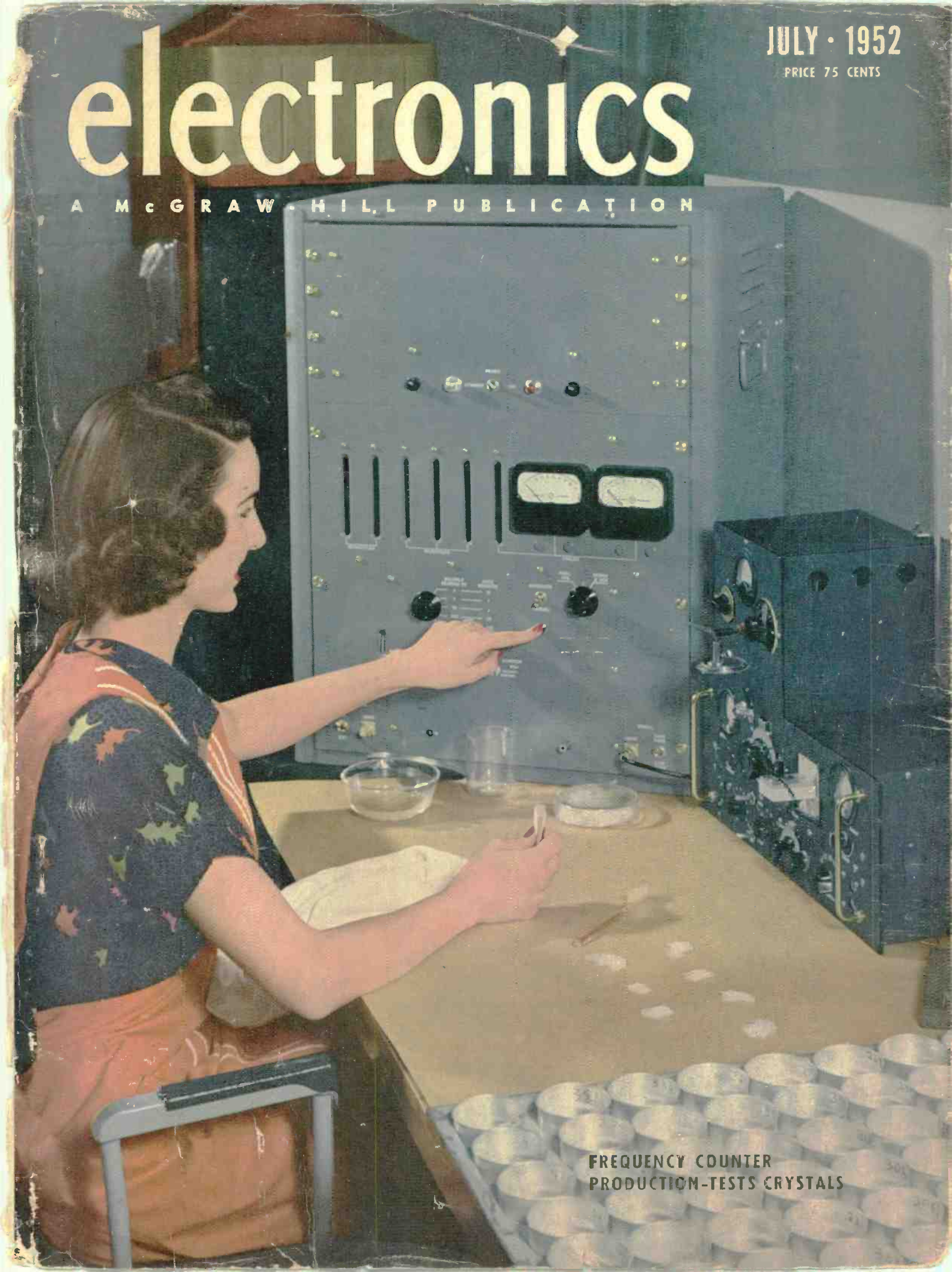
electronics

JULY · 1952

PRICE 75 CENTS

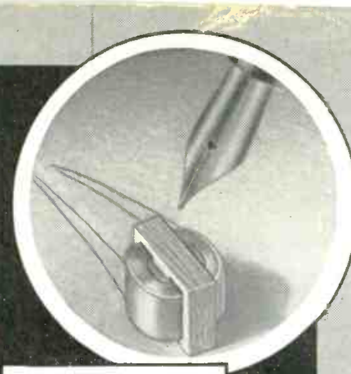
A McGRAW-HILL PUBLICATION



FREQUENCY COUNTER
PRODUCTION-TESTS CRYSTALS

FOR MINIATURIZATION

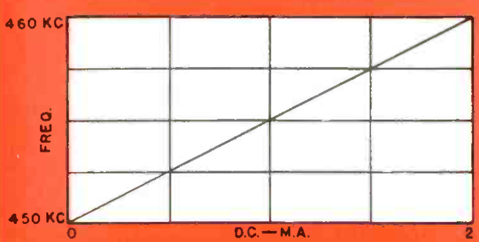
The miniaturization of transformers has been a UTC specialty ever since the development of the Ouncer series in 1937. The importance of this engineering "know how" is reflected by the large number of UTC Miniature components in present military equipment. Some examples of this engineering leadership are illustrated below.

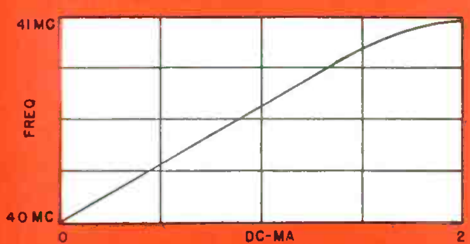


SM Unit ACTUAL SIZE — As photographed with normal pen for comparison.

DC CONTROLLED OSCILLATOR INDUCTORS

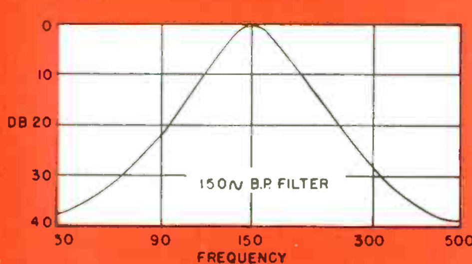
The curves below illustrate oscillator frequency variation using two types of RF inductors varied by the amount of DC through the controlled windings. These units are available in ouncer size and smaller.

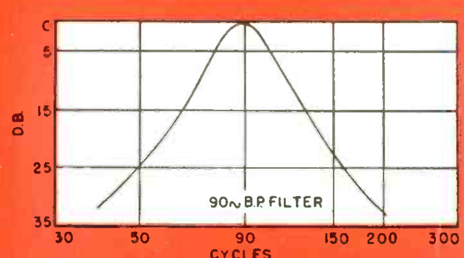




MINIATURIZED AIRCRAFT FILTERS

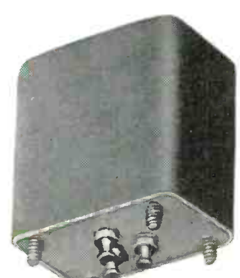
The standard 90-150 cycle aircraft filters have been reduced in size and weight in UTC's miniaturization program. The curves below illustrate the frequency characteristics of these units.



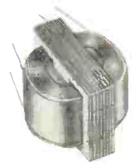


Ouncer case, non hermetic, is 7/8" diameter x 1 1/8" height. Weight — .06 lbs.

Ouncer case, hermetic, is 15/16" diameter x 1 3/8" height. Weight — .11 lbs.



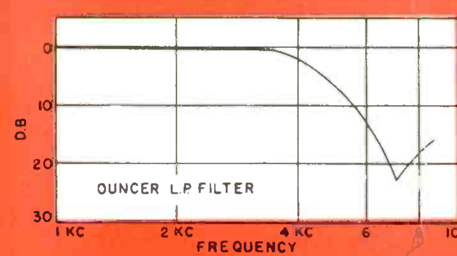
Miniaturized filter case is 1 11/16" x 13/16" x 1 3/8" height. Weight — .3 lbs.

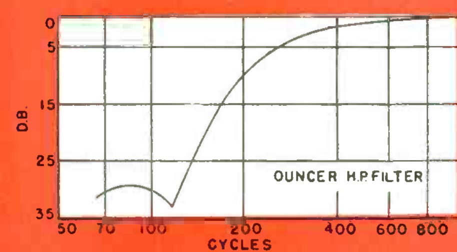


SM sub-miniature audio components, 7/16" x 1/2" x 7/16" height. Weight — .009 lbs.

OUNCER FILTERS

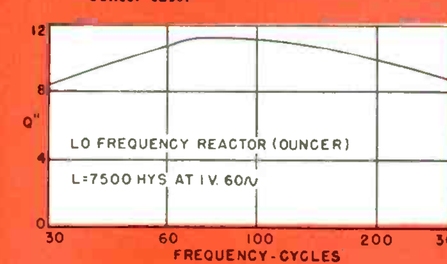
Filter miniaturization is a specialized art. The curves below show a low pass filter and a high pass filter being supplied in the UTC ouncer case.

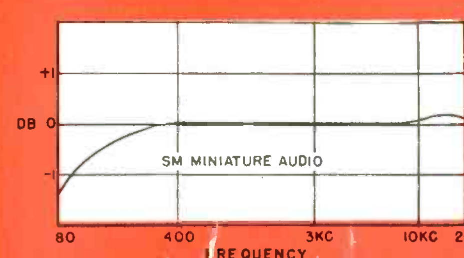




EXTREME MINIATURIZATION

Through the use of specialized materials, extremely compact designs are possible. The curve below illustrates the Q characteristics of a 7500 hy. low frequency reactor housed in the UTC ouncer case.





The sub-miniature audio transformer whose frequency curve is shown above, weighs less than one-seventh of an ounce yet provides wide range frequency characteristics. Its impedance ratio is 500 to 50,000 ohms for operation into a 1/2 meg. Loaded grid.

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

electronics

JULY • 1952
A McGRAW-HILL PUBLICATION

July, 1952 ELECTRONICS Vol. 25, No. 7
Member ABC and ABP

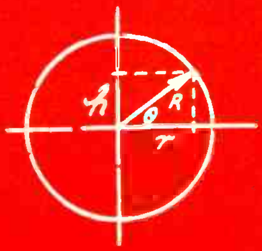
Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication Office, 99-129 North Broadway, Albany 1, N. Y.**

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y. Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publication Division; Ralph B. Smith, Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to Electronics—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow ten days for change of address. Subscriptions are solicited only from persons engaged in theory, research, design, production, maintenance and use of electronic and industrial control components, parts and end products. Position and company connection must be indicated on subscription orders.

Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $2.00. Subscription rates —United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries, $15.00 a year; $25.00 for two years. All other countries $20.00 a year; $30.00 for two years. Entered as second class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U. S. A. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E.C. 4; Washington, D. C., 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1111 Wilshire Blvd., Los Angeles 17; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

MUIRHEAD MAGSLIP RESOLVER NO. 2

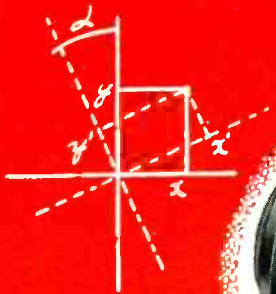


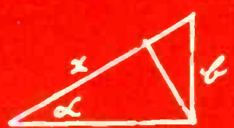
Given R & θ find h & r

$$h = R \sin\theta$$
$$r = R \cos\theta$$

Change of Axes.

$$x' = x \cos\alpha + y \sin\alpha$$
$$y' = y \cos\alpha - x \sin\alpha$$



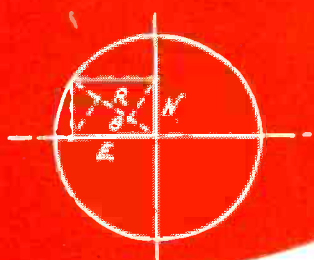


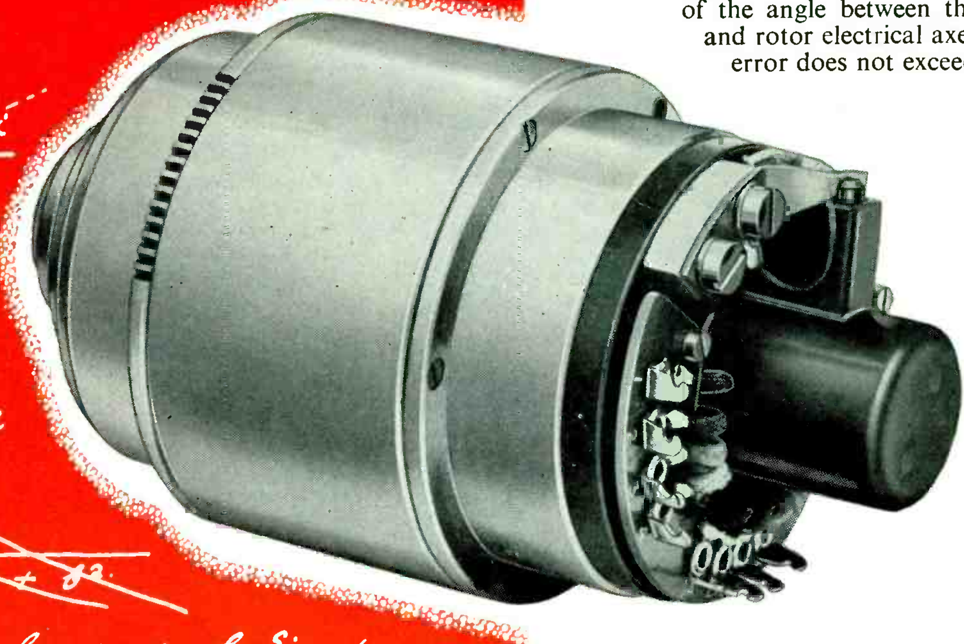
$$x = \cancel{\sqrt{a^2 + b^2}}$$

$$x = a \cos\alpha + b \sin\alpha$$

Given N & E determine R & θ

$$R = E \cos\theta + N \sin\theta$$
$$\text{Zero} = E \sin\theta + N \cos\theta$$





THE RESOLVER No. 2 is a special type of Magslip used for the solution of trigonometrical problems, such as the conversion of polar to Cartesian coordinates.

Each stator phase is energized in accordance with an applied computing voltage. No power is taken from this source, energization being obtained by means of an amplifier and a second (feedback) stator winding. The rotor voltages are proportional to the exciting voltages and to the sine and cosine of the angle between the stator and rotor electrical axes. The error does not exceed 0.1%.

MAIL THIS COUPON FOR DETAILS

Please mail Bulletin B-690 fully describing MUIRHEAD MAGSLIP RESOLVERS

NAME____________________

POSITION____________________

COMPANY ____________________

ADDRESS ____________________

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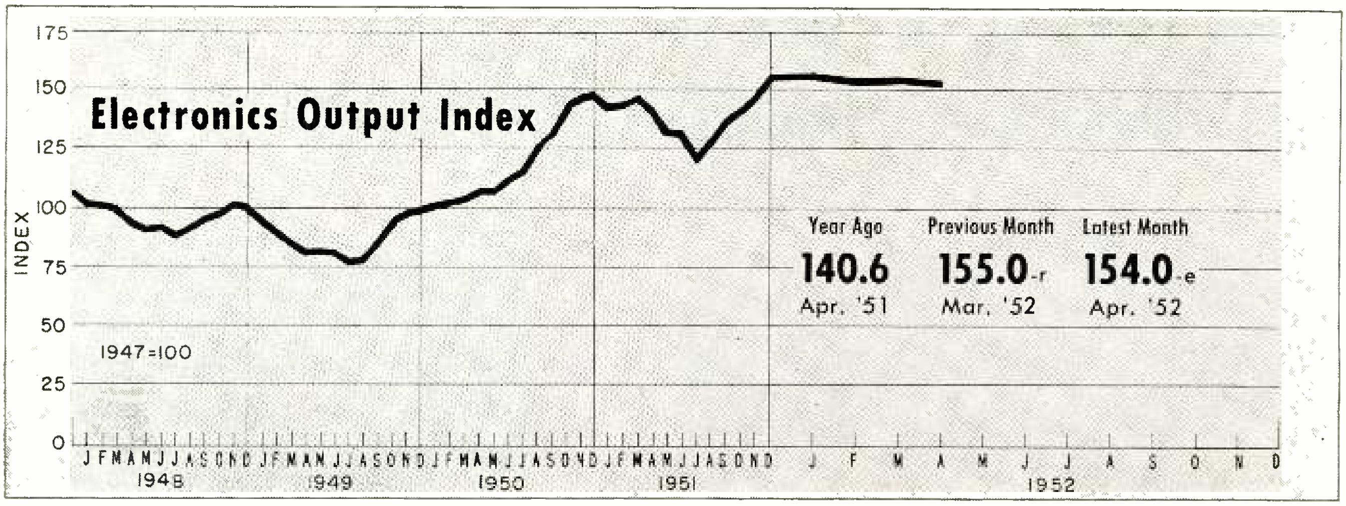
ELECTRONICS 75

MUIRHEAD & CO. LTD. BECKENHAM • KENT • ENGLAND

PRECISION ELECTRICAL INSTRUMENT MAKERS



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago Apr. '51	Previous Month Mar. '52	Latest Month Apr. '52
Television sets	469,157	510,561	322,878-p
Home Radio sets	619,651	532,858	462,167-p
Portable sets	150,494	99,720	110,529-p
Auto sets	542,021	343,314	275,250-p

RECEIVER SALES

(Source: Licensee figures)	Mar. '51	Feb. '52	Mar. '52
Television sets, units	718,986	410,280	370,905
Electric radio sets, units	768,083	344,008	380,846
Battery sets, units	135,300	43,638	68,339
Auto sets, units	273,130	195,689	204,990
Television sets, value	$142,035,675	$71,835,056	$62,988,663
Electric radio sets, value	$21,565,687	$6,488,686	$7,963,825
Battery sets, value	$2,656,750	$844,091	$1,332,640
Auto sets, value	$8,696,203	$5,539,061	$5,912,217

RECEIVING TUBE SALES

(Source: RTMA)	Apr. '51	Mar. '52	Apr. '52
Receiv. tubes, total units	35,883,627	30,935,220	26,247,258
Receiving tubes, new sets	25,284,390	19,513,454	15,334,092
Rec. tubes, replacement	9,052,251	7,231,186	6,095,641
Receiving tubes gov't	229,339	2,776,796	3,257,119
Receiving tubes, export	1,317,647	1,413,784	1,560,406
Picture tubes, to mfrs.	278,955	370,206	270,781

BROADCAST STATIONS

(Source: FCC)	May '51	Apr. '52	May '52
TV Stations on Air	107	108	108
TV Stns CPs—not on air	2	0	0
TV Stns—Applications	408	536	541
AM Stations on Air	2,271	2,347	2,352
AM Stns CPs—not on air	105	68	66
AM Stns—Applications	267	324	323
FM Stations on Air	648	632	630
FM Stns CPs—not on air	14	14	17
FM Stns—Applications	9	9	10

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	Apr. '51	Mar. '52	Apr. '52
AM/FM—ABC	$2,980,183	$3,355,715	3,244,146
AM/FM—CBS	$6,487,717	$5,154,077	$4,943,400
AM/FM—MBS	$1,539,801	$1,826,527	$1,677,748
AM/FM—NBC	$4,897,882	$4,184,074	$4,078,593
TV—ABC	$1,432,319	$2,076,782	$1,686,583
TV—CBS	$2,906,891	$5,643,123	$5,641,831
TV—DuMont	$574,025	$758,763	$738,926
TV—NBC	$4,758,309	$7,357,305	$6,946,751

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago May '51	Previous Month Apr. '52	Latest Month May '52
Sets in Use—total	12,499,900	16,939,100	17,290,800
Sets in Use—netw'k conn.	10,608,300	16,024,900	16,352,300
Sets in Use—New York	2,350,000	2,930,000	2,970,000
Sets in Use—Los Angeles	918,000	1,155,000	1,185,000
Sets in Use—Chicago	921,000	1,135,000	1,155,000

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Apr. '51	Mar. '52	Apr. '52
Aeronautical	32,531	32,176	32,147
Marine	28,722	34,843	35,116
Police, fire, etc.	8,825	10,592	10,787
Industrial	8,852	12,475	12,766
Land Transportation	4,112	4,847	4,886
Amateur	90,691	106,832	108,648
Citizens Radio	497	878	971
Disaster	0	29	31
Experimental	482	458	349
Common carrier	827	922	942

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Mar. '51	Feb. '52	Mar. '52
Prod. workers, electronic	273,200	273,100-r	272,900-p
Prod. wkrs., radio, etc.	183,200	171,000-r	171,100-p
Av. wkly. earnings, elect.	$60.58	$65.14-r	$64.99-p
Av. wkly. earnings, radio	$57.13	$61.28-r	$60.84-p
Av. weekly hours, elect.	41.1	41.2-r	41.0-p
Av. weekly hours, radio	40.4	40.8-r	40.4-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	May '51	Apr. '52	May '52
Radio—TV & Electronics	222.0	292.5	281.8
Radio Broadcasters	208.7	286.2	273.9

INDUSTRIAL EQUIPMENT ORDERS

	Quarterly Figures		
(Source: NEMA)	Year Ago 1st '51	Previous Quarter 4th '51	Latest Quarter 1st '52
Dielectric Heating	$520,000	$560,000	$150,000
Induction Heating	$4,270,000	$3,400,000	$2,400,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	1st '51	4th '51	1st '52
Vacuum (non-receiving)	$6,550,000	$14,300,000	$11,320,000
Gas or vapor	$2,230,000	$3,170,000	$3,100,000
Phototubes	$410,000	$400,000	$500,000
Magnetrons and velocity modulation tubes	$1,400,000	$6,670,000	$8,460,000

p—provisional; r—revised; e—estimated

INDUSTRY REPORT

electronics—JULY • 1952

Atomic Energy Contracts Rising

Electronics industry equipment 'take' totalled $39.5 million in '50-'51; more coming

IMPORTANT to the national economy as well as to the national defense are government expenditures on the atomic energy program. They have totalled $6.5 billion in the last ten years, according to the McGraw-Hill magazine *Nucleonics*.

In the fiscal years 1950 and 1951 the Atomic Energy Commission spent $521 million with 41 American industries for equipment and supplies alone, exclusive of expenditures for construction, research and development and raw materials.

Of this $521 million, $39.5 million (8 percent) went to the electronics industry.

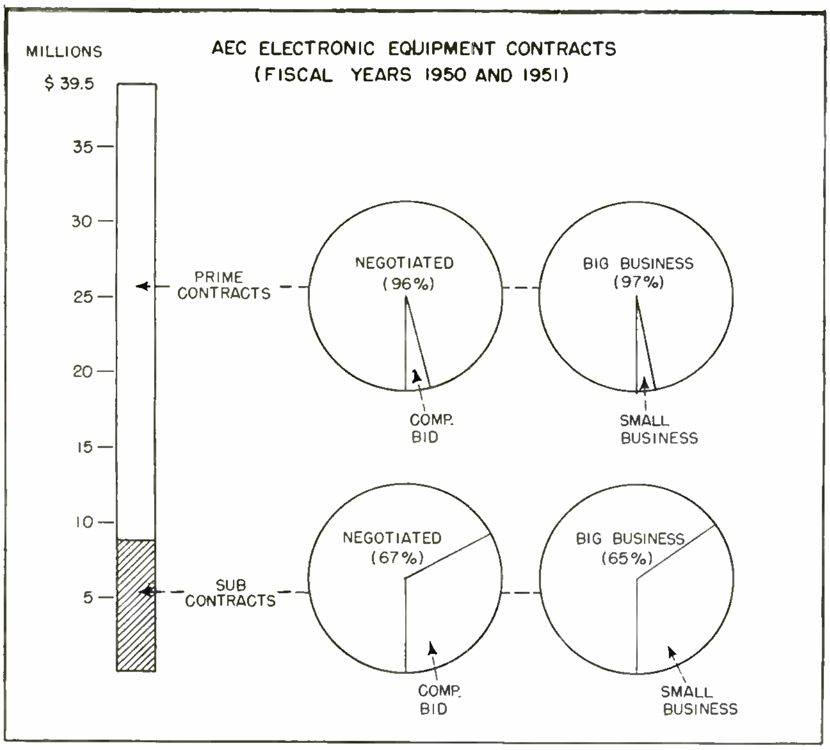
► **Electronics' Share** — Between June 31, 1949 and June 31, 1951 electronics industry contractors received 146 contracts making up the $39.5-million. Subcontractors handled $8.5 million (22 percent) of this business.

Prime contractors obtained 96 percent of their equipment and supply business through negotiations, 4 percent by bidding competitively. Firms having more than 500 employees received 97 percent of the dollar volume, those with fewer employees 3 percent.

Subcontractors negotiated 67 percent of their business, obtaining 33 percent by bidding. Companies with over 500 employees got 65 percent of it, smaller ones 35 percent.

► **Future Prospects**—No estimate of the amount of money to be spent by the AEC on equipment and supplies and, in particular, electronic equipment and supplies, in the fiscal year 1953 (beginning July 1, 1952) is yet available.

The Commission has, however, asked for an overall $4.5-billion appropriation (including a supplemental request), and this is 246 percent higher than in 1952.



Wanted: More Electronic Engineers

$4,000 starting salaries clean up crop of June grads; pirating is costly; last reserve is Europe

THE law of supply and demand determines pay rates. With the shortage of electronic engineers, salaries are rising.

To attract badly-needed engineers, many firms are surveying the industry-wide salary situation almost monthly and adjusting their own rates accordingly.

► **Fledgling Pay**—June graduates with a B.S. degree are signing up at about $320 a month, in a range of $280 to $350.

Some factors affecting the figure are company size and location, fringe benefits, extent of job security, amount of practical industrial or military experience obtained before graduation.

To offset high starting salaries, more complex work is being assigned to graduates right from the start. This includes responsibility for paper work, easing the burden of such work on more experienced engineers.

A Master's degree today rates little or no automatic boost in starting pay. Instead, salary upping is based on ability to analyze circuits and understand theory. A maximum of $50 extra per month for an M.S generally goes to those having a thesis directly related to the work they will do.

▶ **Pirating**—The limited supply of June grads is just about gone. There is now practically universal agreement that pirating of engineers eventually hurts the pirating firm along with the rest of the industry, hence engineer job-changing today is principally for reasons other than salary.

Reserve of engineers in Europe appears to be greater than our own. Already a few U. S. firms are importing these men, despite language difficulties, expenses of moving and delays in getting security clearances.

▶ **Holding Their Own**—Turnover is a major factor in the engineering picture. At least one large electronic firm is now holding engineering turnover below 0.1 percent per month, without paying above-normal salaries, but 1 percent per month is considered good by other companies in the industry.

Car-Card Radio Wins Decision

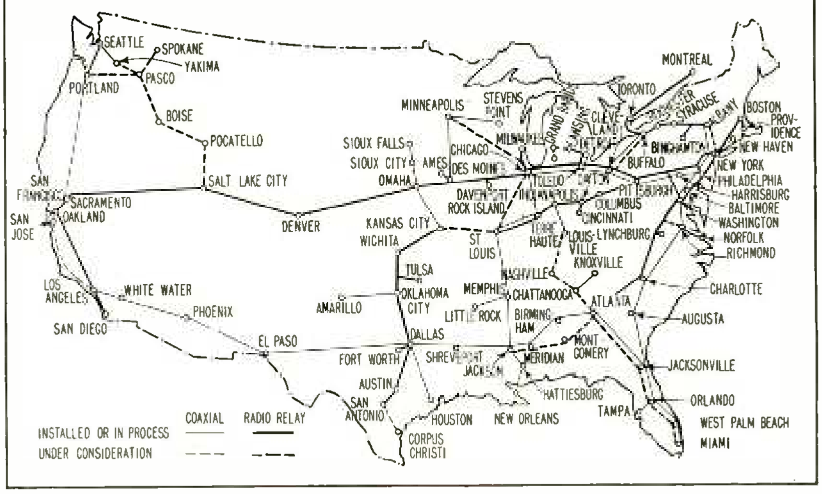
BY A 7-to-1 vote the Supreme Court of the United States has decided that broadcast reception in buses and streetcars does not violate the constitutional rights of passengers.

This was good news for Transit Radio, Inc., chief proponent of the system. Its next hurdle will be to gain unqualified approval by FCC, which has never actually disapproved.

▶ **Counting Sheep**—Advertisers like the idea of broadcasting to a captive audience that can be accurately counted (ELECTRONICS, p 72, June 1948). A musical program available to the general listening public can be hopped up during commercials by a special ultrasonic tone that raises the volume on the bus receivers.

Transit Radio now operates in nine cities and has equipment installed in 3.200 vehicles, according to Richard C. Crisler, president.

BELL SYSTEM RADIO RELAY AND COAXIAL CABLE RELAY ROUTES



Microwave Telephone Expands

Bell System adds new facilities. Several independents enter field

LARGEST OPERATOR of microwave telephone equipment is the Bell System, with 5,350 miles of radio-relay links in operation and an additional 1,560 miles under construction. This represents a total capital outlay of $75 million.

The map shows Bell's microwave network, including 407 miles operated by Bell of Canada. Coaxial cable routes supplementing these facilities are shown as light lines.

Major radio-relay links provide six broad-band communication channels. Each broad-band channel can carry either one television program or upwards of 600 telephone conversations. At present, Bell's microwave facilities largely carry television programs. However the amount of telephone traffic carried by microwave will be doubled by the end of 1952.

▶ **Selling to Bell**—Western Electric, AT & T's manufacturing subsidiary, builds the bulk of the Bell System's microwave equipment, including all major radio-relay links. However, where the great traffic-handling capacity provided by WE equipment is not required, Bell often buys microwave equipment manufactured by outside concerns.

Philco has supplied 218 miles of microwave radio relay for single-channel tv service.

Chief suppliers of so-called "skinny" route equipment that provides up to 24 telephone channels between toll centers include Federal, Philco and REL; 642 miles of such equipment are operated by the Bell System.

▶ **Independent Companies**—Destruction of outside plant by ice, windstorm or rockslide can be disastrously costly to the telephone industry's little fellow. So independent companies, totaling 5,300, are also eyeing microwave favorably.

Peninsular Telephone of Tampa, Fla., Tidewater of Warsaw, Va., and Citizens' Utilities of Redding, Calif., have installed Federal 24-channel links for toll-center hookup.

Outside continental U. S., Maritime Telephone and Telegraph of Canada and the Puerto Rico Telephone Co. use Federal links. In Hawaii, Mutual Telephone has installed Link Radio equipment for intra-island use.

Silicon Transistors?

ONE MAJOR DRAWBACK of germanium transistors, both point-contact and junction, is that above 75 or 80 degrees centigrade they become un-

(Continued on page 8)

SYLVANIA CHALKS UP

Another First

Now an Instant-Firing ATR TUBE

Sylvania proudly announces a new Instant-Firing ATR Tube, Type 6214.

This tube now makes possible for the first time, the operation of a Beacon Radar from a single antenna. Previously, reliable Beacon operation required use of two separate antennae—one for receiving and one for sending.

The New Sylvania Tube permits a Beacon to "clear its throat" immediately and answer a received signal instantly by transmitting a reply signal—OVER THE SAME ANTENNA. It opens the way to new and more compact designs resulting in worthwhile savings in equipment manufacture.

This new component is just one more example of the constant research and engineering skill which has established Sylvania's leadership in electronic development.

For data concerning the ATR-6214 or any other Sylvania Microwave Tube, write today to: Sylvania Electric Products Inc., Dept. E-2507, 1740 Broadway, New York, N. Y.

SYLVANIA

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS stable or may not operate. Reports from the field indicate that silicon, abandoned in early transistor development for more promising germanium, remains stable at higher temperatures.

'Silver Ear' Speaker Due In Few Months

'GOLDEN EAR' high-fidelity audio enthusiasts who are accustomed to pay three and four-figure prices for their equipment recently heard a reasonably high-fidelity loudspeaker destined to sell for $20 to $25.

Using four $1.25, five-inch speaker units in a specially constructed plywood cabinet, Jordan J. Baruch of MIT's Acoustics Lab has obtained a speaker system that is reasonably flat from 40 to 11,000 cycles. He could really please the Golden Ears, using similar techniques, but the end product would cost more.

▶ **Availability**—Good news for Silver Ears (who like high-fidelity but can't afford premium prices) is the fact that Ultrasonics Corp. of Cambridge, Mass., has already taken out a license, made a production prototype and will be in production in a few months.

NARTB Seeks to Ease Federal Operator Requirements

FCC proposal might free needed technicians for coming tv activity

FOLLOWING on the heels of several individual grants to f-m broadcasters, the National Association of Radio and Television Broadcasters has petitioned the Federal Communications Commission for industry-wide relaxation of rules on station operations.

For an f-m transmitter perched upon a mountain accessible only by jeep or skis, remote-control unattended operation may mean the difference between f-m programs or no programs. Any station carrying a high percentage of commercial programs might find a full complement of $85-a-week operators good insurance against a blowup in the middle of a revenue-producer. But most f-m stations are not in the big money.

▶ **Standard Broadcasting** — FCC, nudged by NARTB, now proposes that all nondirectional a-m stations (as well as f-m) with power less than 10 kw shall be allowed to operate by remote control. Moreover, it would relax the requirement calling for a first-class licensee to run the equipment, although NARTB suggests that one operator of this grade be kept on call. Actually, routine station operation by men of lesser license grade under a top-licensed man is already permitted because of personnel shortages. The new proposal would standardize a temporary measure.

Operator unions will file lengthy dissents by the Commission's deadline for comments on August 4, 1952. Labor groups that are usually in bitter competition are united in opposition to what they consider the industry's bid for 'cheap help'. Pointing out that a good operator is paid as much for what he knows as for what he does, the unions feel that by keeping standards high both operating engineers and broadcasters get needed protection.

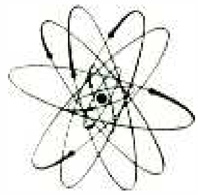
▶ **TV Squeeze**—Strongest motivation for the NARTB petition stems from the economic pressures of

(Continued on page 10)

Tank Trucks Use Electronics to Facilitate Passing

When a motorist wants to pass this truck, his horn signal is picked up by a microphone at the rear of the truck, amplified and fed to a loudspeaker in the cab. The driver then operates the pass or don't pass signal light switch at his fingertips. Designed to increase road safety, the warning device is being installed on Shell tank trucks in Sweden

PERMANENT CAREER OPPORTUNITIES



FOR

ENGINEERS • PHYSICISTS • CHEMISTS

The Sprague Electric Company, one of the basic companies in the electronics industry, offers permanent employment to qualified personnel. Sprague-made components are used by the millions, not only in military electronics, but in peace-time radio, television, electronic computers, and in all the phases of industrial electronics.

You can grow with Sprague!

Pleasant working conditions in modern, well-equipped laboratories and plants in the heart of New England's Berkshire Hills, famous summer and winter resort area—just 45 miles from Albany, N. Y.

PRESENT OPENINGS INCLUDE:

PHYSICISTS: All grades, for research and development on transistors and solid state problems.

ELECTRICAL ENGINEERS: All grades, for research, development, and application engineering on resistors, capacitors, radio interference filters, and pulse-forming networks.

ELECTRICAL ENGINEERS: All grades, for complex test equipment design and production.

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ORGANIC CHEMIST: Ph.D., for investigation of mechanisms of organic reactions and structures of organic compounds.

MECHANICAL ENGINEERS: All grades, for design and development of production machinery.

METHODS ENGINEERS: All grades, for factory planning and methods work.

Please send your full qualifications to:

Engineering Department

SPRAGUE ELECTRIC COMPANY

NORTH ADAMS, MASSACHUSETTS

SPRAGUE®

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT television. In New York City, where salaries in most fields are highest, operators are getting as much as $150 for a 5-day, 40-hour week. Here, the income from f-m is inconsequential and a-m rates are being forced down. Many a-m broadcasters anticipate embarking upon tv's ocean of red ink. They see the engineer market being inflated by the very fact that they must then double their own licensed-operator employment. And this is but a fraction of the nonlicensed technical personnel necessary.

The Commission asks one $64 question: how is it proposed that remotely controlled stations or those using nontechnical operators put into immediate effect, after an alert, the Conelrad (ELECTRONICS, p94, Aug. 1951) frequency-changing program that denies navigational information to enemy aircraft?

Parts Distributors Score Bypassing

DISTURBING to industrial distributors of electronic parts is bypassing by manufacturers dealing directly with large plants. Affected distributors have recently become vocal enough on the subject to induce at least a few parts manufacturers to protect them with respect to price.

Not so readily reduced is the bypassing of radio-tv replacement-part distributors by set makers selling components to servicemen direct or through their own distributors. This part of the distribution picture is complicated by the fact that there are (1) set makers doing a legitimate business in 'original replacement', (2) those that have inadvertently bought more parts than they can use in receiver production and, (3), those that deliberately overbuy to hammer down price and plan to dump the surplus.

Several industry groups are studying the last-mentioned situation but so far the most concrete suggestion reported involves somewhat vague 'monitoring' of suspected factory accounts.

'Community' TV Antennas Big Business

Even applicants for uhf-tv-station licenses are wooing operators; 'built-in' audience easily captured

COMMUNITY TV antenna systems have quietly become a very respectable equipment market.

These systems, which simply pick up distant tv stations on a master antenna and distribute the signals to homes of subscribers via cable, require neither heavy manufacturing facilities nor extensive staff. Thus the new field may very well attract many companies which couldn't possibly consider entering, say, the manufacture of tv transmitters.

▶ **Expansion Plans**—Though only 70 to 80 systems are operating today, serving perhaps 10,000 to 15,000 homes, at least twice that many more are being planned. And the planners seem to have little fear, even though the late unlamented freeze on new stations is over, that the advent of new stations will dry up their future.

Investment per system can be quite substantial. The largest system in operation today, Trans-Video, Pottsville, Pa., has invested $300,000 to serve 1,600 subscribers—and it plans to expand to serve 3,000 or more. Many other companies have even more ambitious plans, in such cities as Harrisburg, (5,000 subscribers) and Williamsport, Pa. (4,000).

▶ **Cable is Key**—Early company in the business was Jerrold Electronics, Philadelphia. RCA, Philco, and Technical Appliance are active and latest is Spencer-Kennedy, Cambridge, Mass. The price differential between companies is as great as 2-to-1.

Such systems are proving a boon to coaxial-cable manufacturers, since each installation uses miles of high-quality lines. To date, most systems have employed cable such as RG/59U and RG/11U. Operators are constantly pushing cable makers to develop lower-loss lines, so that amplifiers may be spaced farther apart—substantially reducing costs.

▶ **UHF 'IN'**—Applicants for uhf-tv stations are wooing community-system operators, for the simple reason that they can provide a 'built in' audience the day a uhf station begins telecasting.

One converter at the master antenna can bring a uhf signal down to a vhf channel to be fed to the entire system—obviating the need for each set owner to buy a converter and uhf antenna at $50 or more.

New Battery Designs Hit Market

Alkaline electrolytes used in B batteries for personal portables

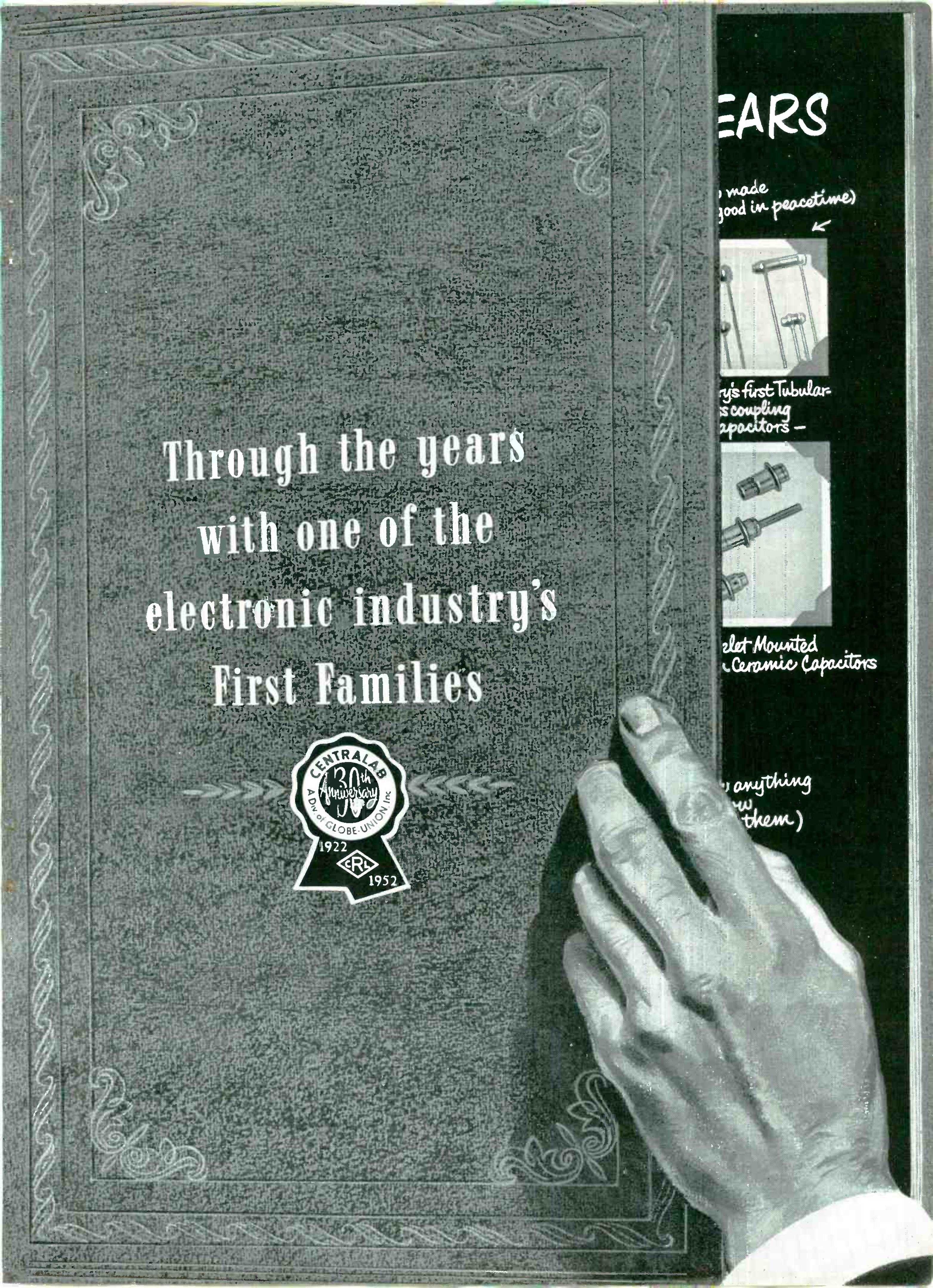
ALKALINE dry-cell batteries have received widespread publicity in recent weeks by virtue of their use as B batteries in personal-portable radios. Two companies, RCA and Emerson, have already announced new sets using such batteries. Others are expected to follow suit.

▶ **Content**—Design of a flat-type alkaline dry cell, according to the Ray-O-Vac Company, centers about the use of sodium-hydroxide (caustic soda) electrolyte, with a

Rear view of the new RCA personal portable, showing the new alkaline B battery at the left

zinc anode and a manganese-dioxide mixture for the cathode material. With usage of the battery,

(Continued on page 14)


Through the years
with one of the
electronic industry's
First Families
CENTRALAB
30th Anniversary
A Div. of GLOBE-UNION Inc.
1922
CRL
1952

CENTRALAB'S ELECTRONIC FAMILY

Many members have made electronic history!

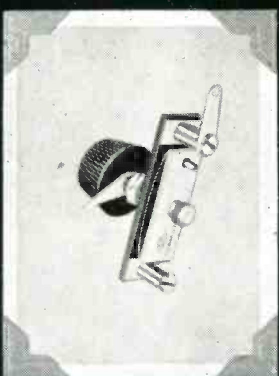
Today, many of the most advanced developments in electronic equipment -- from modern hearing aids to television, radar and X-ray -- are built around the revolutionary components pioneered and introduced by Centralab.

Tangible evidence of the ceaseless research that gives fresh emphasis to the fact that many products bearing your trademark serve better -- last longer ... thanks to the continuing engineering advances of Centralab.

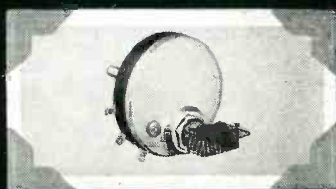
As in the past -- so in the future -- you can look to Centralab for leadership in electronic component research.

Variable Resistors

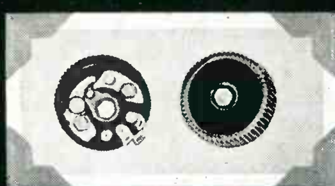
(Great grandad)



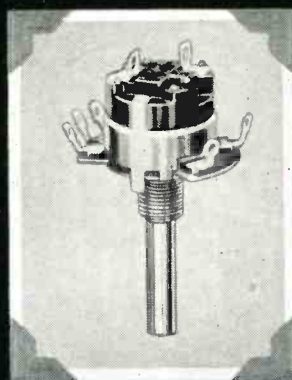
1922 First composition variable resistor ever built



1929 First combination variable resistor and switch

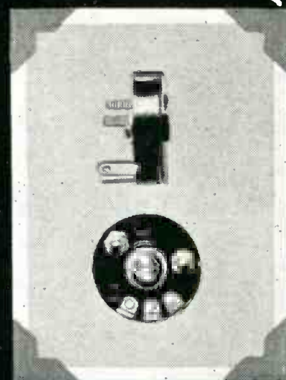


1946 Model 1 - World's smallest switch type variable resistor



1949 Model 2 Radiohm the most modern high quality variable resistor

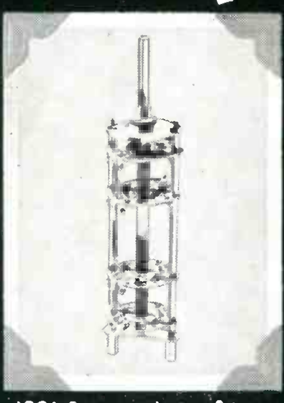
(Latest addition to this part of the family!)



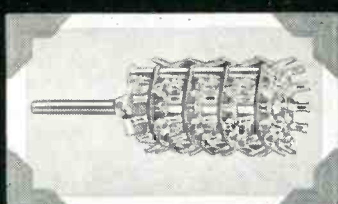
1951 New High Torque Variable Resistor - world's smallest - no bigger than a dime!

Switches

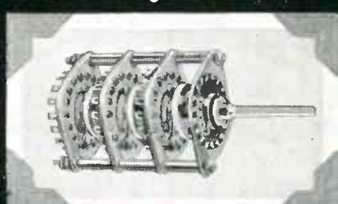
(She started this branch of the family)



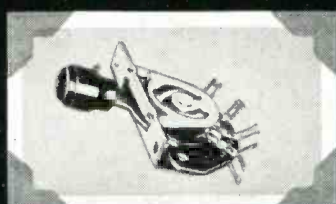
1936 A new and complete line of wave band switches



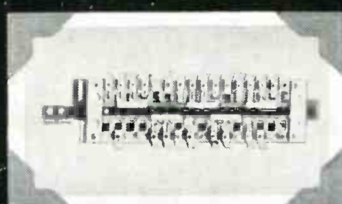
1938 The industry's first 24 contact per single section switch



1943 The industry's first low-loss, high frequency medium duty power switch

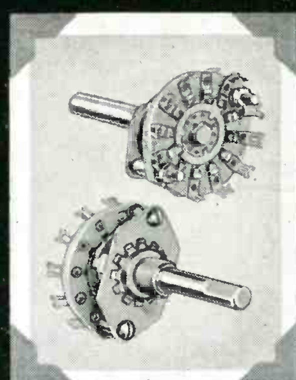


1939 First multiple contact lever action switch



1947 The first slide switch introduced to the industry

(our most beautiful babies!)

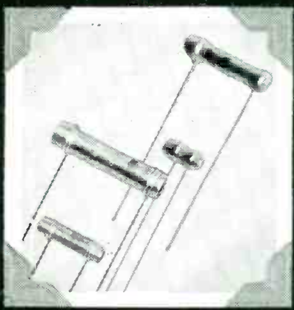


1951 New miniature rotary switch (1 1/16" dia.)

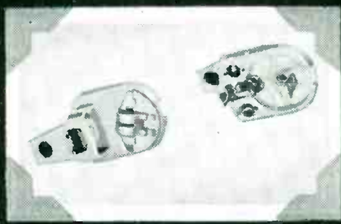
HAS BEEN GROWING FOR 30 YEARS

Capacitors

(War babies who made more than good in peacetime)



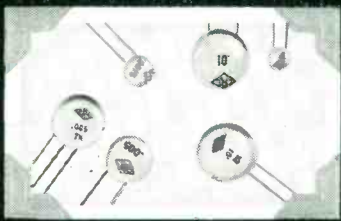
1936 Temperature Compensating Ceramic Capacitors



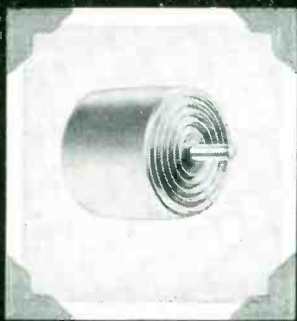
1939 Industry's first Ceramic Trimmer Capacitors

1941 Industry's first High Voltage Transmitting Ceramic Capacitors

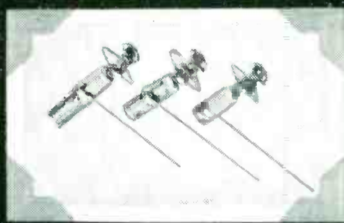
1945 Industry's first Tubular-Type By-Pass coupling Ceramic Capacitors —



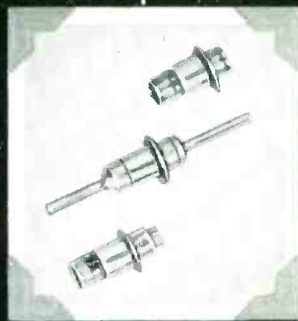
1946 The first Disc-Type By-Pass coupling ceramic Capacitors introduced to the electronic industry



1947 Industry's first TV High Voltage Ceramic Capacitors

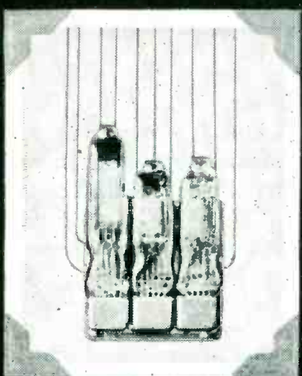


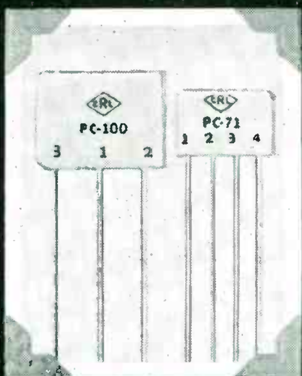
1949 Industry's first Ceramic Tubular Trimmer Capacitors

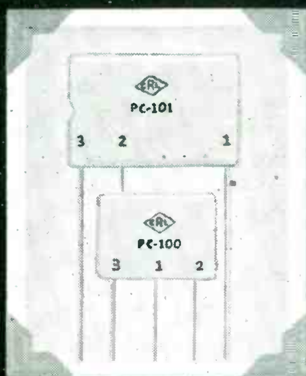


1951 New Eyelet Mounted Feed-Through Ceramic Capacitors

Printed Electronic Circuits



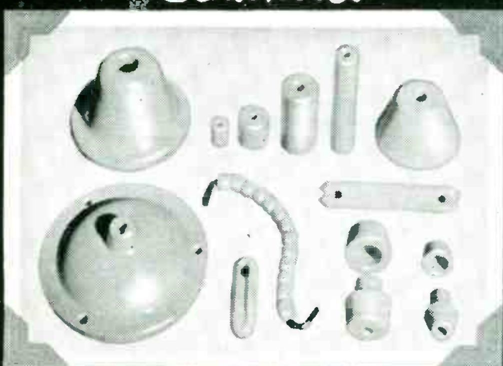




(Nobody ever saw anything like these, but now everybody wants them)

1943 Centralab originated the industry's first printed ELECTRONIC circuit

Ceramics



1942 First offered fine ceramics to industry. Actually, Centralab had been making ceramics for its own use since 1928 . . . but in 1942 developed a grade L-5 Steatite Ceramic superior to the then exisiting Navy grade "G" specification

Centralab was the first to metalize ceramics. By 1945 Cordierite and Zirconite bodies with grade L-4 rating were developed.

(This branch of the family just grows and grows and grows and there's no room for all their pictures)

Centralab CRL®

A Division of Globe-Union Inc.

900 EAST KEEFE AVENUE • MILWAUKEE

the electrolyte becomes absorbed gradually.

For portable-radio use, the batteries are light-drain devices, rated at about 500 milliampere hours and able to withstand up to 15-milliamperes current drain. The same basic design, changed slightly by the addition of mercuric oxide to the electrolyte, gives a heavy-drain battery for other uses.

Several new radios are using two $1\frac{1}{2}$-volt A batteries connected in parallel. These are of the conventional zinc-carbon construction but with a special mix of manganese dioxide for the depolarizer. Leak-proof steel containers seal in the ingredients for longer life.

▶ **Mercury Cell**—The new alkaline batteries are somewhat similar in action to the mercury cell of the P. R. Mallory Company, in which a solution of potassium hydroxide and zinc oxide forms the electrolyte, a pressed zinc pellet or a roll of thin corrugated zinc strip forms the anode and pure mercuric oxide with graphite added forms the depolarizing cathode. Mercury cells have long shelf life because there is little or no internal cell reaction until electrical energy is drawn from the cell.

Batteries of the carbon-zinc type, for portable-radio use, are being revamped by the National Carbon Company and improved designs are expected to be on the market at low cost early in July. The new carbon-zinc B battery will be of the flat-type, and the new cylindrical A battery will be twice the length of the usual $1\frac{1}{2}$-volt cell.

TV Manufacturers Fight Summer Slump

New line introductions plus special convention promotions may boost summer sales

NEW television models and new advertising campaigns are usually introduced in the fall. This year, however, because of the July political conventions, manufacturers have been virtually forced to promote tv sales in what has nearly always been a month of very low buying activity.

▶ **Plans**—Westinghouse, Admiral and Philco are engaged in twin summer promotions. Each is sponsoring convention coverage on television and introducing new tv sets. Other manufacturers such as RCA, Crosley, Zenith and CBS-Columbia are unveiling new tv models during the slow season.

For some companies, this is the third time in 1952 that new set debuts have taken place. There may be more this year. Normally, new models are introduced twice a year.

In addition, many special promotions are planned. Free phonographs with each console sold, free use of a set during the convention and special contests for cash prizes are some of them.

▶ **Outlook**—Consensus of opinion is that price is the really important consideration in today's market. In fact, some companies expect a trend toward greater production of low-priced 17-inch models.

One manufacturer sees 1952 sales by tube size reaching the following percentages: Consoles: 60 percent 20-inch tubes, 40 percent 17-inch tubes; Combinations: 85 percent 20-inch tubes, 15 percent 17-inch tubes; Table Models: 40 percent 20-inch tubes, 60 percent 17-inch tubes.

R-F Heater De-Bugging Slow

Industry struggles to meet FCC's June 30 deadline on radiation and interference

ON JUNE 30 FCC rules limiting radiation from radio-frequency heating equipment go into effect. At the time of this writing, it appears that a substantial percentage of the country's r-f equipment will then be operating illegally, or shut down.

A survey among specialists engaged in de-bugging industrial equipment and issuing FCC-required certificates showing compliance with FCC rules shows that many are flooded with jobs and will not be able to take on additional ones (or even complete those contracted for) by June 30.

Estimates of the percentage of equipment that will be operating legally after June 30 run between 30 and 90 percent, with several expressing concern over industrial production interruptions caused by shutting down equipment that has not been or cannot be certified.

▶ **Relaxations**—Certain of the FCC rules have been eased.

A multi-unit installation covering an area that can be contained in a 500-ft. circle may be covered by one certificate.

Medical diathermy users have been granted a year extension to June 30, 1953.

▶ **Field Findings**—Each installation

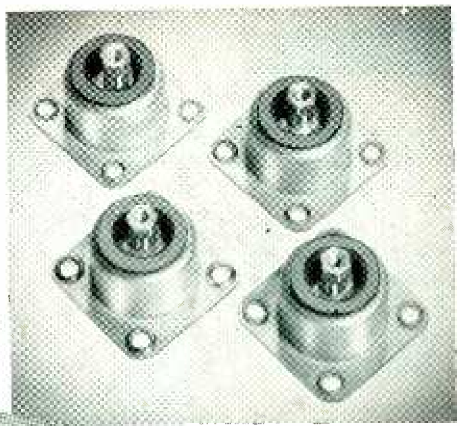
(Continued on page 16)

R-F Heater Interference Experience

Equipment Type	*Freq. Range*	*Recommended Steps*
High-frequency motor-generator sets	up to 3,000 cps	Usually no corrective measures necessary, unless harmonic radiation is high
Vacuum-tube generators	100 to 500 kc	Shielding and power-line filtering
Quenched-gap	200 to 500 kc	Shielding often needed if manufactured prior to July 1, 1947
Mercury-hydrogen gap	20 to 70 kc	Most units already provided with steel shielding. May require extra shielding and some line filtering
Plastic-sealing	6 to 160 mc	Shielding of both vacuum-tube oscillator and electrodes essential
Plastic-preheaters	6 to 50 mc	Usually provided with oscillator and electrode shielding. If not, shielding essential
Wood-gluing, rubber, chemical heating and drying	2 to 50 mc	Usually necessary to improve shielding to meet requirements
Foundry core baking		Most units manufactured after July 1, 1947, and thus certified by manufacturer

an **OUNCE**

(and 1/4) →



of Protection

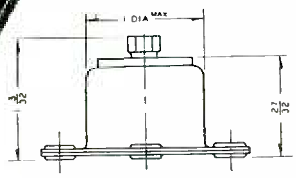
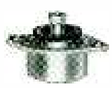


Photo courtesy Vapor Heating Corp.

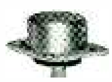
insures the reliability of your equipment.

Miniature air-damped Barrymounts were developed specifically to help you with your miniaturization projects. They give you these advantages:

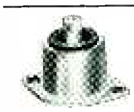
1. Less space — reduced height cuts cubage of mounted equipment.
2. Less weight — only 5/16 ounce per unit isolator.
3. Wide load range — 0.1 to 3.0 pounds per isolator.
4. Satisfy temperature (−67 to +170F), vibration, and other performance requirements of JAN-C-172A — special models available for extreme high or low temperatures.
5. Ruggedized models — available for equipment that must meet shock-test requirements of AN-E-19, MIL-E-5272, and MIL-T-5422.
6. Four styles — available as unit isolators or assembled with mounting bases built to your needs.



TYPE 6475



TYPE 6695



TYPE 6465

TYPE 6690

For complete information, ask for Barry Catalog 523-A; it's free on request. And for greatest benefits with miniature Barrymounts, let our Field Engineering Service share our experience with you in the early stages of your designs.

THE **BARRY** CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington presents different problems to engineers and technicians doing the de-bugging and making certification measurements.

It takes 20 to 40 man hours to add required screening and filtering to make an offending piece of equipment operate properly, and 10 to 20 hours to make certification measurements.

Cost usually runs between $300 and $500. Figures are subject to wide variations.

One specialist saves multi-unit customers money by de-bugging one piece of equipment and letting company employees perform like operations on other units.

In difficult cases, many companies have been forced to use elaborate screen rooms to house heating equipment.

Some firms move equipment into basement locations to take advantage of the natural shielding afforded by the earth.

Electronics Firms Lead In Defense Contracts

Sixteen electronics companies are among top 100 listed by Munitions Board

ELEVEN PERCENT of the $44 billion spent on defense contracts from July, 1950 to December, 1951 went into the coffers of sixteen electronics and related-industry manufacturers.

These firms were among the top 100 military contractors who received 59.9 percent or $26 billion of all military prime contracts for the period.

General Electric again topped the electronic firms on the list but a large percentage of its contracts are for jet engines. Along with GE, Westinghouse and AT&T were other major electronic manufacturers in the first 20 companies. Principal upward change is for Sylvania, which moved from 91 on the list to 71st place on the present one.

▶ **Top Firms**—Following are the electronics and related-industry firms on the list of 100 military prime contractors:

	Position	Millions	Percent of Total
General Electric	5	$976.8	2.2
Westinghouse	12	674.4	1.5
AT&T	13	657.8	1.5
Sperry	17	479.0	1.1
Bendix	18	473.4	1.1
IT&T	22	286.8	0.7
RCA	27	211.3	0.5
Avco	33	184.6	0.4
Philco	40	160.7	0.4
Raytheon	42	142.7	0.3
Collins	44	138.7	0.3
Hazeltine	56	93.1	0.2
American Bosch	59	91.4	0.2
Sylvania	71	76.9	0.2
Stewart-Warner	78	63.3	0.2
Gilfillan	87	53.3	0.1

Kaiser-Frazer Eyeing Electronics

AUTOMOBILE-MAKER Kaiser-Frazer is studying the electronics field, may manufacture power tubes.

Negotiations are reported to be under way with another company that would provide plant facilities and electronic engineers.

What's Behind the Figures—Network Billings

Fifth of a series explaining items reported on statistical page each month

NETWORK BILLINGS, the fifth category of statistics reported each month in *Figures of the Month* (p 4), represent the gross time charges billed to advertisers and agencies each month by the major radio and tv networks, as compiled by the Publishers Information Bureau of New York.

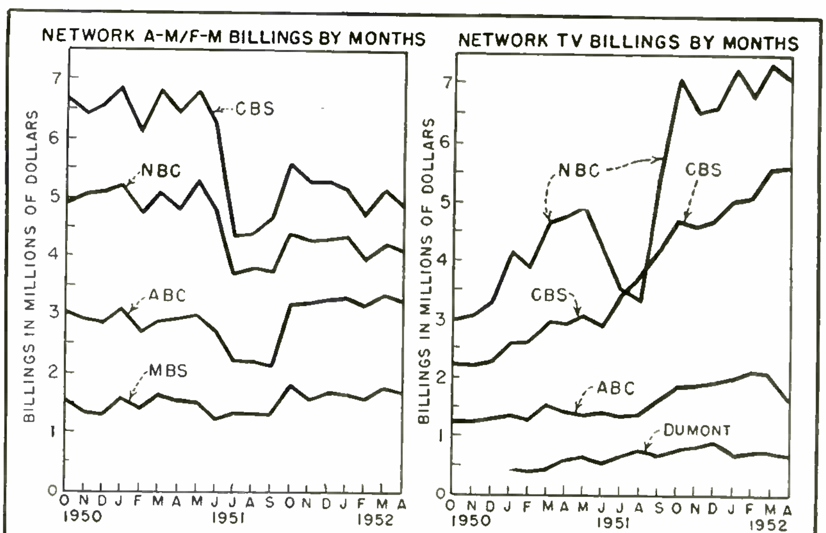
Only *network* charges are included; billings for time sold by individual stations, not carried as network programs, are not reported.

The accompanying charts, which show the trend in billings for each network from October 1950 to the present, reveal that tv is forging steadily ahead of sound radio in gross billings. For the first four months of 1952 network radio (ABC, CBS, MBS, and NBC) produced billings of $56.5 million while tv (ABC, CBS, DuMont, NBC) accounted for $60.7 million.

This is a sharp reversal of position from the previous year. In 1951 network radio billings were $174.7 million for twelve months, against $128.0 million for tv.

▶ **Competition**—NBC has pushed ahead in tv, capitalizing on its early promotion of video as a net-

(Continued on page 18)



Source Public Info. Bureau

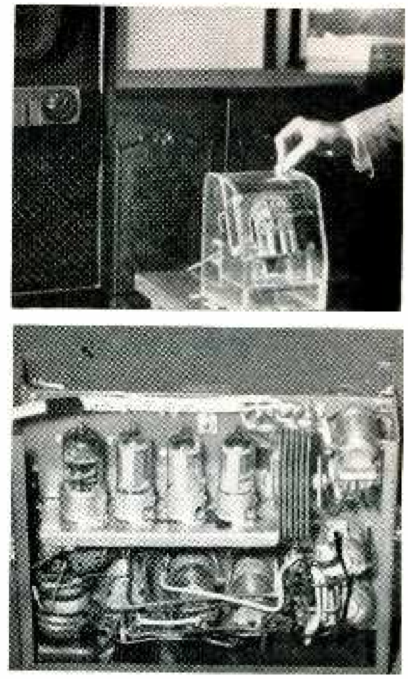
work medium, but is below CBS in radio. The combined billings (radio and tv) of these two networks are about on a par: $111.2 million for CBS vs $113.5 million for NBC during the year 1951, and $41.5 million for CBS vs $44.9 million for NBC in first third of 1952.

Both networks now get more gross income from tv than from radio, whereas ABC still makes its major revenue from radio.

Primes Off W-H Hook

LABOR DEPARTMENT plan to hold government contractors responsible for the wage and hour policies of their subcontractors (p 20, June) under the Walsh-Healey act has been indefinitely postponed.

Secretary Maurice Tobin cancelled a June 10 hearing which was to have lead to a July 1 regulation, has announced no new dates.



Telemeter coin box that shows program price is connected by cable to chassis within television cabinet. When sufficient coins are deposited, the movie is seen and the sound track heard. An electronic tape recorder notes the show and amount paid

Converters Hold UHF-TV Fort

Present price problem defers production of complete-coverage receivers

ALTHOUGH coverage of 82 channels will be provided in the ultimate tv receiver, a survey of 30 receiver manufacturers reveals that the need to maintain present low prices prevents immediate production of such sets.

Only two receiver models so far announced provide complete coverage of vhf and uhf channels without additional parts or accessories. However, some companies have engineering models built, and at least one front-end manufacturer offers a tuner covering channels 2 to 83.

The present uncertainty of when and where stations will open on the uhf channels is reflected in the receiver industry. Manufacturers are more concerned with holding down the cost of a receiver than providing maximum utility in the near future. In the words of one, "We will not use a complete 82-channel tuner until forced to. Some of our new models use strips, others converters."

▶ **Biggest Market**—Manufacturers are most concerned with sales in presently served areas which will get additional stations. In such areas 17 million receivers now operate. Any of these can be used with a converter to receive uhf channels, and those equipped with turret tuners can usually be modified with strips to receive a few uhf channels. As a result, nearly all manufacturers are planning to push the sale of converters.

For the oldest receivers, the converter sets on top of or alongside the receiver cabinet. Some models made since 1949 have had space provided in the design of cabinet and chassis for the converter to be fitted in. Some of these cover only a few selected uhf channels, other tune all uhf channels from 14 to 83.

Some manufacturers will produce their own design of converter, others plan to purchase from front-end makers, as complete chassis or as subassemblies like vhf tuners.

Separate-unit converters covering uhf channels range in price from $29.95 (Teleking) to $49.95 (GE), most companies say "will be under $50." Strips for old sets having turrent tuners cost from $2 up, are given free during 1952 to viewers in cities getting uhf channels by Sparton and Admiral.

Coin-Box Television Will Show on Wire

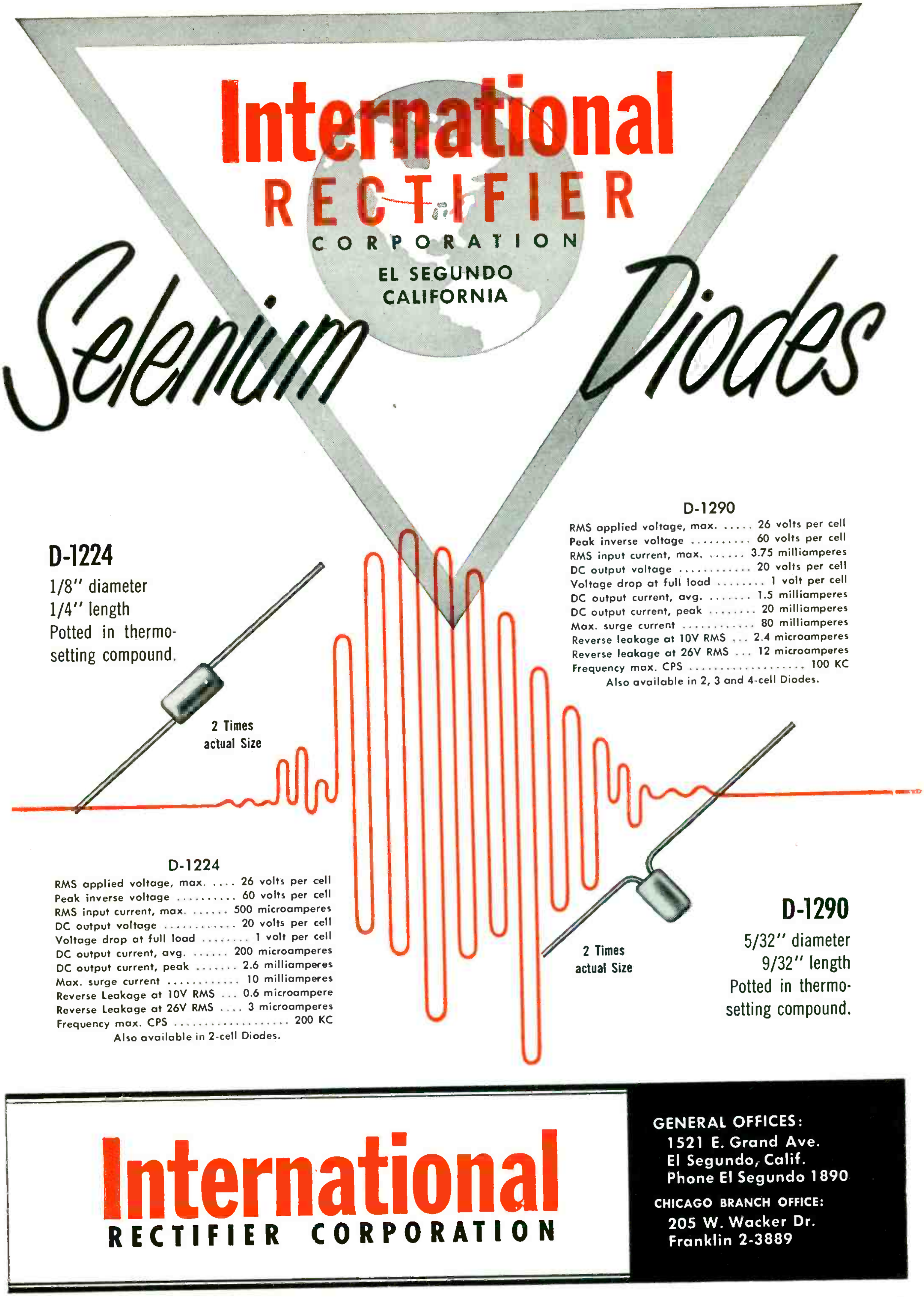
TELEMETER is Paramount's version of subscription television, whereby the home viewer may hope to see first-run movies from his easy chair. Zenith (Phonevision), NBC and Skiatron also have systems for the same purpose but use different methods of denying the program to nonsubscribers and other ways of collecting.

International Telemeter Corp., of Los Angeles, places a coin box beside the television set and wires in a sealed chassis connected by armored cable. When the receiver is switched to a Telemeter band, a dial on the coin box is lighted and soon clicks out the price of the program. At the same time, a 'barker' audio channel starts advertising the attraction persuasively. The screen shows a futuristic pattern of lightning flashes, with an occasional tantalyzing glimpse of a close-up or still scene.

▶ **Nickel-in-the-Drum**—When coins are dropped into the box, the dial revolves to show the balance due. When the full viewing price has been deposited, the show comes on bright and clear. The set automatically switches to the program sound channel. Other sets, unequipped for Telemeter, see only the darting flashes, while two sound channels fight, the barker being somewhat the stronger.

Whether FCC will ever license any subscription tv system over the protests of film exhibitors and constitutionalists is a moot question now. For a field test, Telemeter

(Continued on page 20)


International
RECTIFIER
CORPORATION
EL SEGUNDO
CALIFORNIA
Selenium Diodes
D-1224
1/8" diameter
1/4" length
Potted in thermo-setting compound.
2 Times actual Size
D-1290
RMS applied voltage, max. ..... 26 volts per cell
Peak inverse voltage .... 60 volts per cell
RMS input current, max. ...... 3.75 milliamperes
DC output voltage .... 20 volts per cell
Voltage drop at full load .... 1 volt per cell
DC output current, avg. .... 1.5 milliamperes
DC output current, peak .... 20 milliamperes
Max. surge current .... 80 milliamperes
Reverse leakage at 10V RMS ... 2.4 microamperes
Reverse leakage at 26V RMS ... 12 microamperes
Frequency max. CPS .... 100 KC
Also available in 2, 3 and 4-cell Diodes.
D-1224
RMS applied voltage, max. .... 26 volts per cell
Peak inverse voltage .... 60 volts per cell
RMS input current, max. ...... 500 microamperes
DC output voltage .... 20 volts per cell
Voltage drop at full load .... 1 volt per cell
DC output current, avg. ...... 200 microamperes
DC output current, peak .... 2.6 milliamperes
Max. surge current .... 10 milliamperes
Reverse Leakage at 10V RMS ... 0.6 microampere
Reverse Leakage at 26V RMS .... 3 microamperes
Frequency max. CPS .... 200 KC
Also available in 2-cell Diodes.
2 Times actual Size
D-1290
5/32" diameter
9/32" length
Potted in thermo-setting compound.
International
RECTIFIER CORPORATION
GENERAL OFFICES:
1521 E. Grand Ave.
El Segundo, Calif.
Phone El Segundo 1890
CHICAGO BRANCH OFFICE:
205 W. Wacker Dr.
Franklin 2-3889

proponents expect to tie their idea into a wired-television system serving Palm Springs, Calif. Telemeter programs will be connected into the local cable at certain hours for viewing on one of the receiver channels. By avoiding going on the air, the system can be home-tested without embarrassment to FCC.

Military Parts Orders Momentarily Slow

Recent end-equipment contracts have not yet been reflected to the component-maker's level

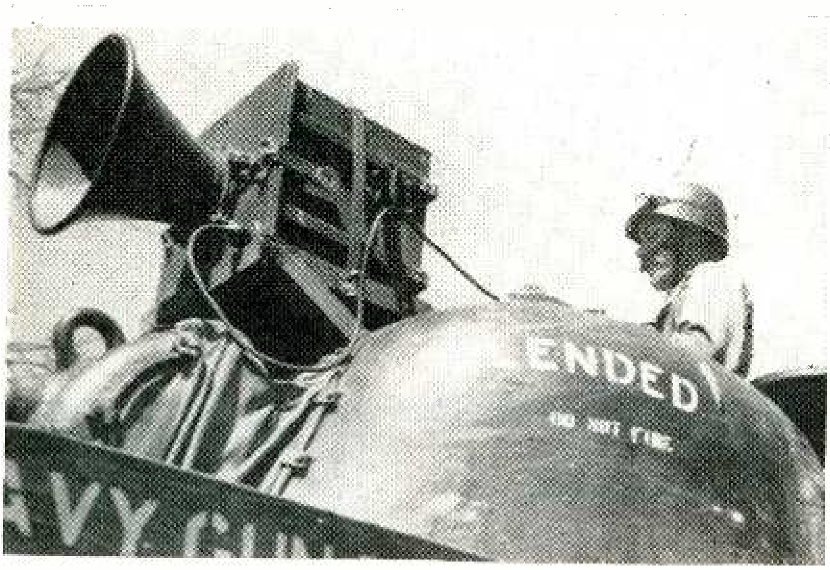
PRESENT LULL in placement of component-part orders by holders of military-equipment contracts is temporary, according to Washington sources.

The military started to 'stretch out' placement of equipment contracts in late 1951 and, seeing less new business immediately ahead, prime contractors tightened up on parts purchases. Parts manufacturers, in turn, became reluctant to expand production facilities and in some instances this resulted in a delivery slowdown even on existing orders.

Military end-equipment orders stepped up a little in May and June, 1952. This should be felt at the component-manufacturing level by August or September.

▶ **'Spares' Too**—Further complicating the planning of component-part makers is the reluctance of the military to commit itself for quantities of spare parts when it places initial end-equipment orders. Government officials, remembering the vast quantities of spare parts stored up during World War II and the criticism which this later invoked, are moving cautiously. "How," they say, "can we determine spare parts needs until a reasonable number of new equipments are field tested?"

Relatively few spare parts are at present manufactured along with those needed for assembly of new military equipment. Thus economies that might be achieved by volume production must be foregone. Several possible solutions are currently under consideration. One of them involves placement of spare parts orders concurrently with equipment reorders.



Audio Ordnance

Rated at 300-watts firepower, this University loudspeaker is mounted atop the turret of a U. S. tank and used by Army 'loudspeaker and leaflet companies' to broadcast surrender invitations and news to the enemy

New Director For NPA Electronics Division

NAMED to a dual post, R. W. Cotton succeeds J. A. Milling as Director of NPA's Electronics Division and Chairman of the Electronics Production Board. He directs the electronics phases of the mobilization program and is responsible for obtaining critical materials and allocating them to electronic producers.

Now on leave from Philco, where he is Assistant to the President, and Vice President of Philco International Cotton was formerly Managing Director and Chairman of the Board of British Rola Ltd., loudspeaker manufacturers. During World War II, he was Controller of Signal Equipment for the British Air Commission. He has been serving as consultant to the U. S. Munitions Board.

California Surveys Electronics Potential

Parts and equipment markets growing but there are cost hurdles

HIGH MARKET POTENTIAL is weighed against high costs in a new survey of California as a location for electronics manufacturing made by the state's Chamber of Commerce.

▶ **Growing Market**—The study indicates that one of the most vitally needed areas of expansion is component parts. Manufacturers need more local production of capacitors and resistors in particular. Only 10 to 25 percent of such parts are available from nearby suppliers.

Industrial electronic equipment is also needed by the state's mushrooming aviation and experimental military installations.

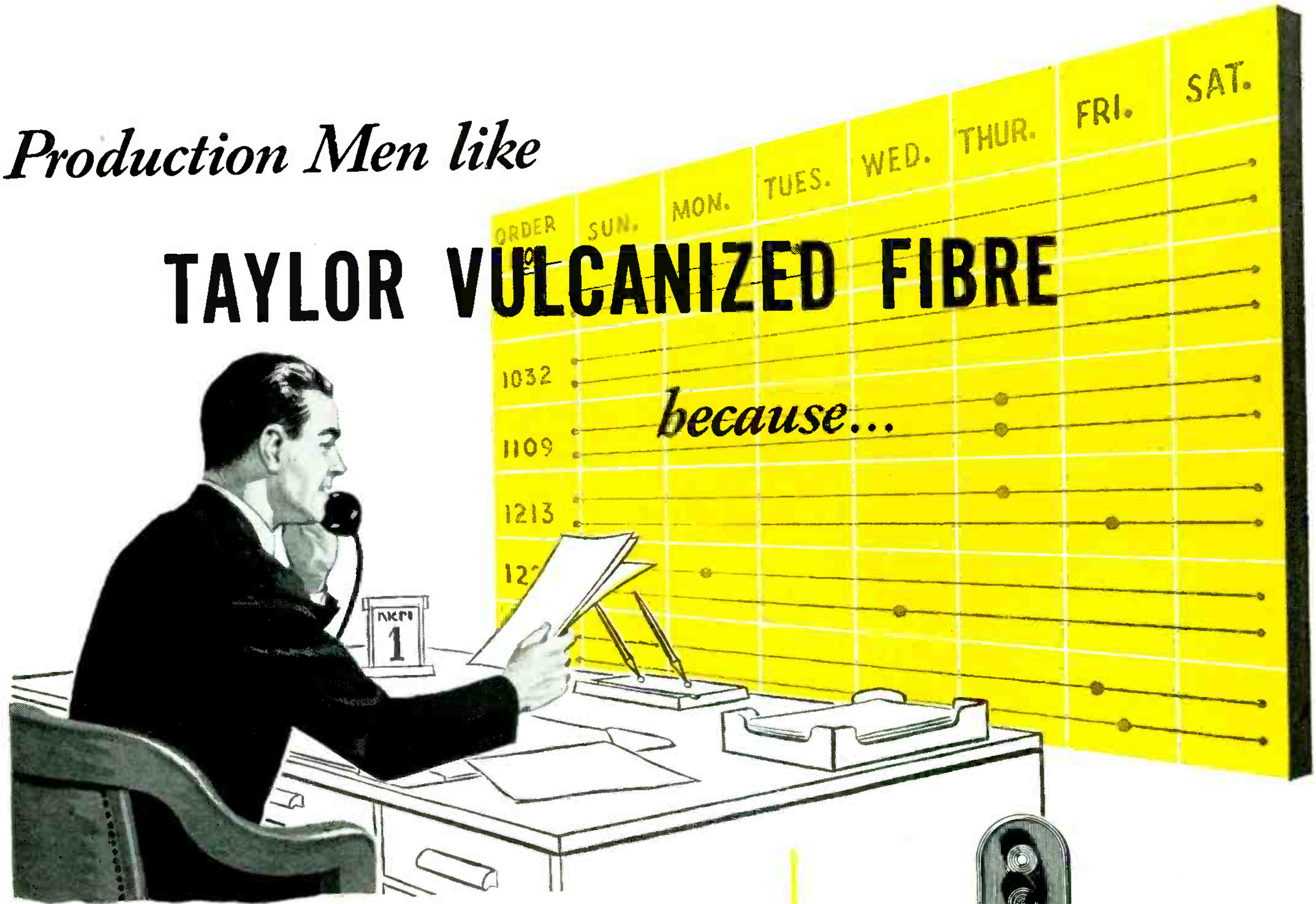
Television and radio market potential is between 300 and 400 percent greater than the state's present productive capacity. One out of five radio and television sets

(Continued on page 22)

Production Men like

TAYLOR VULCANIZED FIBRE

because...



Here's a production man's dream—a uniform easy-to-work material that can be readily machined in any manner in which it is possible to machine metal. Yes, Taylor Vulcanized Fibre, which weighs only half as much as aluminum, is a real time and trouble saver for production men in nearly every branch of the manufacturing industry.

And another advantage in using this workable material is that it is available in numerous forms including sheets, strips, rods, and rolls, and in a wide range of sizes and thicknesses.

When production schedules call for the purchase of *fabricated* parts, made to your specifications, Taylor can furnish them, too—on time—ready for your assembly lines.

It will be well worth your while to get all the facts about Taylor Vulcanized Fibre. You may find new ways and means to use it in making your products better, faster, and cheaper. Let us also give you the details about other Taylor products, such as Phenol, Silicone, and Melamine Laminates, as well as Taylor Insulation.

In the railroad field . . .

Rail-joint insulation—which must withstand, year-after-year, the brutal pounding of locomotive and car wheels—offers conclusive proof of the inherent "toughness" of Taylor Vulcanized Fibre.

This 62-page fact-filled Taylor Catalog describes how the many Taylor Laminated Plastics are made, how and when they're used, and more important, how you can use these basic materials to make your product better . . . at lower cost! Write today for a copy of Catalog E7.

SINCE 1891
Taylor
LAMINATED PLASTICS

TAYLOR FIBRE CO.
NORRISTOWN, PA. • LA VERNE, CALIF.

VULCANIZED FIBRE • TAYLOR INSULATION

PHENOL, SILICONE & MELAMINE LAMINATES • FABRICATED PARTS purchased west of the Rocky Mountains is made in California.

▶ **High Costs**—Balanced against these good market prospects are the state's relatively high manufacturing costs. Electronics manufacturers there pay about 5 percent more for materials than do similar producers in Pennsylvania-New Jersey and Chicago areas.

Labor and shipping costs are also higher in California's electronics industry. The survey's figures show that the average hourly wage for assemblers and technicians is about $1.65, while the average in the Chicago and New Jersey areas is near $1.44.

Employment in the industry has jumped from less than 4,000 to a total of 36,000 in the last ten years.

MEETINGS

AUG. 11-21: Congress of U.R.-S.I. Sydney, Australia.
AUG. 12-15: 1952 APCO Conference, Hotel Whitcomb, San Francisco, Calif.
AUG. 15-16: Emporium Section, IRE, Annual Summer Seminar, Emporium, Pa.
AUG. 19-22: AIEE Pacific General Meeting, Phoenix, Ariz.
AUG. 22-31: Grand German Radio and Television Exhibition, Dusseldorf, Germany.
AUG. 26-30: Australian IRE Radio Engineering Convention, Sidney, Australia.
AUG. 27-29: Western Electronic Show and Conference, Municipal Auditorium, Long Beach, Calif.
AUG. 27-SEPT. 6: British National Radio Show, Earls Court, London.
SEPT. 8-10: American Standards Association, Third National Standardization Conference, Museum of Science and Industry, Chicago, Ill.
SEPT. 8-12: National Instrument Conference and Exhibit, Cleveland, Ohio.
SEPT. 20: Cedar Rapids Section, IRE, Communications Conference, Roosevelt Hotel, Cedar Rapids, Iowa.
SEPT. 22-25: NEDA Third Annual Convention and Manufacturers' Conference, Ambassador, Atlantic City, N. J.
SEPT. 29-OCT. 1: Eighth Annual National Electronic Conference and Exhibition, Hotel Sherman, Chicago, Ill.
OCT. 1-3: Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont.
OCT. 6-8: NAED, Fall Meeting of the Pacific Zone, Hotel del Coronado, Coronado, Calif.
OCT. 13-17: AIEE, Fall General Meeting, New Orleans, La.
OCT. 20-22: Radio Fall Meeting, RTMA Engineering Department, Hotel Syracuse, Syracuse, N. Y.
OCT. 26-29: NAED, Meeting of Board of Governors, Grove Park Inn, Asheville, N. C.
NOV. 10-13: NEMA, Haddon Hall, Atlantic City, N. J.
NOV. 10-30: International Radio and Electronics Exhibition, Bombay, India.
NOV. 17-18: AIEE, Technical Conference on Recording and Controlling Instruments, Benjamin Franklin Hotel, Philadelphia, Pa.
NOV. 19: American Standards Association, 34th Annual, Waldorf Astoria, New York.
JAN. 14-16, 1953: Joint AIEE-IRE Conference on High Frequency Measurement, Washington, D. C.

TV "Saturation-Plus" Seen In Eight Years

NUMBER of television receivers in operation in the United States may exceed the number of homes with electricity by 1960. That is the prediction of W. R. G. Baker, General Electric vice president and general manager of its Electronics Division.

GE market research indicates that 53 million sets will be in operation by 1960, more than three times the present number and five million more than the number of homes expected to have electricity by that time.

Between seven and 10 million homes will have two television sets.

Computers Used To Predict Weather

QUICKER and more exact weather forecasts may result from use of BARK, the Swedish binary computing machine which can retain one hundred 7-digit numbers in its brain.

The application is being worked out by a group of research scientists from eight nations under the auspices of UNESCO.

Business Briefs

▶ **Electronics** and communication equipment production and delivery for the armed forces is now five times greater than it was in January, 1951, according to General Omar N. Bradley.

▶ **21 Servicemen** strategically located about the country form a field advisory board serving the Standard Transformer Corp. They advise the firm on replacement problems, are consulted concerning new products and new technical literature.

▶ **Industry** now leads educational institutions and government agencies as the largest customer for scientific instruments and apparatus, according to the Scientific Apparatus Makers Association.

▶ **Two Contracts** for television equipment have been signed by Bogota, Columbia. One for 6,000 tv sets at $840,000 goes to E. K. Cole Ltd., London. The other, for a tv transmitter and associated equipment costing $230,971, goes to Marconi's Wireless Co. Ltd., London.

▶ **West German** market for radio receivers is expected to increase this year. In 1951, manufacturers there produced 2,500,000 sets, of which 200,000 were exported.

▶ **Magnetic Amplifiers** are being used to regulate current and voltage in a new type of railway passenger car lighting generator system developed by Bogue Electric Mfg. Co.

▶ **Electronics** may eliminate one of the solid institutions of the electrical age, the meter man. Devices that read household meters and automatically transmit the information to distant electronic business machines for billing and complete record keeping are forecast by W. R. G. Baker of GE.

New (40X) Amplifier and

BROWN INSTRUMENTS ACCELERATE RESEARCH

New (*40X*) amplifier combines high gain and sensitivity with good stability.

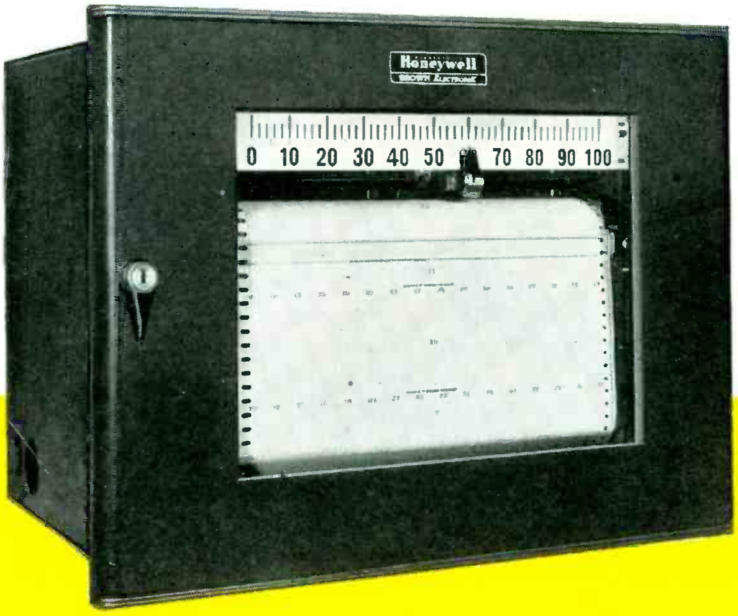
Specially designed to reduce thermal potentials and stray pickup, the new Brown *40X* servo amplifier incorporates an extra stage of amplification to provide increased sensitivity . . . permitting motor drive from signals as low as 0.05 microvolts.

Pictured with the amplifier is the rectifier which provides d-c filament voltage for the first amplifier tubes. It can be used as the basic link in a closed servo loop (where great sensitivity is required) . . . to translate electrical signals into directional motion . . . to provide corrective action in conjunction with minute error signals . . . for null detection . . . or for remote positioning.

Electrical Characteristics

- EQUIPMENT INPUT IMPEDANCE—3000 ohms.
- STABILITY—(after warmup)—within 1.0 μv.
- DEAD ZONE (with 76750-3 motor)—0.1 μv.
- OVERALL VOLTAGE GAIN—40 x 10^6.
- 60 CYCLE OUTPUT CURRENT—0-12 MA.
- 60 CYCLE OUTPUT VOLTAGE—0-154.

Narrow Span Potentiometer



Self-contained *ElectroniK* narrow span potentiometer, incorporating new (*40X*) amplifier, *is ideal for measuring low level potentials.*

Electrical Characteristics

- RANGES—Recorders: 0-100 0-200, 0-500 microvolts, 0-1 millivolts. Indicators: 0-500 microvolts and 0-1.1 millivolts.
- STABILITY (after warmup)—1 microvolt or less for all ranges.
- LIMIT OF ERROR—⅛% of span.
- SENSITIVITY—0.1 microvolt.
- DEAD ZONE—0.1 microvolt or 0.006% of span (whichever is greater).
- PEN SPEEDS—24 or 12 seconds full travel.
- CONTROL FORMS—Any standard pneumatic form, circular chart only.
- CHART SPEEDS—Any standard speed.
- POWER SUPPLY—115 volts, 60 cycles only.
- RANGE OF INPUT SIGNALS TO RECORDER—(approx.) 0.05 μv. to 1 mv.

● *Important Reference Data*

Send for Data Sheet No. 10.20-4 on the (40X) Amplifier . . . Data Sheet No. 10.0-8 on the *ElectroniK* Narrow Span Potentiometer . . . and Bulletin No. 15-14, "Instruments Accelerate Research"

Now, with the development of a new high gain amplifier and potentiometer circuit, extremely low level potentials can be measured, recorded and controlled in this new self-contained instrument. The sensitivity of this instrument is so high that a change in signal as low as one-tenth of a microvolt can be determined. Spans as narrow as 100 microvolts provide a high degree of resolution. Internal design practically eliminates thermal emf's and stray a-c pickups.

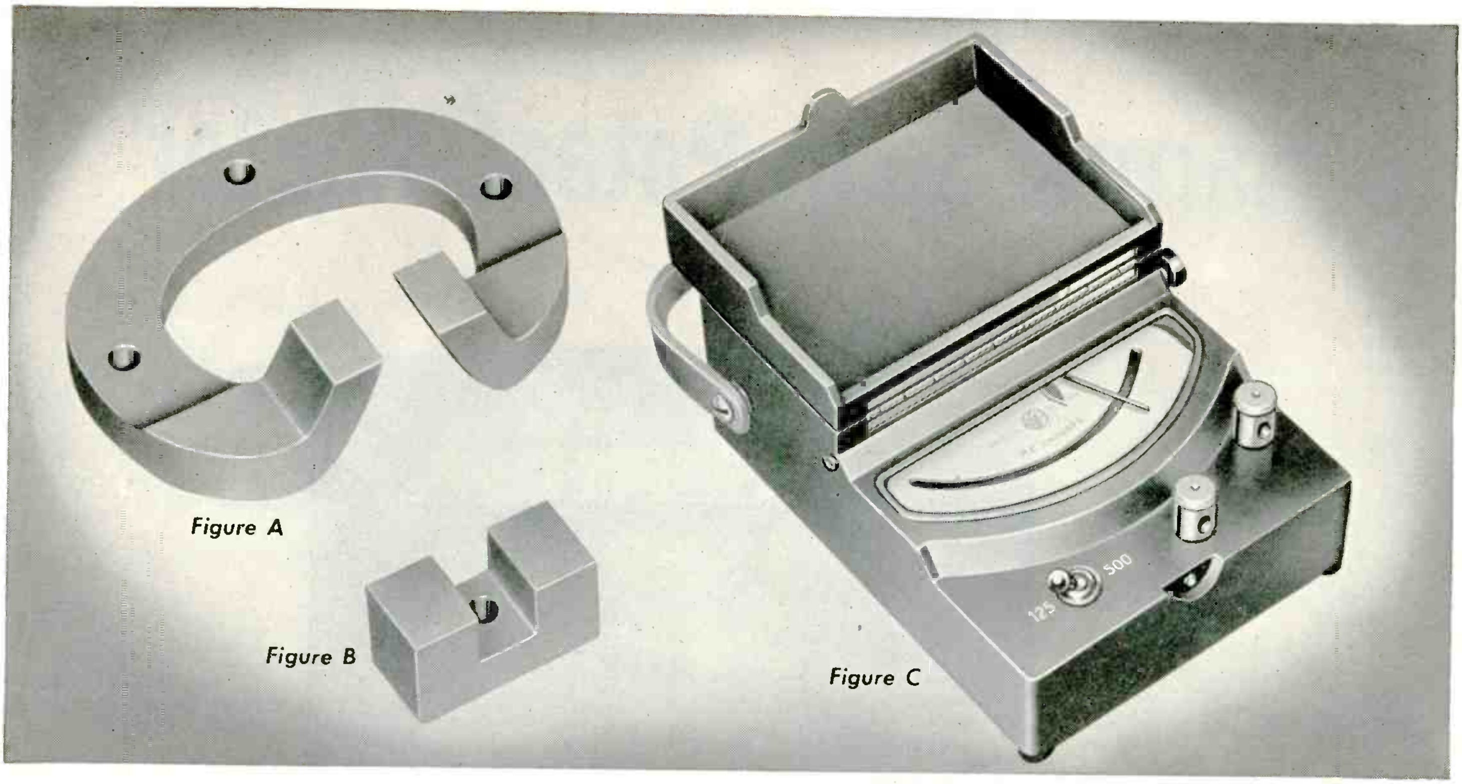
The new *ElectroniK* Narrow Span Potentiometer may be used wherever the accurate measurement of d-c potentials of the order of microvolts is required . . . it is available as a Strip Chart Recorder (illustrated), as a Multi-Point Precision Indicator, and as a Circular Chart Recorder with pneumatic control.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

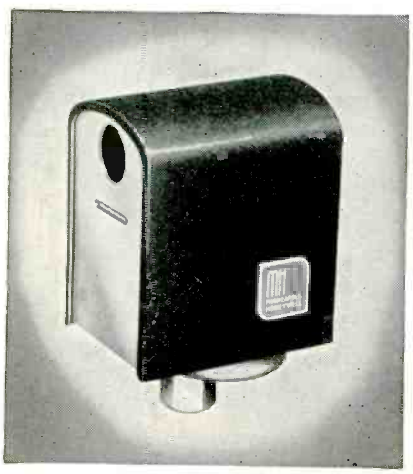
H HONEYWELL

First in Controls



INSTRUMENTS—Fig. A is a damping magnet formerly used in GE portable indicators. Fig. B is the new Carboloy Alnico magnet now used. Its smaller size permitted improved instrument design and lower magnet cost with no decrease in efficiency. Fig. C. New magnet also speeds assembly, makes faster and easier calibrations.

How Carboloy permanent magnets improve electrical products



CONTROLS—Switches in compact Minneapolis-Honeywell controls use permanent magnets to give safer snap action, help quench arcs. The magnets are exceptionally stable; provide uniform high energy for the life of the control.

Want to cut down product size, weight? Build a better-performing product for less money?

Then check the possibility of using Carboloy Alnico permanent magnets wherever you need *lasting* magnetic energy.

Carboloy permanent magnets are simple, self-containing sources of energy that *never* fail. They are powerful in small sizes. Need no outside power supply, no maintenance. They help reduce fabrication costs by eliminating wires, coils and operating parts. Above all, they let you simplify design . . . build a lighter, more compact, finer-performing product at a saving.

On these pages you'll see how others got the jump on competitors by using permanent magnets. Perhaps you'll get an application idea from reading about them.

FREE SERVICES

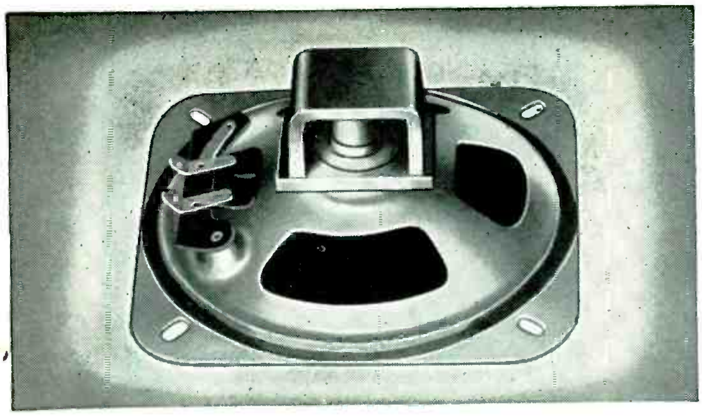
If so, check Carboloy magnet engineers for free, expert advice and an assist in design and application. Look to Carboloy production lines, too, for the uniform, high-energy Alnico magnets you'll need for best results — all sizes, all shapes; cast or sintered to your specifications.

Send coupon for free Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

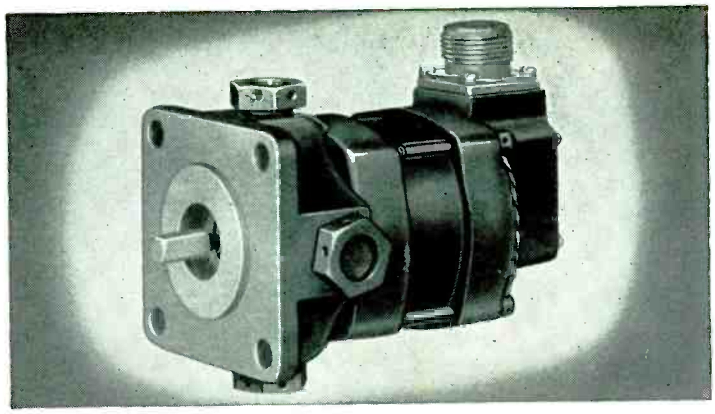
CARBOLOY

DEPARTMENT OF GENERAL ELECTRIC COMPANY

11139 East 8 Mile Road, Detroit 32, Michigan



SPEAKERS — In speakers, permanent magnets replace larger electro-magnets in field structure. Current passing through Alnico's *uniform* field makes voice coil and cone vibrate in proportion to voltage; tone is truer.



GENERATORS—When GE engineers had only 6″ x 6″ area for jet's tachometer generator, they whipped design problem with a tiny permanent magnet. It eliminated coils and wires, supplied the powerful energy required.

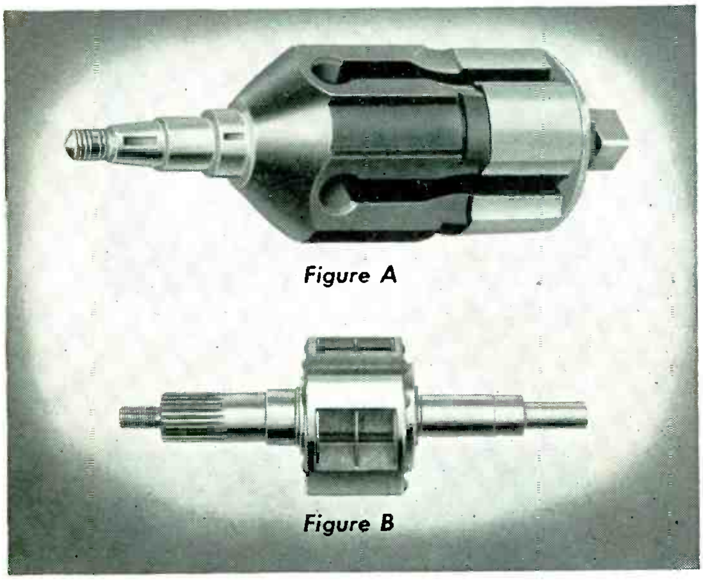


Figure A

Figure B

MAGNETOS — To Scintilla Magneto Division, Bendix Aviation Corp., weight savings are vital in their aircraft products. Fig. A shows chrome rotor weighing approximately 4 lbs. 9 ozs. Fig. B shows newer model rotor using Alnico. It weighs only 2 lbs. 4 ozs.

ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

1. Simple — no operating parts
2. Uniformly powerful
3. Last forever
4. No coils to wire
5. Cool-running
6. No operating costs
7. No power failures
8. Combine electrical and mechanical features
9. Simplify mechanical assemblies
10. Uninterrupted operation
11. Moisture-resistant
12. Create savings

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

Plants at Detroit, Michigan; Edmore, Michigan; and Schenectady, New York

CARBOLOY ALNICO PERMANENT MAGNETS

Mail Coupon Today

Carboloy Department of General Electric Company
11139 East 8 Mile Road, Detroit 32, Michigan

Gentlemen:

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

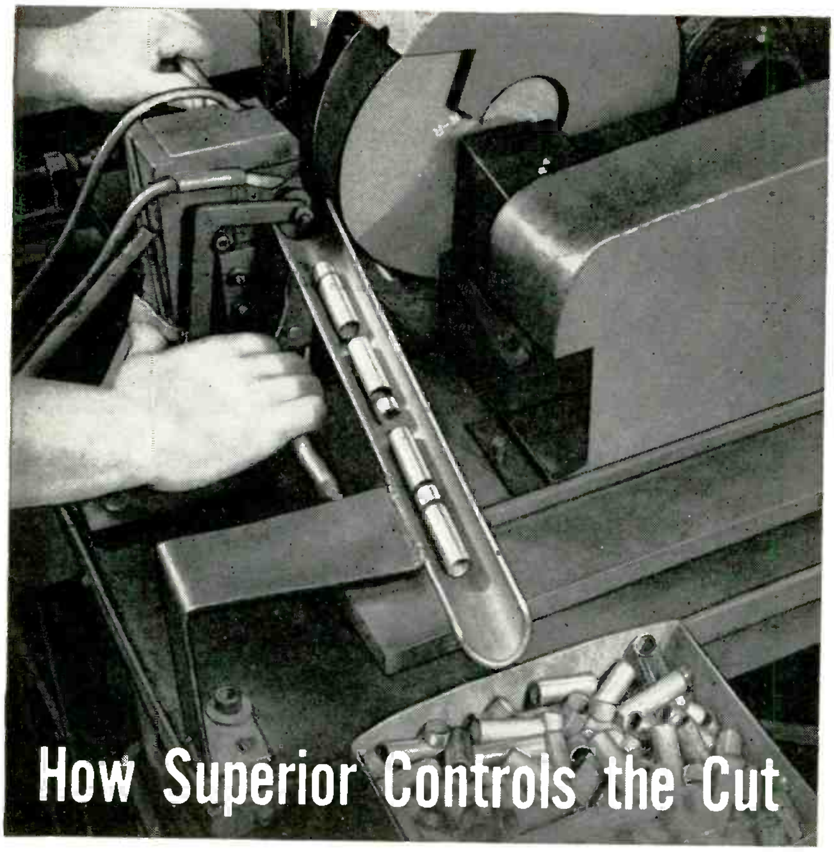
NAME____________________

POSITION____________________

COMPANY NAME____________________

ADDRESS____________________

CITY__________ ZONE____ STATE________



How Superior Controls the Cut

to give you better tubular parts

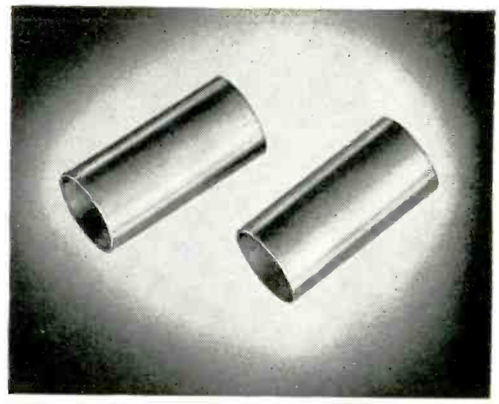
• Cutting tubing into exact lengths as the first step in the fabrication of tubular Electronic parts is a simple operation. Or is it?

Complications set in when the temper of the tubing is changed to meet customer specifications; when the tubing to be cut has a wall .010″ or thinner; when length tolerances as close as .010″ are required; when a 3° to 10° angle cut with a tolerance of ± ½° is called for; and when flattening, denting or other distortion must be prevented.

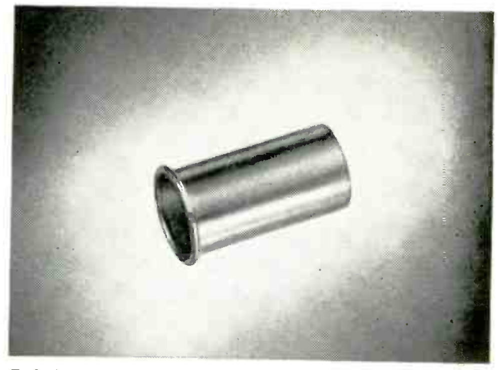
But overcoming complications in simple operations . . . and finding ways around them in other basically more difficult ones, is a specialty of the Electronics Division of Superior.

Our customers for Electronics parts have come to expect us to deliver the goods, exactly to specifications, whether standard production or complex experimental parts. What's more, they frequently ask us for suggestions about improvement on their designs and specifications . . . and they get them.

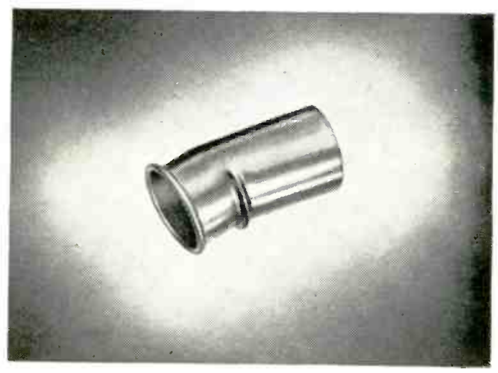
There is nothing unusual about all this—it's our job and we know how to do it. If you are a manufacturer or experimenter in the Electronics Industry and you need a tubular part that presents a problem, tell us about it. We'll probably be able to help and will gladly do so. Write The Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.



Cutting and Tumbling. Cutting machines and jigs of many types and sizes are combined with extensive tumbling equipment to permit fast accurate production of quantities of parts at Superior.



Fabrication: Parts can be readily rolled at either or both ends, flared, flanged, expanded, or beaded (embossed) as required. The anode above is one of many such parts we produce at high speed and low cost.



The Finished Part. Final stage in the fabrication of the part shown above at three stages of production is a bend nicely controlled for both precise angle and freedom from other, unwanted distortion.

This Belongs in Your Reference File
. . . Send for It Today.

NICKEL ALLOYS FOR OXIDE-COATED CATHODES: This reprint describes the manufacturing of the cathode sleeve from the refining of the base metal. Includes the action of the small percentage impurities upon the vapor pressure, sublimation rate of the nickel base; also future trends of cathode materials are evaluated.

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.
Certain analyses (.035″ max. wall) Up to 1¼″ O.D.

***SUPERIOR TUBE COMPANY** • Electronic products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800*

Lapp

GAS-FILLED CONDENSERS

More than 15 years service on thousands of Lapp Gas-Filled Condensers proves them to be completely reliable—electrically and mechanically. They offer the advantages of extreme compactness for high voltage and high current ratings... low loss... high safety factors... puncture-proof design... constant capacitance under temperature variation.

In construction, the condenser assembly is supported on a top aluminum ring, the steel tank serving only as a support for this ring and as a leak-proof gas container. The high potential plates are stationary, carried on a rigid aluminum center stud, supported by a ceramic bowl. Rotor plates are grounded, carried on ball-bearings in a race almost the full diameter of the tank. This construction provides a grounded tuning shaft on variable models, makes possible efficient and complete water cooling for high current operation, and results in direct and short current paths to condenser plates.

Write for complete description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.

MODEL 24 IF
Fixed only
Capacitances up to 60,000 mmf.; 1 mc. current ratings: 175, 350, 525 amps.; Safety gap settings: 14, 25, 38 Kv peak.

MODEL 18 R—*Fixed or Variable*
MODEL 18 I—*Variable only*
MODEL 18 IF—*Fixed only*
Capacitances up to 30,000 mmf.; 1 mc. current ratings: 120, 240, 360 amps.; Safety gap settings: 6, 14, 25, 38, 50, 63, 72 Kv peak.

MODEL 12 R—*Fixed or Variable*
MODEL 12 IF—*Fixed only*
Capacitances up to 15,000 mmf.; 1 mc. current ratings: 105, 210, 315 amps.; Safety gap settings: 6, 14, 25, 38, 50, 63 Kv peak.

MODEL 9 R
Fixed or Variable
Capacitances up to 8000 mmf.; 1 mc. current ratings: 85, 170, 255 amps.; Safety gap settings: 6, 14, 25, 38, 50 Kv peak.

MODEL 7 R
Fixed or Variable
Capacitances up to 8000 mmf.; 1 mc. current ratings: 70, 140, 210 amps.; Safety gap settings: 2½, 6, 14, 25, 38 Kv peak.

for "Bridgeport" *Service*

BRASS "Bridgeport" CO.

OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

BRIDGEPORT WAREHOUSE SERVICE

The Bridgeport warehouses are designed to supply from stock limited quantities of sheet, rod, wire or tubing. It is the policy of the company to maintain adequate warehouse stocks at all times so that small orders can be filled without delay.

The fabricator is in a position to obtain promptly metal to fill orders for experimental work or to start production runs, while waiting for mill shipments.

Bridgeport warehouses make every effort to carry the variety of alloys, sizes and gages which fulfill the requirements of the locality they serve.

To take care of the maximum range of widths of strip metal, slitting service is available—not only to serve warehouse stocks, but also to make customers' stocks of non-ferrous strip metal more flexible.

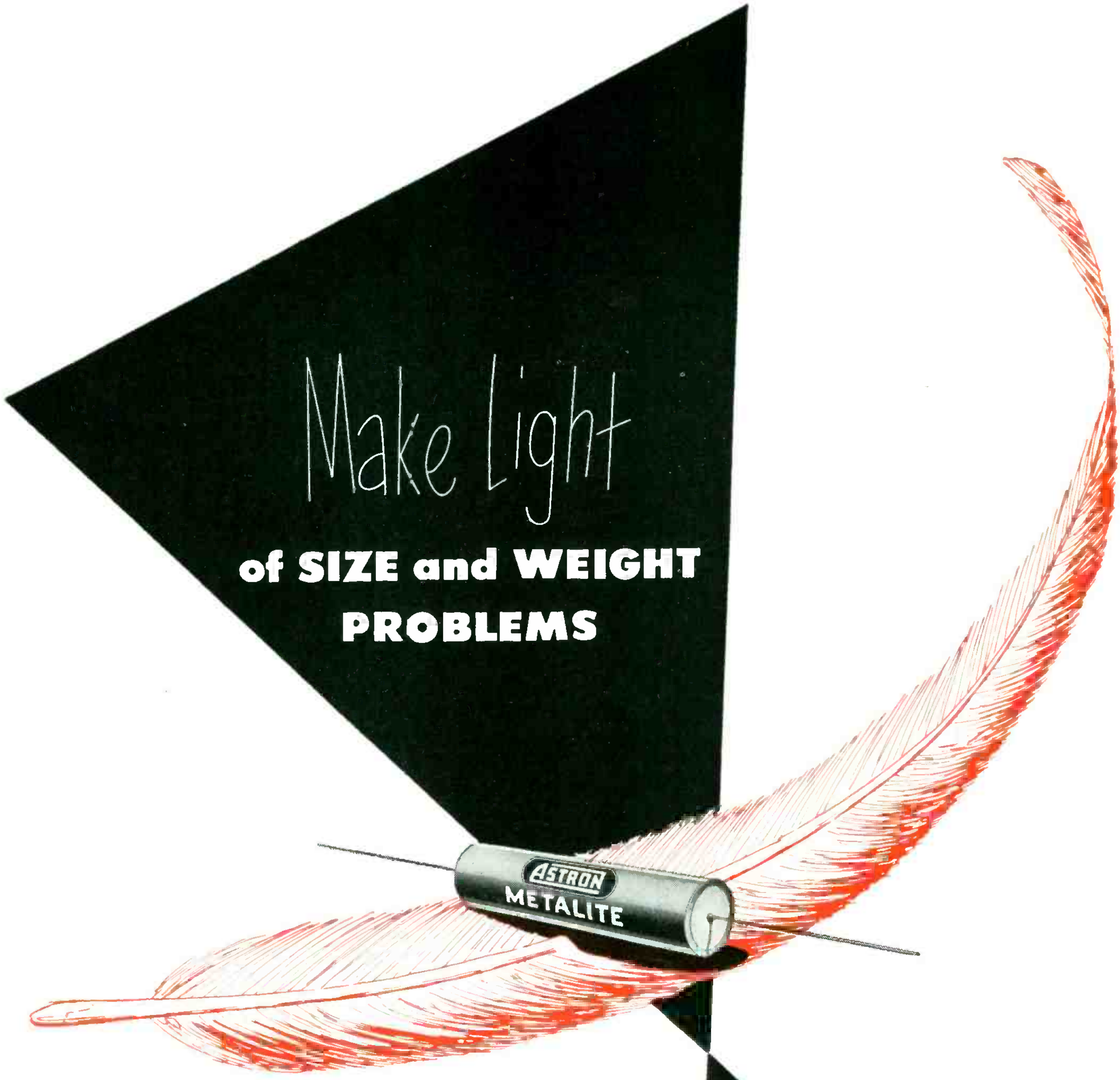
Bridgeport's Warehouse Stocklist carries weight tables and a technical digest giving the properties of the most popular copper-base alloys. If you do not have a copy, ask your nearest Bridgeport office.

Mills in Bridgeport, Conn. and Indianapolis, Ind.
In Canada: Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY

BRASS "Bridgeport" CO.

30 GRAND STREET, BRIDGEPORT 2, CONNECTICUT



with **ASTRON**

SUBMINIATURE

Metalite* Capacitors

Astron METALITE* metallized paper capacitors, distinguished by their extremely small size and light weight, are currently serving commercial and military users who must meet strict government specifications. Their unique self-healing property, long life and *precision manufacture* have made them the accepted standard for quality metallized paper capacitors throughout the world. If you have a capacitor problem of any kind, our engineers will be glad to consult with you.

For complete information on Astron METALITE and other standard capacitors, write for Catalog AC-3.

Depend On — Insist On

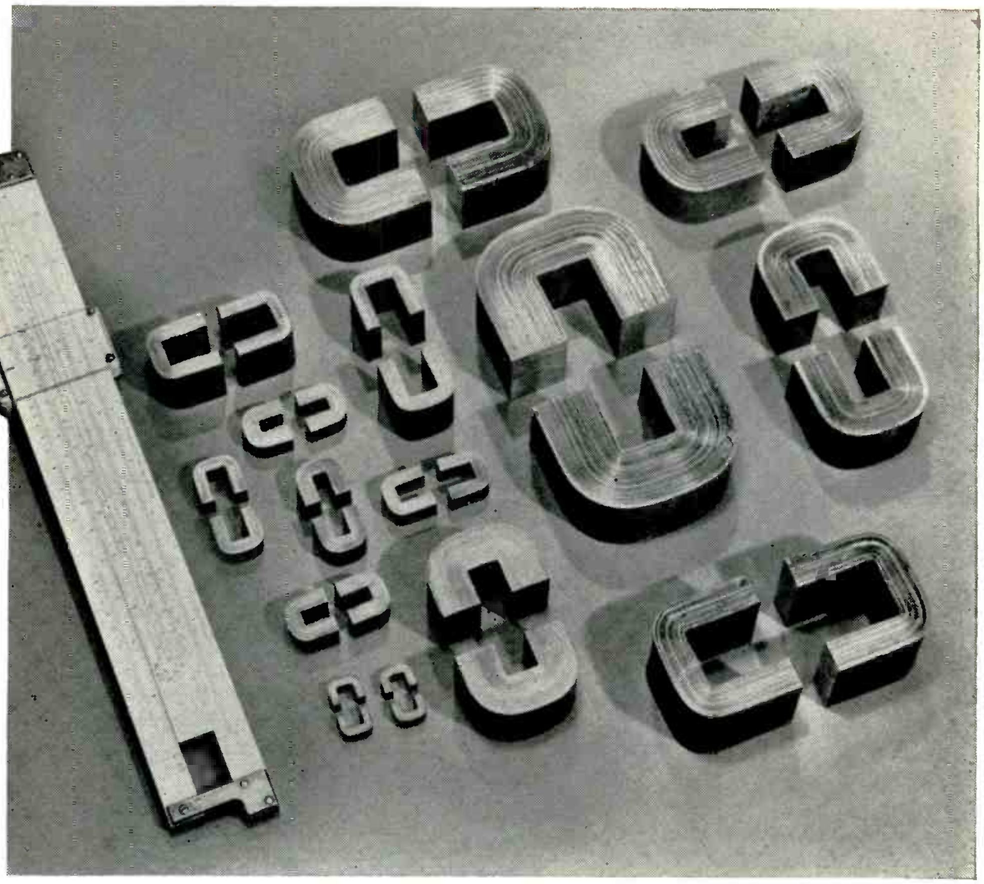
ASTRON CORPORATION

255 Grant Avenue, E. Newark, N. J.

*Trademark

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

SILECTRON "C" CORES *for quick delivery* IN PRODUCTION QUANTITIES



. . . wound from strip as thin as 0.00025"

Quality-Tested and Proved

★ Arnold "C" Cores are made to highly exacting standards of quality and uniformity. Physical dimensions are held to close tolerances, and each core is tested as follows:

★ 29-gauge Silectron cut cores are tested for watt loss and excitation volt-amperes at 60 cycles, at a peak flux density of 15 kg.

★ 4-mil cores are tested for watt loss and excitation volt-amperes at 400 cycles, at a peak flux density of 15 kg.

★ 2-mil cores are tested for pulse permeability at 2 microseconds, 400 pulses per second, at a peak flux density of 10 kg.

★ 1-mil cores are tested for pulse permeability at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss.

★ ½ and ¼-mil core tests by special arrangement with the customer.

Now available—"C" Cores made from Silectron (oriented silicon steel) thin-gauge strip to the highest standards of quality.

Arnold is now producing these cores in a full range of sizes wound from ¼, ½, 1, 2 and 4-mil strip, also 29-gauge strip, with the entire output scheduled for end use by the U. S. Government. The oriented silicon steel strip from which they are wound is made to a tolerance of plus nothing and minus mill tolerance, to assure designers and users of the lowest core losses and the highest quality in the respective gauges. Butt joints are accurately made to a high standard of precision, and careful processing of these joints eliminates short-circuiting of the laminations.

Cores with "RIBBED CONSTRUCTION"* can be supplied where desirable.

Ultra thin-gauge oriented silicon steel strip for Arnold "C" Cores is rolled in our own plant on our new micro-gauge 20-high Sendzimir cold-rolling mill. For the cores in current production, standard tests are conducted as noted in the box at left—and special electrical tests may be made to meet specific operating conditions.

● **We invite your inquiries.**

*Manufactured under license arrangements with Westinghouse Electric Corp.

W&D 4211

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

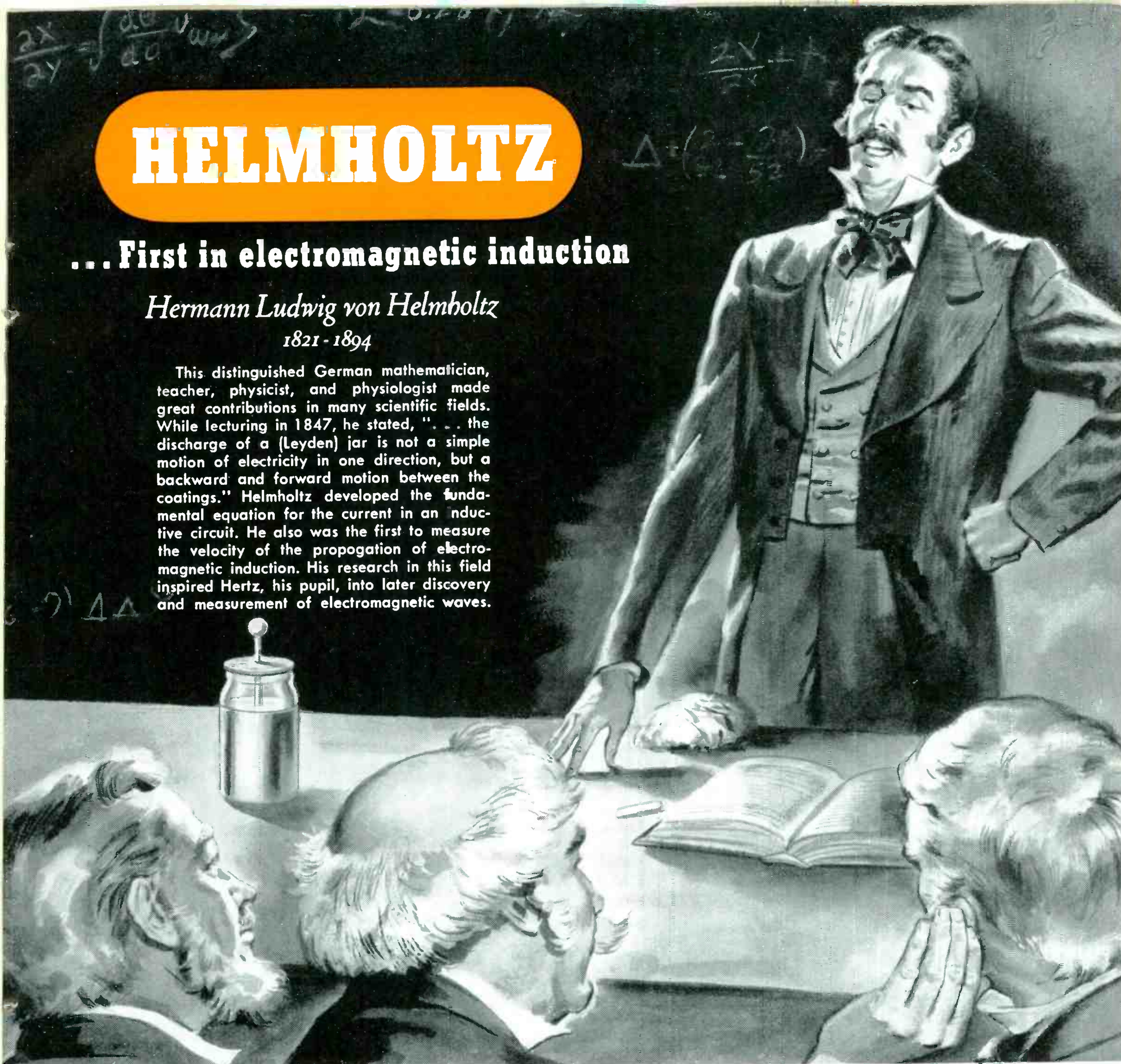
General Office & Plant: Marengo, Illinois

HELMHOLTZ

...First in electromagnetic induction

Hermann Ludwig von Helmholtz
1821 - 1894

This distinguished German mathematician, teacher, physicist, and physiologist made great contributions in many scientific fields. While lecturing in 1847, he stated, ". . . the discharge of a (Leyden) jar is not a simple motion of electricity in one direction, but a backward and forward motion between the coatings." Helmholtz developed the fundamental equation for the current in an nductive circuit. He also was the first to measure the velocity of the propogation of electromagnetic induction. His research in this field inspired Hertz, his pupil, into later discovery and measurement of electromagnetic waves.



From an original drawing made for OHMITE.

OHMITE®

FIRST in resistors ...today

More manufacturers have standardized on Ohmite wire-wound resistors than on any other make. These preferred resistors have a world-wide reputation for *dependability* . . . the ability to give unfailing performance under adverse operating conditions. Furthermore, the Ohmite resistor line is the most extensive available. Investigate these fine units for your product.

Be Right with **OHMITE**

RHEOSTATS • RESISTORS • TAP SWITCHES

OHMITE® Wire-Wound RESISTORS
Built FOR LONG LIFE AND DEPENDABLE OPERATION
EVEN, UNIFORM WINDING
The unsurpassed uniformity of the resistance winding prevents "hot spots" and resultant failures. This uniformity is *permanent* — locked in by vitreous enamel.
VITREOUS ENAMEL COVERING
Acts as both heat conductor and electrical insulator. Holds the winding rigidly in place, and protects it against mechanical damage, moisture, and fumes.
TINNED TERMINALS
Terminal lugs are tin-dipped for ease in soldering to connecting wires. Resistance wire is welded or brazed to the lug, assuring perfect electrical connection.
STRONG CERAMIC CORE
The high-strength ceramic tube provides a sturdy insulating base for the resistance winding. It is unaffected by cold, heat, fumes, or high humidity.
RESILIENT MOUNTING BRACKETS
Hold resistor firmly in place, yet have resilience to prevent shock damage. Brackets are simple to attach; can be easily removed by a slight upward pressure at the base.
OHMITE MANUFACTURING CO.
4816 Flournoy Street, Chicago 44, Ill.
Write on Company Letterhead for Complete Catalog.
Be Right with
OHMITE®
RHEOSTATS • RESISTORS • TAP SWITCHES

One-thousand miles of Y3 Grid Wire . . . .

. . . have gone into America's finest electronic vacuum tubes

- ***Withstands high temperatures***
- ***Adaptable to hand or machine winding***
- ***No substantial primary emission***

Outstanding performances by many, many thousands of electronic vacuum tubes utilizing Y3 grid wire have followed years of research by Eimac engineers. Uniquely treated Y3 grid wire suppresses primary emission by nullifying thorium contamination. It maintains rigidity at high temperatures—has a ductility that makes it adaptable for hand or machine winding and is ideal for spot-welding techniques. Eimac's Y3 is superior to molybdenum or tantalum grids operated in similar tubes and conditions. Intended for use with thoriated tungsten filaments, Y3 has long life and no substantial primary emission up to 1300° centigrade brightness temperature. Type Y3 grid wire is produced by Eimac and is available in quantity lots of 100, 500, 1000, 5000 and 10,000 meters.

Write our application engineering department for further information

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

Follow the Leaders to Eimac TUBES

For low-level d-c measurements use these new, L&N triple-purpose Amplifiers

High precision checking and calibrating under factory conditions using D-C Indicating Amplifier as null detector for accurate bridge and potentiometer circuits. Through combination of a-c amplification and balanced feedback network, zero and gain stability are designed right into instrument. Trimmer controls are eliminated.

SPECIFICATIONS

MICROVOLT UNIT No. 9835	MICRO-MICRO-AMPERE UNIT No. 9836
FULL SCALE RANGES WITH BUILT-IN 4" METERS	
0 to 50 or −25 to +25 Microvolts; scale multipliers: 1, 2, 4, 10, 20, 40	0 to 1000 or −500 to +500 Micro-Micro-amps; scale multipliers: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000
ACCURACY	
Of amplifier: ±0.4% of reading; Of meter: ±1%	Of amplifier: ±0.5 to 0.8%* of reading; Of meter: ±1%
ZERO OFFSET	
Max. offset: ±0.5 Microvolt	Max. offset: ±2% of scale
***SOURCE RESISTANCE**	
Up to 10,000 ohms.	0.1 megohm or more.
REPONSE TIME	
2 to 3* sec.	2 to 3* sec.

OUTPUT

For full scale input on any range: 10 millivolts at output impedance of 500 ohms for null recorder; 1 volt for 20,000-ohm external meter.

Front panel fits standard 19" relay rack.

*Accuracy and Response Time depend on Source Resistance.

Jrl. Ad EM9-51(2)

can be used as . . .

- √ **DIRECT-READING MICROVOLTMETER OR MICRO-MICROAMMETER**
- √ **RECORDER PREAMPLIFIER**
- √ **NULL DETECTOR**

THESE new D-C Indicating Amplifiers are the answer for all your low-level measurements with thermocouples, strain gages, bolometers—bridge and potentiometer circuits—ionization, leakage, and phototube currents—almost any measurement of extremely small direct current or voltage.

Actually 3 instruments in 1, Amplifiers can be used as:

√ Direct-reading instruments—Scale multiplier knob lets you select the range in which you want to work.

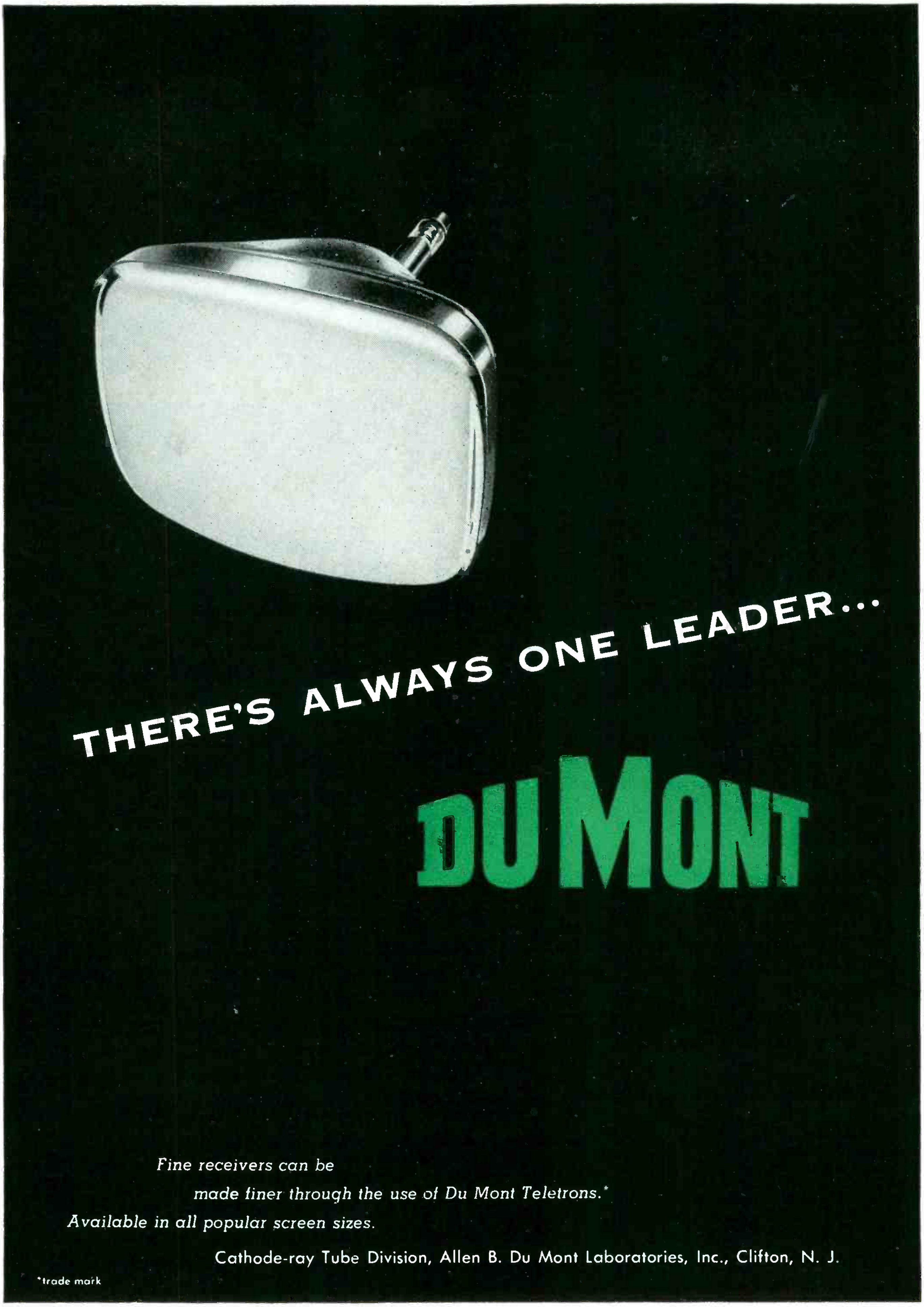
√ Recorder preamplifiers—with broad flexibility. One or two degrees temperature difference can be spread right across a 10" Speedomax recorder chart.

√ Null detectors—more sensitive than most reflecting galvanometers, yet with full scale response time of only 2 to 3 seconds. Leveling is unnecessary; the instrument is not affected by vibration. At the turn of a range knob, you have available a wide choice of sensitivities. And when using non-linear response, not only does the instrument stay on scale at extreme unbalance; sensitivity increases automatically as the null point is approached.

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

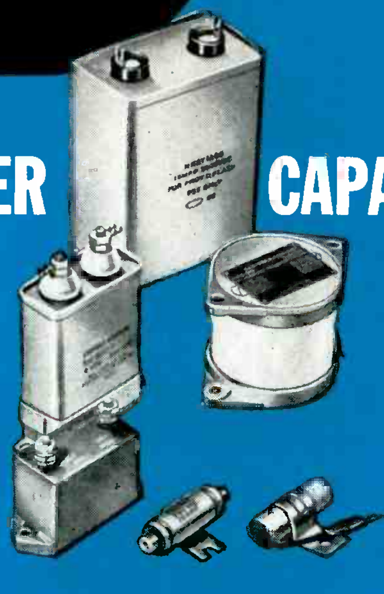
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

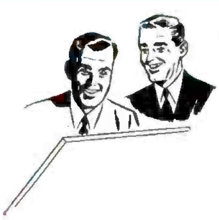
LEEDS & NORTHRUP CO.


THERE'S ALWAYS ONE LEADER...
DU MONT
Fine receivers can be
made finer through the use of Du Mont Teletrons.*
Available in all popular screen sizes.
Cathode-ray Tube Division, Allen B. Du Mont Laboratories, Inc., Clifton, N. J.
*trade mark

Consistently Dependable

CORNELL-DUBILIER CAPACITORS





"Let's take this capacitor problem to C-D" About 3 times out of 4, we find that a capacitor problem submitted to us has come up before, and the solution is ready and waiting.

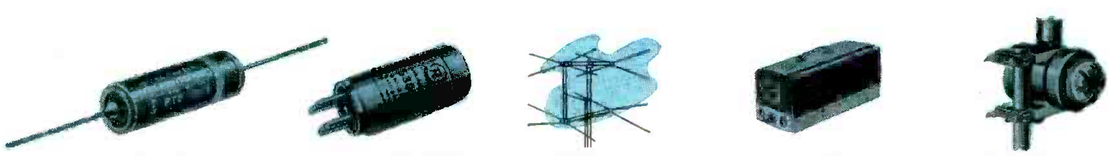
Coincidence? No, just that C-D is usually called on to tackle the capacitor problems of other companies engaged in the same type of work as your own.

If your problem is new or old, our engineers will be glad to collaborate with you. Dept. K-72, Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CORNELL-DUBILIER

world's largest manufacturers of capacitors

SUBSIDIARY



SOUTH PLAINFIELD, N. J. • NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS. • PROVIDENCE, R. I. • INDIANAPOLIS, IND. • FUQUAY SPRINGS, N. C. • SUBSIDIARY, THE RADIART CORP., CLEVELAND, O.

Noise Suppression?

Engineers think of FILTRON for RF Noise Suppression!

FILTRON engineers haven't licked Barber Interference Suppression, yet, but we can solve all your problems of RF Interference Suppression on electronic equipment.

FILTRON will *custom design* the filter for your circuit conditions to meet size, weight and overall configuration—and meet military RF Interference Suppression limits and specifications.

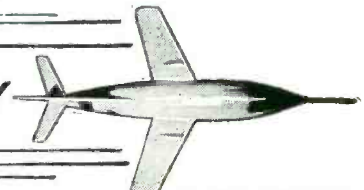
FILTRON's advanced engineering, due to constant research and development, together with **FILTRON's** production know-how, insures quality components to meet your delivery requirements. Your inquiries are invited.

RF INTERFERENCE SUPPRESSION FILTERS FOR:

Motors	Dynamotors
Generators	Power Plants
Inverters	Actuators
Electronic Controls	Gasoline Engines

And other RF Interference producing equipment

filtered by FILTRON



DOUGLAS SKYROCKET

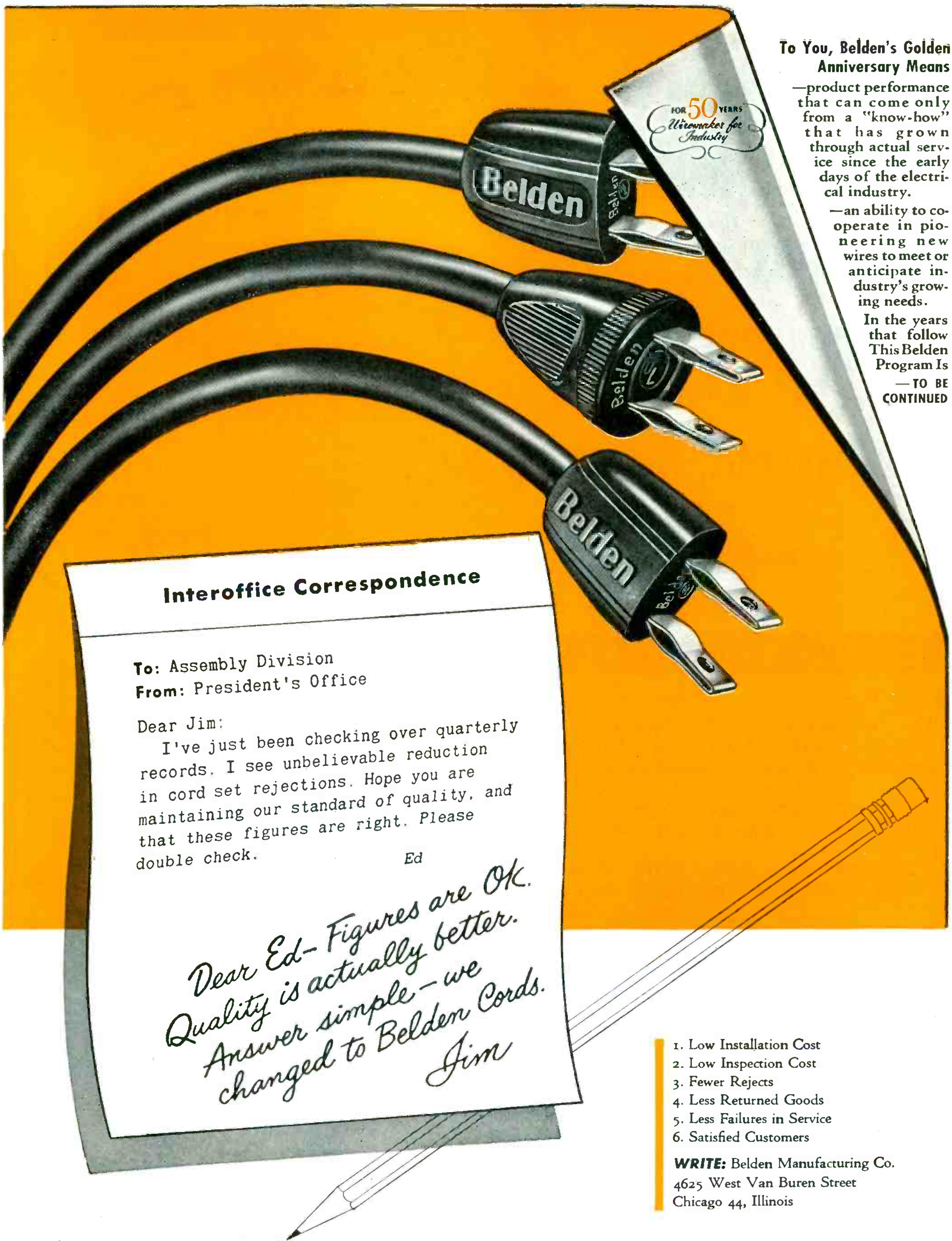
Send for our LATEST CATALOG on your company letterhead

THE FILTRON CO., INC.

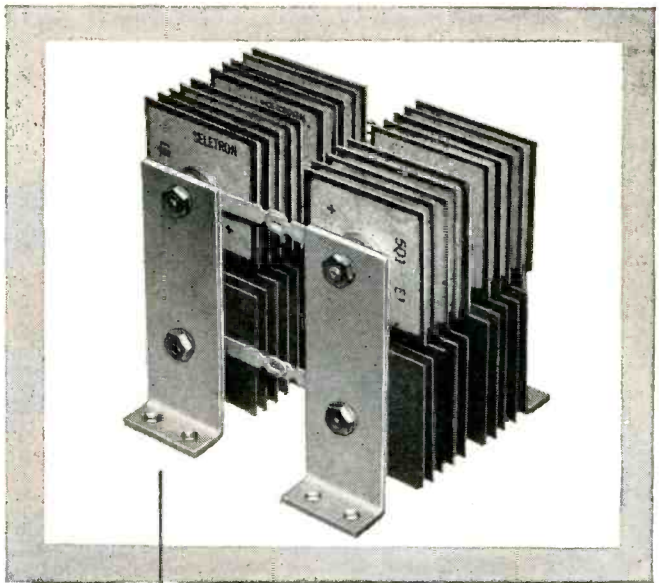
FLUSHING, LONG ISLAND, NEW YORK

LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS


KOLLSMAN INSTRUMENTS
KOLLSMAN
AIRCRAFT INSTRUMENTS AND CONTROLS
MINIATURE AC MOTORS FOR INDICATING AND REMOTE CONTROL APPLICATIONS
OPTICAL PARTS AND OPTICAL DEVICES
RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT


FOR 50 YEARS
Wiremaker for Industry
Belden
Interoffice Correspondence
To: Assembly Division
From: President's Office
Dear Jim:
I've just been checking over quarterly records. I see unbelievable reduction in cord set rejections. Hope you are maintaining our standard of quality, and that these figures are right. Please double check.
Ed
Dear Ed– Figures are OK. Quality is actually better. Answer simple–we changed to Belden Cords.
Jim

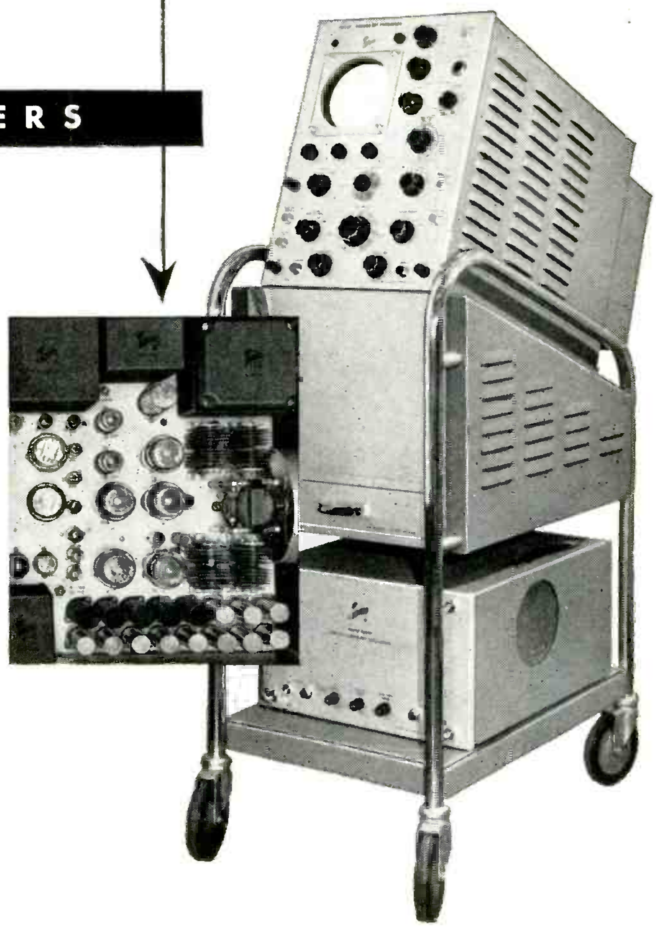
Because product leadership depends on component quality



Tektronix, Inc. relies on . . .

Seletron

SELENIUM RECTIFIERS



The Tektronix Cathode-Ray Oscilloscope, recognized leader in its field, is a high precision instrument and light in weight because of essential mobility. Since it is urgent that sweep rates and deflection sensitivities remain constant in spite of line voltage variations, all critical voltages are electronically controlled.

Specified for the power supply, of course, are SELETRON Selenium Rectifiers to help maintain Tektronix standards. In the type 517 Oscilloscope, SELETRON 5Q1 rectifiers are combined to furnish 750 milliamps at 150 volts and 500 milliamps at 225 volts. Their ruggedness and dependability aid materially in maintaining the stability of this wide band high voltage instrument.

Versatile SELETRON Selenium Rectifiers are available in a complete range of sizes for every electronic circuit—from a few mils up to thousands of amps. Whatever your problem in rectification—whether in radio, communications or for heavy industrial use, count on our engineers to be of real assistance. Your correspondence is invited . . . Remember, product quality depends on *component* quality!

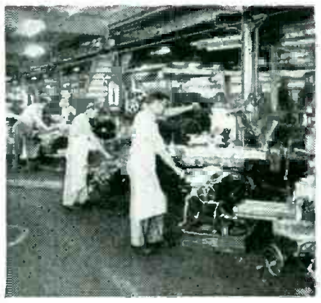
Seletron and Germanium Division

RADIO RECEPTOR COMPANY, INC.

RR *Since 1922 in Radio and Electronics* RR

Sales Dept.: 251 W. 19th St., New York 11, N. Y. • Factory: 84 N. 9th St., Brooklyn 11, N. Y.

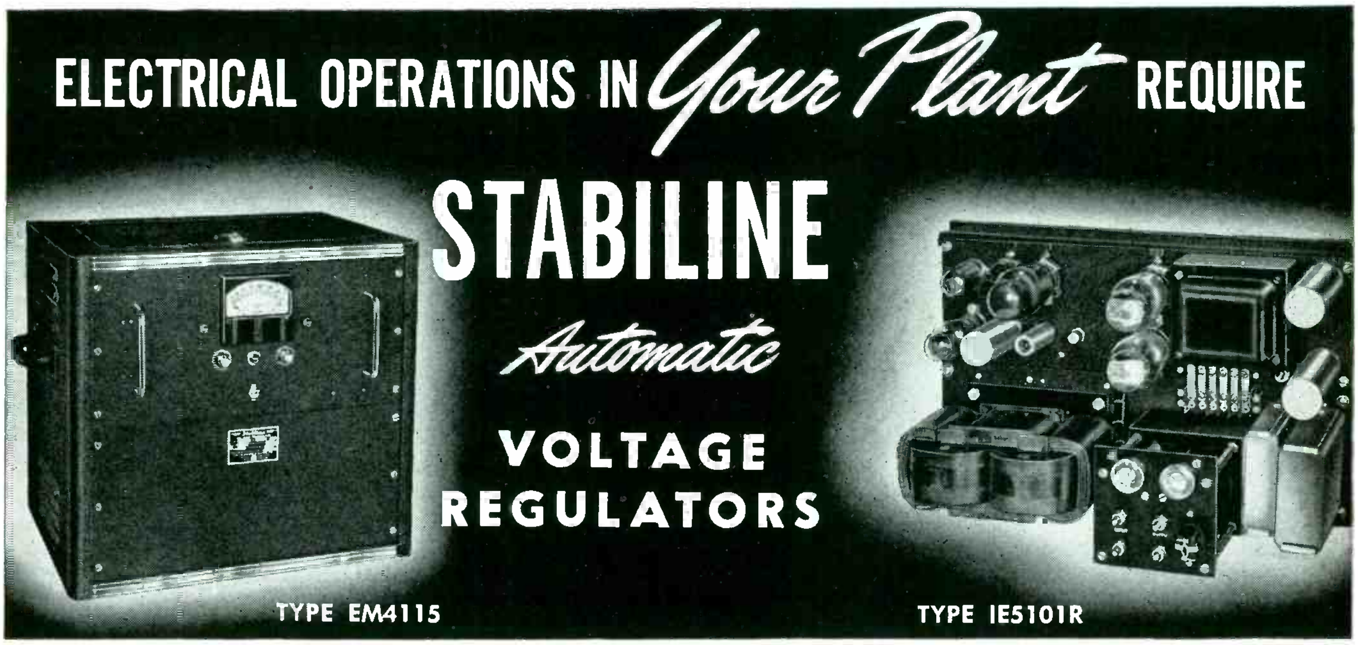
LABORATORIES: Experimental and development work requires extremely close voltage control for accurate and dependable results.



MANUFACTURING: To achieve maximum rated performance of electrically powered equipment, the input nameplate voltage must be maintained.

TESTING: Constant voltage must be maintained when testing or inspecting your product to obtain a valid check.

MAINTENANCE: By maintaining constant voltage to lamp loads and electrically operated equipment, productive life is increased and maintenance costs reduced.



THERE IS NO BETTER WAY TO MAINTAIN CONSTANT OUTPUT VOLTAGE *Automatically*

TYPE **IE**

INSTANTANEOUS ELECTRONIC
Completely electronic automatic voltage regulators with no moving parts. Offer instantaneous correction . . . excellent stabilization and regulation. Waveform distortion does not exceed 3%. Particularly adapted for use in laboratories . . . test lines and for all other applications where the most exacting voltage regulation is necessary.

TYPE **EM**

ELECTRO MECHANICAL
Consists basically of a very sensitive detector controlling a motor-driven POWERSTAT variable transformer and auxiliary transformer. Correction is not instantaneous but is faster than most automatic voltage regulators. Features zero waveform distortion and high efficiency. Ideally suited for controlling large industrial loads.

FOR YOUR ELECTRICAL OPERATIONS . . .

. . . there is a STABILINE Automatic Voltage Regulator right for the job . . . to maintain constant voltage regardless of line or load changes.
Send today for complete information.

WRITE TO — 207 THURE AVENUE, BRISTOL, CONNECTICUT
ASK FOR — SECO BULLETIN S351

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

- STABILINE AUTOMATIC VOLTAGE REGULATORS
- POWERSTAT VARIABLE TRANSFORMERS
- VARICELL D-C POWER SUPPLIES
- VOLTBOX A-C POWER SUPPLIES
- SUPERIOR 5-WAY BINDING POSTS
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PRECISION RESISTORS . . . FOR PRECISION ELECTRONICS
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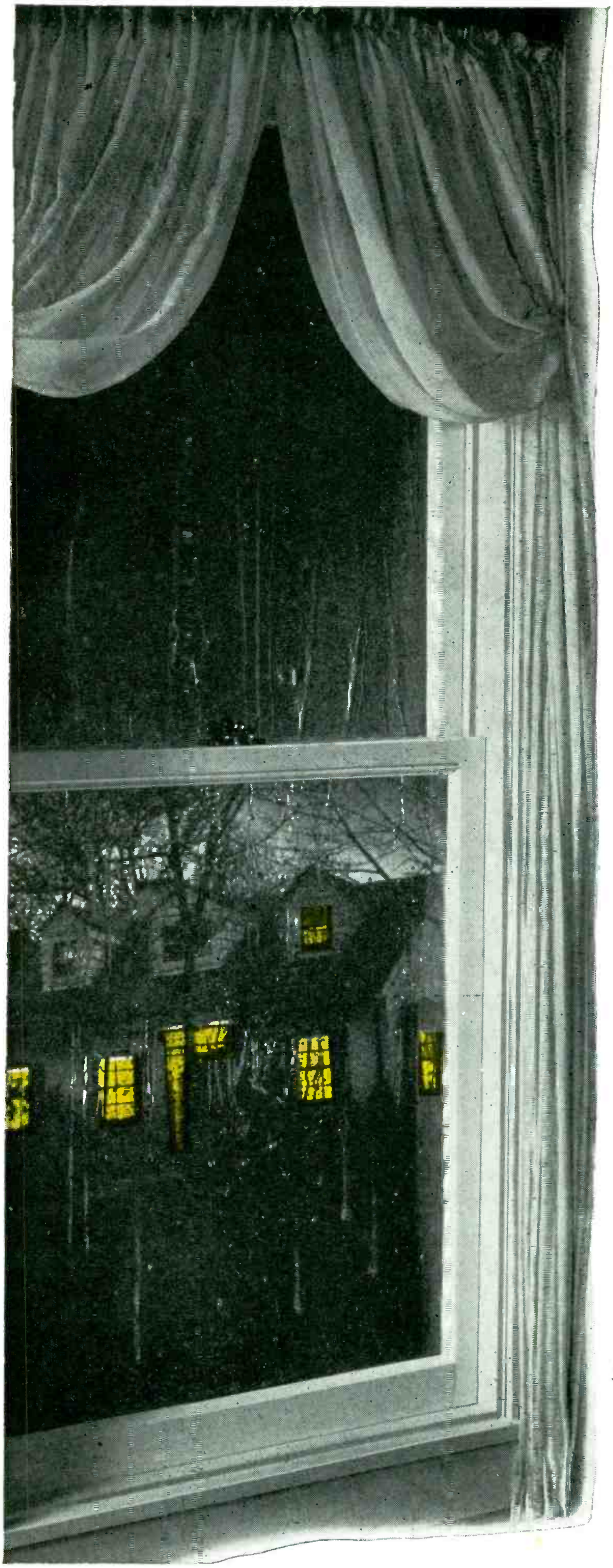
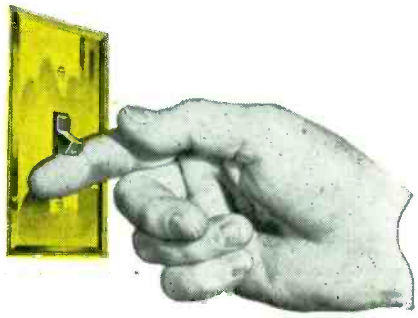
PRECISION
WIRE WOUND
RESISTOR
MEPCO
Precision Wire Wound Resistors:
JAN-R-93, and Commercial
External Meter Multiplier Resistors:
JAN-R-29
Pre-Wired Resistor Switch Assemblies
Other Types to Your Specifications
MEPCO, INC., MORRISTOWN, NEW JERSEY



Gloom chaser . . . that works

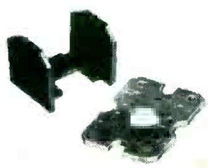


Fair weather or foul, when you flip a light switch you *expect* light. You take it for granted. Actually, like a touchdown in football, the result is the triumph of teamwork in electrical apparatus.

The power company is the captain. The players include the manufacturers of generators, transformers, switch gear, and electrical fixtures. But an *unseen essential* called *Synthane* is present, too.

Synthane is a laminated plastic. It is an excellent electrical insulator. It is also a mechanical material that combines light weight and strength, a chemical-resistant material that machines easily.

Send for the complete Synthane Catalog. Then, if you find Synthane a material you can use, we will be glad to help you with design, sheets, rods, tubes or fabricated parts. Synthane Corporation, 6 River Road, Oaks, Pennsylvania.



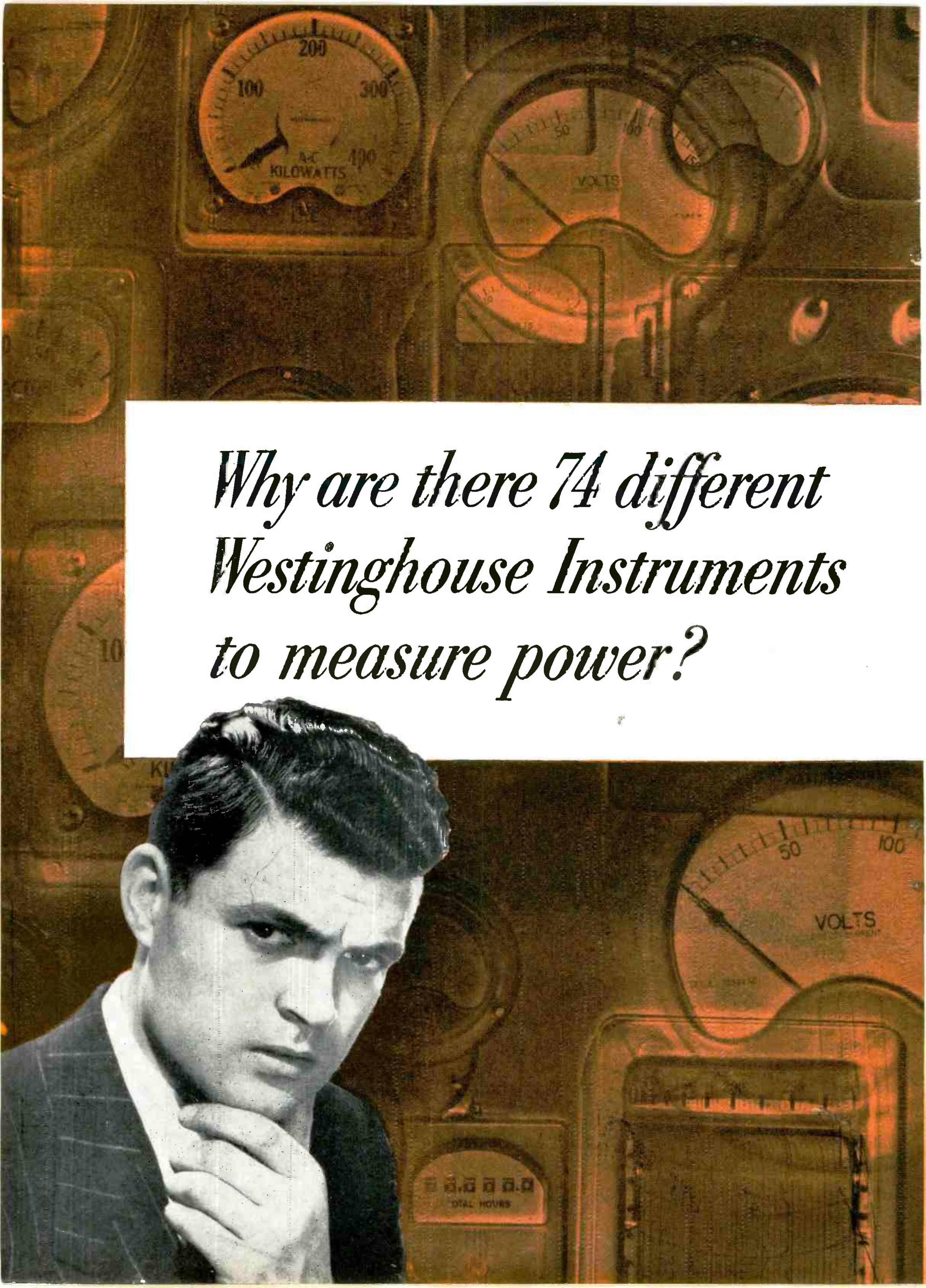
Insulator (left) made from Grade X Black Synthane for Square D Company and switch mounting plate made for Cutler-Hammer Inc. of Grade GLCC-M Synthane. Both parts require good electrical characteristics.

Synthane-one of industry's unseen essentials

SYNTHANE

S

LAMINATED PLASTICS



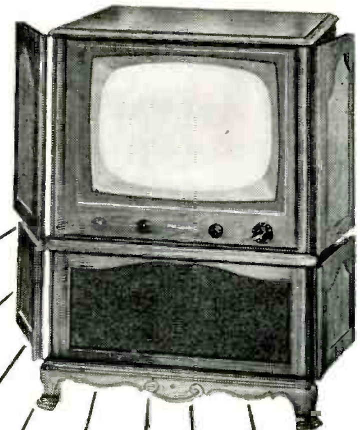
Why are there 74 different Westinghouse Instruments to measure power?

RCA VICTOR Television

CHOOSES

INSUROK®

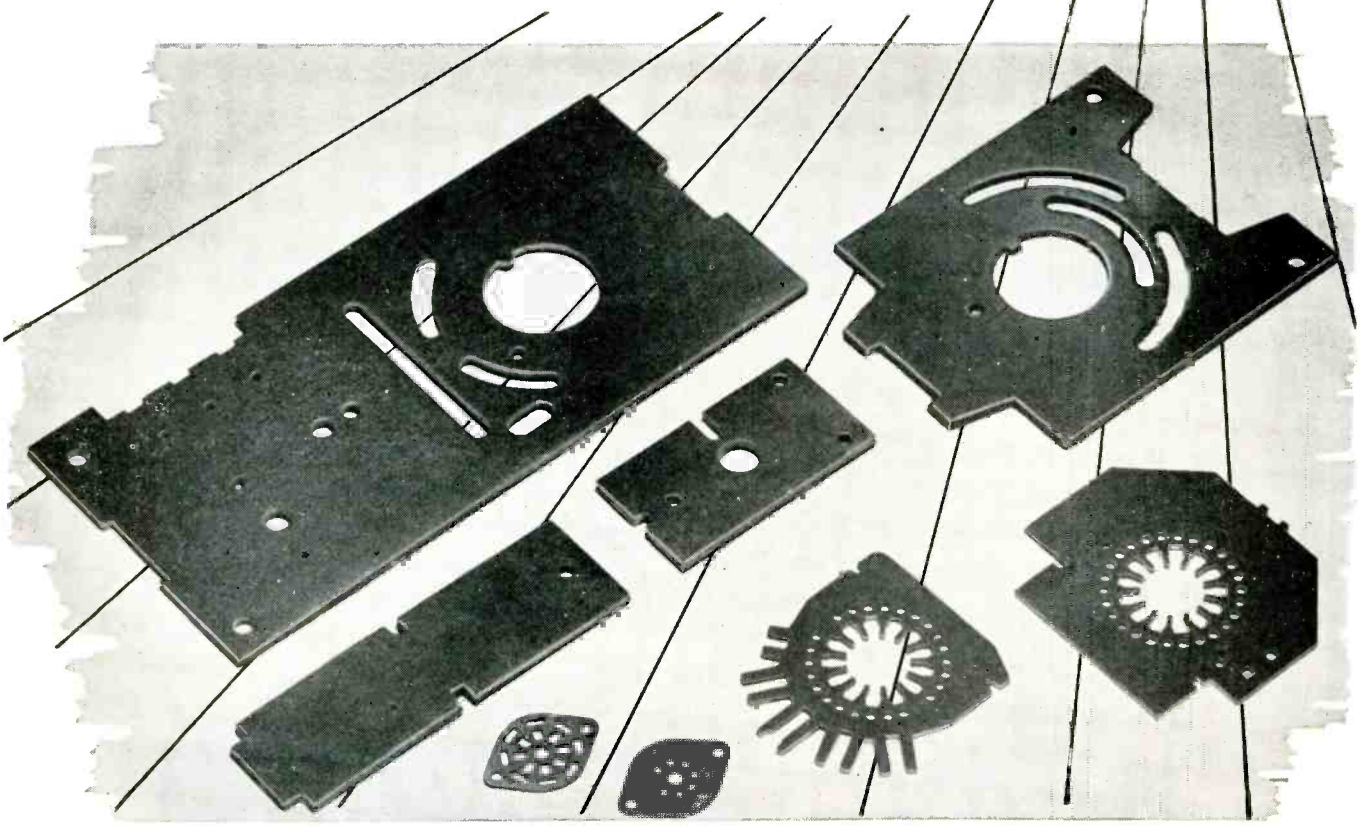
T-725 INSULATING LAMINATE



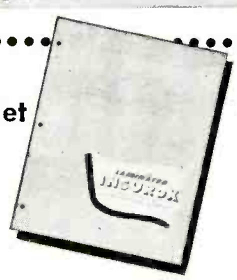
The RCA Victor name is a symbol for the highest quality in electronic equipment. To meet their exacting standards, RCA Victor engineers selected INSUROK Grade T-725 phenolic laminate for their television receivers.

INSUROK T-725 provides RCA Victor with a unique combination of electrical properties. It is used in the R.F. tuners, to maintain insulation resistance under high temperatures and humidities . . . in the I.F. tube sockets, to minimize capacity changes with changes in humidity . . . and in the high-voltage compartment, to provide high dielectric strength and surface resistivity.

For the "tough spots" in your product, write or phone about T-725 and the many other grades of INSUROK laminated insulation.



Write Today for Booklet "LAMINATED INSUROK"



The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO
2797 Lake St., Melrose Park, Illinois (Chicago District)
SALES OFFICES: Cleveland • Detroit • Indianapolis • Lockland, Ohio
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Here at Delco Radio, we are keenly aware of national defense requirements and of the necessity for further accomplishment in the field of radio. Delco Radio is even now developing and producing—on *time*—superior devices that meet the test of modern military needs.

You can depend on Delco Radio for on-time delivery of products with uniformly high quality.

LEADER...

IN PRODUCTION FACILITIES

Delco Radio is the world's largest builder of automobile radios—the leader in production and assembly of component parts.

LEADER...

IN ENGINEERING

Delco Radio developed many of the most important advances in automobile radios . . . has outstanding experience in this field.

LEADER...

IN QUALITY

Each and every step in the manufacturing of Delco Radio products is closely supervised to maintain high, uniform product quality.

LEADER...

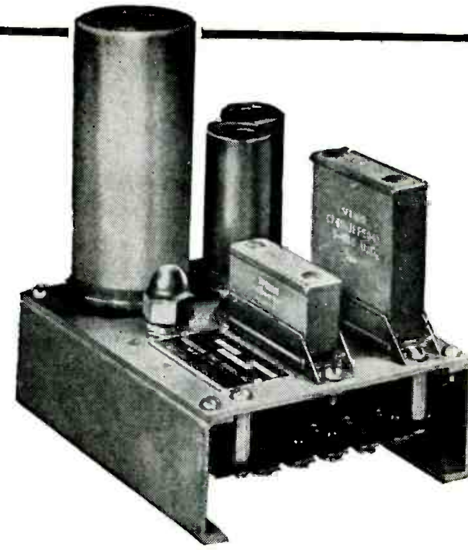
IN MANUFACTURING CONTROL

Completely integrated for efficient production from raw material to finished product, Delco Radio meets any customer need.

DELCO RADIO

DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

40.109
240.65
1174.6
20000.
– OR ANY OTHER



precision FREQUENCY

FROM 40 TO 20,000 CYCLES

CONSERVATIVE ACCURACY UNDER USUAL CONDITIONS
1 PART IN 100,000—(.001%)

CALIBRATED AGAINST A STANDARD ACCURATE TO 1 PART IN 10-MILLION

The basic unit of this frequency standard is an electronically driven fork,—temperature compensated and hermetically sealed against changes of humidity and barometric pressure. Through its use, any frequency or multi-frequencies between 40 and 20,000, fractional or otherwise, are obtainable.

Have you a need for any specific number of cycles in precision frequencies?

Can a source of such frequency solve your design problem or increase its factor of safety?

Have you a system that requires great accuracy, stability and dependability?

The frequencies shown at the top of the page are but a few among hundreds furnished for precision application in industries, laboratories and Government departments.

OUR ENGINEERS ARE AVAILABLE TO COOPERATE ON ANY PROBLEM

American Time Products, Inc.

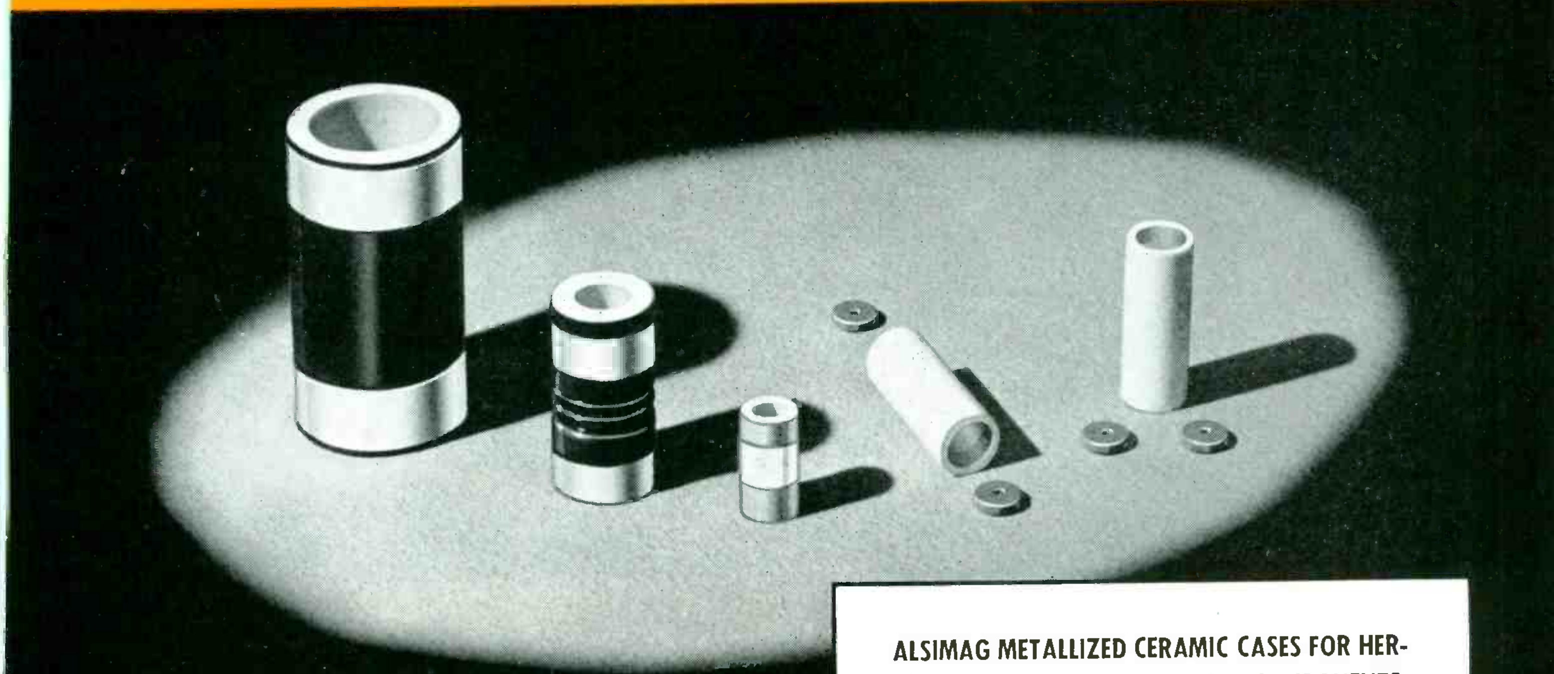
580 Fifth Avenue New York 19, N. Y.

MANUFACTURING UNDER PATENTS OF WESTERN ELECTRIC CO.

AMERICAN LAVA CORPORATION

Spotlights ALSIMAG®

METALLIZED CERAMICS

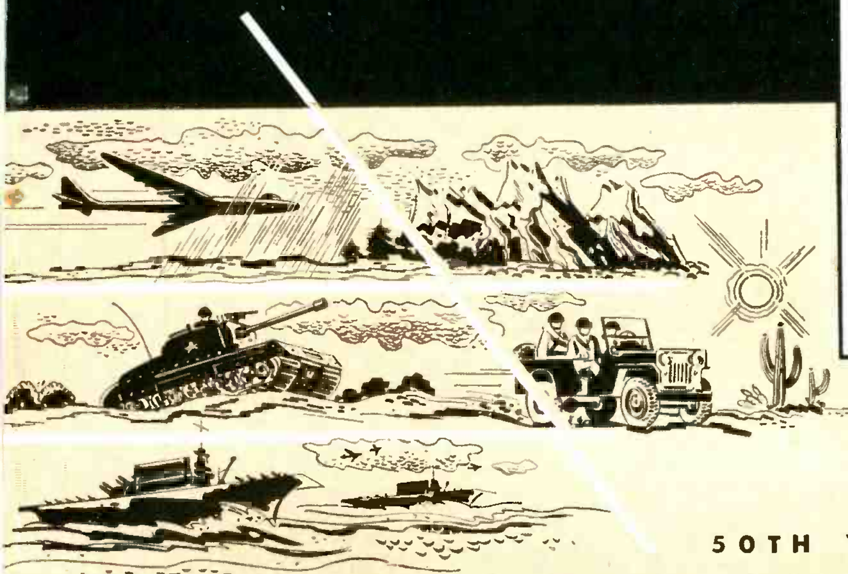


ALSIMAG METALLIZED CERAMIC CASES FOR HERMETICALLY SEALING ELECTRONIC COMPONENTS.

Where a permanently moisture proof envelope for components is required, use an Alsimag metallized ceramic case with Alsimag metallized ceramic cap.

Alsimag ceramics have high mechanical strength. The excellent bond between metal and ceramic form a lasting seal against moisture when soft soldered.

Metal-ceramic combinations provide stable performance under wide variations of temperature and humidity.



Our broad experience in working with metal-ceramic combinations is available to you at any time.

50TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

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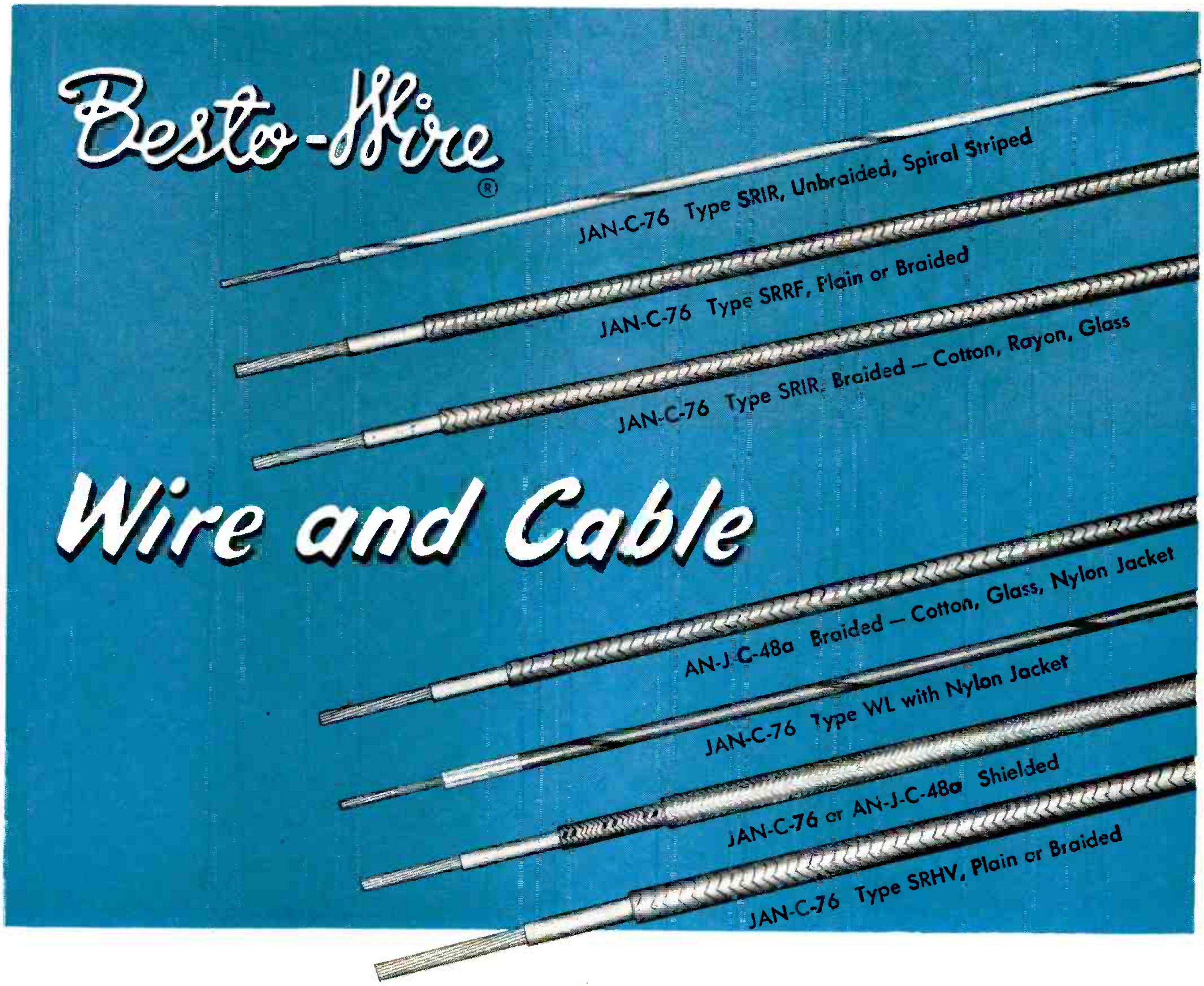

For Aviation and Electronics

Tell us the type of wire or cable you need — the chances are excellent that it is one of our regular production numbers. If it isn't already in our extensive line, we will design the wire especially for you. We have had long experience in coming up with the right answers in wire and cable for many leading manufacturers in the fields of aviation and electronics. Try us. You Specify — We Supply!

Ask us for our new complete catalog. We'll gladly send you a copy.

Besto-Wire

RHODE ISLAND INSULATED WIRE CO., Inc.

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SEABORNE SERVICE

... Custom Designed for every Government and Military Application

CP dehydrators are readily adaptable to the critical requirements of the Armed Forces. Standardized parts permit rapid assembly of equipments suitable for practically any specialized need at minimum cost and without prolonged delay. Over a decade of CP experience in dehydrator design and manufacture insures products of long life and dependable service with an absolute minimum of maintenance. Inquiries are invited.

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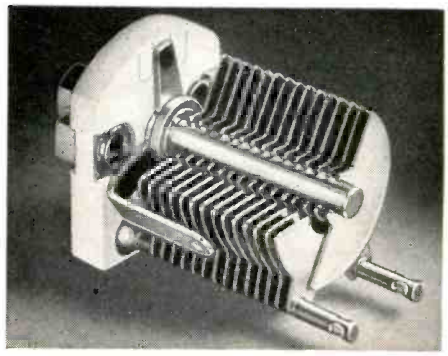
HAMMARLUND

PRECISION-BUILT CAPACITORS

Hammarlund Capacitors, backed by 42 years of design, engineering and production experience, are today recognized by the military services, electronic manufacturers and research engineers, as the finest quality capacitors available. Since the founding of the Hammarlund Manufacturing Company in 1910, it has designed and developed capacitors that today are standard in industry. Millions of them are in use by almost every important manufacturer of electronic equipment.



NOW AVAILABLE!

1952

CAPACITOR CATALOG

This detailed and illustrated 12-page catalog is yours for the asking. It will be a valuable addition to your library of radio parts suppliers, for it includes complete diagrams and electrical and mechanical specifications covering the broadest selection of standard variable air capacitors available to the electronic industry.

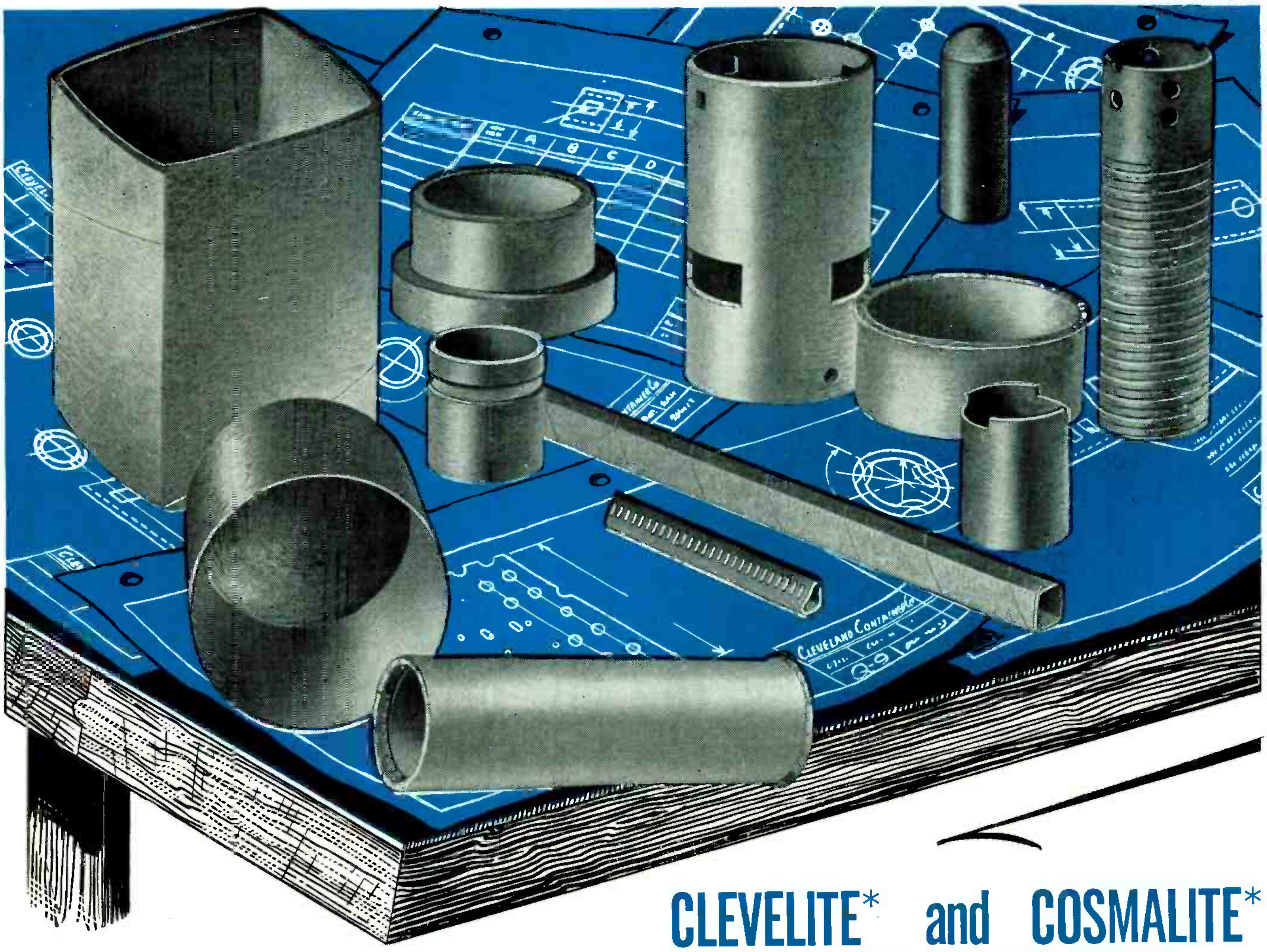
FOR YOUR FREE COPY of the 1952 Hammarlund Capacitor Catalog write us today. All capacitors listed in this catalog are stock items which can be purchased from jobbers, dealers everywhere.

HAMMARLUND

MORE THAN 40 YEARS EXPERIENCE COUNTS!

THE HAMMARLUND MANUFACTURING CO., INC.

460 WEST 34th STREET • NEW YORK 1, N. Y.



CLEVELITE* and COSMALITE*
LAMINATED PHENOLIC TUBING

A GRADE FOR EVERY NEED!

Diameters—wall thicknesses and lengths to meet regular or special adaptations.

IN RADIO AND TELEVISION their use is almost universal. They have high insulation resistance and low moisture absorption. Their low dielectric loss is suitable for ultra high frequency applications.

IN ELECTRIC MOTORS for armature shaft spacers, insulators, brush holders, and many similar force-fit applications requiring machining, Clevelite is particularly suitable.

IN RELAYS, CONTROLS, SELENIUM RECTIFIERS, the various grades of Clevelite Phenolic Tubing have special properties that guarantee complete satisfaction.

are more than ever before—the first choice in the electronic and electrical industries.

They combine proven performance with low cost and excellent service!

Wherever high dielectric strength, low moisture absorption, physical strength, low loss and good machineability are of prime importance . . . the combined electrical and physical properties of

CLEVELITE and COSMALITE
are essential

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IMMEDIATELY AVAILABLE
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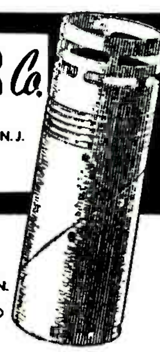
The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO



PLANTS AND SALES OFFICES at Plymouth, Wisc., Chicago, Detroit, Ogdensburg, N.Y., Jamesburg, N.J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

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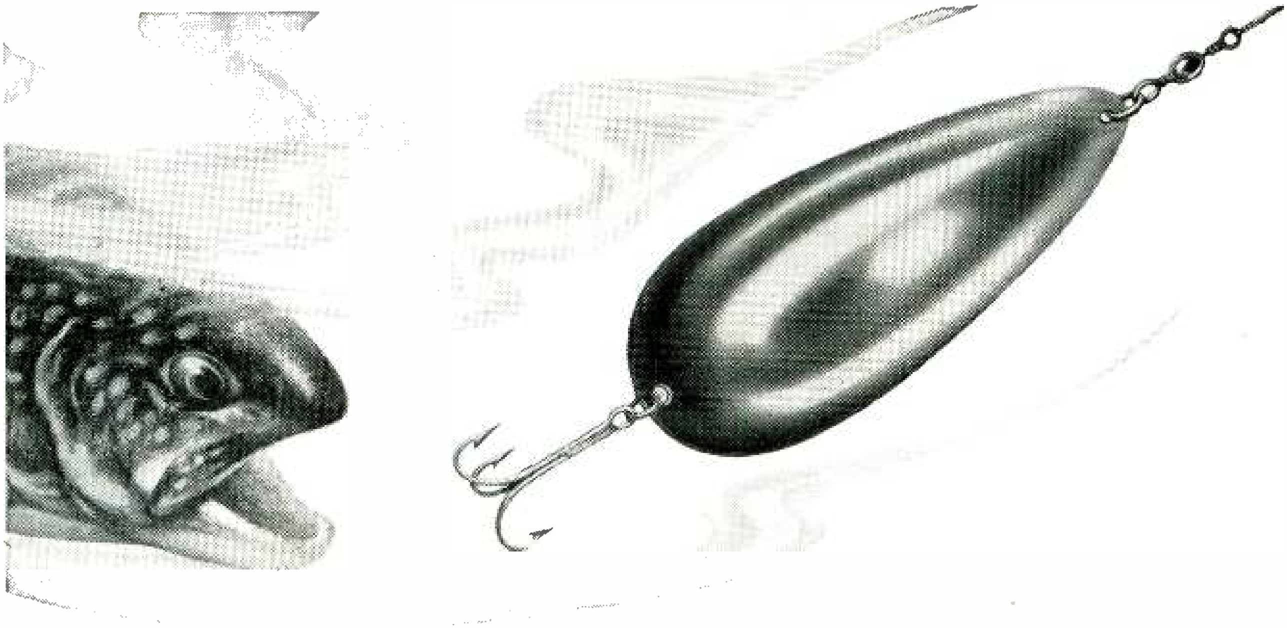
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO

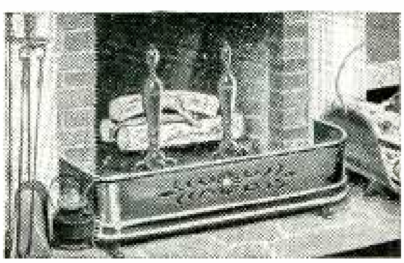


What's the big attraction?

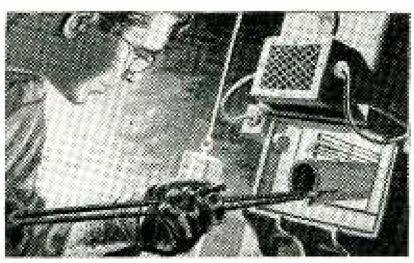
The same brilliance that catches Mr. Trout's eye is also found on a wide range of brass and copper products, from costume jewelry to the gleaming brightwork on a ship.

The clean, bright surface of Chase metals doesn't just happen . . . it is controlled in research laboratories by Chase metallurgists . . . it is checked and tested every step along the way to the finished sheet, rod, wire or tube.

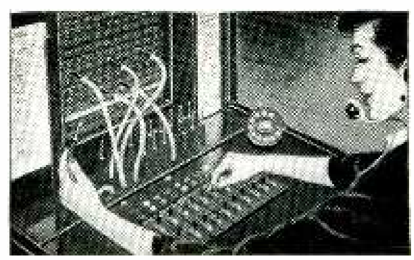
Chase brass and copper products are available, subject to government controls, through dealers, and jobbers across the nation and through Chase's 23 convenient mill warehouses.* Chase Brass & Copper Co., Incorporated, Waterbury 20, Conn.



Chase brass and other copper alloys range in color from rich red to bright yellow. The right color for each product and use is one of the features of Chase research and quality control.



When the Chase Technical Advisory Service is asked to solve a problem by a manufacturer, Chase metallurgists will often find the right answer in this research laboratory test furnace.



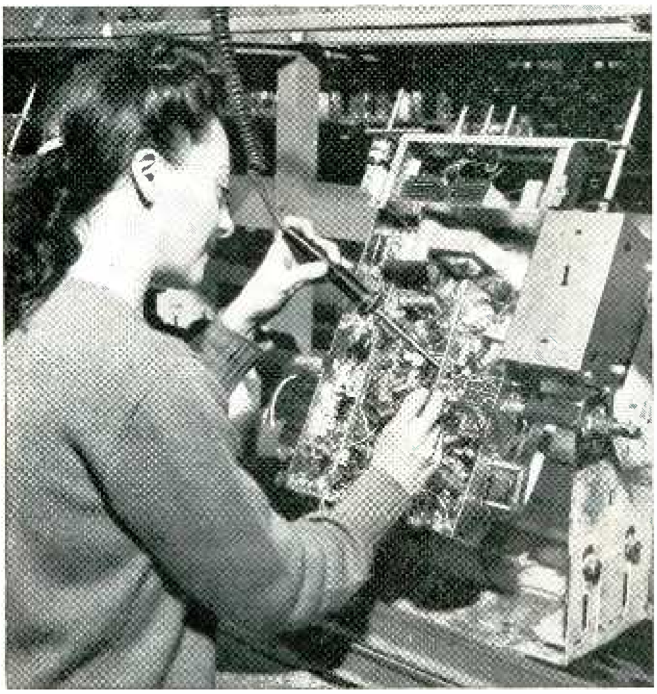
Patented Chase Telnic® Bronze makes better switchboard parts. Chase research developed Telnic for high strength, excellent machinability, corrosion resistance, and conductivity.

Chase® The Nation's Headquarters for **BRASS & COPPER**

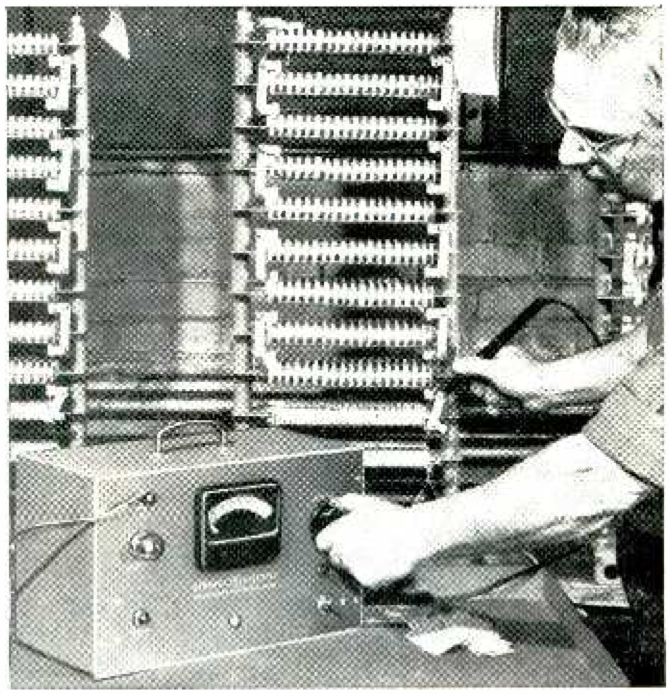
Chase Brass & Copper Co. is a subsidiary of KENNECOTT COPPER CORPORATION

*Albany† Atlanta Baltimore Boston Chicago Cincinnati Cleveland Dallas Denver† Detroit Houston† Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester† St. Louis San Francisco Seattle Waterbury *(†Sales Office Only)*

DESIGNER'S



1. New, fast-heating G-E iron weighs only 8½-oz.



2. New G-E portable hi-pot tester is easy to operate.

Two ways to speed your production

Reach hard-to-solder places with this new thin-shank iron

"As easy to use as a pencil," say operators who use General Electric's new lightweight soldering iron.

Its thin, $\frac{5}{16}$-inch-diameter shank lets the ¼-inch tip into places a regular iron can't touch. Operators can solder more joints per minute—and with fewer rejects—because the iron's lightness, balanced design and comfortable handle all reduce fatigue.

Long-lasting G-E Calrod* heater provides quick heat-recovery properties, gives plenty of heat for uniformly strong soldered joints. Maintenance of this 60-watt, 120-volt iron is low because the long-life Ironclad tip need not be filed or dressed. Send for Bulletin GED-1583.

*Reg. Trade-mark

Eliminate cages and barriers with this new insulation tester

Now you can perform high-potential tests on your equipment with minimum danger to personnel. That's because the current output of General Electric's new high-potential insulation tester is limited to 5 milliamperes—well below the "let go" value.

Testing time is cut, too—no need to set up cages, barriers, or tape. Tester is portable, weighs only 22 lbs. Simply plug it into any 115-volt a-c outlet and start testing.

Line surges are virtually eliminated in output. Flash-overs can't burn insulation. Neon light on panel gives warning *before* insulation breaks down. Output is adjustable from 0 to 3500 volts, with test capacitance up to .006 muf. Bulletin GEC-700.

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

Four ways G-E selenium rectifiers meet your d-c power requirements

Selenium rectifiers provide the electrical designer with versatile and flexible means of getting the right quantity of d-c power. But not all selenium rectifiers are alike. Here are four important "quality points" you'll find in G-E units in comparison with competitive equipment:

1. Lower forward resistance—for higher output and cooler operation—plus lower costs in other circuit components.

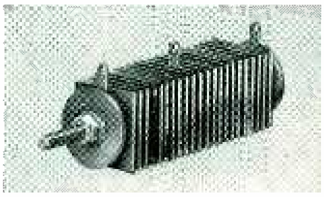
2. Less back leakage—for higher efficiency as well as higher output.

3. Cooler operation—the result of the above characteristics—since there is less heat to dissipate, less ventilation is needed.

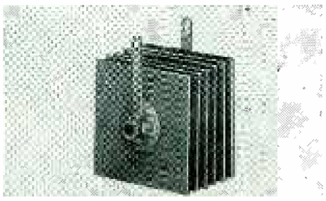
4. Slower aging—which extends expected life at rated output to over 60,000 hours.

And of course the G-E line is complete, to meet all your design needs.

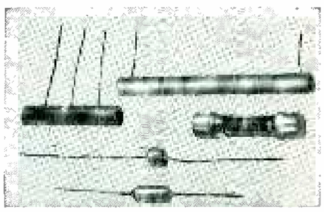
For a complete refresher on rectifier fundamentals, circuits, and applications, send for the new 28-page G-E booklet prepared to aid the design engineer. Check Bulletin GET-2350.



Standard stack construction



Tube-mounted construction



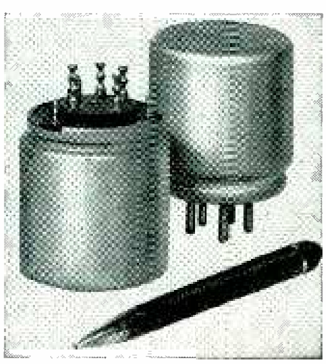
Miniature cell assemblies

Dual-rated capacitors simplify design problems

Meet your design needs, standardize, and cut inventories with these G-E fixed paper-dielectric capacitors. Equally applicable to a-c and d-c, they come in many case styles, with ratings from 236 through 660 volts a-c and 400 through 1500 volts d-c. All units are treated with Pyranol* and hermetically sealed to prevent leakage or contamination. Check Bulletin GEC-809.

Current-sensitive relays stand severe vibrations

G-E current sensitive d-c relays are available with d-c pickup ratings in steps from 4 to 1500 ma. They are especially applicable to circuits using limited power for energizing coils—as in aircraft. Lightweight and corrosion-proof, these relays withstand severe vibration and operate at rated current through a wide range of altitudes. See Bulletin GEC-834.



EQUIPMENT FOR ELECTRONIC MANUFACTURERS

A partial list of the thousands of items in the complete G-E line. We'll tell you about them each month on these pages.

Components

Meters and Instruments	Timers
Capacitors	Indicating lights
Transformers	Control switches
Pulse-forming networks	Generators
Delay lines	Selsyns
Reactors	Relays
*Thyrite	Amplidynes
Motor-generator sets	Amplistats
Inductrols	Terminal boards
Resistors	Push buttons
Voltage Stabilizers	Photovoltaic cells
Fractional-hp motors	Glass bushings
Rectifiers	Dynamotors

Development and Production Equipment

Soldering irons
Resistance-welding control
Current-limited high-potential tester
Insulation testers
Vacuum-tube voltmeter
Photoelectric recorders
Demagnetizers

*Reg. trade-mark of General Electric Co.

General Electric Company, Section A667-21
Schenectady 5, New York

Please send me the following bulletins:

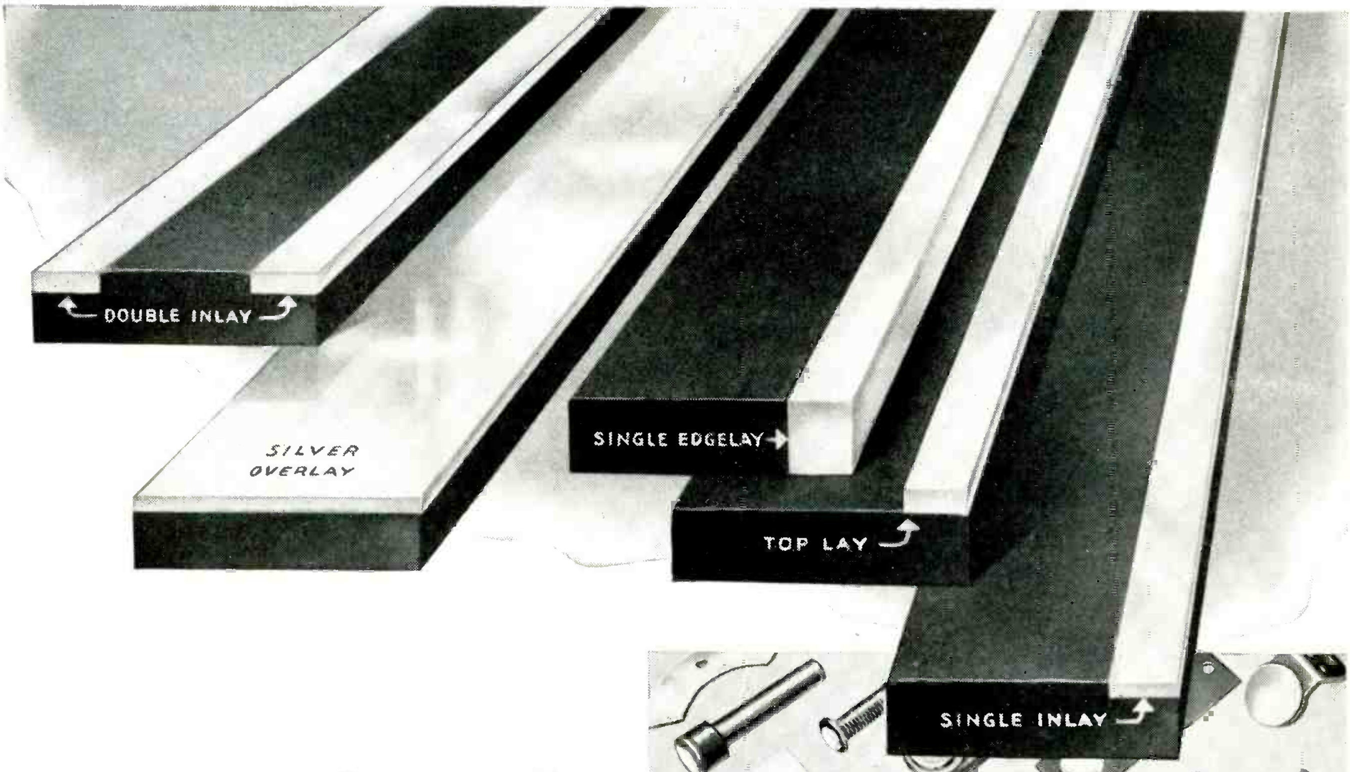
Indicate: √ for reference only
X for planning an immediate project

- ☐ GEC-700 High-Potential Tester
- ☐ GEC-809 Paper-Dielectric Capacitors
- ☐ GEC-834 Current-Sensitive D-C Relays
- ☐ GED-1583 Lightweight Soldering Iron
- ☐ GET-2350 Selenium Rectifiers

Name____________________

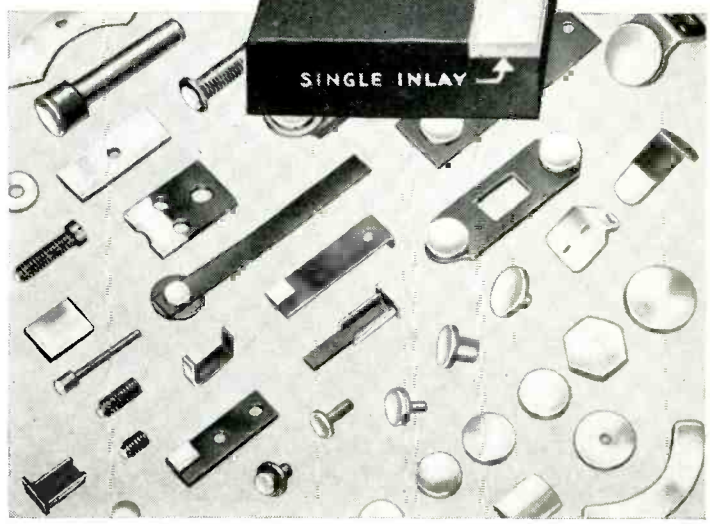
Company____________________

City________________ State________



Raw Stock

or Complete Fabricated Assemblies . . .



General Plate has the Facilities to meet all your Electrical Contact Requirements

There are many advantages for using General Plate composite contact materials and completely fabricated assemblies. Among the more important are better performance, longer operating life and lower fabricating costs.

But that's not all — here at General Plate you have a single source that can supply your contact requirements be it raw stock or complete assemblies. General Plate contacts and stock are available in a wide range of alloys designed to meet your specific requirements.

Raw stock is supplied in various combinations, in overlay, single or double inlay, single or double edgelay, and Top-Lay stock. The precious metal is clad to your required base metals such as brass, bronze, nickel, monel, copper, beryllium copper, etc. In addition General Plate provides composite buttons, rivets, stampings, welded or brazed assemblies.

General Plate fabricated assemblies including assemblies requiring stampings, screw machine or headed parts with contacts attached, etc. are made to your exact specifications.

Make General Plate your headquarters for solid or composite contacts, contact material and fabricated contact assemblies.

GENERAL PLATE PRODUCTS INCLUDE

Precious metals clad to base metals, Base metals clad to base metals, Silver solders, Composite contacts, buttons and rivets, Truflex® Thermostat Metals, Alcuplate®, Platinum fabrication and refining, #720 Manganese Age Hardening Alloy. Write for technical data bulletins.

Have You a Composite Metal Problem?
General Plate can solve it for you

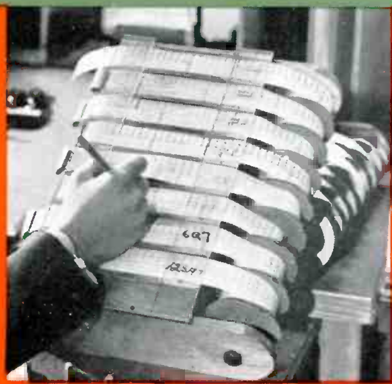
GENERAL PLATE

Division of Metals & Controls Corporation

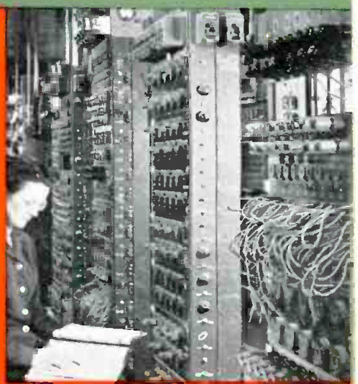
37 FOREST STREET
ATTLEBORO, MASSACHUSETTS

Mica specifications checked to thousandth-inch accuracy.

Completed mounts are inspected for visual defects.



Statistical control assures uniformity of quality and performance.



Life tests prove Tung-Sol Tubes can take it.

complete control of materials— and manufacturing procedures makes Tung-Sol Tubes Dependable!

TUNG-SOL engineering has produced tubes of matchless performance, which Tung-Sol manufactures in large quantities with infinite precision. If you have a product or a problem involving electron tubes—let Tung-Sol help you. You'll like Tung-Sol Tubes—and you'll like Tung-Sol service.

TUNG-SOL ELECTRIC INC., Newark, N. J.

SALES OFFICES: ATLANTA · CHICAGO · CULVER CITY · DALLAS · DENVER · DETROIT · NEWARK

TUNG-SOL MAKES ALL-GLASS SEALED BEAM LAMPS, MINIATURE LAMPS, SIGNAL FLASHERS, PICTURE TUBES, RADIO, TV AND SPECIAL PURPOSE ELECTRON TUBES

Bradleyunits are available in all standard R. T. M. A. values.

This HONEYCOMB RESISTOR CARTON is a Time- and Laborsaver in the Production Line

Differentially tempered leads

The leads of all Bradleyunits are differentially tempered. This graduated softness of leads near the body of the resistor prevents sharp bends and avoids damage to resistor.

SIZES OF UNITS

Rating	L	D
½-w	3/8″	9/64″
1-w	9/16″	7/32″
2-w	11/16″	5/16″

IMPORTANT NOTICE

The tremendous demand for Bradleyunits has, in the past, resulted in disappointments due to extended deliveries. Our production facilities have been substantially increased, and your demands for Bradleyunits can now be satisfied quite promptly.

Give your assemblers the laborsaving advantage of Allen-Bradley honeycomb packaging. This unique container keeps resistor leads straight and free from tangling. It makes it easy to pick up a Bradleyunit from the patented Allen-Bradley carton, which holds the resistors in perfectly spaced rows. The removal of one or even fifty resistors does not affect the alignment of the remaining units.

Bradleyunits have permanent characteristics because they are rated to operate continuously at 70 C ambient temperature and not at 40 C. Therefore, they can withstand extremes of temperature and humidity. Bradleyunits need no wax impregnation to pass salt water immersion tests.

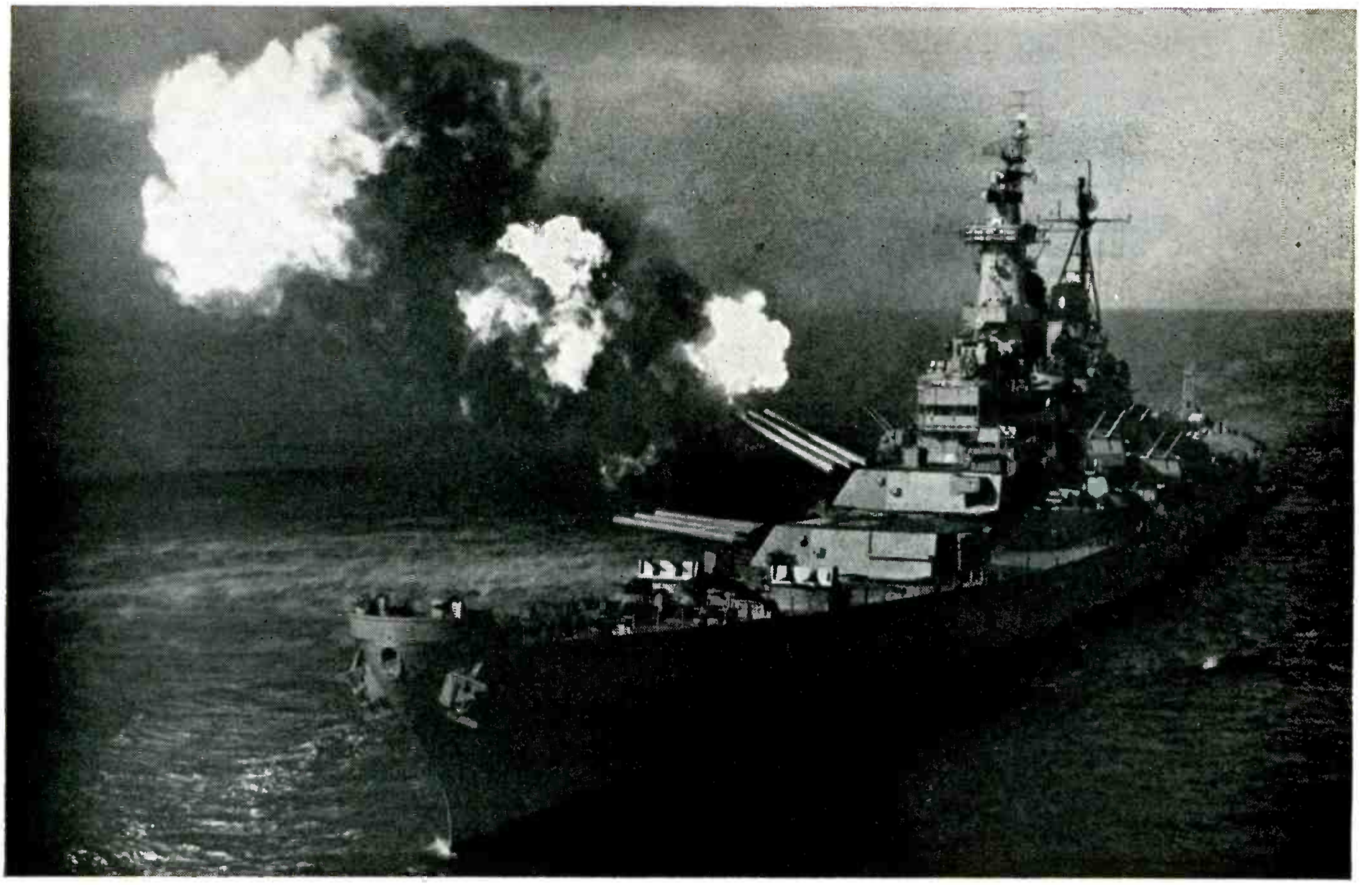
Allen-Bradley Co.
110 W. Greenfield Ave., Milwaukee 4, Wis.

A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment



Official U.S. Navy Photo

range...

The range of these big guns exceeds anything else afloat. In a like manner, Edo echo-sounding equipment now being installed on ships of the U. S. Navy gives far greater range and accuracy than other types of sonar previously used. This superior performance promises important advances in both ocean navigation and naval tactics.

For instance, the Edo Model 185 deep sounder continuously measures and records any known ocean depths giving the navigator a new means of plotting his course by ocean bottom contours. Other Edo sonar devices search out and detect distant vessels with a range and accuracy never before believed possible.

Such successful results come only from a research and engineering staff endowed with imagination, ingenuity and the ability to apply the latest developments in the whole field of electronics to any specific problem — a characteristic Edo trait for over a quarter of a century.

A SYMBOL KNOWN AND RESPECTED FOR OVER A QUARTER OF A CENTURY

Twenty-seven years of experience are behind the leadership which Edo enjoys in the field of sonar development, research and manufacture. Members of the Edo engineering staff have pioneered many of the developments which make the use of echo-ranging underwater detection equipment an increasingly important function not only in anti-submarine warfare but also in the safe and efficient operation of modern ships.

The exceptional performance of Edo equipment brings to the famous flying fish emblem increasing recognition as the symbol of superior equipment.

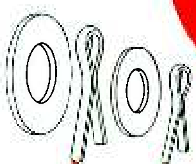
Edo

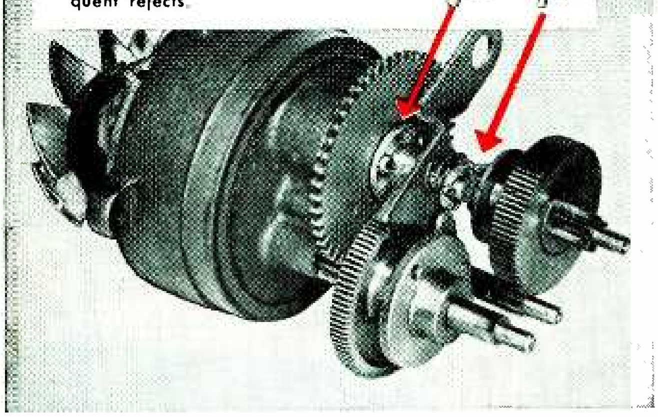
EDO CORPORATION · COLLEGE POINT, N. Y.

2 WALDES TRUARC RINGS
REPLACE COTTER PINS AND WASHERS...
SAVE $.0219 PER UNIT

OLD WAY

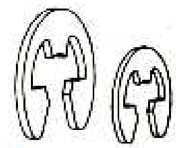
Cam shaft for breathing roll ironer mechanism required: drilling 2 holes; 2 cotter pins; 2 washers. Inaccuracy in locating holes for cotter pins caused frequent rejects.

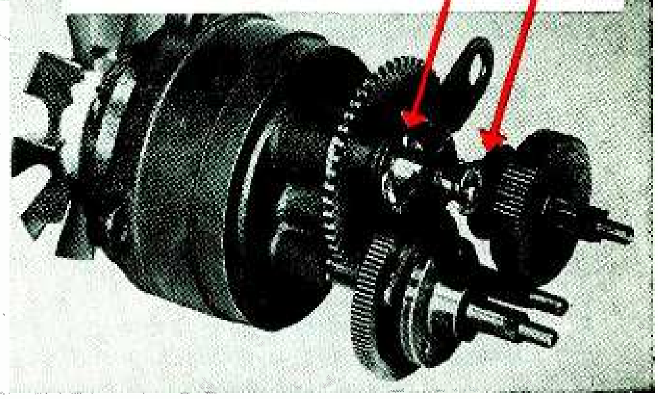




NEW WAY

2 simple grooves to accommodate 2 Waldes Truarc Rings, are cut in shaft during regular screw machine cycle—at no extra cost. Waldes Truarc Rings are applied quickly, easily.





Using 2 Waldes Truarc "E" Retaining Rings in their Automatic Cabinet Ironer, saved The Horton Manufacturing Co., Fort Wayne, Ind., $.0219 per unit. Truarc Rings saved 50% in assembly time . . . cut down on rejects . . . increased efficiency of the unit . . . eliminated risk of damage to hands and clothing of workers in assembly.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Remain circular to give a never-failing grip. They can be used over and over again.

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

COMPARATIVE COSTS—

WITH COTTER PINS		WITH TRUARC RINGS	
MATERIAL:		MATERIAL:	
2 washers	.0045		
2 cotter pins	.0017	2 Truarc E Rings	.0283
OPERATIONS:		OPERATIONS:	
drilling 2 holes in shaft	.0223	Cutting 2 grooves	.0000*
ASSEMBLY TIME	.0485	ASSEMBLY TIME	.0268
Total cost	$.0770		$.0551

TOTAL SAVINGS WITH TRUARC RINGS $.0219 PER UNIT

Grooves are cut in shaft during regular screw machine cycle

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

SEND FOR NEW BULLETINS ➜

WALDES
TRUARC
REG. U. S. PAT OFF
RETAINING RINGS

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

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

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. E-074

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

Name ______________________________

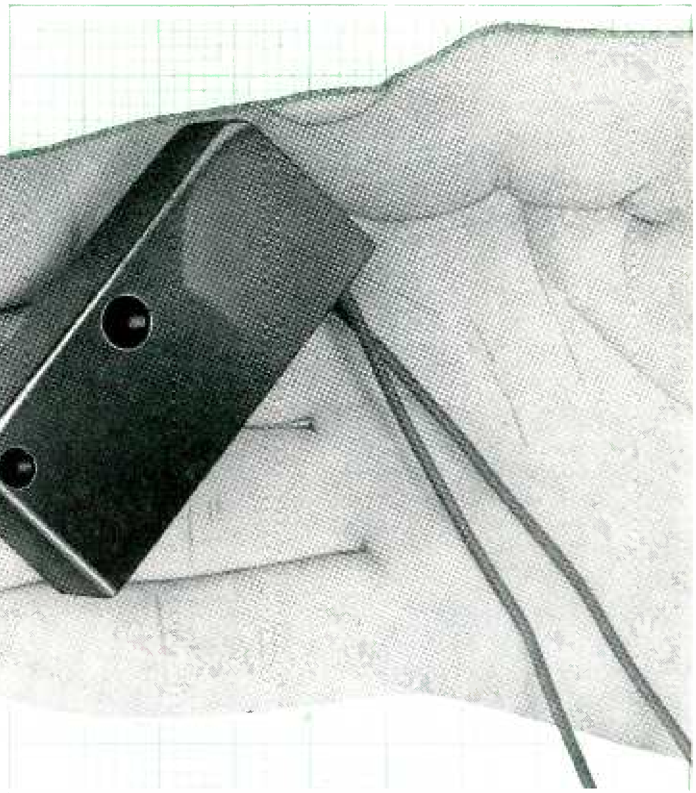
Title ______________________________

Company ______________________________

Business Address ______________________________

City ____________ Zone ______ State ____________ 5678

Honeywell Mercury Switches



PROTECTED FOR
USE UNDER SEVERE
OPERATING CONDITIONS

Honeywell Mercury Switch 1MP1 embedded in plastic case held in hand to indicate size and compactness of design.

HONEYWELL glass-enclosed mercury switches are durable enough to meet every "normal" operating condition. For applications where mechanical shock and impact are present, MICRO has designed added protection for these glass-enclosed mercury switches. This consists of embedding the switches in plastic "potting" compounds.

Pictured here is the new 1MP1 Mercury Switch. This unit provides less than 1 degree differential angle, with a basic 2 ampere, 115 volt a-c; 1 ampere, 115 volt d-c rating. The contact arrangement is single-pole, single-throw. Mounting holes accommodate a ¼" mounting screw and pin. This allows for simple assembly and adjustment which can be locked in position.

There are more than 90 Honeywell mercury tube designs with many variations in size, differential angles, electrical ratings and contact arrangements. MICRO field engineers are located near you to provide full information on Honeywell Mercury Switches, either glass-enclosed or embedded. Contact your nearest MICRO SWITCH branch office.

Cut open view of embedded Honeywell Mercury Switch illustrates switch embedded in plastic "potting" compound.

Let a MICRO SWITCH Engineer show you how you can **"use Honeywell Mercury Switches as a principle of good design"**

MICRO MS SWITCH

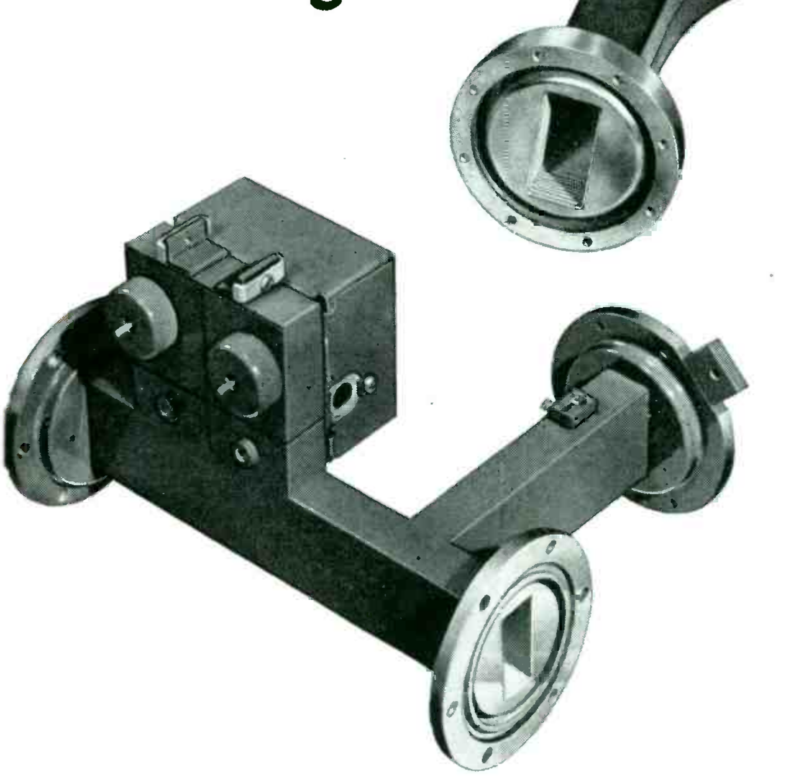
FREEPORT, ILLINOIS

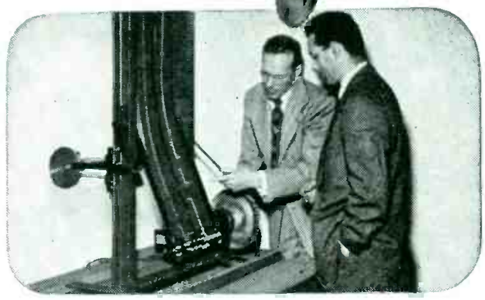
MICRO Snap-Action Switches . . . Honeywell Mercury Switches

H HONEYWELL

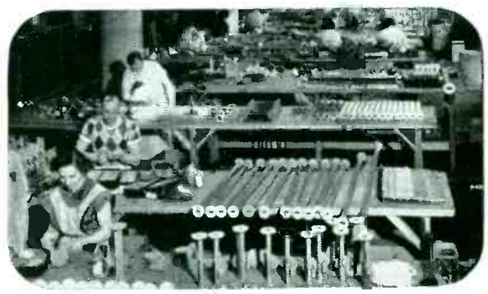
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

A Molehill of Difference Can Make a Mountain of Trouble in Waveguides

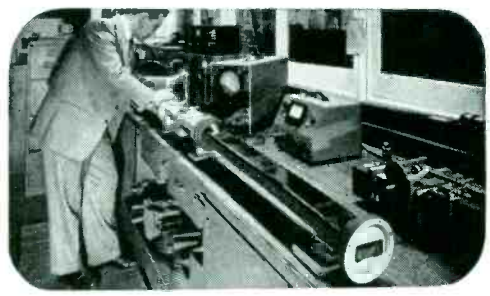




Remember this traffic-stopper at the 1952 IRE Show in Grand Central Palace? It's a torture test. Flexed well over 1,000,000 times, Waveflex flexible Waveguides gave no evidence of failure or loss of physical or electrical properties.



Fabricated to precision methods, Titeflex flexible and rigid Waveguides are produced to the closest tolerances and to exacting specifications. Titeflex maintains strict quality control and inspection from raw materials to finished products.



No Waveguide gets by this department without a thorough electrical check-up. Every single Titeflex Waveguide is tagged before shipment with its test score on JAN-W-287 specifications for flexible Waveguides or JAN-W-85A for rigid Waveguides.

. . . A little difference in waveguides—imperceptible to the eye—can jeopardize a costly investment.

If you want to be sure of your electronic equipment, if you want to reduce operational failures, insist upon Titeflex microwave components.

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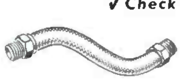
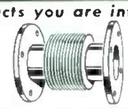
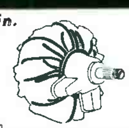


☐ SEAMED AND SEAMLESS METAL HOSE

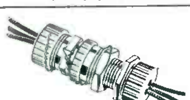


☐ PRECISION BELLOWS

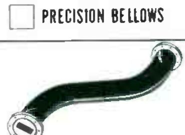


☐ IGNITION HARNESS

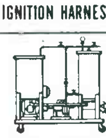
☐ IGNITION SHIELDING



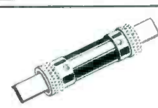
☐ ELECTRICAL CONNECTORS



☐ RIGID AND FLEXIBLE WAVE GUIDES



☐ FILTERS



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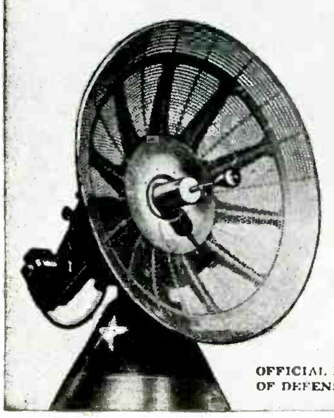

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ANOTHER CBS-HYTRON FIRST YOU'LL BE BUYING SOON

CBS-HYTRON 1AX2

NEW HEAVY-DUTY TV HIGH-VOLTAGE RECTIFIER CAN TAKE IT!

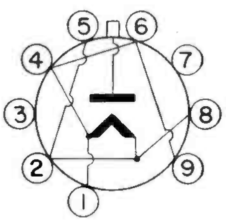
TV high-voltage rectifiers take a beating: Terrific variations occur in applied filament voltage . . . 0.8 to 2.4 volts! Sudden arcs in the rectifying system place destructive electromechanical stresses on the filament. And the increasingly larger TV picture tubes demand peak emission and peak inverse voltage simultaneously. The new CBS-Hytron 1AX2 was especially designed to take such rough treatment and come up smiling.

1AX2 DATA

The CBS-Hytron 1AX2 is a compact, 9-pin miniature TV pulse rectifier. Plate is brought out to top cap and filament is oxide-coated. Absolute maximum ratings are: peak inverse plate voltage, 25,000 volts; d-c load current, 1.0 ma.; and steady-state peak plate current, 11.0 ma.

Typical Operation — TV Pulse Rectifier

Filament voltage	1.4 v ± 10%
Filament current	650 ma
Positive-pulse plate voltage	20,000 v
Negative-pulse plate voltage	5,000 v
Peak inverse plate voltage	25,000 v
D-c output voltage	20,000 v
D-c load current	300 μa



BOTTOM VIEW OF SOCKET

ADVANTAGES OF NEW CBS-HYTRON 1AX2

1. Rugged, high-wattage filament of CBS-Hytron 1AX2 has adequate peak emission for the new, larger TV picture tubes. 1AX2 may be run simultaneously at both its peak inverse voltage and maximum d-c current.
2. Higher load of 1AX2 filament on transformer tends to regulate filament voltage. Eliminates need for limiting resistor. Yet lower plate-to-filament capacitance (0.7 $\mu\mu$f) of 1AX2 prevents loss of high voltage.
3. Insulated tension bar (patent applied for) through center of 1AX2 coiled filament limits destructive movement of filament by electromechanical stresses.
4. Filament of 1AX2 is located in base and shielded to eliminate bombardment of cool ends of filament by gas molecules.
5. An overloaded 1X2A may be replaced with its big brother, the CBS-Hytron 1AX2, by simply removing the limiting resistor. In rare cases, it may be necessary to add another turn to the secondary of the filament transformer to obtain the required 1.4 volts for the 1AX2.

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CBS HYTRON RADIO TUBES

MAIN OFFICE: SALEM, MASSACHUSETTS

TYPE 252, JAN-R-19, Type RA20

2 watt, 1 17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

	RA20, JAN Shaft Type SD		RA20 High Torque, JAN Shaft Type SD	
Resistance	CTS Part	JAN-R-19 TYPE	CTS Part	JAN-R-19 TYPE
50±10%	B8079	RA20A1SD500AK	X3496	RA20A2SD500AK
100±10%	W6929	RA20A1SD101AK	L9388	RA20A2SD101AK
250±10%	X3497	RA20A1SD251AK	M9879	RA20A2SD251AK
500±10%	W6931	RA20A1SD501AK	X3498	RA20A2SD501AK
1000±10%	W6932	RA20A1SD102AK	X3499	RA20A2SD102AK
1500±10%	W6933	RA20A1SD152AK	M9809	RA20A2SD152AK
2500±10%	W6934	RA20A1SD252AK	L9103	RA20A2SD252AK
5000±10%	W6935	RA20A1SD502AK	L9104	RA20A2SD502AK
10,000±10%	W6936	RA20A1SD103AK	H8979	RA20A2SD103AK

TYPE 25, JAN-R-19, Type RA30 (May also be used as Type RA25)

4 watt, 1 17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

	RA30, JAN Shaft Type SD		RA30 High Torque, JAN Shaft Type SD	
Resistance	CTS Part	JAN-R-19 TYPE	CTS Part	JAN-R-19 TYPE
50±10%	X3502	RA30A1SD500AK	W2837	RA30A2SD500AK
100±10%	X3503	RA30A1SD101AK	X3504	RA30A2SD101AK
250±10%	X3505	RA30A1SD251AK	X3506	RA30A2SD251AK
500±10%	X3507	RA30A1SD501AK	M7566	RA30A2SD501AK
1000±10%	X3508	RA30A1SD102AK	S2444	RA30A2SD102AK
1500±10%	X3509	RA30A1SD152AK	X3510	RA30A2SD152AK
2500±10%	X3511	RA30A1SD252AK	S2736	RA30A2SD252AK
5000±10%	Q1409	RA30A1SD502AK	X3512	RA30A2SD502AK
10,000±10%	X3513	RA30A1SD103AK	R1561	RA30A2SD103AK
15,000±10%	X3514	RA30A1SD153AK	L9107	RA30A2SD153AK

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JAN-R-94 AND JAN-R-19 TYPE MILITARY VARIABLE RESISTORS

167 types

Preference given to orders carrying military contract number and DO rating. Other JAN items or special items with or without associated switches can be fabricated to your specifications. Please give complete details on your requirements including electrical and mechanical specifications.

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For further information, write for Stock Sheet No. 162

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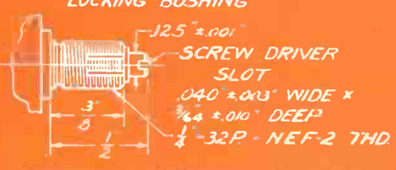
SHAFT TYPES AVAILABLE ON STOCK CONTROLS

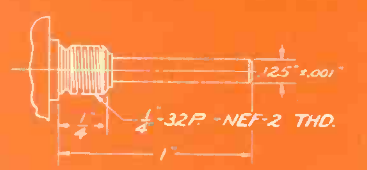
CTS SHAFT TYPE LT-2

LOCKING BUSHING



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 3/8 HEX x 3/32
LOCK NUT 3/8 HEX x 1/16
LOCK WASHER #1914A

CTS SHAFT TYPE RE



MOUNTING HARDWARE ASSEMBLED
MOUNTING NUT 3/8 HEX x 3/32
LOCK WASHER #1914A

TYPE 65

½ watt 70° C, ¾" diameter miniaturized variable composition resistor.

Resistance	CTS Part CTS Shaft Type RE	CTS Part Locking Bushing CTS Shaft Type LT-2
250±10%	X3516	X3530
500±10%	X3517	X3531
1000±10%	X3518	X3532
2500±10%	X3519	X3533
5000±10%	X3520	X3534
10,000±10%	X3521	X3535
25,000±10%	X3522	X3536
50,000±10%	X3523	X3537
100,000±10%	X3524	X3538
250,000±10%	X3525	X3539
500,000±10%	X3526	X3540
1 Meg±20%	X3527	X3541
2.5 Meg±25%	X3528	X3542

TYPE 95, JAN-R-94, Type RV4

2 watt 70°C, 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

Resistance	JAN-R-94 TYPE RV4 JAN Shaft Type SD	JAN-R-94 TYPE RV4 JAN Shaft Type RJ	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	RV4ATSD101A	RV4ATRJ101A	W3160
250±10%	RV4ATSD251A	RV4ATRJ251A	W3161
500±10%	RV4ATSD501A	RV4ATRJ501A	W3162
1000±10%	RV4ATSD102A	RV4ATRJ102A	W3166
2500±10%	RV4ATSD252A	RV4ATRJ252A	W3163
5000±10%	RV4ATSD502A	RV4ATRJ502A	W3164
10,000±10%	RV4ATSD103A	RV4ATRJ103A	W3167
25,000±10%	RV4ATSD253A	RV4ATRJ253A	W3168
50,000±10%	RV4ATSD503A	RV4ATRJ503A	W3169
100,000±10%	RV4ATSD104A	RV4ATRJ104A	W3170
250,000±10%	RV4ATSD254A	RV4ATRJ254A	W3171
500,000±10%	RV4ATSD504A	RV4ATRJ504A	W3172
1 Meg±20%	RV4ATSD105B	RV4ATRJ105B	W3173
2.5 Meg±20%	RV4ATSD255B	RV4ATRJ255B	W3165
5 Meg±20%	RV4ATSD505B	RV4ATRJ505B	W3159

TYPE 45, JAN-R-94, Type RV2

¼ watt, $^{15}/_{16}$" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

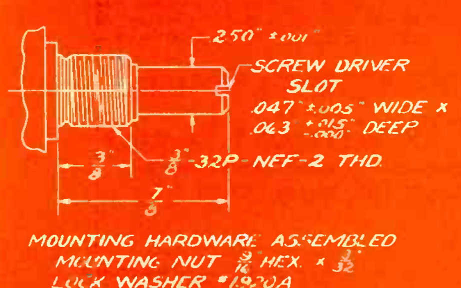
Resistance	RV2, JAN Shaft Type SD CTS Part	JAN-R-94 TYPE	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	A5876	RV2ATSD101A	A5922
250±10%	A5877	RV2ATSD251A	A5923
500±10%	A5878	RV2ATSD501A	A5924
1000±10%	A5879	RV2ATSD102A	A5925
2500±10%	A5880	RV2ATSD252A	A5926
5000±10%	A5881	RV2ATSD502A	A5927
10,000±10%	A5882	RV2ATSD103A	A5928
25,000±10%	A5883	RV2ATSD253A	A5929
50,000±10%	A5884	RV2ATSD503A	A5930
100,000±10%	A5885	RV2ATSD104A	A5931
250,000±10%	A5886	RV2ATSD254A	A5932
500,000±10%	A5887	RV2ATSD504A	A5933
1 Meg±20%	A5888	RV2ATSD105B	A5934
2.5 Meg±20%	A5889	RV2ATSD255B	A5935

TYPE 35, JAN-R-94, Type RV3

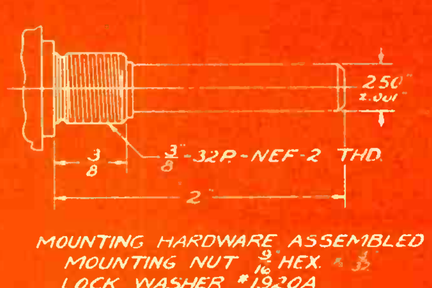
½ watt, 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

Resistance	RV3, JAN Shaft Type SD CTS Part	JAN-R-94 TYPE	CTS Part Non-JAN Locking Bushing CTS Shaft Type LT-1
100±10%	A5861	RV3ATSD101A	A5907
250±10%	A5862	RV3ATSD251A	A5908
500±10%	A5863	RV3ATSD501A	A5909
1000±10%	A5864	RV3ATSD102A	A5910
2500±10%	A5865	RV3ATSD252A	A5911
5000±10%	A5866	RV3ATSD502A	A5912
10,000±10%	A5867	RV3ATSD103A	A5913
25,000±10%	A5868	RV3ATSD253A	A5914
50,000±10%	A5869	RV3ATSD503A	A5915
100,000±10%	A5870	RV3ATSD104A	A5916
250,000±10%	A5871	RV3ATSD254A	A5917
500,000±10%	A5872	RV3ATSD504A	A5918
1 Meg±20%	A5873	RV3ATSD105B	A5919
2.5 Meg±20%	A5874	RV3ATSD255B	A5920
5 Meg±20%	A5875	RV3ATSD505B	A5921

JAN SHAFT TYPE SD

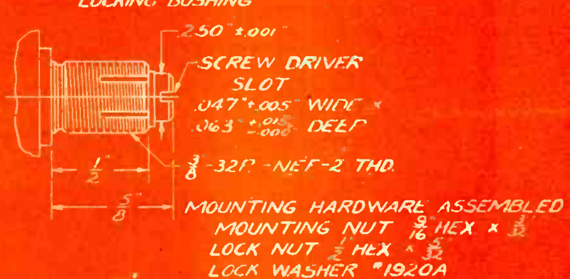


JAN SHAFT TYPE RJ



CTS SHAFT TYPE LT-1

LOCKING BUSHING

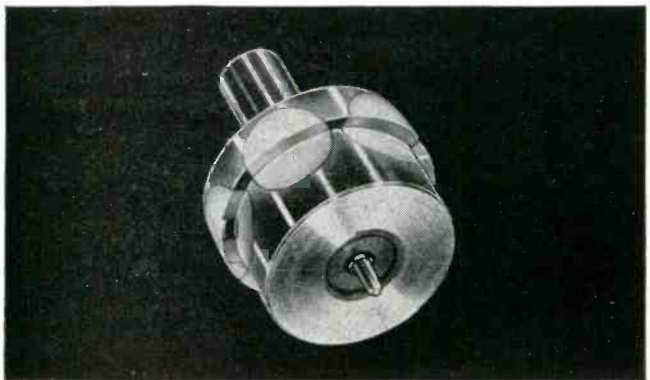


KEL-F*

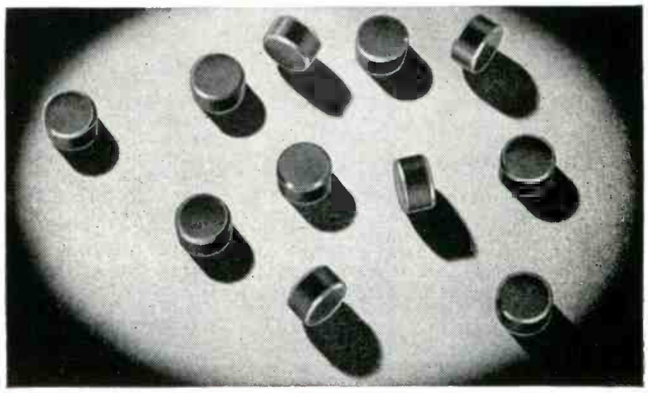
*Reg. U. S. Pat. Off.

Application Report #2

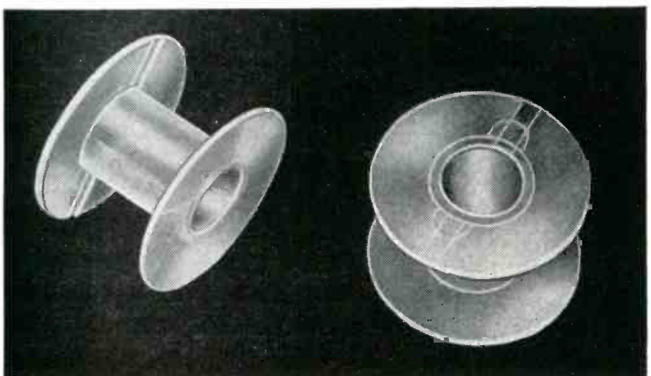
. . . how POLYTRIFLUOROCHLOROETHYLENE has been used to solve tough design problems.



1. This rotary switch demonstrates several of the unusual properties that are winning a leading place for Kel-F in electronic applications. In production, Kel-F is injection molded into the metal switch case *around an intricate insert* . . . result—an hermetic seal between plastic and metal, *plus* high electrical resistance and dimensional stability.



2. Glass fiber and Kel-F are combined to produce these compression-molded valve seats for compressed-gas tanks. Kel-F's chemical inertness eliminates chance of corrosion problems. Its dimensional stability combines with that of the glass fiber to deliver finished parts that have minimum deformation over an extremely wide temperature range.



3. These coil forms are molded on standard injection equipment at very favorable production rates, again pointing up Kel-F's superior molding properties. Further reasons for specification of Kel-F in a rapidly growing list of such high frequency electronic applications are—performance at high temperature; excellent insulating properties; and zero moisture absorption.

4. Machined to close tolerance from solid rod, *on an ordinary automatic screw machine*, these bushings illustrate Kel-F's versatility. Such ready machinability combines with physical strength, chemical inertness, dimensional stability and electrical resistance to make Kel-F a sound specification for many types of chemical and electrical fittings.

A Capsule Report on the Properties of KEL-F

- ★ Chemical Inertness
- ★ Wide temperature range —minus 320 F to 390 F
- ★ High electrical resistance
- ★ Low Cold Flow
- ★ Zero Moisture Absorption
- ★ Variable transparency and flexibility properties
- ★ Readily molded, extruded and machined

Basic Kel-F Products Available

MOLDING POWDERS

Unplasticized

- **#300** . . for high temperature service
- **#270** . . for less severe temperatures

Plasticized *(in either #300 or #270)*

- **P 20** . . with 20% plasticizer
- **P 25** . . " 25% "
- **P 30** . . " 30% "

DISPERSIONS

- **NW-25** . . flows readily at fusion temperatures
- **N-1** . . High molecular weight

OILS, WAXES and GREASES

- **#1** . . Light Oil
- **#3** . . Medium Oil
- **#10** . . Heavy Oil
- **#40** . . Waxy Oil (pour point 80-90 F)
- **#150** . Hard Wax at 70 F

(Greases compounded to order)

Standard Fabricated Kel-F Materials and Parts Available from Commercial Sources

Molded Sheets★ Extruded and Molded Rod★ Extruded Tubing
Thin Film (extruded as lay-flat tubing)
Gaskets★ Washers★ Valve Discs★ "U" Packing
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For full information on various molders, extruders and fabricators of Kel-F products; also technical data on detailed properties, molding and application techniques — write

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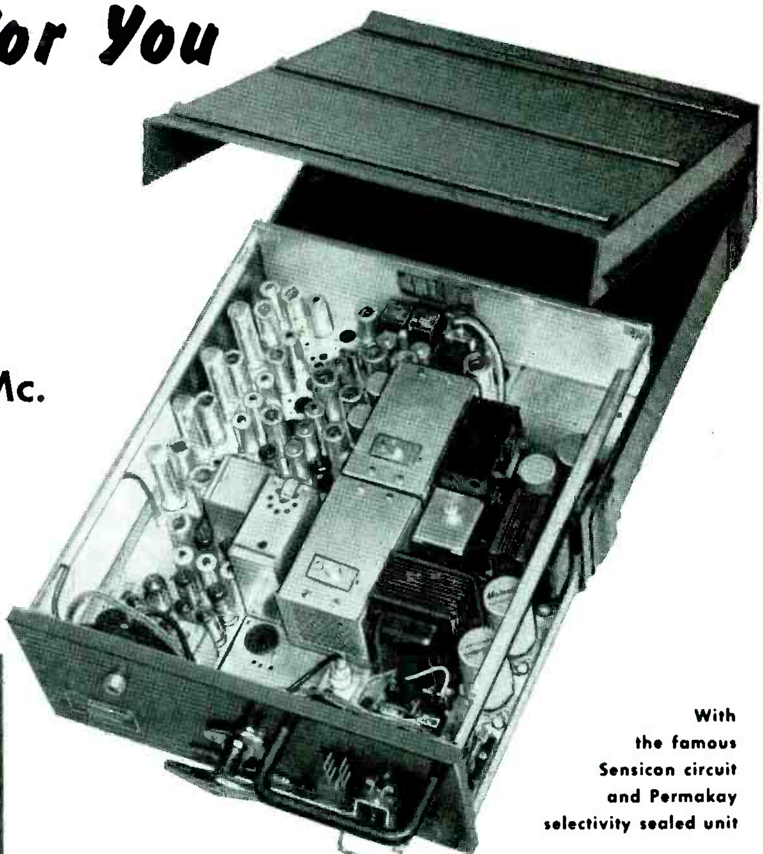

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Eighteen popular styles in ceramic capacitors are shown above. Feed-Thru's are supplied in values up to 2000 mmf, Stand-Off units up to 5000 mmf, Tubular and Disc units up to .01 mfd. Also shown above are two Silver Button Micas representing the 370 series for values up to 1000 mmf and the 4700 series for values up to 6000 mmf. Write for samples to meet your specific requirements.

Electronics Division

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Look Through *this* Line...

● Can't guarantee that the Varflex Line will solve every insulation problem. But . . . Many's the problem—large, small, unusual—that Varflex Electrical Sleeving or Tubing has solved. The Varflex range of application is vast—chances are you'll find the solution to your Electrical insulating problem somewhere in the Varflex line.

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- **VARGLAS TUBING IMPREGNATED WITH GENERAL ELECTRIC PERMAFIL.** Tough, flexible, heat-resistant—available in coils. Premium tubing at a reasonable price.

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- **SYNTHOLVAR EXTRUDED PLASTIC TUBING.** Low temperature flexibility—high dielectric and tensile strength—made from a standard formulation of vinyl polymers.

SAMPLES? All you want with our compliments. For free folder of our complete line, just clip and mail this coupon.

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MAKERS OF ELECTRICAL INSULATING TUBING AND SLEEVING

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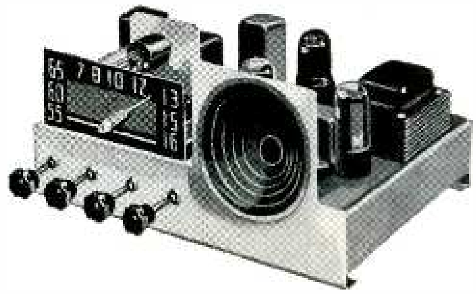

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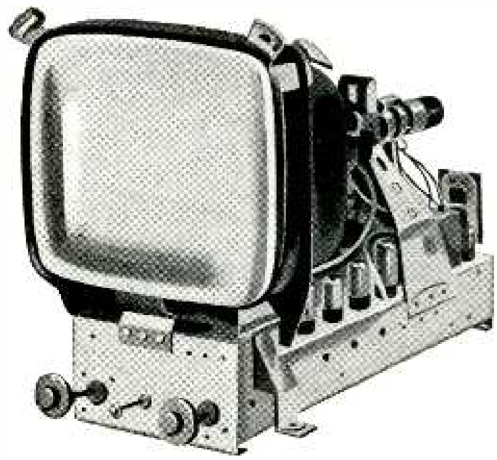

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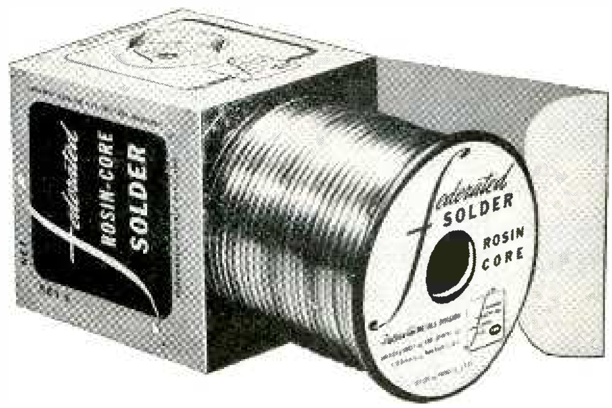
USE...



For any soldering job that demands freedom from corrosion and conductive flux residue . . . for ease of working and unequalled consistency . . . there is nothing better than Federated Rosin Core Solder.

Each Rosin Core Solder composition . . . there is a variety for different purposes . . . is a tin and lead alloy with a rosin flux that is effective but not corrosive. Because the rosin residue is chemically inactive, current leakage at radio and television frequencies is prevented.

Federated Rosin Core Solder is a quality product that is unsurpassed for the permanence of the bond it produces . . . for the consistently easier soldering job it does! Look for it in 1, 5, 20, 25, and 50-pound sizes on the familiar orange and black metal spool. Listed by Underwriters' Laboratories Inc.

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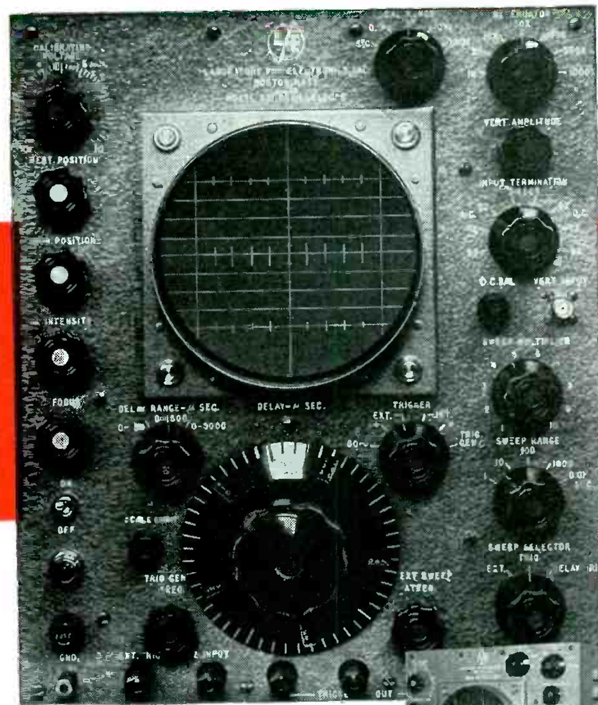
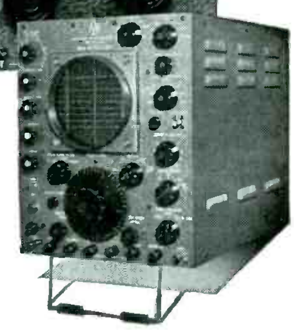
NEW, 10 Mc Wide Band Oscilloscope . . .

for precise, quantitative studies of pulse waveforms, transients and other high or low speed electrical phenomena



LFE Model 401 Oscilloscope . . .
A high gain, wide band, versatile, general purpose instrument

Advances in electronics have placed greater demands on the time, frequency, and amplitude measuring capabilities of laboratory oscilloscopes. LABORATORY FOR ELECTRONICS, INC., recognizing the ever-increasing requirements of the rapidly expanding electronics industry, and using specifications set forth by electronic engineers, has developed the Model 401 oscilloscope to provide the features and conveniences required in a medium price, general purpose instrument.



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Y-Axis

Deflection Sensitivity—15 millivolts peak-to-peak/cm

Frequency Response—DC to 10Mc

Transient Response—Rise Time—0.035 microseconds

Signal Delay—0.25 microseconds

Input line terminations—52, 72, or 93 ohms, or no termination, for either AC or DC input

Calibrating Voltage—60 cycle square wave.

Input Imp.—1 megohm, 30 mmf.

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Sweep Range—0.01 sec/cm to 0.1 microseconds/cm

Delay Sweep Range—5-5000 microseconds in three ranges—continuously adjustable

Triggers—Internal or External, + and −, or 60 cycles, or delayed trigger outputs are available at suitable binding posts.

Built-in trigger generator for triggering external circuits and sweeps.

General

Low capacity probe

Functionally colored control knobs conveniently grouped

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Adjustable scale lighting

Facilities for mounting oscilloscope cameras

Dimensions—12½" wide, 15" high, 19" deep

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Price—$895. F. O. B., Boston

Write for full color booklet with complete information.

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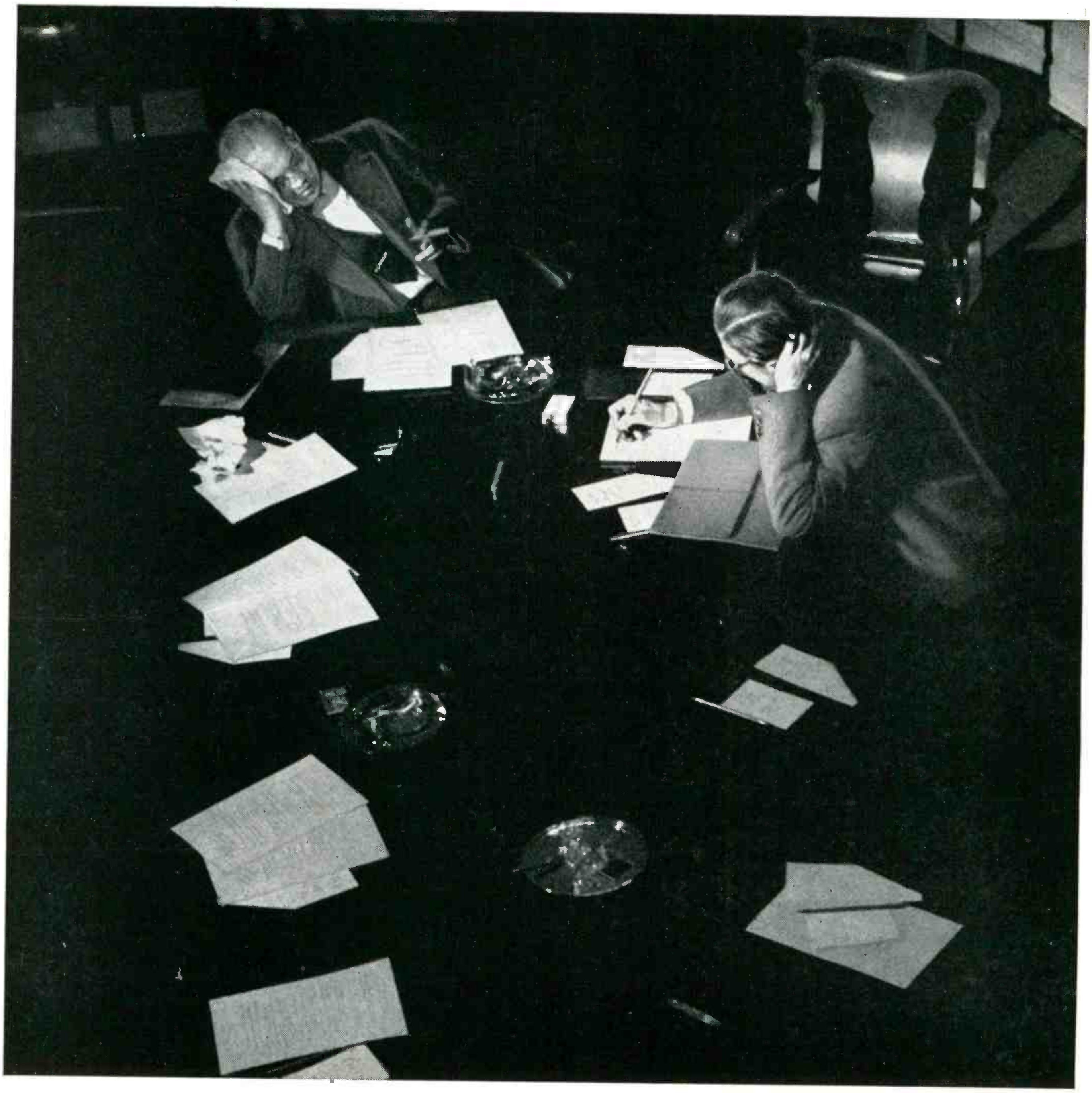

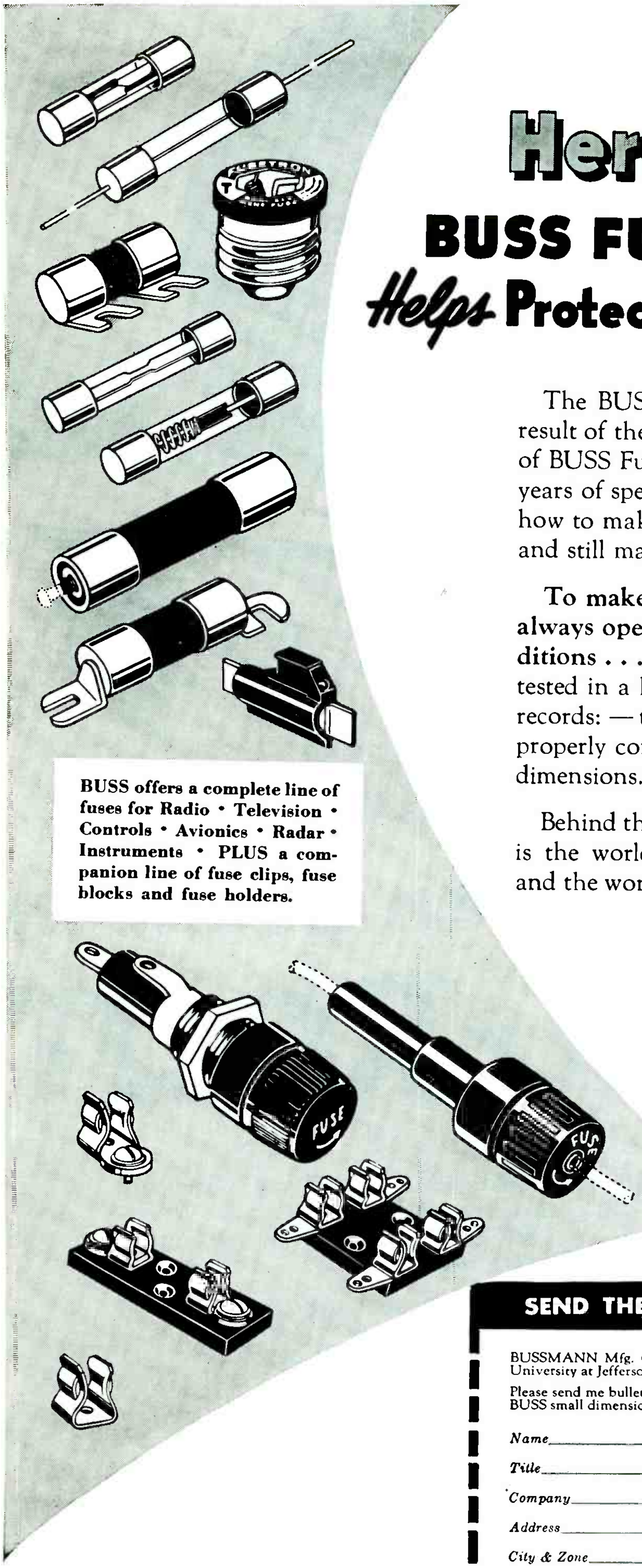

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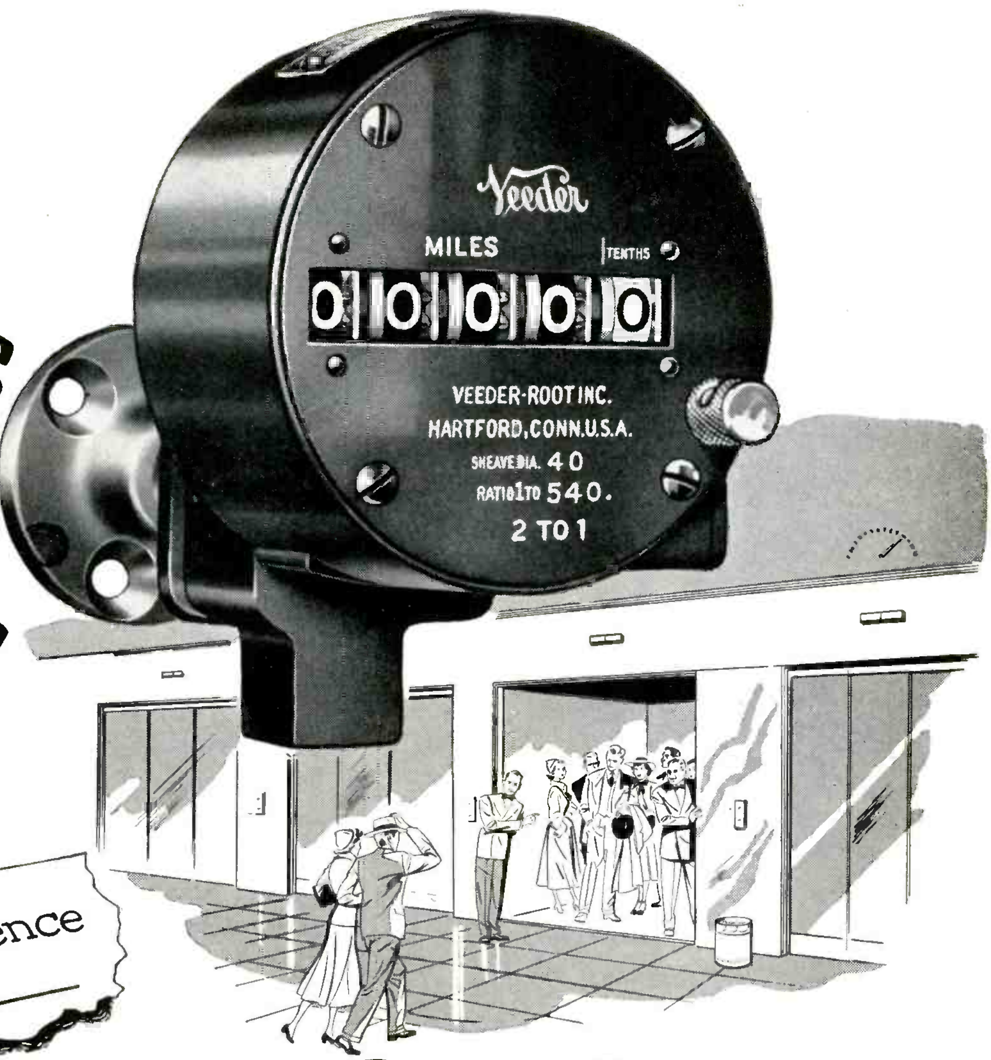

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Yes, the V-R wheelmark monogram protects millions of people daily, from the depths of the sea to the stratosphere. Of course, not all V-R Products and services are available nowadays . . . but if your work counts importantly in defense, then you can count on Veeder-Root to help you, as soon as rush commitments permit.

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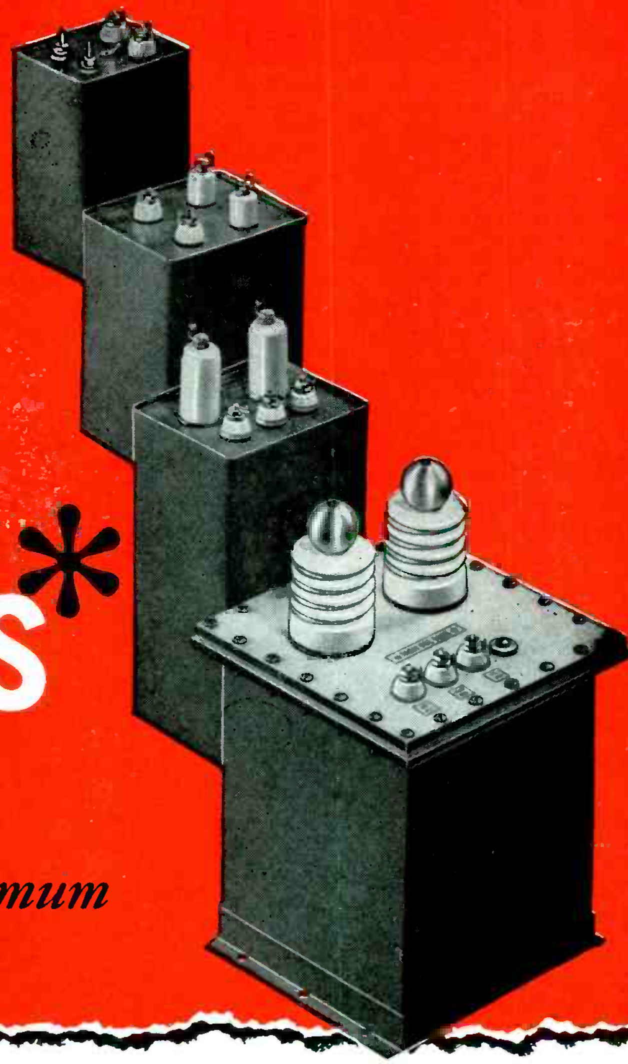
"Counts Everything on Earth"

HiVolt Power Supplies*

where size and weight must be kept to a minimum



These hermetically-sealed, self-contained power supplies are designed to transform AC to high voltage—low current DC for many applications. Our exclusive engineering techniques and oil-filled construction assure smaller, lighter, more flexible units.

Applications:

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- **dust and electrostatic precipitators**
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- **display tubes**
- **etc.**

Send us your requirements and we will recommend the best HiVolt Power Supply.

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THE SX-73 COMMUNICATIONS RECEIVER
"A Gibraltar of Stability"
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540 kc to 54 Mc in six turret-selected bands.
20 tubes, including rectifier, voltage regulation and ballast tubes.
Dual conversion, 455 kc and 6 Mc crystal controlled.
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FRONT VIEW, SX-73
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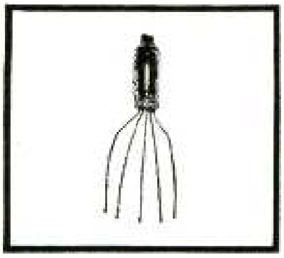

Nickel grid wire and strip, furnished in this case by Driver-Harris Company, Harrison, N. J. and Sigmund Cohn & Co., N. Y., N. Y. are components in this tiny (1" long) pentode amplifier tube used in hearing aids.

Peanuts to Power

...tubes perform better with *NICKEL*

From the tiny peanut tube in hearing aids to the tremendous power producer in transmitting equipment . . . in almost every tube . . . electronics manufacturers turn to Nickel to improve performance.

In cathodes, side rods, lead wires, grids, sleeves, connecting straps . . . in virtually every part . . . it's Nickel's special qualities that make that part do its special job . . . and do it better.

What are these qualities?

- Excellent forming quality. Simplifies production of precision parts.
- Strong, spot-welded joints practically free of oxidation.
- Strength to maintain precision despite handling in mounting parts.
- Rustproof in handling and storage. Corrosion resisting to solvents in cleaning.
- Lower gas content. Faster evacuation because gas can be removed at higher temperatures.
- Greater strength at high evacuation temperatures without crystal change, means less change in dimensions and tube constants.
- Better electron emission from coated nickel cathodes.
- Better carbon coating adherence with less embrittlement of strip.
- Conducts heat better at elevated temperatures.
- Good damping characteristics minimizing microphonic effects.

All of which means an electronic tube made with Nickel and Nickel Alloy components can perform better, whatever its application.

Low carbon Nickel was the choice for the spun anode sleeve and other critical parts in this 40 million watt power tube produced by the Chatham Electronics Corp., Newark 2, N. J.

Perhaps there's a Nickel or a Nickel Alloy that will help improve your product's performance. There's a concise booklet available—"Inco Nickel Alloys for Electronic Uses" which may answer your questions. Send to Bruce Winter for your copy today. Also, if you have a special metal selection problem, just write giving full details.

Nickel and Nickel Alloys are on extended delivery, so anticipate needs. It pays to order well in advance, always giving NPA rating and full end-use information.

The International Nickel Company, Inc.
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NICKEL INCO ALLOYS

Maybe you're missing a bet on

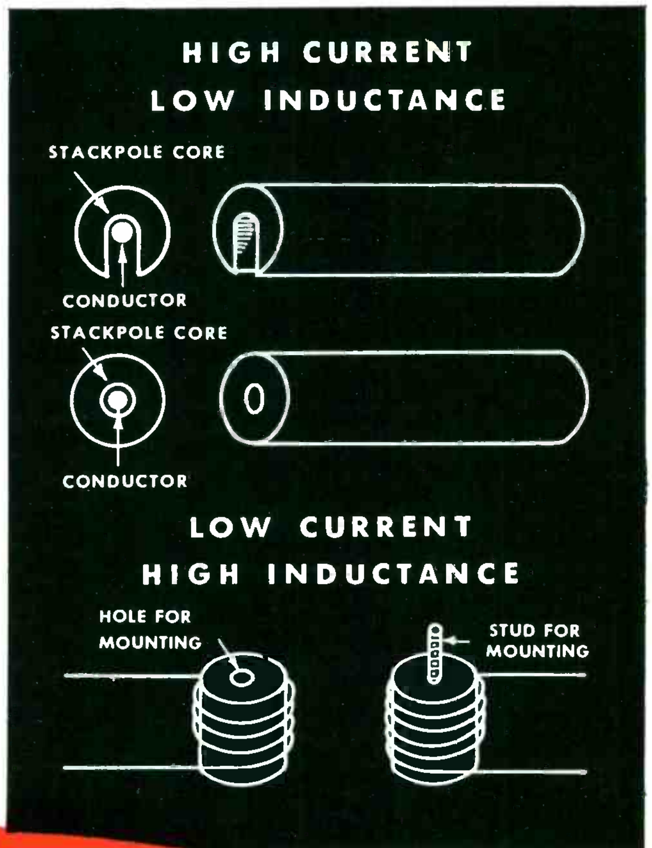
HASH and INTERFERENCE SUPPRESSION!

Recent experience indicates that Stackpole molded iron cores and Ceramag® cores (ferrites) help materially in minimizing "hash" and r-f interference when used in the filter systems of electrical tools and equipment. Their advantages include

- ***Less IR Drop*** **because of lower d-c resistance**
- ***Greater R-F Attenuation*** **because of less distributed capacitance**
- ***Concentrated Field*** **with consequent reduction in coupling to other coils**
- ***Reduced Space Requirements***
- ***Increased Inductance*** **for a given amount of wire . . . . or, conversely . . . .**
- ***Less Wire*** **for the same inductance**

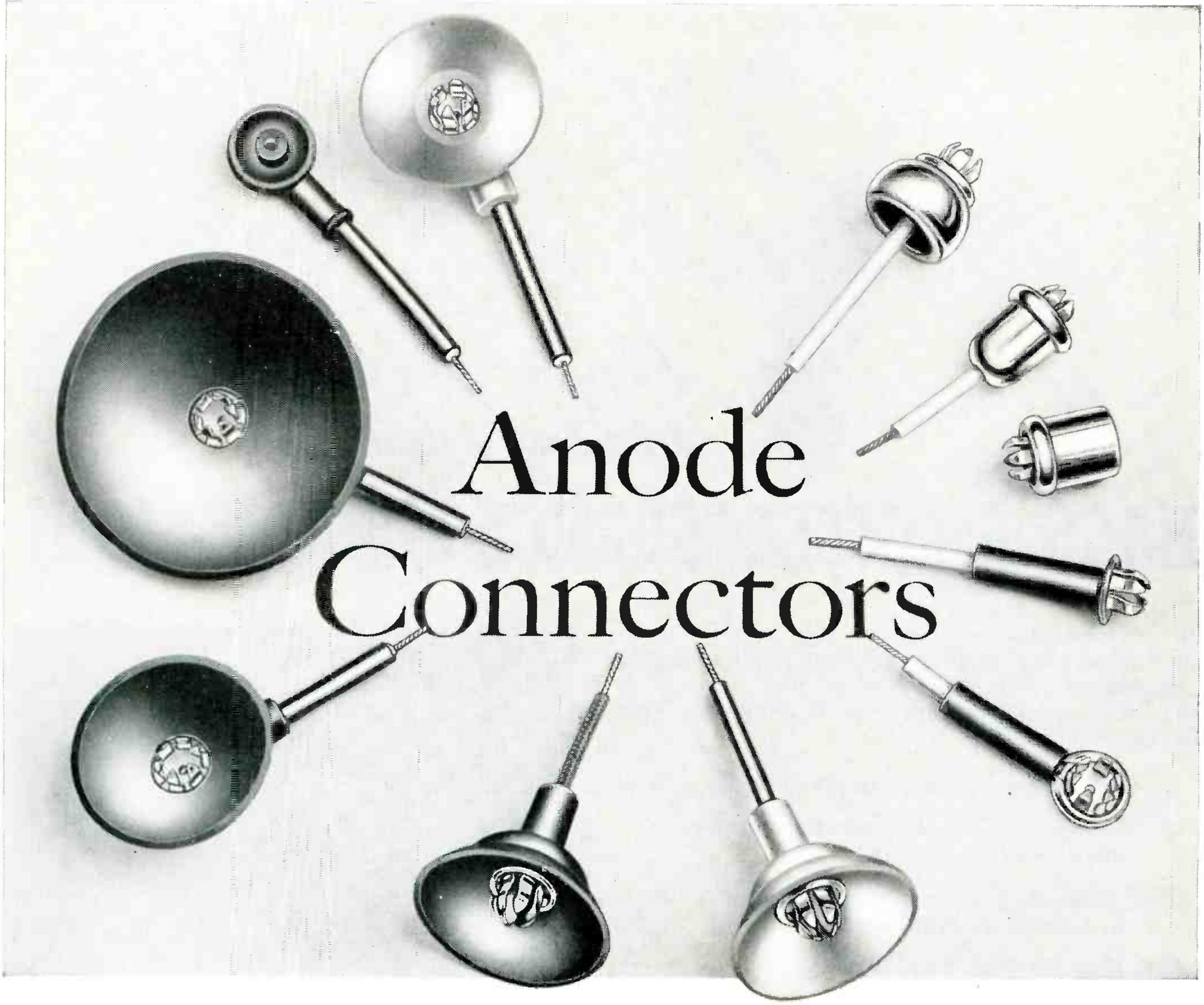
As one of the earliest pioneers in core production, and backed with a complete line of materials, sizes, shapes and production facilities, Stackpole welcomes the opportunity to cooperate in adapting suitable cores to particular noise suppression problems.

Your inquiry entails no obligation and will receive prompt, skilled attention. Write to Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.



STACKPOLE

MOLDED IRON *Cores* **CERAMAG® (FERRITES)**



Ucinite Anode Connectors are available in several types for standard recessed small cavity caps in cathode ray tubes. Straight or right angle lead connections can be made with or without insulating shields. Shields are made from corona resistant neoprene or silicon.

Good contact and firm holding power are assured by silver plated, heat treated steel United-Carr Plug Buttons. Metal parts are designed to keep corona at a minimum.

Also available is the right angle connector with rubber suction cup shield for recessed small ball caps.

Other special corona resistant connectors and adaptors are available or can be readily designed for specific requirements.

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Ucinite offers complete design and engineering services as well as volume production facilities.

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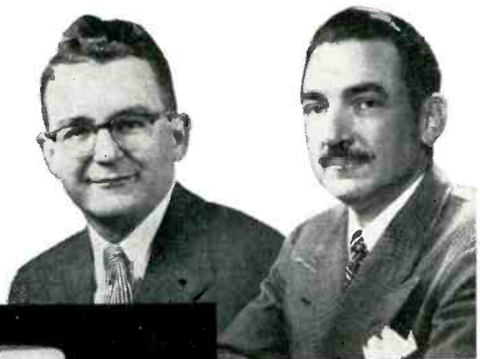
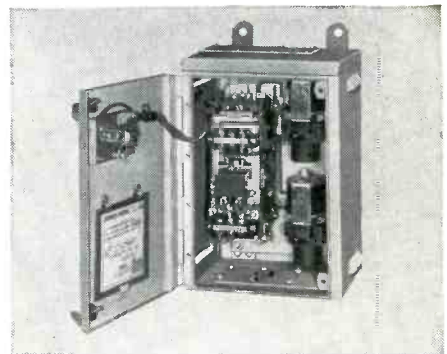
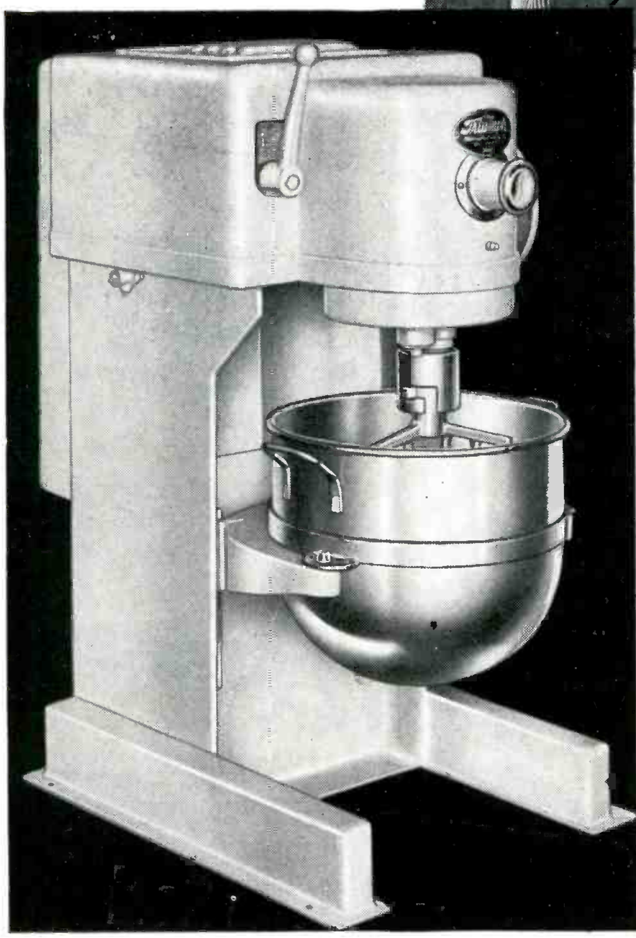
The Triumph Manufacturing Co.

"Galley duty in the Navy requires a motor control as rugged as the machine"

say Sheldon B. Storer (right) and Samuel T. Bryant (left), Sheldon Storer & Associates, Cincinnati, Ohio, representatives, Ward Leonard Electric Company.







This Triumph vertical "kitchen" machine is used by the Navy for everything from mixing dough to cutting French-fried potatoes, grinding coffee, sharpening cutlery.

Such machines are operated by a wide variety of people wherever naval vessels or installations are found and it is essential to keep them in operation with a minimum of down-time.

In order to meet exacting Navy standards, Triumph consulted Ward Leonard for a motor control. Because of their long experience and excellent record in the production and development of Navy controls of many types, Triumph was assured that Ward Leonard could supply them with sturdy, trouble-free equipment which would match the construction of their ruggedly built machines.

The Ward Leonard controllers used by Triumph vary only depending on whether the power supply is a-c or d-c. For d-c applications they are Ward Leonard, Bulletin 4556, across-the-line starters, magnetic type, continuous duty, semi-automatic operation with overload and low voltage protection, drip-proof enclosure and spraytight pushbutton station; Bulletin 4651 is the equivalent for a-c applications.

Complete operating and maintenance instruction books were supplied the Navy as a result of the team work of William Leuze, chief engineer of Triumph, and Samuel Bryant of Ward Leonard.

Ward Leonard field engineers are always ready to work with you to solve your electrical control problems. When your production demands exact engineering, quality manufacturing, prompt, efficient handling and shipping, call on Ward Leonard.

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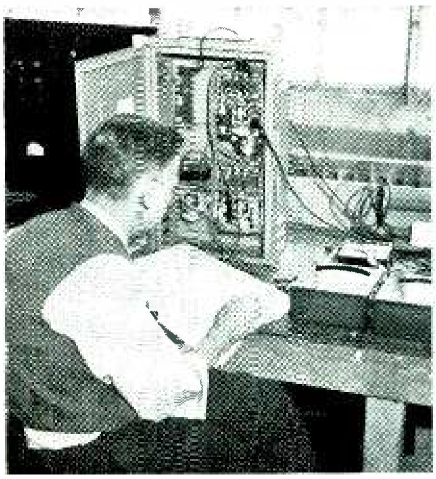
WARD LEONARD ELECTRIC COMPANY

MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

TO INSURE HIGH METAL QUALITY, Frank DePaola, chemist, studies samples microscopically for grain and crystal structure.

MAGNETIC OVERLOAD RELAYS are tested for tripping time by Anthony J. Bellitto before they are installed on motor control panels.



AN A-C MOTOR CONTROLLER undergoes a careful wiring check by Donald A. Parsons of Ward Leonard's Test Department.

COMPONENTS OF A-C SOLENOID STARTERS are being assembled in Ward Leonard's plant in Mount Vernon, New York.

From PT Boats to Battle Wagons — Ward Leonard Designs Controls to Meet Exacting Specifications

At sea, electrical controls or components must meet exacting service conditions involving mechanical shock, vibration, salt spray, plus pitch and roll.

The Ward Leonard control line includes devices designed especially for Navy, Coast Guard and Maritime use, as well as the well-known industrial control line. For example, Ward Leonard makes pushbutton stations for the Navy and Maritime applications, and a comprehensive line of commercial pushbutton stations. This holds true for a great variety of components.

Ward Leonard frequently builds special control items which involve contactors, starters, rheostats, relays, resistors, and other major electric components.

Ward Leonard controls are of unit construction. Each component is manufactured and tested independently. These components are then combined and mounted to suit customer's exact requirements.

Consult Ward Leonard on the extreme flexibility and adaptability of Ward Leonard controls and components to meet your special needs.

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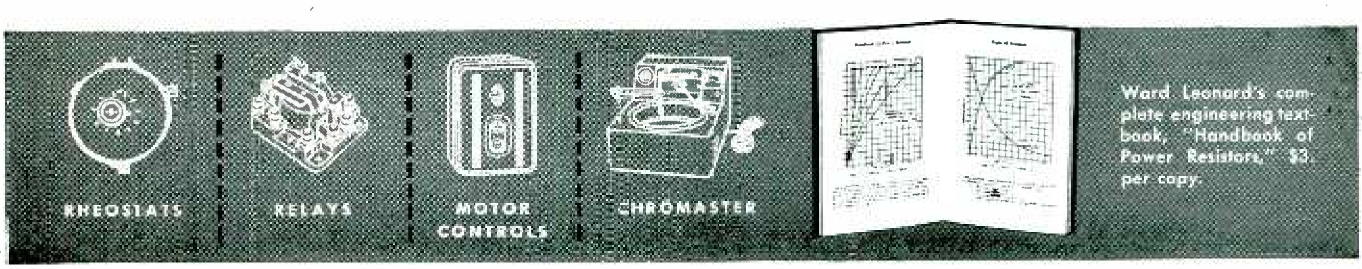

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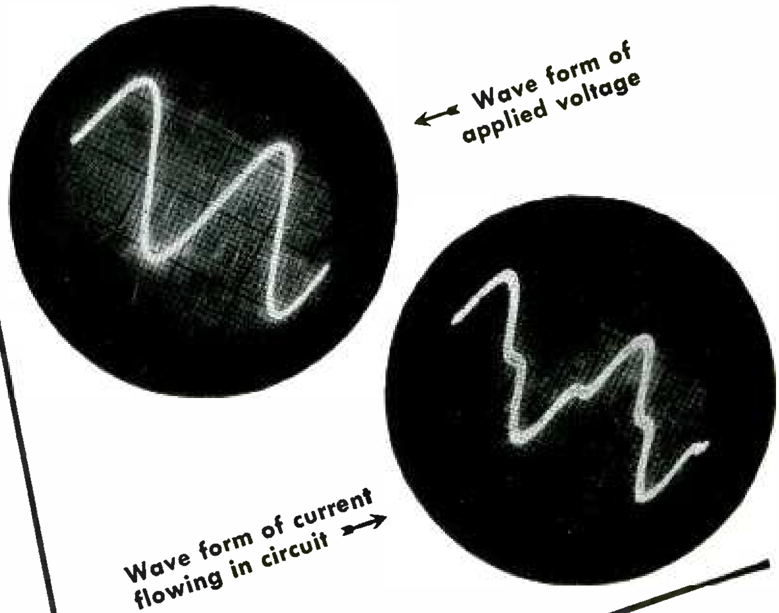
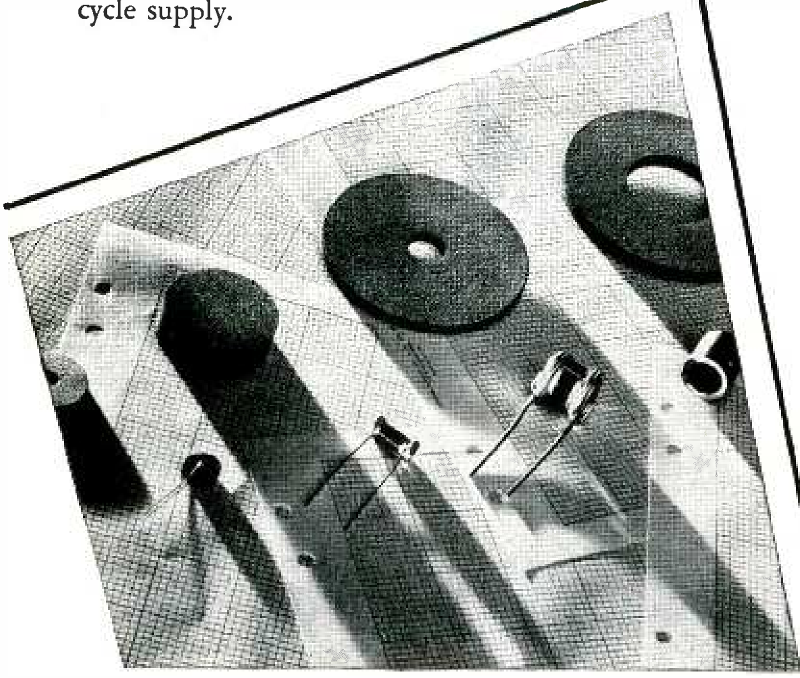
These unretouched photos of oscilloscope screens show the effect obtained by connecting a GLOBAR type BNR resistor in series with a fixed resistor across a 115 volt 60 cycle supply.





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Type BNR conductive ceramic body resistors

Dampen the effect of transient voltages and provide instant protection for electrical circuits.

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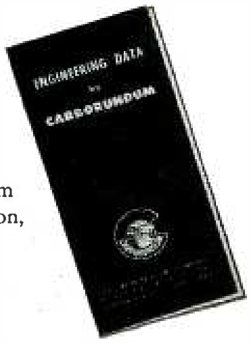

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FOR GRAY AUDOGRAPH

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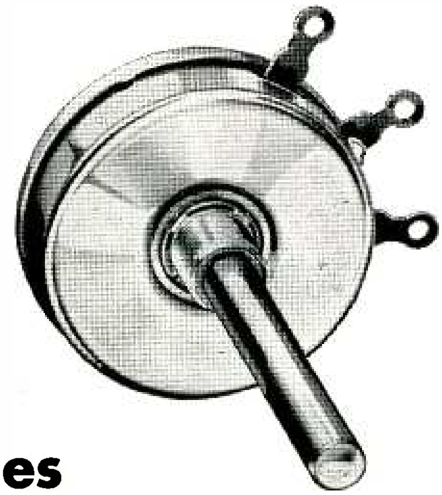

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QC	2	1⅙″	RA15
QR	2	1¼″	RA20
QM	4	1⅝″	RA25 & RA30

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CROSS TALK

▶ **AGE** . . . Electronics is often called a young man's business, despite the fact that it is now well out of swaddling clothes.

Our field continues to attract young men, and profits from their freshness and virility. It does so for two reasons. First, the potential applications of electronics still seem boundless. Second, the field now also represents one of the country's most important going businesses. Mere newness is no longer the sole attraction.

The industry itself is frequently fascinated by youth alone and, currently desperate for technicians, sometimes robs the cradle. There are signs of returning good sense in Help Wanted ads. Several companies are deliberately bidding for the engineering experience found side by side with age. Others are welcoming older engineers into management.

A good oldster is better than a bad youngster. A good youngster is better than a bad oldster. The yardstick is ability, not age.

▶ **BOATS** . . . In the approaching summer season we will spend what is laughingly called spare time cruising Long Island Sound under power and sail.

Marine radiophone WC2600, aboard "Dolphin," taxes the rarely-charged storage battery. Amateur station W2TY normally remains silent for this reason, and because two hobbies overtax weekend recuperative powers. The idea of installing an electronic depth finder is nevertheless appealing. But there is a bug.

Units we've seen tell how much water is *under* the boat. Since we normally puddle-jump close inshore, what is needed is one that puts out a nice narrow pencil of ultrasonic energy *ahead.* This would enable us to duck unlighted buoys on night runs and safely grope our way into tight and shallow little harbors.

There's a market for a different kind of design.

▶ **PARTS** . . . As transistors develop commercially, electronic circuitry will change. This is widely recognized. Among other things, input and output impedances are quite different from those involved in conventional tubes.

Not so widely appreciated is the certainty that other component parts will change too. Consider several publicized virtues of the transistor. It is small. It requires no heater current. It operates at low voltages. So associated parts will also have to be small, and their ability to handle watts may be a minor rather than a major design consideration.

Maybe we are in for an era of sub-subminiature components. Or do you prefer micro-miniature?

▶ **DEFINITION** . . . Making the rounds in Washington to sort out the facts and fictions that so obsess this and other industries, we picked up a phrase about the city that explains why such checking of rumors is necessary.

Washington, it is said, is "the only place in the country where sound travels faster than light."

▶ **SPECIALIZATION** . . . Engineering is a highly specialized field of endeavor. Don't look now, but right in your own shop it is rapidly becoming even more so.

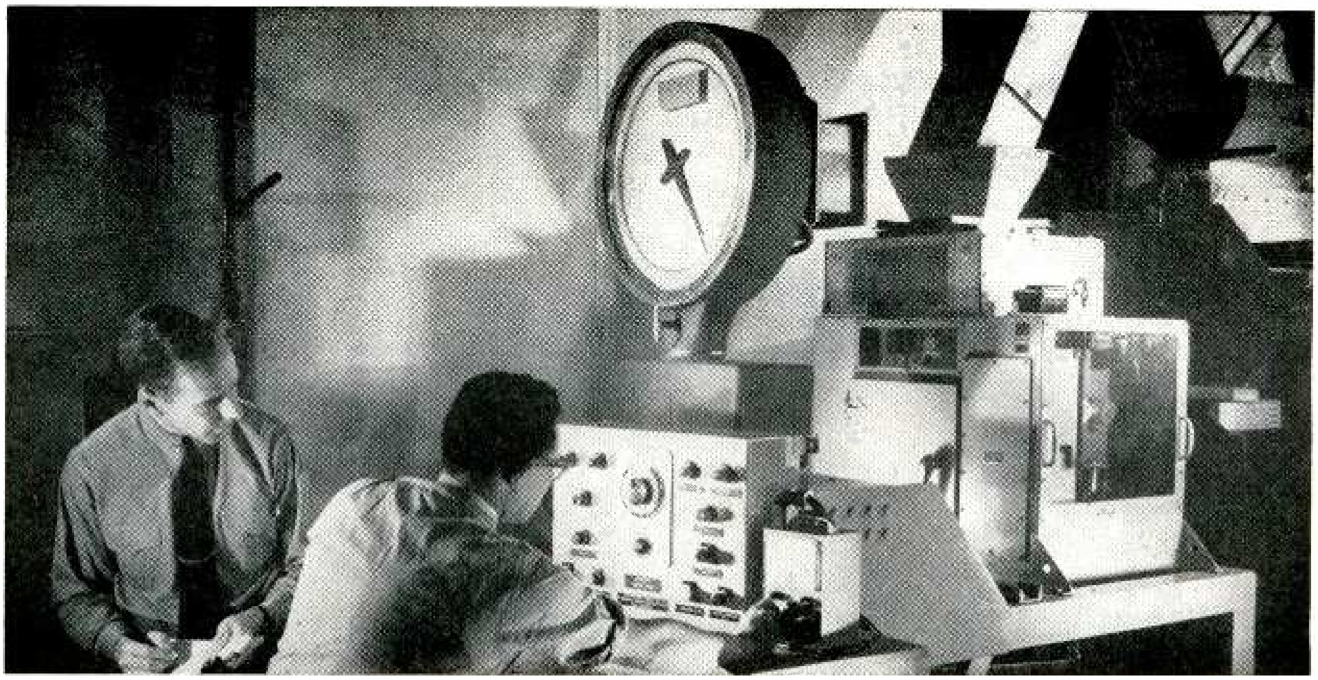
There are administrative engineers, development engineers, systems engineers, project engineers, product engineers, standards engineers, production engineers, quality control engineers, test engineers, packaging engineers, field engineers and even publication engineers. Probably we've left out a few.

Electronic applications of one kind or another are becoming so complex that engineers are subdividing right in their own bailiwick.

▶ **SHOPTALK** . . . Many readers have found "Industry Report" (p 5) interesting and valuable, if not downright indispensable. Others have found "Production Techniques" (p 228) ditto. But some are apparently so far behind in their reading that they are not yet aware of these two innovations running regularly since February.

A piece of our editorial hide adheres monthly to these two new departments. So, we can't resist planting this sixth-month call-up.

Not even electronically do we know a way to put a steam whistle on the contents page.



Weighing industrial-process ingredient by electronic control. Equipment shown is manually sequenced. Fully automatic controls handle several ingredients

Remote-Control Automatic Weighing

By ENRICO KLEIN

Chief Electrical Engineer
Richardson Scale Co., Clifton, N. J.

AUTOMATIC PROPORTIONING of solid and liquid ingredients for industrial processes is accomplished electronically by the Richardson Select-O-Weigh. This device permits remote control of one or more automatic scales to deliver an unlimited number of commodities into a continuous process either cumulatively or consecutively. For example, a proportioning system installed in a rubber-processing plant allows four different grades of carbon blacks to be weighed accumulatively into a single scale-hopper according to preselected schedules. Upon completion of the required accumulation, the machine discharges its load and is ready to begin a new cycle.

The system comprises a dial scale, a remote weight-setting vernier dial, and an electronic cut-off switch to stop the various feeders when the correct weight of an ingredient has been attained. The cut-off switch is actuated by proximity of a metal flag on the weight-scale pointer to a plastic-enclosed metal flag remotely positioned on the periphery of the weight-scale dial by means of a servomechanism.

Figure 1 shows schematically the physical arrangement of the weighing mechanism and feeders. The loading cycle of the scale is as follows: The electronic proximity-switch flag advances to the position pre-established on the servo pickup coil scheduling the first weighing. The first feeder, indexed by selection, starts. When the flag mounted on the dial-scale pointer, in advancing, meets the proximity flag, the feeder stops. The proximity flag then proceeds immediately to the position pre-established by the setting of the pick-up coil scheduling the second weighing and the second feeder starts.

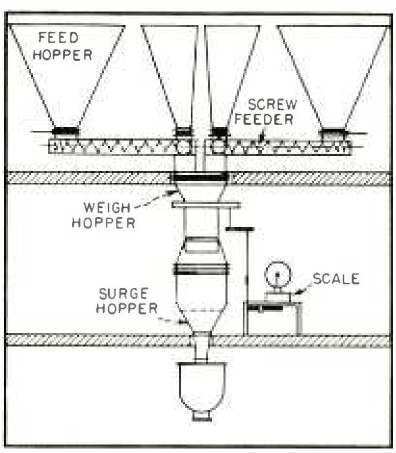


FIG. 1—System schematic showing screw feeders, weigh hopper, and weighing machine

Adequate time lags introduced into the cycle permit the flag to position itself before the feeder initiates. At the conclusion of the second feed, the remaining ingredients are added proportionally as scheduled. When the weighing cycle is complete, the machine rests awaiting the discharging impulse. The order of feeder selection is not critical and several pick-up coils

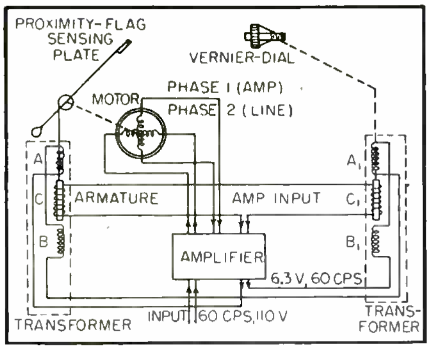


FIG. 2—Servomechanism positions proximity-switch sensing plate to program desired weight

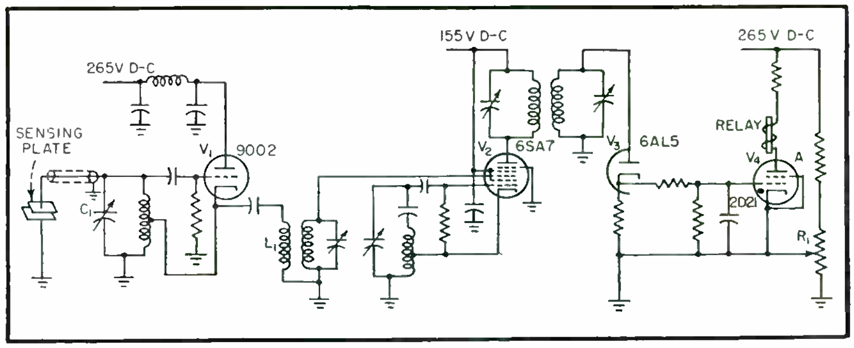


FIG. 3—Proximity flag-to-scale pointer capacitance tunes r-f oscillator of sharply-resonant switch circuit. Diode output voltage fires thyratron with 10,000-ohm relay in plate circuit

Industrial control circuits applied to automatic weighing facilitate remote batching of process ingredients. Desired weights set up on vernier dial are automatically obtained in proper sequence from storage bins by servomechanism

may be sequenced to operate the same feeder.

Each time the scale is discharged, a permanently adjusted pick-up coil is switched into the servomechanism. This compels the proximity switch to position itself at the zero or tare balance position on the weight-scale dial. The proximity-switch circuit is then actuated and a signal indicates complete evacuation of the scale's weigh hopper before the next cycle is initiated. An alarm pilot light indicates failure of the tare-check circuit to the operator.

Servomechanism

The proximity-flag positioning servo consists of two linear variable-differential transformers connected as shown in Fig. 2. Each transformer consists of three coils wound on a single spool with a free-moving armature of magnetic material mounted inside the spool. Alternating current is supplied to the center, or primary coil C and the magnetic flux generated by this coil is distributed by the armature so that a voltage is induced in the secondary coils A and B. If the armature is symmetrically located, the induced voltages will be equal, but if the armature moves to the left (up) the induced voltage in coil A will be greater than the induced voltage in coil B. If the armature moves to the right (down) the voltage in coil B will be greater than that induced in coil A. In normal operation the coils are connected in a series bucking relationship so that, when the armature is centered and both coils have equal voltages induced, the resulting output is zero. If the armature moves to the left a voltage of one phase, A, will predominate and if the armature moves to the right a voltage of the other phase, B, will predominate. Phase A will differ from phase B by 180 degrees.

The pick-up transformer is connected to the vernier dial, which is graduated in pounds and installed on the control panel. This manual control is so calibrated that 0.1 inch motion of the servo pick-up coil armature represents full-scale displacement of the weighing-scale dial. Since the vernier-dial graduations are therefore proportional to the peripherically located weight markings on the weight-scale dial, the servomechanism can be used to position the proximity-switch flag at the desired ingredient weight.

The electronic proximity switch consists of a frequency-drift, proportional-output triggering circuit shown schematically in Fig. 3. Oscillator tube V_1 is tuned to the broadcast frequency that will deliver highest power output through the i-f transformer at 455 kc and through the conventional mixer-oscillator circuit of V_2. Tuning is performed by C_1 and the fixed setting of the sensing plate in proximity to the scale-pointer flag.

Circuit Details

Coupling coil L_1 is a Meissner-type 14-1022 broadcast antenna transformer. The mixer-oscillator stage is a conventional arrangement. Output voltage through diode V_3 when the oscillator swings at the calibrated radio frequency of approximately 1,650 kc with the flag in proper proximity to the scale pointer is approximately 100 volts, while it is only 0 to 10 volts when off resonance. The voltage gradient between these two conditions is due to the sharply tuned i-f transformer.

The rectified output is fed into a 2D21 thyratron V_4, the triggering point of which is adjusted by biasing potentiometer R_1. Automatic-timed interlocks in the process-control circuit reset the thyratron plate circuit, dropping out the plate relay, by interrupting it at point A. A 10,000-ohm, plate-circuit, plug-in relay is used.

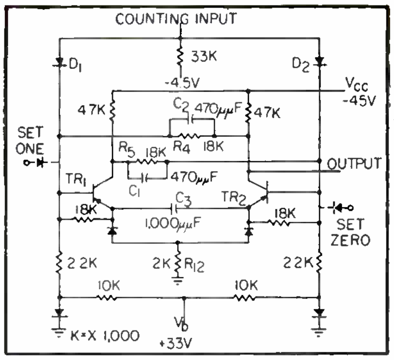


FIG. 1—Schematic diagram of the stabilized binary counter. The two transistors are point-contact type

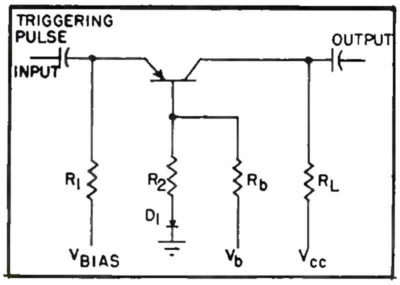


FIG. 2—Stabilized single transistor for triggering pulse input

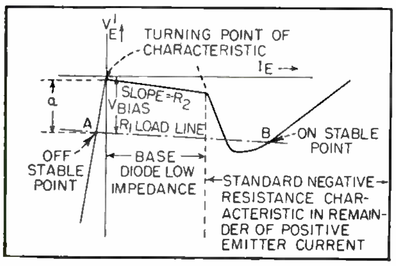


FIG. 3—Characteristic and load line for circuit of Fig. 2

Binary Counter

By ROBERT L. TRENT

Member of Technical Staff
Bell Telephone Laboratories
Murray Hill, N. J.

TWO TRANSISTORS are employed in the general-purpose binary counter with two stable d-c equilibrium points described herein. The counter may be triggered from one stable point to the other by the application of pulses of the same polarity to a common input terminal.

Figure 1 is a schematic diagram of the counter. Two balanced transistor stages with back couplings between collectors and bases, consisting of C_2 and R_4, C_1 and R_5, are used. Direct d-c coupling is obtained by load resistor R_{12} and direct a-c coupling between emitters by C_3.

Regenerative paths for a-c signals are provided by the couplings as well as d-c paths to achieve stability once the transient effects have subsided. A diode steering circuit consisting of D_1 and D_2 impresses triggering pulses upon the transistor bases. The steering circuit is given direction by the difference of potential existing between the bases when one unit is in the ON condition and the other in the OFF condition.

The common emitter resistance R_{12} eliminates the necessity for a separate biasing supply for the emitters because it always passes the emitter current of the ON stage to provide the biasing potential for the OFF stage. The circuit also utilizes base stabilization and a feature insuring low triggering requirements.

Stabilization Feature

Triggering sensitivity and stable operating points of transistor trigger circuits may be affected markedly by variations among transistors and by variations in the operation of a single transistor at different temperatures. Transistors, at present, vary widely from one another in the amount of base current I_{co} which flows when the emitters are biased negatively in the nonconducting region.

The variable base current, when flowing through the large base resistance added in the base circuit to obtain the desired negative resistance characteristic, causes variations in the turning point of the characteristic. By adding a biased diode in the base lead, a low shunting impedance is provided in the negative emitter current range. This feature is illustrated in Fig. 2. The low impedance keeps variations in I_{co} from unit to unit from causing a wide range of voltages to be developed across the base resistances. The remainder of the standard negative resistance characteristic is obtained over a range of positive emitter current because of the high impedance condition.

To insure at least a minimum value of negative resistance as soon as positive emitter current is obtained after triggering, a small resistor has been added in series with the shunting diode. This resistor also gives a sharply defined turning point in the characteristic, resulting in ease of triggering and less loading of the triggering source. Higher frequency response is obtained because the transition time is decreased.

Effects of variations in I_{co} on the turning point may be kept within practicable limits by proper proportioning of the added resistance. The characteristic resulting is shown in Fig. 3. The stabilization feature has been applied to both transistors in the circuit under discussion.

Triggering Sensitivity

A binary counter stage should be stable enough so that when set to one condition, it maintains that

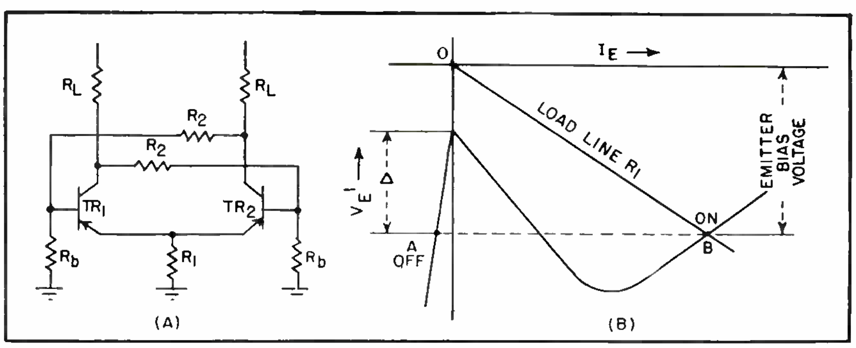


FIG. 4—Trigger circuit with lockup feature (A) and emitter characteristic (B)

Uses Two Transistors

Various timing and registry functions are provided by transistorized counter with repetition rate from 0 to 50 kc. It has stability without the usual sacrifice in sensitivity and it permits either positive or negative triggering pulses to be used

condition indefinitely until the next incident pulse is impressed upon the input lead. Unfortunately, satisfaction of this requirement often leads to poor triggering sensitivity. The counter under discussion uses circuits enabling both stability and sensitivity to be secured.

The simplified circuit of Fig. 4A shows the required lockup feature as performed by the common emitter coupling resistance R_1 and the cross-coupling resistors R_2. Figure 4B is the characteristic for such a circuit, assuming that both transistors have identical characteristics and that each transistor acts separately as a two-terminal device. The ON unit is assumed to be stable at point *B* where the characteristic curve and the load line R_1 intersect. The OFF unit must be stable at the same emitter potential as in the previous case because of the coupling action of R_1. The positive triggering pulse must have an amplitude greater than Δ.

When R_3 and the diodes are added, Fig. 5A, the effect on the characteristic and load line is shown in Fig. 5B. The ON unit has the same operating point *B* as before but the OFF unit no longer operates at point *A*. The diode in series with the OFF unit emitter is biased in the reverse direction to give a new load line E-E_1 for the OFF unit.

The new load line intersects the normal characteristic at point *C*. The triggering pulse amplitude decreases from a value greater than Δ, as in the previous case, to greater than δ. A further decrease in the required positive triggering amplitude is obtained by use of shunt resistor R_3 to give intersection at point *D*. Triggering occurs in this case when the pulse is greater than γ. The sensitivity has been increased without sacrificing stability of the circuit.

Triggering Mechanism

The counter circuit, Fig. 1, may be triggered with either positive or negative pulses if the proper steering diode polarity is observed. With the circuit as shown, the diodes are connected for positive-pulse triggering. Steering is accomplished by the difference of potential between ON and OFF unit base connections. The ON unit base is always 5 to 10 volts more negative than the OFF unit base with the result that a positive pulse at the input will be impressed upon the ON unit base. This pulse also appears on the emitter of the ON unit because of the low impedance from base to emitter in the ON condition.

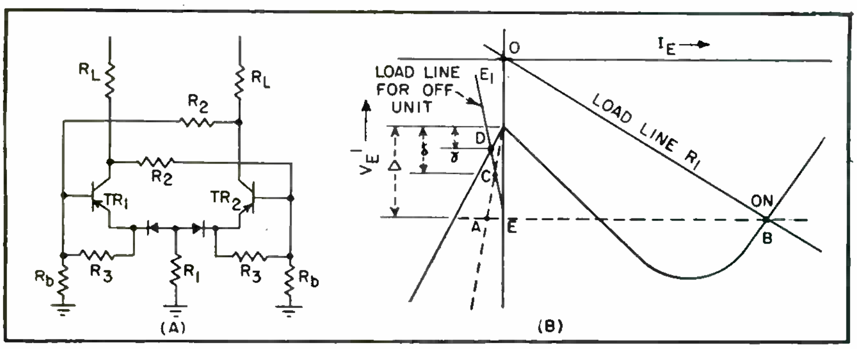


FIG. 5—Modified trigger circuit (A) and emitter characteristic (B)

Coupling capacitor C_3 passes the pulse to the OFF unit emitter which is at a high impedance. The OFF unit is then triggered because it is stable at a point close to the turning point in the characteristic. A sharp pulse, 20 volts in amplitude with a rise time of 0.2 to 0.3 μsec, appears at the collector of TR_1 because of the triggering action. This pulse is passed back to the base of the ON unit by means of capacitor C_1. The characteristic of the ON unit shifts abruptly in a positive direction.

If the characteristic shifts enough so that the emitter load line no longer intersects the characteristic, the only remaining stable point is in the OFF stable region. Following the time constant of C_2 and its discharging resistor, the collector voltage becomes more negative. This time constant sets the upper limit on the repetition rate of the counter.

Capacitor C_3 performs another function in keeping the potential difference existing between the emitters, during the triggering interval. This insures that the steering diodes will remain polarized correctly until the end of the transition period.

Triggering with negative pulses is accomplished by reversing the steering diodes. A negative pulse at the input is then impressed upon the base of the OFF unit.

Triggering pulse requirements for the counter are that the polarity may be either negative or positive, amplitude from 3 to 6 volts and duration greater than 0.6 μsec. Repetition rate is from 0 to 50 kc. Output pulse amplitude is from 16 to 25 volts with a rise time of 0.2 to 0.4 μsec and a fall time of from 2 to 4 μsec. Power input is about 0.5 watt.

TRANSMITTERS for

Design techniques have progressed since the 1948 JTAC report but the necessary megawatts then anticipated have yet to be realized. Transmitter powers to be commercially available in Fall and Winter will not exceed ten kilowatts but substantially higher power may be feasible in 1953

NOW THAT the FCC has officially unscrambled the television broadcasting situation in this country there remains the problem of engineering equipment for useful operation in the channels between 470 and 890 mc. The problem of delivering the required power levels is proving difficult.

When the uhf-tv band was first considered, the FCC asked the Joint Technical Advisory Committee (JTAC) to study the propagation characteristics of the proposed allocations. The resulting JTAC report showed that field strengths as much as ten times those normally required on the vhf channels would be necessary at uhf.[1]

The FCC established a field strength of 500 microvolts per meter as adequate for residential-rural service on the 54 to 216-mc channels. The JTAC report estimated that 5,000 microvolts per meter would probably be required for same grade of service on the uhf channels.

The Norton propagation formula indicates that a signal of 5,000 microvolts per meter from an antenna height of 500 feet can be maintained at 40 miles only if an effective power of 214 kilowatts is radiated. An experimental transmitter on the Empire State Building, operating on 510 and 910 mc showed that an effective radiated power of as much as 5 to 20 megawatts might be required in actual practice for such coverage.

Existing Equipment

At the time the new channels were proposed in 1948, the RMA Television Transmitter Committee reported that the maximum power available from existing tubes over a 6-mc channel was 2,000 watts at 475 mc and 500 watts at 890 mc. Antenna power gains of ten were then considered tops.

To evaluate the practical service possibilities of the uhf frequencies, NBC has operated station KC2XAK at Bridgeport, Conn. since December, 1949.[2] The transmitter comprises a 500-watt commercial vhf unit, providing picture and sound output on 176.75 and 178.25 mc, plus a tripler and power amplifier for each service. Final picture output frequency is 530.25 mc at a power output of one kw on sync signal peaks.

Both tripler and output amplifiers employ cavities with eight 4X150 tubes in each cavity. A slot antenna is employed at this station. A horizontal circular pattern is obtained with 22 sets of four slots alternately arranged at 45-deg intervals about the supporting pole. The measured pattern of such an antenna 40 feet long shows a power gain of 17.

Tubes in parallel as the final amplifier have been operated on 609.25 and 709.25 mc by DuMont. Six 2C39A lighthouse tubes were mounted in a so-called beer-barrel cavity.[3] This is formed of two coaxial-line cavities with the tubes mounted in the center of half-wave foreshortened lines and connected as a grounded-grid amplifier. One cavity becomes the cathode-grid circuit and the other is the plate-grid circuit. Fed to an antenna having a gain of 20, an output of 8 kw erp can be expected.

Another experimental DuMont setup used eighteen tubes in a similar beer-barrel cavity arrangement. About 750 watts of c-w power was available with good modulation characteristics at 600 mc.

To avoid parallel operation of several small tubes, General Electric has used a high-power klystron in a five-kw transmitter.[4] The tube operates single-ended as a linear amplifier and can provide a power gain of 50. Using a helical antenna having a power gain of 20, an effective radiated power of 100 kw can be obtained.[5] Recently, G-E filed specifications with the FCC for a 60-kw uhf transmitter designed around a higher-power klystron. This would produce about 1,000 kw of effective radiated power, the maximum presently authorized for uhf by FCC.

Commercial Equipment

For channels 14 to 83, RCA offers commercially the TTU-1B transmitter which provides 1-kw peak picture power and 500 watts of

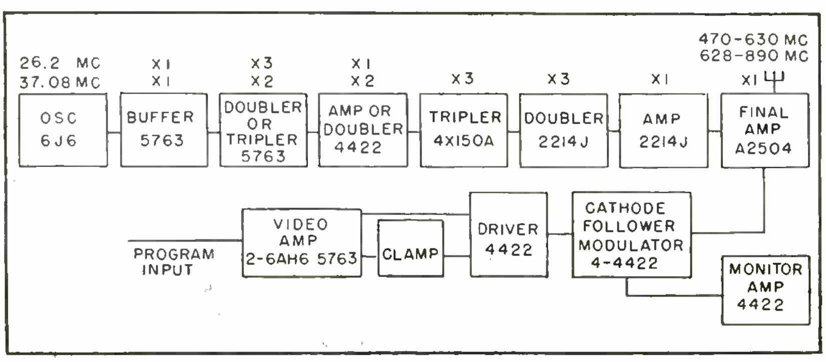


FIG. 1—Tube line-up of RCA one-kw picture transmitter

aural power out of the sideband filter and diplexer. A block diagram of the video transmitter is shown in Fig. 1.

Overtone crystals having output frequencies in the order of 26 to 37 megacycles are used. This permits a low multiplying factor between 18 and 24 (18 from 470 to 630 mc). At station KC2XAK, the crystal frequency of the video transmitter was 4,909.7 kc, and a multiplying factor of 108 provided 530-mc output. On a similar basis, a 6-mc crystal and a multiplying factor of 144 would be required to reach a final operating frequency in the order of 850 mc.

Proper operation of intercarrier receivers requires that the beat frequency between picture and sound carriers be 4.5 mc. The RTMA recommends that the maximum difference between the carriers not exceed 5,000 cycles. At vhf frequencies, this can be achieved by using crystals with a tolerance of 0.0005 percent for the picture carrier and 0.001 percent for the sound carrier. At uhf, a tolerance of 0.0001 percent for the visual carrier and 0.0004 percent for the aural carrier maintain the difference between the two carriers to an acceptable value.

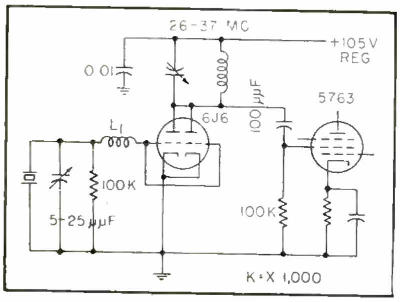


FIG. 2—Oscillator circuit for third-overtone crystal

The difference has been maintained in some designs by using the beat between the carriers to control an afc system in the transmitter but this requires common circuits between picture and sound transmitter. The use of overtone crystals in the transmitter described permits the two transmitters to operate independently.

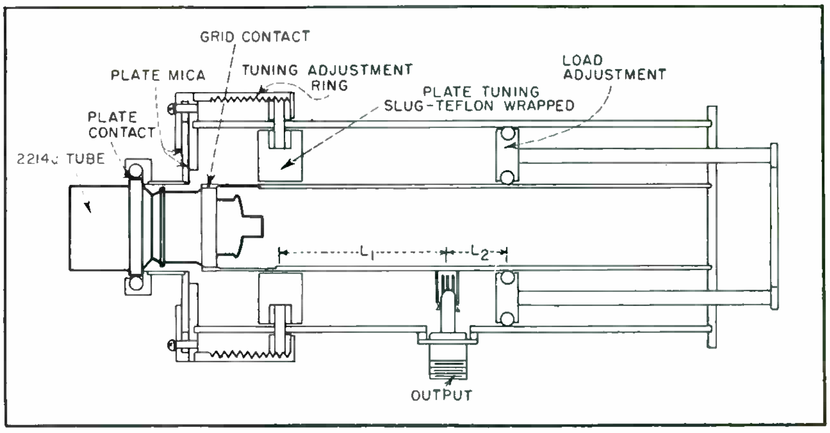


FIG. 3—Quarter-wave plate cavity for 2214J tube

A schematic of the oscillator circuit is shown in Fig. 2. The crystal-holder capacitance and the tube input capacitance combine with coil L_1 to provide a high impedance in the grid circuit necessary to permit the crystal to operate on its third overtone.

Stage Lineup

Following the crystal there is a buffer stage using a 5763 tube. A second 5763 operates as a doubler for transmitter output frequencies between 630 and 890 mc or as a tripler for frequencies between 470 and 630 mc.

A 4422 tube acts as an amplifier for the lower group of channels or as a doubler for the upper group of channels.

The next stage is a 4X150A which operates as a frequency tripler and provides an output of 50 watts in the region of 235 to 445 megacycles. Up to this point, conventional circuitry and lumped-constant plate circuits are employed. The following stages contain coaxial cavities. The remainder of the r-f unit includes two 2214J tubes and the A2504 final output stage.

The first 2214J operates as a frequency doubler and produces an output of about 80 watts. The second 2214J is a straight-through amplifier and develops 180 watts. The 4X150A and the two 2214J cavities are supplied with a plate voltage of approximately 1,100 volts.

A coaxial cavity circuit for the 2214J tubes with a quarter-wave-length plate circuit is shown in Fig. 3 in cross-section. The cavity sketch is simplified to show only the plate circuit. The metallic tuning slug is wrapped with Teflon tape. The portion of the tape parallel to the long dimension of the cavity and the slug and cavity cylinders, both inner and outer, form the output coupling capacitor. The r-f currents flowing between plate and grid must flow through these two capacitors. In effect, the slug capacitor is in series with the tube output capacitance across an equivalent inductance.

Movement of the slug changes the resonant frequency of the plate circuit. Except for a small voltage drop across the Teflon capacitors, the moving slug arrangement can be thought of as a noncontacting short circuit.

The r-f voltage drop across the Teflon capacitors excites the lower portion of the cavity. The distance L_1, between the output connector and the nominal setting of the tuning slug, and L_2, the distance between the load adjustment and the output connector, determines the actual loading across the equivalent plate circuit. Looking into the cavity at the output connector, the distance L_2 determines the amount of inductive reactance placed in parallel with the 50-ohm load. Distance L_1 is chosen so that the impedance at the output connector position appears as resistance shunted across the equivalent output tank at the tuning slug.

The grid circuits of the 2214J cavities are also of coaxial construction. A simplified sketch is illustrated in Fig. 4. The tuning slug which is wrapped with Teflon tape to form a capacitor acts to tune out the reactive component of impedance that the grid of the tube presents. This matches the 50-ohm input line to the grid of the tube and acts as the input tuning control. The knurled grid tuning adjustment moves the Teflon screw which in turn moves the Teflon concentric capacitor.

A cross-section view of the A2504 final amplifier tube appears in Fig. 5. An air-cooled tetrode, it employs a cavity plate circuit like that of the 2214J but larger in diameter.

Video Modulator

Five video stages are used in the modulator portion of the transmitter. The arrangement of stages is shown in Fig. 1. The output stage is a cathode-follower modulator which drives the grid of the A2504 final power amplifier tube directly.

Inverse feedback is used between the first 6AH6 and the second 6AH6 to help reduce distortion, noise and to increase stability.

The 5763, a cathode follower, acts as a phase inverter to drive the first 4422 with a signal of the proper polarity. The 4422 is a conventional video amplifier and its plate circuit contains the only set of peaking coils in the video chain. The clamp circuit operates on the grid of this stage, and the d-c component of the video signal is maintained from this point on.

The output voltage of the cathode-follower modulator is produced across a capacitance of about 225 $\mu\mu$f. To reproduce fine detail in the picture, the voltage across this output capacitance must change in an extremely short period of time. For design purposes, a figure of 0.08 μsec is used. For steep-fronted waveforms, a peak current from the modulator tubes is required that exceeds the current normally required to produce the output voltage across the cathode resistor for relatively slow signal changes. The four 4422 tubes in parallel provide peak plate current of about 800 ma with the grid well in the negative region.

When the grid is driven in the negative direction, the charge across the stray capacitance may not follow the grid signal and distortion will result. Some minimum current is kept flowing through the modulator tubes to keep the equivalent time constant of the R-C discharge circuit fast enough. White-level current through the tubes is not allowed to drop below a certain level and all signal excursions are above this value.

Sound Transmitter

In the sound transmitter, an f-m exciter takes the place of the crystal oscillator and buffer stages of the picture transmitter.

A crystal oscillator and pulse generator produce a series of narrow pulses which are used to synchronize a saw-tooth generator. The saw-tooth output is clipped at a level corresponding to the instantaneous audio modulation applied. A series of pulses from the modulator that have been shifted in phase or timing according to the instantaneous modulation applied are fed to a series of frequency multipliers and restored to sine-wave form. The second crystal oscillator and mixer translates the f-m signal to a new portion of the spectrum without altering the initial deviation. The following amplifiers increase the signal level and act as selective filters.

This unit is a phase modulator and a frequency-selective device is provided at the audio input terminal to make the audio output of the second audio amplifier vary inversely with frequency. This is done to maintain a frequency deviation independent of the modulating frequency.

Other r-f stages of the sound transmitter are similar to the units in the video transmitter.

10 Kilowatts

For higher-power operation, a 10-kw amplifier is planned to be added to the picture transmitter described. This consists of an A2500 tetrode as a linear amplifier using a coaxial plate circuit like that of the 2214J tube. Another A2500 provides sound channel output of five kw.—V.Z.

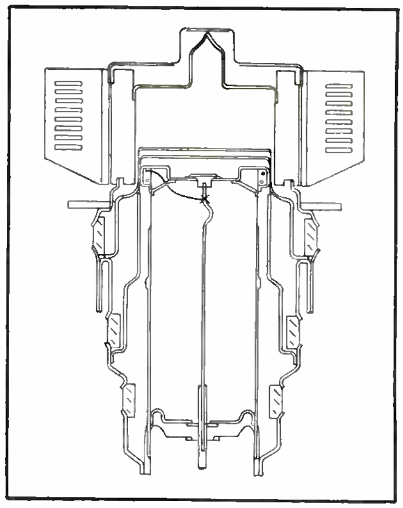


FIG. 5—Cross-section of one-kw final amplifier tube, type A2504, an air-cooled tetrode having ceramic seals

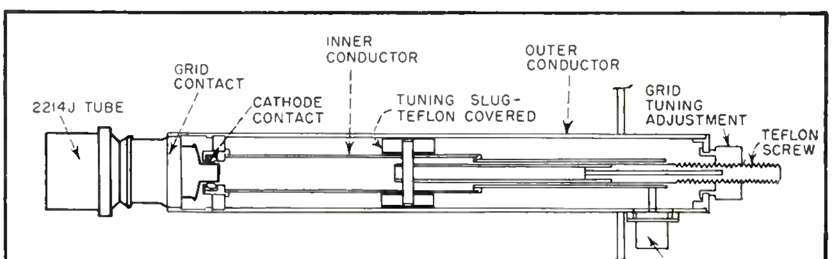


FIG. 4—Simplified drawing of grid cavity for 2214J tube

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Internal Electrostatic Deflection Yokes

Equal horizontal and vertical deflection sensitivities result from simultaneous deflection. Confinement of fringe fields provides greater freedom from scan distortion and defocusing and permits wider angles of deflection

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WHEN COMPARING conventional electrostatic and magnetic deflections in their present forms, it is found that the former is basically sequential and the latter simultaneous in operation. The crossed-pair system of deflector plates delivers first one component of deflection and then the other, whereas the modern magnetic yoke handles both components at once. Undoubtedly, it is desirable to do the same with electric fields.

The resemblance between the physical laws for static electricity and magnetism holds a clue for the construction of an electrostatic yoke. Assuming cylindrical geometry, that analogy demands that we should provide two crossed sets of boundary potentials, each of them with a cosine distribution around either axis of deflection. On the basis of these considerations, the present form of deflection electrode was developed. Since this is a separate unit, structurally and functionally, within the tube, the designation Deflectron was coined for it.

Early Efforts

There have been earlier attempts to solve the problem of simultaneous electrostatic deflection in two dimensions. For instance R. R. Law suggested resistive material to obtain the correct boundary potentials;[1] H. Salinger used, for the same purpose, a 12-wire cage connected to a mixing network outside of the tube;[2] and F. Gray applied V. Ardenne's principle of distributed shielding,[3] to perform various electronic functions, including deflection.[4]

However, none of these earlier efforts seems to have resulted in a practical device suitable for use in modern cathode-ray tubes. To be useful, such a unit should have no more than four terminals, high sensitivity, low admittance, a rigid, lightweight structure and it should be easy to produce and to reproduce. The Deflectron meets all of these requirements.

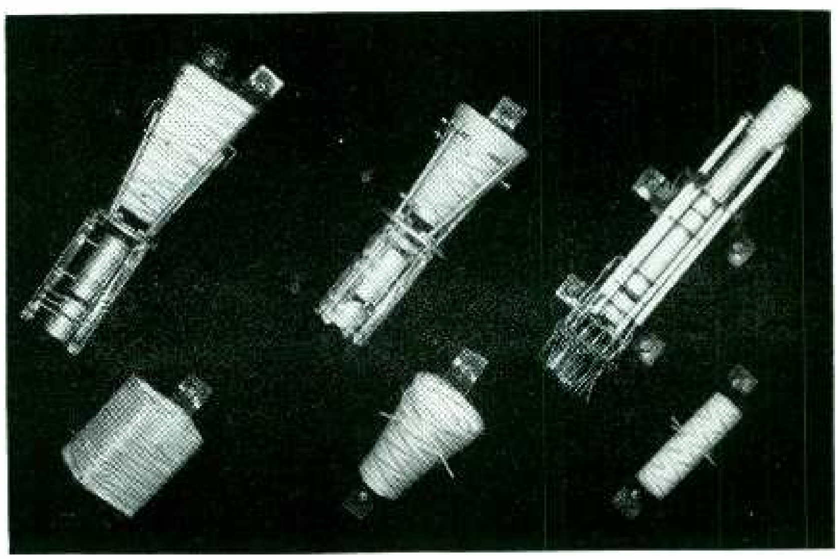
Figure 1 explains the principle of composite electrodes, which are the basic elements of the Deflectron. In Fig. 1A metallic areas of different width are connected, alternately, to separate voltages V_1 and V_2. An electron flying in the Z direction across the strips at an altitude d, will see a resultant potential V as described by

$$V = \left[V_1 \frac{l_1}{\lambda} + V_2 \frac{l_2}{\lambda} \right]$$

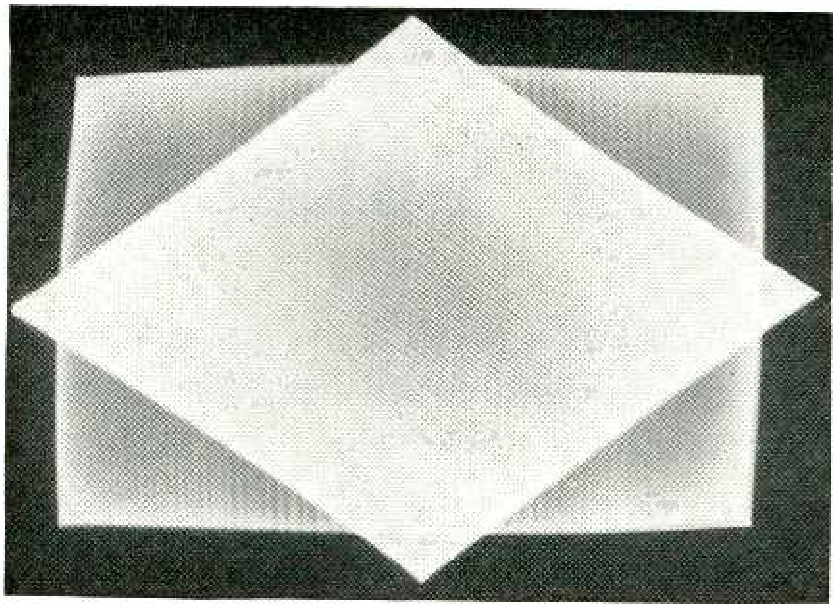
$$+ 0\ 64\ (V_1 - V_2) \sin \left(\frac{\pi l_1}{\lambda} \right)$$

$$\epsilon^{-2\pi} \frac{d}{\lambda} \cos \left(2\pi \frac{z}{\lambda} \right)$$

This effective potential consists essentially of a constant term and an



Typical electrostatic deflection units for tv (left) circular (center) and 30-degree pencil (right) yokes



Sweep patterns from rectangular unit with and without matrix network. Matrix provides almost double scanning area

alternating term. The constant term indicates an average potential which is the sum of the two bias voltages, each weighed by the effective length of the strip, to which they are applied. This term does not change with distance.

The alternating term on the other hand is proportional to the bias-difference between strips, and it is found to decrease rapidly with distance from the electrode. Figures 1B and 1C show the potential-functions at the surface and approximately $\frac{1}{3}$ wavelength away, respectively. An observer who is more than one-half a wavelength away will therefore see less than 4 percent of the alternating component, but all of the average potential.

$$V_{av} = V_1\, l_1/\lambda + V_2\, l_2/\lambda$$

Since the relative strip width may be varied, across the surface by design, we are in a position to realize many desirable potential distributions including the case of a constant gradient parallel to the surface of the electrode. This is illustrated in Fig. 2.

Rectangular Deflectron

Figure 2A shows the conventional sequential type of electrostatic deflection using two crossed pairs of plates as contrasted to an equivalent Deflectron which performs biaxial deflection, simultaneously. The deflection box is only half as long as the crossed-plate structure. The sides of the box are formed by composite electrodes with triangular boundaries. Each coating is continuous along an edge so that there are four terminals.

Center of deflection R is the same for all rays. In the conventional structure, there are two separate deflection centers R_V and R_H and two different sensitivities for the two axes. In the crossed-plate arrangement, the fringe field between pairs has to be traversed by the beam thus giving rise to defocusing and keystone distortion. In the box system, these fringe fields are confined to the vicinity of the composite surfaces. The beam passes through the central region where the field is uniform. This provides greater freedom from scan distortion and defocusing so that wider angles of deflection become practical.

Television test pattern scanned with circular electrostatic deflection unit

Figure 3A shows what happens if the corner terminals are directly connected to two balanced sweep generators V and H. If the box is cut for an aspect ratio of 4×3, the figure of scanning becomes a rhombus, standing on one point and including an angle of 74 degrees.

Figure 3B shows how to obtain a rectangular television scan parallel to the sides of the box. A matrix R-C network is inserted between the generators and the tube. Two arms of this matrix are reactances and the other two are resistances. If designed for a cross-over frequency of 1,000 cps, the network will behave at the line and field frequency as if R or C, respectively, did not exist. As shown in the crt face by the use of the matrix the scanning area is almost doubled.

Deflection Sensitivity

A box in matrix connection is the equivalent of a matched pair, that is, a set of parallel plates cut for the same exit angle. The ultimate deflection sensitivity of such plates depends only on their aperture and the beam voltage as indicated by

$$e_d = 4E_A \tan^2 (\tfrac{1}{2}\, \alpha)$$

where E_A is the beam voltage at the point of deflection, e_d the peak-to-peak voltage between plates and α the total deflection angle.

This expression shows that at 52 degrees, deflection requires as much voltage as acceleration and, at 72 degrees, twice as much.

Fortunately, only one-half of this total has to be supplied to each plate, if push-pull operation is used. This high voltage demand, rather than functional deficiencies, seems to draw a line beyond which the use of electrostatic deflection becomes increasingly difficult. The practical limit appears to be reached at 50 degrees total deflection angle.

Figure 4 gives a general idea of the sweep circuit techniques for television. The system, when sealed into a bulb type 16LP4 run at 15,000 volts, requires 4,500 volts for vertical and 7,900 for horizontal deflection, if no use is made of post acceleration. The vertical sweep voltage may be readily derived from two small triodes type 6SF5, running in push-pull off a plate supply of 2,700 volts and drawing 600 microamperes apiece.

The line sweep comes from a pulse amplifier with reactive load. It uses a power pentode type 6AU5 and a step-up transformer, whose secondary is tuned to approximately one-sixth of the line frequency (2,500 cps.). An early model of this sweep unit consumed 10 watts which is only a fraction of the power input used for conventional magnetic sweep circuits.

The need for a matrix network with its attending frequency restrictions is obviated by the use of Deflectrons with rotational symmetry. The circular unit may be used with or without matrix, in a great variety of applications including tv picture tubes, radar indicators and oscilloscopes. The cylindrical form has the advantage of providing greater spacing between beam and electrode surface for most of the scan, thus minimizing deleterious wall effects. This advantage is largely maintained but the sensitivity is increased, if the cylinder is tapered off to a cone.

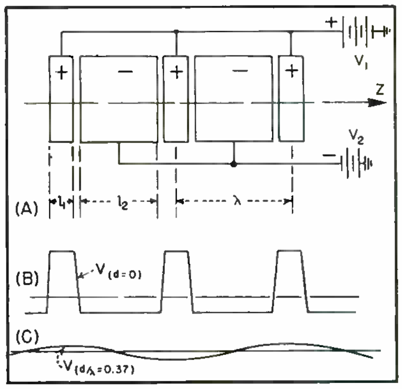


FIG. 1—Typical composite electrode configuration (A) and theoretical potential functions at (B) and at a distance d (C) from electrode surface

Circular Analysis

Figure 5 illustrates the basic conditions under which a uniform field with an inclination of φ degrees is properly reproduced in a

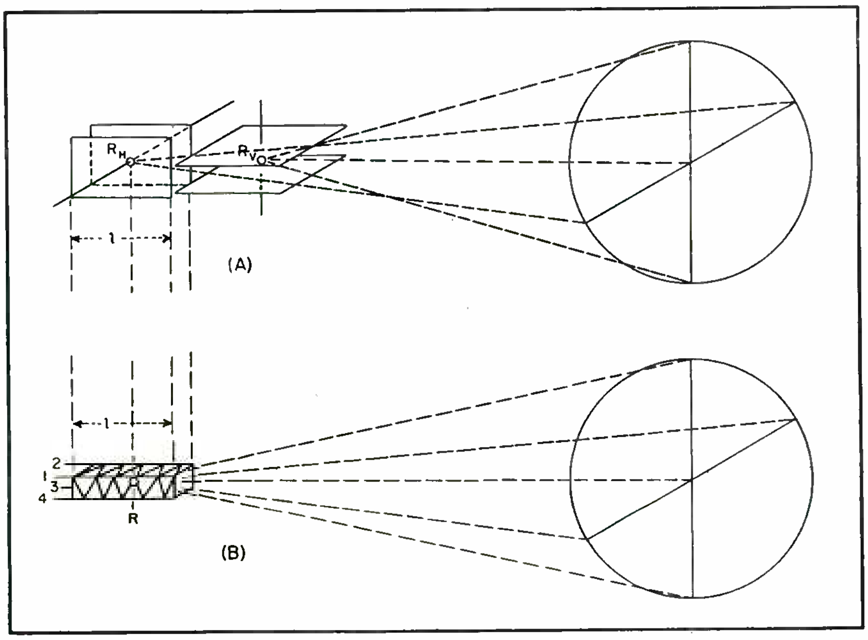


FIG. 2—Biaxial electrostatic deflection system (B) has advantage over concentional sequential type (A) of equal deflection sensitivities and common center of deflection

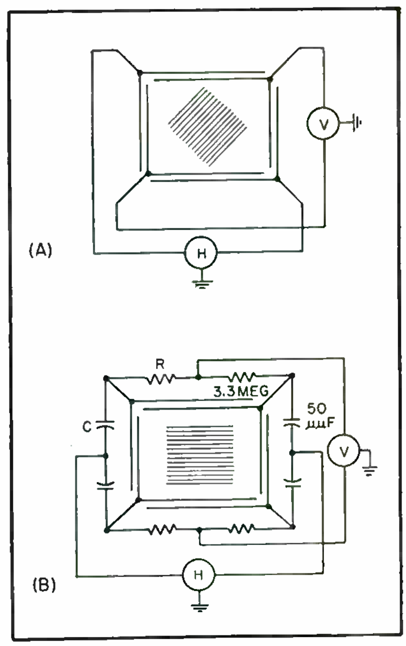


FIG. 3—Matrix connection (B) corrects for rhombic geometry

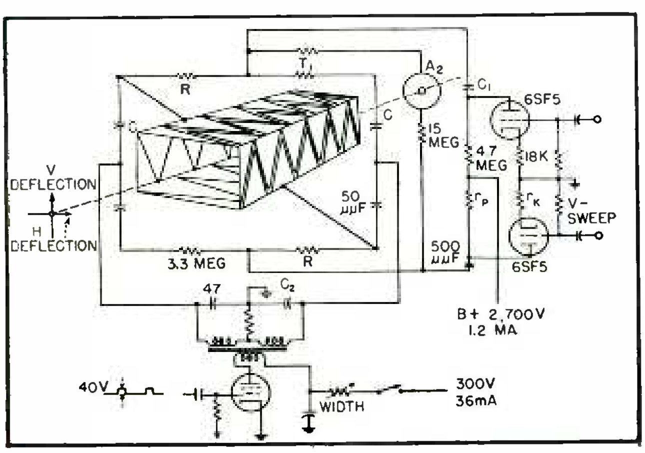


FIG. 4—Rectangular deflection box with matrix and sweep circuits

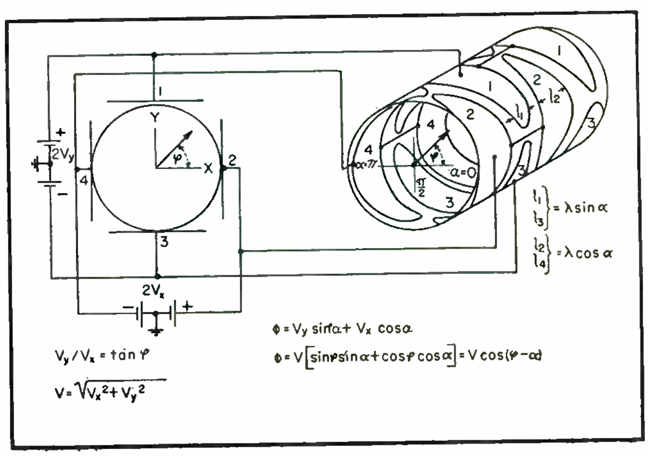


FIG. 5—Circular deflection unit offers production advantages

circular deflectron. Suppose two voltages V_x and V_y are applied to the plates of a conventional oscilloscope in ratio of

$$V_y/V_x = \tan\varphi$$

To reproduce that angle correctly, with the same voltages, a circular deflectron has to be printed in such a way that the active length of the pattern is a sine and/or cosine function of the angle. In Fig. 5 this is accomplished by metallic areas which are bounded by half waves of sine and cosine, respectively. The boundary potential then is the sum of the applied voltages weighed by their respective lengths

$$\Phi = V_y \sin\alpha + V_x \cos\alpha$$

From the voltage ratio equation we find this to be the equivalent of a new cosine distribution.

$$\Phi = V \cos(\varphi - \alpha)$$

where $V^2 = V_x^2 + V_y^2$. The potential described by this equation generates, within the cylinder, a uniform field of the desired inclination. This reveals, moreover, that it is mandatory to keep the deflection voltages balanced at all times, including any d-c shift and positioning voltages. In this respect, the Deflectron is more touchy than its counterpart, the plate deflector, which may be operated from single-ended sources without too much trouble, at least at small angles.

There is apparently more than one way to meet the required cosine distribution of potential in circular configurations. Figure 6 shows three geometries which are equivalent at least to a first approximation. Figure 6A shows the sinusoidal area distribution just mentioned. This pattern has the disadvantage of requiring conducting bridges which spoil the potential distribution and introduce points of high voltage gradient involving insulation difficulties.

The pattern of Fig. 6B shows the offset sine, which has inherent continuity thus avoiding one of the above defects. Figure 6C, or the arrow pattern, offers both continuity as well as good voltage stability. It consists of four groups

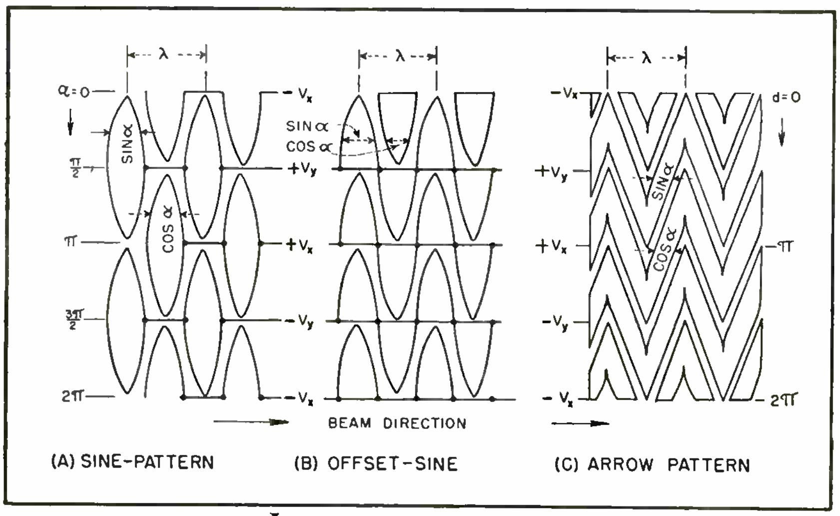
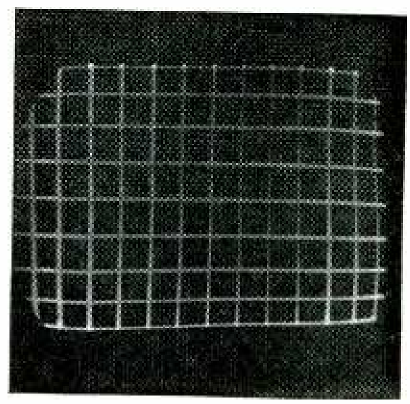


FIG. 6—Pattern geometries for circular Deflectrons



Bar pattern obtained with conical deflection unit

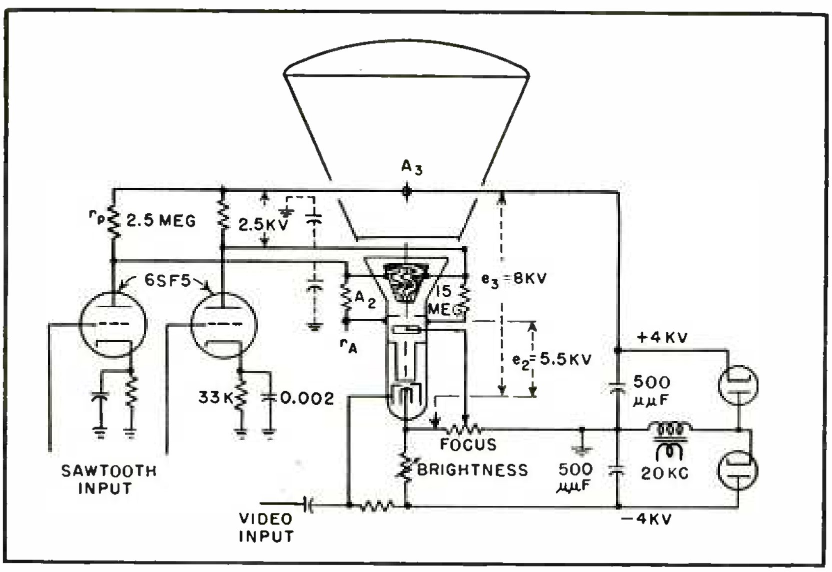


FIG. 7—Circuit illustrates extreme simplicity of conical deflection unit for ppi radar displays. Two 6SF5's generate 7,200-volt deflection signals

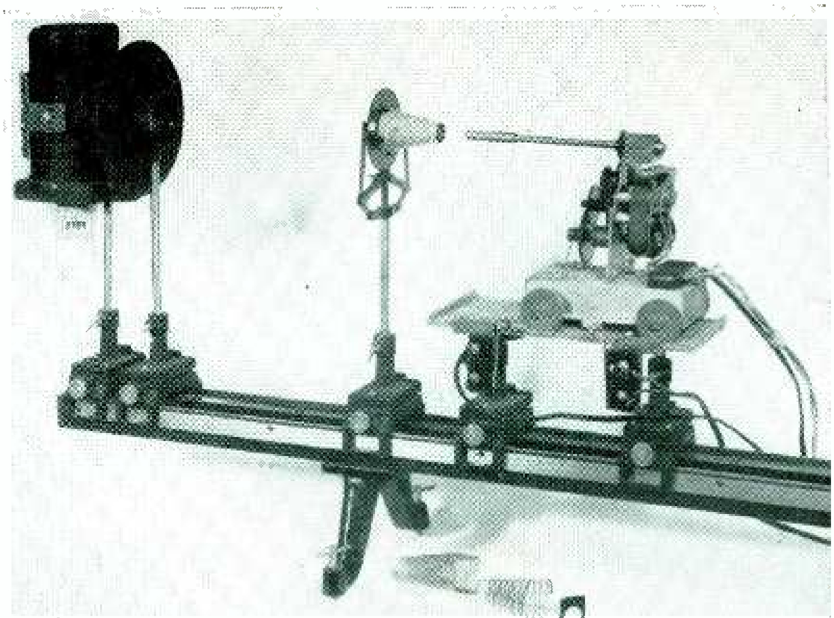
of metallic ribbons, whose width in axial direction varies as a sine-function of the angle. Each ribbon covers one-half of the perimeter.

The center of the photograph of various configurations shows a conical Deflectron of the offset-sine variety. Below it is a conical electrode with arrow pattern. These cones are cut for a 60-degree opening and have a 2 to 1 taper, which results in a sensitivity increase of 30 percent. The positive lens effect caused by the taper is negligible.

The gun used in all these Deflectron tubes is short and straight since no ion trap is required. Focus is done electrostatically at voltages between zero and 300 volts.

The conical unit has been successfully employed for radar applications. Figure 7 shows the extremely simple circuitry required for ppi displays. Two pairs of 6SF5 triodes generate the required 7,200 volts of clipped sawtooth wave in push-pull out of a B-supply of 4 kv. With an input of 45 volts per phase, we obtained 50-degree deflection of an 8,000-volt beam using a moderate amount of post-acceleration (1.4 to 1).

The combined power supply for preamplifiers and tube employs a pulse-operated voltage doubler at a repetition rate of 20 kc. Since balanced d-c deflection is provided for, the spot may be shifted permanently toward the perimeter without defocusing. The small Deflectron capacitance (25 $\mu\mu$f per phase) permits fast sweeps with negligible plate power.



Flying-spot illuminator for photoengraving electrostatic deflection yokes

Radar ppi obtained using conical deflection circuit shown in Fig. 7

To illustrate an oscilloscope application, a 30-degree pencil unit was developed and mounted on top of a standard electron gun type 5CP1-A.

The pencil-Deflectron electrode shown at right in the composite of different types is a glass-cylinder two inches long and ½ inch wide with an arrow pattern. Similar pencil units may also be produced inside of a 1-inch cylinder with ¼ inch diameter.

In its present form, the deflection factor of this tube is about twice as high as that of a conventional 5CP1, but both axes have identical characteristics. The mechanical ruggedness, simplicity of mounting and alignment, and the ease of reproduction may outweigh the loss of sensitivity for many applications.

One of the advantages of the Deflectron over the conventional crossed-pair system is the ease by which it may be reproduced with high accuracy. The Deflectron uses a glass base with narrow inside, but with wide outside, tolerances. Such a body may be readily produced by pressing glass around a precision graphite filler in a mold. The accurate reproduction of the metallic pattern is assured by using methods of photo-engraving. With this technique, all units are printed from a single master negative which is, itself, a photographic copy from an enlarged pattern design drawing.

Production Techniques

In production, a film carrying the master pattern is inserted on the inside of the glass envelope and illuminated by a concentrated arc lamp. The small size of this light source[5] insures sharp contours, in spite of the fact that contact between glass and film may be as far off as 20 mils.

To obtain constant and uniform exposure all along the inside of the electrode, it was found necessary to use a flying-spot method of illumination, rather than a stationary lighthouse setup. A small motor rotates a surface-silvered 45-degree mirror around the axis of the electrode, so that the reflected light hits the film glass surface under almost normal incidence. At the same time, the motor carriage rolls slowly back and forth, so that the inside is scanned in a helix. The rest of the procedure follows the established methods of photo engraving. The etched silver base is built up by electro-plating of copper.

When placed inside the evacuated envelope, the units are able to withstand the high sweep voltages without arc-over. On a glass base, the phase to ground capacitance averages 20 $\mu\mu$f, while the surface insulation after processing regularly exceeds 100 megohms, thus permitting the use of high-impedance sweep circuits with low power consumption.

The project has been supported by D. E. Noble, vice-president of Motorola, Inc. and Director of Research, and benefitted from the assistance of Gerald C. Hoffman, V. Graziano and James H. Grigg.

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INDUSTRIAL

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The complete instrument used for measuring and recording diameters of yarn and other filamentary materials

MEASUREMENT OF YARN and similar materials by means of their shadows in a beam of light falling on a phototube is not new. Most of the instruments designed for this purpose in the past, however, have suffered from a number of faults.

Instability of the d-c amplifiers, lack of provision for a suitable method of passing the yarn or material being measured through the measuring gap and poor choice of the basic method by which the yarn is to be measured are a few of the difficulties often encountered.

Instruments on the market today that utilize the shadow method are entirely satisfactory when the material being measured is perfectly round. In the case of textiles, however, there is reason to measure yarns that may tend to band, ribbon or twist and give erroneous readings due to the apparent change in diameter. Actually, the weight or total amount of material being measured has not changed.

In the instrument to be described, known as the Filometer, this difficulty has been overcome by employing a high-intensity beam of light so arranged that light is actually transmitted through the material being measured. The changing amount of light reaching the phototube is a measure of the amount of material present and not of the physical size alone.

Measurements by this method may cause apparent errors for different-colored yarns but corrections can be introduced to take care of this in most types of yarn.

Instrument Description

The instrument is complete in itself. Within one cabinet are included a small creel or holding arrangement for the yarn to be measured, the actual measuring head with its associated mechanical and electronic equipment, the recorder with the necessary drives and a three-speed winder for spooling the measured yarn. This enables the operator to measure yarn without any auxiliary equipment or special setup.

The yarn to be measured is unreeled from the quill, or spool, and fed continuously through the measuring unit on the instrument. After that it is rewound on a package that may be used on standard textile machinery. The recording pens make a record on chart paper driven by a synchronous motor. The chart is exactly in step with the yarn as it is fed through the machine. At any point on the chart, the size of the corresponding point on the yarn being measured can be read.

From the chart one can calculate the percentage variation existing in the yarn and discover any waves or cyclic variations that may appear. A fairly complete analysis of the quality of the yarn can be made relative to its size.

The instrument is arranged with a sloping panel on which are located all of the controls necessary for easy operation and a window through which the chart may be viewed while the recording is being made.

* Work done by the author while in the employ of Deering Milliken Research Trust in Greenwich, Conn.

YARN CLASSIFIER

Instrument for use in textile industry measures and records diameters of filamentary materials such as yarn. Device is more accurate and has better stability than other similar instruments using phototubes

Figure 1 is a mechanical drawing of the functional parts. The yarn is unwound from bobbin *B* at a constant speed by means of the synchronously driven drum winder *W* and repackaged for further use.

While traveling from bobbin to drum, the yarn passes through the gap between the prisms mounted on the measuring head *H*. The head contains a light source I_1, light beams that are directed on the measuring phototube V_1 and the balancing phototube V_2, the latter through the adjustable shutter *K*.

The purpose of the second phototube is to correct to a first order for variations in the light output of I_1. Balance is achieved initially by adjustment of the shutter *K*. It can also compensate to a degree for variations in the phototubes due to aging and other reasons.

Any material lying within the measuring-head light beam causes the bridge, Fig. 2, to be unbalanced. The resulting signal is fed through the sensitivity control to the channel-one amplifier, its recorder and then to the channel-two amplifier and its recorder.

Integrating Circuit

An integrating circuit located between amplifiers one and two is used to level out the fine short-term variations existing in the yarn in order that the long-term variations may be more easily seen. These are recorded in channel two. A balancing meter M_1, Fig. 1, is included with a switch allowing it to be used on either of the two amplifiers.

Particular attention has been given to make the design of each unit stable and sound. The proper location of each item, with respect to the rest of the instrument, is such that operation requires a minimum of effort. There is no interaction between the various elements or circuits.

Calibration is effected by means of a block on which are fastened four wires of suitable sizes so arranged that when the block is placed in the measuring gap, a wire of a certain size is interposed in the beam of light.

Sizes of the wires are chosen so that the shadow they cast will bear a specified relationship to a given yarn size. As the wire casts a solid shadow compared to the integrated reduction in light caused by the

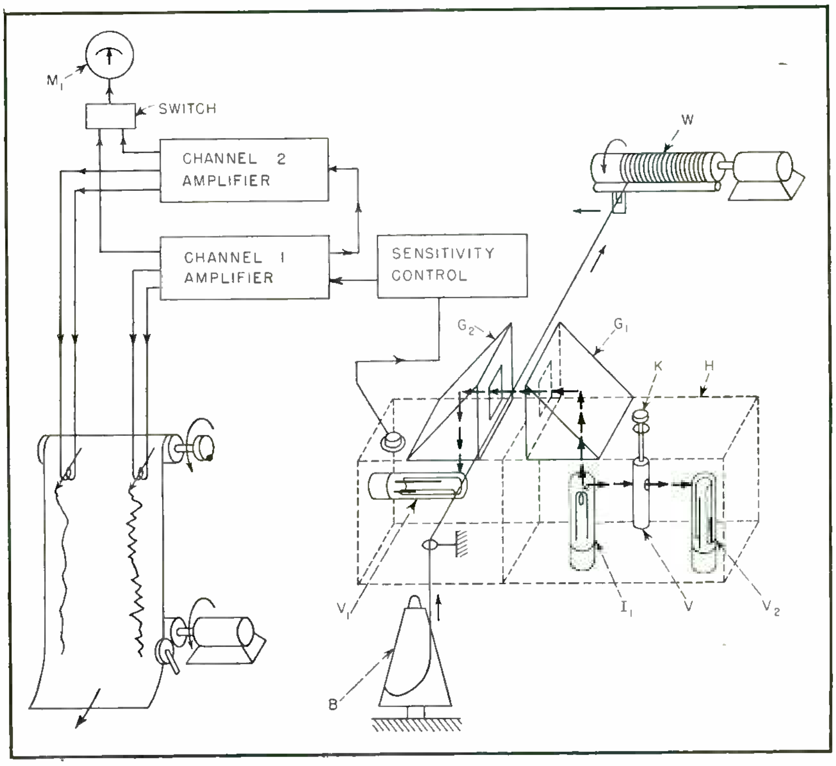


FIG. 1—Principal elements used in the Filometer

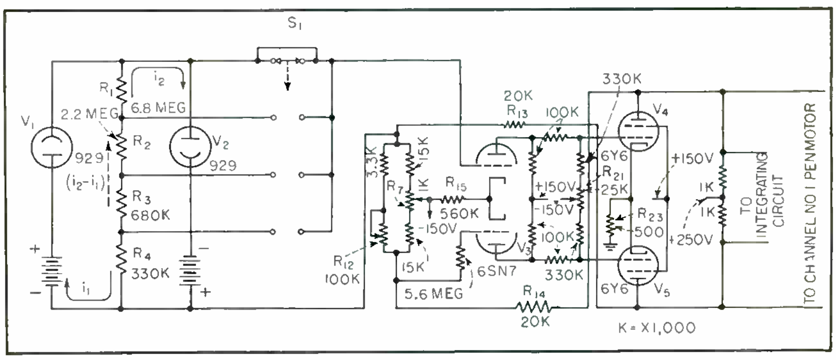


FIG. 2—Simplified schematic of the measuring circuit, coarse-sensitivity control and channel-one amplifier

yarn, a calibration is necessary to establish the relationship between the two.

Calibration is done when the measuring block is fabricated. Different calibration blocks are required for colored yarns. Generally, the percentage variation is the important thing and this does not require absolute calibration. The sensitivity is set so that the recorder pen writes above or below any desired line on the chart. When the chart is finished, the precent variation can be calculated.

If absolute calibration is desired, the yarn is temporarily removed from the measuring slot, the gauge substituted and centering checked. The instrument is then calibrated by means of the gain control R_{12}, Fig. 2. The calibrating block is removed, the yarn replaced and the machine is ready for operation.

Circuitry

Figure 2 is a simplified schematic of the phototube and coarse-sensitivity circuits. Figures 2, 3 and 4 show channels one and two and the integrating circuit interposed between them. It may be seen from Fig. 2 that the coarse-sensitivity control consists of a switch that shorts out progressively R_1, R_2 and R_3. In this manner, the value of load resistance is reduced and, as a result, the maximum voltage appearing across it is also reduced.

When yarn is being measured, the amount of light reaching V_1, Fig. 2, is less than that reaching V_2 because the yarn lies in the light path between the exciter lamp I_1 and the phototube V_1. This in turn reduces the current flowing in V_1 proportional to the amount

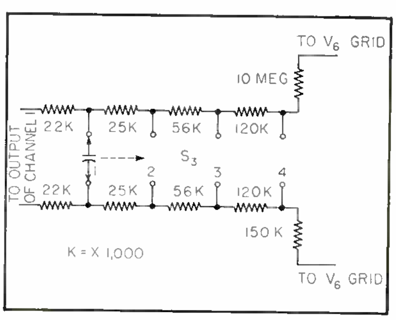


FIG. 3—Simplified schematic of the integrating circuit

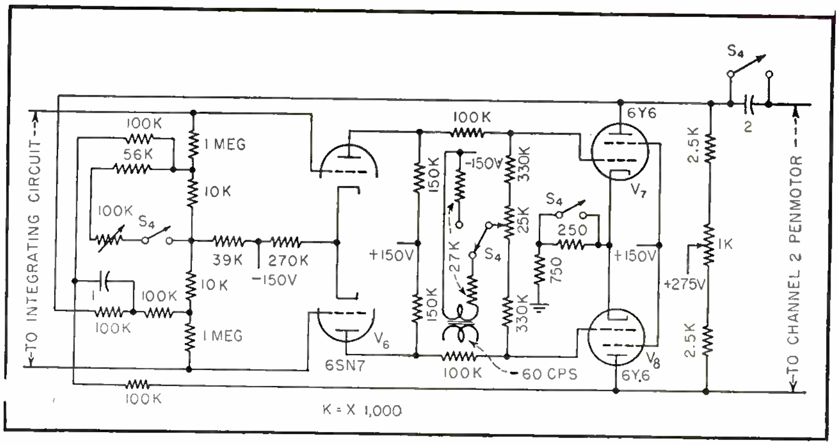


FIG. 4—Schematic of amplifier used in channel two

of yarn present in the beam of light and reduces the current i_1. The difference in i_1 and i_2 now causes a voltage drop across the resistor chain, constituting the signal sent to the channel-one amplifier. This signal is proportional to the yarn size.

A fine-sensitivity control is also provided in the amplifier shown in Fig. 2 and allows adjustment to be made between the positions obtained on the coarse-sensitivity control switch.

Design of the amplifier for channel one, Fig. 2, is standard with a phase inverter and amplifier stage V_3.

Push-pull output tubes V_4 and V_5 drive the pen motor. Negative feedback from the plates of V_4 and V_5 to the grids of V_3 is secured through R_{13} and R_{14}. This feedback in conjunction with the unbypassed cathode resistor R_{23} tends to stabilize the circuit with respect to both gain and drift.

The network of resistors connected to -150 volts reduces the plate voltage from V_3 to a value suitable for the grid circuit of V_4 and V_5.

The cathode of V_3 is also connected to -150 volts through R_{15}. Resistors R_7 and R_{21} provide suitable balancing voltages. With the circuit shown, the impedance of the plate circuit of the output tubes V_4 and V_5 is reduced sufficiently to be used for driving a pen motor.

Output from the channel-one amplifier is also fed into the integrating circuit shown in Fig. 3. This circuit consists merely of suitable series resistors and a capacitor in what is essentially a low-pass filter combination.

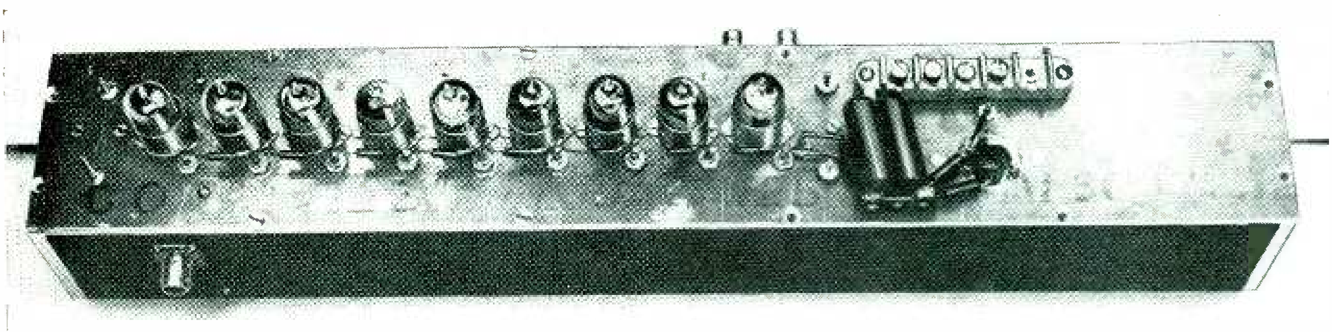
The channel-two amplifier, as shown in Fig. 4, is very similar to the amplifier used in channel one with feedback utilized. A modulating circuit consists of a transformer and its switch, which introduces a 60-cycle modulating voltage in series with the negative supply to the center tap of the grid circuit of the output tubes V_7 and V_8.

Other switches modify the rest of the circuit so that the pen motor will operate about a center line on the chart rather than biased to one side as is the case when the unit is used for measuring size.

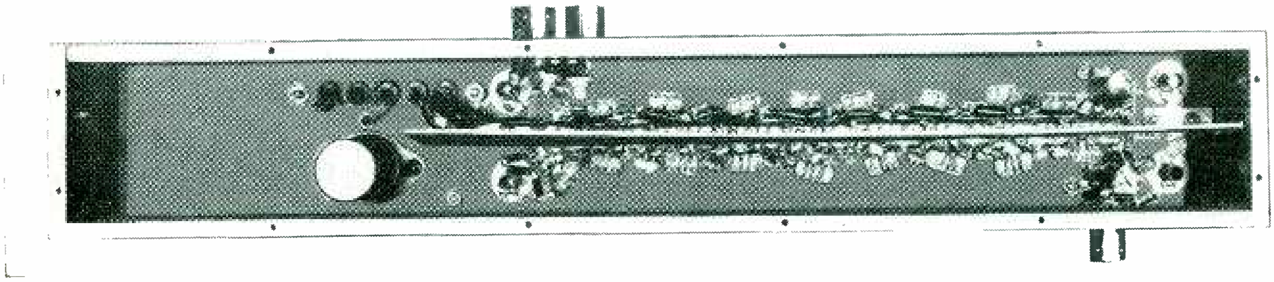
The pattern produced is similar to that of a modulated r-f pattern on an oscilloscope. It may be thought of as a greatly magnified shadow picture of the yarn but compressed in length.

Extensive tests have proved that the measurements made by the machine have sufficient accuracy for practically all textile research and production work.

The writer is indebted to Dr. Norman C. Armitage, president of the Deering Milliken Research Trust, for permission to publish this article, to Walter Frere for his assistance in compiling the necessary data, to Dr. W. C. Anderson and the entire staff of the Research Trust for their contributions, and especially to Dr. D. G. C. Hare, for his suggestions that made these d-c amplifiers practical.



Top view of distributed amplifier shows placement of nine 6AK5's



Bottom view reveals size, shape and position of grid and plate line coils

Distributed Amplifier Covers 10 to 360 MC

Provides 8-db gain, ±2 db, using readily available or easily fabricated parts. Applications include millimicrosecond oscillography, wideband i-f and r-f amplification and any other requiring extremely wideband amplification

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CONSIDERABLE PROGRESS has been made in extending the band width of amplifiers through the use of distributed amplification. Indications that amplification was possible to frequencies approaching 400 mc have been made, and for such applications as millimicrosecond oscillography[1], wideband i-f amplifiers and r-f preamplifiers, a need exists.

A distributed amplifier with a gain of 8 db flat to ± 2db over the 10 to 360-mc band is shown in the photograph. The amplifier employs readily available parts except for the inductors of the grid and plate lines. These are easily constructed. The grid and plate artificial transmission lines are of the constant-k type with m-derived half sections ($m = 0.6$) matching the lines to the terminating resistors. This type of distributed amplifier has been analyzed to some extend[2,3] and based on an extension of this analysis, the present amplifier was designed and built.

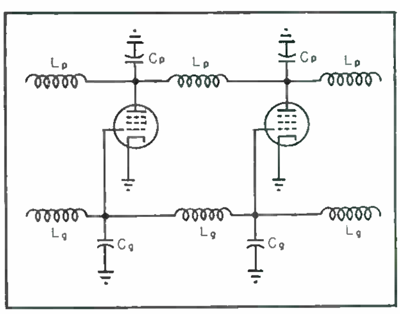


FIG. 1—Two sections of constant-k type circuit used in distributed amplifier

Two sections of the constant-k type of distributed amplifier are shown in Fig. 1. The impedance level of the grid line is 50 ohms and for the plate line it is 93 ohms. The grid-to-cathode and plate-to-cathode capacitances as well as the associated socket capacitances are incorporated in the lumped C's required for the lines. For the low-pass constant-k line employed,

$$C/\text{per section} = \frac{2}{R\omega_c}$$

$$L/\text{per section} = \frac{2R}{\omega_c}$$

where $R = \sqrt{L/C}$ = characteristic resistance of line and w_c = angular cutoff frequency. The 6AK5 was chosen since it has a high figure of merit, is readily obtainable, and is physically small. It was operated with $E_b = E_{sc} = 120$ v, and $E_c = -1.5$ v (fixed bias).

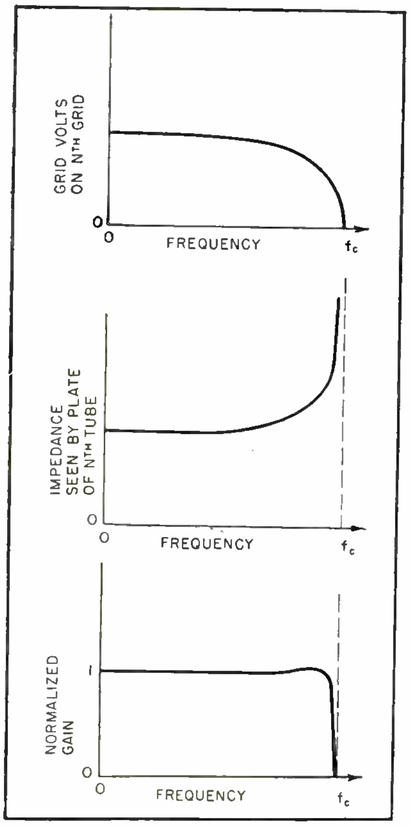


FIG. 2—Curves show grid-line loss compensation at high frequencies

Analysis of the distributed amplifier using constant-k lines in grid and plate circuit has been carried out previously. However, past investigations have been primarily concerned with cascaded distributed amplifiers where grid and plate lines having the same impedance level are desirable. If only a single stage of amplification is necessary (gains of 10 db or less), considerably higher cutoff frequencies are attainable if the plate-line impedance is made larger than the grid-line impedance.

Response

An extension of the analysis made in reference 2 indicates that for maximally flat amplitude response, with a gain of $e = 2.718 = 8.68$ db, the upper cutoff frequency is given as

$$f_c = 0.607\, f_i \sqrt{\frac{g_m}{g_i}\,\frac{R_p}{R_g}}$$

where f_c = upper cutoff frequency, g_m = transconductance of tube, R_p = characteristic resistance of plate line, R_g = characteristic resistance of grid line and g_i = input shunt conductance at a frequency f_i.

Thus, if $R_p = 2R_g$, an increase of over 40 percent in upper cutoff frequency over the case of $R_p = R_g$ is predicted. The maximum R_p is limited by the output capacitance (plus socket capacitance) of the tube used and the chosen upper cutoff frequency through the relationship stated above for constant-k lines, C_p per section $= 2/R_p\omega_c$.

Due to transit-time effects, the input shunt conductance varies proportional to the square of the frequency. Thus, at high frequencies (above 100 mc), the grid line becomes lossy. This is compensated by an increase in the impedance seen at the plate of each tube as the frequency increases as shown in Fig. 2. If the parameters of the circuit are properly chosen, these two effects can be made to cancel yielding a flat response over almost the entire band. This maximally flat response is achieved when $N\, C_c/\omega_c\, C_g = 1$, where N = number of tubes, C_g = grid-to-cathode capacitance, ω_c = angular upper cutoff frequency and g_c = shunt conductance at f_c.

In addition to the shunt conductance variation with frequency, there is also some increase in input capacitance due to transit-time effects. This variation in capacitance with frequency combined with differences in input and output capacitance among a batch of the same tube type introduces mismatch and therefore reflections along the grid and plate lines. These effects are most noticeable at the higher frequencies for the phase shift per section increases sharply as the cutoff frequencies are approached. The gain-frequency curve will then have a rapidly varying form near cutoff. Tube capacitance and lead lengths, as well as any undesired mutual inductance between adjacent inductances, add to this effect.

Impedance Variation

Another serious difficulty arises from the variation of impedance with frequency of the terminating resistors for the lines. Tests on composition resistors indicate that values of resistance below 50 ohms remain more nearly constant with frequency than those above 50 ohms. Consequently, the 93-ohm terminations were made of three resistors in series. Comparison with results using a 93-ohm resistor showed a substantial improvement in flatness of the gain-frequency characteristic.

The m-derived terminating half sections were built with variable capacitors to compensate for reflections and mismatch arising from the aforesaid variables. Trimming of these capacitors had a consider-

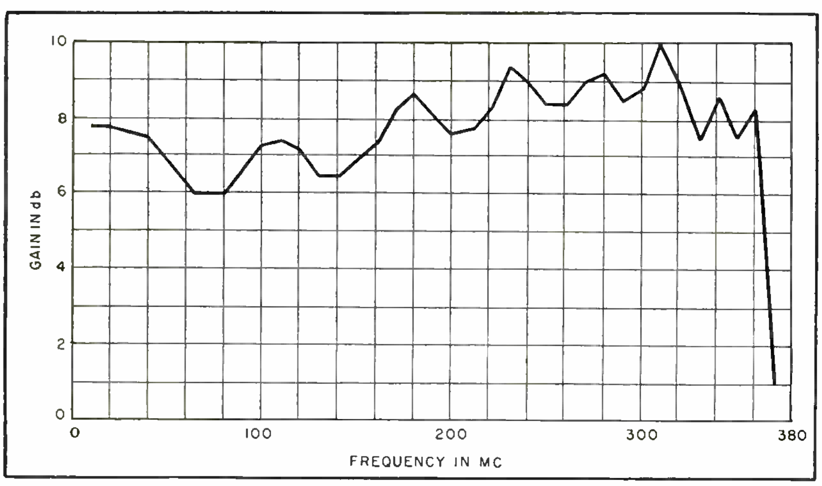
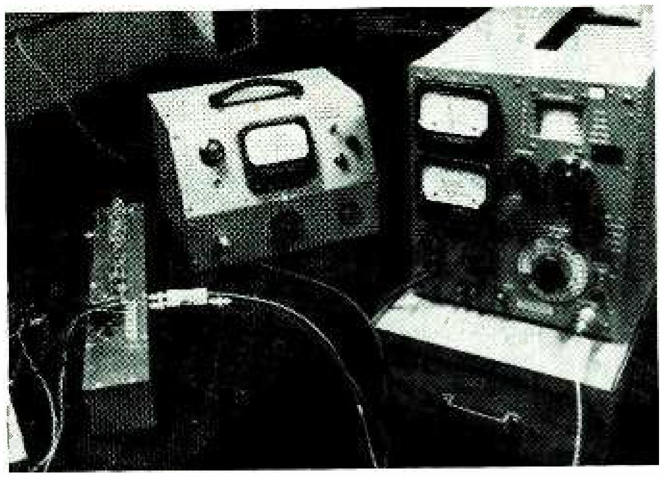


FIG. 3—Gain-frequency curve shows response of amplifier to be flat within ± 2 db from 10 to 360 mc



Gain of distributed amplifier is measured by comparing with accurately-calibrated amplifier-attenuator combination

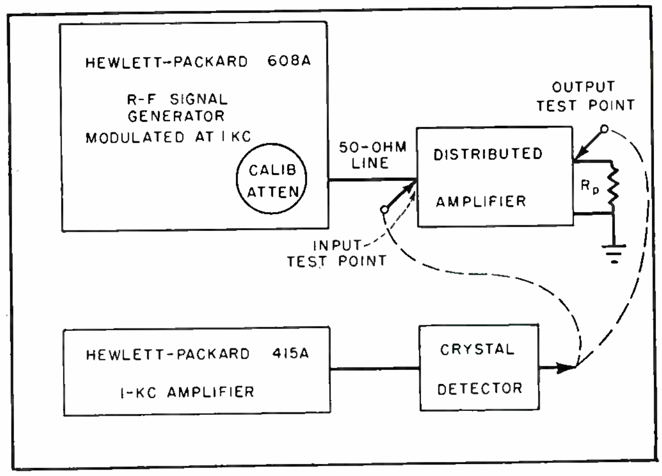


FIG. 4—Measuring system for obtaining gain-frequency curve shown in Fig. 3. Actual setup is pictured at left

able effect on the response curve, especially near cutoff.

In dealing with such a wideband amplifier, oscillation due to undesired feed back is possible despite the nominally low gain. This is particularly true at frequencies just below cutoff where it is possible for the gain to rise sharply due to reflections and increased plate impedance. Any small feedback path through the tubes, through radiation, or through ground currents, can cause oscillation. It was therefore necessary to use ¼-inch 24-ST aluminum sheet for the chassis, place an aluminum shield plate between grid and plate lines, and carefully adjust the inductance of each section to minimize reflections on the lines. The resultant gain-frequency characteristic is shown in Fig. 3.

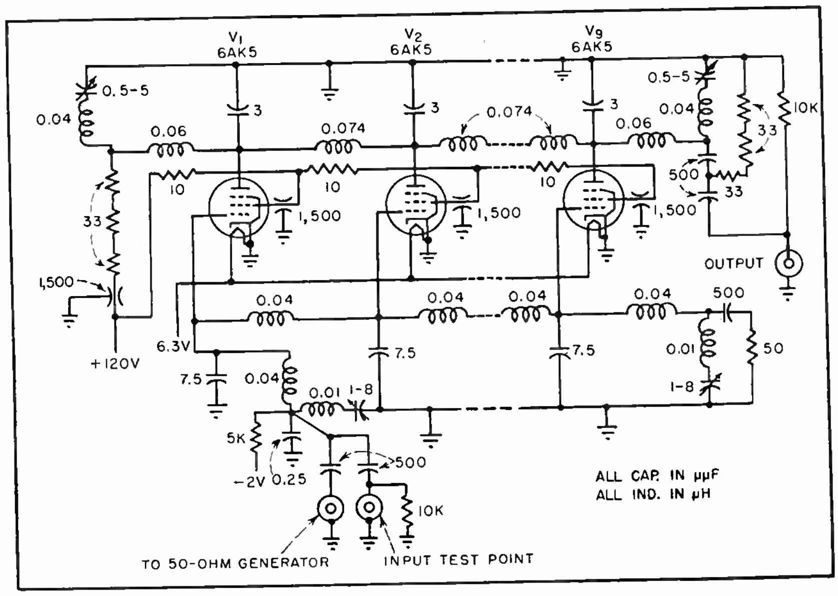


FIG. 5—Partial circuit shows component values for 360-mc distributed amplifier

Test Setup

The system used for the measurement of the gain-frequency curve is shown in Fig. 4. A calibrated r-f signal generator modulated at 1,000 cps feeds the input of the distributed amplifier. The amplifier is terminated in its characteristic plate resistance and the input terminals are also properly terminated as the output impedance of the signal generator matches the grid line impedance. Two fittings permanently mounted on the chassis connect to the input and output points through 0.001-μf ceramic capacitors. A type 1N45 crystal and its associated peak detecting circuit is mounted in a small copper box such that the crystal end can be directly connected to either the input or output test point through a male fitting. The crystal output is determined by using a Hewlett-Packard 415A-1KC amplifier and reading the calibrated input attenuator directly in db after adjusting it for the same amplifier output reading at the input and output test points. If the r-f signal is kept small (less than 10 mv), the crystal will operate in the square-law region, and the difference in amplifier output resulting from connecting the crystal circuit to the input and output test points can be read off the output meter, which is also calibrated in db. These two methods yielded readings that had a maximum difference less than 0.2 db.

It should be noted that the results of the first method are independent of the crystal constants, and that the second method requires only that the crystal characteristics be square law.

The writer wishes to thank D. D. King for his many helpful suggestions pertaining to the measurement procedure, and to M. Brodwin, H. M. Watts and G. de Socio for their help in writing this paper.

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Reducing TV Receiver

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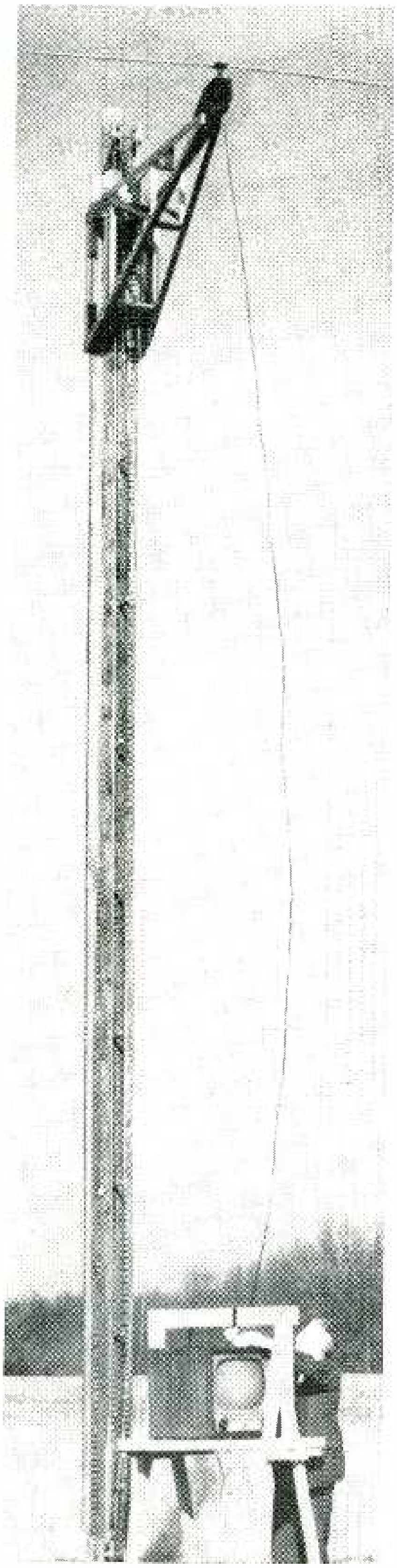


Receiver on turntable, with its antenna 30 feet above ground

INTERFERENCE caused by nearby receiver local oscillator radiation cannot usually be corrected at the receiver which has the interference. Furthermore, the preponderance of oscillator radiation on some channels may place one station in an unfair competitive position with regard to another in the same area. This type of interference has led at least one station to request a frequency reassignment.

Radiations from f-m receivers have seriously interfered with the use of certain air navigation frequencies. This problem has been solved by changing the frequency of the station to which the offending receivers were tuned, but the solution is not fundamentally sound and will become increasingly difficult or impossible as the spectrum becomes more fully utilized.

The choice of a particular intermediate frequency to alleviate oscillator radiation interference may conflict with other important considerations which also are involved in this choice, such as direct pickup of signals on the intermediate frequency and the necessity for obtaining a satisfactory image ratio.

Reverse TVI

When an i-f value is such that the oscillator radiation does not fall in a tv channel, it may fall on a channel occupied in the same locality by some other service that can get along with a field intensity as low as 0.1 microvolt per meter. It is thus possible that relatively more interference can be caused to a service essential to the public interest by the choice of oscillator frequencies outside of tv channels.

The fundamental solution is therefore considered to be a reduction in the level of the oscillator radiation produced by new receivers. This matter is related to costs, but only a small additional cost is required for a considerable degree of suppression. The present lack of shielding may be partly blamed on a lack of an appreciation of the order of magnitude of the radiation and the degree to which radiation can easily be reduced. The lack of appreciation in turn may stem from the dearth of suitable measurements of the strength of the radiations.

Measurement Technique

Spurious radiation may come from the receiver chassis itself, acting as an antenna, or from individual circuit components and wiring. It may also result from coupling of a certain part of the oscillator power into the antenna circuit and its subsequent radiation by the antenna. The field arriving at a distant point is the vector sum of the radiations coming from different parts of the receiver and antenna structure.

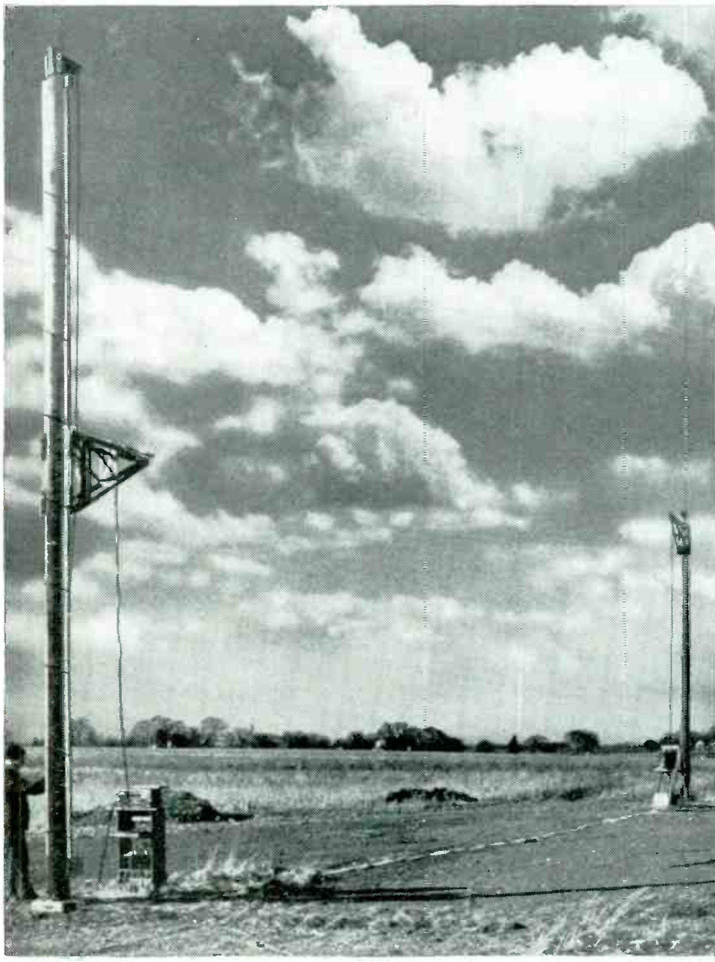
Minor changes in the location of components and leads may result in large changes in the field measured at a distant point, not so much as a result of an actual increase or decrease in the total radiation, but as a result of a change in the distribution of the several components which add vectorially at the measuring point. Recognizing these difficulties of measurement, the Institute of Radio Engineers recently agreed upon and published a standard method of measurement.[1]

The oscillator test range constructed at the laboratory of the Federal Communications Commission permits measurements in accordance with the IRE Standard, as well as other types of measurements. The test site is a level space clear of obstructions for at least 100 feet in all directions from both the receiver and the measuring point.

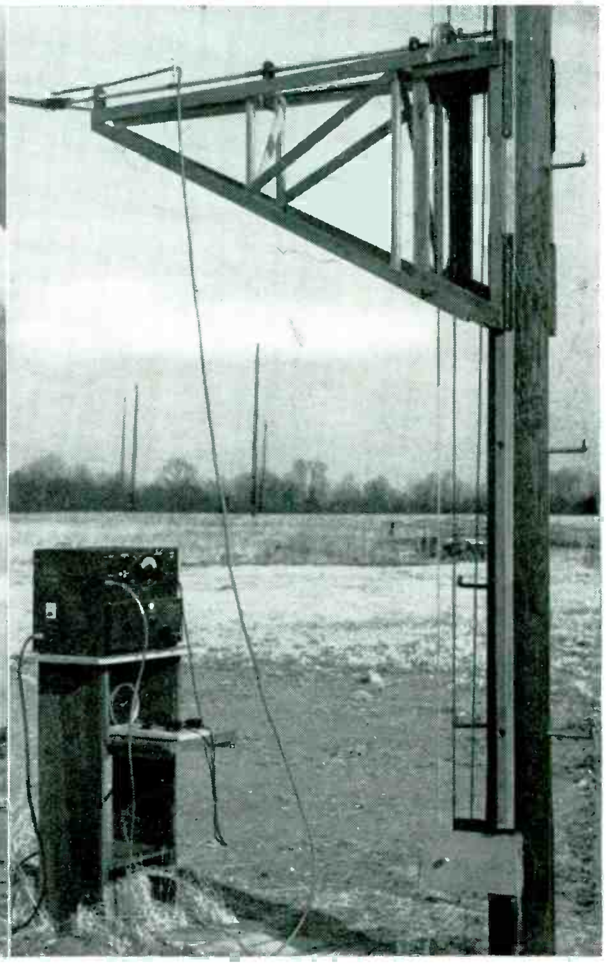
The receiver whose oscillator

Oscillator Radiation

Interference with other receivers can be reduced substantially by simple shielding and filtering of the tv tuner, at little extra cost if incorporated in initial design. Examples of modifications for two types of tuners are given and radiation measuring setup is described



Test range for measuring radiation from oscillator of tv receiver, with field intensity meter and antenna in foreground and receiver 100 feet away at right



Field intensity meter uses antenna mounted so that antenna elevation and polarization can be changed by manipulating ropes

radiation is to be measured is placed on a turntable, the rotation of which is controlled from the measuring point. The electric power for both ends of the system is fed through buried cables. No metallic object greater than 6 inches in length exists in any part of the setup above ground level, with the exception of the receiver being tested, the field intensity measuring set and the associated antennas.

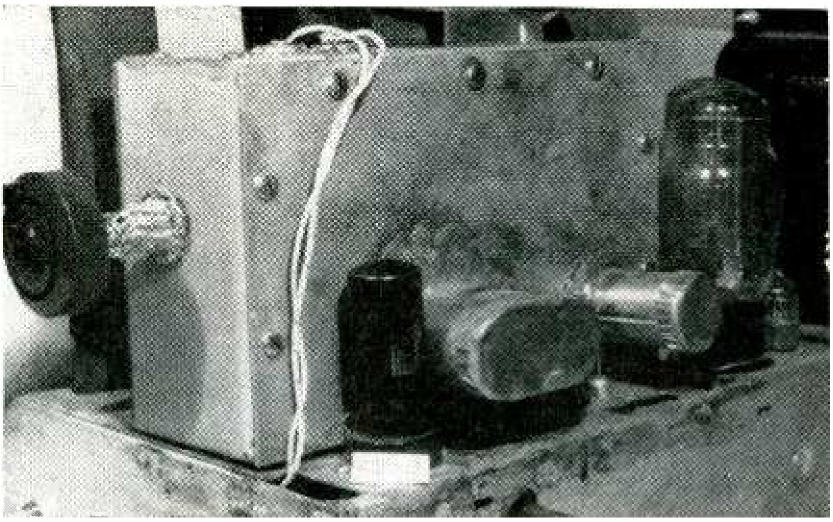
Provision is made to raise and lower the measuring dipole of the field intensity set and to change its polarization. The azimuthal orientation of the horizontal dipole of the receiver is adjustable, independently of turntable rotation, or may be revolved with the turntable. The distance between the two antennas is 100 feet. The elevation of the receiver antenna is 30 ft, and the height of the field intensity meter antenna is continuously variable from 7 to 20 feet. All of the variables are manipulated independently to obtain the maximum possible indication.

Several f-m and tv receivers of post-war manufacture have been tested, employing substantially the methods set forth in the IRE standard. The results are tabulated in Table I.

The conclusion from these measurements is that receiver radiation difficulties can exist and will occur in the future as frequencies occupied by the radiations are assigned for use by licensees in the same area. Frequency evasion is not alone satisfactory as a means of controlling the interference.

Shielding Problem

The usual local oscillator has a plate power input of the order of



Example of continuous type of tv tuner, modified to reduce oscillator radiation below 10 microvolts per meter at 100 feet. Soldered cylindrical enclosures cover the three tubes

1 watt and available output power of ¼ to ½ watt. If all of this power were efficiently radiated by a dipole antenna, a field of 160 millivolts per meter could be produced at a distance of 100 feet in free space. Fortunately, as shown in Table I, only a fraction of this oscillator power is typically radiated from the chassis and from circuit components and wiring.

Most of the measured radiation from f-m and tv receivers is stray radiation from the chassis. This can be demonstrated by short-circuiting the antenna terminals and completely eliminating the antenna and transmission line. It is only when the radiation has been reduced to levels considerably below those originally measured that any substantial radiation from the dipole antenna can be noticed.

More satisfactory shielding enclosures around the receiver or around the tuner itself (since the tuner generally is a separate unit assembled into the receiver chassis) offer the greatest possibility for improvement. Such enclosures should provide feed-through capacitors for power supply leads. Signal leads that must pass through the wall of the shielding enclosure may be equipped with filters, preventing the escape of oscillator energy.

The use of a low-pass filter in the video i-f lead of a wide-band stage may not be desirable because it increases circuit capacitance to ground and thereby reduces the maximum amplification for a given bandwidth. Instead, the video i-f lead may be made very short and covered with a partial or complete shield. In f-m receivers, where the circuit bandwidth requirement is not great, either feed-through capacitors or suitable low-pass filters may be used for the mixer output lead.

The antenna input circuit of the tuner can be shielded from the rest of the unit by using suitable barrier walls and using a pentode or grounded-grid triode r-f amplifier (with the possible exception of the uhf band, where r-f amplifier tubes may not yet be economical). If a pentode is used, the screen should be grounded carefully for r-f potentials. The use of inductance in the screen circuit, as is sometimes done to obtain desirable input impedance characteristics for the r-f amplifier, will largely offset the value of the r-f amplifier as a radiation suppressor.

Fixed or switched low-pass filters may be employed in the antenna input circuit, or an additional tuned circuit may be included to provide further isolation for oscillator frequencies between the antenna and the input stage.

Indoor Tests

While an outdoor test site is preferable for radiation measurements, weather conditions may be unfavorable during a period when a particular tuner design is being tested. An indoor test setup that gives related results is therefore desirable. It can use a field intensity meter (or a receiver with suitable indicator) whose dipole antenna is mounted at some arbitrary position in the room, plus a simple turntable on which the tuner or complete receiver may be placed. A shielded room is not essential. The antenna of the field intensity meter may be placed near a wall, well above the floor. The turntable may be at any convenient point in the room.

The turntable is particularly useful when checking leakage from the chassis. Minor adjustments and modifications may merely shift the distribution of field intensity in the room, without changing the level of leakage. Without a turntable, the impression may be gained that a particular change in the receiver has desirable results, whereas only the angle of peak radiation was changed.

By comparison of indoor and outdoor results, it is possible to arrive at an approximate relationship between the two that will serve as a useful guide in establishing the degree to which suppression must be achieved in the laboratory room before it is worthwhile to measure out of doors.

Certain field intensity meters are equipped by the manufacturers with small magnetic probes that have electrostatic shielding. These probes are useful in searching for leaks and other deficiencies in the enclosure of the receiver or tuner.

Desirable Radiation Limits

While it would be desirable to suppress oscillator radiation completely, there is probably an economic balance between the probability of interference at a given maximum radiation level and the cost of achieving that level in the large number of receivers that are to be manufactured. A goal of about 15 microvolts per meter at 100 feet seems reasonably attainable below about 250 mc. This may still cause interference to the reception of otherwise useful tv signals as strong as 1,500 microvolts per meter, as well as to signals of other services which may use much lower intensities. However, the test conditions are related to the maximum radiation condition; the probability is that certain channels of the receiver will have much lower radiation than the maximum, and the direction of radiation of the maximum signal may not coincide with the location of the nearest receiver. Also, if the limit of 15 microvolts per meter is met in receiver production, most of the receivers will radiate less than the specified maximum and cause less interference.

At frequencies above about 250 mc, other man-made and natural interference is less, permitting the utilization of lower field strengths, and propagation difficulties may require an appreciable portion of listeners to use weak fields. Suppression of oscillator radiation will therefore be important for uhf television tuners and receivers.

Modification of Continuous Tuner

To determine the extent to which existing tuners could be modified to reduce oscillator radiation, two representative types of tuners that have had considerable production were selected for a laboratory experimental program.

The first tuner modified was continuously tunable in frequency over the 12 television channels from 54 to 216 mc. The modifications may be considered extreme in that they include use of a complete metallic covering around the entire tuner, including its tubes. Joints in this covering were soldered except where it was necessary to leave provision for access.

The end of the tuning shaft that projects directly into the oscillator compartment had to be grounded effectively to keep the stray radiated field below the desired 15 microvolts per meter. The mere ungrounding of this one shaft and its protrusion about 2 inches outside the shield resulted in fields at some frequencies of the order of 100 microvolts per meter at 100 feet. An insulated shaft would be desirable.

To reduce the escape of oscillator energy through the i-f output path the first i-f grid coil was moved into the tuner shield box inside a small separate shield. This i-f coil was coupled to a second i-f tuned circuit in the grid of the first i-f amplifier by a capacitive coupling network which included a feed-through capacitor to ground having an impedance of about 200 ohms at the intermediate frequency and proportionately less at the oscillator frequencies.

Power supply leads were brought into the tuner from the top through button-type feed-through capacitors and r-f chokes which were enclosed in a separate shield inside the main shield.

Reduction of the antenna component of radiation was effected by placing a cylindrical shield around the r-f amplifier tube socket. This cylindrical shield has an additional wall across it to isolate the input and output circuits of the r-f amplifier. Bypassing of the screen, filament and cathode leads was done with button-type capacitors placed as close as possible to the socket.

The modified tuner was tested in the standard outdoor test setup and found to produce a maximum field of 10 microvolts per meter at 100 feet at the worst frequency. It is considered that althought the intended goal had been met, certain parts of the work had not been done in the most economical manner; also it would be desirable to provide more satisfactory access to the tuner, especially for replacement of tubes and for alignment adjustments. Therefore, on the basis of the experience already gained, work was begun on a second tuner.

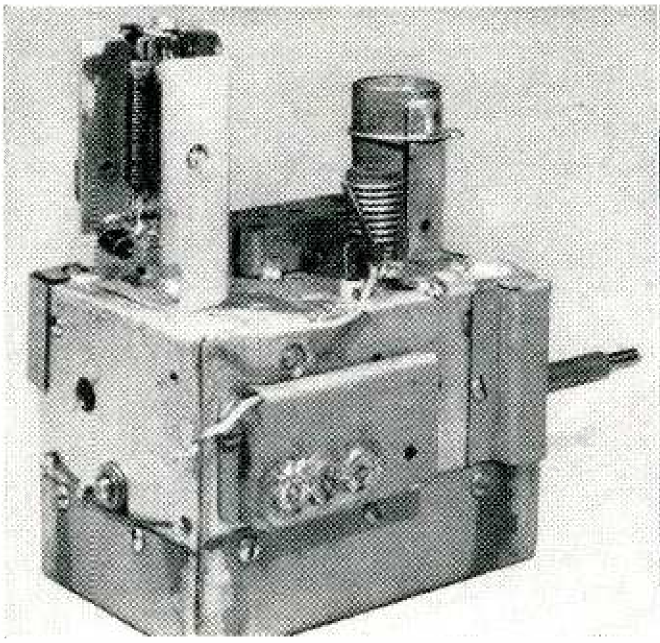
Modification of Turret Tuner

The second tuner used had 12 channel strips, each supporting the necessary r-f, mixer and oscillator coils for one vhf channel. Zinc-coated steel was used for shielding, to stay away from copper or other metals which might be difficult or expensive to obtain. The modifications were as follows.

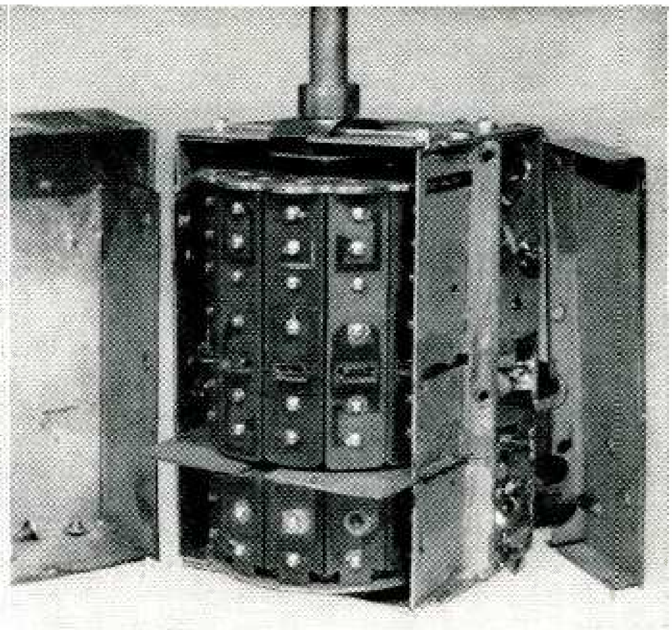
(1) An assembly of three 500-μμf button-type feed-through capacitors was arranged to cover the slot in the side of the tuner through which the power supply and i-f leads originally came, and to filter the power supply leads. These capacitors should have low impedance at the oscillator frequencies as compared to the impedance of conven-

Table I—Radiation Measured on Typical Receivers

	Channel (mc for UHF)	Osc Freq in mc	μv per meter at 100 ft
1948 TV Receiver	2	82	63
	3	88	116
	4	94	145
	5	104	185
	6	110	235
	7	198	627
	8	208	273
	10	220	476
	11	226	362
	12	232	298
	13	238	552
1949 TV Receiver	3	88	176
	6	110	65
	8	208	587
	10	220	600
	11	226	762
	12	232	520
	13	238	269
1950 TV Receiver	2	103	84
	4	113	64
	5	123	88
	7	133	220
	9	146	360
	11	158	390
	13	170	175
1951 TV Receiver	2	81	356
	3	87	90
	4	93	151
	5	103	74
	6	109	83
	7	201	87
	8	207	89
	9	213	95
	10	219	125
	11	225	117
	12	231	131
	13	237	198
1951 UHF TV Converter	500	375	512
	550	425	612
	600	475	650
	650	525	645
	700	575	900
	750	625	1,160
	800	675	805
	850	725	900
	900	775	555
1951 UHF TV Converter	500	420	1,500
	550	470	2,340
	600	520	2,840
	650	570	1,300
	700	620	1,310
	750	670	890
	800	720	560
	850	770	1,000
	890	810	1,300



Modified version of turret-type tuner. Main openings are covered by zinc-coated steel, with button-type feed-through capacitors for filament, plate and avc leads



Method of cutting channel strips and mounting additional shield wall through turret assembly. Tuning shaft at top is grounded by adding collar and spring

tional bypass capacitors.

(2) A cover was folded out of one piece of metal and fastened to the open bottom of the tuner with self-tapping screws.

(3) A bent metal cover was placed over the side opening of the tuner chassis.

(4) A small metal cover was fitted over that part of the top of the chassis where aligning screw adjustments come through. Some of these screws are mounted in Bakelite and are therefore quite hot. Alignment adjustments may be made through holes in the top of the new shield cover.

(5) A single metal shield wall was put through the tuner at the center of the r-f amplifier tube socket, to isolate the r-f input circuit. This required cutting each of the channel strips.

(6) A bent metal piece was used to cover the detent spring, which projects partly through a slot in the chassis.

(7) A grounding spring and shaft collar were used to reduce oscillator leakage through the fine-tuning shaft. (An insulated shaft is indicated.)

(8) The extra screen inductance in the r-f amplifier was eliminated, to further isolate the r-f input.

(9) The picture i-f lead was rearranged so that only about 2 inches of it are exposed to reach the first i-f grid.

(10) The 47-$\mu\mu$f capacitor in the sound trap tank circuit was moved to a point on the surface of the chassis where the sound i-f lead comes through. A feed-through capacitor would be more satisfactory mechanically.

(11) The flanges of tube shields were soldered to the chassis, instead of relying on rivets only.

Conclusions

These modifications serve to cover the entire outer surface of the tuner as completely as practical with a metallic covering and to isolate the antenna input circuit from the remainder of the tuner. There are still numerous joints and connections between the metal parts and there are holes. However, if the holes are kept small and if the joints are tied in such a manner that they are not over two inches in length, no particular difficulty results. A new tuner could very likely be designed and manufactured that would achieve these modifications in a much simpler manner at a cost but little higher than that of the original tuner.

The modified turret-type tuner was installed in a tv receiver, tested for oscillator radiation, and found to produce a maximum of 9 microvolts per meter at 100 feet on the worst channel. Most of the 9 microvolts are still obtained when the antenna and its feed line are completely removed from the tuner, showing that if further suppression were desired it should be sought in the direction of improving the shielding around the chassis.

While the work reported in this paper was performed in the course of official duties, the opinions are those of the authors and do not necessarily represent the position of the Federal Communications Commission.

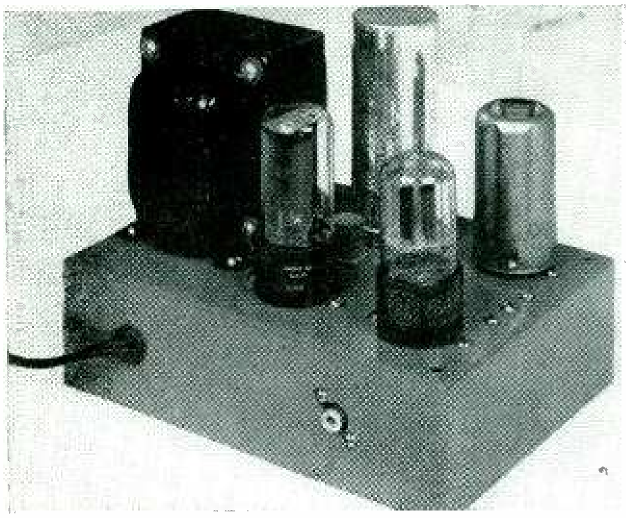
Valuable contributions to this work have been made by other members of the Laboratory staff, especially F. D. Craig, who did much of the development work, and M. C. Mobley, who constructed the outdoor test range. The work was performed under the direction of the Chief Engineer of the Federal Communications Commission, as a result of a suggestion made by Commissioner G. E. Sterling.

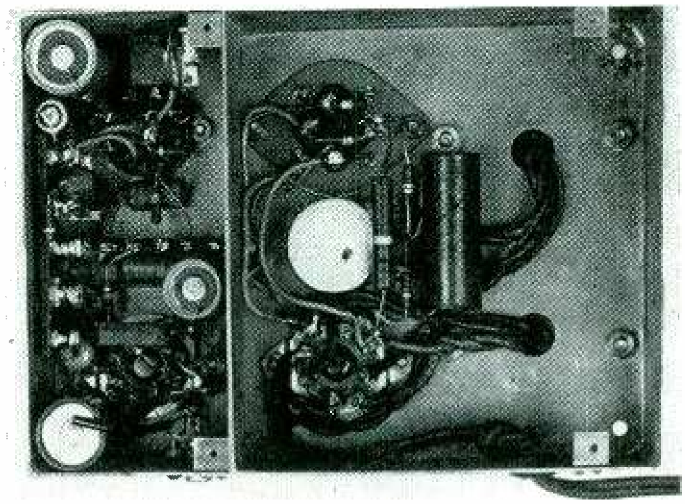
REFERENCE

(1) Subcommittee on Spurious Radiation, IRE Receiver Standards Committee, Standards on Radio Receivers: Open Field Method of Measurement of Spurious Radiation from Frequency Modulation and Television Broadcast Receivers, 1951, *Proc. IRE*, p 803, July 1951.

Precision Preamplifier

New circuit gives 6-db-per-octave rise in response from crossover frequency down to 10 cps to match recent improvements in other components of high-fidelity sound systems. Passive network compensator gives choice of five high-frequency rolloffs





Top and bottom views of preamplifier, showing partition shielding between power supply and amplifier section

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THE DEVELOPMENT of a modern preamplifier leads to many problems from the standpoint of hum, noise, stability and overload characteristics. In addition, the preamplifier should accurately match the 6-db-per-octave rise in response below the turnover frequency, to frequencies as low as 20 cps, to fully justify the use of speakers and amplifiers capable of good response in this region, and greatly improve low-frequency transient response when used with tonearms having little or no arm response.

The preamplifier design presented here meets these requirements for a high-quality sound system. Midfrequency gain is 39 db, maximum input for less than 0.7 percent harmonic distortion is 0.25 v and maximum output is 22 v. Equivalent grid noise at 60 cps is 3.1 μv. Required input for 1.0 v output at 2,000 cps is less than 15 mv.

If a complete radio-phonograph system is under consideration, the preamplifier may be used as a concealed unit, power being switched on and off by a radio tuner. The output of the preamplifier, properly attentuated by means of a gain control initially preset to give matching levels of radio and phonograph program material, is fed into the uncompensated phono-channel of the tuner. The tuner volume and tone controls, a-c line switch and input switching then centralize and simplify the complete operation of the home system without the use of a separate preamplifier control panel.

The low output source impedance of the preamplifier allows its use adjacent to a phonograph turntable, which in itself may be placed remote from the other amplifier stages. Assuming the cable capacitance to be of the order of 40 $\mu\mu$f per foot, it will have little effect upon the high-frequency performance of the unit up to 500 feet. A shunt capacitance of 20,000 $\mu\mu$f on the output will attenuate 15 kc only 3 db.

For broadcast applications, the preamplifier may be fed into a 600-ohm isolating pad if desired and thus into the input channel of a standard program console.

Performance

A preamplifier-equalizer meeting the requirements outlined would ideally have flat response from a selected turnover frequency, say 500 or 600 cps, up to the top end of the desired range, say 30 or 40 kc. Below the crossover, the response would rise uniformly at 6 db per octave down to the lowest frequency desired, at which point the response would fall off rapidly.

The actual measured response of the unit shown in the circuit diagram of Fig. 1 is presented in Fig. 2. Other crossover frequencies can be provided by changing the capacitance values in the two selective networks of the 7F7 plate circuits, or by the use of external networks as described below. The deviation curve shown is a plot of

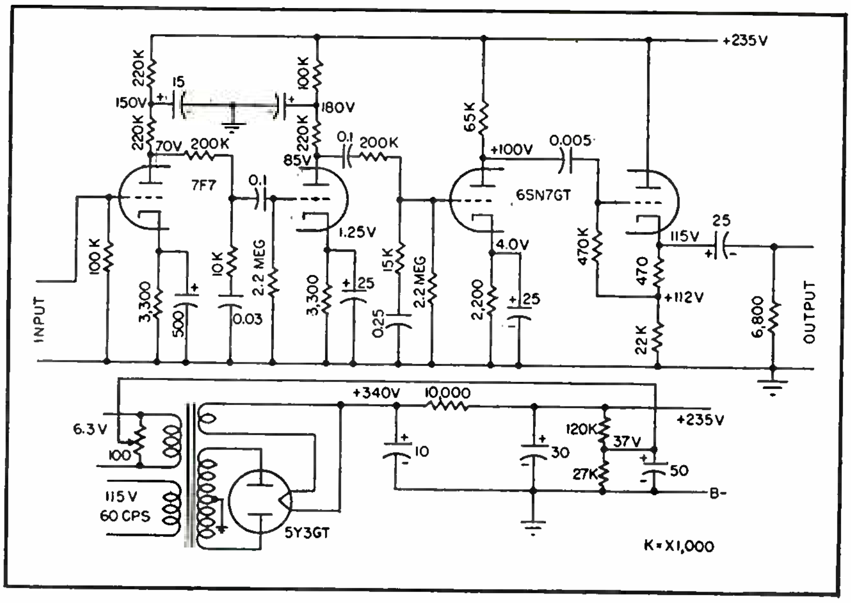

FIG. 1—Complete circuit of new preamplifier-equalizer with selfcontained power supply

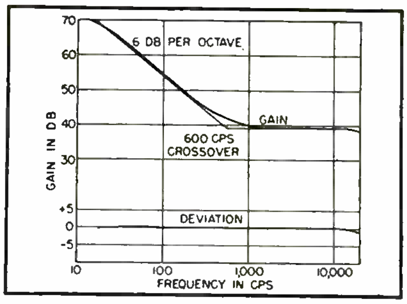

FIG. 2—Frequency response curve of preamp

the difference between the desired curve and the measured characteristics obtained with the unit. It will be noted that the deviation curve is flat within less than one db from approximately 15 cps to over 20,000 cps, providing excellent low and high-frequency transient response.

Circuit Details

The circuit of the preamplifier is relatively straightforward. Cathode bias is used in all cases to minimize distortion which arises from the contact bias used in some preamplifiers. The separation of the two cathodes of the 7F7 is essential to maintain stability in the system, otherwise motorboating will occur regardless of the size of the cathode capacitor utilized to bypass a common cathode resistor.

The 7F7 is operated with positive heater bias derived from the B+ supply. A variable heater center-tap potentiometer, adjusted for minimum noise, is also employed. Wiring of the input stage is point to point, with a common ground return point for the grid circuit, cathode circuit and frequency-discriminating circuit in the plate of each section of the 7F7. This common ground point is the center point on the loctal socket.

The input ground is also returned directly to this point, the input jack being isolated from the chassis. Furthermore, the input magnetic loop is kept small. Loom shielding is unnecessary. Independent decoupling is used in the two low-level plate supplies, although it is omitted from the third stage and cathode follower circuits. This decoupling also provides adequate filtering of the B supply ripple.

Where pickups generating output voltages greatly in excess of 10 millivolts are utilized, it is desirable to provide a gain control in the system so that the output voltage from the cathode follower will be of the same order of magnitude as that derived from a detector in an a-m or f-m tuner. Accordingly, a 10,000-ohm gain control is suggested in place of the 6,800-ohm fixed output resistor in the output circuit of the cathode follower stage. Since the system will tolerate input voltages as high as 250 mv without producing distortion in excess of 0.7 percent, an output gain control is feasible and desirable to maintain the highest signal-to-noise ratio.

Low-impedance output (without the gain control) is not very susceptible to capacitive or resistive loading, hence the preamplifier may be fed directly into any high-impedance input channel or into a 600-ohm input line (unbalanced) if the 6,800-ohm output resistor is retained. A 600-ohm termination results in about 5 db loss at all frequencies in the response range.

The amplifier section is completely isolated from the power supply section, being placed across one end of the chassis and shielded from the power supply components. In-line construction is utilized. Where vibration may be encountered, the two amplifier tubes should be mounted on a cushioned or floated plate sufficiently large to accommodate most of the circuit elements, making necessary only connection of B supply, heater leads and input and output lines.

Response Measurement

A Hewlett-Packard 202D oscillator covering the frequencies from below 10 cycles to above 70,000 cycles was utilized for response tests.

An output attenuator which reduced the output voltage by 200 to 1 was placed across the terminals of the oscillator; the output voltage was developed across 50 ohms. A signal of about 10 millivolts at 2,000 cps was fed to the input of the preamplifier. As the input frequency was varied, the output voltage of the preamplifier was maintained constant regardless of input frequency, the level being read with a Hewlett-Packard 400A vacuum-tube voltmeter. The variations in oscillator voltage as developed across the oscillator terminals were measured with the same vacuum-tube voltmeter by switching it from output to input, and the variations in required input voltage were inversely plotted to measure the overall response of the system.

This method of measurement eliminates any errors present in

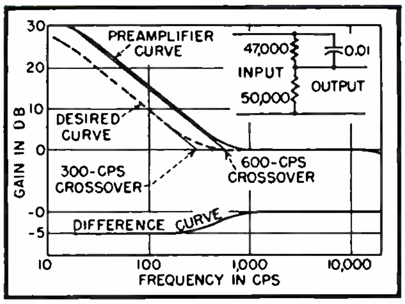

FIG. 3—Method of designing network to give desired high-frequency rolloff

the frequency response of the vacuum-tube voltmeter and errors which might arise due to variation of oscillator output voltage with frequency, since the same errors are present in the measurement of both the input and output voltages.

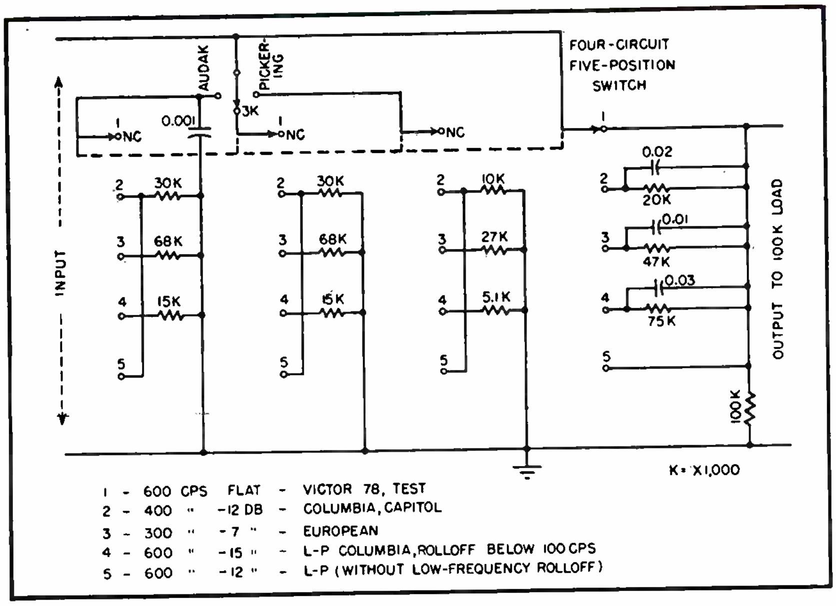

FIG. 4—Recording characteristics compensator

Noise Distortion

Distortion and noise measurements were made by using a General Radio low-distortion model 1301-A oscillator as a source and a General Radio model 1932-A noise and distortion analyzer as a measuring instrument.

The equivalent noise at 60 cps, including nonsinusoidal bounce and flicker noise as well as hum, is computed by measuring the output voltage with the input open-circuited, then measuring the 60 cps gain, which is 60 db. Since this is a factor of 1,000 (voltage gain) the output voltage in millivolts is equivalent to the effective 60-cps input voltage in microvolts at the input grid. The measured output voltage is 3.1 mv (50 db below 1.0 v); the effective 60-cps input noise is thus 3.1 μv.

Distortion measurements were made in the same manner as response measurements, the output voltage being maintained constant at all input frequencies. The distortion of the preamplifier, measured at 0.070 v input, is less than 0.1 percent. Oscillator distortion of the order of 0.1 percent makes measurements below this level difficult. Maximum input limitations are well above the outputs of magnetic cartridges now available.

It is possible, and perfectly feasible, to provide networks external to the preamplifier which will provide various high-frequency rolloff characteristics and change the crossover frequency. Initially this seems a bit difficult, but the basic philosophy of the circuits required is simple.

Crossover Frequency

In Fig. 3 the curve of the preamplifier with its 600-cps crossover frequency is drawn in conjunction with the desired curve for a 300-cps crossover. The difference curve is then derived, resulting in the curve shown at the lower half of Fig. 3.

A network to satisfy such a response characteristic is also shown. Basically, the network must produce the desired loss below the sloped portion of the difference curve. A simple voltage divider network will solve the problem. Above the sloped portion of the curve, no loss is desired. The voltage divider must thus be short-circuited at these frequencies. A capacitor shunting one section of the divider, selected to have an impedance equal to the resistance it shunts in the slope frequency region, preferably near the lower end of the slope, satisfies the requirement. Below the slope-frequency region, the network gives the desired fixed loss.

The circuit components needed to produce crossover frequencies of 400 cps and 300 cps in association with the preamplifier 600-cps crossover are given in Fig. 4. To these are added various shunt resistors on the first three switch decks to give rolloffs for various recording characteristics. The rolloffs are produced by these shunts as a result of the inductance of the cartridge with which they are used. Since various makes of cartridges are different, different shunt circuits are provided. Where the inductive impedance and the shunt impedance are equal, there will be 6-db loss and frequencies above this point will be further reduced, approaching a loss curve of 6 db per octave.

More rapid attenuation may be produced by shunting capacitors across the loss resistors. Little change in level results from these shunts, as the effective source impedance of the pickups is relatively low compared to the shunt values of the capacitors.

The philosophy behind the passive network compensator is that the buried preamplifier should have its circuits intact, without need to extend any of the networks by remote cable and switch. The passive network compensator allows centralization of all controls at the tuner in a small space, or the compensator may be adjacent to the turntable. Since all components of the compensator are small, they may be mounted on the switch itself.

Pulp-Log Metal Detector

Designed specifically to detect relatively large pieces of tramp metal in work areas subject to great vibration. Immunity to strong electromagnetic fields from nearby induction motors and to fluctuating line voltage is provided

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DESIGNED FOR the pulp and paper industry, this detector protects multiblade chippers from damage by pieces of ferrous metal. The device has been installed in the Maryvale pulp mill of the Australian Paper Manufacturers Ltd. of Melbourne, Australia.

In its first months of operation, the new detector has located several pieces of tramp metal which could have caused considerable damage and possible substantial loss of production.

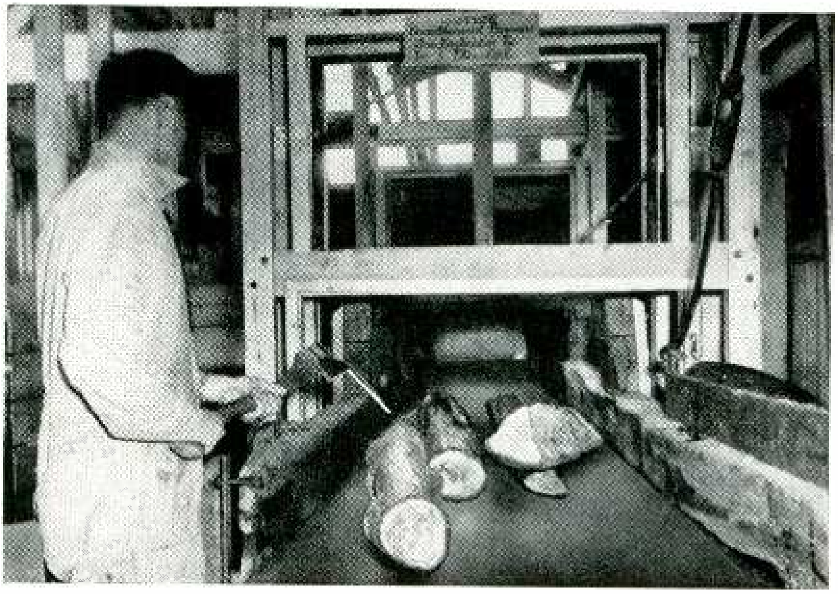
The detector is immune to the effects of fluctuating line voltage and it is automatically compensated against drift from the balance condition.

At the mill where it is now installed, the tramp metal encountered comprised mainly steel wedges used for timber splitting. Other metal encountered was in the form of pickaxe heads and pieces of metal dislodged from the conveyors and barking drums ahead of the chippers.

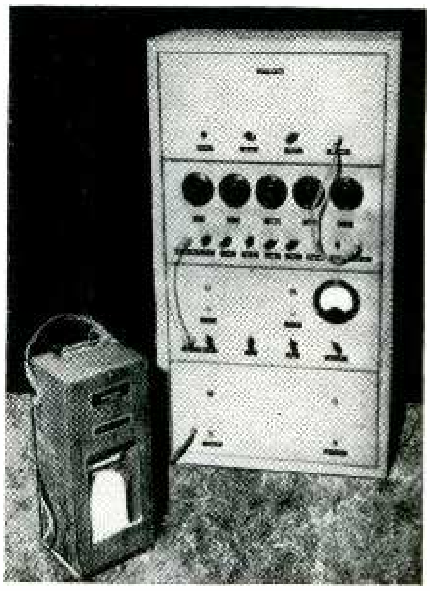
The layout of the plant at the only available site of installation is somewhat cramped and a considerable quantity of mild steel structure is in the immediate vicinity. All surroundings are subject to heavy vibration, a factor which would seriously affect the operation of the usual metal detector. For these reasons a single-coil method has been adopted, although mutual-inductance systems generally offer somewhat better stability and sensitivity.

Frequency of Operation

A frequency of 1,000 cycles is used. The bridge initially tried was of the Maxwell type. This system proved impractical due to the presence of strong interfering electromagnetic fields varying in intensity with the rapidly fluctuating loads



Search coil of the detector is located around the conveyor carrying billets to the chipping machines. Typical pieces of tramp metal encountered were in the form of steel wedges and pickaxe heads



Detector and recorder. Second panel from top has resistance-adjusting knobs for bridge circuit

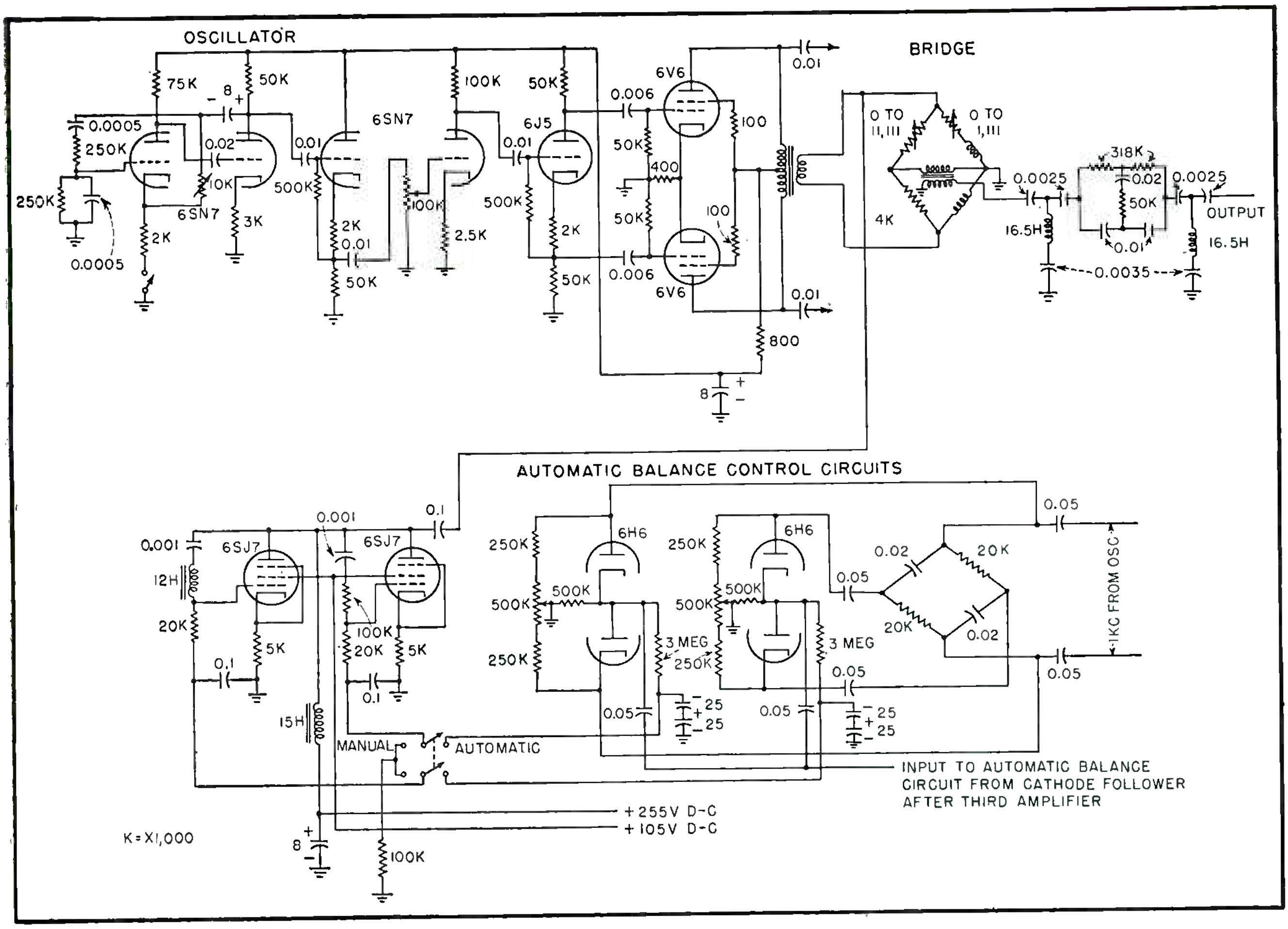


FIG. 1—Oscillator, bridge and automatic balance control circuits for the metal detector

on the induction motors driving the chippers. There are three such motors with an aggregate of 1,000 hp in the vicinity of the equipment installation.

A special inductance bridge using two similar 370-turn coils, each on a wooden form 3 feet 8 in. wide by 2 feet 10 in. high, was used. One coil was wound around the conveyor and the other was placed immediately above in the same plane to assure a like orientation to the interfering electromagnetic fields.

The coils are connected in the bridge so that the unwanted induced voltages are of opposite polarity and therefore cancel each other out.

Further improvements in eliminating the effects of this interference were made by increasing the power input to the bridge from 3.5 to 8 watts and by decreasing the sensitivity of the unbalance detector amplifier.

Because of the vibration present at the site of the search coil, the instrument is located some distance away where the effect is greatly reduced. The 60-foot lead used for connecting the coils is shielded, with the braided metal shield used as a common ground return.

Circuit Description

The 1,000-cycle oscillator used, shown in Fig. 1, is of the Wien-bridge type using a 6SN7. Output of good stability with respect to amplitude and frequency, is fed to the first section of the second 6SN7 used as a cathode follower, from which it is amplified by the second section to drive the 6J5 phase-splitter and pushpull 6V6 vacuum tubes.

Tapped secondary impedances are used on the output transformer so that the bridge impedance, approximately 3,500 ohms, may be well matched. Power output is about eight watts.

The two coils are in opposite arms of the bridge. A Q balance control of 1,111 ohms, adjustable in steps of 0.1 ohm, is in series with one coil. The two ratio arms of the bridge are resistive, and one is variable from 0 to 11,111 ohms in steps of 0.1 ohm. For convenience, the junction of the two coils is maintained at ground potential.

The unbalance is transformer-coupled to a filter system consisting of two 850-cycle high-pass filters separated by a bridged-T network tuned for maximum attenuation at line frequency. This system reduces the interfering voltages to less than 150 μv at the input to the three-stage amplifier.

The first two stages of the am-

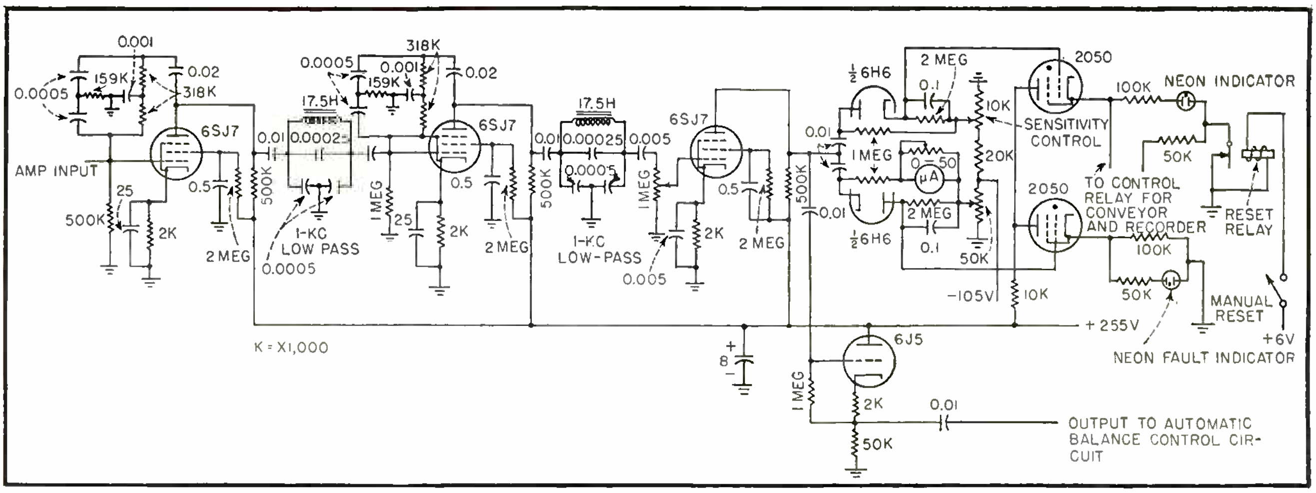


FIG. 2—Amplifier and control circuits for the equipment

plifier, shown in Fig. 2, are tuned to 1,000 cycles by degeneration at all frequencies but 1,000 cycles. This effect is obtained by connecting a bridged-T network tuned for maximum attenuation at 1,000 cycles between the anode and grid of each stage.

Because of the magnitude of harmonics remaining at balance, it was found necessary to interpose 1,100-cycle low-pass filters between the first and second and between the second and third stages. This circuit arrangement produces pure 1,000-cycle signals from the bridge at the input to the third stage in the event of an unbalance. The gain control is situated at this point.

Amplifier Output

The amplifier output is applied simultaneously to two diodes and the d-c output from each is of opposite polarity. Positive polarity is applied to the 2050 thyratron which controls the relay alarm system.

The negative polarity is applied to a second thyratron which is held inoperative by this continuous bias. Should the bias disappear because of a fault in the circuit, the tube conducts and the neon diode in the cathode indicates the trouble. A 50-μa meter measures the current in the diode circuit and serves as a balance indicator.

Sensitivity of the detector can be adjusted by the variable negative bias voltage applied to the grid of the relay control thyratron. A third output from the amplifier is taken via a 6J5 cathode follower to the automatic balance control circuit in Fig. 1.

Balance Controls

Automatic balance control is obtained by the use of two 6SJ7's in parallel with the arm of the bridge containing one coil and the Q balance control. One tube simulates a resistance and the other an inductive reactance.

The unbalance voltages from two balance controls differ in phase by 90 deg and are separated by phase-discriminating rectifiers. Two reference voltages for these rectifiers are taken from the oscillator, one direct and one through a 90-deg phase-shifting network. These voltages are used to suppress the component which is out of phase with the reference.

Each diode gives a d-c potential dependent upon the unbalance of the component to which it is sensitive. The polarity of that potential depends on the direction of unbalance of the component. Each potential is applied between grid and cathode of the impedance tube equivalent to the component which is out of balance and controls the current so that the initial change is opposed. A delay in application of the bias introduced after the rectifier permits detection of rapid pulses.

The unit has maintained balance for periods of several weeks. The bridge is manually rebalanced from time to time so that the automatic balance control is operating near the center of its range.

The detector relay controls the supply to a larger contactor which in turn isolates the log conveyor motor and closes the circuit to a warning light and the marker solenoid valve. The latter is then opened by a time-delay relay. The unit is reset by a push-button control at the search coil. This control opens the cathode circuit of the relay control thyratron. Indications are always shown on a strip-chart recorder.

Marker

The marker is incorporated in the control circuit so that the position of intruding metal is indicated. This became necessary in the local application of the detector because of serious variation in distance traveled by the conveyor after the circuit was opened. This distance depends actually on the load on the conveyor belt.

The detector was designed by the Research Division of the Australian Paper Manufacturers Ltd., Melbourne. Mr. Williams was assisted in the development of the automatic balance control circuit by J. W. Bayliss of Industrial Electronic Instruments Ltd. and in the initial development of his work by A. W. Pybus and G. Karoly of the Australian Defense Research Laboratories.

Recording Cochannel Broadcast Interference

Continuous field-intensity recording of an interfering standard broadcast station is possible using only one recorder. Extremely selective receiver having 13.5-cycle i-f accepts the interfering sky-wave signal while rejecting the stronger desired signal

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SKY-WAVE INTERFERENCE from a cochannel standard-broadcast station may be measured directly using a narrow-band recorder with a 13.5-cps intermediate frequency even before the desired station leaves the air.

The narrow-band recorder consists of a crystal-controlled superheterodyne receiver that incorporates four stages of tuned r-f. A selective i-f amplifier with two parallel-T feedback networks rejects to a high degree any signal differing appreciably from 13.5 cps. Further rejection of the desired signal is achieved by choosing frequencies such that strong unwanted signals are near zero beat with the local oscillator.

Since a standard field-intensity meter will measure some function of the vector sum of both desired and interfering stations, it is otherwise impossible to measure the interfering station's field intensity until the desired station leaves the air.

Standard Practice

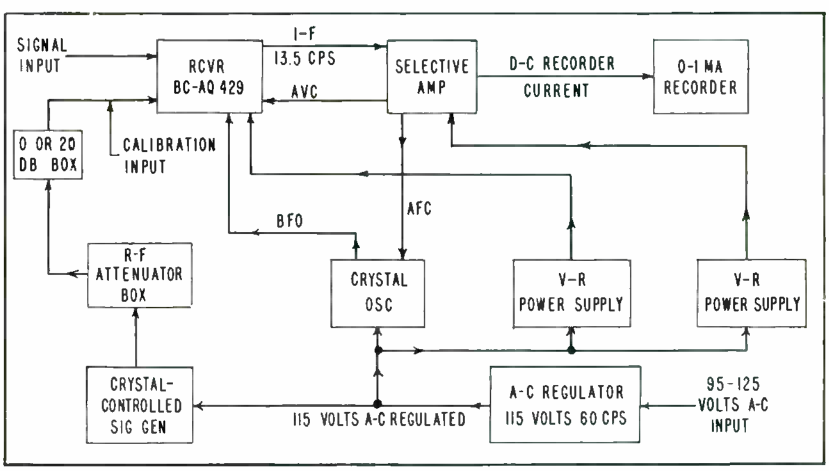
Standard practice[1] is to measure a monitor station from sunset through the evening hours, obtaining its curve of skywave field intensity with respect to time. The monitor station should be close to the station under study, in frequency and location, and should preferably be a clear-channel station with known antenna characteristics.

After the desired station signs off, the undesired station is measured directly and a ratio obtained between its measured field intensity and that of the monitor station. Using the curve of field intensity versus time for the monitor station and the above-mentioned ratio, the field intensity of the undesired station is extrapolated for earlier hours.

The FCC recognizes the second hour after sunset, ss + 2, as the standard hour for calculating or measuring interference. Having already established a field ratio between the undesired station and the monitor station's skywave curve, it is possible to determine the undesired station's field intensity at the standard hour, ss + 2, making any corrections for transmission conditions.

An earlier system for measuring interference directly[2,3] utilized a field-intensity recorder that made two graphical records. The first of these was a chart of the field intensity of the strongest signal on the channel and the second was a chart of the heterodyne voltage between

Narrow-band field-intensity recorder and associated calibrating equipment



Block diagram of complete setup for measuring and recording cochannel interference the strongest and weaker signals.

During summer 1948, measurements were made wherein all signals involved were skywaves. From time to time the desired or strongest signal on the channel varied widely in intensity, upsetting the reference voltage ratio of desired versus undesired signals. Under these circumstances, the equipment provided very little useful information.

Narrow-Band Recorder

The narrow-band recorder, which was developed in the fall of 1948, is shown with its associated calibration gear in the photograph and the block diagram. The receiver consists of four stages of tuned r-f, a diode detector, and an audio stage tuned to 13.5 cycles that actually constitutes the first stage of the i-f system. The selective amplifier follows the receiver. The output of the selective amplifier is connected to a diode detector and also to a cathode follower, which supplies the i-f to a frequency-discriminator circuit. The discriminator provides an afc voltage that is applied to a reactance tube in the crystal oscillator, thereby maintaining the output frequency in such a manner as to sustain the i-f at 13.5 cycles. Figure 1 is the overall i-f selectivity curve.

The crystal oscillator also introduces a voltage ahead of the detector for stabilizing the avc voltage produced by the desired signal. The output of the second detector supplies avc voltage to the first two r-f stages in the receiver and excites a d-c amplifier and graphic recorder. The narrow-band recorder incorporates both primary a-c power regulation and regulated d-c power supplies.

Calibration of the narrow-band recorder is accomplished by using a crystal-controlled signal generator to feed increments of power into the receiver antenna input terminals while maintaining a frequency difference of 13.5 cycles with respect to the receiver oscillator.

Figure 2 shows the response curve of signal input voltage versus recorder output in chart ma. This receiver response curve is corrected for the effective height of the receiving antenna to obtain an

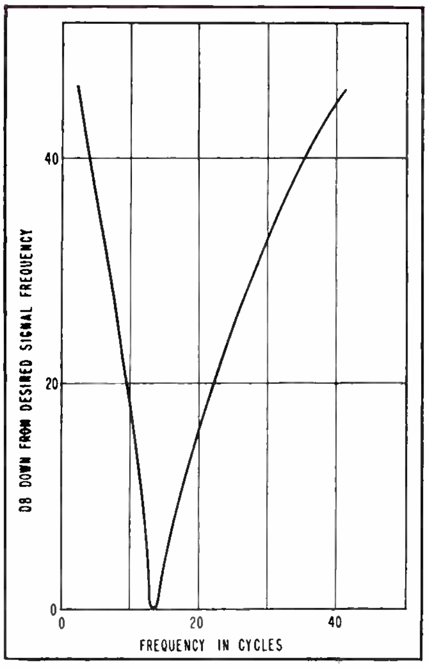


FIG. 1—Overall i-f selectivity curve shows high degree of rejection of signals differing from 13.5 cycles

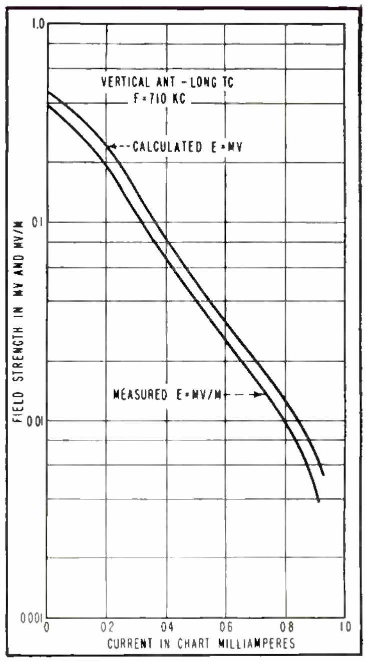


FIG. 2—Basic recorder response curve (right) and the same curve corrected for antenna effective height

output response in millivolts per meter versus chart ma.

After calibration of the narrow-band recorder, the antenna is connected and the signal to be measured is tuned in by adjustment of the local oscillator.

During operation of the recorder, the intermediate frequency is constantly monitored by a frequency meter that operates from the discriminator circuit. A Brush high-speed oscillograph is connected into the i-f system for frequent graphic checks of the intermediate frequency. A vacuum-tube voltmeter reads diode detector voltage, indicating the magnitude of oscillator injection voltage and the beat frequency between the local oscillator and any unwanted signals.

Field Tests

During 1949, the narrow-band recorder was field tested, making skywave studies of clear channel interference problems. Figure 4 shows three charts in terms of sunset hour. The narrow-band chart, Fig. 3A shows the drop in the undesired station's field intensity as operation is switched from nondirectional. Also shown are charts of desired signal, Fig. 3B, and the monitor signal, Fig. 3C.

Figure 4 shows three charts at ss + 4 and ss + 5. Figure 4B is the standard field-intensity recording of the desired station leaving the air with the undesired station remaining on. Figure 4A is the narrow-band recording of the undesired station. The monitor station field-intensity recording is shown in Fig. 4C. Also shown is the frequency check chart, Fig. 4D.

Supplementary Recordings

Cochannel skywave measurements made with the narrow-band recorder were supplemented by recordings of monitor and desired signals on separate recorders since the narrow-band recorder recorded only the undesired signal.

The monitor and desired stations were recorded using converted Command receivers. These receivers operated from regulated power supplies, with avc added for logarithmic recording, and d-c amplifiers driving Esterline-Angus recorders. Vertical antennas were used on all recorders. A Federal field-intensity meter calibrated by the Bureau of Standards was used to correct for effective antenna height of receiving antennas thus correcting the recorders' output response curves to read directly in mv per meter versus chart ma.

One-minute time constants were

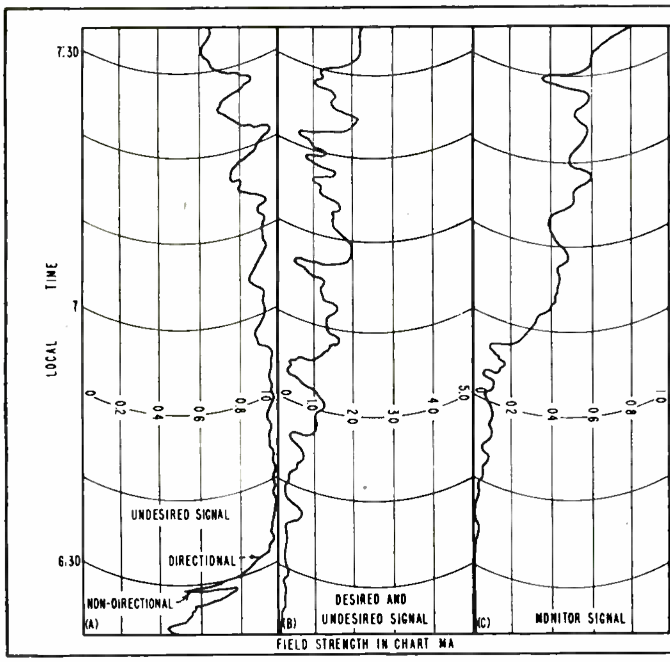


FIG. 3—Field intensity recordings made during sunset hour. Undesired signal (A) shows effects of changeover from nondirectional to directional antenna operation

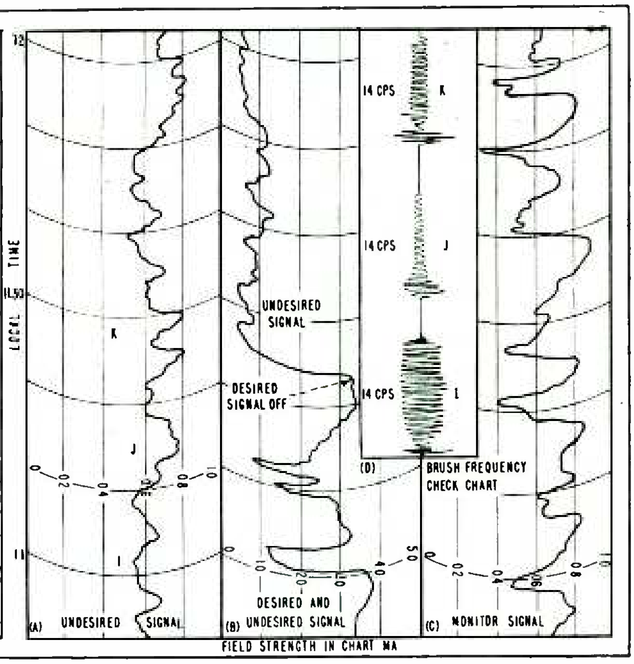


FIG. 4—Field-intensity recordings made at desired station's signoff time. Trace (B) shows interfering station's field-intensity after desired station signs off

used on all three recorders as this value is generally used in skywave studies. Measurements were usually limited to a certain bearing, centered around the desired station's 0.5 mv per meter contour.

Analysis of Data

In an analysis of skywave measurements between two stations, field-strength or interference ratios are determined with respect to sunset time. This is the time of sunset at midpoint of the transmission path between the station measured and the point of measurement. This time is obtained from FCC or Naval Observatory charts showing sunset time with respect to location. Analysis of skywave charts is made, determining the field strength exceeded for either 10 percent or 50 percent of sunset hour and each hour following.

Since skywave transmission varies from night to night, measurements are normally made over a thirty-day period. At the conclusion of the month's recording, the field intensities exceeded for either 10 percent or 50 percent of every hour during each night's operation are plotted against midpath sunset time, resulting in an average skywave curve during the thirty-day test. From this curve, it is possible to determine the average field intensity for ss + 2 or any other time.

Figure 5 shows a thirty-day summary curve of fifty-percent values for the undesired station, desired station, and the monitor station.

In conclusion, it may be of interest to note that nondirectional-to-directional antenna skywave ratio tests showed very poor correlation with calculated and ground-plane measurements. FCC nondirectional-to-directional antenna skywave ratio tests, involving approximately twenty-five radio stations showed similar results.

It appears that many existing directional systems, adjusted by ground-plane measurements, are not giving adequate skywave protection. Improved engineering standards are needed if the growth of cochannel skywave interference is to be kept to the same order of magnitude as that intended.

Credits

The narrow-band cochannel recorder is based upon the ideas of G. F. Leydorf, vice president and chief engineer of WJR. R. K. Clark, C. W. Jones, and G. L. Mills of WJR and R. A. Fox, and W. G. Hutton, of WGAR, developed the equipment under Mr. Leydorf's direction. Field testing was done by Mal Mobley. Mr. Leydorf assisted in the preparation of this paper.

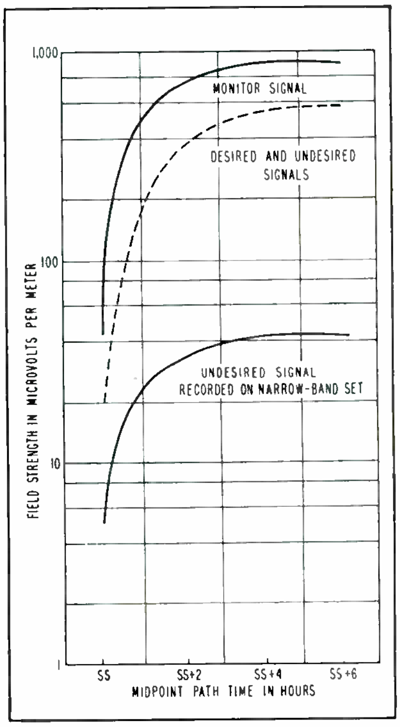


FIG. 5—Thirty-day summary of 50-percent hourly median values recorded both on narrow-band set and by conventional techniques

REFERENCES

(1) Federal Communications Commission, "Standards of Good Engineering Practice Concerning Standard Broadcast Stations", p 11, Washington, D. C., 1947.
(2) Glenn D. Gillett, U. S. Patent 2,079,265, May 4, 1937.
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Constant-Current

Design reduces power-supply requirements because amplifier does not present varying load as do conventional circuits. Costs are cut by using only one high-voltage winding, one rectifier tube and minimum of filtering components in power supply

ONLY a simple, light power supply is required for the direct-current amplifier to be described. It does not present a variable load to the B supply, therefore the supply needs regulation only for line variations. Since line variations require a much smaller percentage of regulation control, a resulting overall system simplification is achieved.

The circuit of the newly developed amplifier shown in Fig. 1 differs from conventional d-c amplifier circuits only in the final push-pull stage. One-half of this stage serves as the output stage delivering power to the load. The other half delivers out-of-phase current to ground through an equivalent load, neutralizing both the flow of load current to ground and the accompanying drain on the B power supply.

The double-ended output stage acts like a single-ended output without the usual load current change in B-supply current. Consequently, the supply shown in Fig. 1 for the amplifier is considerably simpler than a conventional one for a d-c amplifier.

In particular, the simplified supply of Fig. 1 requires only one high-voltage winding and one rectifier tube instead of the two high-voltage windings and two rectifier tubes of the conventional supply. Because the load current does not change, neither voltage amplifier nor power amplifier tubes are required for voltage regulation and a resistor may be used in the place of a choke for filtering.

The divider formed by the two regulator tubes provides a satisfactory ground return because no load current flows to the mid-point of this divider.

Although the quiescent current from the B supply of Fig. 1 is twice the quiescent current of a conventional supply the maximum capacity of a conventional supply must be the same as that of Fig. 1 because at full load it delivers just as much current as does the supply shown in Fig. 1.

Drift of the amplifier of Fig. 1 is comparable to that of conventional, stable d-c amplifiers and averages one mv referred to the input grid. Over its rated operating range this amplifier is linear to $\pm\frac{1}{2}$ percent. Although no choke is used in the B-supply filter, the 60-cycle hum appearing across the output terminals is less than one mv referred to the input grid. Response of the amplifier is flat from zero to 20 kc for gains from 1 to 15.

The operating range of the output for which the amplifier of Fig. 1 retains its linearity of $\pm\frac{1}{2}$ percent is $\pm$ 10 ma into a load of 50 to 1,000 ohms. By changing the cathode resistor in the output stage, the amplifier can be made to develop $\pm$50 volts into loads greater than 50,000 ohms with a linearity of $\pm\frac{1}{2}$ percent.

Adjustment

There are only three points of adjustment; R_a, R_b, and R_n in the amplifier of Fig. 1 and two of these are used infrequently. Potentiom-

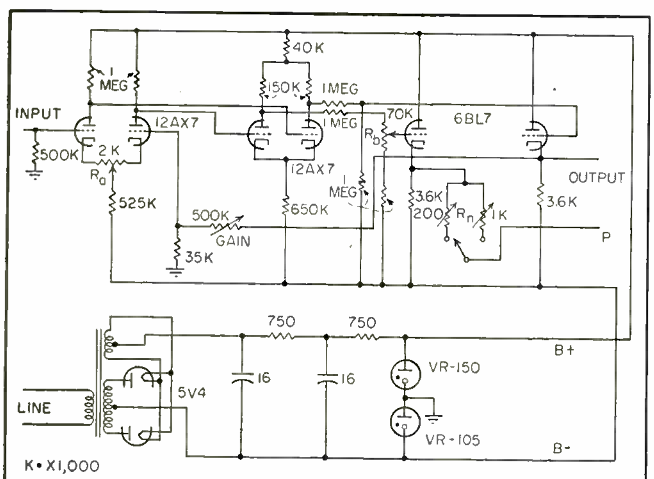
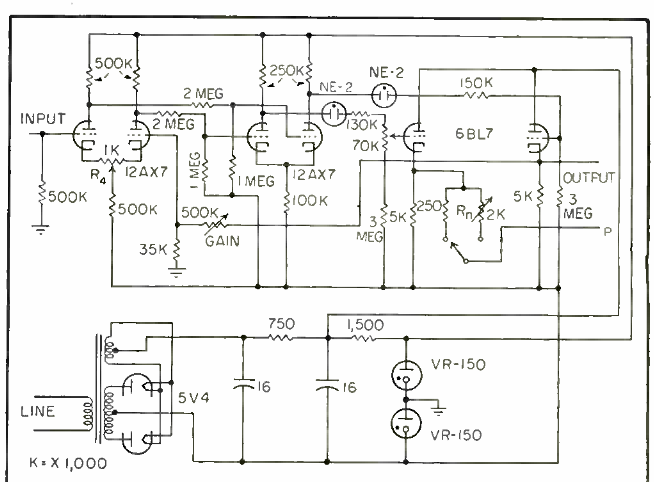


FIG. 1—Schematic diagram of the d-c amplifier. Double-ended output stage acts like single-ended output without the usual load current change



Modified version of the amplifier and power supply shown in Fig. 1. This circuit is designed for driving both photographic recorders and direct-writing recorders

D-C Amplifier

By DONALD McDONALD

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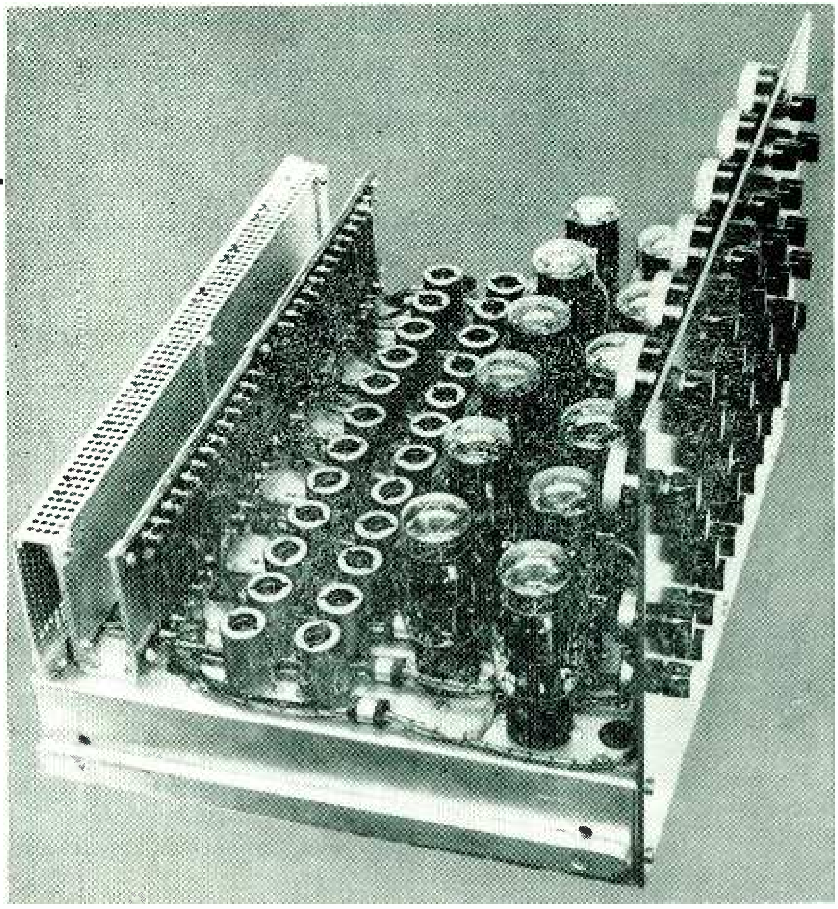
eter R_a is a zero adjustment used to bring the output to ground. Potentiometer R_b is adjusted infrequently and is used to bring the cathode of the left-hand half of the output stage to ground. Potentiometer R_n is touched only when the output load of the amplifier is changed and it is then adjusted for neutralization of the load current flowing to ground. Proper adjustment of R_n is accomplished by inserting a milliammeter at point *P* and adjusting R_n until the meter reading is less than 0.5 ma for full-scale output. Fortunately, this adjustment of R_n is not very critical.

These new d-c amplifiers were developed by the author for driving galvanometer elements of photographic oscillograph recorders used in the playback of multiple-channel magnetic recording systems. In the playback of these systems, permanent visible records were made of as many as 12 channels at one time. This required 12 d-c amplifiers to drive the 12 galvanometer elements.

When the d-c amplifiers use output tubes capable of delivering about ±50 ma and ten or more such amplifiers are powered from one B supply, the load current flowing to ground may cause distortion unless considerable care is taken in adjusting R_n. If it is difficult to adjust R_n satisfactorily then a B supply of the type shown in Fig. 2 will supply these amplifiers without accompanying distortion.



Bank of 12 driver amplifiers capable of delivering ±50 ma into 100 ohms used for driving 12 galvanometer elements

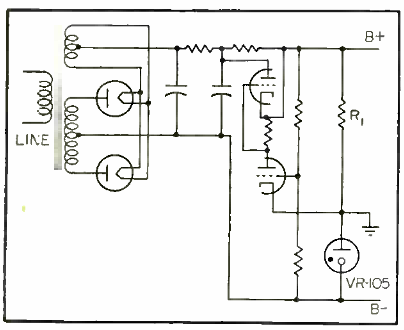


FIG. 2—Schematic diagram of power supply for driving ten or more amplifiers with outputs of about ±50 ma each

The supply of Fig. 2 also uses a voltage divider to provide a ground return. This voltage divider is composed of a resistor R_1 and a VR tube. A regulator circuit is employed, but, as will be noted, the regulating tube is shunted by a resistor which carries the majority of the supply current, because the regulator tube must correct for only small variations in load current.

If excessive unneutralized load current flows to the center of the voltage divider, the voltage across the VR tube may increase. This increase is sensed by the regulating circuit, and the total supply voltage correspondingly increases so that the mid-point or ground return of the divider still remains at the same relative position between B− and B+. Because of the balanced stages used throughout the amplifier, such an increase in the overall supply voltage does not produce appreciable drift or distortion when the ground point remains at the same relative position between B+ and B−.

A modified version of the amplifier and B supply of Fig. 1 makes the fullest use of the power capacity of the 6BL7 output tube. In this circuit, the second stage was redesigned to increase the drive of the output stage. The B supply has been increased to permit a larger swing of the output stage. This amplifier can deliver ±20 ma into a load of 50 to 1,500 ohms, with a linearity of ±½ percent.

Tone-Burst Generator

Transient distortion of loudspeakers, enclosures, microphones and networks can be measured quickly and easily by system reducing such distortions to numbers for comparison. Information supplements sound-pressure curves for better evaluation

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OF MANY FACTORS involved in reproduction of sound, transient distortion is the one measured most rarely. The loudspeaker-enclosure combination is the most serious contributor to this type of distortion.

The three basic driving-force or input functions used in transient work are the suddenly applied sine wave, the unit step function and the unit impulse or delta function. For loudspeaker considerations, it was felt that the simplest and most convenient automatic transient recording system should use the tone-burst type of input signal, a form of the suddenly applied sine-wave method.[1]

A tone consisting of a given number of cycles is applied to the loudspeaker and then turned off for an equal period. All sound coming from the loudspeaker during the time the burst is turned off is recorded on a level recorder as transient distortion. For such a signal, the buildup and decay transients are essentially the same so it does not matter which is measured.

With this recording system, transient and steady-state curves are drawn with the same recorder on the same sheet of paper since both systems measure the full-wave rectified average value of the wave form. Results are expressed in the db difference between the sound pressure and transient curves. This can easily be converted to percentage values.

Equipment Description

The block diagram of the system is shown in Fig. 1. An oscillator of the beat-frequency type is applied to a gate in which the signal is interrupted to produce bursts of tone 4, 8 or 16 cycles long, followed by equal off periods. The bursts feed a power amplifier which drives the loudspeaker. The loudspeaker and a microphone are placed in an acoustically dead room and the microphone develops a voltage proportional to the sound-pressure output from the loudspeaker. This voltage is amplified and applied to a second gate circuit which eliminates that portion of the transient output corresponding to the original burst portion of the signal. The hangover, or transient distortion, corresponding to the sound output when the input signal is turned off, is then applied to the recorder.

To generate the pulses necessary to operate the two gates, the oscillator output is fed to a limiting amplifier where the sides of the wave are made steep enough to trigger a binary counter.[2] Output from the counter operates a flip-flop circuit driving the gate of the tone-burst generator. Two delay networks are driven by the square-wave output from the flip-flop but the waves are 180 deg out of phase.

Two paths of the delay network are adjusted to delay the gating pulses applied to the tone-burst eliminator by the time required for the sound to travel from the loudspeaker to the microphone. Waveforms at each point of the block diagram show how this is done with the use of differentiators, clippers and delay multivibrators. Output of the delay network then feeds the second flip-flop circuit driving the gate of the tone-burst eliminator.

The circuit diagram in Fig. 2 shows the limiting amplifier and the five-stage counter. All voltages are given for normal operating conditions. The limiting amplifier uses four 6AH6 tubes driven into the

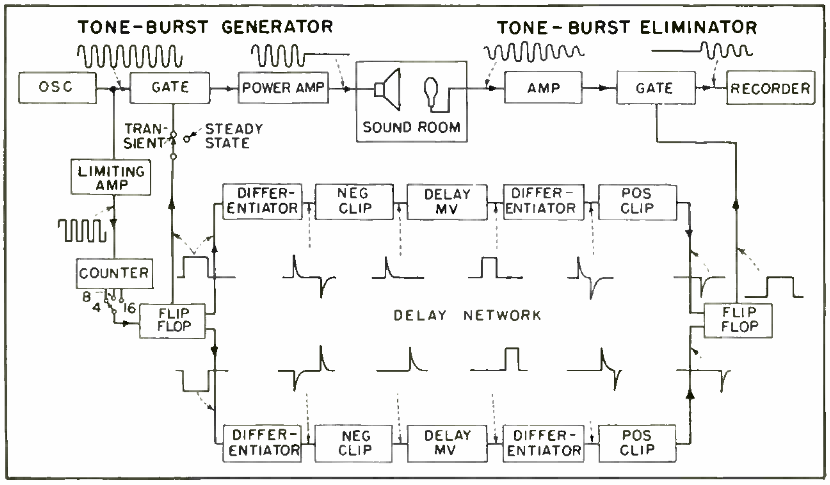

FIG. 1—Block diagram of the transient recorder

Checks A-F Transients

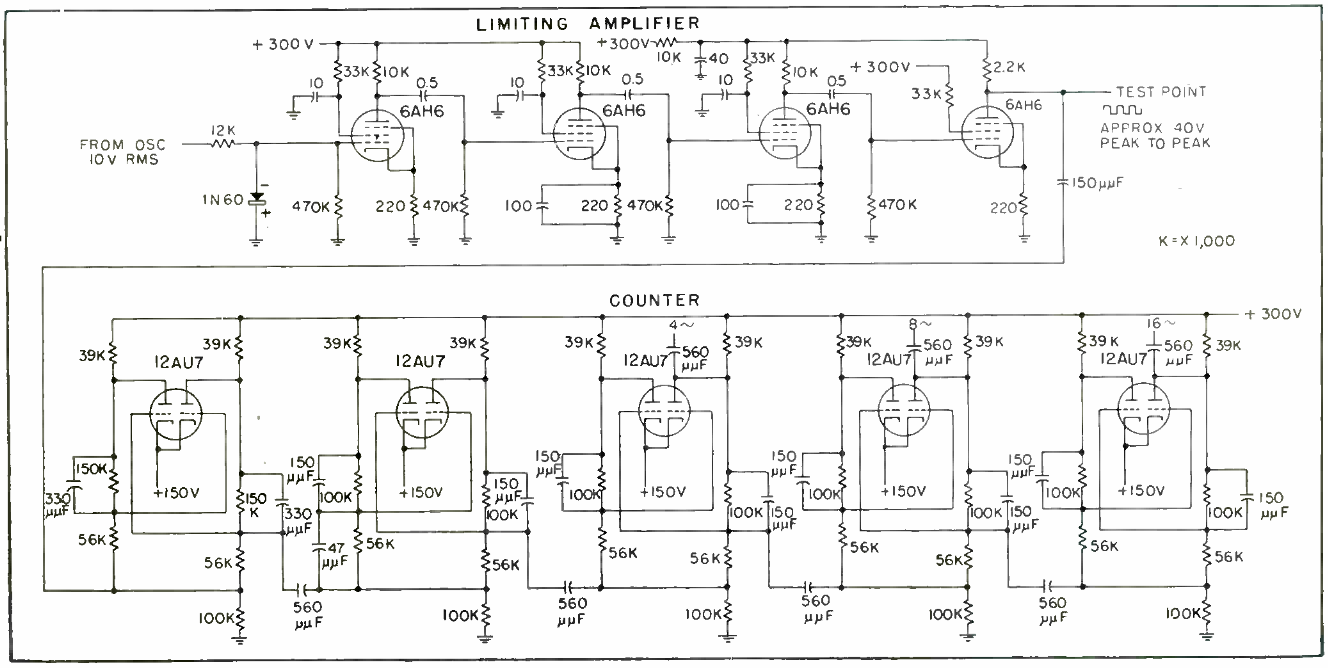

FIG. 2—Schematic diagram of the limiting amplifier and the five-stage counter

grid-current region. These tubes were chosen to get the greatest gain for a given bandwidth. It was found necessary to use four stages of amplification to obtain a square-wave output with a rise time fast enough to trigger the counter at low frequencies.

The square-wave output from the limiting amplifier drives the first tube of the binary counter, which operates like a frequency divider. For every two pulses into each counter tube one pulse comes out. The binary counter is essentially a multivibrator with two stable states. Operation of all five counter tubes is the same except that each one operates at one half the frequency of the tube ahead.

The points marked 4, 8, and 16 cycles are pick-off points for the square-wave signal operating the flip-flop tube. The square-wave period is determined by the number of cycles (4, 8, or 16) of the original sine wave from which all the pulses are derived. Slight variations in the first two counter circuit elements were made to increase the stability of operation.

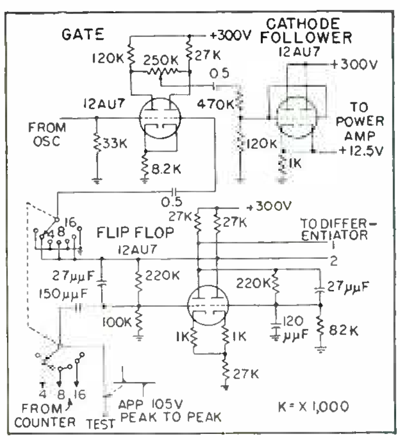

FIG. 3—Tone-burst generator schematic diagram

The circuit for the tone-burst generator is shown in Fig. 3. The 12AU7 gate tube normally has the right side conducting, thus bringing the cathode voltage up and cutting off the left half of the tube. When a negative square wave from the flip-flop is applied to the right-hand grid, the right side of the gate is turned off and the left side conducts. This allows the left half of the tube to operate as a class-A amplifier. The grid is allowed to float and set its own bias.

The right-hand grid bias varies the tube from saturation to cutoff. The potentiometer in the plate circuit of the gate balances out the d-c component. The output is then attenuated with a voltage divider to prevent overloading the cathode follower operating into a 500-ohm load.

Delay Network

The delay network circuits are shown in Fig. 4. Square-wave inputs are applied to the differentiators to produce sharp pulses. The crystal-diode clippers remove the positive pulses. The negative pulses are applied to the grids of the limiting amplifier, which inverts and amplifies the pulses. The combination of the diodes and limiting-amplifier stage is therefore equivalent to a negative clipper. The amplified positive pulses are used to trigger the delay multivibrators. The delay time is adjusted by the variable 5-meg resistor in the grid circuit.

Normally, the right half of the delay multivibrator tube is conduct-

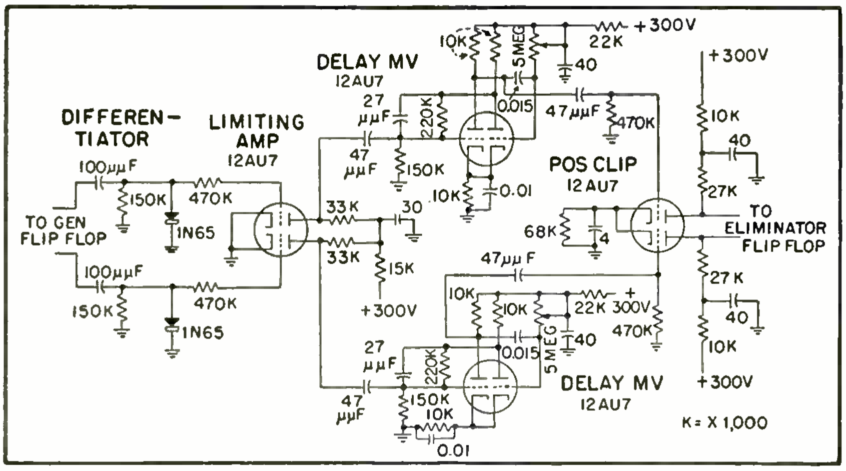

FIG. 4—Schematic diagram of the delay networks

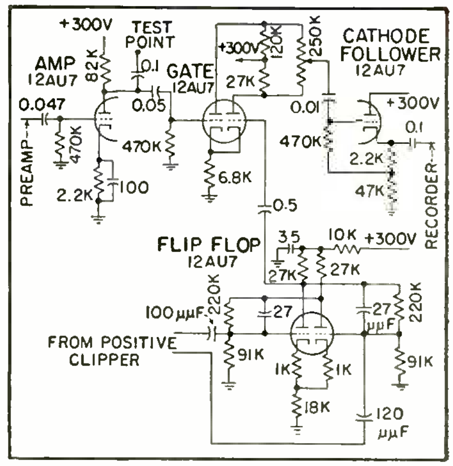

FIG. 5—Circuit of the tone-burst eliminator

ing and the left half is cut off. When a positive input pulse is applied to the left grid, the left half of the tube fires and the right half is cut off. This firing time is determined by the R-C time constant of the 0.015-μf capacitor and 5-megohm variable grid resistor. The delay is normally set for about 2 milliseconds since sound-pressure curves are drawn with a microphone distance of two feet.

The differentiated output of each multivibrator is then fed to the grid of the 12AU7 positive clipper. Clipping is obtained by the use of a large cathode resistor which cuts off both tubes so that after inversion in the tube only negative pulses can be produced in the output.

The tone-burst eliminator is shown in Fig. 5. The negative pulses from the positive clipper cause the 12AU7 flip-flop circuit to operate in the same manner as the tone-burst-generator flip-flop. The output square wave of this flip-flop then opens and closes the 12AU7 gate tube of the eliminator. The generator and eliminator circuits operate in essentially the same manner. The amplified signal from the microphone is observed at the test point.

Equipment Operation

When the transient distortion of a system is measured, three curves are drawn. The steady-state or sound-pressure curve is always drawn for a reference. To make this curve directly comparable with the transient curves it is drawn in exactly the same way as the transient curves except that the speaker is not pulsed with the tone-burst but has a steady tone of variable frequency applied to it.

Microphone Channel

The microphone channel is gated with the tone-burst eliminator so that the recorder receives a signal 50 percent of the time, the same as when the transient curves are drawn. The rectified average value of this wave is recorded and experience shows that the resultant curve shape is always within 0.5 db of the curve obtained when the recorder is fed with an ungated signal, but is 6-db down. To obtain the best presentation of the transient distortion of loudspeakers, the transient distortion curve is drawn in two parts to cover the range of 30 to 15,000 cycles.

The low-frequency end of the spectrum is measured with four cycles on and four off and the high-frequency end is measured with 16 cycles on and 16 off. The changeover frequency at which one curve stops and the other starts is not critical but 200 cycles is normally taken since this frequency is between the fundamental resonance and the cone-breakup resonances for most loudspeakers.

Below 200 cycles the recorder tends to follow the 16-cycle burst instead of averaging it. For enclosure studies the four-cycle burst can be used throughout the range since there are few resonances above 1,000 or 2,000 cycles in most enclosures.

The equipment is designed to operate only when the delay time is less than 85 percent of the period of the highest frequency burst. The delay network has no memory and as the period of the incoming wave approaches the delay time at high frequencies, instability will result. This is because the delay multivibrator cannot be triggered again until it has returned to its previous stable-state condition.

In the initial setup of the equipment, it is necessary to adjust the delay multivibrators so that the beginning and the end of the original

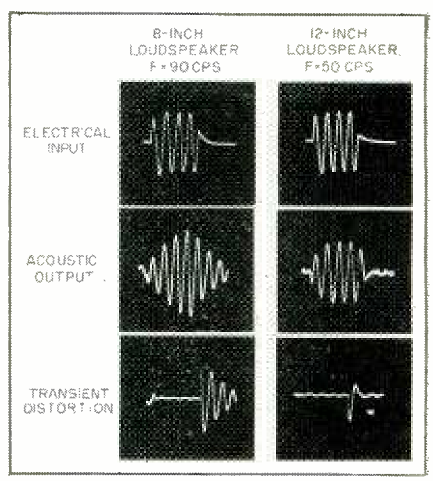

FIG. 6—Voice-coil current, acoustic output and transient distortion for two loudspeakers each operating at the fundamental low-frequency response

burst are just eliminated by the tone-burst eliminator. This can be done most accurately at the high-frequency end of the range of the particular loudspeaker being tested. It is also necessary to carefully balance out any d-c component in the signal fed to the recorder by means of the balancing potentiometers in the plates of the gate circuit since an unbalance will record as transient distortion. Once these adjustments are made, they need be checked only occasionally during the operation of the equipment.

Experimental Results

The oscillograms of Fig. 6 show the voice-coil current, acoustic output and transient distortion for two loudspeakers, each operating at the fundamental low-frequency resonance.

The electrical input to each shows a slight distortion of the wave due to the limited bandwidth of the amplifier but the waveform is still reasonably good.

The eight-inch loudspeaker is a conventional one with a small magnet and low flux density in the air gap. The 12-inch loudspeaker has a very large ring magnet and the mechanical design also incorporates some acoustic damping. These units show the two extremes in low-frequency transient response of loudspeakers.

Figure 7 shows the sound-pressure and transient-distortion curves of the same 12-inch loudspeaker. The ordinate is in db for all curves and zero db is arbitrary. Note the lack of rise in either curve at the low-frequency resonant frequency of 50 cycles. This is characteristic of all expensive large-magnet units. The 16-cycle transient curve always has lower amplitude than the four-cycle transient curve since the decay is averaged over a period four times longer.

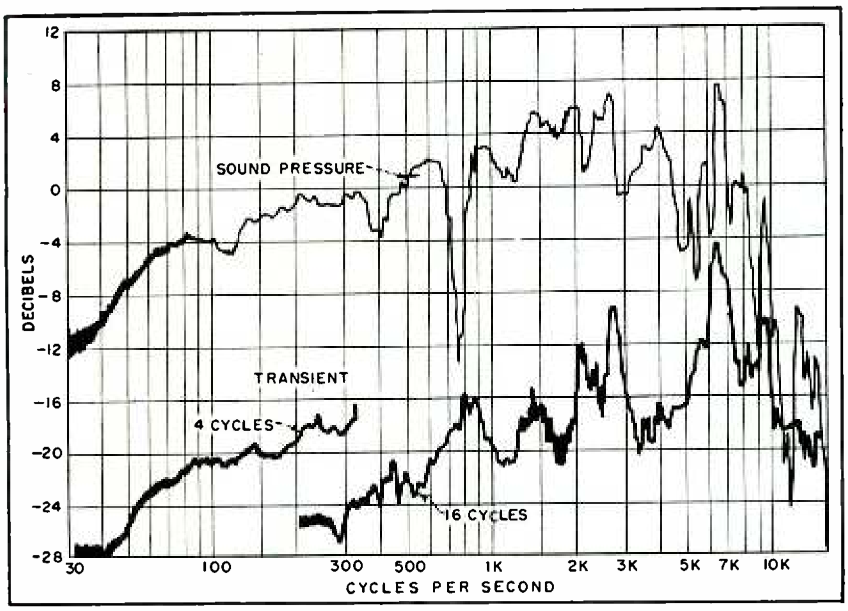

FIG. 7—Sound-pressure and transient-distortion curves for the 12-inch loudspeaker of Fig. 6

The cone begins to act as a transmission line at about 700 cycles and the first major vibrational mode occurs at 800 cycles.[3] This is associated with a dip in the sound-pressure curve and a peak in the transient curve. The next major mode, shown by the transient curve, occurs at 1,400 cycles. This peak corresponds to a peak in the sound-pressure curve. At 2,100 and 2,750 cycles, respectively, two more peaks occur. At higher frequencies the transient response becomes progressively worse.

Figure 8 shows the waveforms associated with the 2,750-cycle resonance. A simple tuned circuit with approximately the same transient response is shown for comparison. Note that the Q of the equivalent tuned electrical circuit is eight.

Conclusions

It is now possible to draw loudspeaker transient distortion curves quickly and easily. The system described isolates and reduces transient distortion to numbers for comparison purposes. Any speaker with less than 10 to 12.5 percent transient curves, 18 to 20 db down, over its useful range is comparable to the best loudspeakers measured. It is felt that this information supplements sound-pressure curves and enables a better evaluation of the variations in these curves, including diffraction effects. The equipment is also useful in measuring transient distortion of enclosures, microphones and networks. It is a very helpful design tool for studying loudspeaker cones.

The author wishes to acknowledge the helpful advice and suggestions of Murlan S. Corrington in preparing this paper.

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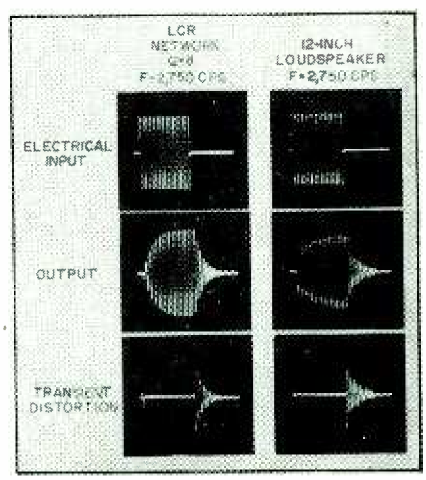

FIG. 8—Waveform associated with 2,750-cycle resonance

Ultrasonic Ranging

Equipment showing increased echo amplitude from cancerous tissue has been used in cancer diagnosis. Results have been confirmed in 20 operations. Crystal transducer is coupled to tissue by water column

X-RAY IS OF LITTLE USE in very early diagnosis of cancer, the existence of which can be confirmed definitely only by microscopic examination of removed suspect tissue. However, ultrasound, since it is a form of mechanical energy, may be employed to investigate tissue properties.

The instrument shown in the photographs detects reflections of ultrasonic energy from acoustic impedance discontinuities between tissue elements of differing elastic properties. Termed the Echograph, it has been used with promising results in efforts to diagnose cancer in 20 human breast tumors before operation, to examine a brain tumor during operation and for laboratory studies.

Preliminary work[1] was carried out using an ultrasonic radar trainer, AN/APS-T3, at its operating frequency of 15 mc.[2] Discovery that internal reflections from cancerous tissue were of greater amplitude than those from surrounding normal tissue prompted development of the portable instrument to be described.

The same crystal transducer is used both to transmit pulsed ultrasound and to pick up reflected echoes. By displaying echoes from a narrow sound beam on a linear time-base cro sweep, confusion from the presence of many structures is greatly lessened.

Frequency Considerations

Frequencies in the megacycle range are necessary to keep wavelength short at the mean velocity of 1,540 meters per second[3] for human muscle tissue. As the frequency is raised, trouble with diffraction effects is lessened and resolution is improved. However, since attenuation by tissue increases with frequency, range is decreased at higher frequencies.

Since crystal transducers must be operated at mechanical resonance to obtain sufficient sensitivity, the frequency of operation depends also upon the crystals available. The limited bandwidth of resonant crystals also affects resolution, placing a lower limit on the length of the transmitted pulse. Damping of the crystal may be used to increase bandwidth.

This investigation was supported by a research grant from the National Cancer Institute of the National Institutes of Health, U. S. Public Health Service.

The crystals used,[4] X-cut, quartz discs thickness-resonant at 15 mc, have a minimum pulse length of about 0.5 microsecond. The crystals are operated undamped, one face radiating into a water coupling column and the other air backed. Mismatch between the acoustic impedance of quartz and air prevents radiation in the back direction.

System Operation

Referring to Fig. 1, the repetition-rate oscillator produces timing pulses at a rate variable from 400 to 4,000 pps. A rapid rate is used to permit short exposures when photographing the oscilloscope screen, minimizing blurring from breathing and other motion of the patient.

Brought to the desired width at sufficient amplitude, actuating pulses are applied to the clamp-tube-controlled oscillator which generates r-f pulses. Output pulses as short as 1.5 cycles at 15 mc can be generated by this circuit. However, the crystal stretches the acoustic pulse to at least 0.5 microsecond. This corresponds to a crystal Q of about ten. It is therefore important to avoid use of high Q circuits in the transmitter if further stretching is to be prevented. This is accomplished using nonresonant impedance coupling in a class-A voltage amplifier, and using the crystal itself as the only resonant element in the output power amplifier. This latter stage is operated class C with fixed bias so that advantage can be taken of the low duty

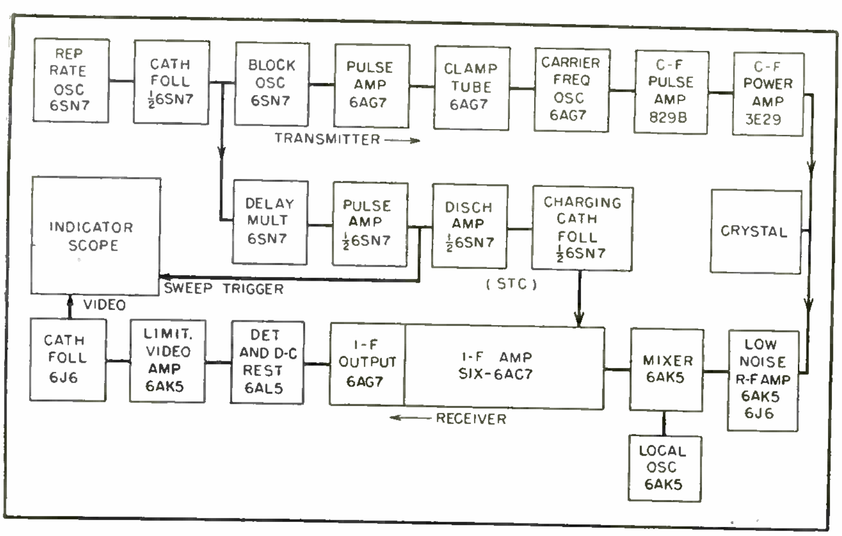

FIG. 1—Block diagram of ultrasonic echo-ranging equipment

for Cancer Diagnosis

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cycle by using a high plate voltage to obtain a high peak-power output. A peak power of about 1 kw is used.

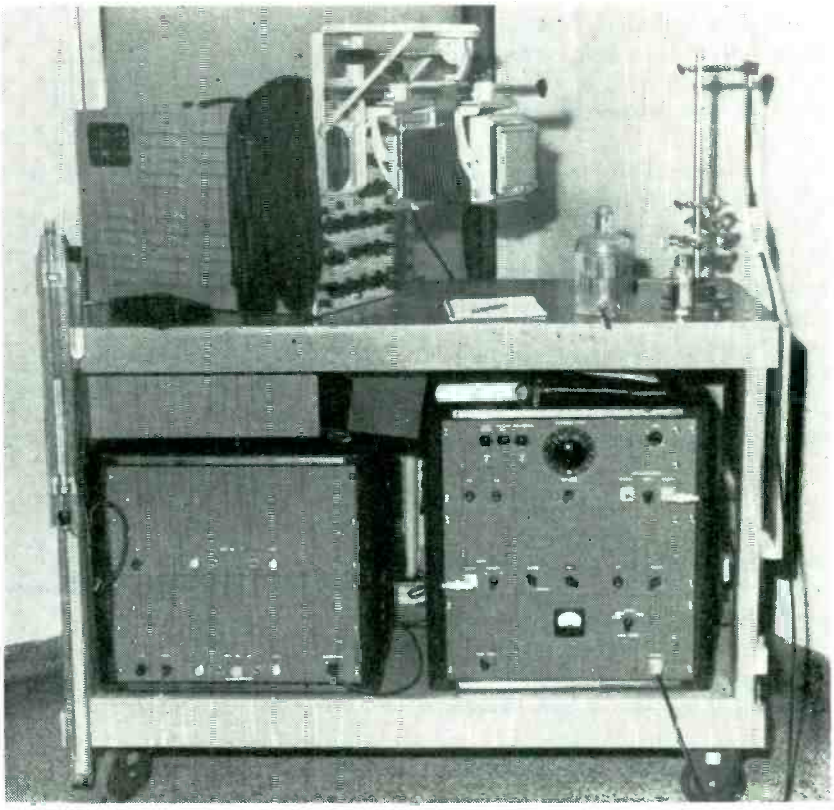
Details of the crystal coupling network are shown in Fig. 2. The coupling network allows both the transmitted pulse and the signals from reflected echoes to be applied through a matching L section to the grid of a low-noise, receiver-input stage.

Receiver blocking by the transmitter pulse is minimized by use of single-tuned, coupling coils connected from grid to ground. These provide a low-resistance path for grid current. Thus, the receiver recovers from the transmitted pulse more rapidly than the crystal, which produces a detectable voltage for about 30 microseconds after the applied pulse ends. The remainder of the receiver is conventional. Overall bandwidth is 4 mc with a gain of about 100 db. A wide-band oscilloscope is employed for presentation of reflected signals on a linear time-base sweep.

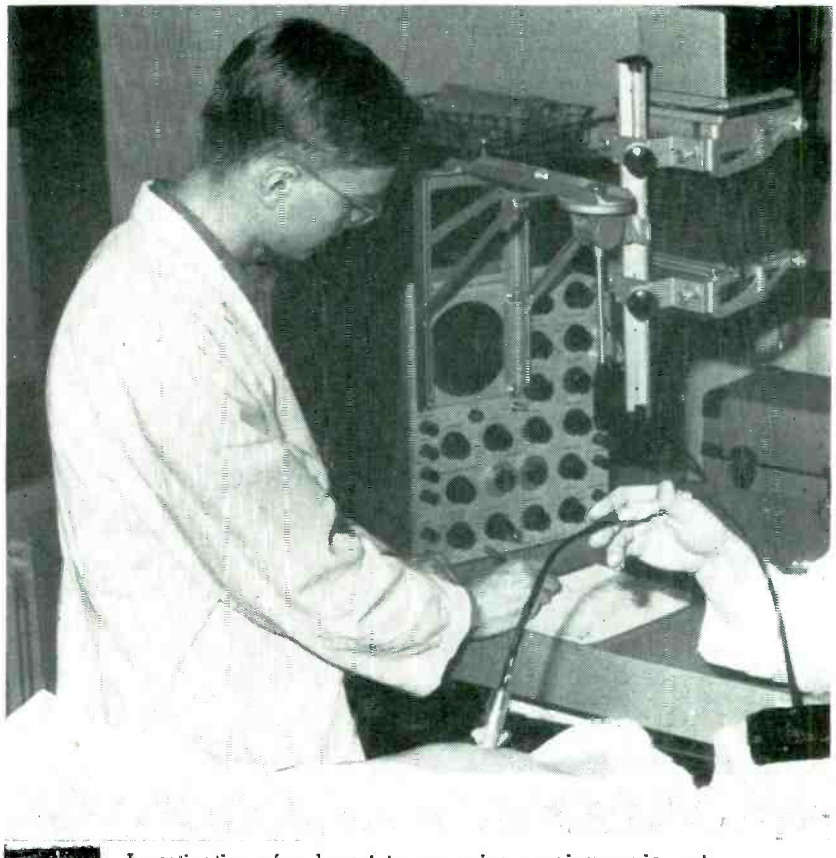
Zero Range

The problem of working to zero range is met by interposing a column of water between the crystal and the tissue, and sealing the assembly with a thin rubber membrane. The signal returned from this membrane becomes the zero-range marker, and arrives after both the transmitted pulse and the crystal's hangover have ceased. The delay multivibrator (Fig. 1) produces a pulse which starts the oscilloscope trace just before the membrane signal is received. The display thus utilizes the entire screen.

The water column conducts the acoustic pulse away from the crystal, and since it does not return



Ultrasonic echo-ranging equipment in use during laboratory examination of removed tissue specimens



Investigation of a breast tumor, using ranging equipment from the membrane until after the applied pulse ends, the crystal is effectively loaded at all times. When the load is removed during handling of the probe, the crystal is not in danger of fracture. The water attenuates the signal somewhat, but a part of the loss can be made up by increasing the pulse power.

This solution to the problem of achieving zero range has the disadvantage that multiple reflections of transmitted energy take place between the sealing membrane and the crystal face. The water column must therefore be long enough to make the second reflection arrive at the crystal later than the deepest signals of interest.

Depth of Penetration

The factor limiting the depth from which echoes can be received is the attenuation offered by intervening tissue. This effect is noticeable at 15 mc for only a few centimeters of depth, appearing as a large dynamic range between early and deep echoes with the result that echoes on the first part of the time base saturate the oscillograph screen.

Attenuation effects may be compensated for by making receiver gain an increasing function of time across the time base, synchronized with the operating cycle. This is the same solution used in radar systems to minimize close-in land or sea return, usually termed sensitiv-

Crystal probe applied to brain coverings after removal of the skull during a brain-tumor operation

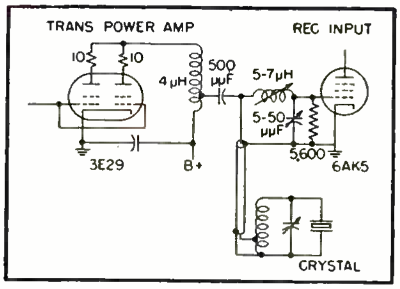


FIG. 2—Crystal coupling networks

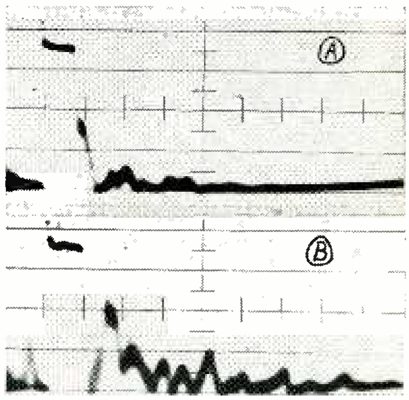


FIG. 3—Oscilloscope traces, showing echoes from normal brain tissue (A) and from a cancerous tumor in the same brain (B)

ity time control. This circuit (see Fig. 1) is actuated by the same delayed pulse that starts the time-base sweep and uses the buildup of voltage across a capacitor to obtain an exponential waveform. Voltage is impressed on the negative voltage used for gain control in the i-f amplifier. Receiver gain is therefore decreased coincidentally with receipt of the membrane echo and rises exponentially across the time base.

Present range of about two cm can be extended by further use of stc until the limit imposed by random noise in the receiver is reached. Increasing depth by the use of greater pulse power should be approached with caution, since the damage threshold on a pulse basis at 15 mc has not been definitely determined. Present power was checked by direct experiments on the living brains of laboratory animals, without producing detectable damage.[5] The present range has allowed examination of practically all breast tumors encountered.

For greater depths, where loss in definition could be tolerated, advantage could be taken of the reduced attenuation of lower frequencies.

Example

Typical oscilloscope traces are shown in Fig. 3. These particular records are from the first known attempt to localize and diagnose a brain tumor in a live human being by this method during an operation. The crystal probe, in a sterilized holder, was applied to the brain coverings after the skull had been removed.

Figure 3A shows echoes from normal brain tissue following the saturated signal received from the water-column sealing membrane. Figure 3B shows signals returned from suspected tissue. The subsequent operation confirmed the location of the tumor, and that it was cancerous (Glioblastoma Multiforme).

The differences illustrated in Fig. 3 have been found almost consistently with cancerous tissues of various types from different parts of the body. Comparison of normal and tumor echoes removes factors such as variation in system sensitivity, differences in crystal efficiency and variations from patient to patient.

Acknowledgement is due Henry E. Hartig of the University of Minnesota and Finn J. Larsen of Minneapolis-Honeywell for their kind help and advice, and to medical photographer Lloyd Wolf of the University of Minnesota.

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Nondistorting CRO Switch

Oscilloscope accessory uses miniature receiving-type tubes and permits simultaneous viewing of two signals from subaudio to ultrasonic frequencies. Distortion of signals is low, and internal amplifiers provide gain up to 28 for stepping up low-voltage signals

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IN MOST LABORATORIES, the simultaneous study of two separate phenomena is required only occasionally, but when the need does arise there is no simple substitute for an electronic switch. It is therefore desirable to have one available, but its cost and complexity should be held within reasonable limits since it is usually regarded as a stand-by piece of equipment.

The electronic switch shown in the photograph performs satisfactorily and yet its design is such that only a few hours and a handful of parts are required for its construction. A brief review of the reasoning behind its design is given prior to actual circuit description.

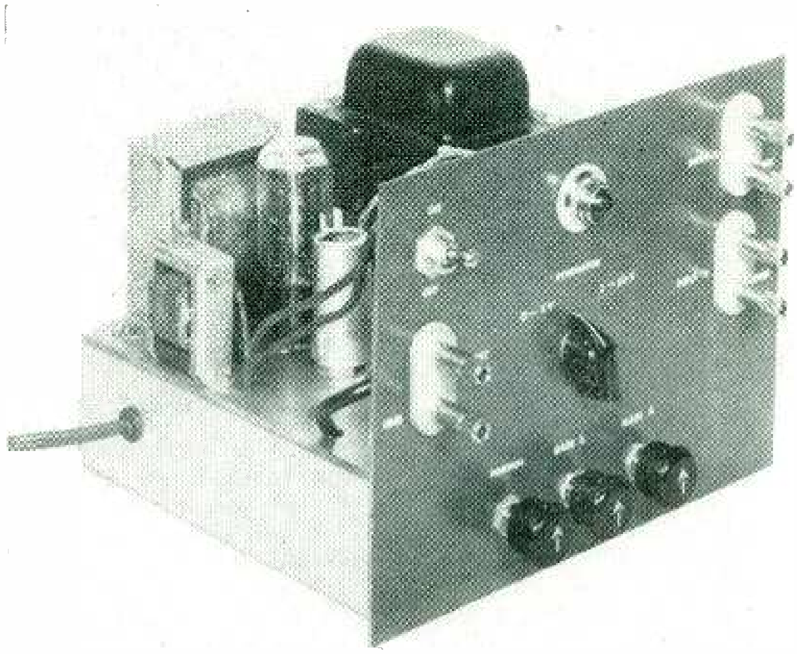
There are two basic methods of alternately sampling two signals for simultaneous display on the face of a single cathode-ray oscilloscope.

Slow Switching

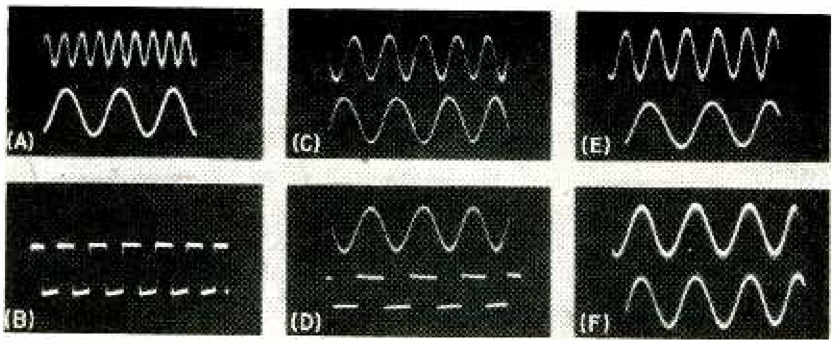
The first method[1], one which has been in use for many years, is to present on the oscilloscope face several cycles of one of the signals and then by switching to present several cycles of the other signal. By continuous repetition of the process both signals appear as continuous phenomena. Even though the switching rate is rather slow the picture may appear continuous because of the persistence of the cathode-ray screen and because of the persistence of vision. This process usually requires a reasonably low switching frequency, particularly when low-frequency phenomena are to be observed. This switching rate is usually made variable and must normally be synchronized with one of the input signals.

Fast Switching

The second method[2], which has found application in more recent times, has a high switching rate of fixed frequency and samples both signals continuously. Each signal is sampled many times during each cycle. This of course necessitates a switching rate which is much higher in frequency than the signal to be viewed. For example, if the switching rate is 25 kc and it is assumed that at least 10 samples per cycle are necessary to have reasonably good reproduction, then the highest signal frequency that



Simplified electronic switch employs readily-available tubes. Signals up to 20 kc can be displayed with almost no distortion



Oscillograms show (A) comparison of 180 and 60-cps sine waves, (B) 7,500-cps switching wave, (C) comparison of 120 and 60-cps sine waves, (D) 60-cps sine and square waves, (E) 5 and 10-kc signals and (F) 20-kc signals applied to each input

may be expected to be observed is approximately 2.5 kc. This second method of switching is normally considered to be primarily for the observation of low-frequency phenomena.

It has not been commonly realized that this second method of switching need not have so high a fixed switching rate nor be limited to viewing phenomena having signal frequencies much lower than the switching frequency.

The switch to be described has several distinct advantages. It uses a minimum number of tubes, namely three, and it permits viewing of all frequencies in the pass band of the gated amplifiers with only two fixed switching frequencies which are not harmonically related. Good signal amplification is provided.

Circuit Details

The circuit is shown in Fig. 1. The output of the 12AT7 square-wave generator alternately cuts off and allows conduction of the 6BE6 amplifiers at a rate of approximately 7,500 cps. Although the frequency is not critical, this value was chosen on the following basis:

Since this device was originally designed for the study of low-frequency signals, a maximum oscilloscope sweep frequency of 75 cps was arbitrarily set. Assuming a trace length of 4 inches and a sampling width of 1/50th inch, a square-wave is required whose period corresponds to a width of 1/25th inch. The switching frequency is therefore 4 × 25 × 75 or 7,500 cps.

The particular square-wave generator[3] used provides an excellent waveshape of sufficient amplitude and does so with a minimum of components. A good waveshape is essential to minimize the switch-over time of the amplifiers and keep each sampling as clean as possible for faithful reproduction.

In keeping with the idea of simplicity of design, a minimum number of tubes was used, and pentagrid tubes were employed because of their great versatility. Positive switching is assured by impressing the square waves on the control grids of the 6BE6's. Separation of the signals on the oscilloscope is accomplished by the difference in screen voltage obtained by the position control.

The gain controls and 10-to-1 attenuator permit input signals of up to 10 volts to be examined. Fixed bias of approximately 6 volts is required to prevent grid current flow and to minimize distortion. The maximum voltage gain of the amplifiers under these conditions is 28. Separation of the signals by varying the screen voltage should be kept to a reasonable amount, since the gain of the amplifiers is a function of the screen grid voltage.

Operation

When possible, the gain of the oscilloscope should be used as an aid to the separation of the signals. Since the screen circuits are symmetrical the signals may be positioned in any manner; either signal may be placed above or below the other or the two signals may be superimposed.

To view two periodic signals of different frequencies, a harmonic relation must exist between these signals, since the oscilloscope may be synchronized to only one frequency. This is a limitation imposed upon any type of electronic switch. No harmonic relation need exist, however, between the switch frequency and the signal frequencies. It will be shown later that it is actually undesirable that such a harmonic relation exist between the switch frequency and signal frequencies.

Although this switch was primarily designed for the viewing of low-frequency phenomena, it is possible to view signals of all frequencies within the response characteristics of the gated amplifiers. This may be explained as follows:

All frequencies passed by the amplifiers fall into two categories relative to the switching frequency: (a) Signal frequencies less than the switch frequency, and (b) signal frequencies greater than the switch frequency.

For signals under category (a), the simultaneous viewing is the result of sampling each signal many times per cycle, resulting in waveforms composed of a number of closely-spaced points. Examples of this type of operation are shown in the oscillograms. As the signal frequency increases, the number of samples per cycle decreases, which would suggest an upper limit on the signal frequency. This apparent upper limit would be determined by the minimum number of samples per signal cycle which would provide an acceptable presentation. Such an upper limit, however, does not exist except for the frequency limitations of the amplifiers. This can be seen by considering a signal frequency of say 5.02 kc and a switching frequency of 7.5 kc. With these frequencies the switch would sample 5.02/(2 × 7.5) or 0.334666. . . . cycles of the signal each time.

Synchronization

If the oscilloscope is externally synchronized by the signal under observation, but not synchronized with the sampling rate, then the sampling of the signal would be at a different place on each cycle.

With external synchronization the sweep would start at the same point on the oscilloscope and always be in synchronization with the signal. However, because the samples occur at different places on the signal they would run on the oscilloscope and consequently blend together, presenting a smooth and continuous waveform. The oscilloscope has in effect integrated the waveform.

Exceptions to the above occur when the signal frequency F_s or any of its harmonics, namely nF_s, is equal to the switch frequency F_o or any of the switch frequency harmonics mF_o. In other words, whenever the following equation is satisfied a signal might not be presented in an acceptable manner:

$$nF_s = mF_o \qquad (1)$$

where F_s = signal frequency, F_o = switch frequency, $n = 1, 2, 3, 4, \ldots$ and $m = 1, 2, 3, 4, \ldots$

This may be shown by considering the case where one signal frequency F_{s1} is 2/3 of the switch frequency, so that $n_1 = 3$ and $m_1 = 2$. Since F_o = 7,500 cps it follows that F_{s1} becomes 5,000 cps. Since the input signals must be harmonically related, the second signal is 10,000 cps and $2F_{s1} = F_{s2}$. Using Eq. 1 again, for the second signal $n_2 = 3$ and $m_2 = 4$. By choosing the signal frequencies in this manner it is possible to examine two cases at one time; that is, signals above and below the switch frequency and harmonically related to it. The waveforms of Fig. 2 indicate the type of presentation to be expected with this condition.

Drift

It should be remembered that if the switch frequency F_o or the signal frequencies F_{s1} and F_{s2} vary, the samples will drift on the oscilloscope. If this drift is fairly rapid the picture presented will be smooth and continuous. Under these conditions the vertical traces created during switchover will decrease in brilliance and become barely noticeable. If two switching rates, not harmonically related, are employed, whenever a combination of switching rates and signal frequencies gives a poor presentation, it is merely necessary to change to the other switching rate. Since the two switching rates are not harmonically related the new sampling rate will result in drift of the samples on the oscilloscope and hence a complete presentation will occur. Since the frequency of the multivibrator is controlled only by a single capacitor C, it is possible to obtain a two-frequency multivibrator by adding one capacitor and one switch.

On the other hand, if the signal frequencies are much lower than the switch frequency, so that $n > 10m$, a good waveform will result even with harmonic relationships being present, because there are a sufficient number of samples occurring in each signal cycle to give the illusion of a continuous trace.

The accompanying oscillograms show waveforms taken under actual test conditions. It has been found that if the input signal at the grids of the gated amplifier is limited to one volt the distortion is kept low even with full gain. However, higher quality reproduction is possible if the signals on the grids are kept somewhat below this level.

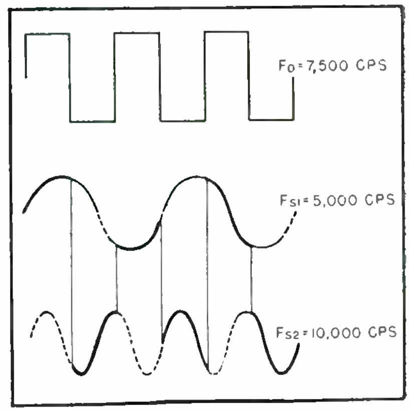


FIG. 2—Relationship between switch and signal frequencies

Operating experience with the instrument has shown that it is possible to view all recurrent-type phenomena within the pass band of the gated amplifiers by using only two fixed switching rates. By using fixed switching rates the multivibrator may be simplified as compared with a variable-frequency type of multivibrator. The switching rates may be close in frequency if desired, but must not be harmonically related.

The signals to be viewed may be either higher or lower in frequency than the switching rates and preferably not harmonically related to it. The switching rates need not be synchronized to any other signal; in fact it is desirable not to do so.

For best viewing conditions the oscilloscope sweep oscillator should always be externally synchronized to one of the signals.

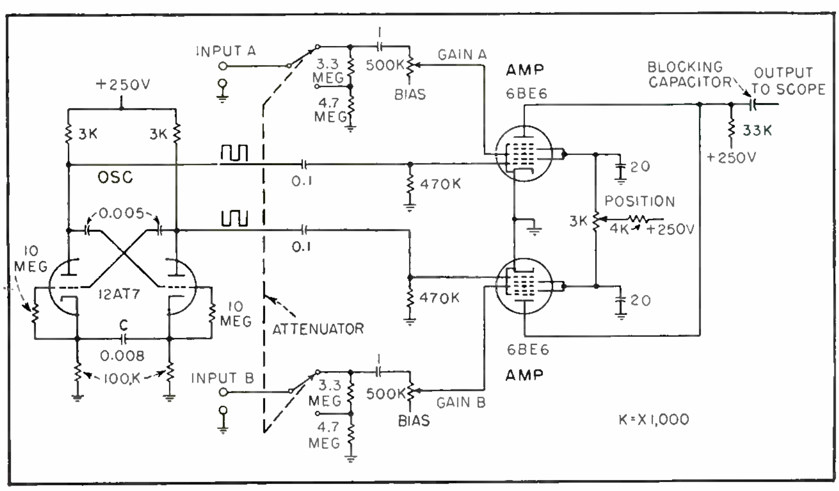


FIG. 1—Electronic switch uses 12AT7 square-wave oscillator to gate two 6BE6 amplifiers

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Protecting SENSITIVE

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MOVEMENTS of meters having full-scale readings of less than one ma can be protected against overload by electronic means. Fuses are not readily available for such sensitive meters.

Figure 1 shows an electronic protection circuit[1] that has been used previously in some test equipment. The circuit consists of a triode amplifier whose input is connected across the meter to be protected and whose output is d-c connected to a thyratron grid. When the voltage across the meter exceeds a predetermined value, the thyratron conducts and actuates a relay which opens the load circuit.

Current meters used in test equipment are often connected in the positive side of the load circuit in which case a separate power supply is necessary to operate the protection circuit.

The circuit of Fig. 1 does not provide protection against overload currents in the reverse direction through the meter. Also, the protection provided is not fail-safe in operation. The circuit of Fig. 2 was developed to overcome these deficiencies. The mechanical size and power consumption were also reduced.

The operation of the circuit of Fig. 2 is basically the same as that of Fig. 1. The following paragraphs explain points of differences.

Neon glow tubes are used as d-c coupling elements to reduce the overall voltage required. Protection against overload in the reverse direction is provided by the following means. For reverse current, the triode grid goes more positive. The plate voltage drops to a point where neon tube V_4 ceases conduction. The thyratron grid voltage then drops to ground potential and neon tube V_5 conducts. The resulting thyratron grid voltage is sufficient to cause the tube to conduct. Proper operating voltages are required to obtain equal protection in both directions.

To reset the circuit of Fig. 1, a reset switch is used to short-circuit the thyratron causing it to cease conduction. When the reset switch is opened, the thyratron may again be triggered to conduction by an anode-voltage surge generated by the stored energy in the relay coil. Reconduction is eliminated by connecting, with the aid of an auxiliary pair of relay contacts, a 20-μf capacitor and series resistor in shunt with the reset switch.

Resetting of the circuit of Fig. 2 or 3 is accomplished by opening the thyratron circuit. The load circuit is opened simultaneously to prevent meter overload while the protection circuit is inoperative. The contacts on the reset switch are mechanically interlocked so that the load circuit is opened before the thyratron circuit and closed in the reverse order. Either of the above methods of resetting appears satisfactory.

To provide fail-safe operation, the load circuit of Fig. 2 is open until current flowing through the relay coil closes the relay. This occurs at about the same time the protection circuit becomes operative.

With universal shunt multirange meters, the terminal voltage corresponding to full-scale deflection changes with the different ranges. In order to get the same protection, independent of range setting, the voltage across the meter coil is monitored by the protection circuit.

A voltage-regulator tube V_2 was introduced in order to improve reliability and stability particularly against line-voltage surges producing erroneous operation. The voltage-regulator tube may not be required in all cases.

Operation

Grid current flowing in the d-c amplifier tube V_3 is a potential source of error in the meter reading. Measurements were made to ascertain the magnitude of the grid current. Using a 1-μa full-scale d'Arsonval-type instrument, no deflection was noticeable for several 6AQ6 tubes operating with plate voltages of 85v and grid voltages of −0.75v. It was concluded that error from this source could normally be neglected.

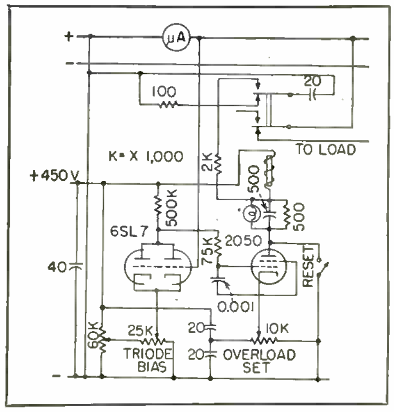

FIG. 1—Basic electronic protection circuit for low-current meters

The protection circuit has been successfully employed to protect meters having 30 to 50 mv corresponding to full-scale deflection. Resetting difficulties were encountered when employed to protect some 10-μa meters. These difficulties, due to stored mechanical energy in the meter movement, can be eliminated by placing a resistor of suitable value in series with the meter and using the voltage drop across this resistor to operate the protection circuit.

Adjustment of meter zero setting can be used to compensate for constant circuit leakage that cannot be eliminated.

The NE51 neon tubes are sufficiently nonuniform that the circuit will usually have to be readjusted when a tube is changed. The neon tubes should be aged several hours initially before adjusting the circuit. With these precautions, after a few minutes initial warmup, the

CURRENT METERS

Damage due to overload of microammeters and milliammeters can be prevented by use of electronic monitor circuit. Thyratron-operated relay opens the load circuit when voltage across the meter exceeds a predetermined value

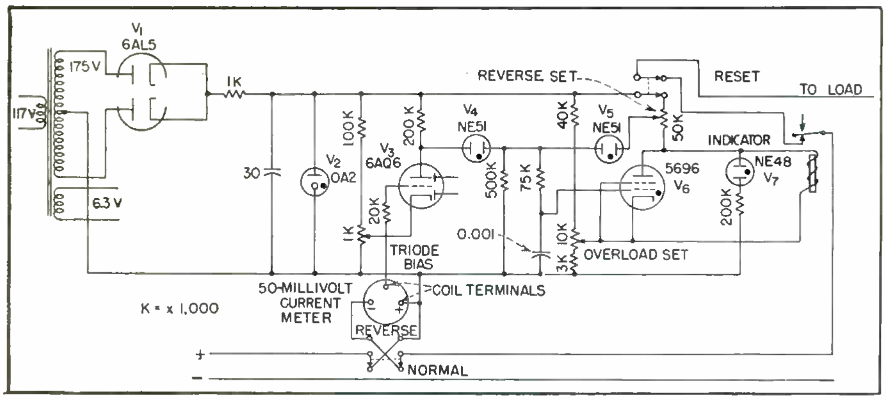

FIG. 2—Improved circuit with reverse-current protection and fail-safe operation. Voltage regulator V_2 prevents damage from line voltage surges

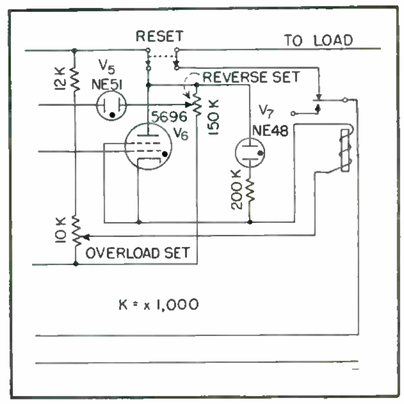

FIG. 3—Revised portion of circuit of Fig. 2 for fast operation

operation of the circuit is reliable and stable even with the overload point set at 1.5 times full load current. A more typical adjustment is to have the relay operate for 2 x forward current and 5 x reverse current. Reverse current protection need not be as good as forward current protection since it is much less likely to occur and since the meter movement is immediately brought to rest in the reverse direction. By careful adjustment, the same protection in both directions can be obtained if desired. For some operating conditions the neon tube will oscillate. This situation is not serious and has not caused improper operation.

Short-circuit protection is of considerable importance for meter safety. It is dependent in part upon the speed with which the relay coil is deenergized through the thyratron. The mechanical and electrical constants of the meter movement and the internal impedance of the power source are also important in determining short-circuit protection. The circuit of Fig. 2 provides reasonably good short-circuit protection.

To improve short-circuit operation, the time required to open the relay must be decreased. The circuit of Fig. 3 was developed to improve short-circuit operation by decreasing the relay operation time.

In this circuit the relay is normally nonenergized until overload occurs. By overdriving the relay, fast operation can be obtained. The time required to open the relay may be further reduced by changing the adjustment of the relay for more sensitive operation at the expense of less open contact pressure, and by increasing the relay overdrive.

Since the overload protection circuit is practically instantaneous in operation, some load-current surges, as for instance capacitor charging current, may operate the relay although the meter would not be in danger of damage. Relay operations caused by very rapid surges are eliminated by the R-C elements in the thyratron grid circuit. The R-C time constant must not be made too large, however, since meter protection against short-circuit overload conditions becomes worse.

Adjustment

The TRIODE BIAS, OVERLOAD SET, and REVERSE SET controls permit initial adjustment of the protection circuit. With V_5 and V_6 nonconducting and no load current, the TRIODE BIAS control is adjusted so that V_4 just conducts. The load current is then increased to correspond with the maximum overload current, and the OVERLOAD SET control adjusted to cause V_6 to conduct. If desired, the maximum overload current can be simulated by connecting a suitable d-c potential at the coil terminal leads.

To adjust the REVERSE SET control, reverse current is passed through the current meter of sufficient magnitude to cause V_4 to cease conduction. The REVERSE SET control is then adjusted so that V_5 conducts sufficiently to cause V_6 to conduct. Normally with this procedure of adjustment the reverse current required to produce relay operation will be comparable to the forward current required to produce relay operation. If this is not the case, the controls can be adjusted slightly to achieve the desired operation.

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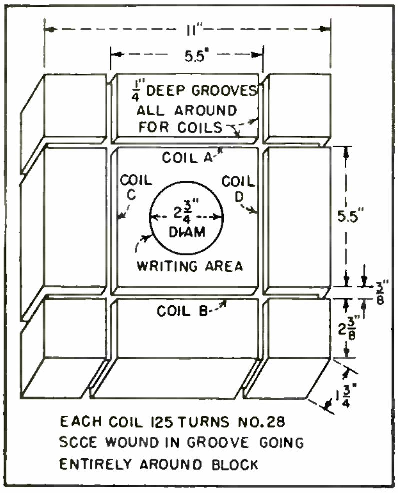

FIG. 1—Construction of wood form for the four rectangular pickup coils

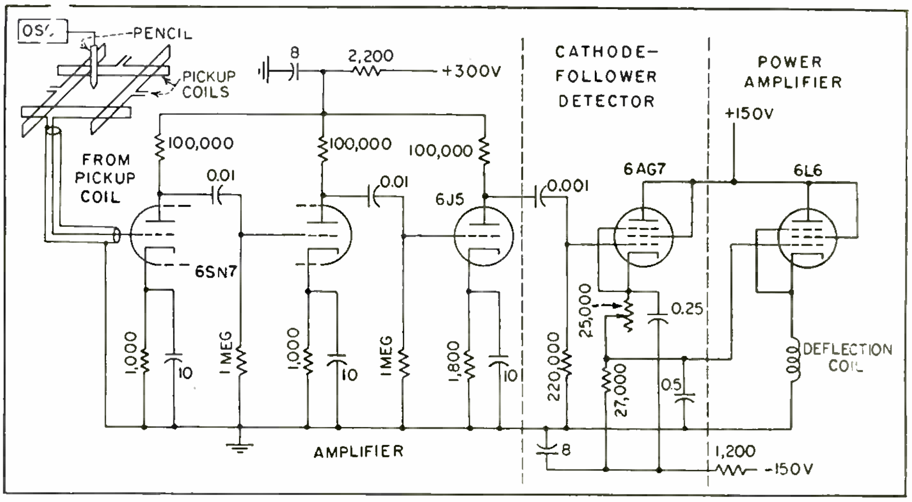

FIG. 2—Circuit of one of the four identical channels that amplify the 10,000-kc signals from the writing-table coils before and after detection

Scriptoscope Shows

Coil surrounding tracing pencil is fed by 10-kc oscillator, producing moving magnetic field that induces varying voltages in the four rectangular coils surrounding the writing board. Output currents are amplified separately and changed to varying direct current for c-r deflecting coils to give exact reproduction of handwriting on long-persistence screen

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When handwriting is to be reproduced electronically on a cathode-ray tube screen, this reproduction must take place simultaneously with the act of writing. The appearance of the trace on the screen should be a proper likeness of the handwriting of the particular individual operating the instrument, though the trace may be in any desired ratio to the original size of the writing.

The Scriptoscope utilizes the process of induction of voltages in suitably disposed coils to achieve this effect. A magnetic field alternating at a frequency of about 10 kc is produced by a small circular coil which is wound on the stylus or pencil used for the writing.

The desired writing is traced on the surface of a square wooden block having four long, rectangular coils wound around it, as shown in Fig. 1. The alternating magnetic field from the pencil induces, in these four coils, voltages whose magnitudes and phases depend on the position of the pencil.

Construction Data

The coil for generating the magnetic field consists of about 200 turns of No. 36 DSC wire wound in a groove 1 inch long and $\frac{3}{8}$ inch deep near one end of the pencil. The coil fills only part of this groove, and is covered with a layer of insulating tape for protection.

The exact number of turns for the coils is not critical. Small wire was used for the generating coil to allow production of a considerable magnetic field by a coil of relatively small size. The number of turns on the coils in the box is a compromise that avoids hum pickup while giving reasonable voltage at the coil terminals.

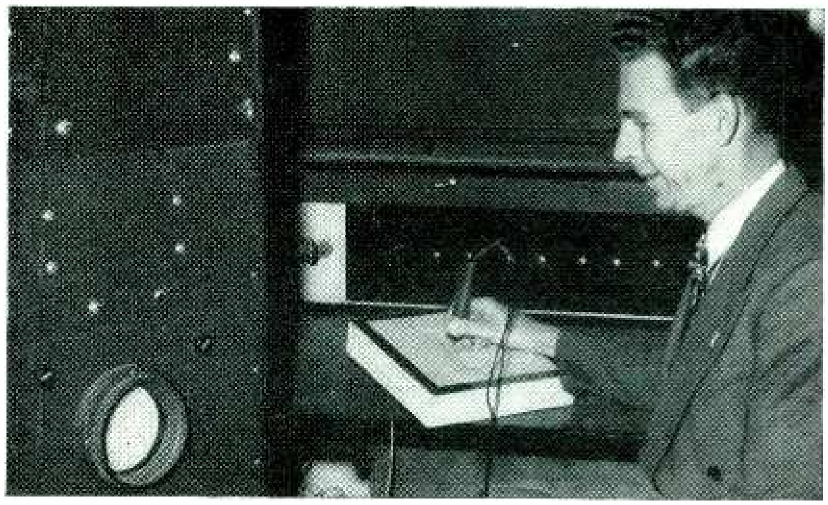
The difference between the induced voltages in the two side coils varies nearly linearly with the side-to-side position of the pencil (and generating coil) in the neighborhood of the center of the surface of the box. The difference voltage from these two coils on the edges of the box is thus representative of the component of the motion of the pencil in the lateral direction.

To make use of the region of linearity, only a small region in the center of the box is used.

The resultant voltages from the four coils are separately amplified, rectified and applied to the deflection circuits of a cathode-ray tube, as indicated in Fig. 2.

It was found convenient to am-

Example of writing as seen on cathode-ray screen



Using Scriptoscope pencil while watching resulting handwriting on rack-mounted cathode-ray tube

Messages on C-R Tube

plify and rectify the signal from each coil separately, since the deflection coils are arranged in pairs for both vertical and horizontal deflection in the cathode-ray section of the radar remote indicator unit used in the first model. A long-persistence screen on the cathode-ray tube allows easy viewing of the trace. The trace is blanked out between words or symbols by means of a switch on the pencil which operates as the pencil is removed from the box. This switch impresses a negative voltage on the grid of the cathode-ray tube which is of sufficient magnitude to cut off the electron beam.

Circuit Details

All four electronic channels employ the circuit of Fig. 2. The three amplifier stages have a gain of about 15 each. The output from the 6J5 final amplifier stage is applied to a linear detector having a resistor-capacitor combination in the cathode return. Direct coupling from this detector to the cathode-ray tube deflection coil is required to handle slow variations and steady deflections. Sufficient power for deflection is obtained from a 6L6 cathode-follower power stage driven from the detector, using the cathode-ray tube deflection coil as a cathode load.

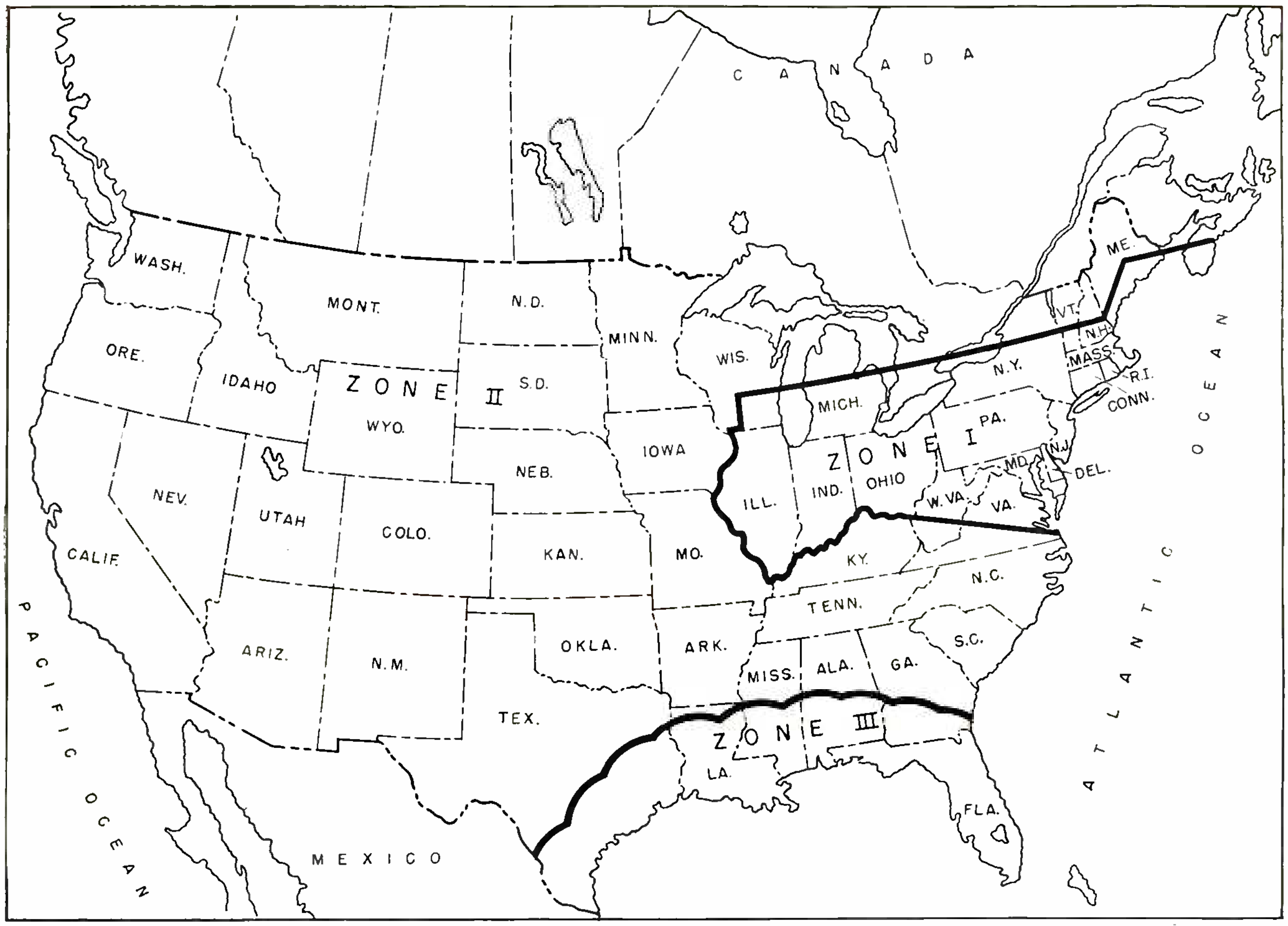
The power stage has its grid voltage centered about zero as a quiescent operating point by returning the detector cathode to a negative voltage supply. The use of the 6L6 as a cathode follower gives a good match to the deflection-coil load and quenches any tendency to oscillate arising from the distributed capacitance of the deflection coil.

A simple 6V6 Hartley electron-coupled oscillator (not shown) provides a signal for the generating coil of the pencil. Four separate conventional power supplies are used for the various parts of the system. A negative supply is used for the cathode-ray tube blanking voltage and for the return from the cathode-follower detector stages. A second supply provides +150 volts for the power output stages, the cathode-follower detectors and the Hartley oscillator. A third supply provides +450 volts (unregulated) for the plate potential and focus coil current for the cathode-ray tube and +300 volts (regulated) for the amplifier stages. The fourth supply is a conventional half-wave rectifier providing 4,000 volts accelerating potential for the cathode-ray tube.

The region of linearity on the box occupies a space of about 6 square inches at the center, at which point the coils are separated by about 5.5 inches. The gains of the four channels are kept approximately equal by choice of components. Centering of the spot on the cathode-ray tube to correspond to the center position of the pencil is secured by adjusting taps on the 25,000-ohm voltage dividers in the cathodes of the detector stages.

The ratio between the size of the actual handwriting and the writing appearing on the cathode-ray tube is adjusted by changing the amplitude of the current into the generating coil, thereby affecting the signal applied to all four channels in an identical way.

This article is drawn largely from a thesis, *Scriptoscope,* presented for the degree of Master of Arts in August, 1948 by A. G. Hubby, who is now with Magnolia Petroleum Co., Dallas, Texas. The authors acknowledge the loan of the cathode-ray tube assembly and other electronic components from the Defense Research Laboratory at the University of Texas operating under Contract No. NOrd-9195 with the Bureau of Ordnance, Navy Department.



Television zone map showing three areas in which standards differ

Maximum Coverage for VHF-UHF TV

Initial choice of transmitter sites and frequencies is facilitated by simplified curves derived from FCC rules. Power limits for two grades of service in the various zones are plotted directly upon antenna height vs distance graphs. Use of decibel scales permits adding antenna gain and subtracting line loss

As a result of three years of technical hearings and research, the Federal Communications Commission has recently adopted extensive revisions of the Standards of Good Engineering Practice and the Rules and Regulations Concerning the Television Broadcast Service.[1] These revisions provide for the allocation of television broadcast stations in the band from 470 to 890 megacycles, and "unfreeze" the expansion of television service on a national basis which has been held in abeyance since 1948.

The new rules make available 70 channels in the uhf band between 470 and 890 megacycles for television broadcasting, in addition to the twelve vhf channels presently available between 54 and 216 mega-

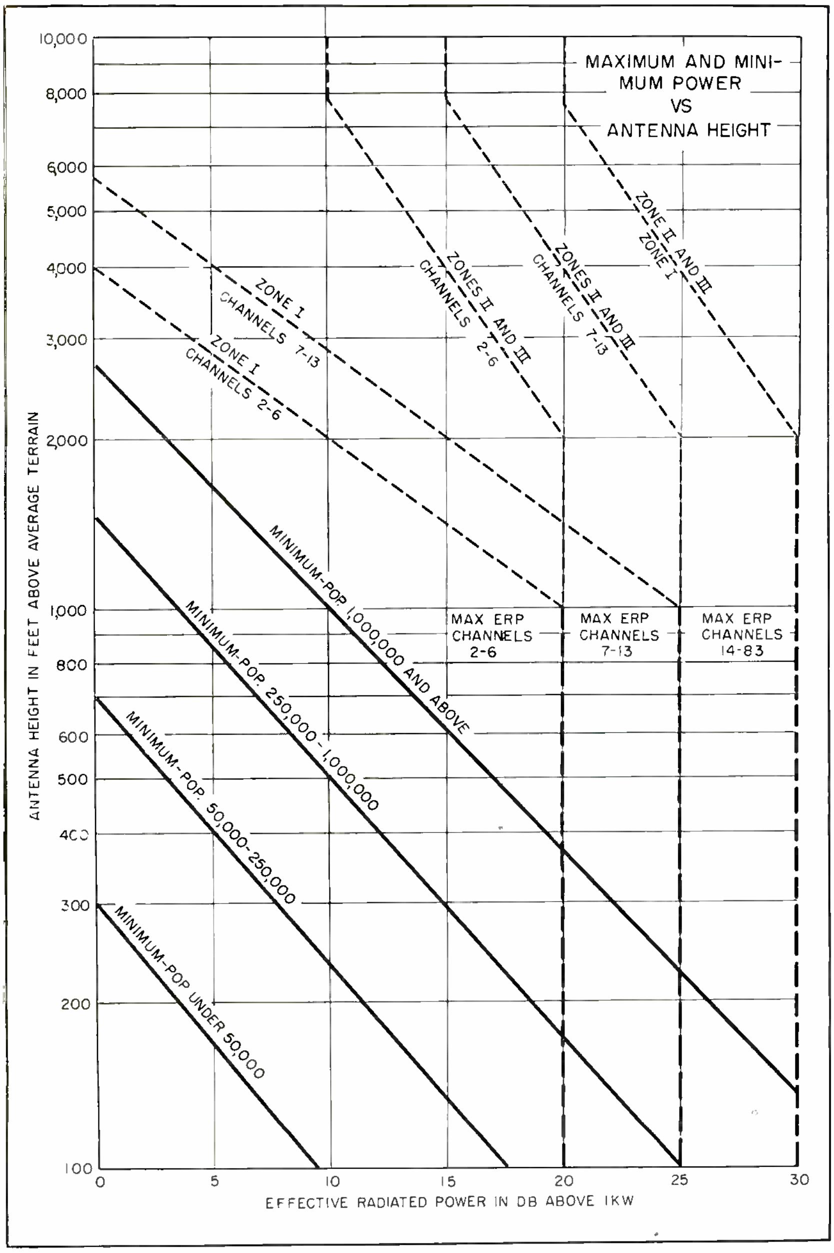


FIG. 1—Maximum and minimum power vs antenna height for all channels and zones

Table I—Required Median Field Strength in db Above 1 μv/m (dbμ) at Outer Limits of Service

Grade of Service	Channels 2–6	Channels 7–13	Channels 14–83
A	68	71	74
B	47	56	64

cycles. Of the important changes to be made in the engineering standards, one of the most significant is an upward revision of the maximum effective radiated power that may be transmitted by television broadcast stations, which will make possible substantial increases in the service radii of existing stations.

The maximum and minimum powers that will henceforth be used in television broadcasting depend on transmitting antenna height and the population of the city to

By **FREDERICK W. SMITH**

Radio and Allocations Engineering
National Broadcasting Co.
New York, N. Y.

be served as shown in Fig 1. For channels 2 to 6 (54 to 88 mc) a maximum of 20 db above 1 kw (dbk) of power may be transmitted for antenna heights of 1,000 feet or less; for channels 7 to 13 (174 to 216 mc) 25 dbk for antenna heights of 1,000 feet or less; and for channels 14 to 83 (470 to 890 mc) 30 dbk for antenna heights of 2,000 feet or less. For greater antenna heights, radiated power of a station must be derated as shown in Fig. 1, according to the particular zone of the country in which the transmitter is to be located. The zone divisions established by the FCC are shown in the map.

It will be noted that in the new standards, transmitted effective radiated power (erp) is expressed in terms of decibels above a reference level of one kilowatt or dbk. The maximum levels of 20, 25, and 30 dbk, therefore, represent power levels of 100, 316, and 1,000 kilowatts, respectively. Likewise, the FCC will henceforth specify field strength levels in terms of decibels above a reference level of one microvolt per meter or dbμ. This convention has the advantage that transmission-line losses and antenna gains may be directly subtracted and added to transmitter power output levels. A power increase of one decibel at the transmitter will result in an increase of a decibel in received field strength.

Coverage Prediction

Under the old standards that have been superseded, the coverage of television stations was described in terms of contours based on a median field strength of 5.0 and 0.5 millivolts per meter. In the new standards, the coverage of television stations is expressed in terms of two grades of service, which are defined in Table I. The grade A and B service classifications are essentially specifications of the extent of signal penetration that will prove to be satisfactory to the average urban or rural observer equipped with an average television receiving system, both from a subjective and a time-availability standpoint. According to the propagation characteristics of uhf and vhf, and considering the performance capabilities of the average television receiver and receiving antenna system, if the field-strength levels specified in Table I are provided, then the requirements for Grade A and B service will be met.

Another innovation is the inclusion in the standards of television field-strength curves that are based on a statistical analysis of the service rendered by the existing television stations. These replace field-strength charts, such as those in the old standards, or previously published elsewhere[2], which were based on the theoretical propagation to be expected over a smooth, spherical earth, and which did not take into account the statistical effects of terrain losses, or provide median field strengths. Figures 2, 3 and 4 represent condensed versions of these curves and are arranged to permit convenient and rapid computation of the distances to the Grade A and B service contours when the antenna height above average terrain and the effective radiated power of a station in dbk are known.

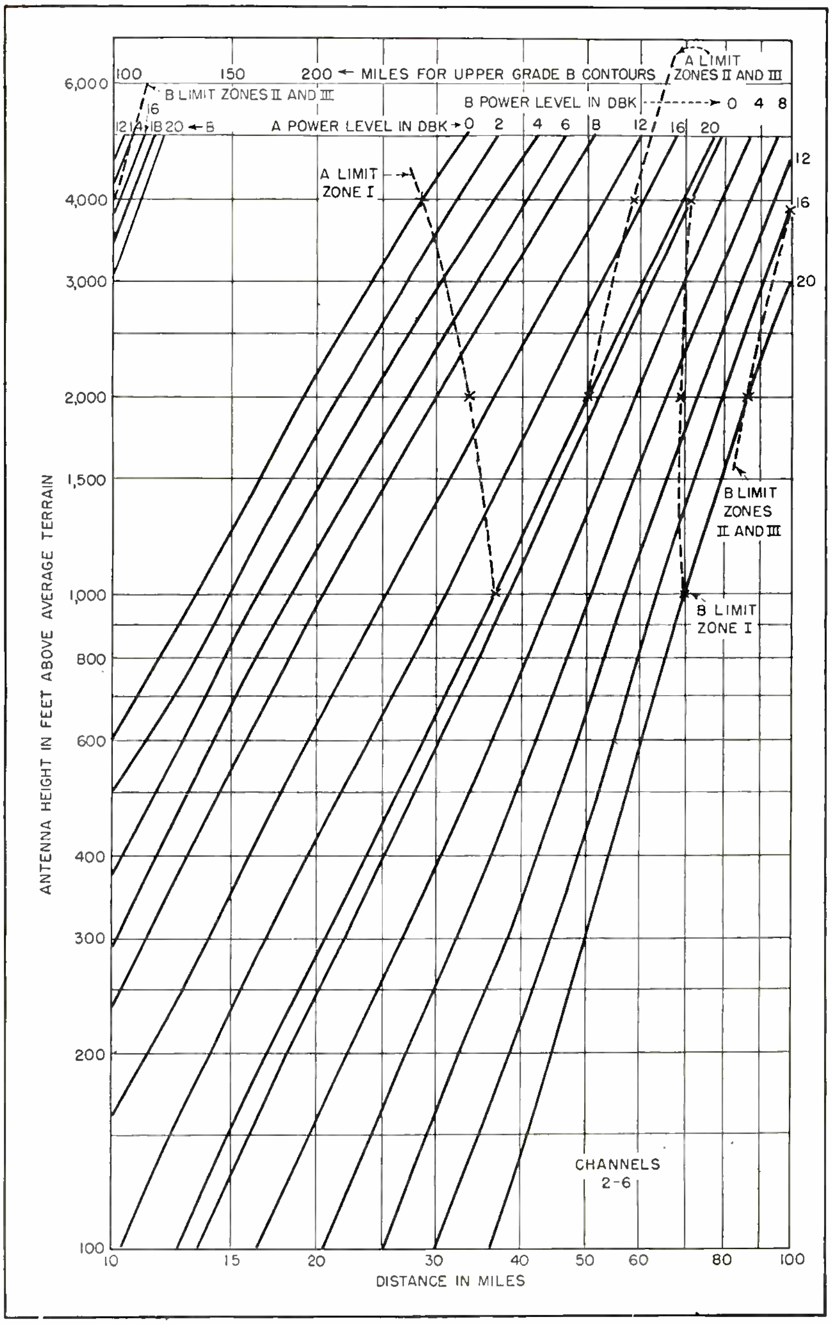


FIG. 2—Grade A and B contour distance for channels 2 through 6

Typical Case

Figures 2, 3 and 4 are used as follows: Assume that an antenna site has been selected for a station to be located in Zone II, and that the radiation center of the antenna will be 1,500 feet above mean sea level. A topographic map, such as prepared by the U. S. Geological Survey, is then secured and eight or more radials are drawn on it, each extending to a distance of ten or more miles from the proposed transmitter location, as described in the FCC standards. One or more of these radials must extend through the major city or cities to be served. A profile graph for each of these radials is then constructed, which also shows the elevation of the antenna radiation center, as shown in Fig. 5. This represents a hypothetical profile that might be obtained along a N 30° E radial from a proposed television site.

Once such a profile has been obtained, average elevation of the profile graph of the radial for the eight-mile distance between two and ten miles from the proposed transmitter location is determined by means of a planimeter or by averaging successive points in the interval.

In the case of the radial profile graph shown, this proves to be 305 feet above mean sea level. The height of the radiation center of the antenna above the average elevation of the radial between two and ten miles, the antenna height above average terrain, is 1,500 feet minus 305 feet, or 1,195 feet. This height is taken as 1,190 feet because the FCC specifies antenna height to the nearest 10 feet, taking the lower alternative for midway figures. The antenna height above average terrain is

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DESCRIPTION	MAT.	JAN S-28	JAN S-28-A	JAN S-28-A AMEND 1	
7 Pin Miniature	Mica	SO-10-M (T9365-1)	TSE7T101 (9356)	TS102P01 (9356)	
7 Pin Miniature	Ceramic	SO-10-C (T9316-1)	TSE7T102 (9355)	TS102C01 (9355)	
8 Pin Octal	Mica	See Note #1	TSB8T101 (51B16203)	TS101P01 (51B16203)	
8 Pin Octal	Mica	See Note #1	See Note #1	TS101P02 (51B16758)	With Mtg. Nuts
8 Pin Octal	Ceramic	See Note #1	TSB8T102 (51B16220)	TS101C01 (51B16220)	
8 Pin Octal	Ceramic	See Note #1	See Note #1	TS101C02 (51B16759)	With Mtg. Nuts
9 Pin Noval	Mica	See Note #1 (53F12875)	TSE9T101 (53F13373)	TS103P01 (53F13373)	
9 Pin Noval	Ceramic	See Note #1 (53F12776)	TSE9T102 (53F13381)	TS103C01 (53F13381)	
7 Pin Shield	*	SOS-3 (8660-1)	TSF0T101 (8690-1)	TS102U01 (8690-1)	1⅜"
7 Pin Shield	*	SOS-6 (8661-1)	TSF0T102 (8691-1)	TS102U02 (8691-1)	1¾"
7 Pin Shield	*	See Note #1 (16G12564)	TSF0T103 (8698-1)	TS102U03 (8698-1)	2¼"
9 Pin Shield	*	See Note #1 (16G12626)	TSF0T104 (16G13375)	TS103U01 (16G13375)	1½"
9 Pin Shield	*	See Note #1 (16G12627)	TSF0T105 (16G13376)	TS103U02 (16G13376)	1-15/16"
9 Pin Shield	*	See Note #1 (16G12628)	TSF0T106 (16G13377)	TS103U03 (16G13377)	2⅜"

*JAN S-28 Shields—Steel—Cadmium Plated
JAN S-28-A Shields } Brass—Nickel Plated
JAN S-28-A Amend 1 } Brass—Nickel Plated
Note #1. Not Included in Jan. Spec.
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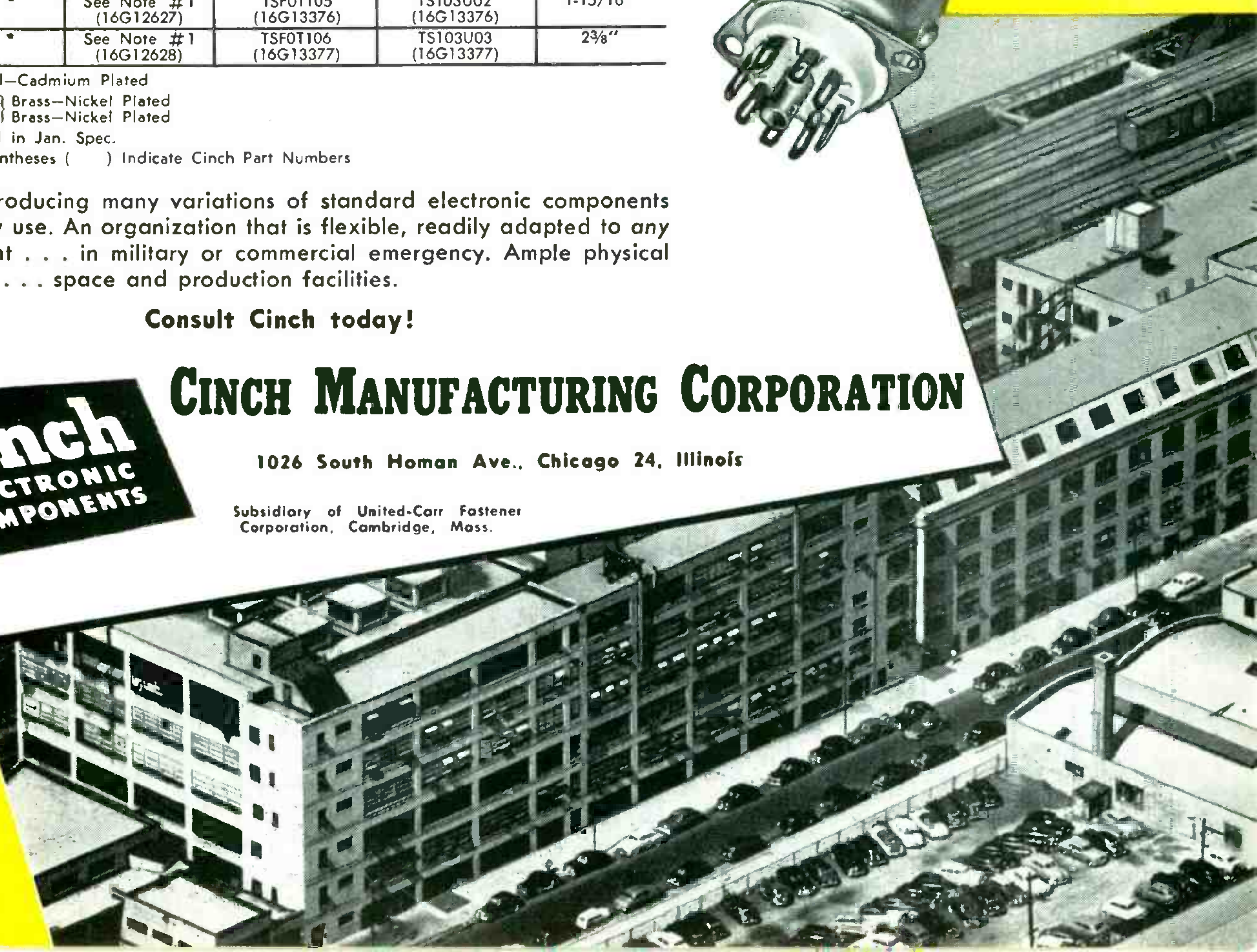

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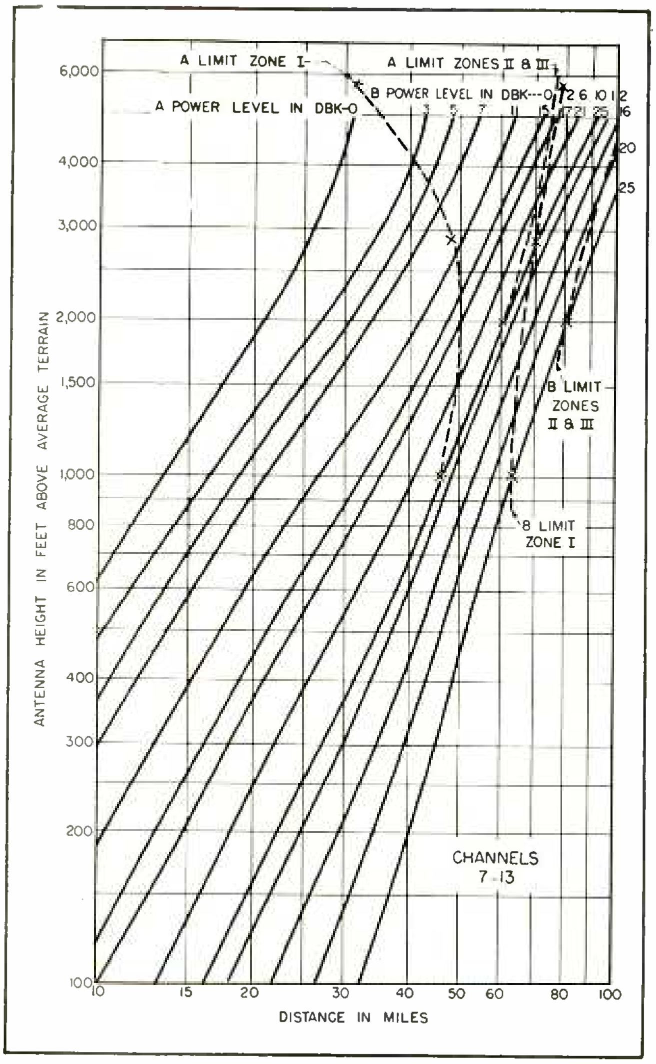


FIG. 3—Grade A and B contour distances for channels 7 through 13

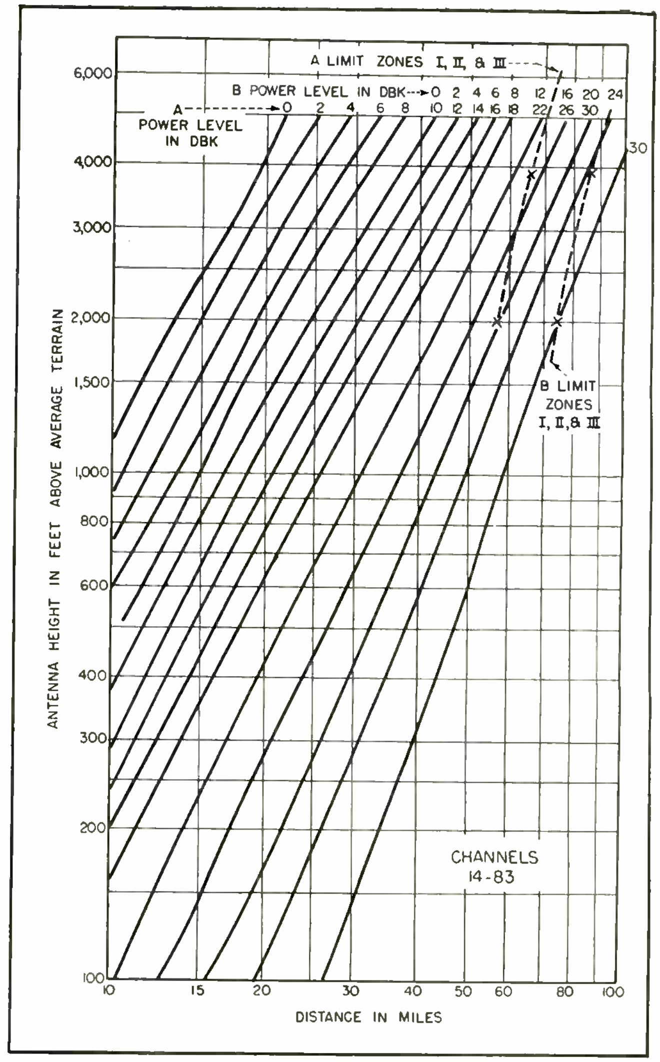


FIG. 4—Grade A and B contour distances for channels 14 through 83

usually taken as 100 feet where it proves to be less than 100 feet or negative.

According to Fig. 2, the coverage for an effective radiated power of 20 dbk on channel 2 at this site, and along this particular radial, will be about 40 miles, A, and 73.5 miles, B. If the station were to be located in Zone I, the coverage limit would be set by the maximum power curve in Fig. 1 as indicated by the dashed lines ("A Limit Zone I" and "B Limit Zone I" in Fig. 2) and would be 36 miles, A, and 69.5 miles, B.

The complete contours for the station are then secured by repeating the above process for each of the radials and by marking off the distances obtained for all of the radials on a suitable map. A smooth curve that joins the appropriate points then represents the contour at which the specified service is obtained. If the coverage map is to be submitted to the FCC as part of an application for construction permit, the contours should be constructed on the Sectional Aeronautical Chart for the area.

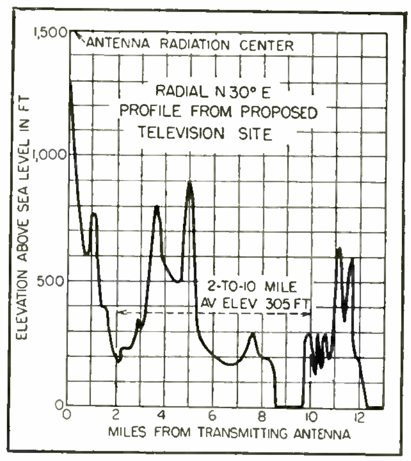


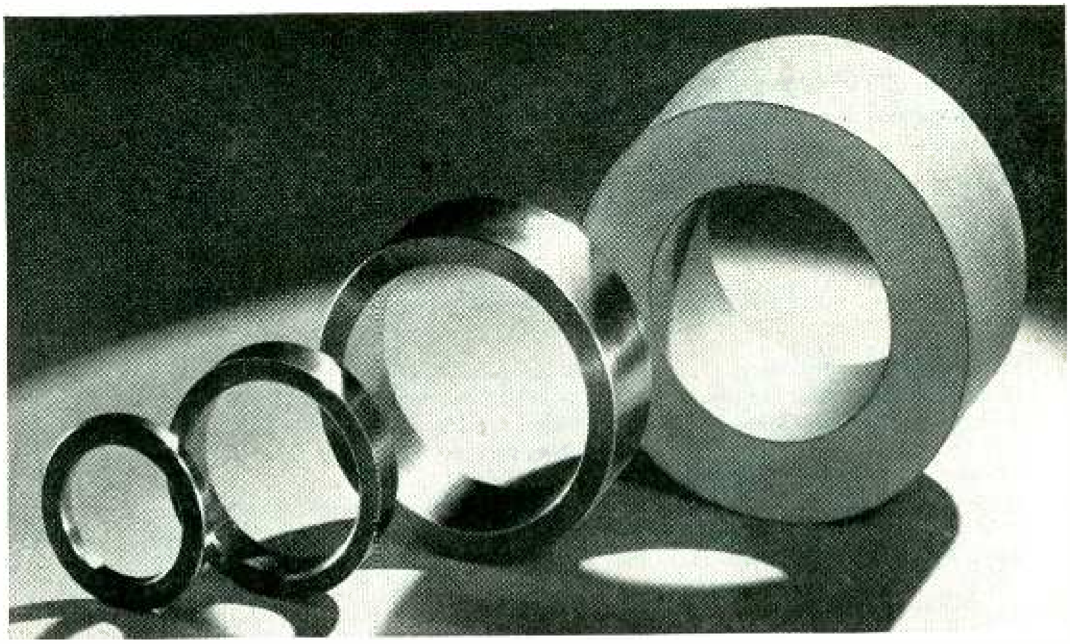
FIG. 5—Representative radial showing method of determining average elevation

The effective radiated power of a television station is the sum of the transmitter power output in decibels above one kilowatt, and the transmitting antenna gain over a half-wave dipole in decibels, less the loss in decibels incurred in the diplexer, triplexer (if used), and transmission-line feed system. When the transmitter power output rating already incorporates the diplexer loss, the latter need not be considered.

References

(1) Sixth Report and Order; Amendment of the Rules, Regulations and Engineering Standards Concerning the Television Broadcast Service, Appendix D, Federal Communications Commission, Washington 25, D. C., April 14, 1952.

(2) F. W. Smith, Calculating UHF Field Intensities, Electronics, p 110, Oct. 1950.



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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

OTHER DEPARTMENTS featured in this issue:

Preamplifier for Medical Use

By J. L. Murphy and H. W. Pavela
Assistant Chairman *Electrical Engineer*
Electrical Engineering Research
Armour Research Foundation
Chicago, Illinois

Electromyography is the electrical recording of the potentials arising in muscle tissue. The preamplifier and amplifier described herein are used with a magnetic recorder for that purpose.

Referring to Fig. 1, a pair of electrodes is inserted into, or near, an area of the muscle of interest. These are the active and reference points and are connected to the two input grids of the differential preamplifier. A third electrode attached to the subject in an inactive area serves as a ground for the system.

The differential action of the amplifier is defined as the ratio of the in-phase voltage to the signal potential for equal outputs. The signal applied between the two grids tied together and ground for a given output should be larger by a factor of over 2,000 than a signal applied between the two grids.

In this amplifier, the first stage consists of two tubes connected in the Toennies differential circuit which provides good in-phase rejection. This input stage consists of a cathode-follower pentode 6AU6 coupled to the cathode of a single-ended amplifier. Test were conducted on tube types 6AU6, 5693, 6SJ7, 6BA6 and 6AG5 for the input circuit and led to the selection of the 6AU6 from the standpoint of low inherent noise, high amplification and high differential ratio. This type of input stage gives a high differential ratio which is further improved by adjustment of C_1 and R_1.

Regardless of tube type tested, selection for gain, low noise and differential ratio was necessary. However, it was found that 20 percent of stock 6AU6's were suitable for input pairs.

The single-ended output of the differential stage is fed into two stages of amplification, each consisting of a 12AX7 dual triode. The first section of each tube is connected as a conventional triode amplifier and is direct-coupled to the second section which functions as a cathode follower, providing good high frequency response and low output impedance.

The preamplifier has a frequency response of 0.5 cycles to 10 kc between 3-db points, a noise level of approximately three microvolts rms referred to the input grids and an overall gain of 16,000. High and low frequency cut-off filters are provided for reducing the bandwidth.

The complete paper entitled "A Magnetic Recorder for Medical Application" was presented by the authors at the 1951 National Electronics Conference.

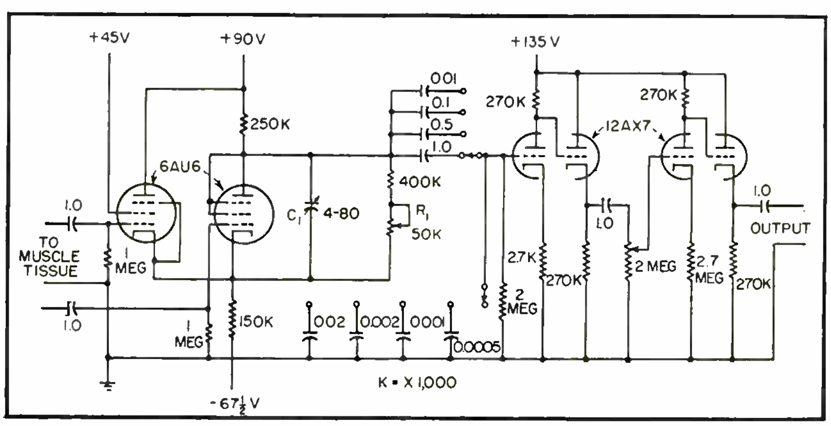


FIG. 1—Schematic diagram of the preamplifier for magnetic recording in medical applications

Electronic Projectile Test Range

In a new projectile test range at the Naval Ordnance Laboratory, White Oak, Md., guns up to 40 mm will be fired through the muffler partly seen at right in the photo-

Type 206-A

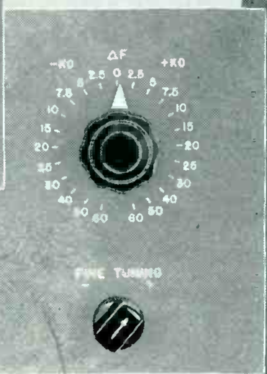
FM SIGNAL GENERATOR

for Mobile Communications Receivers

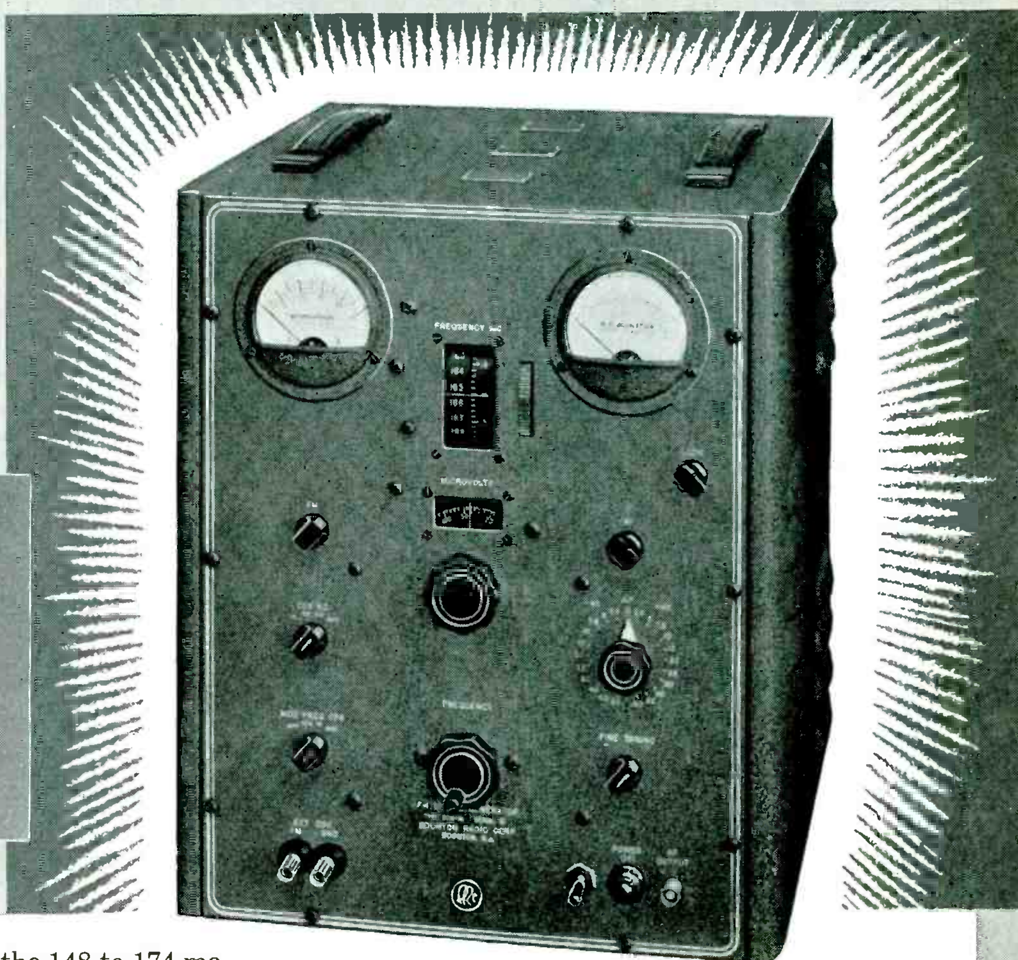
Frequency Range

146 mc to 176 mc

PANEL A



PANEL B



Mobile communications receivers in the 148 to 174 mc range have high sensitivity and rigid selectivity specifications. The receivers must not drift nor suffer detuning from variations in signal level. To be certain that these important requirements are met, laboratories and manufacturers must have a test instrument with capabilities at least an order better than receiver requirements.

The Type 206-A FM Signal Generator meets these needs. Output frequency is adjusted by a mechanism with a fast and vernier drive which is marked in 1.0, 0.1, and 0.01 mc divisions (see panel A). The dial mechanism position can be changed with respect to the tuning condenser shaft by a lock mechanism to calibrate any single point. Tuning in discrete steps for selectivity measurements may be carried out rapidly by a switched electronic tuner (see panel B). Very fine tuning corrections can be made by an additional electronic vernier. Drift of oscillator output with time is very low and variation in output frequency with attenuator setting negligible. A wide range of output levels is available (see panel A). The instrument is characterized by low microphonism and low leakage.

SPECIFICATIONS (Type 206-A)

FREQUENCY RANGE: 146 mc to 176 mc in one range.

FREQUENCY CONTROLS: Main dial marked in 1 mc divisions. Vernier (mechanical) marked in 0.1 and 0.01 mc divisions. △F Switch: ± 60 kc in small discrete increments.

Fine Tune: Continuous electronic tuning over ± 10 kc range.

FREQUENCY ACCURACY: ± 0.2% after warmup.

FREQUENCY STABILITY: With temperature variations: ± 0.001% per degree centigrade.

With line voltage variation: ± 0.002% for ± 10% line variation.

RF OUTPUT VOLTAGE: 0.1 to 200,000 microvolts into a 53 ohm load.

RF ATTENUATOR ACCURACY: Approximately ± 10%.

RF OUTPUT IMPEDENCE: 53 ohms resistive looking into panel connector.

FREQUENCY MODULATION: Frequency deviation ranges (continuously variable) 0-10, 0-25, 0-100 and 0-250 kc.

Frequency deviation accuracy: Can be calibrated to ± 5% by internal standard.

FM DISTORTION: Less than 2% at 100 kc and less than 10% at 250 kc deviation.

MODULATING SOURCES: Internal AF oscillator at 400 and 1000 cps. External AF oscillator may be used.

Output from internal AF oscillator available for synchronizing or other purposes.

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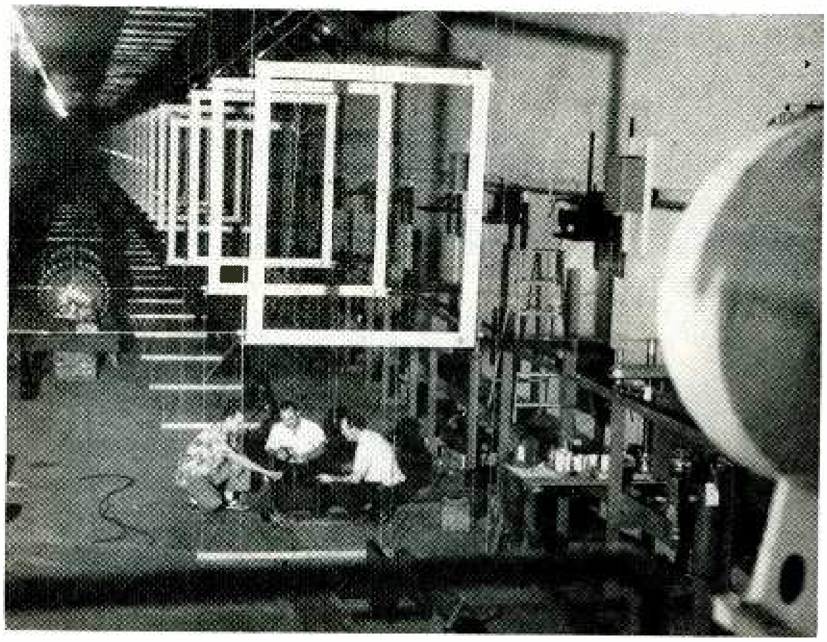


Workmen shown putting finishing touches on new Naval projectile test range

graph. A line of 25 frames will automatically set off a battery of cameras to record the flight of a missile.

Purpose of the range is to carry on stability and drag investigations on spinning and finned projectiles. The range allows for the use of larger missiles and lower mach numbers than is possible in a pressurized range.

Two possible electronic means under consideration for setting off the cameras are the use of a photoelectric beam to be cut by the projectile and use of a magnetic field in which a magnetized steel bullet is fired through a magnetic coil.

Visual Tracking of Superheterodyne Front Ends

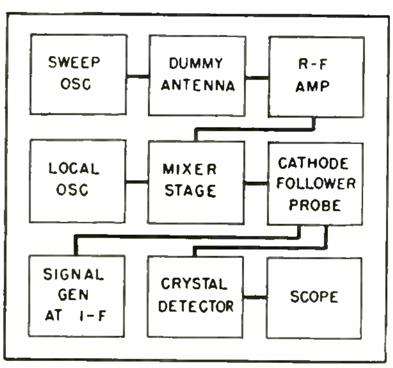


FIG. 1—Block diagram of the setup for aligning superheterodyne front ends

By Philip S. Wessels

Electronic Scientist
Federal Communications Commission
Laboratory Division
Laurel, Maryland

Numerous articles in the literature have presented the mathematics of tracking in superheterodyne receivers, but little has been published on methods of checking possible solutions. The equipment shown in Fig. 1 provides rapid and accurate checking means.

The output of a sweep oscillator is coupled to the antenna in a manner that its effect on the first tuned circuit is minimized. A standard dummy antenna probably would be used in most cases. This signal is taken off the grid of the mixer tube with a cathode follower and detected in a manner that gives a presentation of the response curve of the r-f amplifier on the screen of an oscilloscope.

It is standard procedure to place markers on such a picture by injecting an r-f voltage of appropriate frequency into the circuit. These markers occur when the beat note between the sweep oscillator and the injected signal fall within the pass band of the oscilloscope. In general there will be enough stray pickup from the local oscillator to give such a marker appropriately placed relative to the r-f response curve.

If a third signal is mixed into the system, additional beat notes will appear. Two of these will occur at points on the sweep which represent frequencies equal to the sum and difference of the local oscillator and the third signal. If this third signal is set equal to the intermediate frequency, one of these markers should fall somewhere on the response curve of the r-f amplifier, depending on the tracking error at this particular point.

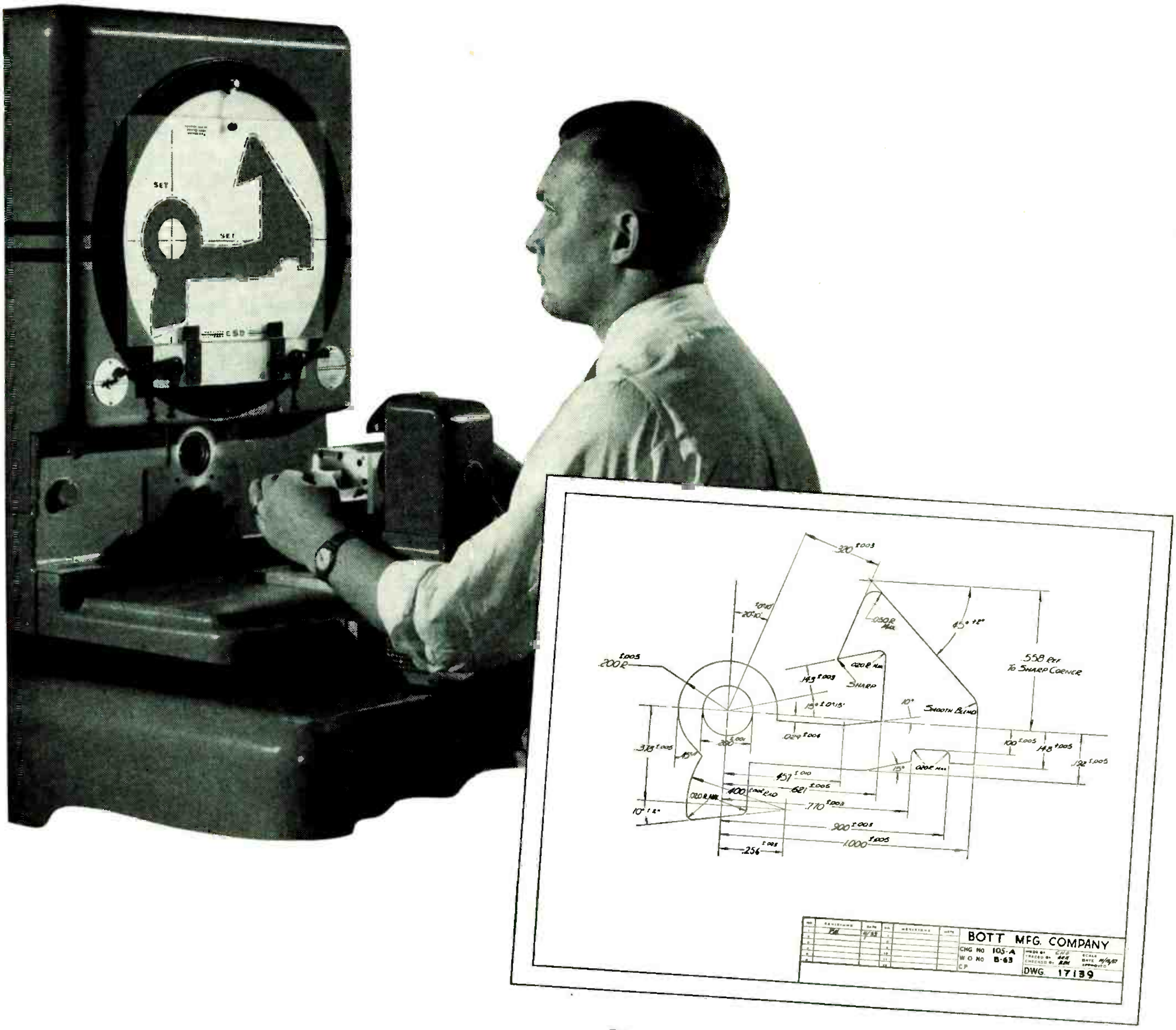
The r-f amplifier now can be tuned from one end of the band to the other and tracking error and changes in the response curve can be observed at the same time. Additional markers could be introduced to designate the desired frequency of either end of the band and perhaps the crossover point.

This system makes it possible to check quickly the solution of any tracking problem. It could be used on the production line where all bands of a receiver could be checked in a matter of minutes.

Sorting Coins Electronically

When the United Kingdom began issuing cupronickel coins and withdrawing from circulation those coins containing silver, an electronic device for sorting the coins was developed. Experimental work indicated that the two types of alloy could be separated by measuring their relative conductivities. The

The coin sorting machine



He checks 15 DIMENSIONS 8 RADII 7 ANGLES in ONE operation

To check this part completely and accurately by usual methods, you might need as many as two dozen or more different gages—and you still wouldn't be sure all corners were sharp, all angles and radii exact. There's a much faster, more accurate way to do the job completely, one that requires no mechanical gages that can lose accuracy through wear.

On the Kodak Contour Projector, Model 3, you just slip the part into a holding fixture and compare its magnified image with a "chart-gage" over the bright screen. *Every* detail shown on the drawing is quickly and directly compared against the part itself, to close tolerances and in *one* operation. Little training or experience is required.

The part we show here is a relatively simple one for an optical comparator. With proper fixtures, charts, and accessories, you can measure all sorts of complex parts, large or small. Changes in specifications generally require nothing more than a corresponding change on the chart.

So overwhelmingly has industry turned to optical gaging that production of the Kodak Contour Projector, Model 3, the outstanding instrument for this method, has been greatly accelerated. Deliveries are rapid, and the cost of projector, fixture, chart-gages, and accessories usually comes below corresponding sets of mechanical gages. To get an idea of the large labor savings that the Kodak Contour Projector can bring to your inspection problems, get in touch with Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

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Optical Gaging

A new sound movie shows how to simplify complex inspection problems. We'll tell you how to get it for a showing.

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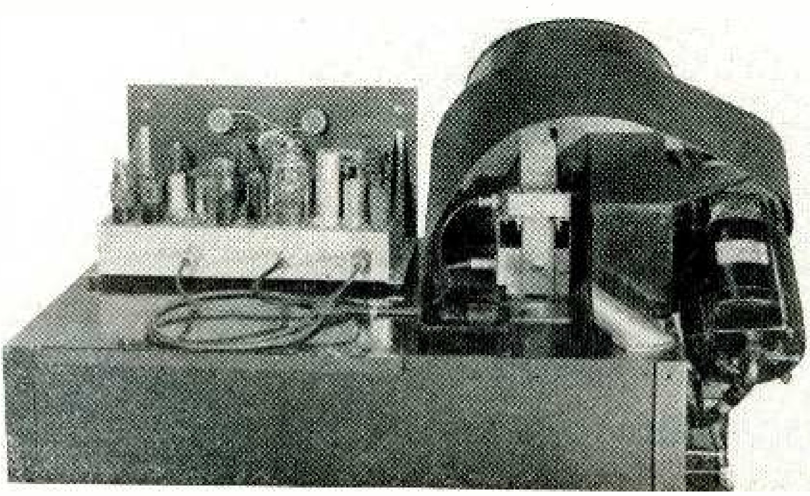
equipment is shown in the accompanying photographs.

The mixed coins are placed in the rotary hopper which feeds them down a vertical chute. The chute guides the coins through a sensing head consisting of a gapped iron-core inductance. The effect the coins have on the flux present in the gap is taken as an indication of their composition.

If the flux variation shows the coin to be of cupronickel composition, the coin falls uninterruptedly down the guide to a receptacle. Silver coins cause accurately-timed pulses to be fed to an ejector unit. The pulses energize a small solenoid causing an inclined deflector, attached to the plunger, to move across the chute and into the path of the falling coins. Upon hitting the deflector, the silver coins are conveyed to a special receptacle.

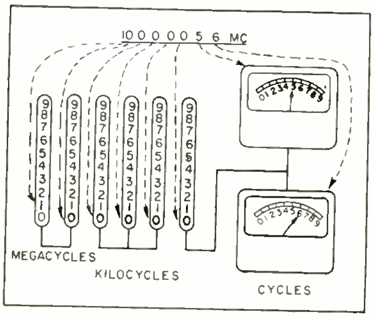
The machine will handle a range of denominations if the guide in the hopper is changed and the right switch position on the control unit is selected. The machine has a capacity of about eight coins per second.

The information in this article was abstracted from *Electronic Engineering* for January 1952. Teledictor Limited of Dudley, England, did the developmental work on the unit. This description is published with the permission of the Superintendent, Royal Mint, London, England.



Rear view of the instrument with covers removed. The sensing head and ejector unit are on the vertical chute behind the rotary hopper

THE FRONT COVER



THE FREQUENCY COUNTER shown in the cover photograph in a crystal-testing application, measures and displays directly the crystal frequency. Range of the instrument is from 0.01 cps to 10 mc. The accompanying drawing shows the display arrangement of the counter. Neon tubes behind the panel slots illuminate the proper numerals for direct indication.

Pulse techniques are used in the device manufactured by the Hewlett-Packard Company. The complete counting circuit consists of eight cascaded scalers with indicating systems. Each scaler is a decade type and generates one output pulse for every ten pulses received.

Vacuum-Tube Analogy of Transistors

By Hans E. Hollmann

U. S. Naval Air Missile Test Center Point Mugu, California

According to duality, the transistor requires a constant bias current instead of a constant bias voltage, reactances in vacuum tube circuits are equivalent to admittances, resistors to conductances, and so forth. Although somewhat tricky in complex circuits, the duality principle has been found to be very useful in practical circuitry design.

If the general rule is followed that the duality principle requires every significant element to be replaced with its dual, this concept may be applied not only in the direction from common vacuum tubes to transistors but also conversely.

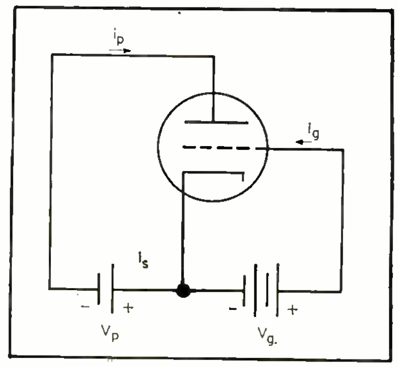


FIG. 1—Basic schematic of the retarding-field tube

The final step would be the exchange of grid and plate of a triode, that is, let the plate carry the input or control energy while the grid is the output electrode.

Such a tube will not operate on the principle of space-charge control. A highly positive grid and a plate potential in the vicinity of zero, however, leads directly to a retarding-field tube. Since this peculiar vacuum tube may not be well known, its basic performance briefly is summarized in modern terminology.

The retarding-field tube has been utilized as a generator and detector for microwaves and has been found to operate successfully beyond the region of electron oscillations. As shown in Fig. 1, the cathode may be assumed to be a tungsten filament and the grid potential to be above

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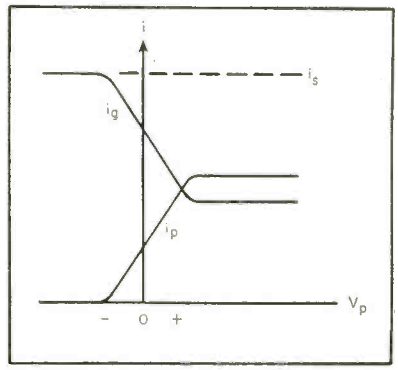


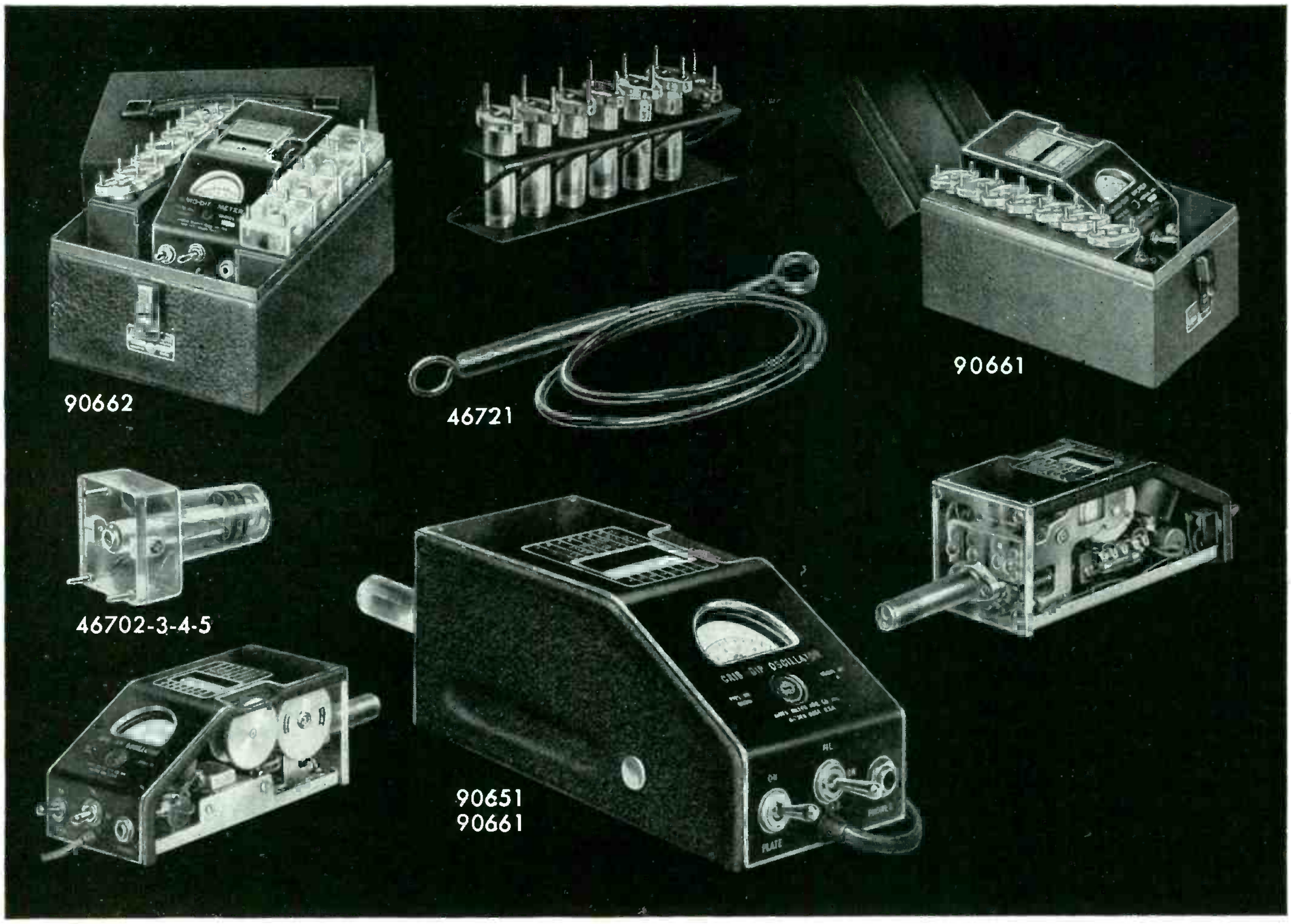
FIG. 2—Idealized grid and plate characteristics of the retarding-field tube at aperiodical conditions of operation

the saturation value.

The grid current is composed of two groups of electrons. One group strikes the grid immediately on its way from the cathode, the other group passes through the grid meshes and is slowed down by the retarding field in the grid-plate space. Depending on whether the plate has a negative or slightly positive potential, these electrons are either repelled or caught by the plate. As a result, the saturation current can easily be seen to be split into grid and plate current. There exists a current transfer in that the grid characteristic i_g versus plate voltage V_p is the mirror image of the plate characteristic i_p versus V_p as shown in Fig. 2. Hence $di_g = -di_p$, or the current gain $\alpha = -1$.

An alternate explanation is the retarding-field tube acting as a constant-current resistance transformer. The input or plate voltage is loaded with the internal plate resistance $r_p = dV_p/di_p$, while the output resistance $r_g = dV_g/di_g$ is almost infinitely high because of saturation. The result is a power gain which asymptotically approaches infinity. Since perfect saturation is not possible, this is only an idealized extreme. If the saturation filament is replaced with the first electrodes of a conventional multigrid tube, for example, with a saturated pentode, the saturation becomes less perfect and the power gain approaches a finite value.

In some types of tubes, particularly characterized by very fine and homogeneous grids, the electrons arrange themselves into groups or bunches that oscillate together. This bunching effect builds up



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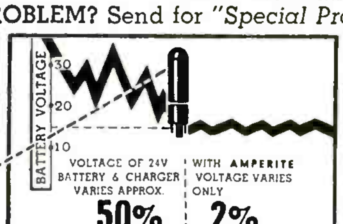

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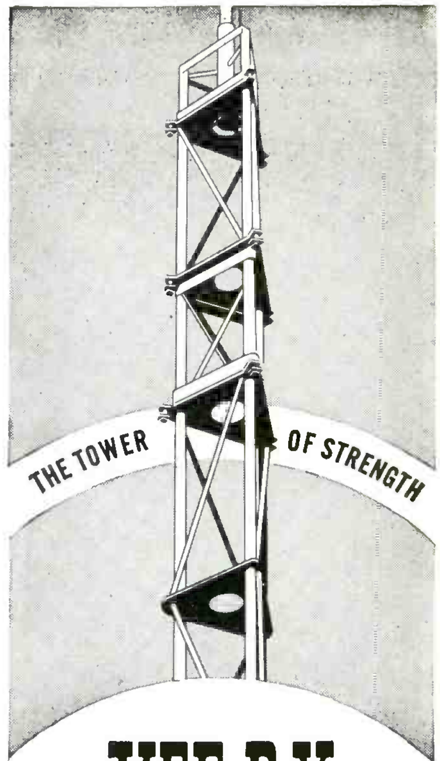

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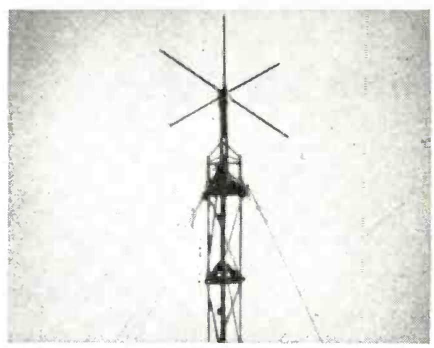

Actual photograph of VEE-D-X Sectional Tower installation showing 152 MC ground-plane antenna suited for ground-to-plane, ship-to-shore, and mobile communications.

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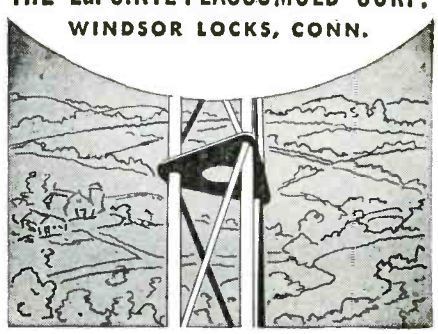

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under the influence of an external or internal resonance system or even of resonating electrodes. Such electron oscillations cause deformations of the aperiodic characteristics in that they may reduce the current gain but, on the other hand, they also may cause α to be greater than one.

Irrespective of this phenomenon, retarding-field amplifiers and retarding-field oscillators have been built, particularly a retarding-field audion in which the nonlinear plate characteristic provides the detector action or rectification while the current transfer produces the amplification of the a-f energy.

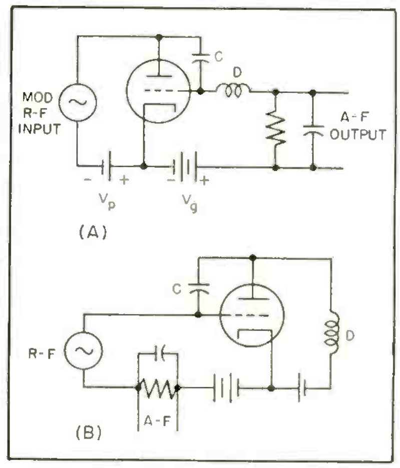

FIG. 3—Retarding-field audion with short-circuit of the current transfer. Plate input (A) and grid input (B)

The input load of the r-f source has been reduced considerably by the so-called "short-circuiting of the current transfer"[1,2]. According to Fig. 3A, grid and plate are bridged over by a capacitor C while the r-f choke D in the grid lead prevents r-f energy from penetrating into the output circuit. The input source can clearly be seen as being loaded with the saturation resistance so that only very low r-f power is dissipated.

Since grid and plate, for the r-f, are short-circuited, it makes no difference whether the r-f voltage is introduced into the plate or grid circuit. This conclusion leads to the diagram portrayed in Fig. 3B. Both circuits, in modern terminology, are grounded-plate circuits, at least for the r-f.

A current gain greater than one, as resulting from electron oscilla-

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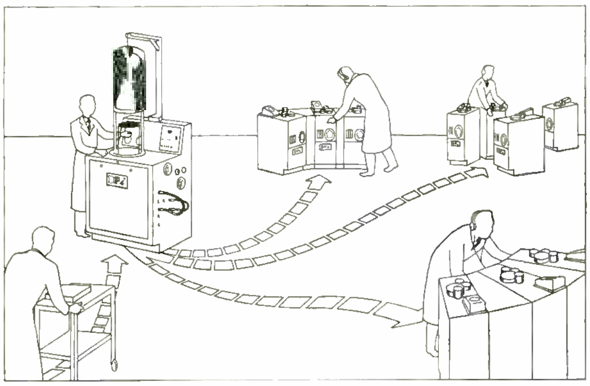

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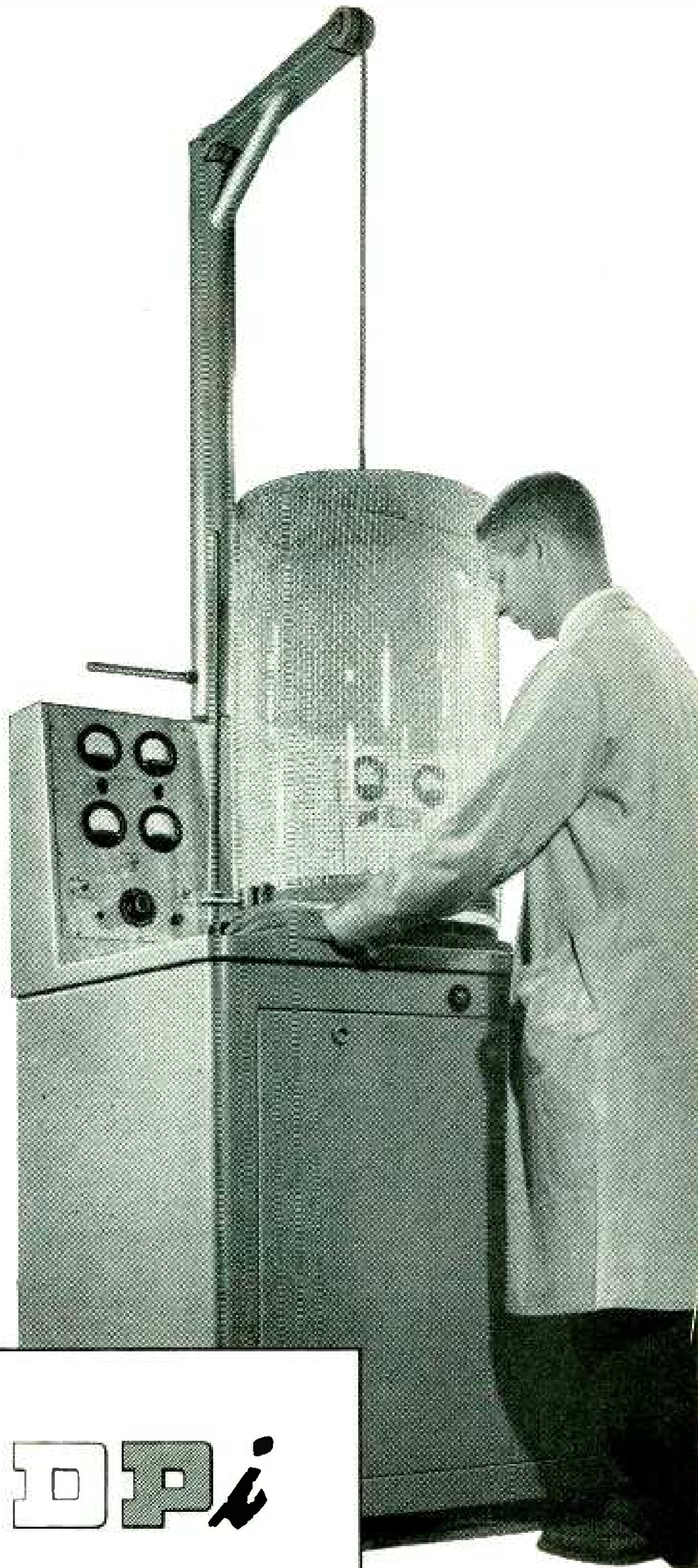

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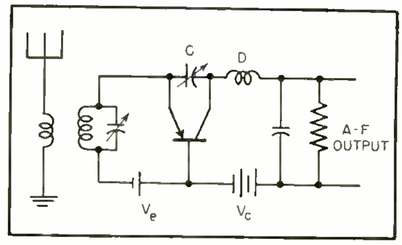


FIG. 4—Transistor audion equivalent to Fig. 3

tions, makes the retarding-field tube unstable. On the other hand, the resulting negative plate resistance produces self-excitation of a tank circuit connected to the plate so that the electron oscillations are self-modulated with a-f or i-f.

By means of this example, it can be seen that the retarding-field tube is the perfect analog of the transistor. This analogy makes it possible to change the retarding-field audion immediately into a transistor audion provided the supply voltages have the right polarity as well as suitable magnitudes in order to cause the transistor to operate in a nonlinear region. In this way the basic schematic of a transistor audion as shown in Fig. 4 is obtained. Depending on whether self-excitation is desired for heterodyning purposes or not, the bridge capacitor *C* must be properly adjusted. Hence, a variable bridge capacitor may serve for the adjustment of damping reduction, similar to the vacuum tube audion with controllable feedback.

Other transistor circuits may be derived from retarding-field technique, for example: oscillators and amplifier cascades in which each base-resistance loads the output circuit of the preceding stage. From such a multistage retarding-field amplifier, the transistor cascade portrayed in Fig. 5 may be derived in which the input stage is the grounded-emitter type, whereas the next stages follow alternately in-

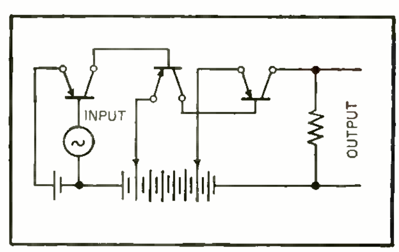
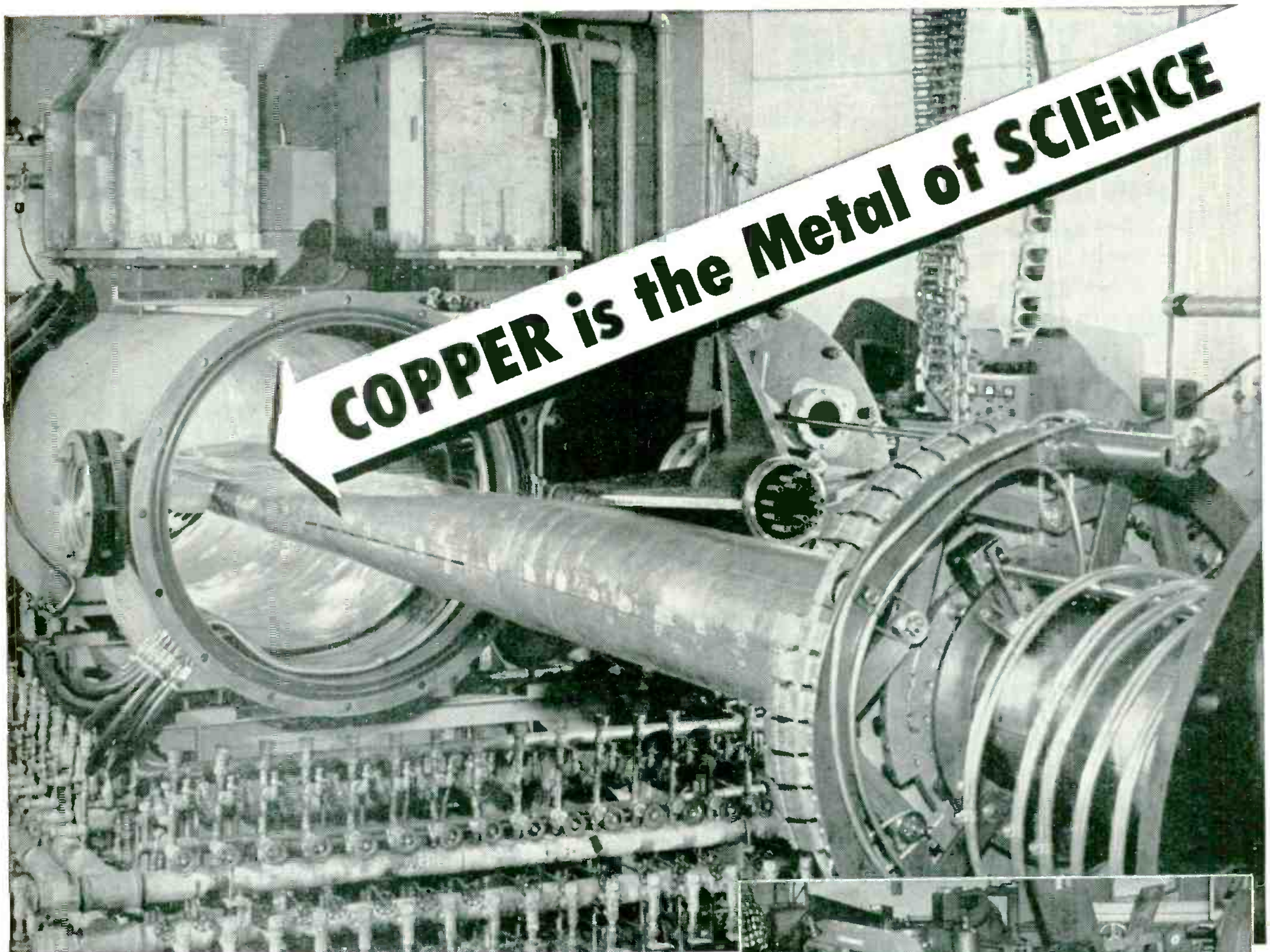


FIG. 5—Transistor cascade equivalent to a multistage retarding-field amplifier



D and D Stem being inserted in Cyclotron; made of Revere Electrolytic high-conductivity copper, hot rolled and annealed, 1/8" thick. Note also large number of bronze valves to control flow of cooling water through brass pipe.

Photo taken in the University of Washington shop during fabrication of the two Ds and D Stems.

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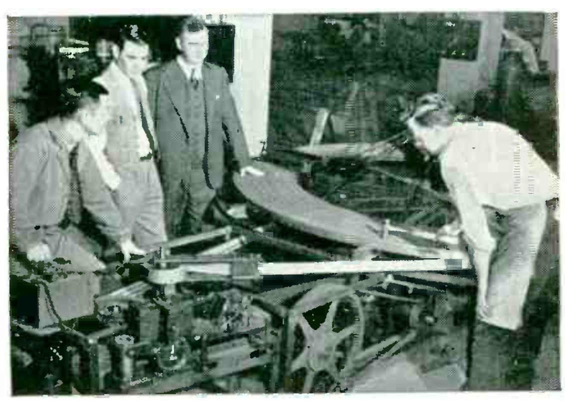

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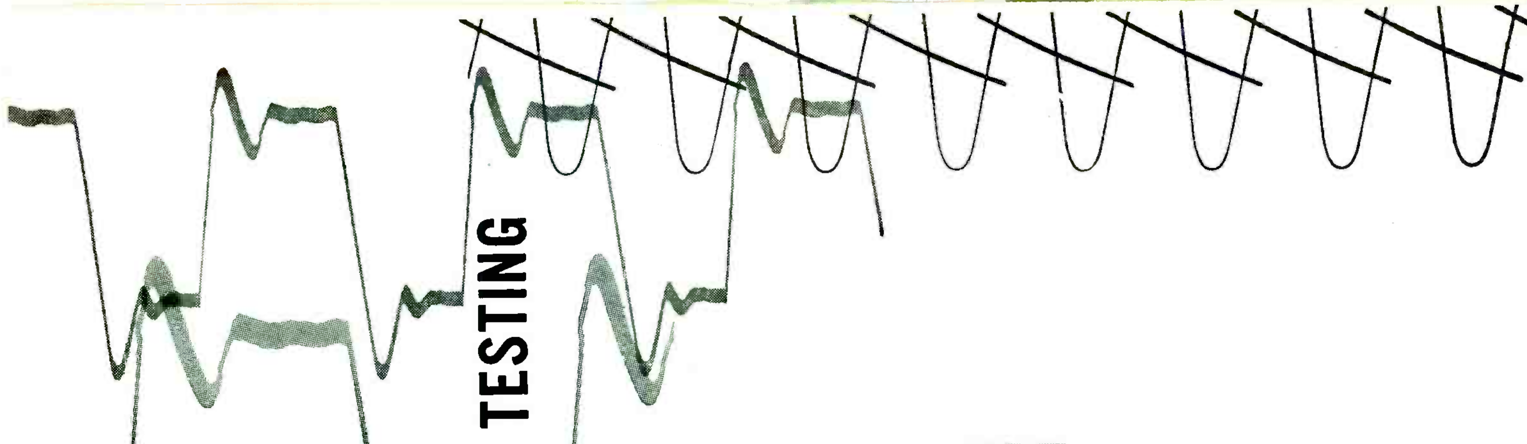

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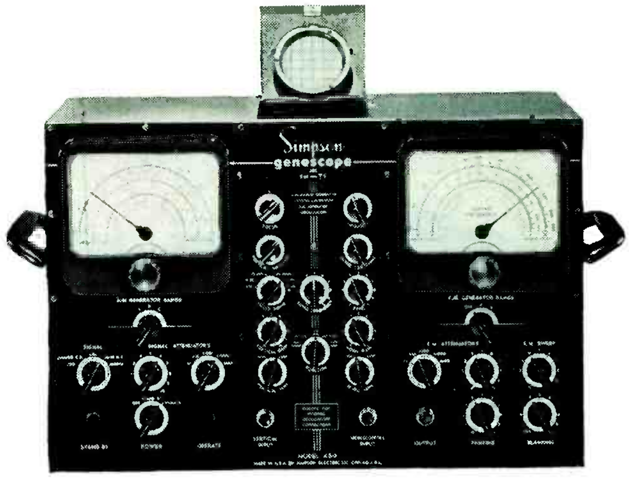

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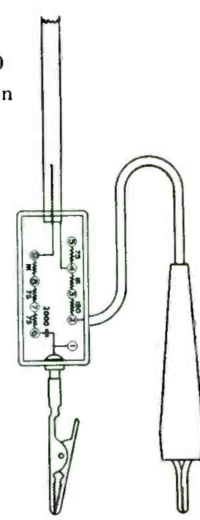

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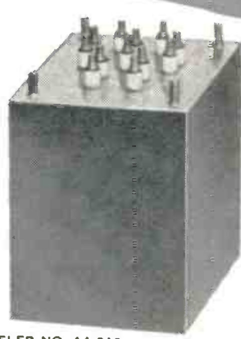

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verted. If necessary, stability may be secured by inserting damping resistors in the input circuit or between the stages, thereby introducing negative feedback.

REFERENCES

(1) H. E. Hollmann, The Retarding-Field Tube as a Detector for any Carrier Frequency, *Proc. IRE*, 22, p 630.
(2) H. E. Hollmann, Positive-Grid Valve as a Detector, *Exp. Wireless*, May 1934, p 245, June, p 309.

Life Testing Reliable Tubes

By HERBERT A. HAMMEL
Sylvania Electric Products Inc.
New York, N. Y.

DURING the last decade there has been a trend towards the use of more complex electronic equipment. This trend has been most evident in the field of military operations. The vital nature of these operations and their reliance upon electronic equipment have brought about the need for vastly increased reliability in such equipment.

A definition currently proposed for reliable tubes is: "Reliable tubes are those tubes so designed and manufactured as to give continuity of operation superior to ordinary commercial tubes." A supplier may submit to the Armed Services as "reliable" only those tubes which have been specifically produced as "reliable" tubes.

The rate of tube failure (inoperative and characteristic failures) must not exceed that stated on the tube specification.

To judge any life test, one must study the distribution of tube failures. Data from many tests run by Sylvania show that the distribution of life test failures with time is a complex curve. Figure 1 shows a typical rate of failure curve (curve 1) and its various components. The first component (curve 2) is a con-

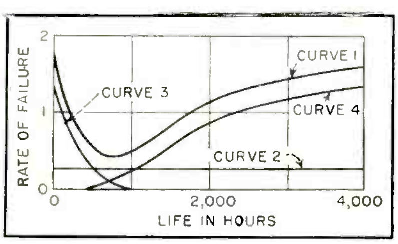
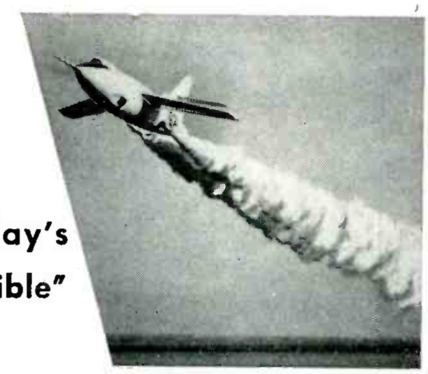


FIG. 1—Typical failure curves for tubes operating under normal conditions



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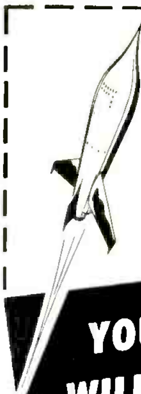

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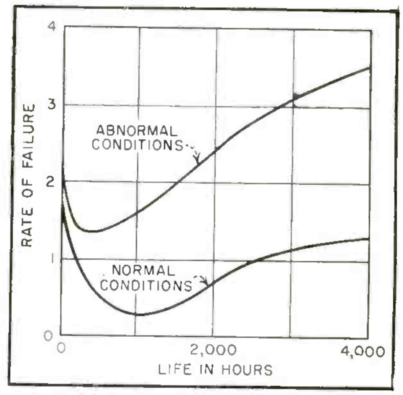

FIG. 2—Typical failure curves for tubes operated under normal and abnormal conditions

stant low rate of failure. These failures are usually of the inoperative type and are due to random failures of welds or heaters.

The second component (curve 3) is a high initial transient resembling an exponential curve. These failures are also of the inoperative type, however, they are due primarily to faulty manufacturing. Finally, there is a distribution (curve 4) of failures, resembling the gaussian or normal distribution, which is due to the wearing out of the tubes. If tubes are operated under normal conditions of voltage and temperature, the lowest point of the overall failure curve (curve 1) generally occurs somewhere between 500 and 1,000 hours. This point will vary widely with the tube type.

High ambient temperature, excessive plate dissipation, or any other unusual operating condition will result in an increased rate of tube failure. This increase causes the wear-out component of tube failures to start earlier in life and to affect a greater number of tubes. Figure 2 shows what may happen to the rate of failure curve when tubes are used beyond their rated conditions.

Subcommittees of the Joint Electron Tube Engineering Council and the Armed Services Electro Standards Agency have developed a life test procedure for reliable tubes which is currently receiving the favorable consideration of both industry and government. The proposed life test is basically a two-step procedure. The first step limits failures to the prescribed rate. The

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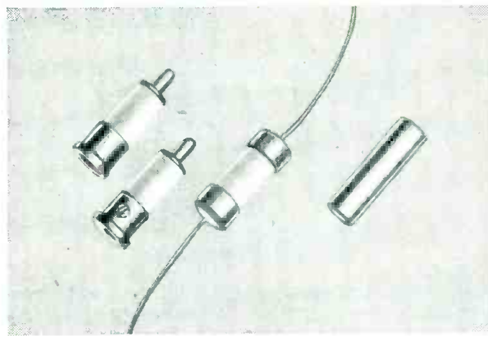

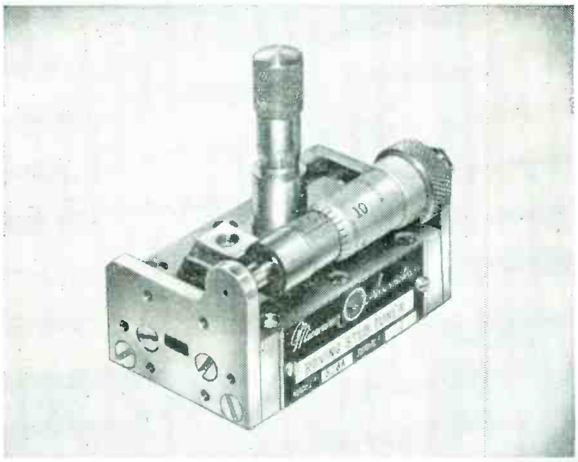

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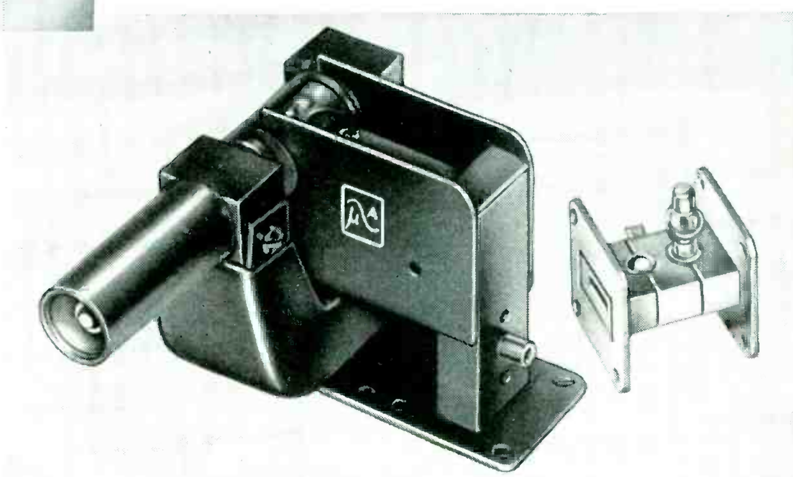

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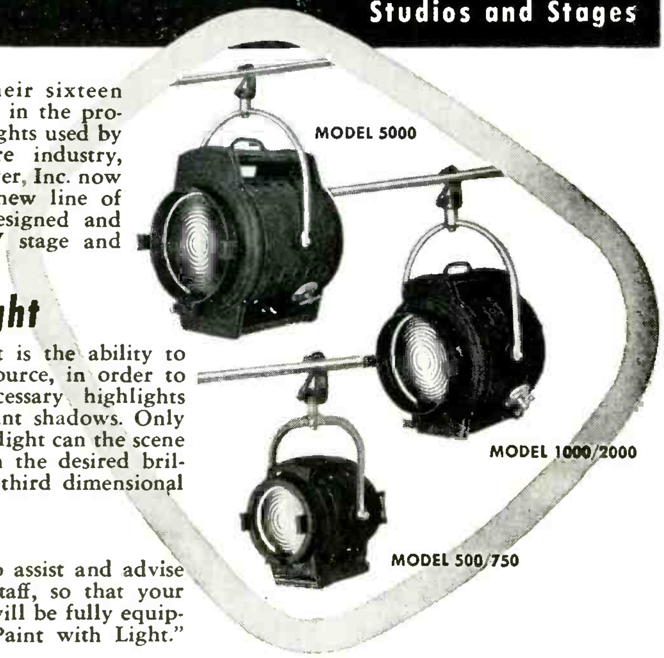

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second serves as a small check on the tube failure rate and protects the buyer against shifts in electrical characteristics greater than those permitted by the specification.

The first part of the proposed life test is an attributes type of sampling plan. This means that each tube in the sample is tested after an appropriate period of time and classified as either good or bad. The Services have recently issued a series of such sampling plans entitled Sampling Procedures and Tables for Inspection by Attributes.

The second portion of the life test protects the buyer against epidemics of failures which occur late in life and against excessive shifting of electrical characteristics. To do this, a sample of 20 tubes is continued on life for 400 hours after the completion of the first portion of the life test. This sample is treated on both an attributes and a variables basis. That is, not more than a given number of actual tube failures of any type are permitted, and the average values of the electrical characteristics are not permitted to shift more than the specified amounts.

Voice and Sound-Operated Relays

By Karl Greif
Norwich, New York

Sound and voice-operated relays have appeared in various publications from time to time, usually relatively involved, using three or four tubes. An attempt is made here to provide two simple sound-operated switches from which a multiplicity of applications might be filled.

The primary element making possible the simplified circuitry discussed here is the use of carbon microphones and efficient sounding boxes or resonant diaphrams. Since there are no problems of fidelity, the carbon microphone with its characteristic high output decreases the gain required in the amplifier. Any sounding board arrangement which might be introduced makes it

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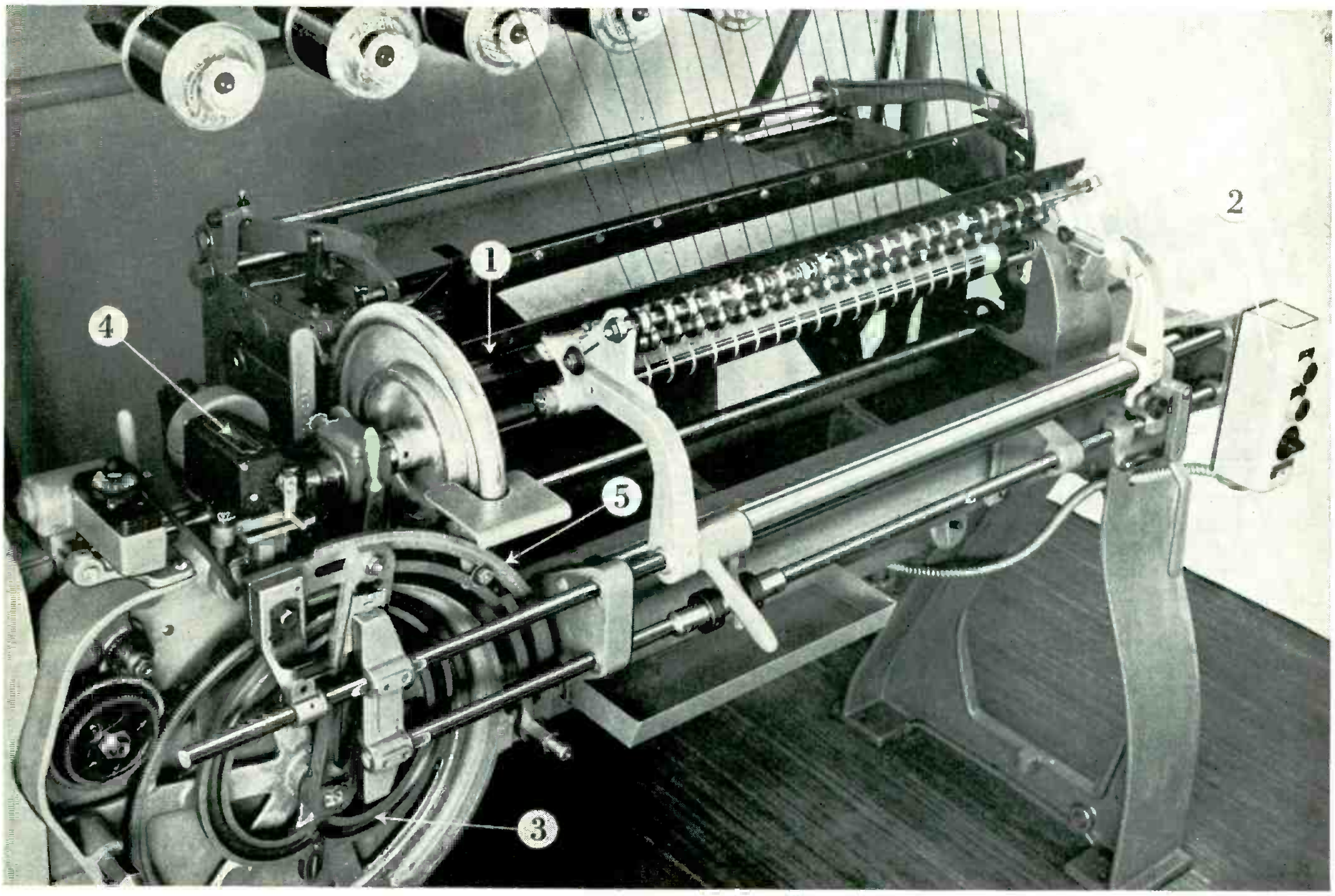

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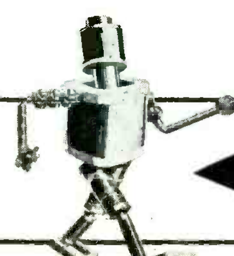

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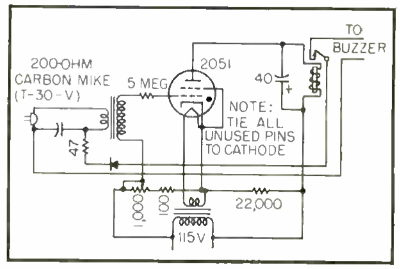

FIG. 1—Sound-operated alarm circuit for actuating a relay. Pickup is through a carbon microphone

simple to obtaining effective amplification.

Such is the case with the circuit shown in Fig. 1. The throat-type carbon microphone is mounted directly in contact with a plastic miniature radio-type cabinet. With such an acoustical arrangement, it is possible to cause the relay to pick up with a snap of the fingers, 15 to 20 feet distant.

One disadvantage in long-term use of any carbon-type microphone is the inherent packing of the granules with time, causing an attendant decrease in sensitivity. This fault can be corrected by giving the microphone, or entire unit if attached as described, a slight shake when turning the unit on. When a hand microphone is used, normal use keeps the granules free.

The unit is called the Baby-Larm, and is intended for use in the nursery. It can be placed on a stand or dresser near the crib and whenever the baby cries or whimpers, a buzzer sounds in the living room, garden or other convenient location. If the relay is to be mounted integral with the microphone unit, some provisions must be made to avoid a cycling phenomena caused by the sound of the relay

Chassis of the baby-watching alarm circuit

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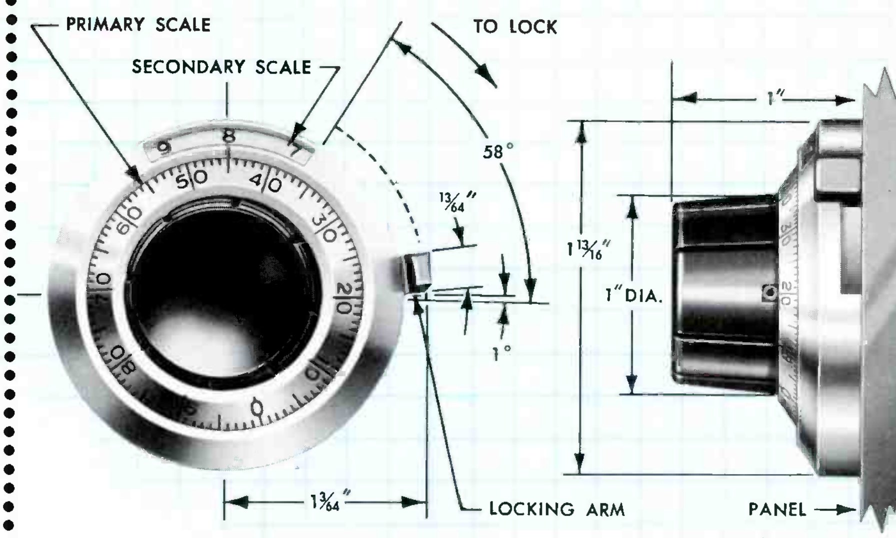

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With its glare-proof satin finish and recessed black numerals that will not wear off, the RA DUODIAL is not only beautiful but is unusually easy to read. Moreover, the secondary dial is driven by a unique jump mechanism that keeps the dial stationary until the primary dial has completed a full revolution—then the turns-indicating dial "jumps" to the next numeral. Thus, the index always points *directly* to the number showing the particular helical turn on which the slider is positioned, eliminating errors in dial readings and settings.

Another convenience feature – three numbers show in the window at all times so that the operator knows instantly in which direction the dial is to be rotated to make the next setting. And with 10 turn potentiometers, readings are made directly in decimal equivalents of the slider position on the resistance winding—simply, accurately, and with maximum convenience for any resistance range.

Vibration-Proof Lock

All RA DUODIALS are equipped with a positive *vibration-proof* locking mechanism that can be easily and instantly set by the same hand that is adjusting the knob. Locking is accomplished by means of a cam actuated brake shoe which acts radially against an inner drum. This arrangement eliminates any possibility of dial movement during or after setting.

Easy To Mount On Panel

The RA is unusually compact—only 1-13/16" diameter (the same as a Model A HELIPOT)—and comes completely assembled, with mounting parts and hex wrench included. Installation is extremely simple. Set the dial and potentiometer at zero. Place the shaft through panel hole. Place lug plate over shaft, and mounting nut on potentiometer bushing. Then place the RA dial over shaft, lining up the register hole with lug—and tighten set screws. *It's as easy as that!*

In addition, the mounting nut is so designed that it is adaptable to thin (1/8" and under) or thick panels by simply reversing ends. No problems of adapting the unit to *your particular* panel reqiurements!

Finest Construction Throughout

In all respects the RA DUODIAL is built to maintain its attractive appearance and quality "feel" throughout its long life. Metal parts are machined from die-cast alloy and plated in accordance with specifications MIL P6871 and QQ P416 (1) for corrosion resistance. Non-metallic parts are made of long-lived nylon, with nylon jump gear to assure smooth quiet operation of the secondary dial. And since the primary dial is connected directly to the potentiometer shaft, no wear or backlash can affect the accuracy of the settings.

Two allen-head set screws—positioned at 90°—lock the dial to the potentiometer shaft, and the black nylon knob insulates the instrument from hand capacity.

The RA DUODIAL is primarily designed for use with the 10-turn Model A HELIPOT. However, it is equally ideal for use with the 3-turn Model C or the ultra-precision models AN and CN when these potentiometers are equipped with bushing mounting. Additional numerals provided on the secondary dial make the RA adaptable for readings up to 15 turns for special applications.

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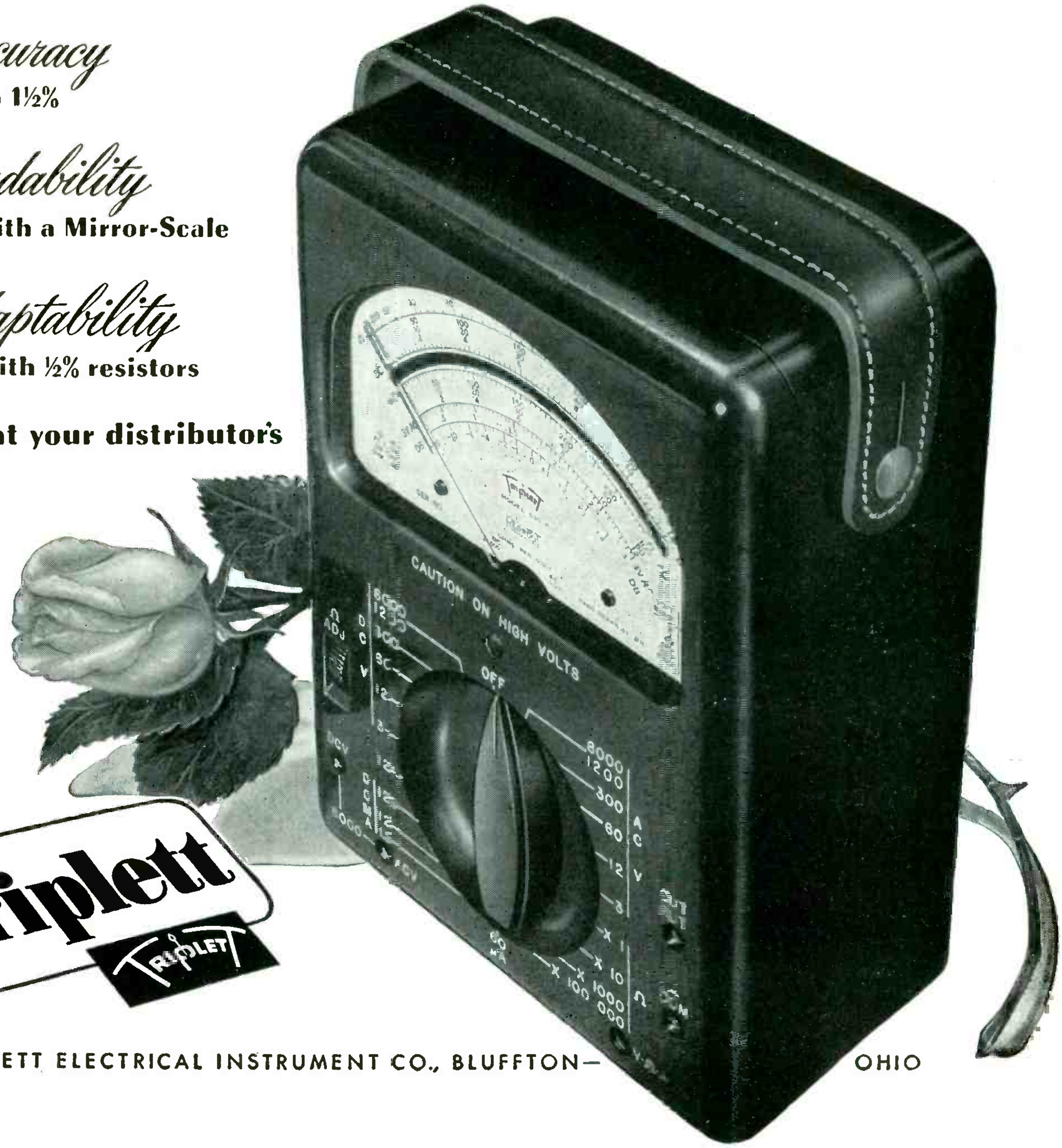

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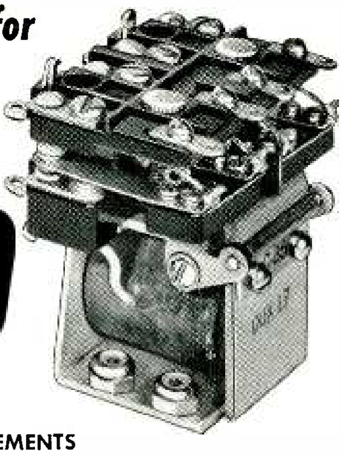

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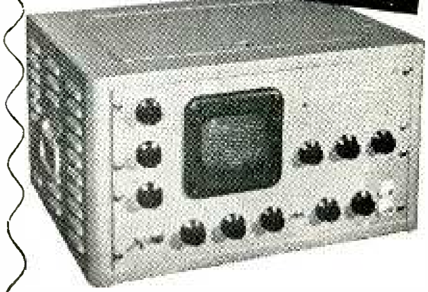

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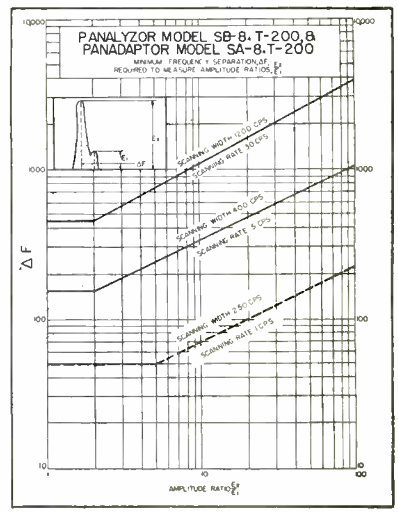

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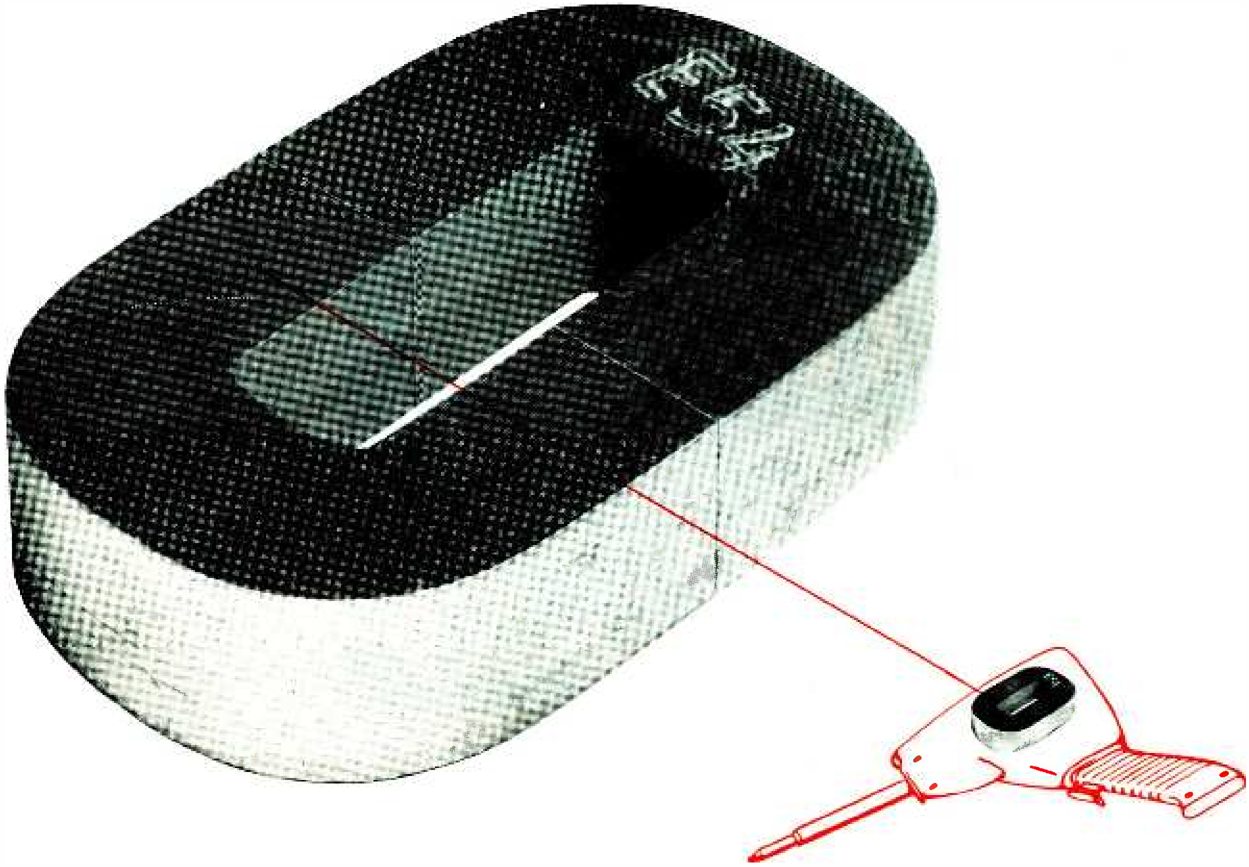

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armature dropping out. The relay must be shock-mounted on soft rubber grommets in the manner of nonmicrophonic tube sockets. It was also necessary to slip a soft rubber sleeve over the armature stop to silence the click made by the armature when it snaps against the stop.

The circuit makes use of a 2051 thyratron and is a-c operated. An adjustable bias is provided by the 1,000-ohm potentiometer. Although such an adjustment is usually sufficient, other uses requiring a continuous sensitivity control from zero can be controlled by placing a 1,000-ohm rheostat directly across the microphone.

A standard carbon-microphone transformer drives the grid. Microphone excitation voltage is derived from the 6.3-volt filament transformer and a single-plate selenium rectifier. Phasing of the microphone transformer was found to be important in that both the thyratron and the microphone are operating substantially half wave. A hold-over delay, consisting simply of a capacitor across the relay, is provided to continue the buzzer circuit for at least one second for any sound.

Other applications of this circuit are as an aid in the home of deaf persons, utilizing a signal light instead of a buzzer, automobile-operated garage-door openers, keying transmitters and call systems automatically, timers and remote triggering of scientific apparatus by a shout, shot or other shock wave. It could be useful at unattended airports, to light the field lights whenever a flyer buzzed the field desiring to land, the sound of his engine could trip the sound-operated relay. A five-minute time-delay tube

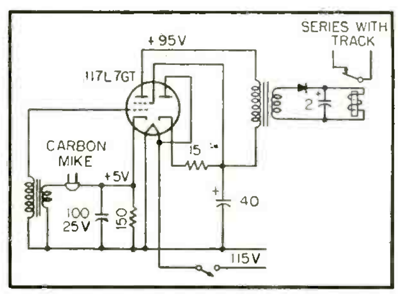
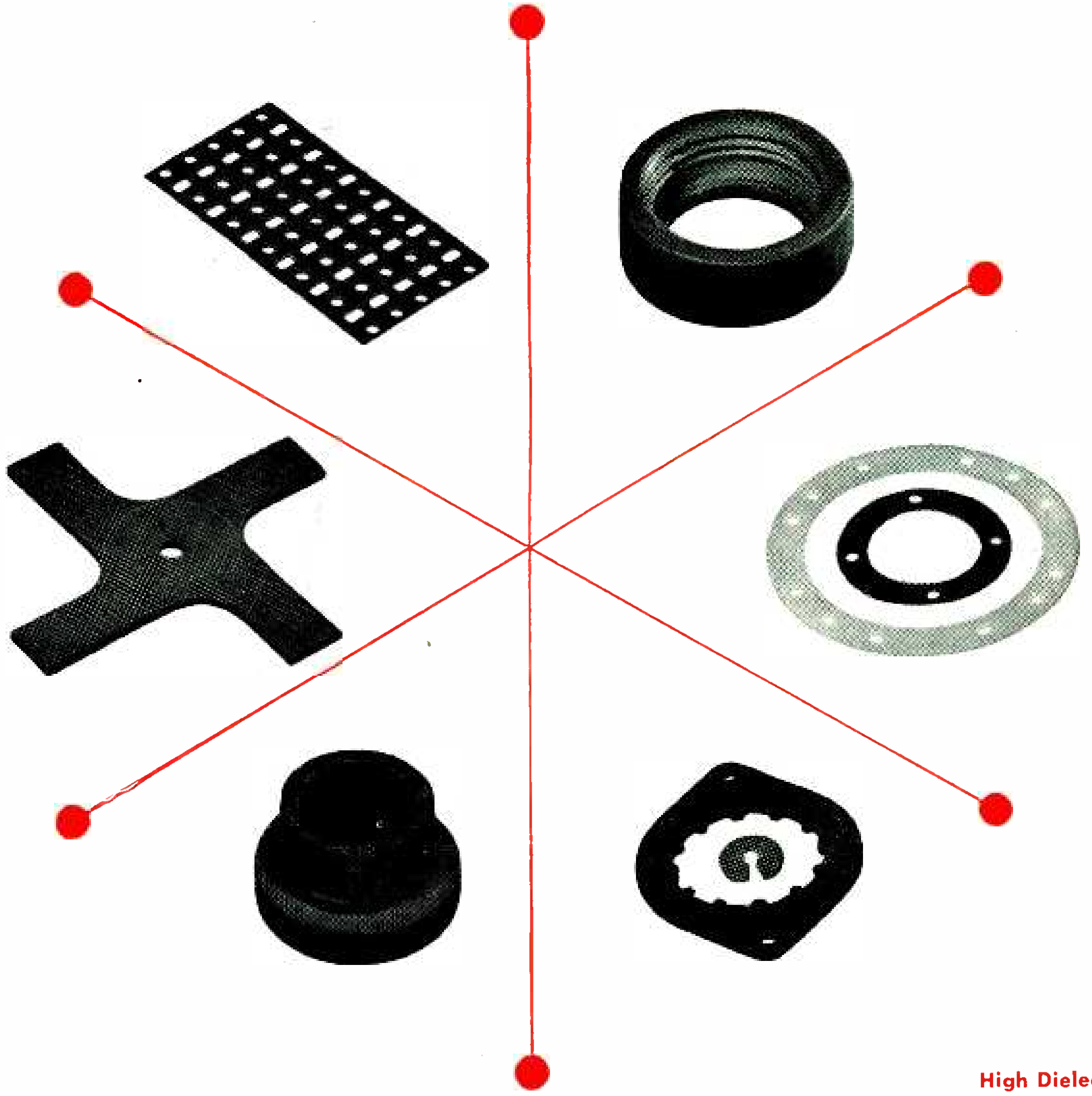


FIG. 2—Voice-operated circuit designed for remote-control toy electric trains



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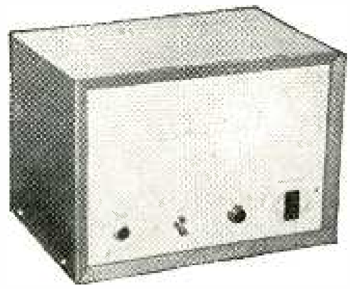

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2

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PLASTIC
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MIL-P-7788

SPECIFICATION

AN-P-89

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Chassis of the voice-operated relay control

would hold the lights on for a maximum of five minutes without reenergizing the thyratron. This would prevent the lights from burning all night after a clap of thunder for instance. The circuit obviously could also be applied to an automobile parked advantageously near a private runway, to turn on the car headlights for marker illumination in landing.

The second circuit, although less sensitive, has interesting uses. It is designed to trip a relay once for each word or syllable spoken, or for each sound impulse of a given duration and repetition rate. The Voice-Trol, a unit making use of this circuit is shown in Fig. 2. It was designed primarily to provide a voice control for standard remote control electric toy trains. Since these trains come equipped with a built-in stepping relay to control their direction, no alterations are necessary.

Normally a button is pressed twice for a moving train to reverse; the current to the track being interrupted twice, causing the stepping relay to move to the reverse position. The two terminals of the Voice-Trol are simply connected in series with the track feeders. The words, "Back-up" are spoken into the microphone, the current is interrupted twice, and the train reverses. "Stop" brings the train to a halt with one pulse, and "Forward" causes it to move forward again. Various combinations of commands were derived which presented a very convincing display. It can be used by the hobbyist, and

1 Part Instead of 3

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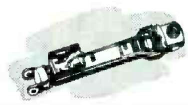

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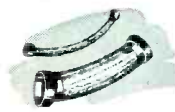

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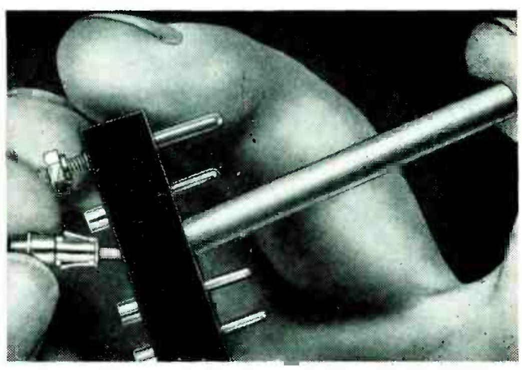


Removable pins in Breeze connectors speed soldering, save time, trouble. Pins snap back into block.

as a novelty attraction as well.

The circuit shown in Fig. 2 is built around a 117L7 tube, the diode section making possible one-tube operation. Microphone current is obtained in the cathode circuit and standard carbon-microphone transformer supplies the signal to the grid. The tube is operating relatively cut-off until a word is spoken. The positive half cycle at the grid turns the tube fully on. This large amplitude square wave is fed through a matching transformer and is rectified to provide the d-c relay excitation. A capacitor, across the relay, was chosen to provide the proper holding characteristics to obtain a relay pick-up once for each normally spoken word or syllable.

The output winding must be so phased as to provide rectification of the negative-going plate signal. Ringing, found to be present with strong signals, during the positive

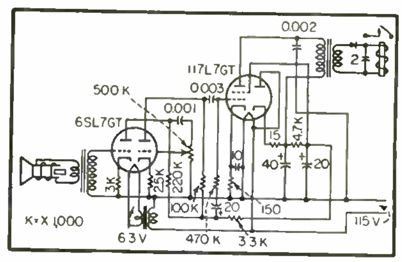


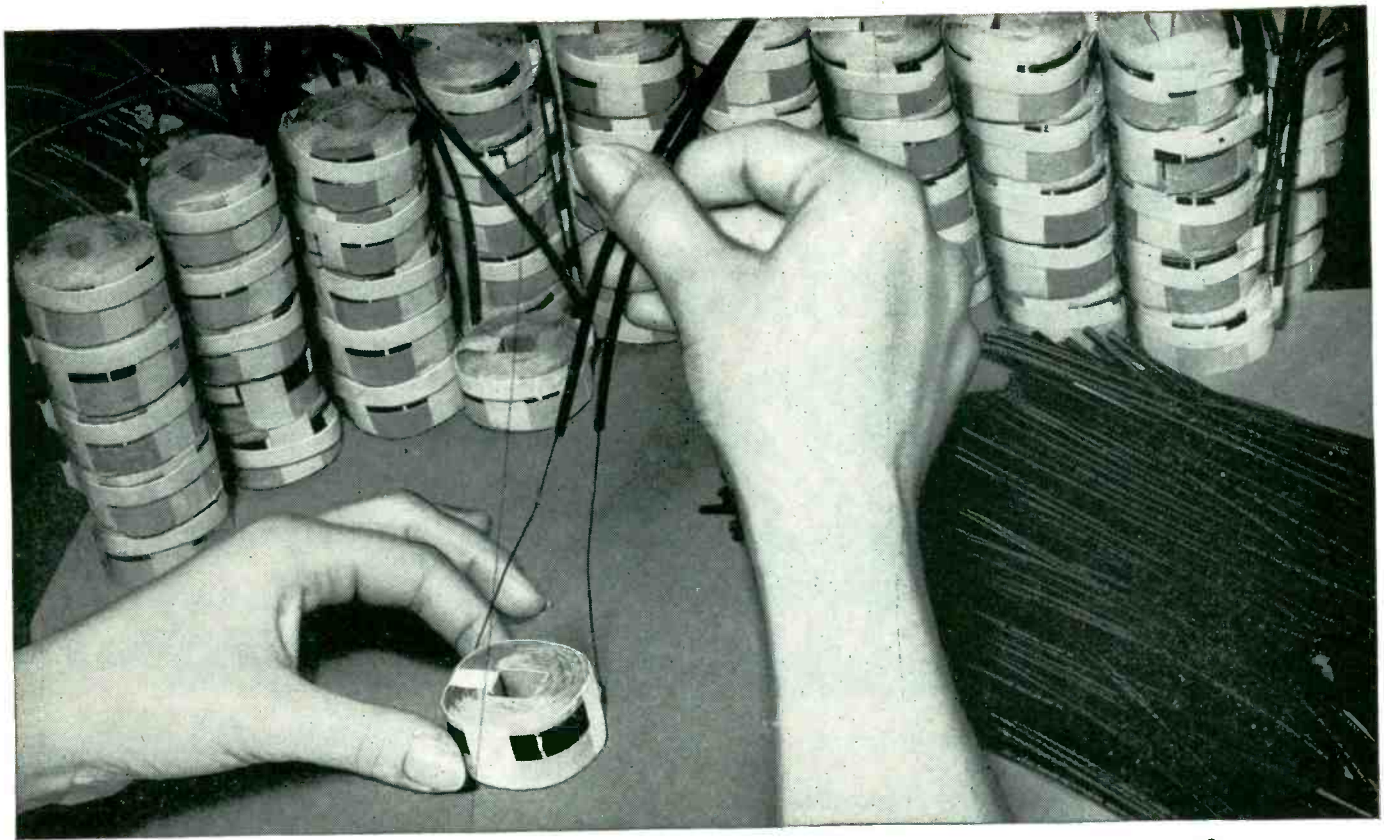
FIG. 3—Modified form of Fig. 2 using a dynamic loudspeaker as a microphone

peaks (when the tube is completely cut off) was of no consequence since that half cycle is unused.

Numerous stepping relay functions can be achieved with the basic circuit to deduce any predetermined intelligence from groups of sound impulses. This circuit lends itself readily to exhibits and demonstrations.

By increasing the relay holding capacitor to approximately 40 μf, and connecting the grid to the voltage amplifier of a public-address call system or transmitter, automatic keying can be obtained with this circuit. Also, a counter could be made to total the number of times any audio equipment is used or any sound has occurred.

A third circuit is shown in Fig. 3 which is used in instances where a carbon microphone would be unde-



sirable. Although using a dynamic loudspeaker as a microphone, and two stages of amplification, the circuit is still moderately simple, using only two multipurpose tubes. The circuit is essentially that of Fig. 2 with the addition of the two-stage preamplifier. Sensitivity is controlled by the input to the second stage. It is advantageous to mount the loudspeaker pickup on some sounding board or resonator.

Design of a Low-Noise Pentode

By P. Welch

Engineering Division
Brimar Valve Works
Standard Telephones and Cables Ltd.
Kent, England

TUBES required for service in the first stage of high-gain amplifiers and similar equipments using very low signal input levels set a special problem in thermionic tube design. The main requirement for a tube of this type is that it should produce very little extraneous noise in relation to the signal level.

Three main sources of tube noise are microphony, hum and hiss. Besides limitation of these noises as much as possible, the tube must be capable of giving a reasonably high gain because if the first stage amplification is not high enough, the noise output from the second tube becomes appreciable.

The 6BR7 has been designed with low noise requirements in mind. The high gain required limited the choice of tube type to a pentode although this structure does introduce certain undesirable noise features. The most natural choice of

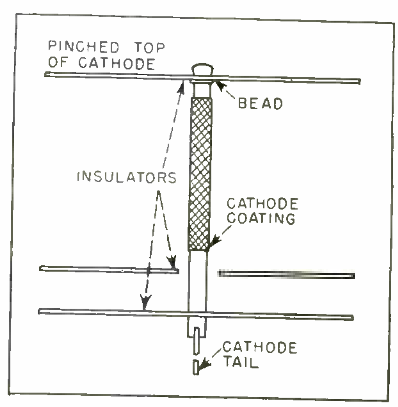


FIG. 1—Means for locking the cathode in the insulating member

existing characteristics was that of the h-f pentode type 6J7 and in order that the 6BR7 should be fully equivalent it was designed with a low anode-to-grid capacitance.

The tube is of the nine-pin jumbo miniature type. This size of single-ended tube has advantages and disadvantages for low noise design.

Reduction of Microphony

The use of the nine-pin miniature construction allowed the tube elements to be mounted close to the glass base. This lowered the center of gravity of the tube, as compared with a conventional octal-based type, and it was therefore less prone to movement under conditions of vibration.

In the design of the 6BR7, the size and shape of each electrode was carefully chosen so that it should not have a low frequency fundamental resonance. This insured that the vibration of the element should not give rise to regenerative feedback at low values of gain in the amplifying equipment. As previously explained, this effect is usually the limiting factor to the tube performance and therefore every effort was made to effect improvements over previous designs.

In order that the general resonance value should be of relatively high frequency and low amplitude, the structural length of the tube was kept as short as possible. Individual electrodes were then studied in turn.

To prevent movement, the cathode of the 6BR7 was locked in the insulating member. This was done by making a small bead in the round wall of the cathode, inserting it through the insulator and then

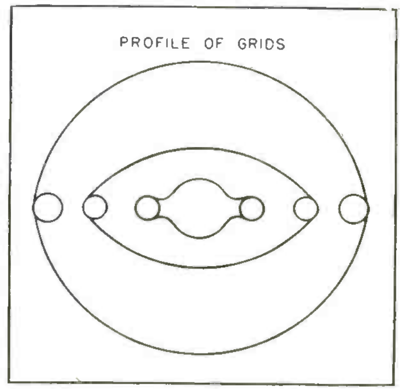


FIG. 2—Grid profile for the 6BR7

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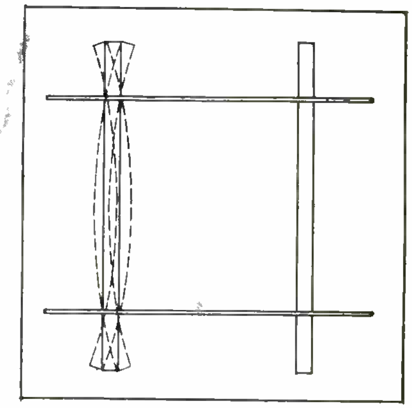


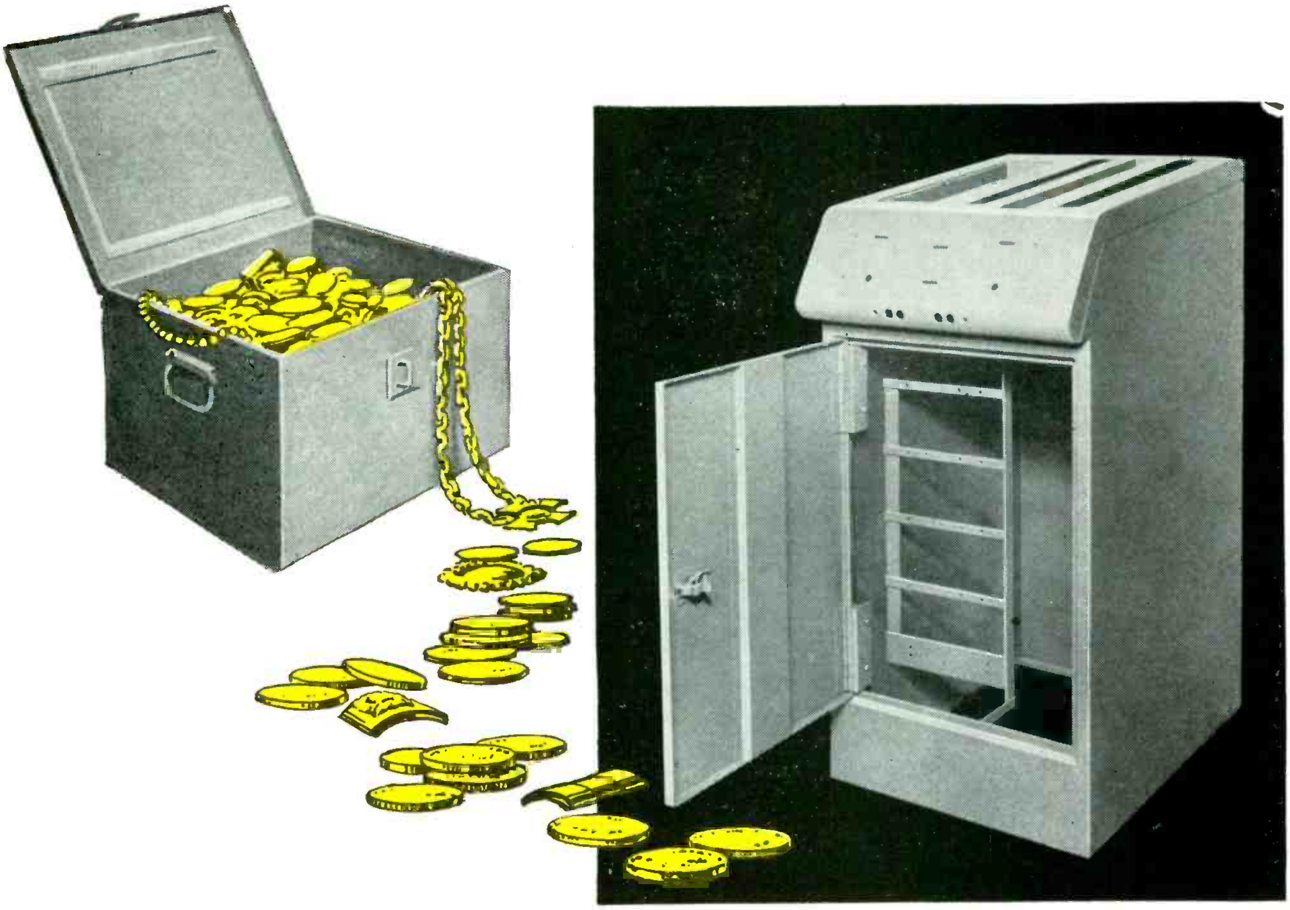
FIG. 3—Conventional insulator and grid assembly

clamping the end together on the other side of the insulator. This is shown in Fig. 1.

The grids of the 6BR7 were made with either a keyhole or an oval type of profile, Fig. 2. This was done so that the grid wires could expand during the heating associated with tube manufacture and yet return to their original shape when they cooled. It was not necessary therefore to provide expansion slots in the insulators for the supporting members, which could then be held by very tight fitting holes.

The most serious cause of grid movement was found to be the resonance of the supporting member itself. Figure 3 shows a consimilarly to a beam supported at two points. If the beam could be supporting member will behave clamped at either end the frequency bly. It can be seen that the grid ventional insulator and grid assem- of resonance would increase and the amplitude for a given accelerating force would be less. The 6BR7 therefore incorporates a double-insulator system at each end with the two insulators separated by a small distance, Fig. 4. This type of construction achieves the results of clamping at both ends and yet allows the grid-supporting member to expand.

Experiments showed that by using the double-insulator construction the fundamental resonance of the suppressor grid could be increased from 700 to 1,700 cps with a decrease of noise output under conditions of constant acceleration of about 10 to 1. This construction was applied to all the grids except the control grid. In this case the



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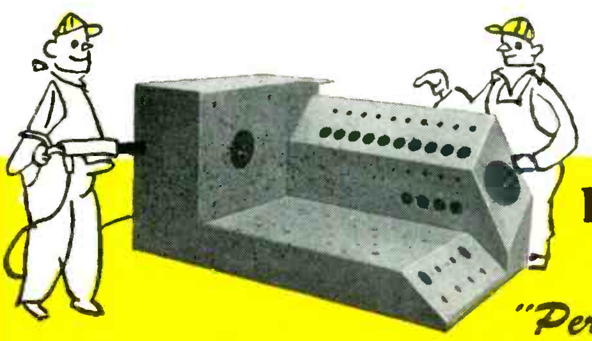

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grid was clamped at the top end but the connecting member to the stem wire at the bottom end achieved the same results.

As a further feature in structural design the four insulators of the 6BR7 were held by four wires which passed through holes near the periphery. The shielding members were all welded to these wires insuring that the insulators were all firmly held.

The anode of the 6BR7 was designed to reduce vibration. Besides the usual strengthening ribs it was supported between the insulators in three places preventing movement in any direction, Fig. 5.

Finally the tube assembly was located in the glass bulb very tightly by virtue of the four-insulator construction. This is important because as a rule the glass bulbs are of irregular internal diameter and a structure which is held by two insulators cannot always accommodate these variations.

Reduction of Hum

Hum is caused by the a-c heating of the cathode. It may be due to the capacitance between heater and grid, the induction effect between heater and grid, the magnetic effect, heater emission and/or by poor insulation between heater and cathode.

Insulation hum is rarely serious with the modern techniques of heater coating and in any case its effects can be largely countered by the cathode by-pass capacitor used in the circuit.

Magnetic hum is always met when faggot-type heaters are used and it may be almost completely avoided by using a double helical heater with a low heater rating be-

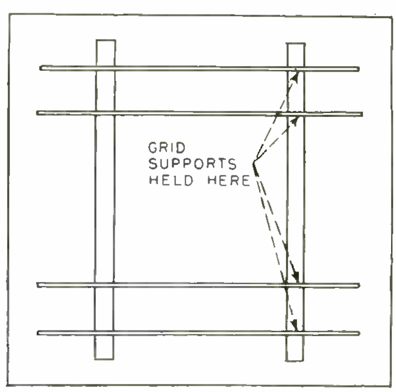

FIG. 4—Double-insulator system

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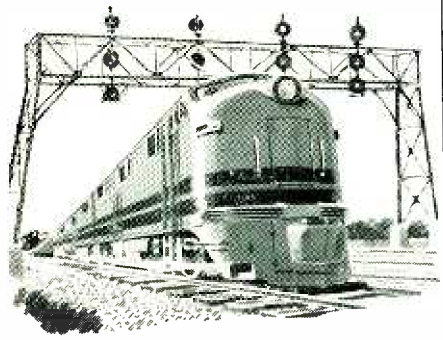

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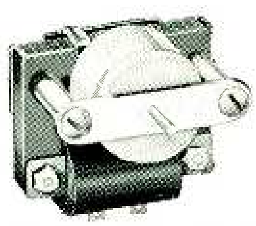

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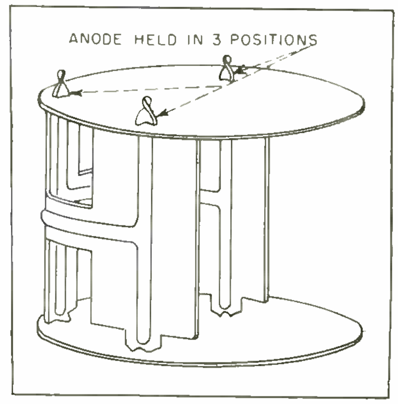

FIG. 5—Means for securing the anode to prevent movement

cause in such a heater design the return helix balances out the magnetic effect of the first helix. The 6BR7 uses a heater of this type with a rating of 6.3 volts at 0.15 ampere.

The static hum, caused by the capacitive effect and induction hum may be reduced by suitable screening between grid and heater. The more serious of these two is that due to the capacitive effect. The 6BR7 incorporates shielding devices so that the capacitance between grid and heater within the tube envelope is practically zero, Fig. 6. The disadvantage of the single-ended tube is apparent, as there must always be a capacitance effect in the glass base. Experiments show that nearly all of the hum produced in the 6BR7 is due to this.

Lastly the conduction effect due to heater emission is nonexistent since the cathode is pinched at the top and the heater shielded at the bottom, Fig. 6.

Reduction of Hiss

It has been explained that hiss noise due to electron emission is of a fundamental nature. The effect can be aggravated, however, if there are gas molecules present within the tube. These will ionize and change the nature of the space current. In the manufacture of the 6BR7, every effort is made to produce a tube with a very good vacuum. Surface texture of the cathode coating, in extreme cases, is also responsible for noise effects. If the emission is limited to isolated patches, the motion of the electrons becomes sporadic. By insuring

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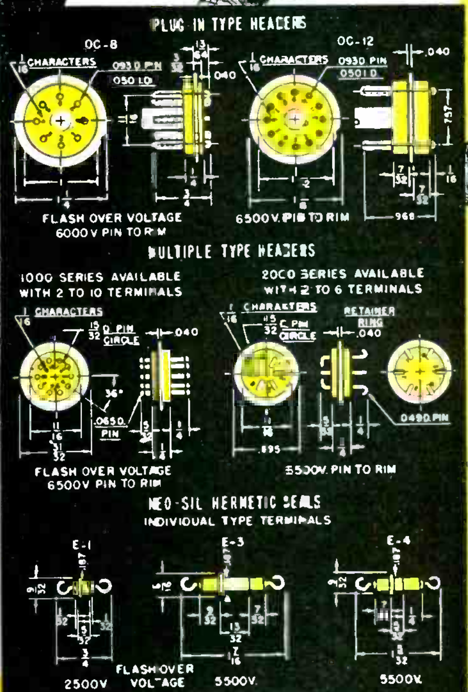


TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 194?, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm centimeters*
1.4×10^{8}	3.5×10^{12}

Dielectric Constant and Dissipation Factor

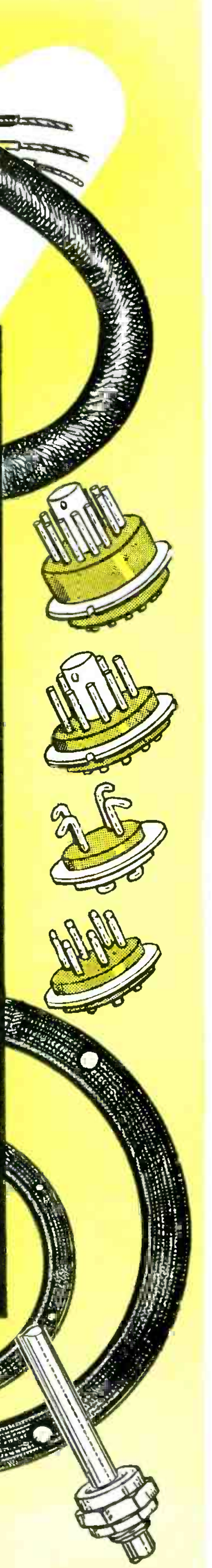
Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

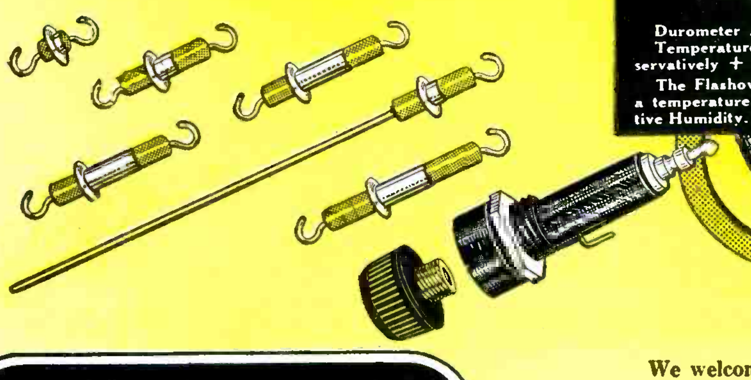
Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 175° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.





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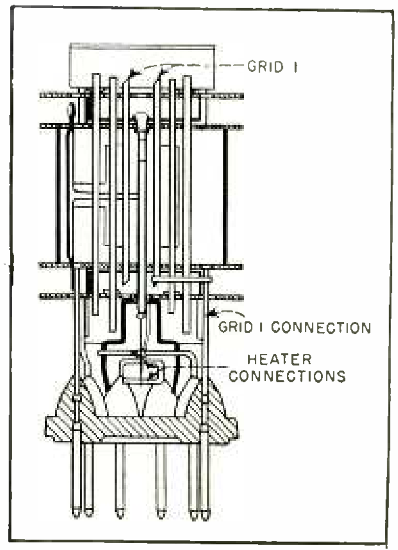

FIG. 6—Section of tube showing shielding (heavy lines) to reduce grid-to-heater capacity

that all the cathodes have a smooth coating and that the processing involved in manufacture is closely controlled, this trouble has been avoided in the 6BR7.

Finally, the insulators of the 6BR7 are all coated with a preparation that insures a very high resistance between electrodes. This is essential because the tube is normally used with a very high grid resistor which would produce a noise voltage at the grid if the leakage current were high. Values of grid current due to this cause for the tube structure alone, vary from 1.0×10^{-8} to 1.0×10^{-10} amperes.

Alarm Signal Generators

By M. B. Freedman and T. E. Rolf

Special Devices Engineering Section
Engineering Products Department
RCA Victor Division
Camden, New Jersey

Figure 1 shows a circuit using the gas tube type VR75–30 to produce a simulated motor-driven horn. Constants were chosen to provide a fixed frequency of approximately 600 cps for the fundamental tone with a very short initial voltage delay to simulate the motor starting time. The tone was roughened by introducing a 60-cycle voltage into the network to simulate the ratchet frequency.

The maximum leakage current of the tube was not a factor in this

This is the second and final section of the paper. The first section appeared in the June issue, page 200.

Brilliant and Steady

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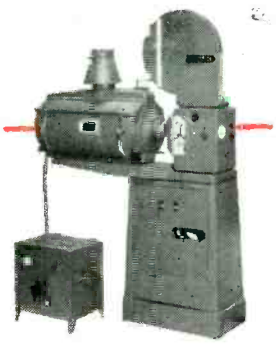

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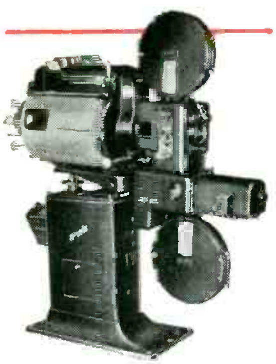
46 ampere arc lamp. f/1.5 20 mm lens, air-cooled film gate, sprocket intermittent that ends film wear and holds old film steady.



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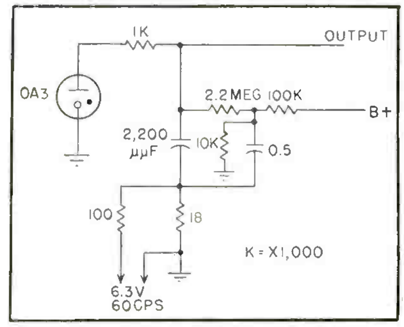

FIG. 1—Gas-tube simulated horn

circuit since the resistance values are relatively low. However, since one multivibrator oscillator could be used for both the siren and horn signals by changing voltage conditions, the gas tube was eliminated entirely.

The multivibrator oscillator has proven to be a versatile tool for the designer of alarm and attention signals because of the ease with which its frequency can be changed by voltage variation. It has been substituted for the gas tube in the siren and horn circuits as shown in Fig. 2 which shows a circuit used to obtain both signals from one oscillator by switching the circuit elements.

The multivibrator oscillator has been further applied in the production of signals for timing the bell repetition rate and the recurrence rate of a siren signal which cycles approximately every three seconds. In these cases a pulsing relay in one of the multivibrator plate circuits applies or varies the frequency control voltages.

Recently, the building-block principle has been applied in the development of a new audio generator for producing alarm signals in an announcing system. Two phase-shift oscillators, two multivibrators

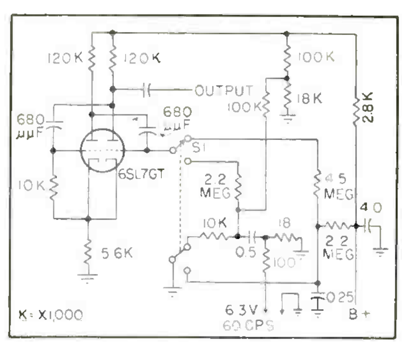

FIG. 2—Siren horn circuit, Switch S_1 is shown in the siren position

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RADIO

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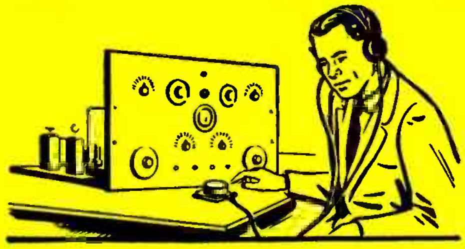
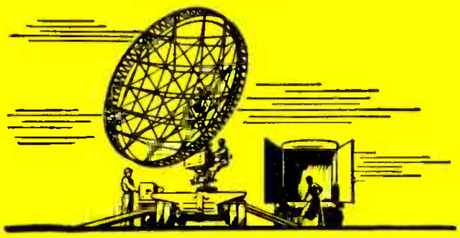


1922 At the very dawn of radio—30 years ago, Aerovox came into being to meet capacitor needs. Pioneer radiophone transmitters and earliest radio receivers specified Aerovox capacitors. Such collaboration has continued down through the first three decades of radio-electronic progress.



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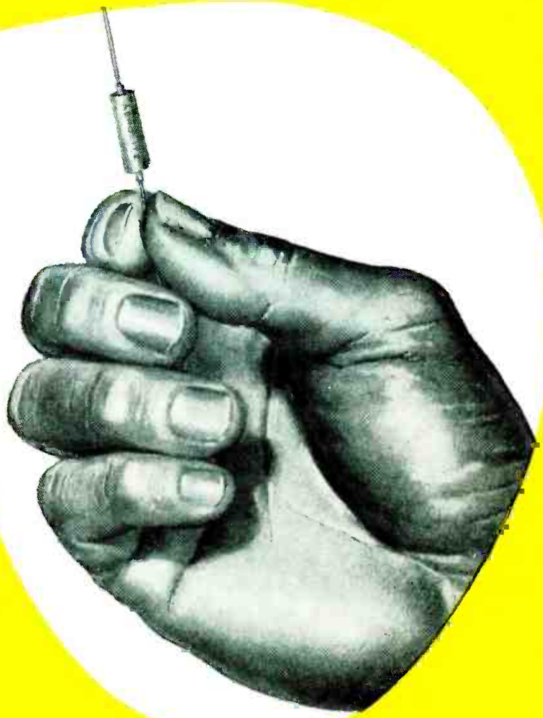

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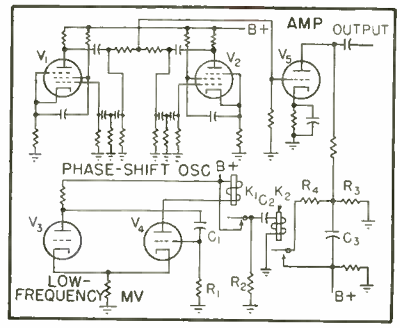

FIG. 3—Bell-generator circuit

and an amplifier connected in various combinations by external switching arrangements comprise all the circuitry needed to create the bell, siren and horn signals.

Figure 3 shows the bell circuit minus the switching setup. The phase-shift oscillators apply a continuous tone signal to the amplifier. The exponential amplitude decay is introduced in the plate circuit of V_5 where C_3 is seen to be in series with the B supply. The charging rate of C_3 through V_5 and R_3 determines the decay characteristic of the bell.

Relays K_1 and K_2 and multivibrator V_3 V_4 comprise the cycling actuator. Relay K_2 is pulsed by the surge of charging current in C_2 each time K_1 is energized by V_4. Contact K_2A remains closed only a small fraction of a second, but long enough to discharge C_3 completely through R_4, a small resistor. The pulsing of K_2 thus results in the momentary application of full B+ voltage to V_5, hence momentary full output. With K_2A open again and C_3 charging, the amplitude diminishes in accordance with the decay of potential on the tube side of C_3.

The time constant is adjusted so that the signal voltage amplitude is about one-fifth of maximum value when recycling occurs. The type of multivibrator shown in Fig. 3 was chosen to insure that when B+ is turned on to start the generator, V_4 would always conduct immediately so that the closing of K_2A would always coincide with the initial application of B+ to V_5. If this were not done, application of B+ to the previously "dead" circuit would start a bell cycle which would be reactuated prematurely when the relay tube did conduct, thus producing a double-strike at the outset.

The siren circuit, shown in Fig.

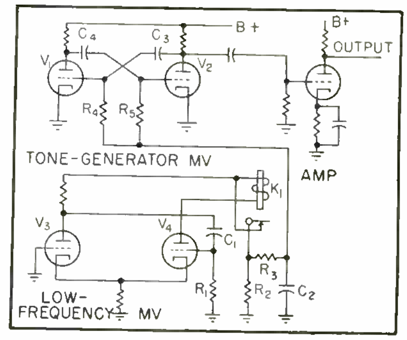

FIG. 4—Siren-generator circuit

4, uses two of the three blocks used for the bell. The tone generator, however, is now a multivibrator. The amplifier is now directly powered by B+. The circuit operation is as follows: Initial application of B+ power starts both multivibrators and the amplifier. Relay K_1 is energized immediately, preventing application of B+ to the tone generator grid circuits. Capacitor C_2 is charged negatively by current from V_1 and V_2 grids and the gradual accumulation of this bias on the grids gradually reduces the plate waveform amplitudes, resulting in lesser grid swings and consequently shorter multivibrator periods.

The frequency rises exponentially toward a much higher value. The decreasing amplitude is not in evidence at the output because of the amplifiers limiting effect. Exponential return of the frequency to the lower value is initiated by the reversal of multivibrator V_3-V_4, whereupon K_1 is deenergized and B+ is applied to C_2 through R_3. Capacitor C_2 must now charge from its negative potential toward the B+ potential, retracing approximately the path it followed in going negative. The charge is never permitted to start positive, for when

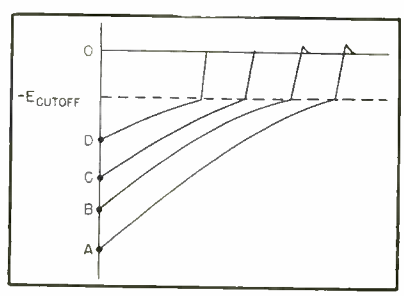

FIG. 5—Grid-circuit waveforms for siren tone-generator multibrator. Explanation of curves is in text

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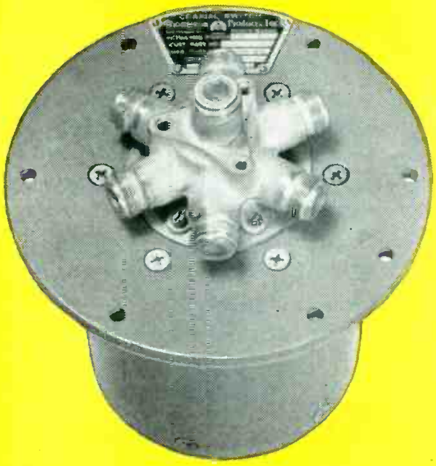

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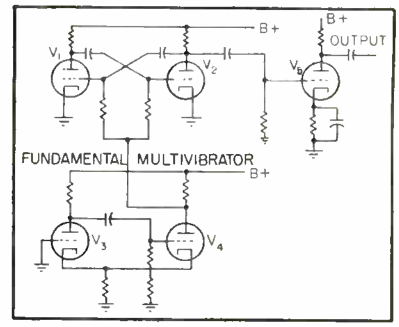

FIG. 6—Horn-generator circuit

the negative potential has been reduced nearly to zero, K_1 is energized again and the cycle repeats. Figure 5 illustrates a series of grid waveforms, *A-D* taken in that order as the frequency rises.

The horn circuit, Fig. 6, utilizes all three of the blocks which were used in the siren. The modulation of the tone generator is now direct, a resistor replacing the relay coil in the V_4 plate circuit. The composite signal appears as a fundamental tone of about 400 cps roughened by a lower frequency tone at about 30 cps, the latter corresponding to the ratchet frequency. The amplitude of the modulating component is about one-fourth the fundamental amplitude and appears both as frequency-modulation and as a mixed-in amplitude component.

Television Spot Wobbler

THE CIRCUIT diagram shown in Fig. 1 is of the "spot-wobble" portion of the Ekco Model TC165 television receiver, designed for the reception of 405-line transmissions as used in Great Britain.

The purpose of the device is to fill in the spaces between the lines on the normal television picture. It is thus of greatest value in receivers employing large picture tubes with a small, well-focused spot.

It will be seen that the circuit comprises a Colpitts oscillator in which the oscillator coil takes the form of an extra pair of vertical deflection coils. These coils are mounted on the neck of the picture tube, adjacent to the focus magnet.

From the point of view of achieving the required result in the picture, the exact oscillator frequency

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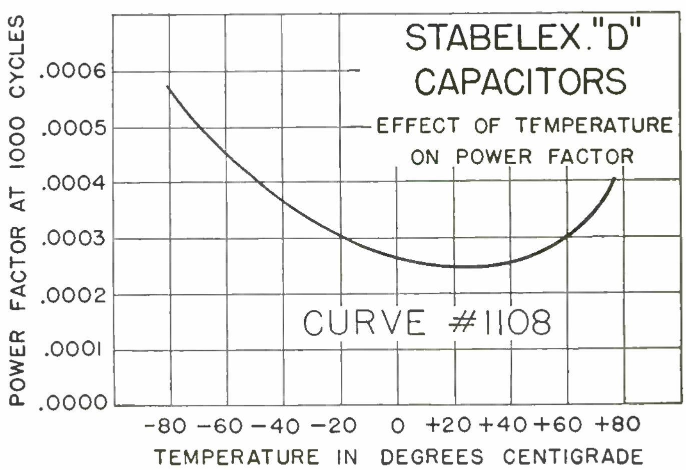

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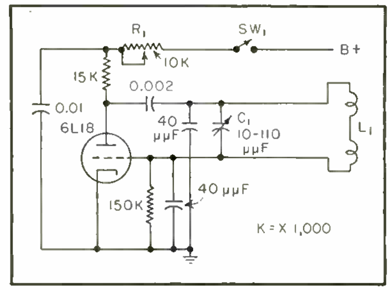


FIG. 1—British circuit uses Colpitts oscillator. Oscillator coil is used as an extra pair of vertical deflection coils

is not very critical but, for normal size picture tubes, should be such as to produce about 1,000 complete cycles or wobbles in each line. As in the British system, the visible portion of each line represents 83.5 percent of the whole, 1,000 wobbles per line will produce 835 visible wobbles across the width of the picture. The "wavelength" of each wobble in a 13-in. wide picture is thus 13/835 in. which is roughly 0.015 in. The required amplitude of wobble is related to the line-pitch of the picture.

For the British 405-line, 25 image-per-second system, 1,000 wobbles per line entails an oscillator frequency of slightly over 10 mc but in practice this frequency is adjusted within this region to a value which eliminates the possibility of harmonic interference with the receiver. This adjustment is carried out in relation to the reception channel to which the receiver is tuned.

Referring to Fig. 1, L_1 is the combined oscillator coil and wobble deflection coils and C_1 adjusts the operating frequency. Resistor R_1 is the amplitude control which is preset and SW_1 permits the device to be switched out of circuit to facilitate adjustment of focus.

Simple Capacitance Alarm System

THE CIRCUIT shown in Fig. 1 is for a simple capacitance alarm device known as the Intrudalarm and manufactured by Harvey-Wells Electronics, Inc., Southbridge, Mass.

Essentially, the circuit consists of a weak oscillator and a relay tube biased to cutoff by some of

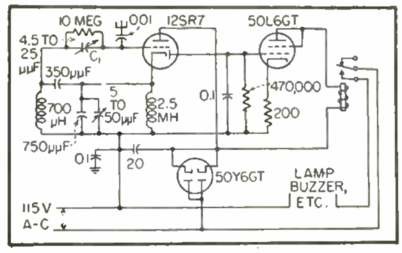


FIG. 1—Schematic of the intruder alarm system

the output voltage from the oscillator. In normal operation, any additional capacitance caused by a person or object coming close to the antenna will cause the oscillator to stop oscillating. When this happens, the bias on the 50L6GT is removed, the tube conducts and actuates the relay which closes the circuit of the warning device.

Ultrasonics Aids Diathermy Experiments

By HERMAN P. SCHWAN and EDWIN L. CARSTENSEN

Department of Physical Medicine
Moore School of Engineering
University of Pennsylvania
Philadelphia, Pennsylvania

IN THE INVESTIGATION of the heating of tissue by high-frequency sound, relatively little work has been reported on the acoustic impedance of tissue. There has been evidence, however, to show that frequencies in the order of one mc are of interest for diathermy.

The first biological material chosen for investigation was blood. Figure 1 is a diagram of the mechanical arrangement used in the measurements. The test vessel is divided into two compartments by a rubber diaphragm. One half is filled with degassed water and the other with the liquid under investigation.

Transducers are mounted on a sliding assembly source in the water chamber and the receiver is located in the test liquid. The separation between the transducers is held constant and the transducer assembly is moved along the axis of the test tank.

Variation of receiving intensity with assembly position is used to obtain the absorption coefficient of the sample liquid. Barium titanate

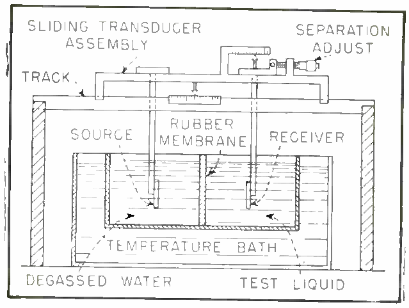


FIG. 1—Mechanical drawing of the set-up for ultrasonic diathermy measurements

plates were used for transducers to cover the range from 300 to 2,400 kc. Magnitudes of acoustic impedance for water and blood are approximately equal. There are only small reflections from the liquid interface and refraction effects at this boundary are negligible.

One of the greatest difficulties associated with conventional techniques for measuring absorption in liquids is that the output of the receiving transducer depends not only on the absorption of the liquid but is also a complicated function of transducer separation. This method avoids these difficulties by maintaining a constant transducer separation.

For velocity of sound determinations, the wave length in the test liquid is measured by comparison of phase of the r-f output of the receiver with a direct signal from the generator while the transducer separation was varied by micrometer control.

Effectively free field conditions are obtained through the use of pulsing techniques. A pulse of r-f is applied to the source, Fig. 2. The output of the receiver is amplified and presented on an oscilloscope. The relative output inten-

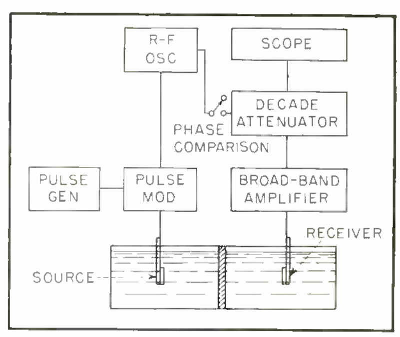
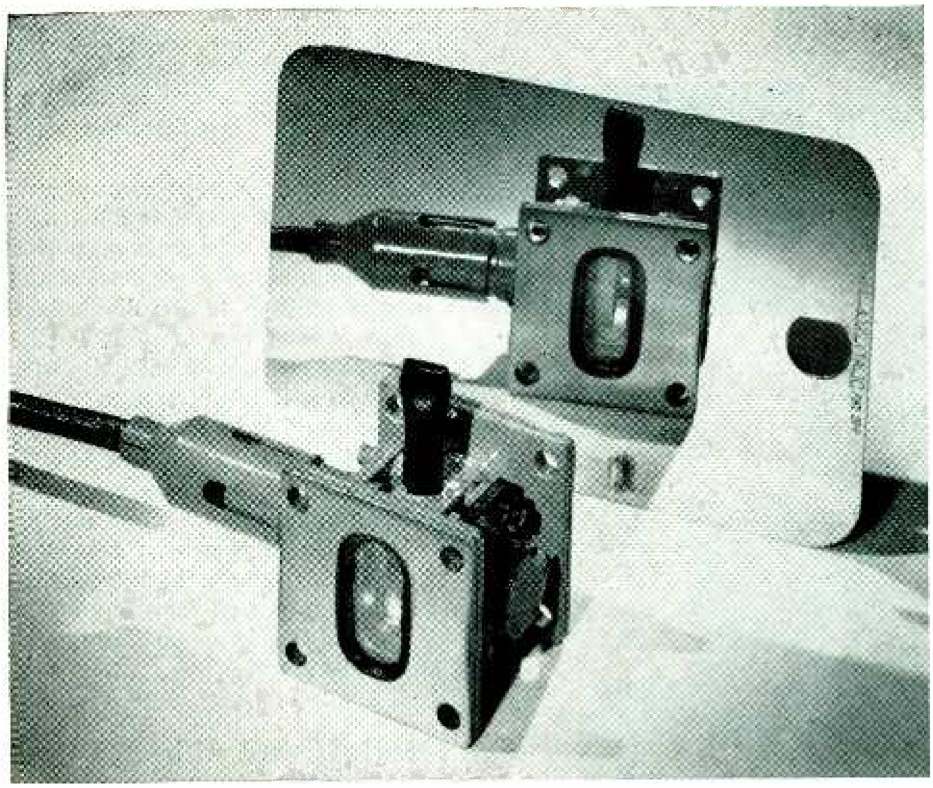


FIG. 2—Block-mechanical drawing of r-f pulse equipment



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OPERATIONALLY, the V-27 provides output powers of 4 to 8 watts c-w or 100 to 500 watts with 3- to 5-kv pulses on a 3 per cent duty cycle. It is rated with a beam voltage of 1350 volts, beam current of 100 ma. Both input and output flanges fit inch by half-inch waveguide.

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For solid tissue measurements the entire test vessel is filled with water and the sample is supported between thin plastic windows placed at the position of the diaphragm. Transmission loss is measured by comparison of output intensity with and without tissue sample.

Depths of penetration for solid tissues are of the order of four to eight cm at one mc. Frequencies up to approximately two mc can be useful for diathermy. According to clinical reports, high-frequency sound can be used for many of the same applications as electromagnetic diathermy.

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Induced currents may also come from mobile radio, although because of low power, vertical antennas and high frequencies, chances are slim that premature explosions would be caused.

Intensity of r-f energy normally

Table I—Safe Distances for Various Transmitted Powers

Power (watts)	Distance (feet)
5– 25	100
25– 50	150
50– 100	220
100– 250	350
250– 500	450
500– 1,000	650
1,000– 2,500	1,000
2,500– 5,000	1,500
5,000– 10,000	2,200
10,000– 25,000	3,500
25,000– 50,000	5,000
50,000–100,000	7,000

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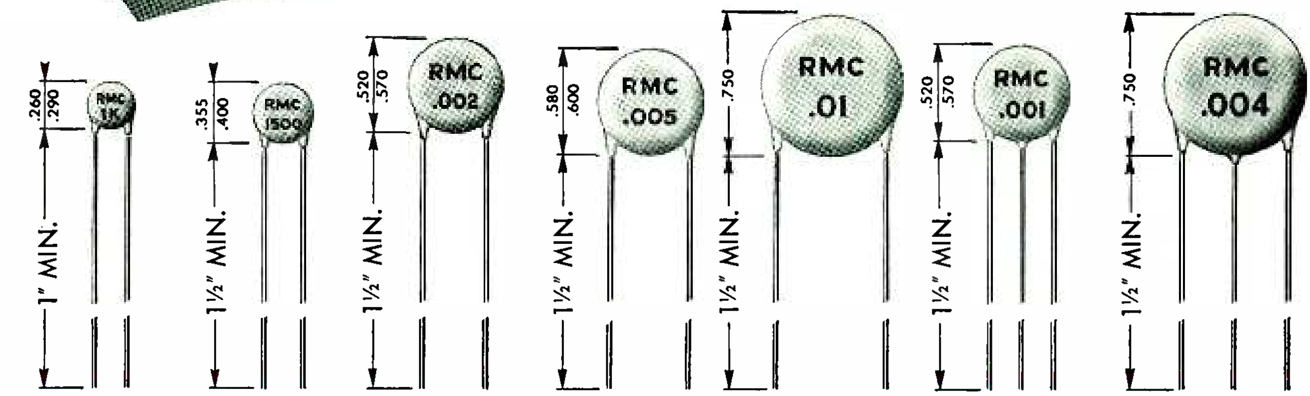

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FLASH TEST VOLTAGE	37,500 VDC	30,000 VDC
POWER FACTOR	Less than 1% at 1000 CPS	Less than 1% at 1000 CPS
LEAKAGE RESISTANCE	Guaranteed higher than 25,000 Meg Ohms	Guaranteed higher than 25,000 Meg Ohms
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decreases as the square of the distance from the transmitter. Table I shows distances beyond which there would seem to be no possibility of a premature explosion for the transmitted powers shown. The distances given are based on the worst possible conditions such as wire length and position of the circuit. A substantial margin of safety is also included.

The induced energy picked up by the blasting cap circuit may be reduced substantially by application of a few rules of thumb. If the wire lengths are made to be other than half or one-quarter the radio wave length, induced currents will be small. The wires should not be parallel to the transmitter antenna nor in its zone of maximum radiation. Induced current is less if the wires are on the ground rather than suspended a few feet above it. Additional information on safe handling of such devices is presented in the E. I. DuPont de Nemours and Company Technical Service Bulletin No. 13.

Spark Speeds in the Audio Region

By Joseph F. Swingle, Jr.
Rouss Physical Laboratory
University of Virginia
Charlottesville, Va.

In many cases where a triggered spark gap is used as a source of light the question arises as to when the spark ceases to follow the input signal. This usually occurs because of too fast an input signal. Figure 1 illustrates the setup for a situation of this type.

In Fig. 1, a light beam from the spark-gap light source S is reflected from a revolving mirror located on the ultracentrifuge shaft and triggers a multiplier phototube. The output is amplified and drives a thyratron circuit which fires the

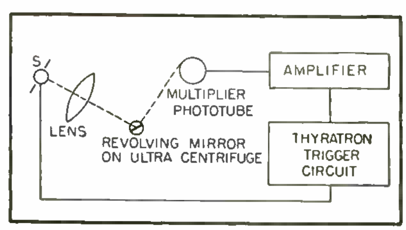
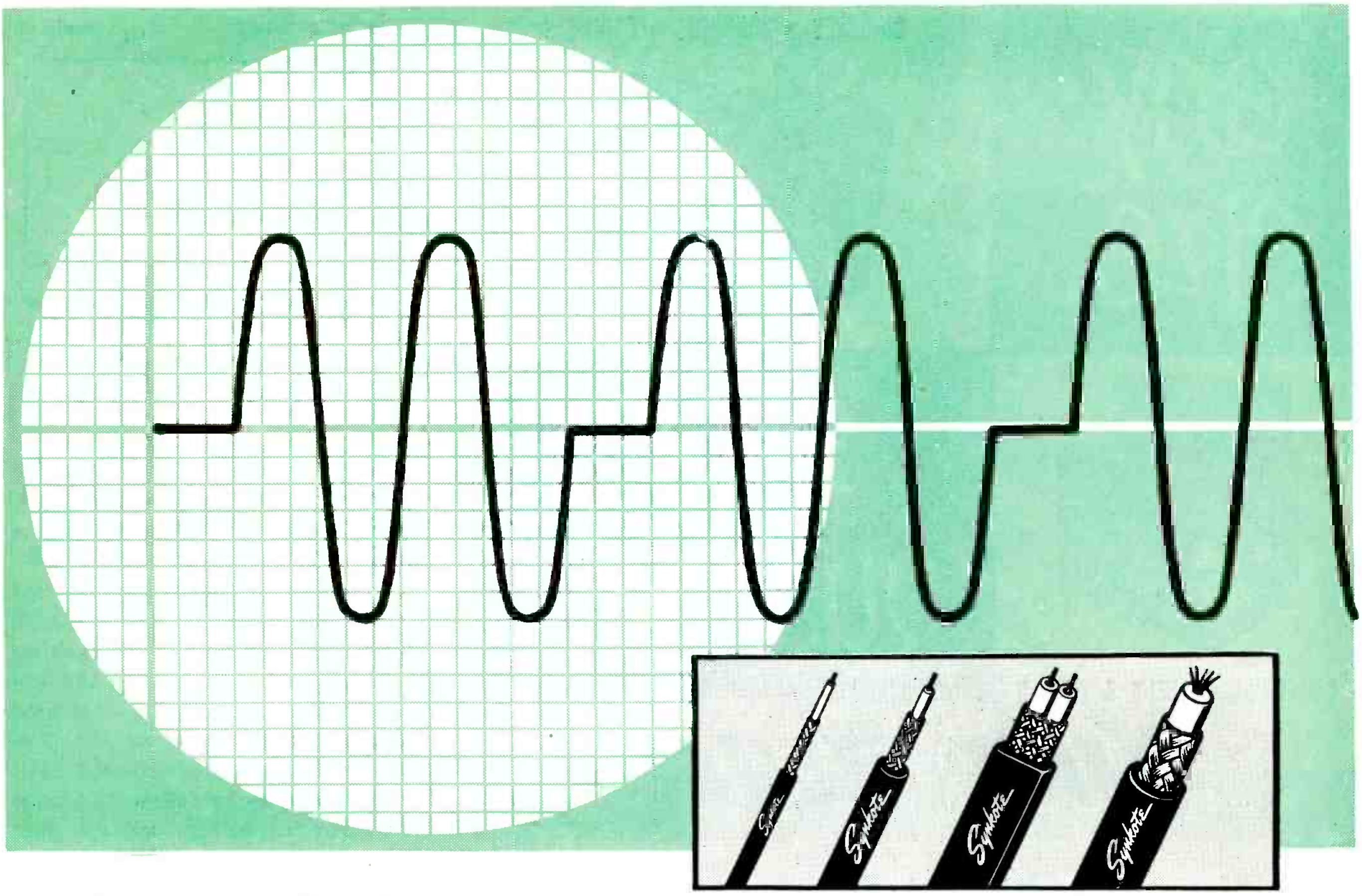


FIG. 1—System using triggered spark gap as a source of light



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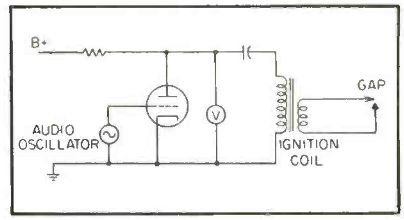

FIG. 2—Circuit for checking to see when the spark gap ceases to follow the input signal

spark gap at the same rate. The problem is to determine when the spark gap ceases to follow the input signal and fires at some other rate lower than the input signal.

An accurate check may be had by driving the thyratron with an audio oscillator and by measuring the voltage to ground of the capacitor, see Fig. 2. The capacitor voltage will decrease as the frequency of the input increases until the gap ceases to follow the trigger. The capacitor voltage then rises.

Another possible method is to observe the output of a communications receiver on an oscilloscope while the gap is firing. This signal is the radiation of the spark gap. The signal may be measured by Lissajous figures and the point where following ceases is easily determined.

Electronic Elevator Touch Button

AN INTERESTING USE of electronics developed in recent years and known as the electronic touch button has been installed in the new Chrysler Building East in New York City by the Otis Elevator Company.

Figure 1 shows a sketch of a typical elevator fixture. An insulating material with a high dielectric constant is used to cover the face of the button. An electrically conductive material coats the back of the button and makes contact through a spring with a similar coating on the top of the tube. The button forms one plate and the dielectric of a capacitor.

The tubes used are neon diodes. Referring to Fig. 2, as long as current flows through the tube, a

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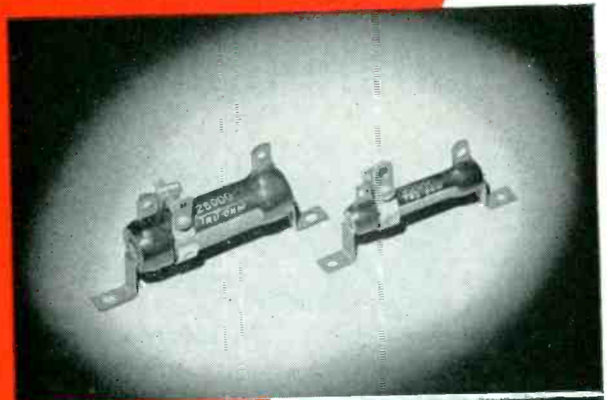

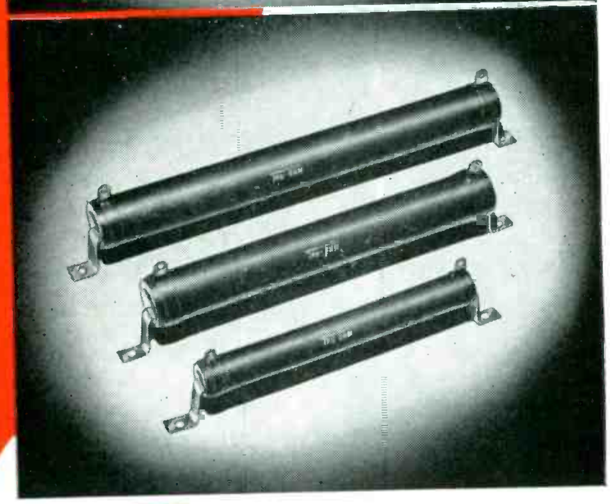

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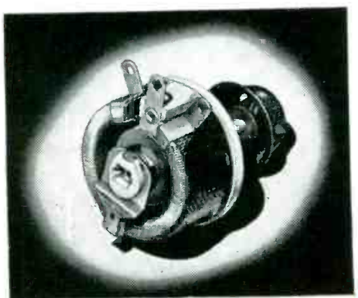

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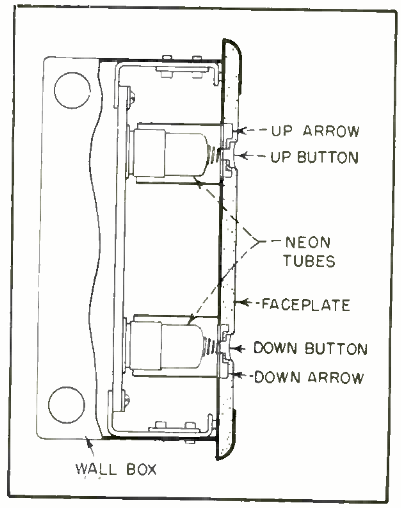


FIG. 1—Sketch of a touch-button fixture

call remains registered. No call is registered when current flow ceases.

If no call is registered and, consequently, no current is flowing through the tube, a 135-volt d-c potential exists across the gap between the anode and cathode of the tube.

This potential is not large enough to cause conduction. However, there is also a 150-volt a-c potential between anode and ground. When a person's finger touches the button, the distribution of electrostatic fields inside the tube is changed sufficiently for the tube to ionize and start conducting current. Current continues to flow after the person's finger is removed because the d-c potential will then maintain the flow of current after it has once started.

A negative pulse of voltage is applied to the circuit when an elevator answers the call. This reduces the voltage across the tube, current flow ceases and the call is no longer registered.

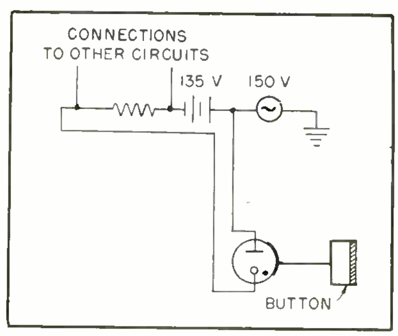
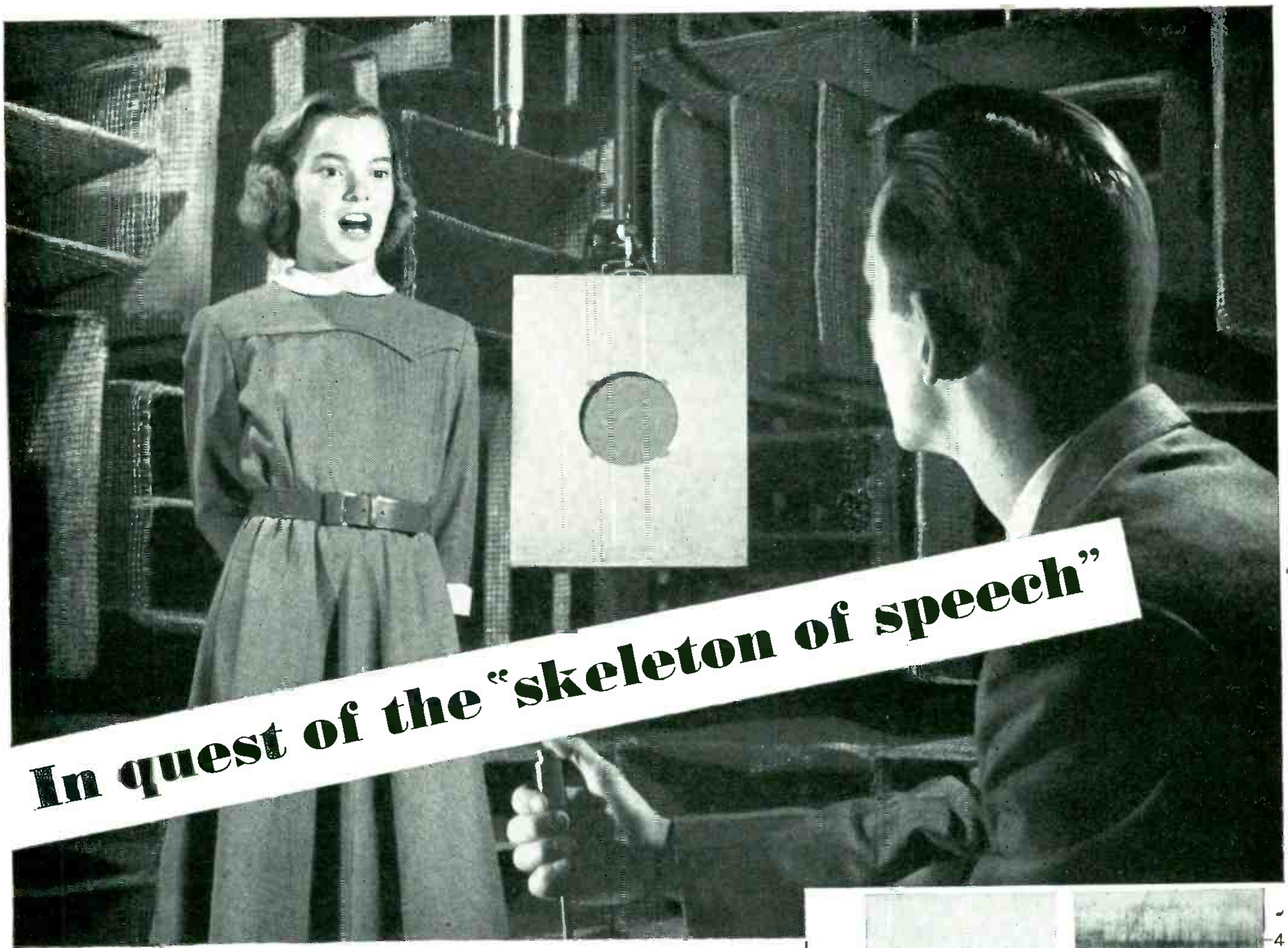
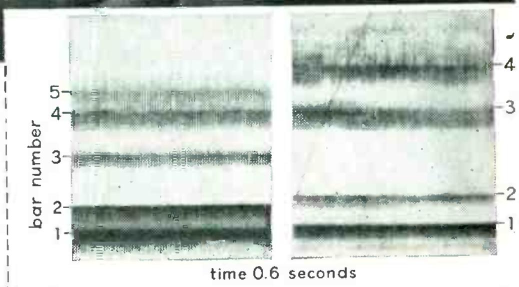


FIG. 2—Simplified schematic diagram of the touch-button circuit

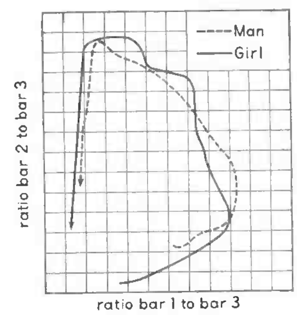
In quest of the "skeleton of speech"



In the famous Quiet Room at Bell Laboratories, this young volunteer records speech for analysis. Scientists seek to isolate the frequencies and intensities which give meaning to words . . . stripping away non-essential parts of word sounds to get the basic "skeleton" of speech.



Spectrograms of young girl's voice (right) and man's voice making "uh" sound as in "up." Horizontal bars reveal frequencies in the vocal cavities at which energy is concentrated. The top of the picture is 6000 cycles per second. Pictures show how child's resonance bars are pitched higher than man's.



The word "five." Graph shows ratio of frequency of spectrogram bars. The solid line is for a girl and the dotted line is for a man. Note the similar patterns despite pitch differences. Human hearing extracts the speech sounds from this sort of pattern in the identification of words. Scientists aim at machines that can do the same.

A child or an adult . . . a man or a woman . . . an American or an Englishman—all speak a certain word. Their voices differ greatly. Yet listeners understand the word at once. What are the common factors in speech which convey this information to the hearer's brain?

Bell scientists are searching for the key. Once discovered, it could lead to new electrical systems obedient in new ways to the spoken word, saving time and money in telephony.

Chief tool in the research is the sound spectrograph which Bell Telephone Laboratories developed to make speech visible. Many kinds of persons record their voices, each trying to duplicate an electrically produced "model" sound. While their voice patterns are studied, a parallel investigation is made of the way human vocal cords, mouth, nose and throat produce speech.

Thus, scientists at Bell Laboratories dig deeply into the fundamentals of the way people talk, so that tomorrow's telephone system may carry your voice still more efficiently—offering more value, keeping the cost low.

BELL TELEPHONE LABORATORIES

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

Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

Tape-Cutting Fixtures Speed Production of Transformers

Winding adhesive tape spirally on drum made from removable U-channels, for cutting into tabs at Keystone Products Co.

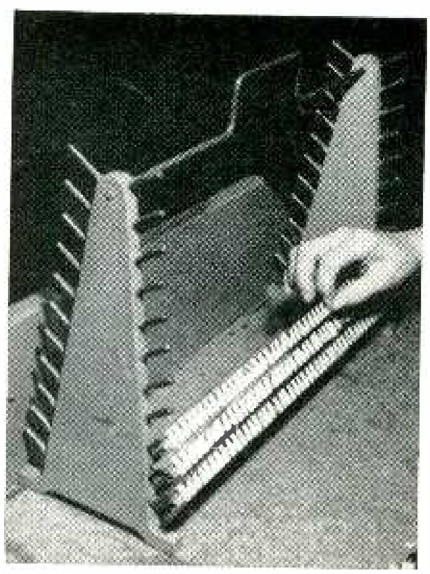
TABS of adhesive tape or cloth, widely used for anchoring coil leads and many other purposes in the production of electronic equipment, present a cutting and dispensing problem that can be solved in various ways depending on the speed and volume of the assembly-line operation.

Where large quantities of tabs are needed for anchoring leads of coils for miniature amplifiers, the elaborate cutting fixture and dispensing rack arrangement used by Keystone Products Co. in Union City, N. J. becomes economically feasible. Here quarter-inch-wide U-shaped channels fit into slots arranged ¼ inch apart on two aluminum disks. A friction fit keeps the channels in position, forming a drum that can be turned by a crank on one end of the shaft.

The tape to be cut is wound spirally on the channels until the drum is full. A razor blade or sharp knife is then run alongside each channel in turn to cut the tape quickly into tabs. Cutting on one side of each channel gives ½-inch tabs, which are the shortest that can be obtained with the setup. Tab length can be increased in ¼-inch intervals by appropriately spacing the cuts.

After the tabs have been cut, the channels are lifted out one by one and placed over metal pegs on the dispensing rack. For a half-inch tab, half its length projects above the channel and can easily be pulled off for use.

A simpler wood cutting drum is in use at Utility Electronics in East Newark, N. J. for smaller production runs. Slots are cut lengthwise in the square drum at the desired tab distance. Dowel rods serve as the shaft and handle. The base and frame are also wood. The tape is spirally wound over the arbor, then cut into tabs by running the razor blade along each groove in turn.

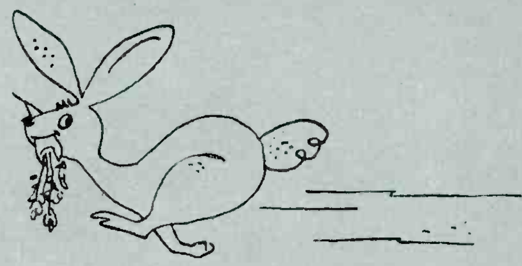


Rack for supporting U-channels with tape tabs alongside coil-winding machine

Wood fixture used at Utility Electronics for cutting tape into tabs

R-F Coil Winder

COILS for television tuners and similar high-frequency applications are wound more efficiently and accurately with a simple hand-operated gear-train arrangement than with elaborate motor-driven equipment in the Television Receiver Division of Allen B. DuMont Labs.,



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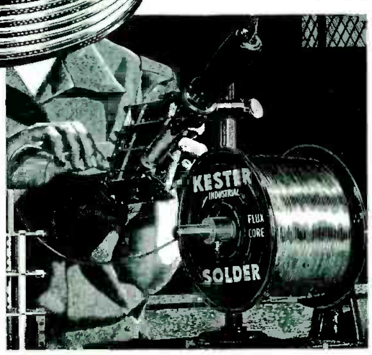

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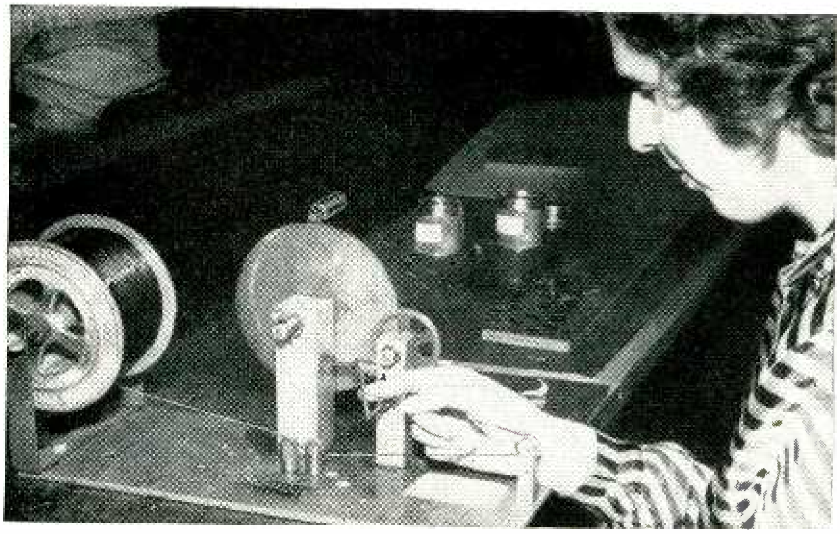
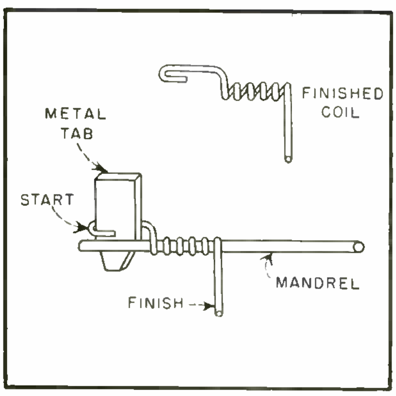


Inserting wire in hole in hinged lever of mandrel. Pulling handle of large gear forward to stop winds complete r-f coil in few seconds

Inc., in East Paterson, N. J.

Metal pegs inserted in the large drive gear are located to hit against the gear bearing supports or other stops, limiting the motion of the gear to the exact angle needed to give the desired number of turns on the coil mandrel. A convenient handle is attached to the large gear for moving it through this angle to wind a coil. By changing positions of stops and/or changing gear ratios, coil turns can be changed.

The entire mechanism, including the axle for the spool of wire, is mounted on a heavy metal plate. From the spool, the wire goes over three straightening pulleys to a mandrel having on its end a hinged lever. The end of the wire is inserted in a hole in the lever, the hole being positioned far enough away from the mandrel to give the desired lead length. With the wire in position, the operator presses against the hinged lever lightly with her left hand to keep it at right angles to the mandrel, then pulls the gear handle forward to its stop to wind the coil. The wire is clipped at both ends with side-cutting pliers, and the hinged lever is straightened out so the completed coil can be slipped off.



Modification of mandrel for obtaining preformed hook in coil lead

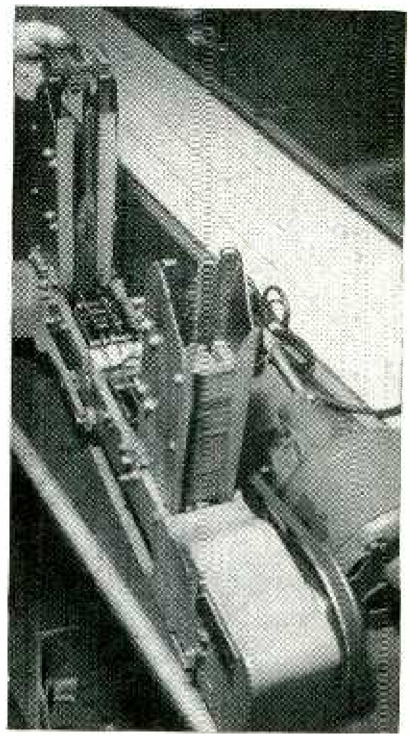
In another setup, a hook is formed in the starting lead of the coil by using a modified mandrel without the hinged lever. The end of the wire is bent around a metal tab inserted in a hole in the mandrel, as shown, and the coil is wound as before. The tab is pulled out after winding so the coil can be removed, then put back in readiness for the next coil.

Laminated Stacker for Magnetic Amplifiers

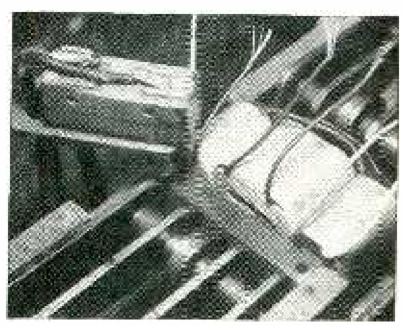
USE of a Lamator automatic E-I lamination stacker speeds production of magnetic amplifiers at Keystone Products Co. in Union City, N. J. As designed for this particular application, the machine takes three coils (one for each leg of the core) and stacks in the laminations from the bottom rather than from the top. The vertical storage racks each contain both E and I laminations. When the left-hand rack releases an E for feeding under the stack already in the coils, the right-hand rack releases an I; on the next pass an I comes from the left and an E from the right, for alternate stacking just as would be done manually.

A split pulley on the motor gear box permits adjusting the speed of the machine for optimum operation without jamming. In event of a jam, the operator moves a lever that slides the motor forward to ease belt tension, then removes the jammed laminations. Bent, off-size or burred laminations are commonest causes of jams.

A snap-action switch is actuated



Loading E laminations into one of vertical racks of stacker for magnetic amplifiers. Jams due to imperfect laminations are minimized by feeding in laminations from the bottom of the stack, so weight of stack aids operation



Partly stacked coils of magnetic amplifier. Spring-loaded cover plate of machine hides laminations. The snap-action switch has a button that is pushed by the cover plate to stop the machine when the coils are full

- **WITHSTANDS 250°C**
- **HAS HIGH SPACE FACTOR**
- **EXCELLENT ELECTRICAL PROPERTIES**

A NEW MAGNET WIRE

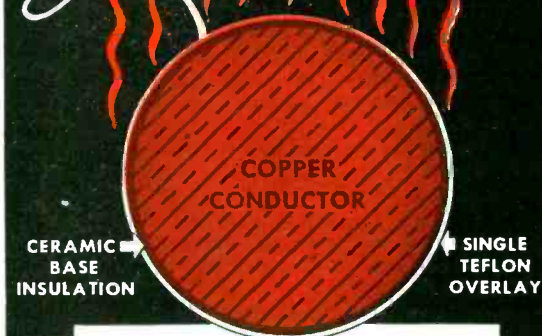
CEROC® ST

If smaller, lighter electrical components are needed in the military electronic gear or aircraft controls you are concerned with, investigate the use of CEROC ST, the newest Sprague magnet wire.

Application of a single Teflon overlay to the base ceramic insulation results in a magnet wire which has many of the best properties of both Sprague's CEROC 200 silicone-coated ceramic-insulated wire and CEROC T double-Teflon ceramic-insulated wire.

Complete details of this important new development are given in Engineering Bulletin 404, available on letterhead request.

For latest information on CEROC 200 and CEROC T, write for Bulletins 401-B, 402-H, and 403-C.



QUICK DELIVERY

Immediate deliveries from stock on small sample quantities of all CEROC wires as well as short delivery cycles on production runs are now in effect.

There is plenty of room for your orders on the production schedules of our North Adams, Mass. and Bennington, Vt. plants with their newly-expanded facilities.

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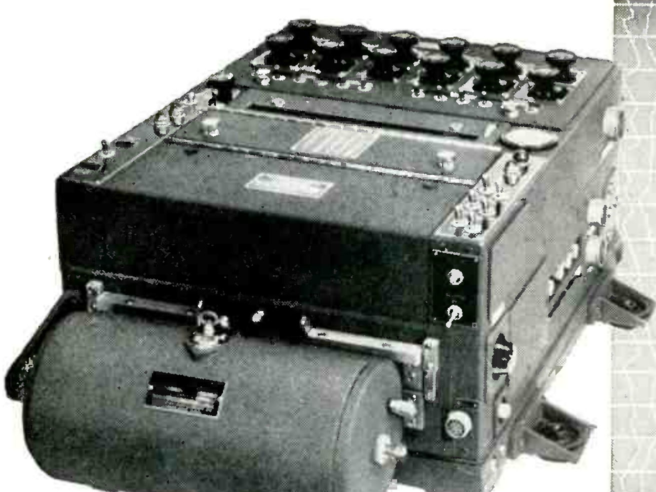

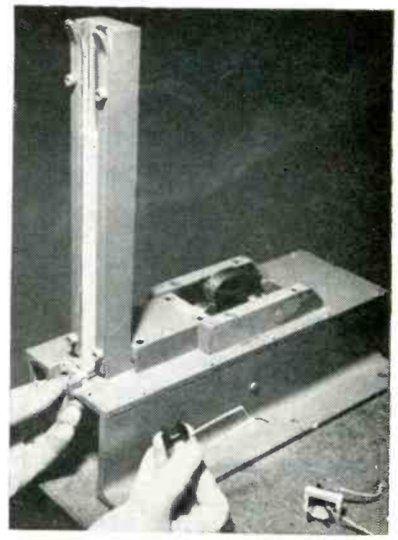

Plunger of butt stacker is here delivering correct number of E-E laminations for half of core for single-coil unit

by the rising stack in the coils, to stop the machine automatically when the desired thickness of stack is attained. The stacker is made by LaCesa Engineering Corp., 5910 W. Division St., Chicago, Ill.

For smaller transformers using butting E-E stacks without interleaving, Keystone speeds assembly of cores with a special LaCesa butt stacker operated by a foot lever. This delivers exactly the correct number of laminations for each half of the core.

When the foot lever is pressed, an accurately machined plunger moves forward under cam action to push the laminations out to the fingers of the operator, for immediate insertion in the single coil. A similar stack is inserted from the other side of the coil to complete the core. An accurately positioned stop bar prevents unwanted laminations from coming out when the plunger moves forward.

Cart for Pass-Along TV Line

EITHER an ordinary surfaced bench or angle-iron rails can be used with the furniture-caster cart developed for Tele-tone's television receiver assembly line. With rails, the free-swiveling casters and the flat plywood base of the cart keep it moving straight down the line. On a flat bench, a fifth ball-bearing wheel mounted vertically under the cart

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MIRAGLAS TAPES are available in a wide variety of widths, thicknesses and styles, for practically every electrical insulation requirement where high dimensional stability and tensile strength are desired. Continuous filament MIRAGLAS TAPES are supplied in thicknesses ranging from .003" to .015" and in widths from ⅜" to 1½". Medium weave tapes, for machine taping, range in thicknesses from .005" to .015" while tight weave tapes for manual taping, range in thicknesses from .003" to .007" only. Staple fiber tapes in thicknesses from .010" to .025" and widths from ½" to 1½" are also available for applications where space is not a primary consideration or where a more resilient wrapper is wanted.

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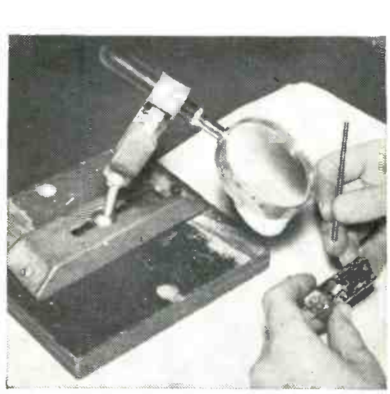
Three-purpose chassis cart for television receiver assembly line

runs between two closely spaced angle-iron strips screwed to the bench. This wheel is at the leading end of the cart.

For a powered conveyor line, a roller-chain conveyor can be run behind or under the line, with rods projecting from the chain to engage some part of the cart.

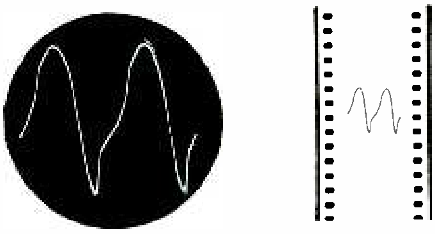
Magnifying-Glass Holders

For inspecting connections and checking clearances in intricate subminiature assemblies for military and commercial electronic units, magnifying lenses are becoming more and more essential. Varieties of holders for these lenses are becoming almost as numerous as for soldering irons, in commercial as well as homemade versions. Three examples are shown, along with a modification of one holder



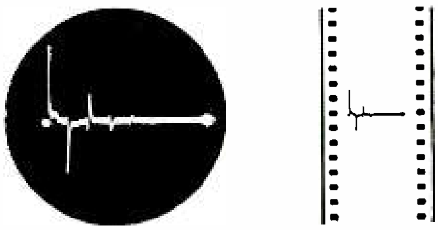
Lens holder devised by RCA engineers to aid inspector in checking clearances between parts on subminiature plug-in i-f amplifier stage

Want an oscilloscope camera NOW?



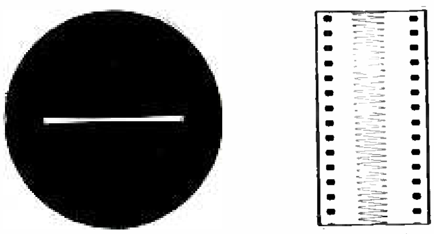
Scope Image — Film Recording

1. Single-frame photography of stationary patterns using a continuously running sweep.



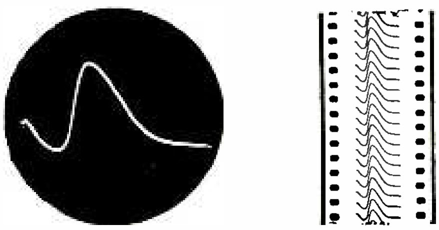
Scope Image — Film Recording

2. Single-frame photography of single transients using a single sweep.



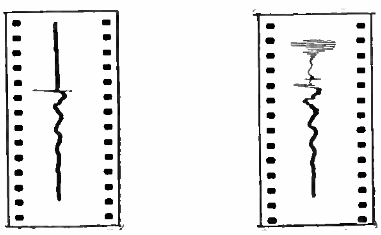
Scope Image — Film Recording

3. Continuous-motion photography employing film motion as a time base.



Scope Image — Film Recording

4. Continuous-motion photography employing oscilloscope sweep as a time base.



FILM MOTION TIME BASE — FILM MOTION AND SCOPE SWEEP

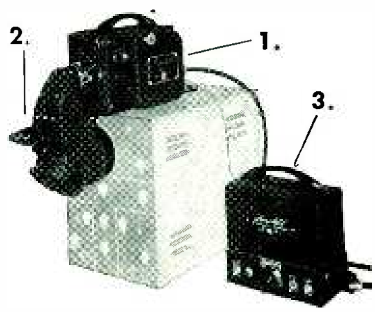
5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

Fairchild Oscillo-Record Cameras are now available *from stock* for immediate shipment. With these units you can make *permanent* photographic records of oscilloscope traces, thereby eliminating possible errors in making hand sketches from memory. In time-saving and convenience alone, these cameras will pay for themselves many times over.

FAIRCHILD OSCILLO-RECORD CAMERA IS UNUSUALLY VERSATILE

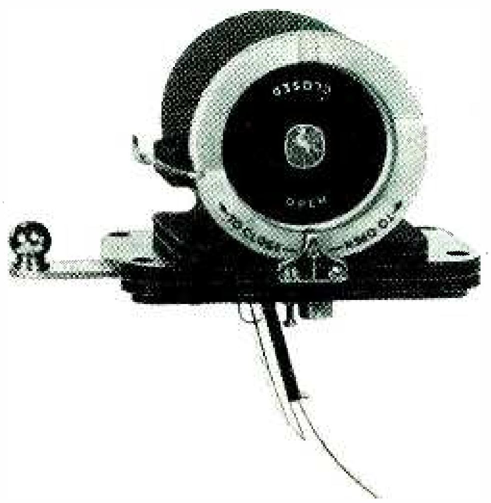
Users of the Fairchild Oscillo-Record Camera like its versatility. Designed for both still and continuous-motion photography on 35-mm film, it records non-recurring phenomena that are too rapid for visual study, others that are so slow that continuity is lost, and the occasions where very high-speed transients are combined with very slow-speed phenomena. For some idea of the types of jobs this instrument can do, study the examples at the left. Each solves a particular problem. Oscillo-Record camera users especially like its:

- **CONTINUOUSLY VARIABLE SPEED CONTROL** — 1 in/min. to 3600 in/min.
- **TOP OF SCOPE MOUNTING** that leaves controls easily accessible.
- **PROVISION FOR 3 FILM LENGTHS**—100, 400 or 1,000 feet.



1. Camera, 2. periscope, 3. electronic speed control. Accessories include 400- and 1,000-ft. film magazines, magazine adaptor and motor, universal mount for camera and periscope, binocular split-beam viewer.

FAIRCHILD TAKE-UP CASSETTE FOR SHORT RUNS



Where only a few pictures are required for quick development and study, a small Take-up Cassette is available as an accessory. The convenience afforded by this unit results in the saving of considerable time in handling short runs and reduces film wastage to a minimum. It is easily attached to the top of the camera by means of an adapter. A built-in knife permits short lengths of exposed film (up to 10 feet) to be cut off and removed with the cassette for developing.

Complete information about applications and operation of both the Fairchild Oscillo-Record Camera and the Fairchild-Polaroid Oscilloscope Camera is available. Write today to *Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, New York, Department 120-18A-1.*

FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS

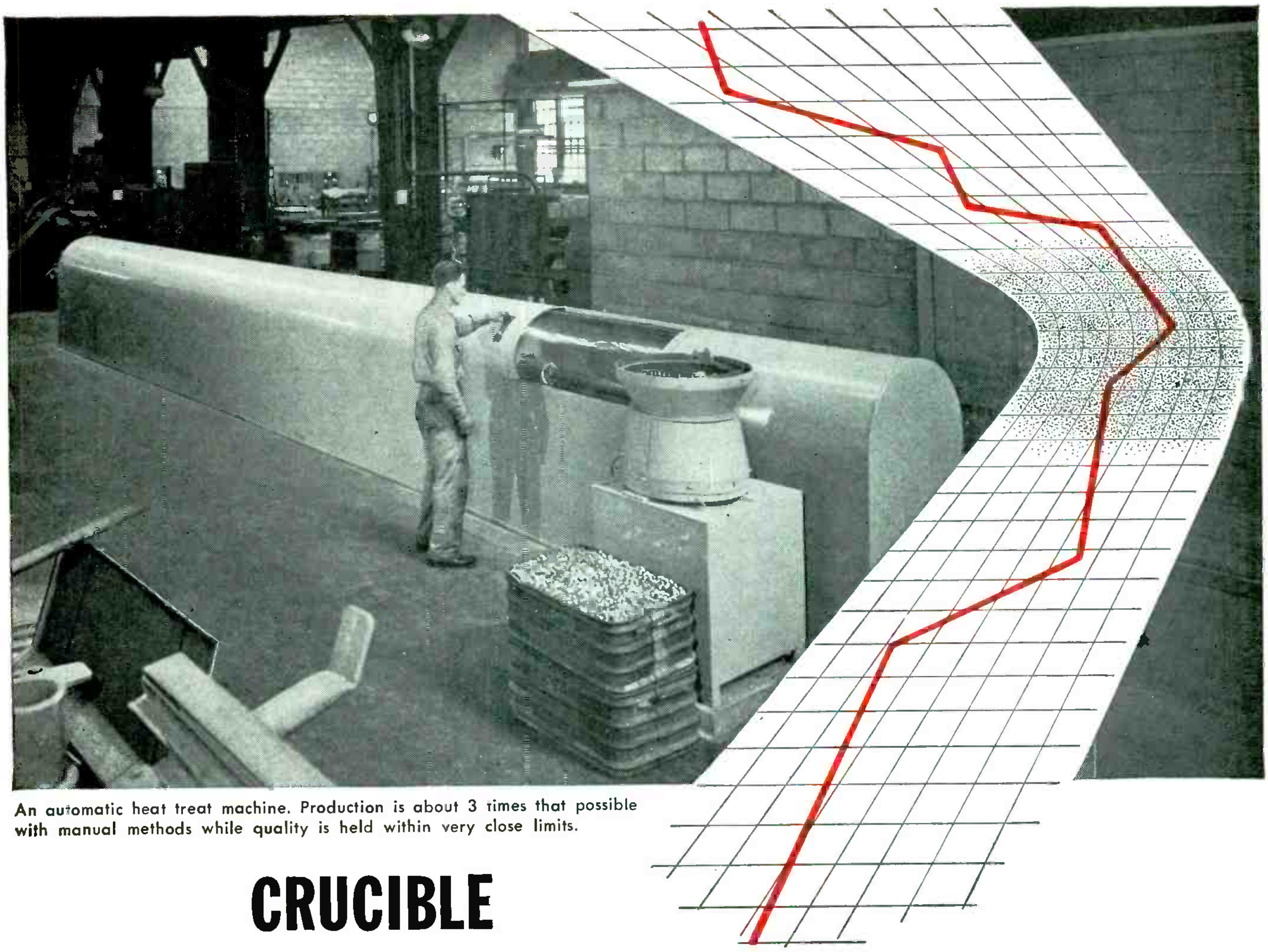
Modification of RCA battery-clip fixture for holding plug-in stage

for supporting the subminiature chassis itself.

A large battery clip screwed to the rod of a ball-and-socket base serves as holder for a conventional reading glass used at an AN/PRC-10 inspection position in RCA's Camden, N. J. plant. The inspector here uses a piano-wire feeler to check clearance between the components and the chassis of a plug-in stage. Holding pressure on the steel ball can be adjusted by loosening or tightening one of the screws that fasten the socket casting to the wood base.

By brazing semicircular pieces to the jaws of the battery clip, RCA methods engineers modified this same holder to support the plug-in chassis during assembly. The circular jaws permit rotating the plug-in base readily for work on both sides, and the fixture itself can be

Large Bausch & Lomb magnifier and stand used by RCA for inspecting subminiature chassis



An automatic heat treat machine. Production is about 3 times that possible with manual methods while quality is held within very close limits.

CRUCIBLE ALNICO MAGNETS

KEEP COSTS DOWN . . . *through automatic production that gives quality control*

Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

Today, Crucible can offer lighter, magnetically stronger Alnico magnets because of these automatic production techniques developed over the sixteen years that we have been producing the Alnico alloys. And behind our familiarity with permanent magnets lies more than 52 years' experience with specialty steelmaking. Let us advise you on your magnet problem.

CRUCIBLE first name in special purpose steels

52 *years of Fine steelmaking*

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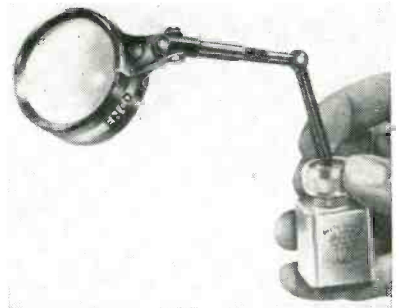


Magnetic holder for supporting 4-power two-inch magnifying lens on ferrous surface

set at the most convenient angle for each stage of assembly work.

At another inspection position in the same RCA plant, a standard Bausch and Lomb magnifying-lens holder is used to obtain a greater range of height adjustment.

For greater magnification, a two-lens 4-power magnifier is now available from Enco Mfg. Co., 4524 W. Fullerton Ave., Chicago 39, Ill., along with a magnetic base holder that grips to any ferrous surface and has a magnetic pull of about 50 lb.

Salvaging Tungsten

AN ultrasonic vibrator operating at 27,000 cycles per second is used to remove glass beads from tungsten rods taken out of defective vacuum tubes at Raytheon's Waltham, Mass. plant. When the tungsten

To remove adhering glass, operator inserts rod in hole in end of ultrasonic vibrator

rod is inserted in a small hole at the end of the vibrator all glass on the rod disintegrates instantly. The former manual hammering-off of the glass was much slower and often resulted in cracked pieces of tungsten that were unfit for further use.

Other glass-sealing alloys can be salvaged by the same method, with similar savings in critical materials such as cobalt and nickel.

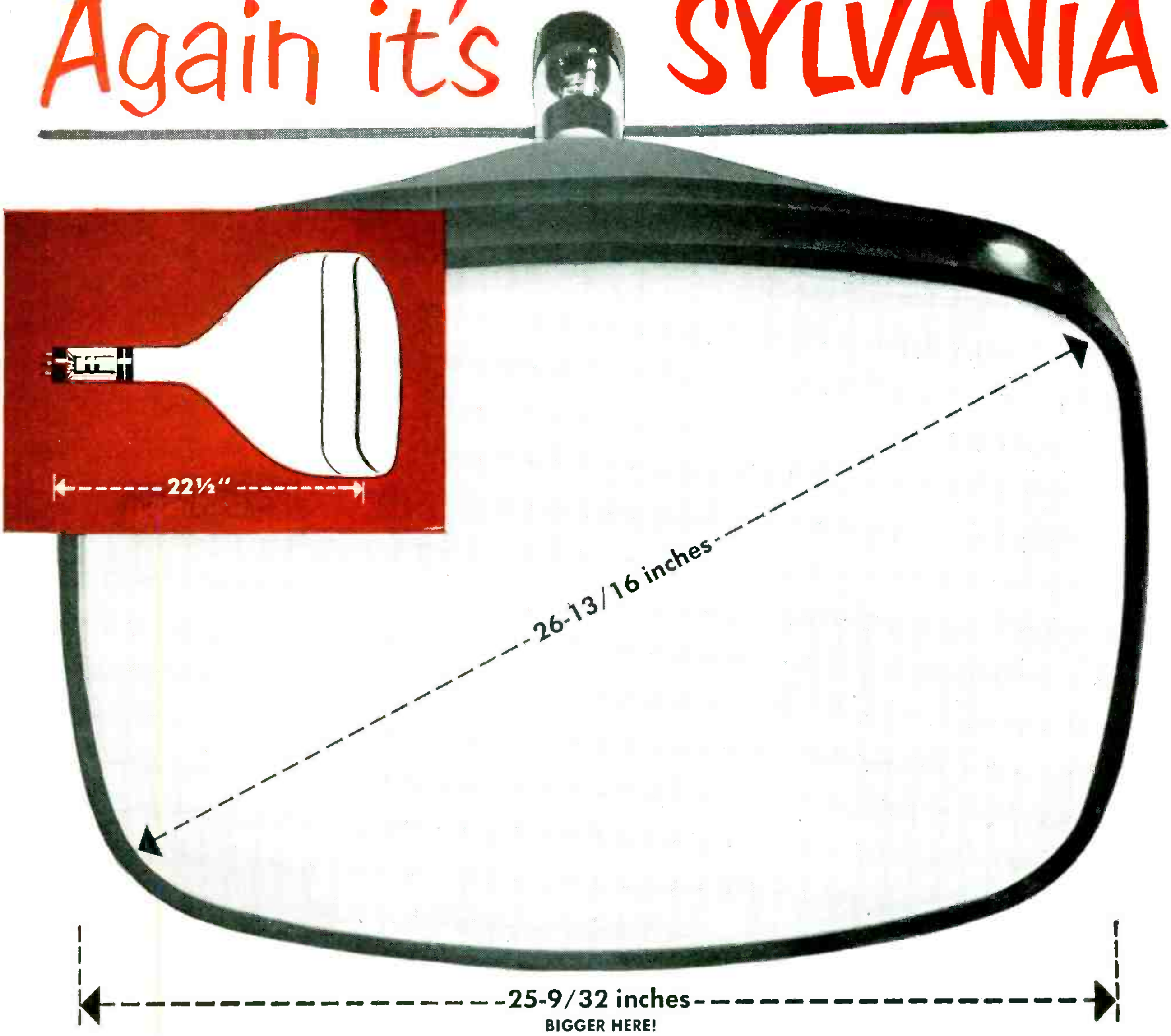
Production-Floor Carts

REMOVABLE steel shelves almost double the capacity of carts used for transporting and storing finished chassis units and larger components on the production floor at Utility Electronics in East Newark, N. J.

Metal brackets were welded to

Inserting extra shelf in cart to increase capacity

Again it's SYLVANIA!



Now with a New 27-inch Rectangular Picture Tube

Again Sylvania steps ahead with a big all-glass picture tube to meet your demands for larger sets and larger screens.

This tube is designed for easier, more comfortable viewing. It employs a neutral-density, gray filter face plate. The tube is magnetically focused and deflected. Equipped with an ion trap gun . . . no external conductive coating.

NEW COMPACT DESIGN

Here is a big tube that's actually shorter in depth to overcome many cabinet design problems. By employing a deflection angle of 90 degrees, the over-all, front-to-rear dimension of this tube has been held to only 22½ inches.

For full detailed data and characteristics of this latest Sylvania picture tube, write today to Sylvania Electric Products Inc., Dept. R-1407, Emporium, Pa.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS the angle-iron framework of the cart to serve as supports for three additional shelves, centered between the four original shelves, for use when handling smaller units. An added advantage of the technique is reduction in the total number of carts and hence of floor space needed for cart storage. The technique was introduced by J. P. Breickner, production manager of the plant.

Output Transformer Tester

By Curtis R. Schafer
The Liquidometer Corp.
Long Island City, N. Y.

FIVE electrical characteristics of a servo-system output transformer are checked automatically by the production-type test setup shown. When the operator inserts a transformer in the test fixture, plate and screen voltages are automatically applied by means of a switch built into the fixture.

Correct phasing of the transformer is checked by noting the di-

Hermetically sealed output transformers, used to couple the electronic amplifier to the two-phase motor of a self-balancing bridge used in capacitance-type aircraft gasoline gages, are checked completely in a few seconds when inserted in socket on box in foreground

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PRODUCTS
keeping communications ON THE BEAM
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CRYSTALS FOR THE CRITICAL
The small, compact H-17 is designated as a military type crystal for its use in mobile units common to the military. Frequency range: 200 kc to 100 mc. Hermetically sealed holders; wire-mounted, silver-plated crystals.
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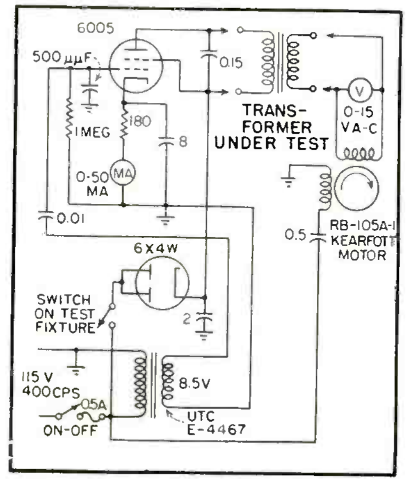
FREQUENCY AND
MONITOR MODULATION
Monitors any four frequencies anywhere between 25 mc and 175 mc, checking both frequency deviation and amount of modulation. Keeps the "beam" on allocation; guarantees more solid coverage, too!
"High Gear" Response to High Power Maintenance!
Dawn or dusk, it doesn't matter. These heroes of the high wires arrive to stop power trouble before it starts. Their "nose for disaster" is in the service truck, in the mobile radio unit which often relies on JK crystals and monitors to keep their assigned radio frequency on the beam
THE JAMES KNIGHTS COMPANY
SANDWICH 3, ILLINOIS



Output transformer test circuit

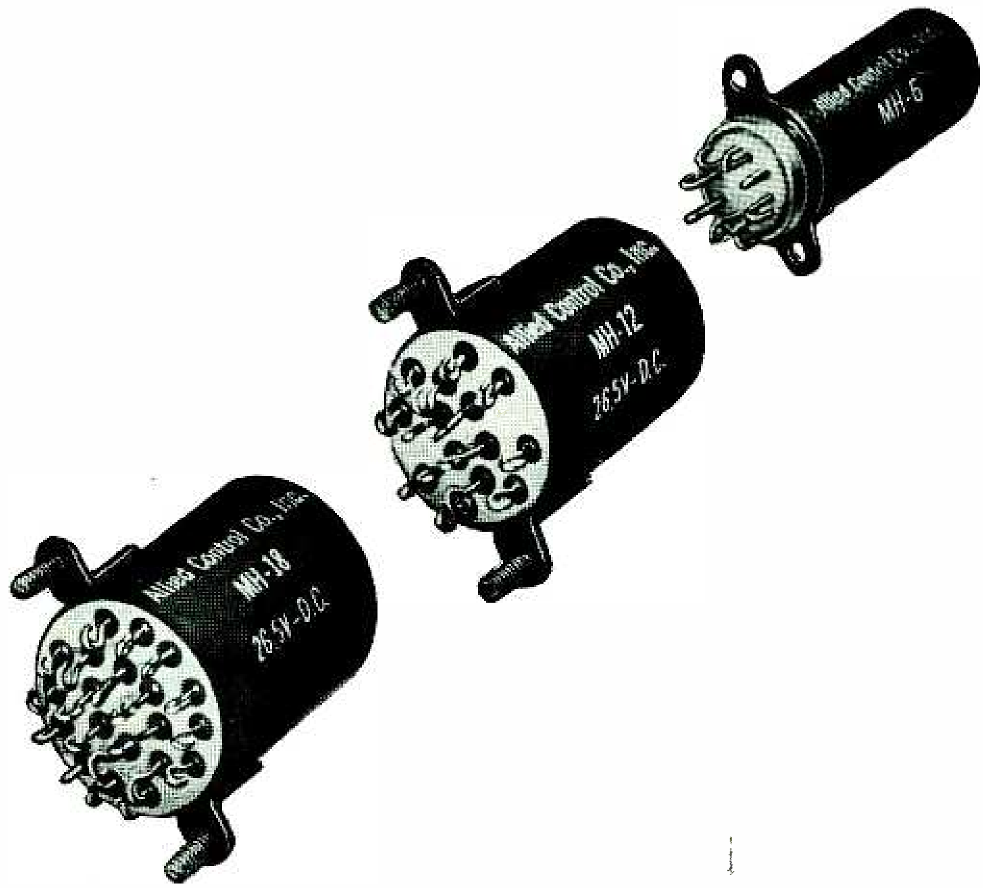
rection of rotation of a pointer attached to the shaft of the panel-mounted load motor. The primary inductance with d-c flowing, the insertion loss, the turns ratio and the power-handling ability are all checked by noting the a-c voltage across one phase of the motor, as all four characteristics will effect this voltage.

The milliammeter in the cathode circuit of the type 6005 Arinc tube serves as a built-in tube checker, providing a continuous check on the test setup itself. The equipment was constructed by Arthur Hull of The Liquidometer Corp.

Magnet-Wire Container

Two identical parts of molded fiber comprise a new method of packaging spools of magnet wire for shipment. Weight is only one-third that of the old-style wooden shipping box. Sharp corners, nail hazards

Molded fiber carton for wire shipment



ALLIED'S NEW 50 G SUB-MINIATURE RELAYS

Developed specifically to meet the rigid requirements of U.S.A.F. Spec. MIL-R-5757A, the new Allied line of sub-miniature double throw relays includes the MH-18 (6-pole), the MH-12 (4-pole), and the MH-6 (2-pole) will follow.

Contacts are rated at 2 amps resistive or 1 amp inductive at 28 volts D.C.

The high performance of these relays has been achieved in an extremely compact, unitized construction and parallels the most recent advances in airborne equipment design.

Complete details in Bulletin 1002.

1ST

Sub-miniature relays to be developed

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

AL 147

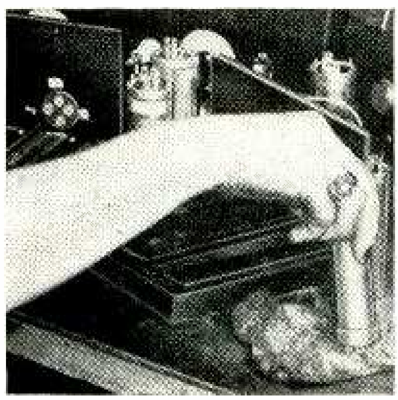
and slivers are eliminated.

After removing the top cover, the customer can lift the lower tray to storage shelves or use it directly alongside coil-winding machinery on production floors, without unpacking.

The new container was developed under the sponsorship of Anaconda Wire & Cable Co. as a solution to the serious problem of damage to magnet wire during shipment.

Steel-Wool Pad on Bench Discharges Capacitors

After testing four-section electrolytic capacitors for capacitance and for leakage current at rated voltage, the units are discharged simply yet completely by jabbing the terminals



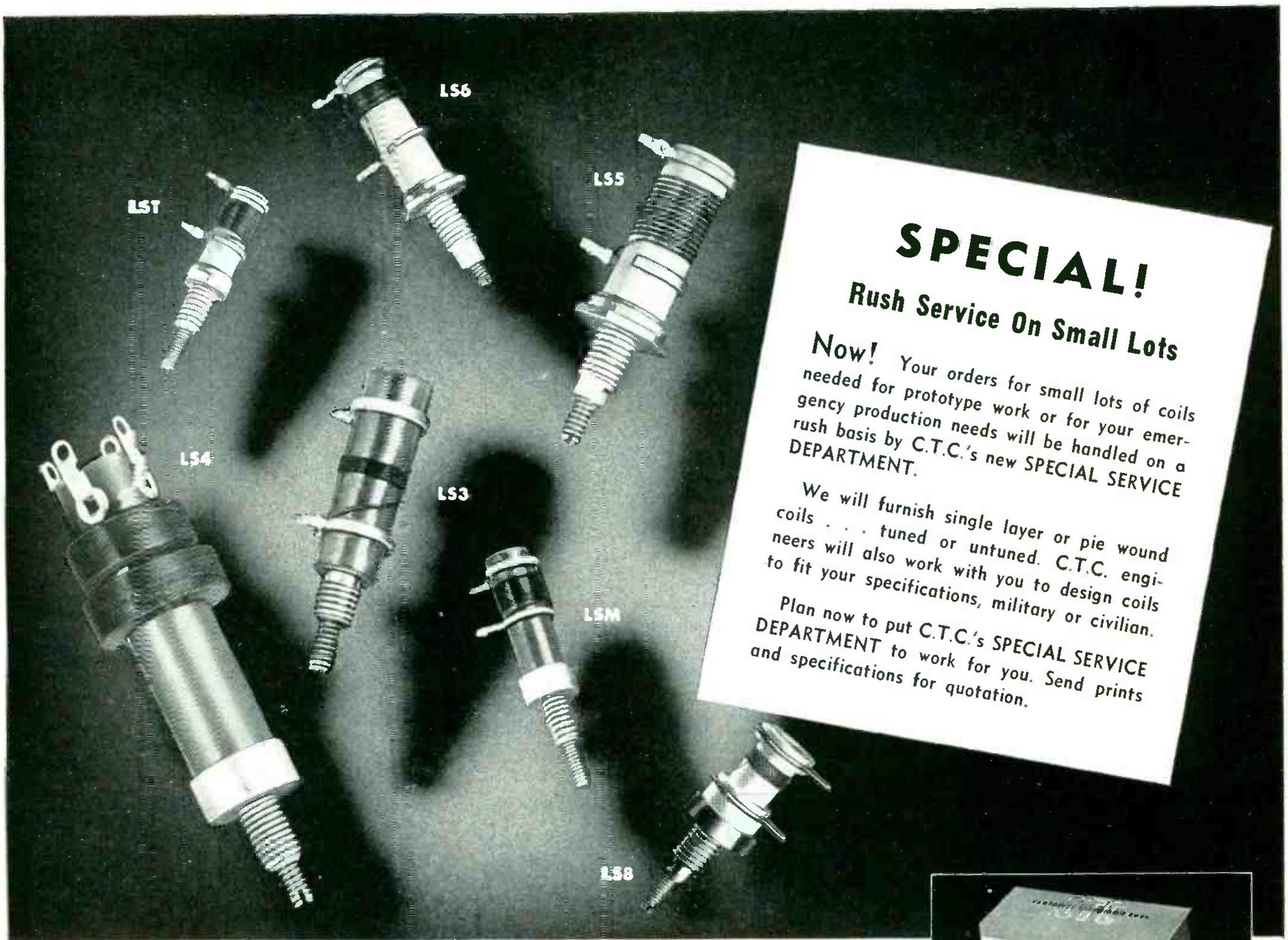
Discharging electrolytic capacitor in steel wool after leakage test

into a pad of fine steel wool at Astron Corporation's East Newark, N. J. plant.

Tiny individual wads of the steel wool are also used behind the holes provided for the capacitor terminals in the test fixture, to make positive contact with the terminals when a unit is slid into the fixture.

Far-Infrared Baking

Breakage loss caused by uneven heating during baking of the interior graphite coating of television picture tubes was reduced more than 80 percent and production stoppages cut in half by changing filament-type infrared heat sources in the baking oven to far-infrared electric radiant heaters. The glass



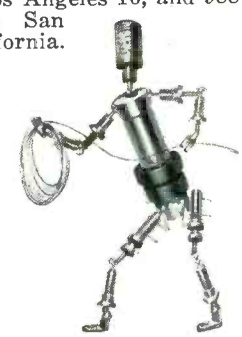
Here are the coils you want ...*the way you want them!*

Take advantage of one of C.T.C.'s most popular and useful services . . . the winding of slug tuned coils to exact specifications. Single layer or pie types furnished. You can be sure your specs — military or personal — will be faithfully followed to the last detail of materials and methods, and with expert workmanship.

C.T.C. coil forms are made of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting bushings are cadmium plated brass and ring type terminals are silver plated brass. Terminal retaining collars of nylon-phenolic also available in types LST, LS5, LS6.

Wound units can be coated with durable resin varnish, wax or lacquer. Both coils and coil forms are furnished with slugs and mounting hardware — and are obtainable in large or small production quantities. Be sure to send complete specifications for specially wound coils.

All C.T.C. materials, methods, and processes meet applicable government specifications. For further information on coils, coil forms or C.T.C.'s special consulting service, write us direct. *This service is available to you without extra cost.* Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers, contact: E. V. Roberts, 5068 W. Washington Blvd., Los Angeles 16, and 988 Market Street, San Francisco, California.

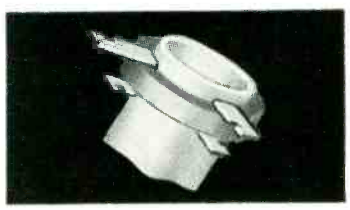


CAMBRIDGE THERMIONIC CORPORATION

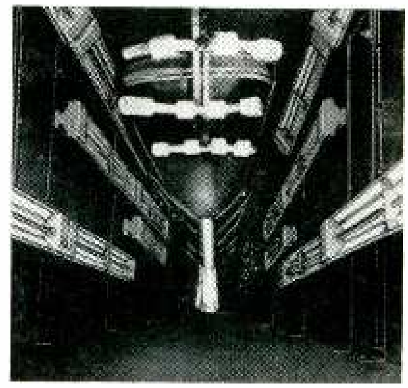
custom or standard . . . the guaranteed components

New Catalog! Send for your copy now.

NEW CERAMIC COIL FORM KIT. Helps you spark ideas in designing electronic equipment or developing prototypes and pilot models. Contains 3 each of the following 5 C.T.C. ceramic coil form types: LST, LS5, LS6, LS7, LS8. Color-coded chart simplifies slug-identification and gives approximate frequency ranges and specifications. Nylon-phenolic collars to replace metallic rings available with kit for all ceramic coil forms except LS7 and LS8.



NEW NYLON-PHENOLIC COLLARS. Terminals held securely; soldering spaces doubled; excellent for both bifilar and single pie windings. Show an increase in Q and many new benefits over metallic rings — without impairing in any way the moisture- and fungus-resistant qualities of coil form assemblies.



Baking coating inside picture tubes with far-infrared heaters in oven through which overhead conveyor runs

absorbs far-infrared energy (between the limits of 1 and 16 microns), speeding up the baking of the coating on the glass, whereas it transmits most of the near-infrared radiation (between about 0.4 and 5 microns). The change also permitted reducing oven power consumption from 66 to 54 kw. Tubular-type Chromalox far-infrared heaters are made by Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.

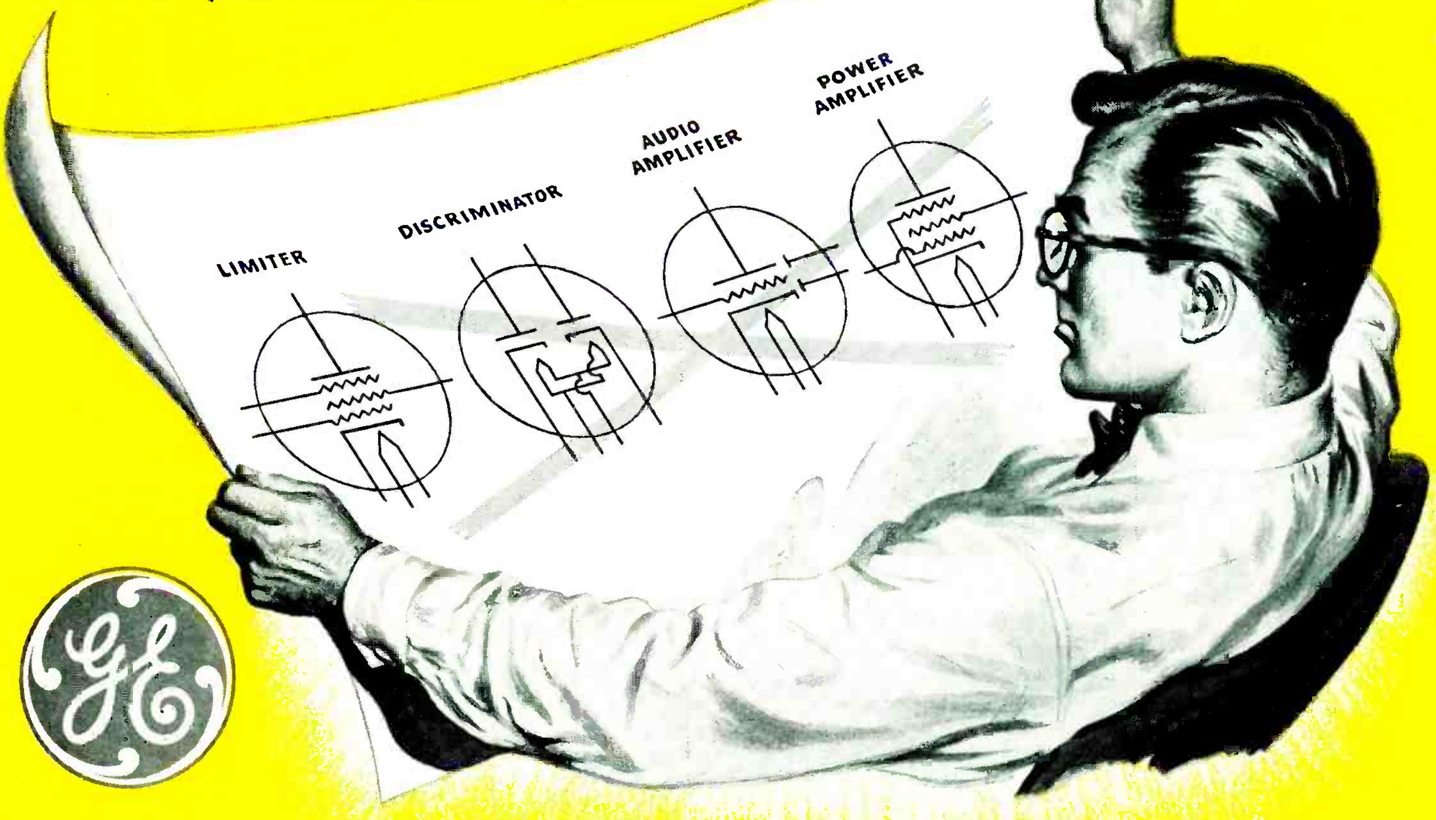
Similar heaters are focused on the bases of kinescopes moving past on a belt conveyor, to dry out the sealing cement.

Spaghetti Chopper

A STANDARD bare-wire cutting machine is being used successfully without modification for cutting many different types of spaghetti and plastic tubing into short lengths required for television receiver production at the CBS-Columbia plant in Brooklyn, N. Y. The operator merely pushes into the feed rollers a handful of long

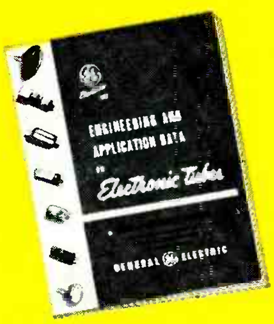
Examples of variety of materials that can be chopped into short lengths

"What audio tubes can I substitute, to trim our TV price another $3.00?"



6BN6
Combined limiter, discriminator, and audio amplifier

6BK5
High-sensitivity power tube, designed for use with 6BN6



New G-E pair does work of 4 tubes!

SAVES TV COST, MAINTAINS QUALITY PERFORMANCE!

The 6BN6-6BK5 audio pair helps solve your chief problem, Mr. Designer—how to bring prices *down,* keep performance *up,* in a TV market that's strongly competitive.

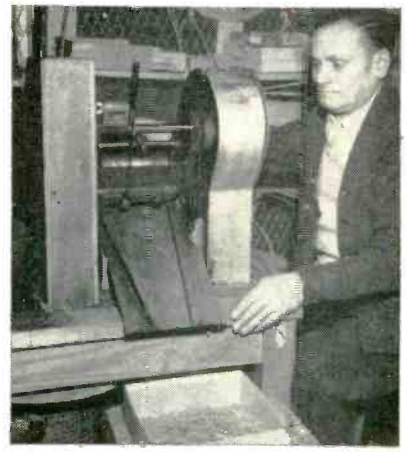
Fine reception: you retain it because General Electric custom-designed the new 6BK5 power pentode to team up with its companion, the 6BN6. High sensitivity . . . plenty of clear audio output . . . are 6BK5 features. The new pentode will produce up to 3½ watts of audio, yet is so sensitive that only 5 volts peak is needed to drive the tube into distortion.

Cost saving—both in tubes and components—is a product of the 6BN6's versatility. This gated-beam tube is a real "triple-threat" performer, serving simultaneously as limiter, discriminator, and audio amplifier.

More TV sets sold, better-satisfied customers . . . that's how the 6BN6 and 6BK5 pay off for you! Booklet ET-B35 describes the tubes fully. Phone, wire, or write for it! *General Electric Company, Tube Department, Schenectady 5, New York.*

GENERAL ELECTRIC

162-1A4



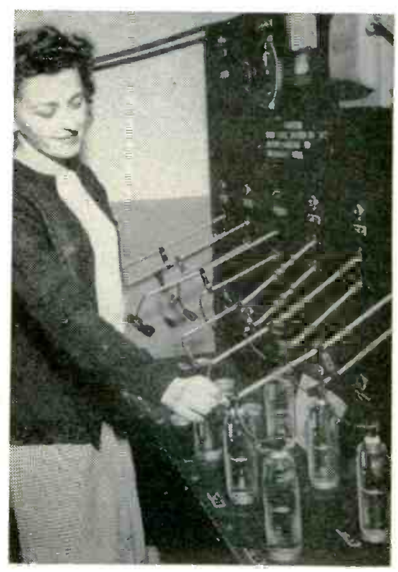
Chopping spaghetti with motor-driven wire-cutting machine

lengths of the material to be cut.

The cutting blade is coupled through a variable-speed linkage to the feed rollers. The rate at which the blade moves up and down in its chopping action thus determines the length of cut, which can be up to 9 inches. Polyethylene tubing up to $\frac{5}{8}$ inch in diameter is cleanly cut, as are other materials heretofore considered difficult to cut accurately into short lengths.

Lead-Positioning Springs

STIFF coil springs hold top-cap connectors directly over their respective tube sockets on a 12-tube aging rack built by Chatham Electronics Corp., Newark, N. J., for aging high-voltage industrial and communications tubes. Plastic strips



Use of springs around top-cap leads to speed up connections on tube aging rack

are bolted to the front and rear springs of each row to provide further stiffening and positioning.

Top-cap connectors can be removed quickly, without leaving loose leads in the way when inserting the next batch of tubes. Connections to new tubes are made almost as fast, for the connectors all stay within an inch or so of the position where they are needed.

Serial-Number Disk

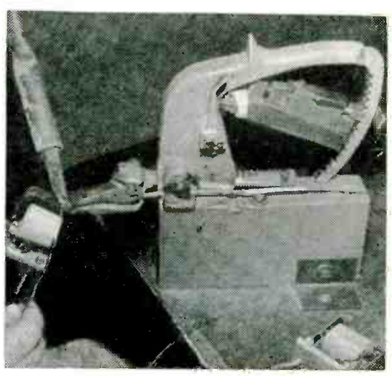
A REDUCTION in the cost of applying individual serial numbers to each Tele-tone television receiver chassis was achieved by stamping the numbers beforehand on left-over brass

Use of scrap brass disk for serial number of tv set

punchout disks and riveting a disk to each chassis. The disk can be attached after assembly of the chassis if desired, as when running models having the same chassis but different picture-tube assemblies.

Core-Banding Tool

AFTER two-section Hypersil cores have been assembled around their coils and banded with a special Westinghouse core-banding tool, the banding clip is soldered for extra locking during production of



Fixed mounting of core-banding tool to facilitate soldering of banding clamp. Solder is brought up through hole in bench so it is always conveniently within reach

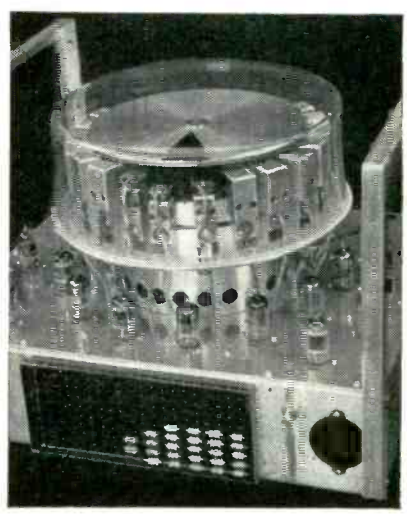
interstage transformers for radar antenna stabilizers at the Union City, N. J. plant of Keystone Products Co.

Though normally hand-held, the banding tool is here mounted on a wood block which in turn is fastened to the bench, so as to leave the operator's hands free to hold the soldering iron and solder.

Diode Clip Boards

Holders for crystal diodes

SIMPLE clips stamped out of flat sheet metal are inserted in round drilled holes in an insulating board to form holders for the 1,200 crystal diodes used in the Maddida computer made by Northrop Aircraft,



Diode clip board mounted on front of magnetic drum memory chassis for Maddida computer

Inc., of Hawthorne, California. Two different sizes of indentations accommodate the two terminal sizes on these diodes. The holders fit snugly in the drilled holes, and are anchored in place by the soldered connections made on the other side of the board.

Hookup Wire Rack

A CONVENIENT rack for spools of hookup wire was constructed from steel bar and rod stock at the Bogue Electric Company's Paterson, N. J. plant. The wire from each spool is threaded through a hole in the wood front-panel boards of the rack just above a white tape strip on which the wire sizes and other specifications are lettered. Holes for the wires are made just large enough to prevent the wires from slipping back onto the spools.

Simple rack holds up to 100 large spools of wire and provides convenient access to ends of wires

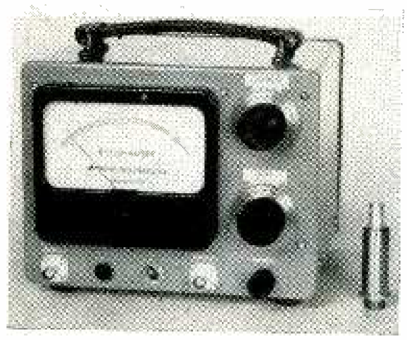
Thick washers are placed between the spools on each shaft, to insure that each spool will turn freely. Shafts are held in position by cotter pins at the ends. Empty spools can be replaced from either end of a shaft after first slipping the shaft out of its bearing hole, but generally all spools on a given shaft have the same type of wire. Replacement of spools is then not necessary until all are empty. The rack saves operator time, conserves floor space and improves the general appearance of the shop.

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

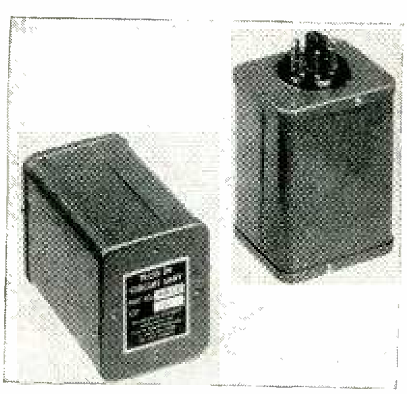
Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Thirty-Five Trade Bulletins Reviewed

OTHER DEPARTMENTS
featured in this issue:



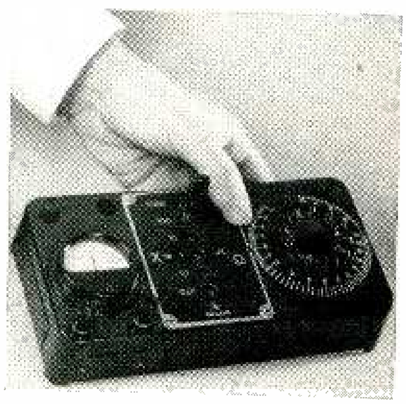
Dynamic Pressure Indicator

RUTISHAUSER CORP., 490 So. Fair Oaks Ave., Pasadena 1, Calif. Model ST-12 electronic pickup indicator measures transient, recurrent and static pressures. Operation is based on phase modulation principle using capacitance-type pickup. Carrier frequency of about 12.5 mc, with only 1/16 in. free diameter pickup diaphragm, enables uniform response to pressure transients having frequency components much higher than heretofore measurable. The unit uses long-life subminiature tubes, takes up less than 1/4 cu ft of space and weighs 13 lb. Multichannel installations are available for rack mounting.



Plug-In Amplifier

ENGINEERING RESEARCH ASSOCIATES, INC., 1902 W. Minnehaha Ave., St. Paul W4, Minn., has developed a new miniature plug-in amplifier characterized by exceptionally high gain and relative independence of power supply voltage fluctuation. The unit, measuring 1 3/8 in. × 2 1/4 in. × 3 in., is potted in a steel case, thus reducing microphonics. Specific characteristics include a maximum gain of 9,000 and a flat frequency response from 2 to 1,000 cps. Power supply requirements consist of 600-ma, 6.3-volt filament supply and a 0.5-ma, 250-volt plate supply. Maximum output voltage is 20 v. Applications include use in wide-range integrating circuits in which integration is achieved by a stabilizing negative feedback circuit.



Measuring Bridge

THE HERMAN H. STICHT CO., 27 Park Place, New York, N. Y. Type Z measuring bridge is designed to take the place of a large Wheatstone bridge for measuring resistances in the field, workshop or laboratory. Its small dimensions make it convenient for carrying in coat pocket or briefcase. Range is 0.05 to 50,000 ohms over six ratios. The source of supply, a standard flashlight battery, is contained in the case. Accuracy of the instrument is approximately ± 1 percent. The bridge comes for d-c measurements with galvanometer and flashlight battery and can also be used for d-c and a-c current by means of an auxiliary plug-in buzzer and head phone.

Wide-Band Voltmeter

BALLANTINE LABORATORIES, INC., Boonton, N. J. Model 314 wide-band electronic voltmeter measures a-c voltages from 100 μv to 1,000 v in the frequency range of 15 cycles to 6 mc. Its accuracy of 3 percent up to 3 mc and 5 percent above is the same at all points on the single logarithmic voltage scale. With its probe, the input impedance is 6 μμf shunted by 11 megohms and the voltage range is 1 mv to 1,000 v in 6 decade ranges. Without its probe it may be used to measure down to 100 μv but the input impedance is reduced to 25 μμf shunted by 1.1 megohms. The unit may also be used as a wide-band amplifier with maximum gain of 60 db vari-

READIN'-'RITIN'-'RITHMETIC

KNOW YOUR THREE Rs

when it comes to Tubes for Industrial, Military and Transportation service

RAYTHEON RELIABLE RUGGEDIZED

Look at the chart. Keep it for reference. It tells you better than a thousand words why RAYTHEON may be regarded as the No. 1 source of Reliable and Rugged Tubes *of all kinds.*

Type	Description	Controlled Characteristics: Shock	Fatigue vibration	Vibration output	Stabilization	Centrifugal acceleration	5,000 hour life	Heater cycle life	High temperature life	Median control	60,000 foot altitude	Proto-type	Heater Volts	Heater Ma.	Plate Volts	Plate Ma.	Grid Volts	Screen Volts	Screen Ma.	Amp. Fac-tor	Mut. Cond.
Reliable Miniatures																					
CK5654	RF Amplifier Pentode	√	√	√	√			√		√		6AK5	6.3	175	120	7.5	—2.0	120	2.5	—	5000
CK5670	Medium Mu Dual Triode	√	√	√	√			√		√		2C51	6.3	350	150	8.2	$R_k = 240$ ohms	—	—	35	5500
CK5686	AF-RF Output Pentode	√	√	√	√			√				—	6.3	350	250	27.0	—12.5	250	5.0	—	3100*
CK5725	RF Mixer Pentode	√	√	√	√			√		√		6AS6	6.3	175	120	5.2	—2.0	120	3.5	—	3200
CK5726	Dual Diode	√	√		√			√		√		6AL5	6.3	300	Max. Peak Inv. 330 volts. $I_o = 9$ ma. dc per plate						
CK5749	RF Amplifier Pentode	√	√	√	√			√		√		6BA6	6.3	300	250	11.0	$R_k = 68$ ohms	100	4.2	—	4400
CK5751	High Mu Dual Triode	√	√	√	√			√		√		12AX7	6.3/12.6	350/175	250	1.1	—3.0	—	—	70	1200
CK5814	Low Mu Dual Triode	√	√	√	√			√		√		12AU7	6.3/12.6	350/175	250	10.5	—8.5	—	—	17	2200
Reliable Subminiatures																					
†CK5702WA (6148)	RF Amplifier Pentode	√	√	√	√	√	√	√	√		√	5702	6.3	200	120	7.5	$R_k = 200$ ohms	120	2.5	—	5000
†CK5703WA (6149)	High Frequency Triode	√	√	√	√	√	√	√	√		√	5703	6.3	200	120	9.0	$R_k = 200$ ohms	—	—	25	5000
†CK5744WA (6151)	High Mu Triode	√	√	√	√	√	√	√	√		√	5744	6.3	200	250	4.0	$R_k = 500$ ohms	—	—	70	4000
†CK5784WA (6150)	RF Mixer Pentode	√	√	√	√	√	√	√	√		√	5784	6.3	200	120	5.2	—2.0	120	3.5	—	3200
CK6021	Medium Mu Dual Triode	√	√	√	√	√	√	√	√		√	—	6.3	300	100	6.5	$R_k = 150$ ohms	—	—	35	5400
CK6110	Dual Diode	√	√	√	√	√	√	√	√		√	—	6.3	150	Max. Peak Inverse 420 volts. $I_o = 4.4$ ma. per plate						
CK6111	Low Mu Dual Triode	√	√	√	√	√	√	√	√		√	—	6.3	300	100	8.5	$R_k = 220$ ohms	—	—	20	4750
CK6112	High Mu Dual Triode	√	√	√	√	√	√	√	√		√	—	6.3	300	100	0.8	$R_k = 1500$ ohms	—	—	70	1800
CK6152	Low Mu Triode	√	√	√	√	√	√	√	√		√	5975	6.3	200	200	12.5	$R_k = 680$ ohms	—	—	15.8	4000
Rugged Miniatures																					
6AK5W	RF Amplifier Pentode	√	√	√				√				6AK5	6.3	175	120	7.5	—2.0	120	2.5	—	5000
6AL5W	Dual Diode	√	√					√				6AL5	6.3	300	Max. Peak Inv. 420 volts. $I_o = 9$ ma. dc per plate						
6AS6W	RF Mixer Pentode	√	√	√				√				6AS6	6.3	175	120	5.2	—2.0	120	3.5	—	3200
6C4W	RF Power Triode	√	√	√				√				6C4	6.3	150	250	10.5	—8.5	—	—	17	2200
6J6W	Dual AF-RF Triode	√	√	√	√							6J6	6.3	450	100	8.5	$R_k = 50$ ohms	—	—	38	5300
6X4W	Full Wave Rectifier	√	√					√				6X4	6.3	600	Max. Peak Inv. 1250 volts. $I_o = 70$ ma. dc.						
Rugged GT Types																					
6J5WGT	General Purpose Triode	√	√	√								6J5GT	6.3	300	250	9	—8.0	—	—	20	2600
12J5WGT	General Purpose Triode	√	√	√								12J5GT	12.6	150	250	9	—8.0	—	—	20	2600
6SN7WGT	Dual Triode	√	√	√								6SN7GT	6.3	600	250	9	—8.0	—	—	20	2600
6X5WGT	Full Wave Rectifier	√	√									6X5GT	6.3	600	Max. Peak Inv. 1250 volts. $I_o = 70$ ma. dc.						

The above listing of Controlled Characteristics is based on the requirements and test limits of the applicable JAN-1A test specification.

Note: All dual section tube ratings are for each section.

*2.7 watts Class A output. 10 watts Class C input power to 160 mc.

†For simplicity of identification with the prototypes, the type numbers with a "WA" suffix were established at the request of the Armed Services to replace the type numbers in parenthesis previously announced for these types.

Over 300 Raytheon distributors are at your service on these tubes. Application information is readily available at Newton, Chicago, Los Angeles.

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division

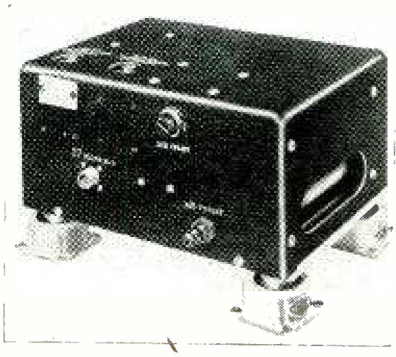
Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

Excellence in Electronics

RELIABLE SUBMINIATURE AND MINIATURE TUBES • GERMANIUM DIODES AND TRANSISTORS • NUCLEONIC TUBES • RECEIVING AND PICTURE TUBES • MICROWAVE TUBES able in 20-db steps and flat within 0.5 db from 100 cycles to 3 mc and within 1 db from 50 cycles to 6 mc.

UHF Oscillator Triode

RADIO CORP. OF AMERICA, Harrison, N. J. The 6AF4 miniature triode is designed to operate as an oscillator in uhf tv receivers covering the frequency range from 470 to 890 mc. It features good frequency stability; short mount structure with small elements to provide low interelectrode capacitances; short internal leads to reduce lead inductance and r-f resistance; silver-plated base pins to minimize losses caused by skin effect at ultrahigh frequencies; and double base-pin connections for both plate and grid. A technical bulletin is available.

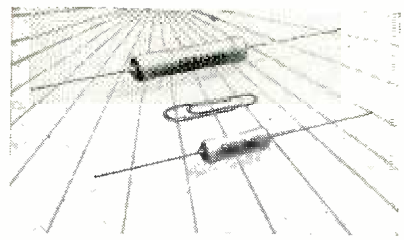


Pressurizing Kit

LEAR, INC., Romec Division, Elyria, Ohio. Model RR-9650 pressurizing kit is designed for use on aircraft powered by gas turbine engine. The object is to take air with elevated pressure from the compressor section of the engine and convert it into dry, oil-free air for pressurizing radar or other electronic plenums of jet aircraft; also to discharge a uniform pressure regardless of gas turbine pressure. Included with the equipment is a 1/15-hp, 27-volt, d-c air compressor with rated capacity of 300 cu. in. per minute at 8 psi absolute inlet pressure and 20 psi absolute discharge pressure. Overall dimensions are $11\frac{3}{4} \times 9\frac{5}{8} \times 7\frac{7}{32}$ in. high. Weight is 13.9 lb. Control of discharge pressure is fully automatic as is the control of inlet pressure fed from the gas turbine, so excessively high pressure is never passed on into the electronic equipment.

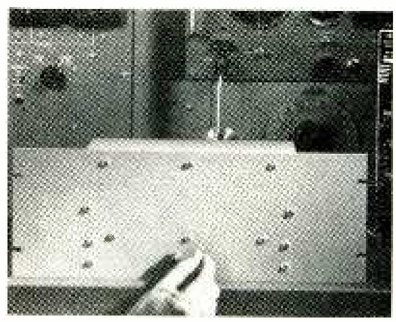
Oscilloscope Calibrator

SIMPSON ELECTRIC CO., 5200 W. Kinzie, Chicago, Ill. Model 276 oscilloscope calibrator just over 2 lb in weight, is completely self contained and operates from 117 v, 50-60 cycles and can be used with any oscilloscope. It has a sine-wave output which is used directly on the $4\frac{1}{2}$-in. meter. The meter is calibrated directly in rms, peak, and peak-to-peak values. Six ranges are provided with peak-to-peak full scale values of 1, 2.5, 10, 25, 100 and 250 v with an accuracy of 3 percent. Each range is continuously adjustable from zero to full scale value. A 12-position function switch provides the range positions. Alternate positions of the switch provide for feeding the signal under test to the oscilloscope. External pickup is eliminated by providing power shut-off in these feed-through positions.



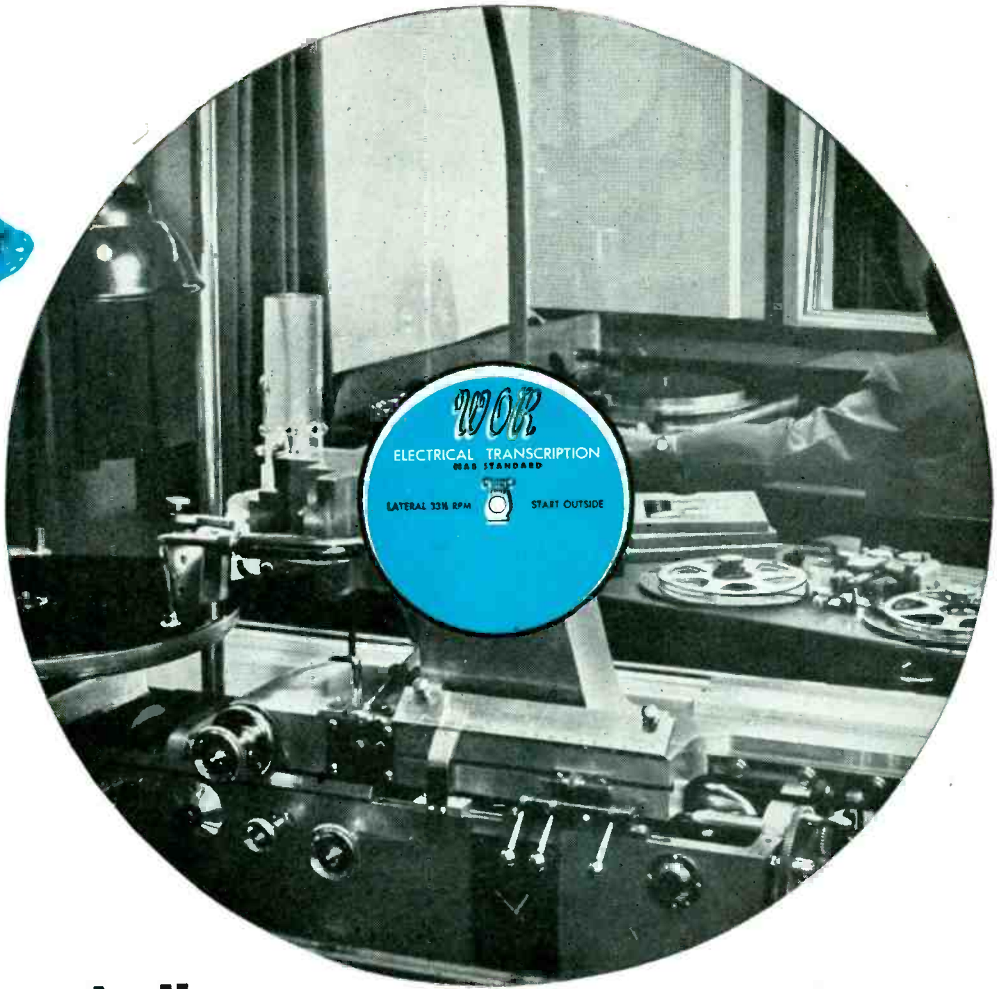
Power-Type Resistors

WARD LEONARD ELECTRIC CO., 115 MacQuesten Parkway South, Mt. Vernon, N. Y., has developed the Axiohm miniature power type resistors with axial leads. They are made with special alloy resistance wire of low temperature coefficient of resistivity wound on tough miniature ceramic cores. Sturdy No. 20 B&S tinned axial leads are mechanically anchored and silver brazed to end caps. The entire assembly is encased in Vitrohm enamel forming a hard, crazeless, heat conducting hermetic seal. The resistors are available in conservatively rated 5 and 10 watt sizes. Standard resistance tolerance is ± 5 percent.



Harmonic Generator

SIERRA ELECTRONIC CORP., 810 Brittan Ave., San Carlos, Calif. Fed by a 10-kc square wave at 5 volts minimum, the model 133 harmonic generator supplies harmonic voltages of this input at every 10-kc point up to 15 mc. Containing its own power supply, it operates from standard 115-v, 50 or 60-cps power, consuming 25 w. Designed for use in an instantaneous frequency-comparison arrangement, the unit has application possibilities wherever such a harmonic frequency source is needed. In frequency-comparison work, an unknown frequency is beaten against an adjacent and identifiable harmonic voltage and the beat frequency meas-



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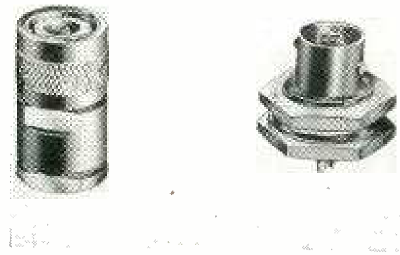
Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB" ured on an oscilloscope or with a frequency counter.



R-F Coax Connectors

DAGE ELECTRIC CO., INC., 62 N. Second St., Beech Grove, Ind. Type C r-f coaxial connectors are designed for use up to 1,000 v under strict military specifications. They are of constant impedance and are to be used with 50-ohm medium size r-f cables. The connectors provide for easy connect-disconnect operations through a bayonet lock top coupling. A minimum of cable indentation is maintained through an improved cable clamping mechanism. Silicone rubber gaskets are used to make the connector waterproof.

Voltage-Regulator Tube

RADIO CORP. OF AMERICA, Harrison, N. J. Type 6073 cold-cathode, glow-discharge tube of the 7-pin miniature type is intended for voltage-regulator service critical as to excessive shock and vibration. It is a premium version of the OA2 and OB2, and is constructed and processed to meet military requirements. The tube can withstand an instantaneous impact acceleration

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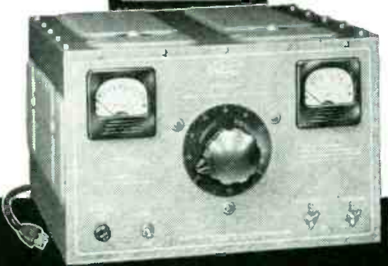

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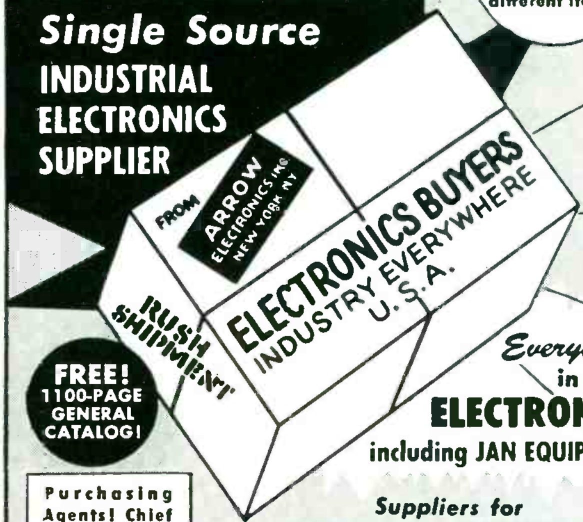

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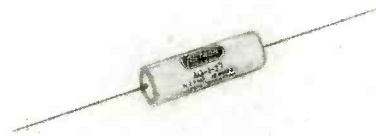
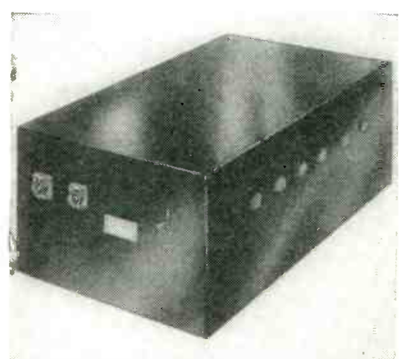
of 900 g, and a vibrational acceleration for extended periods of 2.5 g. Operating-current range is from 5 to 30 ma. It regulates at an average value of 108 v.



Small Paper Capacitor

ASTRON CORP., 255 Grant Ave., E. Newark, N. J., has a new type AQ subminiature paper capacitor designed for operation at temperatures through 125 C. Capacitance stability over a wide temperature range is from −65 C to +125 C, without derating, plus high insulation resistance, low power factor and high test voltage. These capacitors are supplied in the extended foil, noninductive-type construction. Hermetically sealed, they are capable of meeting all military requirements.

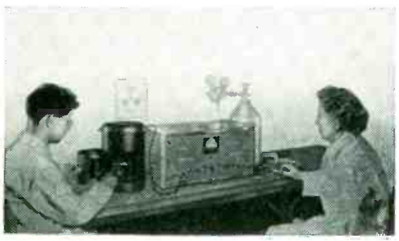


Magnetic Transient Recorder

MAGNE-PULSE CORP., 140 Nassau St., New York, N. Y. Aperiodic or "one-shot" waveforms can now be permanently recorded and displayed at any desired repetition rate on an oscilloscope through the use of the type 102 magnetic transient recorder. Providing a recording rate of up to 1,000 pulses per inch—or a bandwidth of 1 mc—this low cost, lightweight unit, which can also record and display recurrent waveforms, should find wide application in laboratories conducting research on radar, tv, atomic phenomena, computers and allied fields.

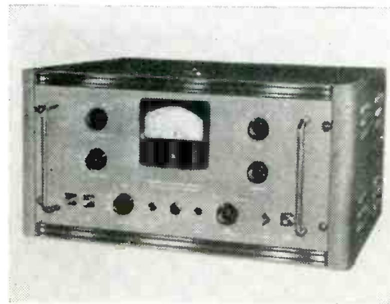
Laboratory Power Supply

ALCO ELECTRONICS MFG. CO., 102 Marston St., Lawrence, Mass. Model 400-A comprises two independently regulated power supplies with extremely low ripple and output impedance. Each of the 200-ma regulated outputs may be operated independently and simultaneously, and by front-panel switching may be combined in parallel to provide double output current (400 ma) over the voltage range of 0 to 425 v. The outputs are floating, permitting operation with other than negative ground. Stabilized negative bias voltage is provided with continuous adjustment from 0 to —150 v. Heater voltages (unregulated) of 6.3 v at 10 amperes are available at binding posts.



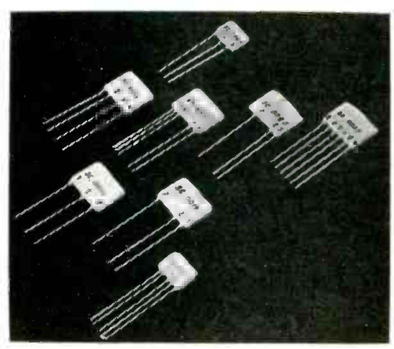
Twin Scaler

RADIATION COUNTER LABORATORIES, INC., 5122 W. Grove St., Skokie, Ill., has designed a Higinbotham binary scaler with two input connectors, two scales of 16 and two recorders. Each scale of 16 and its recorder operates independently from the other, using a single h-v power supply. The single h-v power supply employs two separate regulating circuits so the voltage available at each G-M tube may be regulated to the desired value. A switch enables one to check the voltage on first one and then the other G-M tube. Counting rates up to and in excess of 20,000 counts per minute can be independently registered on each Veeder-Root recorder.



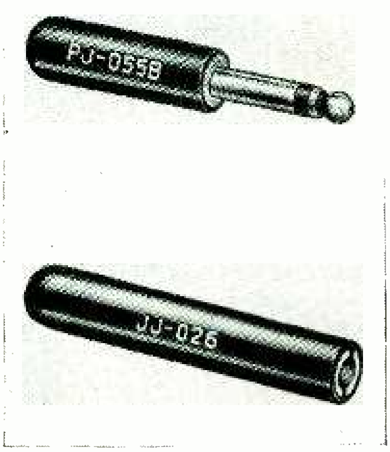
Standing-Wave Amplifier

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., 55 Johnson St., Brooklyn, N. Y. Type 275 amplifier is a high-gain linear audio amplifier designed to accurately indicate vswr's over the full scale ranges of 1 to 1.3, 1 to 3, 3 to 10, 10 to 30 and 30 to 100. A normalizing gain control channel minimizes the effect of power drift on the r-f source. The unit may be operated as either a broadband amplifier over the range of 300 to 3,000 cps or as a narrow-band amplifier at 500, 1,000 and 1,300 cps with a 25-cps pass band. Noise level is 0.03 μv. Full-scale narrow-band sensitivity is 0.1 μv. The input circuit provides for either crystal or bolometer operation with a variable bolometer bias of 2.5 to 8 ma.



Printed Circuits

STUPAKOFF CERAMIC AND MFG. CO., Latrobe, Pa., has developed a line of printed electrical circuits some of which incorporate as many as six separate resistors and capacitors in a permanent circuit. In their production patterns for resistors, capacitors and conductors are printed on vitreous, high-dielectric ceramic plates by a silk-screen process. The dielectric properties of the ceramic are used for the capacitors, while silver is used for conductors and carbon graphite or other resistance materials for resistors. After the patterns are printed they are bonded permanently to the ceramic surface by controlled curing; then are protected from abrasion and humidity by the application of an impervious plastic covering. One printed circuit replaces from two to six individual components. Typical circuits are described in bulletin 1151.



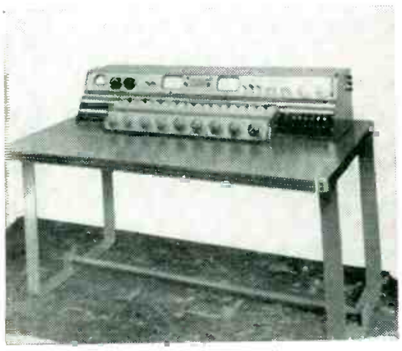
Plug and Jack

SWITCHCRAFT, INC., 1328 N. Halsted St., Chicago 22, Ill., has announced two new related products most commonly used in military communication and industrial equipment. The No. 440 "Little Plug" (PJ-055B) features a one-piece tiprod which together with the sleeve are assembled into the mold as an insert; providing a finished plug with complete continuity of thermoplastic insulation between this tiprod and the sleeve of the plug. Design and material are in accordance with specification JAN-P-642. The No. 820 "Extension Jax" (JJ-026) features spring tempered nickel silver springs assembled into a rigid stack assembly, insulated by phenolic spacers and

tubing, firmly assembled to long brass body by stainless steel screws. Materials and finishes are in accordance with specifications JAN-J-641.

Humidity Control

BARBER-COLMAN CO., Rockford, Ill. Two-position or proportioning, humidifying or dehumidifying, for process or comfort control, the new electronic humidity control features supersensitive, instant response with plug-in elements, wide range and simple adjustments. A moisture-sensitive element changes resistance instantly with minute changes in relative humidity. In spaces supplied by a central fan the sensing element is mounted either in the duct or the conditioned space, remote from the amplifier and adjustments. For controlling the relative humidity in spaces not completely air conditioned, the control is available with all operating adjustment mechanisms mounted in a convenient cabinet.



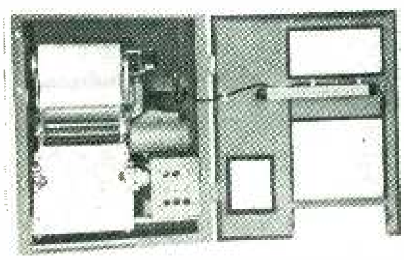
Broadcast Console

ALTEC LANSING CORP., 9356 Santa Monica Blvd., Beverly Hills, Calif. Model 250A console is a completely self-contained a-c operated unit designed for high quality control in a-m, f-m or tv broadcasting. Especially featured in the console is the use of newly designed miniature plug-in preamplifiers, line amplifiers, monitor amplifiers and power supplies. Available input impedances are 30, 150, 250 or 600 ohms with a nominal output impedance of 600 ohms. Frequency response is ± 1 db from 20 to 20,000 cycles and the signal-to-noise ratio is 70 db. Overall dimensions of the con-

sole including table are 36 in. high, 55 in. long and 31 in. deep and weight is 280 lb.

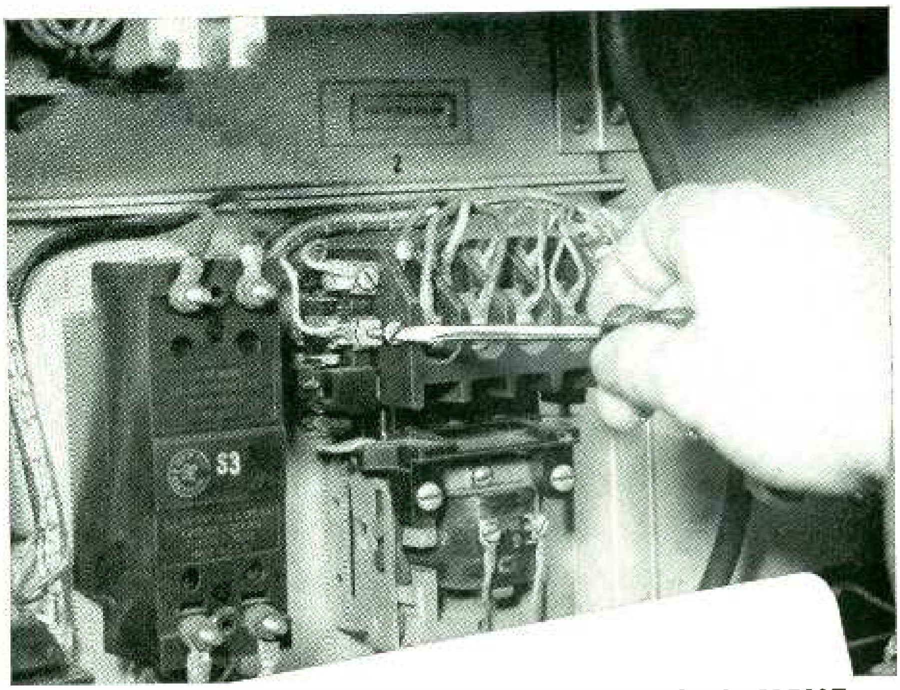
Toroidal Windings

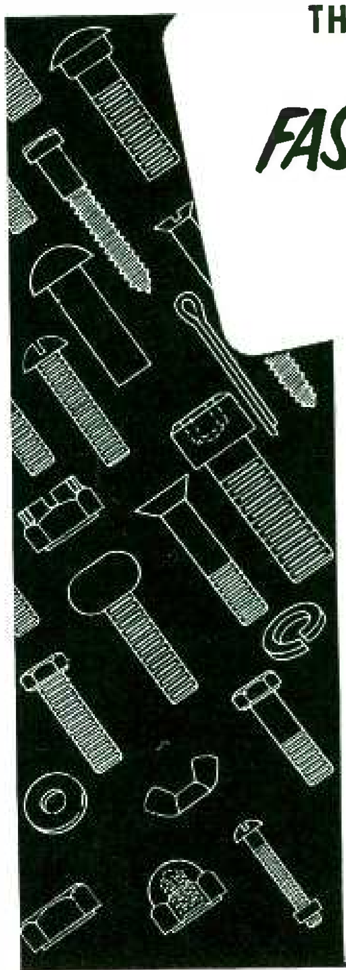
D&R, LTD., 402 E. Gutierrez St., Santa Barbara, Calif., announce the availability of toroidal coils characterized by improved winding techniques. High-Q inductor requirements of miniaturized apparatus may be readily met by the use of these coils. Both powdered-iron and continuous strip-wound core materials are utilized, depending upon the particular application.



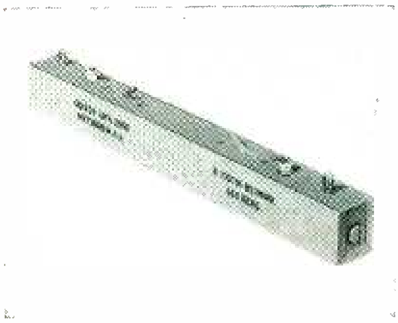
High-Speed Printer

ANELEX CORP., Concord, N. H. The Synchroprinter, a high-speed printer developed for recording the output of analog or digital computers in directly readable form on standard paper, may be used in any application where data is available in electrical or mechanical form. It is capable of printing 15 lines of 40 characters each in one second, or a rate of 600 characters per second. Printing is accomplished by means of continuously rotating type wheels and cooperating print hammers. The device features independent control of printing and





paper feed. This permits data produced at irregular time intervals to be consolidated into adjacent lines of print.



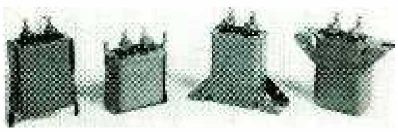
Electrical Delay Lines

GULTON MFG. CORP., 212 Durham Ave., Metuchen, N. J., is offering electrical delay lines for use in computers, radar, tv and other electronic applications where delays are required ranging up to 100 μsec. These feature low-loss, excellent temperature stability through the use of specially engineered temperature compensating capacitors, and small physical size. All of these delay lines are custom engineered to the exact mechanical specifications and electrical characteristics required by the customer. Typical characteristics are delay time, 1.1 μsec; rise time, 0.1 μsec; bandwidth 2.0 mc; attenuation, less than 1 db and characteristic impedance, 460 ohms.

Volt-Ohm-Milliammeter

AMERICAN CHRONOSCOPE CORP., 316 W. First St., Mt. Vernon, N. Y. Model 601 portable v-t volt-ohm-milliammeter is a self-contained, universal test instrument that is battery operated and requires no external source of power supply. The meter accurately measures a wide range of a-c and d-c voltages, resistances and currents. It has six d-c voltage ranges from 3 to 1,200 v full scale, 13-megohm input impedance; 5 a-c voltage ranges from 3 to 300 v full range, 6-megohm input impedance; 6 ohm ranges from 1 to 100 megohms; and 6 current ranges from 3 to 1,200 ma. Designed for all types of radio, electronic or industrial work, the unit is extremely useful when ex-

ternal power is not available; when limitations are imposed by grounds; or to prevent small amounts of 60-cycle hum.



Capacitors

Industrial Condenser Corp., 3243 N. California Ave., Chicago 18, Ill. Illustrated are the type D of the Stabelex "D" hermetically sealed capacitors that hold a charge for as much as 200 days or longer. Case material is lead-coated steel. Terminals are specially prepared and treated glass, standoff type. Type of winding is noninductive. Operating temperature is −80 C to + 75 C. Capacitance tolerance is ± 10 percent. Catalog 117 gives complete details and applications for the entire Stabelex "D" line.

Station Console

Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif. Model 230B console is designed for two-studio station use and is equally suited for use in elaborate p-a and recording installations. In the self-contained, a-c operated unit there are four separate preamplifiers, two booster amplifiers, a line amplifier and a monitor amplifier, all mounted on one chassis. Available input impedances are 50, 150, 300 or 600 ohms and output impedance is 600 ohms. System gain is 100 db (including a 6-db isolation pad). Frequency response is ± 1 db, 20 to 20,000 cycles, and the signal-to-noise ratio is 74 db. Measure-

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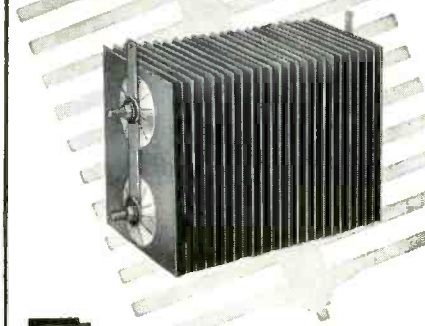

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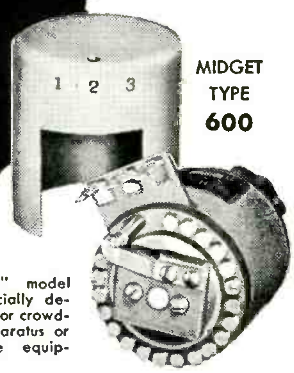

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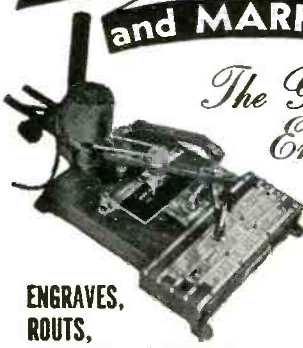

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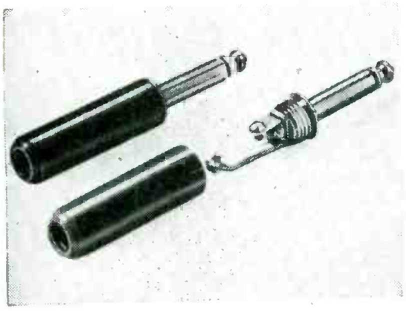
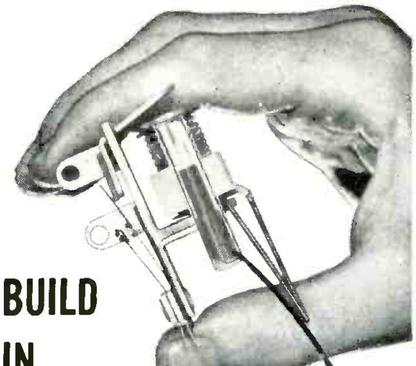


Tiny Phone Plug

CARTER PARTS CO., 213 West Institute Place, Chicago 10, Ill., has introduced a new "imp" phone plug. The tip and sleeve of the new plug fit standard 2-conductor jacks but the molded Bakelite handle has been reduced to about one-half normal size. The new design makes for added convenience and savings in space.

Control Relay

AUTOMATIC TEMPERATURE CONTROL CO., 5200 Pulaski Ave., Philadelphia 44, Pa., has developed an electronic control relay designed to operate in conjunction with a differential transformer transmitter. To obtain control of any variable the differential transformer is adjusted so that its zero position is at the exact point at which it is desired to obtain control. This position is sensitive to less than 0.0001 in., and as the armature of the transformer is moved off this null point by a change in the variable, a signal is generated having amplitude and phase definition. The control relay is sensitive to this minute signal and either pulls in or drops out depending on the direction of the



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...or prevent single-phasing

This tiny, low cost Heinemann Silic-O-Netic Relay puts overload protection right into your circuits . . . or it can prevent single-phasing on three-phase motor applications.

TIME DELAY to allow for starting in-rush or temporary overloads is provided by a hydraulic-magnetic principle . . . and the complete time element is hermetically sealed, forever free of dirt and atmospheric conditions. Delay characteristics are inversely proportional to overload. They are unaffected by ambient temperature . . . and available with curves to suit your requirements.

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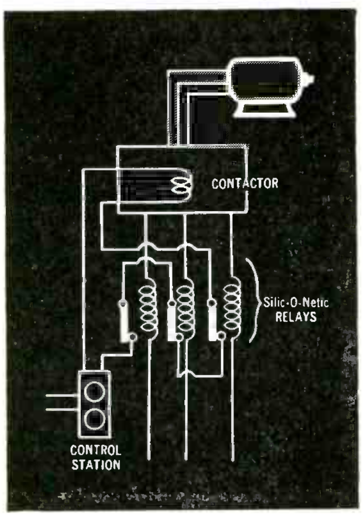

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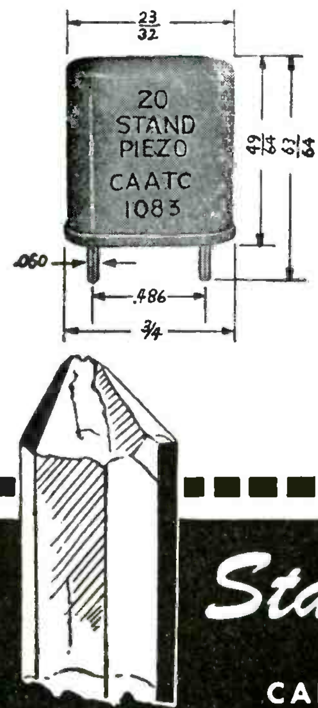

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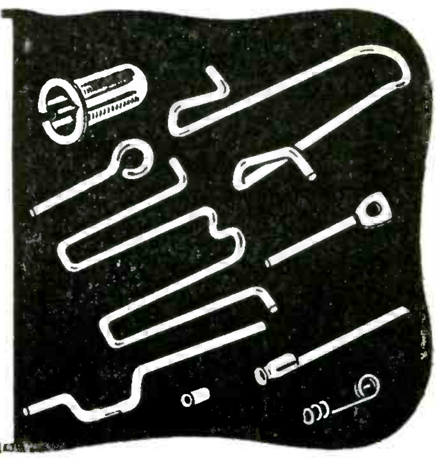
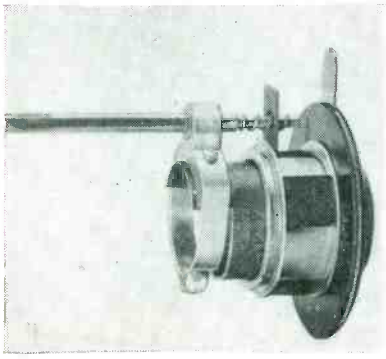


signal. The relay can be installed up to 5,000 ft away from the source of the measured variable.

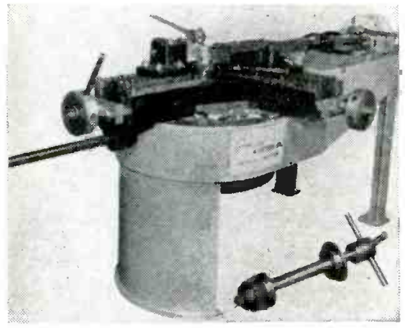


Focusing Device

HEPPNER MFG. CO., Round Lake, Ill., has available a tv p-m focusing device designed for use with the new low-energy magnetic focus tube. It is installed in two seconds by simply slipping over the tube's neck and tightening the clamp. No brackets or special mounting contrivances are required. Because the entire device weighs only 5 oz, including the 1¼ oz Alnico permanent magnet, it cannot damage the neck of the tube. Two turns of the adjusting screw are sufficient to cover the entire focus range.

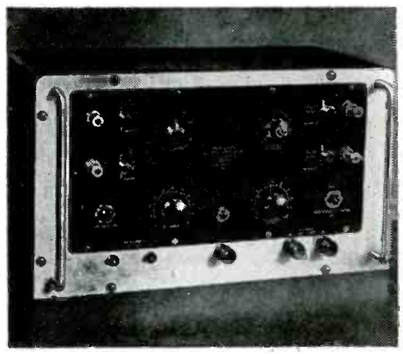
Sound-Level Meter

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1551-A sound-level meter measures product noise and working-area noise levels. Its stable circuit uses a two-stage preamplifier as well as a three-stage main amplifier. Overall frequency response of the amplifiers is flat from 20 cycles to 20 kc so that full advantage can be taken of new high-fidelity microphones. Direct measurement of sound pressure levels can be made over a range from 24 to 140 db, a power range of 400 billion to 1. The unit weighs 11 lb and its overall size is 470 cu in.



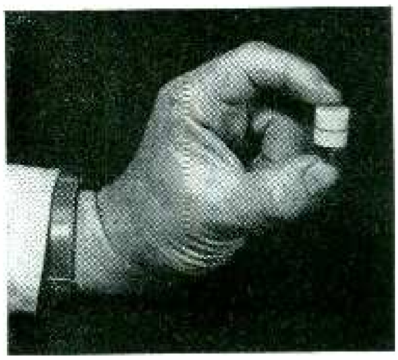
Waveguide Bender

GENERAL RIVETERS, INC., 785 Hertel Ave., Buffalo 7, N. Y., has developed a hand-operated tube bender fitted with specially designed dies for bending waveguides. Capacity of the hand bender using the compound gear is 2-in. standard pipe, 8-in. radius. The dies shown are for bending ½ in × 1 in. 0.065-wall copper tubing. Dies for larger size tubing can be furnished. The machine is arranged to travel 210 degrees for bending parts requiring 203 degrees, allowing for spring back on large radius.



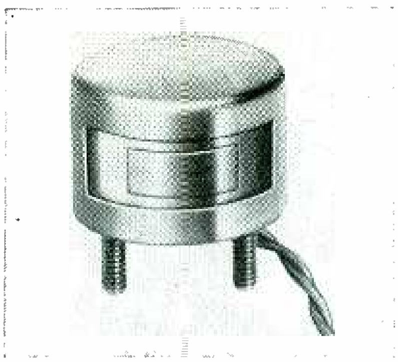
D-C Preamplifier

A. C. COSSOR LTD., Cossor House, Highbury Grove, London, England. Model 1430 d-c preamplifier is a unit of laboratory equipment used for preamplification of minute potentials for the presentation to the input of standard oscillograph amplifiers. The instrument is designed to cover the frequency range from d-c to 30 kc, the response being 15 percent down at 30 kc. Literature giving complete description and specifications is available from the company's U. S. agent, Beam Instruments Corp., 350 Fifth Ave., New York, N. Y.



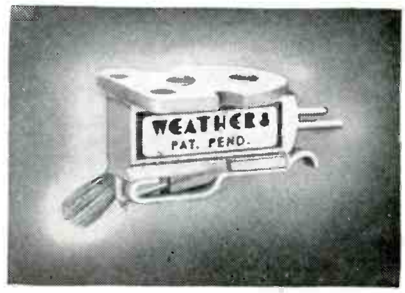
H-V Tip Jack

INSULINE CORP. OF AMERICA, 3602 35th Ave., Long Island City 1, N. Y., has announced the No. 1899 high-voltage tip jack, designed expressly for stability in sensitive electronic test equipment. The insulation is nylon, withstands 10,000 volts and has negligible moisture absorption. The spring contact is made from one piece of phosphor bronze and takes all standard phone tips and test prods. The jack is furnished with a molded washer that affords positive protection against shorts to a metal panel.



Tape Recorder Head

THE INDIANA STEEL PRODUCTS CO., Valparaiso, Ind. The TD-704 high output record-playback head has a frequency response flat within 1 db from 100 cycles to 7,000 cycles at a tape speed of 7.5 in. per second. At a tape speed of 15 in. per second maximum frequency response is increased to nearly 12,000 cycles. Signal output is in the order of 5 mv. The head utilizes a track width of 0.200 in. assuring maximum output and signal-to-noise ratio and a constant overall level of the playback signal. Impedance is 1,000 ohms at 1,000 cps. The unit is designed for single track recording on $\frac{1}{4}$-in. tape.



F-M Phonograph Cartridge

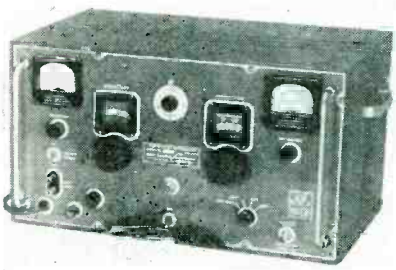
WEATHERS INDUSTRIES, 510 Richey Ave., West Collingswood, N. J., has introduced a new f-m phonograph cartridge operating on a unique variable-capacitance principle. With a good transcription arm it tracks at a stylus pressure of one gram. When installed in modern Webster and RCA-45 record changers the stylus pressure can be adjusted to 3 grams or less. Frequency response is 20 to 20,000 cps. The cartridge operates with an oscillator unit using one 6AT6 tube. Filament and plate current may be taken from the audio amplifier, or from a power supply sold separately.

Timer

NUCLEAR INSTRUMENT & CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill., has introduced the model T100 timer designed to measure elapsed time in one-hundredths of minutes for greater accuracy in radioactive sample counting. The unit operates on standard 110-volt, 60-cycle current and has a convenient off-on switch in the line cord. It can be quickly reset to zero when counting is completed. Measurements are $3\frac{5}{8}$ in. high × $3\frac{5}{8}$ in. wide × 4 in. deep.

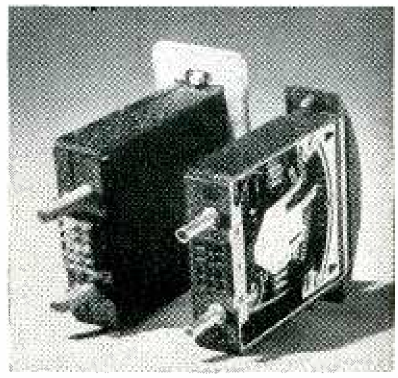
Portable Recorder

AUDIO & VIDEO PRODUCTS CORP., 730 Fifth Ave., New York 19, N. Y. The portable Wagner-16 Micro Disc recorder, model P16-450 is a professional instrument enabling one to record and play back a full hour of speech or music on a single unbreakable vinylite disc that is only $4\frac{3}{4}$ in. in diameter, operating at 16 rpm and at a pitch of 448 lines per in. Contained within the portable carrying case is the complete mechanism and recording head, amplifier and power supply, playback pickup and loudspeaker for recording and playing back instantaneous Micro Discs. The equipment operates from 115 v, 60 cycles a-c.



F-M Signal Generator

NEW LONDON INSTRUMENT CO., P. O. Box 189, New London, Conn. Type 100B f-m signal generator covers the frequency range from 20 to 110 mc. At 150-kc deviation typical distortion is 2 percent at 1,000 cycles modulation to a maximum of 4.5 percent at 15,000 cycles modulation. Distortions are proportionately lower for deviations smaller than 150 kc. In addition to a fine tuning knob the single-band frequency range can be even more precisely adjusted with an incremental frequency dial that changes the carrier up to ±100 kc. It also features a precision piston attenuator—100,000 to 0.02-μv output, and external and internal (100 to 15,000 cycles) modulation.



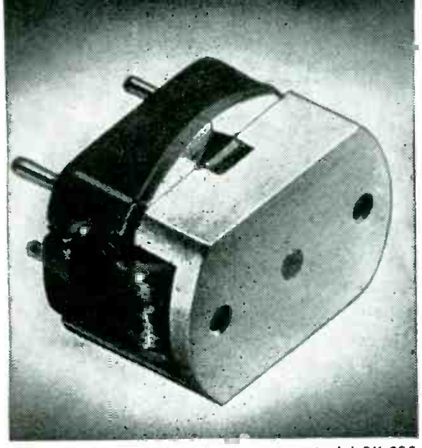
Edgewise Fader

PAINTON & CO. LTD., Kingsthorpe, Northampton, England, has designed a miniature edgewise fader for tv applications where the video signal actually passes through the fader. Features of the instrument include: coaxial plugs and sockets for the incoming and outgoing video signal; provision for a 30-step bridged-T network, insuring smooth video fade; and changeover contacts providing cueing facilities. Attenuations up to 34 db are possible and frequency response is substantially flat up to 5 mc for all attenuations.

Dual Regulated Power Supply

OREGON ELECTRONIC MFG. CO., 206 S. W. Washington St., Portland 4, Oregon. Model D6 is a versatile heavy-duty regulated power supply. It supplies two regulated outputs continuously variable from 0 to 600 v at a maximum current of 200 ma each, with regulation better than 0.5 percent from 10 v to a maximum and ripple of less than 10 mv peak to peak. A turn of a knob combines the two outputs to give a maximum output current of 400 ma. Other outputs are 6.3 v a-c at 10 amperes center-tapped, 650 v d-c unregulated with less than 2 v ripple, 0 to

Brush Magnetic Recording Components



Model BK 985

Better Performance—Uniformity—Stability—Because of 5 Precision Lapping Operations

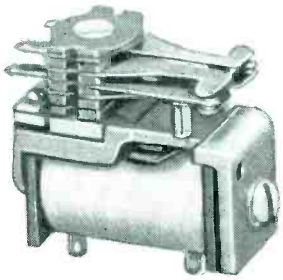
THE MODEL BK 985 narrow channel recording cartridge is typical of the advanced design and production quality of Brush Magnetic Recording Components. Brush engineering leadership in this field means improved basic design. Brush experience and skill in precision production means a product you can count on to do its job efficiently.

Brush Magnetic Recording Components include a full line of single and multiple recording heads applicable to every type of tape recording.

Write us for help on your magnetic recording problems. Your inquiries will receive the attention of capable engineers. Address Dept. E-7.

THE *Brush* DEVELOPMENT COMPANY
3405 Perkins Ave. • Cleveland 14, Ohio
Piezoelectric Crystals and Ceramics
Magnetic Recording Equipment
Acoustic Devices • Ultrasonics
Industrial & Research Instruments

MIDGET TELEPHONE TYPE RELAYS
in hermetically sealed containers



Surface mounting, open type, Series 80 Relay — size: $1\frac{15}{32}''$ l. x $\frac{5}{8}''$ w. x $1\frac{25}{64}''$ h.

Compact, multiple contact with vibration and shock-proof characteristics. Designed to meet various operating requirements typical of Armed Services applications.

Unique pile-up arrangement reduces width below the conventional relay, thereby reducing over-all space volume.

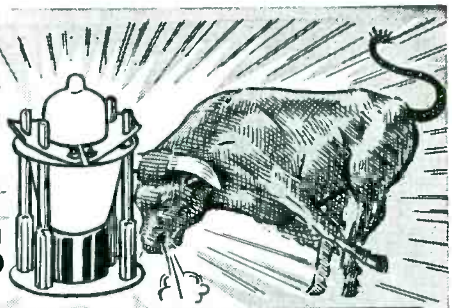
Coils are varnish-impregnated to resist high humidity conditions. All ferrous parts are treated to pass salt-spray tests.

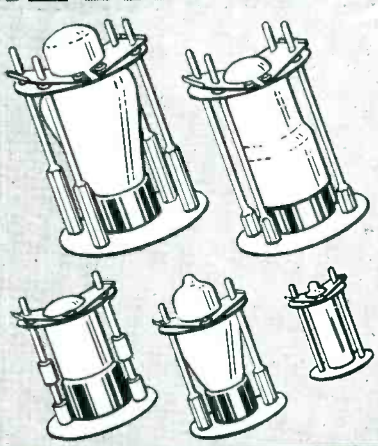
Engineering Representatives in Principal Cities

WRITE FOR BULLETIN *MTR-6*

Wheelock RELAYS
SIGNAL ENGINEERING & MFG. CO.
154 WEST 14TH ST. NEW YORK 11, N.Y.

SHOCKPROOF VACUUM TUBE RETAINERS





These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.
401 CONCORD AVENUE, BRONX 54, N. Y.

-150 v d-c at 5 ma variable and stabilized. Both voltmeter and milliammeter may be switched to monitor any of the regulated or stabilized outputs.

Literature

Snap-Acting Thermostats. Stevens Mfg. Co., Inc., 69 S. Walnut St., Mansfield, Ohio. Bulletin L-4144 covers a line of snap-acting thermostats for operation on wide or narrow differentials. In addition to suggested applications the bulletin describes the operating principle and illustrates it with schematic diagrams. Ratings, typical performance curves, dimensions and construction data are included.

Potentiometers. DeJur-Amsco Corp., 45–01 Northern Blvd., Long Island City 1, N. Y., has issued bulletin 101-E covering its new line of series C-200 external phasing potentiometer. The series described has been engineered and designed to fulfill the exacting requirements of contemporary instrument, computer and similar electronic equipment. Complete specifications are furnished, and a wide variety of applications for single and multiple-ganged units is shown.

Transformers. Crest Laboratories, Inc., Whitehall Building, Far Rockaway, N. Y., announces the availability of an eight-page catalog describing their new hermetically sealed transformers. Complete technical specifications are given on the line of miniature, subminiature and microminiature transformers. Catalogs may be obtained upon letter head request.

Radioactivity Glossary. Radiation Counter Laboratories, Inc., 5122 W. Grove St., Skokie, Ill. Fifty-eight terms commonly used in radio activity measurements are listed and defined in a single-page glossary now available.

Resistor Data. The Daven Co., 191 Central Ave., Newark 4, N. J., has completed a 6-page brochure con-

taining full descriptive material on precision wire-wound resistors, hermetically sealed resistors and miniature resistors. The resistors are individually charted, diagrammed and tabled to provide valuable information, such as wattage dissipation, tolerances, temperature coefficients and maximum resistance values with different types of wire, physical dimensions and types of mounting.

Identification Tape. Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester 9, N. Y. A folder in four colors tells the story of the newly developed pressure-sensitive plastic tape that can be written upon. Many of its countless uses include the identification of circuits in panel boards and the labeling of component parts of electronic testing equipment. Labelon may be applied to any smooth surface, written on with pencil or stylus, and is resistant to dirt, oil, water or acids, and unaffected by temperatures from −40 to 160 F. Data on the many colors and widths are included.

Tube Data. Hytron Radio & Electronics Co., Salem, Mass. Five recent engineering bulletins give mechanical and electrical data on the 5Y3WGT fullwave rectifier, the 12BY7 video pentode amplifier, the 12BZ7 high-mu dual triode, the 12A4 medium-mu triode and the 12B4 low-mu triode.

Servo Stabilizer. Kalbfell Laboratories, Inc., P. O. Box 1578, San Diego 10, Calif., has available a descriptive pamphlet on the Twin-T servo stabilizer, a device that contains a phase-shifting network to compensate for the lag caused by motors or other inertial elements. The unit described overcomes hunting while maintaining fast response time.

Signal-Splitters. J. L. A. McLaughlin, La Jolla, Calif. A recent 6-page folder gives complete specifications on the series 10 signal splitters that eliminate adjacent channel and heterodyne interference. The units described can be used with standard type communications receivers and are

normally supplied with inputs for receivers having i-f amplifiers of 455 kc but can be modified to match other frequencies.

Packaged Pulse Control Units. Control Instrument Co., Inc., 67 Thirty-Fifth St., Brooklyn 32, N. Y., has released a new bulletin on the Burroughs line of unitized pulse generating and control apparatus for use in the fields of tv, radar, digital computers, telemetering and nuclear physics. It contains detailed information, specifications, characteristics and some typical applications.

High-Temperature Magnet Wire. Sprague Electric Co., North Adams, Mass. Engineering bulletin 404 deals with Ceroc ST single-Teflon, ceramic-insulated, high-temperature magnet wire. Standard sizes and performance characteristics are shown. Also included is a guide for application and operation.

Electrical Tapes. Industrial Tape Corp., New Brunswick, N. J., has published a four-page folder covering its line of Permacel electrical tapes. Technical data and prices for thirteen different types are given.

Quartz Crystals. Bliley Electric Co., Union Station Building, Erie, Pa. Bulletin No. 43 is a 16-page catalog dealing with a wide line of quartz crystal units. Descriptions, photographs and mechanical drawings for each are given. Included are a two-page specification index for military crystal units and concise ordering information.

Soldering Hints. Federated Metals Division, American Smelting and Refining Co., 120 Broadway, New York 5, N. Y., has published a new 16-page booklet on the fundamentals of soldering, entitled "How to Solder." It contains simple instructions and illustrations aimed at making soldering more successful and easier to do.

UHF TV. Allen B. DuMont Laboratories, Inc., 1,000 Main Ave., Clifton, N. J. Written in nontech-

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● Now, with the new versatile Gray TELOP II you can produce and broadcast an amazing variety of professional-quality commercials at surprisingly low cost. Local sponsors will marvel at the way TELOP II presents their selling message with opaque cards, photographs, art work and transparencies. *And* you get the real effect of superimposition, lap-dissolve and fade-out. Only limitation is your imagination. Takes up very little space. One operator does it all!

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Zophar Waxes, resins and compounds to impregnate, dip, seal, embed, or pot electronic and electrical equipment or components of all types; radio, television, etc.

Cold flows from 100°F. to 285°F.

Special waxes non-cracking at −76°F.

Compounds meeting Government specifications plain or fungus resistant.

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112-130 26th Street,
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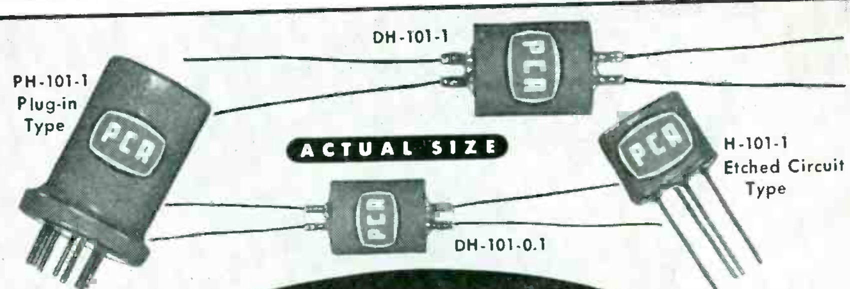


HERMETICALLY SEALED
MINIATURE
PULSE TRANSFORMERS

Designed for PLUG-IN or wiring into etched, printed or conventional circuits. Models available with two, three or four windings for producing pulses from .1 μ sec. to 10 μ sec. when connected in standard blocking oscillator circuit.

Write for bulletins describing over 30 of our hermetically sealed and standard plastic impregnated and embedded transformers.

Research, development and manufacture of miniature electronic components and assemblies

PCA ELECTRONICS INCORPORATED
6368 DeLongpre Avenue
Hollywood 28, California
GRanite 2196

nical language, a recent booklet (while primarily directed at the broadcasters) will be of assistance in providing some background on uhf for everyone. In it are discussed how uhf is different, what a uhf station would cost and how it should be laid out.

Directional Coupler. Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Volume 3, No. 7-8 of the Journal presents a technical article dealing with a precision directional coupler that uses multihole coupling. Units described in this well-illustrated article are useful in many types of applications such as mixing and isolation.

Dynamic Pressure Indicator. Rutishauser Corp., 490 So. Fair Oaks Ave., Pasadena 1, Calif. A seven-page bulletin illustrates and describes the new model ST-12 electronic pickup indicator having very high frequency response. It includes construction and specifications.

Microwave Components. Technicraft Laboratories, Inc., Thomaston-Waterbury Road, Thomaston, Conn., have released their 1952 catalog for general distribution. Subject matter includes illustrations and detailed description of their flexible and rigid waveguide assemblies and other components. In addition, it describes the many laboratory facilities and services offered by the company.

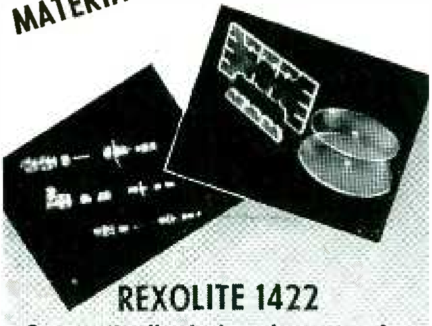
Photoelectric Equipment. De-Tec-Tronic Laboratories, Inc., 1711 Terra Cotta Place, Chicago 14, Ill., has published a new catalog of photoelectric equipment for industry. It illustrates and describes a complete line of amplifier-relays and light source and phototube units with design standardized to eliminate the high cost of specially engineered apparatus.

Loudspeakers. The Plessey Co Ltd., Ilford, Essex, England. Pul lication No. 542 is a 16-page cat log describing in detail a new l of shrouded loudspeakers. line described includes four of circular units, and one

REXOLITE 1422

(FORMERLY G. E. TEXTOLITE 1422)

COMBINES EVERY DESIRABLE PHYSICAL, CHEMICAL, & ELECTRICAL PROPERTY IN ONE INSULATING MATERIAL FOR U. H. F.



REXOLITE 1422

- Specifically designed to meet the growing need for a U. H. F. insulating material thats low in cost.
- Meets JAN-P-77 and MIL-P-77A specifications.
- Withstands high temperature due to its thermosetting nature.
- Has outstanding electrical properties.
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- Its dimensional stability and unusual chemical inertness allow its use where other materials fail.
- Readily machinable to extremely close tolerances.
- Available as centerless ground rods in any diameter up to 1". Also cast in larger diameter rods and sheets.

Write today for technical bulletins and samples. Our engineering staff is always at your disposal.

Manufacturers of Non-strip wire, High Temperature Electrical Tubing and other extruded plastic products.

THE REX CORPORATION
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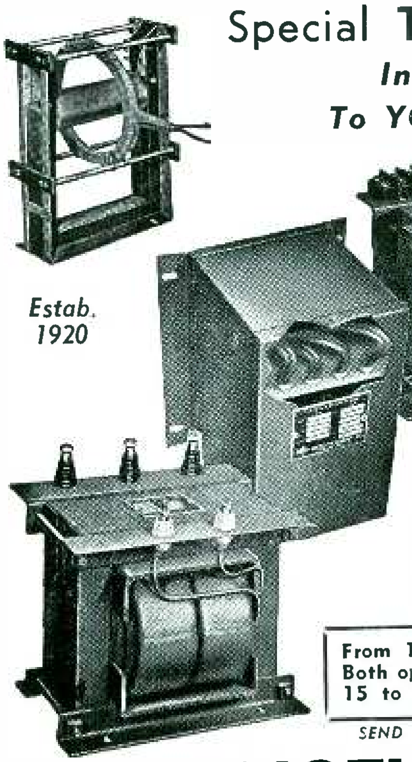
Special TRANSFORMERS

Individually Built To YOUR Specifications

IN SMALL QUANTITIES



Estab. 1920

For 31 years we have been building transformers in single units or in quantity to the most exacting requirements. Cost compares favorably with standard types. Quality proved by years of actual use in Electronics, Research and Special Instrument fields. Built to meet NEMA and ASA Standards.

From 10 VA to 300 KVA Dry-Type only. Both open and enclosed. 1, 2 and 3 Phase 15 to 400 Cycles.

SEND FOR 8 PAGE BULLETIN, AND PRICE LIST

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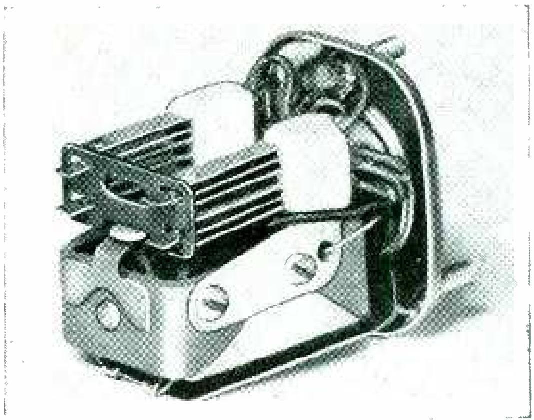
NOTHELFER
WINDING LABORATORIES
9 ALBEMARLE AVE., TRENTON 3, N. J.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION NEMA MEMBER

New G-E Hermetically-Sealed Relay Protected from Breakdowns

Cuts Down on Relay Replacements

General Electric's new aircraft relay is more highly arc-resistant, has non-tracking stack insulation, because of a revolutionary technique for directly molding contact arms into a polyester compound.



Rated at 28 volts d.c., the relay withstands surges up to 1500 volts.

A more powerful magnet structure yields a higher tip pressure, adds to the surety of making contacts. And the relay is available for quick shipment. Write Section 730-38 for Bulletin GEA-5729.

General Electric Co., Schenectady 5, N. Y.

730-38

GENERAL ELECTRIC

tical, each available in a choice of four flux densities, and each providing a choice of cones having performance characteristics adapted for various classes of receivers.

Capacitor Catalog. John E. Fast & Co., 3101 N. Pulaski Road, Chicago 41, Ill. Catalog No. 27 lists an entire line of power-factor-correction capacitors. Section 1 gives general information on their applications and locations, with general standards and specifications; section 2 details individual units; section 3 is devoted to rack-type assemblies; and section 4 lists pole types.

Semiconductors. Carboloy Department of General Electric Co., Detroit 32, Mich. Catalog TH-5 contains 30 pages of general basic information relating to physical and operating characteristics of thermistors, which are electronic semiconductor control elements whose electrical resistance responds negatively to minute temperature changes. Typical applications and wiring diagrams are listed. Graphical data of temperature-resistance ratio characteristics for rod, disk and washer-types are included. The last page gives suggested applications for thermistors in various industries.

Drawn-Oval Capacitors. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-5777 covers the new line of dual-rated capacitors in drawn oval containers. The units described, designed to replace case styles CP53 and CP70, are lighter, smaller, mechanically stronger, 10 to 20 percent lower in cost, and constructed so as to save critical materials. Dimensional drawings and a table of prices and data are included.

Differential Transformers. Automatic Temperature Control Co., 5200 Pulaski Ave., Philadelphia 44, Pa. Bulletin R-31 explains the principles of differential transformers. It covers in detail the characteristics of linear transducers and their wide and varied use in industry. Profusely illus-

trated, it includes all the various types of indicators, recorders, pressure transmitters, control relays, servomechanisms, load cells, demodulators, amplifiers, micrometer positioners and many other industrial instruments.

Moisture & Fungus-Resistant Varnish. Brooklyn Paint & Varnish Co., Inc., 50 Jay St., Brooklyn 1, N. Y. A 4-page brochure deals with the TUF-ON 747-S moisture and fungus-resistant varnish that conforms to government specification MIL-V-173A. The varnish described is designed for the treatment of communications, electronic and associated electrical equipment. Included are a table of test requirements, methods of application, safety precautions and drying information.

Airborne Mounting Bases. T. R. Finn & Co., Inc., 333 Jackson Ave., New York 54, N. Y. Catalog MB-110 is a four-page illustrated brochure on airborne electronic mounting bases; vibration isolators for these mounting bases to JAN-C-172A specifications; type M shock mounts to Signal Corps specifications; and fire control shock mounts for Naval vessels. Included are diagrams showing specifications, technical characteristics and explanatory notes.

Interference Filters. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin No. 180 deals with G.A.B. interference filters for the isolation of narrow spectral bands in colorimetry, fluorimetry, microscopy, photomicrography, flame photometry and color densitrometry. The units described are also used in reflectometry, light-scattering measurements, micro-colorimetry, refractometry, polarimetry, and in all other fields requiring monochromatic light in the visible and near-infrared range.

Low-Voltage Vehicular Capacitors. Sprague Electric Co., 35 Marshall St., North Adams, Mass. Bulletin No. 217 gives full details on type 131J line of hermetically-sealed corrosion-resistant capacitors for

radio-interference suppression on the low-voltage electrical systems of military vehicles and portable gasoline-driven power plants. The metal-encased capacitors described, designed to meet U. S. Army Specification 71-1667 and Ordnance Drawing DQBX1, withstand severe shock and vibration as well as atmospheric moisture and salt spray.

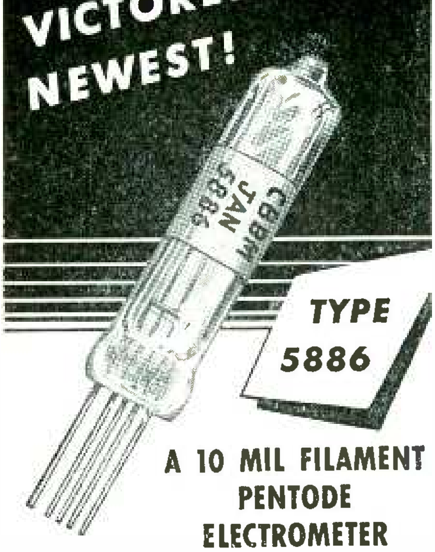
Damage Control. The Brinnell Co., Simsbury, Conn. Bulletin 252 fully describes the Protectron, an electronic device for preventive maintenance and increased production efficiency. The catalog points out that Protectron-equipped plants have been able to step up production of present equipment by 12.5 to 22 percent, have reduced tool and die breakage up to 86 percent, and have been able to effect a manpower gain up to 300 percent, since one man can safely handle four Protectron-eqipped automatic machines.

Picture-Tube Data. Allen B. DuMont Laboratories Inc., 1,000 Main Ave., Clifton, N. J., has announced distribution of the latest edition of the "Picture Tube Data Chart." The chart, printed on heavy stock and suitable for wall mounting, lists the electrical and physical characteristics for any modern RTMA-registered tv picture tubes.

Pressure-Sensitive Tapes. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. Detailed information on characteristics, uses and technical data for Permacel pressure-sensitive electrical tapes is provided in a new 16-page catalog. Descriptions of nonelectrical Permacel and Texcel tapes are included. Cotton cloth, crepe paper, flatback paper, acetate cloth, acetate film, acetate cloth-film combination and vinyl film electrical tapes are covered. A special section is devoted to nonelectrical paper, cloth, glass-reinforced paper, cellophane, and acetate fiber tapes.

Subminiature Terminals. Garde Mfg. Co., 588 Eddy St., Providence 3, R. I. A single-page bulletin

VICTOREEN'S NEWEST!



TYPE 5886

A 10 MIL FILAMENT PENTODE ELECTROMETER

The Victoreen 5886 Quality subminiature electrometer pentode has unusually low filament current and high emission stability. It's structure is designed to reduce microphonics, an improvement of prime importance in portable equipment. The tube has a high ratio of transconductance to control grid current, a feature which makes it especially useful in single stage circuits in portable equipment.

DATA	Pentode Connected	Triode Connected
TYPICAL SERVICE	Electrometer	Electrometer
PLATE VOLTAGE (volts)	+12	+10.5
ACCELERATOR GRID VOLTAGE (volts)	+4.5	———
CONTROL GRID VOLTAGE (volts)	2.0	3.0
PLATE CURRENT (μa)	6	200
CONTROL GRID CURRENT (μa)	3×10^{-15}	2×10^{-13}
μ	1	———
Gm (μmhos)	14	160
FILAMENT	1.25 volts at 10 ma	

Write our Technical Service Department for further details.

COMPONENTS DIVISION
Victoreen Instrument
3800 PERKINS • CLEVELAND 14, O.

TUXEDO 9-2050

RESEARCH DESIGN DEVELOPMENT PRODUCTION

Televiso Corporation

GENERAL OFFICES AND PLANT
7466 WEST IRVING PARK ROAD - CHICAGO 34, ILL.

RADAR DEVICES
MICRO WAVE TECHNIQUE
AUTOMATIC CONTROLS
COMPUTERS
SERVO-MECHANISMS
RADIO COMMUNICATION
RADIO NAVIGATION
GUIDED MISSILES
FIRE CONTROL
AIRCRAFT INSTRUMENTS
AIRCRAFT CAMERAS
PROJECTORS
PRINTERS
DUPLICATING EQUIPMENT
GROUND CAMERAS
INTERVALOMETERS
ELECTRO-OPTICAL SCANNERS
ELECTRO-MEDICAL EQUIPMENT
ULTRASONIC GENERATORS
VIBROMETERS
ELECTRO-MECHANICAL DEVICES
LABORATORY EQUIPMENT
RADIO INTERFERENCE EQUIPMENT
RADIO INTERFERENCE SPECIALISTS
VIBRATION TESTING MACHINES

To: Chief Engineer

Subject: Radio Interference

Gentlemen:

The problem of Radio Interference reduction is coming into greater prominence, with greater emphasis being given in Military specifications, and more stringent rules being enacted by the Federal Communications Commission. In the past, many manufacturers neglected to consider interference in the design of new equipment, and as a result, few companies have adequate measuring equipment or personnel trained to use it.

Televiso has been a pioneer in the Interference Reduction field, and for some time has been performing research and acting as consultant to the United States Navy. We are one of only four companies in the United States - and the only one in the middle-West - authorized to make acceptance tests, and issue certificates of compliance with Military specifications that are recognized by the Navy.

Our facilities include Government approved measuring instruments covering the range from 14 kc to 1000 mc and a screen room 12' by 14' by 7½'. The instruments are portable, and we can make measurements outside our plant when necessary. Our engineering staff has been trained by the Bureau of Ships, U. S. Navy, at Annapolis, and has had extensive experience in the measurement and reduction of Radio Interference.

Whether you are a manufacturer, operator, or repairman of electronic or electro-mechanical equipment, Televiso can solve your Radio Interference problems.

For complete details, please contact the writer.

Very truly yours,

TELEVISO CORPORATION

Fredrick A. Hamilton
Fredrick A. Hamilton
Radio Interference Division

FAH:LG

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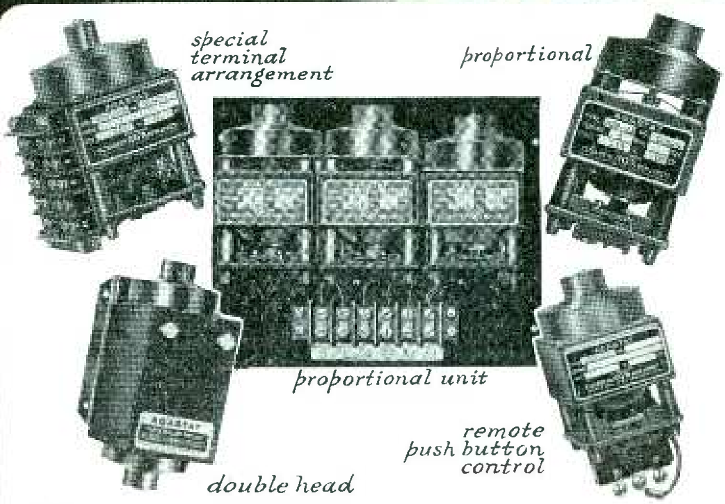
special-type...



AN
AGASTAT
TIME DELAY RELAY for every requirement

A'G'A DIVISION OF ELASTIC STOP NUT CORPORATION OF AMERICA
1027 NEWARK AVE., ELIZABETH 3 NEW JERSEY

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STIMSONITE REFLECTORS

A'G'A
AIRPORT LIGHTING

A'G'A
MARINE LIGHTING EQUIPMENT

illustrates and describes the subminiature insulated standoff terminals featuring a voltage breakdown of 3,500 v a-c, rms, 60-cycle test. The molded Melamine insulation included in the units described is in accordance with latest revisions of MIL-P-14 specification.

Test Equipment. Communication Measurements Laboratory, Inc., 120 Greenwich St., New York 6, N. Y. A recent 12-page catalog contains illustrated descriptions and specifications for the following instruments: models 1430, 1435 and 1420 variable frequency electronic generators; models 1115-A, 1100, 1110, 1130 and 1135 regulated power supplies; model 1010 automatic inspector Rotobridge; models 1060 and 1061 Rotobridge cable test stands; model 1210B stroboscope; and model 1500 megohmmeter. Prices for each are included.

Control Selection. General Electric Co., Schenectady 5, N. Y., offers an eight-page selection guide for a wide range of electric and electronic controls, devices and accessories. Bulletin GEA-5781 contains quick-reference selection data, photographs and listings of additional publications that give complete information on each of the equipments. Products included are: manual, magnetic, combination and reversing motor starters; pushbutton stations; relays; limit switches; solenoids; photoelectric relay; electronic relay; electronic timer; pressure and vacuum switch; float switch; pressure governor; reduced-voltage starter; Thy-mo-trol drive; and smoke density indicator and control.

Mobile Antennas. Ward Products Corp., Division of The Gabriel Co., 1523 E. 45th St., Cleveland 3, Ohio. A new catalog sheet gives complete specifications on model SPPC-88. The sheet describes a special mobile antenna used to eliminate the frequent breakage that occurs when antennas for the 30 to 50-mc bands are mounted on a high vehicle such as a bus or truck.

PLANTS AND PEOPLE

Edited by WILLIAM P. O'BRIEN

Engineers Form New Company

AN electronics development and manufacturing organization in Baltimore, to be known as Phebco, Inc., was recently set up by J. M. Pearce, P. A. Hoffman and T. T. Eaton, previously with the Glenn L. Martin Co. as chief electronics engineer, assistant chief electronics engineer and section head of the missile guidance group respectively. They are specializing in electronic instrumentation, special test equipment and telemetry for the missile and radar fields.

Kupfrian Doubles Plant Space

THE KUPFRIAN MFG. CO., producers of flexible shafting, universal joints, wire shielding and remote controls, announce the recent purchase of a five-story brick building at 395 State St., Binghamton, N. Y., containing over 12,000 sq ft of floor space.

With the new space Kupfrian more than doubles the area in which operations were started in 1950. During this first two years, the number of employees has increased from the initial ten to forty-five. Much of the current production is for military requirements.

Antenna Test Range

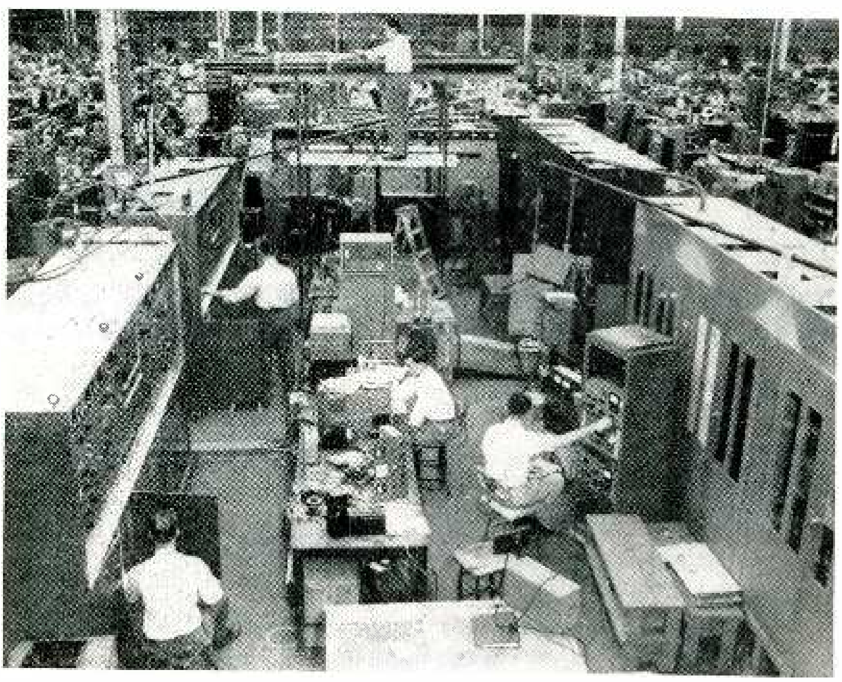
ON THE SITE of their new Natick, Mass., laboratory, Workshop Associates, Division of The Gabriel Co., has completed a new antenna pattern-measuring range. The range will be used for measuring antenna radiation patterns over a distance of about 1,200 feet. It consists of a transmitting tower (illustrated) and a receiver 1,200 feet away where the actual measuring is done.

Transmitting tower for Workshop's new antenna pattern-measuring range

The transmitter is 35 ft above the ground, on the top of a knoll, and the terrain is clear and sloping to the receiver. The enclosure has a 20 ft x 12 ft floor area and provision for transmitting four frequencies simultaneously.

The new range is now in operation and supplements the 3,200-ft range Workshop has been using for several years at its Needham, Mass., plant.

GETTING READY FOR EXPANDED TV



Television transmitters and amplifiers undergoing final testing at GE's Electronics Park plant, Syracuse, N. Y. Pictured are five-kw units for vhf channels 2 through 13 and 35-kw amplifiers for increasing the range and improving the picture quality of present and future tv stations. General Electric anticipated the end of the freeze on new tv construction to make possible the delivery of transmitting equipment this year. The company also has in production low-power transmitters for the new ultra-high frequencies, some of which will be delivered this year

Poole Expands UHF TV

C. F. ROTHROCK, JR., field engineer with Link Radio Corp., has joined the John H. Poole Broadcasting Co., Hollywood, Calif., as uhf television development supervisor to direct equipment improvement in the company's experimental station on channel 22, KM2XAZ.

Rothrock's most recent assignments for Link have included a uhf

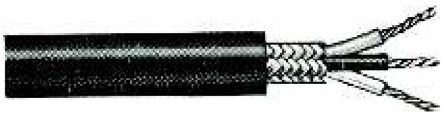
electronic wire and cables for standard and special applications

Whether your particular requirements are for standard or special application, choose *LENZ* for the *finest* in precision-manufactured electronic wire and cable.

GOVERNMENT PURPOSE RADIO AND INSTRUMENT HOOK-UP WIRE,
plastic or braided type, conforming to Government Specification JAN-C-76, etc., for radio and instruments. Solid or flexible conductors, in a variety of sizes and colors.

SPECIAL HARNESSES,
cords and cables, conforming to Government and civilian requirements.

RADIO AND INSTRUMENT HOOK-UP WIRE,
Underwriters Approved, for 80° C., 90° C. and 105° C. temperature requirements. Plastic insulated, with or without braids.

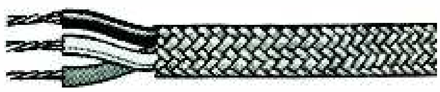


SHIELDED JACKETED MICROPHONE CABLE
Conductors: Multiple—2 to 7 or more conductors of stranded tinned copper. Insulation: extruded color-coded plastic. Closely braided tinned copper shield. Tough, durable jacket overall.

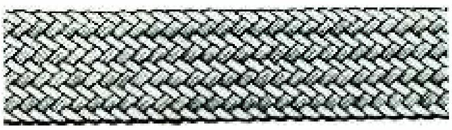
RF CIRCUIT HOOK-UP AND LEAD WIRE
for VHF and UHF, AM, FM and TV high frequency circuits. LENZ Low-Loss RF wire, solid or stranded tinned copper conductors, braided, with color-coded insulation, waxed impregnation.

JACKETED MICROPHONE CABLE
Conductors: Extra-flexible tinned copper. Polythene insulation. Shield: #36 tinned copper, closely braided, with tough durable jacket overall. Capacity per foot: 29MMF.

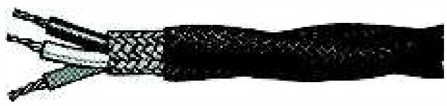
SHIELDED MULTIPLE CONDUCTOR CABLES
Conductors: Multiple—2 to 7 or more of flexible tinned copper. Insulation: extruded color-coded plastic. Closely braided tinned copper shield. For: Auto radio, indoor PA systems and sound recording equipment.



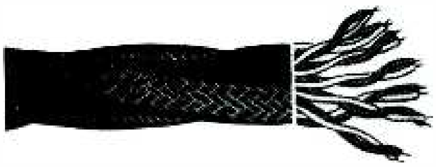
TINNED COPPER SHIELDING AND BONDING BRAIDS
Construction: #34 tinned copper braid, flattened to various widths. Bonding Braids conforming to Federal Spec. QQ-B-575 or Air Force Spec. 94-40229.



SHIELDED COTTON BRAIDED CABLES
Conductors: Multiple—2 to 7 or more of flexible tinned copper. Insulation: extruded color-coded plastic. Cable concentrically formed. Closely braided tinned copper shield plus brown overall cotton braid.



PA AND INTERCOMMUNICATION CABLE
Conductors: #22 stranded tinned copper. Insulation: textile or plastic insulated conductors. Cable formed of Twisted Pairs, color-coded. Cotton braid or plastic jacket overall. Furnished in 2, 5, 7, 13 and 25 paired, or to specific requirements.



CHECK LENZ FIRST!

Lenz Electric Manufacturing Co.

1751 N. Western Ave., Chicago 47, Illinois

cords, cable and wire for radio ◆ p. a. ◆ test instruments ◆ component parts radio-telephone link for a large war plant, the first highway truck radio system in the west and several police radio departments.

His engagement is the latest stage in Poole's uhf developmental program, which has included establishment of KM2XAZ on Signal Hill, Long Beach, in 1949; creation of improved transmission facilities in cooperation with Stanford Research Institute; and enlargement of coverage by moving the station to Mt. Wilson early this year.

WCEMA Addition

NEWEST corporate member elected to the Los Angeles Council of the West Coast Electronic Manufacturers' Association is Franklin C. Wolfe Co., 11,723 Mississippi Ave., Los Angeles, Calif., makers of terminals and other electronic products, and serving also as design engineers and consultants.

Speer Carbon Consolidates

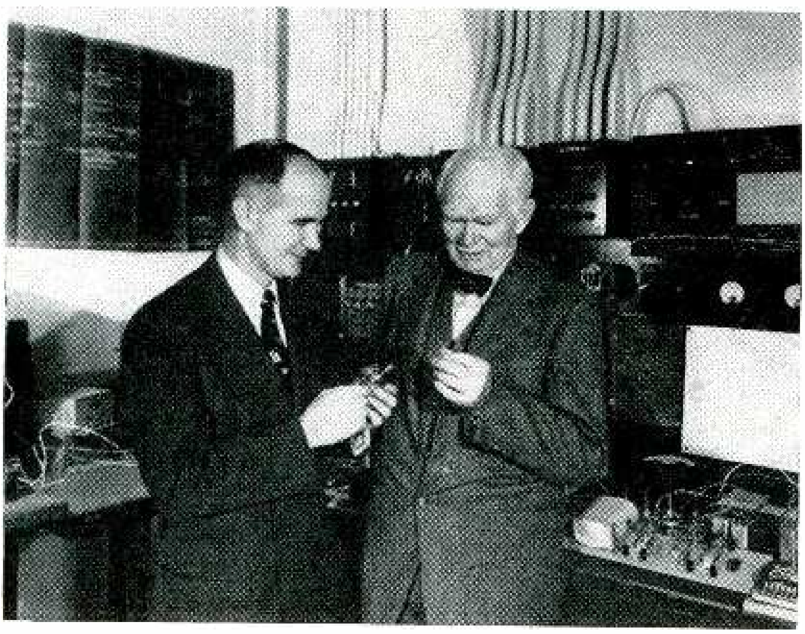
SPEER CARBON CO., St. Marys, Pa., and its subsidiaries, Jeffers Electronics, Inc., DuBois, Pa., International Graphite and Electrode Corp., Niagara Falls, N. Y., and Speer Resistor Corp., St. Marys, Pa., have consolidated into one company, the Speer Carbon Co., with headquarters at St. Marys. The various subsidiaries henceforth will operate as divisions of Speer Carbon Co.

National Union Forms Transistor Division

FORMATION of a transistor division, to be engaged in the manufacture of germanium and silicon diodes and transistors of both the point contact and junction types, has been announced by National Union Radio Corp., Orange, N. J.

Edmund G. Shower has been appointed head of the new division. He was for many years with the Bell Telephone Laboratories where he set up the initial transistor production line. On leave of absence from Bell Labs from 1943 to 1946, he served in the Navy, where as a member of the Bureau of Ships, Electronics Division, he had charge of coordination of electron tube design for the Naval Establishment with the Army, Air Force, Marine and allied agencies.

ELECTRONICS LANDMARKS INSPECTED



Two major landmarks in the history of electronics are represented by the devices in the hands of the men pictured above. On the left is William Shockley of Bell Telephone Laboratories, who directed the research program leading to the invention of the transistor. On the right is Lee deForest, who in 1907 invented the audion, forerunner of modern vacuum tubes, and the cornerstone of modern electronics. The photo, made during a recent visit to Bell Laboratories by Dr. deForest, shows him holding the transistor and Dr. Shockley holding the audion

RDB Appointment

APPOINTMENT of C. Guy Suits as a civilian member of the Committee on Electronics of the Department of Defense Research and Development Board was recently announced by D. A. Quarles, committee chairman.

Dr. Suits, who is vice-president and director of research for the General Electric Co., Schenectady, N. Y., was formerly a member of the Committee on Ordnance of the Research and Development Board, and is presently a member of the Special Technical Advisory Group of the Board and the Joint Chiefs of Staff.

Civilian members in addition to Mr. Quarles, vice-president of Western Electric Co. and president of the Sandia Corp., and Dr. Suits, are Dr. E. W. Engstrom, research director of RCA Laboratories, Princeton, N. J., and Dr. William L. Everitt, dean of engineering at the University of Illinois, Urbana, Ill.

Three representatives from each of the military departments complete the membership of the group.

West Coast Company Expansions

FOUR companies have recently announced plant expansion on the west coast:

The Pacific division of Bendix Aviation Corp., North Hollywood, Calif., has purchased the Photo-Electric Pilot Corp., Seattle, Wash., and Photo-Electric president A. B. Dickison is joining the Bendix organization in an executive capacity. Manufacture of Photo-Electric marine pilots will be continued temporarily at the Seattle plant, and will be moved to North Hollywood in late summer. Pacific division of Bendix first entered the marine field in 1947 with its electronic depth recorder.

Varian Associates, San Carlos, Calif., has awarded a contract for construction of its new research and development laboratory to be built on a 10-acre land tract leased from

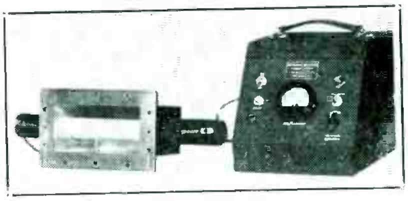
A PRIMARY STANDARD
FOR NOISE FIGURE MEASUREMENT IN THE MICROWAVE SPECTRUM
FAST • SIMPLE • ACCURATE

THE MICROWAVE MEGA-NODES
NOISE OUTPUT (All Guides) 15.8 db Accurate to ± 0.25 db

USES: The Microwave Mega-Nodes are sources of random noise provided in six waveguide sizes. The Microwave Mega-Nodes may be used for the measurement of noise figure, receiver gain, and for the calibration of standard signal sources. The noise figure is obtained by comparing the noise output of a system with the amount of noise introduced by the Microwave Mega-Node. Comparative receiver sensitivity measurements may be easily made unless excessive noise is present in the systems under comparison. In radar systems the Microwave Mega-Node is particularly useful in checking the over-all performance.

DESCRIPTION: The Microwave Mega-Nodes employ a gas discharge which is radiating substantially monochromatic light. The Mega-Nodes are available in the following waveguide sizes and cover the following ranges:

RG 69/U	1,200 to 1,400 megacycles
RG 48/U	2,600 to 3,950 megacycles
RG 49/U	3,950 to 5,850 megacycles
RG 50/U	5,850 to 8,200 megacycles
RG 51/U	7,050 to 10,000 megacycles
RG 52/U	8,200 to 12,400 megacycles



RG—69/U
Microwave Mega-Node

One end of each waveguide is terminated in a standard flange.

A thermometer is attached to each waveguide to correct for temperature variations.

The standing wave ratio is less than 1.2 over the entire range and is usually less than 1.1 over most of the operating region.

PRICE:

Single waveguides RG-48/U, RG-49/U, RG-50/U, RG-51/U, or RG-52/U $195.00

Standard power supply for any of above $100.00

RG-69/U (L-Band) Waveguide .. $400.00

Special power supply for RG-69/U guide $120.00

Set consisting of standard power supply and one each of the following waveguides: RG-48/U, RG-49/U, RG-52/U $600.00

Prices are F.O.B. Factory
Export charges: Add 10% for outside U. S. and Canada.

KAY

KAY ELECTRIC COMPANY

25 Maple Avenue
Phone CAldwell 6-4000
Pine Brook, New Jersey

Stanford University. The new laboratory will be ready for operation by April 1953. At the same time, San Carlos facilities will be expanded to include a staff of about 500 to manufacture klystrons and other electronic products.

The Walkirt Co., designers and manufacturers of electronic pulse circuitry, have moved into their new and expanded quarters at 145 W. Hazel St., Inglewood, Calif. Offices and enlarged production facilities are available for custom engineering and manufacturing, with emphasis placed on miniaturization, resin encapsulation and pulse circuitry for all types of high-speed or high-precision counting or mensuration of time, frequency and rotational speeds. The Walkirt Co. was formerly located in Culver City, Calif.

The Ajax Condenser Co., Inc., of Chicago, Ill., has announced the opening of a capacitor factory at 10905 Chandler Blvd., North Hollywood, Calif. The new factory will soon be able to offer to the electronic and electrical industries on the west coast the same complete lines of electrolytic and paper capacitors and noise filter units produced by the Illinois corporation.

Majestic Appoints Vice-Presidents

FRANK J. DIELI has been appointed vice-president and chief engineer of Majestic Radio & Television, Division of The Wilcox-Gay Corp., Brooklyn, N. Y. He heads the engineering and research staffs for Majestic Radio & Television, Garod Radio, and recently assumed charge of engineering for Wilcox-Gay re-

F. J. Dieli

cording products. He joined Garod ten years ago and was made chief engineer in 1950.

The company has also announced the appointment of Robert J. Leykum to vice-president in charge of

R. J. Leykum

manufacturing. He joined Garod in 1935 and prior to his new appointment served as plant superintendent in the company's Brooklyn tv and radio receiver plant.

OTHER NEWS

New Radio Disturbance Warnings

BEGINNING July 1, 1952, the National Bureau of Standards will broadcast new short-wave radio disturbance forecasts via the NBS standard frequency broadcasting station WWV. This new service will replace the radio disturbance warning notices that have been transmitted by WWV since 1946. The broadcasts will tell users of radio transmission paths over the North Atlantic the condition of the ionosphere at the time of the announcement and also how good or bad communication conditions are expected to be for the next 12 hours.

The NBS radio disturbance forecasts, prepared four times daily, will be transmitted in Morse code twice each hour—19½ and 49½ minutes past the hour—on WWV standard frequencies of 2.5, 5, 10, 15, 20, and 25 mc, as was done prior to July 1. As in the past, the notices will include a letter indicating present radio reception conditions. However, the new notices will also contain a digit indicating the expected quality of future reception. As be-

fore, the letters used will be N, U, and W, signifying that radio propagation conditions are normal, unsettled or disturbed, respectively. The digit will be the forecast of expected quality of transmitting conditions on the NBS-CRPL scale of 1 (impossible) to 9 (excellent).

Digit (Forecast)	Propagation Condition	Letter (Current)
1	Impossible	W
2	Very Poor	W
3	Poor	W
4	Fair to Poor	W
5	Fair	U
6	Fair to Good	N
7	Good	N
8	Very Good	N
9	Excellent	N

If, for example, propagation conditions at the time the forecast is made are normal but are expected to be only "fair to poor" within the next 12 hours, the forecast statement would be broadcast as N4 in Morse code, repeated five times; that is, "N4, N4, N4, N4, N4."

The New NBS radio disturbance forecasts refer only to North Atlantic paths, such as Washington to London or New York to Berlin. The forecasters assume that the most suitable radio frequencies for communications are available and in use along these paths. Because of this assumption, their notices must be interpreted on a relative scale in terms of experience on each radio circuit in use. It is impossible to rate conditions on an absolute scale because the varied effects of transmitter power, type of communications traffic and procedure, antennas and receivers prevent an evaluation that will be valid for all systems and all circuits. One purpose of broadcasting both a description and a forecast is to show more clearly whether propagation conditions are expected to deteriorate or improve in the 12-hour period.

For the past 18 months, the NBS Radio Warning Service has been making continuous 24-hour daily studies of the North Atlantic circuits by specialized techniques. The new disturbance information to be transmitted by WWV is one of the results of this investigation. Other radio disturbance forecasts which NBS has supplied regularly for almost ten years are forecasts of propagation conditions 1 to 25 days in advance and daily 24-hour forecasts.

NEW BOOKS

Nomography and Empirical Equations

BY LEE H. JOHNSON, *Tulane University. John Wiley & Sons, Inc., New York*, 1952, 150 *pages*, $3.75.

THIS interesting and useful book is divided into two broad parts: first, the technique of constructing nomographs or alignment charts for equations containing more than two variables, and, second, the technique of determining the mathematical equation which expresses the relations existing between several variables.

The chapter headings show the range of subject matter:— parallel-scale nomographs, Z-charts, parallel and perpendicular index lines, concurrent scales, recurrent variables, combined nomographs, methods of curve fitting, curves of two, three and four constants.

For anyone who uses alignment charts (and who in this field does not?) and who wishes to know how they are made, this is a good way to find out. Not only will the reader learn the techniques but he will learn much about the accuracy of such charts, how to determine the scales, and other necessary facts—and he need not be a mathematician to do it.—K.H.

Electronics For Communication Engineers

BY JOHN MARKUS AND VIN ZELUFF. *McGraw-Hill Book Co., New York*, 1952, 610 *pages*, $10.

THIS is the third of a series of books by these two authors comprising a collection of previously published articles grouped by subject matter. This book is really a second volume of the authors' "Electronics Manual For Radio Engineers." The first volume covered the years 1940-1948.

The current one covers a period of five years. A total of 252 articles, all from ELECTRONICS, are included. Chapters are: (1) Amplifiers; (2) Antennas; (3) Audio; (4) Cathode-Ray Tubes; (5) Components; (6) Electronic Music; (7) Filters; (8) Measurements; (9) Microwaves; (10) Oscillators; (11) Power Supplies; (12) Propagation; (13) Pulses; (14) Receivers; (15)

Transmission Lines; (16) Transmitters. The chapter on electronic music consists of 10 articles; although not strictly in the communications field, this is a subject in which a considerable number of electrical engineers have become interested of late.

In addition to the chapter article index, there are an author index and a comprehensive subject index that lists many features of the contents that may not be apparent from the titles. Some of the articles have been condensed but the issue of ELECTRONICS in which each appeared is given so that reference to the original source is a simple matter. The many drawings, graphs and wiring diagrams (they average several per page), which added so much to the value of the original articles, have been retained. Any references included in the original articles have also been included so that further information is easily obtainable.

This book makes a valuable addition to the communication engineer's library. His text books are the source of basic information while this book supplies the details and practical aspects of the latest applications and practices.—W. C. WHITE, *Research Laboratory, General Electric Co., Schenectady, N. Y.*

Introduction to Electronic Circuits

BY R. FEINBERG. *Longmans, Green and Co., New York, 1952, 163 pages, $3.50.*

THIS book moves at a fairly high rate from the first page on. Maximum use is made of symbols to represent physical and electrical phenomena, and very few words are wasted.

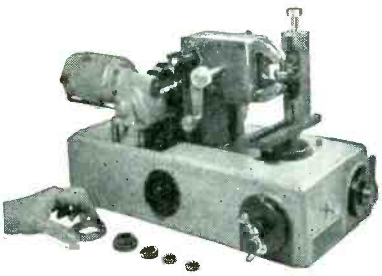
Such a feature should be very appealing to some, but may bring objection from others. The work is complete, but to derive maximum benefit, a great deal of careful analytic reading is required. For the graduate student, this terse writing is usually desirable, but for the second or third year student (for whom the book is intended) it may be difficult to absorb.

Being British, the book naturally

MICO

Precision Apparatus

TOROID COIL



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Flexible machines for your laboratory prototype development work.

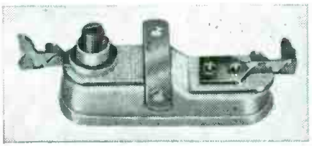
Production machines built for volume manufacturing of specific coils.

MICO INSTRUMENT CO.

76E Trowbridge St., Cambridge, Mass.

Miniature

THERMOSTATS & THERMAL TIMERS

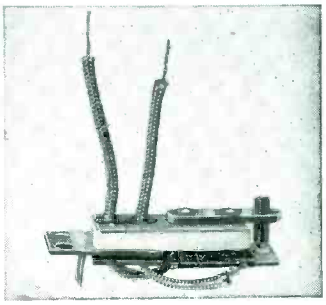


MODEL 13 THERMOSTAT

Designed so precision calibration is unaffected by extreme temperatures. Totally enclosed and mechanically rugged, easily mounted and readily wired. Electrolytic silver contacts.

MODEL PB THERMAL TIMER

Here's a rugged unit with timing ranges of 2 seconds to 3 minutes. Ceramic base provides stability — Bakelite bracket insures full insulation. Made to accepted Ulanet specifications. Clinch bracket secures adjustment screw. Contact rating is 100 watts, 115-230 V. ac.



Your requirements for Timing or Thermostatic Control can readily be met with a Ulanet unit. Please state application and desired operation when writing.

SINCE 1931 ULANET ELECTRIC HEAT CONTROL ENGINEERS

GEORGE ULANET COMPANY

417 MARKET ST., NEWARK 5, N.J.

SINCE 1931 ULANET ELECTRIC HEAT CONTROL ENGINEERS

THE ULANET ORGANIZATION SPECIALIZES IN THE DESIGN AND MANUFACTURE OF

THERMAL UNITS

FOR ALL TYPES OF

TIMING & THERMOSTATIC CONTROLS

It will pay you to compare our units — contact us and you'll save time & money by using engineered Ulanet Controls.

★ ★ ★ ★ ★ ★

Over 85% of the torque wrenches used in industry are

Sturtevant

TORQUE WRENCHES

Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
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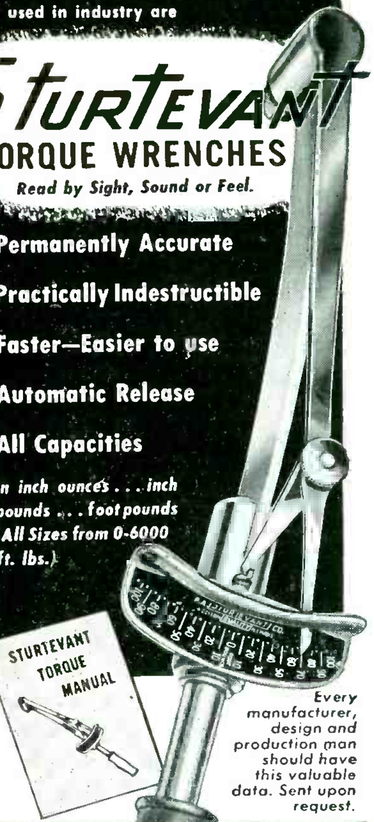
in inch ounces . . . inch pounds . . . foot pounds (All Sizes from 0-6000 ft. lbs.)



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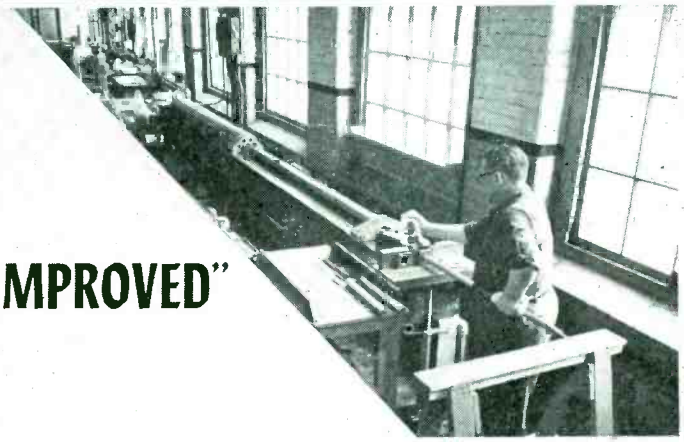

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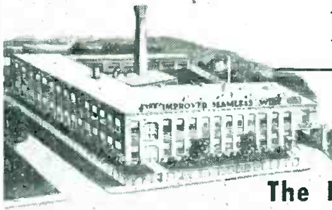

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refers to valves instead of tubes. This difference no longer represents any trouble in the globe-wide information-sharing programs in effect today. Typical tube characteristics are discussed, rather than typical tubes, which makes the material useful to those familiar with British or American types.

For the student who can apply himself, the book is recommended for its direct approach. Analogies used are well chosen and serve fully to explain the concepts that lend themselves to such treatment. The numerous examples given, though brief, are also helpful in understanding ideas.

Main emphasis is directed toward tube construction and internal operation, and typical application of tubes in oscillators, amplifiers and other simple circuits. Some attention is given to industrial tubes and circuits. Since no specific design details (circuit values, tube types, etc.) are given, the book is not recommended for designers, but rather as a text book for a college course on fundamentals of electron tubes.—J.D.F.

Tubes a Modulation Vitesse

BY R. WARNECKE AND P. GUENARD. *Gauthier-Villars, Paris,* 800 *pages,* 1951.

MANY of the older generation of tube engineers believe that too few comprehensive publications exist on many important aspects of vacuum tube theory and design. The need for having assembled in book form technical information which has been accumulated over a period of years is particularly felt at this time when many young engineers are being introduced to the field of electron tube techniques. The book on velocity-modulation tubes by Warnecke and Guenard represents a very complete and systematic presentation of the subject. Both authors are well known for their original contributions in this field and for their skill in presenting technical material. This reviewer believes that their present effort in preparing a book on velocity-modulation tubes will be greatly appreciated both by junior and senior engineers concerned with efficient utilization of engineering talent in

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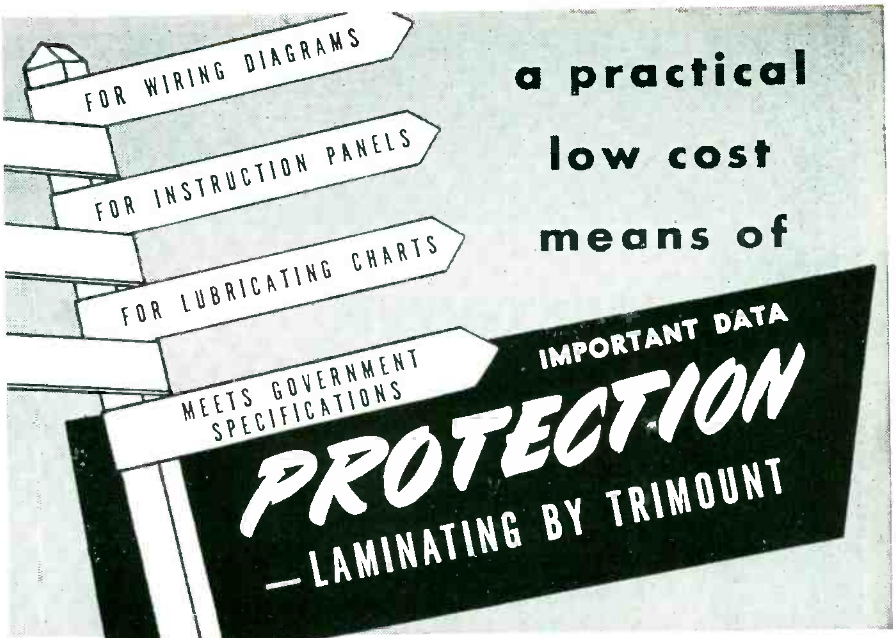

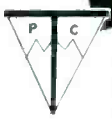

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In the preface the authors state that in reviewing literature on velocity-modulation tubes they were greatly helped by having at their disposal the unpublished lecture notes by Professors Hansen and Feenberg, which contain a summary of most important results of research and development in the United States during the war. The authors' own studies and experiences in the laboratories of the Compagnie Generale de Telegraphie sans Fil naturally served as a guide and influenced the choice of material included in the book.

The book comprises almost 800 pages and is divided into seven parts. After an introduction containing a brief history of the invention of velocity-modulation and allied tubes, the first big chapter is devoted to a review of fundamentals of interaction between electrons and radio-frequency fields and the exposition of the velocity modulation principle involving conversion of electron velocity modulation into current modulation. Bunching and debunching effects, and the influence of finite electron transit time on effectiveness of energy interchange are also discussed.

The second part develops the theory and presents methods of design of cavity resonators suitable for velocity-modulation tubes. The third part describes different types of v-m tubes, such as two and three cavity amplifiers, reflex oscillators and frequency multipliers. The fourth part presents experimental results and technical data on practical tubes. It also describes some special forms of v-m tubes and gives design data on tube components, such as cathodes, guns, cavities, collectors, repellers, etc. The fifth part is devoted to the extension and refinement of the theory and discusses such topics as the behavior of electrons in non-uniform fields, multipactor effect, focusing of electron beams, effects of space charge in drift space, hysteresis effects, tube noise, relativity corrections, scaling methods, and gives examples of design of tubes to specified characteristics. The sixth part is concerned with the problems of frequency limits, bandwidth, modulation, impedance

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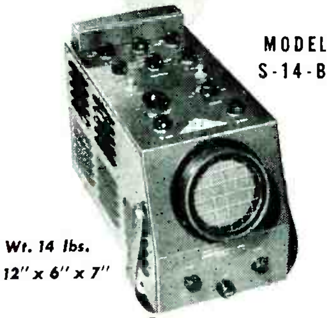

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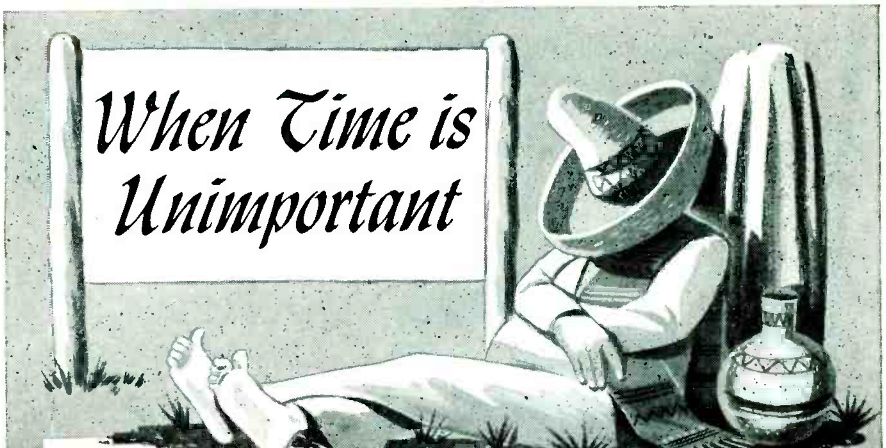

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matching, stability of power supplies, etc. The seventh and final part is devoted to the discussion of future possibilities of velocity-modulation tubes such as achieving greater bandwidth, higher power, lower noise, etc.

The book contains 476 illustrations and a bibliography comprising 385 items including a list of books, review articles, papers on specialized topics, and a list of pertinent patents. This reviewer, who possesses only a limited knowledge of technical French, believes that many tube engineers, even with little familiarity with the language, will be able to follow the presentation and make effective use of the great deal of information contained in the book.—ANDREW V. HAEFF.

Alternating Current Machines

BY GEORGE V. MUELLER. *McGraw-Hill Book Co., New York, N. Y.*, 1952, 502 *pages*, $7.50.

IN SPITE of the inroads of electronic techniques into established areas of electrical engineering, and the creation of new areas, the basic electrical-mechanical energy-conversion process in industry is still accomplished by rotating electrical machinery. Moreover, the use of regulator- and servo-controlled machines is growing, largely through the coordinated application of electronic equipment with electrical machinery. For these reasons, training in the fundamental principles of electrical machinery is a necessity for engineers working in many of the areas now constituting electrical engineering.

There are other aspects of electrical machinery that are important to the electrical engineer and the electrical-engineering student aside from machinery for machinery's sake. For example, the principles of torque and force production through the interaction of electromagnetic fields, and the principles of voltage generation through relative movements of conductors and fields, apply equally well to the conventional rotating machinery as to the wide variety of microphones, recorders, loudspeakers, meter movements, pickup devices, and the like, that serve as the ter-

minating devices of electronic and communications systems. The concepts of sinusoidal space and time waves of B and H that are used to explain the operation of induction motors and synchronous machines apply equally well to the wave picture for open-wire transmission lines and wave guides. Finally, the idea that an equivalent circuit represents a physical device only within specified assumptions is equally important in the analysis of electrical machinery as in the analysis of vacuum-tube circuits.

Professor Mueller's book is designed for fourth-year electrical-engineering students. As such, it covers material on transformers, single-phase and polyphase induction motors, synchronous machines, synchronous converters, and rectifiers.

The section on transformers utilizes 210 out of the 502 pages in the book, and covers not only single-phase and polyphase-connected power transformers, but instrument transformers, constant-voltage transformers, induction regulators, and so forth. The section on polyphase induction motors shows the best balance of content between principles and details and between length of the section to length of the book. In addition to the conventional induction-motor material, the section has interesting discussions of speed control and induction-generator action. The section on synchronous machines includes introductory material on the two-reaction theory. The single-phase-motor material is largely qualitative. The synchronous-converter treatment is conventional, while the rectifier section is short and applied largely to waveforms of the single-phase two-anode rectifier and the three-phase rectifier.

The book is liberally illustrated with oscillograms that provide convincing representations of waveform phenomena. However, they lose their effectiveness where several traces are crowded onto one axis with inadequate labeling. The photographs illustrating equipment types appear up to date and informative. Plots of air-gap flux waves are used relatively little; vector diagrams are apparently the more-

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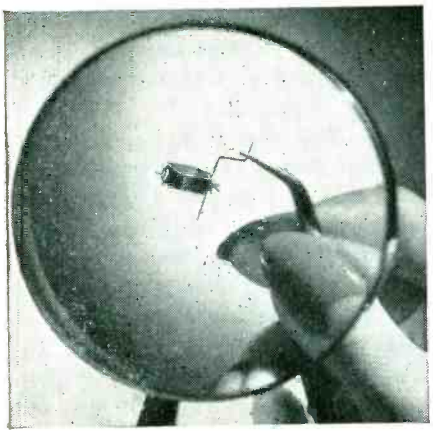

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1902 W. Minnehaha, St. Paul 4, Minn. • *"You Will Enjoy Living In Minnesota"* favored graphical teaching aid. In general, the presentation of physical concepts of machine behavior could be improved.

Examples appear frequently in the text; they serve the triple purpose of illustrating particular points, providing additional subject material, and demonstrating typical sizes and orders of magnitude. As a teaching text, the book has other features. It has a plentiful supply of problems at the end of each chapter. In addition, it has instructions in the appendix for 22 experiments on a-c machinery. The text material is apparently keyed to the experiments to such an extent that parts of the text read like instructions for laboratory work, rather than explanations of particular topics. Nevertheless, this book has advantages for the busy teacher who must be concerned with the combination of class work, problems, and laboratory.—ALEXANDER KUSKO, *Department of Electrical Engineering, Massachusetts Institute of Technology.*

Measurements at Centimeter Wavelength

BY DONALD D. KING, *Johns Hopkins University. Van Nostrand*, 327 *pages*, $5.50, 1952.

THIS is an excellent book for people who have a nodding acquaintance with the properties of centimeter waves. The book is so written that should more theory of microwave propagation be needed, more than adequate references are given in each chapter.

Chapter 1 is introductory, outlining the general scope of the material. It sets the limitations in the use of lumped network elements and ordinary electronic devices at centimeter wavelength.

Chapter 2 discusses methods of transmitting power at centimeter wavelengths. Two-conductor transmission lines and hollow pipes are correlated and normalized transmission formulas are explained. The properties of the more common uniconductor wave guides are completely tabulated. Transmission-line charts are presented along with a discussion about the properties

of each chart and a key as to which chart is the best for a particular type of problems. The physical construction of transmission guides is treated along with methods of suppressing reflections due to physical supports. Matching sections, baluns, switches and attenuators are presented.

Chapter 3 discusses the devices used for converting high frequency power to power at frequencies more amenable to measurement with instruments. Bolometers, thermocouples, load lamps, crystals, electron tubes, barreters and their associated circuitry are described. Methods of coupling these components to lines and guides and ways of calibrating the system as a detector are given. Wattmeters, attenuation and noise measurements terminate the chapter.

Chapter 4 covers the measurement of frequency, wavelength and wave form. Comparison with the harmonics of a known frequency, tuned resonant circuits (lumped and cavities) and measurement of velocity are used for frequency measurements. Methods of panoramic displays are given. The methods of measurement are compared in a table which gives the limitations of each.

Chapter 5 presents the more common centimeter-wave generators. Methods of modulation and stabilization are discussed. Tests on oscillators are outlined. Frequency pulling due to loading is discussed.

Chapter 6 covers impedance measurement by means of lines, bridges and combinations of the two. Standing-wave or resonance ratios, curve width and multiple fixed probes are used on lines. Lumped as well as wave guide bridges are used as impedance comparator devices. Measurement of dielectric properties is accomplished by using wave guides and resonators.

Chapter 7 describes methods of measuring antenna fields. The basic construction of the equipment for making such measurements and its properties are discussed in some detail.

This book fills the need of those who wish to learn the general technique of centimeter-wave measurements without wading through a sea of introductory words and mathematics. The pertinent facts are well presented. No words are wasted. There is no unnecessary mathematical manipulation. Sufficient references are given for the reader who wishes more detail.—CHARLES A. HACHEMEISTER, *Brooklyn Polytechnic Institute.*

THUMBNAIL REVIEWS

CALIBRATION OF COMMERCIAL RADIO FIELD-STRENGTH METERS. By Frank M. Greene, National Bureau of Standards, Circular 517, 5 pages, 10 cents, Government Printing Office, Washington 25, D. C. Describes standards and methods used in calibrating meters in the range 10 kc to 300 mc.

RADIO AMATEUR'S HANDBOOK, 29th Edition. American Radio Relay League, West Hartford, Conn., 1952, $3.00. 784 pages, 93 charts, 459 tube base diagrams, 85 basic formulas. This hardy perennial continues to grow. This new edition containing material published in QST during the past year involves new gear and up-to-date modifications of older radio equipment, plus history, basic theory and a vast quantity of data useful to all practicing radio people.

AN ADHESIVE TAPE-RESISTOR SYSTEM. By B. L. Davis, National Bureau of Standards, Circular 530, 83 pages, 30 cents, 1952, Government Printing Office, Washington 25, D. C. Complete description of NBS development of carbon-film resistor in form of adhesive tape as a useful component in the miniaturization program. Description of ovens, switching equipment, recorder for life tests and data on each of the carbons studied plus sources of supply are included.

TRAITE D'ELECTRICITE THEORIQUE; Vol. 1, Electrostatics. By Marc Jouguet. Gauthier-Villars, Paris; 359 pages, $11.78, 1952. First of what promises to be several volumes of a profound and rigid analysis of all electrical theory.

ELECTRICAL ENGINEERING. Volume 1, Direct Currents. By Chester L. Dawes. McGraw-Hill Book Co., 736 pages, $7.00, 1952. For the beginning student of electrical engineering, a new edition including recent developments in applied electrical science; electrical, magnetic and physical phenomena.

INDUSTRIAL CARBON & GRAPHITE PRODUCTS. A vest pocket handbook giving properties and dimensions of carbon and graphite electrodes of all sorts. National Carbon Company, 30 East 42 St., New York 17, N. Y.

RADIOTELEPHONE LICENSE MANUAL. By Woodrow Smith. Editors and Engineers, Ltd., Santa Barbara, Calif., 1952, 197 pages, $3.75. Answers are given to questions taken from the latest FCC Study Guide for Elements I through IV as preparation for all grades of commercial radiotelephone license. An appendix gives formulas, Q signals, miscellaneous abbreviations and excerpts from laws and regulations. No questions on radiotelegraph operating practice, advanced radiotelegraph, aircraft radiotelegraph or ship radar techniques are included.

SUBCONTRACTING FOR DEFENSE. Chamber of Commerce of the United States, Washington, 6, D. C., 36 pages, 1952, 50¢. A how-to pamphlet on getting subcontract orders on the vast number of items which go into defense end-products.

CORRECTION. By error, the price of "High Frequency Transmission Lines" by Willis Jackson, published by John Wiley & Sons, Inc., was stated in May 1952 ELECTRONICS to be $0.75 whereas the correct price is $1.75.

BACKTALK

Networks

DEAR SIRS:

IN the January 1952 issue of ELECTRONICS appeared an article by Mr. Peter G. Sulzer (p 95, "Single-Band Audio Generator") in which reference is made to an R-C network (reference 8, p 97) that "... has been described in the German and Japanese literature, but suitable reference is not available".

On page 66 of the January 1945 issue of the *Proceedings of the IRE*, I give myself credit for having developed the circuit (network E, Fig. 1 in Mr. Sulzer's paper).

As the development of this network is a rather simple matter it is possible that someone else found the circuit before I did. Such a thing, I understand, happened in the case of the Ginzton and Hollingsworth network (Sulzer's reference 3).

On the other hand, the Sulzer network can be readily shown to be an unsymmetrical twin-T network which may be transformed into an equivalent pi. Examination of the resulting impedance equations do not seem to throw any light as to the manner in which the network meets these conditions. Use of the approximations (according to Mr. Sulzer's circuit constants) $R >> R_3$; $R_1 >> R_3$; $R_1 = R_2$ does not give any additional information. The question arises as to the desirability of a network that does not lend itself to design by means of pencil and paper.

BRAULIO DUENO
Physics Department
Universidad de Puerto Rico
Mayaguez, Puerto Rico

(Editor's Note: Space limitations forced us to omit Dueno's elegant mathematical verification of his contentions as outlined above.)

Audio Generator

DEAR SIRS:

SERGEANT H. B. Kendall, of the Royal Canadian Air Force Station at Clinton, Ontario, has called to my attention an error that appeared in one of the figures in my recent article, "Single-Band Audio Generator" (ELECTRONICS, p 95, Jan. 1952).

In Fig. 2C and 2D the vestor E_B should be drawn downward and

to the right, and the markings of E_c and E_R should be interchanged. These changes do not alter the explanation in the text.

PETER G. SULZER

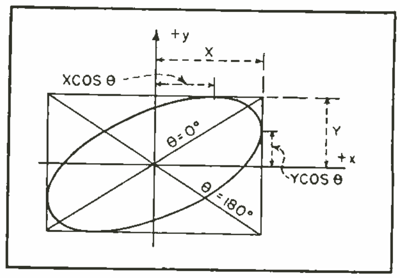
Ionospheric Research Section
Central Radio Propagation Laboratory
National Bureau of Standards
Washington, D. C.

More on Phase

DEAR SIRS:

THE ARTICLE by John L. Glaser entitled, "Accurate Phase Difference by Lissajous Figures" (ELECTRONICS, p 206, Mar. 1952) leads me to mention still another method of determining phase angle between two sinusoidal voltages of the same frequency. The method is so obvious that it might be overlooked. The accuracy possible with this method is particularly good for values of phase angle around 90 degrees, so that it might very well supplement the methods mentioned in Glaser's article.

The horizontal and vertical amplifications are adjusted so that the ellipse is tangent to a pair of vertical lines distant $2X$ apart and to



Additional method for measuring phase between sinusoidal voltages with maximum accuracy around 90 degrees

a pair of horizontal lines distant $2Y$ apart as shown in the accompanying diagram. Then the distances from the coordinate axes to the points of tangency are $X \cos \theta$ and $Y \cos \theta$ as shown.

If the positive x and y directions are to the right and up as shown then θ is the angle by which the X signal laps the Y signal. For θ equals zero the ellipse degenerates into a straight line in the first and third quadrants. With increasing θ the axes of the ellipse rotate clockwise. At θ equals 90 degrees they are horizontal and vertical. With increasing θ the clockwise rotation continues until at θ equals 180 degrees the ellipse becomes a straight line in the fourth and second quadrants.

The average of four values of cos θ may be used for any ellipse to improve the accuracy in determining θ.

Justification for the method is easily provided by considering the projections of two rotating vectors of lengths *Y* and *X* separated by phase angle θ. When one is projected true length, say *X*, the projection of the other is *Y* cos θ. This gives one point of tangency on the ellipse. Vice versa for the other tangent point.

E. E. WEIBEL
Professor of Mechanical Engineering
University of Colorado
Boulder, Colorado

Military Justice

DEAR SIRS:

IN THE March issue of ELECTRONICS there appeared some paragraphs (*Industry Report*, p 16) entitled "What Happens to Drafted Engineers?" There are some glaring errors, or rather omissions in this piece that I feel bear illumination because of your widespread circulation throughout the industry and the possible misconceptions that might be formed, and because I have yet to read an article on engineers in service in any publication which accurately portrays the situation.

The picture you paint of OCS is quite accurate as far as it goes. But it implies that OCS grads are utilized in technical endeavors. To quote your context, ". . . receive assignments in line with their civilian occupations." Nothing could be further from fact. Upon receiving his commission, the new 2nd lieutenant is placed upon the nearest boat to the Far East. He might delay his departure thirteen weeks by undertaking more extensive training in a particular field (radar, radio, wire, photo). Or he might possibly be sent to Germany. But in any case, he winds up as an *administrative officer*, usually in a signal company or service company, or if he's exceptionally lucky, in a signal repair depot. I have yet to hear of the need for an engineer's talents in any of these places.

Incidentally, if your engineers have college degrees, they are eligible for direct commissions. This has the advantage of eliminating twenty-two weeks of OCS, but the ultimate assignment is still the same—administration.

On the other hand, what's happening to the EM (enlisted man) who was an engineer in civilian life? Believe it or not, he is getting a break. A great many of the electronics people are being sent to Ft. Monmouth, New Jersey, where the majority are working in SCEL (Signal Corps Engineering Laboratories) on research and development projects. But lo, the poor officer—he sees SCEL only on guided tours; guides, by the way, are EM's.

This, gentlemen, is the picture as seen through the eyes of a young engineer who is a mere corporal (said rank attained on the basis of military proficiency—not technical ability). By all means check my statements. I hope this letter will cause you to do so. Print it in *Backtalk* if you think it worthy but don't advise unsuspecting people to get into Signal Corps OCS. You're doing them a terrible injustice.

CORPORAL
Signal Corps

(Editor's Note: The above letter expresses a viewpoint different from that of most service personnel in letters to this office. As far as we can determine, the true officer experience lies somewhere between that outlined in our original article and the situation described above. Since we have, in the Corporal's letter, documentary proof that there is at least one enlisted man who is satisfied that his civilian talents are being used, we must conclude that progress is being made. May the trend continue.)

Transistor Supply Increases

IN the item entitled "Transistor Supply Increases," appearing on page 10 of the June issue, the table containing production and delivery figures was based upon information presented by Lt. Col. William F. Starr *but also contained other data gathered by the Editors.* The text of the item, as well, contained data gathered from several sources.

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See page 363

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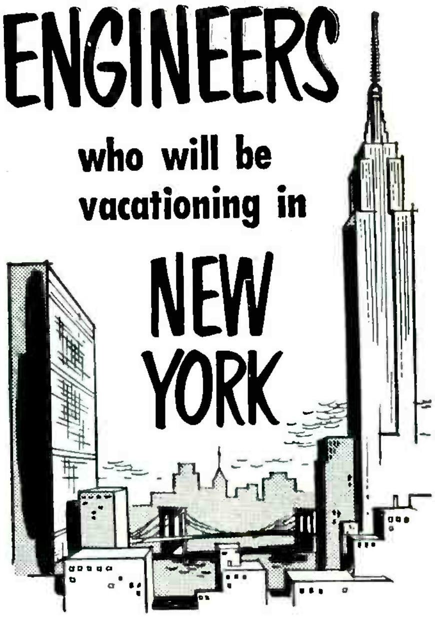

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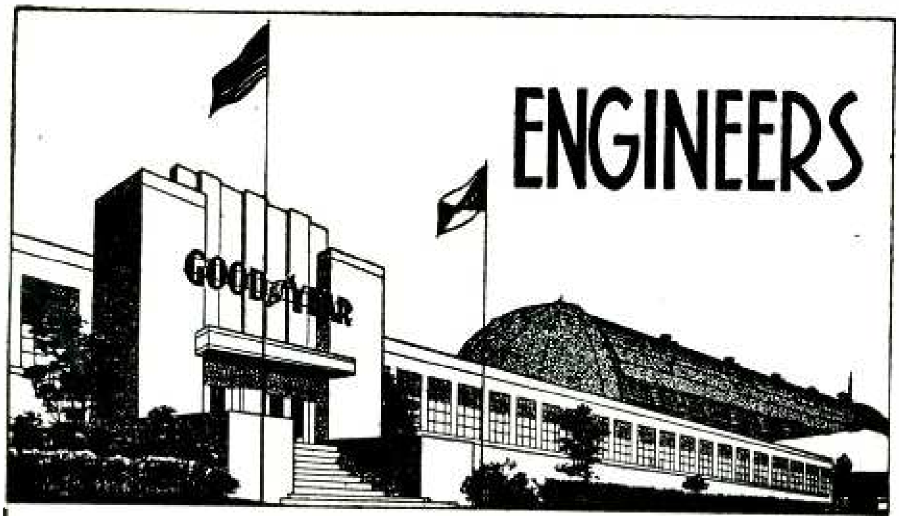

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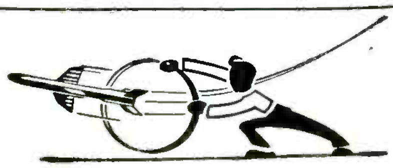

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SEE PAGE 342

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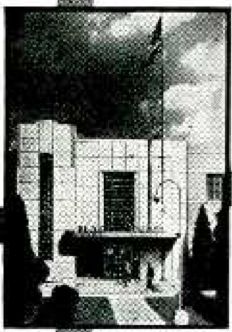

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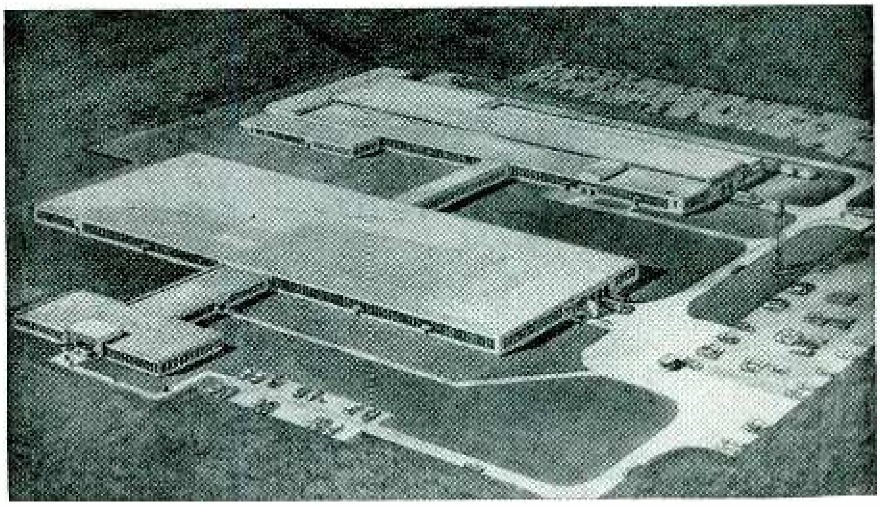

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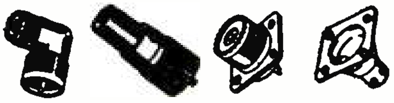
5-5	400	1.65	.5	1500	1.25	.1	7500	2.85	.001	50KV	24.50
1	600	.55	3	1500	2.50	.5	7500	8.95	.025	50KV	42.50
2	600	.69	4	1500	2.95	1-1	7500	22.50	.2	50KV	85.00
2	600R'd	.69	.1-.5	2000	.95	.075-.075	8KV	6.50	.25	50KV	95.00
2-2	600R'd	1.65	.25	2000	1.50	.5	10	16.50	7.5	220VAC	1.95
3	600	.95	.3	2000	1.30	1	10KV	29.50	1-3	330VAC	1.95
4	600	1.65	1	2000	1.95	.1	12KV	8.95	10	330VAC	3.95
4	600R'd	1.65	3	2000	3.75	1	15KV	37.50	12.75	330VAC	4.10
5	600	1.75	12	2000	8.95	.045	16KV	4.70	15	330VAC	4.50
6	600	1.85	1	2500	2.75	.05	16KV	4.95	5	440VAC	3.10
8	600R'd	1.85	1-1	2500	3.85	.075	16KV	8.95	2.9	660VAC	3.50
8-8	600	1.95	32	2500	15.80	.25	20KV	19.95	7	660VAC	4.25
4-4-4	600	2.50	.5	3000	2.40	1	20KV	54.00	8	660VAC	4.50
4 x 3	600	2.50	1	3000	3.40						
10	600	3.25	2	3000	4.50						
1	1000	.65	.03	4000	1.25						
2	1000	.90	3 x .2	4000	2.95						
2	1000R'd	.95	2	4000	6.95						
3.5-.5	1000	1.85	.1	5000	1.60						
4	1000	1.95	.2	5000	2.50						
6	1000	2.50	1	5000	4.88						
8	1000	3.25	2	5000	18.50						
1	1200	.85	.01-.03	6000	1.65						
1-1-1	1200	1.85	.1	7000R'd	1.79						

OILMITES

MFD	VDC	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

COAXIAL CONNECTORS



83-1AC	$ .42	83-1RTY	$.65	83-22R	$ .68
83-1AP	.30	83-1SP	.50	83-22SP	.90
83-1F	1.20	83-1SPN	.56	83-22T	1.95
83-1H	.12	83-1T	1.30	83-168	.15
83-1HP	.25	83-2AP	1.95	83-185	.15
83-1J	.75	83-22AP	1.40	83-765	.24
83-1R	.40	83-22F	2.10	83-776	.85
		83-22J	1.50		

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS
IN STOCK
UHF—N—PULSE—BN—BNC

UG-7/AP	$6.30	UG-23C/U	$1.90	UG-58A/U	$1.15	UG-106/U	$ .15	UG-191/AP	$.80	UG-262/U	$1.20
UG-12/U	.95	UG-24/U	1.30	UG-59A/U	2.25	UG-108/U	2.60	MX-195/U	.75	UG-273/U	2.25
UG-15/U	1.50	UG-25/U	1.35	UG-83/U	2.25	UG-109/U	2.60	UG-197/U	2.80	UG-274/U	2.75
UG-18/U	1.25	UG-27/U	1.30	UG-85/U	1.75	UG-146/U	2.55	UG-201/U	2.25	UG-275/U	5.50
UG-19/U	1.80	UG-27A/U	2.95	UG-86/U	2.50	CW-159/U	.60	UG-203/U	.85	UG-276/U	2.75
UG-21/U	.95	UG-28A/U	3.75	UG-87/U	1.60	UG-166/U	32.50	UG-206/U	1.80	UG-290/U	1.20
UG-21A/U	1.50	UG-29/U	1.55	UG-88/U	1.10	UG-167/U	5.85	UG-224/U	1.20	UG-291/U	1.35
UG-21B/U	1.35	UG-30/U	2.30	UG-89/U	1.35	UG-171/U	2.80	UG-236/U	3.85	UG-306/U	2.95
UG-22/U	1.35	UG-34/U	16.50	UG-90/U	1.60	UG-173/U	.40	UG-245/U	2.30	UG-414/U	3.25
UG-22B/U	1.65	UG-36/U	17.50	UG-98/U	1.85	UG-175/U	.15	UG-254/U	2.75	UG-625/U	1.35
UG-22C/U	1.65	UG-37/U	17.50	UG-102/U	.90	UG-176/U	.15	UG-255/U	2.45		
UG-23/U	1.20	UG-57/U	2.30	UG-103/U	.68	UG-177/U	.24	UG-260/U	1.20		
UG-23B/U	1.90	UG-58/U	.80	UG-104/U	1.40	UG-185/U	1.35	UG-261/U	1.20		

QUOTATIONS UPON REQUEST ON ANY CONNECTORS NOT LISTED HERE

M-358	MC-277	PL-259A	PL-325				
M-359	MC-320	PL-274	SO-239	93-C	49120	D-163950	ES-685696-5
M-359A	PL-258	PL-284	SO-264	93-M	49121A	D-166132	ES-689172-1
M-360	PL-259	PL-293	TM-201				

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-13/U	$216.00	RG-26/U	$475.00	RG-57/U	$325.00
RG-6/U	180.00	RG-17/U	650.00	RG-29/U	50.00	RG-58/U	60.00
RG-7/U	85.00	RG-18/U	900.00	RG-34/U	300.00	RG-58A/U	70.00
RG-8/U	100.00	RG-19/U	1250.00	RG-35/U	900.00	RG-59/U	60.00
RG-9/U	250.00	RG-20/U	1450.00	RG-54A/U	97.00	RG-62/U	75.00
RG-9A/U	275.00	RG-21/U	220.00	RG-55/U	110.00	RG-77/U	100.00
RG-10/U	240.00	RG-22/U	150.00				
RG-11/U	100.00	RG-22A/U	285.00				
RG-12/U	240.00	RG-24/U	675.00				

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

2 φ LOW INERTIA SERVO MOTORS

KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50
PIONEER—10047-2-A 26 volt 400 cycle with 40:1 reduction gear $10.50
PIONEER—CK-2 26 volt 400 cycle....$15.00
PIONEER—CK-14 115 volt 400 cycle—includes damping signal generator (antosyn)....$47.50

HIGH VOLTAGE TRANSFORMERS

G.E.—Pri. 115V 60 cy. Sec. 6250V 80 MA—12.5 KV insulation $18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Insulation....$18.50

ANTENNAS

AT-4/ARN-1 .... $8.25
AT-38A/APT (70 to 400MC) 13.70
AT-49/APR-4 (300 to 3300MC) 13.70
AN-65A (P/O SCR-521) 1.50
AN-66A (P/O SCR-521) 1.75
AIA-3CM conical scan 125.00
ASB Yagi—5 element 400 to 560MC 7.00
ASB Yagi—Double stacked 6 element 12.70
ASA Yagi—Double stacked 370 to 430MC 29.40

RELAYS

Sigma type 4AH—2000Ω 4 ma DC coil—SPDT contacts—hermetically sealed 5 pin plug-in base.$3.30
Sigma type 4R—8000Ω 1 ma DC coil—SPDT contacts—enclosed type 5 pin plug-in base....$4.25
Stevens Arnold type 171 Millisec relay—900 ohm coil SPST NO contacts....$5.50
Cutler-Hammer and Square D type B-7A contactor—24 VDC coil—SPST NO 200 Amp contacts...$4.75
Price Bros. type 161-M—220 VAC contactor—SPST NO double bk 30A contacts....$3.25
G.E. CR5181-1A6—115 V 60 cy. AC contactor—4PST 30 Amp contacts plus two auxiliary SPDT contacts $14.50
RBM—115 V 60 cy. AC coil—DPDT 3 amp Contacts....$3.20

METERS

1 MA DC 3½" R Dejur Mod 310 (0-4KV scale).$5.75
500 Microamps, DC—2½" round—Sun.... 4.30
1ma. DC Fan type—4" scale (rem. from equipt). 3.95
500 ma. DC 2½" R.—General Electric.... 2.95
2 amp. RF 2½" Sq.—Simpson.... 3.15
5 amp. AC 4½" R.—JBT.... 4.11
30 V DC 2½" R.—General Electric.... 3.95
3 amp. RF 3½" R.—Weston.... 6.00

OIL-FILLED 35 KV AND 50 KV ISOLATION TRANSFORMERS

Pri. 460V 60 cy. Sec. 115V 200 VA Insulated for 50KV DC—G. E. Form EIR—36" H x 13" D......$125.00
Pri 115V 60 cy. Sec. 115V 250 VA Insulated for 35 KV DC—G. E. Form EIR—29" H x 12½" D.$125.00

CRYSTAL DIODES

1N21	$1.19	1N27	$1.79	1N41	$11.25
1N21A	1.69	1N31	8.10	1N42	18.75
1N21B	3.50	1N34	.66	1N43	1.55
1N22	1.09	1N34A	.95	1N45	.94
1N23	1.95	1N38	1.70	1N52	1.05
1N23A	3.25	1N39	6.25	1N55	3.15
1N23B	4.25	1N40	10.60	1N60	.55

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

$1.25 each

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets....$9.25

GENERATORS AND INVERTERS

Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output-AC 115V 10.4A 800 to 1400cy. 1φ; DC 30 Volts 60 Amps. Brand new....$38.50
Eclipse-Pioneer type 1235-1A. Output-30 Volts DC 15 Amps. Brand New-Original Packing.....$15.50
PE-218 Inverters-28 VDC to 115 VAC 400 cy 1500 VA. (New) $49.50
G. E. 5D21NJ3A Inverter-24 VDC to 115 VAC 400 cy 485 VA (New)....$32.50
Pioneer Type 800-1B Inverter-28VDC to 120V 800 cy 7 amp AC (used)....$22.65
G. E. Inverter-28 VDC to 120 VAC 800 cy 750 VA 1φ $39.50
ATR Inverter 6VDC to 110 VAC 60 cy 75W....$22.95
PU-7/AP Inverter-28 VDC to 115 VAC 400 cy 2500 VA (used) $75.00
Eclipse-Pioneer type 12121A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3φ 400 cy 250VA 0.7 PF — (New) $225.00

TEST EQUIPMENT

- Gen. Radio 475B Frequency Monitor......*$200.00
- Gen. Radio 681A Freq. Deviation Meter....*$87.50
- I-72K Signal Generator....$48.50
- C-D Quietone Filter Type IF-16 110/220V AC/DC 20 Amps....*$9.00
- TS-143/CPN Oscilloscope *$95.00
- Dumont 175A Oscilloscope....*$225.00
- Gen. Radio 757-P1 Power Supply....*$27.00
- I-130A Signal Generator....*$85.00
- A.W. Barber Labs. VM-25 VTVM....*$86.00
- TS-10A/APN Delay Line Test Set....$45.00
- TS-19/APQ-5 Calibrator $75.00
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars....$39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC....$11.75
- 3 CM Pickup Horn Antenna AT-48/UP.....$9.95
- I-138A Signal Generator—10 cm....*$185.00
- BC-221 Frequency meter....*$125.00
- BC-221 Freq. Meter (late models)....*$125.00
- CW—60ABM Frequency Meter—10 CM.....$97.50
- Weston Model 1 D.C. Milliameter 150/1500 MA with leather case....$75.00

All items New Except Where noted * (Exc. Used Condition.)

MISCELLANEOUS EQUIPMENT

I-82F Selsyn Indicator.... $6.95
SCR-515 compl. w/dynamotor, control box.... 69.50
Amperex 1B98 Gamma Counter.... 9.87
Powerstat 1226—115/230V Input—0-270V out. @ 9 amp. 37.00
EIMAC 35T Ionization Gauge.... 5.95
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
FL-8 1020 cycle filter.... 2.95
RM-29 remote control unit.... 8.95
RM-14 remote control unit.... 8.95
RTA-1B 12/24 V dynamotor.... 40.00
BC-1206-CM2 Receiver 12.95
ASB-4 Radar equip. Complete.... 69.75
RCA AVR-15 Beacon Recvr.... 18.50
Navy DP-14 Direction Finder complete.... 385.00
CU-24/ART-13 Antenna Loading Cond.... 4.95
T-85/APT-5 300-1600 MC Transmitter.... 175.00
BC-1016 Tape Recorder 350.00
AN/APA-30 .... 375.00
BC-910A Oscilloscope 147.50
BC-1068 Receiver 57.50
ATJ and ATK TV Block Equip....Quote

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7350
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse 132-AW	W.E. D-163325
Westinghouse 139DW2F	W.E. D-164661
Westinghouse 187AW2F	W.E. KS-9563

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sinewave modulated signals received by AN-APR-1, AN/APR-2, AN/APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 Microsec. 200 PPS 67 ohms imped, 3 sections....$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 Microsec. 200 PPS, 67 ohms imped, 3 sections....$6.75
7.5 E4-16-60-67P, 7.5 KV, "E" Circuit 4 sections. 16 microsec, 60 PPS, 67 ohms imped....$8.25
15 E4-.91-400-50P, 15 KV, "E" Circuit .91 microsec. 400 PPS, 50 ohms imped. 4 sections....$16.50
15-A-1-400-50P, 15 KV, "A" Circuit, 1 microsec. 400 PPS, 50 ohms imped....$37.50

Terms 20% cash with order, balance C. O. D unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

LECTRONIC RESEARCH LABORATORIES
715-19 ARCH ST. PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

GUARANTEED BRAND NEW

LECTRONIC RESEARCH
TUBE SPECIALS

STANDARD BRANDS ONLY

Receiving Tubes	
OOA	$1.50
O1A	.67
OZ4	.74
OZ4A	.90
1A3	.71
1A5GT	.72
1A6	.72
1A7GT	.91
1AB5	.89
1B3GT	.99
1B4P	1.17
1C5GT	.85
1C6	.69
1C7G	.69
1D5GP	.69
1D7G	.69
1D8GT	.71
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.71
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.74
1H6G	.99
1H6GT	1.01
1J5G	.74
1J6G	.95
1L4	.69
1LA4	.87
1LA6	1.10
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.91
1N5GT	.85
1N6G	.97
1P5GT	.69
1Q5GT	.99
1R4	.69
1R5	.89
1S4	.71
1S5	.81
1T4	.81
1T5GT	.71
1U4	.86
1U5	.81
1V	.69
1X2	1.09
2A3	1.28
2A5	.79
2A7	.89
2B7	.79
2E5	.94
2X2	.89
2X2A	1.85
3A4	.65
3A5	1.89
3A8GT	2.25
3B7	.57
3C6	1.15
3D6	.57
3LF4	.91
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.87
5AZ4	.69
5R4GY	1.59
5T4	1.91
5U4G	.69
5V4G	1.07
5W4	.82
5X4G	.87
5Y3GT	.59
5Y4G	.71
5Z3	.87
5Z4	1.11
6A4	1.35
6A6	1.17
6A7	1.05
6A8	1.08
6AB4	.99
6AB7	1.05
6AC5GT	1.19
6AC7	1.11
6AC7W	3.25
6AD6G	.98
6AD7G	1.31
6AE6G	.89
6AF6G	.89
6AG5	.87

6AG7	1.59
6AH6	1.39
6AJ5	2.50
6AK5	1.35
WE-6AK5	2.85
6AK5W	3.05
6AK6	.99
6AL5	.69
6AL5W	2.90
6AQ5	.89
6AQ6	.79
6AR5	.79
6AS5	.99
6AS6	3.30
6AS7G	4.53
6AT6	.63
6AU5GT	1.21
6AU6	.69
6AV6	.63
6B4G	1.60
6B5	1.20
6B7	.97
6B8	.99
6B8G	.85
6BA6	.72
6BA7	1.20
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.99
6BE6	.72
6BF5	1.10
6BF6	.83
6BG6G	1.92
6BH6	.99
6BJ6	.99
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.65
6C5	.75
6CB6	.89
6C6	.88
6C8G	.96
6CD6G	2.40
6D6	.88
6D8G	.83
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.99
6F7	.85
6F8G	.91
6G6G	1.06
6H6	.83
6H6GT	.83
6J5	.75
6J5G	.64
6J5GT	.64
6J6	1.09
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.83
6K7	.83
6K7G	.88
6K8	1.22
6K8GT	.96
6L5G	1.06
6L6	1.87
6L6G	1.79
6L6GA	1.59
6L7	1.08
6L7G	.95
6N7	1.19
6N7GT	1.10
6P5GT	.96
6Q7	.99
6Q7G	.89
6R7	.99
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.84
6SA7GT	.74
6SB7Y	1.05
6SC7	1.20
6SC7GT	1.05
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.69
6SG7	.91
6SH7	.89
6SH7GT	.89
6SJ7	.89
6SJ7GT	.89

6SK7	.89
6SK7GT	.89
6SL7GT	.96
6SN7GT	.89
6SN7WGT	2.30
6SQ7	.75
6SQ7GT	.75
6SR7	.81
6SS7	.99
6ST7	1.25
6T7G	1.09
6T8	1.11
6U5	1.19
6U7G	.88
6V6	1.60
6V6G	.89
6V6GT	.79
6W4GT	.72
6W6GT	.99
6X4	.59
6X5GT	.59
6Y6G	.99
6ZY5G	.89
7A4	.79
7A5	.88
7A6	.83
7A7	.83
7A8	.83
7AD7	1.44
7AH7	1.08
7B4	.83
7B5	.83
7B6	.83
7B7	.83
7B8	.89
7C4	.69
7C5	.83
7C7	.83
7E5	1.20
7E6	.58
7E7	.83
7F7	.99
7F8	1.59
7G7	1.32
7H7	.83
7J7	1.32
7K7	1.32
7L7	.97
7N7	.97
7Q7	.83
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.89
10	.45
12A	.65
12A6	.71
12A6GT	.69
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.89
12AT6	.59
12AT7	1.15
12AU6	.79
12AU7	.95
12AV6	.63
12AW6	1.20
12AX7	1.08
12BA6	.72
12BA7	.95
12BD6	.99
12BE6	.70
12C8	.77
12F5GT	.79
12H6	.69
12J5GT	.69
12K8	.83
12Q7GT	.67
12SA7	.89
12SA7GT	.89
12SF5	.79
12SF5GT	.79
12SF7	.79
12SG7	.99
12SH7	.73
12SJ7	.79
12SJ7GT	.89
12SK7	.81
12SL7GT	1.03
12SN7GT	.99
12SQ7GT	.79
12SR7	.89
12SR7GT	.89
12X3	1.19
12Z3	.89
14A4	.97

14A7	.97
14B6	.93
14B8	1.09
14C5	1.29
14C7	1.15
14E6	1.09
14E7	1.29
14F7	.93
14H7	.93
14J7	.93
14N7	.93
14R7	.93
14W7	.93
14X7	.93
19	.89
19T8	1.16
22	1.16
24A	.79
25A6	1.16
25L6GT	.89
25Z5	.99
26	.79
27	.69
28D7	1.75
30	.72
30 Spec.	.48
31	.62
32	.99
32L7GT	.87
33	.99
34	.99
35/51	.79
35A5	.89
35B5	.87
35L6GT	.81
35W4	.55
35Y4	.81
35Z4GT	.69
35Z5GT	.59
36	.69
37	.69
38	.69
39/44	.59
41	.71
42	.89
43	.89
45	.89
45Z5GT	.79
46	.81
47	.99
48	1.60
49	1.19
50	1.41
50A5	.91
50B5	.88
50C5	.88
50L6GT	.79
50Y6GT	.92
53	.95
55	.99
BK55B	.40
L55B	.32
56	.69
57	.89
58	.89
59	1.24
70L7GT	.91
71A	.79
75	.79
76	.69
77	.69
78	.79
79	.89
80	.65
81	1.41
82	1.19
83	1.11
83V	1.45
84/6Z4	.79
85	.79
89Y	.55
117L7GT	1.89
117P7GT	1.89
117Z3	.74
117Z6GT	.97
FM-1000	1.59
Cathode Ray Tubes	
2AP1	$9.75
2AP5	9.75
3AP1	10.25
3AP4	10.25
3BP1	7.95
3CP1	2.25
3DP1	4.85
3DP1A	6.75
3EP1	4.95

3FP7	4.95
3FP7A	6.95
3GP1	4.95
3HP7	4.91
4AP10	4.75
5AP1	5.95
5AP4	4.75
5BP1	5.75
5BP4	5.75
5CP1	4.95
5CP7	9.50
5FP7	4.95
5HP1	5.75
5HP4	5.75
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	19.75
5LP5	19.75
5MP1	10.65
7BP1	8.75
7BP7	7.95
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	12.85
9LP7	9.95
10BP4	18.50
10FP4	24.50
12DP7	16.50
12GP7	16.50
12HP7	16.50
902P1	9.95
905	4.45
Photo Cells	
1P23	$4.10
1P24	1.27
918	1.65
919	1.95
923	1.35
927	1.85
931A	6.95
1645	1.95
Thyratrons & Ignitrons	
OA4G	$1.32
EL-C1A	4.75
2A4G	1.25
2B4	2.10
2C33	4.95
2D21	1.55
3C23	9.95
3C31/EL-C1B	3.95
3C45	17.50
4C35	28.75
EL-C5B	9.95
5C22	53.45
C6A	6.75
C6J	9.95
FG-17/5557	5.25
FG-33	17.50
FG-41	122.50
FG-67	14.80
FG-81A	4.95
91	7.85
FG-95/5560	25.00
FG-104/5561	24.60
FG-105	19.50
FG-166	95.00
FG-172	39.50
FG-178	14.50
RX-233A	4.95
FG-235A/5552	94.50
FG-271/5551	62.50
393A	8.60
394A	4.77
GL-415/5550	39.50
KU-610	12.50
KU-623	39.50
KU-628	22.25
KU-634	39.50
WL-652/5551	62.50
WL-654/659	82.00
WL-672	22.00
WL-677	39.50
WL-681/5550	39.50
722A	3.75
884	1.85

885	1.90
1665	1.80
1904	14.80
2050	1.80
2051	1.15
5545	32.50
Transmitting & Special Purpose Tubes	
OA2	$1.30
OA3	1.51
OB2	1.50
OB3	1.29
OC3	1.20
OD3	1.15
1B21A	2.85
1B22	3.25
1B23	9.95
1B24 (West)	12.95
1B24 (Sylv)	18.95
1B26	3.73
1B27	19.50
1B29	2.90
1B32	3.95
1B35	12.50
1B36	12.50
1B38	32.50
1B41	47.50
1B42	9.80
1B54	32.50
1H20	.88
1S21	9.50
1Z2	3.75
2B22	2.20
2C21	.75
2C22	.75
2C26	.49
2C26A	.49
2C34	.49
2C39	22.00
2C40	16.25
2C42	26.50
2C43	22.50
2C44	1.50
2C46	29.50
2C51	5.75
2E22	1.85
2E24	4.10
2J21A	9.95
2J22	9.95
2J26	26.50
2J27	24.50
2J31	39.50
2J32	42.50
2J33	39.50
2J34	39.50
2J36	85.00
2J37	13.70
2J38	17.50
2J39	49.50
2J40	39.50
2J41	175.00
2J48	27.50
2J49	65.00
2J50	39.50
2JB51	2.50
2J55	87.50
2J56	150.00
2J61	45.20
2K23	37.50
2K25	33.50
2K26	107.15
2K28	34.50
2K29	26.00
2K33	295.00
2K45	145.00
2K54	135.00
2K55	135.00
2X2A	1.85
3B22/EL-1C	2.95
3B23	4.75
3B24	5.25
3B24W	7.95
3B25	4.50
3B26	3.75
3B27	3.95
3C24	1.85
3C27	6.95
3D21	1.98
3D21A	2.25
3E29	14.50
3J31	95.00
4-125A	29.50
4A1	1.18
4B22/EL-5B	8.95

4B24	5.75
4B25/EL-6CF	8.95
4E27	17.25
4J36	150.00
4J38	120.00
4J50	375.00
4J52	400.00
5D21	26.50
5J23	24.50
5J29	18.50
6-8B	.85
6AN5	5.95
6AR6	3.35
6C21	29.50
6C24	52.50
6J4	7.95
7-7-11	1.19
10T1	.88
10Y	.45
13-4	.80
15E	2.35
15R	.95
REL-21	2.25
24G	1.85
HK-24	3.95
RK-25	3.82
FG-32/5558	6.75
RK-34	.49
35T	4.95
35T Ion gauge	5.95
35TG	4.95
REL-36	.78
RK-47	4.92
EF-50	.79
VT-52	.65
53A	5.60
RK-59	2.44
RK-60	1.95
VT-62(Br)	1.15
RK-63	22.50
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	3.50
VR-75/OA3	1.51
75T	5.80
VR-78	.64
VR-90/OB3	1.29
VT-98 (Br)	65.00
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
WE-102F	2.85
VR-105/OC3	1.20
WE-113A	1.32
HY-114	.75
WE-117A	.95
F-123A	8.95
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150/OD3	1.15
FG-190	12.15
HF-200	16.50
203A	7.40
203B	6.33
204A	49.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
WE-244A	5.20
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
250TH	22.50
250TL	22.50
WE-252A	5.65
WE-254A	5.90

WE-257A	3.77
WE-274A	5.50
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-286A	7.90
WE-294A	5.75
304TH	9.75
304TL	9.75
307A	5.50
WE-309A	6.45
WE-310A	7.50
WE-313C	4.15
316A	.89
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
361A	4.75
368A	6.95
371A	.95
371B	.95
388A	2.95
WE-399A	4.70
417A	16.95
434A	17.50
446	1.95
446A	1.95
446B	2.25
450TH	42.50
450TL	42.50
451	1.39
471A/1B21A	2.75
SS-501	12.50
503AX	1.65
506AX	1.47
507AX	1.47
527	12.25
530	17.20
531	8.25
532A	3.95
WL-533	65.00
559	2.20
561	3.50
HY615	.49
WL670A	8.70
700A	24.50
700B	24.50
700C	24.50
700D	24.50
702A	2.95
702B	4.25
703A	6.95
704A	.95
705A	2.75
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	9.95
707B	22.50
708A	4.85
709A	4.87
710A	1.70
713A	1.45
714AY	6.95
715A	6.75
715B	12.75
715C	26.50
717A	1.47
718AY	45.00
718BY	45.00
WE-719A	26.50
720CY	75.00
720DY	75.00
721A	4.90
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	8.50
726B	45.00
730A	25.00
731A	2.45
WL-787	9.80
788Y	1.40
800	1.88
801A	.48
803	4.95
804	8.95
805	4.50
806	24.50

807	1.70
808	2.65
809	2.40
810	10.95
811	3.60
813	9.50
814	3.95
815	2.75
816	1.45
826	1.45
828	13.48
829	9.95
829A	14.50
829B	14.50
830B	3.95
832	7.95
832A	9.95
836	3.50
837	1.85
838	3.25
841	.49
843	.59
845	5.75
845W	6.75
849	29.50
851	67.00
852	22.60
860	4.95
861	24.50
864	.39
865	1.28
866A	1.48
869B	45.00
872A	3.95
874	1.45
876	1.60
878	1.85
886	3.50
954	.39
955	.70
956	.49
957	.49
958A	.69
959	1.50
991	.45
1003	.90
CK-1005	.79
E-1148	.35
1201	1.20
1203	.69
1291	.69
1294	.69
1299	.69
1602	2.25
1613	1.20
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.30
1624	1.95
1625	.45
1626	.39
1629	.39
1630	.95
1631	1.38
1632	.75
1636	3.10
1638	.70
1641	1.95
1642	.75
1644	1.17
1655	1.90
1960	.70
5611	135.00
5651	3.05
5654	5.85
5691	7.75
5692	7.75
5693	6.40
UX-6653	.65
7193	.75
8005	5.95
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.05
8020	1.39
8025	6.95
9001	1.75
9002	1.50
9003	1.75
9004	.55
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

SYNCHROS

ARMY ORDNANCE, NAVY ORDNANCE AND COMMERCIAL SIZE 1, 3, 5, 6, 7 and 8 GENERATORS, MOTORS, CONTROL TRANSFORMERS, DIFFERENTIAL GENERATORS AND DIFFERENTIAL MOTORS IN STOCK

AY-101D	1G	5F	7DG	N	C-44968-6	C-69406-1	C-78411
AY-120D	5B	5G	7G	X	C-56701	C-77610	C-78415
AY-130D	5CT	5N	A	2J1F1	C-56776-1	C-78248	C-79331
1CT	5D	6DG	B	2J1G1	C-69405-2	C-78249	C-78254
1F	5DG	6G	M	2J1H1	C-69406	C-78410	C-78670

SEND FOR COMPLETE LISTING

SYNCHRO CAPACITORS IN STOCK

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

LECTRONIC RESEARCH LABORATORIES
715-19 ARCH ST. PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

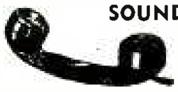
Reliance Specials

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenter's dream! .... Only $6.50

VERNIER DIAL or DRUM (From BC-221)

Dial—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks .... either 85¢



SOUND POWER HANDSET

BRAND NEW

Includes 6 ft. cord.—No batteries or external power source—used. $18.50 pr

AC LINE CORDS 6 ft. long with molded rubber plug 18¢

BALL BEARINGS

Mfg. No.	ID	OD	Thick.	Price
MRC5028-1	5 1/2	6 1/2	1	$3.75
MRC7026-1	5 5/64	6 15/64	9/16	3.50
MRC7021-200	4 1/8	5 9/32	23/64	2.95
MRC106M2	1 17/64	2 7/16	25/64	1.75
MRC106M1	1 13/64	2 7/16	25/64	1.60
Federal LS11	1 1/8	2 1/2	5/8	1.75
Norma S11R	1 1/8	2 1/8	5/8	1.70
Federal AS41	1 1/16	1 1/2	9/32	1.50
Schatz.........	3/4	1 3/4	9/16	1.00
Norma 203S	5/8	1 9/16	7/16	.90
ND5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	15/32	11/32	.60
ND R6	3/8	7/8	7/32	.40
MRC39R1	11/32	1 1/32	5/16	.45
MRC38R3	8/16	55/64	13/32	.45
FAFNIR 33Kdd	1/8	5/8	3/16	.35

NEEDLE BEARINGS

TORRINGTON B108 ½" wide ⅝" 13'16" 30¢

Brand New Meters—Guaranteed 2.50

0-10 ma. D.C. 3½"...3.95 0-80 Amp. D.C. 2½"...$2.25
0-1 ma. D.C. 3½" DeJur...Scale Reads 0-4 KV...$5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V......................... $1.79
Half Wave 100 MA 115V......................... .91

TIMING MOTOR

8 RPM 115V 60 cyc

E. Ingraham Co.

$1.79

400 CYCLE INVERTERS

Leeland Electric Co.

#10890 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase. 1500 V.A. 90 PF................ $24.95

3 AG FUSES

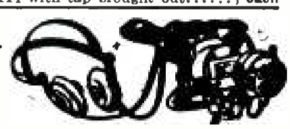
Amp.	Per 100	Amp.	Per 100	Amp.	Per 100
1/8......	$4.00	3/4......	$4.00	8.......	$3.00
3/8......	4.00	1........	3.00	10.......	3.00
1/2......	4.00	4........	3.00	15.......	3.00
		5........	3.00		

3 AG FUSE HOLDERS (Finger) 25¢

DELAY NETWORK—ALL 1400Ω

T 114—Approx. 2.2 micro sec. delay.............. } 95¢
T 115 Similar to T 114 with tap brought out...... } each

Sound Powered Chest Set RCA—With 24 Ft. Cord



Per Pair
USED $17.60
NEW $26.40

POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd
7	25	56	110	250	500	800	.001625	.0044
7.5	26	60	120	270	510	820	.002	.006
8.2	33	62	125	300	560	910	.0027	.0062
10	39	68	150	330	580	.001	.0033	.0065
15	40	70	160	360	600	.0012	.0035	.0068
18	43	75	175	370	620	.0013	.0036	.0082
20	47	80	180	390	650	.00136	.004	.01
22	50	82	200	400	680	.0015		
23	51	90	220	430	750			
24		100	240	470				

Price Schedule

7 mmf to 820 mmf.................................. 5¢
.001 mmf to .001625 .... 8¢
.002 mfd to .0082 mfd.............................15¢
.01 mfd ....28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
8	40	82	155	270	470	800	.0024	.0039
10	50	100	170	325	500	0011	.0025	.004
18	51	110	180	350	510	.0013	.0027	.005
22	56	115	208	360	525	.0015	.00282	.0051
23	60	120	225	370	560	.0016	.002826	.0056
24	62	125	240	390	570	.001625	.003	.006
27	66	130	250	400	680	.0018	.0033	.0068
30	68	135	255	410	700	.0022		.0082
39	75	150	260	430		.0023		.01

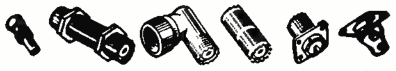
Price Schedule

8 mmf to 800 mfd..................................10¢
.0011 mfd to .002 mfd.............................20¢
.002 mfd to .0082 mfd.............................50¢
.01 mfd $1.00

PULSE TRANSFORMERS

UTAH—9262 9278 9280 9340
WESTERN ELECTRIC—D166173 D161310
KS8696. KS9565, KS9800. KS9862, KS13161
GENERAL ELECTRIC—K2731 K2729A 80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR 1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

COAXIAL CABLE CONNECTORS



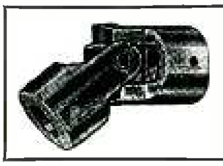
15¢	$1.30	30¢	80¢	40¢	12¢
UG 175/U	83-1F	83-1AP	83-1J	SO-239	HOOD

83-1AC	$.42	UG-22/U	$1.30	UG-104/U	$1.40
83-1AP	.30	UG-22A/U	1.65	UG-106/U	.12
83-1F	1.20	UG-22B/U	1.65	UG-167/U	5.70
83-1H	.12	UG-23/U	1.20	UG-175/U	.15
83-1HP	.25	UG-23B/U	1.90	UG-176/U	.15
83-1J	.80	UG-23C/U	1.90	UG-185/U	1.35
83-1R	.40	UG-24/U	1.30	UG-224/U	1.20
83-1RTY	.65	UG-25/U	1.35	UG-255/U	2.45
83-1SP	.50	UG-27/U	1.30	UG-260/U	1.20
83-1SPN	.60	UG-27B/U	3.45	UG-290/U	1.20
83-1T	1.30	UG-30/U	2.30	UG-306/U	2.95
83-2AP	1.95	UG-57/U	2.30	UG-499/U	1.25
83-2J	2.10	UG-57B/U	2.30	UG-625/U	1.35
83-2R	1.70	UG-58/U	.80	CW-123A/U	.50
83-22AP	1.40	UG-58A/U	1.15	M-358	1.30
83-22R	.68	UG-59A/U	2.25	M-359	.30
83-22SP	.90	UG-85/U	1.75	PL-258	.80
83-168	.15	UG-87/U	1.60	PL-259	.50
83-185	.15	UG-88/U	1.10	PL-259A	.60
UG-13/U	1.70	UG-89/U	1.35	PL-274	1.20
UG-21/U	.95	UG-102/U	.90	SO-239	.40
UG-21B/U	1.35	UG-103/U	.68		

NEW COAXIAL CABLES

	Price per 1000 Ft.		Price per 1,000 Ft
RG 5/U*......	$140.00	RG 22A/U......	$285.00
RG 6.........	180.00	RG 24.........	675.00
RG 7*........	85.00	RG 26.........	475.00
RG 8*........	100.00	RG 29*........	50.00
RG 9*........	250.00	RG 34.........	300.00
RG 9A/U......	275.00	RG 35.........	900.00
RG 10........	240.00	RG 41*........	295.00
RG 11*.......	100.00	RG 54A/U......	97.00
RG 12........	240.00	RG 55*........	110.00
RG 13*.......	216.00	RG 57*........	325.00
RG 17........	650.00	RG 58*........	60.00
RG 18........	900.00	RG 58A/U*.....	65.00
RG 19........	1250.00	RG 59*........	55.00
RG 20........	1450.00	RG 62*........	75.00
RG 21........	220.00	RG 77*........	100.00
RG 22/U*.....	150.00		

Add 25% for orders less than 500 feet.
* No minimum order—others 250' minimum.



UNIVERSAL JOINT ALUMINUM

¼" hole x ½" O.D. 1⅛" long 85¢

SPAGHETTI SLEEVING—assortment—90 feet.....$1.00

TYPE "J" POTENTIOMETERS

100 S.S.*	1,500 1/4S.S.	15K 1/4	200K S.S.*
150 S.S.	2,000 1/4	25K S.S.	250K 5/8
300 S.S.*	2,500 S.S.	70K S.S.	250K S.S.*
400 S.S.	3,000 3/8	80K S.S.	500K S.S.*
500 S.S.	4,000 3/8	100K 7/16	1Meg S.S.
1,000 3/8	5,000 3/4*	100K S.S.*	
1,000 S.S.	10K 5/8	200K 5/8	

*Split Locking Bushing **$1.50 EACH**

TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
1000	S.S.	30K-10K	3/8"†	1 Meg.	1/2"
10K	5/16"	3K-90K	1/4"	1 Meg.	S.S.
15K	S.S.			1 Meg.	S.S.

SD—Screw Driver *—Split Locking Bushing— †—With Switch

PRICE—$2.00 EACH

JONES BARRIER STRIPS

2—140Y	$.17	3—141W	.27	9—141Y	.71
3—140¾W	.21	4—141W	.33	12—141	.64
6—140	28	5—141	.29	3—142	.24
10—140W	.59	5—141¾W	.41	2—150	.43
10—140¾W	.59	7—141¾W	.56	3—150	.60
3—141¾W	.27	8—141¾W	.64		

TIME DELAY RELAY

Raytheon CPX 24166
1 Min. Delay. 115 V., 60 Cycle
2½ second recycling time spring return • Micro-switch contact. 10A • Holds ON as long as power is applied • Fully Cased •
ONLY $6.50

AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.25	20,000	$19.95	8	1,000	$3.25
.075-.075	8,000	1.95	4	1,000	2.25
.15-.15	8,000	2.95	3	1,000	1.75
2 x .02	7,000	1.60	2	1,000	.95
.03-.03	6,000	1.45	1	1,000	.75
.1	7,500	2.25	1	800	.60
.03	7,500	1.95	10	600	2.95
.1-.1	7,000	2.25	8-8	600	1.79
.1	7,000	1.95	8	600	2.05
.02-.03	7,000	1.65	4	600	1.63
.1	6,000	1.75	2 x 2	600	1.35
2	4,000	6.95	2	600	.79
3 x .2	4,000	2.50	4 x 3	600	1.95
.06	4,000	1.40	8	500	1.50
.25	3,000	2.25	4	500	.98
8	2,000	7.95			
3	2,000	3.75			
.5-.1	2,000	1.95			
.5	2,000	1.95			
.3	2,000	1.75			
.1-.1	2,000	1.65			
.02	2,000	.89			
4	1,500	2.50			
1	1,500	1.50			

8 MFD 2000 V.D.C. **$7.95**

PRECISION RESISTORS—¼ WATT—30¢

2	10.48	12.32	14.98	62.54	147.5	1705
2.5	10.84	13.02	15.8	79.81	220.4	2,193
3.5	11.25	13.52	16.37	105.8	301.8	3,500
5	11.74	13.89		123.8	366.6	
6.68				125	414.3	59,148

PRECISION RESISTORS—½ WATT—35¢

.25	11.1	75	400	6,506	16,000	36,000
.334	13.15	87	723.1	7,000	16,700	37,000
.444	13.3	97.8	855	7,300	17,000	45,000
.502	15	125	970	7,500	19,860	47,000
.557	25	178	1,500	8,000	20,150	50,000
.627	44.73	179.5	2,500	8,500	21,300	56,000
.76	45	180	2,850	8,800	25,000	59,000
1.00	46	200	3,995	10,000	26,667	59,905
1.01	52	210	4,000	12,000	30,000	68,000
1.53	55.1	235	4,285	14,825	32,700	79,012
2.04	60	240	4,451	15,000	32,888	100,000
3.25	61	260	5,714	15,750	33,000	180,000
5.26	65	270	5,900	15,755	33,300	
5.89	66.6	290		15,810	35,888	
	69	298.3				

PRECISION RESISTORS—1 WATT—45¢

.1	2.58	15	60	425	7,000	55,000
.11	2.6	18	80	1,530	8,250	56,000
.2	2.66	28	125	2,215	9,000	65,000
.861	3.1	30	250	2,250	10,000	68,000
1.01	3.39	38	270	3,300	12,000	70,000
1,166	4.29	45.5	312	5,221	12,420	84,000
2.55	5.21	54.25	420		50,000	95,000

PRECISION RESISTORS—1 WATT—60¢

100,000	149,500	270,000	348,000	590,000
105,000	150,000	296,000	399,000	600,000
120,000	166,100	310,000	413,000	645,000
128,000	240,000	320,000	520,000	650,000
130,000	260,000		522,000	700,000
132,000				800,000

MEGOHM 1 WATT—1%—$1.50—5%—60¢

PRECISION RESISTORS—2 WATT—75¢

4,385 5,000 6,000 10,000 19,917

DIFFERENTIAL

115 V., 60 Cyc., #C78249 Used 4.95 New 9.95

3⅝" dia. x 5⅝" long
Used between two C7824's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted).......... $5.50
Mounting Brackets — Bakelite for selsyns, and differentials shown above .... 35¢ pair

OIL FILLED A.C. CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
2	750	$0.69	4.4	375	$2.15
8	660	7.50	30	330	8.50
6	660	5.95	25	330	7.50
5	660	5.45	20	330	6.75
4	660	4.95	10	330	4.95
3	660	4.45	6	330	3.25
2.9	660	4.35	4	330	2.25
2	660	3.95	3	330	1.45
1	660	2.95	1.75	330	.85
15	440	6.25	20	220	4.95
6	440	3.95	10	220	2.95
5-3	440	3.95	7.5	220	2.00

1N34 Crystal Diode ....79¢

300 Twin Lead...............02½ per ft. $18.95 per M.

Dynamotor DM 33A........................ $3.75 ea.

Chokes: 30 Hy. 80MA @...$1.29; 6HY, 80MA @...79¢

Power Tap Switch—OHMITE (#312-5 Taps) non-shorting 25A 150 V. A.C........................ $3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A. C. Fully cased Plugs into octal socket $6.50

BC 221 FREQUENCY METER.......... $95. to $125.00

Mike Connector Amphenol 80-81 Interchangeable with Amphenol 80-M cad plated........................ 25¢

2J1G1 SELSYNS

400 CYCLE BRAND NEW

Hardware Assortment
Screws, Nuts, Washers, Lugs, Etc. Mostly Brass 3 Lbs. $1

Minimum Orders $3.......All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

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AIR TRIMMER CONDENSERS

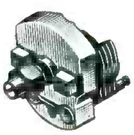


Fig. A

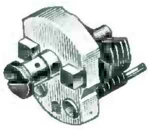


Fig. B

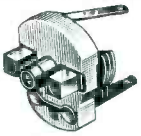


Fig. C

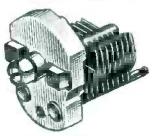


Fig. D

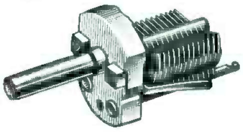


Fig. E

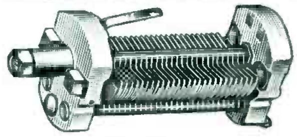


Fig. F

STOCK NO.	CAPACITY Min.	CAPACITY Max.	MANUFACTURER'S NUMBER	FIGURE	SHAFT LENGTH	POST LENGTH	GROUND LUG	PRICE EACH
2937	2.5	7	Hamm 250034	D	5/16	3/32	Right	18¢
5716*	3	8	ASP 17A224	A	9/16	3/32	Top	25¢
5717	3	10	ASP 22G192	A	9/16	3/32	To Post	18¢
4090	2	15	ASP 482212	E	1"x1/4" D	3/32	Left	25¢
2939	3	15	ASP 217-2	C	5/16	1/4	Top	20¢
5718	3	15	Telrad 682070-30	D	5/16	3/32	Right	20¢
5719	3	15	Hamm 682070-30	D	5/16	3/32	Right	20¢
231	3	25	CAIM 481881	A	9/16	3/32	Left	25¢
5720	3	27	Hamm 11725-1	D	5/16	3/32	Right	25¢
5721	2.5	28	Comar M420864-6	D	5/16	3/32	Top	25¢
5723	3	29	ASP 22G190	A	9/16	3/32	To Post	25¢
2940	2	30	ASP A8H-501	D	5/16	5/16	To Post	30¢
5724	4.5	30	OB7751E-25	D	5/16	5/16	Right	30¢
5086	5	30	Hamm SBL-72265-3	B	1/2	3/32	Bottom	30¢
2941	4.5	35	Hamm ESA682070-37	D	5/16	3/32	Left	30¢
232	5	54	Hamm ESA582070-35	D	5/16	3/32	Left	40¢
5087	5	54	Hamm BL 72265-4	B	1/2	3/32	Right	40¢
236**	8	140	ASP 19A34504	D	5/16	3/32	To Post	55¢
5675	6	150	Hamm APCE150	E	1 1/16"x1/4" D	3/32	Right	75¢
5726	9	204	OAK 114M510	F	9/16	3/32	Top	95¢

* Double spaced plates.
** Adjusts both ends, some available w/dust cover.
Fig. A Round Shaft Screwdriver adj. w/locknut.
Fig. B Bakelite Knob Ins. Screwdriver adj.
Fig. C Round shaft Screwdriver adj.
Fig. D Hexnut Screwdriver adj.
Fig. E ¼ Round Shaft.
Fig. F Double End Plate.

SIGNAL CORPS TRANSFORMERS—CHOKES & FILTERS

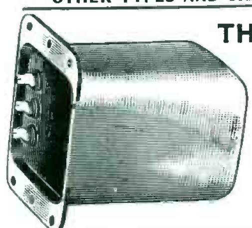
2C6191/K1	2Z9618-42	2Z9636.16	3C106B
2C6191/T3	2Z9619.42	2Z9638.16	3C307-1
2C6191A/3	2Z9619.63	2Z9638.44	3C307-46
2C619F T2	2Z9619-99	2Z9643.42	3C317.33
2C6230/123	2Z9620.1	2Z9655	3C317-43
2C6230.3/124	2Z9621.43	2Z9662	3C317-44
2C6307/AK1	2Z9621-112	2Z9702-2	3C323-6C
2C6386A/T14	2Z9625-1	2Z9760	3C323-14A
2C6494A/C11	2Z9625-8	2Z9805	3C323-54B
2C6530-653A/C10	2Z9625-24	2Z9808	3C323-122B
2C653-653A/T5	2Z9626	2Z9828	3C323-145B
2Z3625-66	2Z9627-35	2Z9851	3C324-4
2Z5731-337	2Z9628-2	2Z9853	3C324-40
2Z9600.3	2Z9631.187	2Z9854	3C335-11
2Z9604.16	2Z9632.8	2Z9855	3C343-2
2Z9608.36	2Z9632.14	2Z9876-2	3C344
2Z9611.115	2Z9632.39	2Z9878-1	3C344-9
2Z9611-289	2Z9632.170	2Z987-11	3C362-8
2Z9612	2Z9632.171	2Z9878-13	3C375-15
2Z9612.52	2Z9632.197	2Z9878-14	3C549
2Z9612.83	2Z9632.248	2Z9879	3C573
2Z9613.14	2Z9632.362	2Z9879-2	3C575G-1
2Z9613.64	2Z9632.365	2Z9879-3	3C362-23
2Z9613.304	2Z9632.366	2Z9900-5	3C362-24
2Z9614-94	2Z9634.4	2Z9931B	3C1987-29
2Z9617-22	2Z9634.39	2Z9944	3C4075
2Z9618-9	2Z9634.46	2Z9984	3F4061B/C1
			6C8/F1

MORE INFORMATION AND PRICES UPON REQUEST

TRANSMITTING MICAS

Stock No.	Cap.	Test Volts	Type No.	Price Each
5493A*	.01	1000	1445	.35¢
5494A	.02	1000	144T	.40¢
5495A	.006	1200	A2	.40¢
5496A	.001	1500	BE 15	.20¢
5493A	.004	2500	4	.30¢
5499A	.001	5000	F	.60¢
5600A	.0036	5000	A2	$1.00
5601A	.15	1000V	XS	1.90
5602A	.00007	2500V	3	.90¢
5603A	.00005	3000V	15L	1.00
5604A	.0001	5000V	F2L	1.00
5605A	.0008	5000V	F2L	1.00
5606A	.000025	10,000	PL-34L	1.95
5607A**	.00015	10,000	PL-315	7.95

* Supplied with Meter Bracket
** D.C. Working Voltage
OTHER TYPES AND SIZES AVAILABLE



THORDARSON AUDIO PASS FILTERS

Band pass 800 to 1200 cycles input 10000 ohms—Output 25000 ohms Level 10DB

Stock No. T48500 Price to: $5.50 ea.

SPECIAL TRANSFORMER BUYS!

HIGH CURRENT FILAMENT TRANSFORMER

Primary 115 VAC 60 Cycle. Secondary 1.25 VAC at 100 AMP.

Stock No. 5783 Price Each $5.00

POWER TRANSFORMER

Horizontal Double Half Shell Type. 117 Volt 60 Cycle Primary. H.V. 380-0-380 Volts at 225 Mils. Filaments: 5V at 3A.; 6.3V at 8A.; 6.3V at 4A. Core Size 4½" x 3¾".

Stock No. 5785 Price Each $4.25

HIGH FIDELITY TRANSFORMER

P.P. 10,000 ohm to 250 ohm Line. Frequency Response 30 to 20,000 C.P.S. plus or minus 1 DB. Grey Rectangular Case 3" x 2½" x 3⅝" high. Bottom Solder Lug Terminals. 4 Stud Mtg. Bolts.

Stock No. 5792 Price Each $5.50

6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.4 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Stock No. 5254A

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. 2½" above Chassis. Solder Lug Terminals—All Terminals Marked.

Price EACH $2.65

HAND MICROPHONE

Replacement for T-17 Mike. English make. Single Button. Removable element. Press-to-talk switch. Stock No. 5883A. Unshielded cable.

Price Ea. $3.25

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Open Account to rated or acceptable reference accounts. Others Pre-payment of 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

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COMMUNICATIONS EQUIPMENT CO.

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: 115v 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-72's, 1-73. New......$110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk Pwr. out 35 KW Energy 0.018 Joules $49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS, 1.5 microsec, pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes..................................$49.50

APS-IC MODULATOR DECK. Complete, less tubes.....$75.00

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec 400 PPS, 50 ohms imp. $37.50

G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS. 50 ohms impedance..................$6.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit: Unit 1, 3-sections, 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, 67 ohms imp. 3 sections...........................$12.50

DELAY LINES

D-168184: .5 microsec. up to 2000 PPS 1800 ohm term....$4.00
D-170499: .25/.50/.75 microsec 8 KV 50 ohms imp........$16.50
D-165997: 1¼ microsec. $7.50
RCA 255686-502, 2.2μ sec, 1400 ohms...................$2.00

RADAR SETS

● AN/APS-3	Airborne 3CM Radar
● AN/APS-4	3CM Airborne Radar
● SQ	10CM Portable Radar 115V, 60 Cy.
● AN/APN-4	Loran Set, Airborne
● AN/APN-3	Shoran, Xmtr. only
● SE	10 cm Surface Search Radar
● SO-1	10CM SEA Radar, 115VDC
● SN	10CM Portable Radar, 115V, 60Cy.
● PP-4/APQ-2	DC Power Supply from 400 Cy........$65.00
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● MKIV	800MC Gun Laying Radar
● SO-8	10CM Radar, 115VDC
● CPN-8	10CM NAV, Beacon, Ground Station
● SG	10CM Heavy Duty Ship Radar

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● Signal Gen.	RCA 710A, 370-560 MC...350.00
● Signal Gen.	Type 605 CS, 9.5KC-50 MC........385.00
● Signal Gen.	20A Microvolter.175.00
● TS 10A	Altimeter Test Set..............32.50
● TS 16/AP	Altimeter Test Set
● TS 36	Power Meter, 3 CM
● TS 47/APR	Test Osc. 50-3000 MC...325.00
● TS 56/AP	Slotted Line, 500 MC.......325.00
● TS 127/UP	Wavemeter, 300-700 MC....72.50
● TS 69/AP	Wavemeter, 340-1000 MC...72.50
● TS 268/UP	Crystal Test Set..50.00
● RA/38	H.V.P. Power Supply

PULSE TRANSFORMERS

U-10198. PRI: 4.5KV, 97A PK. SEC. 18KV 26A. PRR—350-500 Cy. DURATION 1.3 usec...........................$42.50
G.E.K.-2745 ....$39.50
G.E.K.-2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max. 1 microsec. or 1/microsec. @ 600 PPS..$39.50
W.E.-KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s., Permalloy core. $6.00
W.E. #D169271 Hi Volt input pulse Transformer........$27.50
G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G. E..$34.50
G.E. K2748A. Pulse Input line to magnetron............$36.00
Ray UX 7896—Pulse Output Pri. 5v. sec. 41v............$7.50
Ray UX 8442—Pulse inversion—40v + 40v................$7.50
Ray UX 7361 5 microsec. 60-400 cy......................$5.00
PHILCO #352-7250, 352-7251, 352-7287
UTAH #9262, 9332, 9278, 9341.
RAYTHEON: UX8693, UX7428, UX7350.
WEST. ELECT. D-161310, D-166638, D-166173, D-169114, D-161929, KS9948.

U-11716 PRI: 13.2 KV @ 20A. SEC: 3.6 KV @ 72A use pulse. PRR—500 PPS **$65.00**

140-600 mc Directional Antenna

140-310 mc cone and 300-600 mc cone, each consisting of 2 end fed half wave conical sections with enclosed matching stub for reactance changes with changing frequency. New: complete with mast, guys, cables, carrying chest..$49.50

MAGNETRONS

Tube	
2J27	2J62
2J31	3J31
2J21 A	5J30
2J22	718DY
2J26	720BY
2J32	725-A
2J38 Pkg.	730-A
2J39 Pkg.	QK 62
2J49	QK 61
2J61	QK 60

700 A, B, C, D
706 AY, BY, DY, EY, FY, GY

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X BAND – 1" x ½" WAVEGUIDE

1" x ½" waveguide in 5' lengths, UG 39 flange to UG40 cover per length, $7.50
Rotating Joints supplied either with or without deck mounting. With UG40 flanges.............................each, $17.50
2J42 Magnetron Pulse Modulator. 14kw max. rating 7kw min. Plate voltage pulsed 5.5kv 6.5 Amp. .001 duty cycles. 2.5 usec pulse length max. filament 6.3V .5 Amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24. New...................$75.00
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Pressure Gauge, 15 lbs....................................$2.50
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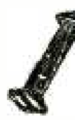
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount. Iris coupling and choke coupling to TR......$22.50
TR-ATR Duplexer section for above.........................$8.50
CU 105/APS 31 Direction Coupler 25 db.....................$25.00
723AB Mixer—Beacon dual Osc. Mnt. w/xtal holder..........$12.00
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend...$4.50
Twist 90 deg. 5" choke to cover w/press nipple...............$6.50
Waveguide Sections 2½ ft. long silver plated with choke flange $5.75
Rotary Joint choke to choke with deck mounting.............$17.50
3 cm. mitred elbow "E" plane..............................$12.00
90 degree elbows, "E" or "H" plane 2½ radius..............$12.50
90 degree twist 6" long....................................$8.00
45 degree twist..$8.00
40KW X BAND Radar, complete as described and illustrated in July 1951 PROC IRE
APS-4 Under Belly Assembly, less tubes...................$375.00





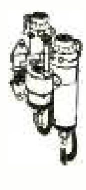
1¼" x ⅝" WAVEGUIDE

Mitred Elbow H Plane UG51-UG52...........................$12.00
CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD.................$10.00
X Band Wave GD. 1¼" x ⅝" O.D. 1/16" wall aluminum per ft. 75c
Slug Tuner Attenuator W.E. guide. Gold plated...............$6.50
Bi-Directional Coupler, Type "N", Takeoff 25 db. coupling..$27.95
Bi-Directional Coupler, UG-52, Takeoff 25 db. coupling......$24.95
Waveguide-to-Type "N" Adaptor, Broadband..................$22.50



S BAND – 3" x 1½" WAVEGUIDE

REACTION WAVEMETER 3000-3700 MC, Mfg. Head. Comp. with Cal. Chart...$125.00
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated.......................................$49.50
BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice each $47.50
MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plate...$45.00
REGULATED POWER SUPPLY for GL 446 type lighthouse tubes (2C40, etc.) 115 vac. 60 cycles. Panel Mounting. Less tubes $32.50
RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR cavity. compl. recvr. & 30 MC IF strip using 6AK5 (2C40, 2C43, 1B27 lineup) w/tubes
721A TR BOX complete with tube and tuning plungers......$12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28...........$4.00
TS 268 CRYSTAL CHECKER................................$50.00
F 29/SPR-2 FILTERS, type "N" input and output..........$12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE, SILVER PLATED BROAD BAND....$32.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized, 45 degrees.........per set $75.00
AS14A/AP-10 CM Pick up Dipole with "N" Cables..........$4.50
S BAND SIGNAL GENERATOR, complete with calibrated attenuator, W. E. coax. wavemeter. McNally Klystron Cavity. Regulated power supply operates from 115 V.A.C. 50-1200 Cycles. Manufactured by W. E...$650.00
OAJ ECHO BOX, 10 CM, TUNABLE.........................$22.50
"E" or "H" Plane Bends, 90 Deg. less flanges...............$7.50



⅞" RIGID COAX—⅜" I. C.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00
SHORT RIGHT ANGLE BEND, with pressurizing nipple......$3.00
RIGID COAX to flex coax connector........................$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00
RT. ANGLES for above....................................$2.50
RT. ANGLE BEND 15 L. OA.................................$3.50
FLEXIBLE SECTION, 15" L. Male to female.................$4.25
FLEX COAX SECT. Approx. 30 ft...........................$16.50
⅞" RIGID COAX. BULKHEAD FEED-THRU......................$14.00
Homedell-to-Type "N" Male Adapters, W. E. #D167284......$2.75
I. F. Amp. Strip: 30 MC, 120 d.b. gain, 2 MC Bandwidth, uses 6AC7's—with video detector. Less tubes....................$24.50
Polyrod Antenna, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50
Antenna, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

THERMISTORS

D167018	$1.50
D167332	1.50
D167613	1.50
D166228	1.50
D164699	2.50

VARISTORS

D171812	$1.50
D172155	1.50
D167176	1.50
D168687	1.50
D167208E, D171858	1.50
308A, 3A, 27-B	1.50

K BAND – ½" x ¼" WAVEGUIDE

APS-34 Rotating Joint...................................$49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane choke to cover.....................$12.00
Mitered Elbow, cover to cover............................$4.00
TR-ATR-Section, Choke to cover...........................$4.00
Flexible Section 1" choke to choke........................$5.00
"S" Curve Choke to cover.................................$4.50
Adapter, round to square cover...........................$5.00
Feedback to Parabola Horn with pressurized window........$27.50
90° Twist $10.00

MICROWAVE ANTENNAS

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $75.00
AS-31/APN-7: 10 cm. Polyrod in Lucite Ball. Type N Fitting. Coax Feed...................................$22.50
TDY "JAM" Radar rotating antenna 10 cm. 30 deg. beam, 115 V AC drive. New..$195.00
Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes $35.00
Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported, with type "N" connector. $14.50

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P.O. ALL MDSE. SUBJECT TO PRIOR SALE, AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK & RAILEX.

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MFRS! MFRS! MFRS!
NEW, FINISHED JAN MATERIAL FOR YOUR WAR CONTRACTS
Write! Phone! Wire!

ID-24 ARN-9 Dual 0-200 Micro-amp. Movement in 3" Case. ILS Equipment $9.95

932 PHOTO TUBE

Gas Phototube having SI Response, particularly sensitive to Red and Near infrared Radiation. Can be used with incandescent light source. Send for data. Price .... **75¢**

ARC-5 XMTR. COILS

MASTER OSCILLATOR

#6029	3-4 MC	$1.85
#6030	4-5.3 MC	1.75
#6031	5.3-7 MC	1.65
#6032	7-9 MC	2.35

POWER AMPLIFIER

#7247	3-4 MC	2.19
#7250	7-9 MC	2.98

ANTENNA LOADING

#6033	3-4 MC	1.39
#6034	4-5.3 MC	1.25
#6335	5.3-7 MC	1.65
	AND 7-9.1 MC	

ELECTROLYTIC CAPACITORS

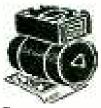
TWIST PRONG

Cap. Mfd	WVDC	Price
8	450	$0.16
30	300	.18
40	450	.38
50	400	.36
60	300	.21
80	150	.29
80	500	.43
8-8	450	.24
30-20	25	.16
20-20	150	.23
80-80	300	.21
90-10	350	.21
80-10	450	.49
150-50-25	150	.49
80-10-10-10	300	.21
40-40-20-2 *	150	.28
30-15-15-15	300	.28
80-10-10-10	350	.32
40/10	450/350	.55
40/20	150/25	.21
40/50	400/300	.28
80/50	450/50	.65
250/1000	10/6	.30
8-8-10	450/25	.26
10-10/10	150/25	.23
10-10/20	450/25	.26
10-15/20	350/25	.18
15-15/10	450/350	.23
16-16/25	450/50	.23
80-40/150	400/50	.45
120-60/20	150/25	.45
30-30-15/30	300/50	.39
40-40-20/20	350/15	.28
60-40-20/50	300/25	.28
60-40-20/200	150/10	.39
80-40-30/20	150/25	.36
80-40-30/100	150/25	.36
8/8/8	475/100/100	.23
10/50/100	350/100/50	.23
10/50/100	450/100/50	.27
20/20/10/20	350/300/300/25	.35

UPRIGHT OIL CAP.

MFD	Each
220VAC/600VDC	
6.2	$1.29
15	3.49
330VAC/1000VDC	
15	3.79
1000VDC	
.5	.69
.5-.5	1.19
1	1.49
4-1.5	2.19
1.5	1.39
1500 WVDC	
1	1.59
1.5	1.59
2	1.79
2000 WVDC	
1	1.79
2500 WVDC	
.5	2.98
4000 WVDC	
.15	6.95
4800 WVDC	
.1-.1	4.79
6000 WVDC	
.1	3.69
.15-.15	3.89
1.5	10.98
7000 WVDC	
.1-.1	3.79
1	9.95
8000 WVDC	
.075-.075	3.79
10K VDC	
.1	8.95
15K VDC	
.0016	7.95
16K VDC	
.015	9.50
20K VDC	
.25	17.50
25K VDC	
1	85.00
.5	65.00

DYNAMOTORS



Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK 11
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

PE-218-H: Input: 25 28 vdc, 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. New..........$44.50
PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5½"x10½". New....$22.50
LELAND #10536: IN: 28 VDC, 12A. OUT: 115V, 115VA, 400 CY 3 PHASE. EXC. COND. **$70.00**

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps input

CTJ5-2-600VCT/.2A, 5V/6A				$5.95
CT-15A	550VCT	.085A	6.3V/.6A, 6.3V/1.8A	2.85
CT-164	4200V.002A/12KV Test, 5VCT/3A/12KV Test, 6.3V/0.6A/5400V Test			12.95
CT-341	1050 10 MA,—625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A			16.95
CR-825	360VCT	.340A	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V	.160A	2.5/12, 30/.100	9.95
CT-071	110V	.200A	33/.200, 5V/10, 2.5/10	4.95
CT-367	580VCT	.050 A	5VCT/3A	2.25
CT-99A	2x110VCT	.010 A	6.3/1A, 2.5VCT/7A	3.25
CT-403	350VCT	.026 A	5V/3A	2.75
CT-931	585VCT	.086 A	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002 A	2.5V/2.1A, 2.5V/1.75A	4.95
CT-866	330V	.065 A	6.3V/1.2, 6.3V/600 MA	1.75
CT-456	390VCT	30 MA	6.3V/1.3A, 5V/3A	3.45
CT-160	800VCT	100 MA	6.3V/1.2A, 5V/3A	4.95
CT-931	585VCT	86 MA	5V/3A, 6.3V/6A	4.95
CT-442	525VCT	75 MA	5V/2A, 10VCT/2A, 50V/200 MA	3.85
CT-720	550-0-550V/250 MA, 6.3V/1.8A			8.95
CT-43A	600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A			6.49
CT7-501	650VCT/200 MA, 6.3V/8A, 6.3V/5A			6.49
CT-444	230-0-230V/.085A, 5V/3A, 6V/2.5A			3.49

Filament Transformers—115V/50-60 cps input

Item	Rating	Each
FT-674	8.1V/1.5A	$1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A, 16KV TEST	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5V/.5A, 7V/7A	2.19
FT-899	2x5V @ 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

Item	Rating	Price
PT-446	185V3.5A	$4.59
PT-699	300/150V/.05A, 300/150V/.05A	2.79
PT-302	120-0-120V/350 MA	4.69
PT-109	17,600V/144 MA	2.30
PT-671	62V/3.5A	7.95

Special Fil. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STF-370	220/440	3x2.5V/5A, 3KV Test 2.5V/15A	$6.95
STF-11A	220V	2x40V/.05A, 2x5V/6A 12.6V/1A	4.49
STF-608	220V	24V/0.6A, 5V/3A, 6.3V/1A, 6.3V/1A	3.45
STF-968	230V	2.5V/6.5A	3.50
STF-631	230V	2x5V/27A, 2x5V/9A	17.59

STEP DOWN TRANSFORMERS

ALL PRIMARIES 220V, 60 Cy., 1 ph.
SECONDARIES 110V, 60 Cy., 1 ph.

NEW STANDARD BRANDS, COMPLETE WITH LINE CORD AND OUTLET

Wattage	Price
250	$5.95
300	7.49
500	10.95
1000	19.95
1500	24.95

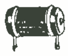
POWER INVERTERS

INPUT—115 VDC OUT: 115 VAC 60 Cy.
500 W. INT. OR 350 W CONTIN.
NEW, ORIGINAL PACKING $75.00

FILTER CHOKES

Stock	Description	Price
CH-917	10H/450 MA—10KV	$12.95
CH-366	20H/.3A	6.95
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual: 120H/17 MA	2.35
CH-8-28	2 x .5H/380 MA/25 Ohms	1.79
CH-8-19	SWING, .006H/5A-.035H/.5A, .032 ohs DCR. 1 KV TEST	2.95
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-917	10H, 450MA, 10KV TEST	12.95
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-511	6H/80MA—310 ohms DCR	2.45
CH3-501	2x5H/400MA	2.79
CH-188M	5HY 200MA	1.79
CH-488	10HY .030A	1.19
CH-791	Dual 1.75-.125 HY 100 MA	1.27
CH-981	15 HY .110A	1.59
CH-22-1	1 HY .100A	1.17
CH-779	.6 HY .490A	1.25
CH-25A	SW .09/.018 HY 3/.3A	8.95
CH-922	10000 HY O MA	2.75
CH-043	2.2 HY 80 MA	.98
CH 89A	2 x 1.52H @ .167A	1.39
CH 69A	Mult. Choke SECT. 1. Swing 3-12H/.52-.05A SECT. 2. Smooth 5H/.52A SECT. 3. Swing 3.25-18H/.138-014A SECT. 4. Smooth 3.4H/.138A	14.95

1 PER CENT PRECISION RESISTORS



ALL VALUES IN OHMS

5	82	150	800	7,500	20,000
5.05	120	250	920	10,000	30,000
10.1	125	430	1100	12,000	35,000
18	128	468	4300	17,000	84,000

30c EACH..........10 FOR $2.50
100K 120K 150K 220K
40c EACH..........10 FOR $3.50
1 MEGOHM..........EACH 75c

400 CYCLE TRANSFORMERS

(All Primaries 115V, 400 Cycles)

Stock	Ratings	Price
352-7039	640VCT @ 250MA, 6.3V/.9A, 6.3V/6A, 5V/6A	$5.49
702724	9800/8600V @ 32MA	8.95
12033	4540V/250MA	17.50
KS9584	5000V/290MA, 5V/10A	22.50
52J652	13,500V/3.5MA	14.65
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V/0.9A, 6.3V/2.5A, 6.3V/.06A, 5V/6A	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/1000/750V @ .005A	7.45
352-7196	1140V/1.25MA, 2.5V/1.75A, 2.5V/1.75A—5KV Test	3.95

POWER RESISTORS

120W—WW—5% Tol.
1⅛" Ferrule, 9½" Long

Res.-Ohms	Price	Res.-Ohms	Price
2.5*	55c	198*	35c
25*	35c	225	30c
30	45c	250	45c
32.5	35c	300*	35c
40	30c	450	65c
50*	45c	500*	40c
70*	45c	630*	55c
100	70c	4,500	50c
125	35c	8,000	90c
125*	45c	160,000	65c

* Tapped to give 10 equal sections with 9 tabs.

SCOPE TRANSFORMER

PRI; 115V, 60 Cy., Sec. 3000V/5 MA, 6.4V/8.7A, 6.4V/.6A 5V/3A, 360-0-360V/200 MA, 1.25V/.3A **$3.95**

SILVER MICA BUTTON COND.

MMF	MMF
40	180
50	185
175	500

PRICE.................. $7.00/100
2000 MMF 15.00/100

CERAMICON TYPE CAPACITORS

MMF	MMF	MMF
14	50	125
15	51	180
20	60	200
27	62	240
30	65	345
47	82	

PRICE.......... **$5.00/100**

SPECIALS

CIRCUIT BREAKERS

24V, 7A—AM1510M-7 ....$1.95
40V, 10A. 1 POLE 1.95

AIR TRIMMERS

3-15 uuf, 8-85 uuf, 3-35 uuf, 5-50 uuf, 3-10 uuf, 3-7 uuf .... .32 each

SHOCK MOUNT RACKS

MT-5/ARR-2/FT-338/FT-156/FT-487/FT-185/FT-265A /MT-62/ARC-5FT-225/FT-162/MT-170A/FT-449/MT-171A/MT-167/U.

Write for Prices

T-30 Carbon Mikes. New	.89
Tel. Tape. ⅜" x 8½" Rolls	.23 ea. 5/1.00
Tel. Tape. 4" Rolls	.12 ea. 10/$1.00
BC366 Interphone Jack Box	$ .79 ea.
AN/109-A Antenna	1.98 ea.
C-30/ARC-5 Control Box	2.35 ea.
EE-89A Telephone Repeater	12.50 ea.
EE-65A Telephone Test Set	50.00 ea.
ID24/ARN-9 Cross Point Indicator	6.95 ea.
TU-8 Tuning Unit 6.2-7.7mc	4.95 ea.
BC496-A Dual Rcvr. Con'l box, 3-6 & 6-9.1mc	1.75 ea.
AN/104-A Antenna, 150mc	1.49 ea.
BC704 Indicator, 5" CR Tube, New	22.50 ea.
BC929 Indicator, 3BPI, all tubes, New	29.50 ea.
Noise Filters, 100 AMP, G.E.	1.39 ea.
MC211 Right Angle Drives	.19 ea.
IF Transformers, 112 KC Double Slug Tune	.69 ea.
IF Transformers, 1600 KC Double Slug	.79 ea.
MD/7 Modulator for ARC/5, All tubes	7.95 ea.
ARC-5 Xmttr. Tuning Cond. #5032	1.49 ea.
ARC-5 Xmttr. M.O. Trimmer #4990	1.29 ea.

BIRTCHER TUBE CLAMPS

926B-16 926C-15 926C-19
926B-18 926K-2 @ 22¢ ea.

COILS FOR BC 230 XMTTRS.

C-293 1250-1500 kc	$ .97 ea.
C-382 3200-4000 kc	.97 ea.
C-184 4-5mc (with 4495kc Xtal.)	1.95 ea.
C-484 5-6.2mc	.97 ea.
Dual Coil Set, C-439 for BC429 Rcv'r., Range: 201-398kc and 2.5-4.7mc	1.29 ea.

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P.O. ALL MDSE. SUBJECT TO PRIOR SALE, AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

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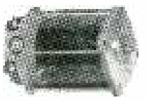
IMMEDIATE DELIVERY — Servo-Tek — FULLY GUARANTEED

BLOWER ASSEMBLY

Lear frame CO10, 5500 rpm motor with 3" Sirroco impeller. Motor 28 v. DC @ 12 Amps. Output 16 watts. Cont. duty. Stock #SA-347 **Price $9.75 each.**

SERVO MOTOR (DC)



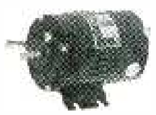
Sperry 8001058
6 terminal-armature and dual field control motor, 2" diam.-3¼" lg. Front flange mounting. Shaft ext. ¼", 5/32" diam. Stock #SA-289 **Price $9.75 each.**

AIRCRAFT MOTOR
G. E. Type 5BA25AJ32A

24 volts at 2.9 amps. 75 in/lb. torque. 3 lead shunt with brake. 1 minute rating. Double worm gear reduction. 4 rpm reversible.

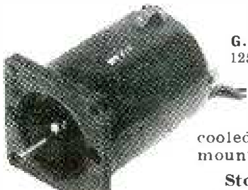
Stock #SA-298 **Price $39.50 each.**

27.5 VOLT DC MOTOR



John Oster Type E-7-5 4 lead shunt. 1/20th hp. Internal fan cooled 4¾" lg. 3¼" diam. ⅞" shaft extension. 5/16" diam. 3650 rpm Stock #SA-311. Price $19.50 each.

G. E. 1/10 HP DC Motor
G.E. Type 5BN58LA5



125 volts DC at 1.2 amps. 4000 rpm. Int. duty Internal fan cooled. 3½" sq. front mounting flange.

Stock #SA-312
Price $19.50 each.

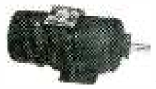
60 CYCLE AMPLIDYNES

G.E. Types 5AM45DB15 and 5AM73AB95. Type 45DB15 input 115 v. 60 cy. at 5 amps. Output 250 volts DC at 0.6 amps. Stock #SA-147.

Type 73AB95 input 115 volts 60 cy. at 9 amps. Output 250 volts DC at 1.5 amps. Stock #SA-257.

PRICES ON REQUEST

DELCO CONSTANT SPEED MOTOR A-7155



1/30 hp. 27.5v d-c 3600 rpm. Cont. duty, 2½" diam. x 5⅛" lg. ⅞" shaft extension. 5/32" diam. 4 hole base mounting. Stock #SA-34. **Price $19.50 each.**

BLOWER ASSEMBLY

Delco 27 v. DC motor, 5400 rpm. 3" Sirroco impeller. Shunt motor. 4 in/oz. torque. Base Mtg. Stock #SA-352. **Price $9.75 each.**

INSTRUMENT INVERTER

Pioneer Type 12128-1B Post War Model. Input 27.5 volts DC at 1 amp. Output 26 volts 400 cy. Single phase. P.F. 0.4. 6.0 VA. Stock #SA-295. **Price $39.50 each.**

SYNCHRO CAPACITORS

Production quantity requirements of the following Synchro "Exciter" Capacitors are available for immediate delivery.

Type 6C—connected 20-20-20 mfd.
Type 1C—Mk. 12—connected .6x.6x.6 mfd.
Type 3C—Mk. 1—connected 10x10x10 mfd.
Type 4C—Mk. 14—connected 3x3x3 mfd.

Quantity Quotations on Request

— SERVO SPECIAL —

Low Inertia Servo Motor
400 Watts Output

115 volt 2 ph. 2 pole. 60 cy. Mfd. by Pioneer-Bendix.

Uses built in Fan Motor.

Navy Type CM-211518A W.E. KS-151182L1
Small Qty. only

AUTOSYN POWER SUPPLY (CONVERTER)

PIONEER Dwg. 12108-2B. Designed to supply 26 v. 400 cycle excitation to from 20-50 Pioneer Autosyn units. Input voltage 24 v. DC at 3.0 Amps. 4000 rpm. Stock #SA-504. **Price $59.50 each.**

MOTOR GENERATOR SET

Navy Type CAJ-21989. For OBE-3 Underwater sound equipment. Mfd. by Holtzer Cabot. Motor—115 volts DC at 8.3 Amps. 0.75 hp. Generator—115 volts 60 cycles single phase, 4.0 Amps. 0.88 P.F. Self-excited. Cont. Duty. Stock #SA-505. **Price $195.00 each.**

1 H.P. VARIABLE SPEED DRIVE
Louis Allis Adusto-Spede

Squirrel Cage A-C motor and an electro-magnetic clutch and pilot governor. Speed range 0-1050 rpm. Three phase. 208 v. operation. 60 cycles. DC excitation 0-10 volts. Small quantity available.

Aircraft Turret Motor—G.E. 5BA501LJ22. ½ hp. Amplidyne controlled motor. Armature voltage 60 max. Field 27 v. Max. Arm. current 8.3 amps. Field 2.9 amps. 10 minute rating. Stock #SA-345.

Quantity prices on request.

BODINE GEARHEAD DC MOTORS

Type NSH-11R. 200:1 reduction. Output shaft 10 rpm. 1/150 hp. Int. duty. 75 volts @ 0.28 Amps. Large Qty. Stock #SA-1001. **Quotations upon request.**

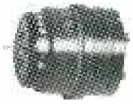
Type NSE-11R. 1/400 hp. 630:1 gear reduction. 250 volts DC or AC. Output shaft 10 rpm. Current 0.15 Amps. Int. duty. Large Qty. Stock #SA-1002. **Quotations upon request.**

Bodine NSH-12R—1/400 hp. 630:1 gear reduction. Output speed 3.5 rpm. Torque 3.5 in/lbs. 115 v. DC. Cont. Duty. Stock #SA-1003. Large Quantity. **Prices on request.**

400 CYCLE INVERTERS

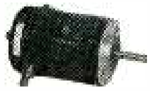
Pioneer—12130-4B; 12108-2B; 12121-2; 12116-2; 12117-5; 12123-1A.
Holtzer Cabot—MG-149; MG-149F; MG-149H; MG-153; MG-153F.
Leland—10339; 10285; PE-218; 10486-846.
Eicor—AN-3187-1.
Wincharger—PU-7/AP; PU-16.
General Electric—5AS131NJ3; 5D21NJ3A: PE-118; PE-218.

DRAG CUP GENERATOR



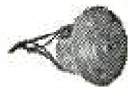
Kollsman Type 977-01630 115 volt 60 cycle input. 60 cycle output voltage proportional to shaft speed rotation. **Stock #SA-307. Price $29.50 each.**

DC MOTOR



John Oster Type A-16A-2B. 28 v. DC Shunt wound. 8000 rpm. 0.09 oz./in. torque. Large Qty. **Prices on request.**

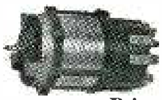
PIONEER AUTOSYNS



Pioneer Bendix Types AY-1; AY-54; AY-14D; AY-14G and others.

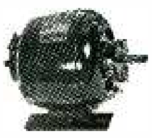
Prices on request.

KOLLSMAN TELETORQUE



Kollsman Type 403 self synchronous units. (Synchro) 115 volt 60 cycle excitation. Use as either generator or repeater. Stock #SA-79.
Prices on request.

115 VOLT D-C MOTOR



G.E. Type SD. 1/20 hp. 4 lead shunt. Reversible. Double shaft extensions. Speed 1725 rpm. **Large Quantity.**

Special $19.50 each.

LEAR POSITIONING MOTOR

Model 156A. 115 watt 24 v. DC motor. 10,000 rpm. Int. duty. Reversible. Dual rt. angle output shaft. Release clutch. 7:1 reduction to output. 250:1 reduction to limit switches. **Stock #SA-343.**
Prices on request

MAGNETIC AMPLIFIER
Pioneer Type 12077

115 V. 400 cy. One Tube Servo Amplifier using saturable reactor type outlet transformer. Limited Quantity

SYNCHROS AND SELSYNS

Navy Types
A; M; 1SF; 5G; 5F; 5SDG; 5SG; 5SF; 5HSF 6DG; 7G; etc.

Army Types
II; IV; V; VII; IX; XXI; XV; etc.

G.E. Types
2J6F2; 2JD5J2; 2J5A2; 2J5HA1; 2J1H1; 2J1F1; 2J1G1;2J1F3; 2JD5HB1; 2J5LA1; 2JD5C2, etc.

SERIES MOTOR
John Oster Type A-21D-7A

24 v. DC. 0.005 hp. .6 Amps. 11,000 rpm. Cont. duty. 1-½" diam. x 2-½" lg. Front flange mtg. Shaft 3/16 dia. x ⅝" ext. Stock #SA-353. **Price $8.75 each.**

Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

WRITE FOR LISTING
Prices F.O.B. Paterson
Phone ARmory 4-3366

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

SURPLUS EQUIPMENT

PE 218 Leland Electric

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. **Input:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5.
BRAND NEW . . . . $39.95 ea.

16486 Leland Electric

Output: 115 VAC; 400 Cycle; 3-Phase; 175 VA; 80 PF. **Input:** 27.5 DC 12.5 amp; Cont. Duty **$90.00 ea.**

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp. ....**$80.00 ea.**

12116-2-A PIONEER

Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC 5 amp...**$90.00 ea.**

MG 153 HOLTZER-CABOT

Input: 24 V, DC, 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA, and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated ....**$95.00 ea.**

94-32270-A LELAND ELECTRIC

OUTPUT: 115 Volts, 190 V.A., Single Phase; 400 cyc.; .90 PF, and 26 Volts, 60 V.A., 400 cyc., .40 PF. **INPUT:** 27.5 Volts DC, 18 amps; Cont. Duty, Voltage and frequency regulated **$95.00**

5 RPM GEAR HEAD MOTOR

Mfg. RAE., Type 7519, 115 Volts AD, DC. Fractional HP, Overall dimension: 5½" ....**$12.95 ea.**
Lots of 10......**$11.95 ea.**

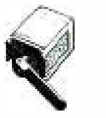
METERS

AMMETER: DC; 2" 100-0-100, complete with external shunt...............**$5.95 ea.**
AC Volt, Westinghouse, Type NA-35—3-inch round. F.S.-10 MA............**$6.95 ea.**

MICROPOSITIONER

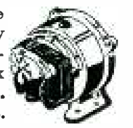
Barber Colman AYLZ 2133-I Polarized D.C. Relay: Double Coil Differential sensitive; Alnico P.M. Polarized field. 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc........**$12.50 ea.**

VEEDER ROOT COUNTER
MODEL S-1



5-figure (0-99,999) non-reset type. Adds ten for each complete revolution of shaft in one direction. Substracts ten for each revolution in opposite direction. Black figures on metal background. Size: ¾" high x ¾" wide x 1-5/16" long. Dovetail mounting — Lever arm removable ....**$1.95 ea.**
10 for **$17.50**

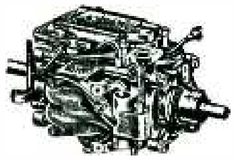
6 RPM GEAR BOX MOTOR



110 Volt, 60 cyc., Single Phase; Ratio—544:1; Mfg. by Merkle-Korff Gear Co., Overall dimensions approx. 3½" x 1½". ....**$9.95 ea.**
Lots of 10...........**$9.50 ea.**

WESTINGHOUSE HYDRAULIC TRANSMISSION

BRAND NEW



Ideal as hydraulic torque converters. Contains hydraulic pump and hydraulic motor; 10 ball bearings; has reversible controls. High quality precision workmanship . . . made to exacting specifications for use on 2-ton 40 mm anti-aircraft guns. Overall dimensions: 12" long x 5½" wide x 6½" high. Shipping weight: 20 lbs. Government cost more than $300. **BRAND NEW** ....**$29.95 ea.**

AC CONTROL MOTOR

Diehl Mfg. Co., FPE-25-7, 20 Volts, 2 phase, 1600 RPM, .85 amps **$15.00 ea.**

G. E. ALTERNATOR

208 Volts, 400 Cycle, 3 Phase Mod. 2CM97B1 55.5 Amps., PF .75, Speed 8000 KW 15, Cont. Duty, Limited Quantity..$320.00

SERVO MOTOR 10047-2-A: 2 Phase; 400 Cycle; with 40-1 Reduction Gear $10.00 ea.

PIONEER TORQUE UNITS

TYPE 12604-3-A: Contain CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1 **$70.00 ea.**
TYPE 12606-1-A: Same as 12604-3-A except it has a 30:1 ratio between output shaft and follow-up Autosyn...........**$70.00 ea.**
TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train.............**$70.00 ea.**

BLOWER ASSEMBLY

115 Volt, 400 Cycle. Westinghouse Type FL, 17CFM, complete with capacitor. New ....**$12.50 ea.**

ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
Delco-Type 5069230: 27.5 volts; DC; 145RPM **$19.95 ea.**

PIONEER AUTOSYNS

AY-1.. ....26 Volt—400 Cycle... ....**$6.95**
AY-5.......26 Volt—400 Cycle........**$7.95**
AY27D **$25.50**
AY6—26 Volt—400 cyc............**$4.95 ea.**
AY30D—26 Volt—400 cyc.........**$25.00 ea.**
AY14D **$14.00**
AY34 ....**$20.00**
AY20—26 Volt—400 cyc.........**$12.50 ea.**

400 CYCLE MOTORS

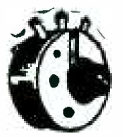
AIRESEARCH: 115V; 40 CPS; Single phase; 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03....................**$10.00 ea.**
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles; 6000 RPM ....**$12.50 ea.**
EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle, Single Phase. **$12.50 ea.**
PIONEER, CK-2, 400 cycle 2-phase. **$20.00 ea.**
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM: 8 amps. ....**$79.50 ea.**
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle; .12 H.P., 6500 RPM: 1.5 amps. **$25.00**

SYNCHROS

1F Special Repeater (115V-400 Cycle) **$15.00 ea.**
2JIF3 Generator (115V-400 cyc)...**$10.00 ea.**
5CT Control Transformer; 90-50 Volt; 60 Cyc. ....**$50.00 ea.**
5F Motor (115/90 volt—60 cyc.)...**$60.00 ea.**
5G Generator (115/90 volt—60 cyc.) **$50.00 ea.**
5SDG Differential Generator (90/90 volts—400 cyc.) ....**$30.00 ea.**
5DG Differential Generator (90/90 volts 60 cycle) ....**$50.00 ea.**
TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle....................**$25.00 ea.**

REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle ....**$37.50 ea.**
1F Synchro Motor 115 V. 60 cycle..**$50.00 ea.**
REPEATER, AC synchronous 115 V., 60 cycle, C-78863..................**$15.00 ea.**

POWER RHEOSTATS



Standard Brands: 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.
Boxed, Brand New with Knob $2.50 each — or — $25.00 per Doz.

SMALL DC MOTORS

(Approx. size....4" long x 1¼" dia.)
General Electric-Type 5AB10AJ37; 27 volts, DC; .5 amps, 8 oz inches torque; 250 RPM; shunt wound; 4 leads; reversible..**$12.50 ea.**
G. E. Type 5BA10FJ215, 24 volts DC, .77 amp. 30 lbs. in. torque, 4 RPM....**$15.00 ea.**
General Electric-Type 5BA10AJ52C; 27 volts, DC; .5 amps, 8 oz. inches torque; 145 RPM; shut wound; 4 leads; reversible **$12.50 ea.**

SENSITIVE ALTIMETERS

Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required...**$12.95 ea.**

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

MOTOR GENERATORS

G.E. Model 5LY77AB1, Input: 115 volts D.C.; 1½ H.P. motor; 13 amp; 3600 RPM; shunt contact regulated. Output: 115 Volts A.C. 60 cycles; KVA .06; shunt self excited. **$129.00 ea.**
MG-183, Input: 70 Volts DC, 5.4 amps., 1/3 H.P., 3500 RPM. Output: 50 Volts AC, 2.6 amps., 175 cycles, 3 phase, .225 KVA. **$79.00 ea.**

SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Deihl and Bendix.
Quantities Available
REPEATERS ....**$15.00 ea.**
TRANSMITTERS ....**$15.00 ea.**

SINE-COSINE GENERATORS
(Resolvers)

Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle.......**$25.00 ea.**
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor ....**$25.00 ea.**

ALL EQUIPMENT FULLY GUARANTEED

Please enclose full amount with order
All prices net FOB Pasadena, Calif.
Prices subject to change without notice

C and H Sales Company
BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

— THE BEST IN ELECTRONIC SURPLUS —

TRANSMITTERS

3 KW GE FM BROADCAST STATION (Formerly WGYN), COMPLETE. 88-108 mc. Includes FM Exciter-Driver in one cabinet, 3 KW Amplifier with Power Supply in second cabinet, 2 RCA type 70-C1 Transcription turntables 33⅓ and 78 rpm include Gray Recorder arms and heads, 1—RCA MI-11301A Power Supply. 1 RCA Type 76-B2 Studio Console, plus Freq. & Mod. Monitor, Station Monitor, Monitor Amplifier, etc., and all tubes for all equipment. All in good operating condition.
PRICE (not crated) **$5,000.00**

2 KW Radio Ranging or Homing Transmitter, 125 to 525 KC; A1, A2 & A3 emission. Consists of Wilcox 96-200A with VFO or Crystal-Controlled Oscillator in one cabinet, Wilcox 36A Rectifier in 2nd cabinet, and Wilcox 50A Modulator in 3rd cabinet. All NEW, unused equipment, export packed. Operation from 220 V., 50-60 cycles, 3-phase A.C. **Write for Price.**

LINK FM TRANSMITTER-RECEIVER. 70-100 mc, 50 watts output. Model 1498 DC. Wall style cabinet containing transmitter, receiver and 14 V. D.C. or 110V. A.C. power supply, hand-set. Dim.: 34" x 21" x 11". NEW condition. Complete with tubes, crystals, special telescopic antenna, instruction book. **PRICE** **$500.00**

MODEL ATD AIRCRAFT RADIO TRANSMITTER EQUIPMENT. This is a Navy Model, 4-channel (motor driven band switching), covering the range of 540 KC to 9050 KC. Output 50 watts phone, but operates A-1, A-2 as well as A-3. Operates from 24-28 volt DC Dynamotor. Each set includes: Dynamotor, Remote Control, Channel Selector Control, Plug Connectors, Operating Tubes, Spare Chest with Spare Tubes and Parts, and Instruction Books. All BRAND NEW, in Original Cases; each with 4 Tuning Units to cover the aforementioned range of frequency.
PRICE EACH **$160.00**

TDQ TRANSMITTERS, VHF, 45 watts output AM, 110 to 156 mc; 115/230 V. AC, 60 cycles, with tubes, cables, EXCELLENT condition. **PRICE EACH** **$650.00**

BC-797-A TRANSMITTERS, 110-126 mc, 50 watts output phone, AM, for 110 V. 60 cycle operation. **PRICE, EACH** **$600.00**

SCR-522 VHF AIRBORNE TRANSMITTER RECEIVERS, With Tubes, LIKE NEW condition.
PRICE, EACH, less accessories **$75.00**

MODEL GP-7 AIRCRAFT TRANSMITTING EQPT., 40 watts output A1, A2, and A3. Range 350 to 9050 Kcs covered by 6 plug-in tuning coil units. Eqpt. includes: External Loading (Ant.) Coil. Operator's Control Box, Pilot's Control Box, Cable Connectors. All NEW material, export packed.
Price, Per Set **$75.00**

NEW GE 1 KW, 3 KW, and 10 KW-RF AMPLIFIERS!!

G.E. Transmitting Equipment of recent design. NOT WAR SURPLUS, all NEW and export cased—at tremendous reduction from original price! Available IN QUANTITY: Type BF-1-A, 1 KW Power Amplifier and Power Supply; BF-2-A, 3 KW Power Amplifier with separate matching Rectifier-Power Supply; BF-3-A, 10 KW Power Amplifier with separate matching Rectifier-Power Supply. This equipment is designed for 88-108 MC FM broadcasting application, beautifully engineered and constructed. (250 Watt FM Exciter or Driver NOT INCLUDED). Conversion to lower frequencies (2 to 24 mc, or other frequencies) can be accomplished at very low cost. Our factory will be glad to quote on conversion to specified frequencies. All units designed for 208/230 volts, 50/60 cycles operation; 3 KW and 10 KW units require 3-phase. All incorporate internal blower systems for forced air-cooling, and use latest G.E. hi-efficiency tubes. Quantities sufficient to interest manufacturers—to convert for other applications. Ideal for FM Broadcasters, communication companies, Schools, Labs! Available as separate units, or complete. Write for more complete specifications and prices.

TRANS-RECEIVERS

TCS COLLINS SHIP TRANSMITTER-RECEIVERS. Each with cables, remote control box and loading coil, radio-telephone and radio-telegraph at 20 and 40 Watts, 1.5 to 12.0 mc. Following power supplies available. 12 V. DC. 24 V. DC. 230 V. DC. 110 V. AC. Complete with all accessories EXCELLENT, like NEW condition. **WRITE FOR PRICE.**

SCR-624 VHF (100-156 mc) TRANSMITTING - RECEIVING EQPT. Same as SCR-522, but with 110V. AC Power Supply, all contained in Chests CH-172-A and CH-173-A, with Antenna Masts MA-7-A for each set. 4-channels, crystal control both X'mttr. and receiver. 6 watts output Amp. modulated. NEW material. **WRITE FOR PRICE.**

SCR-284 EQUIPMENT, consisting of BC-654 Transmitter-Receiver, PE-103 Generator Power Supply, GN-45 Hand Generator with cranks and legs, and PE-104 Receiver-Vibrator Power Supply, plus other minor accessories. All equipment in EXCELLENT Condition, with complete tubes. **WRITE FOR PRICE.**

SCR-511 POGO STICK WALKIE-TALKIE. This is a low-powered portable AM Radio Telephone Transmitter-Receiver. covering a frequency range of from 3 to 6 mc. Pre-Tuned Plug-in Tuning Units (BC-746) which contain appropriate Transmitter and Receiver. Crystals and matching coils are employed to provide quick changeover to any frequency in the 3 to 6 mc. band. The Transmitter-Receiver (BC-745) is mounted on a 30" metal stake, which can be driven into the ground to support the unit. A telescopic antenna is provided at the top, along with a convenient "press to transmit" switch. Each set consists of: BC-745 Transmitter-Receiver, complete with Tubes; 13 Plug-in Tuning Units BC-746, with crystals and coils to provide coverage over the 3 to 6 mc. range; PE-157 Vibrator Power Supply. which incorporates the dynamic Loudspeaker (for reception). Vibrator. Dry Disc Rectifier, and space for a 2 volt non-spillable acid type storage battery (not supplied). Equipment is NEW and UNUSED. A T-17 Microphone and 2-Volt Storage Battery (Plastic case type readily available) are all that are required for each set to put into operation. **PRICE, EACH** **$125.00**

AUDIO SOUND

Beachmaster 250 W.; Western Elec. Model HLAS—500W.; RCA 25W.

RECEIVERS

RBM, RBS, BC-1068 VHF, SCR-206 Direction Finders, **(BC-224. BC-969-T1 & 974-T2. CRV-46136, 100 to 1500 KC,** part of DP-13 Radio Equipt.

RT-3/ARN-1 Radio Receivers, New, **Model ZB-3, Aircraft Homing Adapters,** with plugs and accessories. New Eqpt.

MISCELLANEOUS

GENERAL ELECTRIC VOLTAGE REGULATOR (POWER SUPPLY), Model 3GVD-14B-3, delivers up to 750 volts at 100 MA, with voltage divider network to provide lower voltages all regulated. Incorporates switch for "regulating", "non-regulating", and "stand-by". Uses following tubes (not supplied): 1—807, 1—6SJ7, 2—6H6, 1—VR-105, 1—VR-150, 1—6AG7, and 1—5R4GY. Chassis dimensions 11" x 16" x 3" with chassis cover 9" high. Ideal for laboratories, Frequency Shift Equipment, Stable Oscillator construction, etc. All NEW Units.
PRICE, EACH **$24.50**

RADIOSONDE AN/AMQ-1. Meteorological Balloon transmitter with self-contained instruments. New Units, with slide-rule temperature evaluators and spare (sealed) humidity elements. Large quantity available. Receiving and Recording supplementary eqpt. also available. Type AN/FMQ-1. **WRITE FOR PRICE.**

"SNOOPERSCOPE" TUBES, British Infra-Red Image Converter Tubes, with matching Bausch & Lomb front-end Lens.
TUBE .... $5.00 ea. LENS .... $10.00.

20-40 MC RADIO BEACON EQUIPMENT

For SCR-508, 528, 608, 628, 509, 510, 609, 610, etc.

MODEL RC-163 is designed for ready connection to RADIO SET SCR-508, 528, etc., and 608, 628, etc.—or similar transmitting and receiving equipment. It permits directional transmission and reception for beacon, homing, etc., applications. Eqpt. consists essentially of a rotating directional antenna (Adcock type) synchronized to an automatic code keyer (which can be removed). Four sets of plug-in inductors are supplied to cover the 20 to 40 mc range. Designed to operate from a 12-volt storage battery, power consumed approximately 54 watts (4.5 amps.). Supplied with antenna array, antenna mount with rotating motor, code discs, audio oscillator, phase-load box, mast sight, tuning indicator-receiver which checks field strength as well as frequency, valuable compass and tripod, control panel, all necessary cables and complete technical manuals for installation, theory and service. Equipment is NEW and export packed, two cases per complete set.
PRICE EACH SET **$169.50**

TELEMARINE COMMUNICATIONS COMPANY

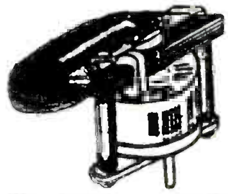
CABLE ADDRESS: TELEMARINE, N. Y. Phone—LOngacre 4-4490 **540 W. 27th St., N. Y. 1, N. Y.**

Westinghouse ELAPSED TIME METERS **$15.50**

General Electric Round Case Smaller Numerals **$14.50**

ALL BRAND NEW

Genuine TELECHRON Motors



2 RPM	$2.90
3 RPM	3.90
3.6 RPM	3.15
1 RPM	3.95
60 RPM	4.30

One of each $15.00

ZENITH 1951 TV Remote Control Motor Units

Reversing control switch at end of 17 foot cable. Powerful 4 RPM clutch motor.
Will drive anything

Can be used for door opener, window raiser, model RR turntable. Complete with transformer. **$10.95** 10 for $95.00

MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$4.90**

Also available in 15 min., 30 min., 1 hr. at $5.90

A similar timer to the above but less calibration and knob. 10 sec. to 24 min. for Photographic, Electric Mixer, Cookers, Time Delay, etc. Biggest BARGAIN We Ever Had $1.00

Veeder-Root Counter, Rotary	$ .90
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ISOLATION TRANSFORMER $1.95

Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices.

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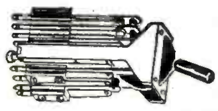
39¢ EACH 3 FOR $1.00

ANTENNA ROTATOR or DOOR OPENER **$7.50**
Geared down 24v. universal motor with transformer
GE Argon Glow Lamps .... 4 for $1.00
100 for $20.00



Mossman Lever Switch $1.50

10 Amp. Heavy Duty Silver Contacts. Contacts can easily be restacked. Now momentary OFF CENTER but can be changed by user to STAY either side. Removed from unused Government Surplus Equipment.

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5..10..50 microamperes

THERMOCOUPLE MILLIAMMETERS
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THERMOCOUPLE VOLTMETERS
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TBK—Navy high frequency transmitter, 2-20 mcs; 500 watts output. Supplied complete with m/g and starter for d.c. or a.c. operation.

TBM—same transmitter but with speech input equipment to give 350 watts phone.

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TAJ—Navy intermediate freq. transmitter, 175-550 kcs; 500 watts output. Supplied complete with m/g and starter for a.c. or d.c. operation.

SCR-284—the famous mobile and ground station for field use. Large quantity of complete sets available.

MAG—10 cm. portable link radar transmitter receivers, 6-volt operation.

TBN—200-500 kcs, complete with 220/440 volt, 3 ph. 50-60c. power supply—conservatively rated at 1 kw. output.

SCR-510 and 610 in quantity.

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AN/CPN-6 .... 3 cm.
AN/CPN-8 .... 10 cm.
YJ and YG .... for shipboard use
AN/CPN-6 .... 3 cm.
AN/CPN-8 .... 10 cm.

AND

TUBES—

SPECIAL PURPOSE and TRANSMITTING TYPES

THIS IS A SAMPLE LISTING • WRITE FOR OTHER ITEMS & UNLISTED PRICES

Tube#	Selling Price	Tube#	Selling Price	Tube#	Selling Price	Tube#	Selling Price	Tube#	Selling Price	Tube#	Selling Price
O1A	write	2J32	65.00	3B28	9.00	250TH	30.00	725A	write	2X2/879	1.75
OC3	$1.60	2J33	100.00	3C31	5.75	250TL	30.00	730A	45.00	1616	2.75
OD3	1.50	2J34	write	3E29	15.00	304TH	9.75	803	7.00	1619	.75
C1A	6.00	2J36	100.00	4C27	25.00	304TL	9.75	807	1.65	1624	2.00
C1B	7.00	2J38	49.50	4C28	35.00	307A	5.00	813	9.00	1625	.65
C6A	write	2J39	49.50	4E27	17.50	339A	35.00	829A	12.00	1626	.75
C6F	12.50	2J42	150.00	4J25	175.00	371B	2.50	832A	10.00	1629	.65
C6J	write	2J49	100.00	4J26	175.00	388A	2.75	833A	42.50	1636	3.00
1B22	3.95	2J50	75.00	4J28	175.00	446A	2.00	836	4.75	1642	3.50
1B23	10.00	2J61	75.00	4J29	175.00	446B	3.75	837	2.75	2050	2.00
1B24	write	2J62	75.00	4J30	write	450TH	45.00	843	write	8012	4.25
2B22	4.95	2K22	write	4J31	175.00	450TL	45.00	849	50.00	8020	3.50
2B26	3.75	2K25	35.00	4J33	190.00	464A	9.50	851	45.00	8025	7.00
2C40	18.00	2K26	150.00	4J52	350.00	705A	3.25	860	5.00	9001	1.65
2C43	25.00	2K29	35.00	5J23	write	706AGY	45.00	861	write	9002	1.50
2D21	1.70	2K36	write	5J26	350.00	707B	12.50	865	1.40	9003	1.75
2E22	3.75	2K41	150.00	5J29	write	714AY	17.50	872A	3.85	9004	1.75
2J21	17.50	2K45	100.00	6C21	29.50	715B	17.50	874	1.50	9005	1.90
2J22	17.50	2K54	150.00	10Y	1.25	720	write	889R	195.00	9006	.50
2J26	27.50	2K55	100.00	100TH	9.00	721A	3.75	891R	250.00		
2J27	27.50	3B24	5.40	204A	60.00	723A/B	25.00	892	150.00		
2J31	27.50	3B27	10.00	211	1.00	724B	6.50	892R	250.00		

ALL TUBES GUARANTEED. ALL PRICES ARE F.O.B. OUR WAREHOUSE, AND ARE SUBJECT TO CHANGE WITHOUT NOTICE

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RELAY NEEDS

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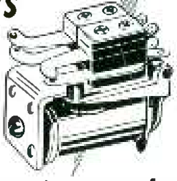

Your requirements of large or small quantities of relays can be quickly supplied from our huge stock.

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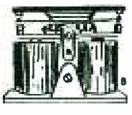


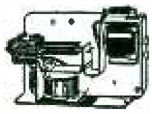
Dual 8000 ohm coils, Armature pivoted between poles, all contacts normally open. High-speed. Suitable for P.P. bridge or balanced circuits where differential action is required.

COOK 11710/613 DPDT, 6 ma., #R605 $5.95

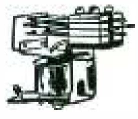
ALLIED 803476 SPDT, 2.5 ma., #418 4.95

ALLIED DSX3 9500 ohm, 4 ma, 2A, 2B, #R941 $5.95

A.C. RELAYS



GUARDIAN: 24 VAC, 25 ohms, Interlocking Relay Breaks 3 Makes 2—Electrical reset #R 806 $2.49

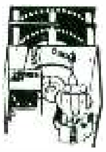


GUARDIAN 110AC: 110VAC; 800 ohm; 2A, 1C; #R946 $1.95

GUARDIAN: 24 VAC, 48 ohm relay, Makes 2 Breaks 2 #R 808..$1.49

Sigma 41FZS7	110VAC	1C	R909	$2.95
Ward Leonard 105	200VAC	1C‡	R911	3.25
G. E. HGA	110VAC	2C‡	R912	5.95
Guardian 200	24VAC	1A‡	R274A	.98
Guardian 200	24VAC	1A, 1C‡	R273A	1.10
Clare B19553†	24VAC	2C, 1A	R582	3.49
Leach 1154	50VAC	2A‡	R431	2.49
	12VAC	2A	R275	.98
Potter Brumfield KR11A	12–24VAC‡ or 6VDC	DPDT	R812	1.95

STEPPING RELAYS GUARDIAN SERIES R



Three basic types for 24V AC operation:

1. Continuous rotation: In this type the contact finger advances one step each time the circuit is made and broken.
2. Electrical reset. Resets when a second coil is energized.
3. Add and subtract. Steps back one or more contacts at a time instead of resetting completely.

10 Pulses per second. Contacts are rated at 1 ampere at 110 volts, 60 cycles, non-inductive AC. The electrical reset type has up to 36 active contacts while the continuous rotation types each have 40 contacts. SEND US YOUR REQUIREMENTS.

* A=Normally Open; B=Normally Closed; C=Double Throw.

† Octal Type Plug Base.

‡ Heavy Duty 10 Amp Contacts.

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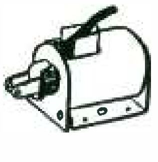

GUARDIAN No. 1: 24 VAC, 6 ohms ⅛ to ½" stroke, 6 oz.-in. #R 804 ....$1.95

GUARDIAN No. 4: 115 VAC, 133 ohms ⅛ to 1⅛" stroke, 14 oz.-in. #R 805 $3.50

GUARDIAN No. 4: 115 VAC, Intermittent Duty, 49 ohms ⅛" to 1⅛" Stroke, 2 lb.-in. $3.50

ALLEN BRADLEY BULLETIN 860, 110VAC, ¼ to 1" stroke, 2 lb-in pull; #R942...........$3.50

WARD LEONARD N83 CONTACTOR: 110VAC, Heavy Duty 5 double make contacts, 3 at 50 Amp, 2 at 30 Amp; 8 lb-in stroke; #R233........$10.95

DELAY RELAYS

PARAGON Model 815; 115V, 60 cyc; Adjustable 0 to 100 sec; 2½ sec Recycling time; SPDT, 10 Amp contacts; #R944 ....$13.95

PARAGON Model 810B; 115V, 60 cyc; 60 sec Delay, 2½ sec Recycling time; SPST, n.o., 10 Amp contacts; #R945 ....$7.95

EDISON 501, 115VAC, 5 sec Delay, SPST, n.o., 10 Amp contacts, #R943........$2.25

AMPERITE 26NO2, 24VAC, 2 sec Delay, SPST, n.o., can be used on 110V with 1250 ohms, #R316 ....$2.25

31V STEPDOWN TRANSFORMER

STURGES ELEC; 1.7KVA; Tapped Pri 115VAC; Heavy Cast Shield; Net Wt. 55 lb; Shipping Wt. 85 lb., #T311.....$37.50

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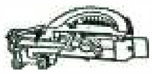

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Two Levels; #R905 ....$15.95

Three Levels with two wipers; #R906 16.50

Four Levels with two wipers; #R907 16.95

Six Levels with two wipers; #R908. 17.75

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A. E. STEPPER 8-12 VDC, 3 deck 20 pos. 360' $8.95

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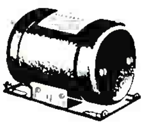

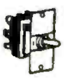


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HS-33	RS-83	

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APS-4	Complete Radar	RC-184IFF
APS-6 Complete	Mark 16	RC-214
APT-1	MD4/APS2	RC-224
APT-2	MD5/APS3	RC-266
APT-3	MD22/UPN2	RT34/APS13
APT-4	MD38/APQ13	T-85/APT-5

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Complete Line!

DuMont 224-A Oscilloscope
1-77 Hickok Tube Checker
1-208 FM Signal Generator
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Hewlett Packard #200-C

1-83G	TS12/AP	TS159
1-86A	TS16/APN	TS170/ARN
1-114	TS19/APQ	TS175/UP
1-183	TS24A/ARR-2	TS182/UP
1-185	TS27/TSM	TS184A/AP
1-187	TS34/AP	TS204/AP
1-198	TS36/AP	TS251
BC-1255	TS61/AP	TS311A/UP
IE-36	TS62/AP	TS323/UP
I-122	TS89	SL1 Slotted Line Test Set
I-139	TS92	Range Calibrator 1-146
I-145	TS100/AP	UPM-1
I-212	TS111/CP	
I-222	TS126	
TS3/AP	TS127/U	
TS10A/APN	TS131	

VHF FREQUENCY METER

Complete, crystal controlled, with 110/220 VAC 60 cycle power supply. 5 channels. Freq. range: 100-156 MC. Mounts in standard rack. With diagram, less crystals. NEW . . . Price on Request.

AN/ART-13 PARTS

Part #	Item
564916	Barometric Switch
565027	4-Pile Ceramic, Variable Cap.
K7890443	6-Pile Ceramic, Variable Cap.
564605	4 Centralab-Type 843-003 Cap. Assembly

RA-38 RECTIFIER

High voltage power supply. Used with ground radar set. New. Price on request.

FLUX METER

For measuring flux density between magnet poles. Has two meters in series with a potentiometer and battery for power supply. Range: 500-4000 Gauss in 3 scales. Requires 1 battery which mounts in case. NEW. Price On Request.

DIRECTION FINDER KIT

Complete kit to make any receiver (freq. range: 200-1750 Kc.) a complete Direction Finder Set. This kit consists of: MN-20 Loop, Loop-To-Receiver Transmission Line, MN-52 Loop Control with 360° azimuth dial and shaft. New. $17.50

RECEIVERS—TRANSMITTERS

APR-4	ID-6/APN-4	R89
APR-5)	MP-10G	RTA/1B
ARC-1	PE-125AX	SCR-522
ARC-3	R-9/APN-4	TA2J-24
R-4/ARR-2	340-580 MC. New complete	733-D

RA-52 RECTIFIER

Transtat controlled to produce high voltage DC from 110 VAC 60 cycle source. Up to 11,500 VDC @ 50 W. Metered high voltage (0-15 KV) and current (0-20 MA). NEW....................$74.50

MISCELLANEOUS

MINE DETECTOR: SCR-625 for prospecting, mining, etc. NEW..............................$59.50
LP-21 LOOPS: Mod. LM, AM, A. Excel. cond.

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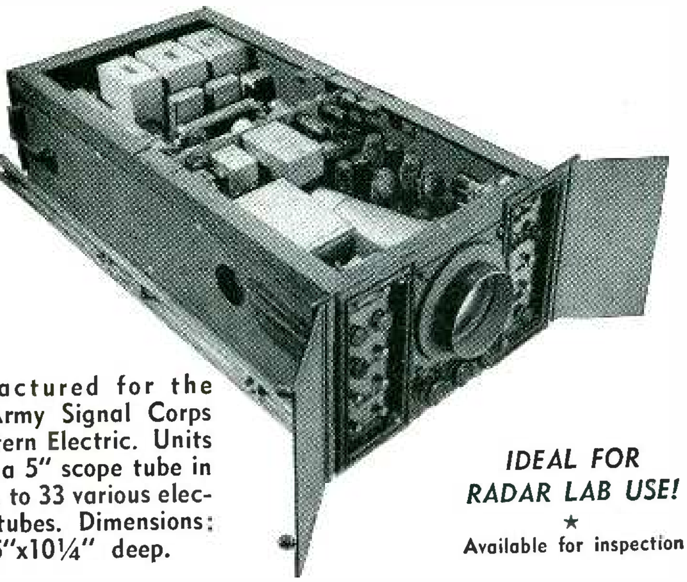

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I-36	TS-16	TS-127
I-130A	TS-34A	TS-170
I-222	TS-46AP	TS-215/AP
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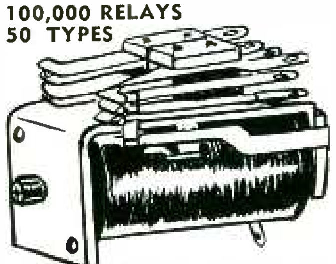

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0-20 Volts D.C. $2.95 — 0-5 Ma $2.95
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RADAR—COMMUNICATIONS AND TEST EQUIPMENT

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TS-33/AP X-band Frequency Meter. 8500-9600 mcs. Contains crystal detector and indicating meter. Output to scope will indicate pulse wave shape.

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TS-102/AP	TS-110/AP	IE-36
TS-47/APR	TS-164/AR	TS-59/APN
TS-184/AP	TS-19/APQ-5	TS-23/APN
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AN/TPS-1 SEARCH RADAR. This is a pack portable ground search radar for the detection of aircraft up to 100 miles. Range and azimuth data is displayed on a 7" P.P.I. and a 5" "A" scope. This set was called the G.I.'s radar because of its ruggedness, dependability and ease of servicing. Complete tech data is as follows:

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Azimuth Mech. 360° Automatic 360° Accuracy ±3°	Pulse Width 2 Micro Sec.
Scanning Manual Automatic	Beam Width 3° Horiz. 13° Vert.
Presentation 7" P.P.I. 5" A Scope	
I.F.F. not provided but has provision for. Frequency 1074-1086 Mcs	Power Input 1100 W at 115V 400 Cyc and 180 W at 27V D.C
Power output 150 K.W.	Weight: 1,518 Lbs.

AN/APS-3 Airborne X-band Search and Homing radar. Complete. Contains RF head, modulator, synchronizer, control boxes, plugs, antenna, etc. 115v 400 cyc.

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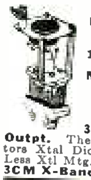

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3cm T-Sect. Waveguide & Atten Outpt. Thermal Comp & Pwr Meas Thermistors Xtal Diode Detector Mtg. & C'ling .$18.95
Less Xtl Mtg. & Thermistor $13.95
3CM X-Band Wave Meter 9285-9465MC $29.95

PULSE TRANSFORMERS

7.5 KV Pulse, Pri 4KV, 50-1000 ohm imped. Permalloy Core, WEco $14.98
Pulse Blocking Osc. 3 wndgs. Video Interstate. 1:1 ratio, 32 mh wndgs, H'Sld, HiVins, GE. .$1.98
Pulse Blocking Osc. 3 wndgs, 1:1:1 ratio, 1 mh wndgs GE H'Sld, HiVins $2.98
Pulse Blocking Osc. Video Interstage, 3 windgs, 1:1:1 ratio, 4.3 mh windgs, GE, H'Sld, HiVins, 1, Micro Second rise time $2.98
PULSE SHAPING Xfmr Raytheon UX12819, 1 MU Sec. 2000 CY $9.95
UTAH 9340 P/O CP-5A/APS15 .... $9.00

400 CYC XFMRS

3140, 3030, 2920, 2810V/35 Ma $4.98
1233vct/350Ma, 1140vct/70 Ma 5.98
788V/200Ma, 210V/15Ma, 5V/2A 4.95
6.3V/7A, 6.7V/.9A,6.3V/.3A 3.98
6.3V/4.65A, 6.3V/.3A 3.49
6.3V/1.25A, 6.3V/1.25A 1.98
6.3V/3A, 5V/2A 2.98
6.3V/1A $1.95; 6.3V/.6A 1.49
FREED 5V/10A 4.95
WEco 5V/4A 2.98
FREED 2.5vct/10A csd 4.95

Mfgrs Tell Us Your Needs. Give Mfgrs and Sig Corps Stock Numbers

POWER TRANSFORMERS

2500V for Crt 6.3V/.6A, 2.5V/1.75 csd Hvins 4/BC412 replmnt $7.98
1320V & 375VCT/110ma, 5V/3A, 2.5V/3.25A; 6.3V/2.75A Hsld Hvins 9.98
1000VCT/200MA, 18V/.55A, 6.3V/5A, 5V/6A 6.98
1000VCT/45MA, 795vct/80ma, 360vct/55ma, 3x5V/3A, 6.3vct/1A, 6.3vct/.3A csd Hvins can be used 2x rating Raytheon Hypersil Core 4.98
900V/35MA, 2x2.5V/2A xclnt 1800V'dblr two 2x2 fil. windgs hsld 3.49
840VCT/110MA, 530vct/21ma, 2x5V/3A, 6.3vct/1A, 6.3vct/.3A 4.98
770VCT/85MA, 5/2A, 6.3V3.5A, Throd 3.98
750VCT/200MA, 6.3V/5A, 5V/4amp 5.95
720VCT/115MA, 2x6.3V/.6A, 5.05V/2A, 6.3V/3.8A 3.95
700VCT/120MA, 2x6.3V/3A, 6.3V/1A 3.98
600VCT/100MA, Tapped 350vct, 6.3V/3A, 2.5V/3A Isolation Windg 115V/.45A 3.25
550VCT/150MADC, 5V/3A, 6.3V/5A 3.49
500VCT/60MA, 6.3V/4A Hsld 2.98
450VCT/200MA, 6.3V/3A, 5V/3A 3.95

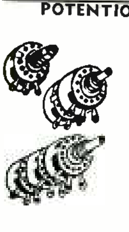
FILAMENT TRANSFORMERS

6.3vct/4A (gud 6.5A) H'Sld HVins $2.69
6.3vct/1A .... $1.98; 6.3v/.6A 1.98
2.5v/2A,...2 for 1.49; **7.5vct/12A**
24v/6a csd .... 4.98; **15Kvins** 10.98
2.5vct/10Amp 5Kvins .... 3.59; 24v/1.25 csd 1.98
5V/2A, 6V/3A ... 2.25; **2x12V/2A** 3.89
5V/60A .... 13.98; **6V/6A** 2.95
5V/115A 16.95

FILTER CHOKES

Dual 30Hy/60ma Csd .... $ .98
15Hy/40ma AC/DC sets ....3 for .98
12 Hy/80ma/Csd/H'Sld/3K Vins USN 2.25
10Hy/85ma @ .98; ....2 for 1.79
10Hy/125ma/UTC/Csd/H'Sld/1KVins 1.69
50Hy/125ma/Csd/H'Sld 2.89
Dual/12Hy/150ma/Csd/2KVins 2.98
12Hy/300ma/Csd/5KVins/H'Sld 4.95
20Hy/300ma or 15Hy/400ma/12KVins 8.95
13.5Hy 1A/17KVins/Raytheon 55.00
10HY 200ma Hmsld Jefferson 2.95
8HY 225ma Thordason 3.50

POTENTIOMETERS—Type J



5 ohm Type J ¼" Flatted shaft $1.19
200 ohm Type J ⅛" Slotted shaft .... .98
1000 ohm Type J ¼" Flatted Shaft 1.19
3500 ohm Type J ¼" Shaft 1.19
7K ohm Type J ⅛" Slotted Shaft .... .98
25K ohm Type J ⅛" Slotted Shaft .... .98
50K ohm Type J ¼" Flatted 1.19
100K ohm Type J ¼" Flatted Shaft 1.19
1 meg Type J ⅛" Slotted Shaft .... .98
1 meg Type JJJ (Triple) 1⅜" Shaft 3.69

UHF ANTENNA

UHF ANTENNA 12"/30CM AT5/ARR1 Usable Citzn & Ham Band Ins. Coax Term Silv Pl Cont Gask & H'ware Mobile Mtg...39c; 4 for $1.00
PL259 for above .... .65
TV CONICAL ANTENNA Sturdy Prefab Incl. 8 elements & 100 ft. Copper Twinex Cross Bar & Hdware, Brand New $6.95
MICROWAVE ANT AS125/APR. 1000 to 3400Mc w/UG58U Term InBuilt HiPass Fltr Flange Mtg Incl. H'ware $5.98
ANT AN130B, 33" Whip 1.95

SECTIONAL ANTENNAS

MS 49-52, 12½ Ft $1.69
MS 49-53, 16 Ft 2.49
BASE: MP22, 3.98; MP47, 3.75; MP48 .... 3.98

DYNAMOTORS

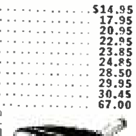
DM37C in 28V/9.2A out 625V/225ma $9.98
Inp 6V Output 200V/100MA 3.75
Inpt 28VDC/1.4A out 250V/60ma 3.69
DM4 12 & 24V out 225V/100ma, 440V/200ma 11.98
DM53A 28V/1.45A out 220V/80ma 3.59
DA3A 28V/10.5A out 300VDC/200 ma 150VDC/10ma, 14.5vdc/.5A 6.75
PE94 Plate Supp., Uses DA3A (SCR522) 8.98
PE97 Plate Supp., Less Tubes 9.98
INPT 6VDC/27.5A Oupt 590VDC/150MA Carter Mag Motor 29.95

SELSYNS

2J1H1 GE Selsyns ....2 for $6.98
2J1F3 GE Brand New 115V/400 cy. ea 9.75
C78248 Sync. Transf 115/60 cy 15.95..2 for 29.95
C78249 Sync. Diff. 115V60 cy 12.95..2 for 25.00
Sync Trans. C-69405-2 Type I-I ....2 for 50.00
Sync Repeater 115/60 cy Type 11-4 New $32.50 ....2 for 59.50
Bendix Auto Syn AY1 & AY5 ....2 for 4.95

TV PICTURE TUBES

10 inch Round $14.95
12 inch Round 17.95
14 inch Rectangular 20.95
16 inch Round 22.95
16 inch Rectangular 23.85
17 inch Rectangular 24.85
19 inch Round 28.50
20 inch Rectangular 29.95
21 inch Rectangular 30.45
24 inch Metal 67.00



Your old pict. tube is worth money, write for trade-in-allowance on RMA coded and dated tubes with one year guarantee. Ship your defective picture tubes prepaid only.
When ordering metal tube, defective metal tube is required.

"TAB" THAT'S A BUY

HIGH CURRENT MICA CNDRS
CYLINDRICAL SIMILAR TYPE "G"

MFD	KV	AMPS	MC	EACH
.01	10	30	3	49.50
.004	20	22	3	45.00
.0025	20	22	3	45.00
.005	15	30	1	48.00
.0025	12	20	3	28.95
.001	30	30	3	110.00

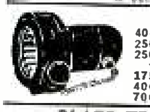
BALL BEARINGS

	ID	OD	Thickness	Each
R4SS Barden	16/64	40/64	13/64	$ .78
34KDD Fafnir	10/64	40/64	12/64	.75
38KDD Fafnir	20/64	55/64	17/64	.98
R6-5 N.D.	24/64	56/64	14/64	.85
13304 SKF	23/64	1 1/64	20/64	.90
200 KDD Fafnir	25/64	1 11/64	22/64	1.00
S12/12R Norma	1 24/64	2 32/64	27/64	1.89
305 Norma	63/64	2 28/64	42/64	1.80
6304 SKF	50/64	2 3/64	38/64	1.45

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW; 5 oz Designed Portable Equip Models....98c; 4 for $3
2V20AH Willard PLUS 2V. Vibrator $2.39
6V/6AH Willd NT6/BB214U 1.98
6V/40AH Willard 6.98
Battery Acid, (R-Exp) 1 pt. 59c; 2 pts .... .98
Hydrometer 1.06 to 1.24 Sp Grav 1.98
Spec Grav Ind & Merc. Thermom .... .98

BLOWERS



40CFM 28 vacdc $5.98
250CFM 28 vacdc 9.95
250CFM with 28 to 115 vac Trans 11.95
175CFM 220 vac 11.98
40CFM 24 vdc BL1000. 6.90
70CFM 115V 400 Cycle 8.98

PLATE TRANSFORMERS

750VCT/650MA W/500V TAP Hmsld $10.95
1100VCT/212MA PRI. 115 or 230V Csd 6.50
15000V AS V'dblr **WE. SIG 3H5629/7500V /35MA** 19.95
3000V/10MA Csd WE 161913 Hvins 8.95
5500VCT/650MA USN Watghs Csd 69.95

END EQUIPMENT BUYS

SCR595 IFF. Less Tubes, As Is 3.98
BC602 Cont Box for 522, As Is 1.29
BC605 Amp. Less Tubes, As Is 3.98
BC906 Freq. Mtr. exc. cond 29.95
I-122A Sig. Gen. 115V/60 Cy $149.50
BC221 Sig. Gen. Exc. Cond $125.00
SCR522A Less/Xtals w/Tubes 69.95
ANTENNA Relay BC442-A, Meter, Thrml Couple, 50 mmf vac Cndsr Complt 5.95
TG5 Kexer, New $5.98
R4/ARR2 Rcvr w/Tubes & Dyns 21.95
BC733D Rcvr CAA Appvd Less Tubes As Is 19.98
RM29 Control Unit BRAND NEW 12.98
EE65 Time Interval Signal, Used 3.98
I-108 Range Calibrator, Metal Case 29.98
I-198 Sig. Gen. Good Cond. Less Tubes 14.95

OIL CAPACITORS

Mfd.	Each
50 wvdc	
4	.49
150wvdc	
1-1-3-5	.69
250wvdc	
2x.25	.35
300wvdc	
1.2	.39
400wvdc	
.1	.49
.5	.59
1	.69
4	1.69
6	2.29
8	2.49
10	2.89
2x.1	.75
2x.5	.94
3x.1	.91
3x.25	.99
600wvdc	
.034	3.69
.1	.52
.2	.69
.25	.61
.5	.65
1	.75
2	.92
3	1.08
4	1.89
5	1.98
6	2.69
7	2.89
10	3.29
2x.1	.79
2x.25	.98
2x.5	.98
2x1	1.19
2x2	1.39
2x8	3.49
3x.05	.89
3x.22	.98
3x.25	1.09
700wvdc	
4	1.98
800wvdc	
.1	.69

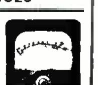
Mfd.	Each
1000wvdc	
.45	.79
1	.90
2	1.69
5	2.98
15	4.98
1400wvdc	
.25	1.29
.5	1.39
1500wvdc	
.5	1.49
.75	1.69
1	1.79
5	3.49
6	3.98
2000wvdc	
.1	1.49
2x.1	1.75
1	1.89
2	2.98
3	.52
8	9.49
2500wvdc	
.25	2.29
3000wvdc	
.1	2.49
.5	2.98
2	4.49
3	6.98
4	7.98
4000wvdc	
2	8.98
5000wvdc	
.2	4.49
2	10.98
4	19.98
7000wvdc	
.002	1.69
.0075	1.98
.1	4.98
7500wvdc	
.03	2.98
.05	3.49
10000wvdc	
.03	3.49
12000wvdc	
.02	4.98

Mfd.	Each
12500wvdc	
2	95.00
15000wvdc	
.0016	9.98
25000wvdc	
.00025	7.49
1	95.00
AC RATED	
220vac/600dc	
2	.69
4	.89
5	1.29
225vac/630dc	
3.3	.79
230vac/630dc	
5	1.29
330vac/1000dc	
1.25	.79
1.5	.89
1.75	.98
2	.33
2.5	1.09
2.8	1.15
3	1.19
4	1.29
5	1.49
12	3.49
15	3.98
25	6.49
40	9.98
405vac/1200dc	
.15	1.29
600vac/1800dc	
16	6.98
660vac/2000dc	
5	4.49
6	4.98
10	6.98
16	7.98

2MFD/330VAC/1000VDC "CD" Rd Can ....3 for $1
9MFD/220VAC/600VDC $1 ....12 for $10

QUANTITY USERS, WRITE FOR SPECIAL PRICES

METER SPECIALS
DC MILLIAMMETERS



0-1Ma 3" sq. Weston $7.50
0-10Ma & 0-5KV (Basic 1 Ma) 3½" 4.98
0-25Ma, Weston 3" sq 6.98

MISCELLANEOUS TYPES

0-50 **Micro Ammeter** 3" sq. Weston $16.98
—20+3 VU, Weston Vol. Level Indict 16.98
0-8V A.C. 3¼" Rnd Weston 3.49
0-150V A.C. 3" sq. Weston Rect. Type 8.98
57-63 Cycles Freq. Mtr. 3" RND 4.98

CONNECTORS CABLE

831R/SO239 Receptacle $0.50 ....10 for $3.90
831SPN/PL259A Plug $0.65 ....10 for 5.50
831SP/PL259 Plug $0.50 ....10 for 4.75
831J/PL258 Junction .... .95
CORD RG8U COAXIAL CABLE per ft .... .12
CORD CD277 6/CNDTR, P/O BC312 .... 1.89
RG59U CABLE per ft. .08; 100 ft. $7; 1M ft. .56
300 M Twinex 100 ft. $1.80; 1M ft 16.00
MICROPHONE CONNECTOR COMB .... .39

TUBES

"TAB" TESTED & GUARANTEED
PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2 .98
OA3/VR75 1.23
OB2 1.37
OB3/VR90 1.09
OC3/VR105 1.19
OD3/VR150 .98
1B3/8016 .83
1B21/471A 2.85
1B22 2.20
1B23 9.90
1B24 17.49
1B26 2.45
1B27 14.98
1B32/532A 3.90
1B35 10.98
1B37 16.98
1B38 29.95
1B40 4.95
1B41 49.95
1B42 18.00
1B46 1.98
1B53 49.95
1B56 38.50
1B58 350.00
1B60 69.75
1B63 50.00
1B63A 75.00
2C39 33.98
2C40 9.98
2C40 JAN 19.90
2C43 26.75
2C43/464A 9.49
2C44 1.20
2C50 3.69
2C51 6.45
2C52 5.98
2E31 1.49
2E36 2.19
2E41 2.39
2E43 1.39
2G21 2.39
2J31 29.75
2J31A 79.95
2J32 59.95
2J33 39.39
2J34 38.50
2J36 120.00
2J37 12.70
2J38 17.75
2J39 11.95
2J42 250.00
2J48 28.50
2J49 39.45
2J50 27.50
2J52 249.50
2J55 85.00
2J56 199.50
2J61 49.95
2J62 49.45
2K25 39.95
2K25/723AB 39.00
2K28 32.00
2K29 23.95
2K33 300.00
2K35 398.00
2K39 100.00
2K42 145.00
2K43 135.00
2K46 360.00
2K47 460.00
2K48 118.00
3B22 2.70
3B23/RK22 4.95
3B24 5.40
3B25 4.50
3B26 3.70
3B28 7.50
3C22 125.00
3C23 12.45
3C31/C1B 3.45
3C33 14.98
3C34/HK24 5.49

3C45 17.98
3D6/1299 .69
3D21A 3.98
3D22 13.95
3D23 4.90
3E29 34.95
4-125A 29.95
4-250A 40.95
4-1000A 108.50
4C35 27.00
EL5BHD 16.98
5C21/C6J 6.95
5C22 52.50
5C30/C5B 3.95
5D21 27.45
5D23/RK65 36.50
5J29 12.40
5R4GY 1.80
5R4WGY 1.75
6AC5 .89
6AG7 1.99
6AH5G 1.99
6AH6 1.99
6AJ5 1.40
6AK5 .90
6AK5W 2.98
6AK6 1.49
6AL5 .69
6AL7GT 1.29
6AN5 2.90
6AQ5 .59
6AQ5W 3.98
6AQ6 1.00
6AQ7GT 1.29
6AR5 .79
6AR6 .79
6AS5 2.98
6AS6 2.79
6AS7G 4.35
6AT6 .82
6AU5GT 1.49
6AU6 .69
6AV5GT 1.29
6AV6 .75
6AW6 1.89
6B4G 1.59
6BA6 .79
6BA7 1.27
6BC5 .69
6BC7 1.23
6BD5GT 1.65
6BD6 .89
6BE6 .79
6BF5 1.06
6BF6 1.49
6BF7 2.55
6BG6G 1.75
6BG7 1.98
6BH6 .89
6BJ6 2.15
6BK7 1.45
6BL7GT 1.45
6BN6 1.49
6BN7 1.69
6BQ6GT 1.29
6BQ7 2.15
6BY5G 1.39
6C21 29.45
6CB6 .89
6CD6G 2.49
6D4 2.70
C6J/SC21 6.95
6J4 7.65
6J5GT .59
6J6 .89
6K4A 6.45
6L6 2.09
6L6G 1.69
6L6GAY 2.29
6SA7GT .89
6SA7GTY 3.37

6SB7Y 1.19
6SC7 1.39
6SD7GT .99
6SF5 .89
6SF7 .89
6SG7 1.39
6SH7 .99
6SJ7 .89
6SK7GT .89
6SL7GT .89
6SN7GT .79
6SN7WGT 2.25
6SQ7GT .79
6SR7 .69
6SS7 1.12
6ST7 1.33
6SU7GTY 3.37
6V6 2.25
6V6GT .69
6W4GT .69
12AH7GT 1.45
12AK5 1.98
12AK5W 2.98
12AL5 1.11
12AT6 .59
12AT7 .93
12AU6 .89
12AU7 .74
12AV6 .69
12AV7 1.35
12AW6 1.79
12AX4GT 1.20
12AX7 .99
12AY7 2.95
12AZ7 1.49
12BA6 .79
12BA7 .79
12BD6 1.75
12BE6 .89
12BF6 .85
12BH7 1.29
12BY7 1.35
12BZ7 1.25
12SG7 1.05
FG17 3.95
19T8 1.09
19V8 1.62
RK20A 8.95
24G/3C24 1.90
25BQ6GT 1.19
25LG6GT .69
25Z5 .79
25Z6GT .99
FG27A 8.70
HV27 10.95
RK28A 4.89
28D7 1.39
FG32/5558 13.85
35Z5GT .59
RK39 2.89
RK48 6.85
RK49 7.50
50L6GT .69
80 .69
81 1.69
FG81A 3.90
82 1.19
82V 1.39
83 1.45
83V 1.79
84/6Z4 .99
FG95/5560 24.85
FG98 19.95
100TH 8.89
FG104 37.98
FG105 18.98
117L/M7GT 1.59
117N7GT 1.79
117P7GT 1.39
117Z6GT 1.19
117Z7GT 1.49
F123A 7.90

F127A 19.98
VT127A 3.90
CV148 4.98
FG166 49.00
FG172 31.50
250TH 22.25
250TL 18.50
304TH 8.90
304TL 8.90
388A 1.49
417A 8.95
417A/5842 18.50
GL434A 29.95
446A 1.05
446B 3.89
450TH 44.00
450TL 52.00
460/HF200 15.95
WL468 13.95
GL471A 2.69
CK501X 1.26
CK501AX 1.26
GL502A 1.79
CK502AX 1.79
CK503AX 1.79
CK505AX 1.79
CK506AX 1.79
RH507 9.98
CK509AX 1.26
CK512AX 3.15
CK522AX 2.49
CK525AX 3.15
CK526AX 3.95
CK528AX 2.39
CK529AX 2.98
GL530 22.00
CK531DX 1.98
531 6.98
CK532DX 1.98
WL532 3.98
CK533AX 1.39
CK534AX .89
CK536AX .89
CK537AX 4.98
CK538DX .89
CK539DX 1.98
CK541DX 1.98
CK542DX .98
CK543DX .98
CK544DX .98
CK546DX 1.98
CK547DX 1.98
CK571AX/5886 4.98
CK573/AX 6029 4.45
WL579 10.49
WL579B 12.98
KU627 18.00
WL652 65.00
WL676 39.95
WL677 34.00
WL686 35.00
707A 7.90
707B 17.49
715A 6.45
715B 8.90
715C 29.85
717A 1.49
718BY 48.45
718CY 48.45
719A 49.95
721A 2.49
722A/287 2.45
723A 11.95
723A/B 25.00
724A 3.95
724B 3.45
725A 8.90
726A 8.45
726B 59.95
726C 69.95

801A .45
803 3.89
805 3.90
807 1.65
808 2.98
809 2.43
810 9.95
811 2.90
812 2.70
813 8.98
814 3.45
815 2.98
816/866Jr 1.07
826 .95
829 11.49
829B 12.45
832 7.65
832A 9.65
833A 39.45
834 5.95
836 4.75
837 1.45
849 29.45
860 4.90
861 23.95
865 1.29
866A 1.50
869 36.95
872A 3.29
893A 250.00
CK1005 .85
CK1027 3.35
CK1028 9.98
CK1089 2.98
CK1090 2.98

Xtal Diodes

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1N21A 1.65
1N21B 3.45
1N21C 27.45
1N22 1.25
1N23 1.35
1N23A 2.45
1N23B 3.70
1N25 7.45
1N26 9.15
1N27 1.65
1N29 3.50
1N32 24.50
1N34 .64
1N34A .98
1N35 1.95
1N38 1.65
1N39 6.15
1N40 9.98
1N41 9.98
1N42 17.50
1N43 1.69
1N44 1.21
1N45 1.39
1N46 .69
1N47 6.39
1N48 .59
1N51 .45
1N52 1.85
1N54 .89
1N55 2.99
1N56 .89
1N57 .89
1N58 1.19
1N60 .60
1N61 2.10
1N63/K63 2.49
1N64 .69
1N67 1.95
1N69 1.98
K34 1.39
CK705 .77
CK706 .54
CK707 1.90

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Current (cont.)	18/14 Volts	26/18 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1AMP			2.10		
2AMP	2.20		3.60	6.50	10.50
4AMP	3.75		6.75	8.75	
5AMP	4.95		7.95	11.95	25.00
10AMP	6.75	9.98	12.00	20.00	45.00
12AMP	8.50		16.00		52.50
20AMP	13.25	16.20	24.00		
24AMP	16.00		31.00		
30AMP	18.50	24.30	36.00		
36AMP	25.50		45.00		

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up to 28VDC at 12 amps 31.98
up to 28VDC at 48 amps 149.50
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31—32—34—36 **Volts/12Amp 2 Kvins** 16.98
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18—12—9—CT—9—12—18V/12Amp 16.75
36VCT—24V—18V/24Amp 35.75

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"Tab" No.	Replaces	W-Sec. Max.	Each
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22ST	FT 110	200	10.98
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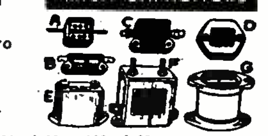

Fig. B. .001 mf. 10c; .006 mf. 23c; .01 mfd. 35c.

Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	Each
600 WV	
.0001	$0.29
.001	.42
.002	.45
.004	.53
.005	.55
.006	.59
.008	.63
.01	.66
.02	$0.76
.03	1.19
1200 WV	
.002	.66
.004	.68
.005	.71
.01	.78
2500 WV	
.00047	.59

Fig. D. Screw Term & Mtg

Mfd.	Each
600 WV	
.0001	$0.29
.00055	.37
.00085	.42
.0012	.44
.003	.49
.005	.54
.015	.71
.02	.78
.03	1.19
.033	1.29
.039	1.98
.04	2.09
.05	2.39
1200 WV	
.001	.61
.002	.66
.0051	.71
.0068	.75
.01	$0.78
.013	.89
.03	1.89
.033	2.39
2500 WV	
.0004	.59
.002	1.09
.0022	1.09
.0024	1.13
.0035	1.19
.0036	1.19
.0043	1.29
.005	1.45
.006	1.55
.01	1.89
.015	2.19
3000 WV	
.005	1.65

Fig. E. Upright Xmtg Micas

Mfd.	Each
250 VDC	
.05	$0.47
.2	2.59
1500 VDC	
.04	.89
.05	1.08
2000 VDC	
.003	1.08
.005	1.19
.006	1.25
.01	1.39
.015	1.68
.02	1.98
.03	2.35
2500 VDC	
.0025	1.08
.006	1.65
3000 VDC	
.00005	.78
.0001	$1.08
.0003	1.15
.0007	1.19
.0055	1.39
3000 VDC	
.0055	1.35
.008	1.79
3500 VDC	
.000033	.78
5000 VDC	
.000082	1.65
.0001	1.79
.00015	2.29
.00018	2.39
.0003	2.75
.00043	2.85
.0006	3.59
.001	3.89
.01	4.79

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CHARACTERISTICS, CLASS A_1 AMPLIFIER

Plate Voltage	300 volts
Plate Current	30 ma
Plate Resistance (Approx.) . . .	0.15 megohm
Transconductance	11000 µmhos
Grid No. 2 Voltage	150 volts
Grid No. 1 Voltage	−3 volts
Interelectrode Capacitances (Without external shield):	
Grid No. 1-to-plate	0.120 µµf
Input	11 µµf
Output	5.5 µµf
Performance, 4-Mc Video Amplifier	
Input Volts (peak-to-peak) . . .	3 volts
Output Volts (peak-to-peak) . . .	132 volts

. . . with the new RCA-6CL6 miniature power pentode

Another RCA First . . . the new RCA-6CL6 miniature power pentode was specifically designed to fill the need for a low-cost, high-output video amplifier tube.

Improved in performance over the RCA-developed 6AG7, this new 9-pin miniature has decreased microphonic response and is capable of driving high-voltage picture tubes with low amplitude distortion.

Having a voltage gain of approximately 44, the RCA-6CL6 can be driven directly by the video detector. It will provide an output of 132 volts peak-to-peak with an input of only 3 volts peak-to-peak from the video detector in a 4-Mc video amplifier.

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