE COMPANY, machine tool manufacturing concern, has formed an electronics division. The company has for some time been experimenting with electronics and has made considerable progress, according to Edwin R. Smith, president. He said that it would seem the time has now arrived, "when any machine tool builder who intends to be in a competitive position in the future should devote some of his time, energy and money to the development and application of electronics."

Robert H. Eisengrein, who is credited with four electronics patents, has been appointed director of the new division. He comes to Seneca Falls from Sundstrand Aviation where he was chief research engineer responsible for

Robert H. Eisengrein

analysis, development and design of automatic control systems and components. Prior to joining Sundstrand he was a research assistant at the Servomechanisms Laboratory of M.I.T. and before that was with GE as a development engineer.

Smith said that with the tremendous development that has been made in electronics, particularly with servo mechanisms, we probably will see in the next few years new and better machine tools which will not only do the work required but also the thinking. . . . It is difficult to tell at the present time just how far this trend is going, but it would seem that if we can produce at reasonable cost machines which further reduce physical and mental effort they will be in demand. Rapid advances have been made already not only in the application of servo mechanisms, but also in new circuits in the servo mechanisms themselves.

Although the company was originally interested in electronics solely in connection with machine tools, he said that it already appears that some of the devices with which Seneca Falls has been experimenting will probably be applicable to other fields.

Magnavox Expands, Appoints Carlton

MAGNAVOX expanded its operations into the field of fundamental electronic research by forming a new division of the company to be known as Magnavox Research Laboratory located in Los Angeles, California.

Ragnar Thorensen has been named director of research to head

Ragnar Thorensen

the laboratory. He formerly headed the computer section of the NBS Institute for Numerical Analysis.

David M. Goodman has been appointed administrative head of the laboratory and west coast regional director of the industrial and defense products division. He was formerly head of management engineering at Hughes Aircraft.

Emphasis will be placed on research and development in high-speed digital computers, military control systems, and data processing equipment at the lab. Research and development is being carried out on magnetic gates and core memories, magnetic drums and other computer components. Long-range plans call for the development of a general research and development center for the firm.

In another move, Magnavox named M. Barry Carlton as general manager of the company's defense products division.

For the past six years, he served as executive director and coordinator of reliability in the office of the Secretary of Defense. In this

M. Barry Carlton

position he guided the government's program for improving the performance of military electronic equipment and helped to establish a single, sound, integrated military electronics program.

Prior to joining the department of defense staff, Carlton was technical administrator of the radio countermeasures division at the Naval Research laboratory. He also served for more than two years as a member of the radiation laboratory at MIT where he participated in the initial development of radar and radar beacons.

He will be retained as an expert consultant, without compensation, in the office of the assistant secretary of defense for applications engineering to continue his contribution to the reliability program and defense effort.

Lion Appoints New Color TV Engineer

BUFORD COX has been appointed assistant chief color engineer of the television and radio division of the Lion Manufacturing Corp. in Chicago.

Cox was formerly associated with the Hallicrafters Co. in Chicago.

Gyromechanisms Names Benson Vice-President

ROBERT M. BENSON has been appointed vice-president of Gyromechanisms in charge of the west coast division.

He will coordinate sales and engineering activities for Gyromechanisms' Western customers.

Benson was formerly chief en-

gineer of American Gyro Corp. Previously he had been supervisor of a gyro design and development unit at the aerophysics laboratory of North American Aviation and a project engineer with Sperry Gyroscope.

Assembly Products Moves Into New Plant

ASSEMBLY PRODUCTS is moving into a modern 'all on one floor' building in Chesterland, Ohio with nearly double the usable floor space that was previously occupied.

Sales of the firm's instruments and controls for automation are running about 25 percent ahead of last year—the best previous year, according to Bradley Thompson, president.

Varian Associates Elects Vice-Presidents

VARIAN ASSOCIATES appointed Emmet G. Cameron as vice-president for production and Merle R. Zinser as financial vice-president.

Cameron, works manager of the Varian manufacturing plant in San Carlos, joined the company in April 1953 and was elected to the board of directors in 1954. He has previously served as works manager with Sarkes Tarzian, as chief engineer at Federal Telephone and Radio and as production manager of Heintz and Kaufman, vacuum tube manufacturers.

Zinser, controller and business manager, has been with Varian Associates since 1951. Prior to joining Varian, he was assistant to

PLANTS AND PEOPLE (continued)

Emmet G. Cameron

the president of Marchant Calculating Machine Co.

The other officers of the firm are Russel H. Varian, president; H. Myrl Stearns, executive vice-president and general manager; Sigurd F. Varian, vice-president for engineering; Richard M. Leonard, secretary and Charles J. Marsh, treasurer.

Della-Corte Joins Anton Labs

JOSEPH P. DELLA-CORTE has been appointed director of engineering of Anton Electronic Laboratories.

Della-Corte will head up the staff of physicists, electrical engineers, mechanical engineers, radiochemists and technicians currently engaged at AEL in the design, development and production of nuclear and electronic equipment.

Prior to his appointment, Della-Corte served for eighteen years with the Fairchild Camera and Instrument Co. During this time he held positions of chief engineer, director of engineering and prior to his resignation, assistant to the president. He holds several patents

for radio navigational devices and was a pioneer in the radio navigation field.

Graflex Purchases Strobo Research

STROBO RESEARCH, a 15-year-old Milwaukee concern which has developed electronic flash units for photography and electronic devices for the armed forces, has been purchased by Graflex of Rochester, N. Y.

In the purchase, Graflex acquires the capital stock of Strobo Research, which becomes a wholly-owned subsidiary of the Rochester firm.

All Strobo Research manufacturing, sales and service activities will

E. R. Farber, left, and G. C. Whitaker

continue in Milwaukee for the time being, according to G. C. Whitaker, Graflex president.

Edward Farber, president of Strobo Research, will continue in that capacity.

Electronics Corp. Adds Two Vice-Presidents

COLONEL JOHN C. HARVELL, U. S. A. F., was appointed vice-president of the military and marine divisions of the Electronics Corp. of America.

Colonel Harvell joined Photoswitch earlier this year as assistant general manager following his resignation as Deputy Commanding General of Air Force Procurement District, a post to which he had been named in 1950. His new appointment reflects the consolidation of Photoswitch, Combustion Control Corp., Fireye Corp. and

Photoswitch Marine Division into the newly-organized Electronics Corporation of America.

Wayne B. Nottingham, has been appointed vice-president for research of the company. Raymond H. McFee was named director of research.

Dr. Nottingham continues as a full professor of physical electronics at MIT. For some years he had been associated with Photoswitch as director of research.

Dr. McFee formerly was project director for Photoswitch. He was a research physicist at MIT and worked in the fields of crystals, optics, infra-red and micro-wave. Burton E. Shaw has been named vice-president for operations and vice-president of the Photoswitch division.

Shaw has been vice-president of Photoswitch since shortly after he became associated with the company in 1946.

New York University Appoints Philpott

LAVERNE R. PHILPOTT has been appointed a coordinator in the research division of New York University's College of Engineering.

Dr. Philpott will direct and participate in basic research problems including studies fundamental to air navagation and scientific photography.

He received a Presidential citation in 1946 for his work with R. M. Page and others of the Naval Research Laboratory who helped to make radar a practical weapon in

World War II and a peacetime aid to flight, navigation, and meteorology.

For his contribution to the development of an American system of radio recognition, Dr. Philpott also received in 1947 the Navy's highest award for distinguished civilian service.

He has designed radio countermeasures "jamming" equipment, naval fire control radar, and industrial electronic control equipment. In recent years, he invented and patented a system of dry-color facsimile, permitting radio transmission of pictures directly in color, without chemical processing.

Before coming to NYU, he was chief scientist for Balco Research Laboratory in Newark, N. J. He also has been employed by Finch Telecommunications and various government agencies. At the Naval Research Laboratory he was a physicist and consultant from 1934 to 1947.

Eitel-McCullough Names Ceramic Chief

PAUL D. WILLIAMS has recently been appointed chief of ceramic development for Eitel-McCullough, manufacturer of Eimac electron power tubes.

Williams will supervise the work being done at Eimac with ceramic materials to replace glass in electron-power tube construction. The use of ceramics will make possible the production of smaller, more rugged tubes with greater resistance to both thermal and physical shock without sacraficing power,

Paul Williams

according to the company.

Williams joined the Eimac staff in 1942 as a research chemist and later became chief research chemist. He was responsible for the development of Eimac Y-3 Grid Wire, the Eimac Pyrovac plate and the Eimac moulded glass header.

National Electrical Elects New President

A. S. CLARKE has been elected president of National Electrical Machine Shops to succeed the late E. M. Nevils, Jr. The company manufactures communications equipment and electronic instruments. It employs 400 people in its Silver Spring, Maryland plant.

Clarke was formerly vice-president in charge of engineering of the company. During World War II he was senior technical aide to the chief of division 4 of the National Defense Research Committee. He was responsible for setting up production facilities for classified ordnance developments, and for his war work received the Presidential Certificate of Merit and the Naval Ordnance Development award.

A. S. Clarke

New Transistor Firm Is Formed

A NEW COMPANY, the General Transistor Corp. has been formed to engineer and manufacture high quality transistors and related semi-conductor products.

President of the firm is Eugene Kral, formerly with Eugene Kral &

Co., manufacturers of quartz crystals. His experience with quartz, the processing of which is similar to that of germanium in some respects, has enabled the firm to develop wafer surfacing techniques for transistors with low noise characteristics. The application of x-ray diffraction techniques to properly orient the germanium wafers, prior to alloying, has improved the yield of highest quality transistors, according to the company.

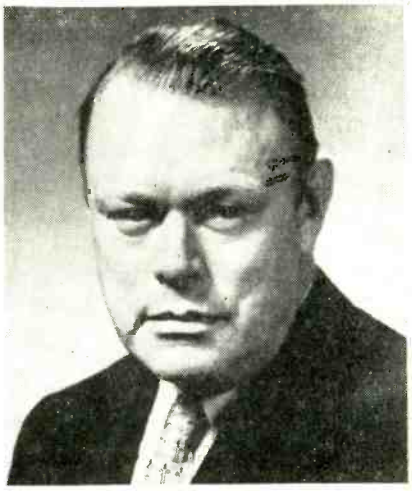
Vice-president of the firm is Herman Fialkov, formerly chief engineer of the germanium division of Radio Receptor Co. Fialkov has also served in engineering capacities with Emerson Radio, the Mutual Broadcasting System and Tele-Tone. He has engineered a modern plant and established a process for the manufacture of p-n-p alloy transistors.

Raytheon Appoints Black And Nichols

NATHANIEL B. NICHOLS, manager of the Raytheon research division, has been appointed an assistant vice-president. K. C. Black was named head of the communications engineering department.

Nichols joined the firm in 1951. He helped develop several of Raytheon's unusual products, leading his scientific group through the investigative phases of work that eventually made possible the mass production of transistors. He helped to develop the "Micronaire" room air cleaner, the "Ultrasonic

Nathaniel B. Nichols



K. C. Black

Machine Tool" and the single-motion duplicator, an electronic brain for machine tools.

During World War II, he was associated with the Radiation Laboratory of MIT where he headed the servo group of the fire control division. Subsequently, he became research director of Taylor Instrument leaving in 1950 to accept a professorship at the University of Minnesota.

Dr. Black comes to the company from his position as business manager of the Polytechnic Research and Development Co. of Brooklyn, N. Y. He has done engineering and research work for AT&T, Radio Frequency Laboratory of Boonton, N. J., Boonton Research Corp., Bell Telephone Laboratories, Aircraft Radio Corp. of Boonton and Air Associates of Teterboro, N. J.

From 1949 to 1952 he was chief scientist at the Naval Air Development Center in Johnsville, Pa., where he was concerned with programs in communications, sonar, radar, counter measures, armament development and missile guidance.

Dr. Black's new position makes him responsible for the design and development of new communications products to fill out Raytheon's line of electronic equipment.

Electronics Conference Makes First Award

E. D. MCARTHUR, manager of the electron tube section at the GE Research Laboratory and E. F. Peterson, manager of marketing for the company's radio and television department, were recipients of the

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first National Electronics Conference Award.

According to R. M. Soria, 1954 NEC president, the new award may be presented annually to "the author or authors of a paper presented at a previous conference which introduced developments of a new and revolutionary character capable of significantly influencing an electronic field or of opening an avenue to a major field of electronic science or application."

McArthur and Peterson were co-authors of a paper entitled "The Lighthouse Tube; A Pioneer Ultra-High-Frequency Development" presented at the first NEC conference in 1944. It described the then-new development of disk-seal tubes which played an important part in World War II radar defense and earned for McArthur the U. S. Navy's Certificate of Commendation.

Hallicrafters Appoints General Willis

BRIGADIER GENERAL JAMES S. WILLIS, U. S. Army, retired, has joined Hallicrafters as coordinator of research and development.

General Willis was commanding general of the Signal Corps supply agency at Philadelphia. Earlier assignments included the post of chief of the engineering and technical division in the office of the chief signal officer in Washington, from 1946 to 1948. From 1945 to 1946, Willis was a deputy theater signal officer in the European theater of operations, with headquarters in Frankfort, Germany. Prior to that,

during combat operations from 1944 to 1945, he was chief of plans and operations for the signal division of Supreme Headquarters, Allied Expeditionary Forces in Europe.

Stanford Organizes New Electronics Lab

THE APPLIED ELECTRONICS LABORATORY, a newly organized engineering research facility, has been formed at Stanford University.

Scientists in the laboratory will be engaged in industrial and government research work. Their efforts are to be directed at the development and exploitation of new discoveries in electronics.

Stanford's electronics research laboratory will now be devoted entirely to fundamental research and teaching, according to Dean F. E. Terman, director of both laboratories.

Bendix-Pacific Names Perrine

C. D. PERRINE JR., was appointed director of engineering of the Pacific division of Bendix Aviation.

Perrine formerly was assistant manager and chief engineer of a Consolidated-Vultee division. For the past two years he specialized in major guided missile development and production for the Navy's Bureau of Ordnance and the Applied Physics Laboratory of Johns Hopkins University. Previously he was for two years assistant chief engineer for missiles and electronics at Convair's San Diego division.

Before joining Convair, the new Bendix executive was for five years

manager of the electronics department of Fairchild's guided missiles division in Farmingdale, L. I. Under his direction and with the aid of the U. S. Naval Research Laboratory, Fairchild developed and tested one of the first radar homing devices for the Navy's "Lark" ground-to-air test missile.

From 1937 to 1945 Perrine was associated with Howard Hughes, advancing to manager of Hughes' radio division.

Toy Manufacturer Builds Electronics Plant

MATTEL, musical toy manufacturer has formed a subsidiary, Mattel Engineering Co., to make aircraft electronic components. A 30,000 sq ft plant has been constructed next to the firm's 65,000 sq ft main plant in Los Angeles.

Eisler Receives Marconi Award

THE BRITISH IRE presented its Marconi Award to Paul Eisler, physicist and inventor of the Technograph process of printing electrical circuits. He is a director and head of the research laboratories of Technograph Printed Circuits in London.

The presentation came in recognition of Dr. Eisler's war-time development and later perfection of a means whereby electrical circuits could be produced by the process of printing rather than by mechanical methods.

Gudeman Buys California Firm

THE GUDEMAN CO., electronic components manufacturer, has purchased Dilectron of Monrovia, California, manufacturer of ceramic capacitors. The 12,000 sq ft Dilectron plant becomes Gudeman's fifth plant and will be known as the Dilectron Division of The Gudeman Company. There will be no personnel changes in Dilectron. F. T. Reischel is vice-president and general manager, George Wiesinger, sales manager and purchasing agent and Steve Taylor is chief engineer.

NEW BOOKS

Information Theory

BY STANFORD GOLDMAN, *Syracuse University. Prentice-Hall, Inc.*, 1953, 385 *p*, $9.00.

AS THE FIRST published text in this field, Dr. Goldman's work attempts to satisfy a very important need both for the classroom and the worker in the field. The material is quite properly intended for use by graduate students in electrical engineering, although the attraction of this subject matter for many phases of applied science has been clearly demonstrated in other publications.

Background

The treatment is based upon the classical work of Shannon (published in 1948), with considerable amplification of the concepts and theoretical development and with much added mathematical and statistical theory. The use of examples is liberally made to aid in the presentation, and many problems are included. Although for the advanced engineer or scientist no article or other publication is better suited for a grounding in the subject than the well written and masterly presentation of Shannon's own work, yet for the student or beginning investigator it would appear that the present volume under review is better suited for an exposition of the field and a guide to its many applications.

Contents

Chapter I, entitled "Information Theory of Discrete Systems", together with mathematical developments in the appendices covers the basic definitions and theorems for communication systems employing a finite set of symbols. The concept of information is discussed and quantitatively defined. Probability theory is introduced as required. For the complete communication channel, the text discusses language as a statistical construction, then coding into symbols which can be handled by the channel, the capacity of the channel, and the relation between the rate of transmission of information and the channel capacity. Entropy and re-

dundancy are defined and discussed. Finally, the relations concerning the transmission of information over a noisy channel are developed.

In chapter II, the informational equivalence of a continuous band-limited signal to a finite sequence of samples either in time or frequency is demonstrated. Chapter II on "Ergodic Ensembles and Random Noise", chapter IV on "The Entropy of Continuous Distributions" and chapter V on the Transmission of Information in Band-Limited Systems extend the theory to deal with continuous types of signals in band-limited noisy channels. This subject is somewhat more abstract and mathematical than the material of chapter I. Major topics covered include certain statistical properties of noise relations between the temporal and frequency distributions, and the transmission capacity of the channel with either average power or peak power limitations. Chapter VI on the "Use of Signal Space" presents an alternative derivation of the relation for the maximum rate of transmission based upon a geometrical argument wherein finite band limited signals are represented by points in a multi-dimensional space.

The material in chapters I through VI represent the basic theory. Chapters VII through IX present detailed applicational studies with emphasis upon communications, optimum filters and improvement in systems employing periodic signals, such as radar and navigation.

Chapter VII discusses first the information transmission rates for the usual modulation systems, and then the noise reduction possibilities for these systems by the use of extra bandwidth, threshold performance and human observer noise reduction.

Chapter VIII, entitled "Linear Correlation, Filtering, and Prediction", presents an interesting and readable exposition of Wiener's work on linear, least square smoothing and prediction. Preliminary material is given on physically realizable filters and the correlation functions. Finally, the application of correlation methods to improvement of signal-to-noise ratio in periodic signal systems is briefly

covered. This material is of special interest since it is in this field that these methods have had considerable early success.

Chapter IX opens with an extended and very useful review of the concepts and general results of the theory. The remainder of the chapter indicates how information theory may be applied to an analysis of thinking, knowledge and scientific procedures.

Conclusions

In summary, the author has done a very fine job of collecting and organizing the material needed for an adequate presentation of the development of the subject of communication theory. As a somewhat personal note, the treatment is not aided by a tendency to coin new words.—M. LEIFER, *Engineering Manager, Electronic Defense Laboratory, Mountain View, Calif.*

Elements of Mathematics for Radio, Television and Electronics

BY BERNHARD FISCHER AND HERBERT JACOBS. *Macmillan Co., New York,* 569 *p,* 1954, $7.20.

A LARGE and practical book aimed at teaching the reader "to use mathematics fluently, easily, accurately on radio and television problems." The endpapers display the color codes for resistors and capacitors, actual sizes of machine screws and the appendices give data on screw threads, copper wire tables, log tables etc. There are hundreds of problems dealing with all manner of electronic circuits including square waves, time constants, tube current, impedance matching, tv test patterns as well as many problems dealing with the formal mathematical processes.—K.H.

Transients, Inverse Feedback and Stability (Einschwingvorgänge, Gegenkopplung, Stabilität)

BY JOHANNES PETERS. *Springer-Verlag, Berlin, Germany,* 181 *p,* 1954, 27*DM.*

A BOOK in the field of circuit theory serves two distinct classes of readers. To some, the study of networks is a full-time job; mathe-

matics, far from being an obstacle, is the habitual and preferred way of thinking. Practical applications seem nice but hardly fascinating.

On the other side of the fence are people whose specialty may range from tape recorders to gas turbines. When they open a book on circuit theory, they do not hope to become expert in the field; they hope to find a little insight, a few bits of additional understanding to add to their bag of tools. They are knowingly trespassing into a highly specialized domain, foreign territory in which they hardly expect to feel like natives. Nevertheless this group probably outnumbers the full-time group by a wide margin. If this is more so in circuit theory than in other theoretical subjects, it is probably because few have an opportunity to design tape recorders or gas turbines on a part-time basis; but almost anyone builds amplifiers.

In the preface, the author says that an approximate treatment will not do for the feedback amplifier, because of the stability problem. Stability criteria, he continues, are not useful unless they contain design information. To attempt to meet a stability criterion by trial and error is no better than to stabilize the completed feedback amplifier by the same method. He hopes to show how one arrives at a stable amplifier of predictable performance.

The first chapter contains an introduction into the methods and mathematics of circuit theory. Starting with fundamentals such as the physical meaning of the complex notation, it progresses smoothly and rapidly to the theorems which govern amplitude and phase response, to Fourier and Laplace transformations, and the like. The second chapter, on transfer functions of passive and active systems, deals with the task of translating a given network into a system of equations by means of admittance matrices. The third chapter treats the problem of stability. With the exception of its last section, this chapter and the preceding two are highly mathematical.

Feedback Design

The last section of the third

chapter, as well as the entire fourth, deal with feedback amplifier design. These parts of the book are likely to be the most valuable to many readers. Generally, they can be understood without a detailed study of the mathematical portions of the book and they contain a great deal of useful information.

Because feedback amplifier theory also applies to purely mechanical and electromechanical systems, there is a brief final chapter on mechanical circuits, electromechanical analogies and transducers. Here the author seems to do a little trespassing of his own, away from his home grounds; this comes to light when he labels a capacitive transducer without restoring force "impossible", not merely unstable.

He might have pointed out that negative compliance, very much unlike negative capacity, is rather common in nature—which no one will deny who has ever tipped over backwards on a reclining chair.

To summarize, this is a well-organized and thorough treatise on circuit theory which uses mathematics abundantly but always tries to explain the result in physical terms. In many respects it reflects the work of H. W. BODE (Network Analysis and Feedback Amplifier Design, 4th ed., Van Nostrand, 1947) to whom the author gives a large measure of credit. The book should be of value to many readers. A nonmathematical book on the same subject is not likely to be written for some time.—ROBERT ADLER, *Zenith Radio Corp., Chicago, Ill.*

The Amplification and Distribution of Sound

BY A. E. GREENLEES. *Chapman and Hall, London, third edition, revised, 300 p, 35 shillings.*

This book applies the typical English virtues of clarity and conciseness to the explanation of the basic principles of public address systems and practices. It is an excellent introduction to basic principles, but the treatment of specific components and operating practices will seem definitely old-fashioned and incomplete to American practitioners of public address who keep up with equipment developments and follow the periodical

literature in their field.

Deficiencies of Treatment

In his preface the author declares his intention to discuss principles mainly, and does not promise the reader a complete manual of public address operation. However, the reader must take this disclaimer with more force than the author probably intended. A kind of no-nonsense, stick-to-old-established-ways approach leads to many errors of detail, such as the discussion of the control of volume from phonograph records on page 146. This would lead the unwary reader to assume that modern practice invariably puts the volume control directly across the pickup terminals, and obvious holdover based on the high-output pickups of the thirties and forties, and not relevant to today's very-low-level records and pickups.

The whole discussion of records as a program source suffers from the same standpatism. Motors, pickups, records, scratch filters are all presented in terms definitely out of date. The author does give an admirable account of fundamentals in each case, but he does not give the reader an accurate notion of what is going on today. In one short paragraph stuck at the end of the chapter like an afterthought, he mentions the fact that there are such things as records made to revolve at 45 and 33⅓ times per minute. To borrow a phrase from the theatre, this is throwing away the long-playing revolution with a vengeance.

Amplifiers and Speakers

Things come out better on amplifiers, because the author does stick to discussing basic types, which haven't changed much in a couple of decades. On loudspeakers, the author is again excellent on fundamentals but very restricted, and sometimes at odds with current practice on practical details.

The treatment of the fundamentals of distribution lines and load matching is excellent, showing at its very best the author's real ability to put technical material into simple, concise, unambiguous, utterly lucid language. The same applies to the sections on micro-

phone and loudspeaker placement, which are, of course, the essence of public address as distinguished from other branches of the art of reproducing sound. The reader will learn what to do with his speakers at a typical stadium, skating rink, large hall, small hall, cinema, bandstand, etc. However, because of the space limitations the author has imposed on himself, he is not able to do more in each case than suggest one typical solution, in very brief style. Thus the book comes out more like a course in types of handling than like a practical manual of public address work.

Comments on High-Fidelity

The plan of the book is exceptionally thorough, including chapters on the fundamentals of sound engineering, on all the components of public address systems including radio receivers, on planning large permanent installations for hospitals and such, on maintenance, testing, drawing up specifications, etc. And, although the author (gratefully to this reviewer) does not mention the words high fidelity, he does range himself on the side of the hi-fi angels when he deplores that fact that a public address system ". . . is often expected to make its presence felt, otherwise it is not considered satisfactory. It is to be hoped that this state of things will pass . . . so that the benefits of the system may be unconsciously enjoyed without its users being reminded of its existence."—R. S. LANIER, *New York, N. Y.*

Engineering Analysis

BY D. W. VER PLANCK AND B. R. TEARE, JR., *Carnegie Institute of Technology. John Wiley & Sons, Inc., New York*, 1954, 344 *p*, $6.00.

THE PROFESSIONAL method in this case is how to solve problems by using one's head plus whatever mathematical tools may be required. But the big idea is to use your head.

The young engineer, once free from school, finds that problems with which he has to cope are not stated in very "clearly worded statements." As the authors say, "you will be confronted with situations out of which you yourself must formulate specific problems to be solved. Until you analyze the

situation it may not be clear what the problem really is, nor is it likely that the important factors will be apparent at first. Often, in practice, it is harder to define a problem than to solve it."

This book, then, seeks to teach young (and old) engineers how to analyze engineering problems that are not stated as clearly as "how many inches are there in five feet"—problems that cannot be handled by jamming some figures into a formula. Creative thinking is the key to practical problems and the whole of this interesting and, at times, exciting, text is to teach the methods of creative thinking as applied to industrial engineering situations.

The Method

The case method is the one used here to a great extent, although some formal gyrations with differential equations are included. The situations employed vary from an accelerometer in the form of a U-shaped glass tube filled with colored liquid, to the magnetic force on an iron core, to a nonfogging mirror, to the life of a roller bearing, and many others. All are analysed, some in several ways, and all are solved.

Since an engineer is not only supposed to figure out how things work but to make things work at practical cost, and not only in his own field, basic principles that apply to all of nature are the starting point—conservation of matter and energy, Newton's laws of motion, electric circuit principles, or the phenomena of heat flow—and the mathematics involved is purely incidental, as a tool should be.

The Contents

The seven chapters are as follows: The Professional Method of Dealing with Engineering Problems, Application of Professional Method, Understanding the Principles Fundamental to Engineering, Translation into Mathematics, Solutions of Some Ordinary Differential Equations, Checking, and Interpretation of Mathematics.

It is a strong hunch that many an engineer, doddering around with formulas, could learn much from this important book, even if he has been away from his formal mathe-

matics for many a year. The processes by which the examples are solved are clear, interesting and surely instructive.—K.H.

THUMBNAIL REVIEWS

Electronics for Everyone. By Monroe Upton. Devin-Adair Co., New York, N. Y., 1954, 370 pages, $6.00. A popular attempt to explain electronics and what tubes do, starting with Alexander Volta and ending up with color television, radar and some industrial applications.

Transient Analysis of Alternating Current Machinery. By Waldo V. Lyon. John Wiley & Sons Inc., New York, N. Y. 309 pages, 1954, $7.00. First systematic application of Fortesque's method of symmetrical components to the solution of transient conditions. Chapters on Static curcuits, Symmetrical components of instantaneous potentials and currents, differential equations for the ideal cylindrical-rotor machine, Transient conditions in the induction machine with stationary rotor and with constant speed, Uniform-air-gap machine with rotor excitation and with speed constant, Synchronous machine with salient poles, Induction and synchronous machines with speed variable, Appendices, Problems and Bibliography.

Rotating Electrical Machinery. Universal Scientific Co., Vincennes, Ind., 1954, 256 pages, $3.50. Manual for civilian and service schools; large type, large illustrations, large format, easy to read and use.

Insulation of Electrical Equipment. Edited by Willis Jackson. John Wiley & Sons Inc., New York, N. Y., 1954, 340 pages, $7.75. Eleven papers by eleven authors representing lectures given at Imperial College, London, for engineers from the electrical industry. Although most of the contents relates to insulators of primary use in the power field, a chapter covers communication components which includes data on particular materials for particular uses.

Fundamentals of Transistors. By Leonard Krugman. John F. Rider, New York, N. Y., 1954, 140 pages, $2.70. A straight-forward text in paper covers and handy format dealing with transistor characteristics, circuit design, and operation. A practical book for the engineer.

RC/RL Time Constant. By Alexander Shure. Rider Publication, New York, 48 pages, 1954, 90¢. First of a series of specialized texts for students of electronics, covering time constants and applications.

BACKTALK

Name Sake

DEAR SIRS:

THANK you for publishing my Transistor Nomograph, p 178, August, 1954 . . . however, the last name is "Bolie" instead of "Bolis" as printed . . .

Since publication of the article I have received requests for about a dozen reprints . . . all addressed with the misspelled name. In fact, I was even invited to join the IRE, an organization with which I was already associated.

VICTOR W. BOLIE
Scientific Staff
Collins Radio Company
Cedar Rapids, Iowa

Editors' Note: We regret the inconvenience caused Mr. Bolie. Printer please note.

Tape Curves

DEAR SIRS:

TWO ERRORS which appeared in the final printing of the article "Magnetic Tape Pickup Has D-C Response" in the September 1954 issue of ELECTRONICS, page 156, should be called to the attention of your readers.

Labels referring to the two curves of Fig. 4, p 158, are reversed. The solid-line curve showing the better high-frequency response should have been labeled "tape coating against pole"; data for the dashed-line curve were obtained with the "tape coating centered."

The second integral in the equation near the center of page 158 should have limits of 8 to 20 rather than e to 20 as shown.

J. W. GRATIAN
Research & Development Dept.
Stromberg-Carlson Company
Rochester, N. Y.

More Amplifier Design

DEAR SIRS:

IN HIS LETTER in June, 1954 *Backtalk* (p 378), Mr. Diamond has inferred that my comments on his article are incorrect. . . .

Mr. Diamond quotes the "Radiotron Designers Handbook" to the effect that pentode output tubes produce more high order distortion than triodes; however, we are dis-

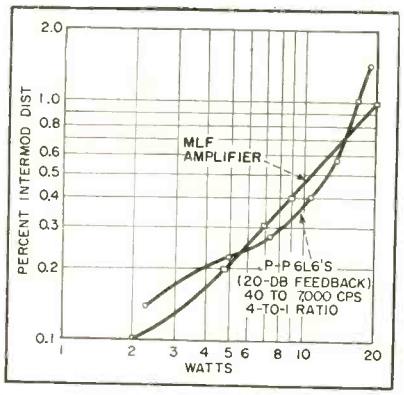
cussing beam tetrode output tubes which comprise still another class of tube. Further down the page the handbook states that beam tetrodes are different from pentodes in that they have more second harmonic and less third and higher harmonic distortion. The Handbook states that push-pull class-A 6L6's will give 18.5 watts output with two-percent harmonic distortion. There are no receiving-type triodes which will match this performance.

I have run intermodulation tests on many amplifiers, including Williamson's, with the output tubes connected as triodes, as tetrodes, and as tetrodes with inverse feedback to the screens (So-called "Ultra Linear"). These curves show no significant difference resulting from the different connections except that with triode connection the power output is greatly reduced.

I think it can safely be stated that with the excellent ouput transformers now available, which allow 20 db of overall feedback with good stability, there is no longer any reason to use triodes in amplifiers up to 100 watts.

My statement concerning the plate-to-grid feedback was that I doubted that it was effective in reducing the total distortion in the amplifier. I will remain of this opinion until I see some facts and figures to prove the opinion wrong.

To show that 36 db of feedback is superfluous I have enclosed a graph comparing one of my 6L6 amplifiers with data on the ampli-



fier published by Mr. Knapp in *Radio and Television News* for May, 1954. Since my amplifier is running with a 300-volt supply it overloads at 18 watts. For anyone who must have over 20 watts, four

6V6's may be substituted for the two 6L6's. The higher distortion shown at the low end of the curve may to some degree be attributed to the fact that the i-d test setup gave a reading of 0.11 percent with no amplifier included.

This amplifier is stable with 0.02 μf across the 16-ohm load. It is also stable with the output terminals open-circuited and either output tube removed. Under this condition the remaining output tube may be driven to clipping level without high-frequency blips or motorboating appearing.

The statement that doubling the gain of one 6L6 will cut the interstage impedance in two, thus halving the gain of the associated 6AU6, is not true in a push-pull circuit with coupling between halves of the primary. If the coupling between halves of the primary is near 100 percent the impedances offered to the plates of both of the 6AU6's will be lowered about 30 percent. Neither of the balanced feedback loops has any tendency to restore any push-pull unbalance resulting from a change in tube characteristics. . . .

I am still of the opinion that 15,000 ohms is a very low load for a 6AU6. Plotting a load line and a transfer characteristic will show that there is considerable second-harmonic distortion. Although this distortion may be balanced out to a considerable degree, it seems much more desirable not to generate it in the first place where it can be avoided.

Mr. Diamond mentions substitution of different type tubes with negligible effects. It would be interesting to see some figures on just how negligible this effect is. Listening is not a very accurate test for power output or distortion. It is reiterated that the two balanced feedback loops do not stabilize the gains of the individual halves of the push-pull circuit and therefore have no tendency to correct for push-pull unbalance. . . .

If the two 6L6's are considered as generators in parallel feeding one load, it must be appreciated that the impedance of these generators is not constant but varies with a variation of the balance of the excitation of the two grids. If

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by some chance the excitation to one tube is reduced in relation to the excitation of the other its internal impedance is raised.

If there is no grid voltage on one 6L6 it will appear as just a 30,000-ohm load across the other. If one 6AU6 deteriorates below the point of offering no signal to its 6L6, the feedback circuit tends to excite the 6L6 180 degrees out of phase with the desired signal, thus tending to reduce the voltage across the output transformer to zero.

The feedback from the output plates to the output grids has a tendency to multiply any unbalance which takes place between the transconductances of the 6AU6's due to age or changing line voltage. It probably results in little or no reduction in distortion, and it is not necessary for the reduction of output impedance. It therefore has more disadvantages than advantages and should be eliminated. The feedback from the output plates to the driver cathodes is useful to reduce distortion; it does not affect the balance or unbalance of the circuit but it does mitigate against the use of self-balancing provisions in the driver stages. It would be improved by increasing the current feedback in the driver circuits, thus making the gains of the two halves more independent of the driver tube characteristics.

The overall feedback loop does the most desirable work and therefore should be increased to the maximum that stability will allow. To permit the greatest amount of overall feedback it is desirable to keep to the minimum the number of stages included within the loop. I consider that the type of amplifier suggested in my previous letter is the easiest way to get adequate power with low distortion and I think that the test information I have collected verifies this.

I would like to see some curves showing the intermodulation distortion versus output power for Mr. Diamond's amplifier when a 6CB6 tube has been substituted for a 6AU6 with the signal balance control set at the optimum position for a 6AU6, and the curve for the amplifier without the plate-to-grid feedback loops connected.

W. B. BERNARD
San Diego, California

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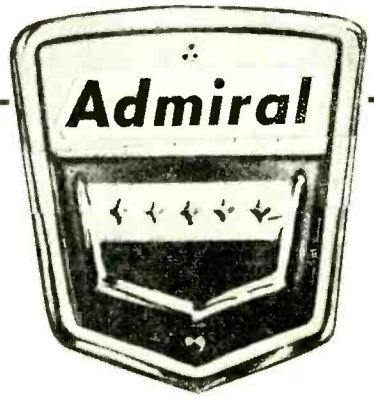

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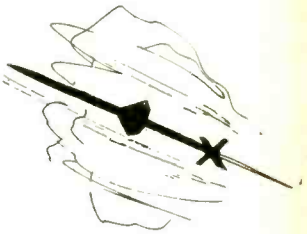

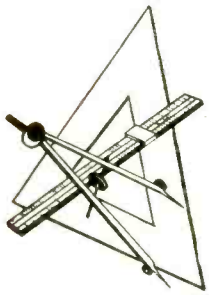

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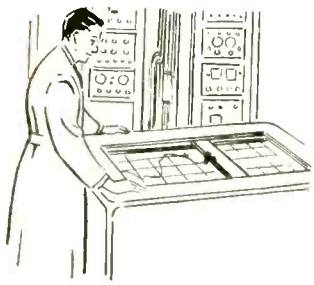

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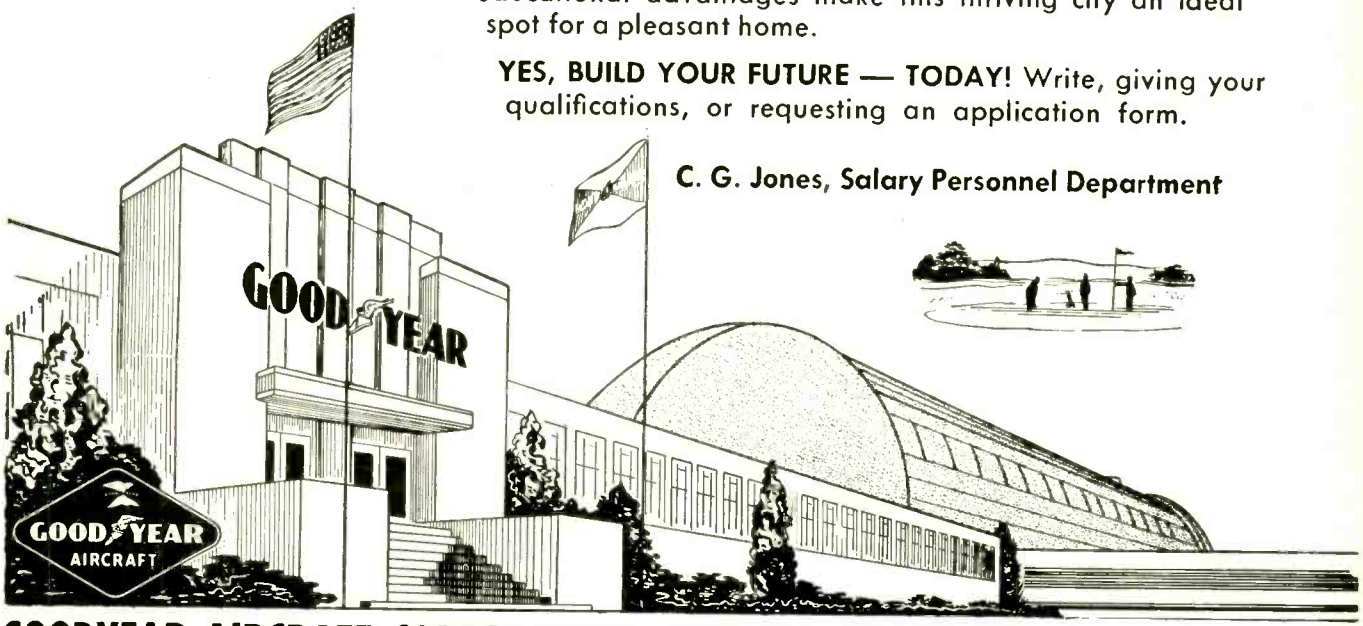

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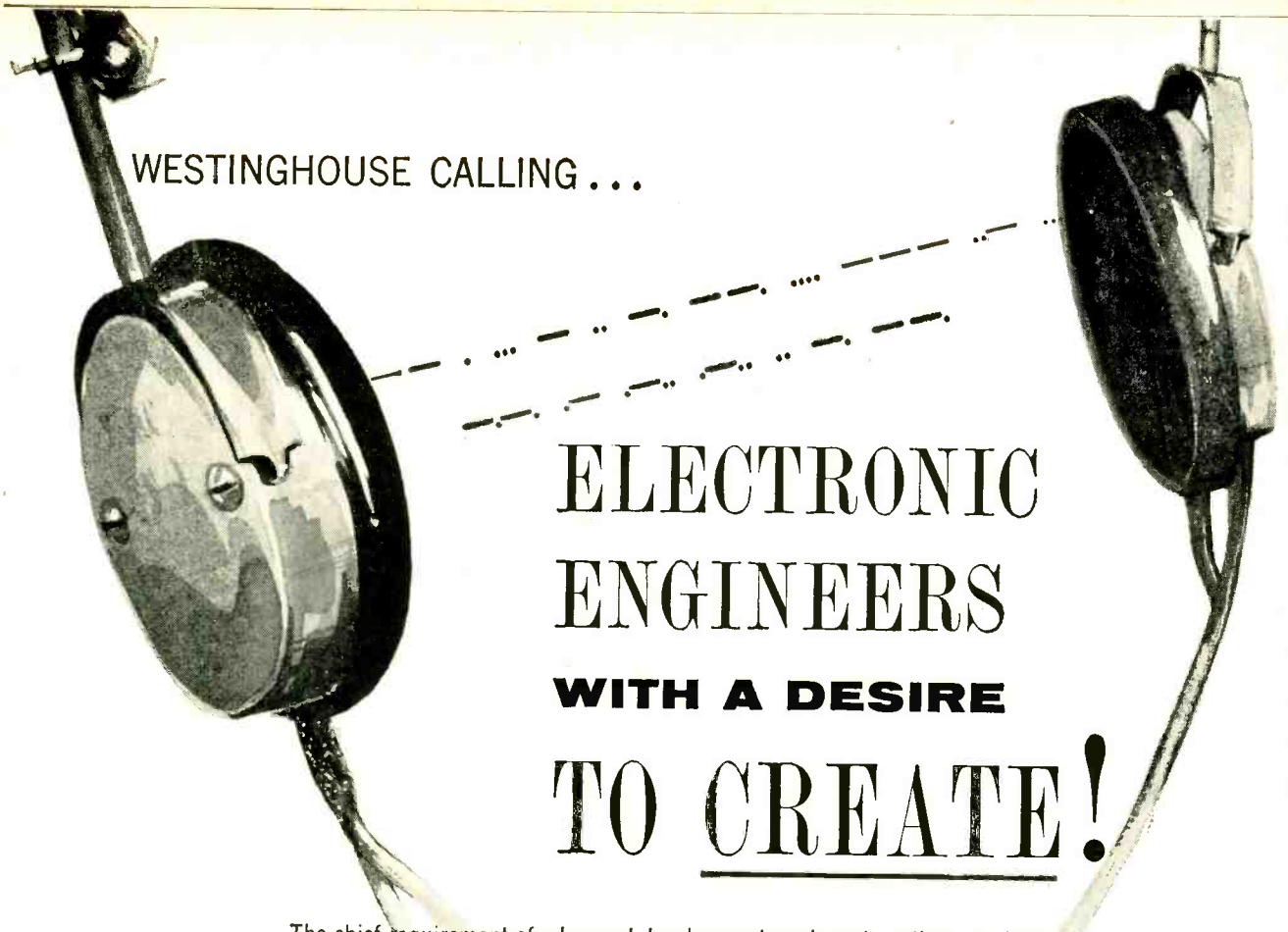

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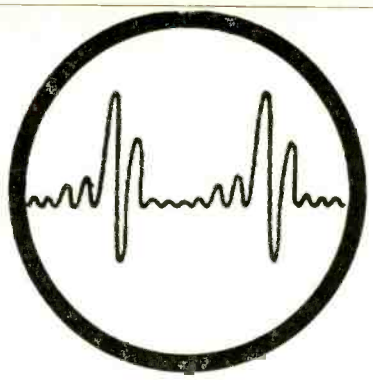

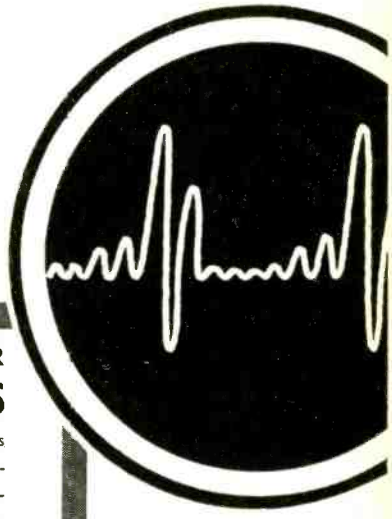

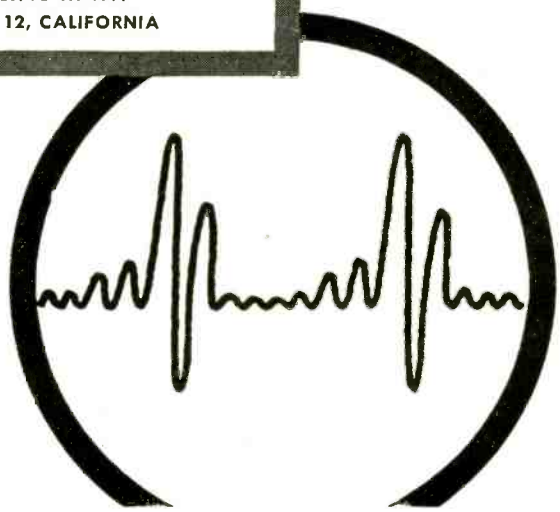

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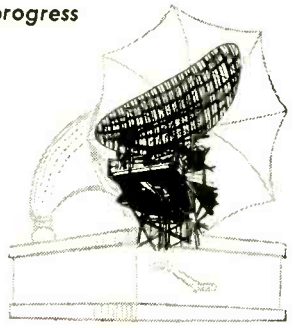

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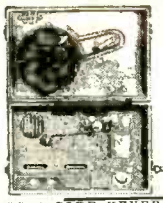

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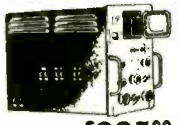

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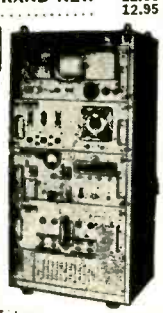
New Complete I.F.F. Equipment RC-188-A



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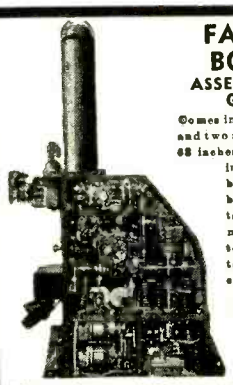
FAMOUS B-29 BOMB SIGHT
ASSEMBLED BY SPERRY GYROSCOPE CO.



Comes in three units—the main body and two attachable periscopes, 22 and 68 inches high, alternate parts of an intricate optical system made by Eastman-Kodak Co. Main body is 35x25x14 inches. Contains at least 8 27 VDC motors, electric heater and temp. control, precision sextant, dozens of switches and controls, hundreds of fine gears and driving rods all types. Shipping wt. 250 lbs.

Cost to U.S. Govt. $21,000
Your Cost **$129.50**
Brand New

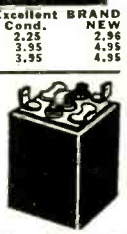
BC-375 TRANSMITTER

A famous transmitter, originally cost $1800. Yours, for a small fraction! Shpg wt 275 lbs. Complete with tubes.
Brand New .. **$49.50**
Used, Excell. Cond. **$29.50**

TUNING UNITS FOR BC-375

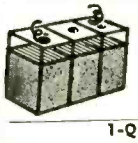
Type	Excellent Cond.	BRAND NEW	Type	Excellent Cond.	BRAND NEW
TU-10,8	$2.25	$2.95	TU-7	2.25	2.96
TU-9	2.25	2.95	TU-6	3.95	4.95
TU-8	2.25	2.95	TU-5	3.95	4.95

GOULD 6-VOLT STORAGE BATTERY



15 Amp. Hour Rating Navy Standard Black Rubber Case, **BRAND NEW** **$5.95**

WILLARD 6-VOLT Midget Storage Battery



3 Amp. Hour. BRAND NEW. 3⅛" x 1-15/16"x2 -⅜". Uses Standard Electrolyte only **$1.85**

WILLARD 2-VOLT STORAGE BATTERY
20 Amp. Hour. BRAND NEW. Transparent plastic case **$1.95**

1-QUART ELECTROLYTE
enough for two cells. Bottle **$1.45**

HEADPHONES

Smashing price reductions!

Model	Description	Excellent Used	BRAND NEW
HS-23	high impedance	$2.25	$4.35
HS-33	low impedance	1.79	4.65
HS-30	low imp. (featherwt)	1.49	1.85
H-16/U	high imp (2 units)	2.75	7.95
CD-307A	cords, with PL55 plug and JK26 jack		.88

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	Carbon hand mike	$5.45	$7.95
T-30	Carbon Throat Mike	.33	.69
T-45	Navy Lip Mike	.....	1.28
RS-38	Navy Type	1.95	5.95
T-24	Carbon mike	.....	3.95

FULL WAVE SELENIUM RECTIFIER
110 V at 150 mil's ..... **59¢**

BEACON RECEIVER BC-1206-C

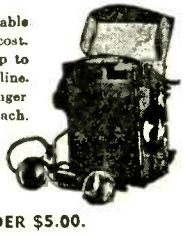
Complete with 5 tubes. Tunes 195 KC to 420 KC. IF Frequency—135 KC. Receiver Sensitivity—3 Microvolts for 10 Milliwatts output. Output Impedance—300 Ohms and 400 Ohms. Volume Control—RF Gain Control. Power Supply—24-28 Volts Aeroplane Battery, Current —.75 Amperes.

BRAND NEW **$11.95**

HANDSET

Cradle-type handset with butterfly switch, unbreakable black plastic, 4-ft 3 wire cable, individually packed, each **$2.95**

EE-8 FIELD PHONES



Talk as far as 17 miles. Dependable 2-way communication at low cost. Ideal for home, farm, field. Up to six phones can be used on one line. Each phone complete with ringer Originally cost govt. $65.00 each.

Excellent Condition
Your cost **$17.95**

Please include 25% Deposit with C.O.D. Order. MINIMUM ORDER $5.00.
All Shipments F.O.B. our Warehouse, N. Y. C.

MURRY'S RADIO

"Serving the Electronics Industry Since 1920"

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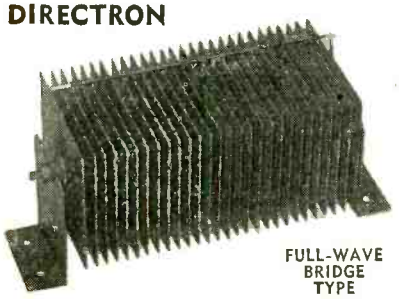
CORTLANDT 7-4605

Immediate Shipment from one of the Most Complete Inventories of

SPECIAL PURPOSE, TRANSMITTING, RADIO AND TV RECEIVING TUBES

DIRECTRON



FULL-WAVE BRIDGE TYPE

SELENIUM RECTIFIERS

Max. Amps	18/14 Volts	36/28 Volts	54/42 Volts	72/56 Volts	130/100 Volts
1	1.40	2.40	3.80	4.60	8.50
2	2.10	3.00	5.40	6.00	10.50
2½	3.00	4.20	6.00	8.00	13.00
4	3.75	7.50	11.50	14.50	25.25
6	4.50	9.00	13.00	17.50	33.00
10	6.60	12.75	20.00	25.00	42.50
12	8.20	16.25	22.50	30.00	46.00
20	13.25	25.50	38.00	49.00	79.50
24	16.25	32.50	45.00	58.00	86.50
30	20.00	38.00	57.50	72.00	.....
36	25.00	48.50	66.00	88.00	.....
50	32.00	62.50	.....	.....	.....
100	60.00	120.00	.....	.....	.....

We Build other Selenium Rectifiers, Transformers and Chokes to your specifications. Buy from the Direct Source for Quick Delivery.

NEW RECTIFIER TRANSFORMERS

Pri: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 Volts.
Continuous Ratings

4 Amps.....58.75
12 Amps.....16.75
24 Amps.....35.75
30 Amps.....45.00
50 Amps.....59.75

New—1 & 2 amp. Write for Prices, Specs.

NEW RECTIFIER CHOKES

1 Amp	.1 Hy	1.5 ohm 3.95
2 Amps	.04 Hy	.9 ohm 4.15
2½ Amps	.01 Hy	.1 ohm 4.95
4 Amps	.07 Hy	6 ohm 7.95
12 Amps	.01 Hy	.1 ohm 14.95
24 Amps	.004 Hy	.025 ohm 29.95

FILTER CAPACITORS

Capacity	W. Voltage	Each
500 MFD	200 V.	$1.95
500 MFD	50 V.	.85
1000 MFD	15 V.	.35
2000 MFD	50 V.	2.25
6000 MFD	15 V.	1.50

3,000 VOLT MULTITESTER

AC: 0-15, 150, 750, 3000 volts.
DC: 0-15, 75, 300, 750, 3000 volts.
DC MA: 0-15, 150, 750 ma.
Resistance: 0-10,000, 100,000 ohms.
Complete with battery, test leads. Only 3½" Wx 4½"Hx1¾" deep. Brand new Only $9.95

TUBE CARTONS

Two-Colored Cartons With New Safety Partitions —Super-Glass Red and Black Carton is the Most Distinctive Box Available Today.

SIZE	EACH	SIZE	EACH
Miniature 6AU6, 6AL5, etc.	$ .01	LARGE GT 1B3, 6BQ6GT, etc.	.015
GT	.012½	LARGE G	.02
6SN7, 6W4, etc.		5U4G, 68G6G, etc.	

"Quantity Users—Buy These Cartons by the Case. Write for Quantity Discounts."

Terms: F O B—N Y C—25% Deposit with order—or send full remittance to save C O D charges—D & B Rated Firms (F2½ or Better) Net 10 Days. CABLE BARRYLECT, N. Y. TELEGRAPH BARRY ELECTRONICS, FAX, N. Y.

Hermetically Sealed Chicago Transformer Co. Components

Class 1A (The *Very Best*)
All in Telephone Black Finish

● **Power Transformer** Cat. No. PHC-200
Primary: 117 v 50-60 cycles. Delivers 390 volts DC (after choke) @ 200 MA. Also delivers 6.3 VCT @ 4.5 amps, 6.3 volts @ 1 amp, and 5.0 volts @ 3 amps.
Test Volts: 2000.....$6.95

● **Choke to match above** Cat. No. HM-12200
9.6 Henries at 200 MA.....each $4.75

● **Filament Transformer** Cat. No. FH-610
Primary: 115 v or 230 volt—50-60 cycles. Secondary: 6.3 VCT at 10 amps.
Test Volts: 2500.....$4.95

● **Power Transformer** Cat. No. PHC-70
Primary: 117 v, 50-60 cycles. Delivers 320 volts DC (after choke) @ 70 MA. Also delivers 6.3 VCT @ 3 amps and 5.0 volts @ 2 amps.
Test Volts: 1750.....$3.95

● **Choke to match above** Cat. No. PH1585
12 Hy @ 85 MA.....$2.75

● **G E Transformer** Cat. No. 2PB2C1
Primary: 115 v, 60 c—Secondary 15 v, 12 amp.....$6.95

SUPER SPECIAL! 3000 Volts DC—330 Ma.

BASIC COMPONENT POWER SUPPLY KIT

Contains:
- 3500 V. AC. XFMR @ 400 MA. Primary—115 V., 60 c.
- 400 MA. Matched Smoothing Choke.
- 115 Volts Primary Bridge Filament for Four 866-A's.

Complete Only $39.95

Also These Individual Components for Sale—Write

RADIOSONDE 500 Pieces Meteorological Transmitter

Type T-49C. Uses RCA 3A5. Complete with tube, antenna, battery harness. Brand New **Only $1.75**

Miniature High-Voltage Converter For Geiger Counter

- Operate your geiger counter from standard 1½ volt flashlight cells.
- This compact powerful unit converts regular battery voltage to 900 volts for direct operation of geiger counter tubes. Actual range of output is 0 to 7,000 Volts AC (easily rectified and regulated with circuits supplied) so that any type of geiger counter or photo multiplier tube can be operated from unit. Weighs only 4 ounces and small enough to fit in the palm of your hand.

$10.00 each with instructions

WE ARE WORKING ON A COMPLETE KIT USING THIS CONVERTOR PLUS OTHER PARTS TO BUILD A SENSITIVE, HIGH QUALITY GEIGER COUNTER.

100 Amp (Fan Cooled) SELENIUM RECTIFIER STACK

Input: Up to 10—0—10 V.A.C.
Output: 7½ V.D.C.

This rectifier will handle 50 amps, convection cooled, or up to 150 amps, fan cooled, depending on air flow. $11 each in lots of 3 or more..... **$11.98**

FAST CHARGER STACKS MADE TO ORDER — 48 HOUR SERVICE

Victoreen Voltage Regulator VXR-130, subminiature. Brand New. Users net cost $5. Quantity in stock .....only **75c**

Western Electric Steel Blank Panels. 10½" high, 19" wide, ⅛" thick. Brand new, individually boxed. W.E. No. 296 A & B, in commercial grey or telephone black. Special .....each **85c**

Johnson No. 122-101, 829B, 3E29 Ceramic Sockets, only **69c**

NEW 6MFD 600 VDC Oil Capacitors **85c**

BC-160 Filter Choke, 20 Hys.—300 MA—125 ohms resis, insulated for 15 kv..... **9.95**

Jefferson Filament Transformer, 115 v, 60 cycle input secondary, 20 v at 10 amps. Brand new, boxed **8.95**

1A7GT		$ .30
1C6GT		.11
1H4G		.11
1N21		.30
1N38A		.65
1P30		3.00
2E26		2.50
2K55		29.50
3BP1		2.95
3BP11		2.95
3DP1		1.95
5BP1		1.95
6F4		2.75
FG17		3.90
7C25		120.00
FG32		3.90
RK62		1.75
215A		3.00
251A		3.00
359A		2.00
403B/5591		3.00
404A/5847		9.90
407A		2.50
408A		2.50
416A		45.00
416B		55.00
417A/5842		12.00
434A		8.50
471A		1.25
503AX		1.25
WL530		16.00
702B		1.95
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4X500F	Orig. Box Surplus	$65.00
304TH 304TL	Surplus, New Lab. Test @ 3000 V Guaranteed	$6.75
872A	$1.75 • 872A-GE	$2.50

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Over 10,000 Sq. Feet to Give You Even Better Barry Service

6AK5W	Original Box Tungsol—RCA—Raytheon	$1.15
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750TL	Surplus JAN, Eimac	$49.00
6J4	RCA Commercial $4.25	RCA JAN $4.50

Many Other Types in Stock.
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Authorized Distributors for Eimac, Westinghouse (WL) CBS-Hytron (CBS), Cetron, Lewis & Kaufman and Penta Tubes.

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OA3/VR75 .75	3B25 2.50	10Y .25	272A 5.00	717A .75	991/NE-16 .35
OA5 3.25	3B26 3.25	12A6 .25	274A 4.75	719A 10.00	CK-1005 .25
OB2 .75	3B28 3.00	12GP7 15.00	274B 1.50	721A 1.50	CK-1006 1.00
OB3/VR90 .75	3C23 4.00	12J5WGT 2.50	275A 5.00	722A 1.50	R-1100 5.00
OC3/VR105 .75	3C24/24G 1.50	12L8GT .50	276A 3.75	723A/B 12.00	R1130B/
OD3/VR150 .50	3C45 6.00	15E 1.50	282A 5.00	724B .75	1B59 10.00
C1B 2.00	3D21A 6.00	15R .25	283A 3.50	725A 7.50	1500T 75.00
1B22 1.00	3D22 9.75	FG-17/5557 3.00	286A 6.00	726A 10.00	1603 4.00
1B23 3.75	3DP1A 7.50	RK-19 1.50	304TH 6.00	726B 30.00	1611 2.50
1B24 3.50	3E29 9.00	RK-20A 12.50	304TL 5.00	726C 30.00	1612 1.50
1B27 8.75	3EP1 1.50	RK-21 1.25	305A 3.50	728AY-GY 10.00	1613 .75
1B32 1.00	3FP7A 5.00	RX-21 5.75	307A/	730A 15.00	1614 1.25
1B35 4.75	3GP1 2.50	PJ-22 1.75	RK-75 1.00	801A .25	1616 .50
1B42 6.00	3HP7 3.00	RK-23 3.00	310A 2.75	802 3.00	1619 .25
1C21 1.50	3KP1 7.25	FG-27A 4.50	311A 5.00	803 2.00	1622 1.50
1P23 1.50	4-65A 12.50	28D7 .75	313C 2.00	804 12.50	1624 1.00
1P24 1.50	4AP10 3.75	28D7W 2.00	316A .50	805 2.75	1625 .25
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1Z2 2.00	4B27 3.50	FG-33/	327A 3.50	809 2.75	1630 .50
VG-2 10.00	4B31 25.00	5720 11.50	328A 3.75	810 10.00	1635 1.50
2AP1 5.00	4C22/	GL-34 2.00	329A 7.50	811 2.50	1851 2.50
2C21/1642 .50	HF-100 7.50	35TG 5.75	348A 4.50	811A 3.50	1852 .75
2C22/7193 .25	4C27/CV-92 5.00	VC-50 5.00	349A 7.50	812 2.50	1853 .75
2C26A .50	4C35 15.00	FP-54/	350A 3.00	813 10.00	1960 .50
2C33/	4E27 12.00	5740 44.00	350B 4.50	814 3.50	2050 1.00
RX-233A 1.25	4J34 25.00	HK-54 3.50	352A 15.00	815 1.00	2051 .75
2C34/RK-34 .25	4J35 75.00	RK-60/1641 1.75	353A 5.00	822 15.00	ZB-3200 100.00
2C39A 10.00	4J42 35.00	RK-62 1.75	354A 15.00	826 .50	R-4330 10.00
2C40 5.00	5BP1 2.00	RK-65/	355A 15.00	828 9.75	GL-5545 25.00
2C43 10.00	5BP2A 5.00	5D23 10.00	368AS 4.00	829B 9.00	5551/652 40.00
2C44 .50	5BP4 2.00	FG-67/	371A .75	830B 1.00	5556/PJ-8 6.75
2D21 .75	5C30/C5B 1.75	5728 13.00	F-375A 15.00	832 4.00	5610 1.25
2E22 1.50	5CP1 3.75	RK-73 .75	388A 1.00	832A 6.00	5645 6.50
2E24 2.25	5GP1 5.00	75T 5.00	393A 5.00	833A 29.50	5656 10.25
2E26 3.25	5D21 7.50	75TL 6.00	394A 2.00	834 7.50	5670 2.50
2J21A 3.50	5FP7 1.00	FG-81A 9.00	WL-417A 6.50	835 15.00	5696 1.25
2J22 3.00	5FP14 5.00	FG-95/	GL-434A 5.00	836 2.50	5725 2.75
2J26 4.75	5J23 25.00	5560 14.00	446A .75	837 .75	5801/
2J27 6.00	5J29 7.50	C-100D 2.00	446B 3.25	838 2.00	VX-33A 4.75
2J29 25.00	5J30 15.00	100TH 5.75	450TL 45.00	843 .25	5820 (See 2P21)
2J30 50.00	5J32 25.00	FG-105 17.50	WL-460 10.00	845 7.50	5827X 4.75
2J31 20.00	5JP1 12.50	RX-120 15.00	464A 3.00	845W 10.00	CK-5829 2.00
2J32 15.00	5JP2 7.50	VT-127A 2.50	WL-468 15.00	846 125.00	5933 8.00
2J33 15.00	5JP4 7.50	F-128A 50.00	SS-501 7.25	849 10.00	5963 1.00
2J34 15.00	5JP5A 7.50	HK-154 3.00	CK-510AX 1.25	850 10.00	5981/5650 50.00
2J36 60.00	5LP1 9.75	VT-158 15.00	527 15.00	851 25.00	R-7301 10.00
2J37 9.00	5R4GY 1.00	FG-172 20.00	WL-530 10.00	860 2.50	8002R 25.00
2J38 8.00	C6A 10.00	FG-190 3.50	WL-531 4.50	861 10.00	8005 4.00
2J39 6.00	C6F 10.00	HF-200 9.50	559 .75	866A 1.00	8011 .50
2J40 25.00	C6J 5.00	C-202 10.00	575A 15.00	868/PJ-23 2.00	8012 1.75
2J50 35.00	C6L/5528 7.50	203Z 5.00	WL-579B 12.50	869B 25.00	8012A 2.50
2J55 50.00	6AC7W 2.50	204A 5.00	KU-610 10.00	872A 1.00	8013 2.50
2J56 75.00	6AJ5 1.00	205B .50	HY-615 .50	874 .75	8013A 3.50
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2K25 15.00	6BM6 45.00	217A 2.00	686 25.00	885 1.35	8025 2.00
2K33A 60.00	6C21 12.50	WL-218 25.00	701A 2.75	902P1 6.00	8025A 3.50
2K41 75.00	6G4/	220C 182.50	702A-B 1.00	917 2.25	PD8365 50.00
2K54 25.00	X-102B 2.50	221A .75	703A 1.75	918 1.75	9001 1.00
2K55 15.00	6J4 4.00	235R 50.00	704A .75	920 2.50	9002 1.00
2P21 (Image Orthicon) 250.00	6L6GAY 1.50	249B 4.00	705A .75	922 1.00	9003 1.00
	6Q5G 3.25	250R 5.00	706AY-GY 20.00	923 1.00	9004 .25
2X2/879 .25	6SB7Y 1.00	250TH 17.50	707A 3.50	925 1.75	9005 1.50
2X2A 1.25	6SC7GTY 2.00	250TL 15.00	707B 7.50	927 1.50	9006 .25
3A4 .50	6SK7Y .50	251A 35.00	708A 1.00	931A 3.00	9906R 1000.00
3A5 .50	7BP7 1.50	252A 15.00	709A 1.50	954 .25	
3AP1 5.00	7C29 65.00	253A 3.50	713A .50	955 .35	
3B22 1.50	7CP1 15.00	257A 2.00	714AY 17.50	956 .35	
3BP1 2.00	9GP7 3.75	264C 3.00	715A 2.00	957 .35	
3B24 2.75	9LP7 1.75	267B 6.00	715B 3.00	958A .50	

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG 48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices.....$27.50

10 CM ANTENNA ASSEMBLY: 3000-3300 Mc. Parabolic Dish, 29 inch Diam. Fed from dipole Rotation: 360 Deg. Azimuth at speeds of 20 and 10 RPM. Tilt: 20 deg. above and below horizontal. Motor-Driven by 2-28V motors. 4.5 A Total Drain. Azimuth info. is fed to selsyn mechanism, and elevation data is obtained from Azimuth potentiometer. Net weight 65 lbs.....$78.50

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" output connectors.....$22.50 EACH

LHTR, LIGHTHOUSE ASSEMBLY. Parts 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 approx. 2400-2700 MCS. Silver Plated.....$22.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each.....$27.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplex Cavity, gold plated.....$45.00

721A TR BOX complete with tube and tuning plungers.....$12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 2700-2900 Mc.....$4.00

WAVEGUIDE to ⅞" Rigid Coax "Doorknor" Adapter Choke Flange Silver Plated Broad Band.....$32.50

AS14A AP-10 CM Pick Up Dipole with "N" Cables.....$4.50

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—less tubes.....$24.00

BEACON 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" PLANE BENDS, 90 deg. less flanges.....$7.50

3 CM.—RG 52/U Waveguide

FLEX. WAVEGUIDE SECTION, 1 ft. long. With UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc, and VSWR is less than 1.02.....$7.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute Elevation Scan: over 2 deg. Tilt: over 24 deg.....$85.00

Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal.....$22.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated.....**per length** $5.00

Rotating-Joints supplied either with or without deck mountings. With UG40 flanges.....**each,** $17.50

Bulkhead Feed-thru Assembly.....$15.00

Pressure Gauge Section with 15 lb. gauge.....$10.00

Directional Coupler, UG-40/U Take off 20db.....$17.50

MAGNET AND STABILIZER CAVITY For 2J41 Magnetron.....$24.50

Rotary joint choke to choke with deck mounting..$17.50

90 degree elbows, "E" plane 2½" radius.....$12.50

ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc.....$14.50

ADAPTER, UG-163/U round cover to special btl. Flange for TS-45, etc.....$2.50 ea.

ECHO BOX RF 3/AP

Cavity has a "Q" of 30,000 and is tuned by means of an internal 24 vdc motor. Unit is tunable over a range of 80 mc. When motor is left on, the tuning plunger goes thru the tuning range three times per minute. During the tuning motion, an eccentric cam on the mechanism causes an additional flutter action of the tuning disk at approximately 200 cycles per minute. This flutter range curves about 15 mc. This eliminates need of stopping the motor at the peak of the signal, and also gives a characteristic pattern to the echo signal. Input is to type "N" input jack.....

$125.

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.85
UG 40/U	1.25	UG 52/U	3.40
UG 40A/U	1.85	UG 52A/U	3.40

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.....$1.35

D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%, 1 Watt.....$1.35

D-166228 Disk Type 7120 Ohms @ 60° F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F., 1640 Ohms @ 120°F. $1.35

VARISTORS

D-167208	$1.35	D-171812	$1.63
D-171858	1.42	D-172155	1.50
D-168687	1.35	D-167176	1.25

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
35X.059	19	3.8	405	.095	$4.35
POSX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	22.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

‡ Less Filter. * Replacement for PE 94.
† Used, Excellent.

PE 94-C, Brand New.....6.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent.....$18.75

PE-218H: Input: 25/28 vdc, 92 amp. Output: 115V. 350/500 cy 1500 Volt-ampere. NEW.....$37.50

PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy, 500 volt-amps. Dim. 13 x 5½ x 10½ New.....$22.50

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
KS9608	1233VCT/.35MA. 1140VCT/.07A	$5.79
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, 6.3V 0.9A, 6.3V 25.A 6.3V/.08A, 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	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A—10KV Test	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-48852	700VCT/806MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300, VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.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 2MA	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	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	4.79
70G30GI	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	2.5V1.79A, 5V13A, 6.5V/6A, 6.5V/1.2A, D/O BC800	4.95
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V.6A, P/O BC-929	6.45
D163253	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

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345-9405	50		$8.75
2J22	3267-3333	265		7.50
2J26	2992-3019	275	.002	7.49
2J27	2965-2992	275	.002	13.50
2J29	2914-2939	275	.002	44.95
2J31	2820-2860	285	.002	21.50
2J32	2780-2820	285	.002	24.50
2J38*	3249-3263	5		8.50
2J39*	3267-3333	8.7		8.50
2J48	9310-9320	50	.001	24.50
2J49	9000-9160	50	.001	54.50
2J56*	9215-9275	50	.001	132.50
2J62†	2914-3010	35	.002	32.50
3J31	24-27KMC	50	.001	85.00
4J34	2740-2780	900		87.50
4J38	3550-3600	750	.001	125.00
4J42†	670-730	30	.003	169.50
5J23	1044-1056	475	.001	42.50
700B	690-700	40	.002	22.50
700D	710-720	40	.002	39.75
706EY	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
QK259†	2700-2900	800	.001	249.50
QK60†*	2840-3005	.100	CW	65.00
QK61†*	2975-3170	.100	CW	65.00
QK62†*	3135-3350	.100	CW	65.00

*—Packaged with magnet.
†—Tunable over indicated range.

MICROWAVE ANTENNAS

AT49/APR—Broadband Conical, 300-3300 MC. Type N Feed.....$8.95

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New.....$100.00

Discone 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.....$4.50

AS46A/APG-4 Yagi Antenna, 5 element array...$22.50

30" Parabolic Reflector Spun Aluminum dish.....$4.85

APS-34 Pillbox Antenna, waveguide input; 24,000-27,000 MC.....$22.50

TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable.....$125.00

AN-154 3 vertical dipoles working against a rectangular mesh approx. 3'v4'. Freq. 140-200 mc. with lobing switch (115v, 60 cy) and portable slatted crate. Extremely rugged.....$27.95

LP-24 Alford loop, for use with glide-path transmitters (MRN-1, etc.) 100-108 mc.....$32.50

PULSE NETWORKS

15A—1-400-50; 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp.....$22.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "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

H-616 10KV. 2.2 usec., 375 PPS, 50 ohms imp.. $27.50

H-615 10KV. 0.85 usec., 750 PPS, 50 ohms imp. $27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32 40H @ .08A, 21 KV 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

PULSE TRANSFORMERS

K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse. 4 KV; 1 usec. and .001 DUTY RATIO.....$6.50

54J318-1 3 wdgs. Ratio: 1:1:1, 1.10 uh/wdg. 2.5 ohms DCR.....$3.50

Westinghouse 4P37: Primary; 50 ohms imp. 750 v. Sec. 15 kv. 1000 ohms imp. Bifar filament trans. built-in deliveries 12.6 c at 2.5 amp. (pri. 115v. 400 cy.) $37.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL TRANS. "BUILT-IN".....$42.50

WECO: KS 9948: Primary 700 ohms; Sec. 50 ohms. Plate Voltage: 18KV, Part of APQ-13.....$12.50

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
Bifar: 1.5 amps. (as shown)..$62.50

GE #K2748-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. Bifar 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. Bifar: 1.3 Amp. Has "built-in" magnetron well.....$42.50

K-2461-A. 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 Bifar: 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.....$5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio. 3 MH. 6 ohms DCR per Wdg.....$5.00

68G711: Ratio: 4:1 Pri; 200V, Sec. 53V. 1.0 usec Pulse @ 2000 PPS. 0.016 KVA.....$4.50

TR1049 Ratio 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms.....$6.75

K-904695-501: Ratio 1:1. Pri Imp. 40 Ohms. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 005 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, UX-7307.....$5 ea.

W.E.: D-166310, D-166638, KS9800, D-163247

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.....$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

K-2450 Pulse-Inversion auto-transformer; primary 12 kv, 4 usec. Output: 14 kv @ 100 kw peak.....$34.50

PULSE EQUIPMENT

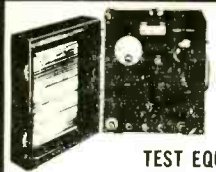
MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-72's, 1-73. New.....Less Cover—$135

ASD Modulator Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes.....$85.00

Airborne RF head, model A1A, delivers 50 Kw peak output at 900 mc. at .001 duty. Complete with pulser unit and all tubes.....$185.00

MAIL ORDERS PROMPTLY FILLED ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P.O.

131 Liberty St., New York 7, N. Y. Dept E-12 Chas. Rosen Phone: Digby 9-4124

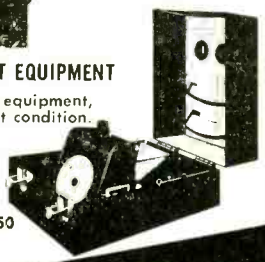


TS 45/APM...$99.50

Stock No. 01

TEST EQUIPMENT

Fine laboratory test equipment, used but in excellent condition.



TS 76/APM...$49.50

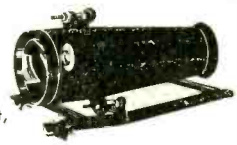
Stock No. 02

PIONEER TORQUE UNITS

TYPE 12602-1-A. Includes CK-5 Servo Motor coupled to output shaft thru 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY-43). Ratio of output shaft to follow-up autosyn is 30:1. Includes base mounting type cover for motor and gear train.....$34.95 ea.

Stock No. 03

LINK COLLIMATOR



An instrument used for projecting infinite light in the Link Navigational Trainer. Consists of a 5" acromat, 2-piece cemented lens with approximate 25" focal length. Includes a first surface mirror reflector. Used commercially for projecting infinite light in the alignment of precision optical instruments. May also be used as a telescope. Size: 14½" L. x 7⅜" W. Used, excellent condition. Original cost over $200.00 **$25.00 F.O.B. Pasadena**

Stock No. 04

TREMENDOUS SAVINGS IN ELECTRONIC

WAR TERMINATION INVENTORIES

SAVE UP TO 85% • IMMEDIATE DELIVERY • EQUIPMENT FULLY GUARANTEED

INVERTERS

PIONEER 12126-2-A
Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF Input: 27.5 volts DC; 1.25 amps.....$24.50

DMF 2506M CONTINENTAL ELECTRIC
24-30 volts input; 5.5-4.5 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; PF 1.0; 50 watts.....$39.50

10563 LELAND ELECTRIC
Output: 115 VAC; 400 cycle; 3-phase, 115 VA; 75 PF. Input: 28.5 VDC; 12 amps.....$39.50

PIONEER 12117
Output: 26 volts; 400 cycles, 6 volt amperes, 1-phase. Input: 24 VDC; 1 amp.....$19.95

ALTERNATOR, CARTER
Mfd. 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.....$29.50

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

PE 109 LELAND ELECTRIC
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp.....$65.00

MG153 HOLTZER-CABOT
Input: 24 VDC; 52 amps. Output: 115 volts—400 cycles, 3-phase, 750 VA and 26 volt—400 cycle, 250 VA. Voltage and frequency regulated.....$95.00

PIONEER 12130-3B
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated.....$69.50

12116-2-A PIONEER
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amp.....$39.95

10285 LELAND ELECTRIC
Output: 115 volts AC, 750 VA, 3 phase, 400 cycle, .90 PF and 26 volts, 50 VA, single phase, 400 cycle, .40 PF. Input: 27.5 VDC, 60 amps, cont. duty, 6000 rpm. Voltage and frequency regulated $59.50

10486 LELAND ELECTRIC
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amps; cont. duty.....$90.00

PIONEER 10042-1-A
DC input 14 volts; output: 115 volts; 400 cycle, 1-phase; 50 watt.....$39.50

10339 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.....$49.50

PIONEER 12147-1
Output: 115 VAC; 400 cycles; single phase. Input: 24-30 VDC; 8 amps. $49.50

MG 149F HOLTZER CABOT
Output: 26 VAC @ 250 VA: 115V @ 500 VA: single phase; 400 cycle. Input: 24 VDC @ 36 amps $49.50

EICOR CLASS "A" No. 1-3012/08-7
Output: 125 VAC; 400 cycles; single phase; 100 VA. Input: 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulator.....$49.50

PIONEER 12123-1-A
Output: 115V; 3-phase; 400 cycle; Amps .5. Input: VDC; 12 amp.....$69.50

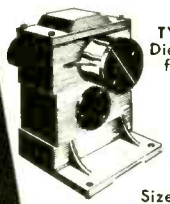
PRECISION GEAR ASSORTMENT

Select assortment of precise gears made by leading gear mfrs., e. g.; Boston, Western, etc. Includes brass, steel, aluminum and other materials in worm, spur, bevel, miter and wide selection of other types. Ranges from 16 to 64 pitch. Origin from Gov't termination contracts... mostly ¼" shafts. A $35.00 value.

Stock No. 05

50 gear asst......$ 5.00 ppd.
150 gear asst......$12.50 ppd.

GEAR REDUCTION UNIT



TYPE B181091 U.S. Ordnance, 22:1 ratio. Die cast aluminum case; precision steel to fiber to steel gears, minimum backlash. Ball bearing mounted shafts. Output (slow speed) is a 2" dia. metal coupling...Input shaft is a 1"dia. brass collar, interchangeable to ½" dia. x ⅝" L. shaft. Input and output direction of shaft is the same. Size: 7" L. x 5¼" W. x 7½" H. Wt. approx. 9 lbs.....$8.50

Stock No. 07

SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approximately 4" dia. x 6" long. Mfd. by Diehl and Bendix

QUANTITIES AVAILABLE

REPEATERS.....$20.00 ea.
TRANSMITTERS.....$20.00 ea.

SYNCHROS

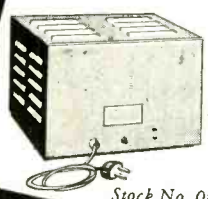
GENERAL ELECTRIC MOD. 2J15M1; 115-57.5 volts, 400 cycle.....$22.50
KOLLSMAN AUTOSYN MTR. TYPE-403; 32 VAC; 60 cycle; single phase.....$9.95
BENDIX AUTOSYN MTR. TYPE-851; 32 VAC; 60 cycle, single phase.....$9.95
MICROSYN UNIT TYPE 1C-006A.....$15.00
IF SPECIAL REPEATER; 115 volt-400 cycle.....$15.00
2J1F3 GENERATOR; 115 volt-400 cycle.....$10.00
5CT CONTROL TRANSFORMER; 90-50 volt; 60 cycle.....$45.00
5F MOTOR; 115-90 volt; 60 cycle.....$45.00
5SDG DIFFERENTIAL GENERATOR; 90-94 volts; 400 cycle.....$30.00
BENDIX TRANSMITTER TYPE C-78248; 115 volt; 60 cycle.....$22.50
DIFFERENTIAL TYPE C-78249; 115 volt; 60 cycle...$5.00
BENDIX REPEATER TYPE C-78410; 115 volt; 60 cycle $37.50
REPEATER, AC SYNCHRONOUS; 115 volt; 60 cycle..$9.95
DIEHL REPEATER TYPE FJE 22-2; 115 volt; 400 cycle; secondary 90 volt.....$27.50
5G GENERATOR; 115/90 volt; 60 cycle.....$45.00
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.....$50.00
2J5F1 SELSYN CONTROL TRANSFORMER; 105/55 volts; 60 cycle.....$22.50
2JD5HA1 SELSYN GENERATOR; 115/105 volts; 60 cycle $50.00
2J1F1 GENERATOR; 115/57.5 volts; 400 cycle.....$12.50
2J1H1 DIFFERENTIAL GENERATOR; 57.5/57.5 volt; 400 cycle.....$12.50
2J1G1 CONTROL TRANSFORMER: 57.5/57.5 volts; 400 cycle.....$7.50
2J5H1 SELSYN GENERATOR: Mfr. G.E.; 115/105 volts, 60 cycle.....$27.50

MAGNETIC AMPLIFIER UNIT

Stock No. 06

Mfr. Pioneer Instrument. **TYPE 12071-1-A.** 110 volts-400 cycle; 26 volts-400 cycles; 4-tubes (12AH7-GT); take-off for four autosyns. **29.95 ea.**

TELEGON OSCILLATOR



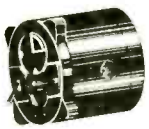
INPUT: 115 volts-60 cycle. **OUTPUT:** 26.5 volts, 400 cycle, 3-watts @ 250 ohm load. Ideal for laboratory use. Approximately 10" x 7" x 8", weight 16 lbs. **29.95 ea.**

Stock No. 08

Stock No. 09

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 amps. Unit has spline drive shaft and is self excited.....$29.95



Stock No. 10

BC-608-A INTERVALOMETER with E-231 Contactor Unit

Mfr. Sangamo Electric. Hand wound clock which controls contacts. Timer hand rotates at one rpm. Makes excellent timing device for laboratory and photographic applications. NEW...in original cartons. $2.95

ALTIMETERS, SENSITIVE

Stock No. 12

Pioneer sensitive altimeters...range 0-35,000 feet. Calibrated in 20 ft. increments. Includes barometric pressure setting adjustment. No hook-up required, ready to install in laboratory, auto or aircraft.....$12.95

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6 VDC 100 CFM—Single, #6100 ..... 7.50
6 VDC 150 CFM—Flange, #6150 ..... 9.95
24 VDC 10 CFM—Min.—Single #2410 ..... 5.95
24 VDC 20 CFM—Min.—Dual, #2420 ..... 7.95

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600 VCT/100 MA—6.3 V/5 A; 5 V/3 A ..... $ 4.95
650 VCT/50 MA—6.3 V/2.5 A; 6.3 V/.6 (Rect. 6x5) 1.95
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RECORDER, SIGNAL GENERATOR—AMPLIFIER, AND VOLTAGE REGULATOR UNIT of BC-968 TRAINER — Used for assimulated Radar identification when used with BC-412 Scope. Signal Generator generates various AC wave forms. Recorder was used to record difference in scope and generator wave forms as guided by operator. 110 Volt 60 cycle operation—with Manual. Shipping Weight: 270 lbs. Complete Unit. ..... **NEW: $59.50**
SIGNAL GENERATOR-AMPLIFIER Only $19.95
RECORDER Only .. $19.95—Cons. V. Regulator $12.95

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5D21NJ3A—27 VDC input; 115 Volt 400 cycle output. 1 Phase 485 VA. $39.50
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24 VDC REVERSIBLE MOTOR—3.7 RPM, 40 lb. Torque. Motor size: 5-½" x 4-1/32" x 3-5/16". Shaft size: 21/32" x 5/16". Also operates 24 VAC. Philco No. 441-1008. ..... $5.95

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GEARED HEAD MOTOR—110 Volt 60 cycle. 24 RPM. 1/100 HP. Right Angle Drive—Size: 7½" x 4" x 4". Shaft size: 3/16" x ¾" ..... **New: $9.95**

115 VAC 60 Cycle INDUCTION MOTOR—1.9 RPM. 75 Torque oz. in; 9 Watts—with variable Multi Disc. Coder Wheel & Micro Switch, mounted on bracket assy. Holtzer Cabot Motor Type RWC 2505 $9.95

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0-5 MA DC WESTINGHOUSE, 2½" Sq. $3.95

D-B METER—10 to Plus 6, G.E., 3½" Rd. $4.95

TS-291/U VOLTOHMMETER—Meter 3" square. 1000 ohms per volt. D'Arsonval Movement—0/300/600 VDC Scale and 0-1 Meg. Case size: 3½"x5¾"x 2¼". W/Test Leads P/O 1-56 Test Set **NEW: $7.95**

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RG-8/U 51.5 Ohm (Special)	.07	.06½	.06
WC-547 95 Ohm—Solid Cond.	.05	.04½	.04
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WC-550 95 Ohm—Twin Solid Cond	.08	.07½	.07
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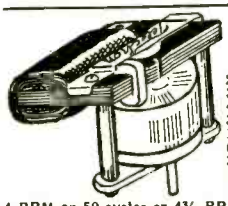
110v. 60 cycle 1 RPM 2.85
230V 60C 1 RPM 1.00
2 RPM 1.00



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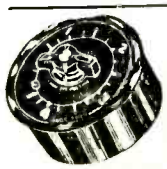

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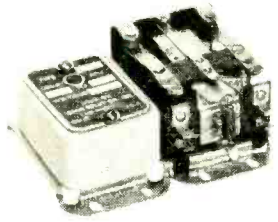

ADJUSTABLE THERMAL TYPE TIME DELAY RELAY

Operates on 115 V.A.C. Continuously adjustable delay from 5 to 20 seconds. ¼ Inch D.P.D.T. 12½ amp. contacts. Primarily designed for use with radio transmitters but has wide variety of other applications.
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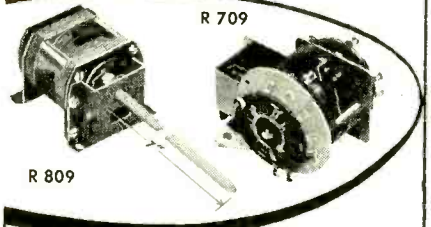

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Operates on 22 to 30 V.D.C. 12 Position driving mechanism operates through 360° in progressive steps. Indexes one position for each momentary current impulse. Attached wafer switch may be used for self interruption. 7 inch flatted shaft will drive pulley, gear or one or more wafer switches.
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1LA4	.50	6AQ5	.45	6SF5	.55	14C7	.64
1LA5	.64	6AS7G	3.35	6SL7GT	.55	19	.65
1LC5	.64	6AT6	.34	6SN7GT	.55	25L6GT	.44
1LG5	.79	6B8	.55	6SK7GT	.44	26	.44
1LH4	.65	6F5	.33	6SQ7GT	.42	28D7	.77
1P5GT	.34	6F6	.50	6T8	.59	30	.75
1Q5GT	.64	6F8G	.33	6V6GT	.50	35Z5GT	.40
2A3	.89	6G6G	.60	7A6	.22	37	.12
2A6	.49	6H6	.22	7C4/1203A	.12	38	.12
2X2/879	.22	6J6	.40	12A6	.29	43	.59
3B7	.35	6J7	.65	12A8GT	.39	46	.55
5R4WGY	1.25	6K7	.44	12B8GT	.29	57	.50
5X4	.50	6K8G	.60	12K8	.44	70L7GT	.85
5Y4G	.55	6L5G	.59	12SG7	.65	71A	.45
6 7 BALLAST	.29	6L6M	1.25	12SK7M	.45	76	.39
6AC7	.66	6L6GAY	.77	12SK7GT	.42	77	.45
6AG5	.53	6L7G	.39	12SL7GT	.55	89Y	.30

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1B35	3.25	7C4/1203A	.12	371B	.75	1629	.10
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1P23	.44	10	.19	374A W.E.	1.75	1632	.22
2C33/RX233A	.88	10 Special	.19	388A W.E.	1.75	1680	1.00
2C43	12.75	10Y	.19	404A W.E.	12.50	5691	5.00
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2J21	1.95	15R	.29	416 W.E.	Write	CK-5744	.77
2J21A	1.95	T20	2.00	417A W.E.	13.75	CK-5784	2.25
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2J32	9.95	23D4	.44	464	3.75	5825	5.50
2K28	20.00	30 Special	.22	CK507AX	.44	5933	7.50
2K31	77.00	FG32	1.00	575A	19.45	5964	.77
2K45	57.00	RK34	.29	705A	1.50	6035	10.00
2K56	55.00	35Tion Gauge	1.75	713A	.41	6038	3.85
2X2/879	.22	39/44	.22	715B	5.50	6045	1.00
3B7	.35	T40	2.00	717A	.55	6099	.77
3BP1	2.75	HY40Z	2.00	721A	1.00	7193	.14
3B24W	9.45	RK49	3.95	722A	.77	8002R	25.00
3B27	7.75	RK62	2.00	730A	12.50	8011	.44
3B29	9.45	VR65	.39	815	4.75	8012	1.95
4B28	3.75	RK72	.77	826	.55	8025	2.95
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5BP1	.99	F-127A	17.75	864	.17	38111A (Low capacitance 211 for crystal application)	.55
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5CP1	3.95	205B	.66	880	233.00		
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5FP7	1.75	211	.49	891	99.50		
		212A	.45	921	.39		
		215A W.E.	2.00	931A	3.35		
		249B	3.75	954	.14		
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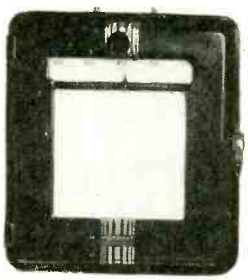

For fast and sensitive recording or controlling one or more points throughout a wide variety of processes. Used originally for temp. ranges of 350-550 Degrees cent. but may be changed for other applications by suitable control units. Control units not incl. with instrument.

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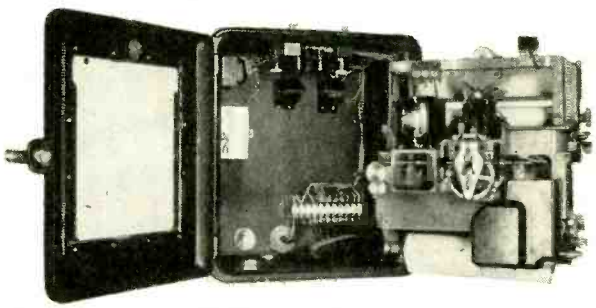
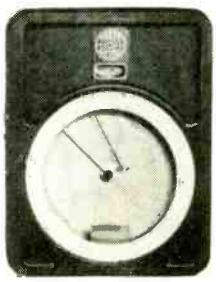


Price - - $89.50



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GUIDED MISSILE F-28/APN-19 FILTER CAVITY. 2700-2900mc. Max. 1.5-db loss at ctr. freq. over band, 3db at 15 mc band ends. JAN spec. Ideal as standard reference cavity. Brand new. Guaranteed. $25.00.
COAXIAL CRYSTAL MOUNT. Type N fittings, tuneable silver plated. Holds any IN21 type Xtal. $9.50.
LIGHTHOUSE CAVITY. For 2C40 tube. Tuneable 2700-2900mcs w/suitable grid cyls. Can be freq. modulated. $22.50.
FEEDBACK DIPOLE ⅞" coax. 1¾" o.a. $14.50.
ECHO BOX. TS-207/UP, 2700-2900mc. $64.50.

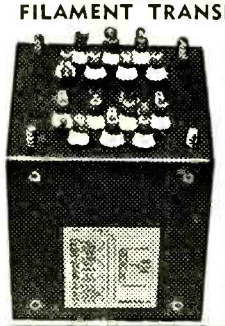
K BAND

MAGIC TEE, precision milled. . . . $45.00
DIRECTIONAL COUPLER bi-dir. UG-115 U flanges, $45.00
KLYSTRON OUTPUT COUPLING for 2K50. RG 66/U guide. $12.50.
H BEND 90 deg. CG346/U.
E BEND 90 deg. CG345/U. Cplg. UG-117 to UG-116. RG66 guide. $25.00 each.
ADAPTERS 1½" lg UG116 to UG116, UG117 to UG117 ea. $10.00

RADIO-RESEARCH INSTRUMENT Co.
550 - 5 Ave., N. Y. 36, N. Y. *Tel: JU 6-4691*
PAUL J. PLISHNER

HERSHEL RADIO CO. BIGGEST BUYS!

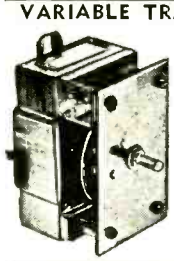
ALL PURPOSE FILAMENT TRANSFORMER



$4.95

Pri. 117 VAC 60 cy. Sec. #1 6.4V 12 Amp. #2 6.4 V 10 Amp. #3 5.0V 3 Amp. #4 5.0 V 3 Amp. #5 5.0V 3 Amp. #6 2.5V 1.75 Amp. Size 5-9/16" x 5-1/16" x 5¼" H.

VARIABLE TRANSFORMER



$4.95

Pri. 115VAC. 4 Amp. 50-60 cy. Sec. 30 to 135V. .25 Amp. Used with Dictaphone Reproducer MFD. U.T.C.

A—TELEPHONE SW. BOARD LITE TYPE 55C. 55V. G.E. 15c
B—ARGON GLOW-LAMP 2½ WATT 105-125V. MED. BASE. 35c
C—CE. PHOTO ELECTRIC CELL USED IN AMPRO PROJ. $1.29
D—BC614E SPEECH-AMP. $49.50

HERSHEL RADIO CO.
5245 Grand River Ave.
DETROIT 8, MICHIGAN

RCA OUTPUT TRANS.

$1.95

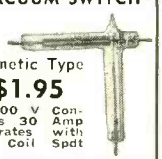
PP 6L6's 25 Watt Pri. 5,000 Ohm Sec. #1 500 Ohm #2 600 Ohm Sidetone 15 to 15,000 cy Flat.

PLATE TRANS.

Only **$9.95**

Pri. 90 VAC 60 cy 3 Amp. Sec. 6400 V. .1 Amp 6¾ x 5¾ x 6¼ H.

VACUUM SWITCH



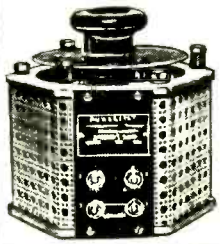
Magnetic Type **$1.95**

15000 V Contacts 30 Amp Operates with DC Coil Spdt

WILLARD BATTERY **$2.65**

2 Volt Wet 20 AMH

POWERSTAT



15 AMP **$29.95**

Pri. 115 V 60 cy Sec. 0-135 V-2KVA 15 Amp. Brand New.

BUTTERFLY COND.

TYPE A 106 to 330 MC Can Use 955 Type Tube

TYPE B 135 to 485 MC Silver Plated

TYPE C 300 to 1000 MC can use 368AS tube. Silver Plated

YOUR CHOICE $4.95

TYPE D 300 to 1000 MC has clip for Xtal Detector

INDEX TO THE SEARCHLIGHT ADVERTISERS

DECEMBER, 1954

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SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

ADVERTISERS INDEX

(Continued on opposite page)

INDEX TO THE SEARCHLIGHT ADVERTISERS

DECEMBER, 1954

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.

(Continued from opposite page)

OIL CONDENSER SPECIAL

10 MFD 600 VDC **$1.75 ea.**

LOTS OF 3

Case Dimensions, Not Including Insulators, 4½"H—3¾" W—1¾" D. Less Than 3 ... $1.98
2 MFD 600V 49c: 10 For $3.50

SELSYNS—SYNCHROS

AY1/Autosyn/26V/400Cy/E.P. ... $3.98 2 for $7
CK-2/Low-in-Servo Motor/E.P. ... 20.00
AY20/Autosyn/26V/400Cy/E.P. ... 4.98 2 for $9
C56776/Type 11-5/Syn RPTR/115V/60Cy ... $15
C69406-1/Type 11-2/Syn Rptr/115V/60Cy ... $21
C78248/SYN Xmtr/115V/60cy ... $12; 2 for $20
C78249/Syn Diff/115V/60Cy ... $7; 2/$12
2J1F3/Synchro Gen/115/57.5V/400Cy ... $9.00
2J1G1/Syn Tran/57.5/57.5V/400Cy ... $5; 2 for $8

OTHER TYPES IN STOCK
GET OR QTY PRICES

FILAMENT TRANS.

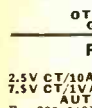
INPUT 115/60 cy

2.5V CT/10A 5 KVIUS ... $3.59; 3/14.00
7.5V CT/1VA CSD 15 KVINS ... $10.95; 2/17.50
AUTOFORMERS 230 TO 115V
For 220–240V/50–60 cy Input. To 110–120V or Step-up with Cord Plug & Receptacle.

TPA 050/50W ... $2.55	TPA 075/75W ... $3.65
TPA 100/100W ... 4.00	TPA 200/200W ... 5.75
TPA 250/250W ... 6.75	TPA 300/300W ... 7.25
TPA 750/750W ... 11.75	TPA 1000/1000W 16.95

GET OUR QTY PRICES

TRANSFORMER SPECIAL!!



6.3 Volt 3¾ Amp.
CONTINUOUS DTY
115VAC Input
SIZE 2 5/16H/2L/1½" W
HVY DTY CHANNEL MTG
INSUL WIRE LEADS
LOTS OF 12 EA ... 89c
QUANTITY OF 25 EA ... 85c
SOLD SINGLY SPEC ... 98c

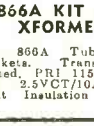
METER BARGAINS

0–1MADC/3½ Rnd/JAN ... $3.95 @ : 2 for $7
0–5MADC/3½ Rnd/JAN ... $3.70 @ : 2 for $6
0–100MADC/3½ Rnd/JAN ... $3.50 @ : 2 for $6
0–1MADC/3½ Sq/Weston ... $7.00 @ : 2 for $12
800VDC/3¼ Sq/Weston ... $8.95
1500VDC/3¼ Rnd ... $4.95
150VAC/2½ Rnd/WH ... $3.25
150VAC/3¼ Sq/WH ... $4.95
3 & 15 Amp/AC/Weston/Portable ... $5.95, Spl 3 for $15
15 Amp/DC/LAB Std Mirror Scale/1% ... $5.95, Spl 3 for $15
5MA/DC/Tuning Meter/AN ... $1.39; 2 for $4.00
Weston 120 MA/RF/3 Rnd/301 #$10.95, 2 for $20
Weston 50 Microamps/DC/3 Sq/301 # ... $14. 2 for $25
Weston VU-20 to +3/3" Sq/301 #$15.98. 2 for $30

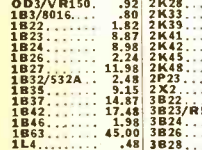
NEW RELAY LIST
Tremendous Bargain Prices

R1ST1 Stevens Arnold Resonant Relay $189 Freq 240 cy ... $3.98; 3 for $10
R4KU1 SPST/MIN/115VAC/4A CTS ... $1.39
R5KU2 SPDT/MINI/115VAC/4A CTS ... $1.69
R7CL1 Clare SK5010 VAC SLD/DPDT/18-28 VDC/3A CTS Octal Base ... $2.98; 3 for 7.50
R10SD1 S'Dunn SPST/115VAC/6-30ACTS. $2.00
R11AC2 Allied-BJ DPDT/115VDC/5A CTS $1.39
R12AC3 Allied-BJ DPDT/115VAC/5A CTS ... $1.49
R13LE1 Leach-DPDT/28VDC/5ACTS ... $1.98
R14AU1 DPDT & SPNO/124DC/10ACTS. $2.25
R17GM1 GM/SPST/24VDC/20A CTS ... $1.49
R18LE2 Leach/DPST/115VDC/10A CTS ... $1.49
R22AD1 Advance-4001 B/DPDT & SPNO/115 VDC/RF-Ceramic Insulation ... $7; 2 for $13.
Sellum Rectifier-FW 116VAC/40MA ... .79c
WRITE FOR QUANTITY PRICE & LISTING

GLOLITE



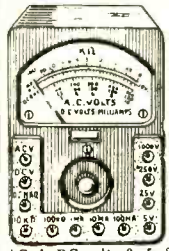
Combo TV Light & Electric Clock (w/color numerals) Provides proper backgrd light for TV viewing. Accurate, rotating numerals. Luminescent window. Walnut case. 12" appr. Size 5"x5½"x3½" "TAB" Special ... $7.95



866A KIT and XFORMER

(2) 866A Tubes & Sockets. Transformer Rated, PRI 115V/60cy Sec 2.5VCT/10A Hi-Volt Insulation $4.98

"TAB" THAT'S A BUY



NEW POCKET AC-DC VOM MODEL 12C

$9.35 ea.

LOTS OF 3

SOLD SINGLY $9.89

(plus 40¢ ship in U.S.A.)

Hi-accuracy precision pocket imported VOM 1000 ohm per/V. Read AC & DC volts 0, 5, 25, 250, 1000V DCMA; 0, 1, 10, 100MA, ohm 0, 10K, 100K Size 1¾" D. 4½" L, 3¼" W. Test leads.

Model TS-52 Smallest precision built VOM jeweled 3" D'Arsonval meter. 1000 ohms per/v. AC & DC volts 0, 10, 250, 500, 1000V. DCMA; 0, 1, 250MA. Ohms; 0–100K. Measures only 1½" D 4" L, 3½" W. Test leads ... $6.89

PRECISION RESISTORS
FOUR MILLION IN STOCK
Western Elec.-IRC-Wilkor-Mepco
All 1% Accuracy Gtd

ORDER ANY VALUE WE HAVE IT: REGULARLY SOLD FOR 69¢ AND UP
"TAB" SPECIAL 35c EACH: **25¢ Ea.**
10 OF ONE VALUE ... $2.00
10 OF ONE VALUE ... $2.00
10 ASSORTED VALUES (U-SELECT) ... $3.00
INDICATE SECOND RANGE, NO MFGRS CHOICE. WE SHIP TYPES IN STOCK

INFRARED SNOOPERSCOPE
SEE IN DARK TUBE

Image-Converter Tube Hi-Sensitivity simplified design 2" dia Willemite screen—Resolution up to 350 lin/in. Tube & Data "TAB" Special ... $10 2 for $18
Snooperscope Pwr Supply 1800VDC/35MA, Using Doubler Crkt, Transformer, Rectifiers, Sockets, Resistors Capacitors and Diagram 115V/60cy Oper. ... $6.98

106 WATT PHOTO-FLASH KIT—AC

Includes transf condensers two/525MFD/450V Total 105W/Sec Seeds. Resistors, capacitors, rectifier, flash tube in indicating flash gun, guide #40 on Kodachrome. Special ... $13.98

BATTERY 106 WATT/SCDS KIT

Same specs only batteries ... $32.98
525 MFD/450V/53 W'Seds conds new low leakage famous mfgr. ... $9 @ 2/$16
16 MFD/2500VDC/16WS Conds Oil. $6 @ 2/$10
10 MFD/1.8 to 2.8kV/60 WS Cond. ... $5 @ 2/$8.
CK5517 mini gas rectifier ... $2.88
600 VAC Selenium Rectifier ... $4.25
1600 VDC Selenium Rectifier ... $2.98
Electronic Flash Handbook ckt data ... 50c

"TAB" PHOTOFLASH LAMPS

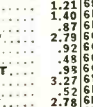
"Tab" No.	Replaces	W-Sec Max	Each
TWL	FA 10/FT118	125	$5.98
THL	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	11.98
TLX	DX & FA100	150	9.00
TDX	DXC/250-350	150	10.00
353GTQ	FT 503	2000	49.98
FT 108	GE FT105	150	4.29

TRIGGER COIL for Lo & Hi Volt Flash ... $1.47
Write For "Tab" Flash Tube Data 50¢

TEST EQUIPMENT

EMC Model #208P Tube Tester LN ... $21.95
EMC Model #106K VTVM Kit Demo ... $21.95
EMC Model #104 Multimeter (20,000 ohm PV) Demo ... $23.95
EMC Model #107 VTVM Demo ... $42.95
(LN) Like New (Demo) Demonstrator GTD

SMALL PARTS CABINETS



#9–11S Four Drawers, 3 Division Per Draw 9⅛"H/10⅛"W/11⅛"D ... $3.99 @ 4 for $14
#602 Four Drawer, 3 Div with 6 Div Each, One Drw Plain 6½"H/6W/8D ... $1.98 @, 4 for 57
#R4599 Personal Correspondence File, A-Z Index ... $2.98
Tool Box 3¾"H/10¾"W/6½"D ... $1.69 @, 4 for $6

NEW "TABTRON" SELENIUM RECTIFIERS
ENGINEERED FOR INDUSTRIAL USE

"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase, also magamps. Write for rectifier catalog.

Max Amps	* FULL WAVE BRIDGE 18VAC* 14VDC	36VAC* 28VDC	72VAC* 56VDC	130VAC* 100VDC	144VAC* 115VDC	266VAC* 217VDC	Ctr Tap AC/DC 30/12	3 Phase–Bridge 120VAC 150VDC	240VAC 300VDC
1	$1.35	$2.35	$4.60	$7.50	$12.75	$22.25	$2.10	14.90	28.95
2	2.00	2.75	6.00	9.25	15.75	28.85	Q	15.90	30.90
3	2.95	4.15	7.90	12.90					
4	3.50	6.50	14.50	22.00	26.75	38.85	2.95	18.90	36.95
6	4.10	8.00	17.50	29.95	34.75	54.85	3.25	20.90	39.95
10	5.95	11.50	25.00	41.50	44.75	84.85	4.75	36.90	71.95
12	7.50	14.50	30.00	44.50	54.75	99.85	5.95	41.90	81.95
20	12.00	23.00	49.00	72.00	82.75	160.85	7.95	50.90	97.95
24	14.50	29.00	58.00	83.50	94.75	190.85	9.95	89.90	159.95
30	18.00	34.50	72.00	110.00	128.75	235.85	Q	117.90	225.95
36	22.50	42.50	88.00	135.00	165.75	295.85	14.95	134.90	269.95
50	29.75	54.50	Q	175.00	195.75	405.85	23.95	179.90	359.95

New Rectifier & Transformer Combo
Sel/Bridge 115 Volt 60 cyc Input

up to 14VDC at 12 amps Cont. Duty ... $19.98
up to 28VDC at 4 amps Cont. Duty ... 14.98
up to 28VDC at 12 amps Cont. Duty ... 29.98
*up to 28VDC at 24 amps Cont. Duty ... 59.98
*up to 28VDC at 50 amps Cont. Duty ... 117.98
*up to 28VDC at 100 amps Cont. Duty ... 199.00
*Transformer has dual primary 115 & 230 v

NEW HIGH CURRENT POWER SUPPLIES GTD*

Variable 0–28VDC Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac Volt & Amp Meters, Switch, Terminals & Fuse. In Heavy Duty Steel Cabinet Standard 115V/60cy Input 220V & Others to Order. * One Year.

Stock# Number	Continuous Rating	With Meters
T28V5 A	0–28WVDC at 5 Amp	$45.00
T28V5ACC	5 Amp (1% Ripple)	60.00
T28V12A	0–28VDC at 12 Amp	89.00
T28V/12ACC	12 Amp (1% Ripple)	125.00
T28V24A	0–28VDC at 24 Amp	129.50
T28V/24ACC	24 Amp (1% Ripple)	175.00
T28V50A	0–28VDC at 50 Amp	239.50
T28V/50ACC	50 Amp (1% Ripple)	350.00
T28V100A	0–28VDC at 100 Amp	469.00
T29V/100ACC	100 Amp (1% Ripple)	650.00

T816 0–8 or 16 VDC Variable up to 10 Amps, rated 6 or 12 VDC Filtered. Continuous Duty ... $34.00
T2V2A BATT 2 VOLT CHARGER ... $3.98

NEW RECTIFIERS XFMRS

PRIMARY 115V 60cyc
SPEC 18–15–9–0–9–15–18 Volts

4 amp ...	$8.65; 2 for $15.75
12 amp ...	$16.65; 2 for $29.95
24 amp ...	$31.75; 2 for $69.95
30–32–34–36V/48A ...	59.50
50 amp* ...	$59.00; 2/$112
100 amp* ...	$108.00; 2/$210

18 Volt 2 amp ... $1.98
25.2V/2A or 12.6V/4A or 2X12.6V/2A Cased ... $3.59; 3/$10.; 12/$36
2¾"W/3¼"H/2¾"D ...
*DUAL PRIMARY 115 & 230 VOLTS 60 CY.

NEW RECTIFIER CHOKES

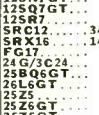
CH07/4 Amp/.07HY/.6 Ohm/10 Lbs ... $7.95
CH01/12 Amp/.01HY/.1 Ohm/12 Lbs ... $14.95
CH004/24 Amp/.004H/.025 Ohm/20 Lbs. $29.95
CH001/80 Amp/Hipersil Core ... $54 00

HI-FI SPEAKERS

All 8 ohm, V.C., Alnico V Magnets, Inbuilt Network, 2 wires needed for HF & LF Response Famous Hi-Fi Mfgrs.

15" Coaxial Pm 5 Tweeter. 25 watt/20–17500 cy. Model P25CO ... $23.75
12" Coaxial Pm & 3¼" Tweeter 12 watt/45–15KC. $12.75; $15
8" Coaxial PM & 2½" Tweeter, 8 watt/70–15000 cy Model F8CO ... $7.98; 2/$15
12" HI-FI PM 10 watt/35–14ko ... $10; 2/$18
8" HI-FI PM 7 watt/45–15ko ... $7.25; 2/$13
Tweeter 5"/12W/2–15ko/16 ohm ... $4.45; 2/$8
Tweeter 3½"/8W/2–15kc/8 ohm ... $3.25; 2/$6

RHEOSTAT SALE
Priced Below Manufacture



15 ohm 25W	$1.10; 10 for $7.00
50 ohm 25W	1.98; 10 for 14.00
60 ohm 50W	1.98; 10 for 14.00
75 ohm 25W	
W. Leonard	1.98; 10 for 14.00
100ohm 50W	1.50; 10 for 9.00
125 ohm 25W	1.10; 10 for 7.00
225 ohm 50W	2.98; 10 for 25.00
250 ohm 25W	1.10; 10 for 6.00
300 ohm 225 W Model P	2.98; 5 for 10.00
500 ohm 25 W Model H	1.10; 10 for 7.50
800 ohm 50 W Model H	1.98; 10 for 15.00
1200 ohm 225 W Model P	2.98; 2 for 5.00
2500 ohm 25 W	1.10; 10 for 7.00
5000 ohm 25W Model H	1.25; 10 for 9.00
350, 500, 5000 ohm 25W	79c; 3 for 2.00

DC POWER-SUPPLY

Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 60cy Output 6.3V or 12.6V 2 Amp.
Model 2DGF (2 amp) ... $12.98
Model 5DGF (5 AMP) ... $22.98

NEW BATTERY CHARGER
SELENIUM RECTIFIER

13–0–13V(CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Replacement 6 Volt Booster Charger. Model CR16 ... $10.98; 3 for $31
16–0–16V (CT) Fan Cooled. For 12V/60 Amp and 6 V/100 Amp Booster Chargers. Model CR30 ... $11.98; 3 for 533

THOR ELECTRIC DRILL
with Jacobs Geared Chuck and Key
Model 200J
¼" Workhorse

HI-torque (Powerful) UL apprvd. 2400 Rpm 115V AC/DC motor, self-aligning oilless ball thrust bearings and 9 drill bits ... $14.25
Model 79J ¼" Drill 600 Rpm &9 Drill-bits $20.95
Model 400J ¼" Drill 425 Rpm &9 Drill-bits 29.95

CHROME VANADIUM SPEED DRILLS

29 Drills Chrome Vanadium (C.V.) Speed Steel Top Quality for Machinists or All Purpose Use. 1/16 to ½ by 64ths. "TAB" SPECIALS ... 7.98
DRILLS, 60 Pcs 1 to 60 C.V. ... 5.95
DRILLS, 13 Pcs 1/16" to ½" C.V. W/Index 1.98
DRILLS, 12 Pcs 1/16" to ½" C.V. ... 2.98
DRILL INDEX Huot case for 29 pcs set. ... 1.98
DRILL INDEX Huot case for 60 pcs set. ... 1.49

We carry a complete line of CUMMINS, THOR & SKIL Drills & Kits; incl the CUMMINS "Do It Shop" 7 Power Tools in 1 Reg $79.95 "TAB" Special .. $64.95

VARIABLE VOLTAGE TRANSFORMERS
SUPERIOR-GR-STACO

0–135V/3A ...	$11.25
Cased/0–135V/7.5A ...	20.70
Uncased/0–135V/7.5A ...	16.20
Cased 0–270V/3A ...	23.40
Uncased/0–270V/3A ...	18.00
Cased/0–135V/15A ...	41.98
Cased/0–270V/9A ...	41.98
GR3A/0–135V/45A/LN ...	100.00
GR50B/0–270V/31A/LN ...	115.00

Write for Catalogue & Quantity Prices
(LN) Like New, Complete GTD.

AUDIO COMPONENTS

GE RPX050 Orig. GE Box ... $6.69
GE RPX040/78 Goldtone ... 5.25
GE RPX041/MG Goldtone ... 5.25
GE RPX052/Dual (D&S)* ... $17.75
GE RPX053/.001 & .003 diamonds. Reg. $34.05: * "TAB" Gtd ... $25.98
"TAB" GTD Phono Needle Replacements

RPJ010 Dual .001 & .003 sapphire ...	$1.69
RPJ012 Dual .001 & .003 diamonds* ...	$20.89
RPJ001/78 or RPJ005/.001 sapphire ...	$1.35
RPJ003/78 or RPJ004/LP diamond* ...	$10.89
RPJ013 Dual /diamond & sapphire* ...	$12.89

Replacement needles for all make phonos. Please specify model & make.

MG or 78 single osmium ...	59c; 12 for $5.98
MG or 78 single sapphire styli ...	$1.15
MG or 78 single diamond styli ...	$10.89
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Famous make 7" Reel. 50–16,000 cy "TAB" SPECIAL ... $1.49 ea 5 for $6.89

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"TAB" TESTED & GUARANTEED
PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.88	2J62	49.45	6A7	.85	6BH6	.63	6SN7GT	.68	12SA7GT	.68
OA3/VR75	1.04	2K22	23.48	6AS6GT	.90	6BJ6	.59	6SQ7GT	.62	12SC7	1.08
OB2	1.37	2K23	11.48	6AC7	.80	6BK7	1.58	6SR7	.62	12SF5GT	.54
OB3/VR90	.96	2K25	28.49	6AG5	.71	6BL6	58.00	6T8	.96	12SF7GT	.84
OC3/VR105	.92	2K25/723AB	23.88	6AG7	1.14	6BL7GT	1.19	6T9	.74	12SH7GT	.68
OD3/VR150	.92	2K28	27.48	6AH6	1.21	6BN7	2.69	6U8	.99	12SJ7GT	.56
1B3/8016	.80	2K33	219.48	6AJ5	1.40	6BQ6GT	1.20	6V6	1.39	12SJ7GT	.66
1B22	1.82	2K39	134.99	6AK5	.87	6BQ7	1.65	6V6GT	.59	12SK7	.66
1B23	8.87	2K41	126.00	6AK5W	2.79	6C4	.52	6W4GT	.52	12SL7GT	.62
1B24	145.00	2K42	145.00	6AK6	.97	6C21	24.50	6X4	.49	12SN7GT	.68
1B26	2.24	2K45	72.50	6AL5	.48	6CB6	.59	6X5GT	.54	12SQ7GT	.66
1B27	11.98	2K48	99.48	6AL7GT	.98	6CD6G	1.69	6Y6G	.88	12SR7	.66
1B32/532A	2.48	2P23	298.00	6AN5	3.27	6D4	2.70	7A8	.68	SRC12	349.00
1B35	9.15	2X2	.42	6AQ5	2.78	6F4	.84	7C7	.76	SRX16	149.00
1B37	14.48	3B22	2.48	6AQ5W	2.78	6F5	6.20	7F7	.82	2SZ6GT	.58
1B42	17.48	3B23/RK22	4.95	6AQ6	.81	6F6	.79	7F8	1.24	35Z5GT	.54
1B46	1.98	3B24	4.70	6AQ7GT	1.29	6CJ/5C21	9.89	7H7	.72	35T	4.88
1B63	45.00	3B26	3.70	6AR6	3.27	6J4	6.66	7N7	.92	35L6	.67
1L4	.48	3B27	7.90	6AS5	.79	6J5	.54	7V7	1.06	35Y4	.68
1L6	1.35	3C22	85.00	6AS6	2.22	6J6	.58	8D21	298.00	45Z3	.88
1LD5	.98	3C23	8.67	6AS7G	3.48	6K6GT	7.54	12AL5	.54	48	1.98
1LN5	.78	3C33	9.51	6AT6	.54	6K7	.53	12AT6	.54	50A5	.76
1U4	.52	3C45	9.98	6AU5GT	1.10	6K8	1.08	12AT7	.89	50C5	.54
1U5	.84	3D6/1299	.69	6AU6	.55	6L6	1.48	12AU6	.72	50L6GT	.62
1V2	.70	3D21A	8.15	6AV5GT	.98	6L6G	1.08	12AU7	.69	RK61/XFG1	2.65
1X2A	.98	3D22	13.97	6AV6	.49	6L6GA	1.08	12AV6	.52	FG67	14.68
2C36	27.00	3D23	4.90	6BA6	1.18	6L6GAY	1.98	12AV7	.94	HY69	4.98
2C39A	28.98	3E29	14.49	6BE6	.60	6SA7GT	.66	12AW6	1.18	71A	.74
2C40	4.98	3K23	349.00	6BA8	.54	6SC7	.90	12AX7	.98	78	.78
2C43	17.48	3K27	149.00	6BA7	1.09	6SF5	.78	12AY7	1.69	80	.58
2C44	1.15	4C35	21.49	6BC5	.63	6SF7	.73	12BA6	.59	81	1.38
2C51	3.88	4D21	18.99	6BC7	1.23	6SG7	.64	12BA7	.94	83	1.12
2D21	1.48	4D27	22.49	6BD6	.83	6SH7	.61	12BD6	.59	83V	1.22
2E43	1.49	4J22	129.51	6BE6	.54	6SJ7	.58	12BE6	.59	84/6Z4	.62
2J31	27.00	4J31	99.51	6BF5	.98	6SK7GT	.56	12BF6	.59	100TH	9.88
2J32	29.48	4J52	199.99	6BG6G	1.58	6SL7GT	.64	12BH7	1.29	FG104	24.58
2J33	27.00	4PR60A	42.50								
2J34	24.98	EL5BHD	15.99								
2J37	12.70	5C21/C6J	9.89								
2J38	69.98	5C22	38.95								
2J39	6.98	5D21	14.98								
2J42	148.98	5R4GY	1.20								
2J48	24.45	5R4GYW	1.78								
2J49	84.00	5T4	1.48								
2J50	99.98	5U4G	.58								
2J51	238.98	5V4G	.98								
2J56	149.00	5Z3	.99								

705A	1.88	917	2.59	5769	298.00						
707A	7.90	925	2.14	5812	2.99						
707B	14.88	927/CE25	1.70	5814	2.08						
715A	4.96	CK1005	.68	5820	148.00						
715B	7.94	1613	.82	5840	2.98						
717A	17.98	1614	1.95	5844	2.98						
717A	24.48	1625	.32	5881	2.78						
719A	3.92	1632	.68	5979/BSI	write						
721A	1.94	1633	.98	8013	2.58						
722A/287	16.98	1636	3.00	8013	3.92						
723A/B	3.95	1642	.62	Xtal Diodes							
724A	2.74	1644	.92	1N21A	$1.55						
724B	9.98	2050	1.48	1N21B	2.10						
725A	3.58	2050W	1.48	1N22	1.22						
726A	31.00	5618	3.50	1N23	1.35						
726B	44.00	5635	11.57	1N23A	1.89						
726C	.42	5637	6.53	1N23B	2.00						
801A	3.48	5640	11.57	1N25	4.98						
803	3.22	5641	7.52	1N26	8.75						
807	1.54	5643	11.57	1N31	1.55						
808	2.62	5644	11.57	1N34	.63						
809	1.79	5646	11.57	1N34A	.88						
810	10.88	5651	2.24	1N35	1.65						
811	3.00	5654	1.72	1N38A	1.29						
811	2.70	5656	12.08	1N41	8.95						
813	11.48	RK5657	298.48	1N42	16.95						
813	4.98	5670	3.44	1N45	1.45						
815	5.98	CK5672	1.20	1N47	4.00						
829	7.94	CK5678	1.28	1N48	.47						
829B	12.48	5687	7.74	1N51	.45						
832	7.73	5691	7.54	1N52	.78						
832A	9.92	5692	8.52	1N54A	1.00						
833A	39.45	5693	6.24	1N58A	1.15						
836	5.95	5694	3.65	1N60	.60						
837	2.49	CK5702	2.90	1N63/K63	2.49						
849	29.45	CK5703	1.29	1N64	.69						
860	4.48	5713	120.00								
865	1.26	WL5736	130.00	OTHER TYPES IN STOCK *WRITE							
866A	1.50	5749	1.72								
872A	3.29	5751	2.88								

INDEX TO ADVERTISERS

Let's face it!

HAVE YOU A DISASTER PLAN FOR YOUR PLANT?

BOMBS...OR FIRE...OR FLOOD...OR TORNADO ...you can handle them if you act now.

Let's face it... the threat of war and the atomic bomb has become a real part of our life—and will be with us for years. Fires, tornadoes and other disasters, too, can strike without warning.

Whatever the emergency is, everybody's going to want help at the same time. It may be hours before outside help reaches you. The best chance of survival for you and your workers—and the fastest way to get back into production—is to know what to do and be ready to do it. Disaster may happen TOMORROW. Take these simple precautions TODAY:

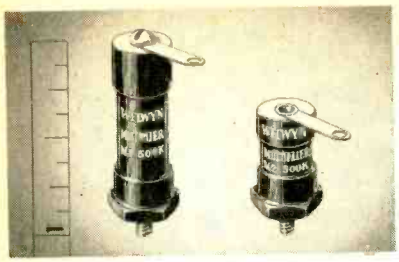
☐ **Call your local** Civil Defense Director. He'll help you set up a plan for your offices and plant—a plan that's safer, because it's integrated with community Civil Defense action.

☐ **Check contents** and locations of first-aid kits. Be sure they're adequate and up to date. Here, again, your CD Director can help. He'll advise you on supplies needed for injuries due to blast, radiation, etc.

☐ **Encourage personnel** to attend Red Cross First-Aid Training Courses. They may save your life.

☐ **Encourage your staff** and your community to have their homes prepared. Run ads in your plant paper, in local newspapers, over TV and radio, on bulletin boards. Your CD Director can show you ads and official CD films or literature that you can sponsor locally. Set the standard of preparedness in your plant city. There's no better way of building prestige and good community relations—and no greater way of helping America.

Act now . . . check off these four simple points . . . before it's too late.



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DEPOSITED CARBON RESISTORS

Designed specifically for panel instrument circuits, Welwyn Meter Multipliers offer definite advantages in both size and economy over previously employed, bulkier and costlier, wire wound units.

Welwyn Meter Multipliers find their greatest application where circuit performance permits stability limits in the order of .25% to .5%. Physically, these resistors are ideally suited for mounting in restricted space, yet they provide ample, convenient tie-in points for connecting other circuit components.

Welwyn Meter Multiplier values range from 20 ohms to 1 megohm.

Manufactured in England and Canada

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The unusual flexibility of the Gries die casting technique may be the answer to your small parts problems. Thanks to the ingenuity of Gries' methods, you gain almost unlimited design latitude; your requirements—from the simplest to the most complex designs—are cast exactly to your specications, swiftly, accurately, and *economically*. GRC zinc alloy parts are produced in *one* labor-saving, automatic operation. They require no trimming, and, in most cases, require no secondary operations. Gries' engineers have solved thousands of "impossible" problems for cost-minded industry.

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(Classified Advertising)

H. E. HILTY, Mgr.

SEARCHLIGHT ADVERTISING INDEX

408, 409

This index is published as a convenience to the readers. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibility for errors or omissions.

Index to electronics

VOLUME XXVII

January to December Issue Inclusive 1954

McGraw-Hill Publishing Company 330 West 42nd St New York 36

Items for which the page reference is marked "D" are editorial material published monthly in Electrons at Work and Production Techniques.

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AUTHOR INDEX

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"DIRECT-TO-THE-MANUFACTURER"

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2. Then fill in the name of the specific product or service and the page number on which it appears.

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4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

THE MANUFACTURER WILL PROMPTLY SEE THAT YOU RECEIVE THE NECESSARY PRODUCT DATA OR THAT HIS REPRESENTATIVE CALLS UPON YOU, WHICHEVER YOU DESIRE.

If there is insufficent space on the postcard for describing your problem specifically, we suggest you write to the manufacturer, spelling out your requirements in detail. Be sure your filled-in postcard accompanies your letter.

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You, as a reader, may never have thought specifically of the viewpoint of the advertisers whose informative and up-to-date product news reaches you through the advertising pages of ELECTRONICS.

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These manufacturers whose products and services are shown in this issue welcome your inquiries and your desire for more information.

If your requirements are complicated and you require more space, we suggest that you write directly to the manufacturer, stating your problem in detail and asking for specific information or assistance. Be sure to include the postcard with your detailed request in order that your inquiry be given prompt and expeditious attention. Make certain that you specify which PRODUCT you are interested in if more than one appears in the advertisement.

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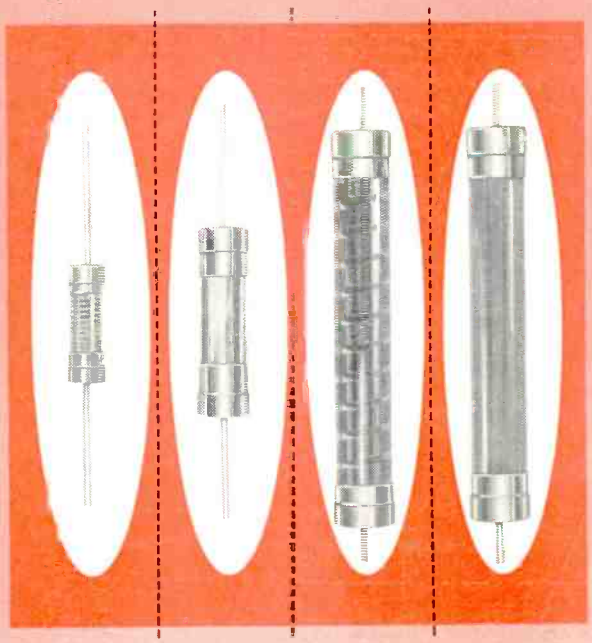
Rugged simplicity keynotes the design of the new Davohm Series 850 resistor. Basically, it is a heat resistant glass tube, with the noble-metal resistive element deposited on the inside surface. Hermetically sealed, the resistive elements need no "protective" coatings, and are deposited with such extreme accuracy that even microscopic examination will show no flaws or raggedness which might otherwise result in noise, erratic readings, hot spots and opens. The temperature coefficient is always positive, always constant, and does not vary with resistance value. High frequency performance is excellent due to low reactive component of impedance.

The unique performance characteristics of the Davohm Series 850 compares with MIL-R-10509A as follows:

	MIL-R-10509A ALLOWABLE CHANGE	Series 850 TYPICAL CHANGE
Temperature Cycling	1.0%	0.02%
Low Temperature Exposure	3.0%	0.04%
Short Time Overload	0.5%	0.02%
Effect of Soldering	0.5%	0.02%
Moisture Resistance	5.0%	0.08%
Voltage Coefficient	0.002%	0.00%
Load-Life (per 1000 hours)	1.0%	0.20%
Temperature Coefficient (PPM/°C)	±500	+370 ±20



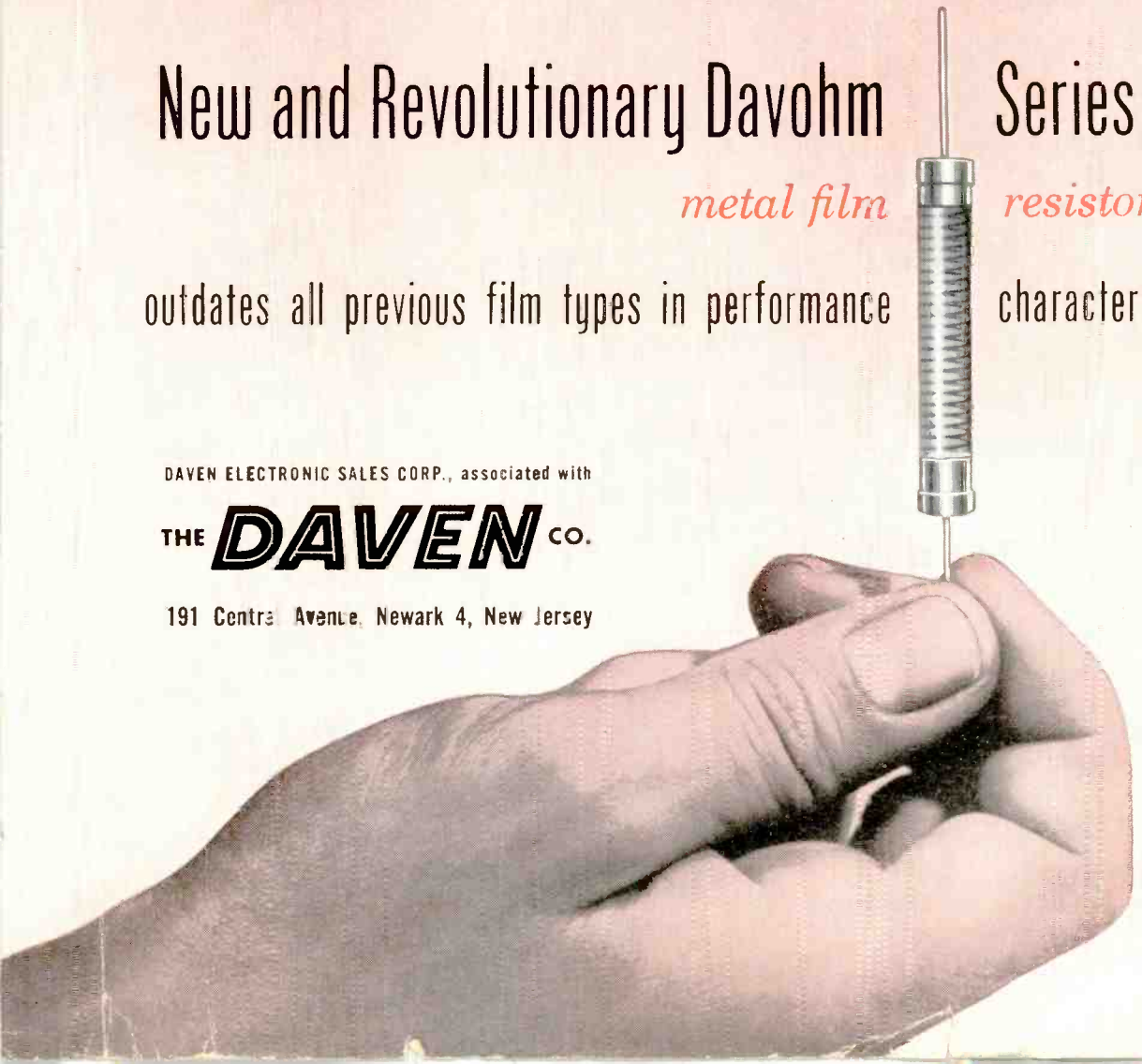
Available immediately in 1/2, 1 and 2 watt sizes and in ±1%, ±0.5%, and ±0.25% tolerances in any desired value.

Write for full technical data or see your local Daven Sales Representative.

New and Revolutionary Davohm Series 850

metal film resistors . . .

outdates all previous film types in performance characteristics.



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The RCA 21-INCH COLOR PICTURE TUBE, *the tube in your future,* is here! Intensive RCA research brings you full-sized pictures of excellent clarity and brightness . . . makes production-line color TV a reality. Outstanding features of the new RCA-21AXP22 are:

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Metal shell means lighter weight and greater mechanical strength.

Thermally-compensated, spherical shadow mask permits uniform expansion of mask for improved color registration and brighter pictures.

70° deflection angle—combined with a short electron gun having improved resolution—provides a short tube which permits reduced cabinet depth.

RCA-21AXP22

- 21-inch metal envelope
- electrostatic focus
- magnetic deflection
- magnetic convergence

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RCA-6BL4— Half-Wave Rectifier Tube (Damper Diode)

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RCA-6CB5— Beam PowerTube (Horizontal-Deflection Amplifier)

RCA pioneered and developed compatible color television

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