MARCH · 1953

PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION

JUNCTION TRANSISTORS IN PRODUCTION

Beginning in this issue "TRANSISTORS: Theory and Application"

for Stock Hermetically Sealed Components

For over fifteen years UTC has been the largest supplier of transformer components for military applications, to customer specifications. Listed below are a number of types, to latest military specifications, which are now catalogued as UTC stock items.

RCOF CASE

Length 1 25/64
Width 61/64
Height 1 13/32
Mounting 1 1/8
Screws ....4-40 FIL.
Cutout ....7/8 Dia.
Unit Weight ....1.5 oz.

MINIATURE AUDIO UNITS...RCOF CASE

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri., MA	Response ± 2db. (Cyc.)	Max. level dbm	List Price
H-1	Mike, pickup, line to grid	TF1A10YY	50,200 CT, 500 CT*	50,000	0	50-10,000	+ 5	$16.50
H-2	Mike to grid	TF1A11YY	82	135,000	50	250-8,000	+21	16.00
H-3	Single plate to single grid	TF1A15YY	15,000	60,000	0	50-10,000	+ 6	13.50
H-4	Single plate to single grid, DC in Pri.	TF1A15YY	15,000	60,000	4	200-10,000	+14	13.50
H-5	Single plate to P.P. grids	TF1A15YY	15,000	95,000 CT	0	50-10,000	+ 5	15.50
H-6	Single plate to P.P. grids, DC in Pri.	TF1A15YY	15,000	95,000 split	4	200-10,000	+11	16.00
H-7	Single or P.P. plates to line	TF1A13YY	20,000 CT	150/600	4	200-10,000	+21	16.50
H-8	Mixing and matching	TF1A16YY	150/600	600 CT	0	50-10,000	+ 8	15.50
H-9	82/41:1 input to grid	TF1A10YY	150/600	1 meg.	0	200-3,000 (4db.)	+10	16.50
H-10	10:1 single plate to single grid	TF1A15YY	10,000	1 meg.	0	200-3,000 (4db.)	+10	15.00
H-11	Reactor	TF1A20YY	300 Henries-0 DC, 50 Henries-3 Ma. DC, 6,000 Ohms.					12.00

RC-50 CASE

Length 1 5/8
Width 1 5/8
Height 2 5/16
Mounting 1 5/16
Screws ....#6-32
Cutout ....1 1/2 Dia.
Unit Weight ....8 oz.

COMPACT AUDIO UNITS...RC-50 CASE

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri., MA	Response ± 2db. (Cyc.)	Max. level dbm	List Price
H-20	Single plate to 2 grids, can also be used for P.P. plates	TF1A15YY	15,000 split	80,000 split	0	30-20,000	+12	$20.00
H-21	Single plate to P.P. grids, DC in Pri.	TF1A15YY	15,000	80,000 split	8	100-20,000	+23	23.00
H-22	Single plate to multiple line	TF1A13YY	15,000	50/200, 125/500**	8	50-20,000	+23	21.00
H-23	P.P. plates to multiple line	TF1A13YY	30,000 split	50/200, 125/500**	8 BAL.	30-20,000	+19	20.00
H-24	Reactor	TF1A20YY	450 Hys.-0 DC, 250 Hys.-5 Ma. DC, 6000 ohms . . . 65 Hys.-10 Ma. DC, 1500 ohms.					15.00

SM CASE

Length 11/16
Width 1/2
Height 29/32
Screw ....4-40 FIL.
Unit Weight ....8 oz.

SUBMINIATURE AUDIO UNITS...SM CASE

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri., MA	Response ± 2db. (Cyc.)	Max. level dbm	List Price
H-30	Input to grid	TF1A10YY	50***	62,500	0	150-10,000	+13	$13.00
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13	13.00
H-32	Single plate to line	TF1A13YY	10,000****	200	3	300-10,000	+13	13.00
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15	13.00
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6	13.00
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.					11.00

The impedance ratings are listed in standard manner. Obviously, a transformer with a 15,000 ohm primary impedance can operate from a tube representing a source impedance of 7700 ohms, etc. In addition, transformers can be used for applications differing considerably from those shown, keeping in mind that impedance ratio is constant. Lower source impedance will improve response and level ratings . . . higher source impedance will reduce frequency range and level rating.

* 200 ohm termination can be used for 150 ohms or 250 ohms, 500 ohm termination can be used for 600 ohms.
** 200 ohm termination can be used for 150 ohms or 250 ohms, 125/500 ohm termination can be used for 150/600 ohms.
*** can be used with higher source impedances, with corresponding reduction in frequency range. With 200 ohm source, secondary impedance becomes 250,000 ohms . . . loaded response is —4 db. at 300 cycles.
****can be used for 500 ohm load . . . 25,000 ohm primary impedance . . . 1.5 Ma. DC.

United Transformer Corp.

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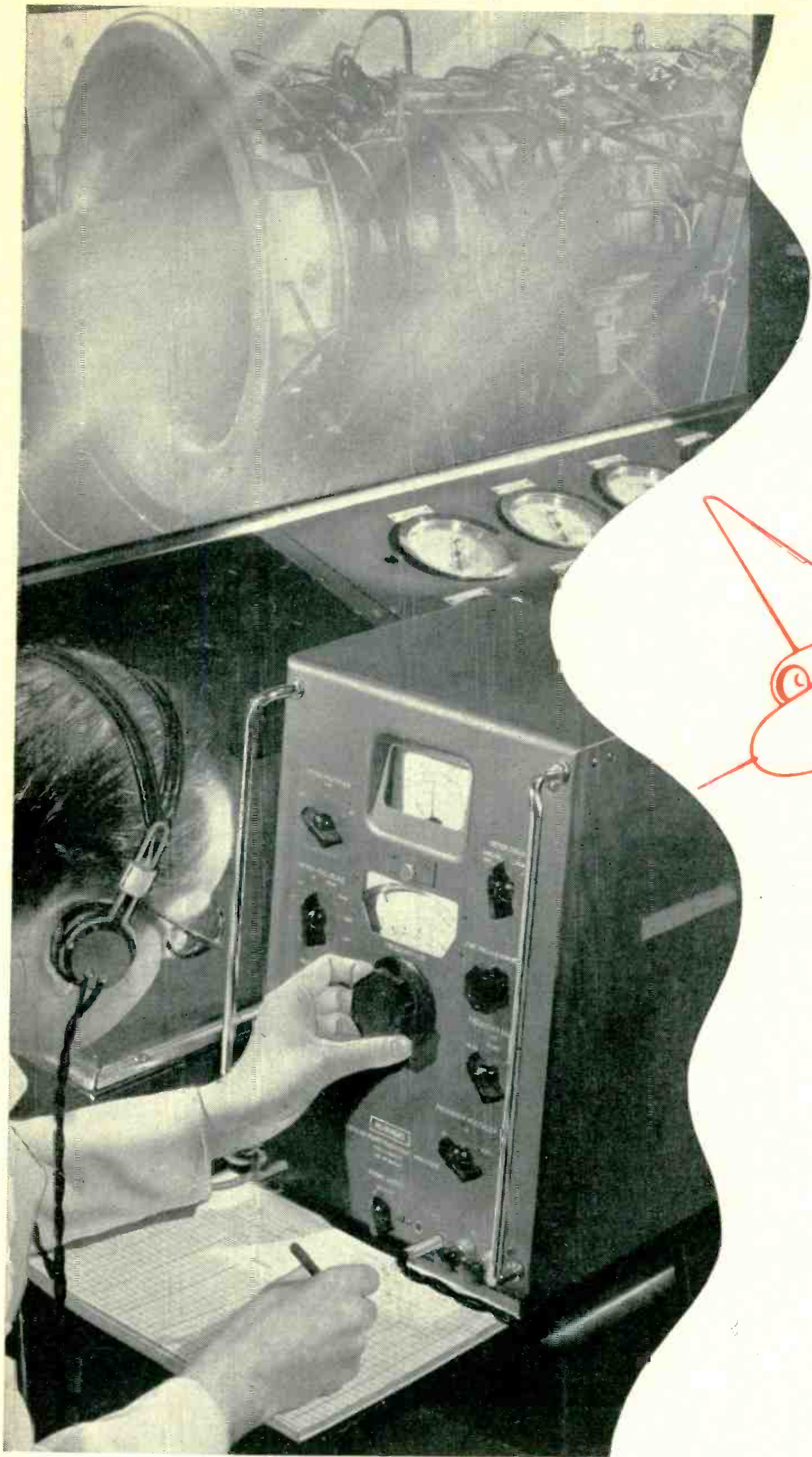
Where every detail matters . . .



Vibration Analysis with the MUIRHEAD-PAMETRADA WAVE ANALYSER at Armstrong Siddeley works, Coventry

At the high speeds encountered with turbo-jet engines, unsuspected blade resonances can cause serious damage. For this reason exhaustive vibration tests must be made, and the source of each vibration located.

Leading British Aircraft manufacturers rely on the Muirhead-Pametrada Wave Analyser — it gives them the frequency and amplitude of each vibration component quickly and accurately; amplitude measurements can, moreover, be made substantially independent of speed fluctuations. Location of the source of vibration then becomes simply a matter of correlating the measured frequency with known engine data.

SEE THE WAVE ANALYSER

AT BOOTH 4-804

RADIO ENGINEERING SHOW

GRAND CENTRAL PALACE NEW YORK

MARCH 23rd-26th, 1953

MUIRHEAD & CO., LTD., BECKENHAM, KENT, ENGLAND

PRECISION ELECTRICAL INSTRUMENT MAKERS

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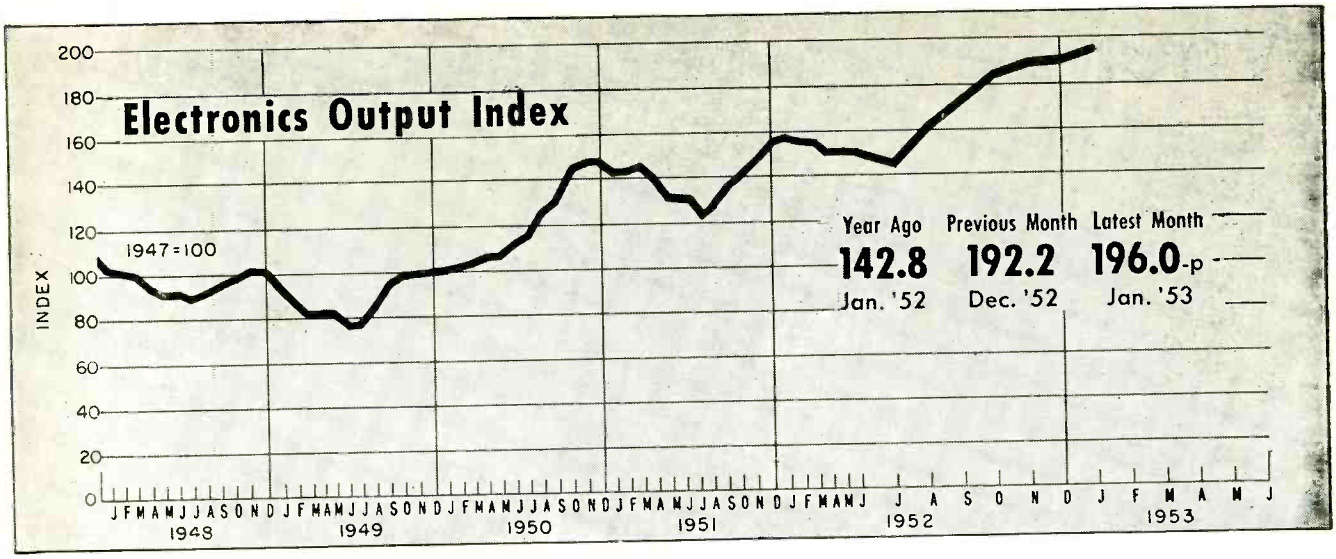


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago Dec. '51	Previous Month Nov. '52	Latest Month Dec. '52
Television sets	467,108	780,486	921,086-p
Home sets	567,929	389,853	452,556-p
Clock Radios	———	185,639	271,507-p
Portable sets	78,056	153,503	194,837-p
Auto sets	222,115	195,200	406,258-p

RECEIVER SALES

(Source: RTMA)	Year Ago	Previous Month Nov. '52	Latest Month Dec. '52
Television sets, units	———	803,327	1,049,770
Radio sets (except auto)	———	486,800	1,514,688

RECEIVING TUBE SALES

(Source: RTMA)	Year Ago Dec. '51	Previous Month Nov. '52	Latest Month Dec. '52
Receiv. tubes, total units	28,000,471	36,942,664	43,220,393
Receiving tubes, new sets	16,176,537	25,898,849	31,061,892
Rec. tubes, replacement	7,117,041	8,568,037	8,771,035
Receiving tubes, gov't.	1,699,914	1,712,080	1,745,491
Receiving tubes, export	3,006,979	763,698	1,641,975
Picture tubes, to mfrs.	371,751	754,060	852,501

BROADCAST STATIONS

(Source: FCC)	Year Ago Jan. '52	Previous Month Dec. '52	Latest Month Jan. '53
TV Stations on Air	108	129	137
TV Stns CPs—not on air	0	144	177
TV Stns—Applications	488	812	791
AM Stations on Air	2,331	2,391	2,399
AM Stns CPs—not on air	75	133	130
AM Stns—Applications	311	251	246
FM Stations on Air	635	616	612
FM Stns CPs—not on air	13	14	15
FM Stns—Applications	7	12	12

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Year Ago Dec. '51	Previous Month Nov. '52	Latest Month Dec. '52
Aeronautical	30,370	34,187	34,600
Marine	33,914	38,166	38,422
Police, fire, etc.	10,161	11,956	12,098
Industrial	11,449	15,347	15,653
Land Transportation	4,653	5,427	5,536
Amateur	100,922	117,069	117,800
Citizens Radio	749	1,803	1,858
Disaster	26	87	87
Experimental	452	503	500
Common carrier	835	1,020	1,023

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Jan. '52	Previous Month Dec. '52	Latest Month Jan. '53
Sets in Use—total	15,777,000	20,439,400	21,234,100
Sets in Use—netw'k conn.	14,931,100	20,408,500	21,136,900
Sets in Use—New York	2,800,000	3,230,000	3,290,000
Sets in Use—Los Angeles	1,090,000	1,320,000	1,375,000
Sets in Use—Chicago	1,090,000	1,325,000	1,360,000

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	Dec. '51	Nov. '52	Dec. '52
AM/FM—ABC	$3,300,219	$2,612,761	$2,856,714
AM/FM—CBS	$5,278,508	$5,419,533	$5,717,800
AM/FM—MBS	$1,697,014	$2,172,485	$1,980,316
AM/FM—NBC	$4,343,307	$4,073,971	$4,370,265
TV—ABC	$1,980,145	$1,368,552	$1,331,588
TV—CBS	$4,736,368	$6,525,176	$7,088,506
TV—DuMont	$937,875	$1,026,566	$1,211,316
TV—NBC	$6,592,673	$7,957,417	$7,830,806

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Nov. '51	Oct. '52	Nov. '52
Prod. workers, electronic	266,500	306,700-r	319,600-p
Av. wkly. earnings, elect.	$64.72	$68.18-r	$68.18-p
Av. wkly. earnings, radio	$61.25	$63.79-r	$63.35-p
Av. weekly hours, elect.	42.0	41.8	41.8-p
Av. weekly hours, radio	41.5	41.1-r	41.0-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Jan. '52	Dec. '52	Jan. '53
Radio—TV & Electronics	270.9	322.7	321.4
Radio Broadcasters	261.4	304.4	300.4

Quarterly Figures

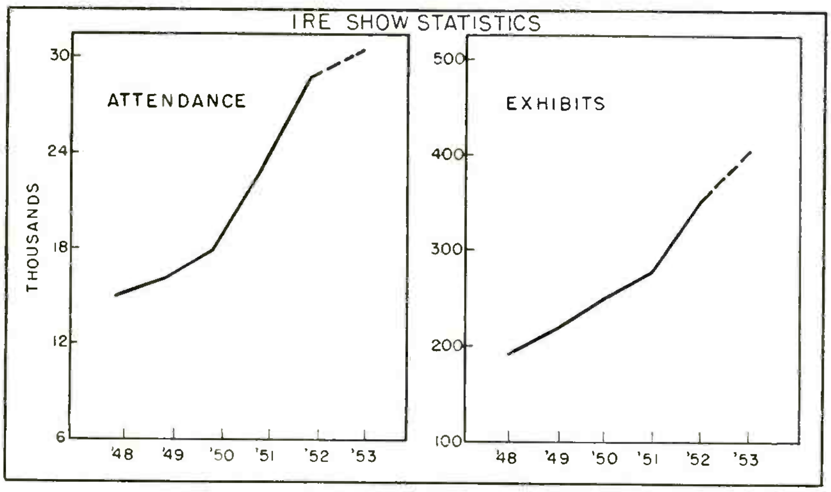
INDUSTRIAL EQUIPMENT ORDERS

(Source: NEMA)	Year Ago 3rd '51	Previous Quarter 2nd '52	Latest Quarter 3rd '52
Dielectric Heating	$210,000	$510,000	$320,000
Induction Heating	$4,060,000	$2,410,000	$1,760,000
Welding Control	$1,280,000	$1,480,000	$1,810,000
Other Electronic Control	$720,000	$1,020,000	$920,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	3rd '51	2nd '52	3rd '52
Vacuum (non-receiving)	$8,420,000	$12,110,000	$10,580,000
Gas or vapor	$2,620,000	$3,150,000	$2,950,000
Phototubes	$270,000	$480,000	$570,000
Magnetrons and velocity modulation tubes	$3,740,000	$9,830,000	$8,500,000

p—provisional; r—revised; e—estimated



MORE engineers and exhibits than ever before will be at . . .

IRE Show, A Preview Of Progress

This year's convention promises to set new high in attendance, exhibits and technical interest

YEAR after year the national convention of the Institute of Radio Engineers has grown in size and scope. It has become a leading national event for the electronics industry commercially as well as technically. Despite future location problems, its continued success in all phases seems assured.

▶ **Progress**—As shown in the charts, the show has more than doubled in size in the last five years. This year's meeting promises to break all previous records for attendance and number of exhibits. Over 30,000 engineers and scientists from all parts of the world are expected to attend. More than 400 exhibits by companies in every facet of the industry will be displayed, representing a value in equipment alone of over $10 million.

Keeping pace with the growth in attendance and exhibits, the technical scope of the convention has also broadened steadily. This year a total of 220 papers will be presented during the 43 sessions and 9 symposia of the show. In 1948 about 140 papers were presented in 27 sessions.

Highlight of the technical program this year will be an all-day seminar on "Acoustics for the Radio Engineer" and 9 symposia organized by professional groups of IRE. The complete technical program for the convention appears in this issue of ELECTRONICS, beginning on page 454.

▶ **Business**—The growth of the show has also meant increased business for participating manufacturers. The fact that companies have continued to return year after year, along with new participants, vouches for its commercial value.

Although the amount of actual orders obtained by exhibitors as a direct result of the show cannot be accurately determined, some smaller electronic manufacturers have indicated that as much as 50 percent of their total annual order volume resulted from show participation. Even without orders, manufacturers have found the convention to be of substantial institutional value and of valuable aid in locating available engineering talent.

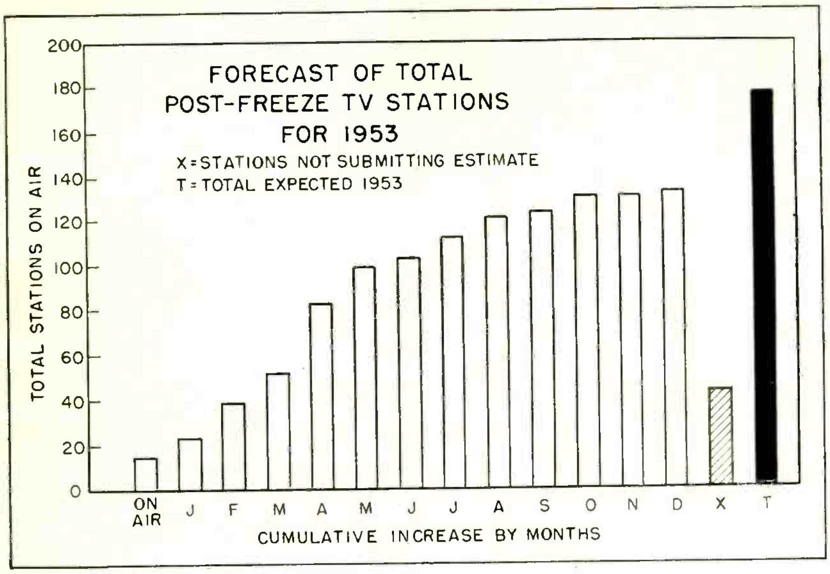
▶ **Future**—Next year's IRE show will be held at the Kingsbridge Armory in the Bronx, N. Y. if the Bureau of Internal Revenue goes through with plans to take over Grand Central Palace for office space. It is considered likely that the Bronx may also be the show site for 1955 although Atlantic City is being considered for that year if the Bronx location proves inadequate.

In 1956 it is expected that the mammoth Columbus Circle Coliseum in New York City will be completed and available for use. If present rate of growth continues, the 1956 IRE national convention will probably need the space.

TV Broadcast Industry Forecasts Own Growth

Month by month totals for post-freeze stations on the air in 1953 are predicted

ACCOMPANYING bar chart showing the probable growth of post-freeze tv stations on the air by the end of 1953 rests squarely upon the shoulders of the broadcasters themselves. In it, some 119 post-freeze grantees indicate their hoped-for starting dates (45 others refused to put themselves on the spot). Added to the year-end total are 13



already making use of their new post-freeze grants.

▶ **Red Faces?**—An additional 25 on the air at year's end would be a source more for rejoicing than embarrassment. Reddest faces so far are those of the uhf transmitter manufacturers, whose production lines have not quite caught up with press departments' output.

Synthetic Mica Used Commercially

Crystals 'grown' in electric furnaces still too small for capacitors, but have other uses

ALTHOUGH military research funds have not yet paid off in freeing U. S. from dependence on India for natural mica splittings, commercial byproducts of the research are emerging. This means that huge electric furnaces for growing mica crystals artificially may soon be in operation without government support.

▶ **The Mica Business**—Over 8,000,000 pounds of mica splittings are imported annually, with roughly 90 percent coming from India and the rest from Brazil, at an average price of $1 a pound. The largest sheets, needed for mosaics of tv camera tubes, are worth up to $500 a pound.

Circle and punch mica, used chiefly for vacuum-tube spacers, runs about 18 cents a pound for the 2,500,000 pounds needed annually by the tube industry. This grade is available from U. S. mica mines and can also be made synthetically, though at about twice the price.

Though some 60,000 tons of scrap and ground mica are used annually, availability is excellent at the going rate of 3 cents a pound. For electric furnaces operating at 30 cents a pound, synthetic production of this grade is economical only as a byproduct of sheet-growing.

About three-fourths of the imported splittings go into built-up or reconstituted mica worth around $2 a pound. Here synthetic mica offers the best possibilities.

▶ **Reconstituted Mica**—Use of smaller mica pieces and elimination of hand splitting are the chief advantages of a relatively new process of reforming mica into large, continuous sheets. The mica is disintegrated by beating it for a minute or two in a blender half-full of distilled water, and the sheet is formed by pouring the mica suspension over a suction filter. After drying, the tiny pieces cohere to give a mat with some strength and elasticity, though less than that of natural mica; the cohesion is believed due to electrostatic charges. The reconstituted mica flakes can be permanently bonded together by hot-pressing near the melting point of the mica.

With synthetic mica flakes, a lower-melting-point synthetic boron mica can be mixed in and heated just above its fusion temperature to give a mica-bonded mica sheet. There are excellent possibilities here of developing an automatic continuous process for manufacturing a high-temperature-resistant mica sheet of controlled thickness for capacitor use.

Community Television Continues To Expand

DESPITE post-freeze station building, the future seems bright for community antenna operators. Systems total 149 today as against 96 half a year ago; 26 new systems are planned.

An estimated 70,000 to 85,000 homes receive their television entertainment via cable, with the viewers coughing up three-billion dollars annually in service charges. Manufacturers can thank community tv for helping sell $17,500,000 worth of sets in otherwise inaccessible communities. Antenna operators have collected $8,750,000 in hook-up fees.

Pennsylvania is still the center of community television, with 53 systems. West Virginia has 23, while California, a comparative latecomer, has 18 systems.

▶ **Multiple Owners**—Reportedly only half the antenna operators are making a profit from their enterprises but this is attributed largely to slipshod business methods. The multiple-system owner, often backed by big-money interests, has made his appearance on the scene. A California operator has a chain of five systems while a Pennsylvanian is running three.

Very ambitious is Jerrold Electronics, backed by J. H. Whitney and Co., large New York investment house. Jerrold is aiming at 6,000 subscribers in Williamsport, Pa.,

(Continued on page 8)

550 TO 3800 MEGACYCLES

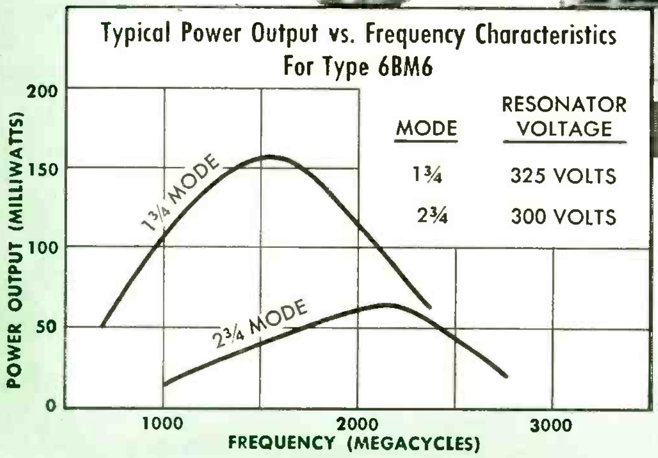
with Sylvania 6BM6 Broadband Tunable KLYSTRONS

Sylvania now offers 4 different Klystron types, designed for external cavity resonators covering a frequency range from 550 to 6500 megacycles.

Types 6BM6 and 6BL6 are designed for CW applications, while types 5836 and 5837 may also be used in pulse modulated oscillation.

Sylvania Klystrons provide continuous tunable output over wide ranges of the micro-wave spectrum. New illustrated catalog gives complete specifications. Mail the coupon for your copy now.

We also welcome your inquiries regarding the designing of cavities for various types of circuits.



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and a second system is under construction in Fairmont, W. Va. The Jerrold-Whitney group has three additional systems in the planning stage. Jerrold also runs systems in Walton, N. Y., Harlan, Ky. and Ventura, N. J.

▶ **Subscription TV**—Community antennas and pay-as-you-go television apparently were made for each other. With FCC approval the sticking point for subscription tv via the air waves, community antenna operators are free to distribute quality programs of local origin over an unused channel of their wire system and charge by the program.

Telemeter has a coin-box system operating in Palm Springs, Calif. The system uses Jerrold 7-channel equipment. Telemeter is so thrilled over the marriage of the cable and coin box that they have now gone in for manufacturing components for community-tv systems themselves. Since turnabout is both fair and profitable play, Jerrold is experimenting with a subscription television system.

▶ **Boosters and Satellites**—An alternative means for bringing television to mountain-ringed communities is the booster or satellite plan. A booster picks up a tv signal and reradiates it on the same channel with vertical polarization. Satellites reradiate the signal on a different frequency. One of each of these systems is now operating experimentally.

Community tv manufacturers announce that they are ready to join in booster operation, pointing out that satellite operation requires additional channel assignments.

▶ **Local UHF**—Local uhf stations have already proved a boon to some community-tv operators. Take the case of Shinshinny, Pa.: Interest in community tv rose in this mountain-ringed community only after nearby Wilkes-Barre began work on its uhf outlet. Community-tv manufacturers state that special crystal-controlled uhf-to-vhf converters designed for unattended operation will be available when system operators require uhf reception.

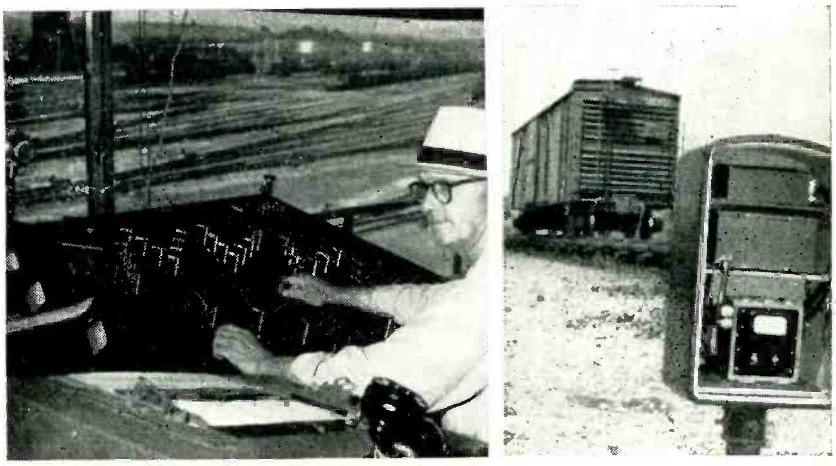
Paramount-ABC Merger Approved

Split decision paves way for the biggest transaction in broadcasting history

APPROVAL by the Federal Communications Commission of the merger of United Paramount Theaters, Inc. and the American Broadcasting Company will have widespread effects on the U. S. broadcasting business. It not only permits the formation of a new broadcasting network but directly affects the operations of four other companies in the broadcasting and tv manufacturing field. The full effects of the merger may not be apparent for some time, however.

▶ **New Network**—The new network that will result from the merger will be known as AB-PT, Inc. and will have assets of about $150 million behind it. Its formation involves a $25 million stock transaction, the biggest in the history of broadcasting.

The new corporation will control five tv stations, six a-m stations and six f-m stations, in addition to 707 theaters throughout the country. It now also has 81 tv stations and 353 radio stations as affiliates.



OPERATOR in freight-yard control tower (left) engages remote car-retarder when speed meter (right) warns that coupling speed is unsafe as . . .

Radar Eases Freight-Car Jolts

Unmanned freight cars roll safely down grade into classification yards

RADAR speed meters, familiar hazard to highway speeders, help insure safe automatic freight handling in railroad classification yards.

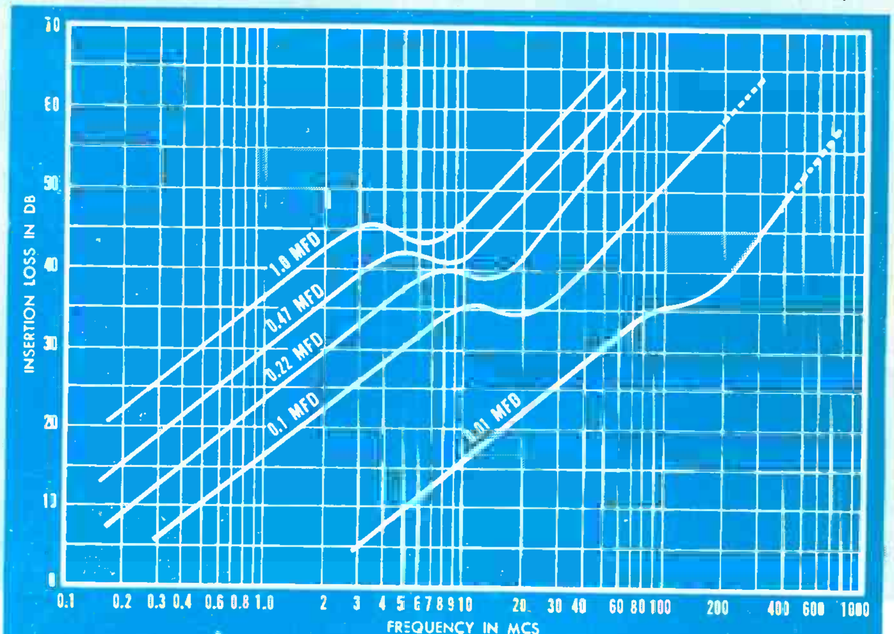
Cars are pushed over a rise of ground by a switch engine and decoupled, rolling by gravity into classification tracks where trains are made up. The speed meter clocks the rolling cars, warning the operator in the yard's control tower if their speed is too high for safe coupling. The operator then manipulates remote electronic controls that slow the car by engaging retarders, long clamps faced with hard rubber that squeeze wheel flanges against the track.

▶ **Equipment**—Operating on 2,455 mc in one of the industrial-medical-scientific bands, the speed meter works on the Doppler (frequency-

(Continued on page 10)

THE MOST EFFECTIVE CAPACITORS FOR R-F NOISE SUPPRESSION...

...are the NEW SPRAGUE THRU-PASS® CAPACITORS



Typical Insertion Loss Curves

THRU-PASS CAPACITORS are a new Sprague development for use in radio interference reduction in communication and radar equipment.

• Thru-Pass Capacitors not only reduce to a negligible value the effect of external connection inductance to a capacitor but they also have a minimum length of internal path for radio interference currents. *Their performance is closer to that of a theoretically ideal capacitor than that of any other paper capacitor!*

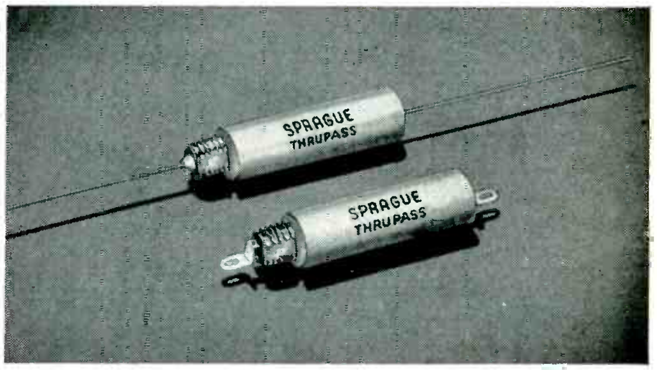
• Electrically, Thru-Pass Capacitors are three-terminal feed-thru devices which are connected in a circuit in a manner similar to a low pass filter; the tab or lead terminals are connected in series with the circuit being filtered while the case is grounded.

• The threaded-neck mounting on Type 102P and 103P Subminiature Thru-Pass Capacitors is designed to give a firm metallic contact with the mounting surface over a closed path encircling the feed-thru conductor and to eliminate unwanted contact resistance so that the theoretical effectiveness of these new units is realized in practice. The milled flats on the threads help ensure vibration-proof mounting since the capacitors cannot rotate if mounted in a flatted opening instead of the usual circular hole.

• Type 102P and 103P Capacitors are all hermetically encased. Glass-to-metal solder-seal terminals are employed in order to assure positive protection against severe atmospheric conditions.

• Both types are impregnated with Vitamin Q, Sprague's exclusive inert synthetic impregnant, in order to provide maximum insulation resistance and minimum capacitance change with temperature. Type 102P units are processed for −55°C to +85°C operation while Type 103P units have their top operating temperature extended to +125°C.

• Engineering Bulletin 215 gives full details and standard ratings. Write on your business letterhead for your copy to Sprague Electric Co., 35 Marshall St., North Adams, Massachusetts.



TYPES 102P AND 103P 5 AMPERE THRU-PASS CAPACITORS SHOWING CHOICE OF LEAD OR TAB TERMINALS

SPRAGUE WORLD'S LARGEST CAPACITOR MANUFACTURER

EXPORT DIVISION: CABLE SPREXDIV, NORTH ADAMS, MASS.

"THRU-PASS" AND VITAMIN "Q" ARE SPRAGUE TRADEMARKS.

See us at the I.R.E. Show—Booths 1-410 & 1-412 change) rather than the pulse principle. The transmitter consists of a single 2C40 'lighthouse' triode operating as a fixed-frequency cavity oscillator. Output is nominally 4.5 watts c-w, delivered to two half-wave dipoles fed in phase.

Equipment costs approximately $1,000 when used in conjunction with a graphical recorder.

▶ **Use**—Radar speed checking is used by the Southern Railway System in the John Servier Yard, Knoxville, Tenn. and in Ernest Norris Yard, Birmingham, Ala. Another user is the New York, New Haven and Hartford Railroad.

Speed checking by Doppler radar is used extensively on highways. Two well-known users are the Connecticut and Maryland State Police, with installations on the Merritt Parkway and Washington-Baltimore Boulevard.

Radioactive Tracers Check Germanium

Minute traces of foreign elements are measurable for research in transistors

ONE OF the most exacting processes involved in the manufacture of transistors is the control of the amount of impurities in the semiconductors used. The usual technique is to refine the material well beyond the required value and then to add appropriate and controlled amounts of the desired impurities.

Production is limited by difficulty of determining when the super-pure state has been reached. A method for achieving this type of measurement to one part in one hundred million has been developed at Sylvania by George Morrison of the Radiochemical Laboratory at Bayside, New York.

▶ **Method**—A sample whose purity is to be determined is sent to Brookhaven National Laboratories, where it is placed in a reactor and thereby subjected to radiation. The sample becomes hot by a measurable amount proportional, among other things, to the percentage of impurities present. It is thus possible to calculate the degree of impurity with extreme accuracy.

The technique has proved successful in preparing germanium samples with arsenic impurities. Other vehicles and impurities may be studied in the same manner.

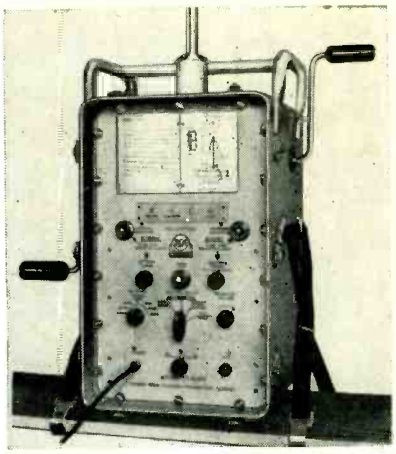
Safety-of-Life-at-Sea Radio Equipment Ready

NEW aids to save lives were provided for under the International Convention on Safety of Life at Sea, London, 1948. With the final ratification (ELECTRONICS, p 10, Mar. 1952) of this Convention, four years later, FCC quickly set up specifications for fulfilling the electronic requirements. In less than two months American manufacturers came up with prototypes.

▶ **The Equipment**—The provision that newly certified ships beginning Nov. 19, 1952 must carry certain main or auxiliary radiotelegraph equipment may mean a bit of extra change for a good many small and big manufacturers. Lifeboat portable radiotelegraph equipment, on the other hand, is so radically new as to require complete redesign and may be attempted by only a handful of those in the field. FCC will await type approval of commercial equipment before specifying a compliance date.

Among the features required of the new lifeboat radio design are ability to send or receive on two distress-frequency bands—492 to 508 kc and 8,240 to 8,800 kc. Transmissions are modulated with an 800-cycle tone and the receiver can be adjusted for tone or continuous-wave signals.

▶ **Autoalarm and SOS**—A hand generator supplies all power and an automatic keying device must be provided to send the international autoalarm signal (12 dashes in one minute) followed by SOS on 500 kc. When switched to the 8,364-kc position, the automatic keyer must send SOS and a 30-sec dash for direction finding by rescue craft. Other requirements include a collapsible aluminum-rod antenna and ground wire with sinker.



RCA version of an automatic transmitter-receiver unit required in lifeboats of American-flag ships

Electronic Plants Are Safer Now

Injury frequency dropped as the industry made progress in safety

DESPITE higher production and employment, work injuries in radio-tv, tube and communications equipment plants have declined significantly since 1949, reflecting the increasing efforts of manufacturers to make their factories safer places in which to work.

The number of injuries per million-employee-hours worked declined to 4.3 in the first six months of 1952 (latest reported period) compared to a high of 5.3 in 1950 when there were almost 50,000 less employees. With about 12 million employee-work-hours clocked in the industry every week, this decline has meant an average of 12 less injuries every week.

▶ **Trend**—As is shown in the chart, the decline in disabling work injuries, which are any injuries occurring in the course of employ-

(Continued on page 14)

announcing the Centralab

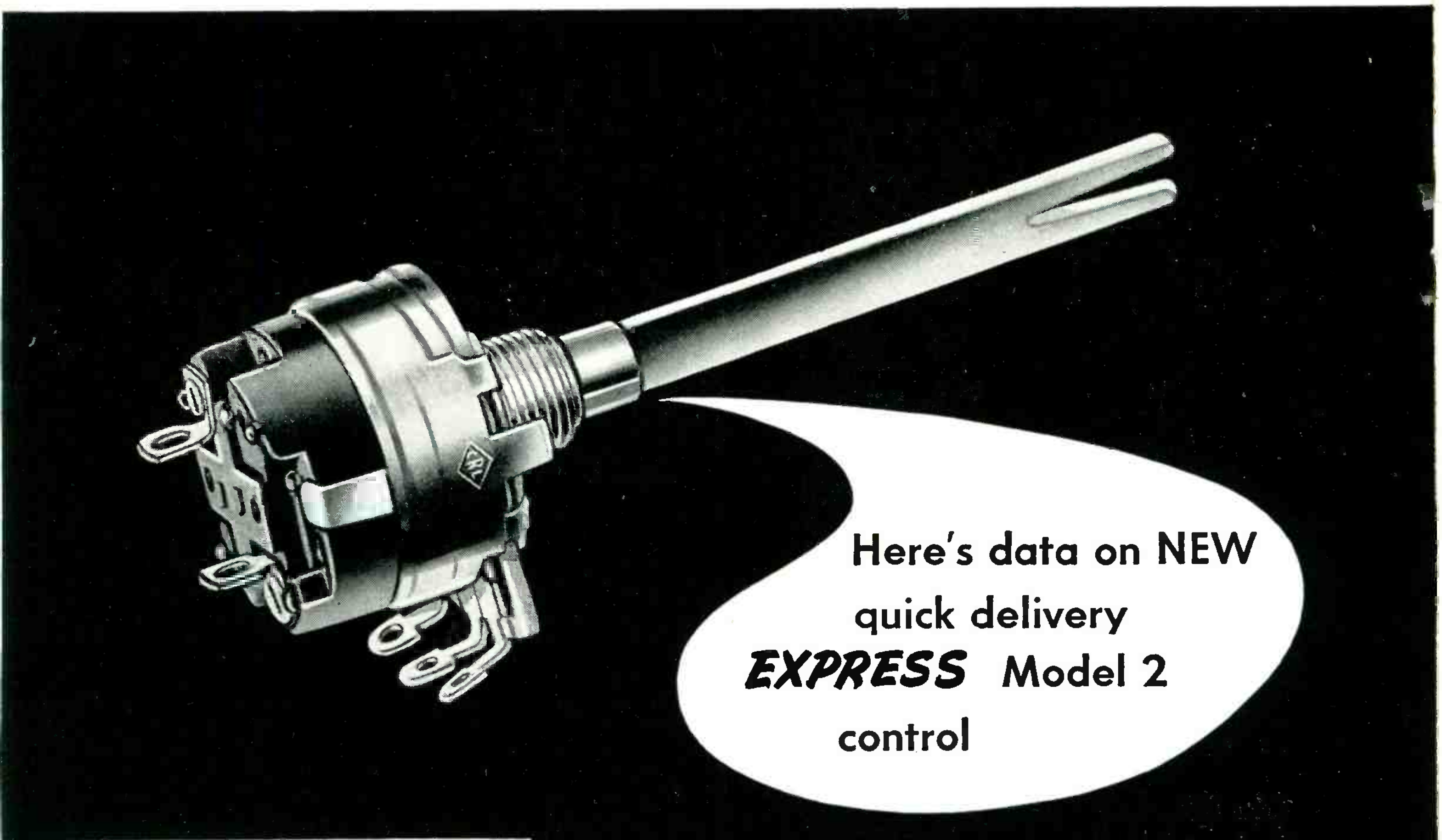
"EXPRESS"

Need popular-taper, standard-shaft controls in a hurry?

Then see next 2 pages

These up-to-the-minute Centralab

You can count on prompt delivery from Centralab's wide variety



Quick delivery plus these features make the Model 2 Express the control for YOU

- **resistance range:** ½ megohm and 1 megohm ± 30%
- **taper:** Audio, Centralab C2
- **wattage rating:** ½ watt
- **voltage rating:** Tested to withstand 1000 volts rms
- **marking:** Control stamped with Centralab part number, resistance and taper; shaft stamped with shaft number (Except Number 1)
- **bushing:** ¼" long from mounting surface. ⅜" — 32 NEF thd.
- **switch:** Single-pole, single-throw, rated 5 amps at 125 volts a-c. UNDERWRITERS APPROVED.
- **how to order:** Specify Centralab Express radiohm, maximum resistance desired (either ½ or 1 meg.) shaft length desired by number and/or length FMS. Specify quantity.

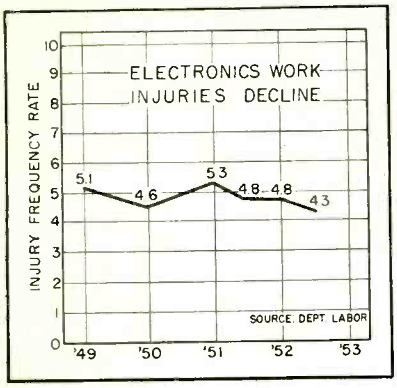
Available in ½ and 1 megohm values...meet 75% of requirements for switch-type controls

HERE'S big news! Centralab's newest — the *Model 2 Express Control* — is just what manufacturers needing controls on extremely short notice have always wanted. Unique time-saving feature simplifies shaft assembly requirements — control shafts fit all standard RTMA split-knurled and certain spring-type push-on knobs.

Shafts and controls are carried in stock at our plants. When your order is received, desired shafts are staked directly to controls. Complete assembly arrives in *your* plant in just a few days. To help you plan . . . Centralab will even tell you approximate delivery time in hours from the date your order is received.

The new Express is available in two values: ½ and 1 megohm, audio taper (C2) with SPST a-c line switch. These two values meet 75% of the requirements for switch-type controls. Talk about versatility! Flat shafts are stocked separately in 14 lengths ranging from ⅞" mounting surface to 2½" fms in increments of ⅛".

Think what this range *plus* quick delivery can do to solve your *immediate* production requirements! Quickest way to get started is to check Bulletin 42-163 in coupon.



ment which makes the injured worker unable to perform his regular duties, has not been a steady decline in the last four years.

With the outbreak of the Korean War in 1950, the injury rate rose to its highest point during the period. One main factor contributing to the rise that year was the relatively sudden demand for production increases brought about by defense needs and tv scare buying. Employment and overtime hours rose suddenly and accidents climbed as work fatigue increased.

▶ **Progress**—Electronic manufacturers see many reasons for the downward trend in the injury frequency rate. Labor unions as well as manufacturers emphasized the safety factor and safety engineering became a regular part of the production plans of many firms.

Other overall factors such as mechanization, better lighting and better facilities have contributed to the decline. Electronic manufacturers have found that such safety progress pays off not only in higher employee morale but in higher production and lower insurance rates.

▶ **Future**—Electronic manufacturers are continuing to improve plant safety conditions and are far ahead of many other industries in this respect.

Recently the television-radio division of Westinghouse established an all-time safety record for the entire electrical equipment industry when 15,040,000 employee-working-hours went by without a lost-time accident. With safety engineering and modern construction increasing in the industry, more new safety records may well be in the making.

Radio-TV Firms Add Other Lines

Diversification trend accelerates as manufacturers continue to broaden their activities

DIVERSIFICATION is not new to many raido-tv manufacturers. Companies in the field manufacture products ranging from sporting goods to bathroom fixtures. But in recent months the trend to other lines has accelerated and important set manufacturers have entered other product fields.

Stabilization is one of the reasons for these moves and indications are that the trend will continue at an even faster pace in the future.

▶ **New Fields**—RCA is the most recent of the major companies to move into new lines. It began with air conditioners last year and then moved into the electric range field. Now it is rumored that the company will market washing machines under its diversification plans.

Admiral has also recently entered more heavily into appliances. The firm has announced plans to manufacture and sell a line of air conditioners and home freezers in 1953. It has been in the refrigerator and range business for some years and has also made a line of dehumidifiers. With the new product additions, the company expects to double the sales of its home appliance division this year.

▶ **Why?**—Probably the basic reason why radio-tv companies have entered new fields was best stated by one manufacturer who bluntly answered—"To make more money." Other reasons for the trend seem to lie in the radio-tv business itself. Its tremendous growth since the war has given radio-tv companies the capital to make acquisitions. In addition, its close association with other products through common wholesalers and dealers, especially in appliance lines, has made the moves easier.

The seasonal nature of the radio-tv business has also been responsible for diversification. Manufacturers have found that one of the best ways to combat the drop in radio-tv sales in the summer and stabilize their sales is to have another line of products to sell that are in season. Home appliances have met this need successfully and this is the field most radio-tv companies have entered.

Another very significant reason for the diversification trend was recently stated by R. D. Siragusa, president of Admiral "In marketing generally, and in the marketing of consumer durables particularly, brand names are becoming more and more important. To establish a brand among the top sellers requires increasingly large outlays for demand creation in the form of advertising and promotion. This also automatically means that successful companies will tend to have a family of related products so that the advertising and promotion investment made for the brand will be spread over more units."

Radiation Instrument Industry Grows

RADIATION instrument industry, virtually non-existent in 1946, had an annual business of $20 million in 1952 and employed more than 2,400 persons, according to a survey by the U. S. Atomic Energy Commission. Seven companies account for about 50 percent of the industry's activity.

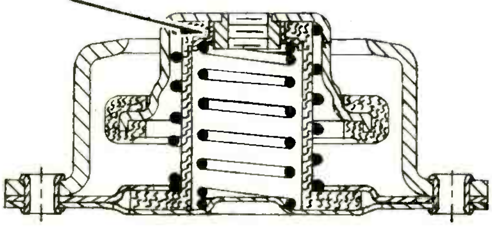
Growth of the new industry has paralleled development of the nation's atomic energy program since early 1947, when the AEC adopted a policy of encouraging its operating contractors to procure radiation instruments from commercial manufacturers.

▶ **Market**—The survey shows an expanding market for radiation instruments outside of the AEC program as well as within it. Military agencies of the government now provide about 50 percent of the

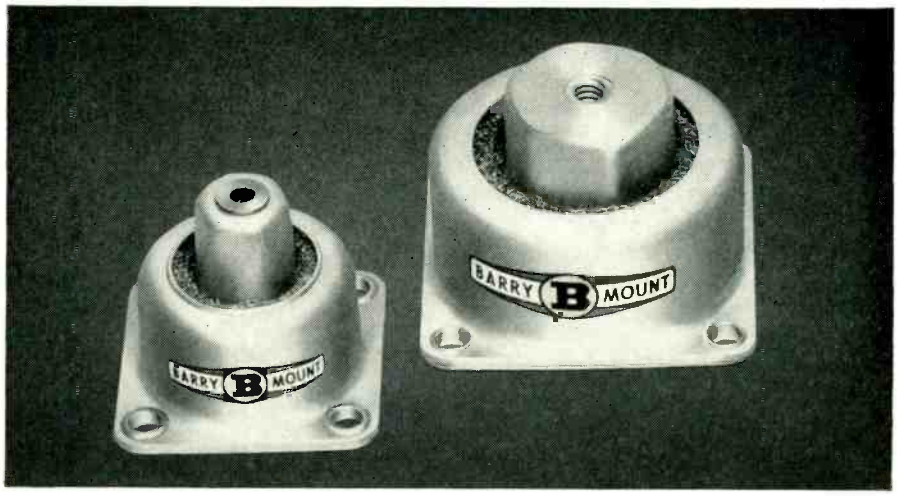
(Continued on page 16)

SHOCK AND VIBRATION NEWS

HERE'S THE SECRET



... of a NEW wire-mesh isolator that won't change on the job!



The new Type 7630 and Type 7640 ALL-METL Barrymounts have been specifically designed to eliminate loss of efficiency due to damper packing. Previous wire-mesh unit vibration isolators exhibited a definite loss of damping efficiency after a period in actual service, because the wire-mesh damper tended to pack. These new unit Barrymounts have eliminated this difficulty, because the load-bearing spring returns the damper to its normal position on every cycle.

- Very light weight — helps you reduce the weight of mounted equipment.
- Hex top — simplifies your installation problems.
- High isolation efficiency — meets latest government specifications (JAN-C-172A, etc.) — gives your equipment maximum protection.
- Ruggedized — to meet the shock-test requirements of military specifications.
- Operates over a wide range of temperatures — ideal for guided-missile or jet installations.

Compare these unit isolators with any others — by making your own tests, or on the basis of full details contained in Barry Product Bulletin 531. Your free copy will be mailed on request.

See these new isolators in action, and discuss their applications with us, at the New York I.R.E. Show.

THE BARRY CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington total market, the AEC and its principal contractors provide about 30 percent and the remainder is accounted for by private industry, universities, hospitals and research institutes, civil defense, export and uranium-ore prospecting.

More than 50 patents in the field are owned by the U. S. and held by the AEC. A total of 51 non-exclusive, royalty-free licenses have been granted on these patents.

US Drops Suit Against Set Makers

CONVENED LAST JANUARY, a New York City grand jury failed to turn up evidence of "the use of force, strong-arm tactics or activities of a similar punitive nature" by the radio-tv industry. As a result, James P. McGranery, now ex-Attorney General, dropped the Government's criminal anti-trust suit which involved many major radio and tv manufacturers.

McGranery stated it was now the Government's opinion that a civil anti-trust suit would get "whatever restraints may exist in the industry", and that's where the matter rests at the moment.

Industrial TV Monitors Production

Electronic watchdog keeps an eye on products ranging from oysters to sugar cane

CLOSED-CIRCUIT television systems for industrial applications involve a number of compact, specialized units permitting centralized control or for watching processes too dangerous for visual observation. Uses range from watching boiler-water level gages and smoke stacks in power plants, to underwater inspection of dock pilings and wharves.

Remington-Rand and RCA color systems are being used in medical schools to permit a large number of students to look over a surgeon's shoulder while he operates.

A stereoscopic tv system developed by DuMont is being used at Argonne National Laboratory to observe work with radioactive materials. Another three-dimensional system, made by the Fenjohn Photo & Equipment Co., is being used by the Maryland Fisheries Commission to study oyster beds.

A system of mirrors installed in a Waialua, Hawaii sugar plantation was an ingenious idea for continuously checking the progress of sugar cane along the conveyors. However, it didn't work because of vibration, dirt and spray.

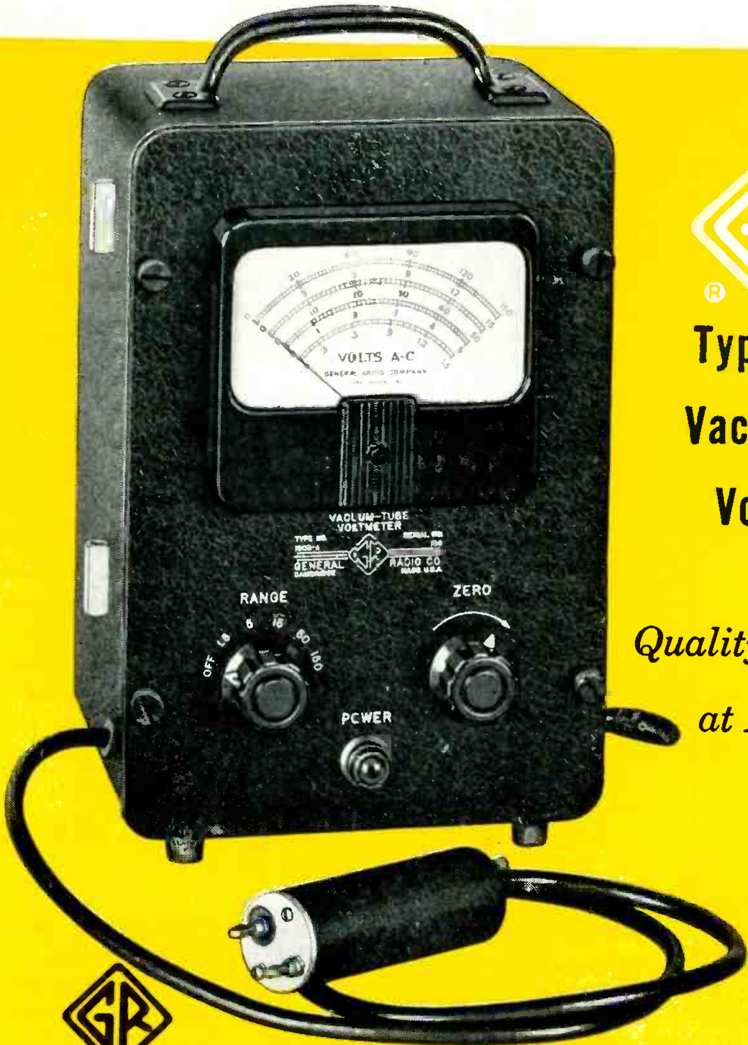
▶ **Electronics to the Rescue**—The need for close control of volume and speed was so great that this plantation, as well as another at Ewa, are installing closed-circuit television systems at a cost of $7,500 apiece. Cameras can be so mounted and protected from dirt and spray that they will give a picture of the cane moving mechanically from cleaning plant to grinding machinery. A coaxial cable system will relay this information from the cameras to a tv receiver at the control center.

▶ **Equipment Requirements**—Since most industrial television equipment is operated by unskilled personnel, adjustments and controls must be kept at a minimum. For the same reason a minimum of

(Continued on page 18)

Closed-Circuit TV Brings Meter Readings to Last-Row Students

Schools are potential market for industrial television systems. In this physics lecture hall at Cornell University, Professor Guy E. Grantham is holding a light-meter in front of the RCA camera. Resulting image of meter scale fills entire screens of two 21-inch television receivers watched by students. Camera can also be aimed into microscopes and cloud chambers to show phenomena that would otherwise be visible to only one person at a time



Type 1803-A Vacuum-Tube Voltmeter

a Quality Instrument at Low Cost

The Type 1803-A Vacuum-Tube Voltmeter fills the need for an easily operated instrument, of adequate range and accuracy, selling at a price within modest laboratory budgets.

This instrument is a standard vacuum-tube voltmeter devoid of frills; it has no d-c or ohm scales, but is a *superior* a-c voltmeter. It will measure voltages between 0.1 and 150 volts to a basic accuracy of 3% and at frequencies up to 100 megacycles. With the accessory Type 1803-P3 Multiplier attached to the probe, the voltmeter range is extended to 1500 volts over a 50 Mc. range.

This voltmeter is small and light in weight, has a completely shielded probe, a single zero adjustment for all five ranges and an internal power supply operating from ordinary 50-60 cycle, a-c lines. For greatest accuracy, there are four meter scales covering the complete 0 to 150 volt range. The cabinet is of welded, heavy gauge aluminum with rubber feet for either vertical or horizontal positioning.

The input voltage is rectified by one section of the twin diode and the d-c passed on to the grid of a triode in one arm of a balanced amplifier circuit. The other, "inactive", diode balances the effects of contact potential of the input diode. The balanced amplifier circuit insures minimum shift in calibration with line voltage changes.

SPECIFICATIONS

Accuracy — *3% of full scale for sinusoidal voltages on all ranges, subject to frequency correction above 50 Mc. (Correction chart supplied)*

Input Impedance — *7.7 megohms in parallel with approximately 10 μμf; the parallel resistance increases at higher frequencies*

Power — *105 to 125 volts or 210 to 250 volts, a-c, 50-60 cycles*

Accessories Supplied — *Type 274-MB Plug, pair of 30-inch test leads, and two alligator clips to facilitate connections*

Dimensions — *(Width) 7¼ x (Height) 11¾ x (Depth) 6$\frac{7}{16}$ inches*

Net Weight — *9¼ pounds*

Type 1803-A Vacuum-Tube Voltmeter $155
Type 1803-P3 Low-Frequency Multiplier ... $21

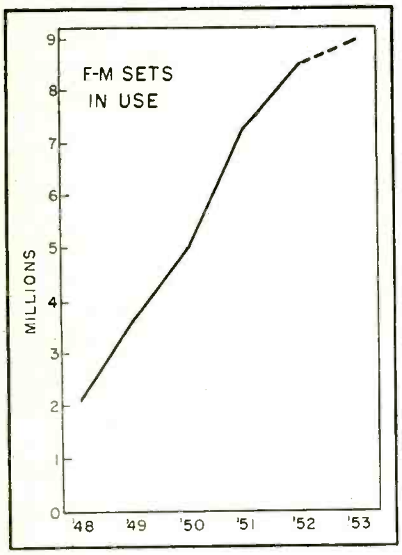
GENERAL RADIO Company
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.
90 West St. NEW YORK 6 · 920 S. Michigan Ave. CHICAGO 5 · 1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Geiger Counters ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators ☆ Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls ☆ Noise Meters ☆ Null Detectors ☆ Precision Capacitors ☆ Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters ☆ U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes

Want more information? Use post card on last page.

maintenance should be required.

A portable unit made by the Diamond Power Specialty Co., with camera, power supply and receiver, weighs less than 150 pounds. Camera units are being made that measure less than 8 by 4 by 4 inches. A mount for this camera made by the General Precision Laboratory permits remote viewing with control of camera angle, focus and lens opening from the viewing point.



THERE are 9 million f-m sets in use and . . .

F-M Radio Catches Its Second Wind

Despite a decline in production there is still plenty of life in the field

PRODUCTION of frequency-modulation radio sets has decreased in the past two years but dollar volume is still significant and the field represents a thriving business for some manufacturers. In some areas where tv's popularity gave f-m a temporary setback there are signs that it is catching its second wind.

▶ **Trend**—As shown in the chart, there is a total of 9 million f-m sets in use in the U. S. In 1950, the banner year for f-m, over 2.2 million units were produced. In 1952, total output stood at 500,000.

Table models were by far the largest sellers during 1952, according to leading producers. Units with f-m only have virtually disappeared from the market and the number of tv sets with f-m included has also declined markedly. In 1950 over 750,000 tv sets with f-m were produced. In 1952, the number had dropped to about 88,000.

Still, f-m dollar volume was sizeable in 1952 despite lower production. With an estimated average retail price for f-m/a-m units of about $65, last year's output meant a dollar volume of over $32 million and represented more than 26 percent of the total dollar volume of home radio sales in 1952.

▶ **Companies**—Big reason why some radio manufacturers are doing more f-m business is that there are fewer manufacturers concentrating on the market and sharing in the dollar volume. In 1949 about 50 companies were producing f-m/a-m table models, the volume seller in the field, while last year there were less than 25 of the radio manufacturers making the combination units.

Zenith, a major producer in the field, reports that its f-m sales have been the biggest in history. They have brought out a greater variety of f-m models for 1953. It is reported that General Electric also plans to go more heavily into the field this year. In addition, f-m station activity, despite some setbacks, has increased.

Company Patent Policies Surveyed

Assignment agreements are universally used, but differ greatly in details

A DETAILED study of patent practices in 48 major corporations, 11 of which are active in the electronics field, was made recently by the National Industrial Conference Board. Forty-three of these firms require some or all of their employees to sign patent-releasing agreements as a condition of employment and two of the remainder have unwritten understandings.

▶ **Who Signs**—Research and engineering employees are almost universally required to sign patent agreements, since they are the most likely to make patentable inventions of interest to the company. In 19 companies, executives and supervisors must also sign up. Ten companies require all their employees to sign.

▶ **Duration of Agreement**—With 33 firms, the agreement expires at the termination of employment. Obligations which are part of the agreement generally continue, however. This insures availability of the former employee to execute necessary papers and perform other actions involved in securing patents for inventions made during his employment.

With 10 firms, the assignments bind the employees completely for 6 months to 2 years after termination of employment. This is based on the premise that subsequent inventions could have been conceived or developed during employment.

▶ **Pay for Patents**—Although engineers are often hired specifically to invent, nominal extra compensation is often made for successful patents, chiefly as a means of boosting morale by giving formal recognition of achievement. Seventeen firms give a fixed amount per invention; one pays $150, six pay $100, six pay $50 and four pay $1 (the latter more in the nature of a legal consideration). Eleven companies give salary increases to prolific inventors. A few share royalties with the inventor when licenses are issued under the patent.

Special cash awards for the best invention of the year, for the best in 5 years, or for every 50 inventions, are made by some

(Continued on page 20)

SORENSEN *electronically*

REGULATES
AND CONTROLS

FREQUENCY

LOW VOLTAGE DC HIGH CURRENT

HIGH VOLTAGE DC LOW CURRENT

AC LINE

Model 2000S

SORENSEN ISOTRONIC AC LINE REGULATORS ARE YOUR BEST CHOICE FOR PERFORMANCE PLUS ECONOMY

The man who **uses** instruments likes Sorensen AC Line Regulators because of regulation accuracy, clean waveform, insensitivity to frequency fluctuation, load range.

The man who **maintains** instruments likes Sorensen AC Line Regulators because of circuit simplicity, conservatively rated tubes (only 3 in all), built-in ability to deliver trouble-free performance for months on end.

The man who **pays for** instruments likes Sorensen AC Line Regulators because of reasonable price and the fact that there are no extras for installation and special wiring.

The man who **designs** instruments likes Sorensen AC Line Regulators because they are ideal for incorporation as reliable components.

ELECTRICAL SPECIFICATIONS

Models available (numbers indicate VA capacities)		
	Input	95-130 VAC, 1φ,50-60~; 190-260 VAC in "-2S" models
	Output	115 VAC ±5%; 230 VAC in "-2S" models
150S 250S	Regulation accuracy	±0.1% against line or load
500S (-2S also) 1000S (-2S also)	Distortion	2% - 3% maximum
2000S 3000S (-2S also)	P. F. range	Down to 0.7
5000S (-2S also) 10000S (-2S also)	Load range	0 to full load
15000-2S	Miscellaneous	Models 150S, 250S, 500S, 1000S, 5000S, 10000S, and 15000-2S are self-contained. Cabinets available for others.
1001	Regulation accuracy 0.01%, load range 0 - 1000 VA, output 115 VAC ±5%, other characteristics similar to those given above.	

* ISOTRONIC=Regulation and control of voltage, current, power, and frequency by electronic means.

OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:

NOBATRONS
(low-voltage, high-current DC Supplies)

B-NOBATRONS
(high-voltage, low-current DC Supplies)

NOBATRON-RANGERS
(full-range-variable DC Supplies)

FREQUENCY CHANGERS

SATURABLE CORE REACTORS

VARIABLE AUTO-TRANSFORMERS

SPECIFY **SORENSEN**

For Complete Information Write

SORENSEN & COMPANY, INC.
375 Fairfield Ave. Stamford 1, Conn.

firms; these are usually $500 or less, but can go up to $5,000.

▶ **Releasing Rights**—Only 8 companies do not release rights to unwanted inventions. On the other hand, 2 actually help the employee to obtain his own patent when they don't want it. Some assignment agreements contain an automatic release clause so all rights revert to the employee if the patent is not prosecuted by the company within a specified time interval after complete disclosure, such as 9 months.

Financial Roundup

PROFIT reports, security offerings and sales, and mergers were made or planned by many companies in the electronics industry during the past month.

Profits of six companies in the field indicate that 1952 business was good:

Company	1952 Net Profit	1951
AT&T	$319,750,000	$279,256,365
Avco	11,028,927	10,089,214
Bendix Aviation	15,295,159	11,818,600
Emerson Radio	2,262,555	3,592,397
Magnavox*	1,546,024	587,795
W. L. Maxson	526,494	524,012

*6 months report

▶ **Security Transactions**—Sylvania Electric filed two registrations with the SEC covering 550,000 shares of its $7.50 common stock and $20 million of sinking fund debentures due in 1978. Net proceeds of the stock sale are expected to total over $19 million. About $15 million of these proceeds will be used for bank reduction. The proceeds of the debenture sale will be used for capital expenditures. The company plans further plant and equipment additions and improvements with an estimated total cost of over $16 million.

Video, Inc. offered 69,725 shares of 5 percent cumulative convertible preferred stock at par "as speculation". Proceeds are to be used for general corporate purposes including debt payment, purchase of equipment and working capital. The company operates a community antenna system in Pennsylvania.

RCA has sold another $25 million of 3¾-percent promissory notes due May 1, 1977, to New York Life Insurance Co. and another investor. This borrowing brings to $30 million the total taken down under a $50 million agreement set up in 1952. The company will borrow the rest before July 1, 1953. The proceeds will be used for working capital and for general corporate purposes, including financing of its defense business.

Sangamo Electric Co. has sold $3,750,000 of 3⅞ percent promissory notes due Jan. 1, 1968 to New York Life Insurance Co. The company has also borrowed $5.5 million from 4 banks. All but 510,000 will be used to pay off bank loans and other debt. This balance will be added to working capital.

▶ **Mergers**—Emerson Radio has abandoned its merger plans with Webster-Chicago because of difficulties that arose within the stock structure of the Webster-Chicago Company.

Defense Sparks College Research

EIGHTY PERCENT of electronics research in colleges and universities is for national defense, with more than half the effort concentrated in eight schools. Unused research facilities amount to about one-third total capacity. A survey by the Engineering College Research Council reveals 425 faculty members in 150 schools eager to do such research if given resources.

▶ **Statistics**—Encompassing 20,000 qualified faculty members in 513 schools, the survey showed 12,700 now active in research of all kinds. Electronics represents 6.3 percent of all college research and 10.2 percent of college defense research. Faculty qualified for electronics research numbers 1,032, with 625 now active.

Sponsors Cut Employee Turnover

Before, half the new tv-production-line workers quit within 3 months; now 90 percent stay on

TO MAKE new employees feel at home during the critical starting period, Olympic Radio & Television uses 'sponsors' chosen for their ability to get along with people. Each department has one or more sponsors, identified by distinctive blue buttons.

Sponsor, at left, shows newly-hired employee how to punch time clock, takes him to cloak room and other facilities

▶ **How Sponsors Serve**—When an employee is hired by the personnel department, a sponsor is called in to meet the new arrival. The two then take an informal orientation tour through the plant on the way to the assigned department. There the sponsor introduces the newcomer to the foreman, shop steward, supervisor and fellow employees. He then explains and shows employee facilities for rest periods, lunch, coffee, purchase of company products at discounts, smoking, and anything else about which questions are asked. This usually takes only a few hours of the sponsor's day. Contacts thereafter are generally during rest and lunch periods, when the sponsor asks how things are going and encourages questions.

After 15 days of work the new employee has an informal meeting with a top official in the plant, and

(Continued on page 22)

PROVEN BEST

IN MILLIONS OF PRODUCTS . . . *EVERY DAY!*

RHODE ISLAND *Insulated Wire*

COME TO RHODE ISLAND FOR YOUR INSULATED WIRE REQUIREMENTS.

QUALITY: Rhode Island Insulated Wire is proven best every day in millions of products for factory, field and home.

PERSONALIZED SERVICE: Rhode Island maintains branch offices with factory trained personnel in every section of the country.

RESEARCH: Complete research facilities at your disposal for the development of specialized wires.

Write today for illustrated catalog.

We'll see you at the I.R.E. Show. Booth 4-703.

Besto Wire

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50 Burnham Avenue, Cranston, Rhode Island

National Sales Offices: 624 South Michigan Avenue, Chicago, Illinois • HArrison 7-6050

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Blue-buttoned sponsor Anthony Marano is inspector in machine shop. Foremen and supervisors are never used as sponsors

is encouraged to come to the front office for advice whenever he wishes. The official is usually Benno Bordiga, director of manufacturing, who initiated the sponsor system.

▶ **Company Benefits**—Whereas 200 people were formerly hired to get 100 permanently, now only 110 need be hired. Reducing new-employee turnover in this way during the critical first three months boosts the number of fully-skilled production-line workers in the plant and thereby boosts output. Along with this comes a real saving in plant overhead, because each lost worker represents an average loss of one week's salary invested in training.

Air Force Global Radio Network Takes Form

WORLDWIDE communications network for ground-to-air and ground-to-ground contact with any Air Force base in the world took another step forward when Westinghouse announced the delivery of $3,375,000 worth of radio transmitters for the project.

The transmitters have a frequency range of 2,000 kilocycles to 30,000 kilocycles. They are equipped to handle telegraph code signals of 500 words a minute, voice communication, and radiotelegraphy by key or teletype.

White Mountain TV Station Proposed

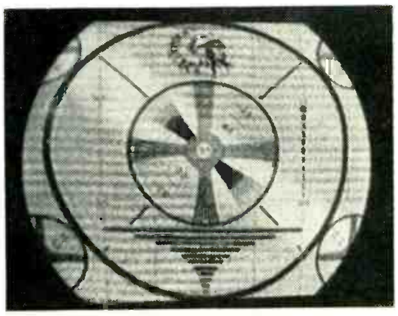
IN THE 30's, the late John Shepard III built a fabulous structure atop Mount Washington, New Hampshire to house an f-m broadcast station that spread Yankee Network programs from Massachusetts to the province of Quebec. Self-contained, with enough food, diesel fuel and supplies to last from September until May, the unit boasted a water well nearly 1,200 feet deep.

▶ **Worst Weather**—Characterized as having "the worst weather in the world", the 6,288-foot mountain has recorded peak gusts in excess of 200 miles an hour and temperatures near 50 below. The antenna, mounted on a 50-foot pole supported by a heavy fabricated base, comprised heavy, copper-plated truck-spring assemblies. These were necessary because of the tons of ice that frequently accumulated.

Although FCC rule changes killed off the f-m venture, the buildings and tower remain. Recently a hardy group proposed to spend nearly a half million dollars to establish a television station in this inhospitable atmosphere. First year operating costs are estimated at $400,000, but revenue is expected to be $450,000.

▶ **The Venturesome**—Principals are: president, Horace Hildreth, former governor of Maine and station owner; John Guider, Maine and New Hampshire broadcast operator; Tyrone Corp. of Pittsburgh, Pa.; Kennebec Broadcasting Co. of Waterville, Me.; Granite State Network with several a-m and f-m stations in New Hampshire.

How soon the new station can begin serving the many little communities of northern New England that haven't even decent a-m reception isn't yet known. FCC must first hold hearings because the facilities requested (Channel 8) are assigned to Lewiston, Me., where there are two other applicants.



Unusual TV DX

Typical fringe-area test pattern snapped atop Mt. Washington, N. H. (6,288 feet) shows that the new Montreal, Canada station puts in a good signal 150 miles away. However, program reception on the famous peak is complicated by interference (shown as venetian-blind pattern here) from New York City station 285 miles away!

Remotes Extend Airways VHF Range

Transmitters and receivers at Scranton and Philadelphia extend N. Y. control to 175 miles

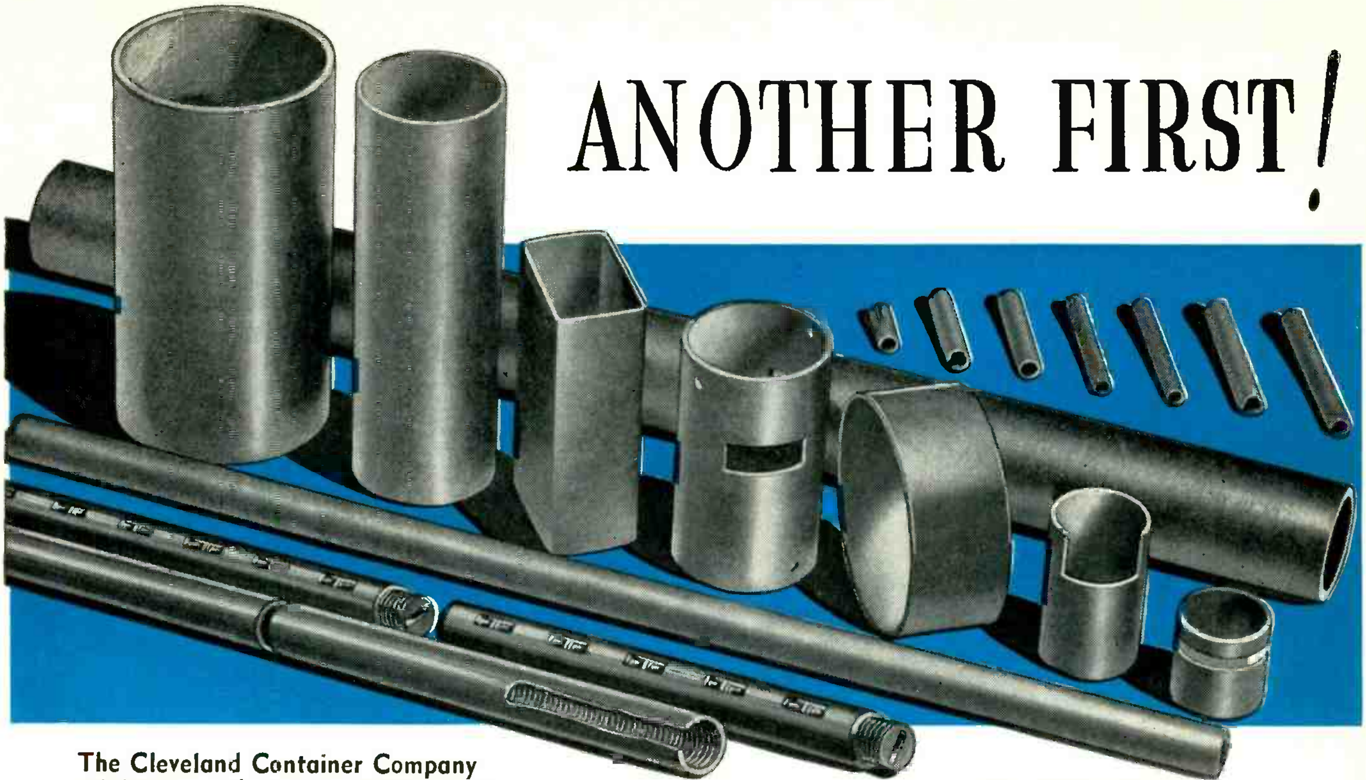
RELIABLE voice communications on regular CAA vhf frequencies have been extended from New York terminals by means of two remote relay stations along the heavily-traveled Chicago and Washington routes. Located at Scranton and Philadelphia, Pennsylvania, these stations increase the effective range of control to 175 miles as compared to 50 miles formerly possible with equipment installed at Douglaston (Long Island), New York.

A combination of factors made the addition of the new facilities necessary. Speed and frequency of flights have increased substantially in the past four years. LaGuardia and Idlewild traffic was further increased by the closing of Newark Airport in 1952. This step-up of activity has greatly increased the demand on communications equipment, especially when aircraft arrive under instrument flight conditions.

▶ **Equipment**—Each of the new installations consists of remote-controlled 50-watt transmitters operating on a dozen standard

(Continued on page 24)

ANOTHER FIRST!



Torkrite Tubing in foreground, enlarged to show detail.

The Cleveland Container Company originates and is now producing for the electronic and electrical industries . . .

★ ★ ★

TORKRITE

CLEVELITE* EE INTERNALLY THREADED AND EMBOSSED TUBING.

TORQUE AND STRIPPING PROBLEMS ARE NOW ELIMINATED!

Electronic engineers find that TORKRITE, this newly designed and constructed Coil Form, has definite advantages over all other types requiring the use of threaded cores.

TORKRITE is one of the many items of CLEVELITE . . . a complete line of tubing for coil forms, collars, bushings, spacers, tubes and other items.

CLEVELITE has long been giving continuous satisfaction because of its dependable performance, uniformity and close tolerances.

Consult our Research and Engineering Laboratory. It is at your service.

WHY PAY MORE? FOR THE BEST . . . CALL CLEVELAND!

* Reg. U. S. Pat. Off.

A few of many
ADVANTAGES:

TORKRITE'S re-cycling ability is unmatched.

After a maximum diameter core has been re-cycled in a given form a reasonable number of times, a minimum diameter core can be inserted and measured at 1" oz. approximately.

TORKRITE has no hole nor perforations through the tube wall. This eliminates possibility of cement leakage locking the cores.

TORKRITE allows use of lower torque as it is completely independent of stripping pressure.

With TORKRITE torque does not increase after winding, as the heavier wall will not tend to collapse and bind the core.

Available in lengths ¾" to 3⅛" to fit a ¼-28 core.

★ ★ ★

See our Exhibit #2-309 at the Radio Engineering Show in New York City, March 23-26.

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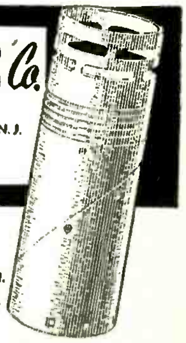
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario



REPRESENTATIVES

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NEW ENGLAND R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
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channels in the vicinity of 120 megacycles. Both the transmitters and associated receivers may be operated remotely from New York.

Similar relay extensions have been installed at Seattle and Chicago, and it is probable that as air traffic at other busy terminals increases more will be added to the list. With the Philadelphia station, it is now possible for a plane to pass from Washington control to New York control without losing vhf contact.

TV Tubes for Rent

Klystrons for uhf tv transmission will be leased to stations on an hours-of-use basis

Now in production, General Electric's high power klystrons for uhf tv transmission will not, at least initially, be for sale. Instead, they will be leased to station operators, who will pay per hour of usage.

The fee provides the operator with three tubes, two in operation and a spare. When a tube gets old and weary it is replaced by a new one at no cost to the station.

Equipment manufacturers will pay GE for the right to build station equipment using the new klystrons.

First of the GE klystrons is a tube having a maximum output power rating of 15 kw.

Electronic 'Watcher' Heightens Train Safety

Installed on Erie track, pickup coil identifies train, flashes signal to dispatcher's office

WEATHERPROOF COILS between Erie RR's tracks at Waterboro, N. Y., are activated by approaching trains; coils carried under the trains cause a dip in the wayside oscillator output, the dip being at the frequency a particular train's coil is tuned to.

The dip causes a coded signal to be sent by carrier transmission, superimposed on existing lines, to the Salamanca dispatcher's office, 22 miles away, where a buzzer signals the operator. A light identifying the train flashes on, and the train's passage and time is recorded automatically.

▶ **Improved System**—A similar system has also been installed permitting the dispatcher at Salamanca to set the block signals at Waterboro, and indications of the signal position are flashed back to the office. The entire arrangement is built along 'fail-safe' principles.

The electronic gear is housed in an unattended concrete shed at the track's side, and included is an automatic emergency battery power supply.

▶ **Anti-collision**—The track equipped with the new control system carries no passenger trains; freight traffic only is continuously and automatically monitored.

Erie looks ahead to the days when crashes are no more, when electronic devices signal trains, stop trains, even announce train arrival on the station's PA system.

Where Navy Needs Electronics Engineers

TESTIFYING to the increasingly important role of electronics in modern warfare, and to the critical shortage of engineering talent, the Office of Naval Research has announced vacancies for electronics engineers, scientists and physicists specializing in electronics at 39 Navy technical activities.

The jobs range in pay from $3,410 to $9,600. A minimum of four years of college or equivalent experience is required for the lowest paying jobs while, on the other end of the scale, an additional four years of progressive professional experience is required.

▶ **Work**—Tasks are highly diversified. Engineers are required for design, development, installation and maintenance. The projects range from acoustic measurements to microwave research, embracing such fields as torpedoes, guided missiles, radar, ship and aircraft armament and many others.

The table below lists activities where jobs exist. Applicants should send a completed form 57, "Application for Federal Employment," to the commanding officer of the activity in which they are interested.

ACTIVITY
Portsmouth Naval Shipyard Portsmouth, New Hampshire
U. S. Navy Underwater Sound Lab., Fort Trumbull, New London, Connecticut
U. S. Naval Underwater Ordnance Station, Newport, Rhode Island
U. S. Navy Central Torpedo Office Newport, Rhode Island
New York Naval Shipyard Brooklyn 1, New York
Special Devices Center Sands Point, Port Washington: Long Island, New York
U. S. Naval Air Station Lakehurst, New Jersey
Philadelphia Naval Shipyard, Naval Base, Philadelphia 12, Pennsylvania
U. S. Naval Air Development Center, Johnsville, Pennsylvania
Naval Air Material Center, Philadelphia 12, Pennsylvania
David Taylor Model Basin, Washington 7, D. C.
Norfolk Naval Shipyard, Portsmouth, Virginia
U. S. Naval Air Test Center, Patuxent River, Maryland
U. S. Naval Aviation Ordnance Test Station, Chincoteague, Virginia
U. S. Naval Gun Factory, Washington 25, D. C.
U. S. Naval Mine Depot Yorktown, Virginia
U. S. Naval Ordnance Experimental Unit c/o The National Bureau of Standards Washington 25, D. C.
U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland
U. S. Naval Proving Ground Dahlgren, Virginia
Naval Research Laboratory Washington 25, D. C.
Bureau of Aeronautics Washington 25, D. C.
Bureau of Ships Washington 25, D. C.
Department Civilian Personnel Div. Room 0015A, Navy Department, Washington 25, D. C.
Office of Naval Research, Room 1070 T-3 Building, Washington 25, D. C.
Charleston Naval Shipyard, Naval Base Charleston, South Carolina
U. S. Navy Underwater Sound Reference Laboratory, P. O. Box 3629, Orlando, Florida
U. S. Naval Ordnance Plant, Indianapolis, Indiana
U. S. Naval Ordnance Plant, Forest Park, Illinois
Industrial Manager, USN, 8ND; Supervisor of Shipbuilding, USN, and Naval Inspector of Ordnance, New Orleans, Louisiana, Building 263, U. S. Naval Station
U. S. Naval Ammunition Depot, Bangor, Washington
U. S. Naval Torpedo Station Keyport, Washington
Mare Island Naval Shipyard, Vallejo, California

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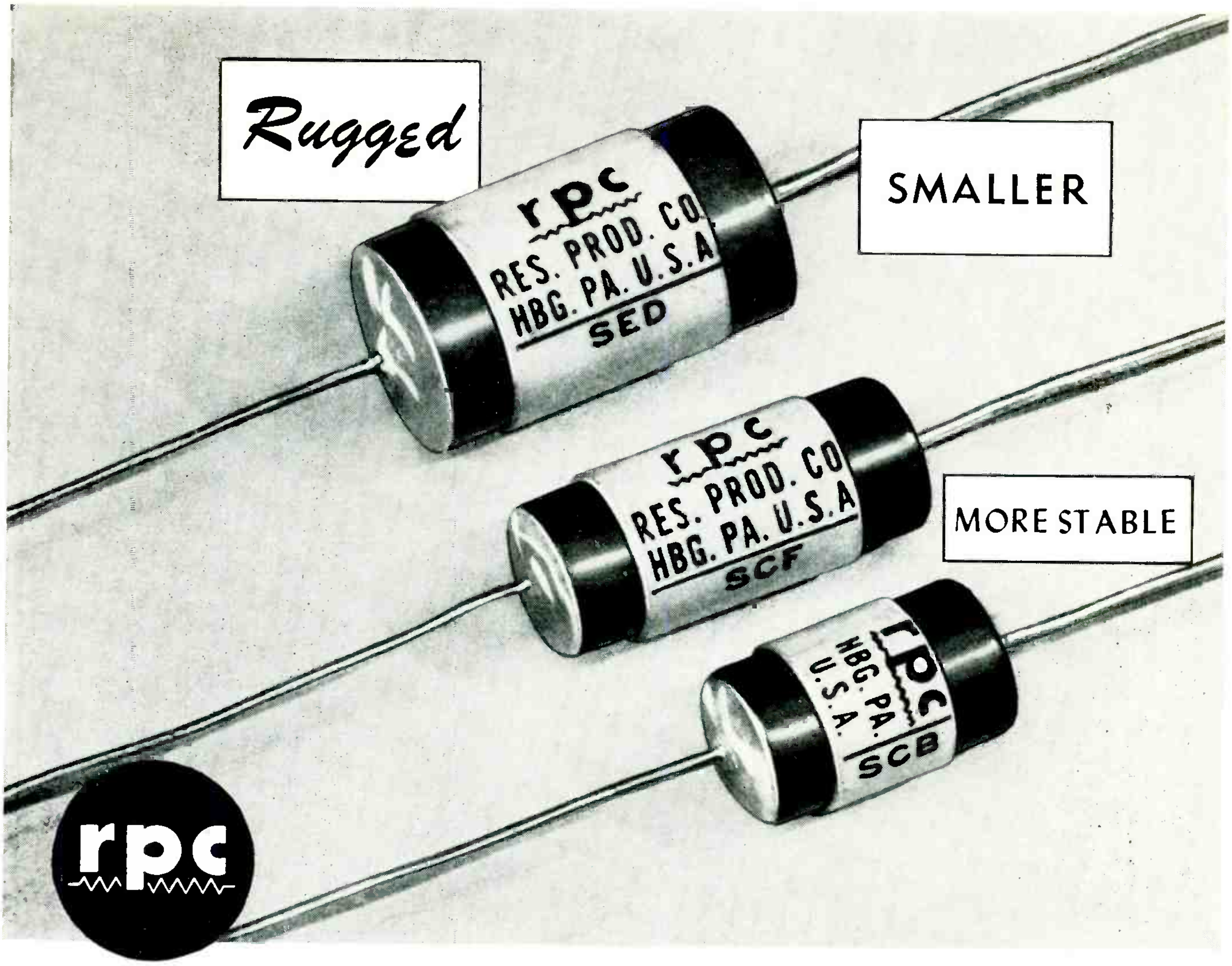

HERMETICALLY SEALED PRECISION WIRE WOUND RESISTORS

When the utmost in permanence and stability are required, these resistors have proven successful. Exposure to extremes in temperature cycling, aircraft altitudes and salt water immersion leave these rugged resistors unaffected.

Resistance Products Company has been able to achieve quality performance in mass production. RPC has the "know-how"—the special equipment and high degree of constant supervision that are needed.

RPC Type S Hermetically Sealed Resistors are wound on *highest grade steatite forms.* Winding forms are *solder sealed* into steatite jackets. Each resistor is *vacuum tested* to insure hermetic seal. *Long leakage path* between terminals provides top performance under most adverse climatic conditions.

Axial wire leads permit wiring directly into circuits—and the smaller size and lighter weight make these resistors self supporting. *Specially tested low temperature coefficient alloys are used.* Standard resistance tolerance 1%. Tolerance of ½% and ¼% available.

Write for complete information and engineering data.

Type	Dimensions		Jan-R-93	Power Rating		Resistance	
	Len.	Diam.		Jan.	Comml.	Min. ohm«	Max. meg«
SCB	9/16	11/32	—	— watts	¼	2.0	0.15
SCF	13/16	11/32	RB51A	¼ watts	½	1.0	0.40
SED	13/16	15/32	RB51A	¼ watts	½	0.5	1.0

RESISTANCE PRODUCTS CO.

714 RACE ST. • HARRISBURG, PENNSYLVANIA

Specializing in manufacture of quality resistors in ANY amount

PRECISION WIRE WOUND • HIGH VOLTAGE • HIGH MEGOHM • HIGH FREQUENCY

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Office of Naval Research Branch Office, 1030 E. Green Street, Pasadena 1, California

Pearl Harbor Naval Shipyard, Navy No. 128, Fleet Post Office, San Francisco, California

U. S. Naval Air Missile Test Center
U. S. Naval Air Station, Point Mugu, California

U. S. Naval Air Station
Alameda, California

U. S. Naval Magazine
Port Chicago, California

U. S. Naval Ordnance Test Station
Inyokern, China Lake, California

U. S. Navy Electronics Laboratory
San Diego 52, California

Military Radio-Radar Shipments Abroad Rise

INCREASING importance of radio and radar equipment in the defense plans of foreign nations is indicated by the larger shipments of these items under the U. S. foreign military aid program. Previously a relatively slow-moving item in the program, radio and radar equipment shipments increased sharply during 1952 and reached a record rate last October when 4,347 items were sent out, representing almost 15 percent of all such items that have been shipped during the four years of the program.

The cumulative total of radio and radar items that have been shipped under the plan stood at 27,648 in October. For security reasons the U. S. does not give the dollar value of such shipments or their destination and reports the quantities by number of items only.

MEETINGS

MARCH 9-12: NEMA, Edgewater Beach Hotel, Chicago, Ill.

MARCH 19: AIEE, Lecture on "High Energy Accelerators", Engineering Societies Bldg., New York, N. Y.

MARCH 19-20: National Collegiate Industry-Government Conference on Instrumentation, Michigan State College, East Lansing, Mich.

MARCH 23-25: Sixth Annual Conference for Protective Relay Engineers, A & M College of Texas, College Station, Texas.

MARCH 23-26: IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.

APRIL 18: Seventh Annual Spring Technical Conference, Cincinnati IRE, Cincinnati, Ohio.

APRIL 23-24: International Symposium on Non-Linear Circuit Anlaysis sponsored by Brooklyn Polytechnic Institute, IRE, Office of Naval Research, Air Research and Signal Corps, Engineering Societies Bldg. Auditorium, New York, N. Y.

APRIL 23, 30, MAY 7, 14: Lecture Series on the general theory of semiconductors by H. K. Henisch of the University of Reading, England, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

APRIL 27-30: Spring Meeting of USA National Committee of URSI-IRE professional Group on Antennas and Propagation, National Bureau Of Standards, Washington, D. C.

APRIL 27-MAY 8: British Industries Fair, Birmingham & London, England.

APRIL 28-MAY 1: Seventh Annual NARTB Broadcast Engineering Conference, Burdette Hall, Philharmonic Auditorium, Los Angeles.

APRIL 29-MAY 1: 1953 IRE-AIEE Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.

MAY 11-13: IRE National Conference on Airborne Electronics, Dayton, Ohio.

MAY 18-21: 1953 Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.

MAY 18-23: Third International Congress On Electroheat, Paris, France.

MAY 24-29: NAED, 45th Annual Convention, Conrad Hilton Hotel, Chicago, Ill.

MAY 24-28: Scientific Apparatus Makers Association Annual Meeting. The Greenbrier, White Sulphur Springs, W. Va.

JUNE 15-19: Exposition of Basic Materials for Industry, Grand Central Palance, New York, N. Y.

JUNE 16-24: International Electro-acoustics Congress, The Netherlands.

JUNE 20-OCT. 11: German Communication and Transport Exhibition, Munich, Germany.

AUG. 19-21: IRE Western Electronic Show & Convention, Municipal Auditorium, San Francisco, Calif.

AUG. 29-SEPT. 6: West German Radio and Television Exhibition, Duesseldorf, Germany.

SEPT. 1-3: International Sight and Sound Exposition, Palmer House, Chicago, Ill.

SEPT. 21-25: Eighth National Instrument Exhibit, Sherman Hotel, Chicago, Ill.

Business Briefs

► **Evidence** of the beneficial effects of tv on sports attendance: An estimated new high of $1.7 billion will probably be taken in by the sports industry in 1952, according to the RTMA Sports Committee.

► **Beer** level checker that inspects 900 containers per minute with an accuracy of 30 drops of beer, or plus or minus 1/64 inch, is a tiny crystal of cadmium sulfide acting on signals from an 80,000 volt GE x-ray tube.

► **Seven** tv experimental relay stations linking Tokyo with Osaka, a distance of about 300 miles, are reported to be in operation. NHK Tokyo Television (JOAK-TV) using Japanese-made equipment is making test broadcasts, according to reports.

► **"Photon"**, an electronic device that sets up type on a photographic film by means of a light that flickers at rate of a million times a second, is now in operation at the Graphic Research Foundation in Cambridge, Mass. (ELECTRONICS, Dec. 1949, p 158). The resulting film can be used directly or indirectly for engraving plates for printing.

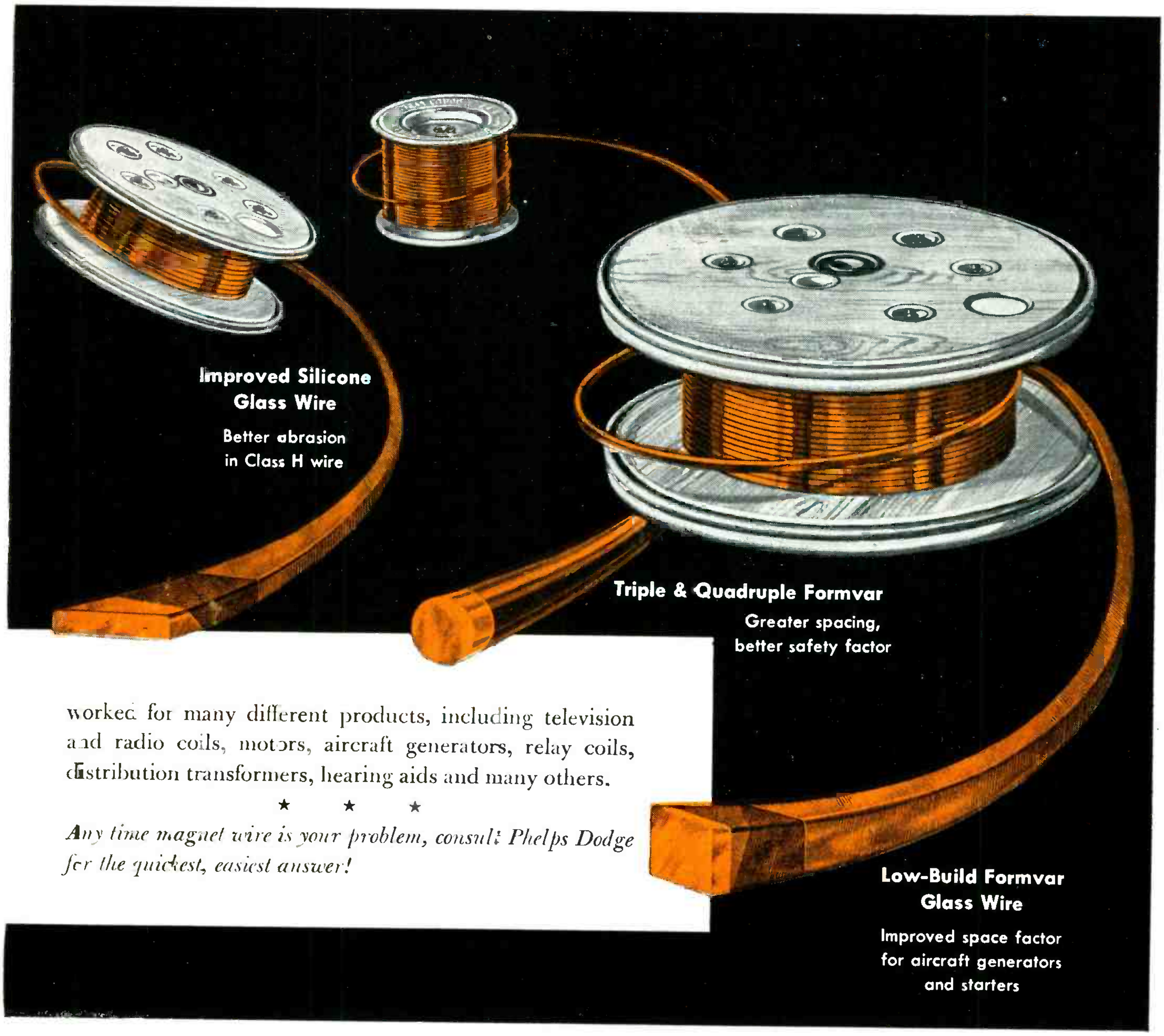
► **Republic of Colombia** plans to organize all communications services under a semiofficial administration. The government also plans to set up omnidirectional radio installations.

► **Norwegian** government recommends that experimental tv transmission be started by the Norwegian State Broadcasting Co. and continued for two years. After that the question of regular tv services will again be submitted to Parliament.

► **Radio** and television interference in the Miami area has been reduced by a truck-mounted washing unit of the Florida Power & Light Co. that removes salt deposits and industrial sediment from transmission line insulators.

"Special" Magnet Wire . . .

PHELPS DODGE "STANDARDS"



worked for many different products, including television and radio coils, motors, aircraft generators, relay coils, distribution transformers, hearing aids and many others.

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

—from Mine to Market!

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

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Resistors STOP Humidity Failures

TYPE	NOMINAL WATTAGE RATING	RESISTANCE MIN.	RESISTANCE MAX.	NO. SECTIONS	SUPERSEDES JAN-R-93 TYPE
RB15 (M15)	.25 .50	0.1 ohm 0.1 ohm	.185 meg. .6 meg.	2	RB10
RB16 (M16)	.35 1.00	0.1 ohm 0.1 ohm	.3 meg. 1.5 meg.	2	RB11
RB17 (M17)	.50 1.00	0.1 ohm 0.1 ohm	.3 meg. 2.0 meg.	4	RB12
RB18 (M18)	.50 1.00	0.1 ohm 0.1 ohm	.75 meg. 4.0 meg.	4	RB13
RB19 (M19)	1.00 2.00	0.1 ohm 0.1 ohm	4.0 meg. 15.0 meg.	8	RB14
RB52 (M52)	.25 .50	0.1 ohm 0.1 ohm	.1 meg. .5 meg.	2	RB51

MIL - R - 93A
WATTAGE & RESISTANCE TOLERANCE

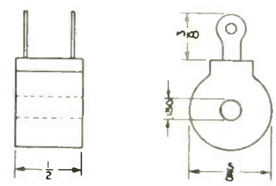
TOLERANCE SYMBOL	RESISTANCE TOLERANCE	PERCENT OF NOMINAL WATTAGE
B	0.10 %	50 %
C	0.25 %	50 %
D	0.50 %	75 %
F	1.00 %	100 %

MIL - R - 93A
TEMPERATURE COEFFICIENT
(REFERRED TO 25°C)

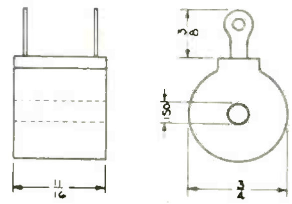
SYMBOL	EXPRESSED IN PERCENT PER DEGREE C. NEGATIVE, MAX.	POSITIVE, MAX.
E	0.0022	0.0022
J	0.0040	0.0155
K	0.0050	0.0255

SPECIAL REQUIREMENTS

Variations of the above ratings, tolerances, temperature coefficient, etc., can be supplied to special order.



MIL RB15 MEPCO M15



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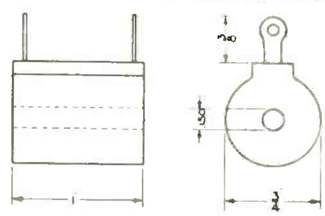

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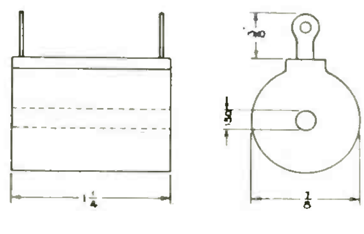
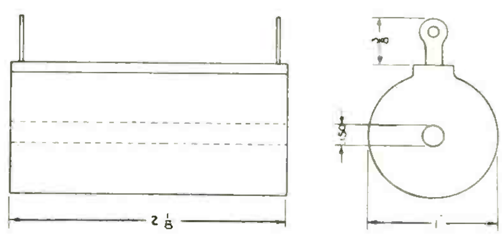


MIL RB18 MEPCO M18



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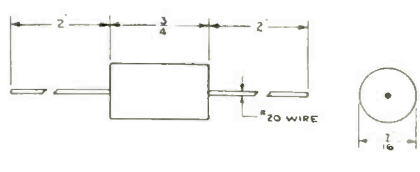

MIL RB52 (PROPOSED) MEPCO M52

MORRISTOWN, NEW JERSEY


KIRCHOFF
... FIRST to formulate laws on the division of current in a network of conductors
Gustav Robert Kirchoff
1824-1887
A German mathematical physicist and teacher, Kirchoff, formulated the theorems now known as Kirchoff's Laws for the division of current in a network of electrical conductors. He also developed the spectroscope, in collaboration with Bunsen, and made many other contributions to the fields of electricity, physics, and chemistry.
From an original drawing made for OHMITE.
OHMITE®
... FIRST in Rheostats
... today
Dependability . . . long, trouble-free life . . . and smoothness of operation . . . these are qualities you can count on in OHMITE rheostats. That's why they're preferred by industry over all other makes. For top performance, make it a point to specify OHMITE rheostats.
Be Right with OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES

FEEL THE DIFFERENCE!

OHMITE® Rheostats have UNMATCHED *Smoothness of Operation*

Turn the knob of an OHMITE rheostat and feel the gradual, smooth-gliding action! You get the close, uniform control usually found in fine, laboratory rheostats. Special OHMITE design features are the reason . . . pivoted universal-joint action of the contact brush for flush-floating contact; a metal-graphite brush for perfect contact and negligible wear on the wire; and a patented, tempered-steel contact arm for uniform contact pressure. No wonder these all-ceramic and metal rheostats are "tops" in electrical control.

OHMITE MANUFACTURING CO.
4817 Flournoy Street, Chicago 44, Illinois

Write on company letterhead for Catalog and Engineering Manual No. 40.

***Be Right with* OHMITE®**

RHEOSTATS
RESISTORS
TAP SWITCHES

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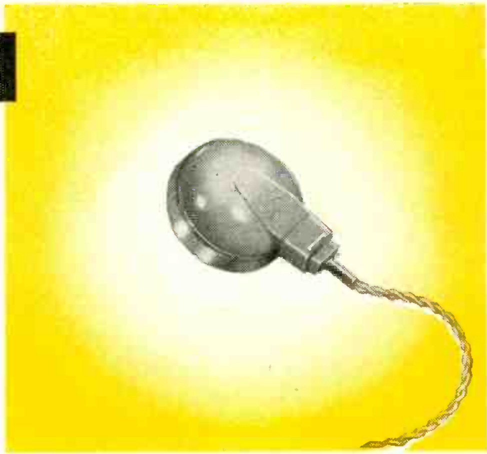
Miniature Components by

MINIATURE EARPHONE



The Fortiphone Earphone is a tiny rugged electro-magnetic instrument of high efficiency and extreme reliability.

The air gap setting is controlled to 0.00025 inches and the output of each unit is measured throughout the frequency band in order to maintain consistent performance and good response. Each instrument is subjected to a prolonged test at overload conditions and is then re-checked.

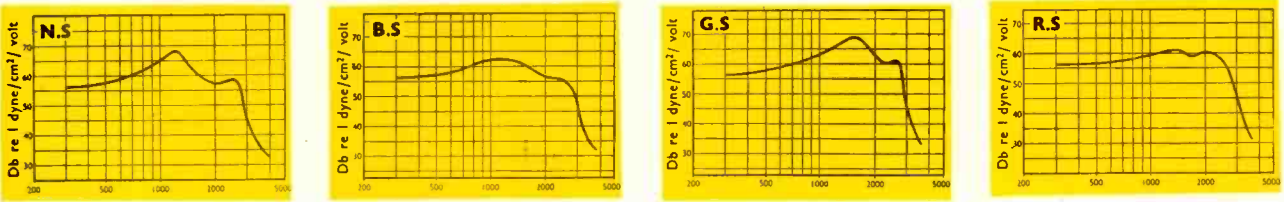
The unit takes a standard earmold, the nipple being carefully designed to ensure no acoustic leakage. A standard miniature round pin plug fits firmly into the earpiece with a positive detent action. The contact springs are of unique double spring design to ensure good contact, to avoid fatigue, and to minimise plug wear.

Alternative types of frequency response are available.

Type	Impedance at 1000 cps	Normal op. conditions	Overload conditions
MME/G (A)	120 ohms	.27 volts	1.4 volts
MME/G (B)	50 ,,	.2 ,,	1.0 ,,
MME/G (C)	30 ,,	.17 ,,	.85 ,,
MME/G (D)	600 ,,	.67 ,,	3.3 ,,
MME/G (E)	1000 ,,	.9 ,,	4.5 ,,
MME/G (F)	1000 ,,	.9 ,,	6.7 ,,

Overall dimensions:
Diameter: 0.82 in. or 2.08 cm.
Width (excl. nipple): 0.38 in. or 0.97 cm.
Width (incl. nipple): 0.47 in. or 1.20 cm.
Weight: 0.3 oz. or 8.5 grams.

MME/G (B). Constant input of 0·2 volts. Sound pressure measured in artificial ear of 1·5 cubic centimetres and 240 ohms acoustic resistance.



Frequency in cycles per second.

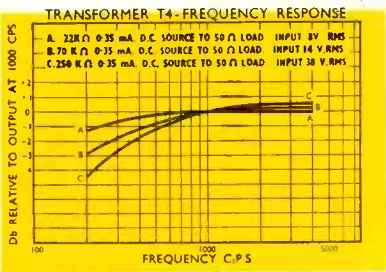
SUB-MINIATURE TRANSFORMER

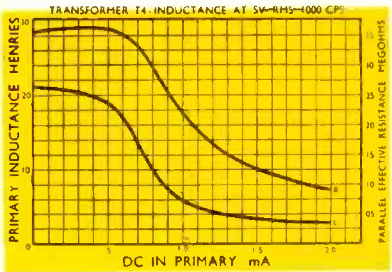
Overall dimensions: 0.660 x 0.484 x 0.460 in. or 1.675 x 1.228 x 1.170 cm.
Weight: 0.204 oz. or 5.78 grams.

The Fortiphone Transformer T.4 is a miniature output transformer of outstanding performance and wide frequency range. The windings are terminated at solder tags molded into the robust phenolic bobbin, thus economising in winding space and increasing efficiency.

Before being laminated each winding is checked to ensure no short-circuited turns. Each transformer is individually tested for efficiency throughout the frequency range.

A large number of ratios is available.





Very Speedy Delivery!

Want more information? Use post card on last page.

Fortiphone Ltd, England

Overall dimensions: 0.780 in. or 1.99 cm. diameter x 0.537 in. or 1.365 cm.
Knob width: 0.190 in. or 0.482 cm.
Weight: 0.126 oz. or 3.575 grams.

MINIATURE VOLUME CONTROL WITH SWITCH

Rigid inspection technique and craftsmanship of manufacture combine to make the Fortiphone Fingertip Controls, Type VC.7, extremely reliable and uniform in performance.

An internal single pole switch of less than 0.05 ohms contact resistance is incorporated. The insulation of this switch is greater than 100 megohms at 100 volts.

The action of the control is smooth and pleasant and the switch has a loud "click" operation. The control is able to withstand savage handling, the end stop torque being greater than 30 ounce inches. Noise level is below 270 microvolts when 1 volt is applied, and the control rotated at 2 turns per second.

The resistance rotation law is logarithmic. Power dissipation is 0.1 watt, when uniformly loaded. The instrument is able to withstand more than 20,000 operations without deterioration.

TWIN VOLUME CONTROL & SWITCH

A tiny attractive matched pair of fingertip instruments are available.

The volume control, Type VC.1, is similar in performance to the Type VC.7, except that no internal switch is incorporated.

The switch, Type SW.1, has four positions and a pleasant and positive "click" action.

The contacts are individually sprung and their contact resistance is low. The centre spindle is isolated, making the unit suitable for high-frequency operation.

Overall dimensions:
0.805 in. or 2.04 cm. diameter
x 0.525 in. or 1.335 cm.
Knob width: 0.240 in. or 0.610 cm.

Also available are Disc Earpieces; Flexible Connectors; Earmolds; Headbands; Hearing Aid Amplifier Units; Microphones; Miniature Electronic Units for special equipment; Plugs; Resistors; Sockets; Stethosets; Telephone Pick-up Coils.

Cable or write for prices, further details, and samples
Please state probable quantities required

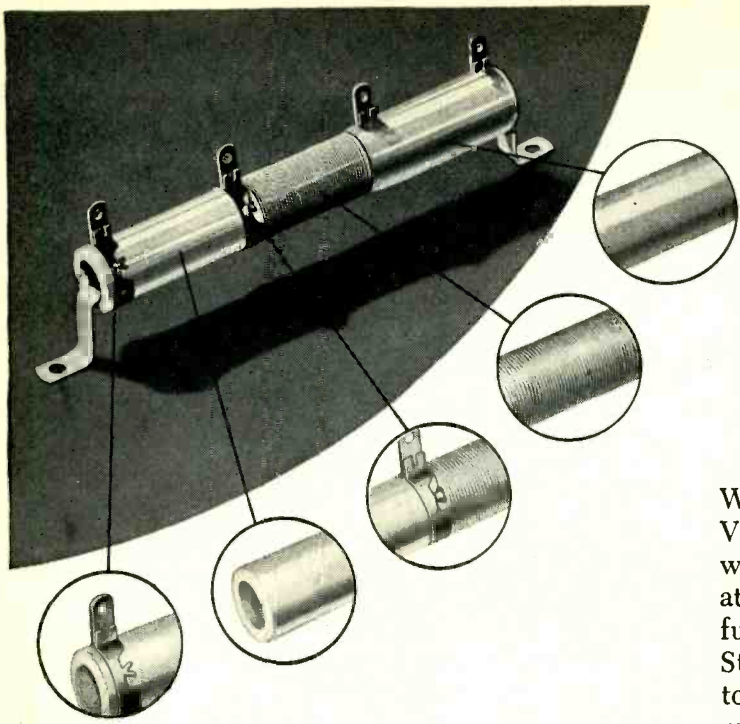
FORTIPHONE LIMITED

FORTIPHONE HOUSE
247 REGENT STREET, W1
LONDON, ENGLAND

Established 1925

Cables: Sonomax, Wesdo, London

Highly Competitive Prices!



VITROHM

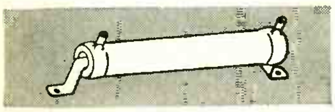
are your

Ward Leonard manufactures its own ceramic cores, Vitrohm enamel and terminals. Even the resistance wire is drawn to our own specifications. Every operation required to build a Vitrohm resistor is carefully and constantly checked and controlled by our Standards Department. That's why Vitrohm resistors assure you complete uniformity, accuracy and reliability, even under the most adverse service conditions.

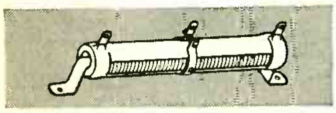
Ward Leonard has the largest selection of stock

7 stock resistors

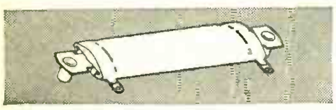
Vitrohm stock resistors range from 5 to 200 watts with resistance values from 1 to 250,000 ohms. Made-to-order Vitrohm's are available from 5 to 550 watts with values from 0.04 to 1,750,000 ohms.



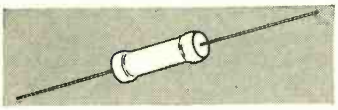
FIXED VITROHM
Used for voltage dropping and current limiting.



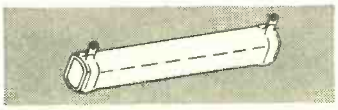
ADJUSTOHM
Gives circuit adjustability for voltage dividing or regulating purposes.



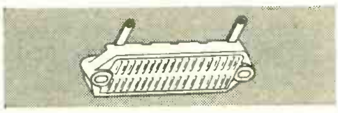
STRIPOHM
For compact aviation, communication and navigation equipment.



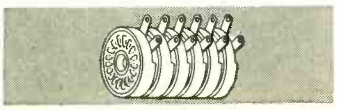
AXIOHM
Used in electronic equipment requiring miniature power resistors.



NON-INDUCTIVE
For low inductance and distributed capacitance in high frequency circuits.



PLAQOHM
Used in compact, high frequency electronic equipment.



DISCOHM
A miniature resistor for low inductance values and distributed capacitance.

WARD LEONARD

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

RESISTORS

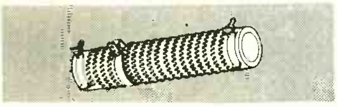
best buy

resistor types and sizes ever offered by any manufacturer. Also available to meet customer's exact specification is a complete stock of components ready for immediate assembly into made-to-order resistors. Our controlled component manufacture and inspection, plus a wider selection of types, make Ward Leonard your best buy in resistors.

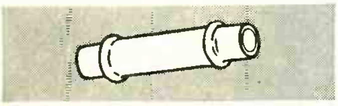
For full information on Vitrohm resistors, write for Catalog No. 15 to Ward Leonard Electric Co., 31 South Street, Mount Vernon, N. Y.

11 made-to-order resistors

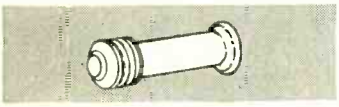
(these plus all the stock resistor types)



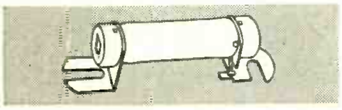
RIBFLEX
Used in circuits where high wattage must be dissipated in small space.



FERRULE TERMINAL
For rapid interchangeability of resistance values or resistor replacement.

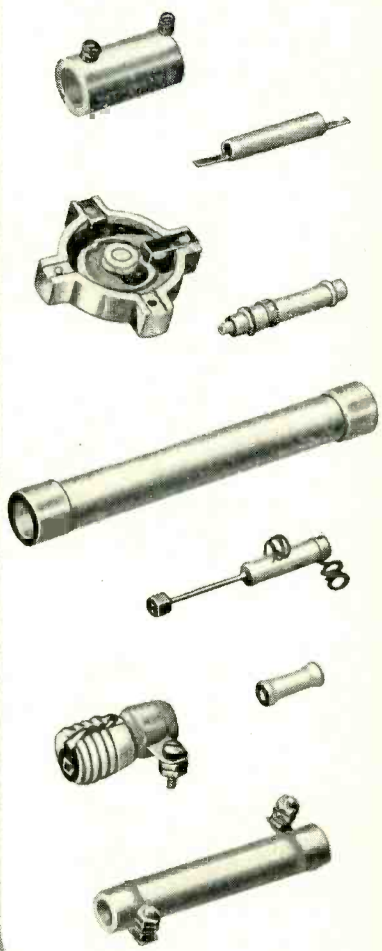


SCREW BASE
With an Edison screw base for mounting to provide rapid means of changing resistance.



BRACKET TERMINAL
Has leads silver brazed to brackets for easy interchange or renewal of unit.

Special form resistors to meet unusual requirements



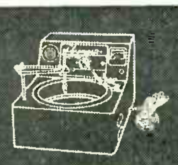
See you at the I.R.E. Show in Booth 3-113

18.3.4

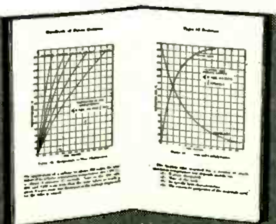
RHEOSTATS

RELAYS

MOTOR CONTROLS



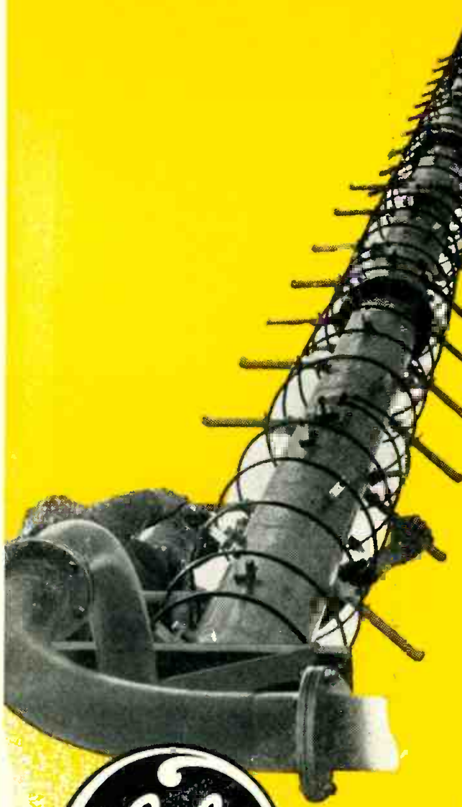
CHROMASTER



Ward Leonard's complete engineering textbook, "Handbook of Power Resistors," $3. per copy.

G-E TUBES AT THE

Everything for u-h-f TV!



New

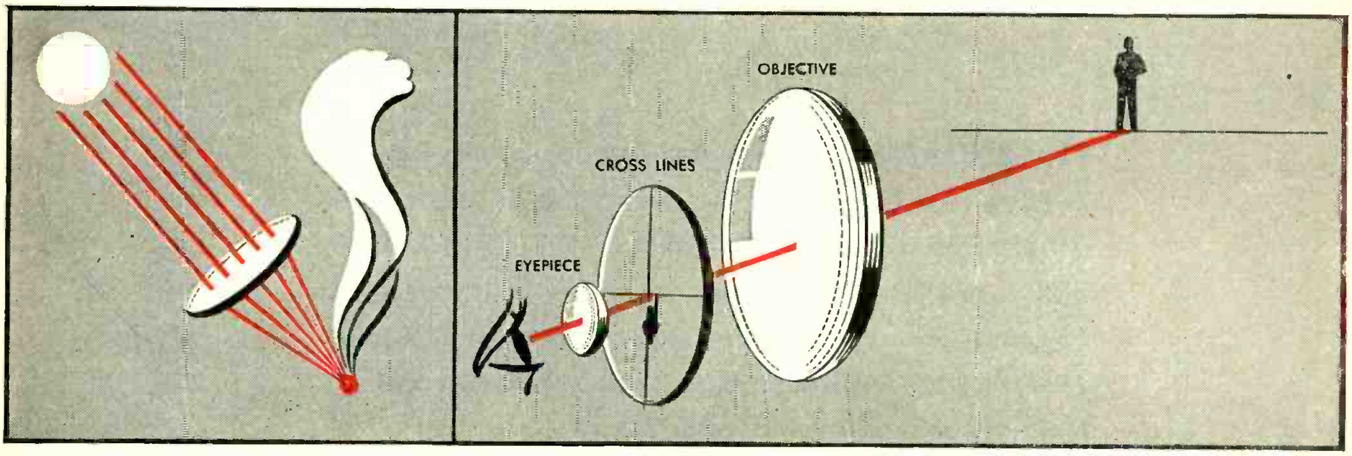
GL-6283—250-w G-E driver tube for u-h-f transmitters. Air cooled, compact, up-to-the-minute in design. Can be installed in seconds!

Tops in Power!

GL-6237 through GL-6242—15-kw klystrons for final transmitter power stage. The 6 types in order handle all frequencies 470 mc to 890 mc. G-E klystrons are the *highest-power u-h-f TV tubes,* giving superior transmission at 200 kw E.R.P.

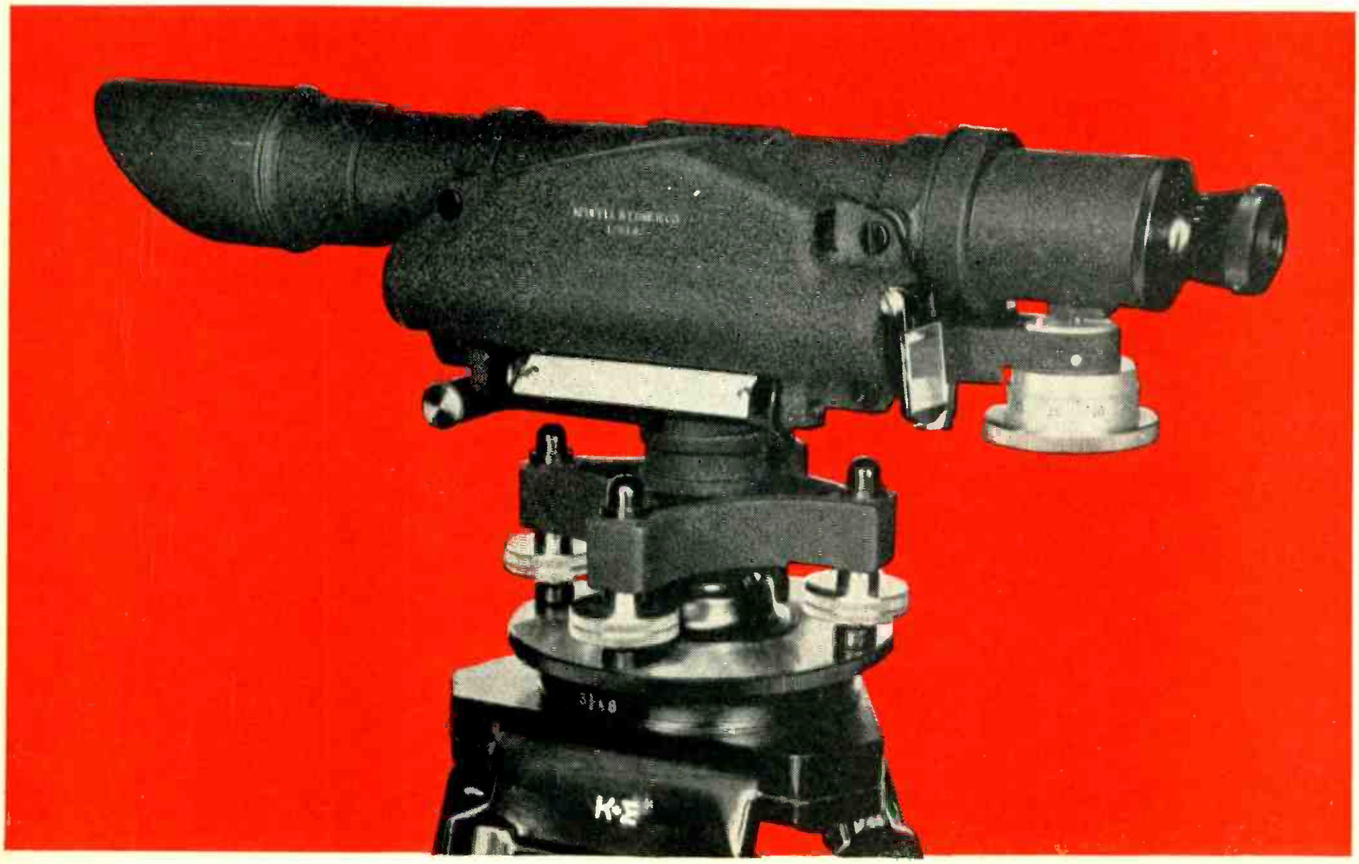
1878 75 1953
YEARS OF ELECTRICAL PROGRESS
Diamond Anniversary

How the image you see gets PARAGON®



Even an ordinary reading glass can produce an image of sorts. That happens when the sun's rays are focused on a piece of paper as shown. All the rays passing through the lens concentrate at approximately one point where they form a small inverted picture or image of the sun.

By means of a lens, rays from any object at a distance can be made to concentrate inside a telescope in the same way. They form a tiny inverted picture of the object. If a screen like the ground glass of a camera were placed there and viewed through a magnifying glass, the actual picture of the distant object could be seen clearly. The lens that brings the tiny picture into a telescope is called the objective, and the small but powerful microscope that brings it out of the telescope into the eye is called the eyepiece.



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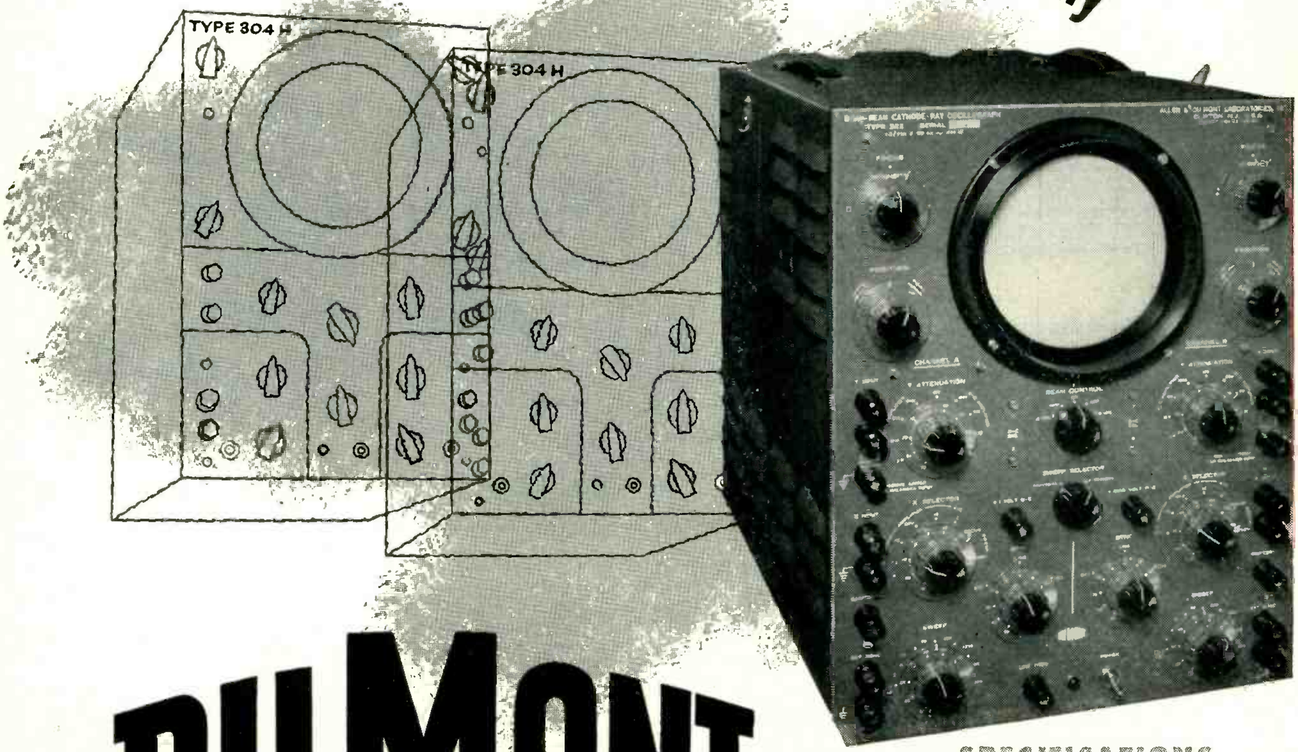
Want more information? Use post card on last page.

A general-purpose DUAL-beam oscillograph to fit your needs technically and financially



the DU MONT
TYPE 322

Not just another specialized dual-beam oscillograph, but a brand-new type designed for general development work but rugged enough for production testing and industrial applications as well. Compactness, lightweight, ruggedness and versatility mark the Du Mont Type 322 as another milestone in cathode-ray oscillography.

FEATURES

All the well-known features of the 304-H, and . . .
Thoroughly field-tested.
Individual and common time bases with driven or recurrent sweeps and sweep expansion on all sweeps.
Conventional single-ended input with stepped and vernier attenuators, or balanced input with no attenuation, on both Y-axes.
Concentric controls for easy-to-operate, compact control panel.
High-gain D-C amplifiers on both channels.
Amplitude calibration on either channel on both axes.
Illuminated scale with dimmer control.

SPECIFICATIONS

Cathode-ray Tube — Type 5SP — Dual-beam Cathode-ray Tube. Accelerating potential, 3000 volts.

Y-Deflection Sensitivity — 0.028 peak-to-peak (0.01 rms) volts/inch from D-C to 300 KC (50% down at 300 KC); A-C coupling, 10% down at 5 c.p.s.

X-Deflection Sensitivity — 0.3 peak-to-peak (0.1 rms) volts/inch from D-C to 300 KC (down 50% at 300 KC); A-C coupling down 10% at 5 c.p.s.; common, D-C to 200 KC (down 50% at 200 KC).

Linear Time Base—Recurrent and driven sweeps variable in frequency from 2 to 30,000 c.p.s. Front panel connections provided for lower frequency by adding external capacitance.

Intensity Modulation — Input impedance 0.2 megohm, paralleled by 80 $\mu\mu$f. Negative signal of 15 volts peak blanks beam at normal intensity settings.

Beam Control Switch — On front panel to turn beams on or off independently or simultaneously.

Calibrator — Regulated potentials of 50 millivolts and 1 volt peak-to-peak squarewave at power line frequency available at front panel binding posts.

Power Source — 115/230 volts — 50-400 c.p.s. — 225 watts.

Dimensions — Height 15¾", width 12½", depth 22⅞", weight 75 lbs.

$835.00

Write for complete technical details:

Instrument Division
Allen B. Du Mont Laboratories, Inc.
1500 Main Avenue, Clifton, N. J.

PRECISION LABORATORY INSTRUMENTS

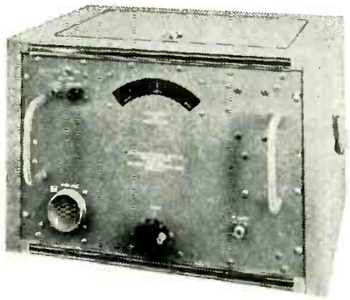
NEW

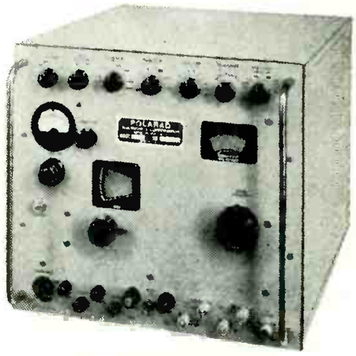
MICROWAVE RECEIVERS

1000—10,750 mc

Four microwave receivers of high sensitivity, wide tuning range and selectivity. Image rejection is greater than 60 db. Gain stability better than ±2 db, permits application as a field intensity meter.

NEW





MICROWAVE SIGNAL SOURCES

Models SSR, SSL, SSS, SSM SSX, 634 MC to 10,750 MC

A reliable source of microwave energy in transmission loss meaurements, standing wave determination, etc. Unidial Control for accuracy and ease of operation. Direct reading (no mode charts to consult).

MICROWAVE SIGNAL GENERATOR

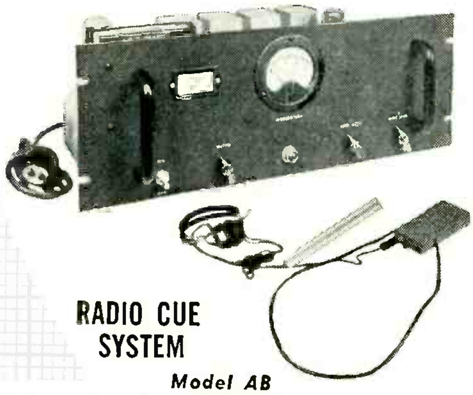
Model MSG-4
7,000 mc—10,750 mc

An ideal source of an accurately known signal voltage, precisely modulated. Sensitivity, frequency and performance of radio and radar equipments in the frequency range from 7 to 10.75 kmc can be readily measured on this continuously variable, direct reading signal generator.

Polarad *Electronics Corporation*

POLARAD ELECTRONICS

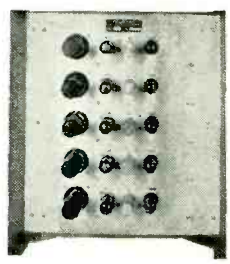
TELEVISION EQUIPMENT



RADIO CUE SYSTEM

Model AB

Used to direct the activities of persons within a limited area from a central control point. Widely used in broadcast and motion picture studios (sound and television). Ideal for factories, yards, hangars, airports, auditoriums, and places where the noise level is high. The Radio Cue System permits efficient operation under difficult conditions.



TELEVISION DISTRIBUTION AMPLIFIER

Model TDA-1

Isolates and distributes television signals over transmission lines for station and production use. TV Synchronizing and picture signals, both monochrome and color can be distributed to as many as five separate points.

See us at Booth 2-511, Radio Engineering Show

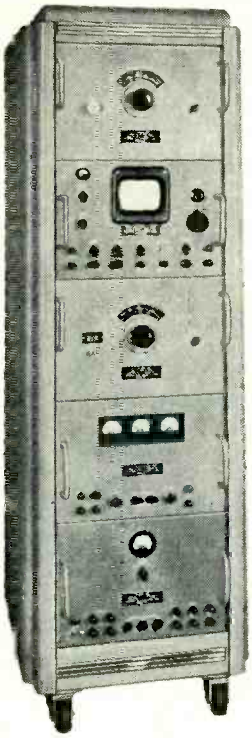
All Band, Direct Reading

IMPROVED

SPECTRUM ANALYZER

Model LSA

10 MC to 21,000 MC



The Model LSA is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an rf signal.

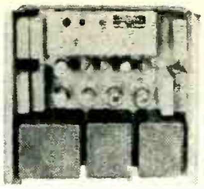
- Frequency accuracy 1 percent.
- No Klystron modes to set.
- Broadband attenuators supplied from 1 to 12 KMC.
- Frequency marker for measuring differences 0-25 MC.
- Only four tuning units required to cover entire range.

REGULATED POWER UNITS

MODEL PT111D

(Dual Regulated)

Consists of two independently regulated D.C. power sources (isolated from ground), mounted on one chassis. Each power source has its own power switch, fuse, pilot light and voltage control.

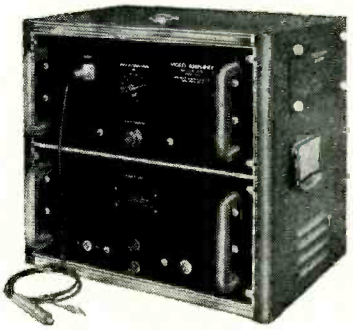


MODEL PT111

Consists of a positive and a negative voltage supply independently regulated.

MODEL PT112

Heavy duty electronically regulated D.C. power source.

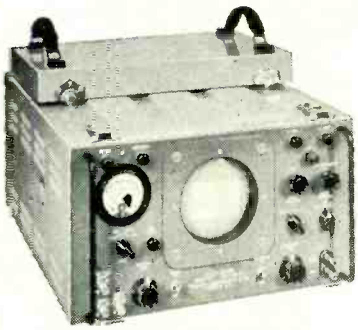


WIDE BAND VIDEO AMPLIFIER

Model VT 10 CPS to 20 MC

Designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of short duration and rise time.

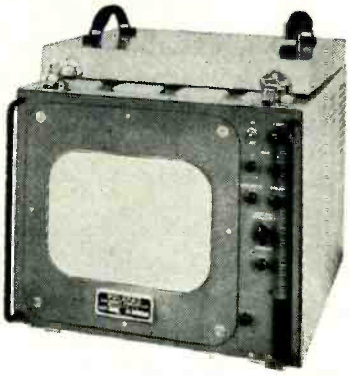
CORP. 100 METROPOLITAN AVENUE, BROOKLYN 11, N. Y.



PORTABLE TELEVISION WAVE FORM MONITOR

Model TO-1

Designed for precise wave form analysis and amplitude measurement of video signal in television circuits. Also ideal as a general purpose instrument in many applications, because of its wide frequency response, high sensitivity, excellent synchronizing capability, precision calibrating circuits and unusually large symmetrical horizontal expansion.



STUDIO PICTURE MONITOR

Model M-105

A high fidelity picture monitor of large size, sufficient for ease of observation under studio conditions. It is a high impedance device and may be connected across a video transmission line without affecting the terminal impedance of the line. Monochrome and/or color signals in black and white reception is provided.

See us at Booth 2-511, Radio Engineering Show

Precision-Built... *for dependable performance*

Whatever your requirements for top quality wire-wound components, you can count on I-T-E products. Power resistors, precision resistors, deflection yokes—all are specially designed and precision-built to meet the exacting standards demanded for critical electronic applications. Close quality control and modern production methods give you assurance of *quality* components in any quantity you need.

I-T-E POWER RESISTORS

Non-hygroscopic ceramic foundations are in accordance with JAN specifications.

Purest resistance wires are uniformly wound to prevent shorted turns and excessive hot spots. All connections silver-soldered.

Vitreous enamel coating (organic if required) provides a glazed moisture-repellent surface with fast heat-dissipation qualities.

Advanced production methods assure high stability, long life.

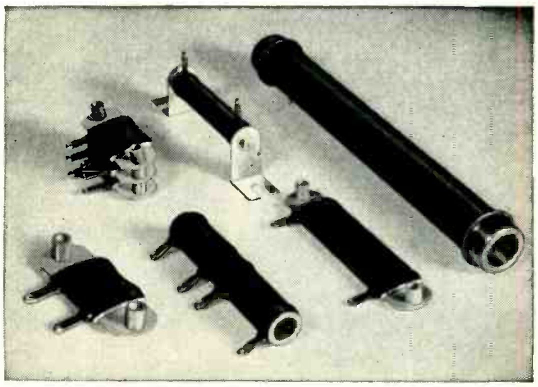
Standard fixed resistors:
5-200 watts

Adjustable resistors:
10-200 watts

Oval resistors:
30-75 watts

Ferrule resistors:
12-200 watts

Special resistors:
built to specifications



Standard Tolerance: ±10%. ±5% *and less* made to order.

I-T-E PRECISION RESISTORS

High-quality wire alloys are used—free from internal stresses and strains.

Automatic precision winding assures even tension—eliminates hot spots.

Hermetic or vacuum-impregnated sealing protects against destructive effects of salts, moisture, and atmospheric conditions.

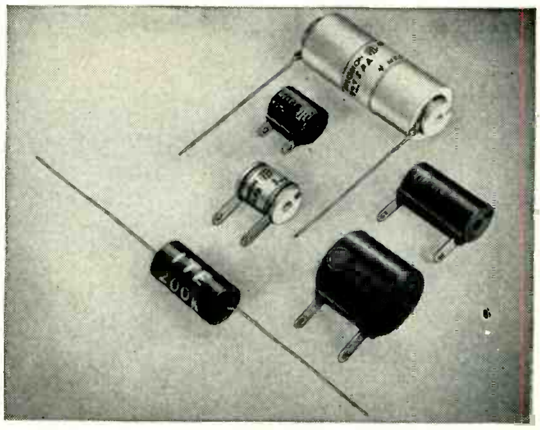
Accelerated aging process prior to calibration assures accuracy.

Critical quality control eliminates all resistors which do not come up to high I-T-E standards.

TYPE A:
lightweight, hermetically sealed—for precision operation up to 125° C. Surpass JAN R-93 A, *Characteristic A,* and MIL R-93 A specifications.

TYPE B:
vacuum-impregnated, moisture-resistant. For JAN R-93, *Characteristic B,* specifications.

Ratings from 0.01 ohm-10 megohms, 0.125-5 watts.



Standard Tolerance:
±1%. Available in specified tolerances down to ±0.05%.

I-T-E DEFLECTION YOKES

Wire size and quality constantly checked. Coils impregnated in special moisture-resistant thermoplastic—properly cured to assure firm coil with minimum losses. Yokes can be obtained complete with wire leads, resistors, and capacitors to your specifications.

WRITE FOR DETAILS

I-T-E

WIRE-WOUND PRODUCTS

I-T-E RESISTOR DIVISION

1924 Hamilton St., Phila. 30, Pa. • A division of the I-T-E Circuit Breaker Co.

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Want more information? Use post card on last page.

WHAT ABOUT THE

Wattage Rating

OF *PRECISION WIREWOUND* RESISTORS?

The wattage rating of precision wirewound resistors is often expressed in two forms—the manufacturer's commercial catalog rating, and the JAN-R-93 or MIL-R-93A rating. Exceptions are the many resistors smaller than JAN and MIL dimensions not rated under JAN or MIL specifications.

THE BASIS FOR WATTAGE RATINGS: Production resistors are wound with resistance wire insulated with either or both enamel and a silk or nylon covering which deteriorates rapidly above 105°C.

JAN and MIL wattage ratings are based on an ambient temperature of 85°C. The wattage rating is limited to the power dissipation which will cause not more than a 20°C temperature rise. This results in a temperature of not more than 105°C at the hottest point ("hot-spot") on the winding.

Shallcross commercial ratings are based on an ambient of 25°C. Wattage rating is limited to the power dissipation which will cause not more than a 20°-40°C rise. Although higher, these ratings are based on hot-spot temperatures of only 45°-65°C.

VOLTAGE DERATING AND RESISTANCE: Above about 50 per cent of the cataloged maximum resistance, the Shallcross commercial wattage rating must be derated by the maximum voltage tabulated in the catalog. Lower thermal efficiency of the small diameter wire used for higher resistance values causes a higher temperature rise for the same dissipation, and the potential gradient in the winding must be held to a safe proportion of the breakdown voltage.

Computation using JAN-MIL wattage ratings, maximum resistances, and voltage limitations, reveals that voltage derating is seldom necessary up to 99% or more of JAN-MIL maximum resistance values.

TOLERANCE DERATING: JAN, MIL, and Shallcross commercial wattage ratings are based on resistors with 1% tolerance. For closer tolerances, the following MIL derating system is a good one to use:

Resistor Tolerance—%	Per Cent of Nominal Wattage
1	100
0.5	75
0.25	50
0.1	50

SPECIAL HIGH WATTAGE RESISTORS: Shallcross also offers non-inductive, precision wirewound resistors rated 5 to 10 times higher than the usual commercial wattage ratings. These "G" type resistors are wound with glass-insulated, low T.C. wire, silicone varnished. They are rated on a 150°C temperature rise above an ambient of 25°C. Their hot-spot temperature is 175°C.

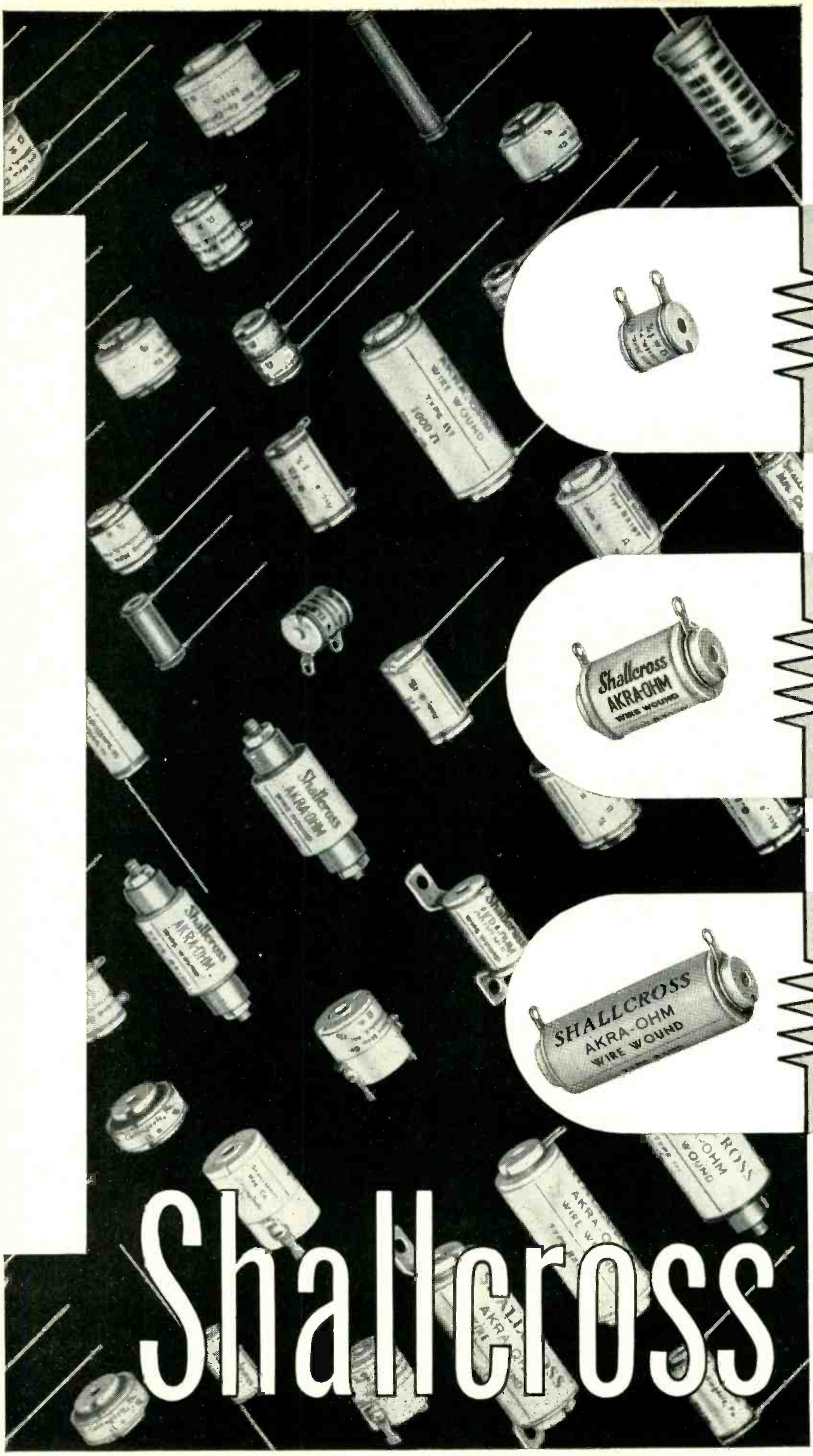
Shallcross also supplies "S" type resistors wound with silicone-enameled low T.C. wire. Better insulation permits these resistors to operate at higher than normal hot-spot temperatures. Exact ratings are still being established, but they can be expected to approach those of "G" resistors while permitting higher maximum resistance values.

Further details on Wattage Ratings and other resistor characteristics are available in Shallcross Bulletin R-3C.

SHALLCROSS MANUFACTURING COMPANY • 522 PUSEY AVENUE, COLLINGDALE, PA.

See us at the I.R.E. Show—Booths 2-210 & 2-211.

The third of a series to promote a better understanding of the performance characteristics of precision wirewound resistors.



NEW 3-WATT RESISTOR

Shallcross Type S 183-A is typical of the higher wattage ratings possible with silicone-enameled wire. Yet it measures only $\frac{9}{16}$" L. x ½" Diam. Maximum resistance is approximately 500K ohms.

8-WATT PRECISION WIREWOUND RESISTOR

Wound with glass-insulated wire, silicone-impregnated, this Shallcross Type G 196-E resistor will dissipate 8 times the nominal wattage of the standard Type 196 resistor. Maximum resistance is 60K ohms. 1¼" L. by ¾" Diam.

HIGHEST WATTAGE STANDARD RESISTOR

The BX 116-2E is the largest Shallcross resistor using standard resistance wire. Rated at 4-watts, the dimensions are only 3⅞" L. by ¾" Diameter. Maximum resistance is 20 megohms.

Want more information? Use post card on last page.

PREFERRED BY CRAFTSMEN
FOREMOST IN QUALITY

ALPHA SOLDER

for everything electronic

CEN-TRI-CORE *ENERGIZED* ROSIN-FILLED SOLDER

Guaranteed non-corrosive for radio, television, electronic and other electrical applications. No other solder works faster or easier . . . It provides greater fluxing uniformity and stronger smoother joints.

No activating chlorides or other chemical agents tending to produce acid conditions, toxic or sticky vapors, or latent corrosion.

Ideal where plated and/or oxidized parts must be soldered. Designed for use where faster fluxing is desirable.

CEN-TRI-CORE's exclusive design guarantees rosin throughout the complete length of the wire. Eliminates rejects commonly encountered in the use of ordinary rosin core solders. CEN-TRI-CORE is faster fluxing: thinner walls between solder and rosin assure faster penetration of heat to the flux – requires less heat and guarantees maximum fluxing action of the rosin.

CEN-TRI-CORE
PLASTIC
ROSIN-FILLED
SOLDER

For those applications where a conventional rosin flux is required. For telephone and other critical soldering operations.

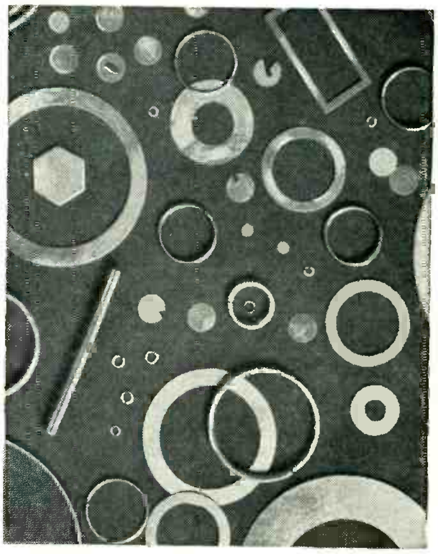
ALPHA *write for generous samples*

ALPHA METALS, INC.
58 Water Street, Jersey City 4, N. J.

speed up production . . . bring your costs down!

ALPHA SOFT SOLDER PREFORMS

Alpha's preformed solders, in any shape or size, cut many hours from your production time. You can select washers, rings, coils, cut shapes, drops, pellets, solder foil, to fit your specific needs. They save you considerable money and materials in repetitive soldering processes.



SPEED AUTOMATIC SOLDERING
for flame, oven or induction heating

Increase Production • Melts Faster • Guarantee Product Precision • With Or Without Self-Flux
Save Labor Costs • Designed For Your Application
All Sizes, Shapes, Alloys • Stronger, Smoother Joints

AVAILABLE IN

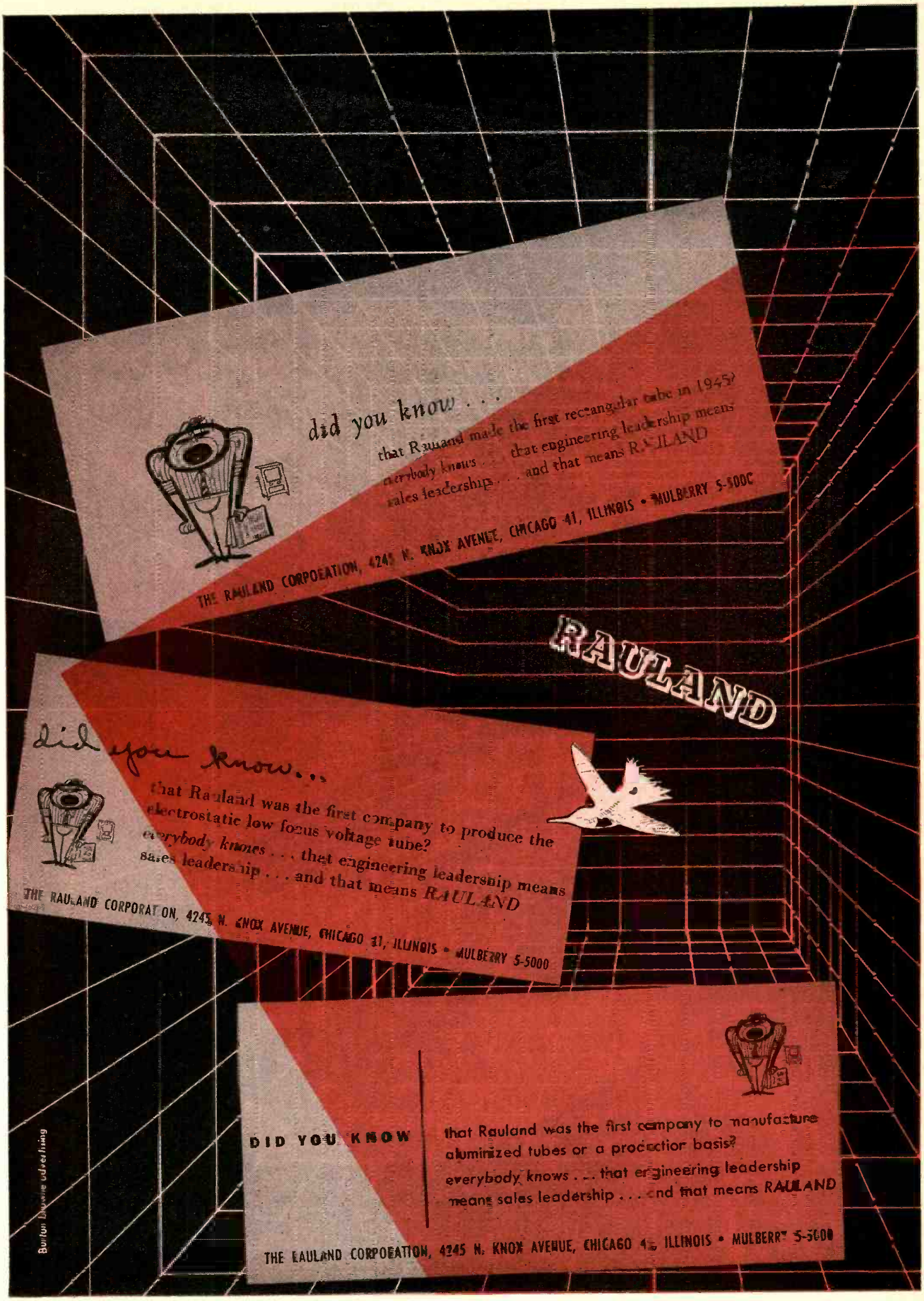
- ★ **CEN-TRI-CORE** *ENERGIZED* **ROSIN-FILLED**
- ★ **TRI-CORE** *LEAK-PRUF* **ACID-FILLED**
- ★ **SINGLE-CORE**
- ★ **SOLID WIRE**
- ★ **SHEET SOLDER**

Please consult us on your soldering problems. Trained Field Engineers always available to assist you. Small or large quantities.

write to ALPHA *for further information*

ALPHA METALS, INC.
58 Water St., Jersey City 4, N. J.

Visit us at Booth 512—3rd floor, I.R.E. Radio Engineering Show


did you know . . .
that Rauland made the first rectangular tube in 1945?
everybody knows . . . that engineering leadership means
sales leadership . . . and that means RAULAND
THE RAULAND CORPORATION, 4245 N. KNOX AVENUE, CHICAGO 41, ILLINOIS • MULBERRY 5-5000
RAULAND
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that Rauland was the first company to produce the
electrostatic low focus voltage tube?
everybody knows . . . that engineering leadership means
sales leadership . . . and that means RAULAND
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aluminized tubes on a production basis?
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Burton Browne advertising

94-5523

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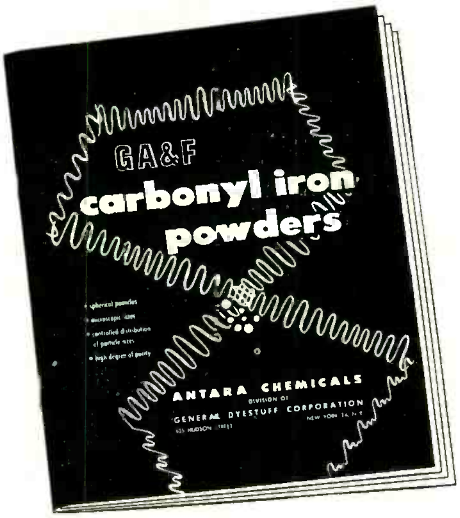
"We will take full advantage of GQ4's higher permeability and Q value"

GQ4 is an almost pure iron powder consisting of spherical particles which are readily compressible, resulting in high permeability. In this respect, it exceeds all other Carbonyl Iron Powders by a considerable margin. The particles possess an efficient insulating coat. The powder was designed to replace HP, mixtures of HP and L, and, in some instances, L itself. Its properties are such that it should yield simultaneously, higher Q value, higher strength and often, higher permeability, than mixtures of HP and L.



We urge you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can increase the efficiency and performance of the equipment or product you make, while reducing both the cost and the weight. We also invite inquiries from those whose requirements call for still greater variations than are offered by any of our existing types.

• • •

This wholly new 32-page book offers you the most comprehensive treatment yet given to the characteristics and applications of G A & F Carbonyl Iron Powders. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. For your copy—without obligation—kindly address Department 42.

MEMBER mpa METAL POWDER ASSOCIATION

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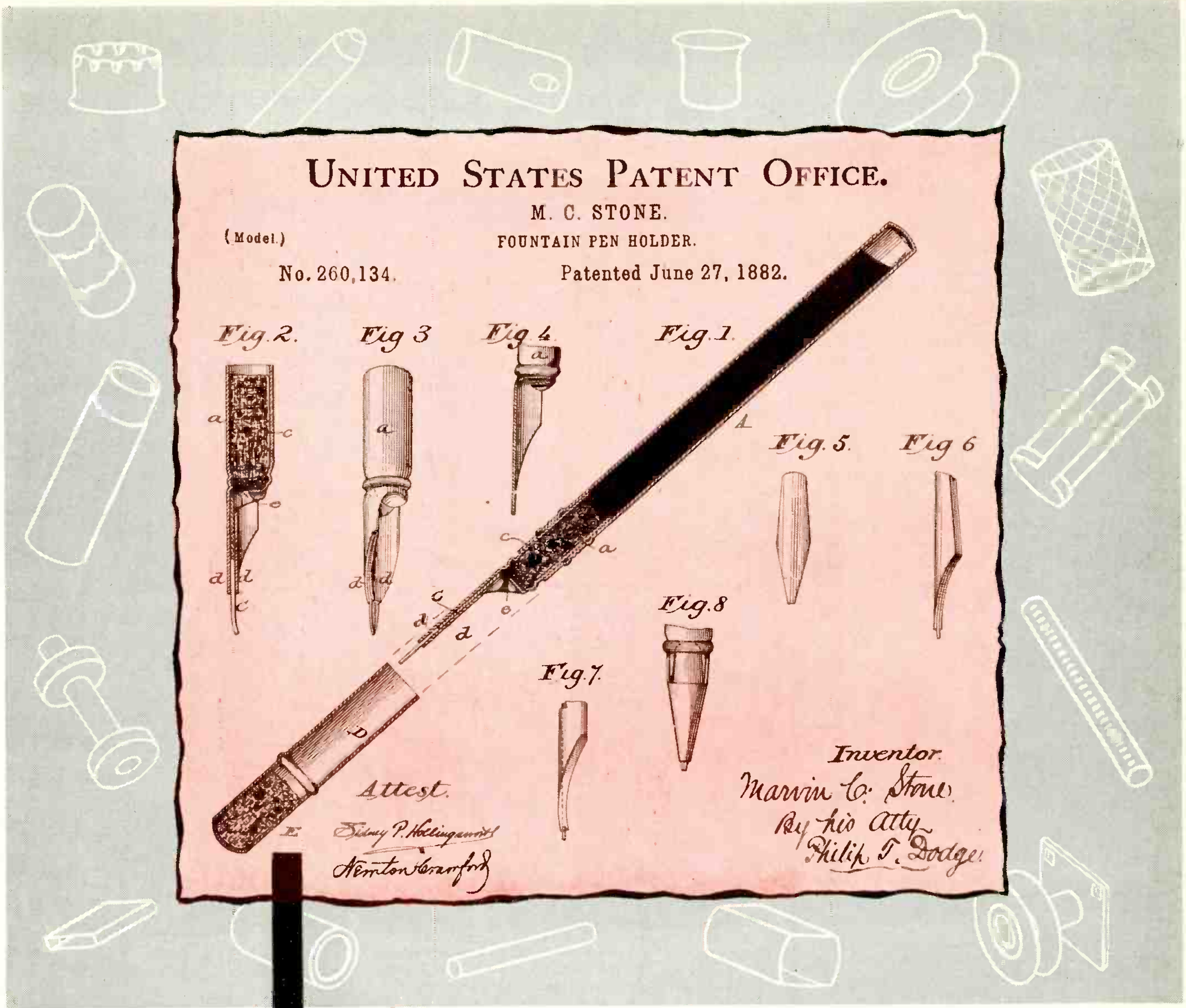
gdc ANTARA gaf


keeping communications ON THE BEAM
JK
PRODUCTS
the JK FD-12
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!
JK STABILIZED H-17 CRYSTAL
CRYSTALS FOR THE CRITICAL
The JK H-17 Crystal meets rigid airline requirements for compactness, light weight, rugged dependability. A Military type, it is hermetically sealed—dust and moisture proof—plated, quartz plate is shock mounted. One of many JK Crystals made to serve every need.
Ceiling Zero... Communications 100%
"Pea soup" over the field . . . and still the giants of air travel come in "on the beam". When visibility is poor, commercial pilots must rely on radio-radar equipment to bring their ship in safely. JK Crystals play an important role in this every day drama of keeping airlines communications "on the beam" in the air and on the ground.
THE JAMES KNIGHTS COMPANY
SANDWICH ILLINOIS



(No. 2 of a series)
The Historical Background of
STONE PAPER TUBE CO

"...I First Provide a Rigid Non-collapsible Tube."

THESE were the words used by Marvin C. Stone of Falls Church, Virginia, in his description of this fountain pen patent granted him June 27, 1882, and later upheld in an infringement suit in 1898 in the Circuit Court of New York.

Marvin C. Stone was the founder of the Stone Paper Tube Company, manufacturers today of both collapsible and rigid non-collapsible tubes, and he was the great-uncle of our president.

Thus it can be seen that more than 70 years ago, Stone's inventiveness and knowledge of the use of tubes was demonstrated . . . qualities which have made Stone one of the largest manufacturers of small diameter paper tubes in the United States.

During these intervening years, Stone has become a specialist in the manufacture of spiral wound insulating tubing, sleeves, and bobbins. Diameters as small as 3/64" ID can be furnished in products of various wall thicknesses and lengths and in many materials including hi-dielectric kraft, fish paper, and plastic films.

Hundreds of America's leading manufacturers in many industries have found that Stone's long experience makes possible the delivery of custom-made quality products to close tolerances at low cost with unsurpassed service.

Whatever your problem—large or small—we welcome the opportunity to serve you. Sales representatives are located in principal cities.

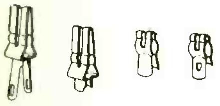
STONE PAPER TUBE CO.
INCORPORATED
Washington 17, D. C.

Want more information? Use post card on last page.

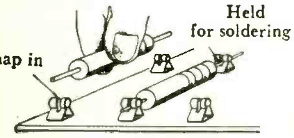
Here is Plug-in Unit Construction

Everything you need to mount, house, fasten, connect, monitor your equipment.

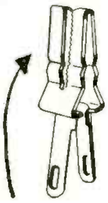
1st START WITH ALDEN MINIATURE TERMINALS



Here's a beautiful new little Terminal that really puts soldering on a production basis; taking a minimum of space and material. Ratchet holds leads firmly for soldering, no wrap-around or pliering necessary. Unique punch press configuration gives rapid heat transfer, taking less time and solder. Designed for Govt. Miniaturization contracts. Staked in Alden Prepunched Terminal Cards, allow patterns for any circuit.

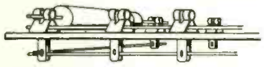


No pliers—No twisting



Ratchet holds leads firmly

Wires—Buss bars easily accessible



Both sides can be used

Snip off loops desired to by-pass.

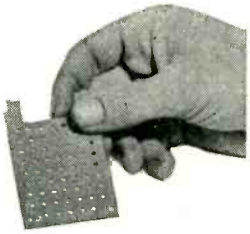
JUMPER STRIP

Stake under Terminals for common circuits. Loops match prepunched holes in Terminal Cards. Snip off loops desired to by-pass.

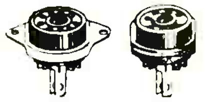
FOR YOUR SMALLER UNITS.

2nd Take Pre-punched Terminal Mounting Card ready-cut to size you require. Stake in Alden Miniature Terminals to mount your circuitry.

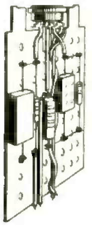
Prepunched Terminal Mounting Cards come in all sizes needed for Packages: miniature 7-pin and 9-pin units, or 11-pin and 20-pin plug-in units. Card is natural phenolic 1/16" thick prepunched on 1/4" centers with .101" holes for taking the Miniature Terminals.



3rd Attach Miniature Terminals, Alden Card-mounting Tube Sockets and Mounting Brackets, which mount in the prepunched holes.



Alden Card-mounting Tube Sockets for miniature 7, miniature 9 and octal tubes, are complete with studs and eyelets for easy mounting on Prepunched Cards.

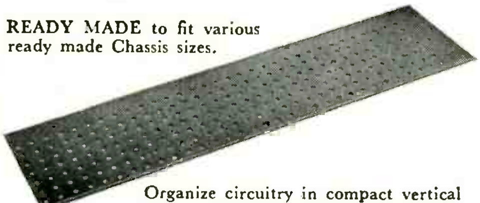


Mounting Brackets stake to the Prepunched Card, mount Card to Package Base and Lid.

FOR YOUR LARGER UNITS.

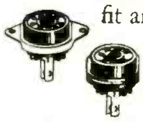
2nd Lay out circuitry with Prepunched Terminal Mounting Card in lengths up to 3'.

READY MADE to fit various ready made Chassis sizes.

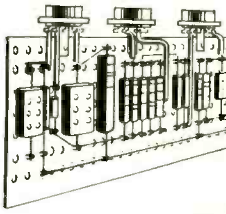


Organize circuitry in compact vertical planes. Use both sides of Prepunched Card to stake in Alden Miniature Terminals to your circuitry layout. Vertical position gives ready accessibility; there is no "underneath" in Alden design.

3rd Attach Miniature Terminals, Card-mounting Tube Sockets and Mounting Brackets, which fit any of the prepunched holes.



Alden Card-mounting Tube Sockets, ready-made in variety of sizes, complete with studs and eyelets for easy mounting on Prepunched Cards.



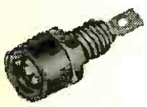
TO OBTAIN COMPLETE DETAILS.

Tiny Sensing Elements specifically designed to spot trouble instantly in any unit.

Here are tiny components to isolate trouble instantly by providing visual tell-tales for each unit.

"PAN-i-LITE" MIN. INDICATOR LIGHT

So compact you can use it in places never before possible. Glows like a red-hot poker. Push-mounts in .348" drill hole. Bulbs replace from front. Tiny spares are unbreakable, easily kept available, taped in recess of equipment. Alden #86L, ruby, sapphire, pearl, emerald.



MINIATURE TEST POINT JACK

Here are tiny insulated Test Point Jacks that make possible checking critical plate or circuit voltages from the front of your equipment panel—without pulling out equipment or digging into the chassis. Takes a minimum of space, has low capacitance to ground, long life beryllium copper contacts. Available in black, red, blue, green, tan and brown phenolic conforming to MIL-P 14B- CGF; also nylon in black, red, orange, blue, yellow, white, green. Alden #110BCS.

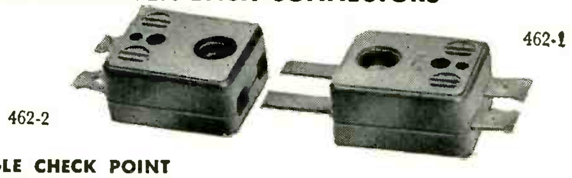
ALDEN "FUSE-LITE"

Fuse Blows — Lite Glows.

Signals immediately blown fuse. Lite visible from any angle. To replace fuse simply unscrew the 1-pc. Lite-lens unit. Mounts easily by standard production techniques, in absolute minimum of space. 110V Alden #440-4FH. 28V #440-6FH.

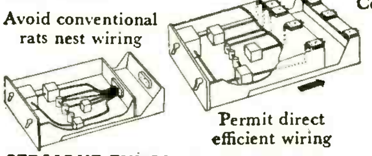
Free Samples Sent Upon Request

Get one point of check of all incoming and outgoing leads thru ALDEN BACK CONNECTORS



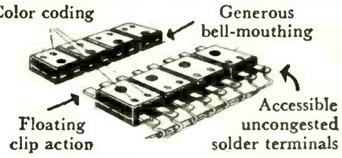
SINGLE CHECK POINT

Here for the first time is a slide-in connector that brings all incoming and outgoing leads to a central check point in orderly rows, every lead equally accessible and color coded.



STRAIGHT-THROUGH CIRCUITRY

Wiring is kept in orderly planes, avoiding rat's nest of conventional back plate wiring. Connections between Terminal Mounting Cards are through Back Connectors so that all circuitry is controlled at this central point. Incompatible voltages safely isolated and separated.



EASY INSERTION AND REMOVAL

Mating tolerances permit easy insertion and removal without demanding critical alignment tolerances. Assure proper contact, with safety shielding of dangerous voltages. Leads can be attached above, below or out of the back for most direct and efficient interconnects.

Ready-made Alden Back Connectors meet all conceivable needs, for slide-in chassis replaceable in 30 seconds with spare.

VISIT OUR COMPLETE DISPLAY AT THE I.R.E. SHOW

NA-ALD **ALDEN PRODUCTS COMPANY**

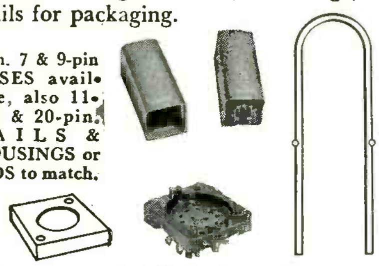
READY-MADE for your Electronic Equipment

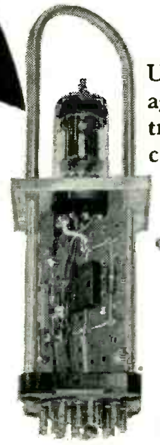
All designed — all tooled — production immediately available — no procurement problems. *Apply ALDEN Standards wholly or in part.*

ALDEN PLUG-IN PACKAGES

4th After mounting your circuits on Terminal Cards, use Alden Standard Plug-in Bases, Housings, Bails for packaging.

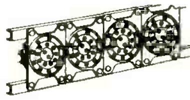
Min. 7 & 9-pin BASES available, also 11-pin & 20-pin BAILS & HOUSINGS or LIDS to match.





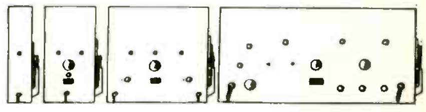
ALDEN PLUG-IN PACKAGES

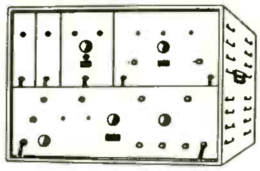
Using standard Alden Plug-in Packaging Components you can mount a tremendous variety of circuits on chassis or in racks.



Alden "20" Rack Mounting Socket with extended ears that mount side by side and in multiple rows on U-Channels that accommodate 50 Alden "20" Plug-in Units illustrated, in 10½ x 19" rack mounting panel.

HOUSE PLUG-IN UNITS IN ALDEN BASIC UNI-RACKS





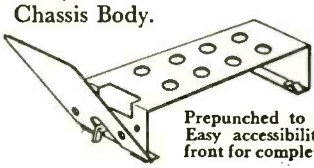
FOUR SIZES OF CHASSIS MOUNT IN ANY COMBINATION IN ALDEN UNI-RACKS

STACKED

Mounting all equipment in Alden Uni-Racks provides a uniform system easy to handle and ship. Can be installed and interconnected as fast as unloaded.

ALDEN BASIC CHASSIS

4th Fit Prepunched Cards carrying completed circuitry into Standard Alden Basic Chassis Body.

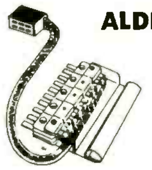


Prepunched to your specs. Easy accessibility at sides, front for completing wiring.

SERV-A-UNIT LOCK
pulls in or ejects chassis.

SLIDE-IN BACK CONNECTORS
See description on opposite page.

ALDEN BASIC CHASSIS
with spares provides 30-second servicing for your unitized circuitry.



ALDEN UNIT CABLE
interconnects between Uni-racks or other major circuitry divisions. Quick, sure, coded means of isolating and restoring (with spare) inter-division circuits.

SEND FOR FREE "ALDEN HANDBOOK"

Your design and production men have always wanted these advantages:

1. Experimental circuitry can be set up with production components, cutting down debugging time.
2. Allows technicians, rather than engineer, to debug, by taking out unit.
3. Given the circuitry, nothing further to design—make up from standard Alden components.
4. Optimum circuit layout using standard terminal card.
5. Absolute minimum requirements of labor, materials, space.
6. The various sub-assemblies can be built concurrently on separate assembly lines.
7. No tooling costs—no delays—no procurement headaches.
8. Fewer prints—smaller parts inventory.
9. Can subcontract assemblies.

Your customers and sales force will welcome these advantages:

The big objection to electronic equipment—from the user's point of view—is that if it goes out of order he feels helpless. But you have a perfect answer when your equipment is made to Alden Standards of Plug-in Unit Construction because they assure DEPENDABLE OPERATION, as follows—

30-SECOND REPLACEMENT OF INOPERATIVE UNITS by plugging in available coded spares.

TROUBLE INSTANTLY INDICATED AND LOCATED by monitoring elements assigned to each functional unit.

TECHNICAL PERSONNEL NOT REQUIRED to maintain in operation, due to obvious color coding and fool-proof non-interchangeability of mating components.

TOOLESS MAINTENANCE made possible by patented Alden fasteners and plug-in locking and ejecting devices.

AIRMAIL SERVICE—
Compact functional units practical to send airmail to factory for needed overhaul.

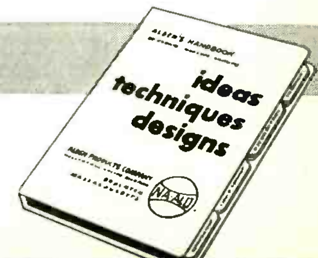
UNI-RACK FIELD HANDLING UNIT—groups functional units into stacking cabinets not exceeding one- or two-man handling capacity—go easily through windows, doors.

CONNECT AS FAST AS UNLOADED, by coded non-interchangeable unit cables plugged in between Uni-racks.

SEND FOR FREE 226-PAGE HANDBOOK

This 226-page Handbook describes fully the Alden System of Plug-in Unit Construction and the hundreds of components ready-made and completely tooled to meet your every requirement. It's a gold-mine for those designing electronic control equipment that is practical in manufacture; dependable in operation.

REQUEST YOUR COPY TODAY — SENT FREE!



127 North Main Street • Brockton 64 • Massachusetts NA-ALD

WHAT IS HERMETIC DOING ABOUT *Transistors?*

PLENTY! HERMETIC is now actively engaged in the development of hermetic seals for both point contact and junction transistors. These are being designed for plug applications, feed-through connections, fuse-type mounts, etc. Typical of other HERMETIC innovations, they will be noted for accuracy, sub-sub-miniature designs and a variety of shapes and flanges to fit every form of housing. In addition, it will be possible to use these new hermetic seals for both single and double mount.

WRITE for information and assistance concerning your own transistor problems. Please submit sketches indicating mounts, limiting dimensions, number and size of contacts and any other applicable specifications.

HERMETIC's 32-page catalog is also available with a wealth of data on hermetic seals. Your copy is free!

HERMETIC SEAL PRODUCTS CO.

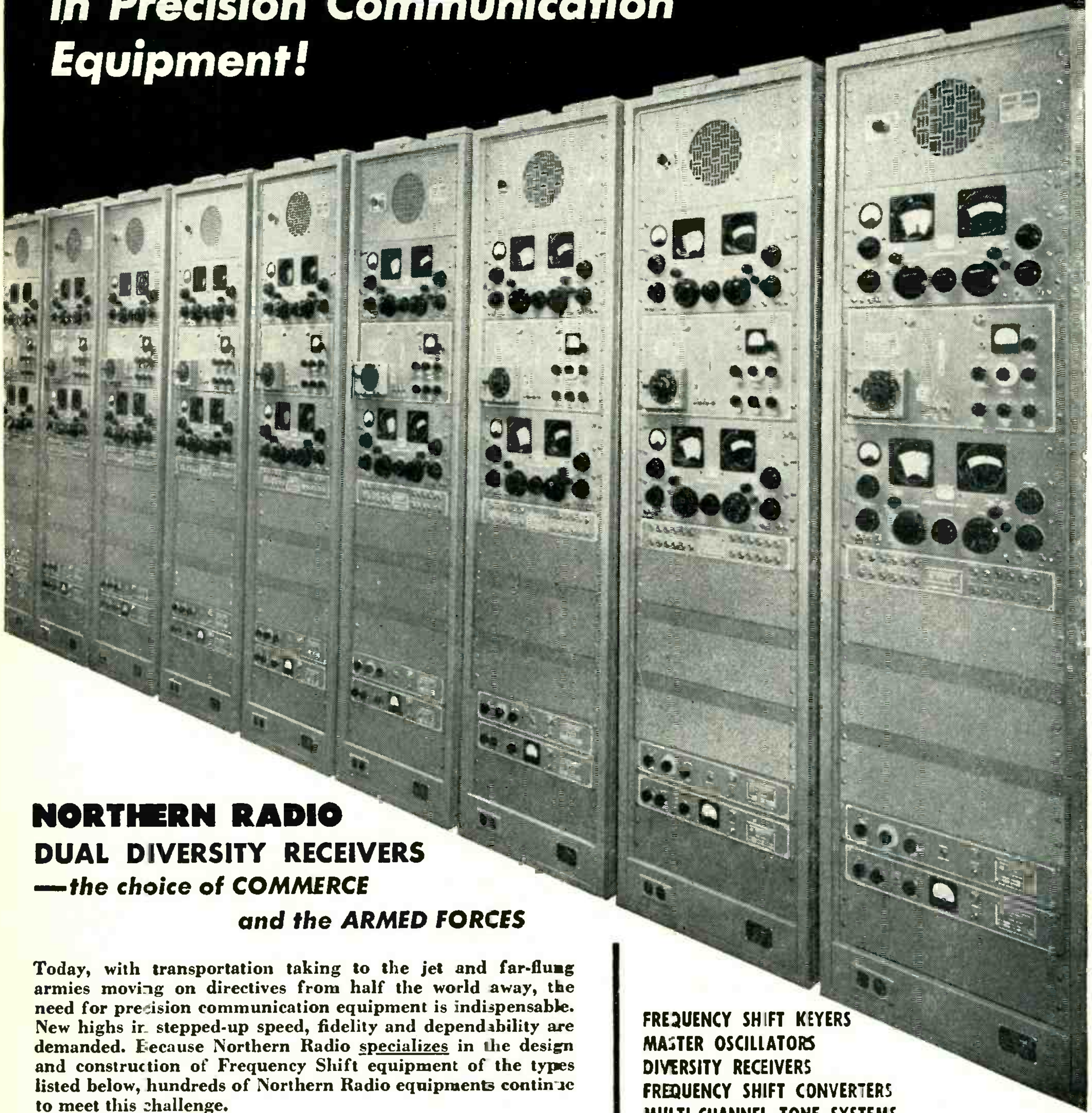
33 South Sixth St., Newark 7, New Jersey

FIRST AND FOREMOST IN MINIATURIZATION

SEALED IN HERMETIC HEADERS

Want more information? Use post card on last page.

PROVEN LEADERSHIP
in Precision Communication Equipment!



NORTHERN RADIO
DUAL DIVERSITY RECEIVERS
—the choice of COMMERCE *and the* ARMED FORCES

Today, with transportation taking to the jet and far-flung armies moving on directives from half the world away, the need for precision communication equipment is indispensable. New highs in stepped-up speed, fidelity and dependability are demanded. Because Northern Radio specializes in the design and construction of Frequency Shift equipment of the types listed below, hundreds of Northern Radio equipments continue to meet this challenge.

For example, the Dual Diversity Receivers of the type pictured above under construction, although designed and built by Northern Radio for commercial use, have been specified *as is* by the Armed Forces.

This is *proven* communications leadership — and only constant research and precision manufacture can produce it. *Write for complete information.*

- FREQUENCY SHIFT KEYERS
- MASTER OSCILLATORS
- DIVERSITY RECEIVERS
- FREQUENCY SHIFT CONVERTERS
- MULTI-CHANNEL TONE SYSTEMS
- TONE KEYERS
- DEMODULATORS
- RADIO MULTIPLEX SYSTEMS
- MONITORS
- TONE FILTERS
- LINE AMPLIFIERS

Pace-Setters in Quality Communication Equipment

NORTHERN RADIO COMPANY, inc.
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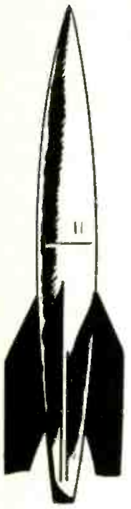

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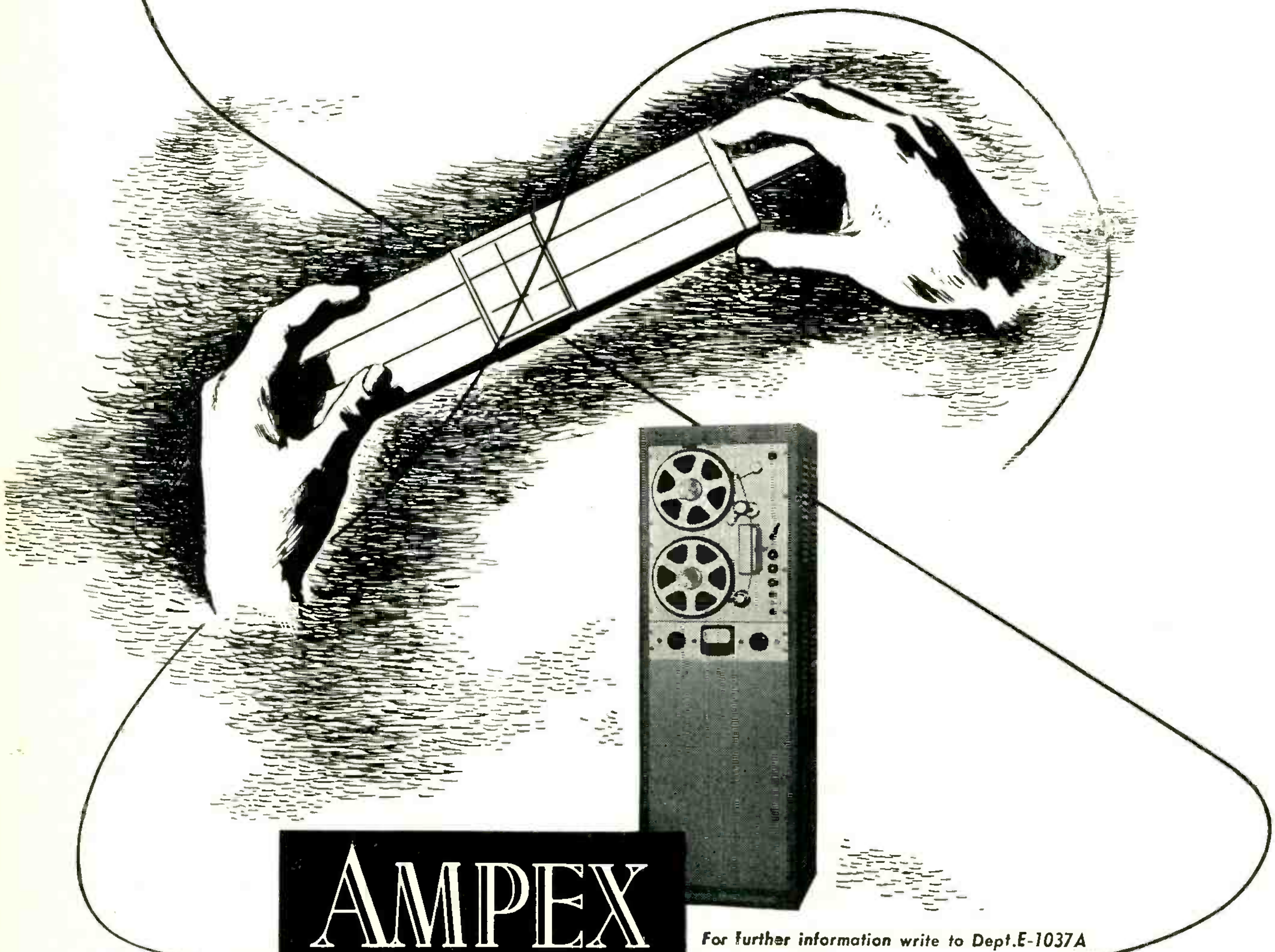

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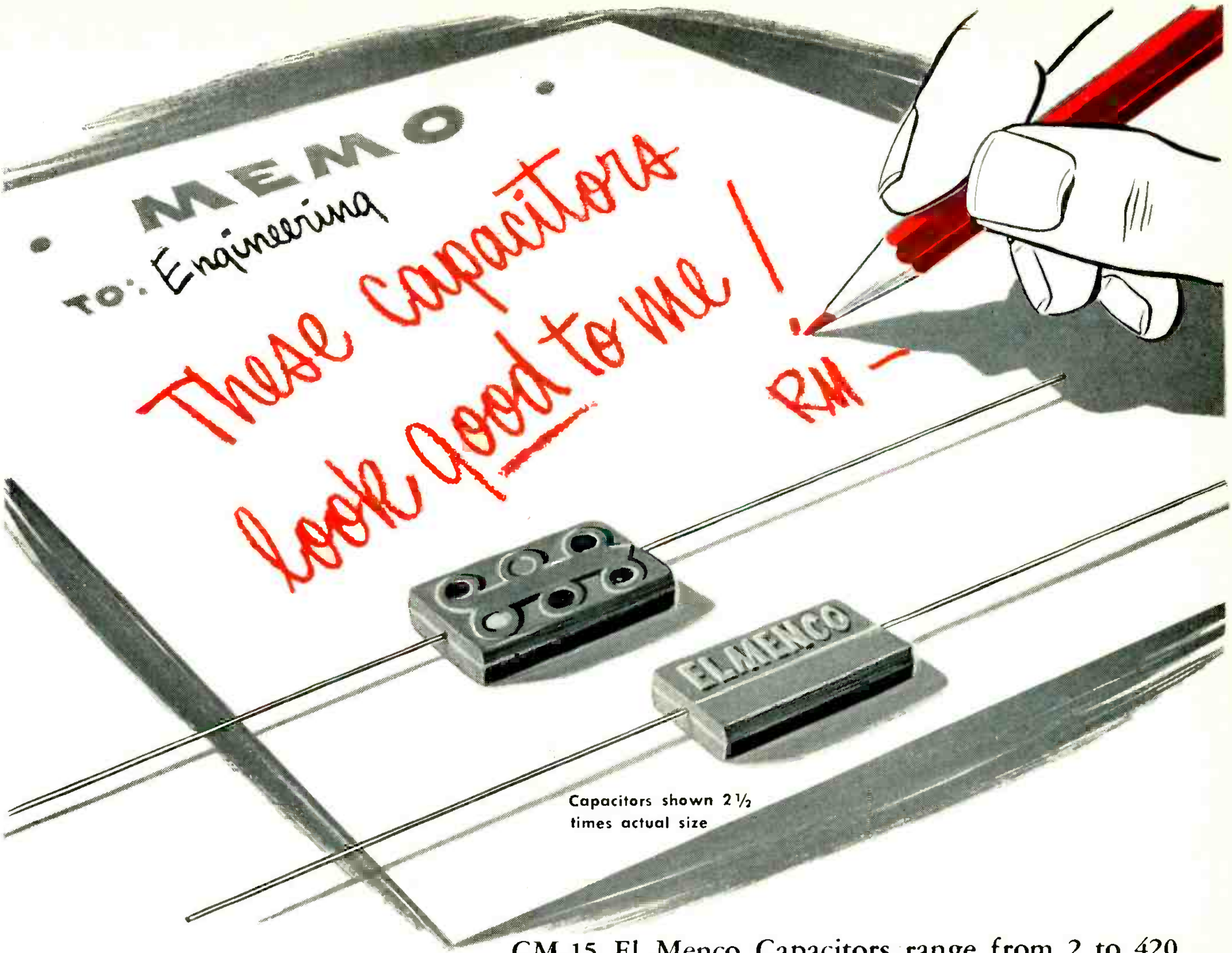

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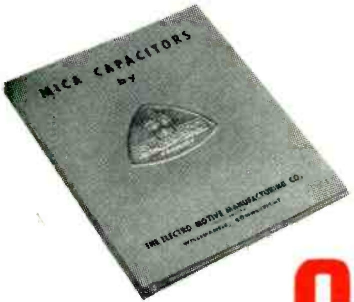

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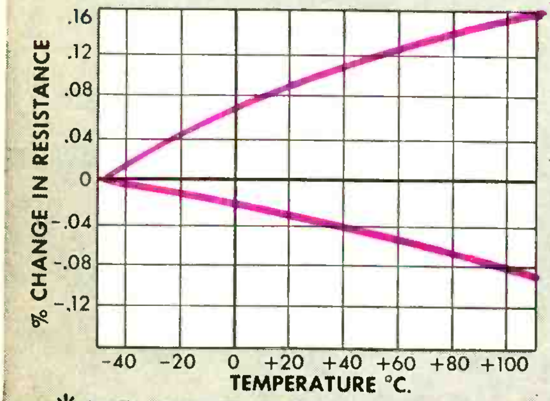

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PROSPERITY IN THE USA:
How Wealthy Are We?

Again, how prosperous *are* the people of the United States?

This is the third of a series of messages devoted to this crucially important and much-debated question. The first two messages dealt with what has been happening to our national income, both in terms of its growth and how it is divided among individuals.

This third message deals with what has been happening to the resources — factories, farms, mines, and equipment of all kinds — out of which income is created. It deals with what economists call our wealth.

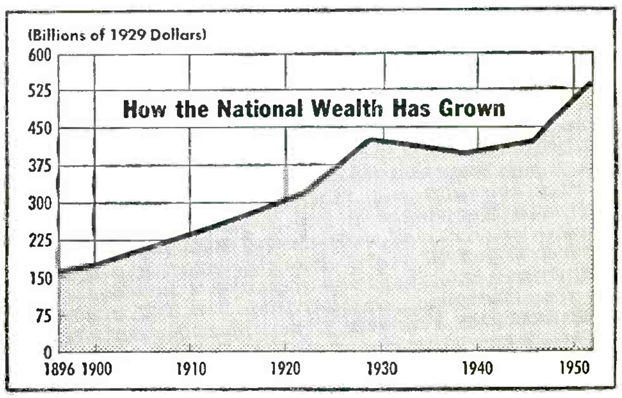
It is possible for a nation to enjoy apparent prosperity for a time by rapidly exhausting its resources. But to sustain prosperity over the long pull a nation must see that its wealth is not dissipated. Hence what is happening to our wealth now is a harbinger of what is going to happen to our prosperity later on.

How Wealth is Measured

It is often asserted that the most vital element in a nation's wealth is its people. There is a lot in this idea. For example, the full value of a country's hospital and surgical equipment depends on its physicians and their skill in handling the equipment.

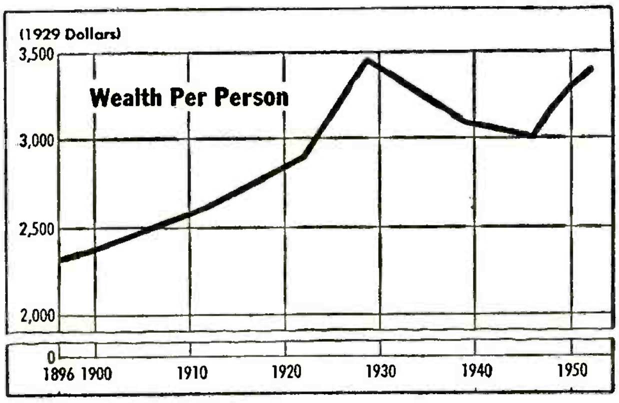
However, no one has ever devised a satisfactory way to put a value on human beings. So people are omitted from calculations of national wealth. So, too, is military equipment. It is regarded as basically destructive and hence not a real addition to wealth. Otherwise, the wealth of a nation is calculated in terms of the dollar value of its physical resources.

The following chart shows the wealth of the U. S. A. at various intervals during the past 50 years. For the period through 1948 the figures come from a pioneering study by Raymond Goldsmith of the National Bureau of Economic Research, which is widely regarded as the foremost organization in its field. The figures since 1948 are estimated. To remove the effect of price changes, all of the wealth figures are calculated in 1929 prices.



From this chart one fact stands out clearly. It is that since 1929 our national wealth has not been increasing as steadily as it did during earlier periods. Indeed, in 1946 our total national wealth was actually less than it was in 1929. Only in the last six years have we been able to make any consistent additions.

Even these gains are less impressive when the growth in our population is taken into account, as illustrated by the following chart.



This chart makes it clear that when the nation's wealth is divided by the population, we are slightly worse off per person today than we were in 1929. This is the case in spite of the large additions to our national wealth since 1946.

Depression and war are the two principal reasons we have made no progress in increasing our wealth per person since the 1920s. The depression brought mass unemployment and greatly reduced production which ruled out any increase in wealth. During World War II and again during the post-Korean mobilization program, U.S. production has reached new peaks. But a considerable portion of this record breaking output has been in the form of military equipment, which is not included in an accounting of national wealth. Consequently, we have been unable to regain the level of wealth per person which we had in 1929.

A Brake of Prosperity

What does this failure to raise our wealth per person mean? It means that we have fewer resources with which to create income for each individual. It means that we have made no progress in the crucial task of assuring future increases in prosperity.

As the second editorial in this series demonstrated, we have gone so far in equalizing individual incomes that "the possibilities of increasing the income of the rest of the people by 'soaking the rich' have largely disappeared." From now on the only promising way to increase our individual incomes is to increase our national earning power.

During the past four years it has taken about \$3.60 of national wealth to yield \$1 of income after taxes. This is a low figure for the wealth needed. Prior to World War II there were long periods when it took at least \$5 of national wealth to produce \$1 of national income. The experts in this field are by no means certain that it will not again take \$5 rather than \$3.60 of wealth to increase income by \$1.

But let us assume that \$3.60 of wealth will suffice to provide \$1 of income in the years ahead. If by 1960 — seven years from now — the income of the average American is to be increased from about \$1490, where it stands at present, to \$2000, we must add \$310 billion to the national wealth. This is nearly three times as much as we have added to our wealth since the end of World War II, seven years ago.

Because we have made large additions to our productive equipment in recent years, fears are frequently expressed that we shall soon be plagued by an excess of such equipment. But the facts about our national wealth do not support this conclusion. They indicate that we still have ahead of us a tremendous job of increasing our resources if the American standard of living is again to resume the steady climb which was interrupted by depression and war.

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--and knowing the advantages of automatic voltage regulation, this man depends on

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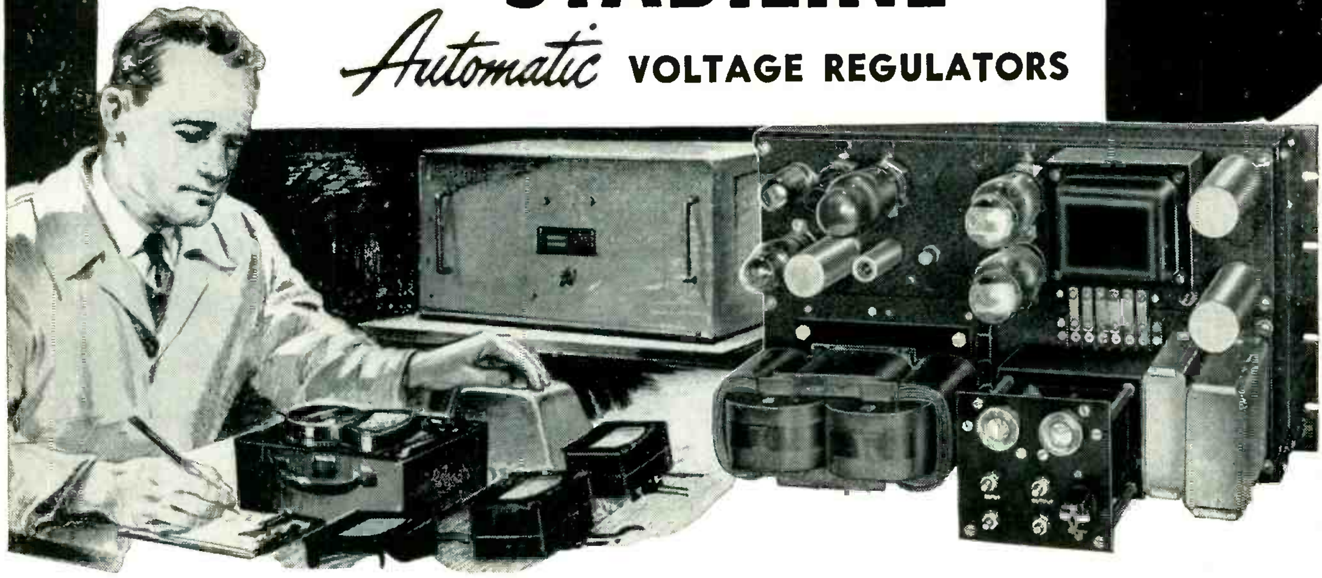

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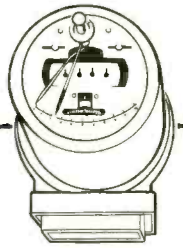
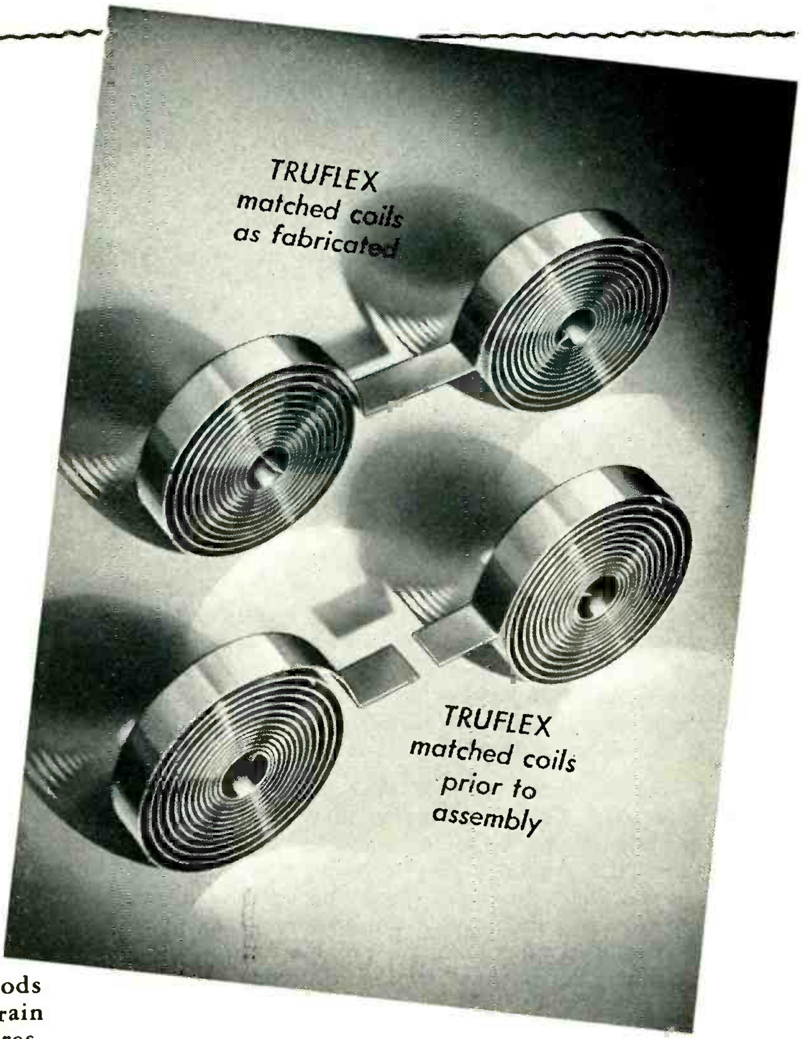
PROBLEM:

To obtain uniformity of performance between two thermostat elements used in thermal type demand meters

SOLUTION:

General Plate provided the solution with identically matched TRUFLEX® Thermostat Metal Coils





Manufacturers of thermal type demand meters were faced with the problem of obtaining two thermostat elements for each meter that had identical performance characteristics.

When these coils were made individually each one had to be tested 100% and then paired together with the coil that had, as near as possible, the same operating characteristics for use in each meter. This meant costly testing procedures, rejects and often unsatisfactory performance.

The problem was presented to General Plate, whose engineers quickly found the solution. *Matched coils* were made from adjacent sections of a single *Truflex* thermostat metal strip as illustrated. Since the coils were made from identical material, they were automatically *paired* with the same uniform operating characteristics.

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Advanced General Plate production methods insure positive consistency in tolerances, grain structures, expansion, hardness, etc. It assures maximum uniformity of materials which reduces costly rejects and guarantees highest quality performances.

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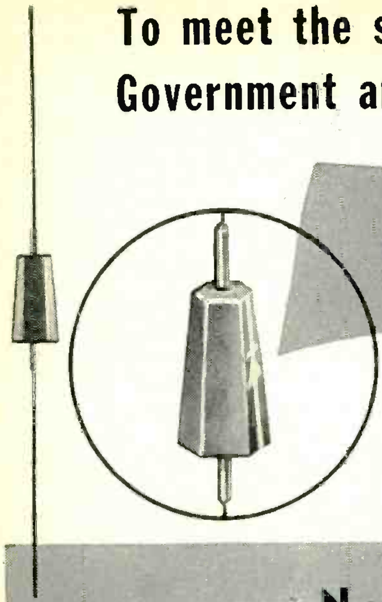
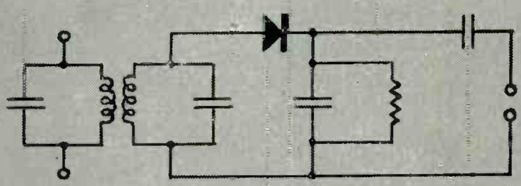


1N69
1N70
1N81

Precision made, easy to handle, easy to assemble — the tapered shape shows polarity at a glance! Make **Radio Receptor** Germanium Diodes your first choice in the large variety of electronic circuits where JAN types are a must.



DETECTOR CIRCUIT

TYPICAL USES

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- CLAMPING CIRCUITS
- RF DETECTORS
- CONTROL CIRCUITS
- DISCRIMINATORS
- MODULATORS
- NOISE ELIMINATORS
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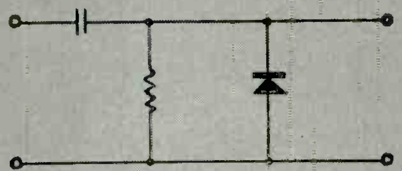


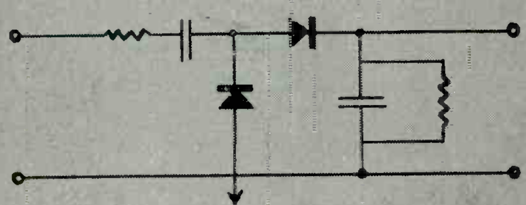
CLAMPING CIRCUIT

JAN TYPES • *ALL VALUES MEASURED AT 25°C.*

CODE NO.	Min. Forward Current at 1 Volt (MA)	Max. Reverse Current (Micro-Amperes)	*Average Rectified Current (MA Max.)	†Minimum Reverse Volts	Max. Cont. Reverse Operating Volts
1N69	5.0	50 @–10V 850 @–50V	40	75	60
Rectification efficiency: 35% minimum in 100 MC test circuit.					
1N70	3.0	25 @–10V 300 @–50V	30	125	100
1N81	3.0	10 @–10V	30	50	40

*Average half wave rectified current at 60 CPS and 25°C. Consult us for ratings at other conditions.

†For zero dynamic resistance.



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staged scenes ... fond of paying tribute to his ... (Continued on page ...)
mantic, spar- ... genius, the funny blond wig which
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RADIO AND TELEVISION

By JOHN CROSBY

Music and Pictures

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pure television

John Crosby

"camera work on
the Waring Show is
... art photography"

JOHN CROSBY

and the cameras are GPL

Columnist John Crosby, discussing not electronics but end results on the screen, calls the Waring show on CBS Television "pure television." Such results come from three things: Waring imagination, CBS Television techniques, and GPL camera chains.

> *"The pictures move . . . are a combination of light and shadow, of form and substance that catch and hold the eye."*

A GPL extra in engineering accounts for much of this. Camera and operator may be moving on a boom in a 3-dimensional pattern. Yet the operator has only to concentrate on aim, while the director at the Camera Control Unit adjusts the iris for light and shadow.

> *"The cameras seem to roam at will on that show with a fluidity and grace almost never found in the movies."*

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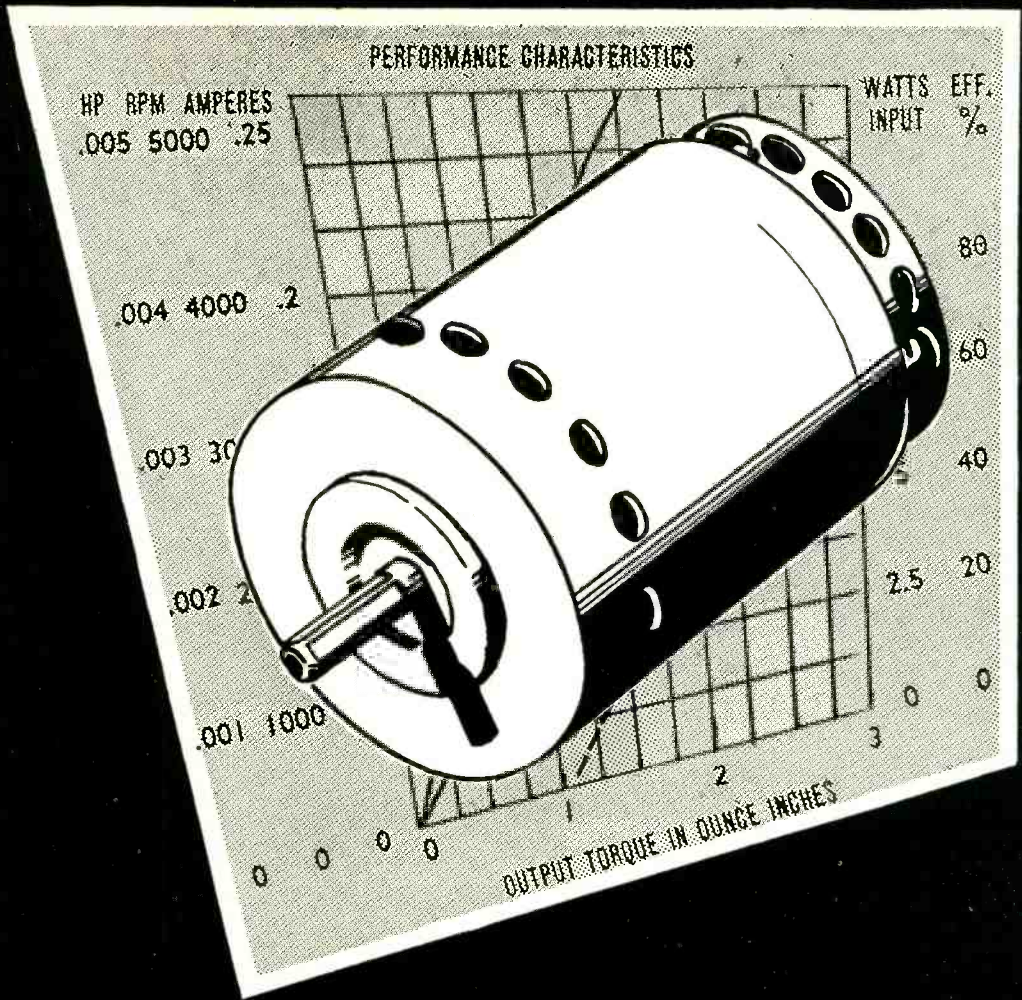

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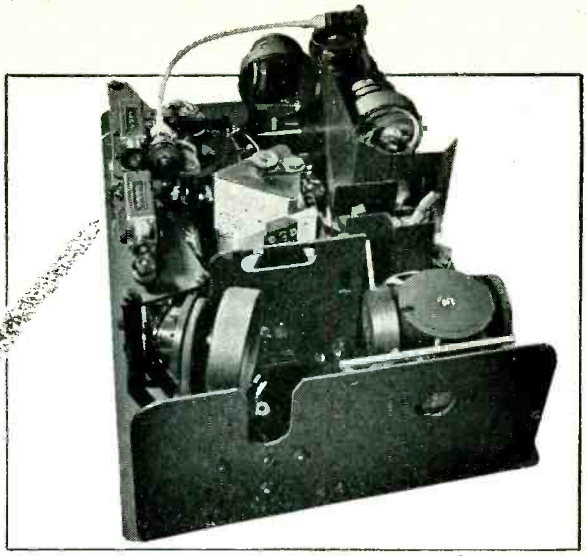
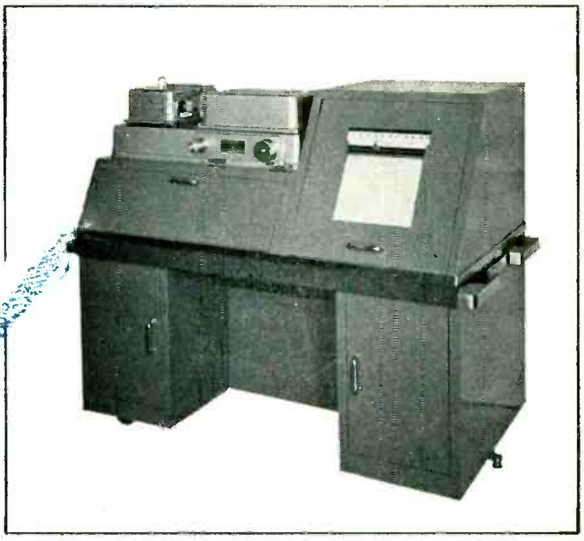


Above: Perkin-Elmer infrared spectrometer —in its Karp-built cabinet, below.

but

this is your "trademark"



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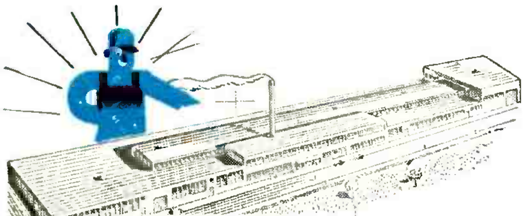

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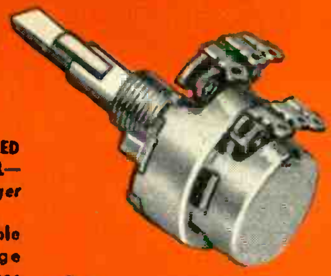
TYPE C45-70



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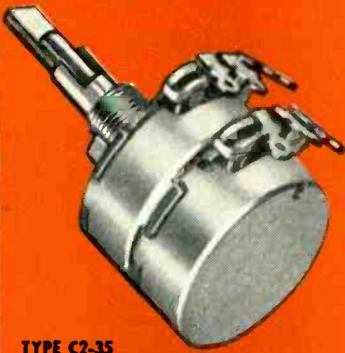
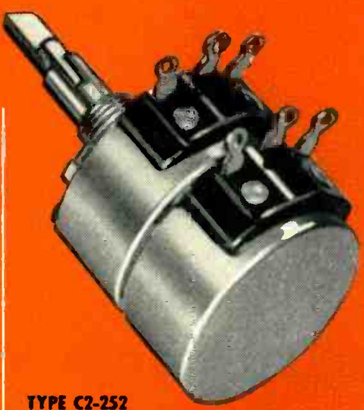
TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.

TYPE C2-45

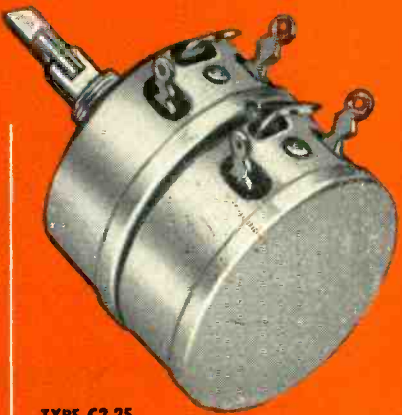
TYPE C2-35



TYPE C2-252



TYPE C2-25

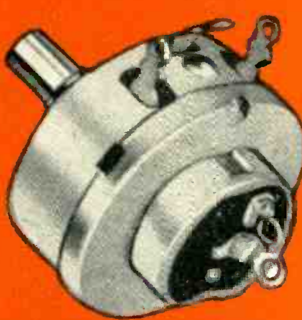


TYPE GC-45, 15/16" diameter variable composition resistor. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms, 1/4 watt with 500 volts maximum across end terminals for resistances over 100,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-45 as shown above.

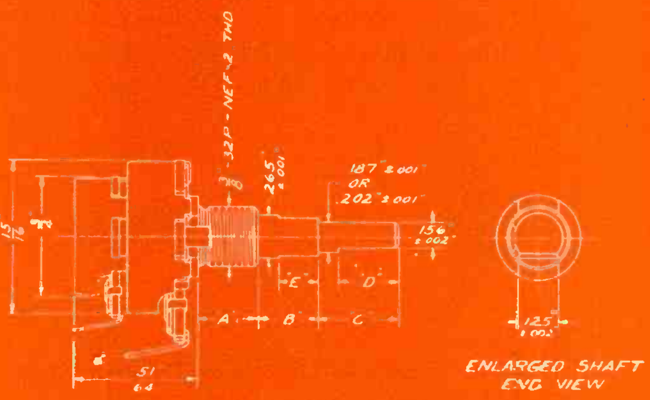
TYPE GC-35, 1 1/8" diameter variable composition resistor. Wattage rating: 3/4 watt for resistances through 10,000 ohms, 2/3 watt for resistances over 10,000 ohms through 25,000 ohms, 1/2 watt with 500 volts maximum across end terminals for resistances over 25,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-35 as shown above.

TYPE GC-252, 2 watt, 1 17/64" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-252 as shown above.

TYPE GC-25, 4 watt, 1 17/32" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-25 as shown above.



Typical concentric shaft tandem with panel and rear sections operating separately from concentric shafts (TYPE C45-70 ILLUSTRATED). Similar construction available for all military resistors.



TYPE C45-70

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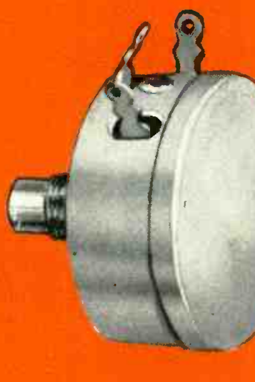
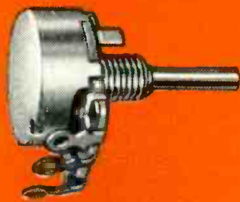
TYPE 45, (JAN-R-94, Type RV2)
1/4 watt, 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 35, (JAN-R-94, Type RV3)
1/2 watt, 1 1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

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 including concentric shaft tandem construction. Attached switch can be supplied.

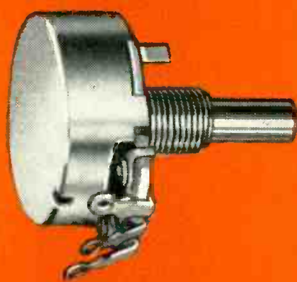


TYPE 25, (JAN-R-19, Type RA30)
(May also be used as Type RA25)
4 watt, 1 17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.



TYPE 65, (Miniaturized)
1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.

TYPE 90
1 watt 70°C, 15/16" diameter variable composition resistor. Attached switch can be supplied. Also available in concentric shaft tandem construction.



TYPE 95, (JAN-R-94, Type RV4)
2 watt 70°C, 1 1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

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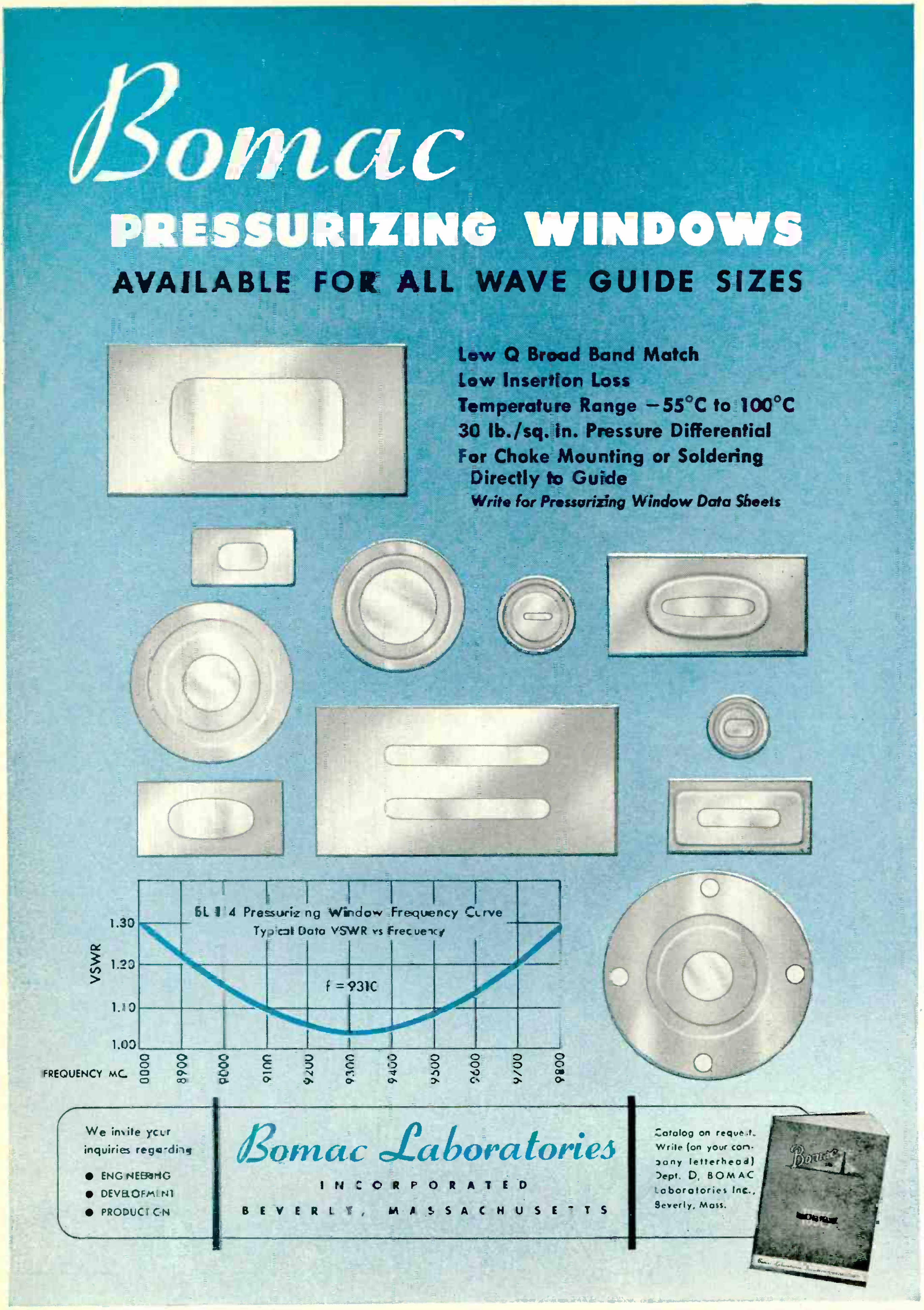

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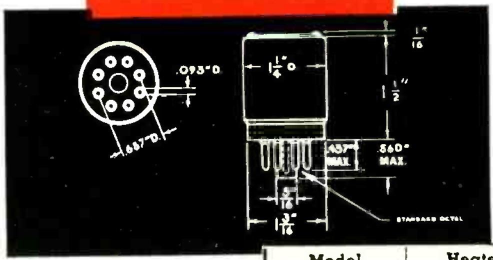
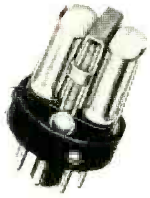
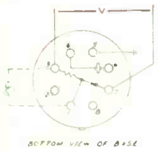




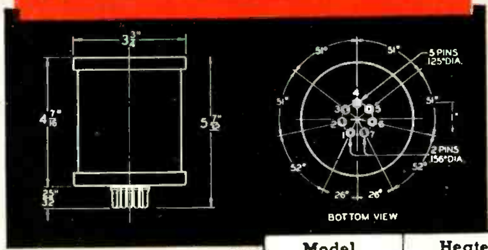


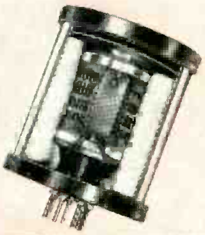
NOTE: BROKEN LINES INDICATE CONNECTIONS IF PILOT LAMP IS USED IN CIRCUIT TO SHOW WHEN HEATER IS ENERGIZED

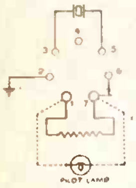
Designed specifically for use with Bliley types BH6A and SR11 crystal units. Standard models are supplied as indicated:

Model	Heater Voltage	Watts	Crystal Sockets	Control Temperature
TCO-1A	6.3	5.5	1	75°C or 85°C
TCO-1C	24 or 26.5	7.75	1	75°C or 85°C
TCO-2	6.3	5.5	2	75°C
TCO-2	6.3	7.9	2	85°C
TCO-2D	24 or 26.5	7.75	2	75°C or 85°C

TYPES TC911-TC92-TC93







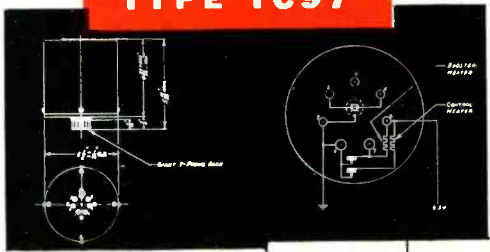
Designed specifically for use with Bliley Crystal units. Standard models are supplied, for crystal types, as indicated:

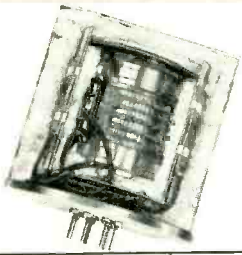
Model	Heater Voltage	Watts	Crystal Group	Control Temperature
TC911	115	10	B	70°C
TC92	6.3	10	A	60°C
TC93	18	10	A	60°C

Crystal Group A Types FM6, BH81A, MC7, AR4, AR5

Crystal Group B Types BH8, MC75, MS46A

TYPE TC97





Exceptional temperature stability is provided by two separate heaters, individually regulated by separate thermostats. Ambient temperature variations are first minimized by outer stage (booster) heater with final regulation by inner stage (control) heater.

Model	Heater Voltage	Watts	Crystal Group	Control Temperature
TC97	6.3	11	A	75°C

Crystal Group A Types FM6, BH81A, MC7, AR4, AR5

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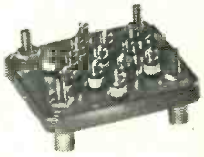

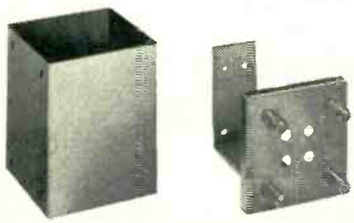

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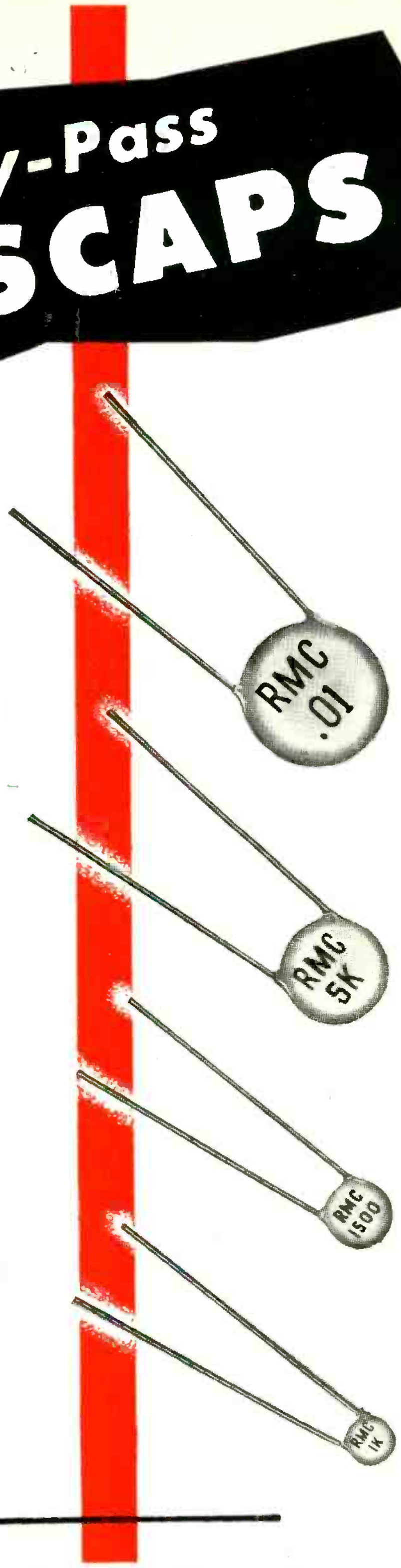

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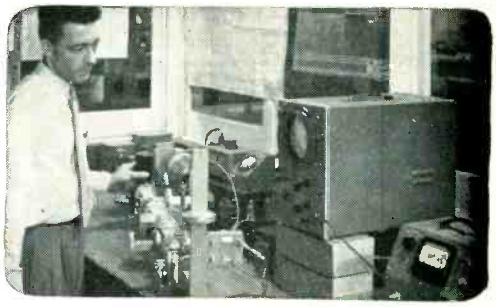

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Microwave components are not costly in relation to the whole job. But they can make or break the performance of a sizable investment once they are installed. It is, therefore, imperative to see that your microwave components are built and checked precisely to your drawings or specifications by a manufacturer who has the knowledge, experience, and facilities to meet these requirements.

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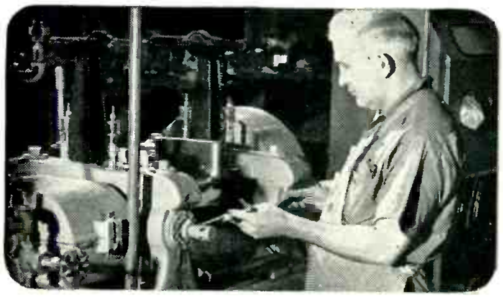
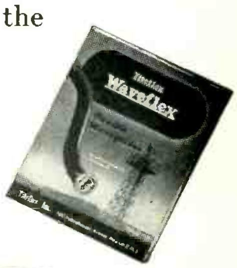


Milling the rubber-like compound which is subsequently molded over Titeflex flexible waveguides to protect them.



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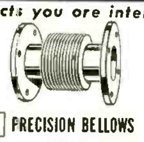

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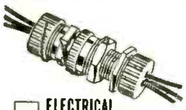

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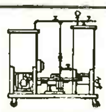

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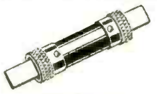

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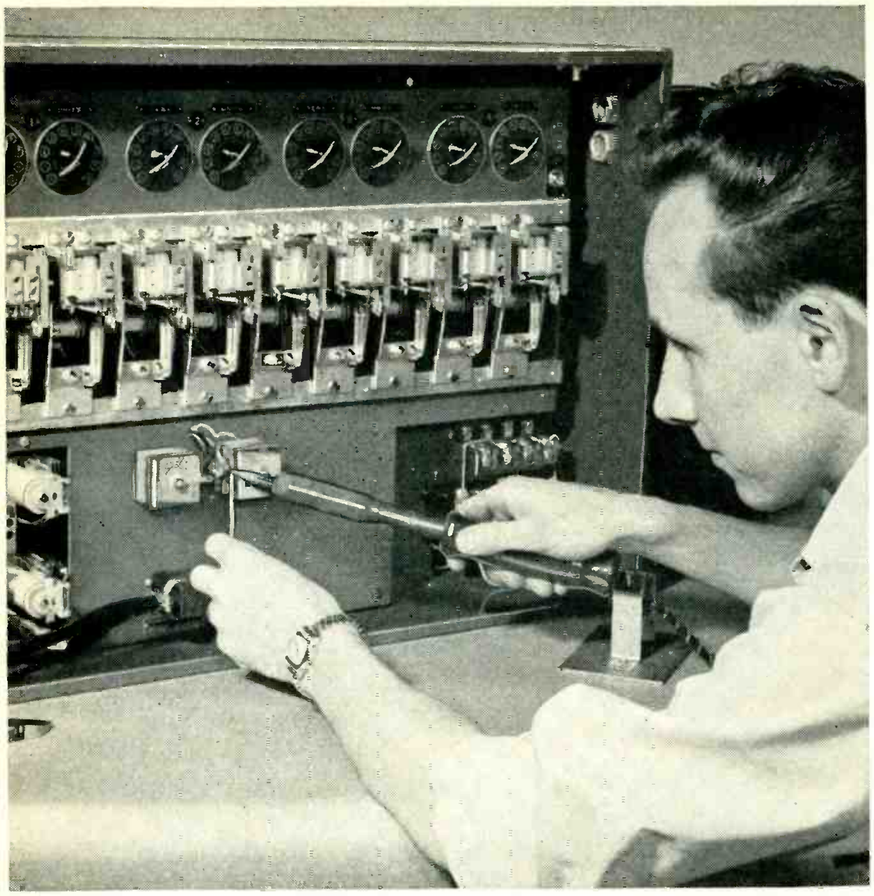

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G-E Selenium Rectifiers Cut Costs and Save Space

"We greatly simplified a serious space problem, increased current capacity by 30 per cent, and even saved money as well, by our use of General Electric Selenium Rectifiers in our product," reports Production Instrument Company, Chicago, Illinois, large manufacturers of electrical counters.

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FOR MORE INFORMATION, consult your nearest G-E Apparatus Sales Office or write for the Selenium Rectifier Application Manual GET-2350. And you can test G-E Selenium Rectifier quality for yourself, with GEA-5524A, Testing Directions for Selenium Rectifiers. Address Section 461-26, General Electric Company, Schenectady 5, N. Y.

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METALLIC RECTIFIER FACTS FOR ENGINEERS

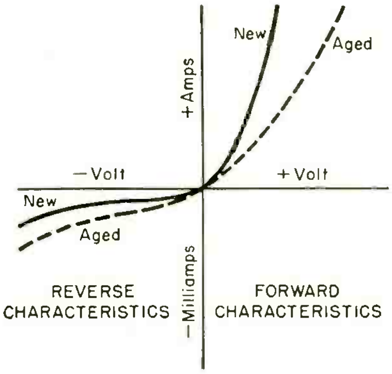
AGING

by C. E. Hamann

Frequently the aging of selenium rectifiers is thought of as an increase in forward resistance resulting in a reduction of voltage output.

Aging of metallic rectifiers is defined by the American Institute of Electrical Engineers as "any persisting change (except failure) which takes place for any reason in either the forward or reverse characteristic."

Therefore, it is a mistake to think of aging only as a change in forward resistance. Aging can, and often does, affect the reverse characteristics of a selenium cell. With age the cell may lose its ability to block voltage. When this occurs, the back leakage increases, and consequently the losses are increased and the operating temperature rises.



Therefore, if you wish to determine the quality of a rectifier cell, it is necessary to consider the forward and reverse characteristics and the effect that aging has on both characteristics.

A high quality rectifier cell must have initially a low forward resistance and high back resistance. In addition, a high quality rectifier cell must show a minimum of change in both forward and reverse characteristics with time.

If you would like information on how you can test initial characteristics of selenium stacks, write for the bulletin mentioned at left.

C. E. Hamann

General Electric Company

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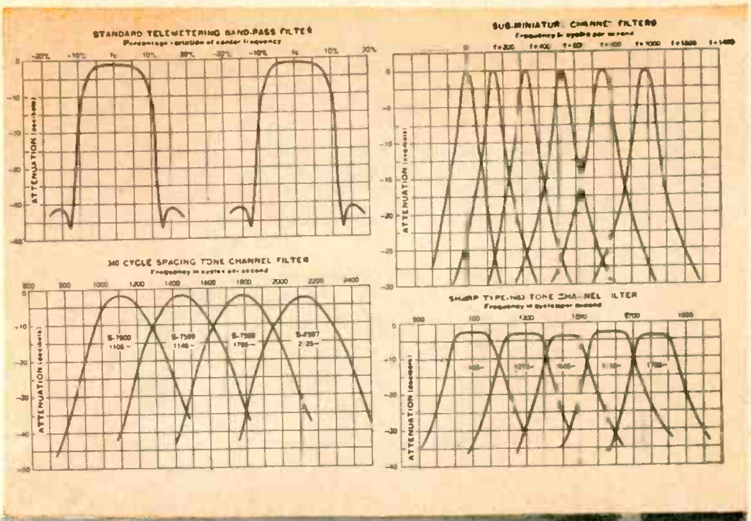
EXPANDING PRODUCTION

in Toroids & Filters



At every management meeting in Burnell & Company there is an unseen but highly respected visitor. He is the spectre of all our customers and his opinions carry weight. Recently he suggested that in addition to our other expansion measures that we must find a way to improve deliveries for emergency and special sample orders. Our solution is certainly not original but no less effective.

Burnell & Company's new sample department has been able to produce audio filters from proverbial 'scratch' to the customer's waiting hands in as little as ten days!

Frankly, this cannot always be accomplished but our average has been ranging between three to four weeks for emergency samples and four to six weeks for regular prototypes instead of the former twelve weeks of the pre-sample department days.

Adding this to our new winding department and our new testing and finishing departments the sum total has been a *still* better product at a better delivery than ever before.

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displayed on the panel (in seconds and milliseconds). The count may be started or stopped from common or independent sources by using either positive or negative "going" waves. The level of trigger voltage is continuously adjustable for each channel from − 100 to + 100 volts.

GENERAL DESCRIPTION

Model 522B consists of five decade counters, a wide range time base, and gating and auxiliary circuits applying counters and time base to the broadest possible variety of measurements. The unknown is applied to the counters through a gate circuit. This circuit remains open for a précise interval controlled by an oven-housed quartz crystal. Stability of this crystal is at least 5/1,000,000 per week, and may be standardized against WWV.

-hp- 522A ELECTRONIC COUNTER

For applications where wide-range frequency and period measurements are desired, *-hp-* 522A is offered. Frequency counting facilities of this instrument are identical with *-hp-* 522B, except that gate time for frequency measurement is 1 second or any multiple of 1 second, and the standard frequency counted for period measurement is 100 kc. The automatic illuminated decimal point is omitted. *-hp-* 522A does not include time interval measuring circuits. $775.00 f. o. b. factory.

BRIEF SPECIFICATIONS—MODEL 522B

FREQUENCY MEASUREMENT:

- **Range:** 10 cps to 100 kc.
- **Accuracy:** ± 1 count ± stability (5/1,000,000 per week).
- **Registration:** 5 places. Output pulse available to actuate trigger circuit for mechanical register to increase count capacity.
- **Input Requirements:** 2 volts peak minimum.
- **Input Impedance:** Approx. 1 megohm, 50 μμfd shunt.
- **Gate Time:** .001, .01, .1, 1, 10 seconds. Extendable to multiples of 1 or 10 seconds by manual control.
- **Display Time:** Variable .1 to 10 seconds in steps of gate time selected. Display can be held indefinitely.

PERIOD MEASUREMENT:

- **Range:** .00001 cps to 10 kc.
- **Accuracy:** ± .03% ± stability (for measurement over a 10 cycle period).
- **Gate Time:** 1 or 10 cycles of unknown. Extendable to any number of cycles by manual control. (For frequencies under 50 to 60 cps).
- **Standard Freq. Counted:** 1, 10, 100 cps; 1, 10, 100 kc; or external.

TIME INTERVAL MEASUREMENT:

- **Range:** 10 μsec to 100,000 seconds (27.8) hrs.
- **Accuracy:** ± 1/std. freq. counted ± stability.
- **Input Requirements:** 2 volts peak minimum.
- **Input Impedance:** Approx. 250,000 ohms, 50 μμfd shunt.
- **Start and Stop:** Independent or common channels.
- **Trigger Slope:** Pos. or neg. on start and/or stop channels.
- **Trigger Amplitude:** Continuously adjustable on both channels from − 100 to + 100 volts.
- **Standard Freq. Counted:** 1, 10, 100 cps; 1, 10, 100 kc; or external.
- **Price:** $900.00 f. o. b. factory.

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- Interval stability
- Frequency ratios
- Phase delay

The broad applicability of *-hp-* electronic counters makes them of greatest usefulness in any laboratory or factory. In many cases, one counter will make all your important measurements itself, and give you accuracy unavailable with other equipment. In other applications, standard transducers may be required. See your *-hp-* sales representative for help in applying Model 522B to your measurement problem.

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INSTRUMENTS ***Complete Coverage***

CHATHAM
ELECTRONIC TUBES

Hydrogen Thyratrons

—for Pulse Voltage Generation

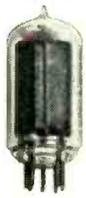
ELECTRICAL DATA*				
Type	VC-1258	5949/1907	5948/1754	VC-1257
Maximum Peak Forward Anode Potential	1000 volts	25000 volts	25000 volts	38000 volts
Maximum Peak Anode Current	20 amps	500 amps	1000 amps	2000 amps
Maximum Average Anode Current	0.05 amps	0.50 amps	1.0 amps	2.0 amps
Maximum Heating Factor (epy x prr x ib)	1.0×10^8	6.25×10^9	9.0×10^9	—
Nominal Filament Power	12.6 watts	95 watts	190 watts	230 watts
Hydrogen Reservoir	No	Yes	Yes	Yes

*More detailed information on electrical and mechanical data will be supplied on request.

TYPE VC-1257
Hydrogen filled, zero bias thyratron with hydrogen generator for generation of pulse power up to 40 megawatts.

TYPE 5948/1754
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

TYPE 5949/1907
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.



TYPE VC-1258
Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW.

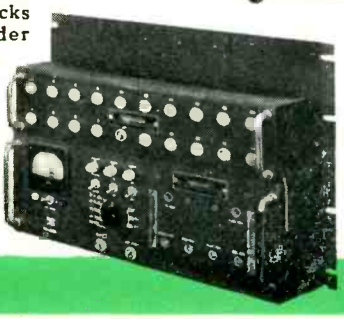
A NEW CONCEPT OF HYDROGEN THYRATRON DESIGN! The tubes illustrated represent a departure from conventional hydrogen thyratron designs and are a result of several years of concentrated development work. They are primarily employed in the generation of peak voltages with durations in the order of microseconds.

Custom-built Electronic Equipment

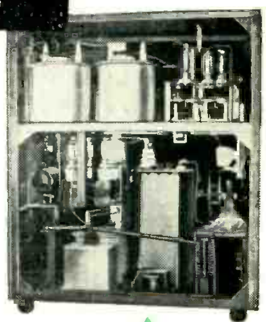
At the I.R.E. Show—Booth #4-512!

CHATHAM specializes in the development, design, and construction of custom-built electronic equipment to exactly meet customers' requirements. Our capable staff of engineers will furnish prompt estimates or, if desired, will call to discuss your problem personally. Call or write today.

20 Megawatt Hydrogen Thyratron Test Equipment built by CHATHAM to customers' specifications.



Pulse life test equipment built by CHATHAM checks receiver type tubes under pulse conditions.



5 Megawatt radar modulator built by CHATHAM to rigid government standards.

ELECTRONICS AND EQUIPMENT

Electronic Tubes

Ruggedized Type Tubes

The following tubes fully conform to JAN specifications and can be supplied promptly, usually direct from stock:

5R4WGY	2D21W
6AL5W	OC3W
6H6WGT	OD3W
25Z6WGT	2050W

TYPE 719-A HIGH VACUUM CLIPPER DIODE

This tube is used primarily for clipper diode service in hard tube modulator circuits. Filament 7 volts, 7 amps . . . Inverse peak anode voltage 25 kv, Max., peak anode current 10 amps, Max., anode dissipation 75 watts.

TYPE 1Z2 RECTIFIER

A small bulb high voltage vacuum rectifier. Low cathode heating power and low dielectric losses make tube suitable for radio frequency supply circuits. Filament 1.5 volts, .290 amps . . . Inverse peak anode voltage 20,000, average plate current 2 ma. . . . peak plate current 10 ma.

TYPE 1B46 REGULATOR

A cold cathode glow discharge tube designed for voltage stability. DC operating voltage 82 volts, operating current range 1 ma minimum, 2 ma maximum. Regulation 3 volts.

TYPE 395-A COLD CATHODE GAS TRIODE

Requires no filament supply and is used in many grid controlled rectifier and relay applications. Maximum D.C. anode current—10 ma. Maximum D.C. anode voltage—150 volts

TYPE 4B32 RECTIFIER

A rugged half-wave Xenon filled rectifier. Operates in any position throughout an ambient temperature range of −75°C to +90°C. Filament 5 volts, 7.5 amp . . . Inverse peak anode voltage 10,000 average anode current 1.25 amps.

TYPE 394-A THYRATRON

A Mercury vapor and Argon filled thyratron for grid controlled rectifier service. Operates over wide ambient temperature range. Heater 2.5 volts, 3.2 amps . . . Inverse peak anode voltage 1250, average anode current 640 ma.

TYPE 3B28 RECTIFIER

This rugged half-wave Xenon filled rectifier will operate in any position and throughout an ambient temperature range of −75°C to +90°C. Filament 2.5 volts, 5.0 amps . . . Inverse peak plate voltage 10,000, average anode current .25 amp.

Chatham Vacuum Switches

TYPE 1S22 (illustrated) is a mechanically actuated, single-pole, double-throw, glass vacuum switch. This and other types can be supplied.

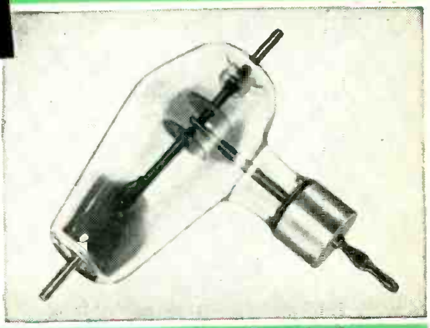
SPECIFICATIONS

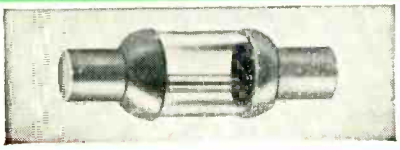
HOLD OFF VOLTAGE: Internal—10,000 volts rms; External* (at 27,000 feet altitude)—10,000 volts rms; External* (at 40,000 feet altitude)—7,500 volts rms.

INTERRUPTING RATING, RESISTIVE LOAD: 1,000 operations life at 10,000 v, ac, rms—10 amp, ac, rms; 1,000,000 operations life at 10,000 v, ac, rms — 2 amp, ac, rms; 500,000,000 operations life at 10,000 v, ac, rms—0.1 amp, ac, rms.

NET WEIGHT (approx.) .... 2 ozs.
MAXIMUM LENGTH (overall) .... 3 5/8 ins.
MAXIMUM WIDTH (overall) .... 4 1/16 ins.
MAXIMUM THICK. (overall) .... 1 9/16 ins.

*at 50% humidity





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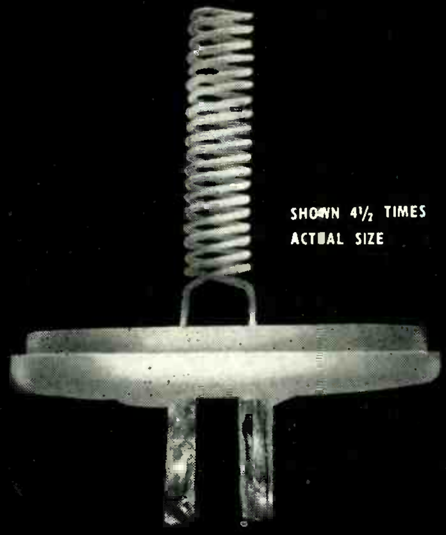


SHOWN 4½ TIMES ACTUAL SIZE

This assembly provides controlled heater-to-cathode positioning; eliminates heater shorts resulting from rupture of the heater coating, as shown below.

SHOWN 20 TIMES ACTUAL SIZE

Exclusive mounting makes the heater an integral part in the Teletron gun.

In the Du Mont Teletron, the heater "feet" are welded to stainless steel lugs which accurately position the heater on a ceramic disc. The result is a firmly welded, vertically aligned assembly which is inserted in the control grid cup and automatically positions the heater within the cathode. This eliminates critical, uncontrolled hand positioning of the heater. Positive centering prevents chafing of the delicate heater coating and avoids heater-to-cathode shorts.

Less open-heater failures

Stronger connections obtained by welding the tungsten heater "feet" to the stainless steel lugs rather than directly to the nickel stem leads, greatly reduce open heater failures.

Greater heater efficiency

When the control grid is assembled, the distance between the top of the heater helix and the outer ridge of the ceramic disc controls the depth to which the helix is seated inside the cathode. Optimum-depth seating is thus predetermined, insuring maximum heater efficiency.

Du Mont quality control of heater design and assembly builds longer, fuller, trouble-free life into every Teletron.

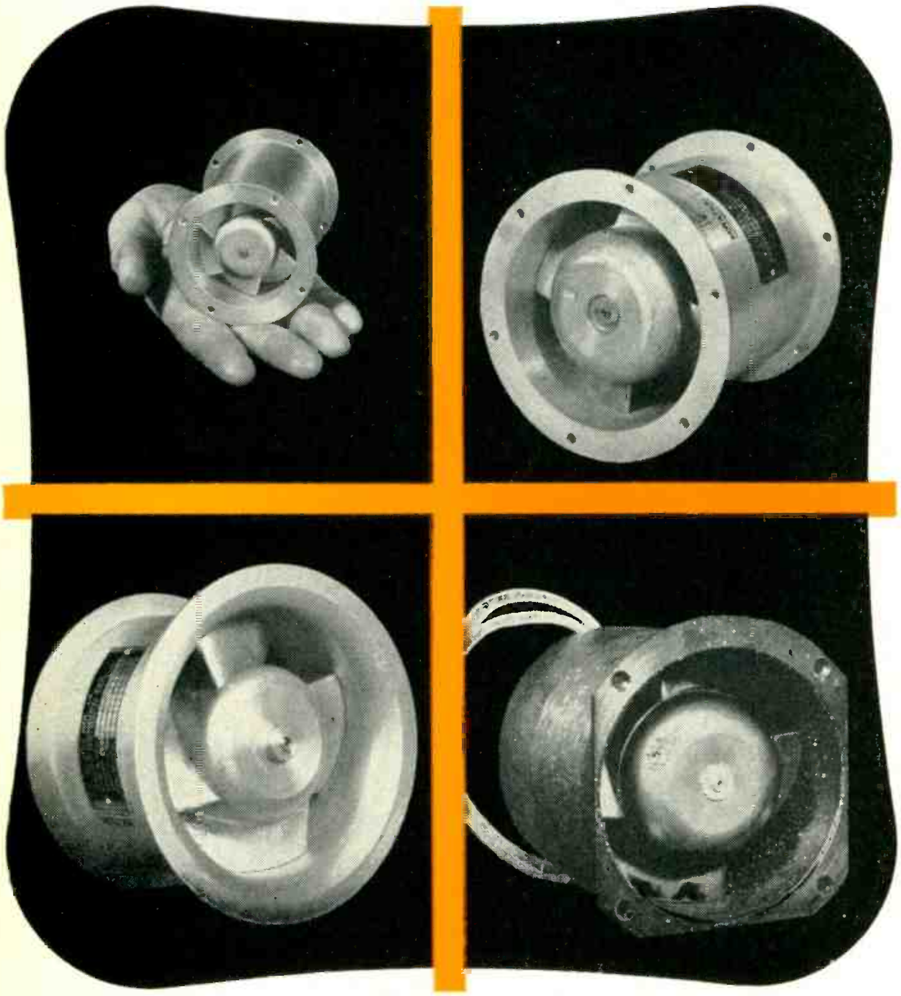
DU MONT *Teletrons**

*Trade Mark

in picture tubes . . . *fine details make Du Mont the finest*

Cathode-ray Tube Division, ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J.

Let JOY handle Your FAN ENGINEERING on ELECTRONIC COOLING PROBLEMS



JOY AXIVANE* Fans offer you advantages in electronic equipment cooling which have been thoroughly proved in service. The higher pressure-output of these vaneaxial blowers generally permits more compact arrangement of the equipment. Additional advantages are: light weight, high strength, high shock and vibration resistance, and high efficiency in low or high pressure service.

For minimum weight, JOY electronic cooling fans are made of aluminum, magnesium, or combinations of these metals. They are designed to meet all present Air Force and Naval electronic specifications, and are available in fan sizes from 2″ I.D. up. Totally-enclosed or explosion-proof motors can be furnished where required. ● If you have a problem in heat dissipation from electronic units, no matter what the service conditions may be, let us place at your disposal JOY'S experience as the world's largest manufacturers of vaneaxial-type fans.

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Over 100 Years of Engineering Leadership

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IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

New! push-button oscillator

for rapid and recurrent frequency measurements

THE MODEL 440-A PUSH-BUTTON OSCILLATOR *is designed for applications requiring very low distortion or extremely good frequency stability and resetability. It provides both sine waves and square waves at any frequency between 0.01 cps and 100 kc.*

For fine control of frequency, three banks of ten push-button switches are provided. An additional vernier control varies the frequency continuously by an amount equal to the increment between adjacent buttons of the third switch bank.

Hum and distortion are attenuated when the setting of the calibrated logarithmic output level control is reduced and are thus maintained at a constant low percentage of the desired output signal.

This exceptional instrument is ideally suited for bridge measurements, tuned filter alignment, rapid spot frequency checks, and distortion measurements.

model 440-A

from 0.01 cps to 100 kc

specifications

FREQUENCY RANGE: 0.01 cps to 100 kc continuously variable.

FREQUENCY ACCURACY: Calibration ±1% from 1 cps to 10 kc, ±3% over the entire frequency range.

SINE WAVE OUTPUT:

- **Voltage:** 30 volts peak to peak maximum, adjustable continuously.
- **Power:** Maximum .... 100 mw
- **Amplitude:** Varies less than ±0.25 db over the frequency range from 0.1 cps to 10 kc, less than ±1 db over the entire frequency range.
- **Distortion:** Less than 0.1% from 1 cps to 10 kc, less than 1% over the entire frequency range.
- **Hum:** Less than 0.1% at any output level setting.

SQUARE WAVE OUTPUT: 10 volts peak to peak.

INPUT POWER: 105-125 volts, 50-60 cps, 120 watts.

price $450 *net f.o.b. Cambridge, Mass.*

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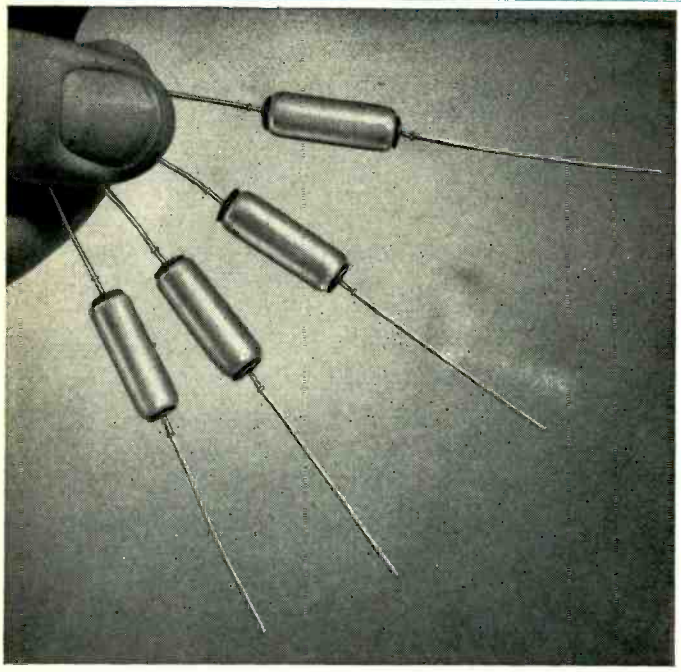


Miniaturize your product with Tantalytic* capacitors

On low-voltage d-c applications, where your equipment miniaturization calls for both small size and superior performance, General Electric Tantalytic capacitors offer a host of advantages. These foil-type, tantalum-electrode, electrolytic capacitors have greater capacitance per unit volume and far longer shelf life than aluminum-electrolytic types. Long operating life, too, is provided by their inherently inert characteristics, and the use of non-corrosive, chemically neutral electrolyte. And leakage current is low—less than 10 microamps per microfarad.

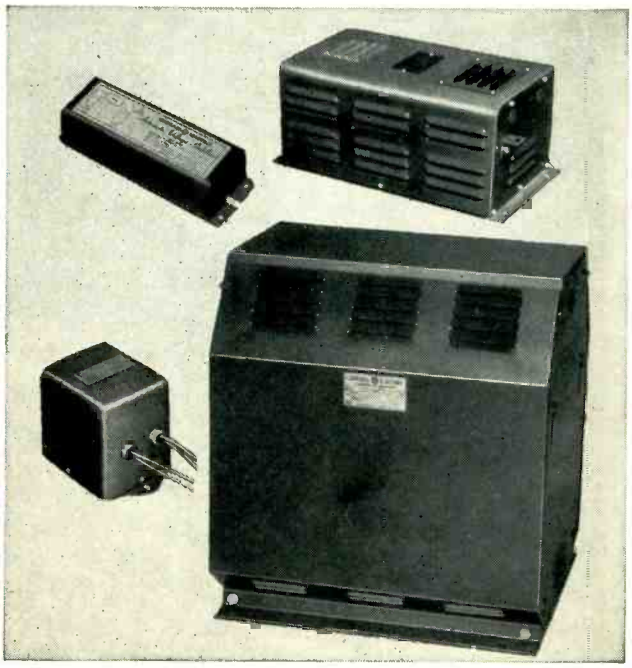
Built to withstand severe shock, these lightweight units operate over a wide temperature range (−55 C to +85 C and higher). Hermetic sealing protects them against leakage and contamination. Available in polar and non-polar construction, in ratings from 175 muf at 5 volts d-c to 12 muf at 150 volts d-c. For complete description of the line, plus application information, check Bulletins GEC-808 and GER-451 in the coupon on the next page.

*Trade-mark of General Electric Company.

Now—greater flexibility in voltage stabilizers

Fluctuating voltage is serious on sensitive electronic equipment designed for best performance at a specified voltage. Now, to help you get rid of voltage ups and downs, G.E. offers a new 15- to 5000-va line of automatic voltage stabilizers that gives you greater design flexibility at no increase in price, plus weight reduction in larger sizes. New output ratings of 1000, 2000, 3000, and 5000 volt-amperes—with 115 and 230 volts on both input and output—permit operation in any combination of these input and output voltages.

Fluctuations between 95 and 130 volts, or 190 and 260 volts, are corrected to a stable 115 or 230 volts within ±1 percent—and in less than two cycles. Single-core construction permits input circuit to be completely isolated from output circuit. Installation is easy: connect one set of terminals for supply and another set for the load. With no moving parts, maintenance is virtually eliminated. See Bulletin GEA-5754 for complete description.



GENERAL ELECTRIC

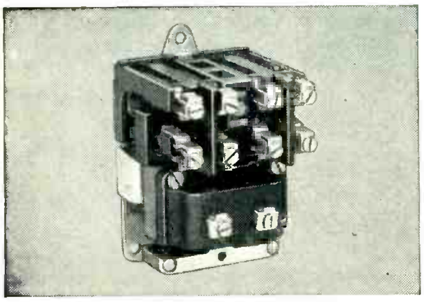
DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

Prices reduced as much as 35% on light, flexible delay line

Increased use of delay line in special circuits for electronic equipment now enables General Electric to mass-produce it, at savings to you of up to 35 percent. Originally developed to provide delay with minimum distortion in radar equipment, G-E delay line now has many commercial uses such as color television and electronic calculators.

Bulk line is available in lengths of 100 feet or less to be cut as desired. Time delay is approximately ½ microsecond per foot for 1100-ohm line, ¼ microsecond per foot for 400-ohm line. Line is light in weight, ¼-inch in diameter, and easily bent into a 4-inch diameter coil. Operates between −50 C and 100 C. Bulletin GEC-459.



Size 00 relays cut inventories

Many of your control-circuit needs can be met with compact G-E size 00 contactors and relays—available in any combination of normally open and normally closed contacts from 2 to 8 poles. Since contact tips are easily changed from NO to NC without extra parts, your "specials" inventory is cut. Easily accessible terminals take up to 3 wires, speed connections. For complete details, see your General Electric apparatus sales representative.

Reliable d-c to a-c amplification

Designed mainly for 400-cycle excitation, the General Electric second-harmonic converter is a magnetic-amplifier type unit that converts low-level d-c error signals (such as thermocouple output) to 800-cycle a-c output. Static operation and hermetic sealing make it reliable under extreme conditions of acceleration, temperature, and pressure—important in aircraft applications. Length is $3\frac{1}{16}$ in., tube diameter $1\frac{1}{4}$ in., weight, 0.2 lb. See Bulletin GEC-832.

Now—sealed-relay line expanded

G-E hermetically sealed relays for 28-volt circuits are now available in these forms: DPDT, 3PDT, 4PDT, 6PNO—with coil ratings up to 10,000 ohms. Certain other configurations available on request. All have extra-high tip pressures, yet don't exceed Air Force-Navy size and weight specs. They withstand all outside atmospheric conditions, 50g operational shocks, and instantaneous voltage surges up to 1500 volts. Bulletin GEA-5729.

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☐ GEC-459 Delay Line
☐ GEC-808 & GER-451 Tantalytic Capacitors
☐ GEC-832 2nd-Harmonic Converter

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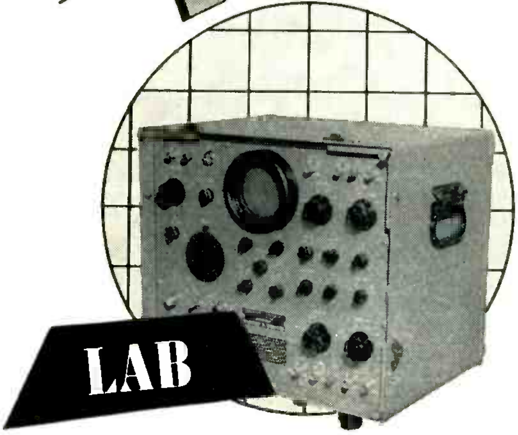
The Oscilloscope that portrays the Pulse by Waterman



Classic Examples of Precision Engineering...

Investigations of complex waves take great strides forward when either a Waterman SAR or LAB PULSESCOPE is employed. Their compactness, portability and precision have established a new high in pulse measurement instruments for all electronic work. Each PULSESCOPE has internally generated markers which are synchronized with the sweep with the basic difference that the sweep in the LAB PULSESCOPE initiates the markers while in the SAR PULSESCOPE it is the crystal controlled markers which initiate the sweep. Power supply requirements of 50 to 1000 c.p.s. at 115 Volts permits operation almost anywhere.

The SAR PULSESCOPE, model S-4-A, is characterized by a pulse rise time of 0.035 microseconds thru a video amplifier with a sensitivity of 0.5 Volts p to p/inch. A vertical delay of 0.55 microseconds is optional. A and S sweeps covering a continuous range from 1.2 to 12,000 microseconds are augmented by R sweeps, which in turn are variable from 2.4 to 24 microseconds. A directly calibrated dial permits R sweep delay readings from 3 to 10,000 microseconds.

The LAB PULSESCOPE, model S-5-A, has equivalent rise time of 0.035 microseconds, a fixed 0.55 microseconds vertical delay and 0.1 Volts p to p/inch sensitivity, so arranged as to assure portrayal of leading edges on displayed signals. A precision calibrated voltage is provided as well as an optional sweep expansion of 10 to 1. A built-in trigger generator voltage is available for synchronizing any associated test equipment.

WATERMAN RAYONIC® CATHODE RAY TUBE DEVELOPMENTS

Since the introduction of the Waterman RAYONIC 3MP1 for miniaturized oscilloscopes, scientists in our laboratories have diligently searched for more perfect answers to present day cathode ray tube problems. Such research led to the introduction of the revolutionary new 3SP and 3XP type cathode ray tubes. These tubes were designed with multi-trace oscilloscopy in mind. Every avenue of practical design was explored to produce tubes with bright, sharp traces and high deflection sensitivity at medium anode potentials.

TUBE	PHYSICAL DATA			TYPICAL VOLTAGES				DEFLECTION FACTOR V/IN.		MAX. VOLTS	
	Face	Length	Base	Anode # 3	Anode # 2	Anode # 1	Grid # 1	D1 to D2	D3 to D4	Anode # 3	Anode # 2
3JP	3 inch Round	10 inches	Medium Diheptal 12 Pin	3000	1500	300 to 515	−22.5 to −67.5	127 to 173	94 to 128	4000	2000
				4000	2000	400 to 690	−30 to −90	170 to 230	125 to 170		
3MP	3 inch Round	8 inches	Small Duodecal 12 Pin		1000	200 to 350	0 to −68	140 to 190	130 to 180		2500
					2000	400 to 700	0 to −126	280 to 380	260 to 360		
3SP	1½x3 inches	9.12 inches	Small Duodecal 12 Pin		1000	165 to 310	−28.5 to −67.5	73 to 99	52 to 70		2750
					2000	330 to 620	−58 to −135	146 to 198	104 to 140		
3XP	1½x3 inches	8.88 inches	Loctal		2000	400 to 690	−22.5 to −67.5	68 to 92	25 to 35		2750

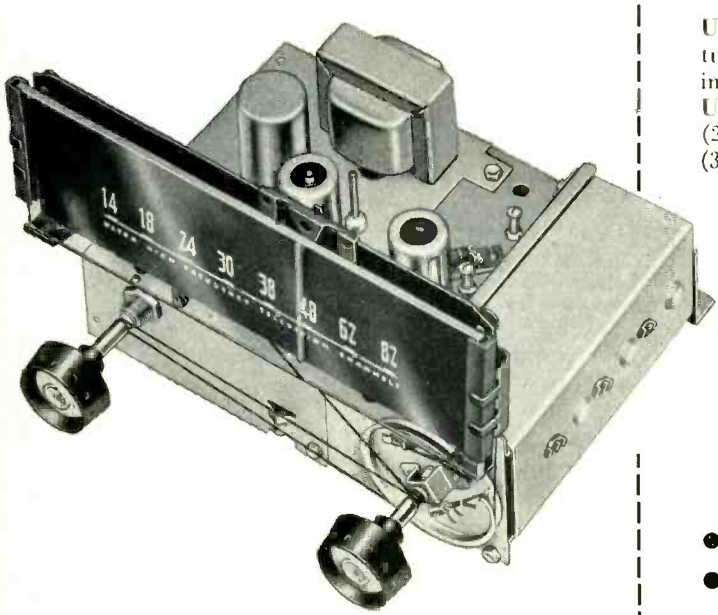
Visit Our Booth 1-414, IRE SHOW, MARCH 23rd to 26th

Why the Mallory **UHF** Tuner Should be Part of Your New TV Plans

The Mallory UHF Tuner can be the complete answer to your UHF tuning problems . . . whether you build converters, all-channel receivers, or both. It consists of three sections of variable inductance. It covers the range between 470 and 890 megacycles with approximately 2 mf of shunt capacity. Selectivity is excellent over the entire band.

No matter how you decide to handle the problem of UHF reception, it will pay you to investigate the various possibilities offered by the Mallory UHF Tuner. One of the following combinations is the answer to your requirements . . .

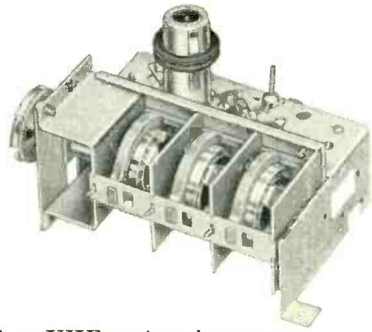
FOR CONVERTERS . . .



- Mallory UHF Tuning element for manufacturers building their own converters.
- Mallory UHF Converter chassis . . . ready to mount in your cabinet.
- Complete Mallory UHF Converter with your brand label.

FOR RECEIVERS . . .

UHF Tuners, for use in combination with VHF tuners, are available in 3 different designs . . . each in 3 different stages of assembly: (1) To convert UHF signals to 82 megacycles on channels 5 or 6. (2) To convert UHF signals to 130 megacycles. (3) For operation into a 41 megacycle IF amplifier.



- Mallory UHF tuning element.
- Mallory RF assemblies. This includes the tuner, oscillator, tube, crystal and associated circuitry.
- Mallory RF assemblies with an IF amplifier operating at conversion frequency.

Get in touch with us regarding the Mallory UHF Tuner. We will be glad to work with you . . . see how these various possibilities can be fitted into your plans for UHF television. Write today.

Television Tuners, Special Switches, Controls and Resistors

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SERVING INDUSTRY WITH THESE PRODUCTS:

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P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

electronics W. W. MacDONALD, Editor MARCH • 1953

CROSS TALK

▶ **RADIATION** . . . Television receiver design engineers have embarked upon a program intended to reduce radiation which interferes with other sets and occasionally with other services.

The program will cost manufacturers a few pennies but should be supported on several counts. Radiation reduces the service available to the industry's own customers, and can be severe at ultra high frequencies. Voluntary reduction of radiation would avoid any possibility of direct or indirect dictation by the Federal Communications Commission. And if more uniform use of a standard intermediate frequency is involved in the program the industry will have valid grounds upon which to suggest that this frequency should be cleared.

▶ **MANPOWER** . . . Engineering manpower is still critically short. Part of this shortage is due to the fact that many men are engaged in the design of military electronic equipment while many others are supporting the economy by turning out a more or less normal number of commercial items. The two-way strain is unique in the history of the country.

Industrial growth is today closely linked to technological advances. Even if there were no need to devote so much engineering effort to strictly military projects it is unlikely that the number of graduates turned out by accredited schools would prove adequate in the decade ahead. That's why a grassroots campaign has been started to interest young men in engineering at the first-year highschool level; proficiency in math at very least is necessary if these young men are to meet college entrance requirements.

▶ **WELDING** . . . Tube elements have been welded for years, and now we hear that several electronic equipment manufacturers are considering welded wiring.

Among the possible advantages of welded wiring are virtual elimination of joint resistance, comparative freedom from broken-connection troubles and conservation of materials. Among the possible disadvantages are the necessity for bringing the work to the welder, comparative inflexibility of the tool with respect to work shapes and sizes and the necessity for cutting out failed components in the field. The latter is no great handicap in plug-in subassemblies intended to be expendable, where welded wiring may find its first commercial application.

▶ **TRANSISTORS** . . . In line with its usual tendency to put new eggs in the basket intended for the biggest customer, the electronics industry has put its first commercial transistors largely into communications devices.

As the art progresses it may be that there will be a shift in emphasis toward industrial and other non-communications devices because, among other reasons, noise is less of a factor in such applications. Here then is one possible point of cleavage in the market for tubes and transistors, and one that may leave each a pretty big basket more or less its own.

While we are on the subject of transistors we are reminded that a friend of ours, bothered by *pnp* and *npn* terminology, calls the first *Penelope* and the second *Neptune*. He points out, further, that Neptune is often represented by a trident (three terminals) and that under Penelope the dictionary quotes "every night unraveled what she had woven by day" . . . an experience not entirely unlike that some engineers are having with transistor circuitry.

▶ **TAGGED** . . . On election day a young lady borrowed from the actuarial department of an insurance company operated a calculating machine called "Monrobot" in a network studio. Her first name happened to be Marilyn, so now she is frequently called Marilyn Monrobot.

TRANSISTORS . . .

Part I

Basic concepts of electron flow in semiconductors are explained, need for revised thinking to understand transistor action is outlined, and concept of hole introduced. Principle of current amplification in point-contact transistor is described

By ABRAHAM COBLENZ and HARRY L. OWENS

Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

THE ACCOMPANYING photograph shows a number of experimental transistors of the point-contact and junction types. These units occupy about one thousandth of the volume, represent on hundredth of the weight, and require about one tenth the power of the average type of radio receiving tube, yet they will perform many of the functions of vacuum tubes.

Transistors are capable of being used in circuits to provide amplification, oscillation, pulse generation, pulse counting, pulse storage, gating, and pulse delay, coincidence gates, and so on. They are more rugged than vacuum tubes in general and their life has been said to be about three times the normal life of a vacuum tube; the expected life has been extrapolated to 70,000 hours.

The transistor was invented in 1948 and at that time the total investment of private and government funds in transistor work, as such, was limited to perhaps five-figure numbers. Increasing confidence in the potential utility of the transistor has resulted in both acceleration and expansion of the transistor development activity. The very large investments in transistors by tube manufacturers indicates that the long-term outlook for this new circuit element is sound and inviting.

The youthfulness of the field and the extraordinary promise it holds forth to capable technicians in the field of electronics and electricity render it extremely fruitful for the development of new and ingenious circuit and system applications.

In this virgin and unexplored field the need for electronic engineers and technicians specially trained in the transistor art is urgent and continually increasing. This series of articles should serve to initiate technical people with varied backgrounds in electronics into this fascinating subject.

A FRESH START

This article is the first in a series on transistors which will be published in ELECTRONICS to enable engineers, technicians, amateurs and students to understand clearly the operation of these important circuit components.

The articles have been specially designed to provide theoretical, practical and working knowledge of the properties and applications of transistors, especially for those readers who do not have an extensive background in advanced mathematics and physics. Many readers will find these lessons valuable preparation for more advanced study of transistor electronics

Transistor theory represents a radical departure from vacuum-tube theory. The reader must be prepared to give careful thought to certain concepts of physics which are not difficult but are noticeably different from the principles with which he has become acquainted in his study of vacuum-tube theory and electronics. A scientific open-mindedness and a willingness to accept ideas that may appear to contravene long-established or long-accepted concepts will be found not only desirable but almost essential.

Preliminary Fundamentals

The flow of electrons accounts for both alternating and direct current. The theoretical explanation can be found in virtually all text books on a-c and d-c theory, electronics, and electrical phenomena in general.

A close scrutiny of the supporting evidence, however, reveals that electron flow is simply a convenient theory used to explain the phenomenon known as electric current. No one has ever crept into a conductor or electrolyte and witnessed the actual flow of electrons.

The theoretical explanation is the result of indirect experimental evidence and, while this experimental evidence is sound and will withstand very critical examination, the conclusions based upon it must be viewed as an inference or a hypothesis and not as a law of nature.

The fact that electron flow, as an

Theory and Application

explanation for electric current, is only a theory is strikingly demonstrated by experimental observations that cannot be explained by the use of electron theory alone. Just such a case exists in the field of semiconductors—materials that exhibit conducting properties in a range between insulators and conductors. A particularly important phenomenon in transitor action is observed that does not lend itself to a direct explanation by means of electron theory alone.

Semiconductor Conduction

Consider the arrangement shown in Fig. 1. A small block of a semiconductor material such as germanium or silicon is placed in electrical contact with a conducting metal which is then grounded, as shown at *B* of the figure. On the top of the semiconductor block, spaced a few thousandths of an inch apart. are two cat whiskers such as were common in connection with the cat-whisker galena crystals used as detectors in the early days of radio.

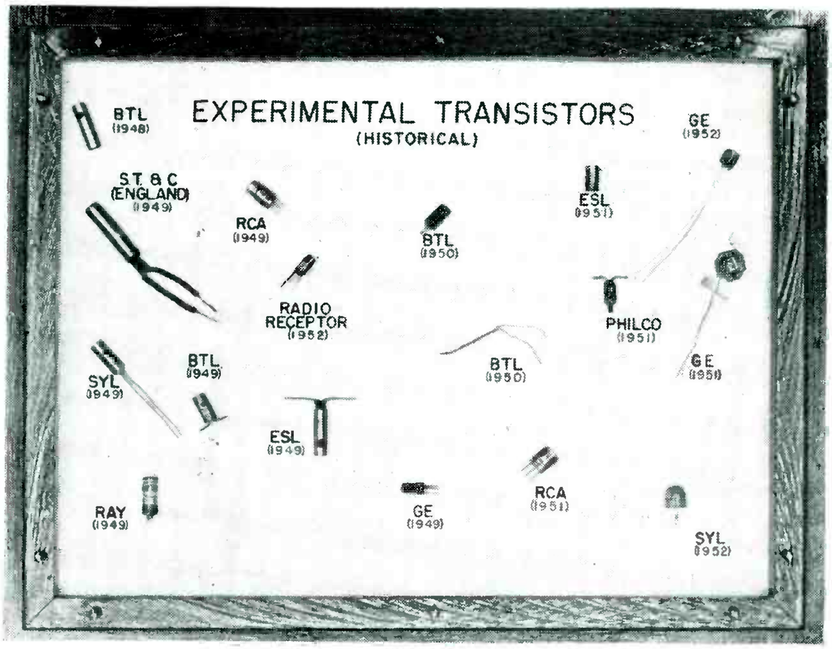
The cat whisker marked *C* is negative with respect to the semiconductor block by virtue of the battery E_c with its negative terminal connected to the cat whisker. A milliammeter is shown in series with this connection and the current indicated will be designated as I_c. The circuit indicated may be considered as a crystal diode biased in the reverse or high-resistance direction. If the applied voltage E_c is approximately 10 volts, I_c may perhaps be of the order of 1 ma. (The figures used here are not intended to be significant; only orders of magnitude are important.)

Analyzing the observed data from the standpoint of electron theory one would say simply that electrons flow from the cat whisker to the base through the semiconductor material under the influence of the applied potential E_c, and it is the flow of these electrons which gives the meter indication I_c. The dashed lines from *C* to *B* in the figure show the approximate flow or stream lines of electrons within the semiconductor block.

At the cat whisker marked *E* the polarity of the applied potential E_e is opposite to that at *C*; the positive terminal of the battery is connected to the cat whisker. A milliammeter in series with this circuit, if switch S_1 were closed, would then indicate the current in the *E-B* circuit, and since the diode on the *E* side is connected in the forward or low-resistance direction, a very small potential at E_e when the switch is closed, say of the order of 0.5 volt, will cause a current flow of the order of perhaps 1 ma.

If the reader will, for a moment, imagine the *C* circuit open and S_1 closed then, as before, I_e indicates the current flowing in the *E-B* circuit due to electron flow from *B* to *E*. Again, as before, dashed lines indicate the stream lines of electrons in the *E-B* circuit within the semiconductor material.

Now consider the *C-B* circuit closed as shown and S_1 open. As



Collection of typical junction and point contact transistors

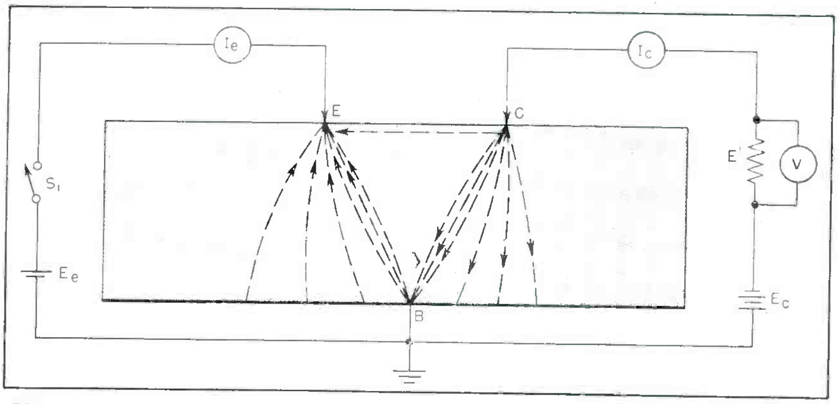


FIG. 1—Study of current flow in external circuit shown yields paradoxical phenomena that cannot be explained on basis of electron flow alone. A new concept, that of holes, must be adopted to understand transistor action

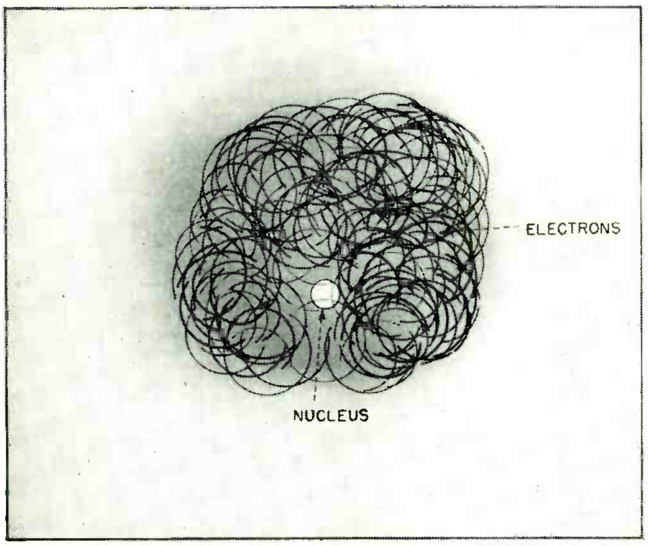


FIG. 2—Smeared drawing of atom shows orbital electrons surrounding nucleus. Net charge of such an atom is zero

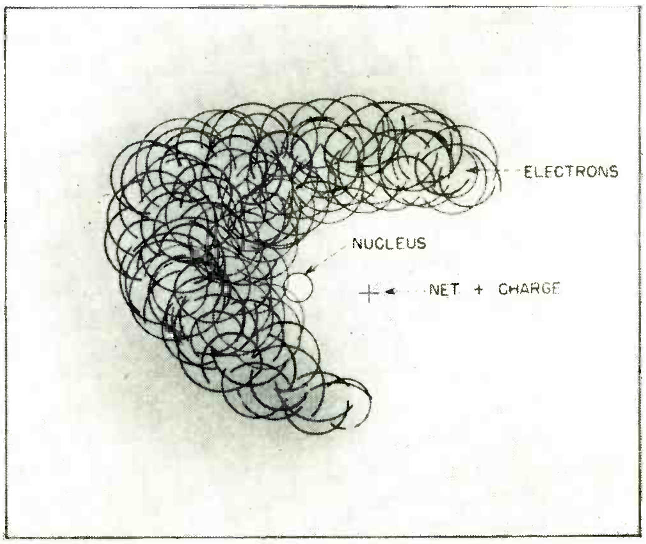


FIG. 3—Removal of one electron from neutral atom results in net positive charge due to hole (missing electron) in vicinity of nucleus

mentioned above, under the specified conditions, I_c will be about 1 ma.

When S_1 is closed an extraordinary phenomenon, loosely described as transitor action, is observed—the current in the *C-B* circuit increases markedly and may, in a typical case, reach 2 or 3 ma. Typical transistors yield current amplifications of this magnitude but exceptional units have produced current gains as great as one hundred. In any case, a significant and highly important current amplification is observed.

It is instructive, following the remarks made at the beginning of this article, to attempt to explain the observed data by means of electron theory alone.

This is no simple undertaking. If the reader will carefully trace polarities around the circuit he will observe that the *E* terminal is actually positive with respect to the *C* terminal. One might then expect that electron flow within the semiconductor block would be from *C* to *E*, making less electrons available to contribute to the conduction process from *C* to *B* and therefore one might, at a first glance, expect I_c to decrease.

If fewer electrons were available for the conduction process the current would be smaller and the observed increase in I_c is certainly perplexing. Extraordinary and unconventional variations would be required in electron theory to explain how the two divergent streams of electrons in the material can cause an interaction which will lead to the current amplification observed, particularly in view of the electric field which tends to draw electrons from the *C-B* stream.

It is virtually impossible to explain the phenomenon delineated by means of the electron theory alone and certain reinforcing or auxiliary concepts must be introduced to complement electron theory to explain properly this transistor action. The phenomena observed in semiconductors that lead to effects such as the one described do not require a modification of electron theory, but they imperatively demand an important additional concept.

Added Concept

In practice, a body of facts and experimental data accumulate and thereafter a hypothesis may be proposed which seeks to explain all the data. This is the normal progress of the scientific method.

Electron theory explains a host of phenomena already well known but does not preclude the possibility that a modification of electron theory will not only equally well explain the great number of experiments in a-c and d-c circuits but will, in addition, explain transistor action in a semiconductor. We must next examine the external evidence upon which we base our knowledge of the direction of flow of current and the nature of the current carriers.

Electron Flow

Our knowledge of the direction of electric current flow is most frequently based on the direction of the magnetic field associated with electric current. The left-hand rule for electron flow states that if the left hand grasps a conductor so that the fingers point in the direction of the lines of flux, then the thumb will point in the direction of electron flow. From this rule it may be shown that if the electrons in a wire flow in a loop clockwise, in the plane of the paper the reader now sees, the north pole would be above the paper toward the reader and the south pole under the paper.

About 1889 a well known physicist, H. A. Rowland, performed a simple but extremely important experiment. In equally-spaced sectors of an ebonite disk were placed negative charges obtained by the time-honored method of rubbing cat's fur against a glass rod. The sectors were separated by raised portions so that each sector contained its own set of charges. This ebonite disk was then rotated at high speed and it was observed that a magnetic field was present identical to what would have been expected if a flow of electrons had occurred in a loop of wire in the same direction of rotation. If the plane of the disk were parallel to the plane of the paper then the north pole for clockwise rotation of the disk would be above the paper exactly as in the case discussed above.

When these negative charges were removed and replaced by positive charges and the ebonite disk then rotated *counterclockwise* the same direction of magnetic field was observed, north toward the reader if the disk is again considered parallel to the plane of the paper.

The significance of this experiment must not be overlooked. Our ideas about the direction of electric current are usually based on the direction of the resultant magnetic field. We assume that electric current is flowing from left to right because we can explain the resulting magnetic field on the grounds that negatively-charged electrons are flowing from left to right. The phenomenon we are observing, namely, the magnetic field, *could also* be caused by positive charges moving from right to left.

Rowland's classical experiment indicates that the external or phenomenological manifestations are the same. When we say electric current we never, unless by special training, think of the motion of positive charges, and in this way we subconsciously exclude the possibility that the carriers may be positive. Once we consider this possibility then our habit of associating electric current with the flow of electrons leads to this anomalous situation about the direction of flow.

In the transistor explanations that are to follow, it is essential that the reader bear in mind the possibility that electric current may be due to the flow of positive charges as well as to negative charges. The possibility that these two processes may be simultaneously active in an electronic semiconductor material is fundamental to the theory of transistor action.

Holes

Modern theory of the structure of matter pictures the atom as containing a core or nucleus with electrons outside of the nucleus, rotating about it. This subject will be covered fully in a subsequent article of this series. It may be said here, that the present picture of what the electrons look like as they rotate about the nucleus is given by Fig. 2. The electrons are pictured as a sort of smeared out or hazy region about the nucleus as the figure shows. For purposes of this introductory discussion, let us grant that the cloud about the nucleus is due to electrons.

Hole Formation

If we were to remove one electron by some means, a net positive charge will be left since the atom with its normal complement of electrons is electrically neutral or has a net zero charge. By removing an electron from the picture presented in Fig. 2, we have created in the atom a sort of rarified area where an electron is not particularly likely to be found. This area looks like a hole, as illustrated in Fig. 3. A positive charge is associated with the hole.

The picture presented is not an entirely accurate description of a hole, and a more satisfactory definition of a hole will be given later. The rather crude picture is intended only for the purpose of introducing this new concept which is essential in the analysis of transistor action. (Having established that electric current can be carried by positive charges, and considering a net positive charge as a hole, it follows that electric current can be carried by holes.) The physicist uses the word hole in transistor theory a trifle differently from its usage in normal everyday conversation.

Because this concept of holes is so essential to the study of transistors, a few more ideas regarding its nature may be in order. The concept of a hole came into existence in the study of the physics of solids because it was found to be a convenient physical-mathematical abstraction for specifying the behavior of atomic structures in the solid. By endowing the hole with a definite mass, a definite positive charge, a definite velocity and an associated energy—in short, by treating it as a true particle, very convenient mathematical relations are obtained and much useful and practical information about specific materials, particularly the semiconductors, can also be obtained.

It can be shown that holes are acted upon by electric and magnetic fields in exactly the way one would expect a particle with the mass of an electron and a positive charge to react under equal conditions. A particularly important aspect of hole behavior is its attraction by a point of negative potential. The reader will find it convenient in all future thinking about holes to consider them equivalent to positively charged electrons, that is, particles with mass equal to the mass of the electron and charge equal to that of the electron but of opposite sign. The more accurate definition of a hole to be given later will not conflict with this simple picture.

Hole Effect

Having introduced these preliminary concepts,—let us return to the laboratory-observed phenomenon discussed in connection with Fig. 1. In Fig. 4 is shown essentially the same arrangement electrically, as

THE FRONT COVER

PROGRESS in transistor production methods is illustrated in this month's cover. Junction transistors produced in Raytheon's Newton, Massachusetts plant are subjected to 12-hour aging periods prior to shipment. The CK 721 transistors being inserted in the aging racks have an average power gain of 38 db when used in a grounded-emitter circuit with a collector voltage of 1.5 volts, collector current of 500 μa and a base current of 6 μa.

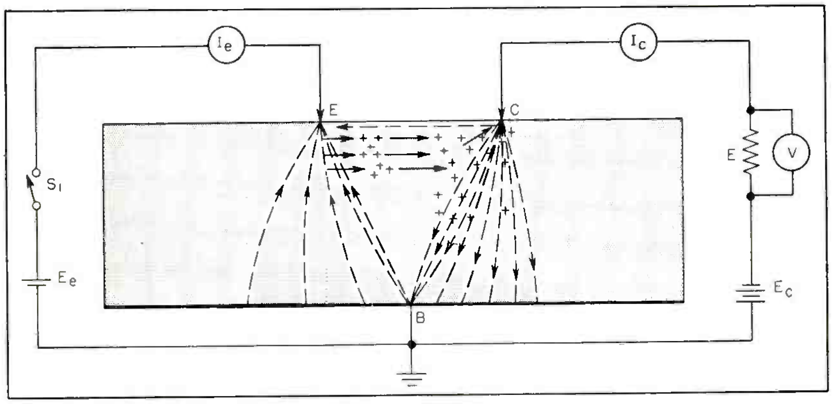


FIG. 4—Drawing shows simplified essentials of transistor action (when S_1 is closed) for point contact transistor. Plus signs indicate positively-charged holes that migrate from emitter toward collector

in Fig. 1. Let us try now to see how the introduction of the concept of holes can lead to a plausible explanation for the phenomenon of current amplification.

Current Amplification

As electrons leave the germanium block at point E due to battery E_e, holes are created in the material in consonance with the elementary principles just discussed, wherein electrons removed by any means from their atomic location give rise to holes as shown in Fig. 3. Under the influence of the electric field (note that point C is negative with respect to point E) the holes drift toward the C side of the circuit.

We have already seen that ordinarily the current I_c is small because the number of electrons available for conduction is inadequate to support a larger flow.

If the reader will recall his experience with the behavior of a negative space charge from vacuum-tube theory, he will realize that the presence of a positive space charge due to holes between C and B can create a strong attracting region for electrons in this space. Electrons from neighboring sites are thus attracted into the C-B region and add to the available electrons for conduction.

The result is a circuit which possesses lower resistance due to the abundance of electrons. The evidence that the circuit has lower resistance is that current I_c will increase when S_1 is closed.

This is a rather crude explanation of what happens and later a more accurate and sophisticated explanation will be presented. The introduction of the additional concept of holes assists in the explanation of transistor action involving current amplification. Before introduction of the concept of holes no satisfactory explanation for transistor action was apparent.

It must not be inferred, merely because this is an elementary explanation, that the hypothesis presented here regarding the motion of holes is merely a guess. There is a good and sound body of evidence to support this hypothesis and a particularly interesting experiment along these lines will be described.

In transistor parlance, the cat whisker at point C is known as a collector and the cat whisker at point E is known as the emitter.

Assume that the physical position of the emitter is fixed and that the spacing between emitter and collector is varied by moving the collector whisker. It has been mentioned in the description of a hole that it can be acted upon by a magnetic field. In addition, holes do not actually flow from the emitter to the collector in perfectly straight lines. The motion of the holes toward the collector is due to the force of the electric field plus an ordinary diffusion action; the electrons traverse curved paths from emitter to collector, possibly approximating arcs of circles.

Hole Characteristics

If a magnetic field of proper direction is applied across the slab, the diffusion of the holes into the slab is restricted and the current of holes can be made to flow more nearly in a straight line. As the holes move from emitter to collector many of them collide with an electron associated with an atom, recombine and disappear. This recombination is always going on and is one of the important phenomena in transistor action. For this first article it is sufficient to point out that unlike the electron, the hole has a finite life. Typical values of average hole lifetime for single-crystal germanium lie in the range from a few microseconds to several thousand microseconds. The velocity of a hole is also a fixed quantity. The velocity of the hole multiplied by its lifetime will determine the distance the hole will travel before recombination.

Since a straight line is the shortest distance between two points it is clear that holes that follow a straight line from emitter to collector will more nearly complete the trip before disappearing due to recombination than those that travel in a curved path. The magnetic field, by forcing the holes into the upper portion of the block, compels them to follow paths which are more nearly straight lines.

Experimentally it is observed that transistor action is obtainable at the collector in the presence of a magnetic field when the collector is physically spaced further away from the emitter than without the magnetic field. This experimental fact tends to strengthen the belief that positive particles of some kind flow from emitter to collector in the case of the arrangement shown in Fig. 1.

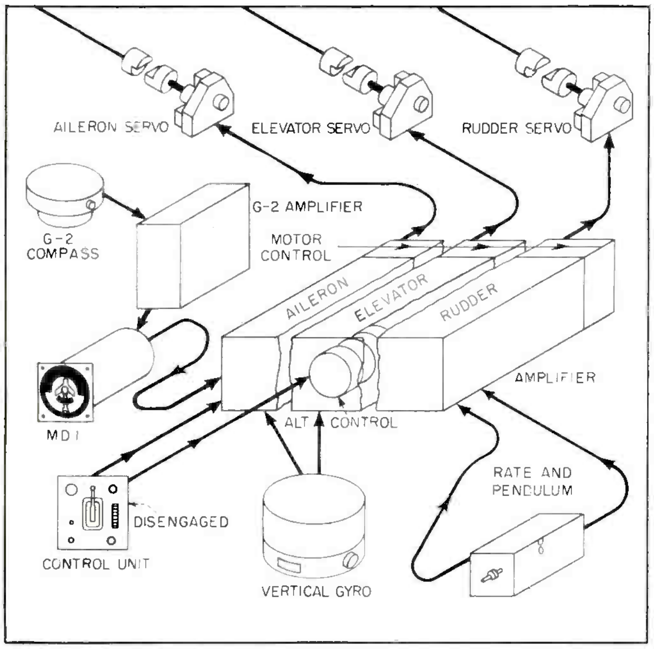
Summarizing the major points of this first article the reader is urged to retain the following essential points:

(1) Transistor action in units of the type illustrated in Fig. 1 is characterized by current amplification.

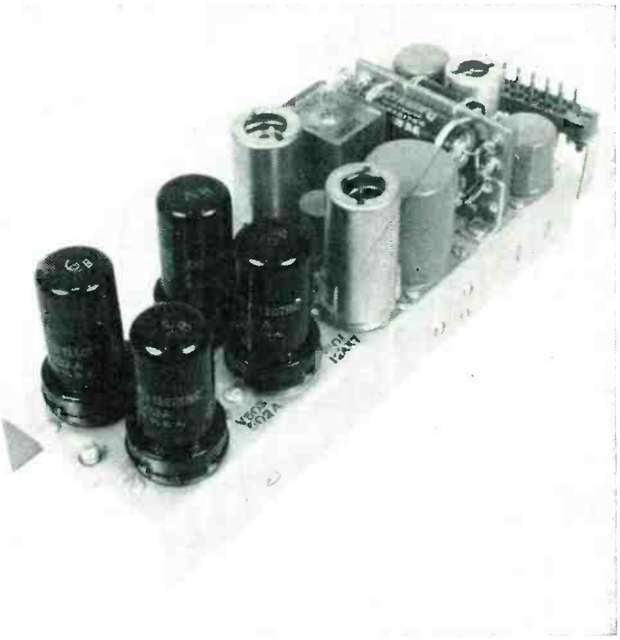
(2) It is necessary to introduce the concept of holes to explain transistor action.

(3) For practical purposes a hole may be considered to be a positively-charged particle with a positive mass.

(4) In the study of transistors the reader must be prepared to consider and master new concepts which may be radically different from many of the scientific principles he has studied previously.



Typical autopilot for fast jet plane has aileron, elevator, and rudder motor controls



Control weighs 2¼ lbs, compared to 6 lbs or more for previous model. Built on plug-in chassis, unit reduces servicing problems

Free-Wheeling Thyratrons Cut Autopilot Weight

Thyratron motor controls operate through full cycle, but need no heavy transformers. In spite of long cables, signals provide fast, accurate positioning response of control surfaces. Full control is gained with 0.1-volt in-phase signal

By CHARLES G. YATES

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AUTOMATIC pilots fly planes on set courses by positioning the control surfaces in accordance with gyro instructions and signals from instruments measuring the control surface positions. These signals position the surfaces through electric motors, the motor controls telling the motors which way to turn and how fast, as the instruments instruct.

The motor control's task, then, is to supply power to the electric motors which move the control surfaces of the airplane. It must also control the amount and direction of the power according to the deviation of the airplane from the desired direction of flight and altitude. Since there are three motor controls per autopilot—rudder, aileron, and elevator—their weight is an important consideration.

Operationally, the motor control must suit these requirements: It must have sufficient power output to drive the airplane controls, normally about 10 watts. The motor and motor control must be able to move the control surface rapidly. In servomechanism terms, the motor and motor control must respond accurately to 2.5 cps to give stable operation on the latest model jet fighters. Finally, the motor control must operate satisfactorily through a wide band of variation in the temperature, supply frequency and voltage ranges.

The Basic Circuit

The main power amplification in the motor control is supplied by thyratrons, operating from a 400-cps power supply and driving a split-field series motor. To avoid using a transformer, the thyratrons operate half wave directly from the a-c line. The characteristics of the split-field motor permit a simplified method of control (Fig. 1). For each direction of rotation, the corresponding thyratron is fired, controlling the current through the armature and half the motor field.

To more than double the current through the motor, so-called "free-wheeling" thyratrons are added to the circuit (Fig. 2). These thyratrons fire automatically at the proper time, requiring no complication of the control circuit. The circuit is shown in Fig. 2 (top). As the plate of the upper thyratron is made positive by the a-c supply, the tube conducts and current flows through the motor. The IR drop voltage polarities across the armature and field of the motor are shown. The free-wheeling thyratron does not fire because of the negative potential on its plate. When polarity reverses (Fig. 2, bottom), the main thyratron cuts off. The collapsing magnetic field in the motor winding tends to act like a generator to keep the current flowing. The polarity across the motor and therefore across the free-wheeling tube reverses, causing this tube to fire and conduction to continue in the same direction as before. Therefore, current flows in the motor in the same direction throughout a full cycle, just as in a full-wave thyratron circuit but without a transformer or complicated control circuit.

Controlling The Output

To control the firing of the thyratrons, a special circuit (Fig. 3) generates a saw-tooth waveform in the grid circuit. For ease of explanation, consider the firing tube circuit first without the capacitor across the load resistor. The resulting waveform is shown as a dotted line in the diagram. Since the power supply voltage is a sine wave, the output voltage waveform is also approximately a sine wave. Diode action of the firing tube permits conduction during one half cycle only. It is possible to vary the peak of the resultant voltage by control of the firing tube grid (either by d-c or a-c voltage).

When the capacitor is added, the saw-tooth waveform shown in the solid line is produced. The amplitude of this saw-tooth may be varied by changing the input voltage to the firing tube grid. If the amplitude of the saw-tooth waveform can be controlled up and down, then the point of intersection of the saw-tooth and the thyratron critical grid voltage may be moved back and forth and the conduction of the thyratron controlled smoothly from no conduction to full conduction.

If there were sufficient gain from this input point to the motor, the autopilot signal could be brought directly to this firing tube grid. However, additional gain is needed so another tube must be added to the circuit.

A discriminator is necessary to detect the polarity and amplitude of the alternating voltage. Both discrimination and gain can be obtained with a single tube, as shown in Fig. 4. Operation of the discriminator is similar to that of the firing tube previously explained, except that power for the tube comes from an excitation transformer connected to the tube plate, rather than coming directly from the a-c line. This allows the cathode side of the load resistor to remain at a-c ground potential with respect to the next stage.

A little more gain was necessary than was available in the discriminator tube, so the input transformer was added to get a three-to-one step up. As all these circuits are double ended, the input transformer also serves as a phase inverter for input to both discriminator tubes.

The operation of the discriminator is as follows: The signal input to the tube grid is a-c. Then with a-c on both the grid and the plate, the tube essentially conducts only when both grid and plate are positive on the same half cycle. If both are positive, then a rectified current flows through the load resistor. In the firing tube only the saw tooth or a-c portion of this wave was used. Actually, the wave also contains a large d-c component which is important in the control of the next tube, the firing tube. (The amplitude of both the d-c and a-c portions depend on the amount of capacitance across the load resistance.)

Therefore, if the input is out of phase with the excitation to the discriminator tube, the tube will never supply control to the firing tube regardless of the amplitude of the input voltage. If the input is in phase, the discriminator will supply a d-c control voltage and the

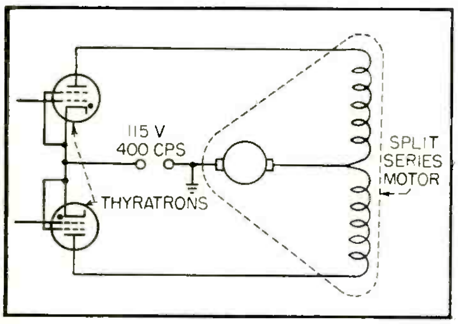

FIG. 1—Basic control operates thyratrons half wave direct from a-c line, using split-field series motor for simplified control

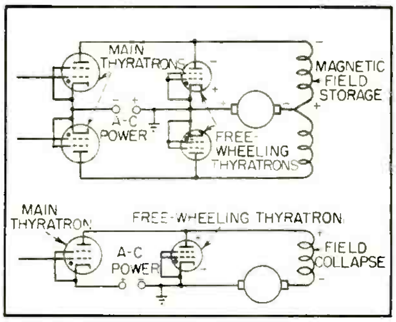

FIG. 2—Adding "free-wheeling" thyratrons doubles the current through the motor, gives full-cycle output, for autopilot controls

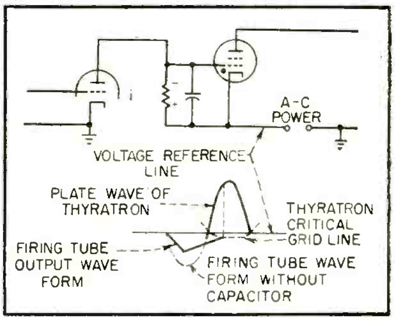

FIG. 3—RC network in grid circuit generates saw-tooth wave whose amplitude can be varied to control firing time of thyratron

amplitude of this voltage may be adjusted by amplitude control of the input voltage.

Quadrature Voltage

The circuit connected to the input transformer in Fig. 4 is called a quadrature eliminator. Quadrature voltage is objectionable in most high-performance motor controls and especially in this one, since it decreases the overall gain of the control to the point where performance is unsatisfactory. Quadrature voltage occurs in the autopilot signal circuit since a number of selsyn signals are added in series. It is further generated by various noise and stray capacitance effects of the long signal leads from remote autopilot components. In practice, some of the electrical cables are more than 100 ft long.

The quadrature circuit for this control consists of a transformer, a resistor, and a capacitor in series with the output transformer and the cathode of the tube. The quadrature rejector cuts down the sampling or detection time of the discriminator to a very small range, when the in-phase or useful signal voltage is at its peak. This is also the interval of minimum quadrature voltage during the a-c cycle. Effectively, the resistor and capacitor are a grid-leak for biasing the tube. The excitation transformer injects 13 volts into the grid circuit.

When the power is first turned on, even with zero signal, the tube grid momentarily draws current until the grid-leak is charged to approximately peak voltage. The average d-c grid potential is then negative with respect to the cathode potential. The normal in-phase signal voltage adds to or subtracts from the transformer voltage, thereby controlling the discriminator tube.

Due to the peaking of the large 13-v excitation wave, the signal has control over the discriminator tube for only about 20 degrees of the 360-degree cycle. The quadrature voltage is always going through zero during the 20-degree sensitivity range of the discriminator (dotted wave in Fig. 4). Actually, the in-phase and quadrature voltages are not broken up but are present as a resultant wave, but the circuit operation is the same.

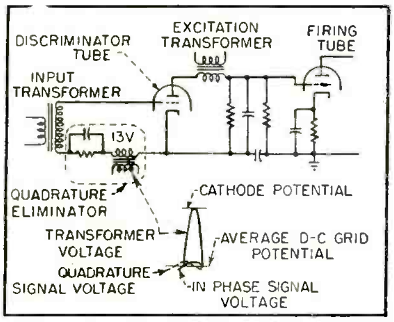

FIG. 4—Discriminator circuit gives added gain and eliminates most of out-of-phase or quadrature component of signal voltage

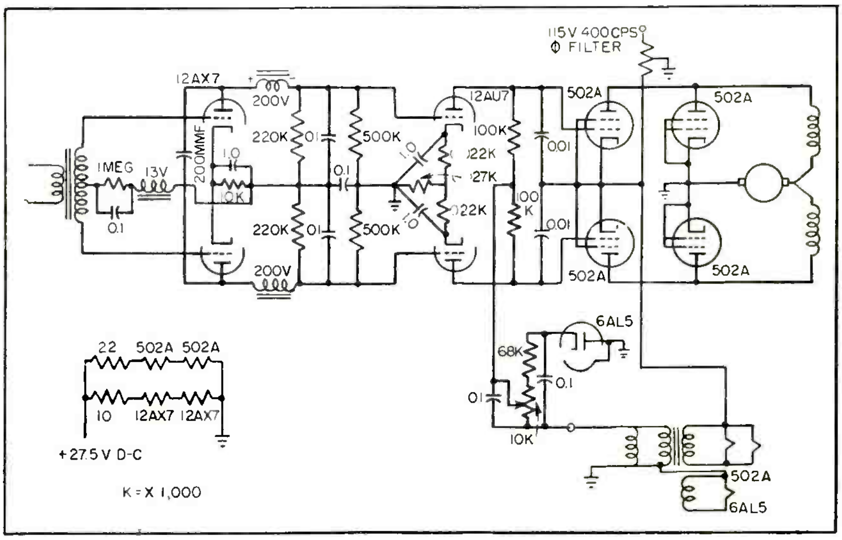

FIG. 5—Complete motor control circuit is double-ended, with complete discriminator and firing circuit for each direction of rotation. Added d-c bias source increases gain in the firing stage

The Final Circuit

The motor control is double-ended; for each direction of rotation there is a complete discriminator and firing circuit. However, one side of one circuit is common to one side of the other circuit (Fig. 5). Note there is a d-c bias source added between the firing stage and the main thyratrons, to achieve increased gain in the firing stage. The gain is increased by holding the discharge portion of the saw-tooth wave closer to a horizontal line (Fig. 3). Since the leveling of this discharge wave would preclude completely the intersection with the critical grid line, the bias source is added to raise the entire firing tube output, permitting intersection.

The final wiring diagram is shown in Fig. 5. The unit consists of a small chassis which can be plugged in or removed from the autopilot in a few seconds. The housing of the controlled motor also contains a tachometer for aiding in the stabilization of the motor as an autopilot component.

The chassis weighs 2¼ lb, while previous motor controls weigh 6 lb or more. Since each autopilot contains three of these controls, the weight advantage amounts to 11 lb or more. This makes it possible to cut the weight of present autopilots to almost half that of their predecessors.

Along with weight reduction, it has been necessary to improve the response of the motor and motor control so that the autopilot response will be far ahead of the jet fighter motions. This thyratron control is capable of 50-cps response. The motors available limit the overall response but they have been improved to follow accurately the variations of a 7-cps signal.

As far as quadrature elimination is concerned, the motor control will remove 3 v of quadrature noise and will give full control for 0.1 v of in-phase signal.

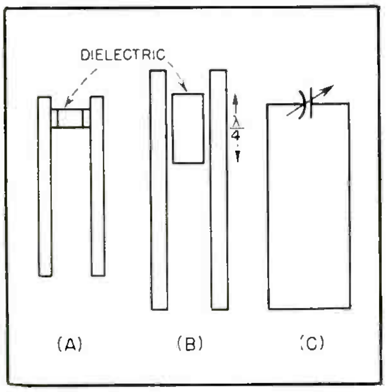

FIG. 1—Sliding (A), open-end, quarter-wave (B), variable-capacitor tuning (C)

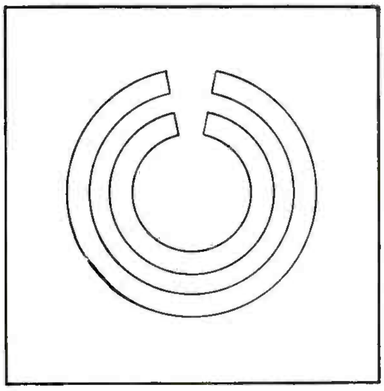

FIG. 2—Slotted concentric cylinders give wide-angle tuning

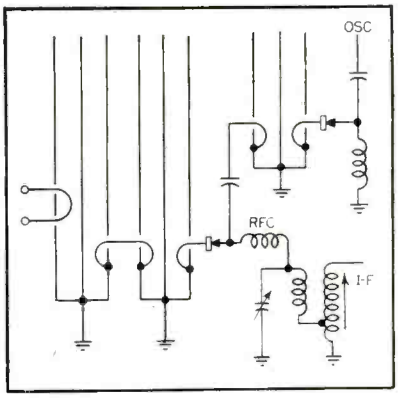

FIG. 3—Single-channel converter designed for minimum noise figure

Analysis of UHF Tuner Design

CONSIDERATION of the fact that the combined vhf and uhf frequency span covers approximately four octaves, with added complications due to transit-time effects and the distributed nature of tuning elements, may help develop the proper perspective in relation to the overall tuner-design problem.

Techniques effective in dealing with problems peculiar to the individual bands are frequently mutually exclusive. Transmission lines, for instance, prove rather awkward at vhf while lumped constants at uhf are almost ruled out. This alone should cast some doubt on the feasibility of a successful design of a combined vhf-uhf tuner using common tubes and tuning elements. Much time elapsed before a vhf tuner having approximately uniform performance characteristics over the two vhf bands was evolved. To extend the range to 900 mc is a challenging task indeed.

If it were possible to accomplish this, one might ask whether such a course would necessarily be desirable. On the positive side of the ledger is the feature of greater compactness, simplified mechanical design and possibly a measure of elegance as an engineering solution. But to accomplish this, continuous tuning would almost certainly have to be employed (even though some detent mechanism may be included) and sliding contacts, notoriously noisy, are a forgone conclusion.

The switch type vhf tuner has been widely accepted as more reliable and convenient. It may not be prudent to compromise these qualities because of the inclusion of uhf.

Tuning Devices

From the point of view of tuning range, the use of a sliding short would appear most attractive. There is one serious drawback, contact noise. A modification which overcomes this problem to a large extent consists of replacing the sliding metal-to-metal contact with a sufficiently large capacitance formed by inserting a dielectric between the sliding sleeve and the conductor (Fig. 1A).

An open quarter-wave line can also serve as an effective short. Broad-band characteristics can be secured by making the surge impedance of the line section very low relative to the surge impedance of the tuned line. A range of 2:1 can be readily attained by adjusting the line-length to a quarter-wave at the center frequency of the band.

Since the grounded-end is movable, capacitive rather than inductive coupling is indicated if one seeks to avoid the use of a movable coupling loop. Fig. 1B shows a single-tuned transmission line employing this method of tuning.

Teflon as a dielectric spacer suggests itself in circuits in Fig. 1A and 1B. It has excellent wearing properties, low friction and low dielectric losses.

The circuit shown in Fig. 1C relies on capacitive tuning. This method is quite simple and convenient. However, the Q is generally degraded by the insertion of capacitance.

Simultaneous tuning of the inductance and capacitance of the tuned circuit will result in greater

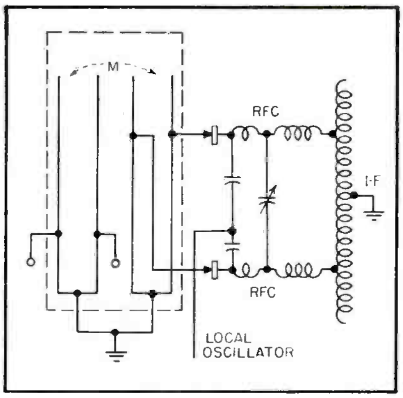

FIG. 4—Broad-band preselector, with balanced crystal output

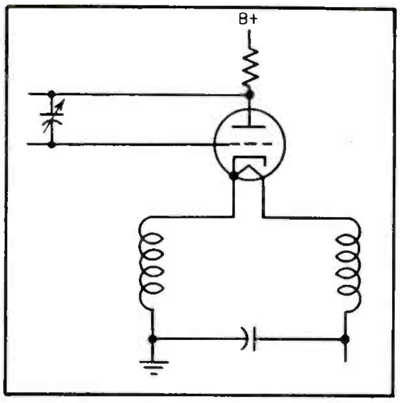

FIG. 5—Transmission line-tuned oscillator covers full uhf band

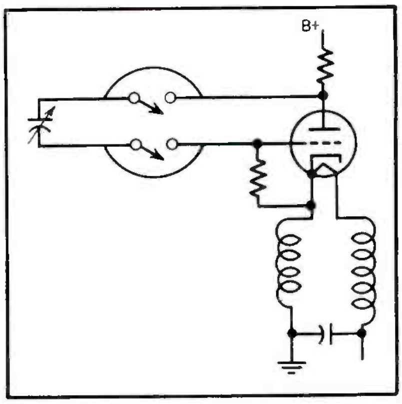

FIG. 6—Capacitance-tuned oscillator has limited range

With no strict rules of design procedure, judgment and discrimination must be used in selecting circuits and components to meet specific requirements economically. The fundamental aspects of uhf reception have been treated, but detailed design problems remain

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range. Butterfly and semi-butterfly circuits fall into this category of tuners.

Two slotted concentric cylinders (Fig. 2) offer perhaps the simplest form of a wide-range tuning mechanism. The circuit is inherently unbalanced and some form of link coupling is frequently necessary.

The use of a single and a relatively low intermediate frequency in the uhf region places stringent requirements on the preselector design. A narrow-band, multiple-tuned preselector is subject to losses due to finite unloaded Q's. These losses are a function of conductor dimensions. Thus size and material cost enter the picture. In addition, as the number of tuned circuits is increased, the tracking problem becomes more difficult.

Based on the premise that in their fundamental nature the vhf and uhf bands are sufficiently distinct to warrant different techniques, a double superheterodyne system which would include a uhf converter working into the vhf tuner is considered, for the present at least, the most practical approach. Wide variations are possible within the framework of this basic scheme.

Mixer Circuits

Currently available germanium and silicon uhf mixer crystals are similar in their essential characteristics, except that the conversion loss is lower for silicon crystals, resulting in a noise-figure improvement of 2 to 3 db.

Some uhf mixer tubes have also become available but they require higher levels of oscillator injection, calling for higher selectivity to maintain oscillator radiation at a reasonable level. In addition the noise figure of the mixer tube is generally higher. Such tubes are most useful in circuits using r-f amplification.

A simple crystal mixer is part of the circuit shown in Fig. 3. Within the normal range of crystal current due to oscillator injection (0.3-1ma) the variation of minimum noise figure is slight. The r-f and i-f impedances vary considerably and the required input and i-f circuit adjustments vary correspondingly. It is essential therefore to maintain the injection level fixed over the band.

In most oscillators the output level falls off gradually at higher frequencies. A simple R-C equalizing network, consisting of a small coupling capacitor and a small resistor across which the output voltage is developed, is often satisfactory. In some instances the effectiveness of this scheme is reduced due to the loading effect of the mixer circuit.

Some improvement can be obtained by shunting the resistor with a circuit designed to tune out the incidental reactances at the proper frequency, usually above the maximum oscillator frequency.

The same considerations apply to balanced converters (Fig. 4) which at the expense of an additional crystal offer certain unique advantages. Being inherently balanced the circuit is more suitable for use with the standard 300-ohm balanced line at the input and the vhf tuner connected to the output of the balanced i-f. The amount by which oscillator radiation is reduced depends on how closely the crystals are matched with regard to their impedances and particularly their shunt capacitances and forward resistances. With a properly matched pair, the improvement can be substantial.

The balanced mixer also serves to suppress oscillator noise. The noise contributed by the oscillator is a function of its tank-circuit Q and the intermediate frequency, being higher for low circuit Q and low i-f. This factor is seldom significant at uhf and much effort to eliminate it is not warranted as a rule.

Oscillator Circuits

The choice of tubes for fundamental operation is relatively restricted. As a practical tube the 6AF4 is finding wide acceptance.

Because of its simplicity, the Colpitts circuit is almost universally used. Cathode and filament chokes serve to raise the r-f circuit above ground. The effect of ground impedances on oscillator operation and radiation is thus minimized.

The required tuning range to cover the full uhf band can be realized by using a variable-length transmission line as the tuning element (Fig. 5).

Capacitive tuning as employed in the circuit in Fig. 6 has a somewhat limited range and usually calls for band-switching.

Because of the relatively low oscillator power required to operate the crystal mixers, the use of second-harmonic injection is quite feasible. A circuit tuned to the oscillator second harmonic and ganged with the oscillator tuning device can serve to extract the second-harmonic component and suppress the fundamental.

Crystal diodes have been used successfully to generate harmonics. Many oscillators, particularly class-C oscillators, have a significant harmonic content which can be made available without recourse to harmonic generators. The push-pull oscillator is particularly suitable for this application. At the neutral points of the circuit, cathode and center tap of the plate load, the fundamental is suppressed to a degree depending on the balance of the circuit.

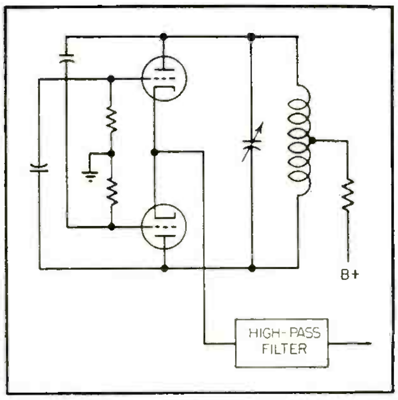

FIG. 7—Half-frequency oscillator injects second harmonic through high-pass filter

The fundamental suppression by virtue of balance is seldom adequate and additional selectivity must be relied upon. The use of a high-pass filter in place of the tuneable resonant circuit would result in greater simplicity and economy and it would, above all, eliminate the tracking problem. With double conversion, however, the tuning range is in excess of 2 to 1, making it impossible to devise an effective filter unless band-switching is employed.

Using a single i-f system of 41 to 47 mc, a relatively sharp cut-off must occur within a band of approximately 50 mc. It is possible to accomplish this using a multisection high-pass filter. Sufficient harmonic content must be available to compensate for the filter insertion loss within its pass band.

Figure 7 shows an oscillator circuit operating at half frequency, supplying second-harmonic injection through an intervening high-pass filter.

Interference Sources

Generally, a fair degree of selectivity is essential to provide immunity against interfering signals. The two most potent sources of interference are signals within the i-f and image bands.

Selectivity against interfering signals outside the uhf band can be readily secured through the use of fixed-tuned rejection filters. Specifically, as regards i-f rejection and the rejection of vhf signals, a high-pass filter can be quite effective.

The degree of image selectivity required at uhf should be reexamined as to possible sources of interference and their relative strengths. Much depends on the permissible channel spacing within a given service area. It is expected that local channel assignments will preclude the possibility of image interference in receivers employing standard intermediate frequencies.

Oscillator radiation is another potential source of interference. The input circuit selectivity determines both the susceptibility to extraneous oscillator interference and the transmission of oscillator power to the antenna. In this case also, local channel assignments calculated to meet such conditions will be effective except in instances of off-channel tuning.

The rejection offered by a multiple-tuned high-Q preselector is proportional to

$$\left[\frac{2\,|f_r - f_s|}{\Delta f}\right]^n$$

where f_r and f_s are the frequencies of the r-f and the spurious signals respectively, Δf is the preselector bandwidth and n is the number of tuned circuits. In case of the image signal $|f_r - f_s| = 2f_i$, f_i being the intermediate frequency.

Although higher intermediate frequencies relieve the preselector requirements, the i-f noise figure suffers. On the other extreme, the choice of a very low i-f may also lead to a degradation of the overall noise figure as a result of preselector insertion loss. Increased selectivity will be sought either by raising the loaded Q, by increasing the number of tuned circuits, or both. In any case losses are likely to occur with tuning elements of practical size.

Improper i-f choice can also give rise to spurious beats at certain characteristic frequencies. A particularly objectionable condition prevails when the signal frequency is translated to the i-f by virtue of second harmonic as well as fundamental conversion. The following relation expresses this condition: $2\,f_o - f_i = f_o + f_i$ or $2\,(f_s - f_i) - f_i = f_s$, resulting in $f_i = f_s/3$. Intermediate frequencies above 160 mc should, for this reason, be avoided.

Noise Figure

The required degree of selectivity may be problematical at present, but there is general agreement about the importance of noise figure. The overall noise figure is a function of the i-f noise figure, the crystal noise temperature where crystals are used, conversion loss and preselector loss.

The following is a list of symbols to be used:

F —noise figure
F_{min}—minimum F under optimum input circuit conditions
F_m —noise figure under conditions of match
F_B —noise figure for a specified bandwidth and input capacitance
B —input circuit bandwidth (single-tuned)
B_o —B under optimum noise figure conditions
R_g —Generator resistance as seen at the grid of the i-f amplifier
R_{go} —optimum value of R_g resulting in F_{min}
R_{eq} —equivalent noise resistance as referred to the input
R_t —input resistance due to transit time
T —effective temperature of R_t
T_o —room temperature —290 K
t —crystal noise temperature
L —crystal conversion loss
g_m —tube transconductance
C —input circuit capacitance
f_i —i-f center frequency
a —input transformer turns ratio
a_o —optimum turns ratio

For a triode R_{eq} is a function of g_m. $R_{eq} = \frac{2.5}{g_m}$; R_t varies inversely as f_i^2 and $R_t = \frac{K}{f_i^2}$.

The characteristics plotted in Fig. 8 and Fig. 9 were computed for a typical low-noise input stage (6AK5) having the following constants: $g_m = 6.5 \times 10^{-3}$ mhos, $C = 10^{-11}$ farads (total, including crystal and stray) and $K = 8 \times 10^{10}$. Assuming small enough transit angles to minimize coherence effects between grid and plate noise.

$$\frac{T}{T_o} \approx 5.$$

I-F Noise Figures

The i-f noise figure depends critically on tube characteristics, in particular the $g_m k$ product, as well as on the input circuit design. Triodes are superior by virture of their low R_{eq}, and cascode circuits are generally favored in this application.

For a grounded-cathode stage, conditions for minimum noise figures are obtained when the generator resistance as seen at the grid satisfies the following relation

$$R_g \approx \sqrt{R_{eq} R_t \frac{T_o}{T}} = \frac{1}{f_i}\sqrt{\frac{K}{2g_m}} \quad (1)$$

This results in a noise figure

$$F_{min} = 1 + 2\sqrt{\frac{T}{T_o}\frac{R_{eq}}{R_t}} = 1 + \frac{7f_i}{\sqrt{g_m k}} \quad (2)$$

The maximum input-circuit bandwidth under optimum conditions is in addition a function of C

$$B_o = \frac{1 + \sqrt{\frac{R_{eq}}{R_t}\frac{T_o}{T}}}{2\pi C R_t \sqrt{\frac{R_{eq}}{R_t}\frac{T_o}{T}}}$$

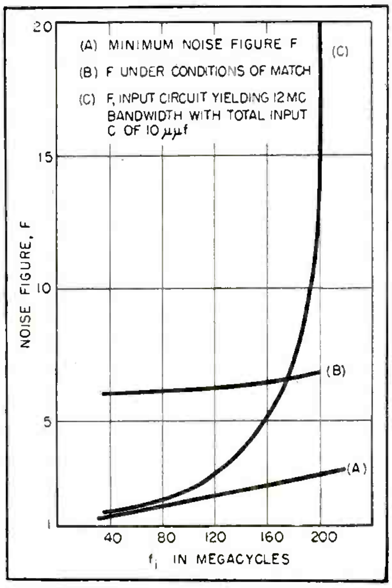

FIG. 8—Noise figure F versus frequency

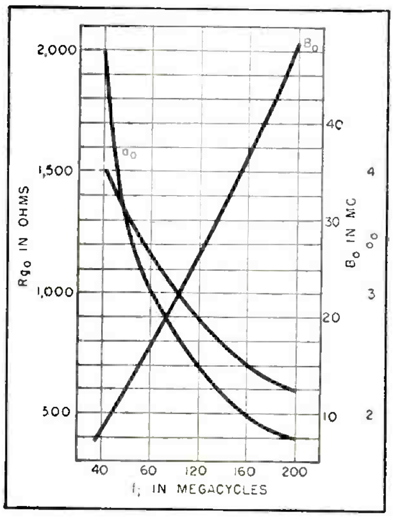

FIG. 9—Turns ratio, bandwidth and optimum R_{go} versus i-f frequency

$$= \frac{f_i}{2\pi C}\frac{\sqrt{2g_m}}{K}\left(1 + \frac{f_i}{\sqrt{2g_m K}}\right) \quad (3)$$

The bandwidth B_o is that of a single-tuned circuit. Double-tuning will increase the bandwidth by a factor of approximately 1.4, and should therefore be used at low intermediate frequencies where B_o is not much in excess of 12 mc, the width of two channels.

The linear relationship of F_{min} versus f_i is shown in Fig. 8A. The considerably higher noise figures under conditions of match are plotted in Fig. 8B.

$$F_m = 6 + \frac{10}{g_m R_t} = 6 + \frac{10 f_i^2}{g_m K} \quad (4)$$

The noise figure obtained when the turns ratio is adjusted to yield a bandwidth of 12 mc is shown in Fig. 8C. Between 40 and 100 mc the increase in noise-figure over F_{min} is very slight. This is due to the fact that B_o is approximately 12 mc in this region. This portion of the vhf spectrum would appear therefore to be quite suitable.

Above 100 mc, F_B rises sharply and reaches the value of approximately 20 at 260 mc. The relevant expression is

$$F_B = 1 + \frac{\frac{T}{T_o} f_i^2}{2\pi B K C - f_i^2} + \frac{2.5}{g_m k}(2\pi B K C - f_i^2)\left(1 + \frac{f_i^2}{2\pi B K C - f_i^2}\right)^2 \quad (5)$$

When it is desired to use a high i-f and restrict the bandwidth below B_o, circuit capacitance should be added instead of changing a_o. Optimum turns ratio a_o as well as B_o and R_{go} are plotted in Fig. 9

$$a_o = \frac{\sqrt[4]{2g_m K}}{\sqrt{f_i}} \quad (6)$$

Noise Temperature

The term noise temperature is somewhat misleading. It refers to a factor by which the temperature of the crystal i-f resistance (assumed at room temperature 290 K) must be multipled to produce an equal amount of noise power as that produced by the crystal at its i-f output terminals.

The available output noise power of the crystal is $t \times kTB$. By definition, the noise figure is the quotient $\frac{N_o}{GN}$, where N_o is the available output noise power of the network, G the gain of the network and N the available thermal agitation noise power kTB. The crystal noise figure designated by F_1 is therefore $\frac{t}{G}$. The overall noise figure is

$$F = F_1 + \frac{F_2 - 1}{G} = \frac{t + F_i - 1}{G}$$

or $F = L_c\,(t + F_i - 1)$ where $L_c = 1/G$ is the conversion loss and F_i is the i-f noise figure.

The crystal noise temperature is a function of oscillator injection. It is very high at low frequencies but levels off to a constant value at approximately 10 mc. The noise temperature bears a straight-line relationship to oscillator injection, starting with unity at zero rectified current. The conversion loss reaches a minimum at a certain level of oscillator injection and F assumes a minimum slightly below this value.

Conversion Loss

Conversion loss is the greatest factor contributing to the overall noise figure. It is lowest with fundamental conversion. Harmonic conversion should be avoided as it results in increased loss and consequently a higher noise figure. This does not mean the oscillator must be operated at the injection frequency. The use of harmonics of the oscillator frequency is quite acceptable, provided the fundamental and the undesirable lower harmonics are adequately suppressed before injection.

Although conversion loss is for the most part a characteristic property of the crystal, it is also influenced by the associated circuits. The image response of the preselector, for instance, affects the noise figure to a degree depending on the inherent crystal loss. In the case of an ideal mixer, the loss due to image response can be as high as 3 db when conditions of match prevail at the image frequency.

With no conversion loss and conditions of input circuit match at the image frequency, the image frequency power will be equal to the i-f power. Since this power emanates from the signal source, only half of the signal power is converted into useful i-f power and a 3-db conversion loss is incurred.

This effect, which would be of importance with highly efficient mixers, can be minimized by making the preselector present either very high or, as is usually the case, a very low image impedance. In practice, no special precautions are warranted in view of the relatively high conversion loss. The effect of this loss is first to attenuate the i-f power considerably below the r-f level and then further attenuate the image beat at the preselector. The circuit impedance interaction between r-f and i-f is also decreased in relation to the conversion loss.

It should not be concluded that loss is a desirable characteristic, but as the losses are decreased the optimum conditions are subject to more critical adjustments.

Typical conversion loss figures for uhf silicon crystals range between 8 and 12. The noise temperature corresponding to optimum oscillator injection (minimum noise figure) is approximately 1.5.

Preselector Loss

The preselector losses contribute to the noise figure in a very direct way. Since the output noise level is not changed by the insertion of the preselector but the loss is increased by a factor L_s (the preselector loss), the overall noise-figure is increased by the same factor.

The preselector loss is related to the operating Q and the unloaded $Q = Q_o$ by:

$$L_s = \frac{1}{\left(1 - \frac{Q}{Q_o}\right)^{2n}}$$

n being the number of tuned circuits and $Q = \frac{f_r}{F}$ The resultant overall noise figure is

$$F = \frac{L_c\,(t + F_i - 1)}{\left(1 - \frac{Q}{Q_o}\right)^{2n}}$$

Under conditions of optimum F_i,

$$F = \frac{L_c\left(t + \frac{7f_i}{\sqrt{g_m k}}\right)}{\left(1 - \frac{F_r}{Q_o \Delta F}\right)^{2n}} \qquad (7)$$

The noise figure is seen to be a function of the ratio of the loaded to unloaded Q. For a given size of tuning elements the preselector losses and consequently the noise-figure will decrease with increasing r-f bandwidth.

I-F Amplifiers

Most modern vhf tuners employ a cascode r-f amplifier stage and little can be gained in noise-figure improvement by adding a preamplifier. It is only necessary to transform the impedance level of the input circuit for optimum noise figure.

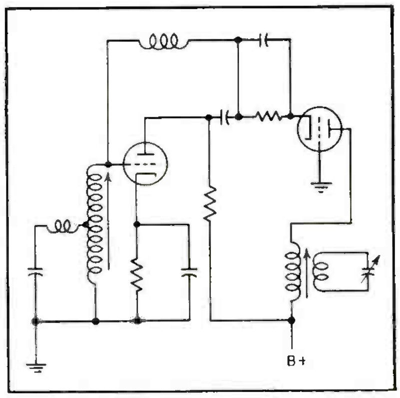

FIG. 10—Cascode i-f amplifier is most suitable for single-ended converters

Preamplification at the i-f is indicated if the converter is a self-contained unit intended to be used in conjunction with a variety of vhf tuners. The cascode circuit shown in Fig. 10 is most suitable for use with single-ended converters. The simple cross-neutralized push-pull amplifier shown in Fig. 11 can yield equally good results at low vhf frequencies. As a result of the relatively wide bandwidth and low amplification, stability is readily achieved.

Three Converters

Basic converter systems include the single-channel strip type, the broad-band and the tuned narrow-band converters.

The crystal mixer is part of every circuit considered. Amplifier and mixer tube circuits are not treated because of the early stage of tube and applicable circuit development.

The fixed-tuned strip lends itself to an economical and very satisfactory design. It is most adaptable to turret-type tuners where several switch positions can be reserved for uhf use.

In general, it comprises a narrow-band preselector and a crystal mixer working into the vhf r-f stage which in the uhf position serves as an i-f stage. Since high selectivity can be attained, a single i-f in the 41 to 47-mc band would probably prove most satisfactory. Being fixed-tuned it is not particularly subject to tracking problems.

High unloaded Q's in the preselector are indicated. Considering the space limitations in a turret-type tuner this is not an easy task. Capacitance-tuned transmission lines appear most suitable. When noncoaxial construction is used adequate shielding must be provided, mainly to reduce radiation losses and also to minimize the circuit's susceptibility to stray signals. The vhf local oscillator can be used in conjunction with a crystal harmonic generator as part of the strip.

The most serious drawback of this system is its highly limited range. It makes only a few of the 70 channels available in any one receiver, rendering it a local receiver.

A circuit of a single-channel converter is shown in Fig. 3. The i-f transformer is part of the strip and is designed to yield minimum noise figure.

Broad-Band Converter

In the broad-band converter all or a large number of channels can be transmitted simultaneously through the input circuit, which may be several hundred megacycles wide. Channel selection is accomplished merely by tuning the oscillator.

As already indicated, to a degree the losses are reduced by increasing the bandwidth. This is unlike the conditions at vhf where the required bandwidth and the circuit capacitance determine the stage gain, the figure of merit being fixed. At uhf, loading is the limiting factor and in absence of any added capacitance wide bandwidth is inherently obtained.

Selectivity is sacrificed, but as was pointed out, its importance is somewhat problematical. The use of a trap tuned to the image frequency and ganged to the oscillator tuning device can insure good image selectivity in spite of the broad-band feature. The tracking of such a circuit is noncritical as the transmission characteristics of the desired signal are not affected by slight mistuning. The bandwidth of the crystal viewed as a lumped circuit having 1 μμf of capacitance and an input resistance of 300 ohms is approximately 500 mc.

Since it is somewhat difficult to secure the desired oscillator tuning range in one band, a division into two or more bands is generally favored. By reducing the bandwidth of the input circuit correspondingly, selectivity can be improved.

The circuit of a broad-band converter is shown in Fig. 4. Two crystals are used in a balanced circuit, resulting in a reduction of oscillator radiation. The noise contributed by the oscillator is also reduced but this is not usually a significant factor. In addition the use of a balanced transmission line is facilitated.

The balanced output circuit shown in Fig. 4 might feed a single cross-neutralized push-pull i-f amplifier. Such a circuit affords a favorable noise figure, assuming of course an optimum design of the input circuit. The balanced output circuit is also desirable when the converter is used in conjunction with a vhf tuner having a balanced input.

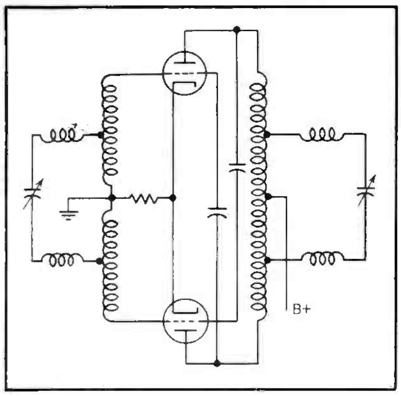

FIG. 11—Push-pull i-f amplifier is cross-neutralized, good at low vhf frequencies

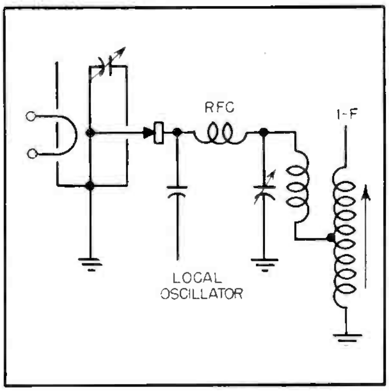

FIG. 12—Narrow-band capacitance-tuned transmission-line converter

Narrow-Band Converter

In the narrow-band converter, conservative selectivity requirements are aimed for. Using a single i-f system (41 to 47 mc) and assuming an asymmetrical i-f response, the oscillator must operate above the signal frequency. The highest required oscillator frequency is thus raised.

A single-tuned circuit in the preselector usually suffices where double conversion with a reasonably high first i-f is used. The circuit in Fig. 11 employs a capacitance-tuned transmission line which is ganged with the oscillator tuning mechanism.

The circuits discussed cover uhf-tuner designs which seem promising. Much exploratory work is being done on which it is premature to report.

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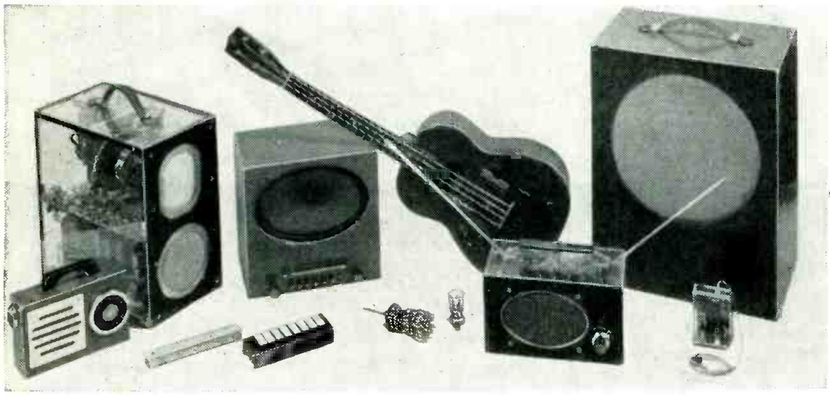
Experiments Illustrate



Group photo shows many of transistorized items described in text. Left to right in rear are, portable radio, tv receiver, auto radio, ukulele and public address amplifier. Front row shows roving microphone, toy organ, decade scaler, complementary symmetry audio amplifier, portable f-m receiver and paging receiver

By

JAMES D. FAHNESTOCK

Associate Editor, ELECTRONICS

It is difficult to attach an order of importance to the various pieces of transistorized equipment shown by RCA at their Princeton, New Jersey, laboratories recently. Each has its own aspects of importance, though in some cases these are more obvious than in others.

Complementary Symmetry

The concept of complementary symmetry promises to be the basis of one of the more important applications of transistors. Using this technique, it is possible to split a signal into two out-of-phase signals for push-pull amplification without the use of transformers. The principle is illustrated in Fig. 1A.

The bases of two junction transistors, one pnp and one npn, are fed in parallel. Due to the opposite signs of the transfer characteristics of these two types of transistors, the output signals will be 180 degrees out of phase—one having been shifted 180 degrees, the other going straight through.

A practical application of this principle is illustrated in Fig. 1B. A pair of transistors in complementary-symmetry arrangement is used as a phase-splitting preamplifier stage. The out-of-phase signals thus produced are connected directly to the base-input complementary-symmetry stage following. In this stage the split-phase signals receive further amplification and are recombined into a single-ended signal that is applied directly to the 16-ohm voice coil of a loudspeaker. The entire output signal is connected back to the input stage as a form of degeneration. This connection provides fairly high gain with low distortion.

The circuit shown in Fig. 1B preceded by a single-transistor preamplifier is capable of producing a half watt of audio from a conventional phonograph pickup.

All-Transistor Television Set

A thirty-six transistor television set was built as an experiment. Its stage lineup is as follows: A point-contact local oscillator is fixed-tuned on the low side of the station carrier (channel 4). Two crystal diodes convert the local oscillator output and received signal to 8 mc for amplification in the six-stage point-contact transistor intermediate-frequency amplifier. Bandwidth is two mc. Two diodes are used in the second detector—the output of one feeds the video amplifier and the other feeds the intercarrier-sound i-f amplifier.

The video amplifier is comprised of two stages, the first using an experimental junction transistor and the video output a point-contact unit. A point-contact sync detector and sync separator (junction) furnish sweep signals for the vertical deflection circuits. These consist of a point-contact vertical oscillator, a junction driver and a pair of junction output transistors driven in push-pull without transformers by means of complementary symmetry.

Two experimental junction transistors comprise a horizontal afc circuit that controls a point-contact horizontal oscillator and a two-junction-type horizontal amplifier of conventional design. These are followed by a push-pull junction amplifier that drives the horizontal coils of the yoke and a pair of pulse-amplifying junction types the output of which is rectified by a selenium diode for the picture tube second anode voltage.

The sound channel consists of a 4-stage point-contact type i-f amplifier at 4.5 mc, followed by a two-diode ratio detector, a junction low-level audio stage and a pair of output junctions in complementary symmetry.

The set provides good pictures within 5 miles of WNBT using a

WHAT'S INSIDE

This article is in answer to the many requests received for more information on the transistor devices shown at the RCA Princeton Laboratories recently, and mentioned in *ELECTRONICS* ("John Q. Meets the Transistor" p 5, Jan. 1953.)

The information presented was obtained in personal interviews with the engineers and scientists at Princeton who figured in the developments discussed. Some of these developments will be described in more complete detail in future issues of *ELECTRONICS*

Transistor Applications

Small in size, but tremendous in impact, the transistor has already assumed an important place in the electronics industry. That potential applications are virtually unlimited is illustrated clearly by experimental devices described here

built-in loop and 15 miles from the station with a simple rabbit-ear antenna.

Automobile Radio

A natural application of the transistor is to automobile radios and other mobile and portable equipment. To see what could be done with existing automobile power sources (6-volt batteries) a program was launched to build an all-transistor broadcast receiver.

The goal was met with 11 transistors and one crystal diode. A loudspeaker of the type normally used in automobile radio sets is transformer driven through an output transformer by a pair of push-pull junction transistors operating in class B with essentially zero bias. This output stage is transformer driven by a single junction transistor operating class A which in turn is preceded by two cascaded low-level junction preamplifiers.

Junction transistors are used in the local oscillator, mixer, second detector and 3-stage 455-kc i-f amplifier. The diode serves as the avc detector.

Receiver sensitivity is around 50 μv and total current drawn from the 6-volt electrical system by the radio averages 300 ma and is dependent on magnitude of output, since the final stage is operated class B. Audio output of the class-B circuit is almost a watt, with frequency response comparable to that provided by commercial tube receivers.

Flea-Power Transmitters

The high-efficiency characteristics of the transistor make it useful in hearing aids ("Transistors Replace Hearing Aid Tubes," ELECTRONICS, p 5, Feb. 1953) and other small light-weight devices. A pill-box size transmitter with output in the broadcast band capable of being modulated by a phonograph pickup was shown by RCA engineers. The pill box transmits modulated signals to a near-by receiver that recovers the audio signal and reproduces it in the loudspeaker. Power consumption is about 100 microwatts and self-contained battery life is 3,000 hours.

Another transmitter, intended for public address work, is about the size and weight of a fountain pen and pencil, and contains two transistors, an r-f oscillator and a modulator, and uses a 22.5-volt battery. Good noise-free signals may be heard in a conventional broadcast receiver from a distance of 30 feet or so.

In all these miniature devices, ferrite core coils are used to obtain maximum radiation from the smallest possible space.

A by-product of a program to develop transistor oscillators is a toy organ that operates through any broadcast receiver. An experimental junction transistor is used in a 540-kc oscillator which is caused to block at different audio rates by a keyboard that switches different values of capacitance in the emitter circuit. The oscillator runs continuously to maintain control over receiver avc when notes are not being played. Two 1.35-volt cells power the 8-note organ for about 5,000 hours.

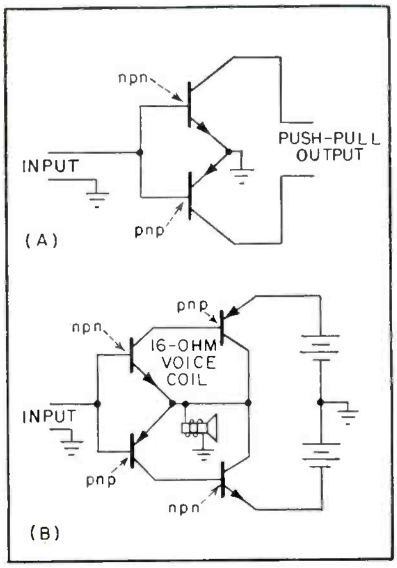


FIG. 1—Circuits illustrate complementary-symmetry principle

Portable Radios

Portable personal radio sets may be an early commercial application of transistors. A set using nine junction transistors has been demonstrated that has a 300-μv sensitivity and operates over 100 hours on a small 6-volt battery. The circuit is similar to that of the auto radio, except that single-ended output is used since it provides sufficient power for normal portable use.

Three junction transistors are used in a vest-pocket receiver for hospital paging systems operating on a frequency in the neighborhood of 100 kc and using a long wire stretched around a building as a radiator. The entire receiver, using an r-f stage, a detector and a stage of audio to drive a hearing-aid earpiece, operates for 500 hours on a single miniature 1.35-volt mercury cell.

It should be emphasized that without exception the above mentioned devices were designed and built to see what *could* be done. None are recommended as finished commercialized pieces of equipment, though they do point up the possibility of such application some day in the future.

Photoelectric Width Gage

Optical image of each edge of white-hot moving strip is scanned by system of phototubes and motor-driven slotted disks from relatively cool position 15 feet above bed of mill. Control circuit transforms outputs of the two phototubes to a single signal that indicates deviations in width to accuracy of $\pm\frac{1}{8}$ inch, independent of lateral or vertical motion

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ALTHOUGH the x-ray gage for measuring steel thickness has become a common device in the modern steel mill, measurement of width of hot strip is still being made by manually-operated calipers. These at best provide only an approximate and occasional indication of the actual width. Moreover, measurement of width is usually made only at one point along a strip length and this does not necessarily represent the true width along the whole length of the piece. Due to the jagged edges found in many lengths of hot steel, it is also difficult to obtain much information about average width from individual measurements.

The severe heat in the area of measurement creates a second disadvantage in the present technique. Measurement in this manner is an extremely uncomfortable task for the caliper operator. A third disadvantage is that the strip must be stopped before a measurement can be made.

The photoelectric width gage described here was developed to meet the foregoing specialized needs of the steel industry. The gage measures, indicates, and can provide a record of strip width within the range of 10 to 96 inches with an accuracy of better than $\pm\frac{1}{8}$ inch. No contact between the strip and gage is required. The width indication is independent of reasonable lateral and vertical motion of the strip as it bounces rapidly along a rolling mill table. The light radiated from the hot strip edges is used to obtain signals for measuring width.

The detector, located 15 feet above the hot strip, is largely unaffected by extreme ambient conditions such as temperature, moisture, fumes and dirt of the mill near the strip itself.

General Description

The main functional units of the width gage are the detector, the electronic control cabinet, the operator's control cabinet and the indicators, as shown in Fig. 1.

The detector generates two electrical signals which contain information for accurately measuring the width of the strip.

The electronic control cabinet contains the majority of electronic components which transform the two signals from the detector into a single signal for indicating width deviation.

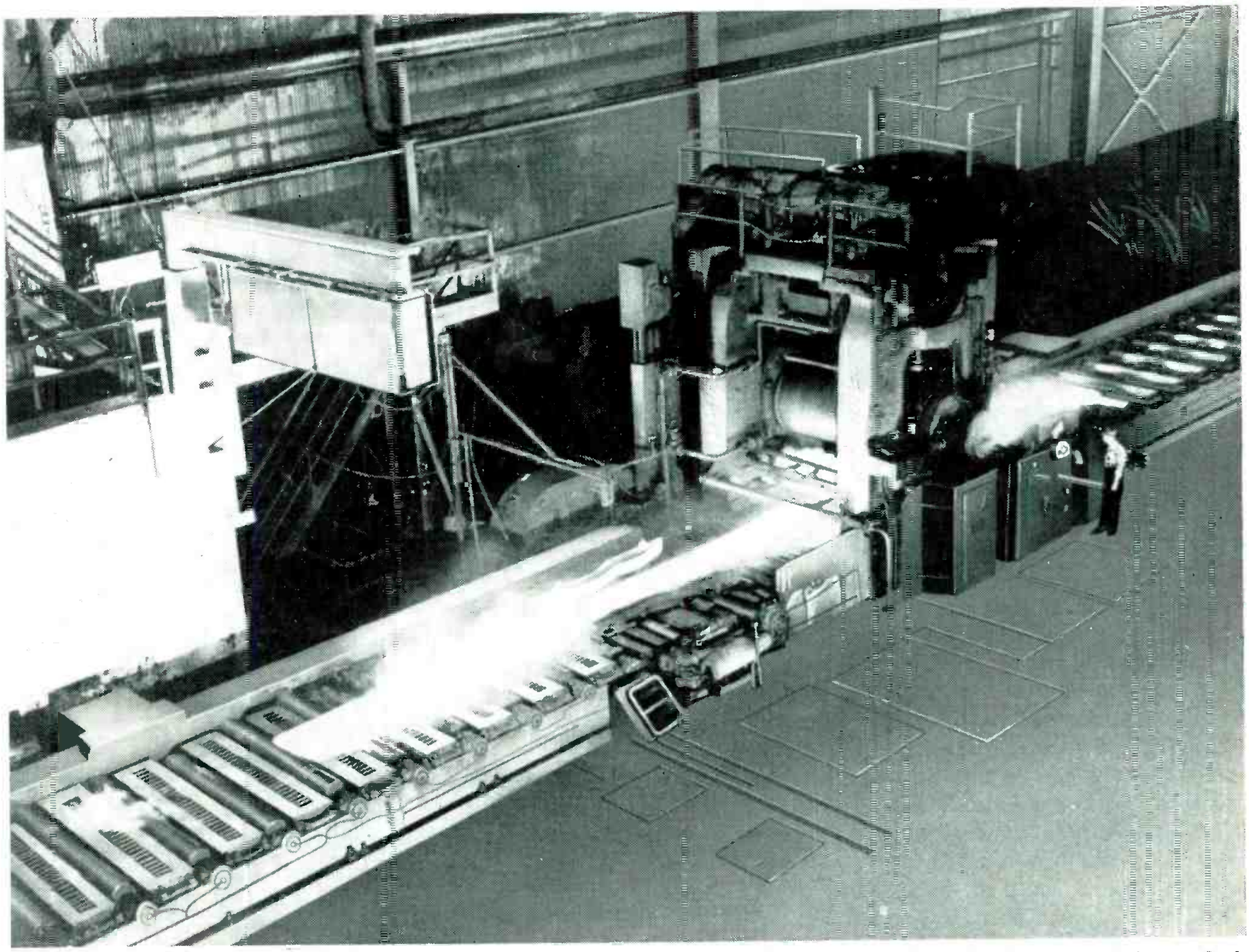
The operator's control cabinet contains the width-indicating devices and the controls for operating the gage. The width-indicating devices consist of a visual mechanical counter which is set by the operator to the desired width of the strip to be rolled, and a deviation indicator which shows any deviation from the width desired.

Figure 2 shows that the gage operates by scanning an optical image of each edge of the strip to be measured. The position of the two scanning units located inside the detector is adjusted by a motor-driven screw, which is controlled from the operator's control cabinet and which places the two scanning units directly above the nominal position of the edges of the strip.

The lens at the bottom of each scanning unit focuses the image of the edge of the strip onto a scanning disk behind which is placed a phototube. The optical image for each edge of steel is converted into an electrical signal by the phototube. The rotating slotted disk provides means for repeatedly scanning across the image of the edge of the strip at right angles to the direction of strip travel. Each unit scans approximately 10 inches, nominally 5 inches off the edge of the strip and 5 inches on the strip. The scanning field is thus wide enough to allow for a certain amount of sidewise motion of the strip as well as for normal changes in width.

The scanning action causes each phototube to generate a rectangular

for Hot-Strip Steel Mills



First installation of noncontacting width gage, in Irvin Works of U. S. Steel Co. Detector head is in housing suspended over bed of mill at left, with phototubes inside reacting to edges of hot strip as it flies back and forth underneath. The strip thus serves as light source for the system. Operator's controls and width deviation indicator are on side of mill, near operator at right center

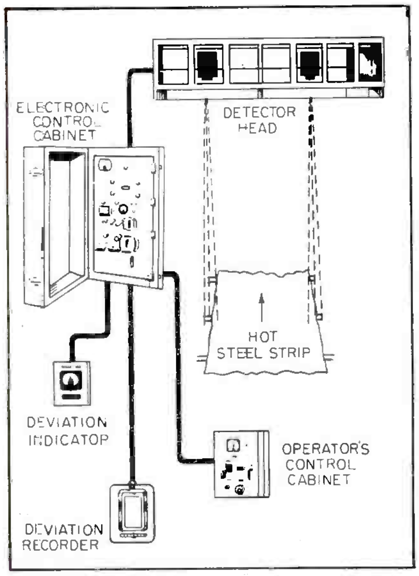


FIG. 1—Arrangement of main units of width gage

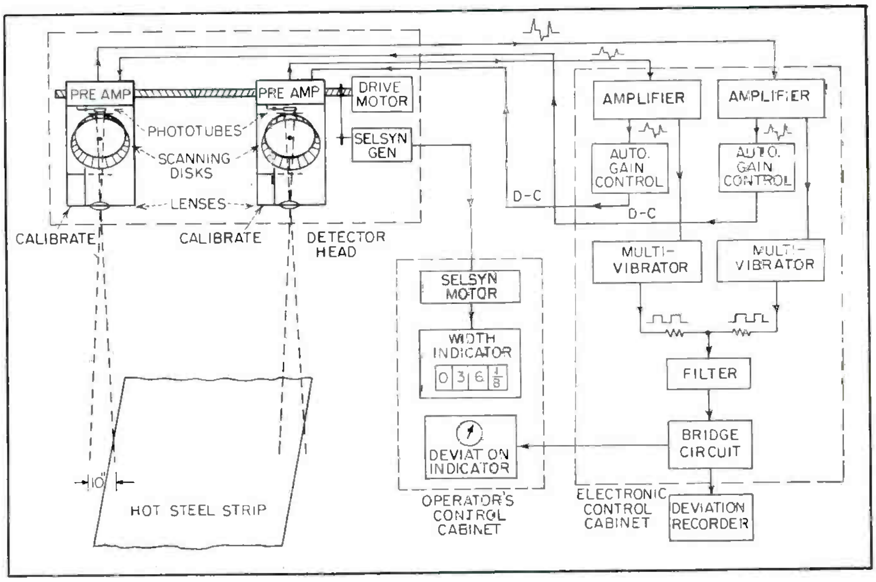


FIG. 2—Block diagram of entire system, showing how lenses project images of edges of strip through scanning disks onto cathodes of phototubes

wave shape of voltage vs time in which the percentage pulse width is directly proportional to the position of the edge. The two sets of signals, one from each edge of the strip, are then differentiated to produce spikes at the leading and trailing edge of each square pulse signal. These signals are then amplified in the scanning units to avoid electrical interference and are transmitted to the amplifiers in the electronic control cabinet. Here the signals are again amplified.

Utilization of Pulses

By means of a special bistable multivibrator circuit, rectangular pulses are generated from the sharp positive and negative pulses. These rectangular pulses can vary in width but not in amplitude. The two sets of constant-amplitude pulses are then applied to the pulse width analyzer circuit where they are added, and the sum is averaged to obtain a d-c voltage depending only upon the width of the pulses. By means of a bridge circuit this d-c voltage is used to operate the deviation meters and recorder.

A selsyn generator, geared to the lead screw which positions the scanning units, generates an electrical signal which provides an indication at the operator's control cabinet of the spacing of the scanning units. The electrical signal from the selsyn generator is applied to a corresponding selsyn motor geared to a counter which then indicates this distance to a precision of better than 1/64 inch.

A calibrating mechanism is provided to insure that the optical and electronic parts of the width gage are functioning properly. This mechanism provides an overall calibration of the deviation measuring circuit. One such calibrating mechanism is located in each scanning unit.

To calibrate, the operator closes a switch located on the operator's control cabinet which causes a shutter to block the light from the hot steel and also turns on an incandescent lamp. The lamp illuminates a frosted window one edge of which is imaged onto the phototube in such a way as to generate a 50-percent pulse signal from each scanning unit. Such a pulse signal

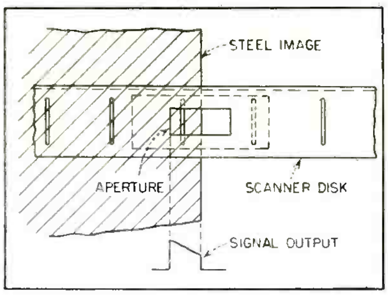


FIG. 3—Operation of scanning disk

exactly duplicates the normal operating signal for zero deviation of the strip from the width for which the gage is set. A zero set control, also located on the operator's control cabinet, is then adjusted by the operator to correct for any drifts and to give a zero indication on the deviation meters.

Sidewise motion of the strip will increase the pulse width from one scanning unit and decrease that from the other unit. The average of the two remains constant, and hence there is no change in deviation indication. A reasonable amount of up and down motion of the strip results in only a very small change in the sum of the individual pulse widths because the separate scanning units are located directly above the respective edges of the strip.

Design Consideration

From the practical standpoint, the width gage is designed to provide ease of operation, rapid and continuous indication of width, and ease in maintenance and service. Tubes especially designed for long life and industrial-type components are used wherever possible. Heavy-gage steel is used in the fabrication of the cabinets and housing units to provide a maximum of strength and durability.

The electronic circuitry and adjustment is simple and insensitive to changes in power supply variations. The measuring circuits consist of two amplifier channels, each of which contains only four amplifier tubes, and a filter and bridge circuit which employs only one amplifier tube. Large changes in tube characteristics and large changes in signal amplitude can occur without changing the width indication. Simplicity and permanence in design in this manner are extremely important in industry, where there is usually a limited time available for maintenance work on electronic equipment and where frequently highly skilled electronic personnel are not always readily available.

Electronic Circuits

Figure 3 shows diagrammatically the arrangement of the components of the image scanner for one of the scanning units. As a slit in the scanning disk moves rapidly across the aperture, the phototube, located behind the aperture, conducts a current proportional at every instant to the amount of light in that part of the image exposed by the slit at that particular instant. A large current flows during the time the slit uncovers the bright image of the steel strip, and a very small current flows for the remainder of the scan. The waveform of the signal generated in this fashion is shown. This process continues repeatedly so that a 30-cps rectangular-wave signal is generated in each scanning unit.

In Fig. 4, tube V_1 is the gas phototube which generates the signal voltage when the image of the strip is scanned, while V_2 and the first half of V_3 amplify the signal. The second half of V_3 acts as a cathode follower type impedance-matching device to transmit the signal over the cable with low losses. The two preamplifier chassis are identical in construction and operation.

The signal from the preamplifier is amplified again in the first half of V_4. The signal from R_1 is used to drive the multivibrator and the automatic gain control circuits.

The second half of V_4 amplifies the agc signal. This signal from the second half of V_4 is applied to a peak rectifier to produce a negative d-c voltage proportional to the peak of the signal pulses. The output of the rectifier circuit is filtered by the network comprising C_1, R_2 and C_2. The resultant d-c voltage is returned to the preamplifier circuit in the detector and applied to the grid of V_2 to provide agc which acts to maintain a relatively constant signal amplitude to the multivibrator circuit regardless of the temperature of the steel strip.

Normally for a steel temperature change from 2,050F to 1,350F the signal generated in phototube V_1 would change 200 to 1 in amplitude. The agc circuit reduces this 200-to-1 range to a 3-to-1 range. The transconductance of V_2 is reduced 20 to 1 to provide most of the gain control required. The remainder of the gain control is accomplished by reducing the sensitivity of the phototube 3.5 to 1 by reducing the d-c voltage applied to it.

The cathode electrode of the phototube is returned to the screen grid of V_2. When the agc voltage becomes more negative, the screen voltage rises, thus reducing the net d-c voltage on the phototube and hence its sensitivity.

A bistable multivibrator V_5 furnishes a rectangular signal which can vary in width but not in amplitude. One stable condition of the multivibrator exists when the first half of V_5 is not conducting current, while the second half of the tube is conducting current. The other stable condition exists when the conducting current is reversed from the second half to the first half of the tube. As the signal pulses arrive at the grid of the first half of V_5, the positive pulses switch this half to a conducting state while switching the second half to a nonconducting state. As the alternate positive and negative pulses are applied to the multivibrator circuit, the output of the multivibrator becomes a rectangular constant-amplitude signal that varies in width depending upon the spacing between the positive and negative pulses.

Special precautions were taken to insure that the square-wave rectangular pulses from the multivibrator circuit are constant in amplitude irrespective of pulse width or changes in characteristics of V_5. The peak positive voltage of the rectangular pulse occurs when the second half of V_5 is not conducting current. The peak positive voltage is therefore fixed by the resistor divider circuit in the plate circuit.

The peak negative voltage of the rectangular pulse occurs when the second half of V_5 is conducting current. However, the lowest peak voltage that can occur at this plate is determined by the low-impedance resistor divider network made up of R_3, R_4 and R_5 and rectifier CR_1. The voltage determined by this network is always greater than the voltage that would normally be determined by the saturation current of the tube. The peak-to-peak amplitude of the rectangular pulse is therefore determined essentially by two resistor divider networks and not by V_5.

As the plate potential fluctuates between the two fixed d-c levels as described above, the average voltage at the plate becomes a d-c voltage proportional to the pulse width and hence to the width deviation. By means of the voltage divider circuit consisting of R_{12}, R_{13} and R_{14} these two average d-c signals from the multivibrators are added and applied to the indicator circuit. Components R_6, R_7, C_3, C_4, R_8, C_5 and C_6 comprise a 30-cps band-rejection bridged-T filter circuit for reducing the amplitude of the a-c components of the signals so that the voltage applied to V_6 is essentially a d-c voltage proportional to width.

Tube V_6 is a power amplifier of the cathode follower type and is used to drive the deviation indicators and the recorder.

The zero-set rheostat, fixed resistor R_9 and V_7 comprise a voltage divider network used to balance out the fixed potentials in the indicator circuit which are not related to pulse width. The deviation indicators and the recorder are connected between a point on this voltage divider and the cathode output terminal of V_6.

Rheostat R_{10} is the sensitivity control for the deviation indicators and R_{11} is the sensitivity control for the recorder. These controls are adjusted at the factory for correct indications of width deviation and require no further adjustment.

The arrangement used in the bridge circuit offers a high degree of stability. It is relatively insensitive to changes in the d-c power supply voltage and to changes in the transconductance of V_6.

Detector Unit

The detector unit incorporates the optical and mechanical devices and the electrical circuits used in

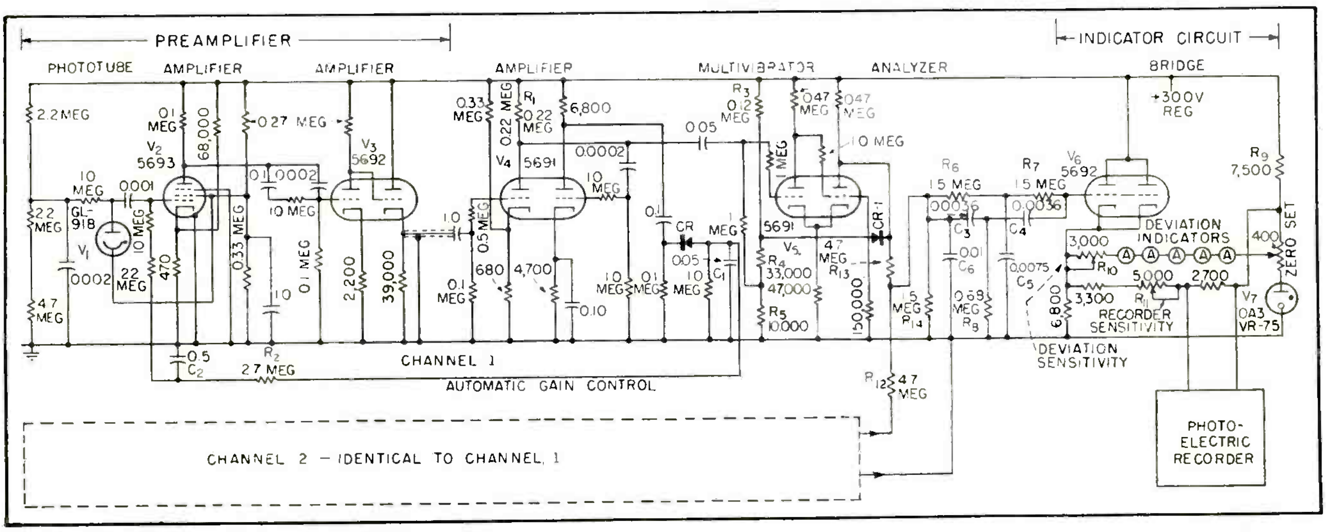
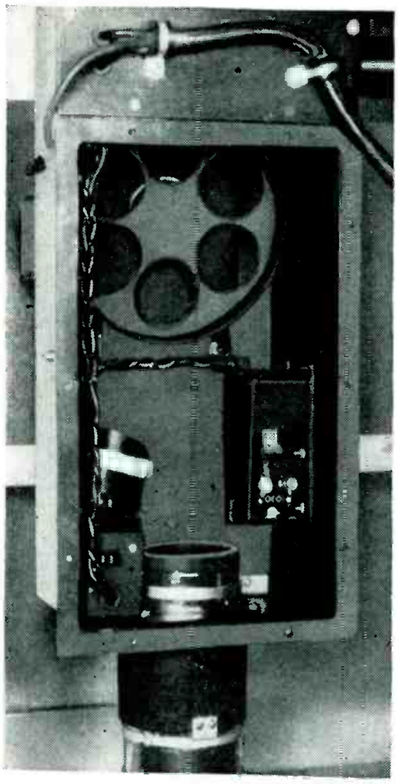
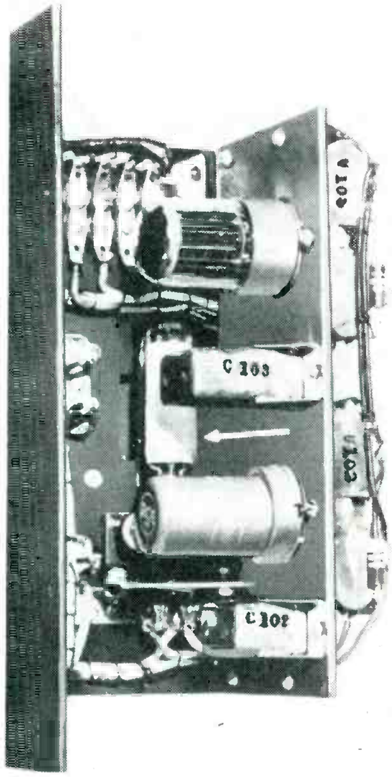


FIG. 4—Circuit arrangement for combining outputs of the two phototubes to actuate width deviation indicators and a standard photoelectric recorder



Scanning unit for width gage. Phototube is in housing at top, with scanning disk visible through opening below. Image-forming lens is at bottom



Phototube chassis, as seen when removed from operating position above scanning disk. Arrow points to phototube, mounted above slot in chassis

positioning the scanning units and in generating the width and the width deviation signals.

The optical devices for each scanning unit consist of one f/3.5 lens for imaging the strip edge onto the scanning disk, one f/2 lens for imaging a simulated steel edge onto the scanning disk during calibration, an aperture and a rotating slotted disk for systematically controlling the light received by the phototube, and a solenoid-operated shutter for preventing the light radiated from the strip edge from falling on the phototube during calibration.

Since the desired width of strip to be rolled may vary over wide ranges each day, it is necessary that the two scanning units which are positioned over each edge be easily moved from one desired spacing to another. A right-hand screw and a left-hand screw coupled together and driven by a motor are used for this positioning. An Oilite nut which couples the individual scanning units to their respective screws moves the scanning units smoothly to the desired setting when the rolling mill operator actuates the drive motor switch located on the operator's control cabinet.

The mechanical design of the scanning units provides accurate alignment of the optical parts with respect to one another. Serious width measurement errors can result if exact alignment is not maintained.

The detector is mounted 180 inches above the steel strip level. If the maximum tolerable error due to the optical system alone in one scanning unit is to be held to 1/64 inch, the resulting angular tolerance on alignment is the angle whose tangent is $1 \div (64 \times 180)$, or 1 part in 11,500. In order to meet this tolerance, each scanning unit is rigidly mounted on a bearing which slides along a stainless steel beam in each half of the detector head housing. The two support bearings are 10 inches long, thus assuring intimate alignment with the beam.

Electronic Control Cabinet

The electronic control cabinet contains all the circuits which are not required to be located near the gaging area, including the regulated d-c power supply, power transformers, circuit breakers and motor relay switches. The cabinet is especially designed to be dust and moisture tight and to provide easy access to the components. All input cables are brought to the terminal strip in the rear of the cabinet. The electronic circuits are mounted on a hinged panel which may be swung outward to give ready access to all the components from one position.

Indicators

The edges of the strip to be measured are scanned 30 times per second by the scanning slits, each of which include light from a region 3 inches long in the direction of the length of the steel strip. The spacing between the successive scanned portions of the strip to be measured therefore depends directly on strip speed. For example, if the strip is moving at 10 feet per second, the successively sampled portions would be spaced 10/30ths of a foot or 4 inches apart. Since the length of each portion is 3 inches, such a strip speed would yield practically continuous coverage of the steel strip.

The response time of the deviation indicator is about 0.8 second, so that its indication at any time represents a width deviation averaged over 24 successive scanning operations. In the example chosen above, for a strip speed of 10 feet per second, the width deviation indication will be averaged over a length of 8 feet.

If it is desired to measure changes in width occurring over shorter intervals of length than that obtained with the deviation indicator, then a deviation recorder may be used. The recorder specified for this use has a very short time constant, in the order of 0.2 second. For a strip speed of 10 feet per second, the recorder will faithfully indicate width changes occurring over a 2-foot length. However, since the above time constant refers to the time for the pointer to reach virtually its final value, some indication of changes in width will be shown for even shorter distances along the strip being measured as it flies back and forth on the bed of the mill.

Butterfly Curve Tracer For Magnetic Materials

Curves of a-c permeability versus d-c magnetizing force are displayed on a cathode-ray tube. The instrument meets needs for rapid and accurate means of determining properties of magnetic materials in expanding use of saturable reactors

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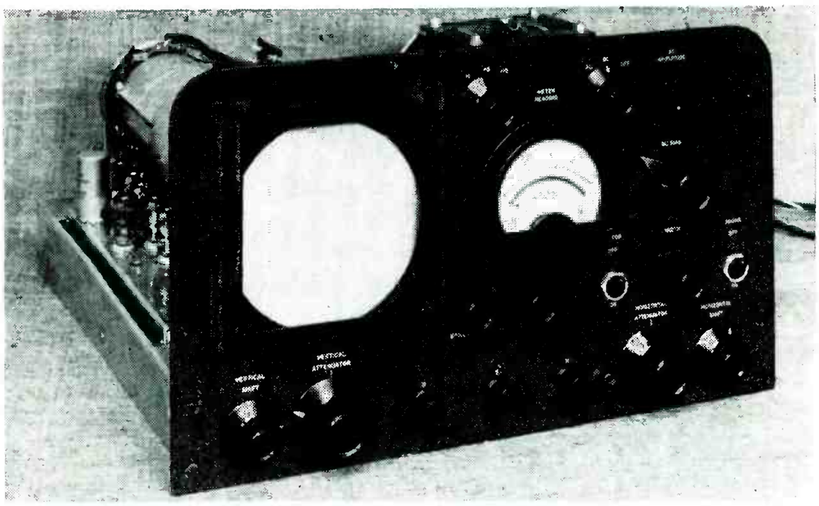


Controls for magnetizing circuit of butterfly tracer are on right of front panel, scope controls on left

THE EFFECT of d-c magnetization on a magnetic core material is best expressed by the butterfly curve of which a typical example, due to Elmen[1], is shown in Fig. 1. The double-humped nature of the curve, which gives it its name, is due to the magnetization remaining when the magnetizing force is reduced to zero.

Elmen's curve was obtained with small alternating flux density, at a frequency of 200 cps. To specify completely the properties of a magnetic material, data at higher values of flux density and at several frequencies are required.

Basic Design

Figure 2 is a block diagram of the instrument. The specimen carries a primary and a secondary winding. A source of variable frequency f_1 and variable amplitude a-c is connected to the primary circuit in series with a source of very low frequency a-c f_2 and a series resistance R. A d-c amplifier of small bandwidth, connected across R, yields an output proportional to the instantaneous amplitude of the bias current at the low frequency f_2 only. This output is applied to the horizontal deflection plates of a cathode-ray tube.

The emf developed across the secondary winding provides input to an electronic integrator, whose output is proportional and in phase with the alternating flux density in the sample. The bandwidth of the integrator is small enough to attenuate completely components of flux density varying at frequency f_2. For magnetizing a-c of constant amplitude, the output of the integrator is proportional to flux density and therefore the a-c permeability of the magnetic sample. The output of the integrator amplifier is applied to the vertical deflection plates of the crt.

The pattern obtained on the crt has the form shown in Fig. 3. The envelope of this pattern, the required butterfly curve, gives the relation between a-c permeability and d-c magnetizing force, for the condition of constant magnetizing a-c.

By turning a single switch, the

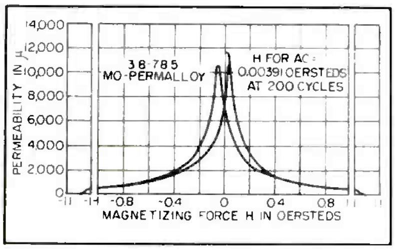


FIG. 1—Butterfly curves of one magnetic sample show typical peaks due to residual magnetism

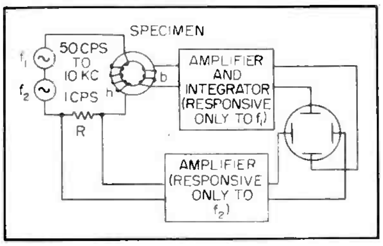
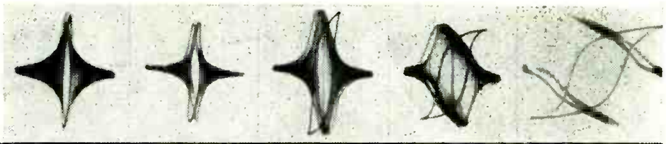


FIG. 2—Basic circuit of tracer requires low and high frequency a-c source, plus d-c bias

butterfly curve tracer may be converted into a conventional hysteresis loop tracer. The hysteresis loop in Fig. 3 was so obtained.

Figure 4 shows butterfly curves and superposed hysteresis loops obtained for a 79-Permalloy sample, at 200 cps and at five currents corresponding to peak magnetizing forces in the range from 0.09 to 1.35 oersteds. Figure 4 also gives information on a-c permeability and the rate of change of a-c permeability with d-c magnetizing force. For the test conditions under which the curve in Fig. 3 was obtained, this last quantity was approximately 27,000 gausses per oersted squared for $H_{d.c} = 0$ to 0.3. This agrees well with the 27,500 figure obtained by Elmen for a similar sample by an a-c bridge method.



$\frac{d(\mu_{A-C})}{d(H_{D-C})}$	100,000 *	112,000 *	27,000 *	6,800 †	1,700 †
μ_{MAX}	20,000	22,500	15,750	8,100	5,800
D-C SWEEP ± OERST	0.94	1.38	1.38	1.38	1.38
H_{A-C} OERST	0.9	0.16	0.4	0.93	1.35

* BETWEEN $H_{D-C} = 0$ & $H_{D-C} = 0.1$ † BETWEEN $H_{D-C} = 0$ & $H_{D-C} = 0.3$

FIG. 4—Curves photographed from crt at various values of currents giving peak magnetizing force

Circuit Details

Current at the higher frequency f_1 is supplied to the primary of the magnetic sample from a transformer, a 200-μf capacitor, a low-pass filter, and a 50-ohm resistance (Fig. 5). Bias current is obtained by half-wave rectification of the 50-cps line supply, the ripple removed by a filter of which the 200-μf capacitor is an element. The d-c is varied from positive to negative values at a very low frequency (about 0.2 cps) by driving the potentiometer P_1 back and forth with an automatically reversing motor.

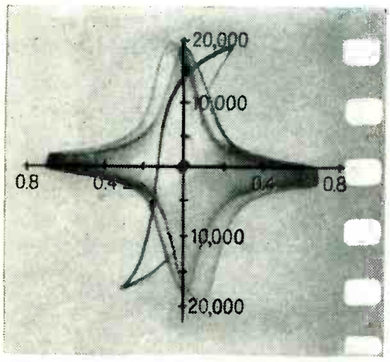


FIG. 3—Trace obtained on crt has butterfly curve as envelope. Also shows superposed hysteresis loop

This portion of the circuit is shown separately in Fig. 6. The potentiometer is connected across two rectifiers, W_1 and W_2, arranged back-to-back. When the potentiometer slider is in position *A*, W_1 is short-circuited and W_2 gives almost complete half-wave rectification. With the slider in mid-position *B*, the resistances across the rectifiers are equal and no d-c flows.

Adjusting potentiometer P_2 varies the effect of the sweep potentiometer P_1 on the rectifiers. Maximum variation is obtained with P_2 set at zero, minimum variation with P_2 at maximum.

Varying P_3 (Fig. 5) gives fine control of the amplitude of magnetizing a-c. This variation has almost no effect on the direct or low-frequency bias current, since the d-c resistance of the choke L_2 is much lower than the minimum resistance of P_3. Various capacitors or a short circuit can be connected across the filter circuit. In another switch position, the choke L_2 is is shunted by a capacitor to form a parallel circuit resonant at 50 cps. This further attenuates hum from the variable d-c supply when the magnetizing current is at any frequency other than 50 cps.

The voltage across the 50-ohm resistance (Fig. 5) provides input to the horizontal deflection amplifier. If the test frequency need not be variable, a common tapped transformer may be substituted for the two separate transformers shown.

Amplifiers

As explained before, the horizontal deflection amplifier (Fig. 7) must be made responsive only to the very low frequency f_2, as in order to trace butterfly curves. The amplifier is direct coupled, consisting of two voltage amplifier stages and a push-pull phase inverter output stage. Miniature pentodes, Brimar (England) type 8D3, similar to the 6AK5, are used throughout.

An RC filter is connected between the two voltage amplifiers. When the switch S_1 is closed, the filter reduces the 50-cps gain of the amplifier to almost zero, while the gain for d-c or the low frequency bias current is not affected. With S_1 open, the bandwidth of the amplifier extends well beyond the test

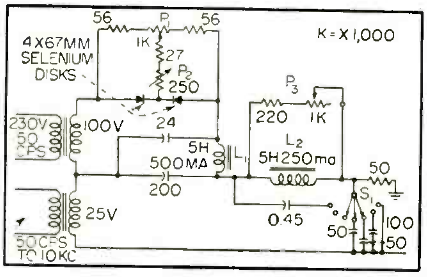


FIG. 5—Motor-driven potentiometer P_1 provides low-frequency a-c. Sweep width is controlled by P_2

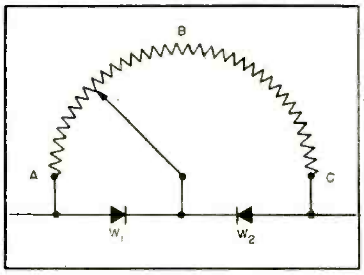


FIG. 6—Back-to-back rectifiers and motor-driven arm vary voltage at low frequency from plus to minus

frequency f_2 so that normal hysteresis loops are traced whose shape depends on the setting of the sweep potentiometer P_1 in the magnetizing circuit.

The vertical deflection amplifier (Fig. 8) incorporates an electronic integrator. It is designed to have negligible response at the low frequency f_2, which represents bias current variations. It is also designed to have substantially 90-degree phase shift (6 db per octave drop) over the range 50 cps to 10 kc. Direct couplings reduce low-frequency phase shifts other than those due to the integrator.

The circuit, of 8D3's or 6AK5's, comprises a cathode follower, voltage amplifier V_2 subjected to negative feedback by the 150,000-ohm resistor, a Miller integrator and cathode follower, and a push-pull output stage similar to that in the horizontal amplifier.

Regeneration, effective at frequencies above 50 cps only, is obtained by a 1-meg resistance connected between the grid of V_2 and a 0.01-μf blocking capacitor. This regeneration has been shown to improve the accuracy of integration[5]. The 180K resistance between plate of V_4 and screen of V_2, bypassed by 2 μf, gives degeneration at very low frequencies, so that amplifier drift over long periods is reduced.

Power Supplies

Regulated positive and negative supplies are provided from a separate unit of conventional design. The high voltage supply for the crt, however, comprises a special r-f oscillator (Fig. 9) powered from the 50-cps supply line and employing self-rectification, so that no d-c supply is required. The oscillator tube, a 6V6, acts as its own half-wave power rectifier. Negative voltage may be continuously varied from -2.5 kv to -4 kv by adjustment of the oscillator grid-leak resistance.

Credit

This apparatus was developed at Standard Telecommunication Laboratories Ltd., London, England. Thanks are due to J. K. Webb and T. R. Scott for much helpful advice.

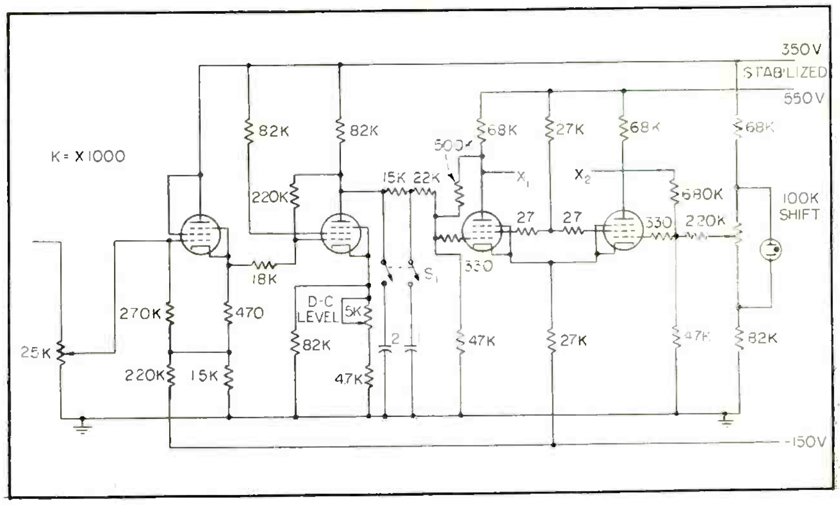


FIG. 7—Horizontal deflection amplifier responds only to low-frequency f_2, is direct-coupled. Miniature pentodes are used (Brimar 8D3 or 6AK5)

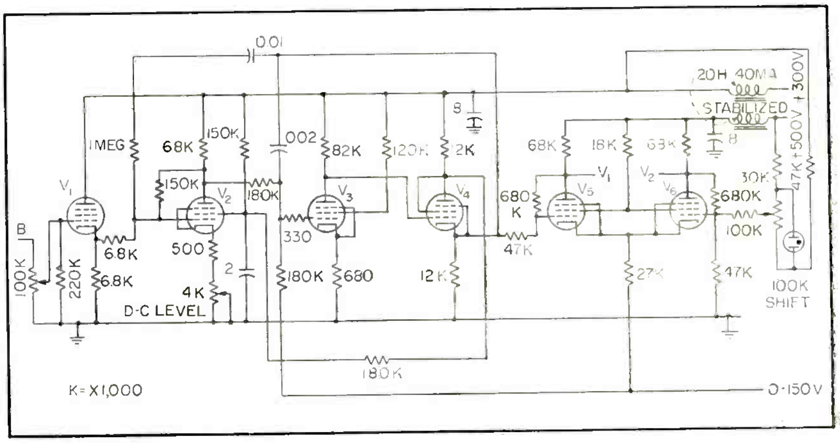


FIG. 8—Vertical deflection amplifier includes an electronic integrator, responds to variable frequency f_1. Uses same tubes as horizontal amplifier

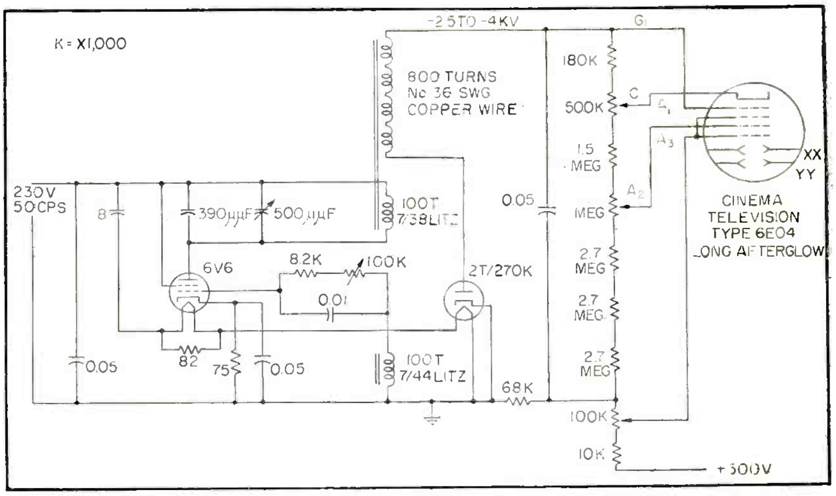


FIG. 9—Cathode ray tube circuit includes special r-f oscillator (6V6) which supplies continuously variable —2.5 to —4.0 kv high voltage

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Constant-Current Audio Power Amplifiers

Design procedure and complete circuit of new audio amplifier in which constant-current operation permits use of a form of automatic bias control to counteract effects of tube aging or tube replacment, giving reliability along with high fidelity

THE TRIODE class-A push-pull amplifier is still one of the fundamental types of low-frequency power amplifiers, despite the fact that many other types of power amplifiers are available to the designer.

Getting the most from this amplifier involves more than the simple consideration of power output per dollar of tube cost. In addition to power capability and efficiency, distortion, noise, reliability and maintenance problems should all be taken into account, since all these are vital aspects of the performance of the completed amplifier. This paper discusses two types of class-A triode power amplifiers and analyzes their performance with regard to all these factors.

Optimum and Constant-Current Amplifiers

There are two fundamental types of class-A triode push-pull operation, one employing high peak currents and low load impedances for optimum operation, and the other employing lower peak currents and much higher load impedances. This distinction does not seem to have been made previously; for lack of better terminology, the two modes of operation are here called optimum operation and constant-current operation.

In optimum operation the plate-to-plate load obeys the familiar relationship $R_L = 4\,r_p$. Optimum operation will provide the greatest output that can be obtained with given tubes and supply voltages, provided the operating conditions do not change with signal. In practice, there is usually a sharp increase in d-c plate current at maximum signal, so that extremely good power-supply regulation is required to maintain operating voltages truly constant. Since power-supply regulation is not usually this good, the conditions for optimum operation are seldom fully realized.

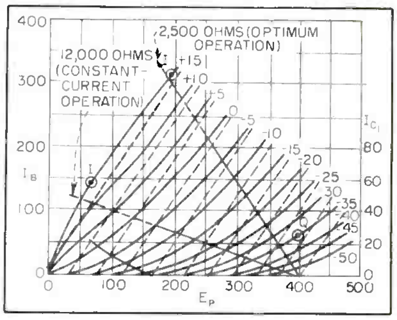

FIG. 1—Typical characteristics of triode-connected 807's, with load lines for both types of operation shown for comparison

On the other hand, constant-current operation is characterized by little or no change in d-c plate current as the signal goes from zero to maximum. This condition may be obtained by proper proportioning of load resistance and supply voltage. With constant-current operation the variation in power-supply loading will be negligible, and the operating point will remain substantially constant no matter how poor the regulation of the supply may be.

Figure 1 shows the plate characteristics for triode-connected 807's, to illustrate these points. Load lines are shown for both optimum (2,500 ohms) and constant-current (12,000 ohms) conditions. The solid line indicates class-A_1 operation, with signal swing up to the grid-current point in each case. Class-A_2 operation is indicated by the continuation of the load lines up to the +15-volt grid line. This additional swing represents an increase of 3 db—a factor of two in power.

For optimum operation the peak current is some five times the quiescent current and the d-c plate current at maximum signal will be almost twice that for no signal. (The quiescent point is designated by Q and the peak plate current points by I for class A_2 in Fig. 1.) For constant-current operation the peak current is much less, and the total change in d-c plate current can be held to well under 10 percent.

Comparison of Output

The power output and plate efficiencies for the operating conditions of Fig. 1 are shown in Table I. There is a loss in power of about 40 percent when going from optimum to constant-current operation. The figures for optimum operation can only be fully realized in a system incorporating fixed bias and an electronically-regulated plate supply.

The conventional choke-input power supply may have an effective internal resistance of several hundred ohms. With the increase of plate current with signal which

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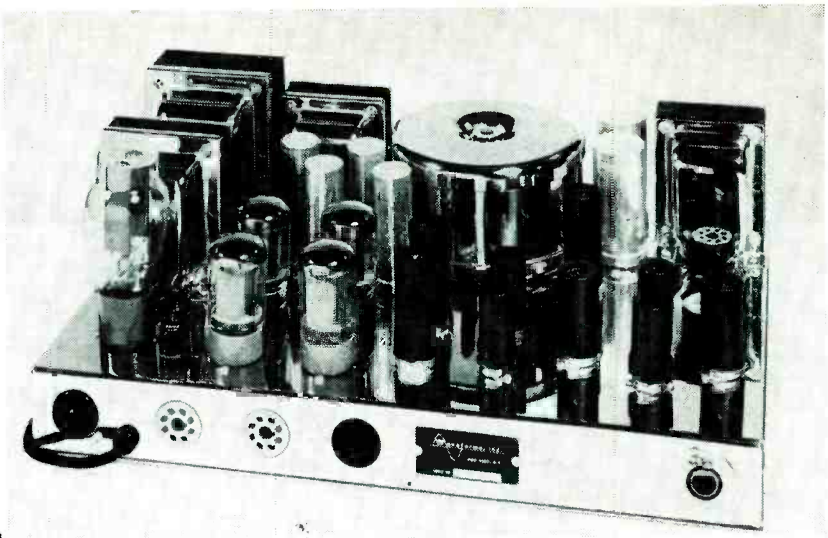

Example of audio amplifier using constant-current operation of output stage

is typical of optimum operation, the resulting drop in supply voltage would cut these output power figures by 20 percent hence the difference between optimum and constant-current efficiencies is only about 25 percent in practice.

For class-A_2 operation the efficiency figures for the two modes of operation are not only relatively high (about 63 percent), but remarkably similar.

The principal disadvantages of constant-current operation, as opposed to optimum, are the lower output available from given tubes and, for class-A_1 operation, the lower efficiency. One of the principal advantages is the fact that power-supply regulation becomes much less of a problem, since the change in plate current from no-signal to full-signal conditions can be well under 10 percent. A higher-impedance, less-expensive power supply can thus be used.

Table I—Comparative Output and Efficiency Values

Conditions and Load Resistance		Power Output in Watts	Percent Efficiency
Optimum—2,500 ohms, push-pull	A_1	14.5	39
	A_2	30	65
Constant-current—12,000 ohms push-pull	A_1	8.5	30
	A_2	18	62

Since the d-c plate current changes so little, it is possible to introduce d-c degeneration into the system to minimize variations in tube operating conditions. Cathode bias is unfeasible for true optimum operation; tube-handbook operating conditions for cathode bias usually show higher plate-to-plate load impedances so as to limit the peak plate current and hence the change in d-c plate current with signal. These figures usually do not go as far as constant-current operation.

If cathode bias is to be used, it is most effective if individual cathode resistors are used for each tube. If this is not done, the operating conditions of one tube are affected by the operating conditions of the other.

Automatic Balancing

With individually bypassed cathode resistors, bias of each tube is a function of its plate current alone, and is not affected by the other output tubes. By making the amount of this d-c inverse feedback great enough, the effect of a change in perveance or transconductance is significantly reduced. The larger the proportion of the total plate-circuit resistance in the cathode, the more degeneration, and hence the smaller the changes in operating conditions with change in tube characteristics.

The result of this is to make the provision of special plate-current balancing arrangements and periodic checks of plate current quite unnecessary. As an example, in the amplifier described here, using 1,000-ohm cathode resistors for each power tube, a departure from normal current is reduced by about 80 percent. In a tube where plate current would otherwise be high or low by 20 ma, this form of automatic bias control will reduce the error to 4 ma, or a total unbalance of about 4 percent. For tubes more nearly normal this error will be reduced still further.

Efficiency and Reliability

Class-A operation is the least efficient of all power-amplifier types, and constant-current operation is somewhat less efficient than optimum operation. However, plate-circuit efficiency is, for almost all applications, one of the least important factors in determining an amplifier's utility.

In a typical audio amplifier, the output power represents from one-fifth to one-half of the power drawn from the line. The rest of the input power goes to heat filaments and supply power to the driver and preamplifier stages which are part of any audio amplifier system. Unless line power is very expensive, it can make little difference whether a 50-watt amplifier requires 175 watts or 135 watts of line power. Furthermore, where line power is expensive, amplifier reliability is also usually at a premium, and the greater reliability of constant-current class-A operation, due to the lower plate-current demand, may

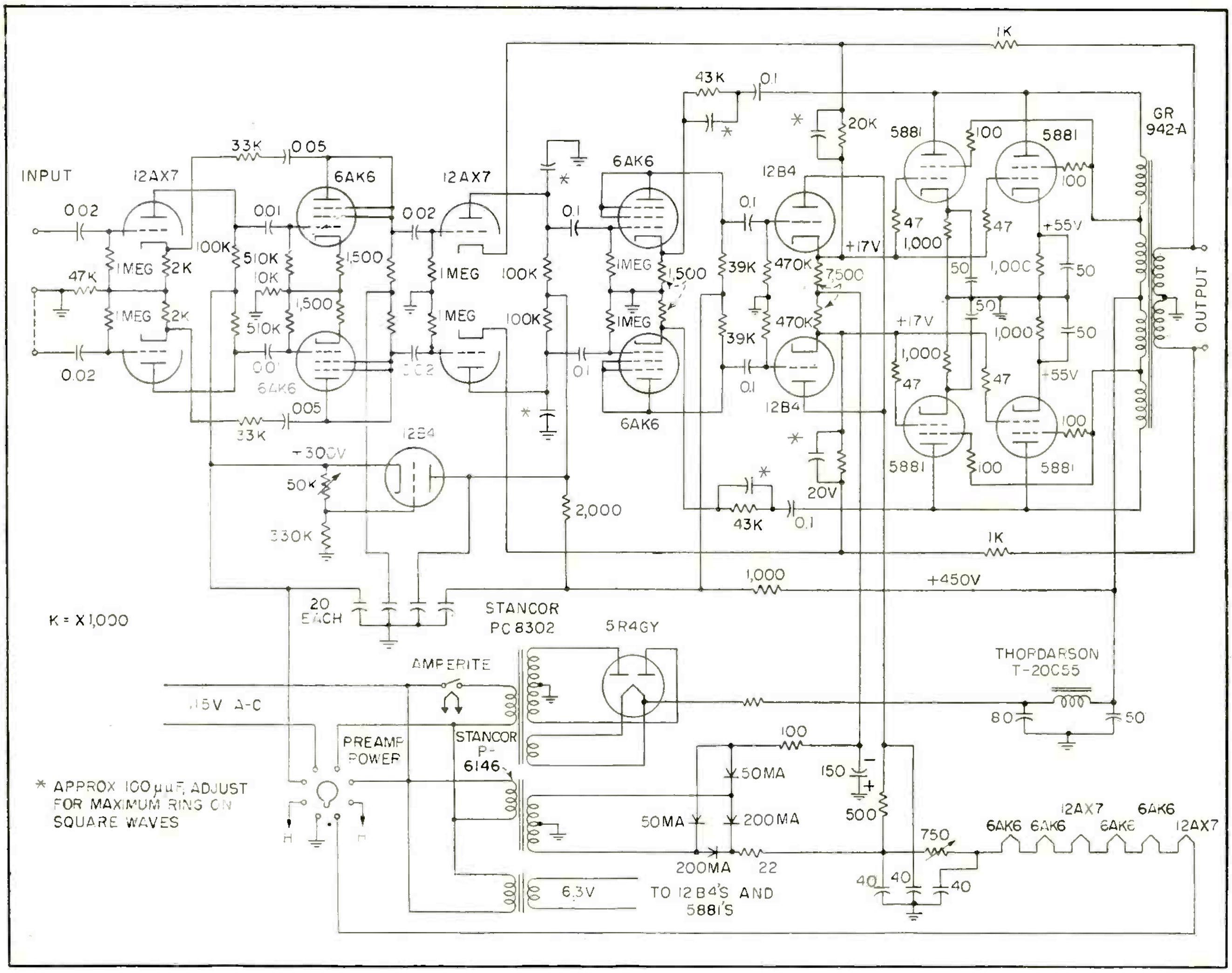

FIG. 2—Complete circuit of amplifier and its power supply. For unbalanced input either grid may be grounded, as indicated for one grid by dashed line. Amperite time-delay relay keeps high voltage off input capacitor of filter until tubes are drawing current

more than outweigh the greater efficiency of a class-B output stage.

Most engineers will agree that in the present state of the art all good amplifiers sound alike. In fact, amplifier design has progressed to the point where presence, the much-desired feeling of realism in the performance of a music reproduction system, is mostly a function of the transducers employed. The contribution of the amplifier to the overall distortion of the system can be made essentially negligible.

In effect, absence—the lack of audible indication of the presence of the amplifier—may well be taken as the definition of a good amplifier. The amplifier contribution to system noise and distortion should be so much less than that of any other component that it can be ignored. Once this point has been reached, further improvement will not result in more pleasing sound, however impressive it may be as an engineering achievement.

Another aspect of absence is reliability. Performance of the sort we require should be achievable with a minimum of maintenance—a criterion which is desirable for laboratory work but mandatory for field use. Absence, then, should imply not only the elimination of artificiality or audible distortion in the reproduced program, but absence of maintenance worries as well.

Specific Amplifier Design

The amplifier circuit presented here was designed with the foregoing criteria firmly in mind. Performance is fully abreast of the present state of the art, but no compromise has been made with long-term reliability. In addition, sufficient flexibility has been built in to accommodate most types of program sources and it will perform well under a reasonable variety of load impedances.

Figure 2 shows the basic circuit of the amplifier. Push-pull parallel 5881's are used, with the screens connected for ultra-linear operation. The General Radio type 942-A toroidal output transformer provides a suitable winding configuration for the required impedance relationships. Operation is substantially constant-current, with individual 1,000-ohm resistors in each cathode for d-c degeneration.

Since the output stage is to operate well into the grid-current region, the source of driving voltage must offer a very low resistance. In addition, the usual grid-current problems must be considered.

Grid-Current Considerations

There are three principal types of grid current which must be considered in a power amplifier. The first is conduction current, which occurs when the grid is driven positive with respect to the cathode. The second is emission current, either directly from the grid because of high grid temperature, or as secondary emission due to bombardment by electrons from the cathode (and promoted by the deposit of cathode material on the grid as the tube ages). The third is gas current, resulting from positive ions in the tube.

Gas current and emission current may result from improper operation, tube defects or tube aging. These currents are of such a nature as to develop a positive voltage across any resistance appearing in the grid circuit. Such a voltage will reduce the effective bias on the tube, causing higher plate current which in turn causes higher grid current. The vicious circle thus established will generally bring the career of the tube to an abrupt and untimely end. The obvious cure, or at least palliative, for this trouble is to keep the d-c resistance in the grid circuit at an absolute minimum.

Cathode followers as drivers, direct-coupled to the output-tube grids, fill this requirement, and at the same time provide a low-impedance source of the current required to drive the output grids positive without peak clipping. The d-c resistance in the grid circuit is very low, being essentially the reciprocal of the cathode-follower transconductance. Further, there is no series coupling capacitor to charge up during peaks and then block the output stage while it discharges through a large grid-return resistor.

Design of the cathode followers is conventional, except in the choice of high-perveance tubes and low operating voltages. These drivers are called upon to deliver a peak current of the order of 40 ma. (As an example, in Fig. 1 the grid-current characteristics for constant-current operation of 807's are shown. The peak grid current of 20 ma at +15 volts represents an equivalent shunt resistance of about 750 ohms.) When the output-tube grid goes positive, the path of driver plate-current flow is from the +150-volt line through the cathode follower, and thence through the grid-cathode path of the power tube to ground. The high peak value of this current flow calls for fairly good regulation of the +150-volt line.

The cathode impedance of the drivers must be low, particularly when the 5881's draw grid current. The 12B4's used in this amplifier may be operated at reasonable quiescent current in such a way that the transconductance rises sharply at the point where it is needed.

The peak current capability of the 12B4 is about 100 ma, more than twice the 40 ma required. The driver impedance is lowered still further and distortion in the voltage amplifiers minimized by feedback taken to the 12AX7 cathodes.

Voltage Amplifiers

The remainder of the amplifier is more conventional. The last voltage amplifier stage, uses 6AK6's, triode-connected. These tubes, which have recently been added to the Armed Services Preferred List, are excellent for many audio applications. Hum, noise and microphonics are low, and they are linear both as triodes and as pentodes. In this application they are used as low-mu triodes; they are more linear than any of the miniature dual triodes, and draw only half the heater current (150 ma per tube) of the others.

The input stage for the basic amplifier is a 12AX7. Balanced feedback is taken from the voice coil through the cathode-bias resistors to the cathodes, and feedback is also brought from the driver cathodes. Additional feedback is brought from the plates of the output tubes to reduce the amplifier impedance seen by the transformer, and further to reduce the low-frequency distortion. While some phasing is used in these feedback paths, use of feedback over a balanced system eliminates the problems of differential phase shifts encountered when the phase inverter is included in the feedback loop.

About 30 db of feedback is used over the power amplifier, in addition to some 10 db from the drivers. This provides a damping factor of over 100. The amplifier is stable with feedback for any load impedance, resistive, reactive or open-circuit.

An amplifier which is stable with considerable feedback when connected to a resistive load may oscillate uncontrollably when the load is open-circuited, since under open-circuit conditions the transformer stray reactances may play a rather surprising role. Similarly, the phase shifts which occur when the amplifier is connected to an inductive load, like a loudspeaker, may be such as to produce oscillation. It is therefore a wise precaution to check a completed amplifier by operating it into an open circuit.

The input voltage required to drive the basic amplifier to 50 watts will be of the order of 30 volts grid-to-grid. This is easily supplied by a phase inverter using cascaded long-tailed pairs, with feedback from the output plates to the input cathodes. The net gain of this arrangement is such as to give a sensitivity of about one volt at the amplifier input, although this can be adjusted by changing the feedback in the phase inverter. Either grid may be grounded if the input signal is unbalanced, or both may be used if balanced operation is required. An octal socket is provided in the input circuit so that this may be done without the necessity of wiring changes in the amplifier. Alternatively, a plug-in preamplifier, an input transformer or some other network may be plugged into this socket.

This type of phase inverter represents a definite improvement in reliability over the direct-coupled cathodyne arrangement in general use today. In the direct-coupled configuration the operating points are interdependent, and with tube aging the phase inverter grid may be carried positive, resulting in serious distortion. With the balanced system shown here, wide variations in individual tube characteristics will actually have very little effect.

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Note: Acknowledgement is made to Ray Prohaska for his definition of audio amplifier presence.

Improved-design recording tube gives long storage time despite repeated playbacks. Electron lens between anode and first screen avoids performance limitations of earlier-model tube

Single-Gun Storage Tube

Improved recording tubes retain charge up to one week; 27,000 read-outs cause only slight blemish on pattern. Applications may include study of fast transients, improved ppi radar display, frequency conversion, computer storage and trans-Atlantic tv via high-fidelity telephone circuits

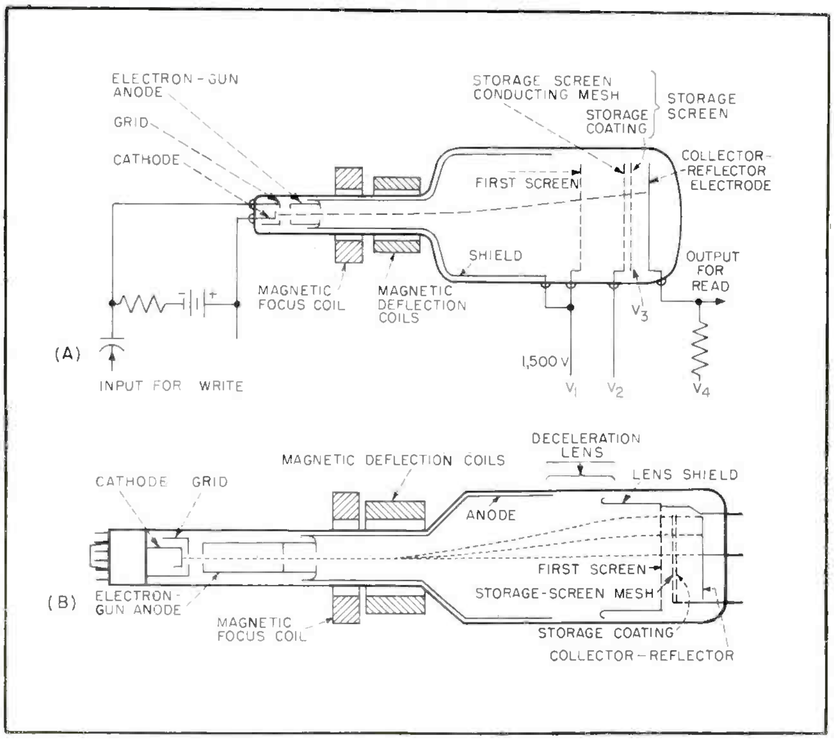
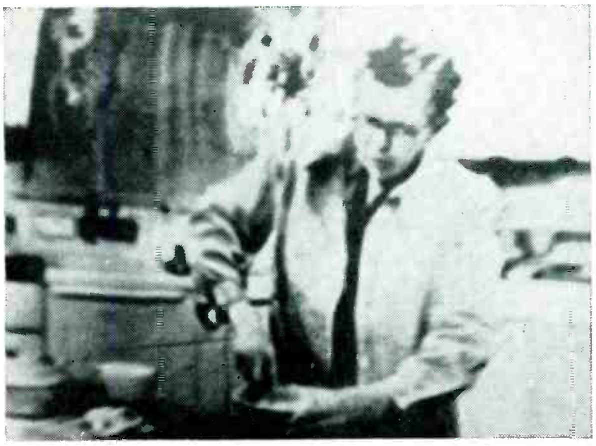
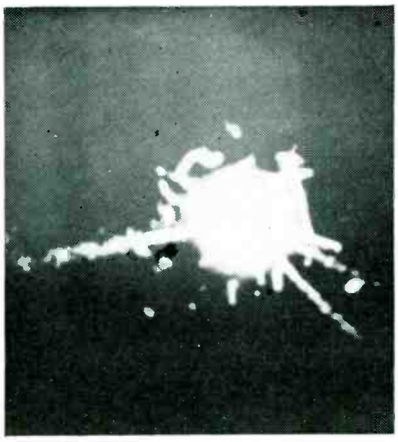


FIG. 1—Limitations placed upon earlier-model tube (A) are avoided by electron lens used in improved model

WHERE INFORMATION must be recorded at the rate of one microsecond per bit or faster, mechanical storage methods become impractical and are replaced by electronic devices. The advantage of electron-beam storage devices comes from the rapidity with which a cathode-ray beam can be deflected across a storage target. This storage target is an insulating surface on which a charge may be deposited without affecting adjacent or nearby surfaces. To store coherent information on this surface, either the electron beam is modulated or the characteristics of the storage target varied so that, as the beam is deflected across the target, a meaningful charge pattern will be formed. A storage tube also

This article is based on a paper delivered at the 1952 National Electronics Conference. The conference paper will appear in the *NEC Proceedings*.





Recording tube finds application both in television and radar. Photograph of monitor tube (left) shows read-out of a stored television picture. Radar ppi display (right) was written continuously for ten minutes. Trails show paths of aircraft

Writes, Reads and Erases

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incorporates means for reading-out or retransmitting information contained in the charge pattern.

Examples of such storage tubes are the Graphicon[1], Radechron[2], Haeff Memory Tube[3], and Recording Tube[4]. These differ basically as to the number of voltage levels that can be stored, magnitude of output, rate at which operations can be performed and number of information elements or bits that can be stored.

Storage devices introduce several new degrees of freedom into a communications system. By their use, a retransmitted signal can be made to differ from the original one in time scale; that is, all frequencies in the signal may be increased or decreased from the original by a given ratio. Also, the time sequence of information can be changed by reading out the recording device in a mode different from that used for writing the information in.

The storage tube shown in the photograph has been designed to store information accurately for a period in excess of ten minutes and to provide many playbacks without loss of recorded information. It has also been designed to store as many elements or bits as possible and to provide a continuous dynamic recording range.

To obtain repeated playbacks and dynamic range, reading is effected by an electron beam that does not come in direct contact with the stored charge. The beam becomes amplitude modulated by passing through the fine-mesh screen containing the charge pattern. This permits the tube to maintain half tones and to be read an almost unlimited number of times without disturbing stored signals.

To obtain high resolution it was necessary to use a small well-focused electron beam for writing and reading. A fine-mesh screen having a half dozen or more openings within the area of the electron spot and a high transmission coefficient also was required.

To obtain high writing and erasing speeds current density in the focused electron spot had to be high. Various compromises, such as between spot size and current density, determined the final design of the tube.

Tube Performance

The recording tube is especially useful for storing transients and allowing them to be studied for long periods. Recorded waveforms may range in speed from servomechanism response curves requiring seconds or minutes to complete a cycle to one-mc r-f oscillations.

Writing speed of the tube is sufficient to permit storage of one frame of a television broadcast or tube voltages may be adjusted to permit cumulative writing for many frames. The photograph at the left shows a television picture stored for five frames and read out continuously during photographing. The picture has tonal quality and detail comparable to the received television picture. Some definition is often lost during a multiframe exposure because of motion of the camera or picture elements.

Trans-Atlantic TV

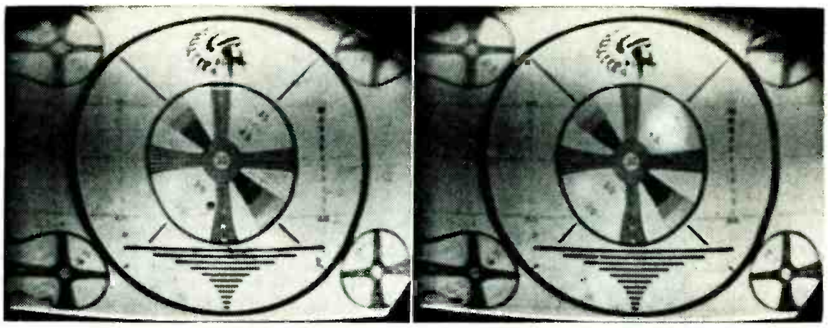
Since reading speed does not influence the tube, pictures may be stored at any rate up to 0.12 microseconds per storage element and read out with either faster or slower sweep. This permits the tube to be used for frequency conversion. For example, a stored signal containing frequencies up to three mc. if read out at 1/200 writing speed, will have a maximum frequency component of 15-kc. The 15-kc signal can then be transmitted over high-fidelity telephone circuits and stored on a second recording tube at the receiver. This signal can be read out at two hundred times writing speed and reconverted to the original three-mc signal.

Frequency conversion by time-scale expansion has been suggested for trans-Atlantic television using high-fidelity telephone circuits. Received pictures will be stills changing at the rate of one every 10 seconds, but presumably this will not be objectionable to audiences if the pictures are played continuously for the 10-second period with a steady accompanying commentary.

Radar Applications

The tube has several applications in connection with radar ppi displays. A ppi display stored for a complete revolution of the antenna will be seen as a picture with uniform brightness, in contrast to the usual display that fades behind the beam trace. If desired, the stored display may be read continuously for a long period of time.

If several complete rotations are stored, moving targets will produce a trace the length of which is proportional to their relative speed. The photograph at the right shows the result of writing a 25-mile-range ppi signal into the storage tube for 10 minutes. The stored signal was read with raster scan and photographed. Paths of aircraft flying in and out of Boston International Airport are clearly indicated.



Monitor output shows effect of continuous reading. Test pattern (left) is shown after 1,800 read-outs. Same pattern (right) shows bright spot near center after 27,000 consecutive read-outs

Retarding Field

An earlier model storage tube is shown in Fig. 1A. This is a magnetically-focused and deflected cathode-ray tube with triode gun designed to give a small focused spot. The electrodes at the front of the tube are the collector-reflector and storage screen. The large potential difference between anode shield and storage screen causes a retarding field. This retarding field is a uniform electric field produced between parallel planes comprising the first screen and storage screen.

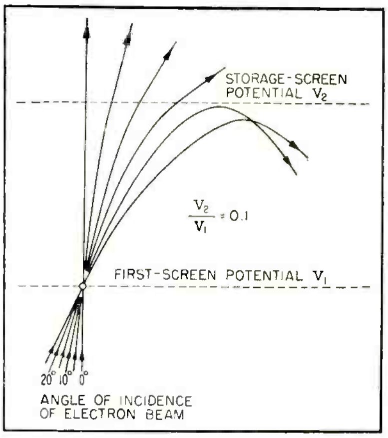


FIG. 2—Refractive effects of deceleration field limit anode voltage and deflection angle in earlier-model tube

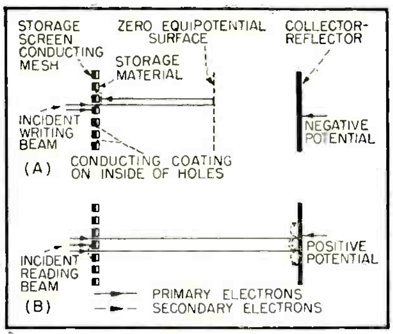


FIG. 3—Electron beam action during writing (A) and reading

The use of a uniform electric field for retarding the beam from anode voltage to storage screen voltage resulted in several design and operational limitations. When, because of scanning deflection, the electron beam enters the retarding field at an angle, the component of beam velocity in the direction of the electric field is less than total beam velocity. This limits maximum useable deflection angle for a given ratio of storage-screen voltage to anode voltage. Figure 2 shows how electron trajectories are affected by the angle of incidence and how the beam is reflected at too high an incidence angle.

Deceleration Lens

Refractive effects produced by the uniform deceleration field are avoided if the deflected electron beam strikes perpendicular to the first screen. This requires an electron lens between the anode and first screen. If the focal point of this lens is located at the center of deflection of the electron beam and the storage screen located in the corresponding principal plane, the electron beam will strike the first screen perpendicularly for all deflection angles. Such an electron lens is used in the present recording tube shown in Fig. 1B. The required electric field for this lens is produced by lowering the first-screen potential to 300 volts. This electron lens removes previous restrictions on anode voltage and deflection angle and permits operation of the electron gun at anode volt-

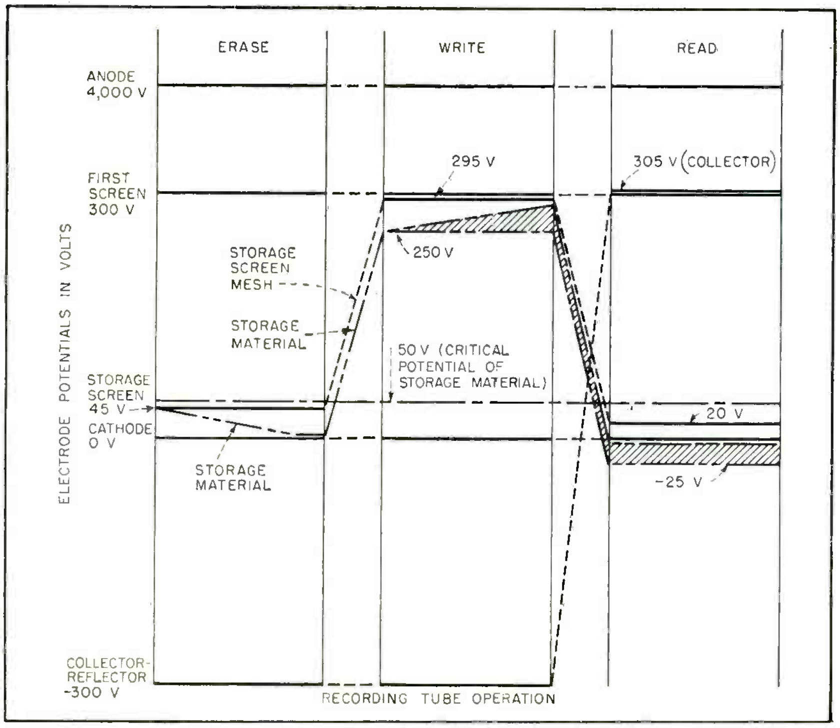


FIG. 4—Recording tube electrode potentials for reading, writing and erasing

ages of three or four kv with improved electron-gun performance.

Writing and Reading

Information is written onto the storage material as shown in Fig. 3A. A signal-modulated electron beam is sent through the storage screen and reflected by negative voltage on the collector-reflector onto the reverse or coated side of the screen. Since, during the writing operation, storage-screen potential is greater than the critical potential of the storage surface, the secondary emission ratio is greater than unity and a positive electric charge is built up dependent upon the current density of the electron beam and its speed of motion across the screen. Since the charge formed is proportional to beam current density, it is possible to vary the quantity of charge from point to point on the scan by modulating this current. The electrode potentials for writing, erasing and reading are diagrammed in Fig. 4.

To read out stored information, storage screen voltage is dropped to such a level as to make uncharged areas of the screen have a negative voltage sufficient to cut off an electron beam aimed at them. The storage screen is then scanned with a constant-current electron beam. The percentage of beam current passing through an area is proportional to the charge in that area. As shown in Fig. 3B, the collector-reflector now has a positive potential to attract electrons passing through the screen. The signal output is developed across the load resistor in series with the collector. When the read and write scans are in register on the storage surface, the beam reaching the collector will be modulated with a signal proportional to that previously written onto the screen.

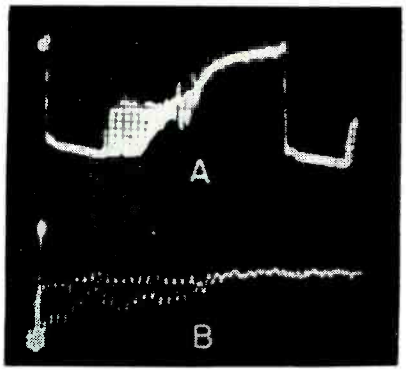


FIG. 5—Recording-tube output measuring resolving power showing vertical trace of storage tube (A) and a four-to-one expansion of part of the trace

The number of elements that can be stored in a storage tube is stated in terms of the tube's resolving power. This can be measured by writing a tv resolving-power chart into the tube and reading the stored image on a monitor. Resolution can then be judged from the monitor picture.

Measuring Resolution

A more accurate method is to write a single-field constant-intensity raster into the tube using a uniform sawtooth horizontal sweep and an exponential vertical sweep. The resultant stored raster will have horizontal lines compressed at one edge and spread apart at the other. If the tube is read out using a single-line vertical sweep and the output signal displayed on a synchronized oscilloscope, resolving power can accurately be determined by measuring the minimum spacing between adjacent lines showing 50 percent modulation. Recording tube resolution measured in this way gives 200 lines across the screen diameter for 50 percent modulation. This is 400 total lines of alternate white and black as measured on a tv resolving-power chart. Figure 5 illustrates this measurement.

Half-Tone Shades

The number of half-tone shades that can be distinguished in the output of a storage tube can be determined by using a one-field write of a television raster with a linearly decreasing beam current as the spot scans from the top to the bottom of the screen. The tube is then read out using a single-line vertical trace and the output signal viewed on a synchronized oscilloscope as was done in the resolution test. Oscillograms of the output traces obtained are shown in Fig. 6.

Writing and Erasing Speed

No accurate method of measuring writing speed has been developed. However, since a single frame of a television picture can be written to 100 percent modulation with 400-line resolution, maximum writing speed is in excess of 0.12 microsecond per storage element or 48 microseconds per line.

Accurate erasing-speed measurements have not been made. Tests indicate that the time for total erasure is in the order of 1.5 microseconds per storage element.

Repeat Readings

The tube will retain a stored picture for a period of up to one week with no noticeable deterioration if the tube is turned off during the waiting period.

Repeated readings at the television rate of 30 frames per second were taken on a stored resolution chart. The photograph at the left was taken 1,800 readings after the chart was stored. The unit was then left reading continuously for 15 minutes (27,000 readings). The photograph at the right shows the only change is the formation of a light spot near the number 45. The loss of signal through reading can only be produced by positive ions that are attracted to the negatively-charged storage surface. The erasing effect of positive ions is proportional to reading-beam current and residual gas pressure in the tube. It can be reduced by improving tube vacuum.

Noise

If noise is defined as any undesired signal, there are two different types of noise that originate in the tube. One type is random noise that comprises both shot noise originating in the electron beam and partition noise caused by the beam passing through the screens. Since the beam current is about 10 microamperes for both reading and writing beams, the theoretical signal-to-noise ratio for this type of noise is very high (of the order of 10^5) and this noise is not detectable in the output signal.

The other type of noise is fixed-pattern noise, produced by defects in the storage screen. These defects include plugged holes and enlarged holes occuring in the original mesh used for making the storage screens. These defects are few in number and small and can be eliminated by improving the metal-screen manufacturing technique. The electron spot covers about eight normal screen holes so the mesh of the screen itself is not resolved and produces no additional fixed-pattern noise.

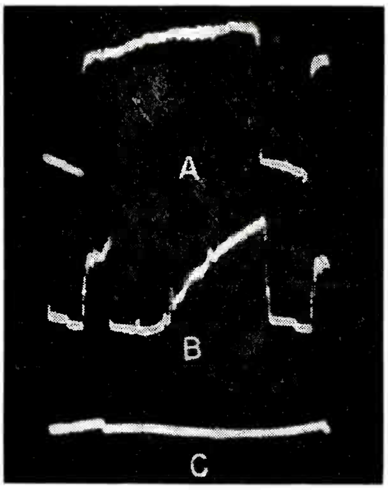


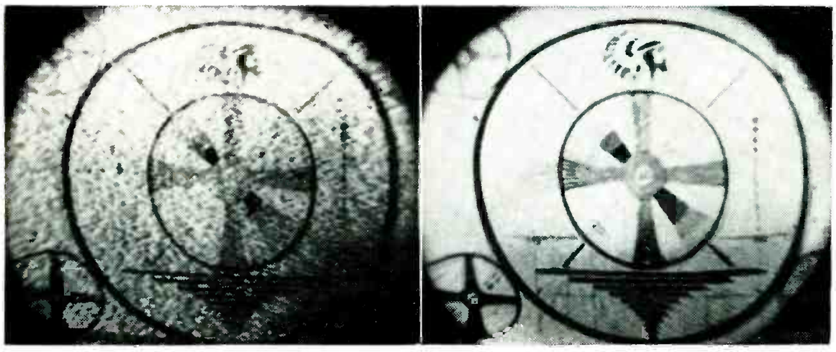
FIG. 6—Recording tube output measuring half-tone shades. White level is shown at (A), black level at (C); (B) is a sawtooth signal ranging from black to white

Integration

Use of storage devices to integrate repetitive signals mixed with random noise and thus improve signal-to-noise ratio has been studied by several investigators.[5] An ideal storage device would improve the signal-to-noise ratio by a factor equal to the square root of the number of signal repetitions. This improvement results from the random character of the noise as opposed to the fixed character of the desired signal. In the recording tube, any signal will build up charge on the storage element but, with repeated integrations, the random characteristics of noise will result in only small differential variations in noise signal across the storage surface. The repetitive signal, on the other hand, will additively build up variations across the storage surface. In reading out the signal from the recording tube, background charge produced by noise can be suppressed by adjusting storage-screen potential so that only residual differential variations in integrated noise appear.

The effect of integration was tested using as a signal a standard television resolving-power chart with superposed random noise frequencies up to 500 kc at approximately unity signal-to-noise ratio. The photograph at the left shows the recording tube output when one frame of this signal was stored. The same figure was then written into the recording tube for 20 successive frames. The photograph at the right shows the noise integration effects that had been predicted.

The recording storage tube is a reliable, compact tube adapted to production. It is presently in pilot production and is being studied for use in commercial and military applications. Design modifications to reduce tube size or to make it a two-gun tube capable of simultaneous reading and writing are feasible if needed. Further development to increase erasing speed is also being considered.



Integration of repeated signals mixed with random noise. Pattern written for one frame (left) is much improved after 20 frames despite one-to-one signal-to-noise ratio

Acknowledgments

The authors wish to express their gratitude to John Buckbee who developed the circuits for the various tests and to William Whynot, assistant project engineer.

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Performance of High-Output Magnetic Tape

Newest recording tape gives 6-db greater signal output than standard American tapes, without an increase in noise level. Alternatively, recording equipment designers may use extra gain to boost signal-to-noise level, reduce tape speed or reduce tape track width

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RECENT advances in the formulation of magnetic materials have produced a marked increase in magnetic remanence of the oxide used for magnetic recording tape. This results in a gain of approximately 6 db in signal output over that of standard American tapes. The gain is achieved with no increase in noise level, thereby giving a definite improvement in signal-to-noise ratio.

Hysteresis Curves

A comparison of the hysteresis curves of the new tape with that of two older tapes shows marked differences in their characteristics, particularly in the remanence values. Figure 1 shows second-quadrant plots of B-H as a function of H for the early German type L tape, standard American tape as represented by "Scotch" Brand No. 111 magnetic recording tape, and the new recording tape known as "Scotch" Brand No. 120 high-output tape. The data for these plots were obtained on a 60-cps hysteresis loop tester operated at a peak field of 1,500 oersteds, which carries the tapes well into saturation.

The remanence value B_r may be read from the curves at the point $H = 0$. The intrinsic coercivity H_{ic} is read from the plots as the value of H at the point where $B—H = 0$.

The true coercivity H_c, which represents the value of the field H where $B = 0$, is the more significant term since H_{ic} is a function of the remanence of the magnetic material; H_c may be read from the H axis at a point where a line of unit slope intersects the hysteresis curve. These values are given in Fig. 1 for each of the three curves.

An increase in H_c from 50 to 220 oersteds is accompanied, as may be expected, by an increase in remanence from 100 to 500 gausses when the German and standard American tapes are compared. The increase from 500 to 1,100 gausses, although accompanied by a slight increase in the value of H_c between the standard high-output American tapes, does not entirely account for the factor of 2.2 increase in B_r. This increase is associated with a fundamental change in the nature of the magnetic material employed.

The output of a tape, at recorded wavelengths which are long compared with the thickness of the magnetic coating, is a function of the a-c bias field, the gap width used in the recording heads and the

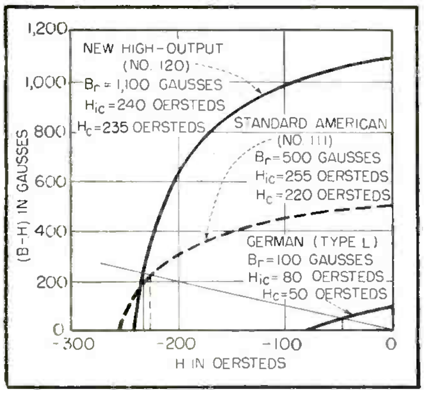


FIG. 1—Hysteresis curves showing differences in magnetic properties

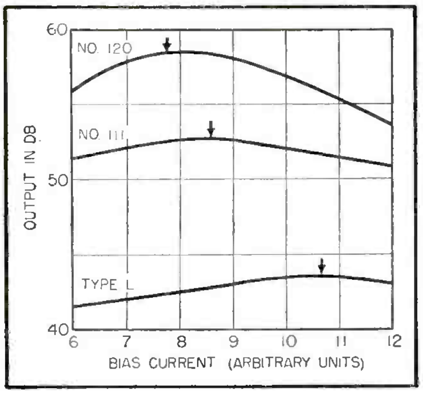


FIG. 2—Effect of bias current on output when using 400-cps input current

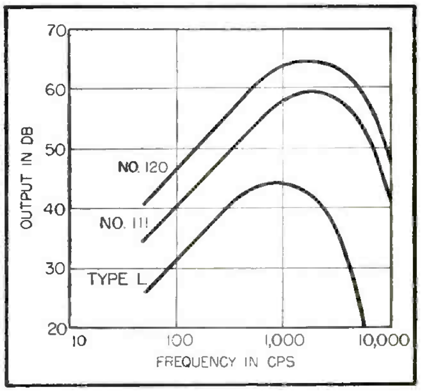


FIG. 3—Frequency response curves, recorded at constant current

remanence of the tape. Other factors remaining equal, the tape with the highest remanence value may be expected to have the highest output. At wavelengths which approach the coating thickness of a tape the remanence and coercivity influence the output, other factors remaining fixed. It has generally been assumed that higher-coercivity material forms tape with the better relative high-frequency response.

On the basis of the B_r and H_c values given in Fig. 1, both the low-frequency output and the relative high-frequency response should improve as remanence is increased.

Bias Requirements

If a tape is recorded with a low-frequency signal of fixed input and the output is studied as a function of the a-c bias current, an optimum value of bias may be selected for the maximum low-frequency ouput. The optimum bias for greatest high-frequency output is somewhat lower than the above value but machine manufacturers do not universally select a compromise current between these two settings. At progressively higher bias currents than the optimum for low frequencies the high-frequency output declines at a more rapid rate than that for the lows. However, at the higher bias values a gain in uniformity of output is obtained. Some manufacturers prefer the uniformity feature and choose to operate at high bias currents.

Figure 2 shows curves of low-frequency output as a function of bias for the three tape constructions under consideration. While No. 111 and No. 120 tapes peak at nearly the same bias current, type L requires a considerably higher current to reach its maximum.

Figure 3 illustrates the output obtained from the three tapes as a function of frequency under unequalized record and playback conditions. For comparison purposes the record conditions are chosen to be those of optimum bias as selected from the curves of Fig. 4. Constant-current recording is used, with the current fixed at that required to give 1-percent 3rd harmonic distortion at 400 cps. The playback was measured using flat amplifiers. The tape speed during the measurements was 7.5 inches per second.

The impregnated type L tape at the lower frequencies has an output about 8 db lower than No. 111, which in turn is about 6 db below that of No. 120. At the higher frequencies, type L output falls off rapidly while the other two tapes maintain essentially constant level differences of 6 db.

The bias currents for type L, No. 111 and No. 120 tapes were chosen as 10.5, 8.5 and 7.6 units on an arbitrary scale. While a somewhat better ratio of high- to low-frequency output may be obtained by a reduction of bias for the type L tape, this will be had partially at the expense of low-frequency output, as may be seen in Fig. 2. The flatter frequency response of the American when compared with the old German tapes may be attributed to the marked increase in coercivity of the latter over type L tapes. The small differences in either H_c or H_{tc} for the two American tapes are apparently insignificant in their influence on the frequency response.

Distortion

As magnetic tapes approach saturation during the recording process, they also approach higher distortion values. In a suitably adjusted recorder which contains neither d-c components of magnetization nor equivalent even-harmonic distortion in the bias field, only odd harmonic components are found in the signal output and the third-harmonic distortion component predominates. For simplicity, the third harmonic may be taken as a good first approximation to the total harmonic distortion.

Figure 4 shows output vs third harmonic distortion at 400 cps for the three tapes. These results were taken at the bias values and tape speed used to obtain the curves of Fig. 3. Within the accuracy of the determination the curves maintain essentially equal output level differences over the distortion range. This shows that each tape approaches saturation with approximately equal grace as far as distortion is concerned.

While exhaustive tests have not been made on layer-to-layer transfer of signal for the high-output tape, there appears to be no essential difference between the signal-to-print level in the two modern constructions. The time and temperature effects on transfer appear identical, as do the absolute level of both the erased noise and the modulation noise. Signal transfer is apparent more frequently in the new construction than it was in the case of present standard tapes. This is to be expected from the increased recorded flux associated with a given distortion.

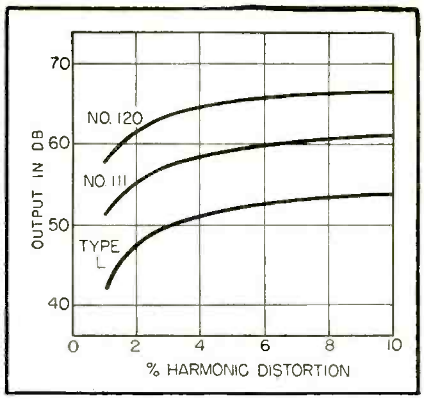


FIG. 4—Harmonic distortion, showing similarity of curve shapes

The memory effect is a descriptive name for the partial recovery of level in an erased recording when it is subjected to a bias field. All oxides have this memory of prior states of magnetization to varying degrees. Black oxides are the worst offenders in this respect. The degree of memory associated with a properly formulated magnetic material is so small that it can be detected only through the use of filters which pass the frequency used in the test and suppress the major portion of the masking noise spectrum. The new high-output tape has no detectable memory effect under normal conditions.

The new tape does not show a measurable change in erase current requirements as a function of the time a signal has remained recorded. This increase with time in the difficulty of erase has been reported only in the case of certain forms of Fe_3O_4.

General Considerations

High-output tape cannot be expected to exhibit its inherent 6-db

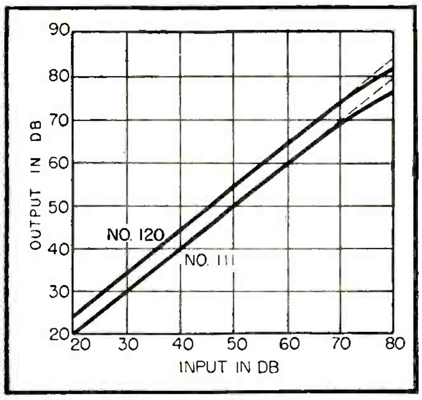


FIG. 5—Sensitivity plots, showing increased output of new type

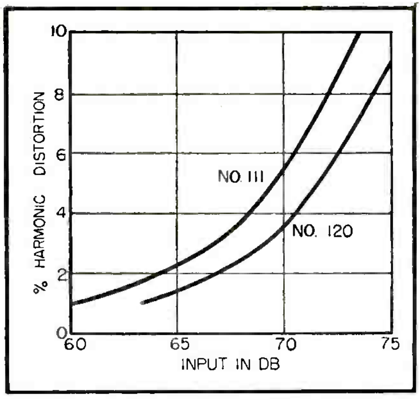


FIG. 6—Distortion curves, showing that new tape will take higher input

higher output on any recording machine without machine alterations. While a portion of the increase may be attributed to a higher recording sensitivity (where sensitivity is expressed as the ratio of output to input), a second portion is due to the fact that the input may be increased somewhat without attaining higher distortion.

Figure 5 shows curves of input vs output for the two modern tapes as determined on a professional type recorder. The bias values were chosen as optimum for each tape. It can be seen that a difference of approximately 4 db in output results at any given value of input.

Figure 6, which shows curves of input plotted as a function of distortion, illustrates the fact that to develop the same degree of distortion in the signal output, No. 120 tape requires a somewhat higher input than No. 111.

Figures 2, 5 and 6 illustrate the necessity for choosing the proper bias and recording levels in order that a given piece of equipment develop the full benefits of high-output tape.

Manufacturing Problems

The coercivity of iron oxides and hence the signal output may be enhanced by including minor percentages of impurities in the oxide crystals, introducing physical strains in the crystal lattice, and choosing a crystal habit which exhibits a desirable degree of shape anisotropy. All three means are deliberately employed in the manufacture of oxides commonly used on magnetic tapes made in this country.

In addition to the increase in output which may be associated with increased remanence of American oxides, the frequency response is enhanced, since the ability of a tape to retain magnetization for very short wavelengths generally improves with an increase in coercivity.

Backing Film

Excellent cellulose acetate film is available in this country and has been used as the supporting backing for the majority of tapes. This permits the use of a magnetic coating containing a high percentage of oxide, to form a magnetically active layer which in itself has a relatively low tensile strength. It is common practice to formulate the coating dispersion with the oxide concentration of from two to four parts of oxide to one part of a resinous binder. This additional oxide loading, taken together with the improved remanence of the oxide, accounts for the increase in signal output of present American over the early German tapes.

Type L tape was made from a calendered film and suffered from the inherent difficulty of caliper variation associated with this process. The best commercial practice in calendering produces films with a thickness tolerance of ± 10 percent. This represents a variation in signal output of ± 1 db, if the film is made from a magnetic dispersion. This caliper difficulty is reflected in type L tapes where variations of ± 1.5 db from roll to roll were found. Within a roll the output variations were smaller, amounting to ± ½ db.

Coating techniques developed in this country are consistently producing tapes which vary less than ±¼ db within a roll and which are uniform from roll to roll to within ±½ db. This means the coating thickness is maintained to less than ± 0.0000125 inch within a roll. The better uniformity represents a third improvement of American over early German tapes.

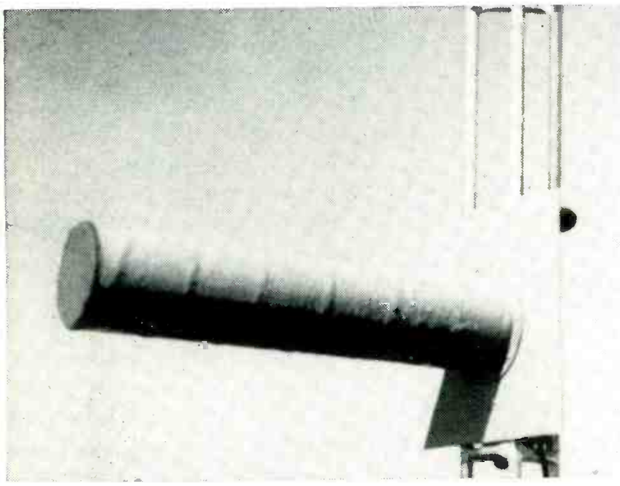
Tape Speed

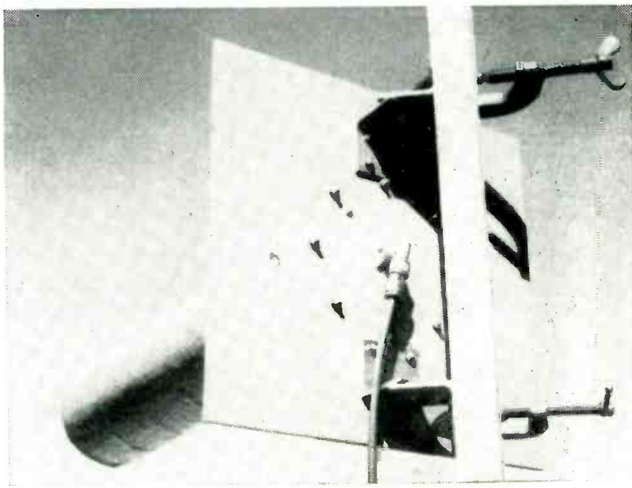
The German Magnetophone recorder, using type L tape, had a flat response to 10 kc at a tape speed of 30 inches per second. The minimum recorded wavelength was, therefore, 0.003 inch. Through careful design of machines and by the use of the improved American tapes it is now possible to obtain professional type recordings with a flat response out to 15 kc at a tape speed of only 7.5 inches per second. This requires the tape to maintain wavelengths as short as 0.0005 inch. The economy involved in the lower speed is obvious. It is doubtful if magnetic recording of sound would have achieved a fraction of its present popularity if the 30-inch-per-second velocity had not been reduced. As an example, satisfactory amateur recordings may now be made at a tape speed of 1⅞ inches per second.

Conclusions

The availability of a tape having an increase in output of approximately 6 db without deterioration in other characteristics should allow additional latitude to designers of magnetic recording equipment. Alternative ways in which the additional output may be employed are: To increase signal-to-noise level in recording equipment; to use narrower recording heads and recorded tape tracks to obtain output comparable with old tapes at a saving of tape area; to reduce tape speed through the use of greater pre-equalization of high frequencies and a lower record level without sacrifice of band width or output level; to design equipment having fewer electronic components.

A Helical Beam for





Mounted on relay tower, helical beam can be easily oriented by swivel brackets (shown in rear view on right). Coaxial feed finds natural termination in the helix itself

A HELICAL beam antenna capable of meeting the most rigid commercial requirements in the 450-mc range has been made possible by recent advances in the field of fiberglass moldings. The helical beam, with its circular polarization, possesses added advantages of economy and strength, as well as high gain and bandwidth.

The corner reflector, a simple design, affords 8 to 10 db gain. The yagi has a slightly greater gain but suffers in bandwidth so that ice and snow may reduce its efficiency more than 50 percent. Parabolic antennas have high initial cost and require expensive high-strength towers. The helical beam antenna, now that production has been made practical, has none of these disadvantages.

Construction

A 16x16-in. solid aluminum plate (Fig. 1) is used for the ground plate. Molded integrally into a fiberglass radome-type cylindrical housing, the helix consists of a length of $\frac{3}{8}$-in. copper braid. The radome is molded with a base flange which bolts directly to the ground plate.

A type N coaxial connector mounted at the center of the ground plate acts to terminate the cable and feed the helix. Since the

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radome is sealed and closed on its far end and the flange affords a seal to the aluminum ground plate, the entire configuration is weatherproof. Swivel brackets mounted on the back of the aluminum plate allow for mounting to a tower leg and for orienting the helical beam.

Calculations of the stresses involved under conditions of 100-mph wind velocity and $\frac{1}{2}$-in. radial ice show that wind loading of the order of 40 pounds is experienced on the radome and the maximum stress on the base fibers of the housing at the flange is about 250 psi. Since the material is capable of stresses of the order of 30,000 psi, the safety factor is considerable.

Performance

Operation was checked in a helix-to-helix overall system, using iden-

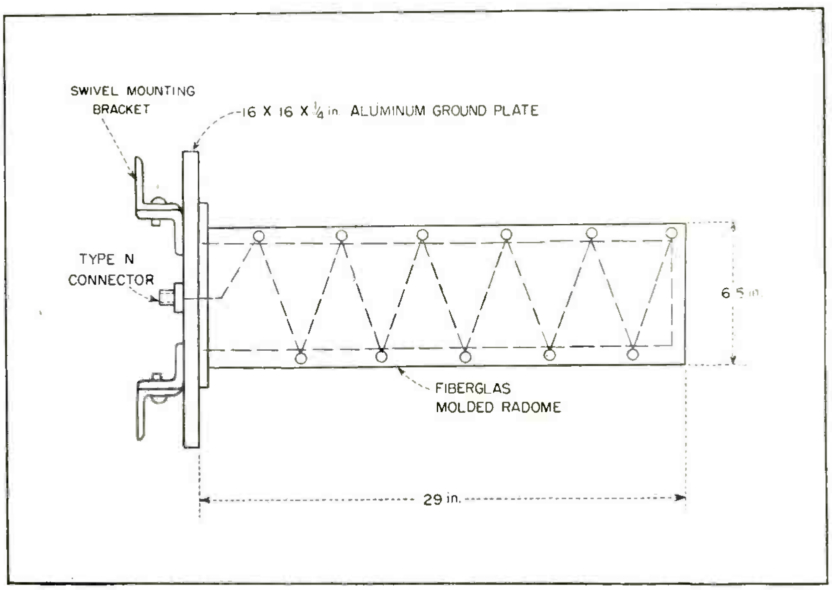


FIG. 1—Six-turn 14-degree pitch helix of ⅜-inch copper braid is molded integrally into cylinder. Base flange of radome bolts to aluminum ground plate

Citizen's Radio

With high gain and circular polarization, the helical beam antenna offers good bandwidth and pattern properties, plus good stress and ice loading safety. Radome is sealed and weatherproof. Helix designed at 450 mc stays unidirectional from 390 mc to 600 mc

tical receiving and transmitting helices. Figure 2 shows the measured radiation pattern of the receiving helix under these conditions of circular polarized transmission. Note the extremely smooth pattern and the total lack of any spurious lobes. Since all reflected radiations are of the opposite sense, the receiving helix does not respond to them and the pattern measured is more nearly the free space wave.

The helix configuration is essentially broad band, a property which makes for non-critical operation. To investigate the pattern bandwidth a helix-to-helix circuit was set up and patterns taken from 350 mc through 750 mc. Figure 3 shows the patterns as measured on an automatic polar recorder. Although the design frequency is 450 mc, the pattern stays unidirectional from 390 through 600 mc. Operation remains excellent well below 400 mc, so that this unit will find application in government services around 410 mc as well as at other frequencies throughout its range.

It is desirable to design for such a pattern as is obtained at 600 mc; however if this were scaled to 450 mc the unit would become too bulky for good commercial design. Now that a mechanically suitable design is available its properties could very well be extended to application in the 890–960 mc region also.

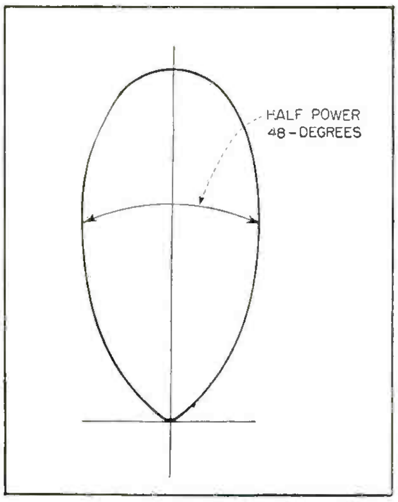


FIG. 2—Circular polarization of transmission as measured in a helix-to-helix overall system

Multiple Helices

Large increases in gain may be had by using several helices arrayed on a common ground plane. Four such elements mounted in a square will provide a nominal increase of 6 db over the single radiator and the assembly does not become unwieldy. A 4-helix array at both ends of the circuit will increase system gain on a repeater unit by 12 db, and still retain all the advantages of circular polarization. Four of the standard helical beam units described may be combined with the necessary ground-plane kit for such service and the feed remains straightforward and broad band.

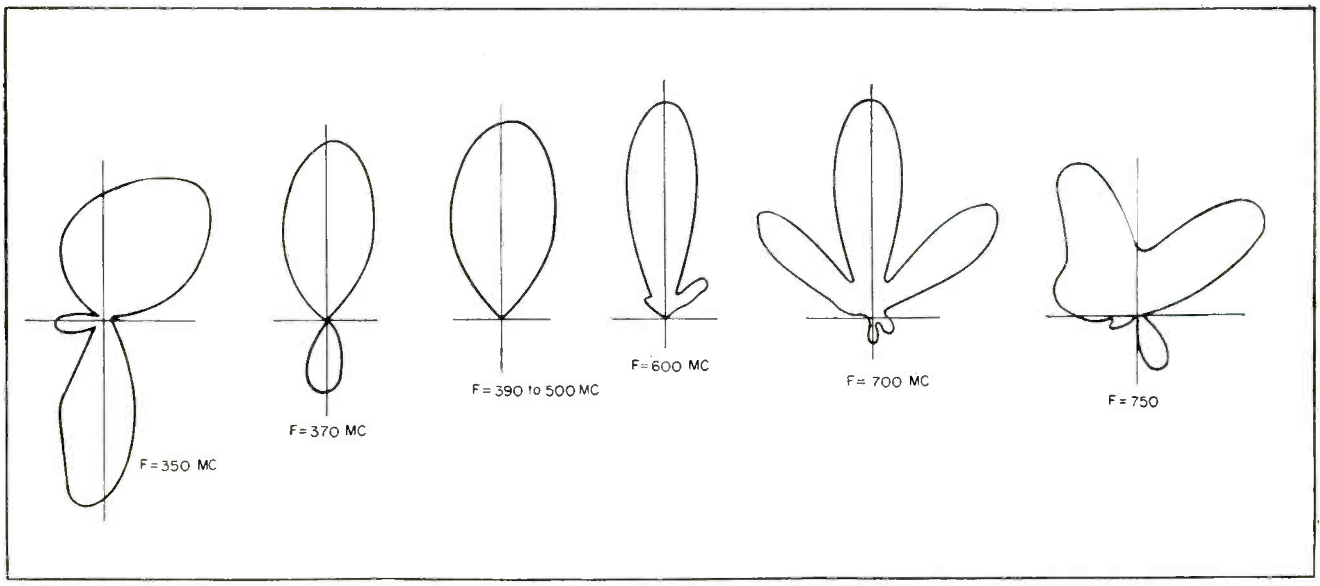
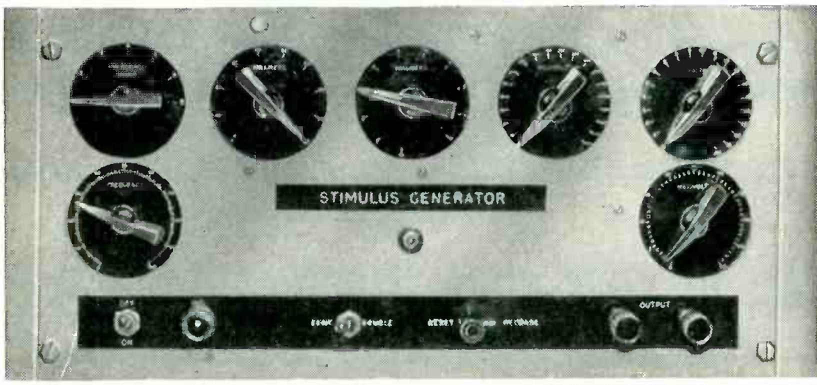


FIG. 3—Pattern for helix designed at 450 mc stays unidirectional from 390 to 600 mc. Half power beam width at 390 mc is 53 degrees, at 600 mc is 38 degrees, representing a very high-gain mode of operation

Pulse Generator Has



Front panel of the instrument showing the various controls for repetition rate, pulse width and amplitude

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AT THE REQUEST of the Zoological Department of the University of Cape Town, a stimulus generator was designed and constructed for physiological research. The apparatus produces rectangular pulses with a pulse repetition rate variable from one to 1,000 cps. The desired frequency can be set by turning of coarse and fine frequency dials.

Pulse width is variable from one to 100 milliseconds. Variation can again be obtained by setting two dials, the dial settings being additive.

Pulse amplitude is variable from zero to 20 volts. One dial is provided for volts and two dials for millivolts. The two millivolt dials are also additive, when the volt dial is on zero. When the volt dial is used, the millivolt dials are inoperative.

By setting the CONTINUOUS-DOUBLE switch, Fig. 1, to CONTINUOUS, a continuous series of pulses may be obtained. On DOUBLE, only two pulses are produced when setting the pulse switch to RELEASE. The circuit can be made ready for the next set of double pulses by setting this switch to RESET.

Operation of the instrument may be described by referring to the schematic diagram in Fig. 1. It consists essentially of a square-wave generator supplying pulses to an output circuit, via a gating circuit and three multivibrators (V_5, V_7 and V_8). On continuous pulses, the gate is open and all pulses pass on to the output of the device.

On double pulses, V_5 is triggered by a negative signal obtained by differentiation (C_1 and R_1) of the first pulse following the operation of the release switch. Tube V_5 opens the gate immediately via the buffer stage and the next pulse from the generator passes along the direct line through the gate to the output stage. The output pulse is also applied to V_7. Tubes V_7 and V_8 constitute a scale-of-two and switch circuit which close the gate via the buffer stage after exactly two pulses have passed to the output.

Gas triode V_1 together with its associated components produces a variable-frequency saw-tooth waveform. This signal is applied to the pulse-length modulator V_2. A rectangular waveform is obtained at V_2 which can be varied in width by the capacitance range of C_2, actually consisting of 19 separate capacitors. The positive square pulses are then shaped by V_{3A} and applied to a cathode follower V_{3B}. At the cathode of V_{3B}, square waves of approximately 30 volts peak-to-peak amplitude are developed.

Continuous Pulses

Pulses produced by the generator are applied to the gate and multivibrator V_5 simultaneously. However, V_5, V_7 and V_8 remain inoperative due to the high grid leak resistor (100K) with the pulse switch open (RESET). With switch S_1 set to CONTINUOUS, the suppressor grid of gate tube V_{10} is at ground potential. This tube conducts and the pulses will pass on to the first half of V_{12}. The pulses are then inverted and applied to the output cathode follower, second half of V_{12}. Amplitude of the output signal is adjustable by means of preset potentiometer R_8. The attenuators give the required amplitude for the output signal.

With S_1 open, the gate tube is at cut-off, as its suppressor is at -95 volts because of the current through V_9. With S_2 at RELEASE, V_5, V_7 and V_8 are all in operation. The first pulse after operating the release switch will now trigger V_5, applying a negative potential to the first grid of V_9. The decrease of anode current of V_9 makes the suppressor of V_{10} more positive and the tube again conducts and the gate is open.

The next pulse from the generator now passes through the gate to the output. This output signal is also applied to V_7. The V_7 stage, which constitutes a scale-of-two circuit, operates switch V_8 after exactly two pulses have passed on to the output. The switching multivibrator V_8 applies a positive signal to right-hand grid of V_9, which causes this tube to conduct and to close the gate V_{10} by increasing its suppressor voltage again to about -95 volts.

A neon indicator V_{13} gives a visual indication of the pulses, particularly at the lower pulse repetition rates.

Accuracy of the output attenu-

Wide Control Range

Rectangular-shaped pulses, either continuous or in pairs, are provided at repetition rates from one to 1,000 cps. Pulse width is variable from one to 100 milliseconds and amplitude is variable from 0 to 20 volts

ator is better than five percent. The pulse-width and frequency settings are only approximate, but as the unit is intended for use in conjunction with an oscilloscope and photographic equipment, external time marks will allow exact determination of pulse width and frequency.

The instrument described is an attempt at the construction of a relatively inexpensive but versatile stimulus generator which incorporates most of the necessary requirements for use in an electrophysiological laboratory. The number of tubes is relatively small and the operation of the instrument is comparatively simple. The instrument was developed in the Electronics Section of the South African National Physical Laboratory.

The author wishes to acknowledge the aid of D. J. Holshausen and J. H. J. Filter of the Electrical Standards Section.

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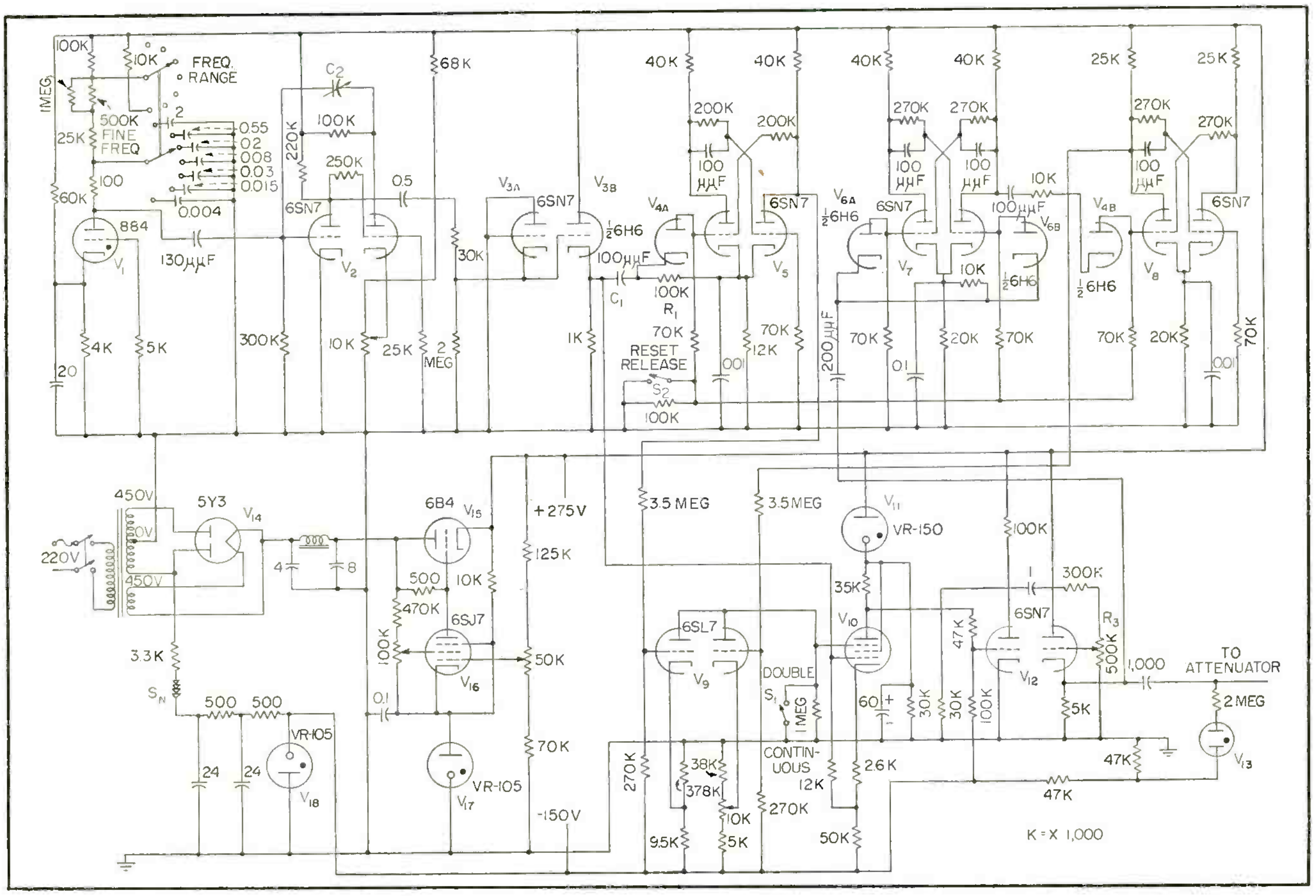

FIG. 1—Schematic diagram of the rectangular-pulse stimulus generator

How To Use Mechanical I-F Filters

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Collins Radio Company
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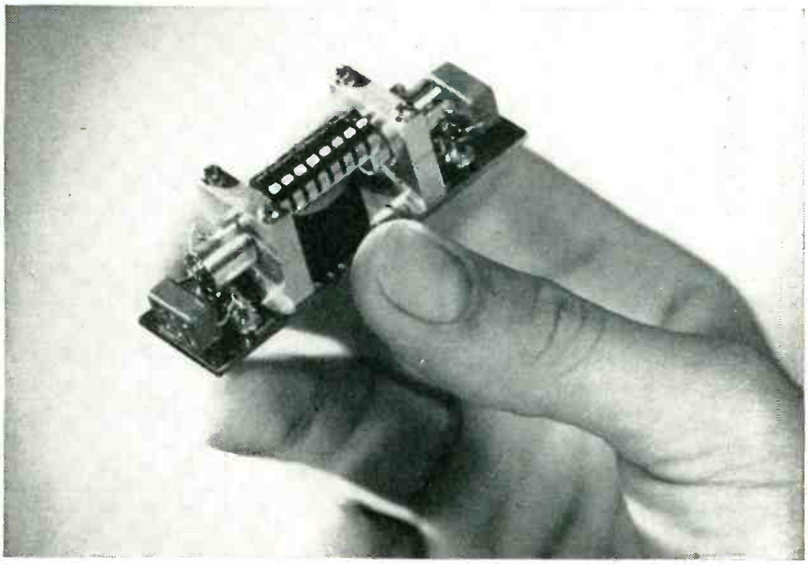


Mechanical filter takes less room than most 455-kc L-C filters and gives superior shape factor to i-f response characteristic

THE MECHANICAL FILTER was developed to fill the need for a compact and permanently-tuned bandpass filter at intermediate frequencies. The selectivity characteristic is achieved by means of overcoupled mechanical resonators driven by magnetostriction. Frequency response is characterized by a nearly flat top and steep skirts on both sides of the pass band, as shown by Fig. 1.

Figure 2 shows the functional elements of the mechanical filter. A signal current is fed to the input coil at one end causing the nickel driving wire, in the center of the coil, to expand and contract due to the magnetostrictive effect. The resulting longitudinal vibration drives the first resonant disk. Mechanical vibrations are coupled through the six disks by means of three wires acting as springs. At the output end of the filter, the longitudinal motion of the nickel end wire is transformed into an electrical current by the inverse magnetostrictive effect.

The construction details of a complete filter assembly are shown in the photograph. The six center disks comprise a mechanical bandpass network, while those at each end are untuned and function only as rigid supports. Each supporting disk is soldered to a brass tube, which serves as a mounting and shield for the driving coil. Wire leads from the coils are soldered to hermetically sealed feed-through terminals in the base plate, and small mica capacitors are connected across these coils to provide low-Q resonant circuits at each end of the filter.

The complete assembly is mounted and sealed in a brass case 1 inch high, $\frac{15}{16}$ inch wide, and $2\frac{13}{16}$ inches long. In application, the filter is connected directly to the plate and grid circuits of tubes.

Characteristics

Magnetostrictively-driven mechanical filters have several advantages over their electrical equivalents. In the region from 100 to 500 kc, the mechanical elements used are extremely small and it is possible to construct filters having better selectivity characteristics than the best of conventional i-f

Rugged fix-tuned interstage coupling units provide steep-skirt selectivity for intermediate-frequency amplifiers used in communications receivers, and in ssb transmitters for eliminating undesired sideband from low-frequency dsb signal

systems in less than the space required by a single i-f transformer.

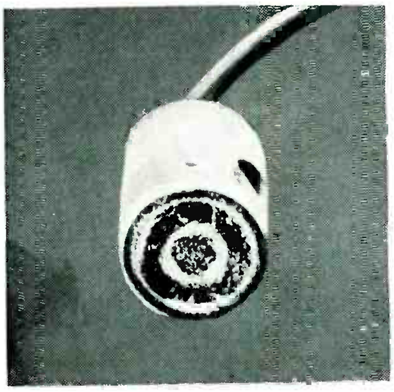
Since mechanical elements with Q's of 2,000 and over are easily obtainable, it is possible to construct filters of extremely narrow bandwidth with characteristics following the theory for lossless elements. This allows filter designs which are unattainable with electrical elements because of their relatively high losses.

A third advantage, that is not immediately apparent, lies in the permanence of the tuning adjustments. Once the various mechanical elements have been constructed, the filter frequency characteristics are permanent and no subsequent trimming is required or is possible. While this makes the initial design difficult in many ways, it removes the usual difficulties with malfunctioning of equipment due to improper trimmer adjustment, coil aging, humidity and other detuning effects. The latter may eventually become the most important characteristic since it has the effect of reducing servicing complexity of already overly complex electronic equipment.

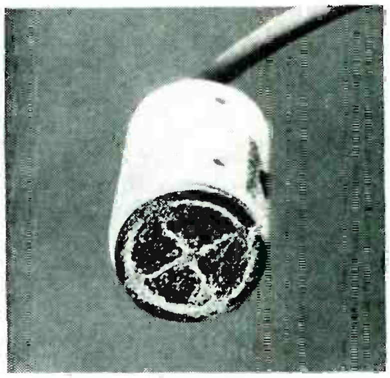
Filter Elements

The mechanical filter bandpass system is composed of metal disks and wires. The disks function as high-Q resonators, while the wires provide coupling between disks and function as magnetostrictive transducers at the terminations of the filter.

Two normal vibration modes of a single disk are illustrated in the photographs. The mode with two rings has been selected for most of the filter work, while the other is a



Lycopodium powder shows desired mode used in mechanical filter



Spurious mode appears close in frequency to desired mode

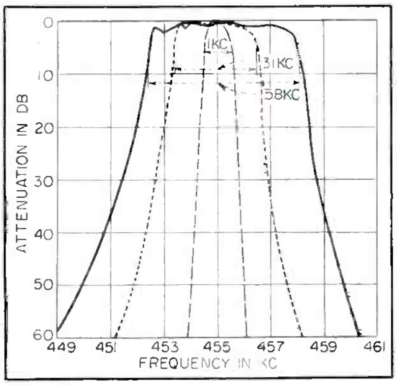


FIG. 1—Frequency response of three different mechanical filter designs described in text

spurious mode appearing relatively close in frequency to the desired mode.

The patterns shown were obtained by burnishing the surface of a disk and sprinkling it with lycopodium powder. The disk is driven with a nickel wire excited by magnetostriction. The resulting vibration caused particles to collect at the nodes; thus the pattern showing two rings indicates that the disk in vibrating with two nodal rings and with both the center and the outside edge moving at high velocity. Similarly, the other pattern shows a mode involving one nodal ring and crossed nodal lines.

An analysis of the vibration of a circular plate shows that an infinite set of different vibration modes exists. These are in general not harmonically related but frequently two will appear rather close together in frequency[1]. The major problems in the design of this type of resonator are first, the selection of a desirable mode of vibration, that is, one well separated from all others, and second, the selection of a thickness-to-diameter ratio such that spurious modes are still further removed. Analysis of thin plates shows that the frequency of the two-ring mode varies inversely as the square of the diameter and directly as the thickness. It has been found experimentally that this relation holds approximately for the relatively thick disk used.

In the mechanical filter assembly, the disk resonator functions as an essentially lossless element. The material selected for disks is a nickel-iron alloy with high Q and zero thermoelastic coefficient. The high Q of a disk is illustrated by the

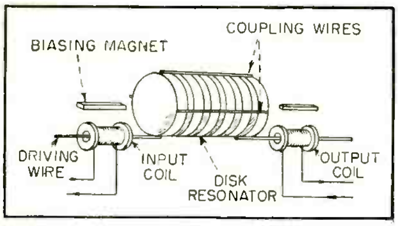


FIG. 2—Components of six-disk mechanical filter

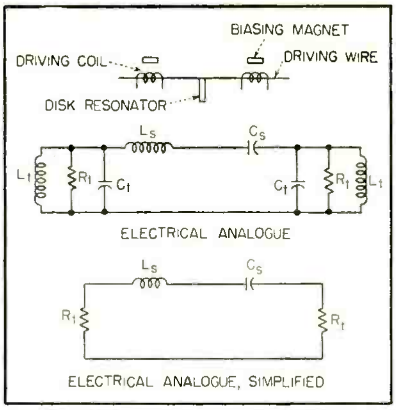


FIG. 4—Single disk filter and electrical analogue

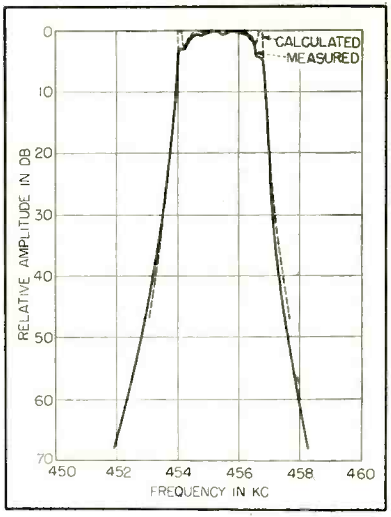


FIG. 6—Calculated frequency response of electrical analogue compared with measured frequency response of a mechanical filter

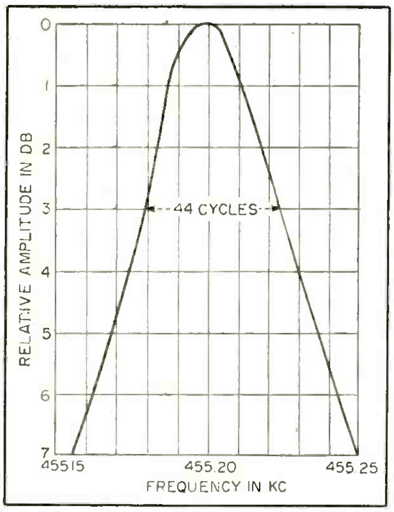


FIG. 3—Single disk resonance curve is down 3 db at 44 cycles

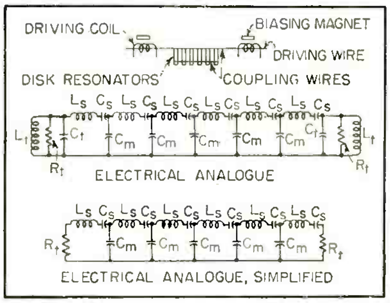


FIG. 5—Six-disk filter and electrical analogue

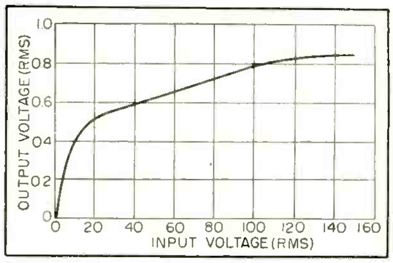


FIG. 7—Mechanical filter overload characteristic at 455 kc

resonance curve of Fig. 3. This curve has a center frequency of 455.2 kc and a half-power bandwidth of 44 cycles. The value of Q calculated from the fractional bandwidth is 10,400.

Mechanical coupling in the filter is provided by three nickel wires welded to the peripheries of disk resonators. These wires function as springs connected between disks. Nickel was selected for use in coupling elements since it gives the desired degree of coupling with a convenient wire size and is easily welded to the disks. The relatively low Q of nickel is not a serious detriment since losses in the coupling elements have a small effect compared with losses in disk resonators.

Commercially pure nickel wire has been found to be an excellent transducer material for use at the filter terminations. It has an inherent Q of the order of 50, controllable by heat treatment and magnetization. Many steel alloys have magnetostrictive properties, but in general they have rather high effective Q's. This makes them undesirable as transducers since added frictional losses are required for proper matching of the filter. Transmission losses using nickel transducers depend on the nature of the driving coils. These coils may be constructed for resonant electrical impedances that vary from a few hundred ohms to 50,000 ohms or higher. The higher impedance coils result in somewhat greater transmission losses because of the lower concentration of flux in the driving wires. Optimum magnetic biasing fields exist for the transducers, but are quite broad. The location of the optimum can be obtained by differentiation of published curves on the relative length versus field strength for nickel.

Analysis and Design

In analyzing the mechanical filter, it has been found convenient to use an electrical analogue for the mechanical vibrating system. The electrical circuit is obtained by using the mechanical-electrical analogy, where velocity is equivalent to current and force is equivalent to voltage. Also, damping is equivalent to resistance, mass to inductance, and stiffness to elastance. In the following paragraphs some considerations involved in filter analysis and design are discussed for a single-disk filter and for a multi-disk filter.

A single-disk mechanical filter and its electrical analogue are shown in Fig. 4. The driving wires at each end of the filter are tuned to antiresonance and correspond to two parallel tuned circuits in the electrical analogue. The disk resonator is equivalent to a series resonant circuit joining the two parallel resonant circuits. Energy loss and transfers in the end elements are represented by resistances in the parallel circuits. The Q of these parallel circuits is sufficiently low so that, in the frequency range of the filter, they may be represented by the resistors R_t. If the output current of the electrical analogue is measured with a constant current source applied to the input, a single resonant peak is obtained.

The fractional bandwidth of the peak is determined by the ratio of the terminating impedance to the series resonant impedance. Similarly in the mechanical filter ($\Delta f/f_o = 2R_t/\omega_o L_s$), bandwidth is determined by the ratio of the impedance of the terminating wires to the disk impedance. Here, mechanical impedance is defined as the ratio of force to velocity.

The bandwidth of single-disk filters can be adjusted by varying the radial position of the transducer wires on the disk. Observation of the vibration pattern indicates that high velocities exist at the center of the disk with a zero velocity region occurring at the first nodal ring. Therefore, the bandwidth of a single-disk filter using specified disks and end wires will be a maximum with the wire attached at the center and will decrease towards zero as the wire is moved out towards the first nodal ring.

A second method of adjusting bandwidth is to vary the cross-sectional area of the end wires. The vibration equations of this wire or rod are analogous to those for an electrical transmission line with velocity taking the place of current and force that of voltage. The equations indicate that the characteristic impedance varies directly as the cross-sectional area of the rod and, therefore, that the anti-resonant impedance of a length of line some odd multiple of $\frac{1}{4}$ wavelength varies directly as the area.

Figure 5 shows a six-disk filter and its electrical analogue. As in the case of the single-disk filter, end wires are equivalent to parallel resonant circuits, and disks to series resonant elements. One new element has been added in the form of bottom capacitance coupling. These capacitors are the electrical analogues for coupling wires less than $\frac{1}{8}$ wavelength long, welded in place between successive disks. The portion of the wires between disks represents the mechanical equivalent of a short transmission line, or a capacitance. In designing filters with two or more disks, the cross-sectional areas of both driving wires and coupling wires are adjusted to control bandwidth.

The calculated frequency response of the electrical circuit is compared with the measured response of a mechanical filter in Fig. 6. The curves correspond very closely except near the edges of the pass band, where the measured response is less than the calculated value due to losses in resonators and coupling elements.

Performance

The performance characteristics of a six-disk mechanical filter are summarized in Table 1. This filter has been designed to have a 6-db bandwidth of 3.10 kc with a center frequency of 455 kc. The peak-to-valley ratio in the pass band is less than 3 db. The shape factor of the filter response is defined as the ratio of bandwidth measured 60 db below the highest peak to bandwidth at 6-db attenuation. The present filter has a shape factor of less than 2.25 to 1. Improvements approaching a 2 to 1 shape factor should be obtainable by further refinement of the design. The low value of shape factor achieved with mechanical filters permits unusually high rejection of adjacent channel signals in communications receivers.

Transmission loss measured on present filters is less than 26 db. Design improvements on future models will permit tighter coupling between filter driving wires and coils, with a resulting transmission loss of 15 db or less. This loss can be offset easily by one stage of amplification.

The overload input voltage level, listed in the table, is the value of input voltage at which the filter saturates. The effect of saturation is illustrated in Fig. 7. This curve shows the filter output voltage measured as a function of input voltage at 455 kc. The curve is nearly linear from 0 to 10 volts, while the knee occurs at approximately 15 volts. To determine the effect of overload on frequency response, the output voltage was measured as a function of frequency with input voltages ranging from 0.5 to 300 volts rms. No change was observed in the response at these levels. These measurements indicate that the mechanical filter will be suitable for use in receiver i-f strips and similar low-level applications.

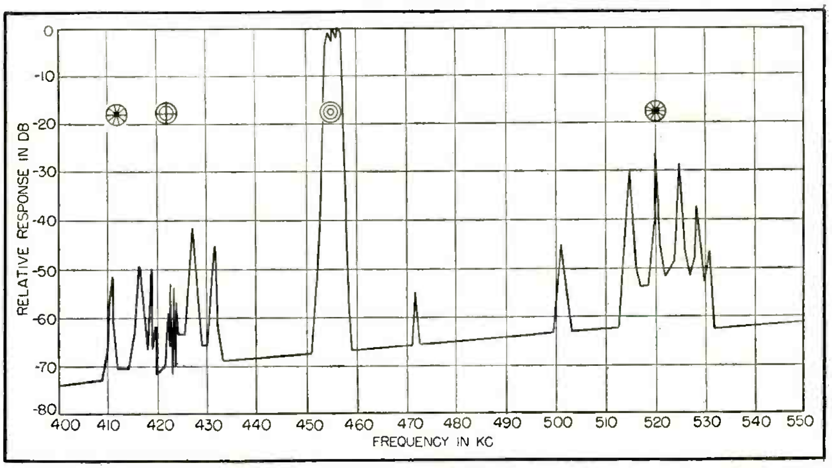


FIG. 8—Spurious response of mechanical filter. Different modes are indicated in circles

Spurious Responses

The spurious responses occurring in the frequency range of a filter are plotted in Fig. 8. The major peaks are a result of disk vibration modes other than the two-ring mode discussed above. Normal vibration patterns are illustrated on the top of the graph at their respective frequencies. The rings and diameters indicate positions of nulls in the vibration pattern. A provision has been made in this filter design to reduce the spurious amplitudes by drilling a hole in the center of each end disk. This has the effect of reducing the frequencies of the three spurious modes shown in Fig. 8, with a consequent decrease of about 20 db in the amplitude of undesired filter responses. Also, the hole drilled in each end disk reduces the mechanical disk impedance to about half the original value, thereby providing half-section terminations for the filter and decreasing the peak-to-valley ratio in the pass band.

The delay characteristic of a mechanical filter is shown in Fig. 9, together with amplitude response. The time delay varies from ½ millisecond to 1 millisecond in the pass band. Two large peaks occur near the edges of the band and a small peak near the center. The dissymetry of the characteristic is caused by a slight mistuning of filter elements.

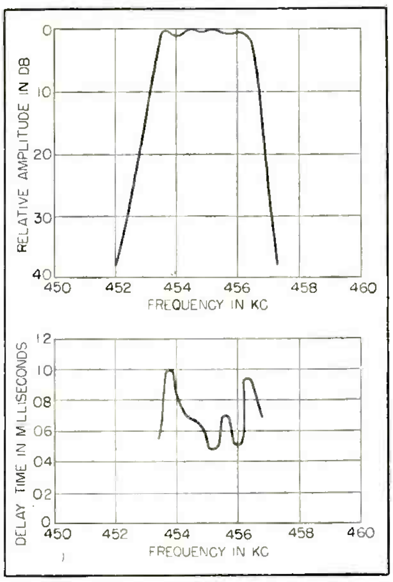


FIG. 9—Amplitude response and delay time of a six-disk mechanical filter

Service Tests

Tests have been made to determine the filter operating characteristics under a variety of service conditions. Since no trimming adjustments are required, the case is hermetically sealed, and no difficulty is expected due to high humidity. The effects of temperature variation are illustrated in Fig. 10. The major change is an increase in peak-to-valley ratio at temperature extremes, as a result of the detuning of filter end wires. The ratio approaches a maximum of 6 db at −30 C and 80 C. The frequency of peaks on the response curve shifted a negligible amount.

To determine the effects of vibration, a filter was subjected to the vibration test in the Army-Navy Specification, AN-E-19. During the test, a 455-kc carrier was fed through the filter to a low frequency receiver. This permitted the detection of any modulation resulting from vibration. No mechanical resonances were observed and no modulation was detected in the range from 10 cps to 55 cps. Response curves measured before and after each test indicated that the filter had suffered no damage.

The service tests described above indicate that mechanical filters will be satisfactory for most commercial applications. It is expected that they will satisfy military requirements when provided with suitable temperature compensation.

Table I—

Performance Characteristics of Six-Disk Mechanical I-F Filter

Operating Frequency	455 kc
Bandwidth at 6 db	3.10 kc±0.25 kc
Peak-to-Valley Ratio	Less than 3 db
Shape Factor (6 db to 60 db)	Less than 2.25
Transmission Loss	Less than 26 db
Overload Input Voltage Level	15 volts
Operating Temperature Range	−30 C to 80 C
Vibration—Satisfies the Requirements of Army-Navy Specification AN-E-19	
Case Size	$1'' \times \frac{15}{16}'' \times 2\frac{13}{16}''$
Input and Output Impedance	6,500 ohms

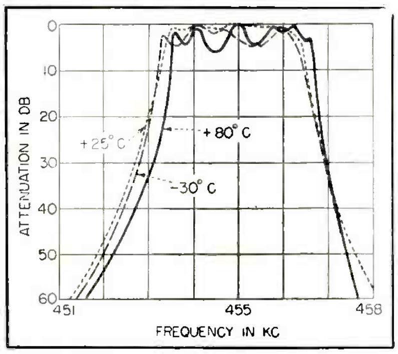


FIG. 10—Curves show temperature dependence of mechanical filters

Experimental filters with bandwidths ranging from 800 cycles to 8 kc have been construced at 455 kc and it has been found that, as expected, essentially scaled reproductions of the curves of Fig. 1 are obtained regardless of bandwith when the same number of resonant elements are used. The parameters limiting the bandwidth range for the present design are the practical limits on the size of coupling and driving wires on the narrow end of the scale and the limits on achievable bandwidths of terminating wires in the wide-band direction.

It is believed that a reasonable range of center frequencies lies between 100 kc and 1 mc. The limitation on the lower end lies largely in the size of the elements and on the high end in the precision required for very small elements.

Applications

Filters of various bandwidths have been installed on an experimental basis in the i-f systems of several communication receivers by replacing the first i-f transformer following the mixer by the filter and substituting broad-band circuits for the subsequent i-f transformers.

The 3.10-kc bandwidth filter was found to be useful for ssb reception of a-m signals, allowing a choice of sidebands and consequent reduction of interference. From the curve of Fig. 1, it is observed that, with the carrier placed at 453.5 kc, signals at 453.0 will be rejected by 20 db. At 452.5 they are down 35 db, thus allowing fairly complete rejection of the unwanted sideband.

A second application lies in the field of ssb generation. Assuming a lower limit of 400 cycles in the modulating spectrum, carrier suppression would be 17 db and the lowest frequency component of the other sideband down 29 db, with the higher frequency components suppressed still further. These figures are for a single unit and two cascaded units would provide appreciable improvement.

Reference

(1) Mary D. Waller, Vibration of Free Plates, *Proc. Roy. Soc.*, 211, p 265.

Recording Photometer Provides Log Response

Instrument provides continuous measurement from 10^{-3} to 10^{3} microlamberts. Intensity recordings are made on recording milliammeter. Two-tube circuit corrects high-intensity response without range switching. Phototube is protected from injury

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LIGHT measurements over a wide range of intensities require an instrument that can be varied to suit the particular level at which the measurement is to be made. Phototube photometers that use a manually-operated switch present a disadvantage if many positions are needed to cover the required range.

Feedback circuits have been employed in photometers using multiplier phototubes.[1] However, certain design features have limited their use in direct measurements in wide-range problems such as time versus brightness measurements on phosphorescent materials, monitoring light sources and experiments wherein an extreme brightness range is encountered.

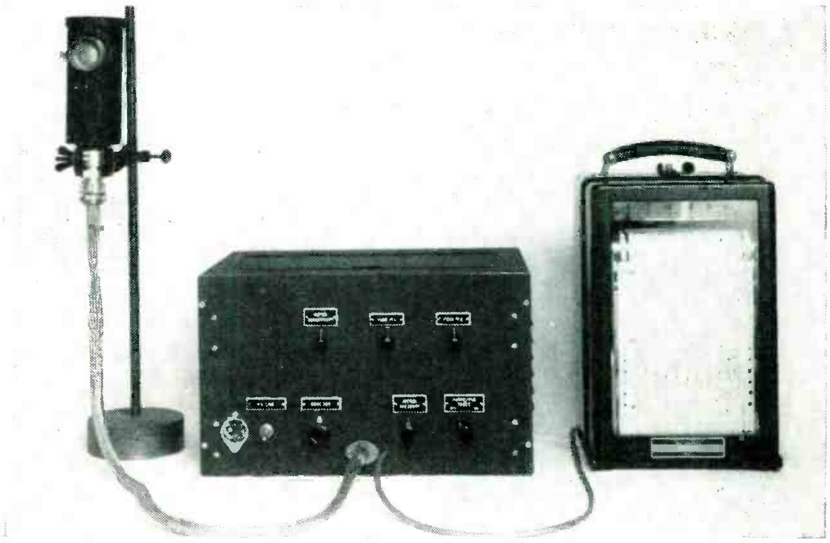
For many purposes it is desirable to have a true logarithmic response over an intensity range of 10^{-6} to 1 or greater. However, scale compression can reach a point where accurate readings are difficult and instrument stability is affected by forcing the dynode voltage of the multiplier phototubes to values for which the tubes were never designed.

The photometer to be described has a true logarithmic scale covering six cycles, which is adequate for most work from very low to medium light intensities. By addition of neutral filters, the photometer may be used from medium to very high intensities without appreciable fatigue of the multiplier phototube. The additional convenience of recording fluctuations on a strip-chart recorder makes the instrument valuable in either experimental or control work. For example, much time can be saved in decay measurements of phosphors having relatively long glow periods.

Photometer Circuit

A schematic diagram of the complete circuit is given in Fig. 1. The dynode supply is a voltage doubler using an ordinary power transformer with resistors inserted in the 816 filament leads so that both spare windings may be used. A full-wave power supply furnishes voltage for the bucking and compensating circuits. A voltage divider across the filter output consists of an OA3 and OD3 that also serve as voltage regulators.

The 807 control tube for the dynode voltage regulator has its grid coupled to the output of the type 1P21 or 1P22 multiplier phototube. Total dynode voltage for an average phototube may vary from 175 to nearly 1,100 volts under operating conditions. An OA3 in the



Complete photometer showing phototube pickup, control panel and recording milliammeter

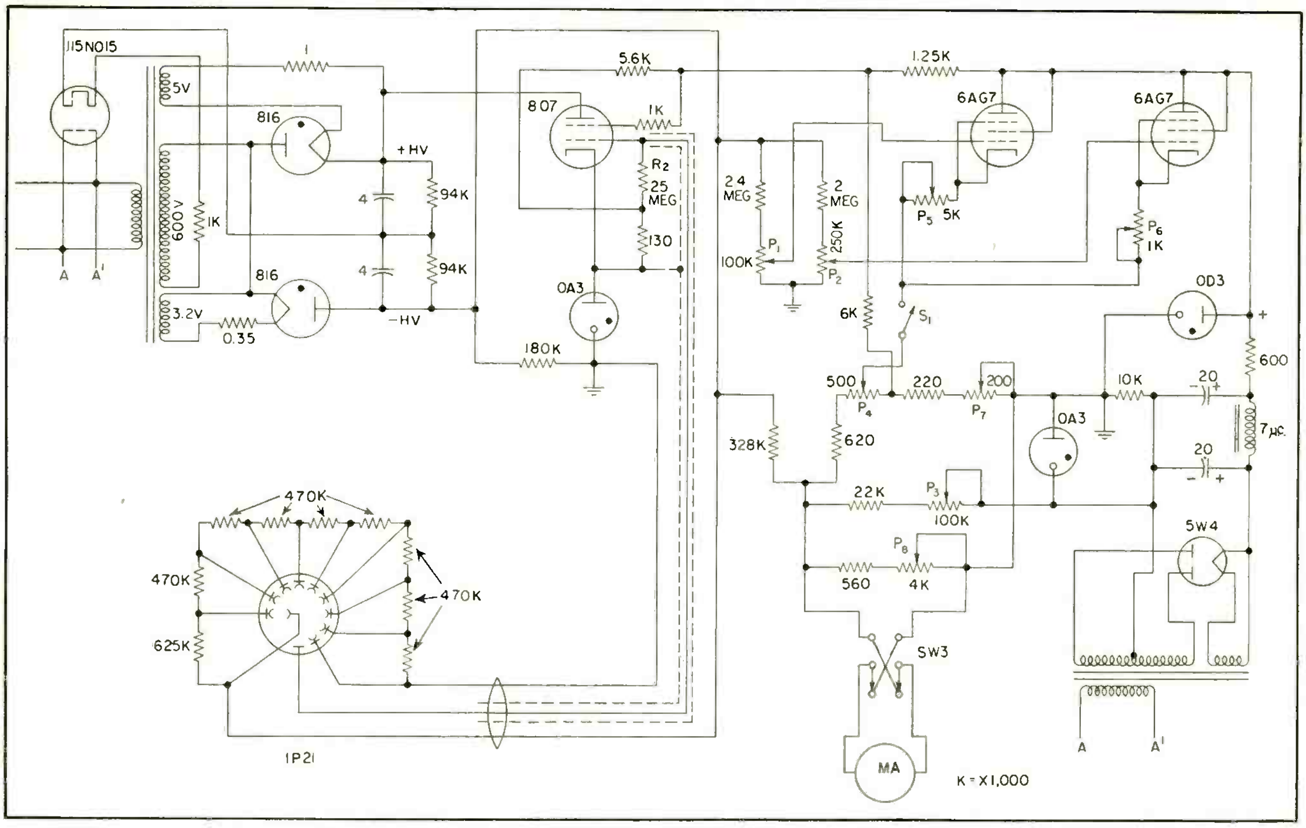


FIG. 1—Schematic diagram shows complete photometer circuit

cathode circuit of the 807 is held in operation through R_1 from the positive terminal of the full-wave power supply. This tube fixes the anode voltage on the multiplier phototube at slightly less than 75 volts when only dark current is flowing through load resistor R_2. As the phototube anode current increases, there is a reduction of several volts from this value but anode characteristics of the 1P21 and 1P22 tubes show that operation somewhat below 75 volts is permissible.

Circuit Design

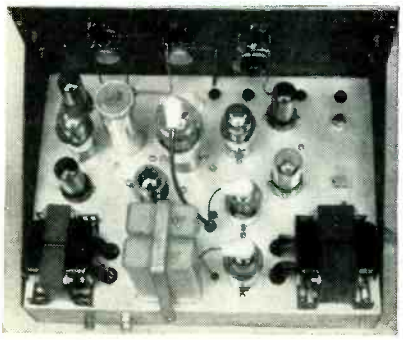
The network containing the strip-chart recorder is presented in rudimentary form in Fig. 2, where E_c = voltage across dynodes, E_b = bucking potential, E_p = compensating potential, R_1 = dynode input resistance, R_2 and R_3 are dropping resistors.

For full deflection of the recorder: E_c = 150 volts (approximately), E_p = 75 volts, I = 1 ma and IR = 1.4 volts.

For no deflection (null balance): E_c = 820 volts (approximately), E_p = 75 volts, I = 0 and IR = 0.

With a value of 83,000 ohms assigned to R_3 and an arbitrary value of 4.4 volts given to E_b, it was found possible to effect a solution whereby R_1 = 330,000 ohms and R_2 = 1,220 ohms.

From these values a tentative circuit was set up and minor adjustments made until reasonably good meter performance was noted as the dynode voltage was varied from about 150 to approximately 1,000 volts. The final circuit is shown in Fig. 3 where the voltage E_b is supplied by an IR drop from the OD3 with suitable divider resistors. For additional control and final balancing, several small rheostats were added to the basic circuit. These are shown in Fig. 1.



Top view of control chassis

With the feedback circuit connected to the circuit of Fig. 3, the voltage curve from darkness to direct measurement of a screen brightness of 0.5 microlambert, (Fig. 4) was found essentially linear for phototubes having high saturation characteristics. This gave linearity for a range somewhat less than 1,000 to 1 and it was found necessary to add a correcting circuit to compensate for nonlinearity at low dynode voltages.

Two 6AG7's were inserted in the circuit in such a way that they would automatically become operative as the dynode voltage became less negative. By proper adjustment of grid potentiometers P_1 and

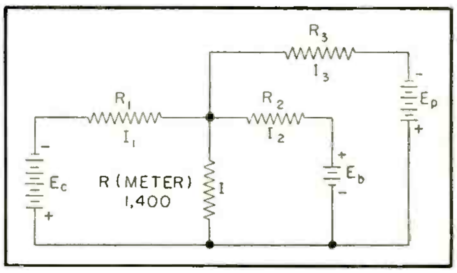


FIG. 2—Rudimentary null-balance circuit

P_8, any two points along the curve could be chosen and the instrument corrected at these points. In Fig. 5 is shown the basic circuit for such a corrector tube. As each tube conducts a certain amount of cathode current is introduced in the circuit causing an increase in positive voltage E_b. The magnitude of current in each tube is controlled by rheostats P_5 and P_6 shown in Fig. 1.

Adjustment and Operation

The problem of getting a light source of sufficiently wide range is the most difficult part of calibration. A long optical bench with a set of neutral filters may be used and two or three small lamps with fixed levels of brightness can be of value in checking the calibration. The instrument can ordinarily be operated to low intensities and dark-current fluctuations in the multiplier phototube may be observed on the recorder chart.

Zero-trace adjustments are made with the phototube shutter closed. Potentiometers P_1 and P_2 are turned fully counterclockwise; all other controls are set near midpoint; and switch S_1 is open. Rheostats P_3 and P_7 control the balancing circuits; P_7 is adjusted so that the recorder trace can easily be set to zero by P_3. If this is impossible, the multiplier phototube has an exceptionally high dark current and may not be satisfactory.

It is best to run a tentative calibration on the instrument before adjusting shunt rheostat P_8 or cutting in the 6AG7 corrector tubes. When a brightness vs deflection curve is plotted on semilog paper, the plot will be essentially straight over nearly three cycles with a curvature at about half scale. In this region, P_8 is effective and the

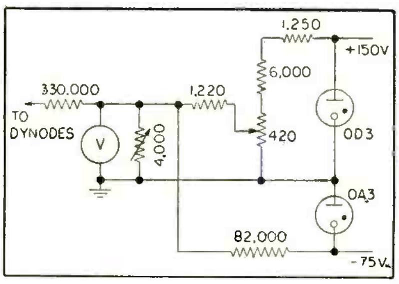


FIG. 3—Null-balance circuit using calculated values

deflection may be adjusted to some desired value. This is illustrated as point A on the graph of Fig. 6.

If the instrument is allowed to go without correction to higher brightness values, the line in Fig. 6 will tend to curve upwards from point A. When S_1 is closed and P_1 in the grid circuit of the first 6AG7 adjusted, the curve can be pulled into a straight line up to a point B on the graph. This may require resetting cathode rheostat P_5 to produce proper deflection on the recorder

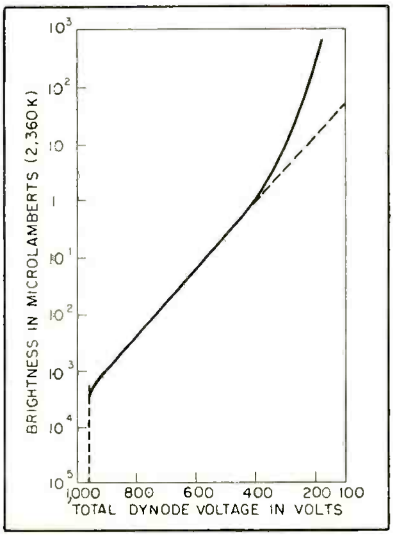


FIG. 4—Dynode voltage-light intensity characteristic for phototube

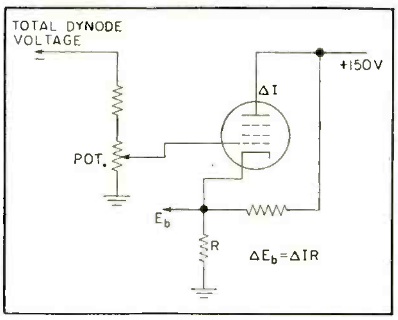


FIG. 5—Basic correcting circuit for high-intensity response

but an appreciable change in deflection should be noticed while adjusting either P_1 or P_5. Potentiometer P_1 is used chiefly to vary the point of cut-in for the 6AG7 while P_5 controls the magnitude of correcting current added to the network.

When higher brightness values are reached, the upper portion of the curve can be straightened by

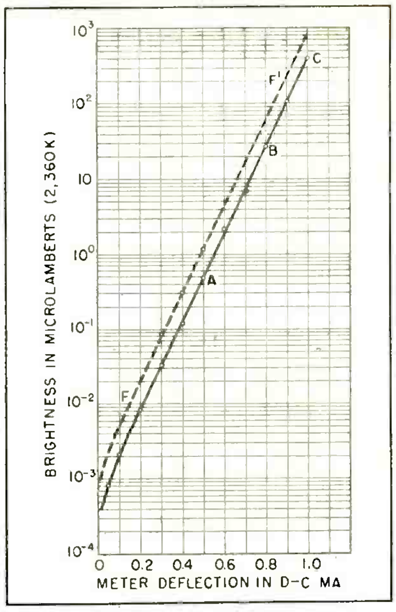


FIG. 6—Photometer calibration curve showing correction points. Broken curve holds when filter is used

setting P_2 and P_6 controlling the second 6AG7. The effects of both corrector tubes may be varied somewhat by P_4, which is introduced to compensate for variation in current characteristics of multiplier phototubes.

Sensitivity and Stability

Tests show that the photometer holds calibration remarkably well and the performance of the whole circuit is limited only by the stability of the phototube. Noise effects in a multiplier tube, ordinarily very noticeable in linear photometers, are not as pronounced in a feedback circuit. Most effects noticed are due to phototube fatigue and the fact that normal dark current changes slightly after the tube is subjected to appreciable light. Fatigue effects tend, however, to be minimized by the fact that total dynode voltage is automatically reduced when the phototube is exposed to light.

When used with a strip-chart recorder, response of the instrument is limited to 0.5 sec. Nevertheless, with suitable designing and use of a synchroscope, it should be possible to record light flashes of only a few microseconds duration.

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(1) M. H. Sweet, Logarithmic Photometer, ELECTRONICS, p 105, Nov. 1946.

——Television Receiver

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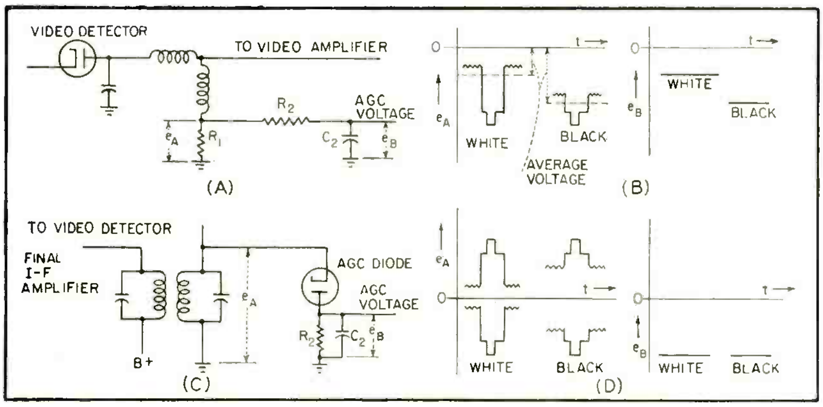

FIG. 1—Average agc circuit (A) and pre-war peak agc circuit (C) with graphs of instantaneous voltages

THE choice of the agc system installed in a tv receiver is often a compromise between cost and the importance of particular operational features. It does not necessarily follow that the more economical design is less desirable from a functional point of view. In some instances, the average agc system, which involves the least cost, might be preferred over some more expensive circuits. To determine an optimum design a thorough understanding of the agc mechanism is essential.

Average AGC System

The simplest and most inexpensive agc circuit is shown in Fig. 1A with the video detector peaking network included for completeness. The value of R_1, the detector load resistor, is usually about 4,000 ohms. Instantaneous voltages, e_A and e_B, for both a white picture and a black picture are shown in Fig. 1B on a horizontal line basis.

The agc voltage will be a function of picture content as well as of signal strength. Furthermore, even with the blackest picture content, average agc voltage will be less than the sync peak voltage, limiting the capability of this circuit to produce substantial amounts of negative voltage. This means that the receiver will be more susceptible to overloading in very strong signal areas, particularly if white picture material is being transmitted.

Since the developed agc voltage will vary also according to the transmitted scene light background, the proper gamma of the picture may not be reproduced.

The noise immunity of this agc system is excellent. Practically all impulse noise disturbances result in sharp spikes which may attain considerable peak amplitudes but are relatively widely spaced and sporadic when observed at the video detector output. The interposition of the integrating network, R_2 and C_2, between this point and the agc voltage output results in an averaging out of the noise, minimizing the effects of the high, intermittent noise peaks.

Values selected for R_2 and C_2 are of considerable importance. The R_2-C_2 time constant should be of the order of 0.1 sec. This large constant is necessary because the vertical blanking and sync pulses introduce a 60 cps component which if not filtered out adequately results in more instantaneous agc voltage during the vertical sync time. The effect of this would be to depress the vertical sync pulse making it more difficult for the sync circuits and other sections of the receiver to operate properly.

The necessary employment of a large R_2-C_2 time constant results in a slow acting system with agc voltage unable to follow rapid fluctuations of input signal levels. This is most dramatically observed in the airplane flutter effect. A faster acting agc system would also tend to correct partially for low-frequency distortions appearing in the signal at the video detector.

To insure further impulse noise immunity the possible situation where a noise peak might cause grid current to flow in one or more of the agc controlled tubes should be considered. In this case it is highly desirable that the agc source impedance have minimum resistance and maximum capacitance for a given time constant. Although slightly costlier, an R_2 of 100,000 ohms and a C_2 of 1 μf is to be preferred over the frequently used 1-megohm and 0.1-μf values.

The design considerations for R_2 and C_2 are not unique to the average agc system but are equally applicable to all agc systems where vertical pulses in the transmitted television signal may contribute 60-cps components to the agc output.

In weak signal areas where overload is no problem and where noise immunity is vital, an average agc system involving only two additional components may outperform costlier systems.

Peak AGC System

A pre-war peak agc circuit is shown in Fig. 1C, with graph of instantaneous voltages, e_A and e_B in 1D. In this circuit R_2 was 27,000 ohms and C_2 was 0.05 μf, giving a time constant of about 20 horizontal lines. An additional RC low pass filter, not shown in the circuit, of much faster time constant value served as additional isolation in order to prevent remanent i-f energy from getting back into the i-f amplifier tubes. Loading across the secondary of the final i-f ampli-

AGC Systems

Operating characteristics of seven gain control circuits currently being used in tv receivers. Design factors important in obtaining the most efficient circuit together with noise immunity and protection against overload are described on the basis of field and production experience

fier double tuned circuit introduced by the agc circuit is $R_2/2 \times$ diode efficiency.

Although the R_2-C_2 time constant is long enough to peak-detect at the horizontal sync repetition rate, it is not long enough to prevent relative depression of the vertical sync pulse[1]. Furthermore, large amplitude impulse noise pulses may charge C_2 to negative values approaching the peaks of the noise pulses. This undesirable voltage will hang on until discharged through the R_2-C_2 loop, tending to cut off receiver operation during this interval. The use of a larger R_2-C_2 time constant will result in worse noise performance but improved vertical sync reproduction.

A practical approach to this dilemma has resulted in the compromise peak agc circuit shown in Fig. 2 which has found wide acceptance in current television receivers. The R_1-C_1 time constant is somewhat longer than one horizontal line, common values being 680,000 ohms and 120 $\mu\mu$f. Design considerations discussed in the average agc circuit apply to R_2 and C_2. In the circuit shown a shunt type agc diode is employed making for a neater design with a single tuned final i-f amplifier load. In this case, the loading introduced by the agc circuit across the tuned circuit is $R_1/3 \times$ diode efficiency.

Since a fast R_1-C_1 time constant is employed, this is not a truly peak agc system, there being some decay of negative voltage from C_1 through R_1-C_1 between horizontal sync pulses. There is, however, a significant improvement in noise immunity over the peak agc system since the undesirable voltages built up across C_1 by high noise peaks decay rapidly.

This double time constant principle has been used with great success to improve noise immunity in the input of sync separator circuits. Field tests have shown that the compromise agc circuit is still well behind the simple average agc system in noise immunity where high noise pulse and weak signal conditions are encountered.

AGC Amplification System

In this system, an agc voltage is obtained by rectification of either the picture carrier or the video modulation with its d-c component intact. This voltage is fed to a d-c amplifier and then applied to the agc controlled tubes giving extremely flat output versus input signal characteristics.

The major design difficulty is in selection of d-c amplifier supply voltages. Since the output voltage of the amplifier must be referenced with respect to ground it is common to return its cathode to a negative supply voltage and its resistive plate load either to ground or to a slightly negative or positive potential. The choice of suitable supply and bias values to insure about -0.5 volt output for quiescent operation (zero input signal) and increasingly negative output for increasing signal input levels depends upon the ingenuity of the designer. Several different conditions of operation have been successfully used in the past.

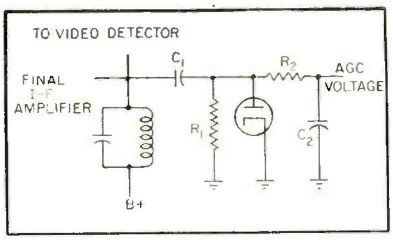

FIG. 2—Diagram of widely used compromise peak agc circuit

As with most d-c amplifiers, proper and reliable operation is critical with respect to changes of supply and bias voltages and must be considered carefully in the design. Regeneration within the closed agc loop must be watched due to the increased system gain and additional phase shifts. Also, there is a trend in current receiver design practice away from the use of negative supply voltages.

A special type of agc amplification referred to as keyed agc has been adopted by a number of companies. This circuit, shown in Fig. 3A, has a flat output versus input characteristic, is highly noise immune for both the agc and video output, is not critical with respect to supply voltages, does not require a negative voltage source, and supplies a fast acting agc voltage.

The 300 to 350-volt peak plate-keying pulse may be either series fed as shown, or shunt fed. Since a pentode is used as the keyed agc tube considerable amplification is obtained and proper operation is not critically dependent on the keying pulse amplitude. Common values of R_2 and C_2 are 100,000 ohms and 0.5 μf. R_3-C_3 form an additional filter to prevent a residual amount of horizontal frequency energy from getting back into the agc bus. This time constant must be made as high as possible, consistent with obtaining sufficient filtering action, to prevent the additional phase shift at low frequencies from causing overall agc regeneration.

The circuit may be analyzed by considering the dynamic transfer characteristics of tubes V_1 and V_2, shown in Fig. 3B. As a simplification in the analysis, a very high g_m from cutoff on is assumed for V_2 and e'_{sc} is of such value to result in a 5-v grid to cathode cutoff characteristic of V_2. In this case e_{sc} is considered to be 125 volts.

With no signal applied to the grid of V_1, about 6 ma quiescent i_p current flows through its 5,000-ohm plate load, resulting in −30 v applied between V_2 grid and cathode. Since V_2 is cut off with or without the keying pulse, no i'_p current flows, and no agc voltage is developed. No i'_p current will flow until e_g becomes instantaneously negative enough to reduce i_p to 1 ma coincident with the plate keying pulse. As soon as i'_p starts to flow it will produce enough agc voltage due to the high g_m of V_2 to prevent the incoming signal at e_g from reducing i_p any further.

If i_p were reduced below 1 ma coincident with the plate keying pulse, excess agc voltage would be developed reducing e_g, and resulting in increased i_p. If i_p were increased above 1 ma during the keying pulse interval, the agc tube would be cut off and the agc voltage would decrease, increasing e_g and decreasing i_p. Thus, the horizontal sync tips are held at the 1-ma i_p point of V_1 as indicated by X in Fig. 3B.

It is simple to obtain quantitative and qualitative results with varying parameters. Consider the following:

(A) Lowering the V_1 screen voltage.

The dynamic transfer characteristic for e_{sc} = 100 volts is shown in Fig. 3B. Since the 1-ma i_p criterion has not been changed, the horizontal sync tips are held at Y. Signal to noise ratio and sync compression at the video amplifier output are practically unchanged. The video detector output level is reduced as is the video amplifier output level.

(B) Reducing the 5,000-ohm V_1 plate load (or tapping down to ½ of the 5,000-ohm load for agc feed). Since 5 volts across 2,500 ohms, or i_p equal to 2 ma, becomes the snyc peak equilibrium position, the peaks are held at Z, resulting in reduced sync compression and worse signal to noise ratio at the output of V_1. There is also some reduction in video detector and video amplifier output levels.

(C) Raising V_2 screen voltage.

Assuming V_2 cutoff now occurs at +130 v, a 10-v drop across the 5,000 ohms, or an i_p of 2 ma determines the equilibrium position. The results are therefore similar in all respects to case B above.

(D) Adding a resistor (270,000 ohms) from V_2 grid to ground.

Approximately 0.5 ma of current now flows through the 5,000-ohm V_1 plate load resistor in the same direction as i_p due to the bleeding resistor. When V_1 draws an additional 0.5 ma of i_p, the equilibrium point is reached. Therefore the horizontal sync peaks are held closer to cutoff and sync peaks are compressed. If the resistor were connected from V_2 grid to a source more positive than 140 volts, additional current would flow through the 5,000-load opposite in direction to i_p. Then V_1 must draw more i_p to counteract this opposing current in addition to supplying a 1 ma i_p. The sync peaks would therefore be held further away from cutoff with less resulting sync compression.

(E) Varying R_2, the i-f amplifier tube gains, or the number of stages to which agc is applied, effectively changes the speed of response of the system with only second order effects on the other operating conditions discussed.

An interesting application used in the CBS-Columbia Model 1000 series may be visualized readily on the basis of this analysis. In the long-distance switch position, one of the functions of the switch is to raise the V_2 cathode voltage, resulting in decreased V_2 screen to cathode voltage. The sync peaks are therefore held closer to cutoff with significant improvement in the signal to noise ratio at the output of V_1. Also, the agc voltage is delayed since a stronger input signal is now necessary to reduce i_p to its lower equilibrium value before the agc threshold is reached. Both the improved noise immunity and lowered tuner noise factor provide for more

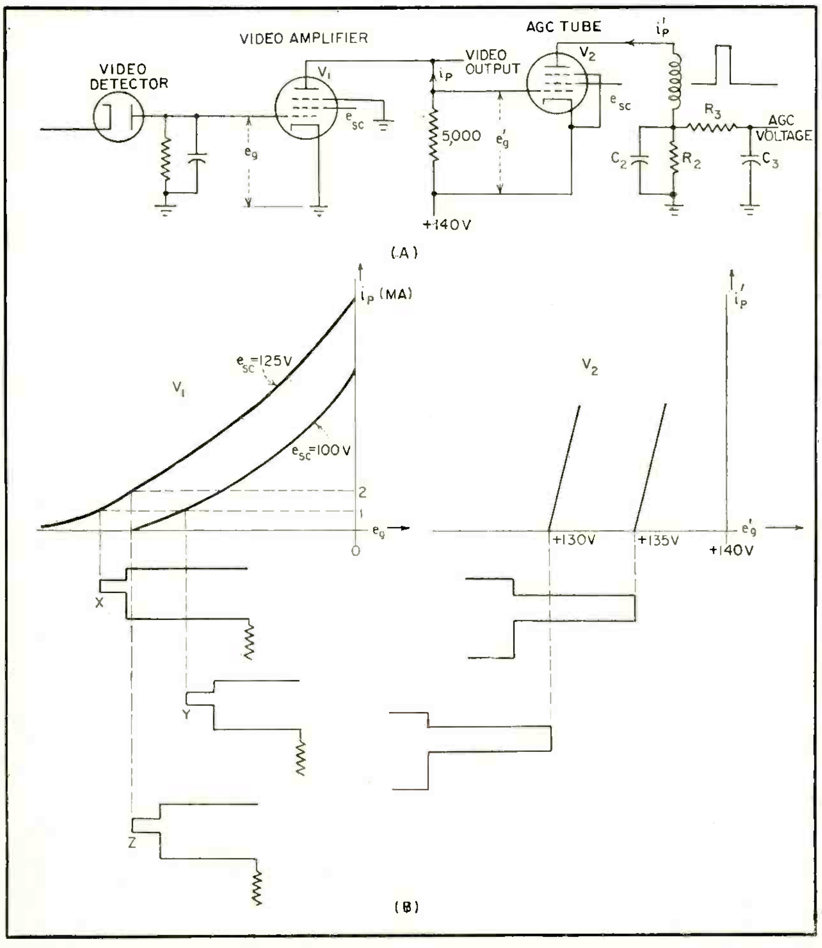

FIG. 3—Keyed agc system (A) and analysis of circuit operation (B)

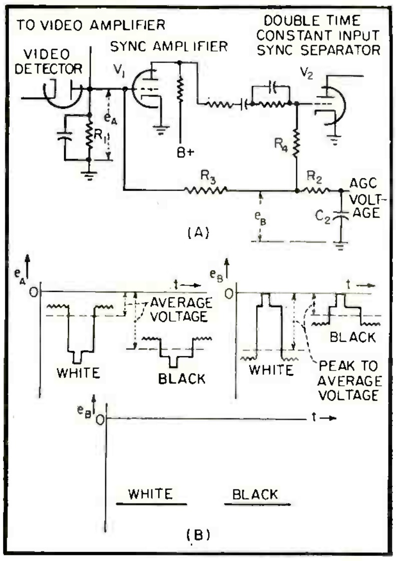

FIG. 4—Variation of peak agc circuit (A). Instantaneous voltage values are shown in graph (B)

satisfactory operation in weak signal areas.

Although additional design difficulties are presented by the use of a triode V_2 instead of a pentode, its use is promising in low-cost receivers where half a double-triode tube might be employed.

AGC System Variations

In the peak agc circuit shown in Fig. 4A, V_1 has a voltage gain of 10, $R_1 << R_3$, and $R_4 = 9R_3$. As shown in Fig. 4B, the linear addition of the average voltage e_A plus the divided-down peak to average voltage at the V_2 grid results in a truly peak agc voltage at e_B independent of picture modulation. Due to phase shifts, component tolerances and other factors, there will not be a perfect cancellation of picture modulation content at e_B, which would have occurred under the ideal conditions shown and so a low pass R_2-C_2 filter is inserted before the agc voltage take-off.

Since both sources of voltage are relatively noise immune, their additive resultant likewise will possess a high degree of noise immunity. To insure against the possibility of agc regeneration, the value of R_3 must not be larger than necessary.

The circuit shown in Fig. 5A is a variation of the compromise peak agc system. Since the agc diode cathode and R_1 are returned to the video detector load instead of to ground, an effective voltage doubler action is obtained. This comes about because the agc diode conducts only during the horizontal sync pulse interval when its cathode has a negative sync peak voltage applied. The sync peaks of the i-f waveform find themselves clamped at the diode plate to a negative voltage equal to the sync peak voltage at the video detector instead of to ground. The R_2-C_2 filter bypasses the picture modulation components.

Since more than sufficient agc source voltage is made available by double action, the R_1-C_1 time constant may be made considerably smaller than one line—1 megohm and 27 $\mu\mu$f for example. The noise immunity is markedly improved,

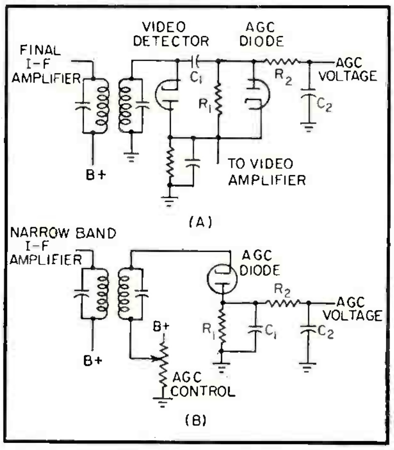

FIG. 5—Two variations of the compromise peak agc system

and the potential agc voltage source is still greater than the compromise peak or the peak agc systems.

Another variation of the compromise peak agc circuit is drawn in Fig. 5B. A narrow band i-f amplification stage to reject the higher frequency noise components feeds an agc diode which has an R_1-C_1 time constant considerably less than one horizontal line. Due to the additional i-f amplification of the sync pulses, the relative reduction in recovered agc voltage is not significant, while the noise immunity is markedly improved.

The use of a back panel agc control is also demonstrated in the circuit. In weak signal areas a positive delay voltage is applied to the agc diode cathode to prevent substantial agc voltage from being developed. In stronger signal areas this positive delay voltage is reduced manually.

Two operational features which would be desirable in all agc systems are the maintenance of low bias voltages on the r-f amplifier tube for weak signal inputs and the application of high bias voltages on the right tube for very strong signal inputs. The first characteristic results in the best noise figure for the tuner at the time when it is most needed. The second characteristic prevents overload in the receiver with the attendant washing out of flesh tones on the kinescope.

Although overload occurring in the last i-f amplifier tube is not to be neglected, the primary cause of overload difficulty arises at the first i-f amplifier tube grid. Since the conversion gain of the mixer stage is constant and unaffected by the large agc bias developed by a very strong signal input, a relatively large i-f signal arrives at the first amplifier tube grid operating near its cutoff point, resulting in compressed whites and elongated sync at its output. The correction for this is to apply greater agc bias to the r-f amplifier grid than to the first i-f amplifier grid.

A simple circuit for achieving the

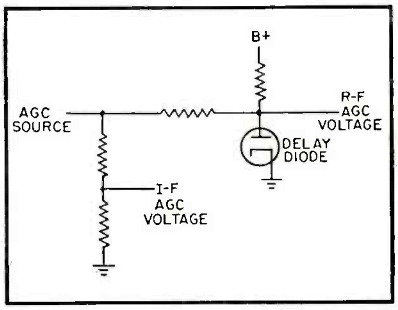

FIG. 6—Cross-over network for reducing agc bias on i-f amplifier

two features is shown in Fig. 6. A potentially strong agc source is necessary since the i-f agc is permanently divided down. The resistors may be proportioned over exceedingly wide limits to obtain the desired r-f agc delay and cross-over characteristics.

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(1) "Television D-C Components," RCA Industry Service Lab. LB-745.

Arithmetic Processes

By J. H. FELKER

Military Electronics
Bell Telephone Laboratories
Whippany, New Jersey

(OP, A1, A2, A3, A4)
OP = OPERATION TO BE PERFORMED
A1, A2 = ADDRESSES OF NUMBERS TO BE OPERATED ON
A3 = ADDRESS AT WHICH RESULT IS TO BE STORED
A4 = ADDRESS AT WHICH CODE GROUP FOR NEXT STEP WILL BE FOUND

FIG. 1—Four-address code

$a_n x^n + a_{n-1} x^{n-1} \cdots + a_1 x^1 + a_0 x^0 + a_{-1} x^{-1} + a_{-2} x^{-2} \cdots$
WRITE IN POSITIONAL NOTATION AS:
$a_n a_{n-1} \cdots a_1 a_0 . a_{-1} a_{-2} \cdots$
EXAMPLE: RADIX 10
$\pi = 3.1415 \cdots$
$a_2 = a_1 = 0 \quad a_0 = 3 \quad a_{-1} = 1 \quad a_{-2} = 4 \cdots$

FIG. 2—Number as a polynomial

7^3	7^2	7^1	7^0	7^{-1}	7^{-2}
343	49	7	0'		

ONE THOUSAND IN SEPTENARY CODE

2	6	2	6		

COUNTING

2	6	2	6	=	1,000
2	6	3	0	=	1,001
2	6	3	1	=	1,002
2	6	3	2	=	1,003
2	6	6	6	=	1,028
3	0	0	0	=	1,029

FIG. 3—Example of radix seven

0	0	0	1	0	1	=	5
0	0	0	1	1	0	=	6
0	0	0	1	1	1	=	7
0	0	1	0	0	0	=	8
1	0	0	1	0	1	=	37
1	0	0	1	1	0	=	38
1	0	0	1	1	1	=	39
1	0	1	0	0	0	=	40

FIG. 4—Examples of binary numbers

MODERN, automatically-sequenced electronic computers[1] have a large memory organ which can be thought of as consisting of a very large bank of pigeonholes. Each pigeonhole has a unique address which permits the machine to locate any information in the memory. The machine also has a control unit and an arithmetic unit that can perform the ordinary arithmetic operations.

In action the control unit consults a specified pigeonhole in the memory and, in effect, pulls out a slip of paper which has an instruction written on it. The machine then executes that instruction and advances to another pigeonhole and executes the instruction contained therein. An intermediate step may be to consult some other pigeonhole and extract a number to be manipulated during the execution of the instruction.

Programming

The arrangement and writing of these instructions is called programming the machine. One programming scheme that has been used is based on the four-address code shown in Fig. 1. When the control unit extracts an instruction from the memory, it finds written in the instruction a representation of the operation to be performed. It may also find two addresses for numbers in the memory which are to be processed by the operation. A third address will specify the pigeonhole into which the result of the operation is to be stored, while a fourth address specifies the pigeonhole which contains the code group for the next step.

Number Representation

A basic feature of our mathematical education is that we often learn things before we understand them. This is especially true of the manner in which we learn to write numbers. It is only after studying algebra that we become aware that in writing a number we are actually writing a polynomial. In decimal notation a number is represented as a polynomial in which the argument is 10. Figure 2 illustrates this principle. In writing a number as a polynomial, we leave out the radix, the value associated with each place in the number, and write only the coefficients of the powers of the radix. It is customary to indicate the point between the coefficients of the 0 and the -1 power of the radix by a radix point. Thus when we write 3.1415, what we really mean is $3 \times 10^0 + 1 \times 10^{-1} + 4 \times 10^{-2}$ and so forth. It is fundamental that numbers exist independently of the way in which we choose to represent them.

Figure 3 shows the number 1,000 represented in the septenary code for which the radix is 7. This

for Digital Computers

Special codes and arithmetical processes enable digital computers to perform rapidly many heretofore laborious mathematical tasks. Review of these processes serves as introduction to newcomers to field and review for veteran computer engineers

figure also illustrates the way in which counting takes place. Regardless of the radix, the count is always increased by one from the original count in the following manner. The coefficients are examined in turn starting with the coefficient of the zero'th power of the radix. The first coefficient that is not the highest order coefficient of the set of coefficients is replaced by the next higher one. All coefficients of lower powers of the radix are replaced by zeros. This is illustrated in Fig. 3 by transition from the septenary 2,666 to 3,000.

In the ordinary desk calculator the radix used is 10. A ten-tooth gear on a shaft makes a convenient way of representing decimal numbers. When the shaft is turned so that the fifth tooth is at a reference mark, the shaft position can, for example, be used to represent the number 5. Unfortunately, there is no very attractive electronic analog for a ten-tooth gear. In electronic computers we deal with devices that are most reliable when we ask them only either to pass current or not pass current. Such two-state devices are used most efficiently in binary numbering schemes. In the binary system the radix is 2 and the only possible coefficients are 1's and 0's. We can imagine a row of vacuum tubes in which some of the tubes are conducting and some are not. We can let a conducting tube represent a 1 and a nonconducting tube represent a 0. The row of tubes then can represent a complete number. Figure 4 illustrates the binary equivalent of several decimal numbers. As a matter of interest, note that 40, which is 5 × 8, is represented by binary 5 followed by 3 zeros.

$$\begin{array}{r}0\\0\\\hline 0\end{array}\qquad\begin{array}{r}0\\1\\\hline 1\end{array}\qquad\begin{array}{r}1\\0\\\hline 1\end{array}\qquad\begin{array}{r}1\\1\\\hline 10\end{array}$$

$$\begin{array}{r}10\\11\\\hline 101\end{array}\qquad\begin{array}{r}110\\101\\\hline 1011\end{array}\qquad\begin{array}{r}1010\\0111\\\hline 10001\end{array}$$

FIG. 5—Addition of binary numbers

ADDEND	AUGEND	CARRY	SUM	NEW CARRY
1	0	0	1	0
0	1	0		
0	0	1		
1	1	0	0	1
1	0	1		
0	1	1		
1	1	1	1	1

THESE FUNCTIONS CAN BE OBTAINED BY FLIP-FLOPS AS COUNTERS OR BY DIODE COINCIDENCE CIRCUITS

FIG. 6—Three-terminal binary adder

IN A 4-DIGIT DECIMAL CALCULATOR REPRESENT $-|X|$ AS $10{,}000 - X$

$-187 = 10{,}000 - 187 = 9{,}813$
$500 - 187 = 500 + 9{,}813 = \boxed{1}\,0313$

9,813 = 10's COMPLEMENT OF 187 = 9's COMPLEMENT + 1

IN BINARY SYSTEM CHANGE 0'S TO ONE'S AND VICE VERSA, THEN ADD ONE

FIG. 7—Negative numbers in a digital computer

In devices that have only two states it is still possible to construct the electronic equivalent of a ten-tooth gear. Picture ten vacuum tubes in a row. If the third one in the row is conducting and all others are cut off, we can imagine the row as representing the decimal number 3, while if the seventh vacuum tube were conducting, the row would represent the number 7. This is analogous to representing the number 3 by holding up the third finger on a hand. Using both hands it is possible to represent numbers up to ten in this manner. The inefficiency of this method is brought out by the following: If we let each finger represent a coefficient of a power of 2 and adopt the convention that a raised finger represents a coefficient of 1, while a lowered finger represents a coefficient of 0, we can count up to the decimal number 31 on one hand and up to 1,023 on both.

Binary System

This illustrates why many electronic computers compute in straight binary code, since numbers

```
          +8  =  0 0 1 0 0 0
                 1 1 0 1 1 1
                           1
                 -----------
          -8  =  1 1 1 0 0 0
          +8  =  0 0 1 0 0 0
                 -----------
                 0 0 0 0 0 0
 -8 + 5 = -3
          -8  =  1 1 1 0 0 0
          +5  =  0 0 0 1 0 1
                 -----------
          -3  =  1 1 1 1 0 1
          +3  =  0 0 0 0 1 1
                 -----------
                 0 0 0 0 0 0
```

FIG. 8—Examples of binary arithmetic with negative numbers

```
MULTIPLICATION          EXAMPLE
    TABLE
   0 x 0 = 0              101      5
                          110      6
   0 x 1 = 0              ---
                          000
   1 x 0 = 0             101
                        101
   1 x 1 = 1            -----
                        11110     30
```

FIG. 9—Binary multiplication

```
 -8 x 7 = -56
         8  =   0 0 0 1 0 0 0
                1 1 1 0 1 1 1
                            1
                -------------
        -8  =   1 1 1 1 0 0 0
         7  =   0 0 0 0 1 1 1
                -------------
                1 1 1 1 0 0 0
                1 1 1 0 0 0
                1 1 0 0 0
                -------------
      -8x7  = 1 1 0 0 1 0 0 0
 CHECK:
       +56  =     1 1 1 0 0 0
   PRODUCT  =   1 0 0 1 0 0 0
                -------------
                0 0 0 0 0 0 0
```

FIG. 10—Multiplication of negative numbers

```
    DIVIDE 15(1111) BY 24(11000)

             0.1 0 1  =  1/2 + 1/8 = 5/8
 1 1 0 0 0 ) 1 1 1 1.0 0 0
             1 1 0 0 0
             ---------
               1 1 0 0
               0 0 0 0
               ---------
               1 1 0 0 0
               1 1 0 0 0
               ---------
               0 0 0 0 0
```

FIG. 11—Binary division

can be represented with a minimum of apparatus.

In machines where very lengthy computations are to be performed before an output is to be presented, the cost, in time consumed, of converting the decimal numbers from the outside world into binary numbers for computation is justified by the saving in equipment resulting from binary representation. In machines used for computations in which the ratio of the number of internal computations to the number of decimal to binary conversions is not extremely large, the conversion from decimal to binary notation may result in a waste of time which is not acceptable. For such applications, two-state electronic devices can be used to code individual decimal digits. Before describing how this is done, a description will be given of the manner in which binary arithmetic is performed.

Binary Arithmetic

Because there are only two possible coefficients in binary arithmetic, operations are simplified enormously. Figure 5 shows examples of binary addition. Note that when two 1's are added, the sum digit is 0 and the carry is a 1. The mechanization of binary adders is quite simple and a common type of adder has an addend, an augend, and a carry terminal. At each step the addend, augend and carry from the previous step are examined and outputs are developed in accordance with the table shown in Fig. 6. This is typical of the operations that go on in computers. Signals on input leads are examined and outputs are produced according to what the examination reveals.

Negative Numbers

A general purpose computer must be able to represent negative numbers as well as positive numbers. Suppose that we are designing a decimal calculator to handle numbers up to 999. If we were willing to use a fourth digit place to indicate the algebraic sign of numbers, we could employ the scheme shown in Fig. 7, where $-X$ is represented as the remainder when X is subtracted from 10,000. A 9 in the fourth digit place is used to indicate that a number is negative, whereas a zero means that a number is positive. The number -187 is represented, for example, by 9,813.

Suppose -187 were to be added to 500. As the figure shows, a sum of 10,313 would be obtained. Since the calculator has only four digit places, the 1 would fall off onto the floor and the correct sum of 0313 would be obtained; the 0 indicates that the number is positive. The result of subtracting X from 10,000 is referred to as the 10's complement of X. The 10's complement can be obtained very simply by subtracting each digit from 9, which gives the 9's complement, and then adding 1 to the result.

In binary computers, negative numbers are often represented by their 2's complement. The 2's complement can be formed simply by changing all the 1's to 0's and vice versa and then adding 1. The formation of -8 from $+8$ is illustrated in Fig. 8, and an example of addition involving a negative number is given. In the example, the result is -3, the negative sign being indicated by a 1 in the most significant digit place. The fact that this is a true representation of -3 can be checked by adding $+3$ to it, which gives zero.

Binary Multiplication

The binary multiplication table is ridiculously simple, since the product of two digits is always zero unless both of them are ones, in which case the product is one. The multiplication of two numbers follows the conventional algorithim shown in Fig. 9. Each digit of the multiplier is examined in turn, and if the digit is a one the multiplicand is added, while if the digit is a zero, the multiplicand is not added. As successive digits are examined, the point at which the multiplicand is added is moved to the left.

The correct algebraic product of negative numbers can be obtained automatically without any special attention to sign as illustrated in Fig. 10, where -8 is multiplied by $+7$. Note that though the seventh digit place represents the algebraic sign, multiplication by the seventh digit is no different than by any of

$$R - X + \frac{X}{2} = R - \frac{X}{2}$$

```
           1 0 0 1
 1 0 1 ) 1 0 1 1 0 1
       - 1 0 1
         -------
         0 0 0 1
       -     1 0 1
         ---------
         1 1 0 0 0
       +     1 0 1
         -----------
         1 1 1 0 1 1
       +       1 0 1
         -----------
         0 0 0 0 0 0
```

FIG. 12—Simplified binary division

```
DECIMAL  328 = 3(100) + 2(10) + 8

100=64+32+4     =      1100100
          3     =           11
                       1100100
                      1100100
        300     =    100101100
10X2=1010 X 10  =        10100
        320     =    101000000
          8     =         1000
                     101001000
```

FIG. 13—Example of decimal-to-binary conversion

the others. It should be noted that only seven digits of the product have been accumulated and the reader can check for himself that digits beyond those would be meaningless. This method of negative number manipulation could be followed with any radix.

Division has sometimes been obtained in high-speed computers by first obtaining the reciprocal of the divisor and then multiplying it by the dividend. The reciprocal can be obtained by a reiterative process, which requires only multiplication, addition, and subtraction. Starting with a suitable guess X_0, the recurrence formula

$$X_k = X_{k-1} \, (2 - N \, X_{k-1}) \quad (1)$$

tends to the reciprocal of N as successive approximations are obtained. Suppose, for example, that a machine is called upon to divide some number by 3. The machine might multiply the number by $\frac{1}{3}$ instead and obtain the polynomial representation (Fig. 2) of $\frac{1}{3}$ by repeated use of Eq. 1. For an initial guess of 0.5, Eq. 1 would give

$$X_0 = 0.5, \; X_1 = 0.25, \; X_2 = 0.3125, \; X_3 = 0.33203125, \text{ etc.}$$

Binary division is so simple, however, that many binary computers carry out division directly, rather than by the obtaining of reciprocals. Figure 11 shows an example of binary division, and it is apparent that binary division can be carried out with pencil and paper in the same manner as decimal division. However, it is awkward for a machine to make trial divisions, since the only way it can tell whether a number can be subtracted from another with a positive result is to examine the result after the subtraction has been made. If the result is negative, as indicated by a one for the most significant digit, the machine would then have to add the number back in and shift before subtracting again.

A virtue of binary division is that this trial subtraction can be avoided. This is because, as Fig. 12 shows, if a number X has been subtracted from a number R and the result is found to be negative, indicating that $X/2$ should have been subtracted rather than X, the computer can obtain the correct result without retracing its steps merely by adding $X/2$.

Thus, in binary division one examines the result of each subtraction. If the result is negative, a zero is written in the quotient. If the result is positive, a one is written in the quotient. After a positive remainder the divisor is shifted in the next step and subtracted, whereas after a negative remainder the divisor is shifted and added. This automatically gives the correct result as illustrated in Fig. 12.

Binary Conversion

Since the world external to the computer seldom deals in binary numbers, binary computers must frequently convert decimal numbers into binary numbers. This can be done entirely with binary operations. Figure 13 shows an example of such a conversion.

A binary computer also must convert binary results to decimal numbers, and this can be done by successive divisions by the binary representation of the number ten. Division by ten is carried out until a remainder is obtained which is less than ten. The first such remainder is written as the least significant digit of the decimal number. The quotient obtained is then divided by ten until a remainder is obtained that is less than ten, and this remainder is taken as the next digit in the decimal number. This process is repeated until a quotient less than ten results. An example is worked out in Fig. 14.

The above discussion of binary arithmetic is not exhaustive and more detail can be found in an article by R. F. Shaw[2].

Because of the time required to make binary-to-decimal and decimal-to-binary conversions, computers are often built which perform their arithmetic with decimal numbers. A number of coding systems can be used in which each decimal digit is coded as a separate binary number. This makes arithmetic complicated, since when adding two digits, a number greater than ten will often be obtained. Nine plus three, for example, can be added to give twelve, but the machine must then convert the binary number twelve into the binary representa-

```
            100000
1010 | 101001000
       1010
       000001000 = DECIMAL 8

           11
1010 | 100000
        1010
        01100
         1010
          010   = DECIMAL 2

       0
1010 | 11       = DECIMAL 3

BINARY 101001000 = DECIMAL 328
```

FIG. 14—Example of binary-to-decimal conversion

DECIMAL	EXCESS-THREE CODE
0	0 0 1 1
1	1 0 0
2	1 0 1
3	1 1 0
4	1 1 1
5	1 0 0 0
6	1 0 0 1
7	1 0 1 0
8	1 0 1 1
9	1 1 0 0

FIG. 15—Excess-three code

```
(x+3) + (y+3) = (x+y-10) + 16
EXAMPLE
   9         1 1 0 0
   3           1 1 0
CARRY→ 1   0 0 1 0 = 2; MUST ADD
               1 1   3 TO GET EX-
                     CESS 3 AGAIN
           0 1 0 1

IF THERE IS NO CARRY, 3 MUST BE
SUBTRACTED
   5       1 0 0 0
   2         1 0 1
           1 1 0 1
  -3       1 1 0 1
           1 0 1 0 = DECIMAL 7
```

FIG. 16—Excess-three arithmetic

tion of two and add one into the next column.

Excess-Three Code

Using the excess-three code, the correct carry can be obtained quite simply. In this system the decimal digits are each represented by the binary number which is greater by three, as shown in Fig. 15. The binary sum of two such digits is excessively large by six. To convert the sum to excess-three representation it is necessary to subtract three. However, when carry is necessary the fact that six is the same as sixteen minus ten results in the fifth binary digit constituting the correct carry. In the addition of two excess-three numbers, the fifth binary digit is examined, as in Fig. 16. If this digit is a one, the next decimal digit is increased by one, and three is added to the binary digits of the sum, giving the correct excess-three representation. If, on the other hand, the fifth binary digit is a zero, three must be subtracted to obtain the correct excess-three representation of the sum digit. It is possible, using this scheme, to code ordinary binary arithmetic elements to perform decimal arithmetic.

Biquinary Code

Another manner of representing decimal numbers is based on the biquinary code. The biquinary code, Fig. 17, may be recognized by the reader as the code used in that ancient calculating machine, the abacus. In this code each decimal digit is represented by, let us say, seven relays. These relays may be divided into a group of two and a group of five. Figure 17 illustrates that for a digit to be represented by the relay pattern, one relay of each group, and only one, must be closed. This code is inefficient or redundant in that it takes seven devices to represent a decimal number, whereas the excess-three code, for example, requires only four devices. As will be shown later, this redundancy can be put to excellent use in making a machine detect its own errors.

Besides the excess-three code and the biquinary code, other coding arrangements for decimal digits are possible. In a decimal multiplier, the multiplication table must be stored. Coding arrangements are possible that simplify this multiplication table by increasing the redundancy in the digit representation. This is a matter of considerable interest to professionals in the field of coding.

Error Correction

In the early days of electronic computer evolution there was more emphasis on getting machines assembled than there was on making them work without error. Today, however, machines are expected to execute many millions of consecutive operations without failure. This requirement has led to the development of error-detecting codes which make it possible for a machine to recognize when it has made an error. Error-correcting codes which make possible the automatic correction as well as detection of an error have also been developed. These codes involve the incorporation of redundancy in the number representation. This use of redundancy parallels the use that is made in ordinary transactions. When, for example, a check is written, the value is both spelled out and written as a figure. Thus, if the writing is illegible or subject to misinterpretation, the bank teller can usually determine by examining both representations what the writer had in mind when he wrote the check.

The more complex machines become the more they approach human frailty of the sort that is responsible for our redundant method of writing checks. Accordingly, computer designers are interested in codes for numbers, which when a mistake has been made will enable the computer to say "This code group doesn't represent a number and I'd better stop and call the boss," or even more preferably, "This code group doesn't represent a true number and it is clear that what it should be is so and so."

Error Detection

The biquinary code has been described as a redundant code and its importance lies in the fact that the redundancy offers a simple basis for error detection. In this code, as pointed out previously with respect to Fig. 17, one and only one of the symbols in the group of two and group of five must be a one. If a single error has been made in the code group, it will be evidenced either by a one appearing where it shouldn't or failing to appear at all. Suppose that a closed relay symbolizes a digit being a one. Seven relays would be used to represent the code for a decimal digit. If, after each representation of a new decimal digit, the machine examines the group-of-two and group-of-five relays and determines that one and only one relay in each group is closed, then it knows that the digit representation is correct. The only time that this could fail to reveal an error is when two failures have simultaneously occurred. If a machine were supposed to represent the number 6 (see Fig. 17) and by mistake represented the number 7, it would have been necessary for the relay in the one column to have failed to close and the relay in the 2 column to conduct of its own accord. If the probability of one out of five relays failing is very small, the probability of two failing simultaneously may be negligible.

The biquinary code has been em-

COMPUTERS AND ELECTRONICS

Electronic digital computers are today in evidence in virtually every phase of industry. The marriage of electronics and high-speed computation has been responsible for tremendous advances in both fields.

It is conceivable that even greater progress could result from a more widespread understanding, among electronics engineers, of computer processes. To that end, this article is published in ELECTRONICS as an introduction to some and as a review to those already familiar with the computer language of words and numbers

5	0	4	3	2	1	0	DECIMAL
	X					X	0
	X				X		1
	X			X			2
	X		X				3
	X	X					4
X						X	5
X					X		6
X				X			7
X			X				8
X		X					9

FIG. 17—Biquinary code

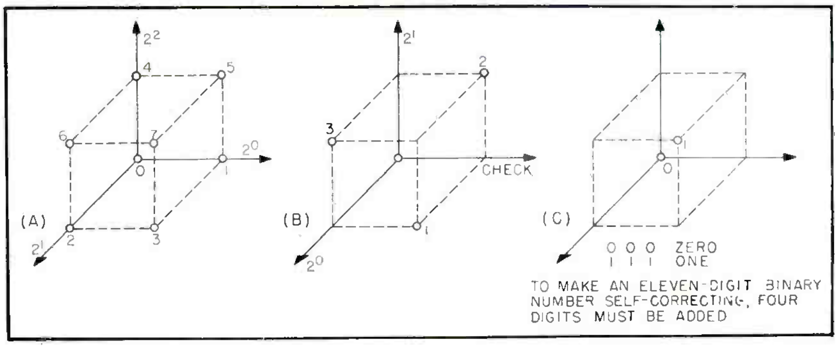

FIG. 19—Geometry model of a number (A), of even parity check (B) and self-correcting code (C)

	NUMBER	CHECKING DIGIT
13	1 1 0 1	1
14	1 1 1 0	1
15	1 1 1 1	0
16	1 0 0 0 0	1
17	1 0 0 0 1	0
18	1 0 0 1 0	0
19	1 0 0 1 1	1

FIG. 18—Even parity check

ployed in several relay computers[3], and these machines have set a record for error-free operation.

Checking Digit

The conventional binary code can be made redundant by inclusion of a checking digit with each number. In Fig. 18, the checking digit is added in a manner that makes the number of 1's in the number even. Thus the checking digit for the binary number 16 is a 1, whereas the checking digit for the binary number 17 is a zero, because there are already an even number of 1's in the binary number 17. If a single digit in the number 15 for example, were produced incorrectly, then the code group would contain an odd number of 1's and the machine could thereby recognize the result as an error. Note that the error could be recognized even if it occurred in the checking digit.

It is also possible to use an odd parity check in which the checking digit is added to make the total number of 1's an odd number. This is a more sensible check because a very common type of machine failure is to make all digits zeros. This error would be caught in an odd parity check even though the error is produced by failure in more than one digit place. Neither of these two checking schemes would detect double errors in general, since a double error might leave the number of 1's or zeros unchanged.

Error Theory

A general theory of error detecting and correcting codes has been developed by R. W. Hamming.[4] To avoid the pictorial difficulties of spaces with more than three dimensions, consider numbers with only three digits. Each of the eight possible three-digit binary numbers can be imagined as a unique vertex of the cube shown in Fig. 19A. In this representation each binary digit is a coordinate. The model can be generalized to the extent that each of the possible n-digit numbers lies at the vertex of an n-dimensional cube.

Figure 19B shows a model for an even parity check. Note that the binary numbers 0, 1, 2 and 3 appear at vertices of the cube. If we were to proceed along the edges of the cube from a vertex representing a number to any other vertex that represents a number, it would be necessary to go through a vertex which does not represent a number. If in representing the binary number 3, for example, a mistake were made in one of the digit places, that single mistake in a coordinate would throw the number to a vertex which it has been agreed does not represent a number. A single mistake will always result in such a position and can, therefore, be recognized.

Error Correction

A model of a self-correcting code is shown in Fig. 19C. In this model, the origin of the graph represents the number zero, whereas the code group 111 which represents the seventh vertex represents the binary number 1. Suppose now that a mistake is made in developing the code group for one. If instead of producing the code group 111, the code 101 were produced, the machine would stop at the fifth vertex (assuming that the vertices are numbered as in Figure 19A). It would recognize that this vertex does not represent a number. It could further recognize that the closest vertex which does represent a number is the seventh vertex and could move to that position, thereby producing the correct code group 111. To produce a model of a self-correcting code for numbers with more digit places, it would be necessary to conceive an n-dimensional cube. The vertices of this cube would be assigned to definite numbers with two forbidden vertices between every pair of vertices that represent numbers. It would then be possible for the machine to recognize when it has made a single mistake and tell at which vertex it should be (the closest one). The idea can be extended to show the possibility of a coding system which would automatically correct for more than one error in a code group.

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Transistor Equations

Circuit gain and impedance characteristics are given in terms of transistor parameters for grounded base, grounded emitter and grounded collector configurations. Simplifying approximations are given where appropriate

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THE ACCOMPANYING tabulation summarizes some of the important circuit equations useful to engineers in the application of transistors.

All equations are given in terms of the transistor parameters: collector resistance r_c, base resistance r_b, emitter resistance r_e and current amplification constant α. These quantities are all described in references listed in the bibliography. The quantity r_c is almost always much larger than r_b and r_e and often is even much larger than the load resistance. This makes possible approximations that greatly simplify the complicated exact equations. To evaluate these approximations in this tabulation, the exact expression is always given first followed, where appropriate, by a simpler approximation equation.

The other quantities listed are self-explanatory.

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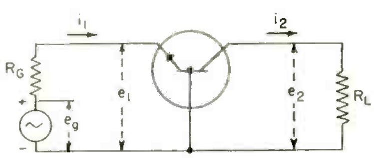
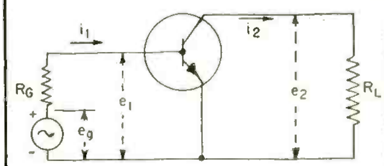
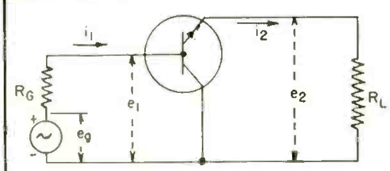
	GROUNDED BASE	GROUNDED EMITTER	GROUNDED COLLECTOR
			
$\frac{e_2}{e_1}$	$= \dfrac{\alpha R_L}{r_e + r_b(1-\alpha) + \dfrac{(r_e+r_b)R_L}{(r_c+r_b)}}$ IF $R_L \ll r_c$ $\cong \dfrac{\alpha R_L}{r_e + r_b(1-\alpha)}$	$= \dfrac{-R_L\left[\alpha - \dfrac{r_e+r_b}{r_c+r_b}\right]}{r_e + r_b(1-\alpha) + \dfrac{(r_e+r_b)R_L}{(r_c+r_b)}}$ IF $R_L \ll r_c$, $r_e + r_b \ll r_c$ $\cong \dfrac{-\alpha R_L}{r_e + r_b(1-\alpha)}$	$= \dfrac{r_c}{r_c+r_b}\left[\dfrac{1}{\dfrac{R_L+r_e}{R_L} + \dfrac{r_b(1-\alpha)}{R_L}}\right]$ IF $r_e \ll R_L$, $r_b(1-\alpha) \ll R_L$, $r_b \ll r_c$ $\cong$ UNITY
$\frac{e_2}{e_g}$	$= \dfrac{\alpha R_L}{\left[r_e + r_b + R_G\right]\left[1 + \dfrac{R_L}{r_c+r_b}\right] - \alpha r_b}$ IF $R_L \ll r_c$ $\cong \dfrac{\alpha R_L}{r_e + R_G + r_b(1-\alpha)}$	$= \dfrac{-R_L\left[\alpha - \dfrac{r_e+r_b}{r_c+r_b}\right]}{\left[r_e+r_b\right]\left[1+\dfrac{R_L}{r_c+r_b}\right] + R_G\left[1+\dfrac{R_L+r_e}{r_c+r_b}\right] - \alpha(r_b+R_G)}$ IF $R_L + r_e \ll r_c$, $r_e + r_b \ll r_c$ $\cong \dfrac{-\alpha R_L}{r_e + (1-\alpha)(r_b+R_G)}$	$= \dfrac{1}{\left[1+\dfrac{r_e}{R_L}\right]\left[1+\dfrac{r_b+R_G}{r_c}\right] + \left[\dfrac{r_b+R_G}{R_L}\right]\left[1-\alpha\right]\left[1+\dfrac{r_b}{r_c}\right]}$ IF $r_e \ll R_L$, $r_b + R_G \ll r_c$, $r_b \ll r_c$ $\cong \dfrac{1}{1+\left[\dfrac{r_b+R_G}{R_L}\right]\left[1-\alpha\right]}$
$\frac{i_2}{i_1}$	$= \dfrac{\alpha}{1 + \dfrac{R_L}{r_c+r_b}}$	$= \dfrac{-\left[\alpha - \dfrac{r_e+r_b}{r_c+r_b}\right]}{\left[1-\alpha\right] + \dfrac{R_L+r_e}{r_c+r_b}}$ IF $r_e \ll r_c$, $r_e \ll R_L$, $r_b \ll r_c$ $\cong \dfrac{-\alpha}{(1-\alpha) + \dfrac{R_L}{r_c}}$	$= \dfrac{1}{\left[1-\alpha\right]\left[\dfrac{r_c+r_b}{r_c}\right] + \dfrac{R_L+r_e}{r_c}}$ IF $r_b \ll r_c$, $r_e \ll R_L$ $\cong \dfrac{1}{(1-\alpha) + \dfrac{R_L}{r_c}}$

(Continued on p 158)

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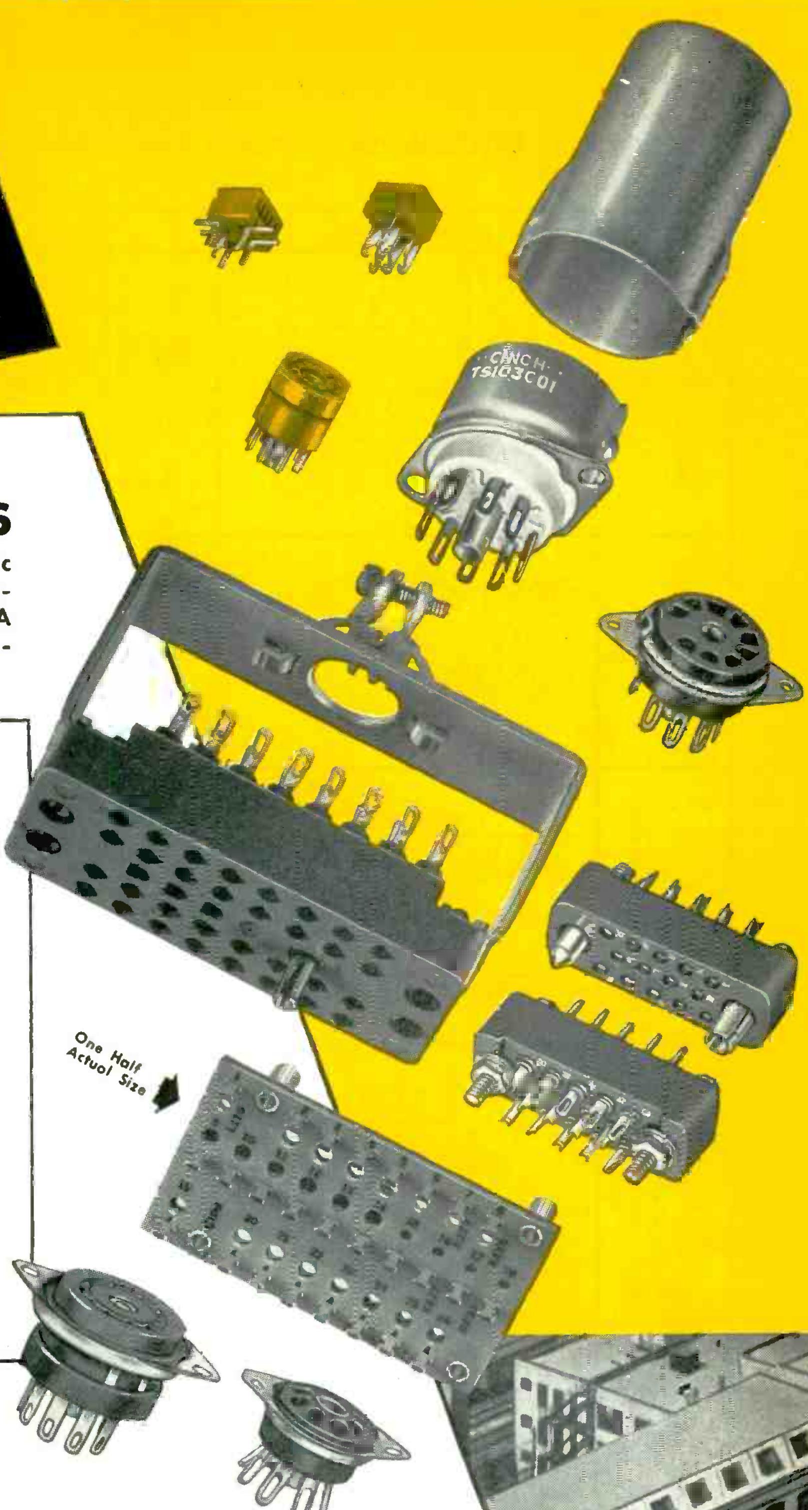

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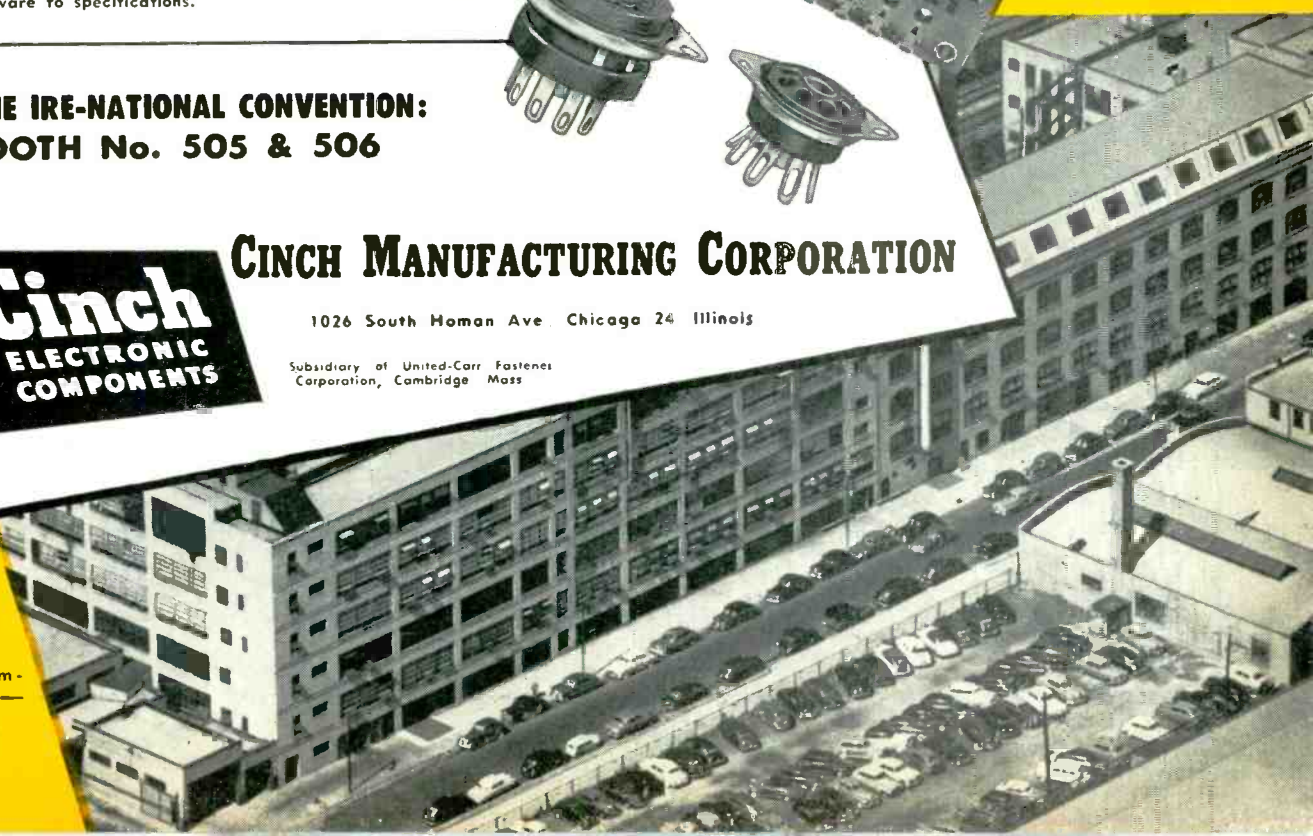

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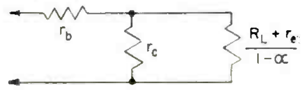
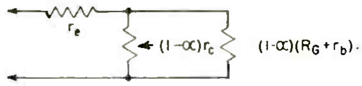
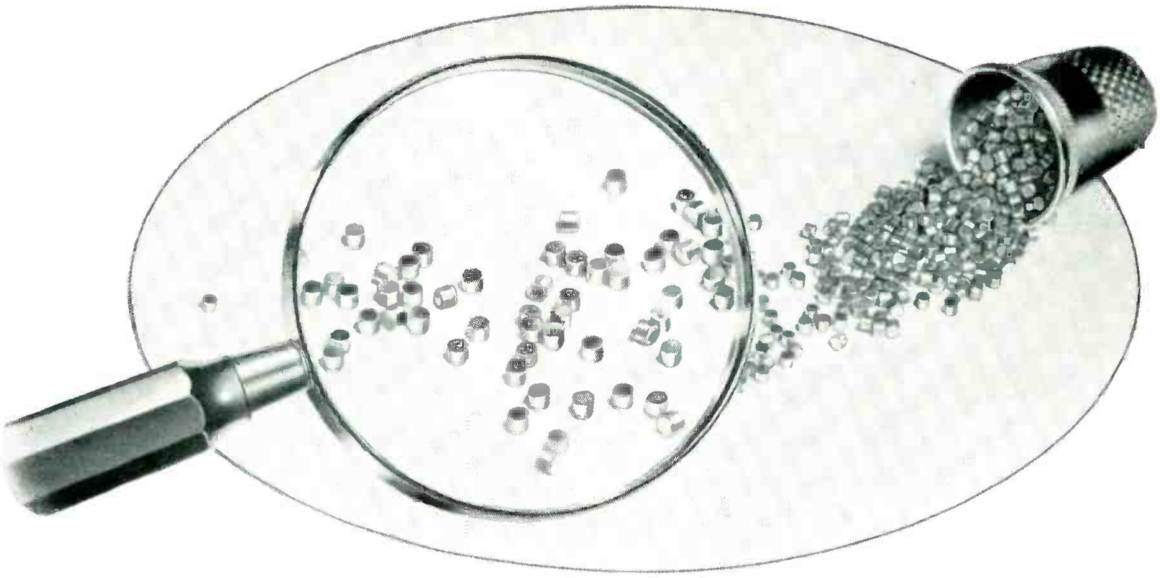
Transistor Equations (continued from p 156)

	GROUNDED BASE	GROUNDED EMITTER	GROUNDED COLLECTOR
INPUT RESISTANCE R_{IN}	$= r_e + r_b\left[1 - \frac{\alpha}{1+\frac{R_L}{r_c+r_b}}\right]$ IF $R_L \ll r_c$ $\cong r_e + r_b(1-\alpha)$	$= r_b + r_e\left[\frac{\frac{r_c+R_L}{r_c+r_b}}{\frac{R_L+r_e}{r_c+r_b}+(1-\alpha)}\right]$ IF $r_b \ll r_c$, $r_e \ll R_L$ $\cong r_b + r_e\left[\frac{1+\frac{R_L}{r_c}}{1-\alpha+\frac{R_L}{r_c}}\right]$ IF IN ADDITION $R_L \ll r_c$ $\cong r_b + \frac{r_e}{1-\alpha}$	$= r_b + \frac{r_c}{1+\frac{(1-\alpha)(r_c+r_b)}{R_L+r_e}}$ IF $r_b \ll r_c$ THIS IS EQUIVALENT TO 
OUTPUT RESISTANCE R_{OUT}	$= (r_c+r_b)\left[\frac{r_e+r_b(1-\alpha)+R_G}{r_e+r_b+R_G}\right]$ IF $r_b \ll r_c$ $\cong r_c\left[\frac{r_e+r_b(1-\alpha)+R_G}{r_e+r_b+R_G}\right]$	$= r_c\left[\frac{\left[1+\frac{r_b+R_G}{r_c}\right]\left[r_e+(1-\alpha)r_b\right]+R_G(1-\alpha)}{r_e+r_b+R_G}\right]$ IF $r_b+R_G \ll r_c$ $\cong r_c\left[\frac{r_e+(1-\alpha)(r_b+R_G)}{r_e+r_b+R_G}\right]$	$= r_e + \frac{(1-\alpha)(r_c+r_b)}{1+\frac{r_c}{R_G+r_b}}$ IF $r_b \ll r_c$ THIS IS EQUIVALENT TO 
OPERATING GAIN = POWER TO LOAD / MAX. POWER FROM GEN.	$= \frac{4R_LR_G\alpha^2}{\left\{\left[\frac{R_L}{r_c+r_b}\right]\left[r_e+r_b+R_G\right]+\left[r_e+R_G+r_b(1-\alpha)\right]\right\}^2}$ IF $R_L \ll r_c$ $\cong \frac{4R_LR_G\alpha^2}{[r_e+R_G+r_b(1-\alpha)]^2}$	$= \frac{4R_GR_L\left[\alpha-\frac{r_e+r_b}{r_c+r_b}\right]^2}{\left\{[r_e+r_b]\left[1+\frac{R_L}{r_c+r_b}\right]+R_G\left[1+\frac{R_L+r_e}{r_c+r_b}\right]-\alpha[r_b+R_G]\right\}^2}$ IF $R_L+r_e \ll r_c$, $r_e+r_b \ll r_c$ $\cong \frac{4R_GR_L\alpha^2}{[r_e+(1-\alpha)(r_b+R_G)]^2}$	$= \frac{4R_G}{R_L\left\{\left[1+\frac{r_e}{R_L}\right]\left[1+\frac{r_b+R_G}{r_c}\right]+[1-\alpha]\left[\frac{r_b+R_G}{R_L}\right]\left[1+\frac{r_b}{r_c}\right]\right\}^2}$ IF $r_e \ll R_L$, $r_b+R_G \ll r_c$ $\cong \frac{4R_G}{R_L\left[1+\left(\frac{r_b+R_G}{R_L}\right)(1-\alpha)\right]^2}$
INSERTION GAIN = POWER TO LOAD / POWER GEN. WOULD DELIVER TO SAME LOAD	$= \left[1+\frac{R_G}{R_L}\right]^2 \frac{\alpha^2R_L^2}{\left\{[r_e+r_b+R_G]\left[1+\frac{R_L}{r_c+r_b}\right]-\alpha r_b\right\}^2}$ IF $R_L \ll r_c$ $\cong \left[1+\frac{R_G}{R_L}\right]^2\frac{\alpha^2R_L^2}{[r_e+R_G+r_b(1-\alpha)]^2}$	$= \frac{\left[1+\frac{R_G}{R_L}\right]^2\left[\alpha-\frac{r_e+r_b}{r_c+r_b}\right]^2}{\left\{\left[\frac{r_e+r_b}{R_L}\right]\left[1+\frac{R_L}{r_c+r_b}\right]+\frac{R_G}{R_L}\left[1+\frac{R_L+r_e}{r_c+r_b}\right]-\alpha\left[\frac{r_b+R_G}{R_L}\right]\right\}^2}$ IF $R_L+r_e \ll r_c$, $r_e+r_b \ll r_c$ $\cong \left[1+\frac{R_G}{R_L}\right]^2\left[\frac{\alpha R_L}{r_e+(1-\alpha)(r_b+R_G)}\right]^2$	$= \frac{\left[1+\frac{R_G}{R_L}\right]^2}{\left\{\left[1+\frac{r_e}{R_L}\right]\left[1+\frac{r_b+R_G}{r_c}\right]+\left[\frac{r_b+R_G}{R_L}\right]\left[1-\alpha\right]\left[1+\frac{r_b}{r_c}\right]\right\}^2}$ IF $r_e \ll R_L$, $r_b+R_G \ll r_c$ $\cong \frac{[R_L+R_G]^2}{[R_L+(1-\alpha)(r_b+R_G)]^2}$
MAXIMUM AVAILABLE GAIN	$= \frac{\alpha^2(r_c+r_b)}{(r_e+r_b)}\times\frac{1}{(1+\beta_b)^2}$ $\beta_b=\sqrt{\frac{r_e+(1-\alpha)r_b}{r_e+r_b}}$ IF $r_b \ll r_c$ $= \frac{\alpha^2 r_c}{(r_e+r_b)(1+\beta_b)^2}$	$= \frac{\left[\frac{r_e+r_b}{r_c+r_b}-\alpha\right]^2}{\left[\frac{r_e+r_b}{r_c+r_b}\right]\left[\frac{r_e}{r_c+r_b}+(1-\alpha)\right]\left[1+\beta_e\right]^2}$ $\beta_e=\sqrt{\frac{[r_c+r_b]\{r_e+(1-\alpha)r_b\}}{[r_e+r_b][r_e+(1-\alpha)(r_c+r_b)]}}$ IF $r_e+r_b \ll r_c$, $r_b \ll r_c$ $\cong \frac{r_c}{r_e+r_b}\times\frac{\alpha^2}{1-\alpha}\times\frac{1}{(1+\beta_e)^2}$ $\beta_e \cong \sqrt{\frac{r_c[r_e+(1-\alpha)r_b]}{[r_e+r_b][r_e+(1-\alpha)r_c]}}$	$= \frac{1}{\left[\frac{r_b+r_c}{r_c}\right]\left[\frac{r_e}{r_c}+\frac{(1-\alpha)(r_c+r_b)}{r_c}\right]\left[1+\beta_c\right]^2}$ $\beta_c=\sqrt{\frac{r_e+(1-\alpha)r_b}{r_e+(1-\alpha)(r_c+r_b)}}$ IF $r_b \ll r_c$, $r_e \ll r_c$ $\cong \frac{1}{(1-\alpha)(1+\beta_c)^2}$ $\beta_c \cong \sqrt{\frac{r_e+(1-\alpha)r_b}{r_e+(1-\alpha)r_c}}$
LOAD AND GEN RES. FOR MAX AVAIL GAIN R_{GM}	$= (r_e+r_b)\beta_b$	$= (r_e+r_b)\beta_e$	$= (r_c+r_b)\beta_c$ IF $r_b \ll r_c$ $\cong r_c\beta_c$
LOAD AND GEN RES. FOR MAX AVAIL GAIN R_{LM}	$= (r_c+r_b)\beta_b$ IF $r_b \ll r_c$ $\cong r_c\beta_b$	$= \left[r_e+(1-\alpha)(r_c+r_b)\right]\beta_e$ IF $r_b \ll r_c$ $\cong \left[r_e+(1-\alpha)r_c\right]\beta_e$	$= \left[r_e+(1-\alpha)(r_c+r_b)\right]\beta_c$ IF $r_b \ll r_c$ $\cong \left[r_e+(1-\alpha)r_c\right]\beta_c$

Millions of Cycles of Contact Life...



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ELECTRONS AT WORK

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Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Electroluminescent Screens

DIRECT TRANSFORMATION of electrical energy into light through electroluminescence is becoming increasingly important in the lighting field, but even more important uses may lie ahead in the field of electronics.

Electroluminescence is the property of certain materials that causes them to emit light when placed in a fluctuating electric field. It may be produced by a device comprising a film of phosphor dispersed in the dielectric between two conducting plates. Such a luminous capacitor is shown in Fig. 1. One plate is of electrically-conducting glass while the other is formed by coating the dielectric with vaporized aluminum. Another type of luminous capacitor consists of a pair of enameled copper wires in close contact wound side-by-side on a glass tube. Phosphor suspended in oil is brushed over the wires and luminescence produced by an alternating potential of about 200 volts.

Present applications include illuminated clock faces, instrument dials, dashboard and cockpit lights.

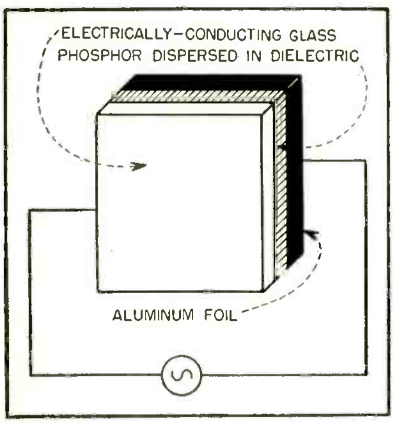


FIG. 1—Electroluminescent screen resembles ordinary capacitor

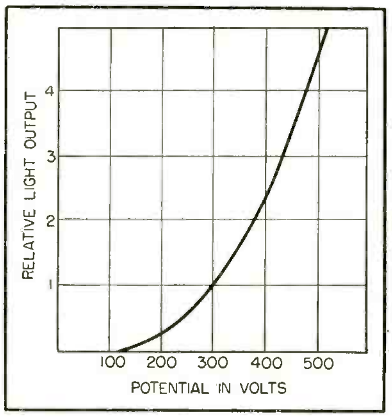


FIG. 2—Relative light output versus voltage at constant frequency

These lamps are characterized by instantaneous operation and smooth dimming to extinction through control of applied alternating potential.

Intensity of emitted light depends upon thickness, resistivity and dielectric constant of the phosphor and the frequency and magnitude of the applied potential. Figure 2 shows the variation in light output with voltage for a 60-cps alternating potential. Figure 3 shows the relation between light output and frequency; the potential was held constant at 100 volts. A given amount of light is emitted each time the luminous capacitor is charged to a given voltage. The more times per second this occurs, the greater will be the amount of light emitted.

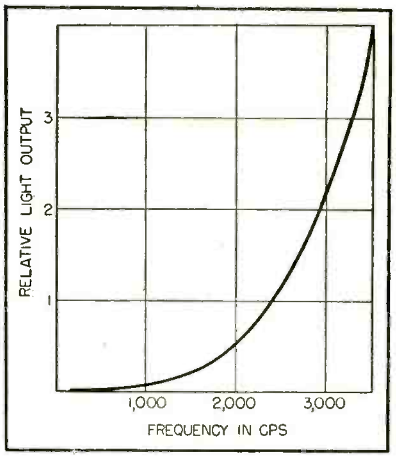
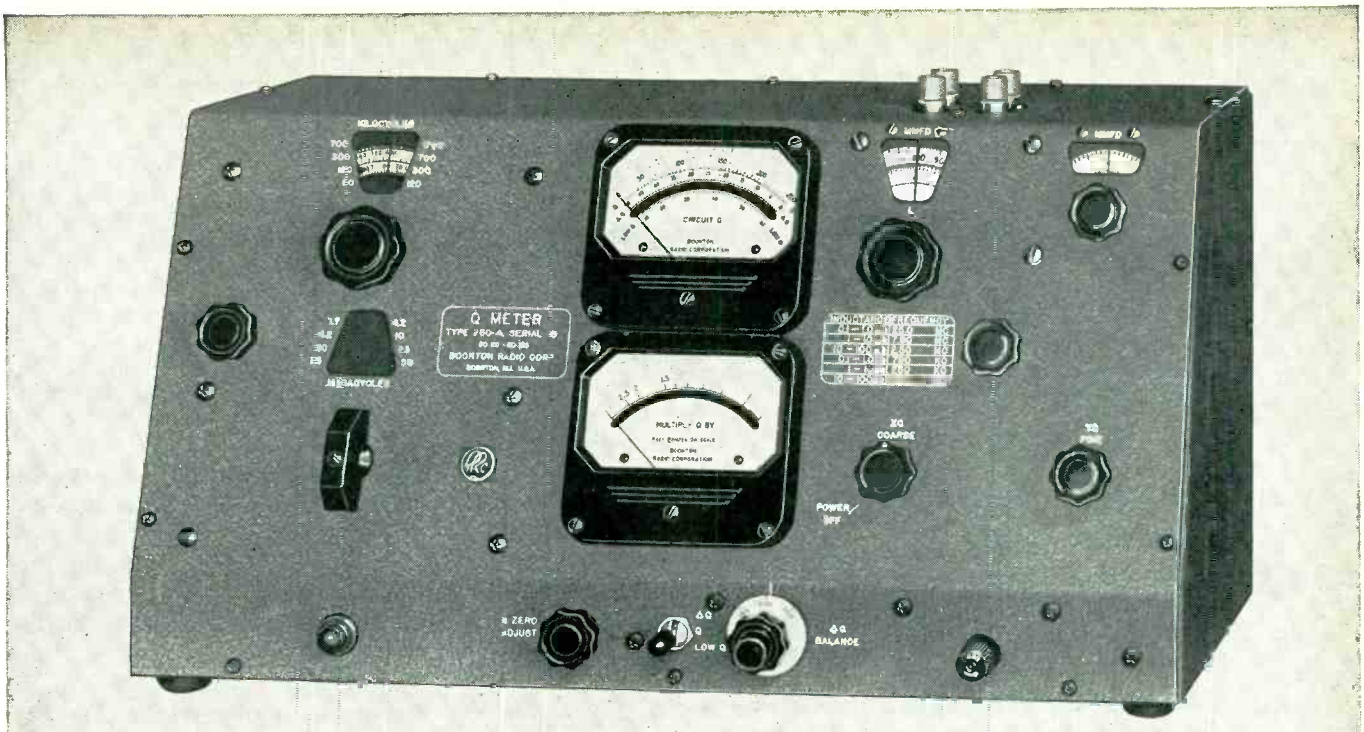


FIG. 3—Relative light output versus frequency at constant voltage

The luminous capacitor is being investigated as a possible substitute for cathode-ray tubes.

Although no perceptible color change occurs as a luminous capacitor is dimmed, a definite color change has been observed with variable frequency operation. A lamp that luminesced yellow-green at 60 cps can be made to glow pale-blue-green at 3,000 cps. This



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SPECIFICATIONS:

FREQUENCY COVERAGE: 50 KC to 50 MC Continuously variable in eight ranges.

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Main Tuning Dial: 30 to 450 mmf (direct reading) calibrated in 1.0 mmf increments from 30 to 100 mmf: 5.0 mmf increments from 100 to 450 mmf.
Vernier: —3.0 to +3.0 mmf (direct reading) calibrated in 0.1 mmf increments.

ACCURACY OF RESONATING CAPACITOR:
Main Tuning Dial: Approximately ±1% or 1.0 mmf, whichever is the greater.
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property has suggested several additional uses for the luminous capacitor.—J.M.C.

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Voltage Regulator Tubes

By Walter R. Jones

Panel on Electron Tubes Research and Development Board New York, N. Y.

USE OF VOLTAGE REGULATOR tubes in military equipment is increasing. As the many uses for these tubes increase, difficulties encountered in their applications will likewise increase. Certain fundamental characteristics of a voltage-regulator tube must be considered if reliability and satisfactory performance are to be obtained.

Voltage regulator tubes are usually recommended for use under various conditions of current drain from 5 milliamperes to 30 or 40 milliamperes as shown in Table I.

Essentially, voltage-regulator tubes of the glow-discharge variety contain a cathode, usually cylindrical in shape, of relatively large area, and a relatively small anode. Upon the cathode is deposited a thin film of some material that serves as an activator. The electrodes are sealed in a bulb containing an inert gas—argon, helium, neon, krypton or a mixture of gases at pressures that may be as low as a few millimeters to more than a centimeter of mercury, depending upon the operating conditions under which regulation is desired. Figure 1 indicates the basic structure of a glow-type regulator tube.

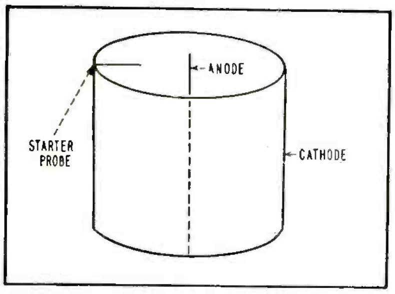

FIG. 1—Voltage-regulator tube structure

Table I shows that the minimum plate current for these tubes is 5 milliamperes while the maximum varies from 30 to 40 milliamperes depending upon the tube type. Frequently a voltage regulator tube is employed as a reference tube where the drain is less than 5 milliamperes. Erratic performance is obtained under these conditions owing to the fact that only a small amount of the cathode surface is covered by the glow.

In applications of this sort the use of a voltage-reference tube is required if reliable operation is to be obtained. In instances where a reference tube is not employed, the current drain must be increased to at least 5 milliamperes if satisfactory operation is to be obtained with a voltage-regulator tube.

The second part of Table I shows the characteristics of two voltage-reference tubes that are currently available.

It is a characteristic of glow-regulator tubes that the current density remains constant so that the cross-sectional area over which current flows varies instead. Thus when the current is small, the glow does not cover the whole of the cathode surface but concentrates on a part of it. As the current is increased, the area of the cathode covered by the glow increases linearly with the total current.

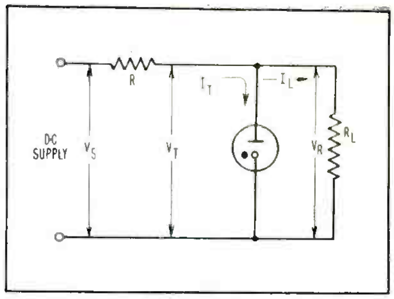

FIG. 2—Parameters for proper operation explained in text

Under many conditions of operation if the voltage-regulator tube is observed it will be noticed that the active glow area within the tube shifts considerably. This shifting that occurs within the tube accounts for small variations in the regulated voltage developed across the tube itself. This effect is sometimes referred to as jitters.

During the long-time life of the tube the voltage regulation may change and the regulated voltage will increase. This results from partial cleaning up of the activator during life.

If the regulator tube is subjected to very high starting currents, the regulated voltage may require as long as 20 to 30 minutes to drop to its normal operating voltage. The regulation is affected by

Table I—Voltage Regulator and Reference Tubes

Tube type	Minimum current in ma	Maximum current in ma	Maximum breakdown D-C volts	D-C operating volts	Minimum breakdown in darkness D-C volts**
OA2*	5	30	185	150	225
OA3*	5	40	105	75	160
VR75					
OB2*	5	30	133	108	210
OB3	5	30	130	90	175
OC3	5	40	133	105	210
VR105					
VR150	5	40	185	150	225
5644*	5	25	130	95	***
5787	5	30	141	100	***
6073	5	30	185	150	***
6074	5	30	133	108	***
Voltage Reference Tubes					
5651*	1.5	3.5	115	87	160
5783	1.5	3.5	125	87	***

* Armed Services Preferred List.
** This is the minimum value if tube is held in dark for 24 hours before testing and tested in total darkness.
*** These values for the darkness test are currently being determined.

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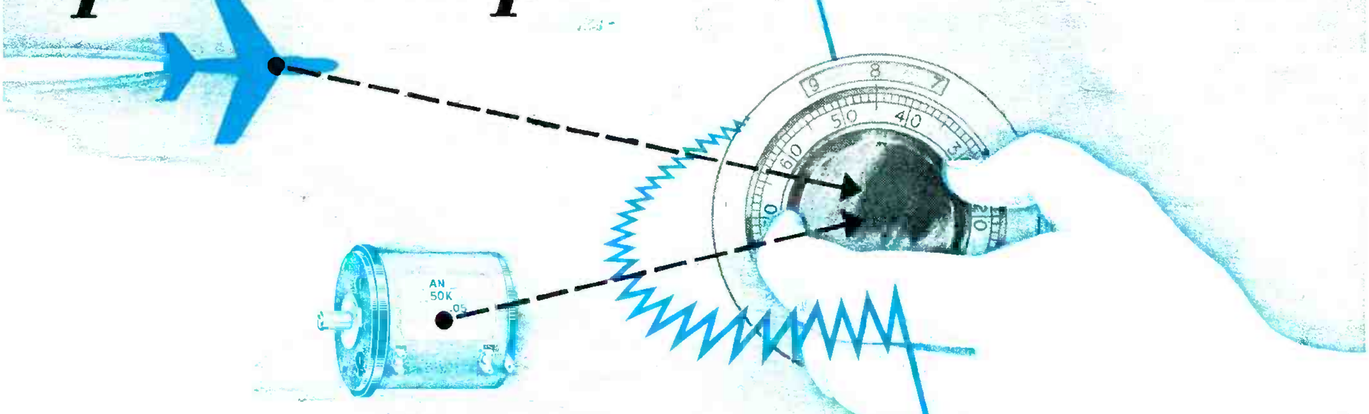

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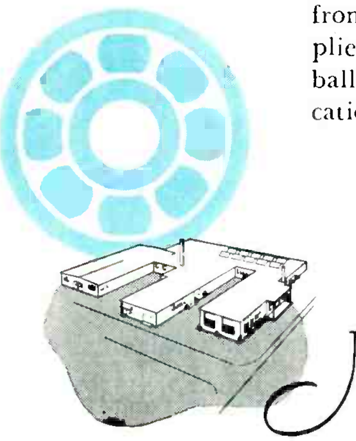

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changes in current within the operating range. Thus, if a tube that has been operating for a long time at low current is suddenly changed to higher current the regulated voltage value may be somewhat different from the value obtained after a long period of time at the higher current value. If a voltage-regulator tube is not used for awhile the regulated voltage will likewise require considerable time before it becomes stabilized.

The minimum d-c voltage required for breakdown of various voltage regulator tubes is shown in Table I. Voltages somewhat in excess of the values shown must be available to be certain that the tube will completely ionize so the proper d-c regulated voltages will be obtained. These values are also shown in Table I.

Ionization of these tubes is accomplished from three sources: photoelectric effects on the cathode from external light sources, radioactive effects from radiation and finally the field owing to voltage applied between the cathode and anode of the tube. The sum of these effects establishes the value of minimum breakdown voltage shown in Table I. If now the tube is operated under conditions of total darkness, then more voltage, perhaps as much as 50 or 60 volts, will be required for breakdown since the contribution from photoelectric radiation has been removed. Likewise, if the tube is mounted where radioactive radiation is completely removed, the breakdown voltage will also be increased.

It is important to determine whether the published ratings cover operation in the dark or in lighted areas. The conditions are specified on the rating sheets and these values will not be realized in service unless the operating conditions duplicate those under which the production tests are conducted.

Often it is desirable to shunt the voltage-regulator tube with a capacitor. It is necessary to keep the value of capacitance at or below 0.1 μf. If this value is exceeded instability and oscillations may occur.

In this discussion it has been assumed that the proper circuit design has already been completed. If the voltage regulator tube is to operate within its rated conditions there are three conditions that must be satisfied. These limiting conditions are given in Table I for several types of voltage regulator tubes.

Referring to Fig. 2 these conditions are:

(1) The voltage V_T supplied to the tube before firing is equal to or exceeds the minimum breakdown voltage specified in Table I. Thus the d-c supply voltage V_s must equal V_T plus the voltage drop across R when the only current flowing is that due to the load R_L.

(2) The current I_T flowing through the tube after breakdown is held above the minimum permissible value shown in Table I.

(3) The current I_T flowing through the tube after breakdown will not exceed the maximum value shown in Table I even if the load current should be reduced nearly to zero.

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PERTINENT PATENTS

For some time microwave spectroscopy has been reported from laboratories in the electronics and chemical industries as a means for analyzing the composition of gases and fluids. One use of this method has been detection of moisture in oil lines by a sweep frequency application of microwave energy to the oil line. The range of frequencies at which the line is swept includes the molecular absorption frequency of water.

An interesting patent in this field is number 2,602,835 granted to W. D. Hershberger and assigned to Radio Corporation of America. The invention covers the method and apparatus for microwave spectroscopy in the analysis of organic and inorganic gases.

Figure 1 shows the general arrangement of apparatus in Hershberger's technique. Microwave f-m energy is applied to a waveguide into which is inserted a gas cell. The gas cell may be continuous with a gas line, or a separate chamber, but in every case, it has microwave transparent seals into the waveguide. Microwave energy is detected after passing through the cell. Simultaneously the same microwave energy is applied to a standard of frequency through a directional coupler.

The frequency standard may be a resonant chamber operating at the molecular absorption frequency of the gas under analysis, or a standard gas chamber under con-

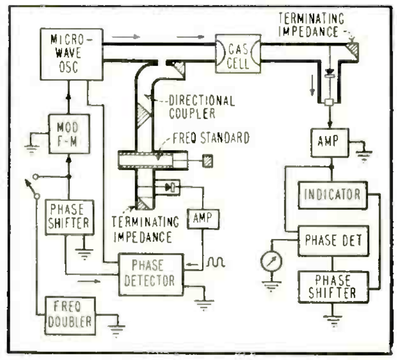

FIG. 1—Microwave spectroscopy apparatus provides comparison between gas chamber resonance and standard resonance

trolled conditions of temperature and pressure having the desired microwave molecular resonant frequency. Means are provided for controlling the modulation and center frequency of the microwave generator and for accurate comparison between the test gas-chamber resonance and the standard resonance. Indicators for the comparison are provided.

Computers

Computers employing electron tubes and circuits of all types are the subjects of increasing numbers of patents being issued currently. The inventions range from the comparatively simple but complicated looking circuit awarded patent number 2,603,415, issued to Daniel Silverman, J. D. Eisler and J. H. Huth, assignors to the Stanolind

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

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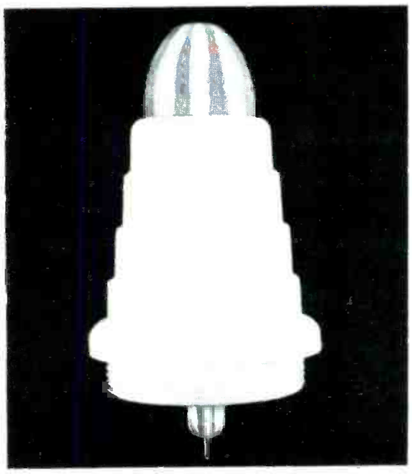
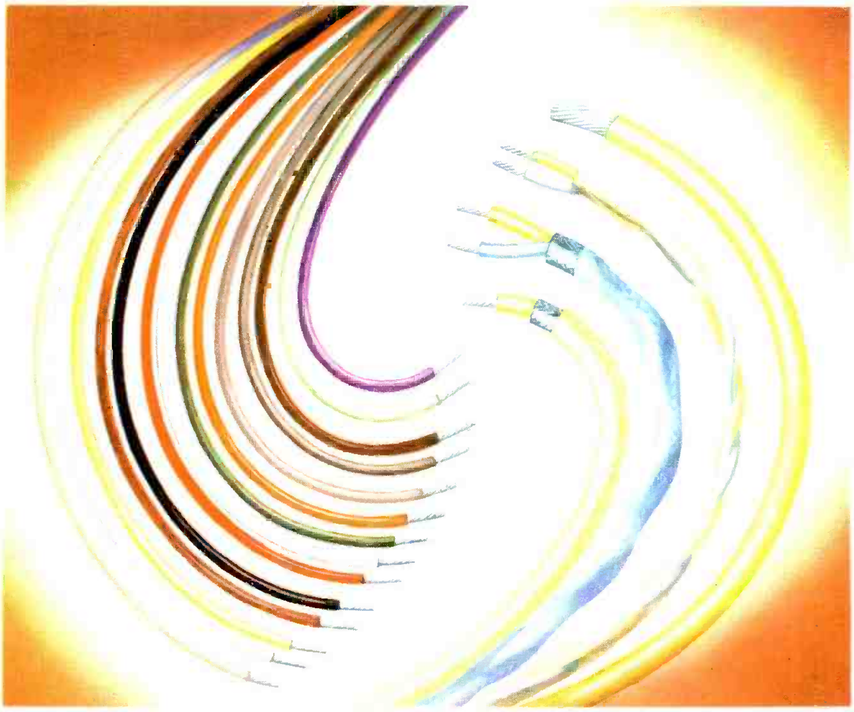




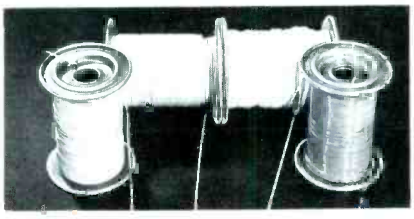
New Hook-up Wire with Extruded KEL-F* Insulation Solves Heat and Damage Problems

This new wire, coated with KEL-F*, is ideally suited for the totally-enclosed or hot wiring job where it solves the dual problem of heat and damage that has faced designers for years. *First*, even in the most cramped assembly jobs, a careless slip of a tool or soldering iron won't damage Kel-F — you can't split it with a hammer under normal conditions; it melts at about 410° F. *Second*, the insulation retains its *full* physical and dielectric properties at temperatures to 300° F. No leakage... no shorts.

Surprenant Mfg. Co. of Boston, Mass. was one of the first extruders to recognize these Kel-F qualities, and the company developed its own techniques for extruding an evenly balanced coating of the plastic on wire of all types. Early stranded single conductors have been followed by twisted paired wires individually insulated with Kel-F and encased with a jacket of Kel-F... then individually insulated wire — or a twisted pair — surrounded by braided metallic shielding and covered with a plastic jacket. Surprenant has also developed a wide range of color-coded wire — 13 colors in all.

All Surprenant wire coated with Kel-F polymers is marketed under the company's trade name "Surflene".

While resistance to heat and damage, and excellent insulating qualities are most important in the usual application, wiring installations for service in sub-zero or humid, tropic locations, or exposure to corrosive chemicals or vapors can utilize the unusual chemical inertness and 4 to 500 degree effective utility range of Kel-F to insure trouble-free performance.



Refer to Report E 101

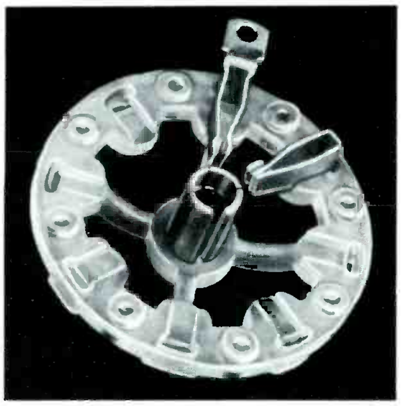
(SEE REVERSE SIDE)

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

CONTINUED FROM PRECEDING PAGE

KEL-F

FLUORO CHLORO CARBON PLASTIC



Early Application Demonstrates Major Advantages of KEL-F* in Design of Electrical Parts

The UHF socket pictured demonstrates a specific type of application for which Kel-F* polymers are especially suited. However, it also serves excellently to illustrate the unique combination of properties that has caused designers to specify Kel-F for many other electrical and electronic applications.

The two upper pictures illustrate the accuracy of the parts obtained by ordinary injection molding of Kel-F. Neither the molded socket base (top), nor the cover piece (middle) had to be "finished" in any way prior to assembly. Grommet holes, slots for contact clips, the slits through which connection terminals extend, and even supports and spacers . . . *all* were formed in a single injection molding operation for each piece . . . to such close tolerances that the contact clips on this particular socket provided the most positive electrical contact ever attained . . . resulted in a 2,000 RMS voltage rating.

Pressure Assembly Techniques can be used

The extraordinary mechanical strength of Kel-F polymers is demonstrated in the lower picture of the assembled socket. These tube sockets were assembled on a one-ton press . . . the mechanical properties of Kel-F permitted this type of pressure assembly without cracking or chipping.

The Brilhart Plastics Corporation of Mineola, N. Y., in undertaking the job of molding Kel-F into the two Kel-F insulators described here, pioneered the techniques for injection molding of intricate parts from trifluorochloroethylene.

Refer to Report E 102

New KEL-F Plant Slated for Early Operation . . . .

The new 1,000,000 pound plant for the production of Kel-F polymers is scheduled to go into full-scale operation within the next month. It is believed that the radically-increased production from these new facilities will completely relieve the tight supply situation which has existed because of the widespread use of Kel-F for defense projects . . . enabling industry to proceed into commercial production with the many projected applications of this unique fluoro-chloro-carbon material.

Molders of the Month

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

Chicago Die Mold Division
U. S. RUBBER COMPANY
Chicago, Ill.
Compression and Injection Molding
Valve Diaphragms
Military Components

Plax Corporation
Hartford, Conn.
Extruded Rod and Tubing
Molded Rod and Tubing
Molded Sheets (to 1/8" thick)
Injection Molding
Military Components

Resistoflex Corporation
Belleville, N. J.
Extruded Rod and Tubing
Compression Molded Sheets and Discs

Revere Corp. of America
Wallingford, Conn.
Coated Wire and Cable

United States Gasket Company
Camden, N. J.
Compression Molding
Gaskets and Packing
Extruded Rod and Tubing
Injection Molding
Military Components

The Visking Corporation
Terre Haute, Ind.
Extruded Thin Film
Extruded Lay-flat Tubing

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

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CHEMICAL MANFACTURING DIVISION

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

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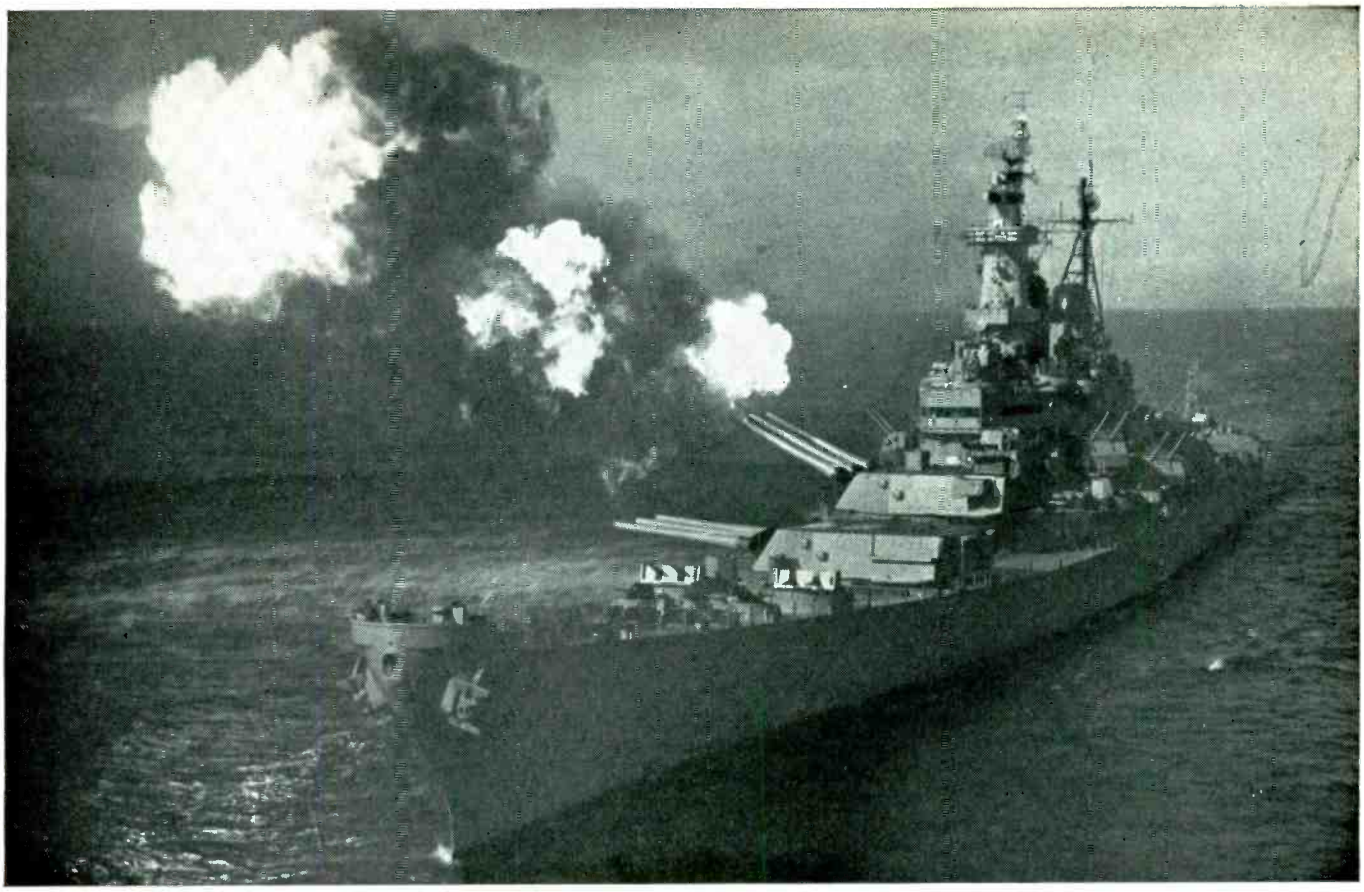
** Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymers*



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.

Oil and Gas Co., Tulsa, Okla., to the complex device incorporated in the Tristimulus Integrator invented by S. A. Loukomsky and E. I. Stearns, and awarded patent number 2,603,123, assigned to American Cyanamid Company, of New York.

In the "Electrical Computer" illustrated in Fig. 2 electrical resistance circuits in several meshes are employed to compute the economic factors of a distribution system. A series of adjustable impedances Z are so arranged that

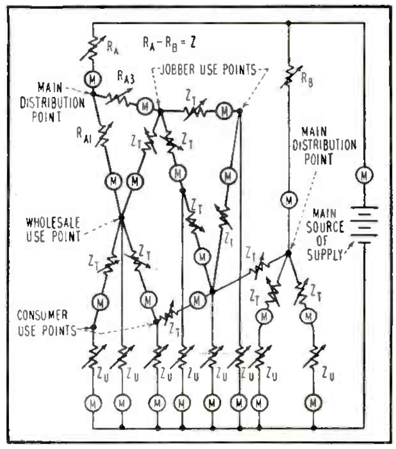


FIG. 2—Meters in mesh circuits indicate oil supplied to distribution points in this business-type computer

current flowing through each of them is proportional to the relative amount of goods (oil in this instance) that is to be supplied to use points from each distribution point. There is a variable impedance Z_U representing each use point and arranged so the current flowing through each impedance represents consumption of the goods at each associated use point.

A third set of impedances Z_T, is generally adjustable in nature and connects supply points to use points. They are called transportation units. If a use point is supplied by more than one source point, the corresponding number of transportation units will interconnect the appropriate points. Subsidiary distribution points corresponding to the jobber or wholesaler are appropriately connected, or if the producer is to distribute direct to consumer, a transportation unit connects between them. With the system connected to an appropriate set of connection devices such as pushbuttons, an oil company with several interconnecting pipe lines to its distribution centers and consumption areas may calculate by analogy the load requirements of its distribution system. Meters M will show each consumption or distribution point's requirements.

The tristimulus integrator is designed to compute the tristimulus values of colored samples. It is a physiological fact that the effect of light of any color can be specified by three numbers that are the relative amounts of each of the primaries to be mixed in order to produce a match. The apparatus incorporates a flickering beam spectrophotometer, as a driver for a pulse generator and a weighting system, output pulses of which are applied to a decade counter.

It has not been practical to use digital computers, according to the inventor, for integration of the tristimulus functions by the selected ordinate method because the maxima of tristimulus functions are so close together. Apparatus capable of producing electrical pulses proportional to reflectance or transmission of a number of closely spaced selected ordinates is not mechanically practical.

In the present invention the selected ordinates are divided into groups of varying spaces. The center unit of the selected group is then used by giving it a suitable weighting factor, in this case, in the simplest terms, based on the powers of two, as 2, 4, 8, 16, etc. The system is then in condition to be handled by binary electronic computers.

The wavelength drive of a re-

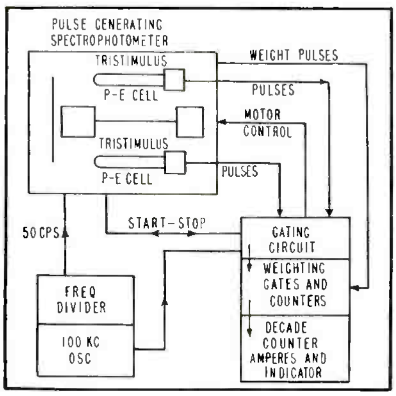


FIG. 3—Color matching is facilitated by tristimulus integrator that provides an accuracy of 1 part in 5,000

Need Precision Pots *NOW?*

CALL HELIPOT!

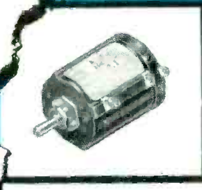
When you need top quality potentiometers fast, call Helipot . . . first in precision potentiometers!

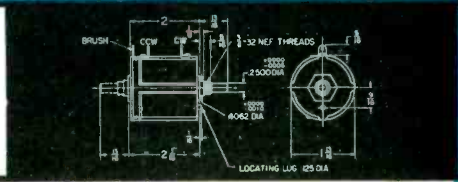
Shown on these pages are various types and ranges of Helipots—both single and multi-turn—that Helipot now stocks for immediate delivery. You can have stock prototypes immediately. On large orders for stock items, initial deliveries in substantial quantities will be made promptly, with balance on close schedule.

Prompt attention will be given your requirements for Precision Pots to your individual specifications.

Helipot's objective is to give you the same flexibility and efficiency as a department of your own company. Our trained personnel and unequalled facilities are ready to serve your needs, whether for standard units shown here or for special designs in quantity to meet particular applications.

For fast service, call the nearest representative listed below. Or write, wire or phone direct!





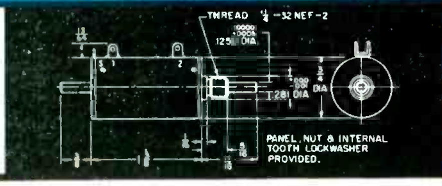
MODEL A HELIPOTS

The most widely adaptable of all multiturn Helipots. A 10-turn unit of convenient, compact size offering resolution accuracies 12 to 14 times that of conventional single-turn units of same diameter. 10-turn range permits direct decimal readings.

10-turns . . . Power rating 5 watts . . . Coil length 46.5" . . . Linearity tolerances: ±0.5% (Std. all values), (±0.1% 5K and up, ±0.25% below 5K).*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
25-AZ	25	3,000	.00071
50-AZ	50	3,200	.00071
100-AZ	100	3,800	.00071
200-AZ	200	4,750	.00071
500-AZ	500	4,000	.00002
1,000-AZ	1,000	5,000	.00002
2,000-AZ	2,000	6,500	.00002
5,000-AZ	5,000	7,200	.00013
10,000-AZ	10,000	9,000	.00013
20,000-AZ	20,000	10,000	.00013
30,000-AZ	30,000	11,500	.00013
50,000-AZ	50,000	12,500	.00013
100,000-AZ	100,000	15,000	.00013
200,000-AZ	200,000	15,500	.00013
300,000-AZ	300,000	16,000	.00013



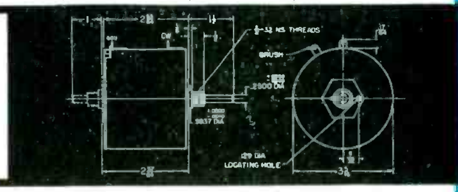
MODEL AJ HELIPOTS

The AJ is a high performance 10-turn helical potentiometer of miniature size (¾" dia.) and light weight (1 oz.). Available with bushing mount (AJ) or servo mount (AJS), both with sleeve bearings. Servo mount also available with precision ball bearings (AJSP).

10-turns . . . Power rating 2 watts . . . Coil length 18" . . . Linearity tolerance ±0.5% (Std.) . . . Starting torque 0.75 oz. in. . . . Wgt. 1 oz. . . . Dia. ¾".*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-AJZ	100	3,000	.00071
500-AJZ	500	2,500	.00002
1,000-AJZ	1,000	3,400	.00002
5,000-AJZ	5,000	4,250	.00013
10,000-AJZ	10,000	4,000	.00013
20,000-AJZ	20,000	5,350	.00013
30,000-AJZ	30,000	5,450	.00002
50,000-AJZ	50,000	6,550	.00002



MODEL B HELIPOTS

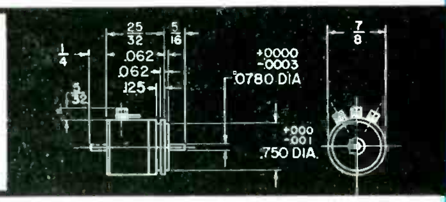
A large diameter (3-5/16") 15-turn Helipot with 139" slide wire length providing the highest resolution (.01% to .003%) and adjustment accuracy available today in a standard mass-production unit. Rugged, dependable, low in cost.

15-turns . . . Power rating 10 watts . . . Coil length 139" . . . Linearity tolerance ±0.5% (Std.).*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
1,000-BZ	1,000	10,900	.00002
5,000-BZ	5,000	19,600	.00002
10,000-BZ	10,000	17,700	.00013
25,000-BZ	25,000	21,800	.00013
50,000-BZ	50,000	25,400	.00013
100,000-BZ	100,000	34,100	.00013

Please note that 1000 volts is highest that may be applied across coil regardless of resistance value.



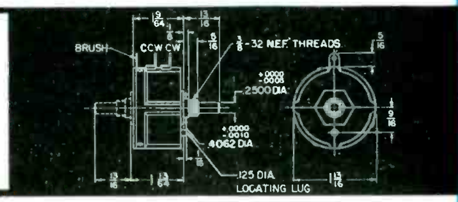
MODEL T HELIPOTS

A single-turn, continuous-rotation servo-mounting unit of minimum weight (0.56 oz.) requiring very small cubic space and operating with negligible torque. Shaft rotates on precision ball bearings—unit built throughout to highest possible precision.

1-turn . . . Power rating ½ watt . . . Coil length 2" . . . Linearity tolerance ±0.5% (Std.) . . . Starting torque .015 in. oz. (Running torque is negligible) . . . Wgt. 0.56 oz.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
1,000-TZ	1,000	705	various
2,000-TZ	2,000	750	various
5,000-TZ	5,000	800	various
10,000-TZ	10,000	1,650	various
20,000-TZ	20,000	1,500	.00002
25,000-TZ	25,000	1,500	.00002
30,000-TZ	30,000	1,400	.00002
50,000-TZ	50,000	1,400	.00002
100,000-TZ	100,000	1,500	.00002



MODEL C HELIPOTS

Identical in general design to Model A except has only 3 helical turns of resistance winding and proportionately shorter length. Ideal for high-accuracy applications with restricted behind-panel depths.

3-turns . . . Power rating 3 watts . . . Coil length 13½" . . . Linearity tolerance ±0.5% (Std.) . . . Behind-Panel Length 1-9/64".*

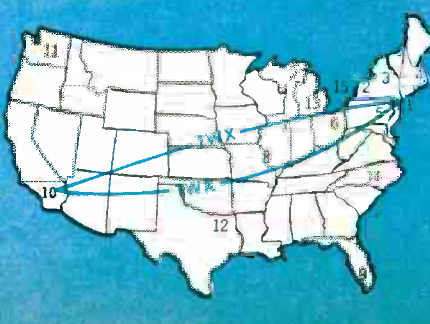
TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
10-CZ	10	1,000	.00071
50-CZ	50	1,390	.00071
100-CZ	100	1,100	.00002
500-CZ	500	1,850	.00002
1,000-CZ	1,000	1,360	.00013
5,000-CZ	5,000	2,500	.00013
10,000-CZ	10,000	3,100	.00013
20,000-CZ	20,000	3,900	.00013
30,000-CZ	30,000	4,400	.00013
50,000-CZ	50,000	4,250	.00013

*ON SPECIAL ORDER most of the above potentiometers are available with Rear Shaft Extensions . . . Extra Spot Welded Taps at any location . . . Ganged Assemblies . . . Special Temp. Coefficients, Resolutions, etc. Write for details!

Design details on above units subject to change without notice. Certified drawings available on request.

Engineering Sales Representatives are located near you to assure personal attention. Teletype connects our New York, Boston, Chicago and Los Angeles offices for rapid information on orders and deliveries. And our Mountainside, New Jersey plant, now under construction, will soon be in production to further assist you.



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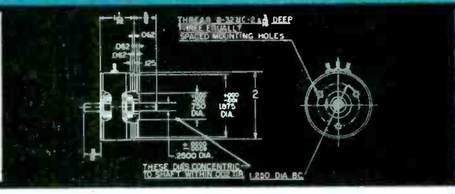


MODEL J HELIPOTS

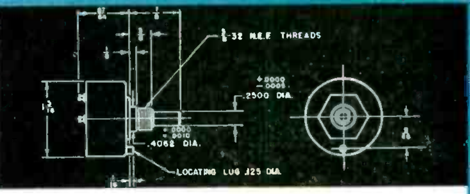
First production potentiometer equipped with ball-bearing shaft supports as standard and 3-way servo-type mounting. Ganged assemblies can be independently phased after installation without external clamps or brackets.

1-turn . . . Power rating 5 watts . . . Coil length 5½". . . 360° Cont. Mech. Rotation . . . Linearity tolerance ±0.5% . . . Starting torque 1.0 ± .25 oz. in.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-JZ	100	630	.00002
1,000-JZ	1,000	875	.00017
5,000-JZ	5,000	1,300	.00017
10,000-JZ	10,000	1,475	.00017
20,000-JZ	20,000	1,900	.00017
30,000-JZ	30,000	1,975	.00017
50,000-JZ	50,000	2,260	.00002

Please note that 400 volts is highest that may be applied across coil regardless of resistance value.

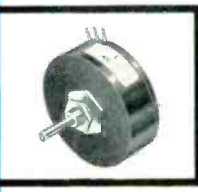
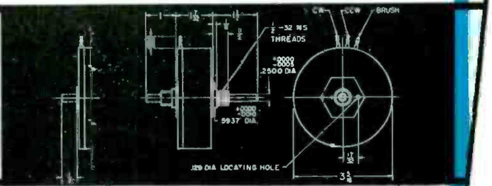
MODEL G HELIPOTS

A small, extra rugged single-turn pot developed initially for aircraft servo mechanisms. Its compact size, high accuracy, long life make it ideal for many instrumentation and servo-mechanism applications.

1-turn . . . Power rating 2 watts . . . Coil length 3¼". . . 360° Cont. Mech. Rotation . . . Linearity tolerance ±0.5% (Std.) . . . Wgt. 2 Oz. . . . Dia. 1-5/16".*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
10-GZ	10	300	.00071
100-GZ	100	400	.00002
500-GZ	500	500	.00013
1,000-GZ	1,000	650	.00013
5,000-GZ	5,000	750	.00013
10,000-GZ	10,000	950	.00013
20,000-GZ	20,000	1,200	.00013

MODEL F HELIPOTS

A 3" dia. single-turn high-precision potentiometer with continuous mechanical rotation and minimum dead spot between electrical ends. Versatile in application. Ideal where continuous rotation simplifies circuitry.

1-turn . . . Power rating 5 watts . . . Coil length 9¼". . . Linearity tolerance ±0.5%.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-FZ	100	800	.00002
500-FZ	500	1,300	.00002
1,000-FZ	1,000	1,200	.00013
5,000-FZ	5,000	2,000	.00013
10,000-FZ	10,000	2,500	.00013
20,000-FZ	20,000	2,700	.00013
50,000-FZ	50,000	4,000	.00013
100,000-FZ	100,000	5,000	.00002

Please note that 400 volts is highest that may be applied across coil regardless of resistance value.

NOT CARRIED IN STOCK but quickly available on order

MODELS AN and CN HELIPOTS

Mechanically precise, highly linear potentiometers of same general dimensions as Models A and C, except have servo-mountings, ball-bearing shafts and are built to highest precision possible. Have approximately 2:1 advantage in linearity accuracies over corresponding A and C Helipots. (Model AN linearity tolerances as close as ±.025% in values of 5K and above.)

AN (10-turns) resistance ranges, 100 to 250,000 ohms . . . **CN** (3-turns) 30 to 75,000 ohms.

Write for full details on linearity tolerances, special features, etc.

MODELS D and E HELIPOTS

Large diameter (3-5/16"), wide range Helipots with extremely long resistance windings for highest possible resolutions coupled with close linearity tolerances.

Model D has 25 turns, 234" coil length, 9000° of rotation, is 4-9/64" deep behind the panel, and is available in ranges from 100 to 750,000 ohms.

Model E has 40 turns, 373" coil length, 14,400° of rotation, is 6-1/64" deep behind panel, resistances 200 to 1,000,000 ohms.

Write for full details on linearity tolerances, special features, etc.

OTHER UNIQUE HELIPOT PRODUCTS

MODEL RA Precision DUODIALS

A beautiful, precision-built, multi-turn dial of compact dimensions (1-13/16" dia.) for all types of quality multi-turn installations. Features unique "jump" mechanism that keeps secondary dial stationary until primary dial has completed a full turn—then secondary dial "jumps" to new position. A vibration-proof lock holds dial settings whenever desired.

Black nylon knobs, satin aluminum dials, quality "feel" and appearance throughout. Available in 10-turn design for use with 3 and 10-turn Helipots and in RAJ version for use with small AJ Helipots.

Write for full details.

MODEL W DUODIALS

A large diameter (4¾") multi-turn dial ideal for primary control applications. The inner dial shows the exact position of the slider on any multi-turn Helipot while the outer dial shows the particular turn on which the slider is moving. Thus with 10-turn units, readings can be made directly in decimal equivalents of total resistance winding.

Since primary dial is direct-connected to shaft, backlash is eliminated.

Available in 10:1, 15:1, 25:1, and 40:1 Ratios for use with various Helipot models as well as with other multi-turn equipment.

Write for full details.

LABORATORY HELIPOT—MODEL T-10A

This unit combines in a handsome walnut case a 10-turn Helipot, an "RA" Duodial, and three-way binding posts for quickly setting up and changing experimental or temporary circuits. Ideal for laboratory and instruction purposes . . . is far more compact, simpler and 5 times faster to set than decade boxes.

Power rating 5 watts . . . Linearity 0.1% . . . Standard Resistance Ranges 100 . . . 500 . . . 1,000 . . . 5,000 . . . 10,000 . . . 20,000 . . . 50,000 . . . 100,000 ohms in stock. Other ranges on order.

Write for full details.

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EXPORT AGENT: Frathom Company, 33 West 42nd Street, New York 36, New York, BRyant 9-1296 cording flickering beam spectrophotometer is arranged to gate a pulse generating system into the circuit at wavelengths of light corresponding to the selected ordinates, and to cut in the electronic gates to the counter circuits so the pulse generator applies pulses to the counter directly for ordinates of maximum weight, and to flip-flop circuits that precede the counter for lesser weights. For weights of, 1, 2, 4, 8, 16, and 32 there will be a total of five flip-flop circuits.

Ordinates bearing the weight 32, will open the gate circuit directly connecting the pulse generator to the counter. For an ordinate weighted 16 the last flip-flop before the counter is interposed between the pulse generator and the counter, and weights of 1 will open the first flip-flop circuit and so on. The number of pulses generated at each ordinate is proportional to the reflectance or transmission as measured by the spectrophotometer for that particular wavelength.

While a separate integrator could be set up for each primary wavelength the tristimulus integrator can be economically provided with switches to obtain as many tristimulus values as desired. An accuracy of 1 part in 5,000 is claimed for the system of this invention which is equal to or better than the accuracy of the human eye, for all practical purposes.

The system of the tristimulus integrator is illustrated in Fig. 3. It has been simplified considerably in block form.

Multiplex Telegraph

A recent patent for a "Multiplex Telegraph System Utilizing Electronic Distributors" was awarded to T. A. Hansen. The patent number 2,609,451 is assigned to Teletype Corp. of Chicago, Ill. It is the inventor's object to provide a multiplex telegraph system capable of higher speeds and an increased number of channels with great stability. The system provides means for ascertaining when specific channels are open, and for varying the speed at which transmission is carried in any channel. The distributors are all electronic as are all test and control facilities and the entire

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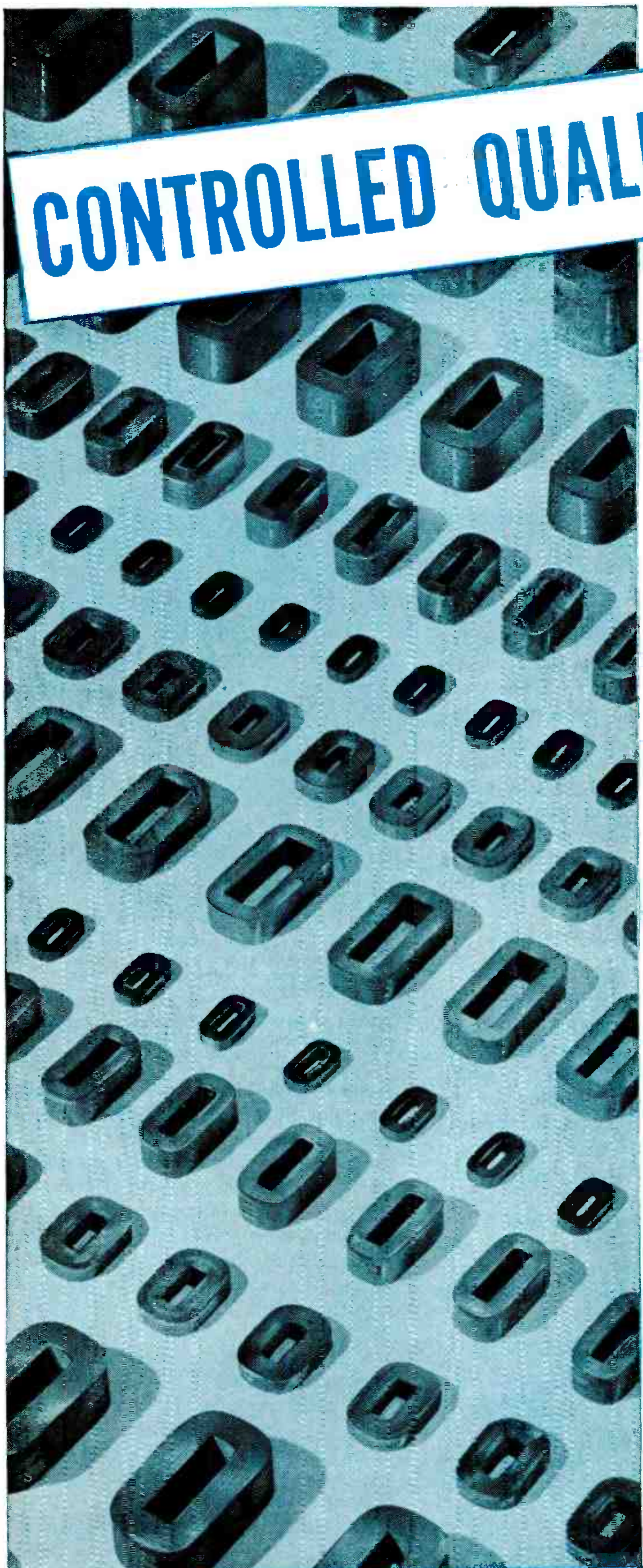

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Brass Plumbing Integral Part of Magnetron Tube

During World War II the magic word RADAR denoted a new and powerful secret weapon which proved instrumental in our ultimate victory. Today many advanced types of radars are being designed for both military and civilian use. Some military radars are fire control systems used to aim and fire different types of weapons. Others are search radars which detect enemy ships, planes, etc., in time to alert our defenses. Civilian radar is used by commercial ships and planes as a navigation aid to combat poor visibility.

Although these equipments all differ in their construction and application, they have one thing in common, a high frequency oscillator and output tube called a magnetron.

Military Magnetron

Illustrated is the RK2J56 Magnetron used in fire control radar equipment. This tube uses a special brass wave guide assembly to couple its output to the antenna system. All parts conducting high frequency waves such as the rectangular and circular sections are made from Red Brass tubing (approximately 85% copper and 15% zinc) because of its high resistance to corrosion and ability to take a good plate. A smooth mirror-like internal surface is necessary in order to properly reflect the high-frequency waves.

After the tubing is silver soldered in place, the internal surfaces are broached to remove any excess solder and to prepare them for either silver or bright alloy plating. The mounting bracket and flange are blanked from high brass (approximately 66% copper, balance zinc). The stock used for the flange must be extra flat to insure an airtight connection with the wave guide as the whole system is pressurized.

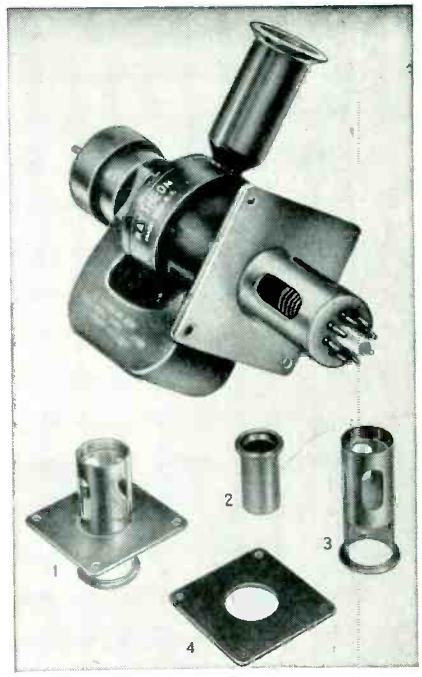
One end of the rectangular section is closed with a brass plug made in two sections. The bottom or inside surface is drawn from Red Brass sheet stock. The top or outer surface is blanked from high brass strip and the two sections are soldered together. A threaded mounting hole is located on top of the plug.

Civilian Magnetron

Magnetrons are also found in other types of high frequency equipment besides radar. The illustrated QK174 is a continuous-wave frequency-modulated magnetron used in television relay equipment. The plate support assembly consists of a high brass mounting plate 1/8" thick with four 3/16" mounting holes at the corners and a 1 1/4" hole in the center. A tubular section 3 1/4" x 1 1/4" made from free machining brass is inserted through the center hole in the mounting plate and silver soldered in place. The assembly is bright-alloy plated for greater protection from corrosion and then connected to the magnetron by means of three mounting screws inserted through one end of the tubular section. An octal tube socket is fitted on the other end of the tubular section enabling the magnetron to be plugged into the circuit. The whole unit is held in place by four screws which fasten the mounting plate securely to the transmitter chassis.

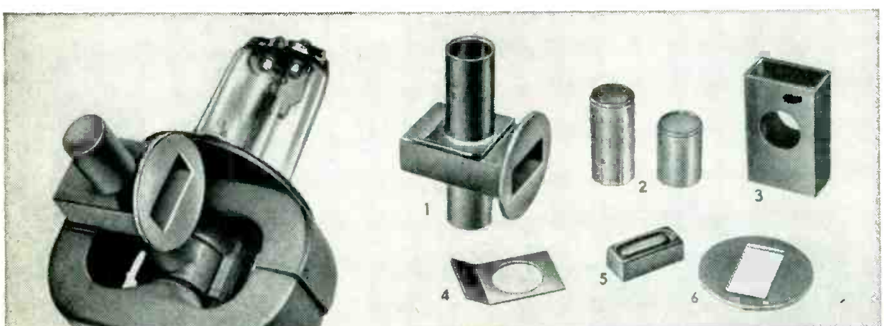
A brass coupler 1 7/8" long made from 1 1/4" free machining brass rod stock serves to couple the output of the magnetron to the wave guide system.

In high frequency applications a number of qualities such as machinability, conductivity, resistance to corrosion, and ability to solder and plate well, must be considered when choosing a copper-base alloy. Bridgeport Brass will be glad to help you determine the alloy best suited to meet your exacting requirements. (9419)



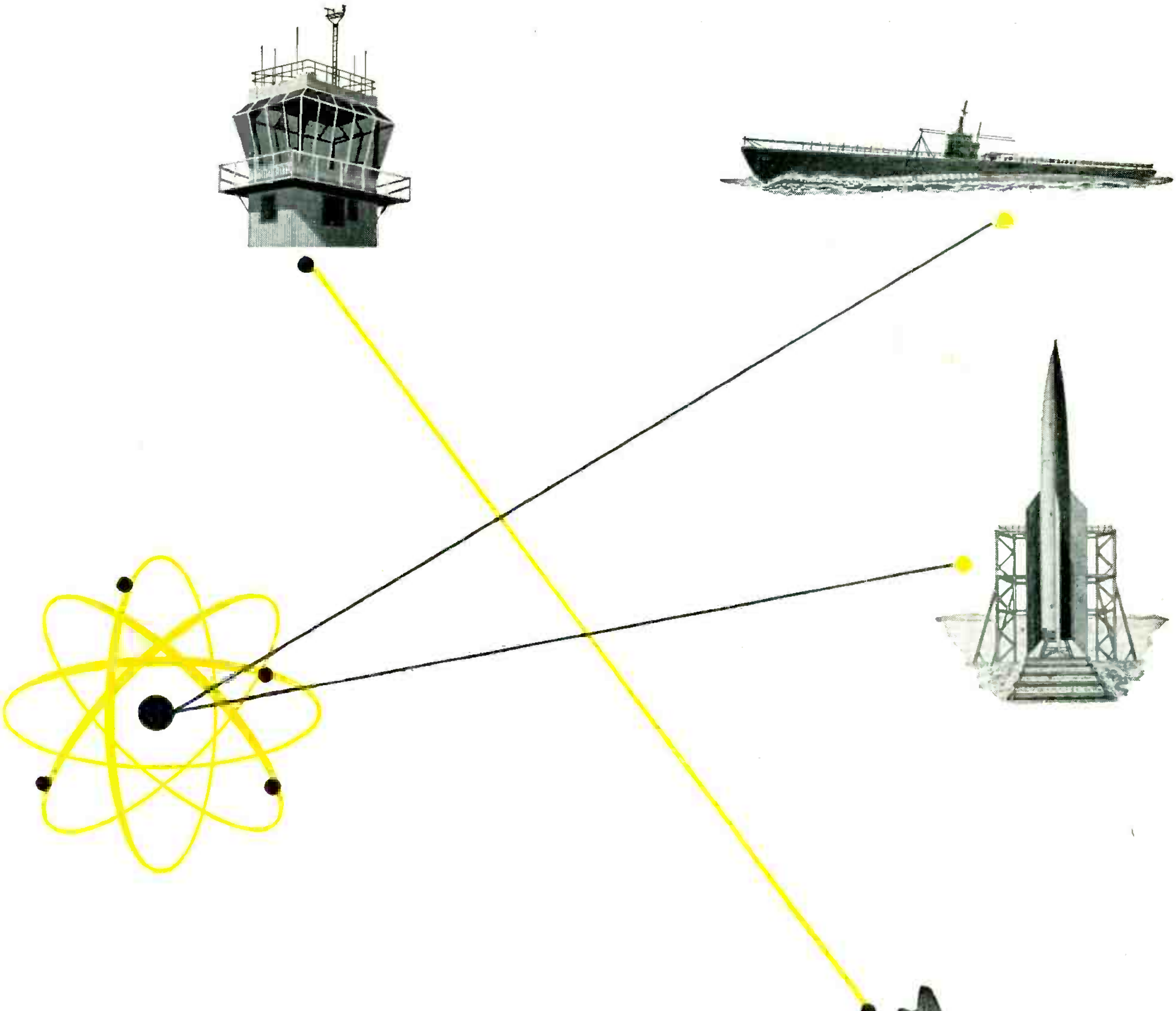
QK174 PLATE SUPPORT ASSEMBLY
1. Complete plate support assembly
2. Output coupler
3. Tubular section
4. Mounting plate

QK174 Magnetron and Plate Support Assembly. Courtesy Raytheon Manufacturing Co., Waltham, Mass.



RK2J56 WAVE GUIDE ASSEMBLY
1. Complete wave guide assembly
2. Tubular sections
3. Rectangular section
4. Mounting bracket
5. Plug
6. Flange

RK2J56 Magnetron and Wave Guide Assembly. Courtesy Raytheon Manufacturing Co., Waltham, Mass.



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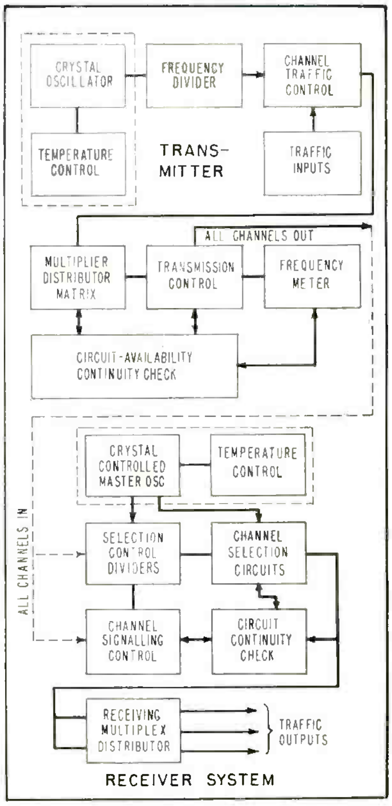

FIG. 4—Multiplex telegraph system is capable of higher speeds and greater stability

system is stabilized by precision quartz-crystal oscillators. It is possible to control the facilities to allow transmission from two, three or four signal sources to divide equally over any available number of channels in use. Twenty-three sheets of circuit diagrams are required to set forth the multiplex telegraph system. A block diagram of the system is shown in Fig. 4.

Magnetic Tape Performance

A system of testing the performance characteristics of magnetic tape used in sound recording is the subject of patent 2,610,230 granted to D. E. Weigand of the Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. The patent is assigned to the latter Foundation, and describes an "Integrator and Hysteresis Loop Tracer". Employing the pickup shown in Fig. 5 a magnetic tape sample is passed through the device wherein it is energized and de-energized by a 60-cycle field. Pickup loops in the device compare the energizing field with the flux density and magnetomotive force de-

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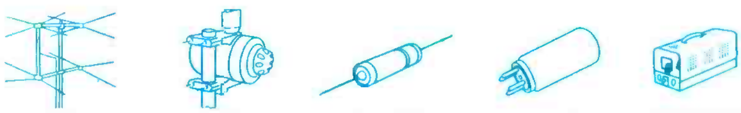

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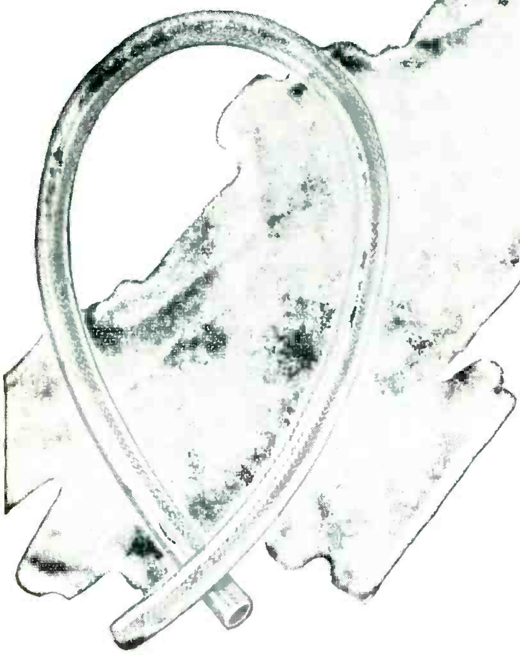

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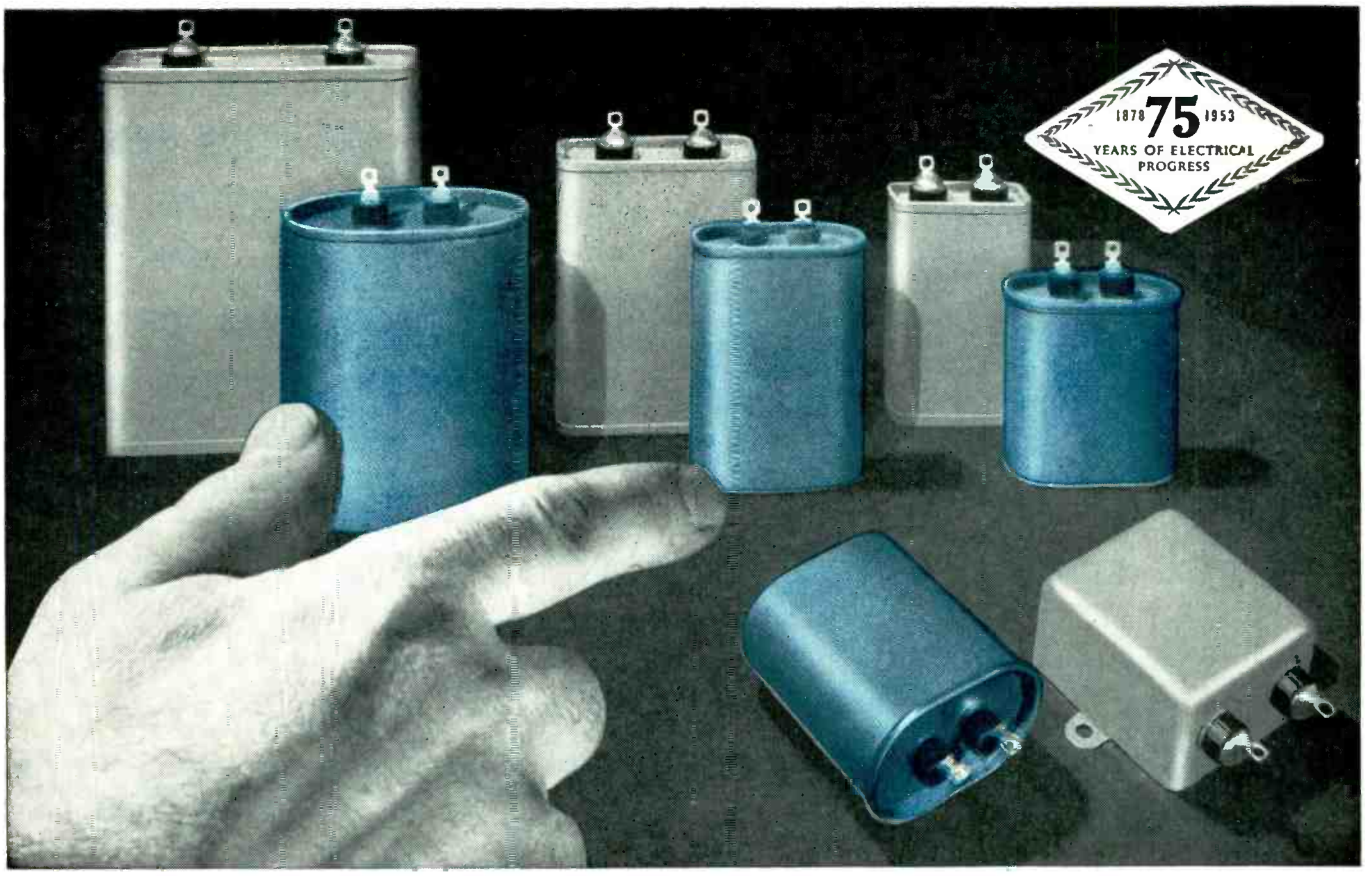

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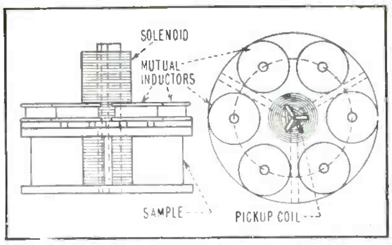

FIG. 5—Pickup device used with a magnetic tape sample when testing performance characteristics

veloped in the tape through an integrating circuit as shown in Fig. 6 to produce instantaneously a hysteresis loop display on a cathode-ray indicator. The novelty and particular advantage of the *B-H* curve tracer is embodied in the employment of fundamental magnetic and electric properties referred to the permeability of air in a fairly simple equipment that does not require the use of calibrating samples or the like.

Recently issued patents in the field of microwave antennas and waveguides tend towards directive means for these antennas, which essentially require no movement of the antenna structures. A patent issued to C.B.H. Feldman of Bell Telephone Laboratories, 2,594,409 describes several slot antenna arrays containing motive phase-shifting devices within the fixed antenna structure. In the illustration of Fig. 7, an example of this technique is shown. The motive member rotating within the waveguide-feed structure of a linear slotted antenna array shifts the phase relationship of the wavefronts applied to the slot to result in a variation in the direction of the radiated beam over a predetermined range. Apart from the movement of the elements

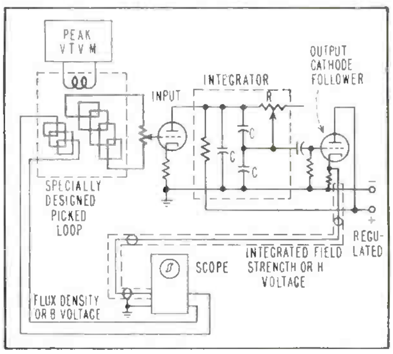

FIG. 6—Integrator circuits used with cathode-ray tube produce *B-H* display for magnetic tape

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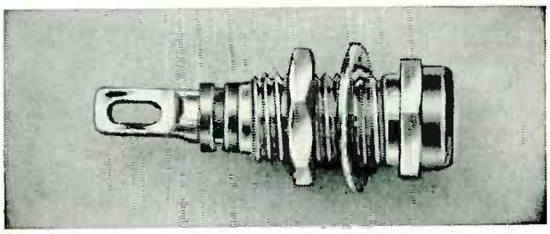
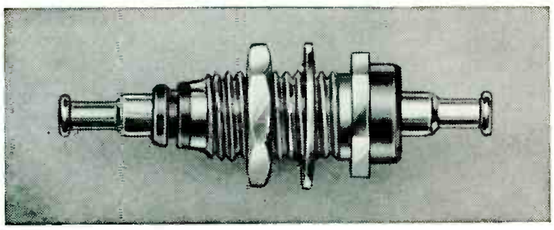


119052. *Same as 118930 but with special milled end with elongated hole for wiring.*



118984. *Feed through type, similar to 118930 but with one-piece brass terminal stud, tin-plated.*

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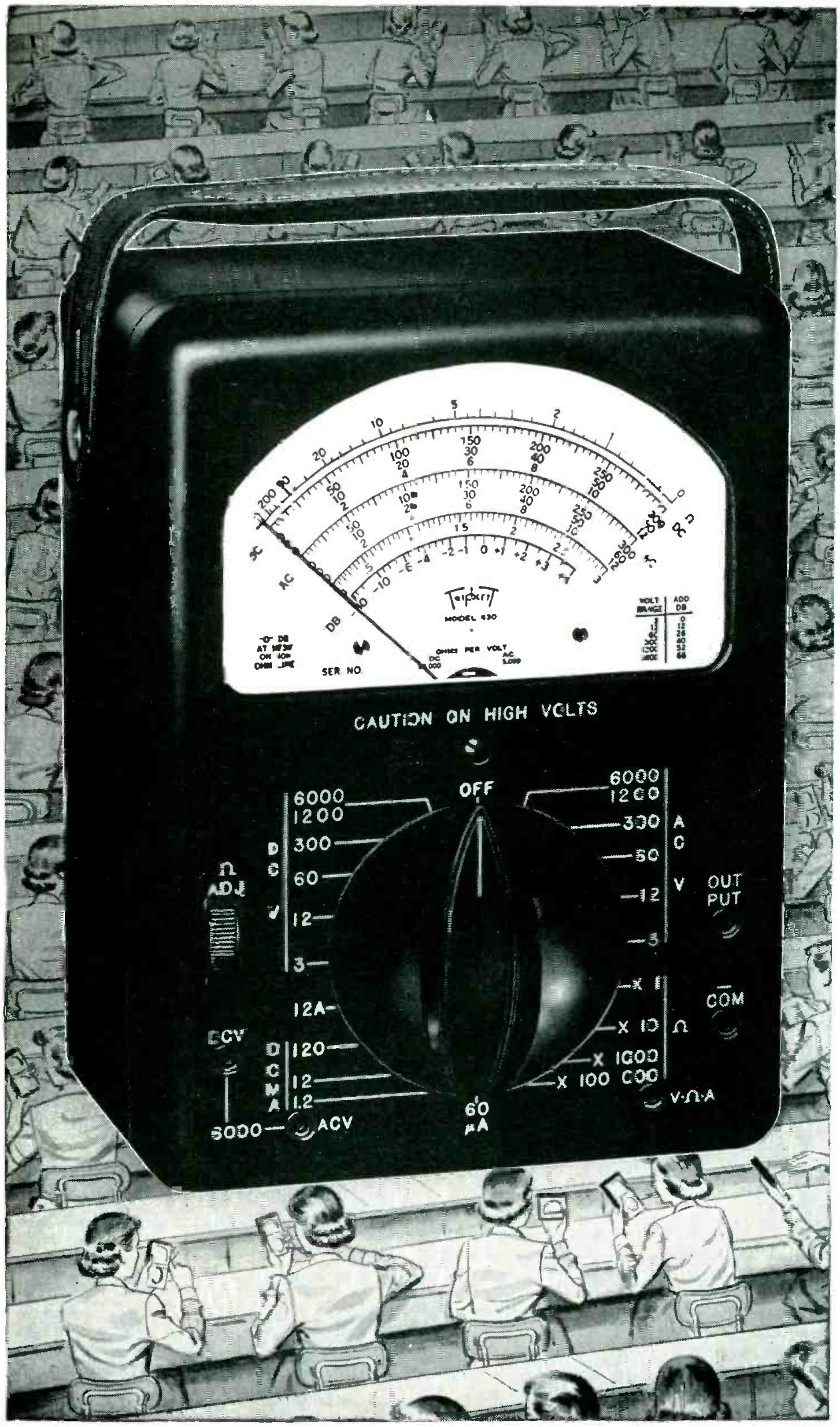

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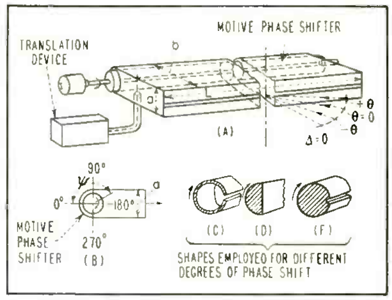

FIG. 7—Nonmechanical antenna director uses motor-driven phase shifter within a fixed antenna structure

within the antenna structure, the antenna is stationary with respect to the variation in beam direction. The patent shows many variations in structure, which include this technique.

The telephone system that is the subject of patent 2,609,455 issued to A. E. Bachelet assigned to the Bell Telephone Laboratories, is a thing that can be anticipated as a probable development in the use of cathode-ray beams for various applications, ranging from information-storage devices to the present invention. The use of a cathode-ray beam is disclosed in this invention to switch the connection between subscribers in a telephone system. The advantage of rapidity and the effective absence of inertia leads to consideration of the possibility of multiple-transmission multiplexing of two-way circuits with the switching accomplished by the application of circuits like those used in the deflection of the cathode-ray beam in tv cameras, receivers and in crt oscillographs.

A diagram of the circuit is shown in Fig. 8. A telephone subscriber's station is connected to the collector

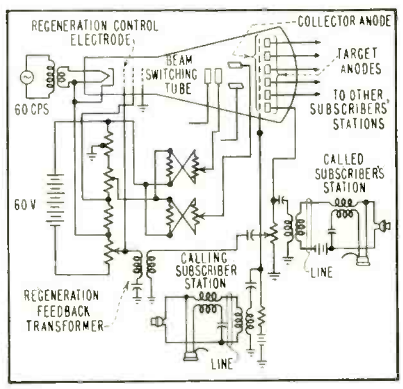

FIG. 8—Cathode-ray beam-switching tube is used as an inertialess switchboard for telephone subscribers

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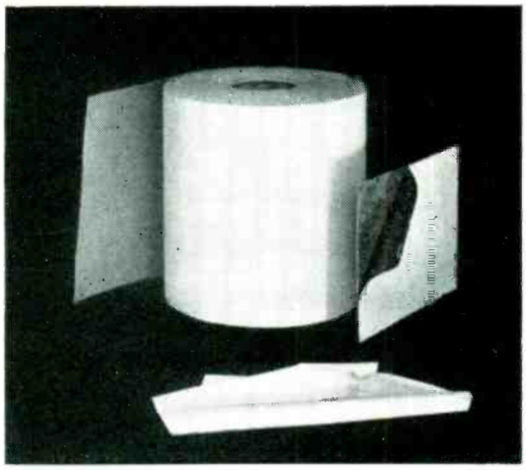

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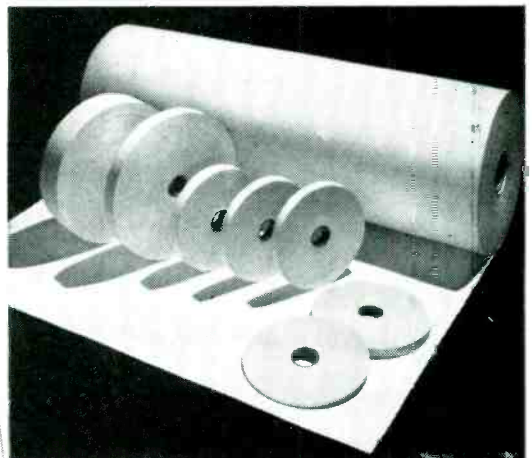

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anode of a device resembling the cathode-ray tube and called a beam switching tube. When the beam strikes the appropriate portion of a target anode of the switching tube to which the subscriber is connected, a two-way circuit is established between two subscribers. The gain of the channel may be adjusted by controlling the beam intensity, just as the brightness of the spot on a crt is controlled. The control grid of the beam-switching tube is coupled to one of the target anode connections and acts as a regenerative feedback circuit.

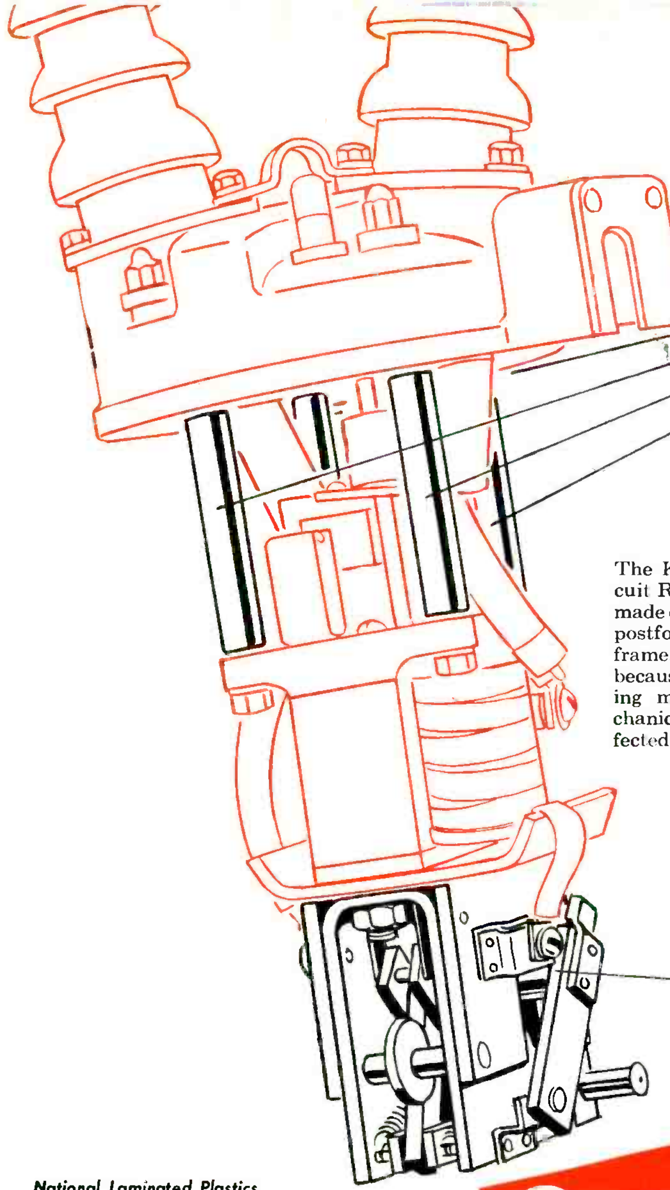
Rhombic Relay Antennas

By Richard C. Webb

Denver Research Institute
University of Denver
Denver, Colo.

The superior gain and directional properties of rhombic antennas as well as their broad-band characteristics so desirable for television have been known for many years. However, use of the rhombic has been restricted mainly to commercial point-to-point communication service because of its large size[1,2,3]. The gain as well as the sharpness of the directivity pattern increases with the length of wire used in each leg of the antenna as compared to the wavelength of the signals to be received or transmitted. Fortunately at the short television wavelengths a rhombic antenna only 80 feet on a leg, as indicated in Fig. 1, is $4\frac{1}{2}$ wavelengths long per leg at channel 2 and proportionately greater at the higher channels. This size is sufficient to secure from 7 to 10 times as much voltage from the rhombic as would be obtained from a simple dipole antenna in the same location. In addition, the unidirectional characteristic of the rhombic renders it less sensitive to noise and interference.

In an installation on a mountain top above a home in the Big Thompson Canyon, Colorado, one rhombic antenna unit, which has a line of sight path to the television transmitter, is used for receiving. A second unit connected to the first by a short length of 600-ohm transmission line reradiates the received energy down into the shadowy canyon. This is not accomplished with-



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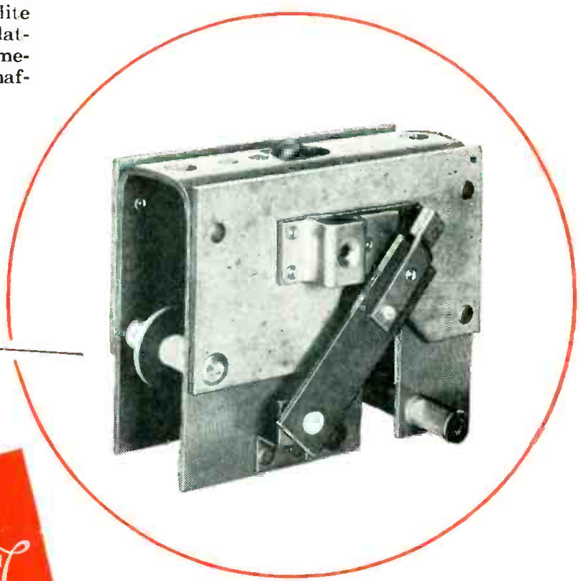

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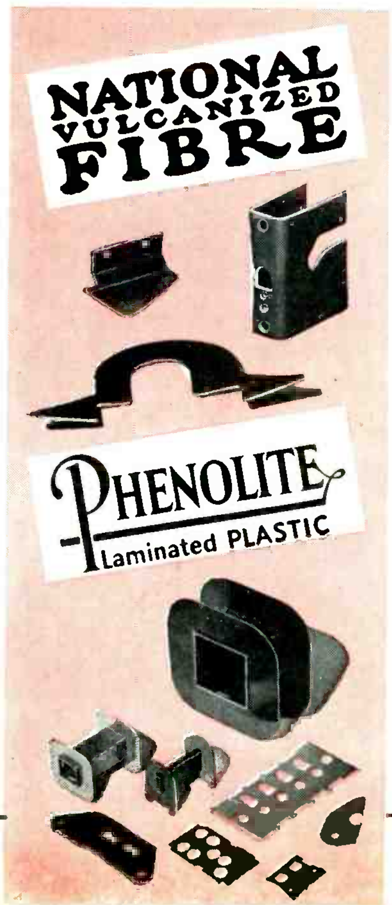

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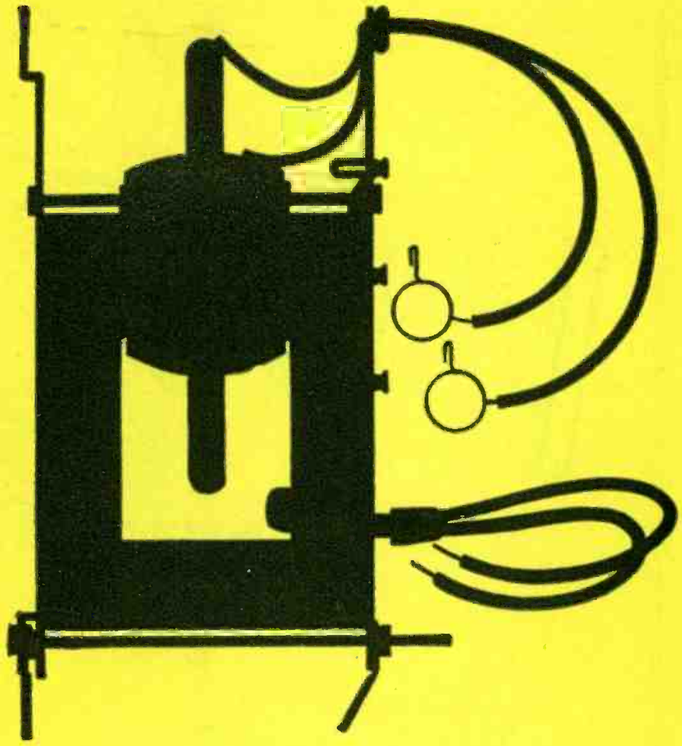

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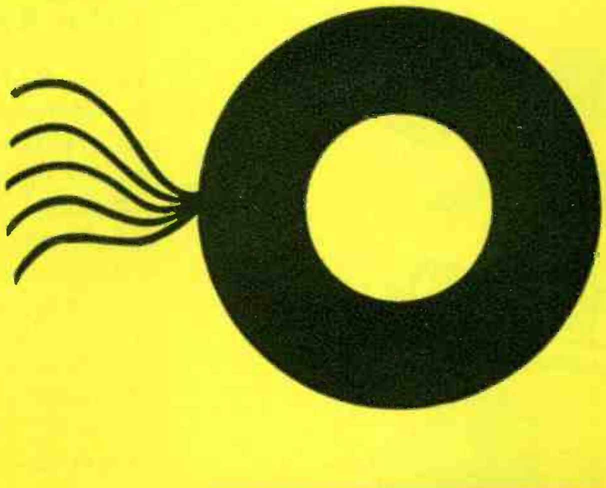

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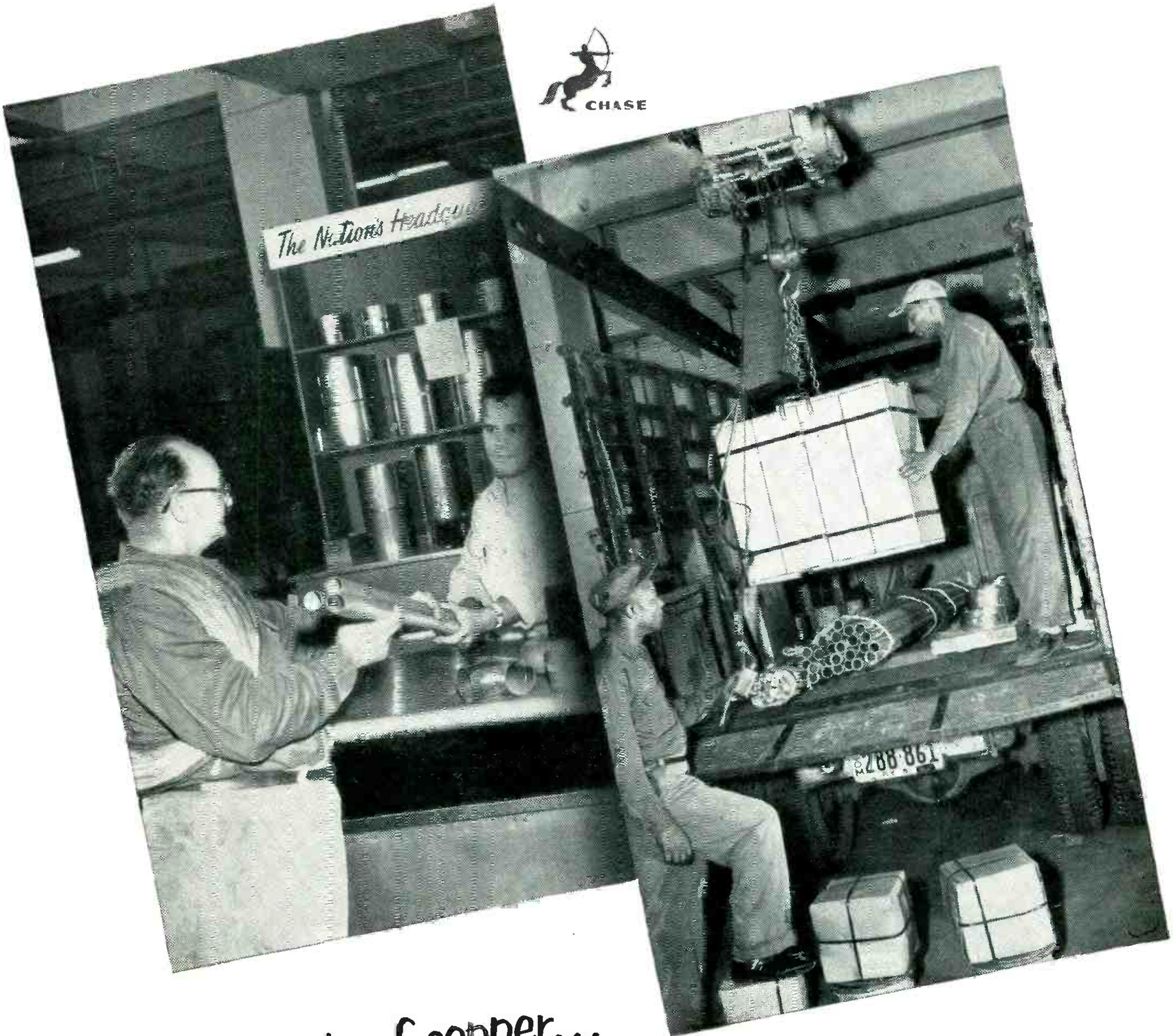

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out losses. However, by virtue of the strong signal picked up in the receiving unit, sufficient energy can be thrown into the canyon to enable satisfactory operation of television sets. Previous signal levels had been immeasurably low.

Values given in Fig. 1 appear to be about optimum for the vhf television channels although the lower group (2 to 6) is undoubtedly favored somewhat. Increasing the angle ϕ to as much as 70 deg by stretching out the length along the

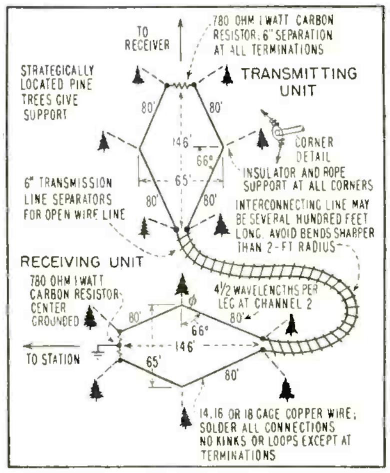

FIG. 1—Two rhombic antennas connected by transmission line relay television signals to a third rhombic at the receiver. System must be kept grounded even during construction on clear days owing to static charges. Earth around driven ground should be moistened with brine

major axis to 150 ft tends to favor the higher-frequency group (channels 7 to 13). The directivity pattern of each rhombic unit is extremely sharp (±2 deg.) To obtain maximum signal strength the major axis of both units of the relay pair must be aligned very accurately with the transmitter and receiver locations. A portable receiver or field strength meter with a direction-finding antenna on it is recommended for establishing the axis of the receiving unit. Since the receiver location should be visible from the site of the transmitting unit ordinary surveying methods can be used to direct it.

At a distance of 1 mile from the transmitting unit of the system the ±2-deg transmitted beam is only 120 yards wide; hence, houses located far outside this range will not enjoy the full benefit of the reradiated signal. In the installa-

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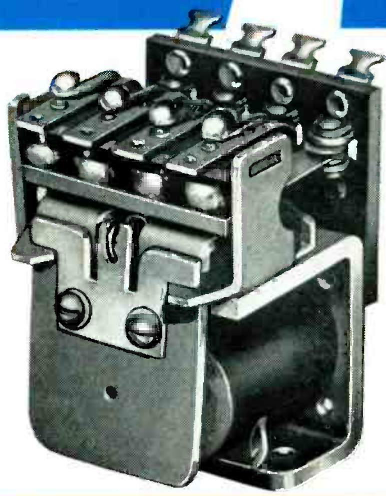
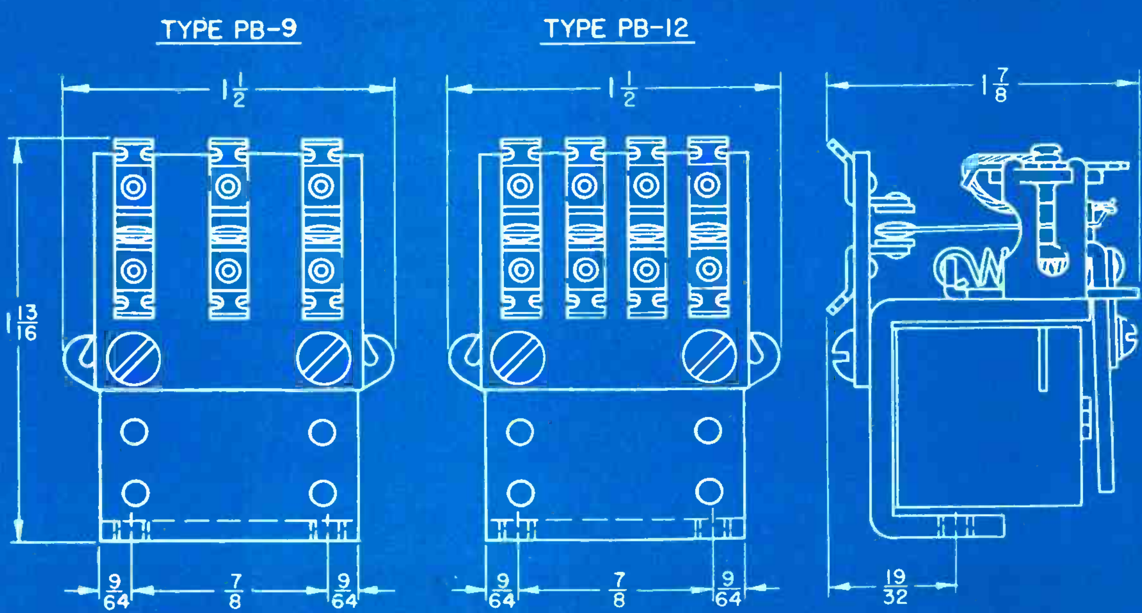


4-POLE TYPE PB RELAY



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Developed primarily for the aircraft industry*, where size and weight must be kept to a minimum, this compact power relay is suitable for hundreds of industrial applications. Available in two, three and four pole, double throw contact arrangements, for A.C. and D.C., the Allied Type PB withstands 50G shock and 10G vibration (up to 55 cps) without any false operation of the contacts, due to the semi-balanced armature and extremely compact design.

***The Allied Type PB Relay has the following AN approvals: AN 3306; AN 3307; AN 3308; AN 3310; AN 3312**

Here are the Facts and Figures

Contact Ratings: 10 amperes non-inductive 29 V.D.C. or 115 V. rms 60 or 400 cycles. **Nominal Coil Power:** 2.5 watts for D.C. operation, 6.0 Volt-Amperes for A.C., 60 cycle operation.* **Maximum Coil Power:** Input at 25°C for 85°C Temperature Rise: 5.5 watts for D.C. operation and 10.0 Volt-Amperes for A.C. operation. **Ambient Temperature Range:** —55°C to +71.5°C.*

• The Allied Type PD relay, similar to the Allied Type PB except for smaller contacts, has a contact rating of 3 amperes. Nominal coil data for D.C. operation is 1.5 watts and 3.6 volt-amperes for A.C., 60 cps. **Input power for 2 and 3 pole types may be reduced if sensitivity or temperature rise are factors. Special coils are available for higher ambient temperatures.*

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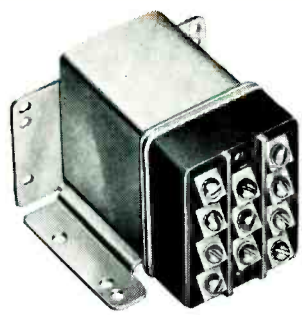

SCREW TYPE

PB, Open—1 9/32" x 1 13/16" x 1 13/32"—4 oz. **PB, Sealed,** Cannon Plug—3 5/32" x 1 41/64" x 1 49/64"—8 oz. **PB, Sealed,** Solder Terminals—2 9/16" x 1 49/64" x 1 41/64"—7.5 oz. **PB, Sealed,** Screw Type—3" x 2 5/8" x 3 5/32"**—13 oz. **PD, Sealed,** Solder Terminals and Plug-In—2 7/16" x 1 19/32" x 1 13/32"—6.5 oz.

** Includes mounting ears and terminals.

ALLIED CONTROL COMPANY, INC.

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tion described a third rhombic unit identical to each of the relay pair is used at the receiving point, its transmission line simply being brought in to terminate at the receiver.

Thus the transmitting unit on the hill and the rhombic at the receivign point near the house serve to bridge the distance between the television set and the master receiving antenna atop the mountain without the use of a long transmission line that is both expensive and hazardous from the viewpoint of lightning. Simple high-gain housetop antennas can be used within the beam of the transmitting unit on the hill. The third rhombic is recommended where optimum performance is required as for a community installation.

The height of the antennas above ground need not be greater than 15 to 30 feet and although it is desirable to keep the plane of the wires nearly horizontal the system does not appear to be particularly sensitive to tilts of a few degrees. The directivity pattern of a rhombic antenna in the vertical direction maximizes 5 to 10 degrees above the plane of the wires, hence, it is desirable to lower the end of the receiving unit in the direction of the tv station 5 to 10 degrees below the line-of-sight path. Likewise, the plane of the transmitting unit should be tilted a similar amount below the line of sight path to the receiving point.

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D. Foster, Radiation from Rhombic Antennas, *Proc IRE*, 25, 1937.
J. Minter, Rhombic Antennas for Television, *Electronic Industries*, Oct. 1946.

Twenty-Five Cent Oscillator

BY JAMES FAHNESTOCK
Associate Editor

ABILITY of transistors to operate from extremely small power sources can be demonstrated vividly by the accompanying circuit. It comprises a single-transistor feedback oscillator that provides a tone at earphone volume when powered by a quarter coin and a piece of saliva-

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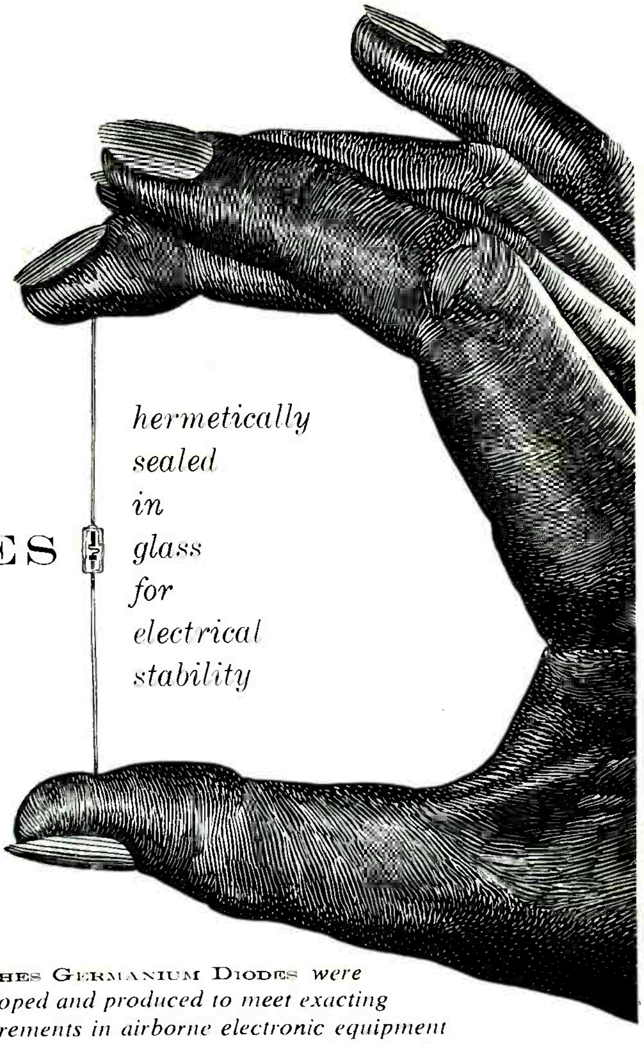
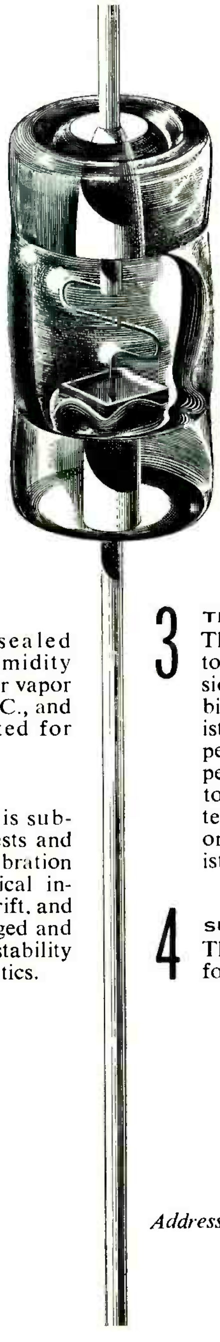


hermetically sealed in glass for electrical stability



HUGHES GERMANIUM DIODES *were developed and produced to meet exacting requirements in airborne electronic equipment for navigation, fire control, and guided missiles. In addition to the advantages of germanium diodes over vacuum tubes,* HUGHES GERMANIUM DIODES *exhibit these outstanding characteristics:*

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ELECTRICAL SPECIFICATIONS AT 25° C.

RTMA Type	Peak Inverse Voltage*	Minimum Forward Current at +1 volt—ma.	Maximum Back Current ma. (volts)
1N55B	190	5.0	0.5 (–150)
1N70A	130	3.0	0.025 (–10); 0.3 (–50)
1N67A	100	4.0	0.005 (–5); 0.05 (–50)
1N81A	50	3.0	0.01 (–10)
1N89	100	3.5	0.008 (–5); 0.1 (–50)
1N68A	130	3.0	0.625 (–100)
1N69A	75	5.0	0.05 (–10); 0.85 (–50)
1N90	60	3.0	0.8 (–50)

*NOTE: It has been found that Hughes Diodes will support 80% of this inverse voltage applied continuously at 25° C.

Because of expanded production capacity, HUGHES DIODES *are now available for commercial sale. Moderate quantities can be delivered from stock.* HUGHES DIODES *are classified in accordance with RTMA specifications, and also are supplied to special customer specifications, including high temperature electrical requirements.*

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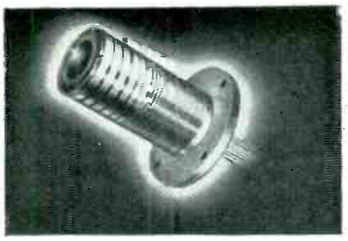
Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D. approx. 5 2/3".



An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.

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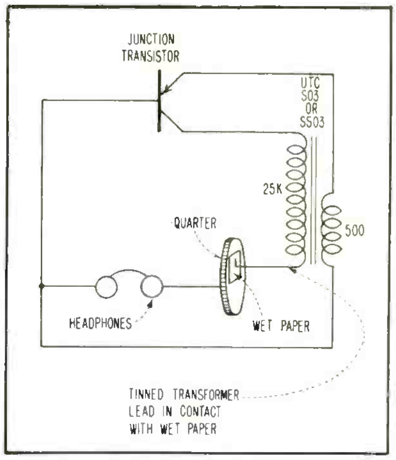

Simple oscillator uses commercially available parts. Tone is heard in headphones from transistor oscillator powered by power source made from a quarter, a tinned transformer lead, and a piece of saliva-soaked paper

soaked paper. Power obtained by irradiating a photovoltaic cell may also be used. The entire circuit may be built on the back of a single earphone. Oscillations will continue as long as the paper remains damp.

Survey of Waveguides and Lines

RECENT reports in the public press described a British development in which a length of metal tubing was to be used for the transmission of electric power, multichannel communications circuits and television programs.

In a statement prepared for ELECTRONICS, Prof. Harold M. Barlow of University College London says, in part: "This objective was envisioned in outline as long ago as 1947. Since that date much progress has been made towards translating the idea into a practical form."

"It will be appreciated that the capabilities of the coaxial line as a trunk communication and television link have now been fully exploited and for further extension of facilities in this field we must look to some form of microwave service. The H_{01} tubular waveguide is an attractive proposition because it offers a completely screened channel not subject to interference and with the possibility of a very wide band of frequencies available for multichannel work. In any country having large centers of population

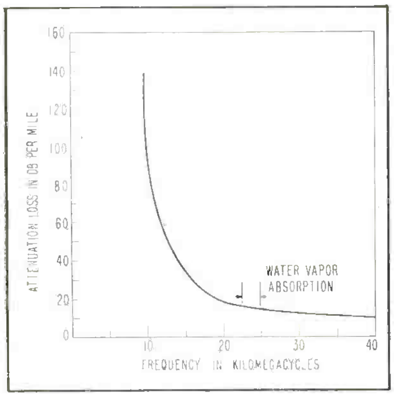

FIG. 1—Attenuation loss of cylindrical copper waveguide having inside diameter of 1½ inches (Barlow)

there is not only a big demand for independent communication channels between such centers, but also for the transmission and distribution of electric power."

"The tubular waveguide suitably designed can quite readily make provision simultaneously for both needs. Furthermore, when the conductor is properly supported it is capable also of guiding a cylindrical surface wave along its outside surface, thus, if necessary, providing a triple service. In such a case we should have microwave channels both inside and outside the tube, while the power-frequency currents flow along the tube itself."

"Our efforts have been concerned more particularly with the problem of the waveguide. We are not quite ready yet to describe the technical details of our work. We are examining the performance of our microwave channel at a wavelength in the region of 8 millimeters."

Barlow's original suggestion proposed a frequency of 40,000 mc, the same order of magnitude as the area of current strenuous activity at Bell Telephone Laboratories. Despite the difficulty of generating power at frequencies this high, there is good reason for the choice. As shown by the graph, Fig. 1, the attenuation losses fall off very rapidly in this particular type of waveguide propagation as the frequency is increased. Because the waveguide is likely to contain a slight amount of dry air, the region between 23,000 and 25,000 mc must be avoided since these are the frequencies of absorption by water vapor. Frequencies around 60,000 mc are likewise forbidden because of

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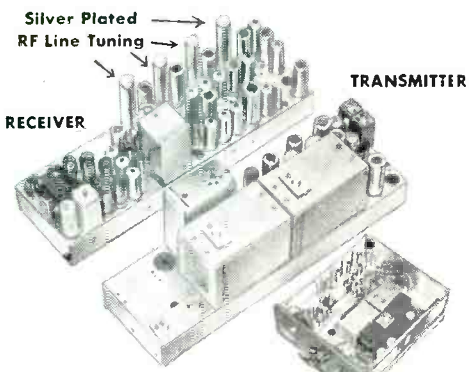

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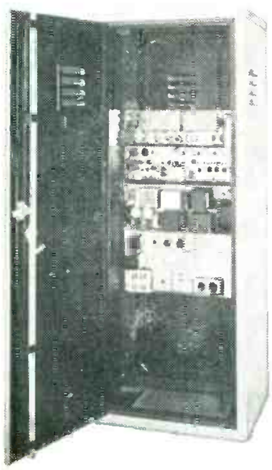

Pole mounting cabinet

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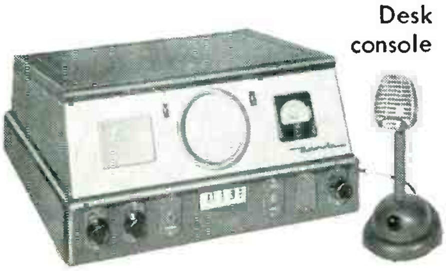

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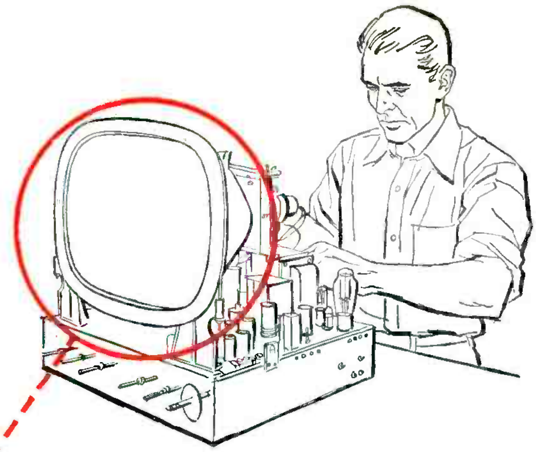
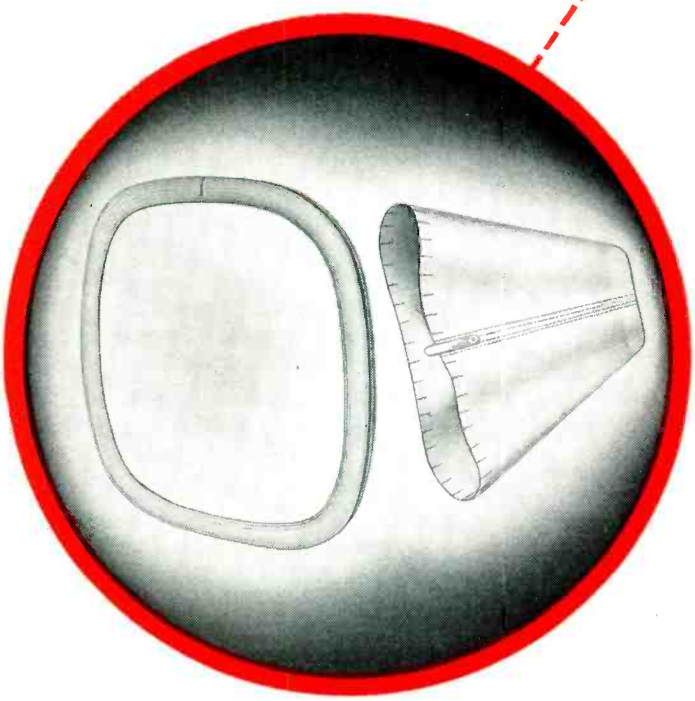


Du Pont "Alathon"* insulates TV tube carrying 20,000 volts



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Du Pont "Alathon" offers other important advantages. Its flexibility simplifies installation. Shipping costs are reduced because "Alathon" absorbs shock . . . makes possible packing of sets as units . . . eliminates shipping the delicate tubes separately. And reassembly time and labor at outlets are eliminated. Many TV manufacturers now use these rings and sleeves.

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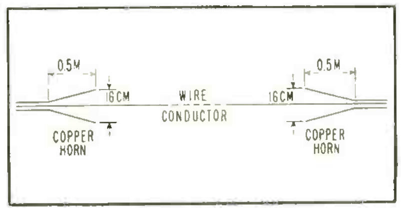

FIG. 2—The experimental surface-wave transmission line used by Grace and Lane in England

absorption by oxygen.

Reference to the cylindrical surface wave includes the work of Georg Goubau and others, principally for the Signal Corps. Since 1950, experiments with this so-called G-string have extended its range of practicable operation to two miles. While details of this work are expected to be published soon, it is known that this particular installation employs a single copper line three quarters of an inch in diameter covered with polyethylene. Used in the vhf region, it has a bandwidth of 200 mc.

Grace and Lane in England have recently published loss figures for a similar transmission line with an enameled surface. Maximum horn losses (the ends of the lines are matched into coaxial lines by horn-shaped outer conductors as indicated in Fig. 2) for radio frequencies between 3,000 and 9,000 mc are about 2 db coupled with a line loss varying from 0.07 to 0.26 db per meter and increasing with frequency.

Miller and Beck of Bell Telephone Laboratories will describe their work with circular waveguides in a forthcoming issue of *Proc. IRE*. as summarized below.

To reduce theoretical heat losses of hollow metallic waveguides to 0.25 db per 100 feet at frequencies above 2,000 mc, it is necessary to use the guide as a multimode medium. Above 10,000 mc the circular electric mode in round metallic tubing becomes more attractive than the dominant mode because it provides a medium with the 0.25-db-per-100-foot loss in a smaller space.

Using the circular electric wave, theoretical heat losses of 2 db per mile are associated with tubing diameter of 2 to 6 inches and carrier frequencies between 50,000 and 5,500 mc respectively. Increased transmission bandwidth, reduced

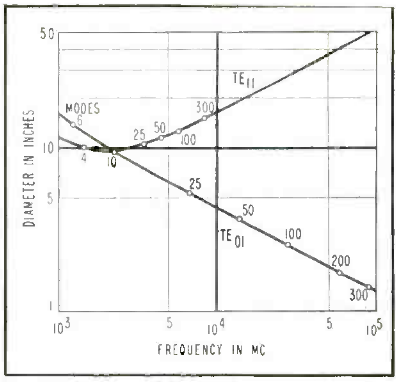

FIG. 3—Round guide diameter vs frequency for loss of 2 db per mile

delay distortion and reduced waveguide size are factors favoring use of the highest practical frequency of operation. The number of freely propagating modes lies in the range 175 to 20 for the 2 to 6 in. diameter region, as shown in Fig. 3 taken from the paper.

Experimental work has been carried out at 9,000 mc on a waveguide having theoretical loss of 2 db per mile for the TE_{01} wave. Transmission losses on the order of 3 db per mile over distances as great as 40 miles, with tolerable signal distortion of a 0.1 microsecond pulse, have been observed on a well-constructed line. Mode filtering and pure-mode generation has been accomplished.

Experimental work, described in still another Bell Labs paper, demonstrates the feasibility of transmitting the TE_{01} wave around bends. The circular wave can be transmitted around bends either by altering the form of the wave in the bend region (as in Fig. 4) or by altering the waveguide itself.

Still another technique under development at Bell Labs is the laminated transmission line. Here, skin-effect losses are reduced by properly laminating the conductors and adjusting the velocity of transmission of the waves by means of a suitable dielectric. Such a con-

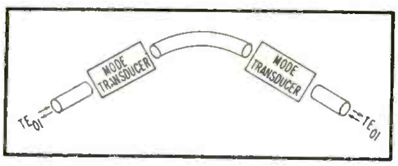

FIG. 4—Representation of the kinds of elements that are necessary in a normal-mode bend

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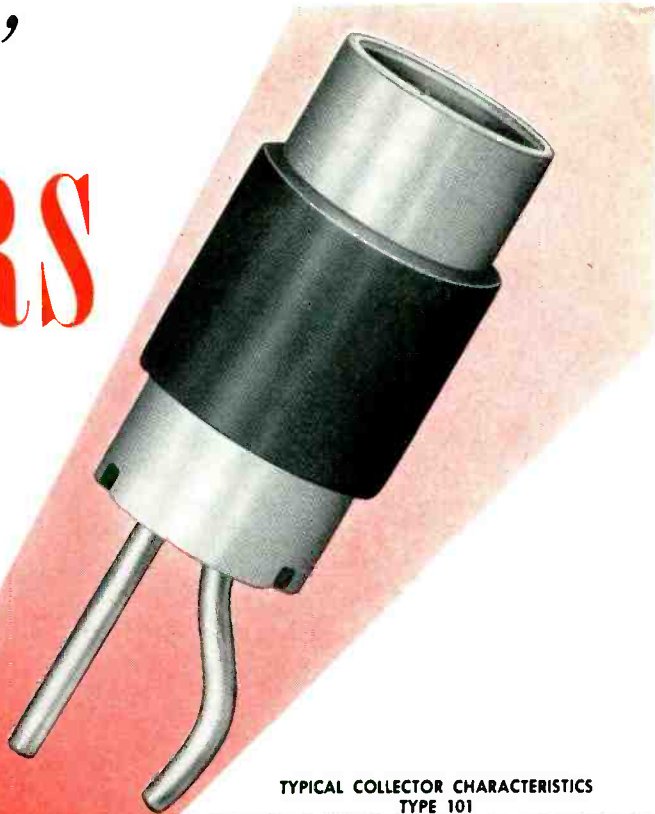

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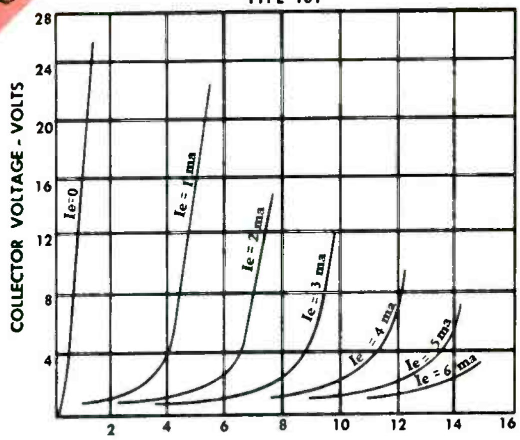

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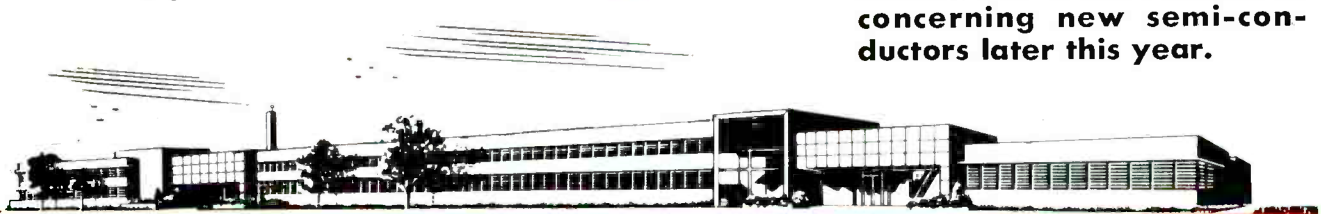

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BIBLIOGRAPHY

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C. E. Sharp and G. Goubau, A UHF Surface Wave Transmission Line, *Proc. IRE*, p 107, Jan. 1953.

Spatial Harmonic T-W Tube

TRAVELING-WAVE TUBES operate satisfactorily as wide-band amplifiers for microwaves and are beginning to find use particularly in the region of 4 kilomegacycles, corresponding to a wavelength of 7.5 cm.

Increased experimentation in the region of 50 kmc has brought an extension of the traveling-wave technique resulting in a tube of the general type capable of operation at 48 kmc, a wavelength of 6.25 mm.

Because the helix, which characterizes the traveling-wave tube, becomes increasingly delicate as frequency is raised, it has been entirely eliminated from the design of this experimental tube.

As explained by Sidney Millman in the Nov. 1952 issue of the *Bell Laboratories Record*, to obtain amplification in a traveling-wave amplifier, a stream of electrons and the electromagnetic wave to be amplified must travel together down the tube at approximately the same speeds. Since the electromagnetic wave travels at a speed approaching that of light, and since electrons cannot be given such speeds except under the influence of extremely high voltages, some method must be devised for slowing down the wave to speeds that electrons will attain under the influence of practicable voltages. In most traveling-wave tubes that have been described, this slowing down was achieved by making the wave travel along a closely wound helix. Despite the

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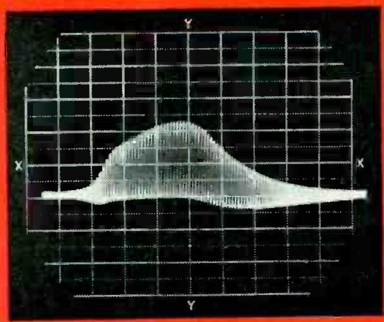
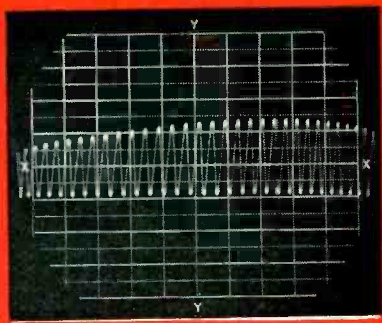


Sweep – 0.4 µ sec/cm



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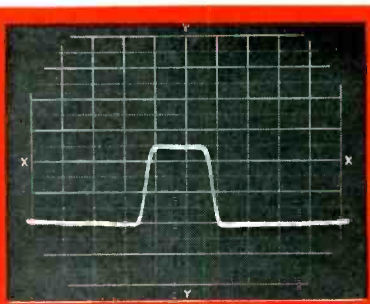
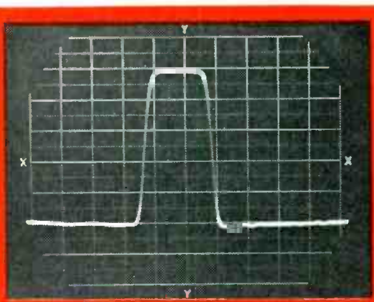


37.5 Mv., 0.2 µ sec width, 1 µ sec sweep full scale



75 Mv., 0.2 µ sec width, 1 µ sec sweep full scale

LINEARITY OF VERTICAL DEFLECTION The vertical amplifier provides up to 2.5 inches positive or negative uni-polar deflection without serious compression; at 3 inches, the compression is approximately 15%. The accompanying photographs illustrate transient response and linearity of deflection.

SWEEP DELAY The accurately calibrated delay of the 401 provides means for measuring pulse widths, time intervals between pulses, accurately calibrating sweeps and other useful applications wherein accurate time measurements are required.

The absolute value of delay is accurate to within 1% of the full scale calibration. The incremental accuracy is good to within 0.1% of full scale calibration.

SPECIFICATIONS

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Deflection Sens. – 15 Mv./cm, p-p
Frequency Response – DC to 10 Mc
Transient Response – Rise Time (10%-90%) 0.035 µ sec
Signal Delay – 0.25 µ sec
Input line terminations – 52, 72 or 93 ohms, or no termination
Input Imp. – Direct – 1 megohm, 30 µ µ f
Probe – 10 megohms, 10 µ µ f

X-Axis

Sweep Range – 0.01 sec/cm to 0.1 µ sec/cm
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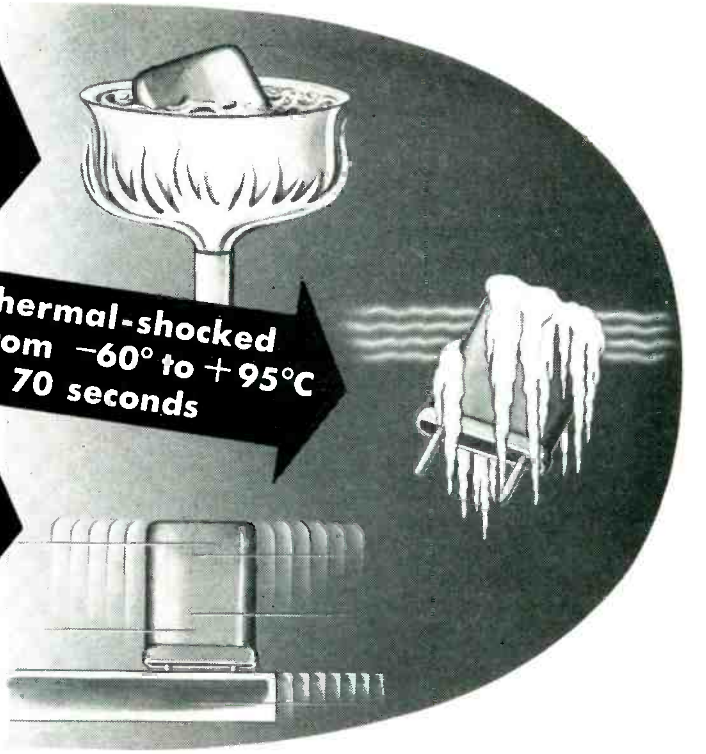

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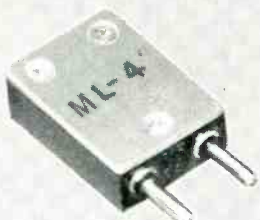

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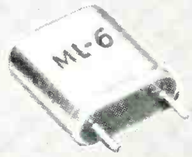

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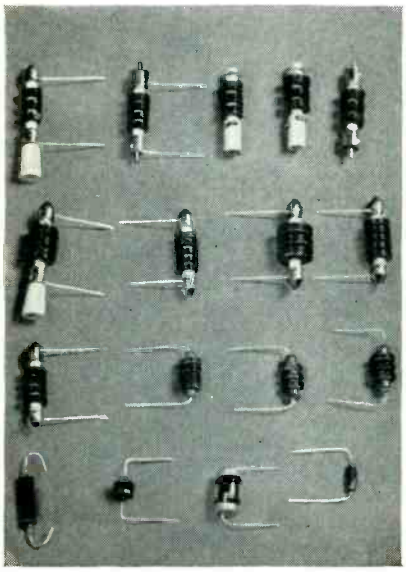
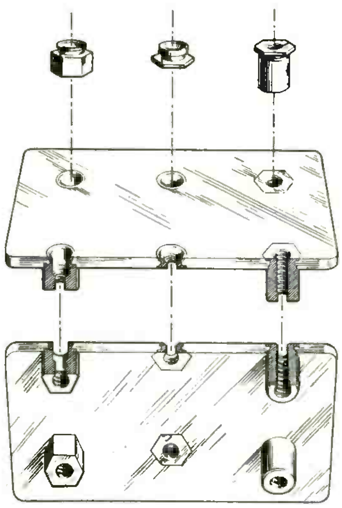




fact that its velocity along the wire is high, its axial velocity along the tube is reduced by the ratio of distance along the wire to distance down the tube.

In the new tube the magnetic wave is not slowed down in this way. Instead, the electron stream is made to react with what is termed a spatial harmonic of the original wave.

The new tube is shown in cross section in Fig. 1. Electrons emitted from the cathode at the left pass down the center of a channel in a copper block to a collector at the right. They are caused to travel with a minimum of transverse motion by a magnetic field, as in other traveling-wave amplifiers.

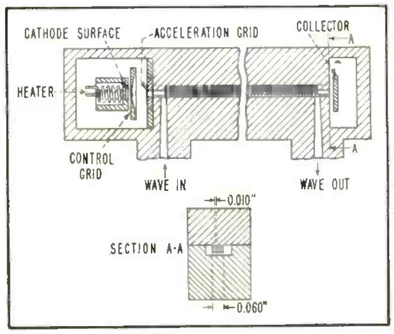
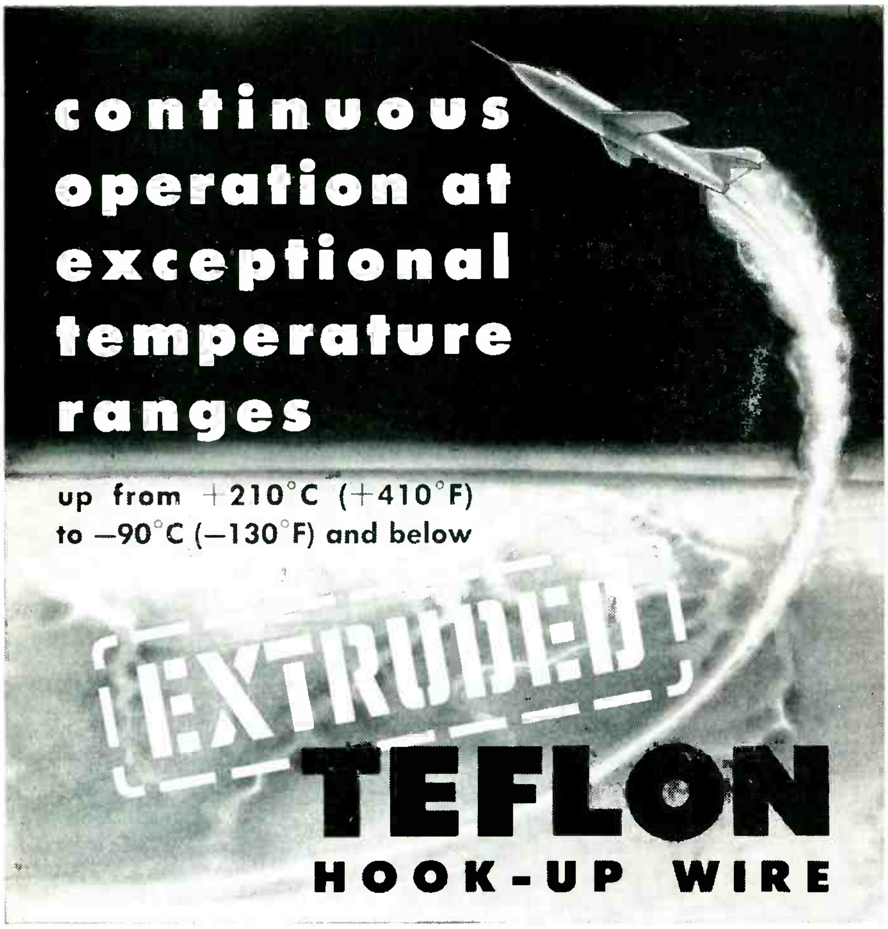


FIG. 1—Cross section of tube used as spatial harmonic traveling-wave amplifier at 50,000 mc

The electromagnetic wave enters and leaves the tube through waveguides at the beginning and end of the channel as indicated. Down the center of the channel is a metal block with three axial slots indicated in section *A-A*. The main stream of electrons travels down these slots and close to each side of the projecting block.

Transverse resonator slots, 100 of them in all, cutting through the central block at right angles to the axial slots, constitute the radio-frequency circuit guiding the electromagnetic wave.

Amplification is accomplished by the reaction of the electrons and the axial component of the electric field of the traveling wave. Near the surface of a conductor, however, the axial component of the electric field disappears. It is, therefore, only while the electrons and the electromagnetic wave are crossing the transverse slots that the prin-



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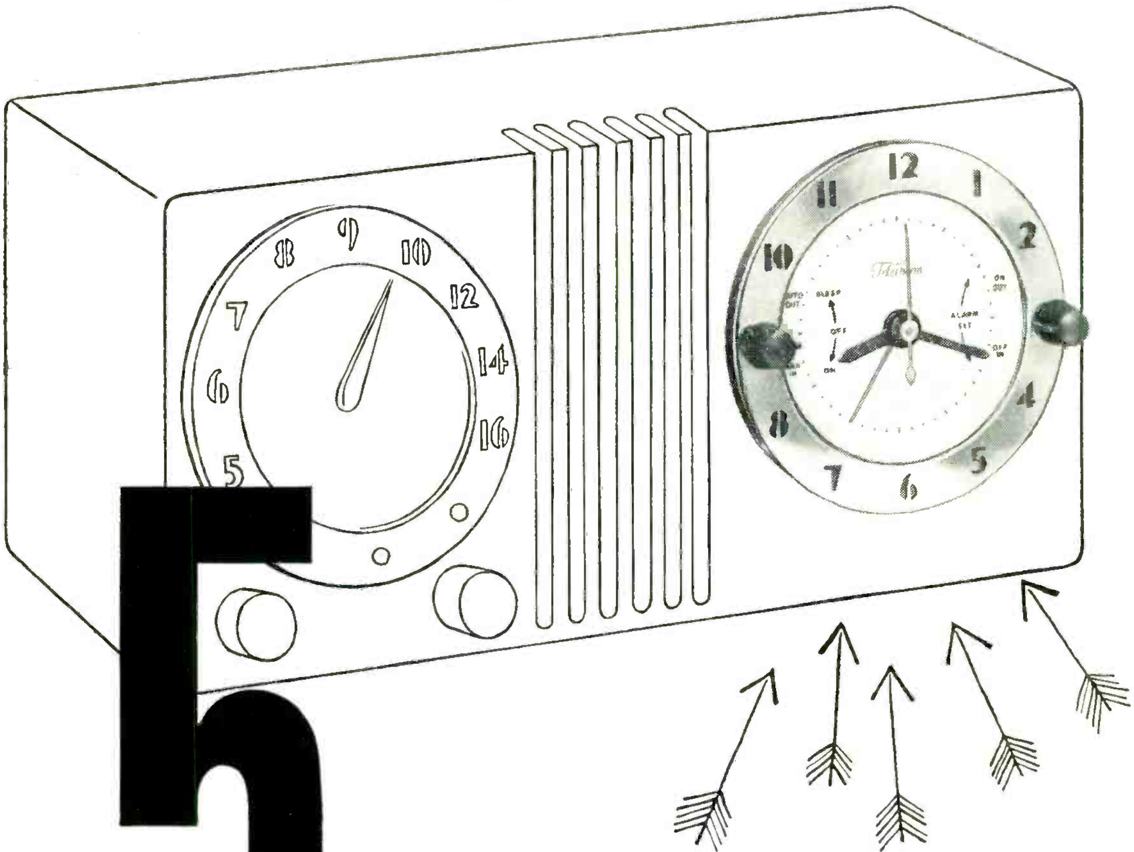

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cipal reaction between them occurs.

If electrons are traveling at the same speed as the wave, and at some particular slot the wave were at such a phase that the electrons exerted an amplifying effect on it, then at the next slot the phase relations would be the same and amplification would occur there also. This would continue for the rest of the way along the path of the slots.

Consider that at some slot near the beginning of the path the wave at a transverse slot is at a phase such as to permit amplification by a group of electrons passing that slot. Suppose, however, that the electron stream is moving so much slower than the wave that by the time the same group of electrons reaches the next transverse slot, the wave has traveled one whole wavelength farther than in the example cited.

The wave and electrons at this second slot will then also be in the proper phase for amplification, but this time the electrons react on the next following cycle of the wave.

A group of electrons marked E_1, shown in Fig. 2, is interacting at a transverse slot with a particular phase of cycle A of the wave. When this group of electrons has reached the next slot, the wave has advanced sufficiently to bring the corresponding phase of cycle B to the next slot, and again amplification takes place. At each successive slot, the electrons react favorably with the wave, but with a later part of it.

Since the same action is taking place with all the electrons, the total amplifying effect is essentially the same as though the electrons were traveling at the same speed as the wave. Actually, they are traveling slower in the ratio of $d/(d + \lambda)$, where d is the distance between

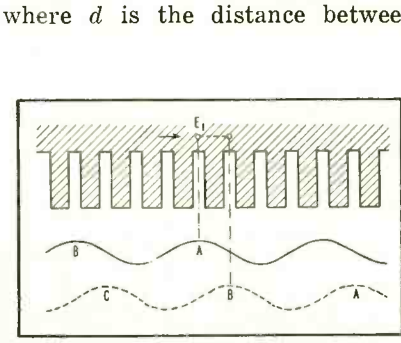

FIG. 2—Electron group E_1 interacts with successive peaks of electromagnetic wave in phase

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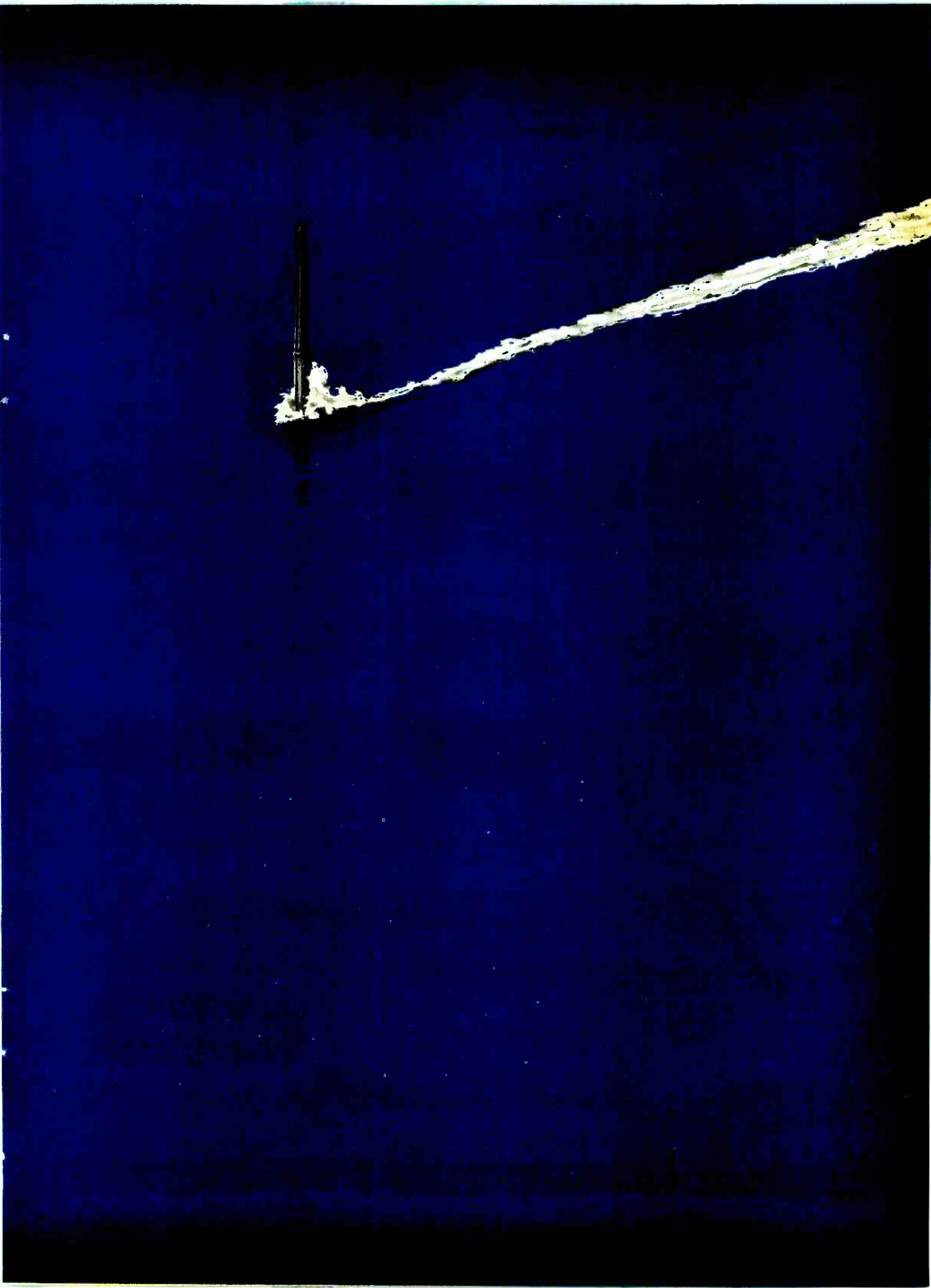

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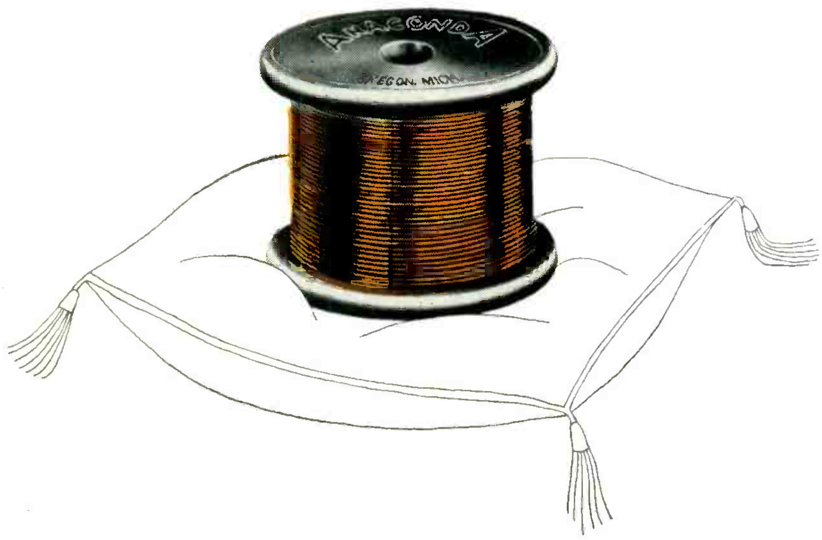

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centers of adjacent slots and λ is the wavelength of the traveling wave in this particular structure.

Such a method requires an electron speed corresponding to only 1,200 volts. The resultant structure is rugged and only about two inches long. Bandwidth of a representative amplifier is 1,500 mc and estimated power is around 25 milliwatts. Gain is over 20 db.

Fringe-Area TV Booster Transmitter

EXPERIMENTS recently authorized by the Federal Communications Commission provide enhanced television signals to areas distant from the main transmitter or shadowed by high terrain between it and the receiving locations.

Station WSM-TV in Nashville, Tenn. has established a low-power relay transmitter at Lawrenceburg that picks up horizontally polarized signals and retransmits them with vertical polarization. The combination of non-standard polarization and low power is expected to prevent cochannel interference beyond the area resulting from normal operation of the main transmitter.

The system proposed by J. H. DeWitt, Jr. to FCC comprises a high-gain receiving antenna and a relatively low-gain transmitting antenna placed back-to-back and connected together through a low-power radio-frequency amplifier system that has an overall gain of approximately 100 decibels. Actual equipment is still undergoing field modifications. Using vertical polarization for booster transmission minimizes feedback problems in booster station construction and allows the receiving and transmitting antenna to be placed relatively close together, in this case, 500 feet apart.

For covering most small cities, the transmitting antenna should have a single-lobe radiation like a cardioid pattern. Such a pattern is easily achieved by placing a vertical dipole in front of a large mesh screen. Using such an antenna, a maximum effective radiated power of 10 to 20 watts at an elevation of approximately 100 feet above average terrain should provide adequate signal for reliable service in

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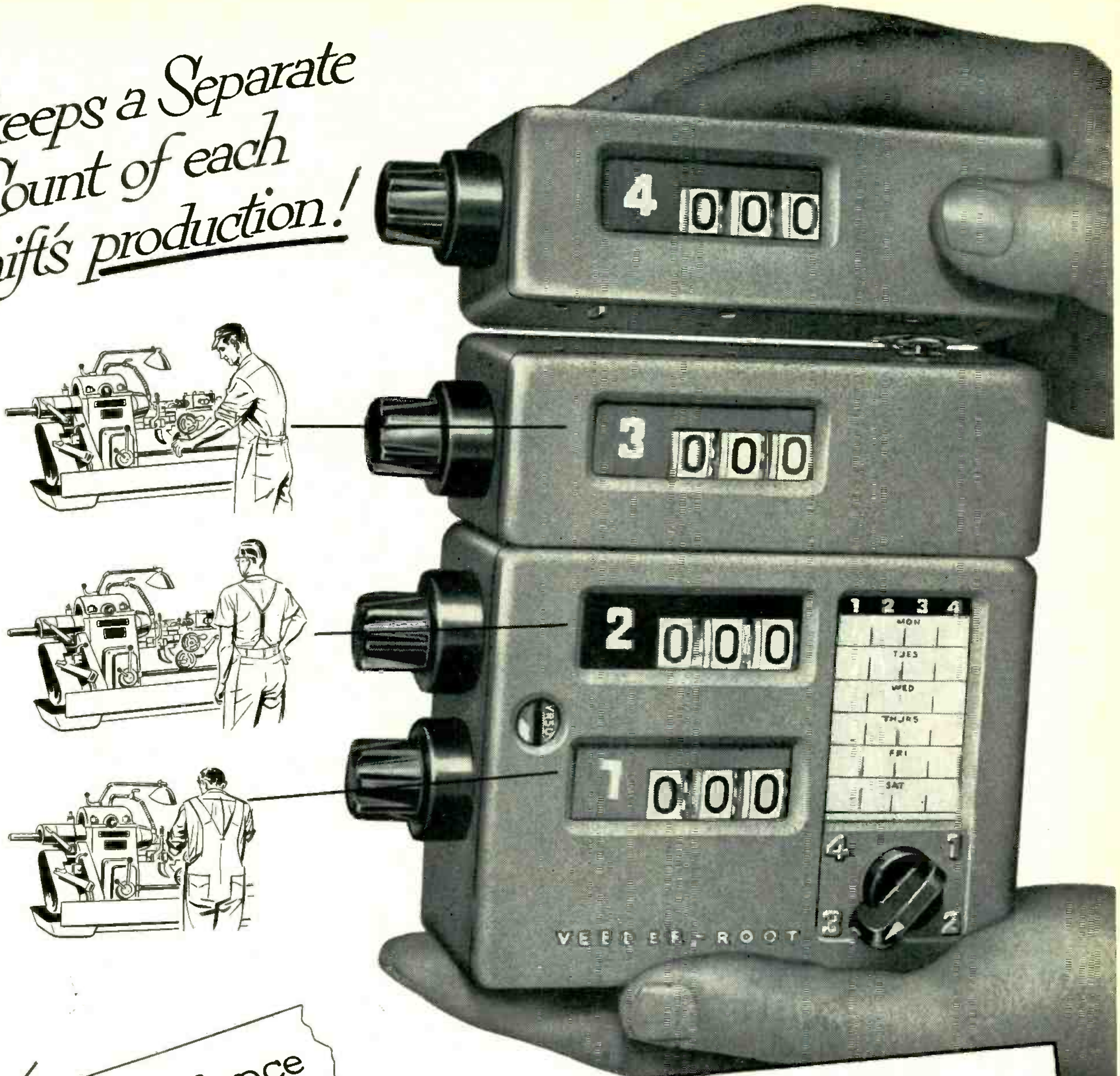

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most small towns and cities. Such urban districts normally measure two or three miles across.

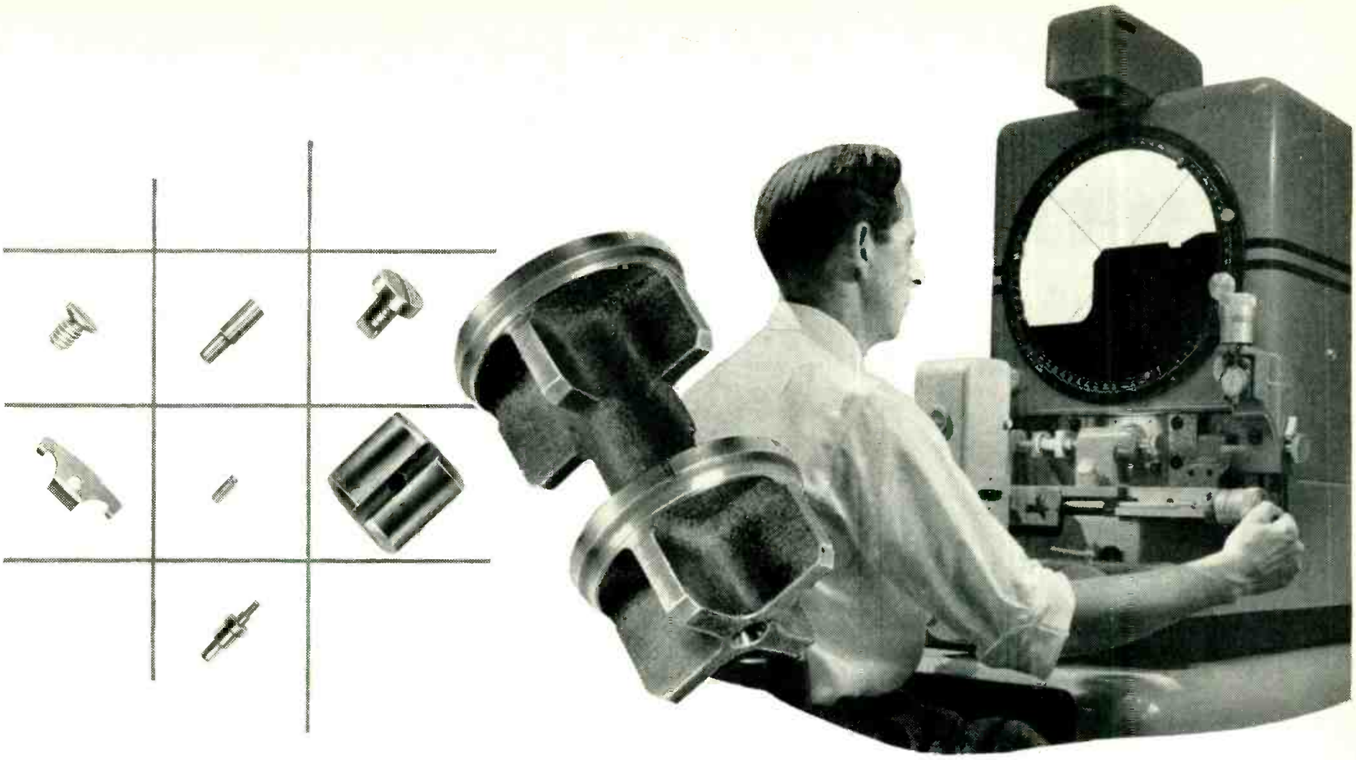
Booster Equipment

The receiving antenna is a billboard array made up of nine horizontal half-wave dipoles arranged in three rows of three each in front of a mesh screen. Binominal grading is employed to reduce side-lobe response thereby minimizing interference from other stations on the WSM-TV channel 4, as well as the reception of signals fed back from the booster transmitting station.

The receiver preamplifier is similar to the basic Wallman radio-frequency amplifier. The input circuit consists of a neutralized cascode arrangement employing a triode connected 6AK5 tube and a 6J4 tube. Following the cascode circuit are three stagger-tuned stages employing 6AK5 tubes. The amplifier has a maximum gain in excess of 60 db over a 6 megacycle band at channel 4 frequencies. Automatic gain control is employed to hold the output at a relatively constant level.

The booster transmitter is essentially a low-power linear radio-frequency amplifier designed for unattended operation. It is connected to the receiver preamplifier through a 500-foot length of coaxial cable and is located at the transmitting antenna. The booster transmitter has a gain of approximately 40 decibels. Three 2E26 amplifier tubes operating Class A drive a final stage of two 2B26 tubes that operate Class B. Normal average composite carrier output when black picture is transmitted is approximately 5.5 watts, of which 2.5 watts is aural carrier output and 3 watts is average visual carrier power. Therefore the transmitting amplifier will normally deliver 5 watts peak visual carrier power and 2.5 watts aural carrier power.

Automatic power level control is achieved in the transmitter by monitoring the radio-frequency voltage level across the output transmission line. A balanced crystal voltmeter circuit measures peak transmission-line voltage and through an associated direct-current amplifier and a regulator tube controls the bias on



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There is such a great variety of Weston instruments to measure all sorts of variables in all sorts of ranges that production on most individual items is small.

This creates a parts inspection problem. Precision requirements in many cases are so stringent that any measurable deviation from specifications is too big. Setting up toolroom instruments takes too long for the small volume of work being checked at any one time. Mechanical gages are even less economical at the low volume levels, and they just did not give the required accuracy on such jobs as checking the shoulder angles, concentricities, and specifications of the double-acting valve body shown above. (It goes in a recording thermometer and Weston makes it in many different sizes.)

Now Weston has converted to Kodak Contour Projectors. An inspector merely picks up the specification sheet covering a given part, gets the chart gage indicated there, puts it on the screen of the projector, and proceeds to sample according to specifications. Often, as with the valve body, gage blocks are used to step off the traverse of the projector work table. The inspector notes whether a shadow image coincides with a chart line after the table has carried it by the specified distance.

Possibly your inspection problems are volume and speed rather than the flexibility that Weston wants. In that case you will want to know about the Kodak Contour Projector, Model 3, which is designed for use with special staging fixtures instead of a moving work table. There is a field engineer in your area who can show you which model best fits your problem. To get in touch with him, just drop a note to *Eastman Kodak Company,* Industrial Optical Sales Division, Rochester 4, N. Y.

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FM Signal Generator **100B**
20 to 110 mc (single range)

FM Signal Generator 100B uses a novel circuit with a variable permeability modulator and a single tube in the r-f, instead of the usual three or four. There is no beating and no multiplication, eliminating spurious frequencies. Output is from 0.02 microvolts to 0.1 volts.

FM Signal Generator **I-208-D**
1.9 to 4.5 mc and 19 to 45 mc

With a marker every 2 kc on the low band and every 20 kc on the high, the I-208-D has 1300 calibration points. This requires 25 feet of film—each individually calibrated. Accuracy is kept within 0.03%. Output voltage is from 0.2 microvolts to better than 0.6 volts.

Signal Generator and Power Meter **TS-155C/UP**
2700-3400 mc (S Band)

As a signal generator, the TS-155C/UP, with an output (50 ohms impedance) of -20 to -100 dbm, is widely used for testing radar receivers and transmitters. It can be pulse modulated internally or from an external trigger source.

As a power meter, the TS-155 measures power from +20 to +100 dbm (or up to 200 milliwatts).

Leakage is low—less than 95 dbm.

Panoramic Adapter **BC-1031**
250 kc to 470 kc

The Panoramic Adapter BC-1031 operates on an input frequency of 450 kc to 470 kc with a maximum sweep width of 200 kc.

Used extensively for rapid visual spectrum scanning, it also enables the operator to determine whether transmission is by cw, am, fm, or pulse modulated signals.

The BC-1031 is also used for deviation measurements of FM waves by the methods of dropouts.

Square Wave Generator **150A**
50 cycles to 1 mc

Square wave generator 150A provides waves at five spot frequencies from 50 cycles to 1 mc with a maximum rise time of 0.05 microseconds. Continuous frequency variation can be obtained by using an external frequency control capacitor. A pulse for oscilloscope syncronization is available.

Output is controllable from 0-20 volts peak to peak and is constant at all frequency settings.

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Silver-plated wires, in coarse and fine sizes for high-frequency conduction. Also intended for use in high-temperature applications. Available in various specifications and constructions.

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the grids of the final amplifier, thereby holding peak transmission-line voltage constant. Such a power output regulator can be used since the transmitter operates into a matched transmission line. The power output of the booster remains constant despite normal line-voltage fluctuations and despite small signal level fluctuations that are not removed by the automatic-gain-control circuit of the receiver preamplifier.

A squelch relay control operates to remove screen voltage from the final driver tube and thereby interrupt booster carrier output when the main television station is off the air or when the received signal at the booster site is excessively noisy.

Since the entire booster system operates as a linear amplifier there is no need for frequency control or frequency measurements at the booster transmitter. Obviously, booster station output frequencies will depend directly on the output of the main television station that is amplified by the booster.

The transmitting antenna is a vertical folded dipole antenna operating a quarter wavelength in front of a mesh screen approximately one wavelength square.

Transmission of Microwaves Through Plexiglas Windows

Use of Plexiglas housings to protect antennas and other tv and radar equipment from the effects of wind and weather has made necessary investigation of the transmission efficiency and distortion caused by the material.

In the relay station housing shown in the photograph, sheets of Plexiglas one-eighth of an inch thick were used. For rigidity the sections were corrugated in a deep V-rib shape. The V's are spaced eight inches apart and are three inches deep, giving high rigidity.

Tests made so far indicate that the main factors in obtaining satisfactory transmission efficiency are: thickness should not be greater than one-tenth the wavelength of the microwave transmitted, the dielectric constant should be less

— *Robert M. Feemster, Chairman of Exec. Comm., Dow-Jones & Co., Inc.*

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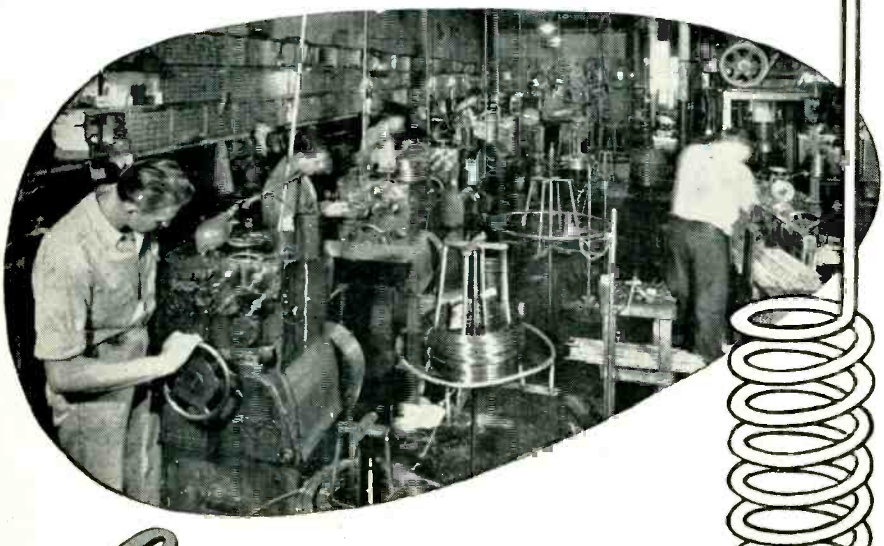

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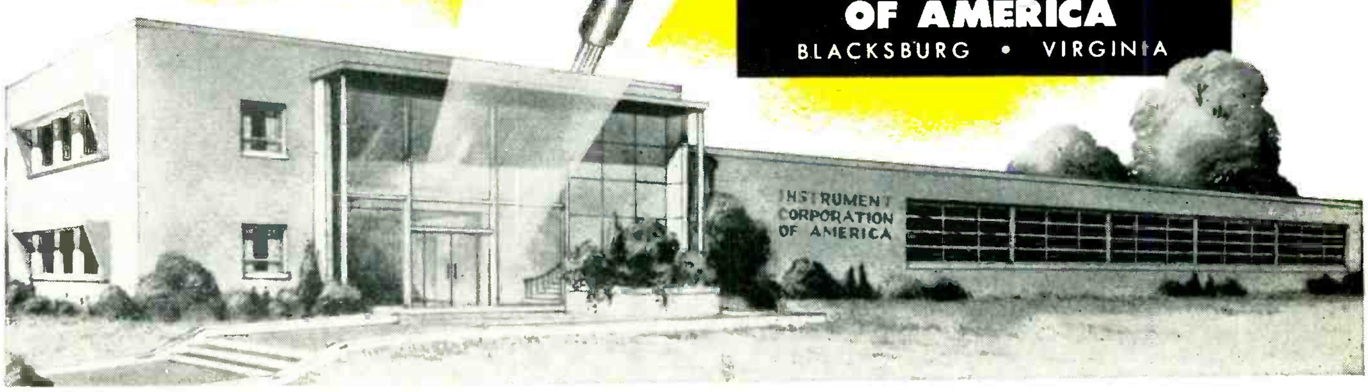

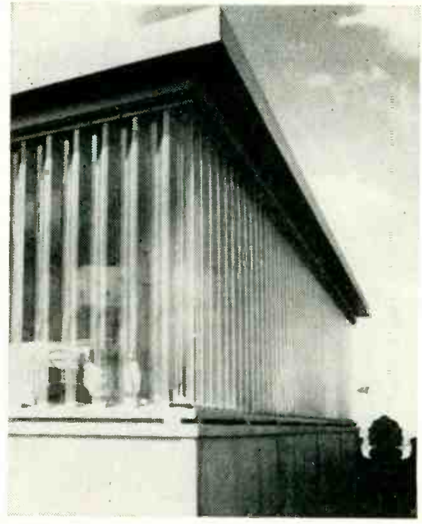

Television relay station in Philadelphia, Pa. using plastic windows to protect parabolic reflector from weather. Windows permit visual pointing of reflector at broadcast point

Table I—Microwave transmission through polymethyl methacrylate

Frequency in Mc	Dielectric Constant	Loss Tangent
1	2.76	0.0140
10	2.71	0.0100
300	2.66	0.0062
3000	2.60	0.0057
10,000	2.59	0.0067

than four, the loss tangent should not exceed 0.015 and the angle of incidence should be less than 60 deg.

Measuring Magnetic Tape Recorder Flutter

BY HAROLD N. MORRIS

Chief, Data Recording Section
Technical Systems Laboratory
Air Force Missile Test Center
Patrick Air Force Base, Florida

DATA STORAGE requirements for instrumentation recorders are severe, especially in the field of guided missiles. Magnetic tape recorders in general use today at scientific centers are precision machines carefully designed and well constructed. However, they are not perfect data storage mechanisms, and the data obtained upon playback has errors introduced by the machine.

These errors can be classified as two general types. First are the low-frequency errors caused by tape stretch, tape slippage at the capstan and nonlinear tape speed

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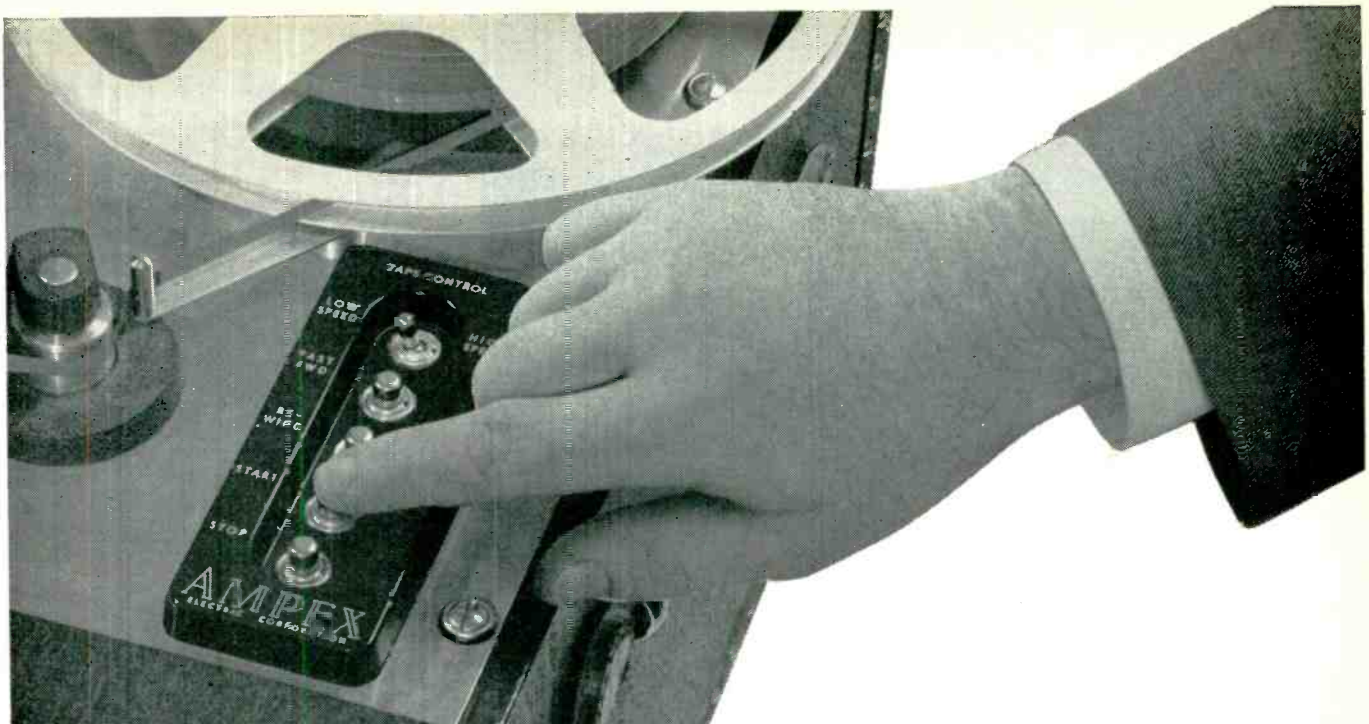

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Supreme reliability is the most important quality your tape recorder can have—whether your station is 250 watts or 50,000 watts. Countless operators have found that AMPEX eliminates the fussing, the adjustments, and the uncertainty they had previously suffered in using tape recorders that were "built to a price."

The AMPEX 400 Series Recorder is the one outstanding bargain in tape recorder service. It costs least per hour of use; it minimizes maintenance and adjustment; it protects your programs from the hazard of sudden failure; and its reliability frees your engineer's attention for other tasks.

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- *When you press the button, it operates*
- *Program timing stays accurate*
- *Starting, stopping, and rewind will operate smoothly*
- *Fidelity will still be high*
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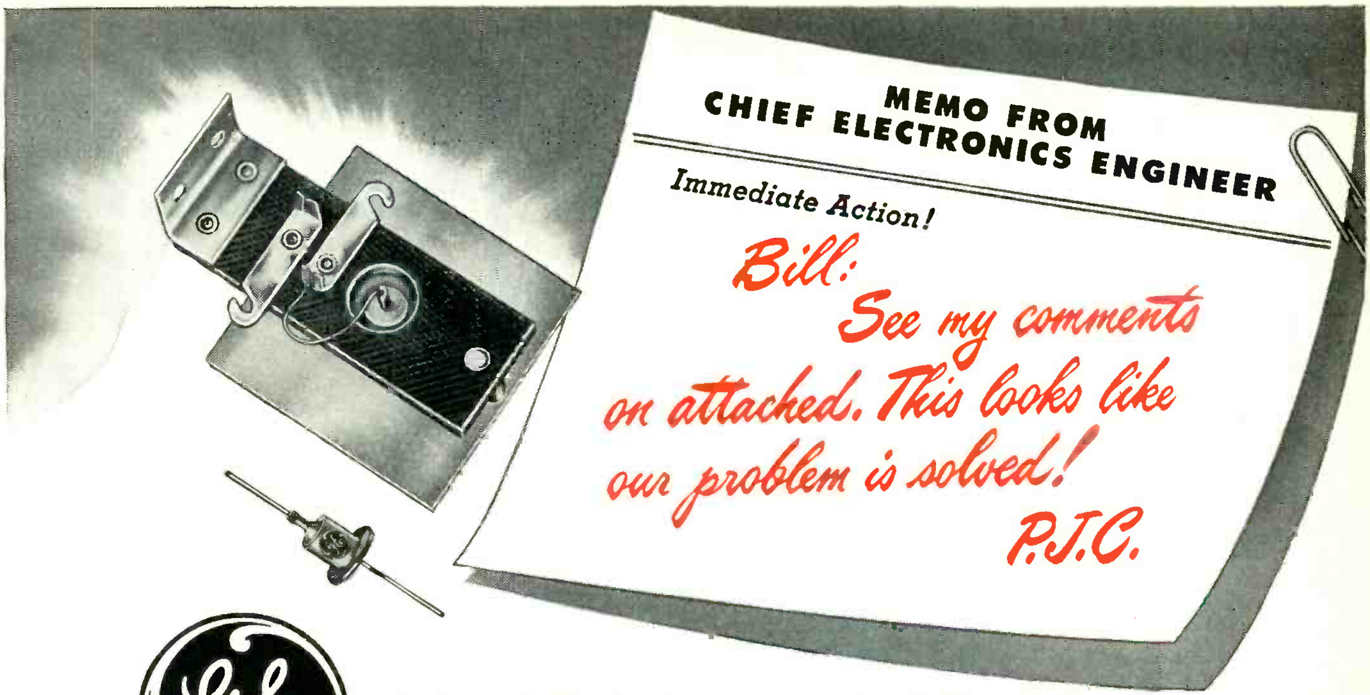
caused by capstan idler, flywheel or drive pulleys. These are referred to as d-c errors or wow. Second are high-frequency errors called flutter and caused by a wide variety of phenomena such as unsupported vibrating sections of the tape near the magnetic heads, poling of the capstan drive motor, and bouncing and friction of the tape as it slides over the heads. By far the most difficult error to correct is the flutter, and therefore a measure of the worth of a recorder for instrumentation work is the amount of flutter it introduces.

There are several techniques for measuring flutter, including some instruments that actually give a direct meter indication. Available instruments of this type, however, will not function to the accuracy required for an instrumentation recorder.

The method generally employed to measure flutter by the manufacturers of instrumentation magnetic tape recorders is as follows: A c-w signal of constant amplitude is recorded on the tape at normal operating levels and then played back through a wideband discriminator. The output of the discriminator is fed to the x-axis amplifiers of an oscilloscope with a fast writing speed. A shutterless camera is placed before the scope and provides a y-axis sweep by the

Test setup for evaluating short sample method of measuring flutter introduced by magnetic tape recorders used in guided missile instrumentation. Discriminator is on panel below tape recorder. Dual-beam oscilloscope and recording camera are at left



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PEAK FORWARD CURRENT (amps)	0.47	0.31	0.25	1.57
D.C. OUTPUT CURRENT* (Ma)	150	100	75	500
D.C. SURGE CURRENT (amps)	25	25	25	25
FULL LOAD VOLTAGE DROP (volts peak)	0.5v	0.5v	0.5v	0.7v
FORWARD RESISTANCE AT FULL LOAD (ohms)	1.1	1.5	1.9	0.5
CONTINUOUS REVERSE WORKING VOLTAGE (volts D.C.)	30	65	100	185
FREQUENCY OF OPERATION (kc)	50	50	50	50
STORAGE TEMPERATURE (°C)	85	85	85	85

*Typical absolute maximum ratings. For other combinations refer to Fig. 1.

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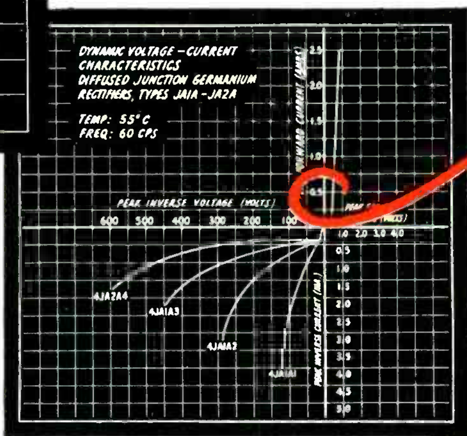

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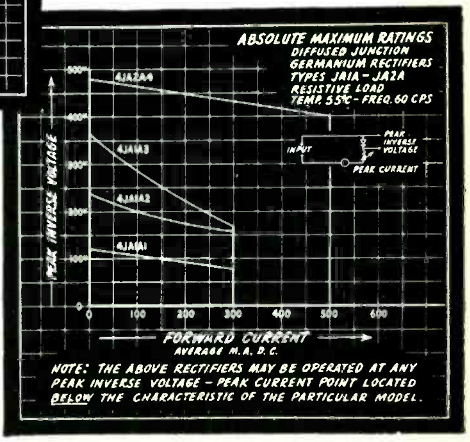

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For complete information write for bulletin L-100.

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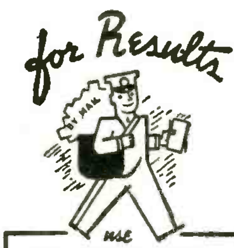

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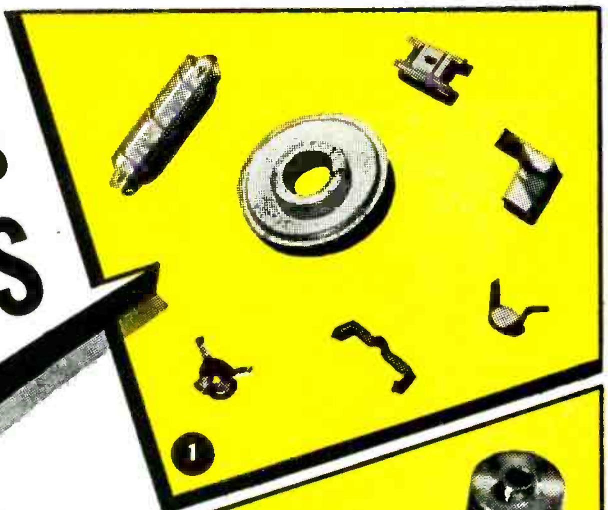

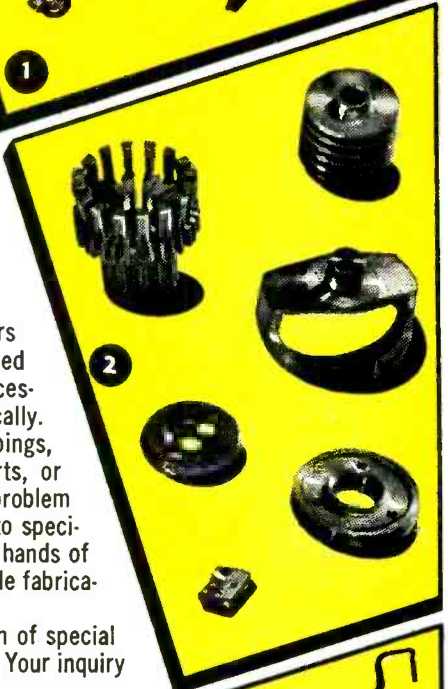

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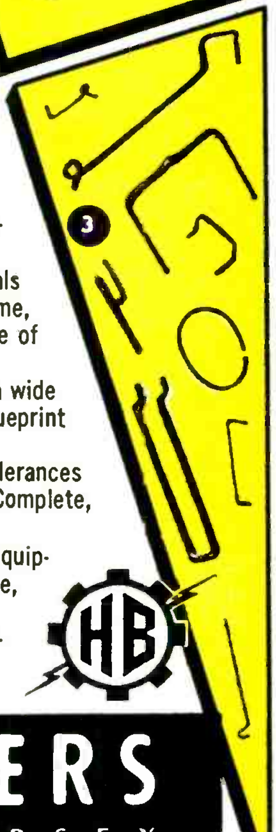

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movement of the film behind the camera lenses.

This arrangement, then, gives a graphic record of actual flutter produced by the recorder. If the recorded signal frequency remains constant upon playback, the film trace appears as a straight line. If the frequency deviates from the original, then the discriminator produces a varying voltage and the film trace forms a picture of these variations as shown in Fig. 1. By simple calibration, these variations can be translated into terms of frequency and the flutter calculated as a percent of the recorded frequency.

The response of the discriminator is a limiting factor in the accuracy of such a measurement since it must pass all modulating frequencies up to an arbitrary limit with a flat response so that each component may be considered in its true proportions. The generally accepted limit for this modulation frequency is 4,000 cps; that is, all flutter frequencies up to 4,000 cps will be considered at full value, and those above will be attenuated in accordance with the pass band of the discriminator.

Since the most damaging components of flutter are the peaks, this phenomenon is usually referred to in terms of average peak-to-peak flutter. It is this value that must be determined from the graphic film record. This brings

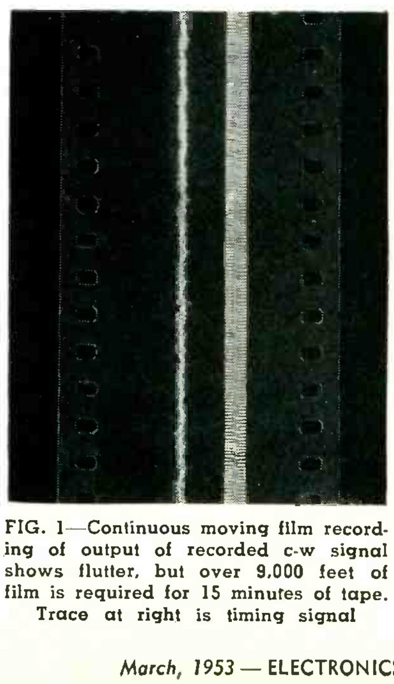

FIG. 1—Continuous moving film recording of output of recorded c-w signal shows flutter, but over 9,000 feet of film is required for 15 minutes of tape. Trace at right is timing signal

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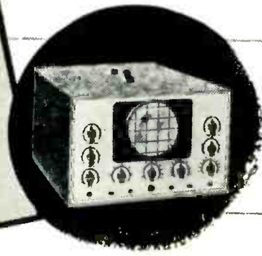

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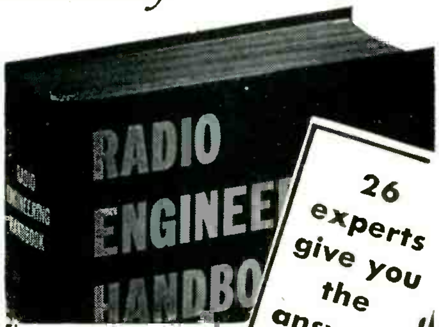

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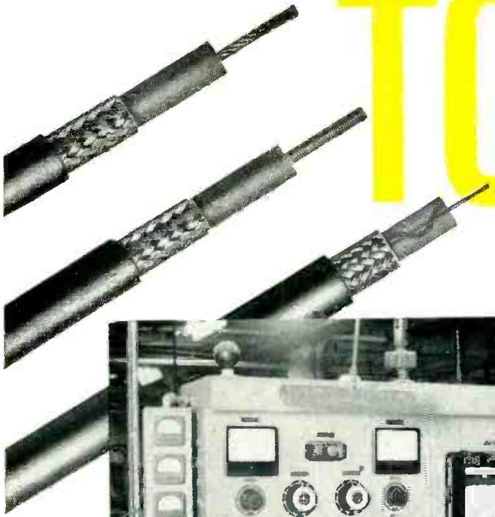

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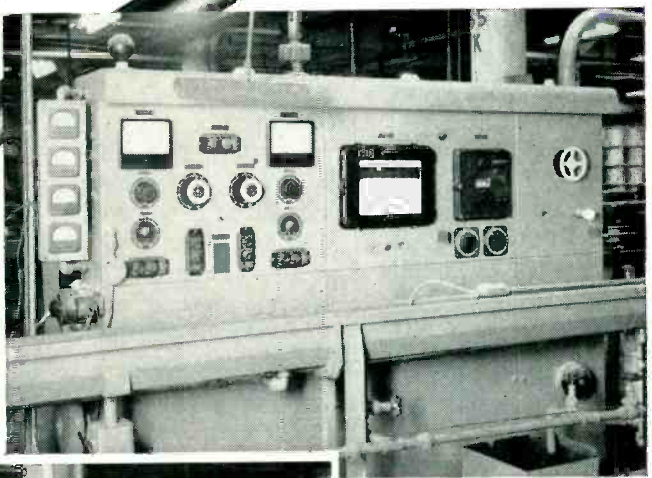

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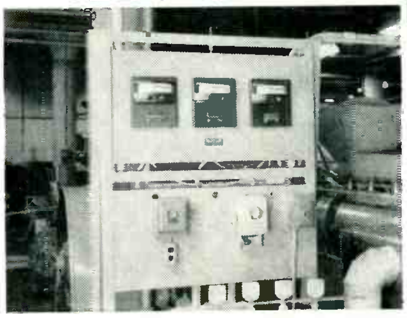

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up the problem of analysis of the film record to arrive at a reasonable and repeatable measurement.

One technique is to make a film record of the entire spool of tape and then analyze all the film to obtain peak-to-peak flutter. When using this technique it is also recommended that flutter spikes of less than 0.001 second, and more than a certain value in amplitude, be disregarded. To perform this analysis, one must have sufficient resolution of the film to be able to read to 0.001 second of time. This would require at least 0.01 inch of film for a manual readup system or 0.001 inch of film in case some optical system, such as Recordak were available. Some new recorders hold as much as 5,000 feet of magnetic tape, and even at the high speed of 60 inches a second, it would require 15 minutes to complete the playing of one reel. This means that the oscilloscope recording camera must also record for 15 minutes and run at a speed of 10 inches per second, to achieve the required resolution. The results would then be spread out over 9,000 feet of film and a tremendous amount of labor would be involved in reducing the data to a percentage figure.

Other possible methods for obtaining this answer would be to analyze only the front portion of the recorded tape or only the last few minutes or possibly the worst section as viewed on the scope or again perhaps only the best section.

None of the previous methods presents a good solution to the problem. There is one method that does allow a reasonable answer to be obtained and yet does not involve as much work as the first technique explained. This is one of random sampling of the flutter throughout the tape. Since flutter itself is a purely random function, the laws of probability can be applied and enough samples taken to arrive at an answer with the required accuracy and within a certain probability.

Mathematically the problem reduces to one of compromise between the number of samples taken and the desired accuracy

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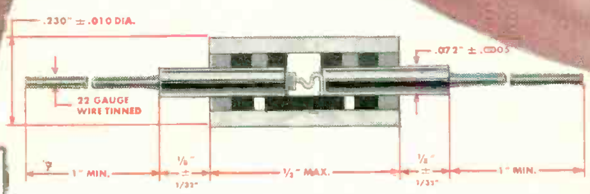

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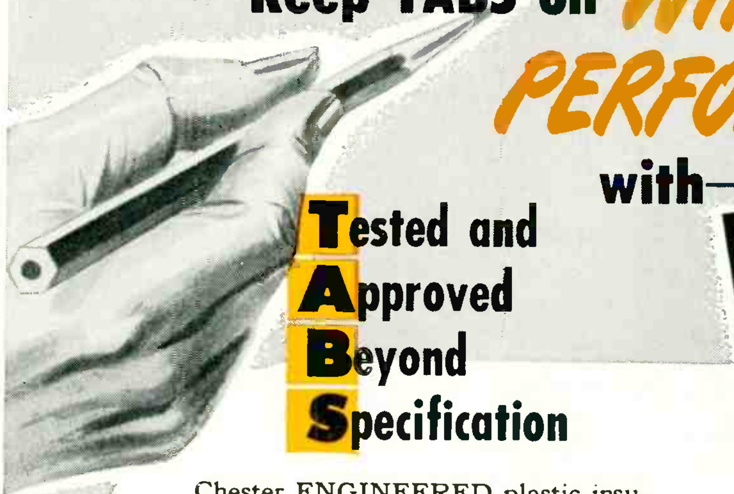

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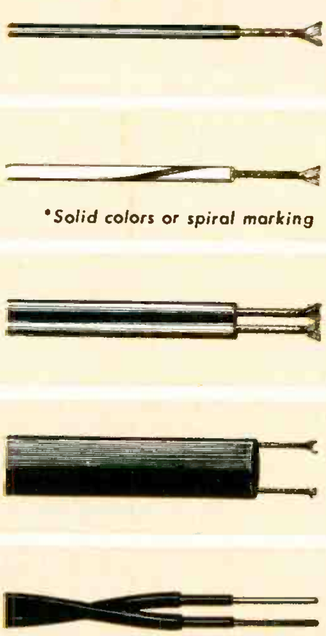

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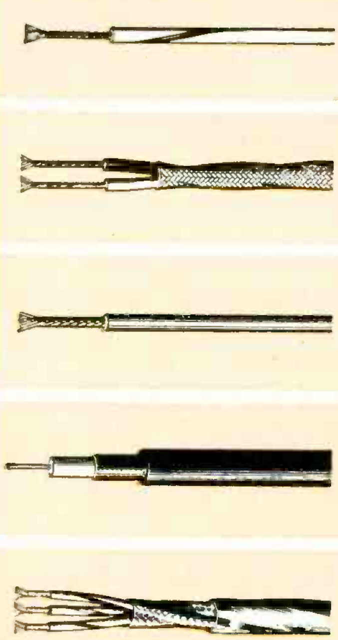

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and probability obtained. As the total number of samples being considered increases, the accuracy of the result increases and the probability of the result being within this accuracy also increases.

This mathematical analysis has been checked in the Technical Systems Laboratory of the Air Force Missile Test Center and results agree with theory. The test setup for this work was similar to that outlined previously for the continuous check except that several bursts of record were taken, spaced approximately evenly throughout the tape. Portions of these bursts, termed long samples, were then broken down into short samples as indicated in Fig. 2. These short samples ran concurrently within the long sample. The purpose of this procedure was to aid in eliminating the d-c or wow errors from the measurement.

Short sample lengths were chosen at 0.04 second of record. The length of this sample determines, within limits, the magnitude of the final answer. It is important that a universal short sample length be established so that comparison can be made between all test results. This value of 0.04 second actually means that any flutter with a half period exceeding 0.04 second (12.5 cps) will not add its full weight to the result.

Referring to Fig. 3, it can be seen that since the measurement is taken from peak to peak, the maximum deflection possible begins to drop off as the frequency of the flutter goes below 25 cycles. As the frequency goes below 12.5 cycles, the flutter can no longer contribute its maximum regard-

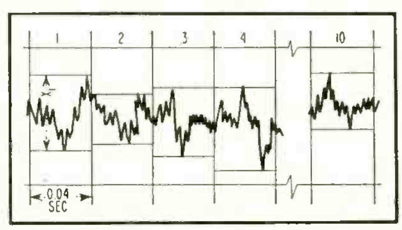

FIG. 2—Short samples provide sufficient accuracy in making flutter measurements on instrumentation tape recorders

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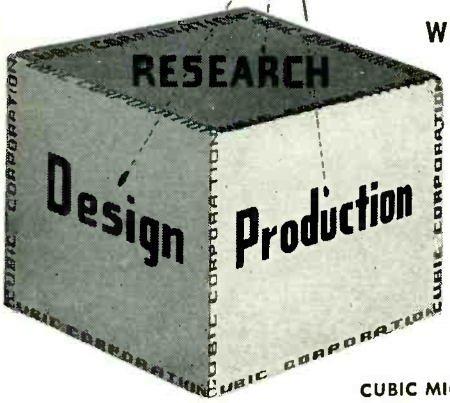

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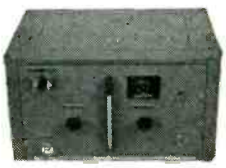

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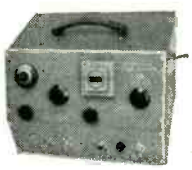

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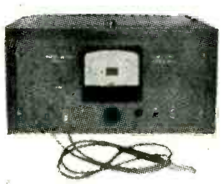

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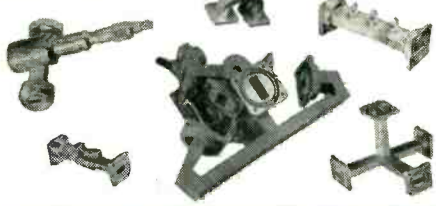

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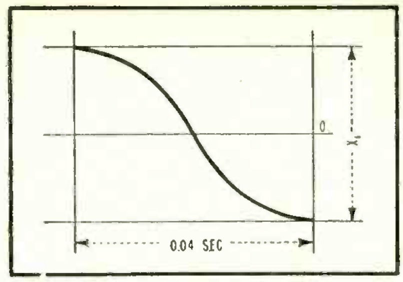
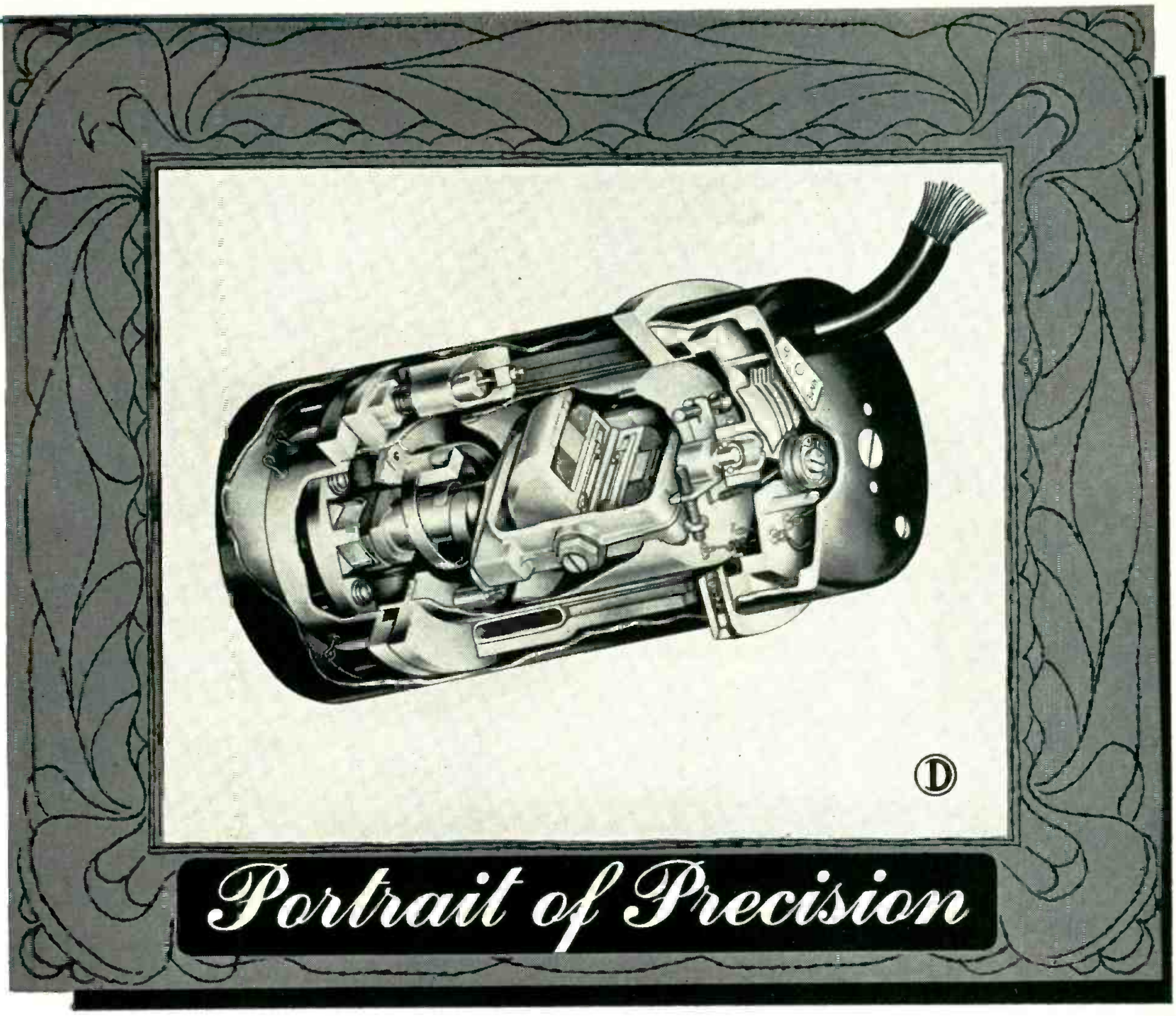


FIG. 3—With 0.04-second samples, any flutter less than 12.5 cps will have little effect on the measurement, thus eliminating wow errors

less of the phase relationship within the short sample.

For the purpose of this evaluation, many more samples and read-ups were made than will be necessary for actual practice. A total of 1,650 short samples was analyzed and the peak flutter determined for each sample. The weighted average was calculated and plotted for all samples running consecutively from the first to the last of the film record. This was repeated with the analysis starting from the last of the film and progressing to the beginning. The third series of calculations and plots was made by choosing the data (that is, the individual samples) at random. After a total of 1,650 samples the curves approach a constant value in all three cases. This value is assumed to be the true average. After 500 samples, the maximum deviation from this true average was 2.35 percent, and after 1,000 samples it was 1.09 percent. If theoretical calculations are made, based on the mathematical analysis of a random function then after 500 samples the result is 2.85 percent maximum error for 95 percent of the time. The maximum error on the laboratory curves was 2.35 percent, which falls under the 2.85 percent predicted.

These tests, while they are certainly not conclusive, indicate that flutter can be measured to better than 3 percent accuracy with 500 readings through a reel of tape. These 500 readings can be made up of 50 long samples, which in turn can be obtained from approximately 10 record bursts while the tape is running. It was found that 10 record bursts can be



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made conveniently from the standard 100-ft film capacity of most oscilloscope cameras.

It must be kept in mind that this measurement for a value of flutter is influenced by the pass band of the discriminator, the length of the short sample and the frequency of the recorded tone no valid comparison can be made between flutter measurements unless these variables are held constant. At best, the technique described still entails a fair amount of work and some expensive laboratory equipment. With this in mind, the Air Force Missile Test Center is continuing work to develop an electronic technique for a more direct measurement of the phenomenon called flutter.

The author wishes to acknowledge the contributions of O. E. Hull and T. S. George towards the information contained in this paper.

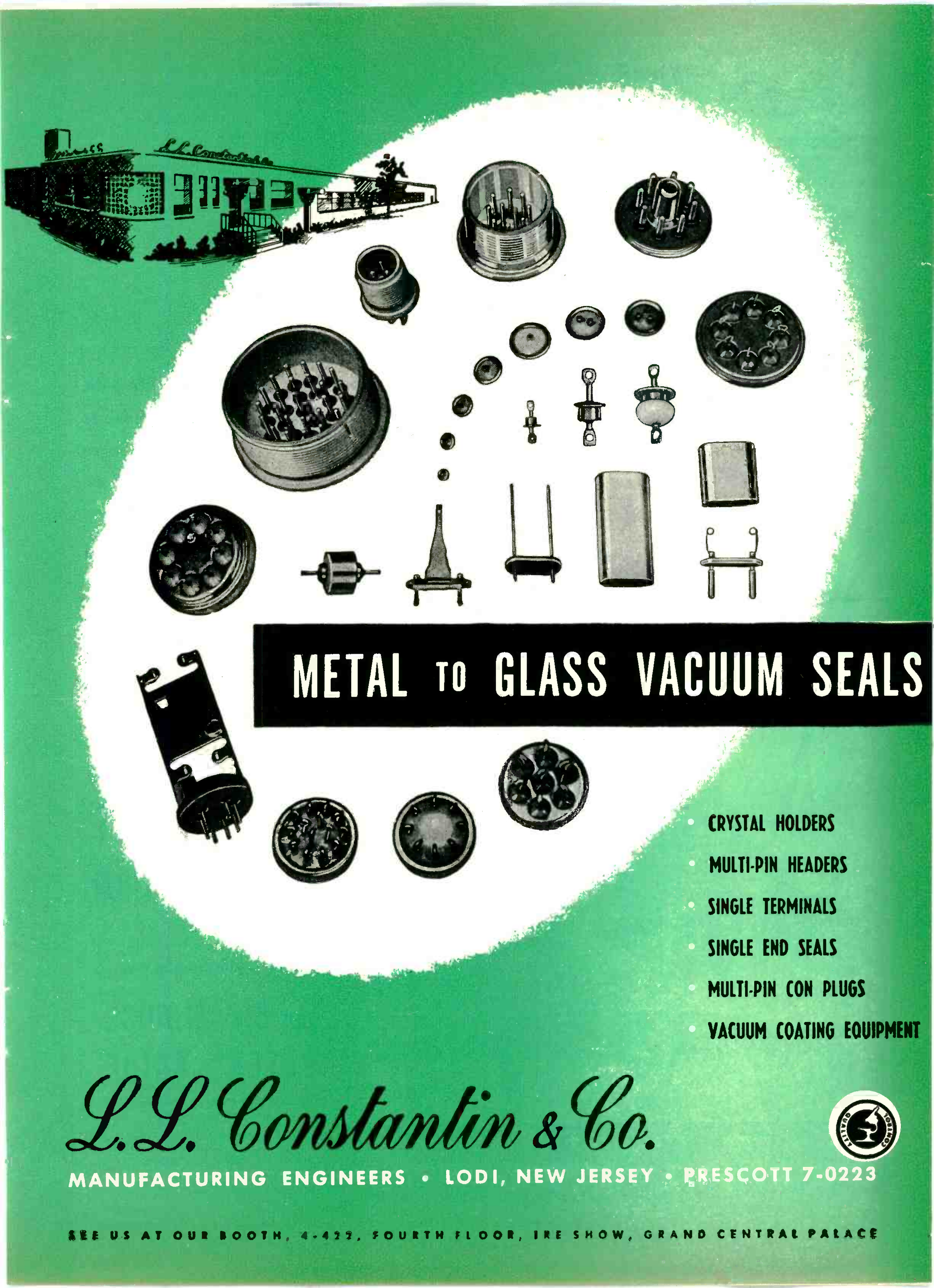
Single-Frequency Audio Filter

By T. M. Dauphinee
Division of Physics, National Research Council Ottawa, Canada

An Audio Filter that gives up to 50-db attenuation for a single frequency may be made quite simply from easily obtained components. The basic circuits of several such filters are shown in Fig. 1 and 2.

In the circuit of Fig. 1 the incoming signal is impressed across the series combination of parallel resonant circuit and a large value variable resistor. The parallel resonant section is composed of a suitable capacitor *C* and the primary winding of an audio transformer *T* with large step-up ratio. One side of the transformer secondary is connected to one terminal of the applied signal. The output of the filter is taken between the other side of the secondary and the other input terminal.

If the frequency of the input signal matches the resonant frequency of the tuned circuit the signal appearing across the secondary winding of the transformer will differ in phase from the input signal by 180 deg assuming the proper secondary terminals have been se-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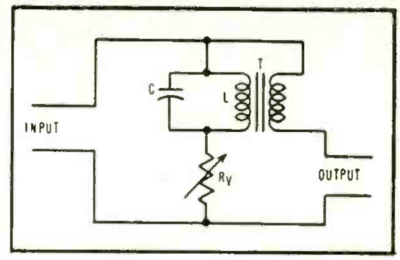

FIG. 1—Single-frequency audio filter giving up to 50-db attenuation

lected, while the amplitude will be at a maximum. By a proper adjustment of resistance R_v, the magnitudes of the input and secondary voltages may then be made exactly equal and under these circumstances the net output signal is zero. Any change of input frequency away from resonance shifts the phase of the secondary voltage and a zero signal is no longer possible.

A very slight deviation from exact phase opposition results in appreciable output signal and the effect is enhanced by rapid phase shift near resonance.

The circuits of Fig. 2 show alternative methods of obtaining a similar kind of filtering action. These circuits have slightly different characteristics but operate quite satisfactorily.

In the case of low-Q circuits the maximum amplitude of the secondary voltage does not occur exactly where the phase shift is 180 deg. However, the rate of change of phase angle at this frequency is still relatively large and the only effect is a broadening of the attenuation peak, without limiting the ultimate attenuation that can be obtained.

Filters of this type have some very useful characteristics. The components are few in number, cheap, and easily obtained. Simple iron cores are sufficient for input signal levels below a few tenths of a volt and the cheaper audio transformers frequently work better than expensive ones. Very large relative attenuations can be obtained for the filter frequency, 40 db relative attenuation over less than one octave on either side being readily obtained.

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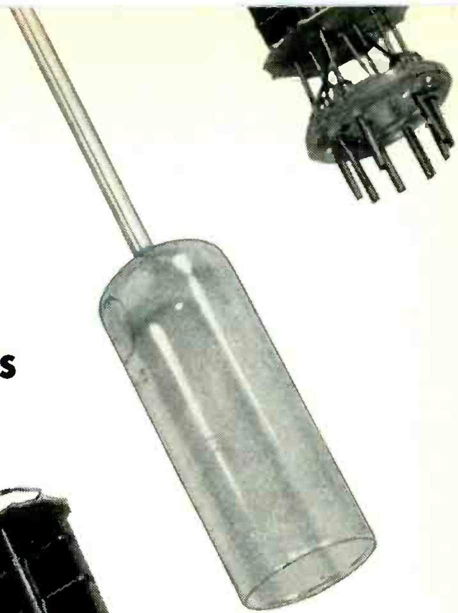
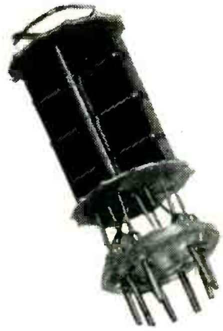
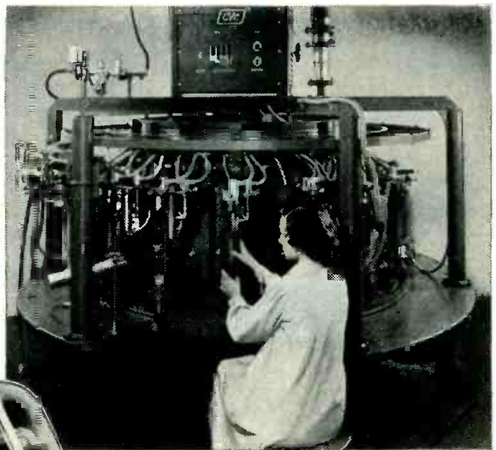

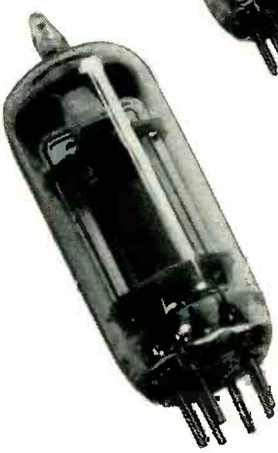

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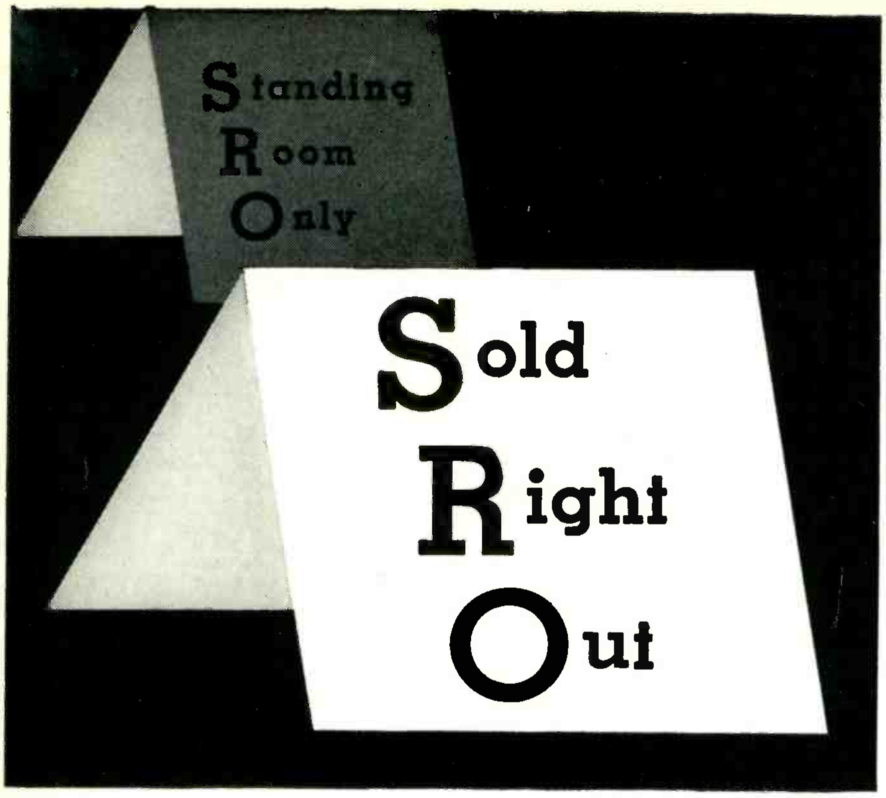

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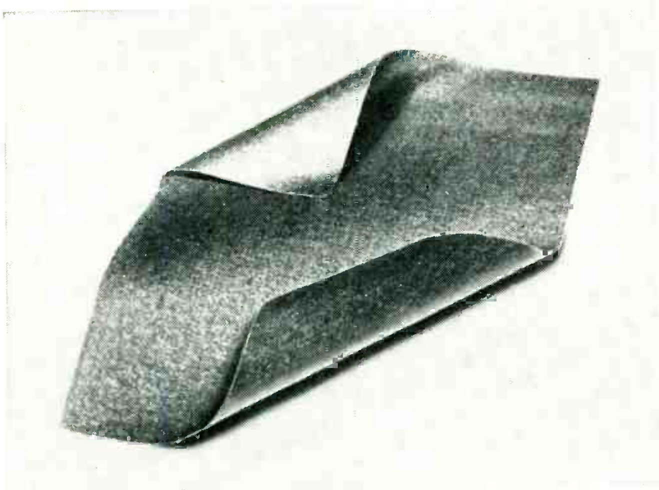

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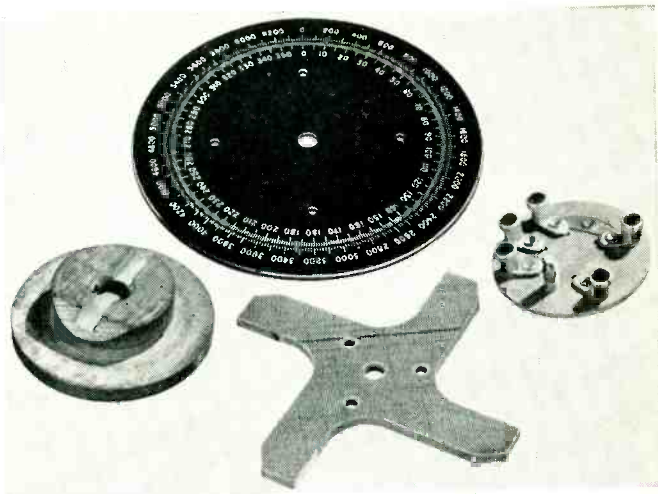

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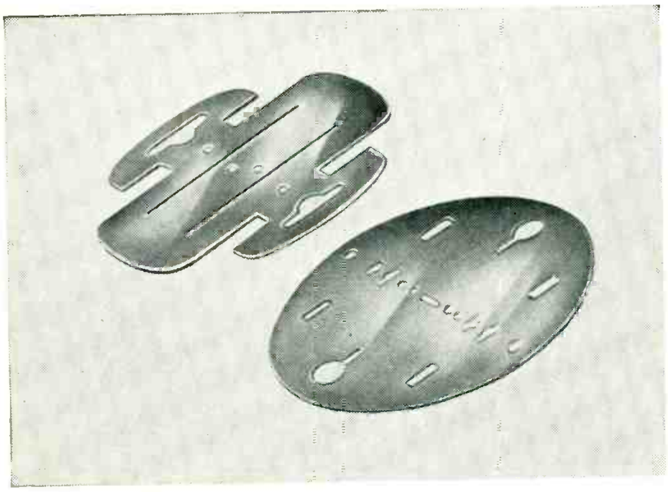

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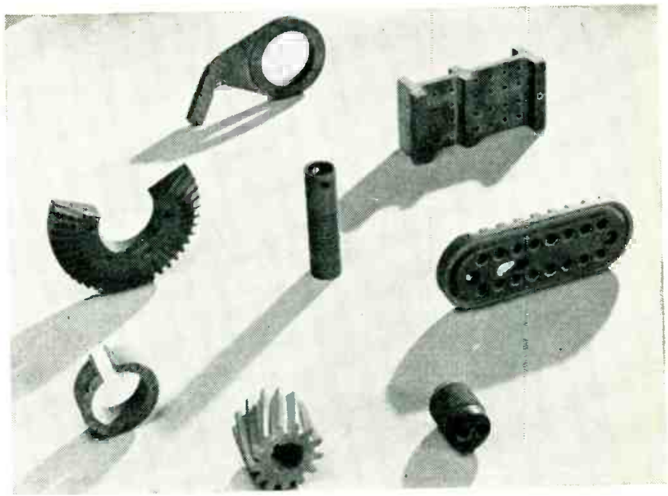

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stability is usually not sufficient for long periods unless the temperature is controlled. Input impedance is high, as much as half a megohm in the intermediate audio range. Response is nearly flat outside the attenuation region, the curve approaching a fixed value at frequencies far from resonance rather than tending to infinity or zero as in many conventional filters.

Limitations

The filters have some disadvantages arising mainly from the limitations of transformer design. The filter frequency changes at high signal levels because of changes in incremental permeability of the core material with increasing signal. This effect can be eliminated by use of powdered iron cores, but at some sacrifice of input impedance and availability.

The filter frequency is also slightly temperature sensitive, a change in frequency of about 0.1 percent per deg C with ordinary transformers. High impedance loads (for example, a tube grid) are desirable on the output, so it is not easy to place filters in series, and the frequency range of the transformers may be slightly restricted by the fact that they are operating into unmatched loads. In most cases the body of the transformer is above ground, and at high

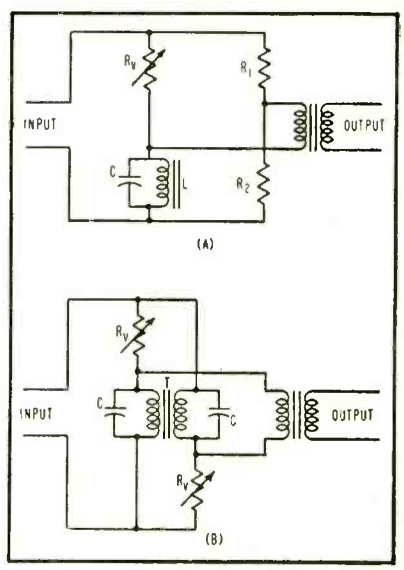

FIG. 2—Two alternate audio filters using a parallel-resonant circuit (A) and a tuned transformer (B) to attenuate a single frequency

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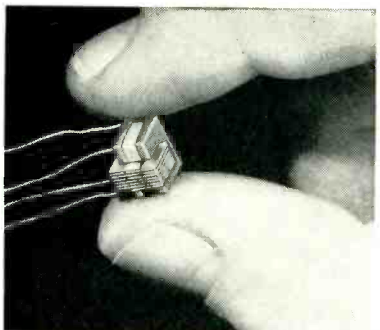
These stock transistor transformers are available through your Stancor distributor:

TYPE	APPLICATION	PRI. IMP.	SEC. IMP.
UM-110	Interstage	20,000	1,000
UM-111	Output or matching	1,000	60
UM-112	High imp. mic. to emitter	200,000	1,000

Other transistor transformers, built to your special requirements, are available for original equipment production only. Write for Bulletin 462.



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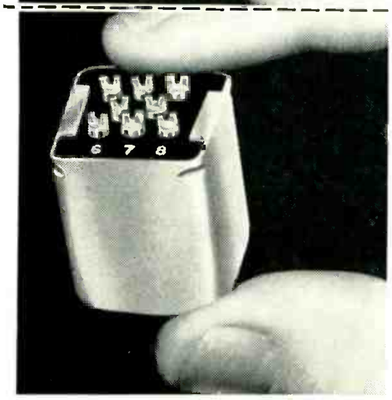
TYPE	APPLICATION	PRI. IMP.	SEC. IMP.
TT-11	Mic., pickup or line to single grid.	50, 200/250, 500/600	50,000
TT-12	Mic., pickup or line to push-pull grids.	50, 200/250, 500/600	50,000
TT-13	Dynamic mic., to single grid.	7.5/30	50,000
TT-14	Single plate to single grid.	15,000	60,000



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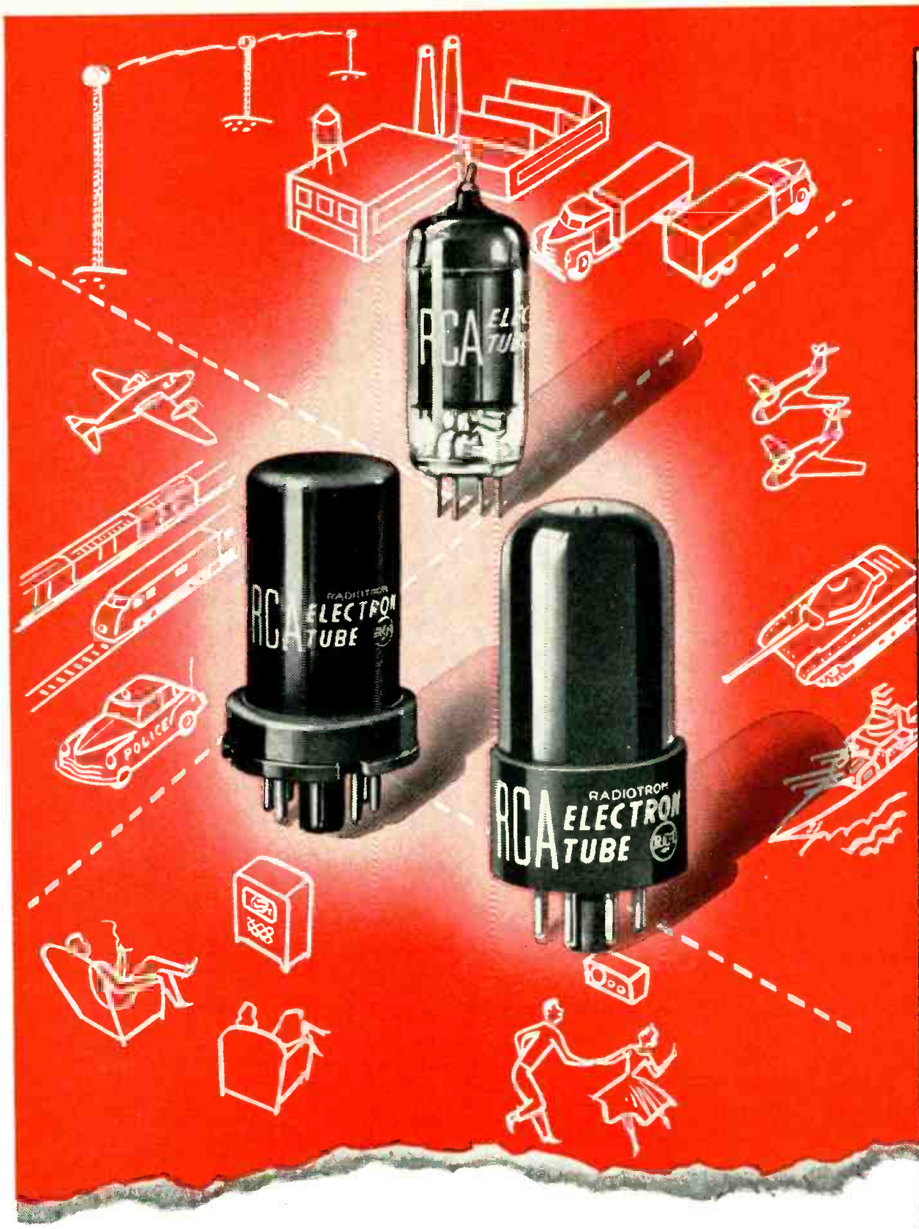

10 reasons why standard RCA receiving tubes offer built-in Performance Security

- The cathode base metal and the carbonate coatings are individually matched for each tube type to provide superior performance. Both are continuously RCA-engineered for maximum quality control.
- The specially processed carbonized nickel-coated anodes developed and used by RCA provide 97% of the radiating effectiveness of a true black body as compared with the 68% figure for the older-style carbonized nickel-plated anodes. This increased effectiveness means better life for RCA tubes because the anodes operate at lower temperatures.
- Lead-glass envelopes at a cost differential of about 10 to 1 compared to lime-glass envelopes are used by RCA for certain capped types which operate at very high voltages. Such use results in much better life performance.
- Gold-plated grids are used in certain RCA tube types for better control of critical tube characteristics.
- The RCA-developed "A" frame construction—used in 6 of the popular metal types—gives rigidity to the tube elements and provides increased resistance to vibration, thus reducing microphonics and stabilizing tube characteristics.
- Strict mica tolerances, tighter than usual in the industry, provide improved stability and freedom from microphonics.
- Certain RCA tubes incorporate cathode clips and inverted-pinched cathodes to provide improved ability to withstand vibration; as a result there is greater freedom from microphonics. RCA types for battery operation use a filament damper bar to minimize microphonics.
- RCA not only uses the highest quality mica but also utilizes a higher percentage of sprayed micas than industry in general. These precautions provide greater freedom from leakage noise and other internal leakage effects.
- Double-helical coil heaters are used in many types to provide more reliable performance and to insure greater freedom from hum.
- Each RCA receiving tube has been designed to minimize the number of welds. With such designs there are fewer points at which possible failure can develop. As an additional precaution, RCA welding is done on accurately timed unit welders to insure that each weld has maximum strength and uniformity.

Why you can expect <u>plus</u> performance from standard RCA receiving tubes...in every field

Over the years RCA has fostered the use of advance design and quality-control techniques in tube manufacture. Since World War II, RCA has stepped up its continuing program for quality improvement. As a result, the *standard* RCA receiving tubes of today often provide the superior performance and reliability usually expected from specialty-designed types of other manufacturers.

In addition to this built-in performance security, standard RCA receiving tubes cover a wide range of types, are inexpensive, and are readily available both to the equipment designer and the ultimate user.

RCA Application Engineers are ready to consult with you on the adaptation of standard RCA receiving tubes to your equipment designs. For further information write RCA, Commercial Engineering Section 42 CR, Harrison, N. J. . . . or contact the nearest RCA Field Office: (East) Humboldt 5-3900, 415 S. 5th St., Harrison, N. J. (Midwest) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill. (West) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Calif.

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frequencies the shell may have to be connected to an appropriate point on the circuit and insulated from the chassis.

Some performance curves and data are given in Fig. 3. In many ways these filters have better characteristics than T, π or twin-T filters[1, 2], particularly at low frequencies. Better performance could be expected from the use of powder cores.

Since the transformers used are imperfect ones, no attempt has been made to develop a detailed theory of the filter. Some expressions applicable to ideal transformers when the load resistance is effectively infinite are given as a guide in choice of components.

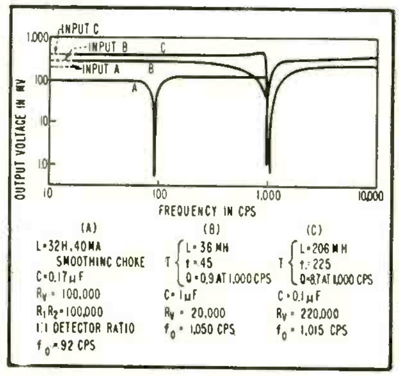


FIG. 3—Attenuation curves obtained with filters using various values of circuit components

The filter frequency $f_o = \dfrac{\omega_o}{2\pi}$ is given by

$$\omega_o L + \frac{R^2}{\omega_o L} = \frac{1}{\omega_o C}$$

or

$$\omega_o L \left(1 + \frac{1}{Q_o^2}\right) = \frac{1}{\omega_o C}$$

where R is the transformer primary resistance

and $Q_o = \dfrac{\omega_o L}{R}$

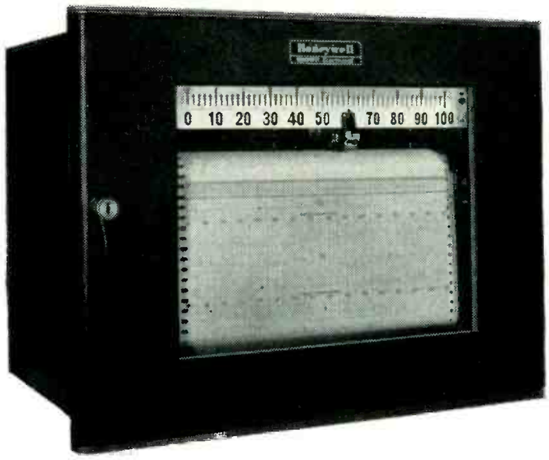
$$R_v = \frac{t - 1}{R\omega_o^2 C^2 \left(1 + \dfrac{1}{Q_o}\right)}$$

$$\approx \frac{Q_o^2}{R}(t - 1) \text{ for large } Q$$

where t is the turns ratio of the

for measuring low level potentials–

the narrow span ElectroniK recorder



CHARACTERISTICS

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Pen Speeds—24 or 12 seconds full scale travel.

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This high-gain amplifier is also supplied as a separate unit for use in null detection, servo circuits, or other work where its extreme sensitivity and high stability prove valuable.

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● **REFERENCE DATA:** Write for Data Sheet No. 10.0-8 on the Narrow Span *ElectroniK* Recorder . . . Data Sheet No. 10.20-4 on the *40X* Amplifier . . . and for Bulletin 15-14, "Instruments Accelerate Research."

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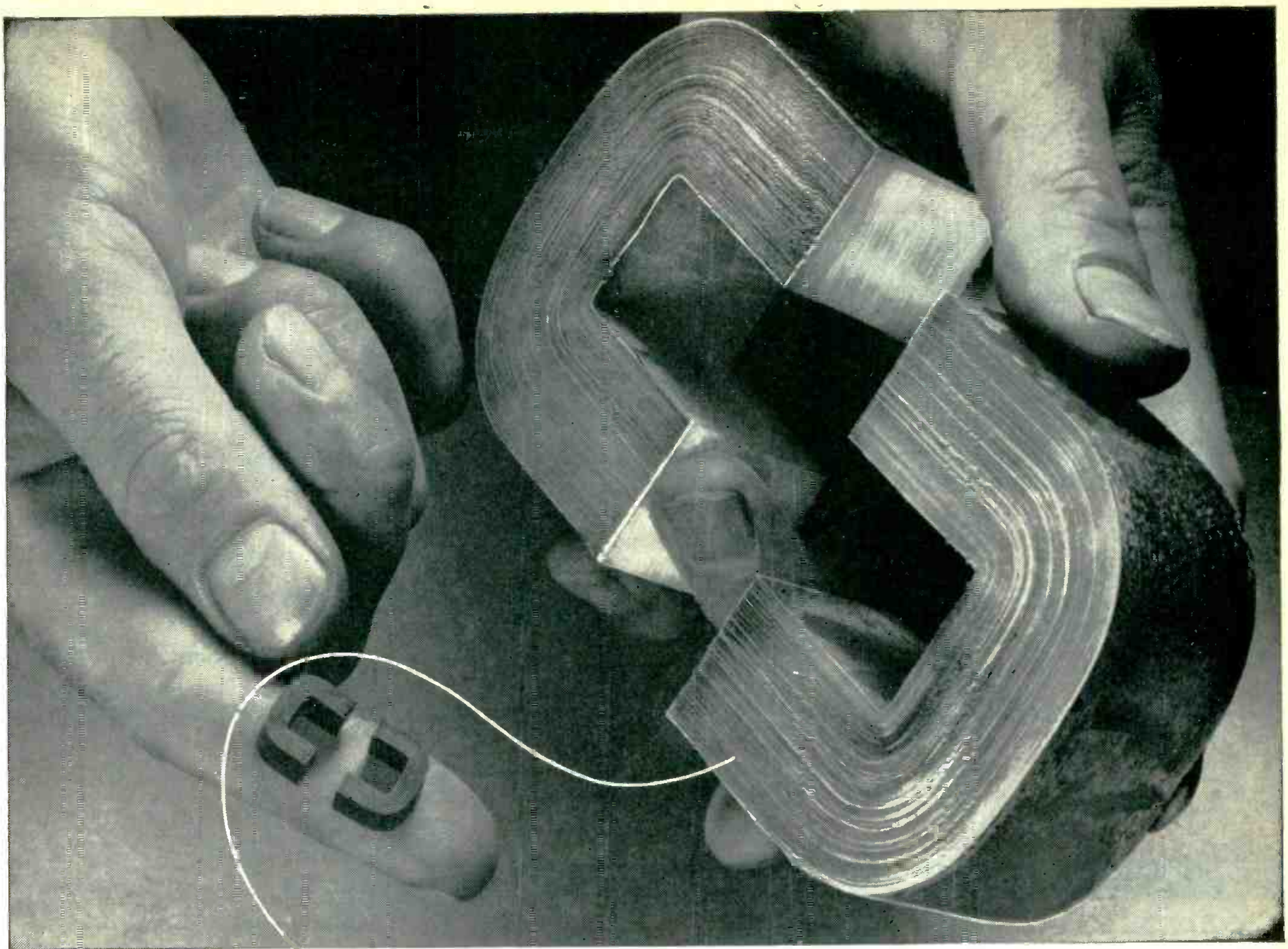

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transformer

$$\text{Gain} = \left|\frac{E_o}{E_i}\right| = \frac{\omega^2 LC}{R}\left(\omega L + \frac{R^2}{\omega L} - \frac{1}{\omega C}\right)$$

$\omega^2 LC \approx 1$ near resonance

The variation of gain (G) with frequency near the frequency f_o is

$$\frac{dG}{df} = \frac{4\pi L}{R}$$

The phase shift near resonance is approximately 90 deg and the sign reverses on passing through the minimum.

The effect of variation of resistance R_v at resonance is given by

$$\frac{dG}{dR_v} = \frac{1}{R_v}\left(\frac{t-1}{t}\right)$$

For 40 db attenuation R_v must be adjusted to 1 percent.

REFERENCES

(1) F. E. Terman, *Radio Engineers Handbook*, Section 3, McGraw-Hill, 1943.
(2) W. N. Tuttle, *Proc. IRE* 28, p 23, 1940.

Storage of Magnetic Recording Tape

RECOMMENDATIONS by the Minnesota Mining and Manufacturing Co. concerning the storage of magnetic recording tape includes the following points:

Tape should not be stored unboxed because of danger of physical damage and dust contamination.

Tape reels should be loosely wound and stored on edge. Stacking should be avoided because plastic reels may be distorted and tape edges damaged.

Ideal relative humidity conditions for tape storage are between 40 and 60 percent. If humidity variation is large the tape should be kept in sealed containers. Use of desiccants or humidifying agents is not recommended because of difficulty in controlling results.

Avoid exposing tape to temperature extremes. If tape is subjected to extreme temperatures allow it to return to room temperature before using.

Occasional use of tape improves storage characteristics as use on a machine relieves strains and adhesions.

Excessive tension should be avoided in rewinding tape as it may become stretched or permanently distorted if wound too tightly.

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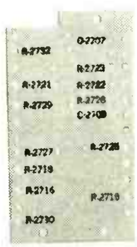

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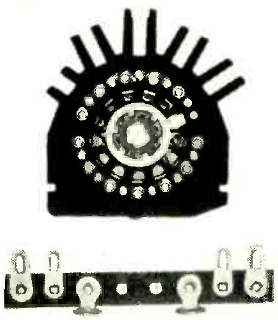

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774	XXP	......
776	XXXP	MIL-P-3115B (PBE-P)
900	C	MIL-P-15035B (FBM)
910	CE	MIL-P-15035B (FBG)
940	L	MIL-P-15035B (FBI)
950	LE	MIL-P-15035B (FBE)
580	A	...... (PBH)
980	AA	...... (FBH)
115	G8	......
120	G1, G2	......
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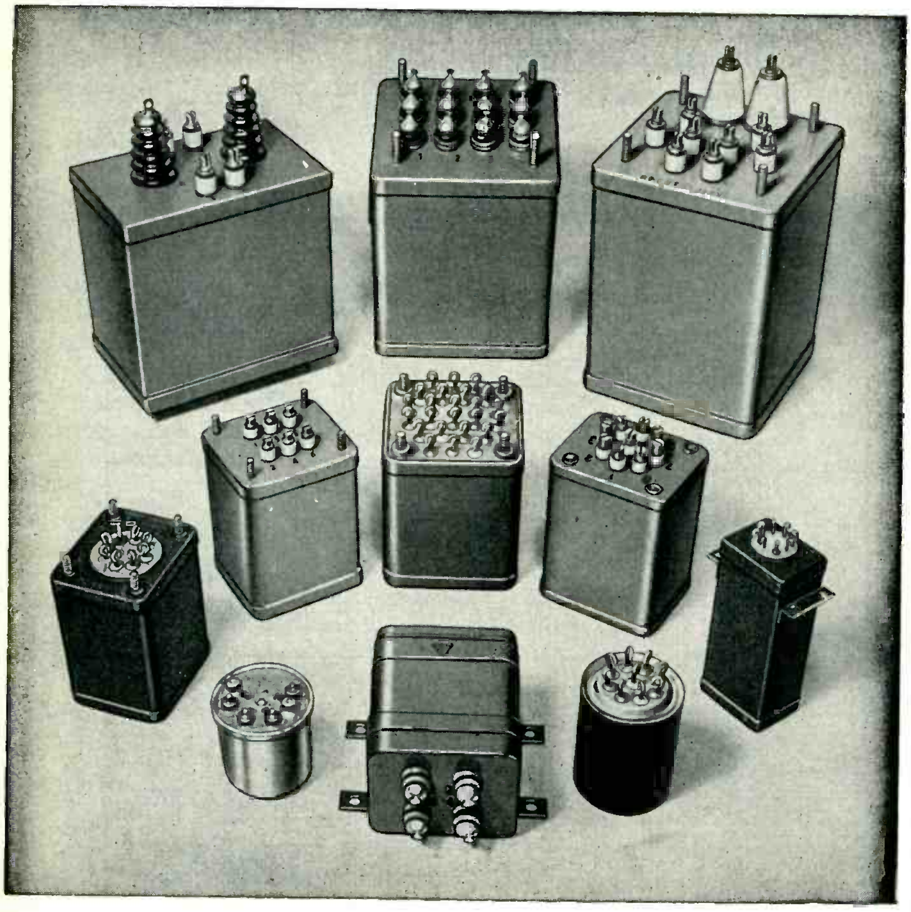

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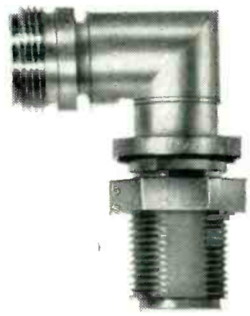
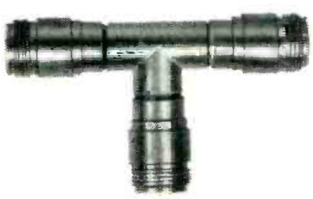
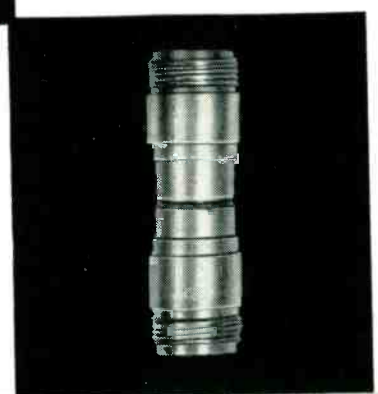


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Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

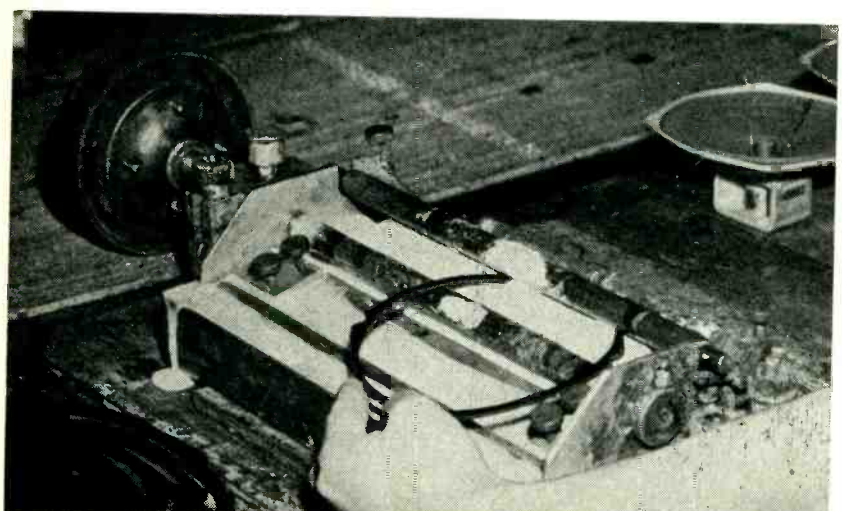
Cement-Applying Shortcuts Boost Speaker Production

A CEMENT applicator operating much like a washing-machine wringer applies cement uniformly to one side of the loudspeaker cone gasket in about a second in the Cincinnati plant of Crosley Division, Avco Mfg. Corp. The cement-applying roll turns in a pan of Arabol adhesive 34A.

Drive power for the roll is taken from the moving-conveyor belt on the loudspeaker assembly line, by means of a flat pulley that is mounted on the shaft of the roll and is in contact with the belt. The gasket rings are preheated in batches under an infrared lamp to make them pliable before they are put through the applicator, because previous inpregnation with varnish makes them too stiff for the cementing operation.

An entirely different type of fixture is equally fast and efficient in applying thermosetting cement to the speaker basket prior to assembly of the voice coil-cone unit. The cement is applied in two operations, using one fixture for the spider cement and the other for the cement going into position for the outer rim of the diaphragm. Each fixture has cleats for positioning the speaker frame face-down over the cement pot. Each has a cement-applying ring that normally sets down in the pot. When the speaker frame is in position, the operator moves a lever that brings the ring up out of the pot into contact with the speaker frame, thus applying cement to the required frame area.

Operator demonstrates use of fixture for applying ring of red thermosetting cement to speaker frame for anchoring spider. When she releases lever in right hand, the ring and its strap iron side supports will drop down into the pot to pick up cement for the next speaker

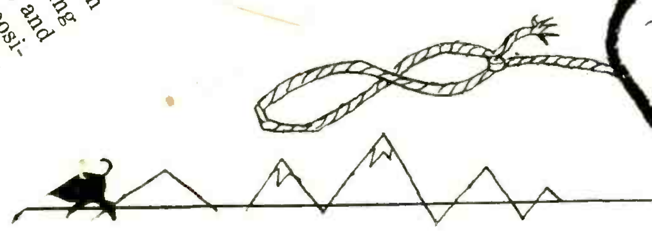


Wringer-type cement applicator driven by friction from assembly-line belt, designed by Crosley for applying cement to speaker gaskets

When both rings of cement have been applied, the voice coil-cone assembly is placed in position. The cement is set afterward in an oven through which the conveyor runs.

Cement is quickly applied to a speaker dust cover with a castellated metal tube. This tube is in-

kipAlong,
-"brand you know



"Maverick" usually spells trouble, on the production line as well as out on the range. Being an unknown quantity or a "Johnny-come-lately," it leaves room for genuine doubt both as to performance and quality. And that's the reason so many experienced buyers —production experts to supervisors—insist on Kester . . . the one "brand" that is synonymous with the best solder and solder products.

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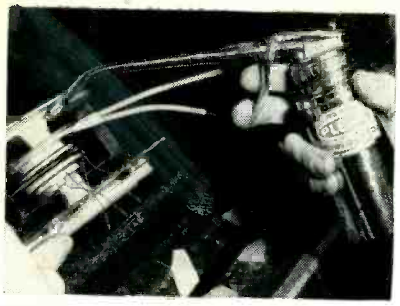

Applying household cement to television transformer with oiler

serted in the cement dispenser, dabbed on a sheet of paper on the bench to remove surplus cement, then twisted lightly over the dust cap to apply cement neatly around its circumference.

When spots of cement are to be applied quickly, such as for cementing sponge rubber pieces to a television transformer assembly, the model 965D Plews oiler proved highly satisfactory as an applicator. A variety of cements can be used, including household cement.

Lubricant for Powdered Iron Cores

INSERTION of powdered iron cores in i-f traps and similar components is speeded up in DuMont's plants by using talcum powder as a lubricant. The cores are dusted with the talcum before insertion in the forms. An air gun with a screwdriver bit is then used to turn them in at high speed to approximately the final position.

Printed Resistor Production Tricks

FOUR methods of increasing the overall yield of printed resistors are are suggested in National Bureau of Standards Report NAer 00686, "Printed Circuits".

(1) Inks should be formulated and the screens or other printing means designed in such a way that when the resistor goes off tolerance, it is always low in value. The resistance value can then be raised as needed by abrasive means to make an entire assembly come within tolerances.

(2) Where the nature of the composition of the resistor and its cure permits, more resistance ink may be added by hand to reduce the value of the resistor.

(3) Circuitry may be designed so that, for example, only a ratio between the values of two resistors is important. Here variations in the resistance ink or in processing techniques would make both resistors high or both low but in most cases k[eep the ratio with]-ance lim[its].

(4) Cir[cuits may be engi]-neered that two out of ea[ch] per stage need ances. This in yield of complet[e] tions.

Modules for Engineers Give Privacy Without

COMBINING a modular arrangement of desks with four-foot-high barriers has minimized unnecessary distractions in one electronic engineering section at Convair's San Diego plant while still allowing for easy conference among engineers working on a single large electronic project. The arrangement gave a space saving of about 10 percent over that required for desks without barriers.

Each 7 x 10 foot module for two desks, a lock-equipp cabinet for classified drawing a visitor's chair. The desks are tioned at opposite walls and staggered so that each occupant h the full between-desk area as push back space for his chair.

The barriers have a one-foot space off the floor to give better circulation of air. This also permits running telephone and power lines

Staggered arrangement of desks within a module. Shared telephone, on shelf between desks, can also be used by engineers on other side of barrier

Portion of Electronics and Missile section, showing modular arrangement of desks for engineers. Filing cabinets contain classified data, hence must have OPEN signs when unlocked

ANOTHER PERFORMANCE REPORT FROM CONDENSER PRODUCTS COMPANY

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"CPs" engineers came up with this...

LSG 102-25

1⅜" OD x 8"

"Using design factors similar to 'CPs' standard Plasticon Glassmike (plastic film, glass tube) capacitors rated up to 3500 V, a 1000 mmf. 25 KV Glassmike was constructed. Tests under full power showed a Q of 3000 at 1 megacycle. The temperature rise was 15°C at 12 amps. at 500 Kc. This Plasticon Glassmike, LSG 102-25, was substituted for a mica capacitor in a Commercial Broadcast Transmitter. Its cost was approximately 40% of the cost of the mica capacitor. The base dimension of the mica capacitor was 5" x 6½"; the height, 5¾". The LSG 102-25 is 1⅜" OD x 8" long.

"A year and a half later, our LSG102-25's are still in operation."

"CP" is now filling orders for high voltage, high power LSGs in the following ranges: 5,000V, 7,000V, 10,000V, 14,000V, 17,000V, 20,000V, and 30,000V. Sizes range from 19/32" to 1⅝" OD and from 1" to 8" in length. "CPs" Plasticon Glassmike LSGs are more compact, easier to mount, and less expensive.

● ***Your engineering problem*** will receive the immediate attention of our design and specification engineers.

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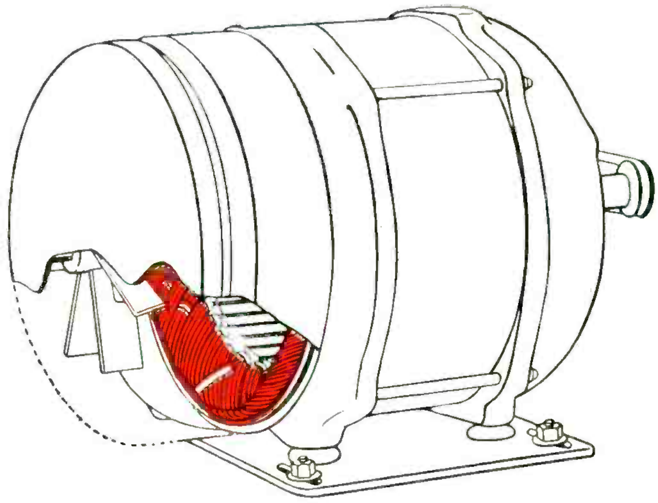
Arrangement of aisles between modules

along the bottom of the barrier through ordinary messenger loops, facilitating janitor cleaning work. The four-foot height is sufficient to block the view of an engineer while he is bent over his desk, but is low enough so that he can see into ajoining cubicals if he straightens up in his chair. He can thus easily determine whether an engineer a few modules away is available for a quick conference or coffee. Although men vary in height, all are about the same eye level when seated.

The modular arrangement was devised by V. E. Thomson, a supervisor in the Guided Missile Division. Cost of the system of barriers was $5,400 installed, or about $35 per person for the 154 engineers accommodated. No special construction or remodeling was necessary.

Capacitance Bridge for Subminiature Tubes

ACCURATE measurement of interelectrode capacitance of subminiature tubes is expedited through use of a special Sylvania-designed capacitance test adapter. Holes for the eight long, flexible leads of tubes such as the type 5896 duo-diode are sufficiently large to permit easy insertion. The outside of the adapter is then turned to the left, to push contact pins inward in such a way that they make good contact with the leads without appreciably in-



1¢ *lengths* of BH Sleeving STOP $50 REJECT LOSS

A reject rate of three to seven motors a day was cutting the profits of a motor manufacturer. The varnished tubing insulation on the motor leads cracked when tapped into position. Taken off the assembly line — devarnished, re-insulated, reassembled and revarnished — each motor reject meant a $50 loss.

Then the manufacturer changed to BH "649" . . . a braided, Fiberglas, vinyl coated electrical insulation. It cost approximately 1c for each 2-inch length of BH "649" — and stopped the reject troubles!

More and more manufacturers are turning to BH Fiberglas Tubing and Sleeving for electrical insulation. It pays off by preventing insulation breakdowns, avoiding costly rejects. Its permanent flexibility prolongs product life.

Whether you're concerned with excessive current loads, vibration, extremes in temperatures, flexibility, fungus resistance, or what . . . let us help you. Send facts on your requirements, voltages and temperatures encountered. We'll make our recommendations and send you production testing samples.

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BH 1ST
in use of Fiberglas
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in true high temperature flexibility
in vinyl-coated Fiberglas
in silicone rubber coating
in colors in silicone rubber
in true Class B (130°C.) protection

BH *Fiberglas** SLEEVINGS

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

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SPECIALTY INSULATIONS

A COATING FOR EVERY APPLICATION

A partial list of INSL-X product groupings is given below: literature and samples gladly furnished on request.

FUNGICIDAL COATINGS that prevent moisture infiltration and effectively inhibit organic attack. All of the coatings are easy to apply, non corrosive, biologically effective, and non toxic to humans. INSL-X fungicidal coatings meet rigid Government specifications.

ARC RESISTING COATINGS that in addition to arc resistance, possess very high dielectric strength, water resistance, and the ability to withstand high intermittent temperature up to 400° F. or prolonged temperature up to 300° F.

COIL COATINGS that are rapid drying, have high dielectric strength and are chemically neutral to fine wire. They are thermally stable, and suitable for long lived applications. Outstanding anti-corona properties are highly desirable for *TELEVISION INSULATION.*

TOOL INSULATION. A tough, high dielectric acid resisting, waterproofing compound designed for the insulating of tools. It may be reinforced and built up to practically any dielectric and mechanical strength by the use of glass, asbestos or fabric sleeving or tape. This method provides a foundation capable of withstanding severe impact and abrasion.

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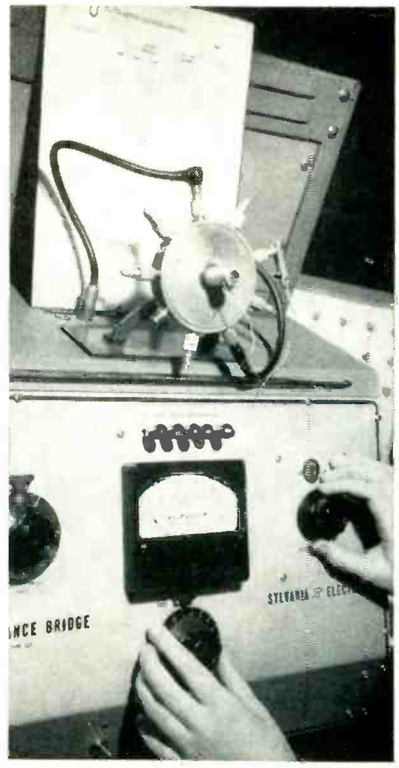

Tube is plugged into holes in center of adapter on top of bridge, and metal shield is pushed over tube as shown, for sampling inspection check of interelectrode capacitance. Chart behind adapter gives approximate values and bridge connections

creasing the capacitance between leads. The adapter also maintains complete shielding of each lead from all other leads.

In one typical measurement, pins 2, 3, 4, 6 and 7 are grounded and the Sylvania type 125 capacitance bridge is connected to pins 1 and 5 by means of coaxial cable. A typical reading for this setup is 0.012 $\mu\mu$f.

Ageing Rack for Bathtub Capacitors

RUBBER tubing provides spring pressure against the bottoms of metal-encased paper capacitors for forcing their terminals against foil-

Method of loading ageing rack

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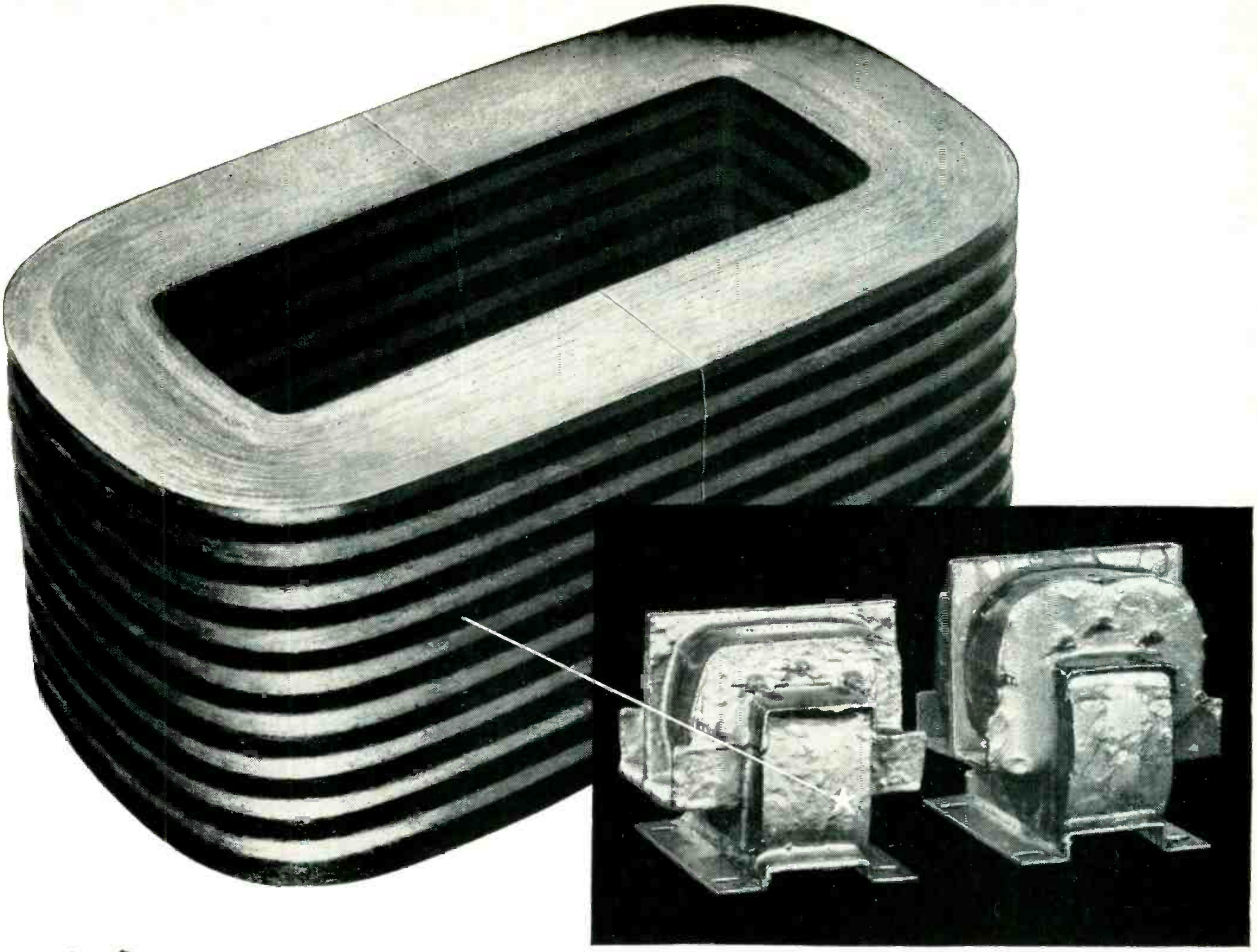

New HIPERSIL CORE
cuts air-borne transformer size and weight

Transformer weight reduced 25%, size cut 20% in a single unit of air-borne electronic equipment. This is the mark set by a new lightweight Hipersil® Core designed by Westinghouse for the Navy Bureau of Aeronautics.

Adaptable to commercial as well as military use, the new core makes possible more powerful equipment within the size and weight limitations of previous models. A special silicon steel, rolled to a new 4-mil thinness, with grain structure super-oriented by a refinement of the Hipersil process, achieves the size and weight reductions.

Hipersil Cores cut size and weight in *all types* of electrical and electronic transformers. They combine highest permeability with lowest losses in a wide range of sizes (1 through 5 and 12 mils). Two-piece assembly simplifies transformer manufacturing, cuts fabricating costs. Greater flux-carrying capacity, increased mechanical strength help to make them the best core on the market. For specific information on how to apply Hipersil Cores to your product, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70632

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HIPERSIL CORES

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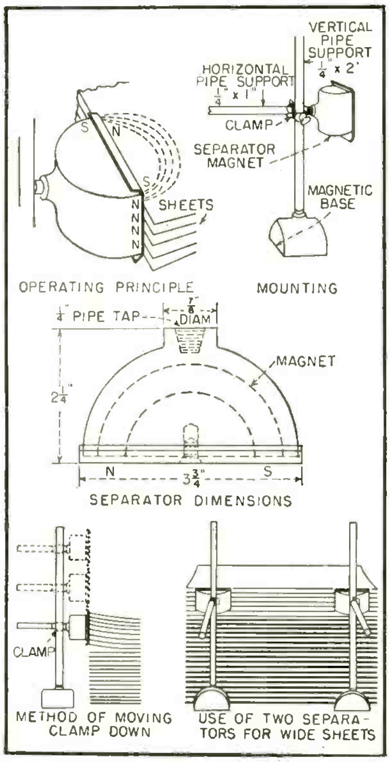
covered wood rods that serve as electrodes for a simple but effective ageing rack devised by production engineers at Pyramid Electric Co. Loosening four wing nuts permits raising the electrode bars so the units can be inserted one by one. When the rack is fully loaded, the nuts are tightened to get good contact pressure, and clip connections are made to projecting foil on each electrode for applying the desired ageing voltage.

Construction of Magnetic Sheet-Steel Separator

SPECIAL permanent magnets for assembly into a separator that will make top sheets of steel lift themselves are now available from Carboloy, Department of General Electric Co., Detroit. The separator prevents the feeding of doubles to a punch press, speeds feeding of the press by making the top sheet readily available, and minimizes cutting of fingers while grabbing a sheet.

A powerful U-shaped magnet positioned as in Fig. 1 is in contact with the edges of the stack of



Construction details and suggested methods of using special Alnico permanent magnets as sheet-steel separators

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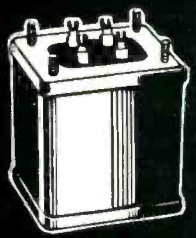
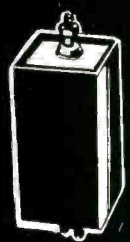
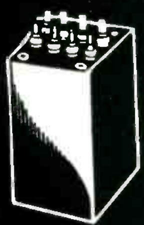


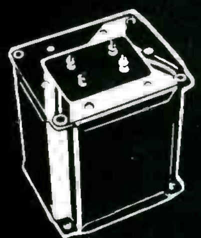
High Fidelity Transformers



Slug Tuned Components

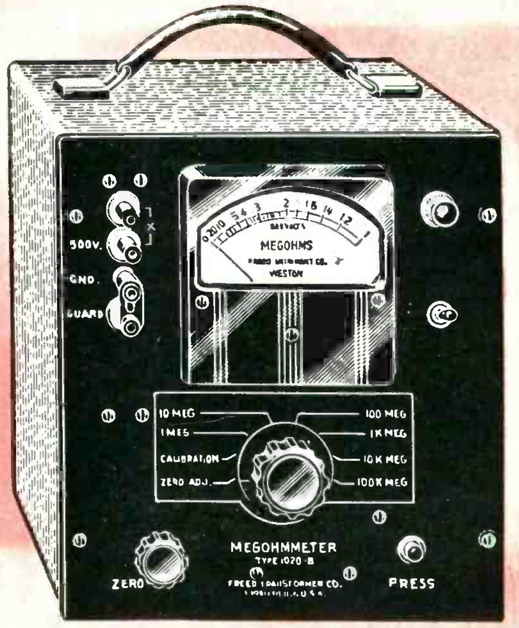


Hermetically Sealed Components to meet MIL-T-27 Specs



Commercial Components

FREED 1020-B MEGOHMMETER



A precision electronic megohmmeter which for years has given satisfactory service in hundreds of laboratories and on production lines.

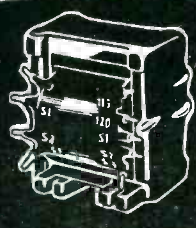
- **EASY TO READ** Direct reading on a 4" scale.

  Protected against overload.
- **RAPID & SAFE TO USE** Test voltage removed from terminals and capacitive components discharged to ground in all positions of multiplier switch.
- **ACCURATE** Within 3% up to 100,000 megohms, 5% from 100,000 to 2,000,000 megohms.

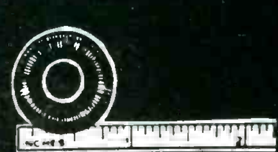
SPECIFICATIONS

Range: 1 megohm to 2,000,000 megohms in six overlapping ranges selected by a multiplier switch.
Voltages on Unknown: The voltage applied to the unknown terminals is 500 volts d-c and is independent (less than 1%) of the value of the unknown.
Stability: Line voltage variations from 105-125 volts will cause less than 2% variation in the meter reading.
Power Supply: 105-125 volts A.C. 50-60 cycles 30 watts.
Dimensions: 9½ x 10½ x 8 inches.
Net Weight: 18 pounds.

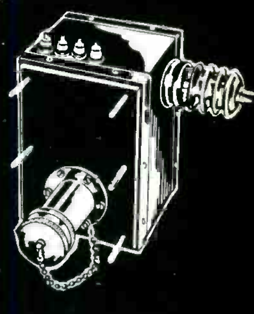
Sub-miniature hermetically sealed Toroidal Inductors



Freedseal Treatment ANE-19 Specs



Miniature Inductors



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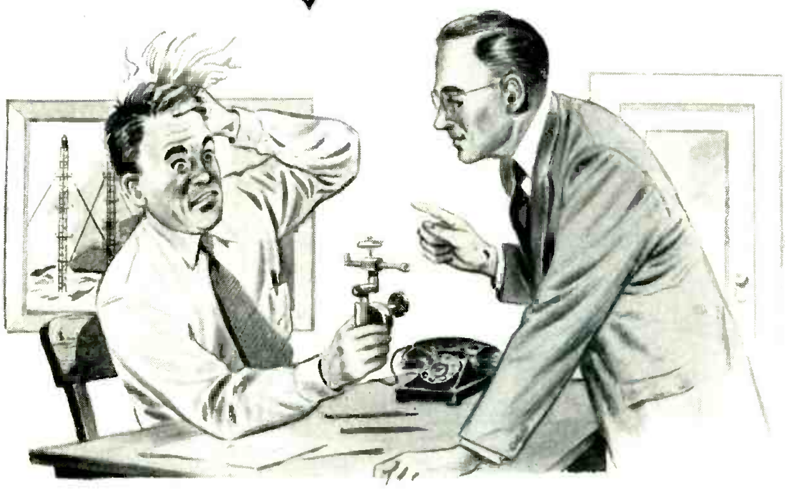
"TOWER LIGHTING KITS"

said the General Manager,

"Can't grow hair, but...



"Nice looking hair you're pulling out," said the G. M. of Station XYZ, "but when do we get lighting clearance on the new tower?"

"See that!" groaned the engineer. "That's a whoozit. It takes 5 whoozits to light our tower—about $4 worth of metal. But there just aren't any whoozits right now. No whoozits, no lights."

"Then let's do it the easy way," counselled the G.M. "Get in touch with our nearest Hughey & Phillips distributor and order a complete, packaged tower lighting kit. Just give 'em the tower specs. They'll ship pronto and include every item to light our tower—down to the last nut, bolt, and whoozit. And you'll save wear and tear on your hair."

The G. M. is right—but he told only half the story. Through years of experience in buying, designing, testing and packaging, Hughey & Phillips have gained world leadership in the field of tower lighting. And because of this specialized "know-how" H & P tower lighting kits cost less to buy, less to install, less to maintain. Drop us a line for the name of your nearest H & P distributor.

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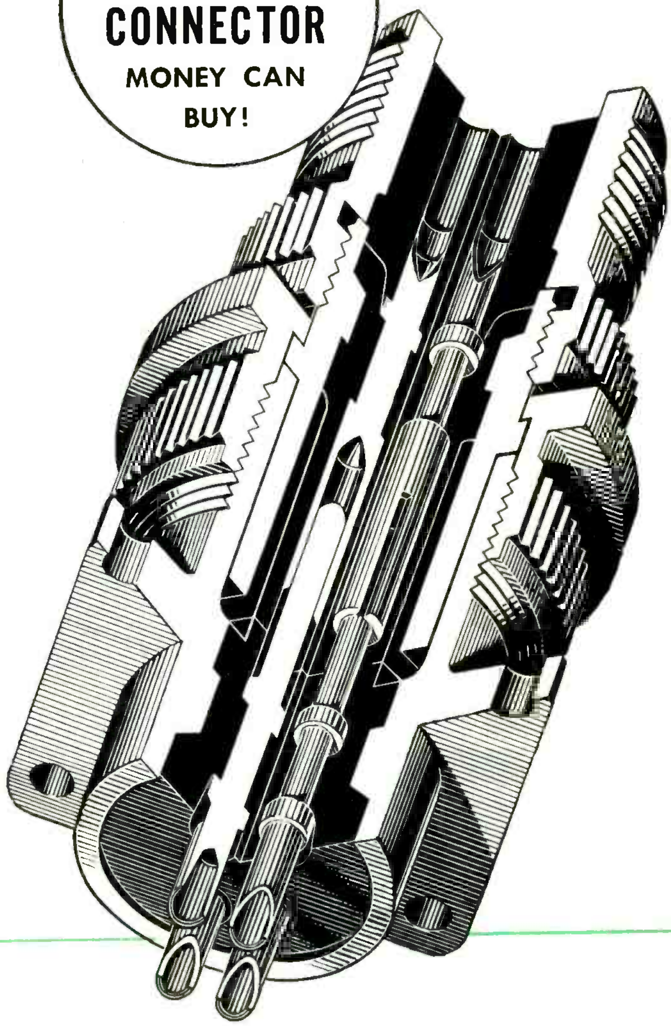

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SIDNEY, NEW YORK

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

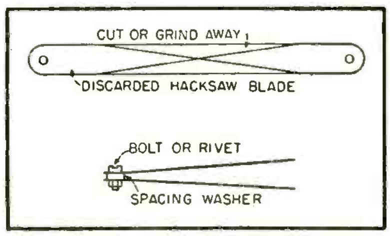
FACTORY BRANCH OFFICES: **118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California** sheets. The magnetic lines of force going through each sheet from one magnet pole to the other are equivalent to magnetic poles in the sheets themselves. With the magnet orientation employed, the S poles will all be in one vertical line in the sheets opposite the N pole of the magnet, and the N poles in the sheets will likewise line up vertically opposite the S pole of the magnet. Since like poles repel, the sheets literally lift themselves from the stack.

A single separator magnet is satisfactory for sheets up to 15 inches wide and 0.014 inch thick. The separator should be positioned in the center of one side of the stock, flush with the sheets. For sheets wider than 15 inches, two or more separators are needed. Optimum number and spacing can be determined by trial, but spacing should not be less than two inches.

The separator magnet mounts directly onto a ¼-inch pipe that can be one foot long. A clamp permits sliding this magnet up or down on a vertical pipe support that can be screwed into a magnetic base. With the magnetic base, a steel table must be used for the sheets of steel. The magnetic base is powerful enough to hold the assembly yet can easily be slid up against the edge of the stack after adding a new supply of sheets.

Screw-Holding Tweezers Made from Hacksaw Blade

A DISCARDED hacksaw blade can be converted into a pair of tweezers in 10 minutes by making two cuts as shown in the diagram, then bolting or riveting the ends of the blade together. Grinding may be used in place of cutting if desired. This



Method of making homemade tweezers for speeding electrical maintenance work. The points can be filed and bent to suit the needs of any job

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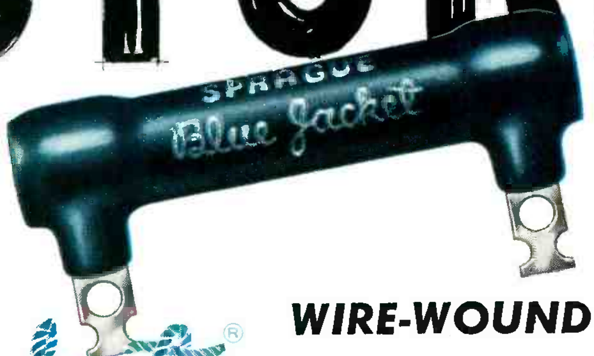

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Blue Jacket resistors are made in types to meet the tough performance requirements of Military Specification JAN-R-26A, Characteristic "G". See Engineering Bulletin 110 for complete details. Blue Jackets are also available in commercial styles that excel in the most severe industrial electronic service. Engineering Bulletin 111 describes these superior units—*that cost no more than ordinary resistors!* Send for your copies to:

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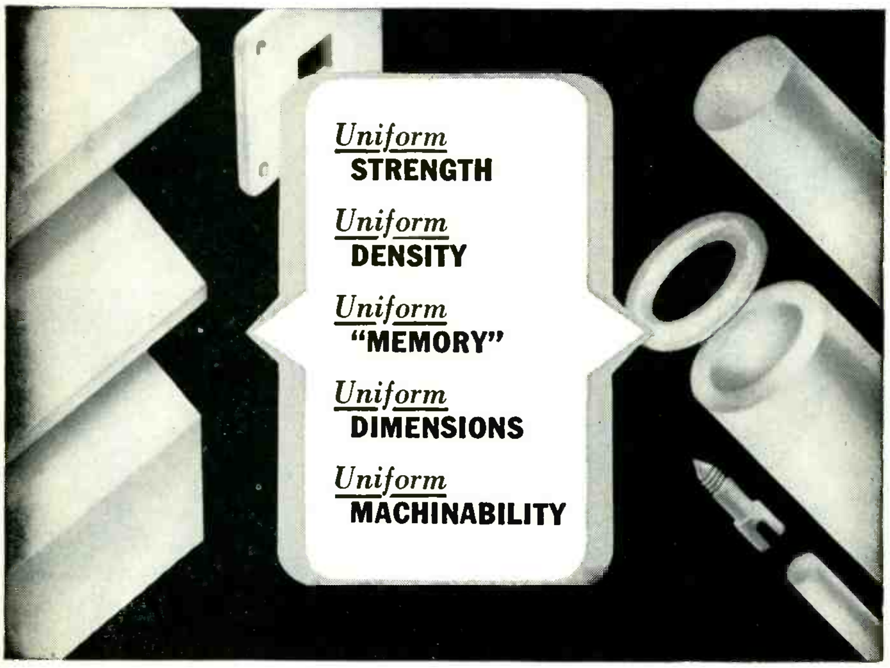

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■ "Teflon" powder is converted into Fluoroflex-T rod, sheet and tube under rigid control, on specially designed equipment, to develop optimum inertness and stability in this material. Fluoroflex-T assures the ideal, low loss insulation for uhf and microwave applications . . . components which are impervious to virtually every known chemical . . . and serviceability through temperatures from −90° F to +500° F.

Produced in *uniform* diameters, Fluoroflex-T rods feed properly in automatic screw machines without the costly time and material waste of centerless grinding. Tubes are concentric – permitting easier boring and reaming. Parts are free from internal strain, cracks, or porosity.

For maximum *quality* in Teflon, be sure to specify Fluoroflex-T.

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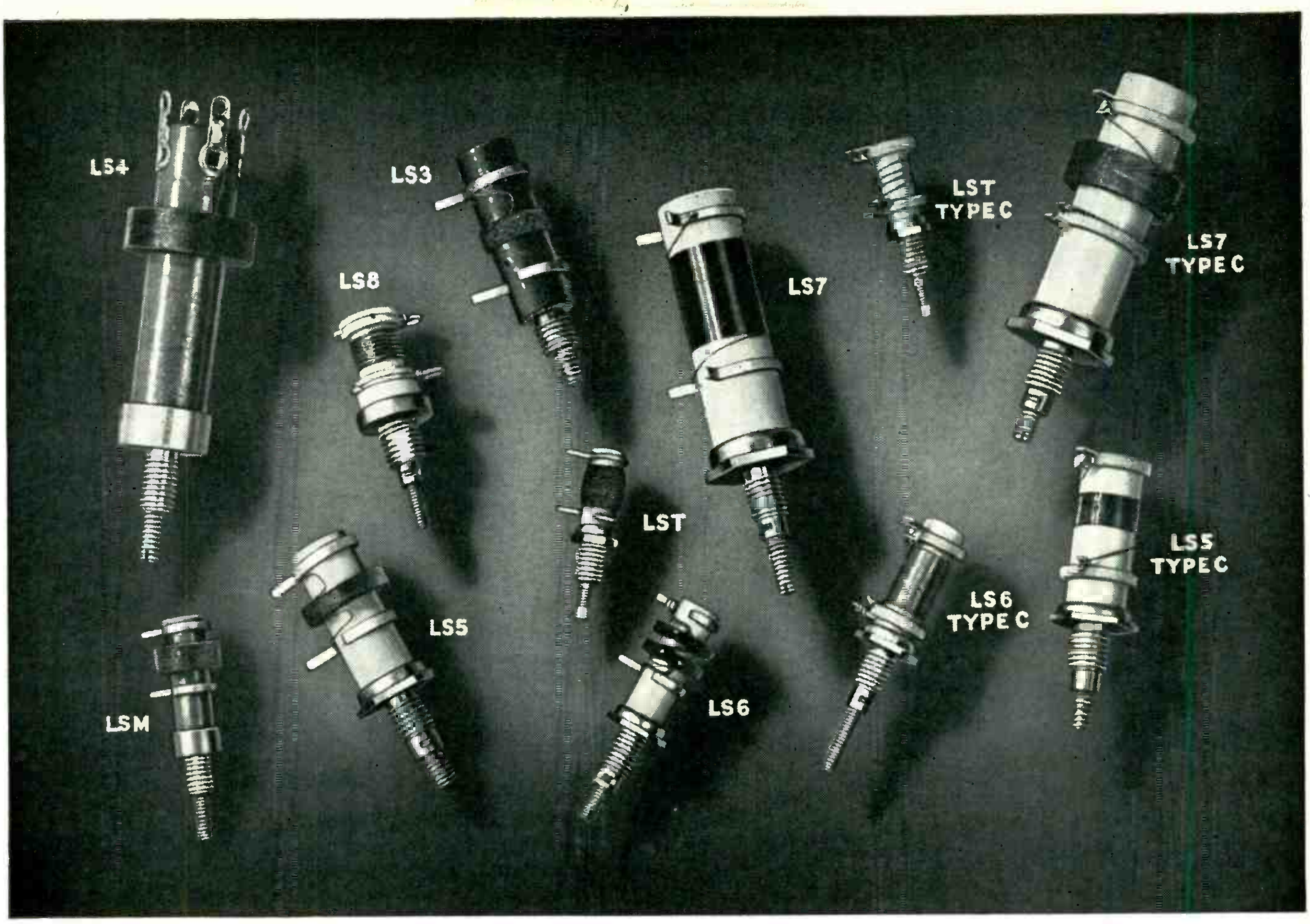


Here's how to get exactly the coils you need

You can get C.T.C. slug tuned coils, single layer or pie type windings to your exact specifications — military or personal — with expert workmanship and correct in every detail as to materials and methods.

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; ring type terminals are silver plated brass protected by water dip lacquer. Terminal retaining collars of silicone fibreglas which permit 2 to 4 terminals, are available on forms designated Type C above. Wound units can be coated with resin varnish, wax or lacquer. All units are furnished with slugs and mounting hardware.

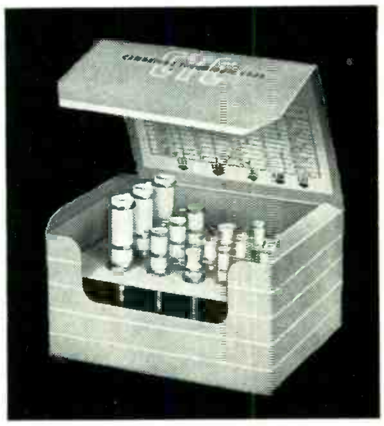
A table of frequencies and permeabilities relating to the slugs used in the coils shown above is contained in C.T.C. catalog 400. Send for your copy, and ask for prices and specifications on the coils you need. Be sure to send complete specifications for specially wound coils.

All C.T.C. materials, methods and processes meet applicable government specifications. Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West coast manufacturers contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles, and 988 Market Street, San Francisco, California.

COIL FORM SPECIFICATIONS

Coil Form	Material	Mounting Stud Thread Size	Form O.D.	Mounted O. A. Height
LST	L-5 Ceramic	8-32	3/16"	19/32"
LS6	L-5 Ceramic	10-32	1/4"	27/32"
LS5	L-5 Ceramic	1/4-28	3/8"	1 1/16"
LS8	L-5 Ceramic	1/4-28	25/64"	23/32"
LS7	L-5 Ceramic	1/4-28	1/2"	1 11/16"
LSM	Paper Phenolic	8-32	1/4"	27/32"
LS3	Paper Phenolic	1/4-28	3/8"	1 1/8"
LS4	Paper Phenolic	1/4-28	1/2"	2"

NOTE: Types LS5, LS6, LS7, LS8 have slug locking spring. Type LST, available with slug locking spring as type LSTL. Type LS4 has fixed lugs — all others have adjustable ring terminals.



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. Fibreglas collars and metallic rings are furnished with kit for all ceramic coil forms except LS8 which is furnished only with clip terminals.

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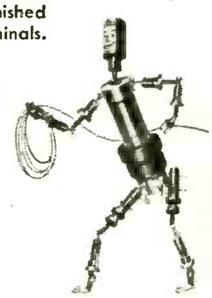

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idea, from *Coal Age* magazine, is credited to Harry Lainer of The New River Co., Summerlee, W. Va., who used the tool to put screws in terminals and leads of switches and other controls.

Subassembly Soldering Jigs

INGENIOUS yet inexpensive jigs for holding up to ten parts at a time for preliminary soldering of small components and leads can greatly boost the output of subassembly departments in receiver plants. A special fixture must generally be designed for each type of part. Examples of eight such jigs are shown here.

The operation of soldering a wire to the outer sleeve of a speaker plug is expedited at Emerson's plant by using jacks as holding jigs. The jacks are fastened to a block of wood with wood screws. A finishing nail is driven alongside each jack and bent downward, and a groove is cut in the top of the fixture board for the wire. The

Jig for holding phono-type plugs while soldering leads to outer skirts of plugs for use as speaker cables. Plugs were previously soldered to the center conductor at a dip soldering operation

Laboratory Model

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TUBE TESTER

Model 539A

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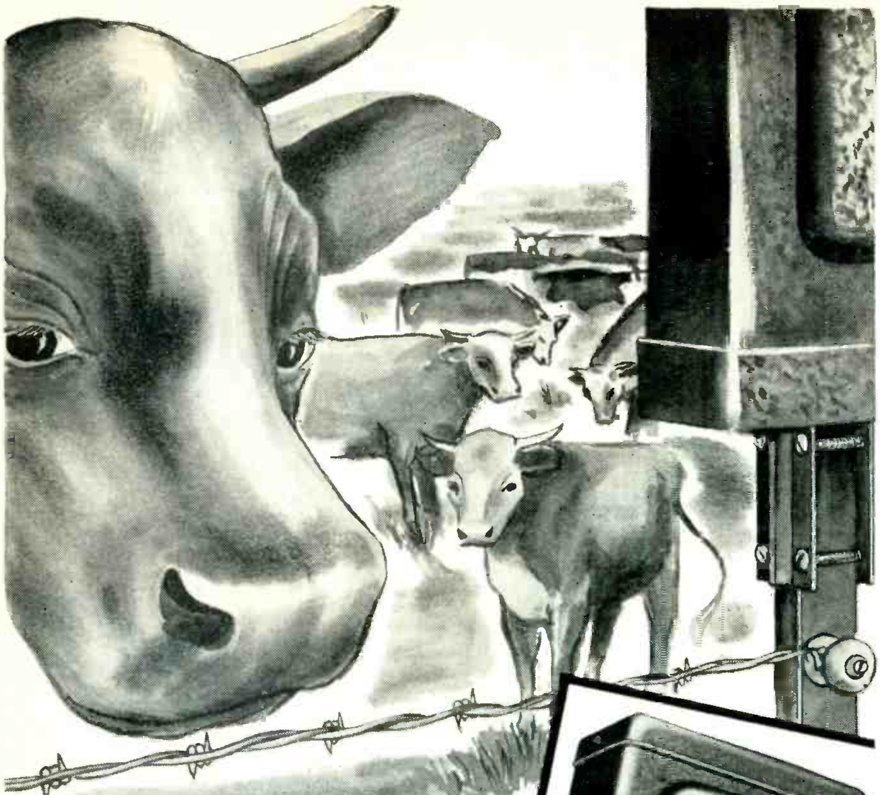
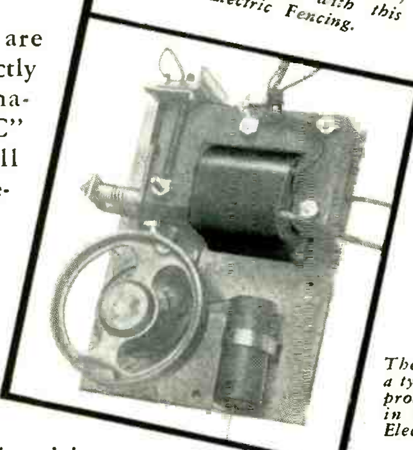


Unusual Applications demand GTC Transformers

The illustrated "electric fencer" is a product of Parker-McCrory Mfg. Company. More than 6,000,000 farmers save time, money and labor with this Parmak Electric Fencing.



The illustrated, a typical "GTC" product, is used in the Parmak Electric Fencer...

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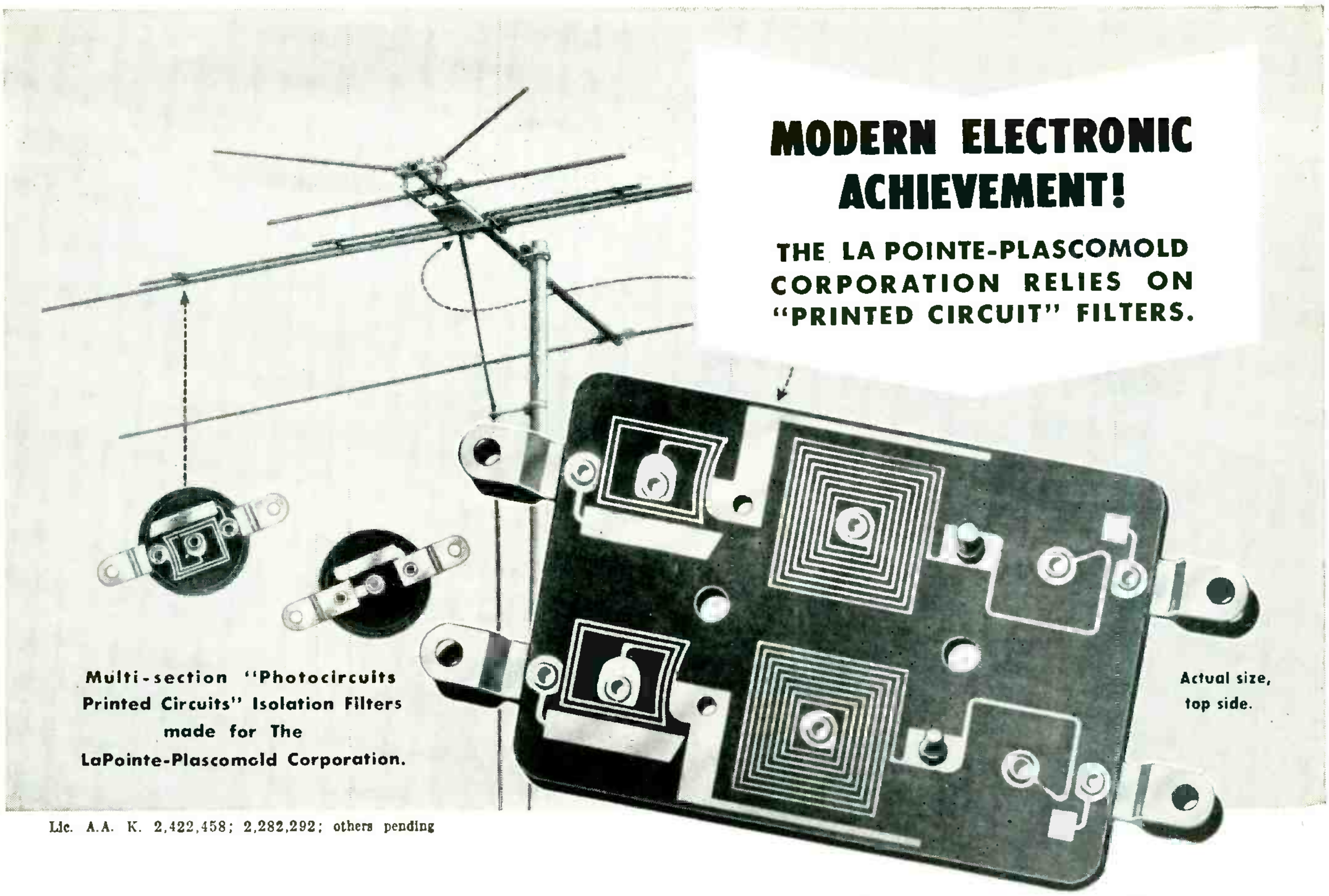

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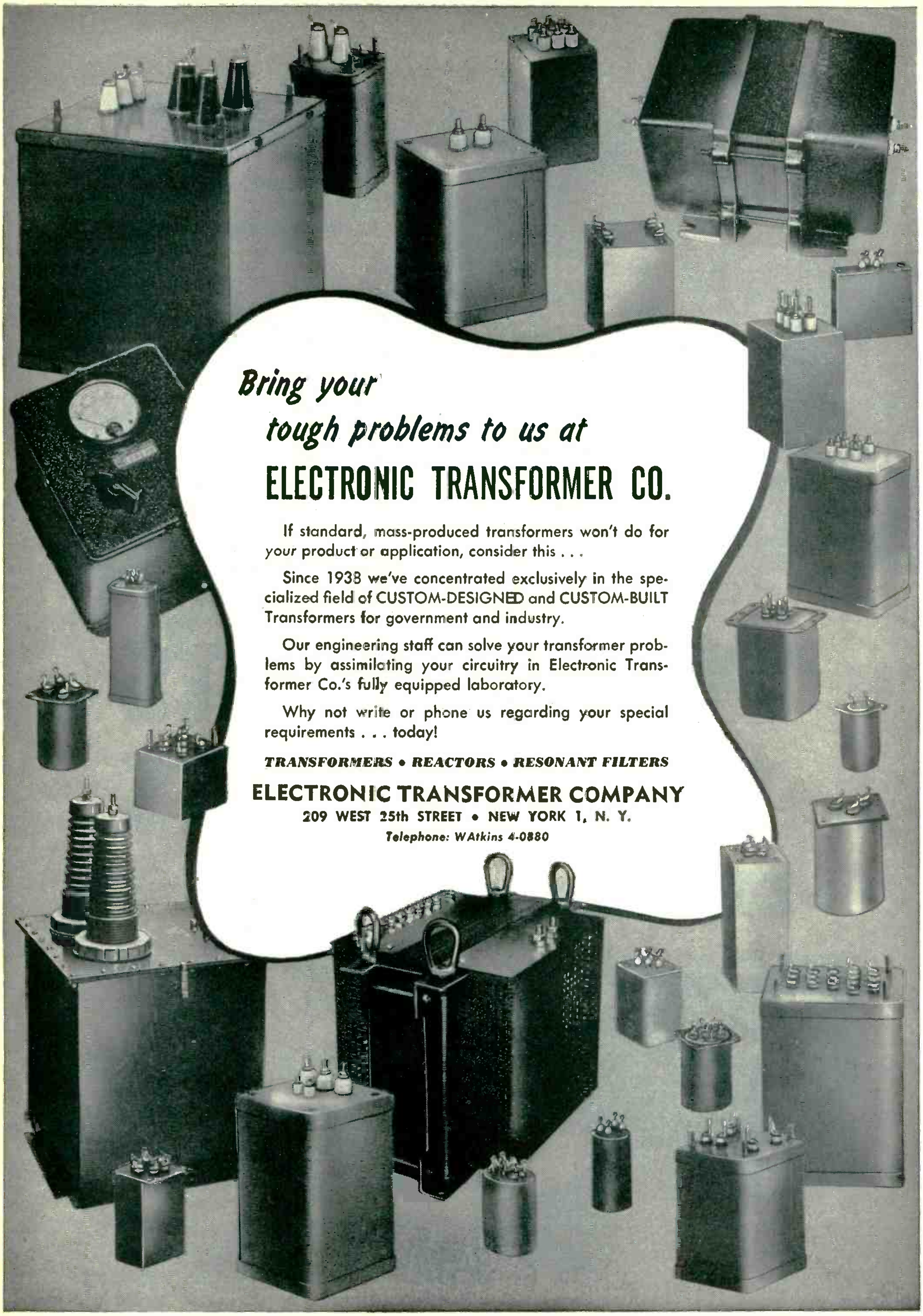
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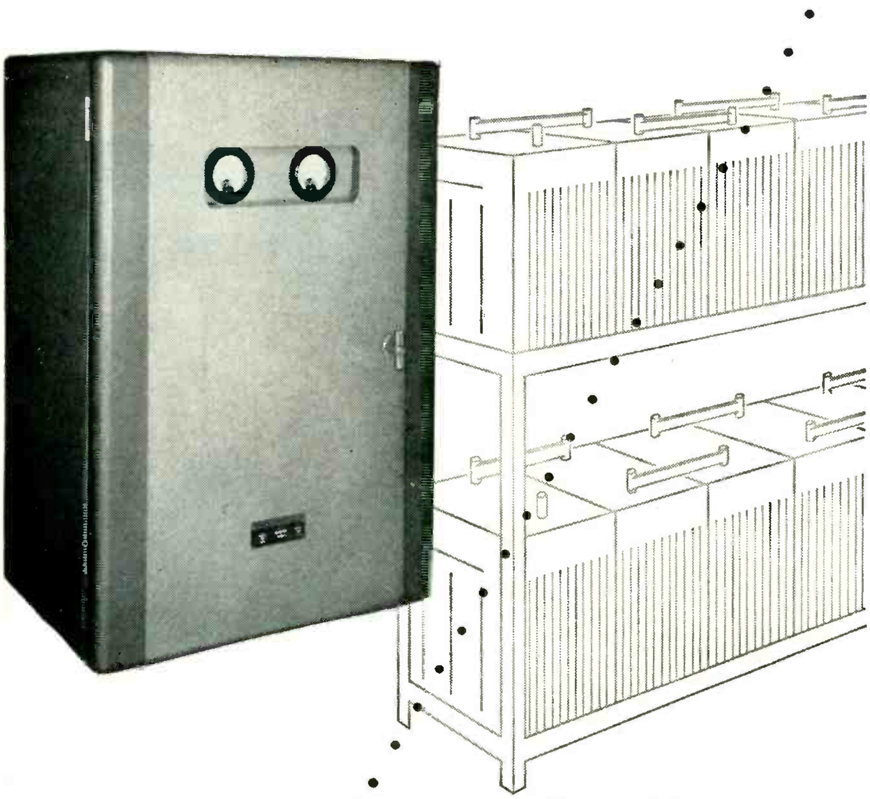
Fixture for holding three-potentiometer strips. Soldering iron is plugged into overhead outlet, and rests in horizontal holder at back of bench when not in use. Solder reel holder is screwed to bottom of bench

operator places the stripped end of the wire in the desired position on the plug sleeve, loops the wire under the nail, then brings it up into a slot and over the top of the fixture. The wire stays in position through its own springiness, leaving the hands of the operator free for high-speed soldering after all the wires have been placed in position.

A wood U channel supported at a 30-degree angle toward the operator is used for holding potentiometer strips during subassembly wiring at Emerson's television receiver plant. Metal pegs hold the end strips in position. Additional pegs are provided for some of the other strips, even though not actually needed. Wires used in this operation are precut and stripped on an Artos machine. Short wires are kept in an ordinary one-pound breadpan. Longer wires are stored in cardboard tubes of different lengths, resting in holes in a plywood frame set on the back of the bench. The holes are positioned so that the tubes slant toward the operator, bringing the wires within easy reach.

A more elaborate holding jig for miniature tube sockets, widely used throughout Emerson's plant, permits simultaneous rotation of nine

for LONGER battery LIFE



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THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it" — "they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

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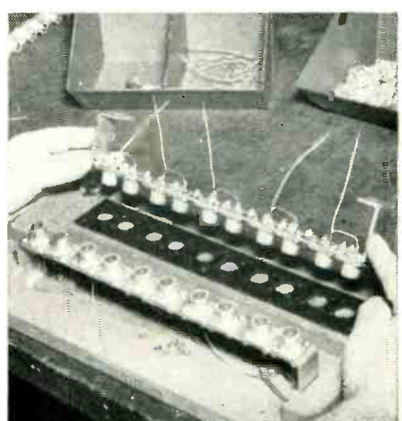
Jig for holding and rotating nine subminiature sockets simultaneously

sockets. The operator can bring a given terminal on all sockets to the optimum position for connecting and soldering a lead or part. Rotation is achieved through use of gears inside the metal housing of the jig, meshing together so that all turn when the control knob on the shaft of the center socket is turned.

One of each pair of socket support pins is spring-loaded to hold the socket during assembly work. To load the fixture, the operator places one socket mounting hole on the fixed pin, then moves the spring-loaded pin inward until the other socket hole is over it. Unloading is done simply by grasping the assembled wires and pulling off the sockets. The two-pin holder for each socket can be removed by loosening a single screw, and other holding devices can be placed on the geared-together shafts for assembly work on other types of parts. The entire fixture may be



Two-position jig for assembling jack strip of distribution amplifier for field television camera

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Announcement

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When the new Sanborn "150" Series is seen for the first time, all will agree that Sanborn engineers are really outdoing themselves in their *design for versatility.*

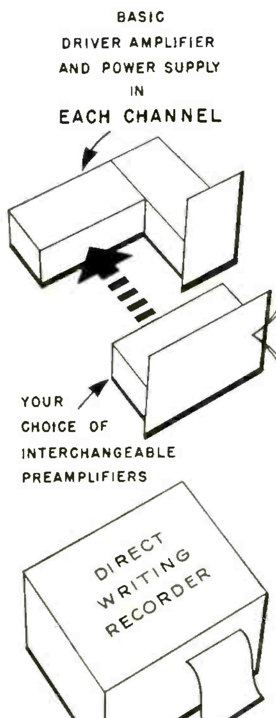
This increased versatility is being made possible by:

(1) the availability of a greater variety of newly designed *interchangeable* Sanborn amplifiers and preamplifiers which together encompass such a variety of uses that the recording possibilities of Sanborn Systems will include *almost every* phenomenon whose frequency spectrum covers the range from 0 to 100 cycles per second, and

(2) by an original design idea which makes such interchangeability *more practical.* Built into each System will be a *separate* DC driver amplifier and power supply for *each of the System's channels,* with provision for "plug in" connection to the driver amplifier (as shown in the diagram at right) of the *user's choice* of a preamplifier and control panel to complete the desired network for each channel.

IN ADDITION, the "150" series will include these Sanborn improvements:

- **Increased frequency response**
- **Improved regulated power supply**
- **Individual stylus temperature control for each channel**
- **Improved, single control, paper speed selector. Nine speeds — .25 to 100 mm/sec**
- **Greater convenience and more area for immediate study of recorded events, and for notations on record**
- **Amplifier panels and Recorder panel all in one vertical plane on the 4-channel model. Complete system takes less floor space.**



AC-DC PREAMPLIFIER will produce 1 cm deflection for a 1 mv AC signal, and a 1 mm deflection for a 1 mv DC signal. Also provides for calibrated DC zero suppression (20X full scale). Balanced or single ended inputs.

CARRIER PREAMPLIFIER permits a choice of three interchangeable oscillators — 400, 1000 and 2500 cycles. Each amplifier equipped with calibrated zero suppression network (20X full scale). Overall sensitivity 80 microvolts/cm deflection, or 40 microinches/inch/cm (one active arm; gage factor of 2). With commercial transducers, sensitivity usually sufficient for 20X full scale with maximum load on the transducer.

SERVO MONITOR PREAMPLIFIER — AC phase discriminating, with overall sensitivity of 10 mv/1 cm deflection. Provides DC outputs proportional to error signals from 60 to 10,000 cycles per second.

LOG-AUDIO PREAMPLIFIER provides a 50 db dynamic range wtih resulting chart calibrated 1 db/mm. (At maximum sensitivity, bottom of chart equals 0.3 mv input, and top of chart 100 mv). 50 db (5 db steps) input audio attenuator. Input provision for either DC or audio signals. Audio range 20 cps to 20 kc. DC input range from 0.6 to 200 volts.

DC CONVERTER (Chopper Amp.) for low level DC recording such as thermocouple output. Sensitivity 1 mv/cm deflection.

COUPLING PREAMPLIFIER will take balanced or single ended inputs providing 50 mv/cm sensitivity.

*

First showing of the new Sanborn "150" series will be at BOOTH 2-116, I.R.E. Convention, Grand Central Palace, New York City, March 23-26. Be sure to see it!

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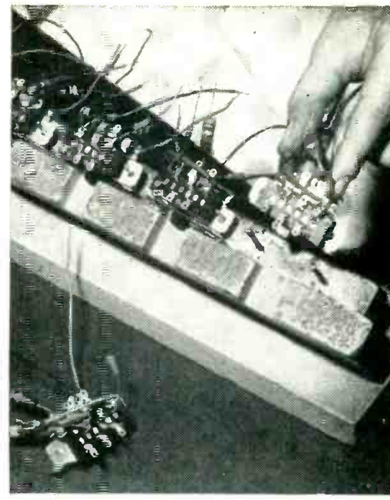

Jig for slide switches used in three-way portable radios

set at another angle by loosening wing lock nuts on the end support brackets.

Permanent mounting of ten Amphenol silver-plated coax jacks on their mounting strip is done with the aid of a jig in RCA's Camden plant. Two pivoted wood tabs slide over the mounting feet to hold the strip upright in the foreground position while mounting each jack with four nuts and bolts. The strip is then turned over and set into rubber-covered holes at the rear of the jig for wiring work. The ⅛-inch thick rubber pad protects the silver plating and threads on the jacks.

Metal pins serve for holding slide switches on an Emerson jig, designed for processing seven

Jig for television receiver slide switches. Solder spool holder has notched frame that slips over angle iron running across rear of bench

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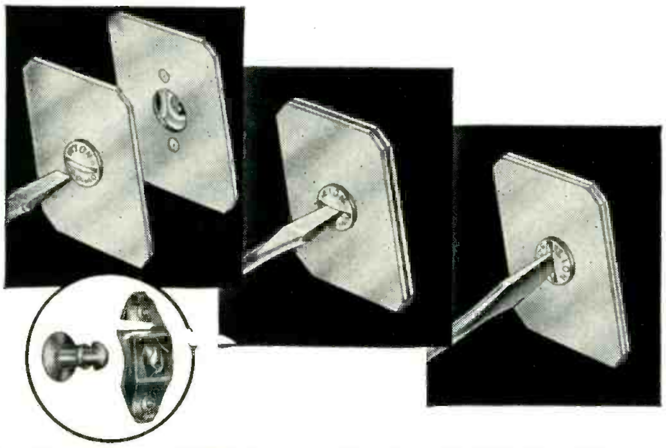

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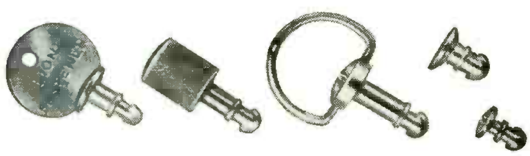

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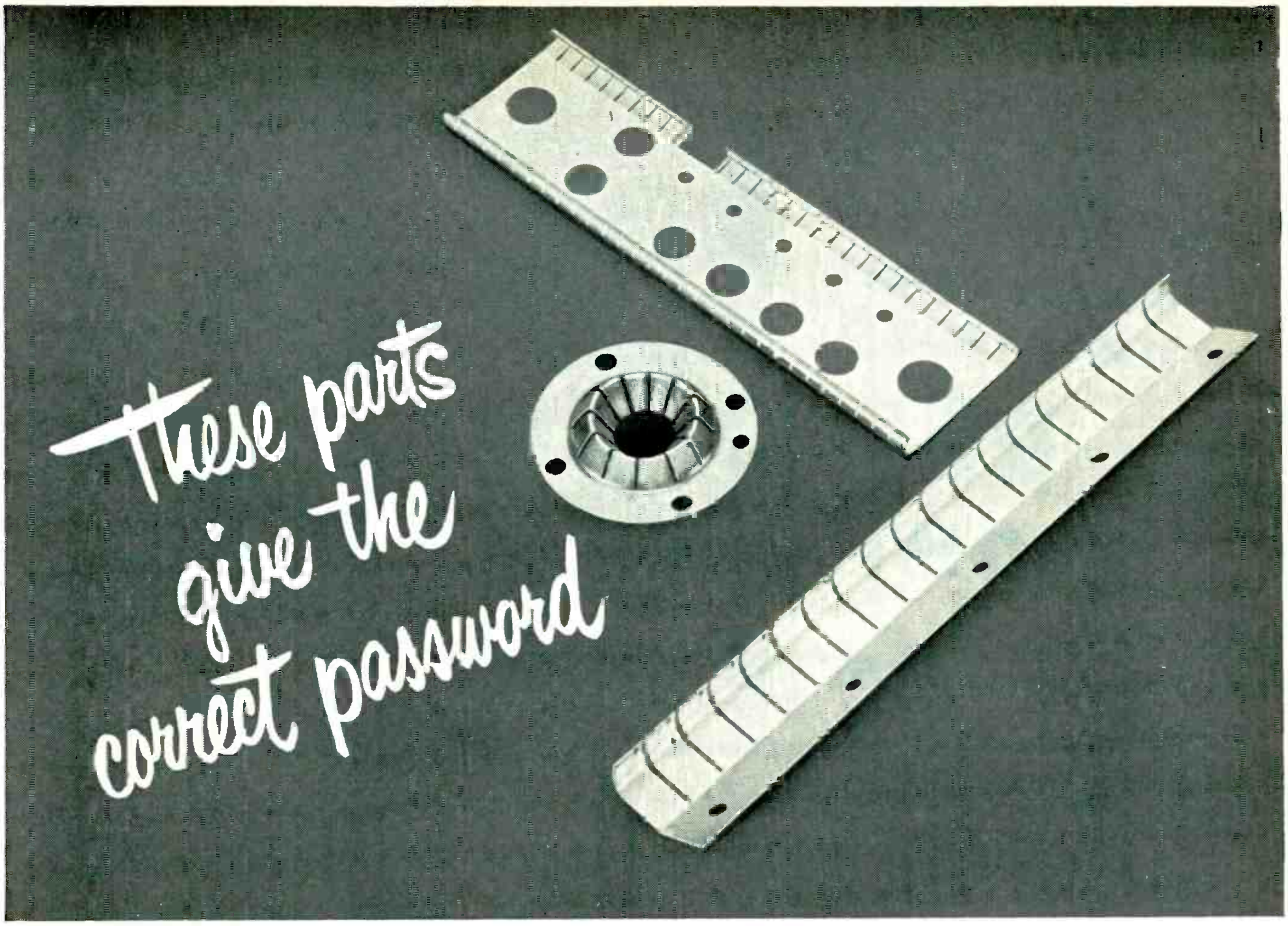

Parts shown processed by H. Braun Tool & Instrument Co., Hawthorne, N.J.

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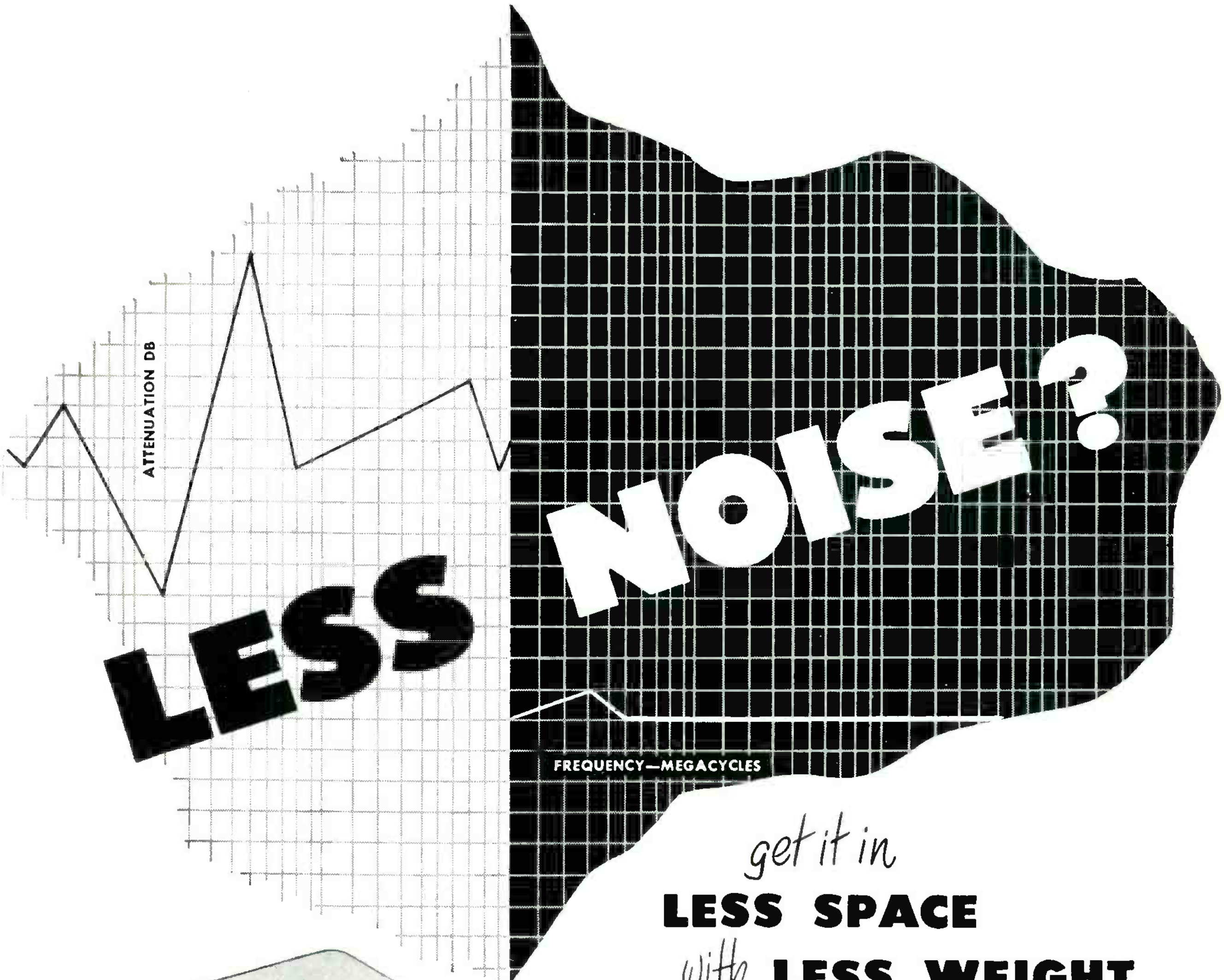
Recessed jig for trimmer subassembly work

switches at a time. Grooves are cut into the wood strip to accommodate the slide buttons.

Another type of jig for holding slide switches, used by DuMont, is made entirely of metal. This clamps over the front edge of the workbench, and has a shaft that permits adjustment to any desired angle. The switch plates are pushed into spring steel clips to load the jig for applying and soldering cable leads to the terminals.

Irregular-shaped cutouts in a metal-faced plywood jig hold ten ceramic trimmer capacitors during subassembly work for DuMont tele-

This chassis support jig rotates on an angle-cut pedestal. Spinning the jig changes the angle as required for optimum work with the pencil-type soldering iron



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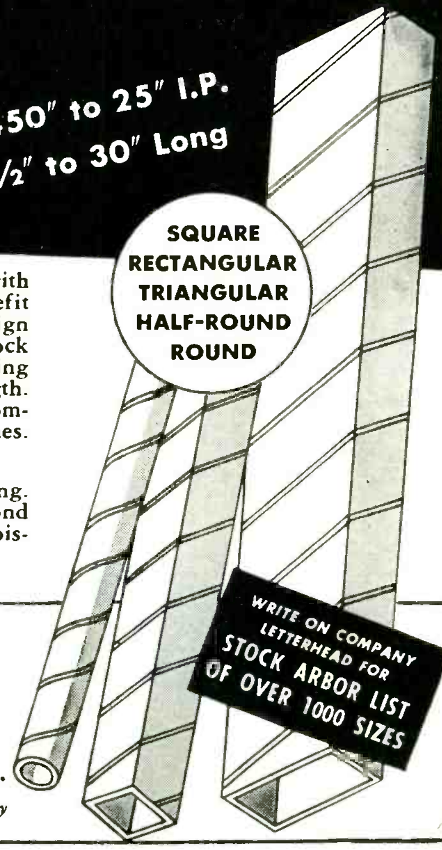

It pays to check your requirements with PARAMOUNT . . . because you benefit from PARAMOUNT'S coil-proved design and construction—vast range of stock arbors—wide experience in engineering special tubes! Hi-Dielectric. Hi-Strength. Kraft, Fish Paper, Red Rope, or any combination wound on automatic machines. Tolerances ± .002".

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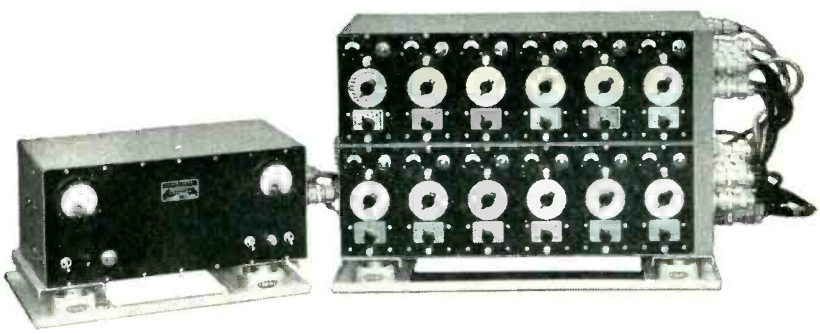
Century VIBRATION AND STRESS ANALYSIS SYSTEM



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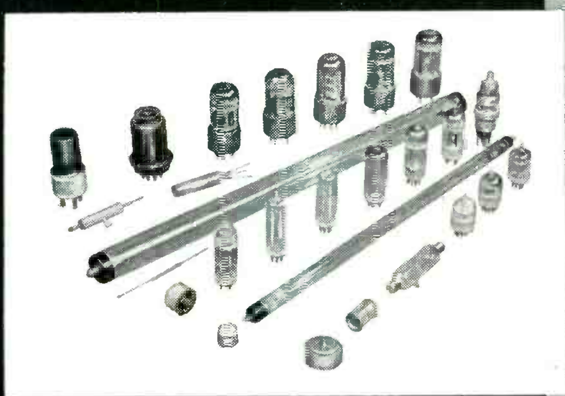
INVERTERS



SPECIAL-PURPOSE ELECTRON TUBES

DYNAMOTORS

Bendix Aviation Corporation

concentrates development, sales and production of special-purpose electron tubes, inverters and AC generators with its dynamotors and small motors at its

Red Bank Division

To provide its customers with an unequalled source for special-purpose electron tubes, inverters and AC generators, Bendix Aviation Corporation has placed its entire development, sales and manufacture of these products with its Red Bank Division at Eatontown, N. J. Here in a modern new plant of over 118,000 square feet have been concentrated the most highly skilled personnel and the latest available machinery to produce the highest quality electron tubes, inverters and AC generators possible. At the same time, a full-scale program is being carried on continuously at Red Bank to develop these products for even greater efficiency and versatility. In addition to its new products . . . taken over from the Eclipse-Pioneer Division, Teterboro, N. J. . . . the Bendix Red Bank Division will continue producing its established line of dynamotors and small DC motors. If you require precision items of these types, it will pay you to take advantage of the unique experience and facilities offered to you by Bendix Red Bank.

Division of THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

Bendix Red Bank

EATONTOWN, NEW JERSEY

Export Sales: Bendix International Division, 72 Fifth Avenue, New York, 11, N. Y.

Want more information? Use post card on last page.

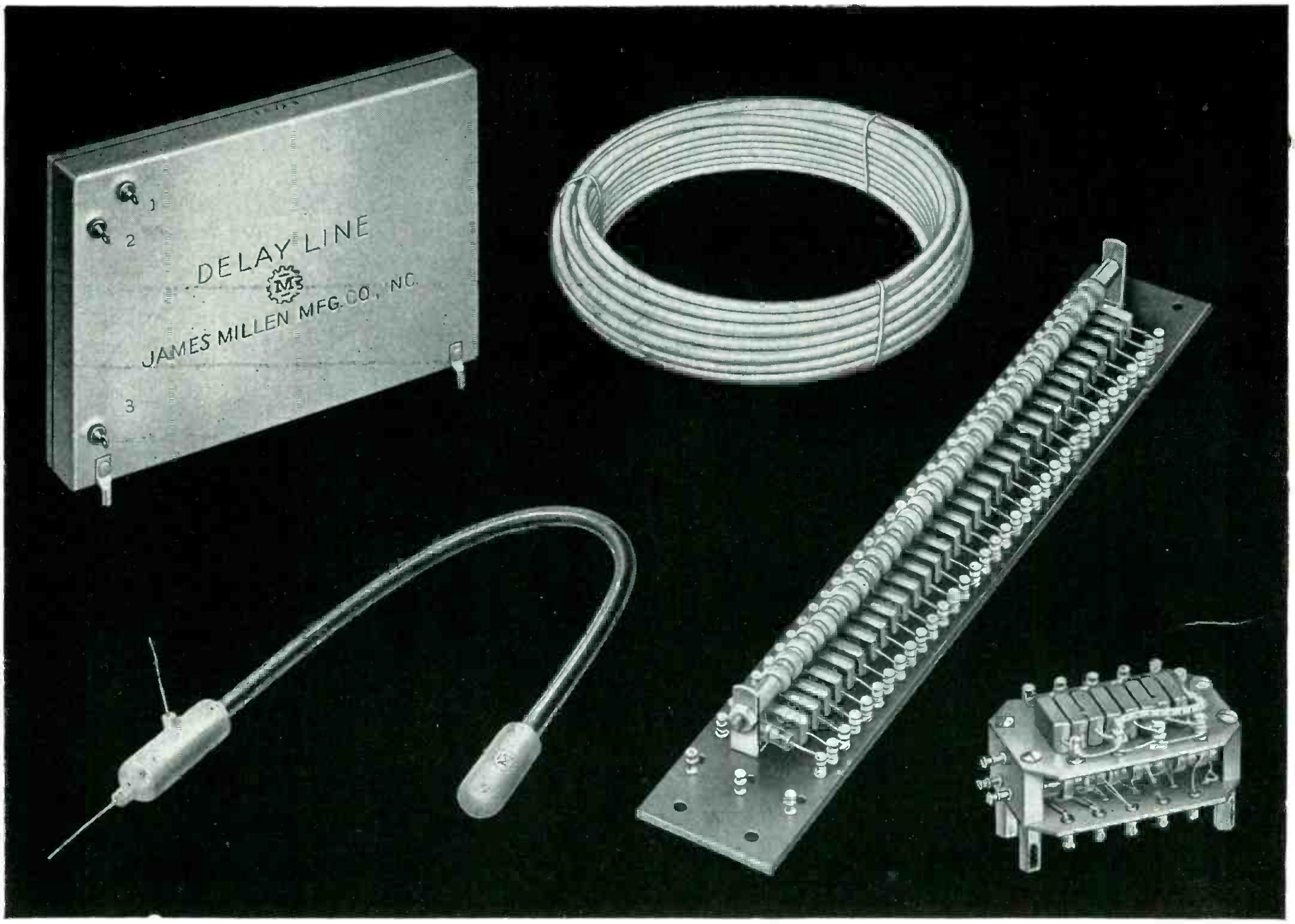
vision receivers. The work done here includes fastening standoff insulators to the trimmers. The metal plate permits more precise holding action than could be obtained with drilled holes in wood alone.

An angle-mounted locating jig aids in assembly of small parts inside a tiny subassembly chassis for the PRC-6 transceiver at Utility Electronics. A completed sample chassis is permanently mounted at the rear of the jig as a sample to guide the operator.

Tweezer-Type Soldering Tool

RESISTANCE-SOLDERING of small parts in subminiature equipment is accomplished faster, more neatly and with improved joint quality through use of a tweezer-type soldering unit that is equally suitable for production-line and laboratory use. The Hotip unit made by Contact, Inc., Cambridge, Mass.,

Use of tweezers for soldering a small joint in an experimental hearing-aid unit in an MIT laboratory. Tool rack fastened to front edge of bench keeps most-used tools within reach and encourages putting each one away when work with it is finished. Loop of wire inserted in edge of bench is support for clip leads



"Designed for Application"

Delay Lines and Networks

The James Millen Mfg. Co., Inc. has been producing continuous delay lines and lump constant delay networks since the origination of the demand for these components in pulse formation and other circuits requiring time delay. The most modern of these is the distributed constant delay line designed to comply with the most stringent electrical and mechanical requirements for military, commercial and laboratory equipment.

Millen distributed constant line is available as bulk line for laboratory use and in either flexible or metallic hermetically sealed units adjusted to exact time delay for use in production equipment. Lump constant delay networks may be preferred for some specialized applications and can be furnished in open or hermetically sealed construction. The above illustrates several typical lines of both types. Our engineers are available to assist you in your delay line problems.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN, MASSACHUSETTS, U. S. A.

Want more information? Use post card on last page.

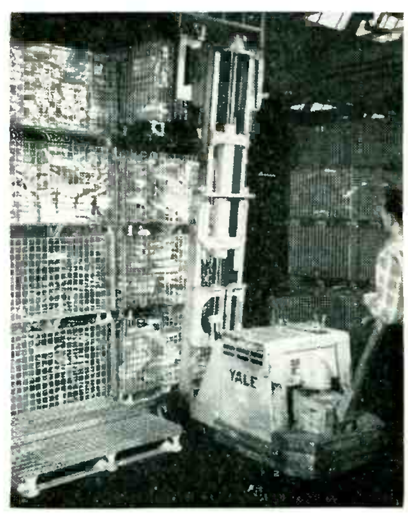
consists of soldering tweezers with an insulated handle and a control box for use with either a foot or knee switch. Power input is 115 v a-c, and output is up to 15 amperes at 4 volts. A rotary selector switch on the control box provides a choice of five temperatures, from low heat for soldering fine wires such as No. 52 AWG up to high heat for soldering the equivalent of two No. 14 wires.

The tweezers themselves weigh only 2½ ounces, which minimizes fatigue in production use. The separate switch permits using the tweezers to position parts and hold wires together before and after soldering, with heating current being applied only when actually wanted. The resulting pin-point localization of soldering temperature tends to eliminate rosin joints, minimizes insulation shrink-back or burning and reduces fire hazards and possibility of burns.

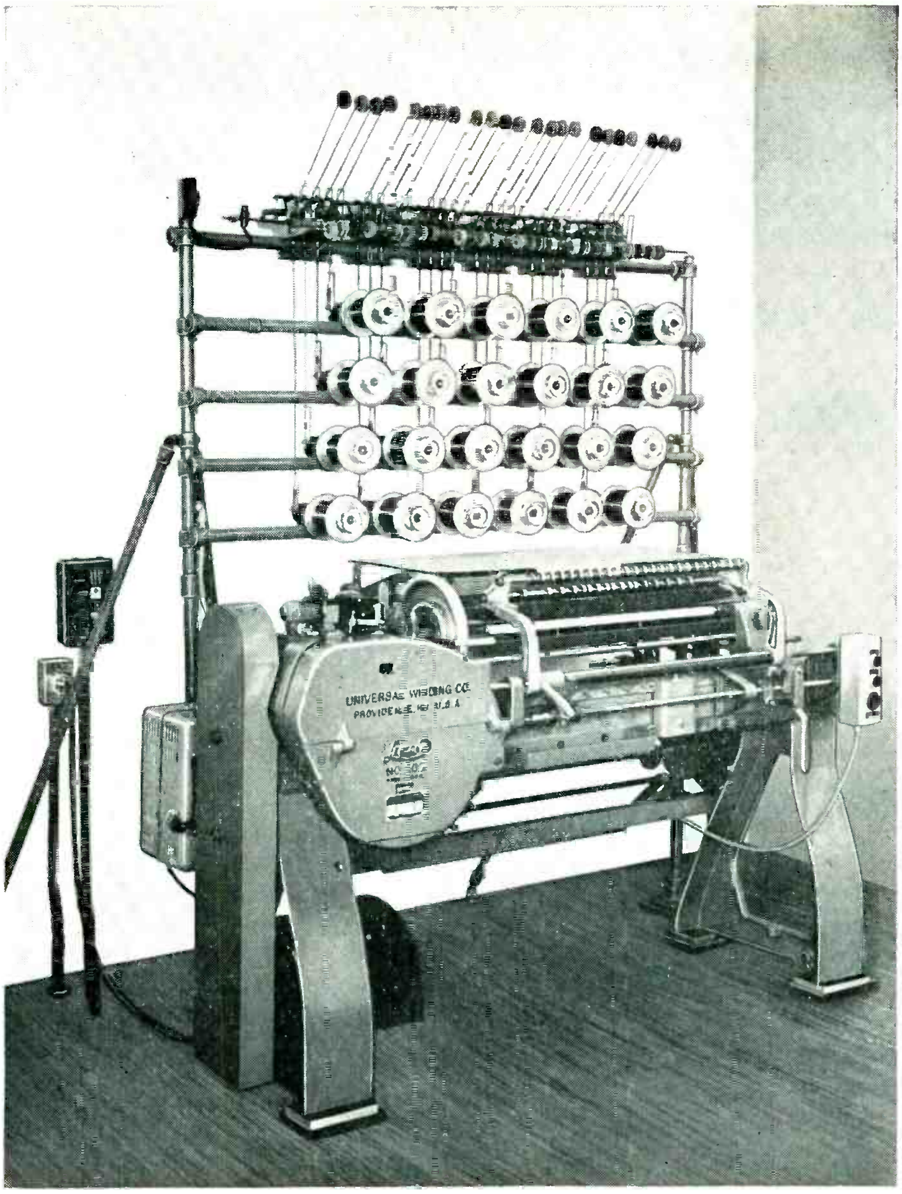
Material-Moving-Techniques

WITH ELECTRONICS plants operating at full capacity practically everywhere today, efficient utilization of space for storing incoming raw materials has a direct bearing on plant output. Under these conditions, new material-moving equipment pays for itself quickly.

In Sylvania's Buffalo plant, changeover from conventional wood crates to folding steel crates doubled the storage capacity of each square



New method of storing auto radio stampings. Collapsed crate is on floor in foreground



Automatic features

SPEED UP COIL WINDING

Assure accuracy and low cost

Leesona® No. 107 Coil Winder Offers Many Advantages

1. Automatic Delivery Shelf does it! New shelf feeds the paper inserts to the coils, exerting uniform tension on the paper as it is fed into the coil. This means tighter finished coil. Staggers overlaps to insure perfectly round or square coils. Delivery shelf automatically lengthens each insert as the coil diameter increases. This makes certain that the coils produced are within the maximum allowable outside diameter.

2. Automatic Electronic Speed Control. Slow, cushioned start . . . gradual speed build-up . . . constant high running speed for uniform wire tension and coil density.

3. Automatic Stop Motion — stops the machine whenever a spool runs out or a wire break occurs.

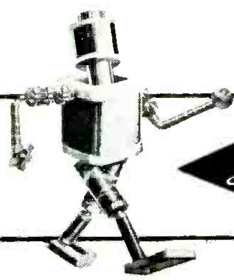
4. Automatic Counter stops the machine when the required number of turns have been reached.

Send for Bulletin 107 — get the details on this fully automatic Leesona® No. 107. It will show you how to get the exact electrical characteristics you want in either paper or acetate insulated coils, at the highest production rate, and lowest cost.

UNIVERSAL WINDING COMPANY

P. O. Box 1605, Providence 1, R. I.

Chicago office and Demonstration Room, 9 So. Clinton St., Chicago 6, Ill.



LEESONA ®

For winding coils in quantity accurately . . . automatically use Universal Winding Machines

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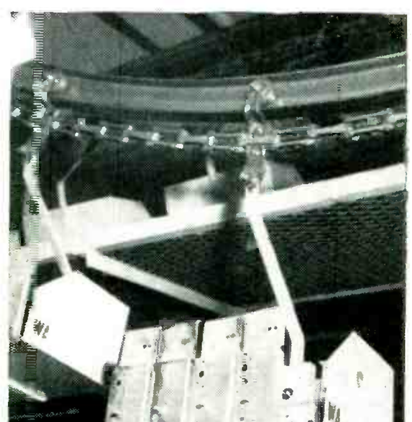
Two-way radio on lift truck

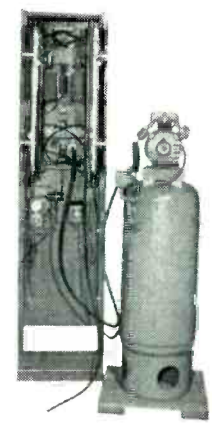
foot of floor space for punch-press parts awaiting assembly into auto radios. The design of the new Palletainer crates (made by Union Steel Products Co., Albion, Mich.) permits four-high stacking, whereas wood crates could be safely stacked only two-high. When not needed, the new crates can be collapsed for compact out-of-the-way storage. A walk-along fork truck is used for stacking and unstacking the loaded crates.

While not used in Sylvania's Buffalo plant, dispatching and utilization of lift and fork trucks may be expedited by use of new GE industrial two-way radio operating directly from the truck storage battery. Installation is simplified by having all operating con-



Use of conveyor pan for wrap-around auto radio housings

"Check your air, Sir?"



Air compressor and tank are at right. Long cylinders on rack dry air before it enters cables.

He's checking the air pressure in a branch cable, one of scores serving a town. The readings along the cable are plotted as a graph to find low-pressure points which indicate a break in the protecting sheath.

Master meters keep watch over the various cable networks which leave a telephone office in all directions to serve a community. Air enters the system at 7 pounds pressure, but may drop to 2 pounds in outermost sections—still enough to keep dampness out.

To keep voices traveling strongly through telephone cables, you have to keep water out. This calls for speed in locating and repairing cable sheath leaks—a hard job where cable networks fork and branch to serve every neighborhood and street.

At Bell Telephone Laboratories, a team of mechanical and electrical engineers devised a way to fill a complex cable system with dry air under continuous pressure. Pressure readings at selected points detect cracks or holes, however small. Repairman can reach the spot before service is impaired.

It's another example of how Bell Laboratories works out ways to keep your telephone service reliable—and to keep down the cost to you.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in mechanical engineering trols on the front of the radio cabinet, with control knobs large enough to permit adjustment even with gloves on. Use of radio reduces aisle traffic in plants, as trucks do not need to travel empty to dispatching centers for new orders.

Replacement of hooks with pans on an overhead chain conveyor permits handling of four auto radio housing units per conveyor section in place of one. Other pans carry a still larger number of top and bottom cover units for the auto radio, so that one feed conveyor serves the entire assembly line. Large lettered labels Scotch-taped to the pans indicate the required loading of each to maintain the correct ratio of the three parts; thus, WA identifies the pan for wraparound housing, TC is for top covers and BC is for bottom covers. This technique is used in Sylvania's Buffalo plant.

I-F Transformer Jig

SPRING contacts mounted just behind vertical guide bars provide a quick means of connecting to five stud-type terminals of a television i-f transformer for sampling in-

Setup used in DuMont's incoming inspection department to check i-f transformers. Jig gives free access to adjusting screws at both ends of the transformer

Want more information? Use post card on last page.

spection tests of electrical characteristics. Another spring clip holds the unit in position when it is pushed against the contacts, leaving both hands of the operator free for adjusting controls and recording test data.

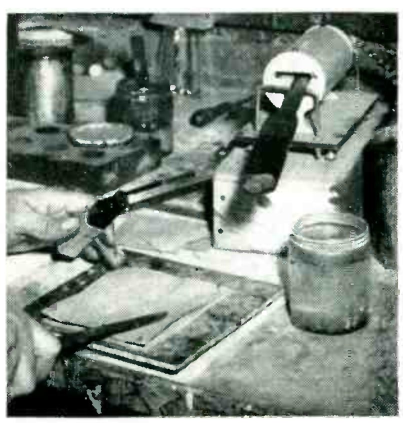
Sandpaper Holder

IN THE cabinet refinishing department at Olympic Radio & Television Inc., four small finishing nails driven into a piece of asbestos board serve as a convenient holder for pieces of No. 8 sandpaper. Up to a dozen sheets at a time are pushed down over the heads of the nails when the supply needs replenishing. An individual sheet can then be easily lifted off as required for rubbing down a repaired area on a cabinet.

The sandpaper is used directly on its holder for cleaning heated spatulas before using them to apply stick shellac. The blade is rubbed over the top sheet of sandpaper on the pad.

Each spatula in this plant is made by grinding down a discarded large half-round file, then fitting on an oval-shaped wood handle. The oval handle helps the operator to hold the working surface of the blade exactly flat against the work.

When not in use, the spatulas are kept hot by pushing the blades into a 140-watt electric oven made for the purpose by H. Behlen & Bros., Inc., New York. Water is kept alongside for cooling the blades slightly when they become over-



Cleaning spatula on pad of No. 8 finishing paper before using it to burn in stick shellac

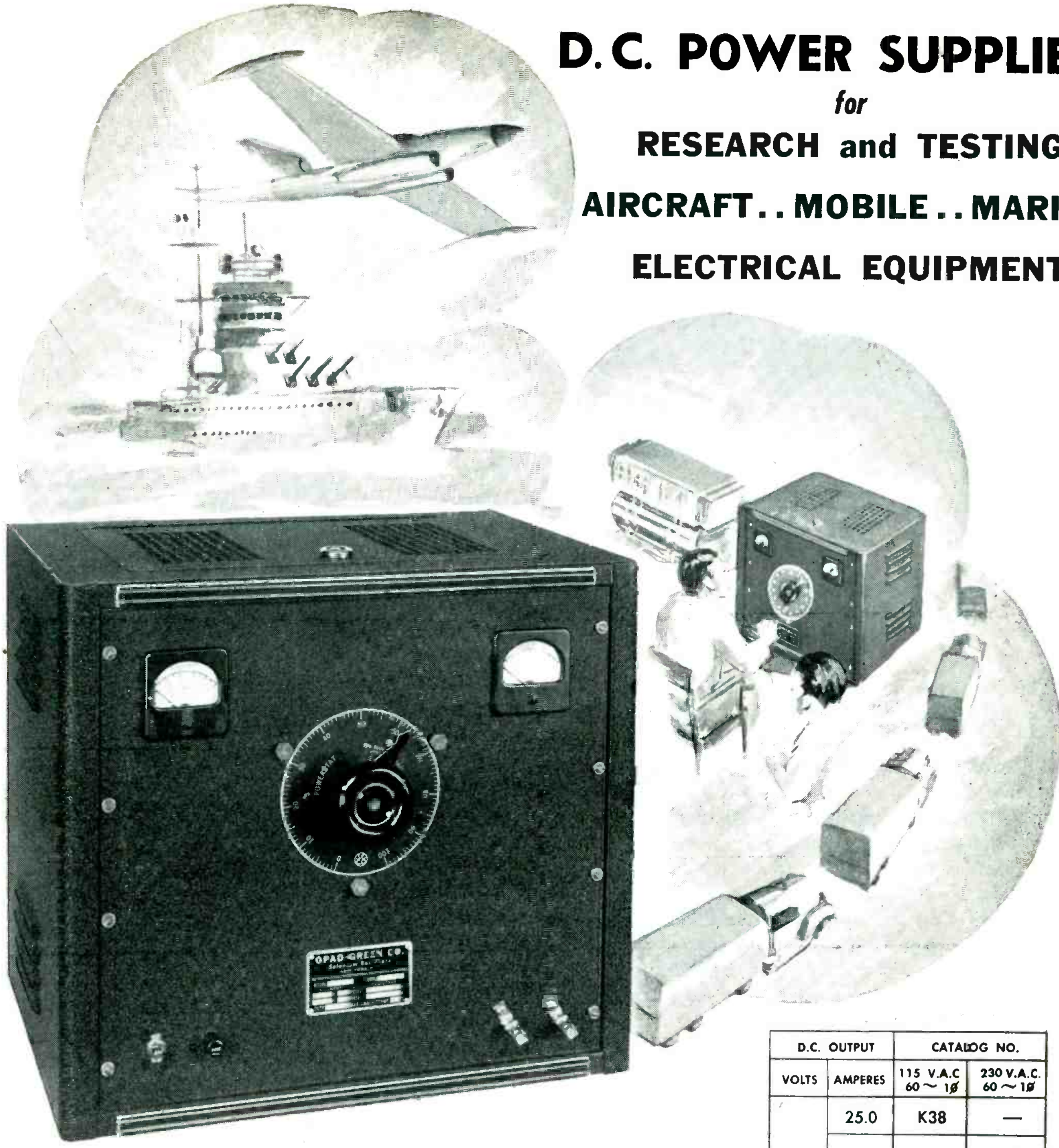
D.C. POWER SUPPLIES

for

RESEARCH and TESTING

AIRCRAFT . . MOBILE . . MARINE

ELECTRICAL EQUIPMENT



D.C. OUTPUT		CATALOG NO.	
VOLTS	AMPERES	115 V.A.C 60 ~ 1Ø	230 V.A.C. 60 ~ 1Ø
O-6	25.0	K38	—
	50.0	K47	K48
	100.0	K56	K57
O-12	12.5	K65	—
	25.0	K74	K75
	50.0	K83	K84
O-28	10.0	K92	—
	20.0	K101	K102
	40.0	K110	K111

The OPAD-GREEN General Purpose Power Supplies are designed to furnish an adjustable source of unfiltered direct current from single phase 50 or 60 cycle A.C. power lines. A unique feature is their stepless control of the D.C. output voltage which permits them to serve as power sources for a wide variety of electrical equipment and electro-chemical processes. *For additional information write for Bulletin No. 147*

Opad-Green COMPANY

71-2 WARREN STREET, NEW YORK 7, N. Y.

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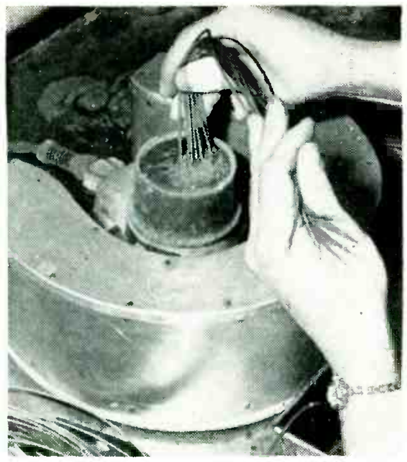
heated because of insufficient use. Benzine in a glass jar alongside is used for wetting sandpaper for sanding down the shellac after burning it into a dent or crack on a cabinet.

Solder Pot Protector

TO PREVENT solder pots from being tipped over accidentally while being used for tinning stripped ends of stranded wire, each pot is protected with a U-shaped base and guard in the wire-cutting department of



Aluminum guard prevents solder pot from being knocked over and at same time serves as convenient hand rest for controlling immersion of wires in solder

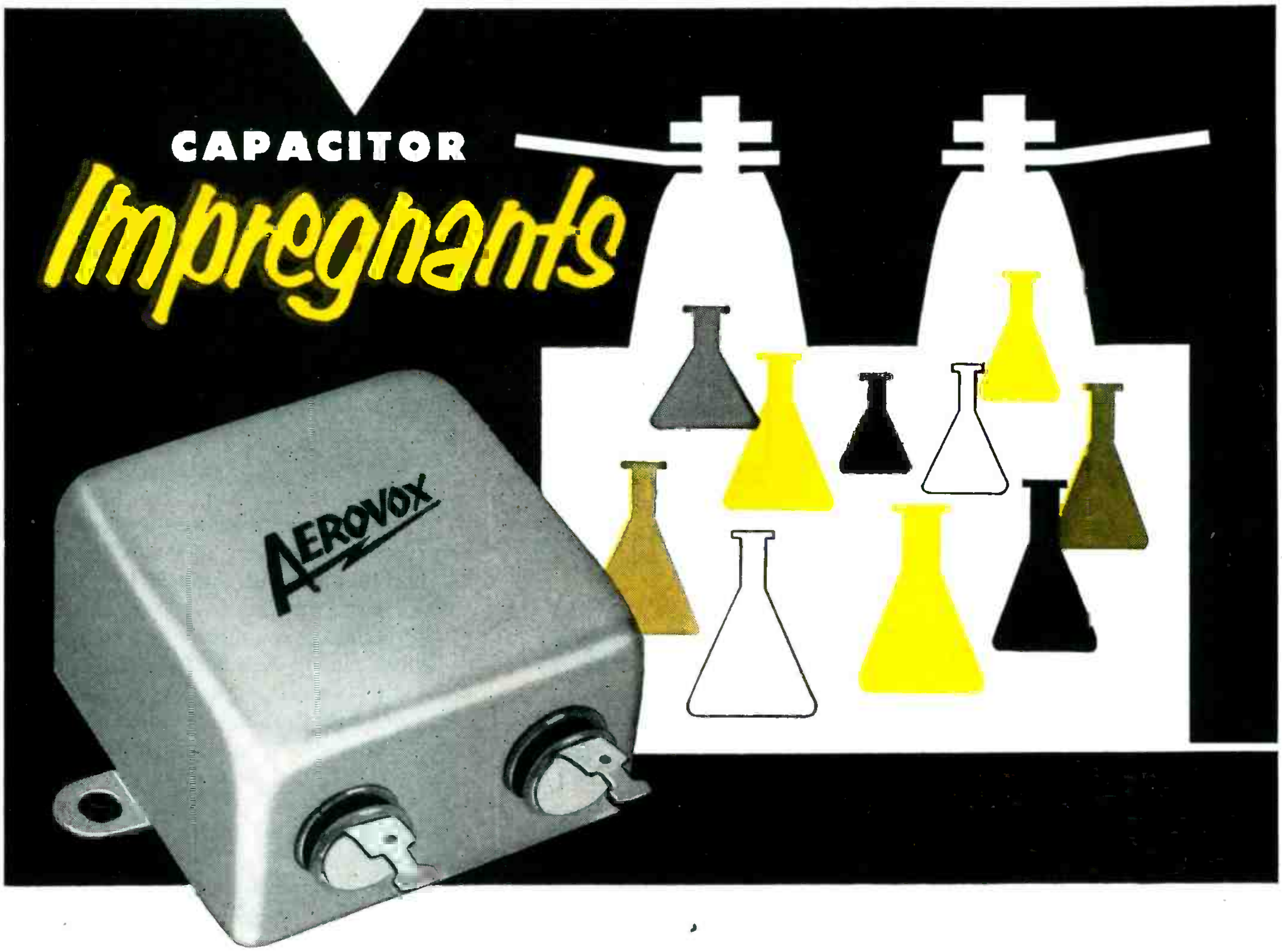
Olympic's plant. The base of the holder is heavy sheet asbestos. The guard is riveted together from sheet aluminum and nailed to a U-shaped wood base fastened on top of the asbestos sheet.

Vacuum Metallizing Process

IN PLATING or metallizing metals and plastics by high-vacuum evaporation, articles to be coated are placed upon suitable jigs and introduced into the chamber which consists of a bell jar, or in large industrial units, a steel tank. A small amount of the coating metal is placed on filaments arranged in the chamber.

The chamber is evacuated to the required degree of vacuum, and low-voltage current is fed to the filaments. These become incandescent and heat the coating metal to a point where it boils and vaporizes;

FUNCTION-FITTED*



Aerovox offers the widest choice of function-fitted* impregnants. Examples:

For minimum size and average operating conditions, there are several wax impregnating compounds.

For minimum weight and size yet providing maximum reliability, there is Hyvol D.

For marked stability and reliability over wide temperature ranges, there is Hyvol M.

For utmost dependability under severe operating conditions, there is Aerolene.

For extreme stability, plastic film dielectrics are available.

For heavy-duty AC operation, there is synthetic Hyvol F.

Tell us what that capacitor is expected to do.
We'll select the impregnant best fitted to that function.

FUNCTION FITTED

*** Aerovox engineers are always ready to study your circuitry, associated components and operational requirements, *if you wish.* This can mean marked savings in component costs, along with the best choice of capacitors. Let us tell you about it.**

AEROVOX capacitors

AEROVOX CORPORATION
NEW BEDFORD, MASS.

HI-Q® DIVISION OLEAN, N. Y. **WILKOR DIVISION** CLEVELAND, OHIO

Export: 41 E. 42nd St., New York 17, N. Y. • Cable: AEROCAP, N. Y. • In Canada: AEROVOX CANADA LTD., Hamilton, Ont. JOBBER ADDRESS: 740 Belleville Ave., New Bedford, Mass.

the metal vapor thus generated condenses on the articles in the chamber, producing a bright coating of microscopic thickness. When the coating is applied to only one surface of an article, it may be held stationary in the chamber. When a number of surfaces must be coated or where irregularly shaped pieces must be completely covered, rotary jigs are employed.

In at least 95 percent of applications, the coating metal is aluminum, although silver, gold, copper, zinc, chromium, cobalt, nickel, selenium, and in fact, practically any metal and many metallic compounds, as well as alloys, can be deposited in the same manner. Aluminum is distinguished by its low cost, availability, resistance to tarnish, high reflectance and ease of evaporation. One pound of aluminum will cover 25,000 square feet of surface. The thickness of the film is usually four millionths of an inch, although for special purposes it is possible to produce deposits ranging from half a microinch to forty microinches. In the case of plastics or other nonmetallic base materials where greater thickness is required, the vacuum evaporation method provides an ideal electrically conducting base for subsequent buildup by conventional electroplating.

The surface and hence the brilliance of the metal coating is governed by the smoothness of the surface to be coated. It is sometimes desirable to precoat the plastic articles, particularly where enhanced brilliance is desired. The costly buffing operation necessary to achieve brilliant electroplated finishes on metals may be totally eliminated by substituting an easily applied precoat.

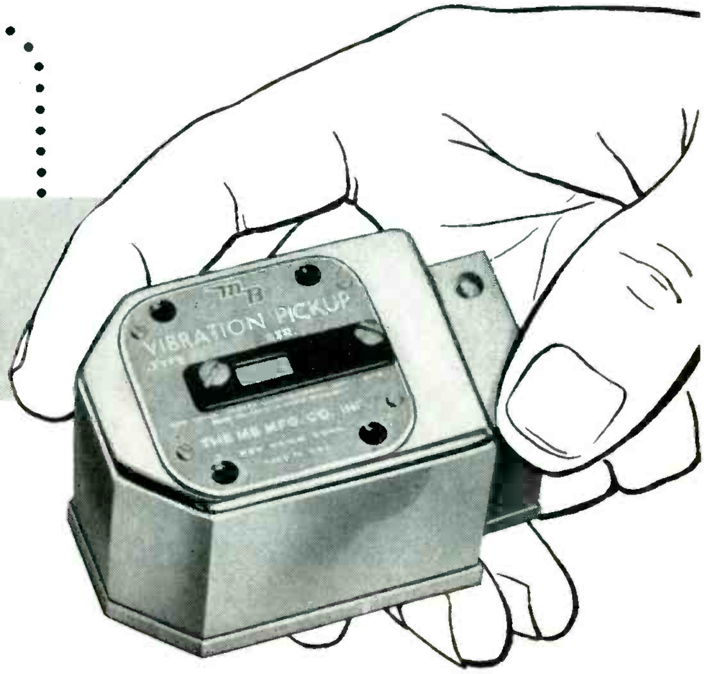
Depending upon the type of service, it may be necessary to overcoat the aluminum coating to protect it from abrasion and strongly corrosive atmospheres. Both dip and spray methods are successfully employed in the application of organic topcoats and undercoats.

Overcoating offers the advantage that considerable variation in color is possible while retaining the metallic luster. For example, an amber-tinted topcoat will simulate a gold, copper or brass finish. The

Vibration Engineering that solves your problems

PROBLEM: To locate vibration and measure it

SOLUTION: This sensitive, velocity-type MB Vibration Pickup



Illustrated here is the MB Type 122 Vibration Pickup developed for jet engine testing. it withstands 500° F.

TO LICK VIBRATION you've got to *locate* it first. That's a job for which the MB Vibration Pickup was developed. It has the sensitivity needed to detect the faintest vibration—the stamina to withstand the strongest.

When fastened to the product, component or structure under test, this pickup faithfully converts vibratory motion into elecrical output. Its signal can be seen and studied on the oscilloscope; or measured by meter such as the direct-reading MB Vibration Meter; or fed to vibration analyzer.

The pickup is usable from 5 to 2000 cps in horizontal or vertical operation. Magnetic damping assures calibration stability. Lightweight moving coil and low-friction pivoting account for the pickup's wide range of serviceability.

Today, this unusual instrument is being found indispensable for accurate vibration detection. It's one more reason why MB is known as headquarters for the answers to vibration problems—including those in shake testing, measurements, vibration isolation and shock mounting. Full details on pickups in Bulletin No. 124-5. Write us.

Double duty vibration exciter

Specification MIL-E-5272 and other vibration testing specifications can be met with the Model C-1 Shaker. It develops 50 pounds of force. An electromagnetic shaker, it features easy, continuous control of force and frequency. It also serves as a calibrator for vibration pickups.

The technique of calibration has been thoroughly presented in MB's booklet entitled "The Calibration of Vibration Pickups to 2000 cps." Send for Book let C-11-5.

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

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT wide variety of attractive finishes thus possible is limited only by the ingenuity of the designer.

Vacuum coating units used in connection with this process are available commercially from the Equipment Division of National Research Corp., Cambridge, Mass. Chief use in the electronic field is for finishing both metal and plastic escutcheons and nameplates for television and radio receivers.

Cathode Sputtering

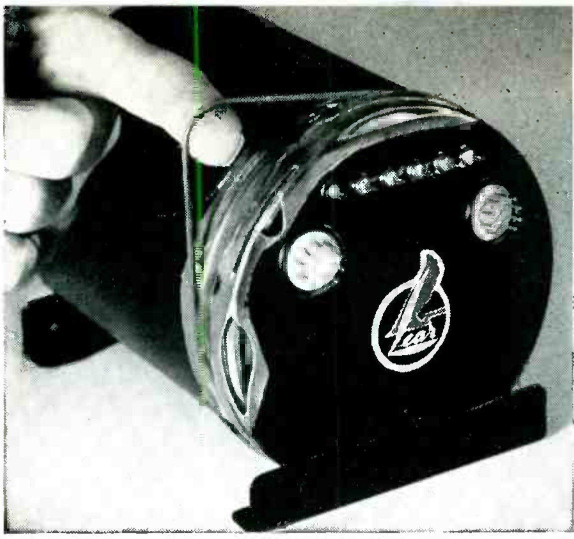
The cathode sputtering process, although related to vacuum evaporation, differs in several aspects. In sputtering, the metal to be coated is transferred to the article by high-voltage bombardment rather than by direct thermal evaporation. Equipment required is similar to the evaporation unit except that a more moderate vacuum with provision for adding an inert atmosphere is required, and a high voltage rather than high-amperage power supply is employed.

The sputtering process is used mainly in work with precious metals. It is not used in high production, since rates of metal transfer possible are far less than with vacuum evaporation.

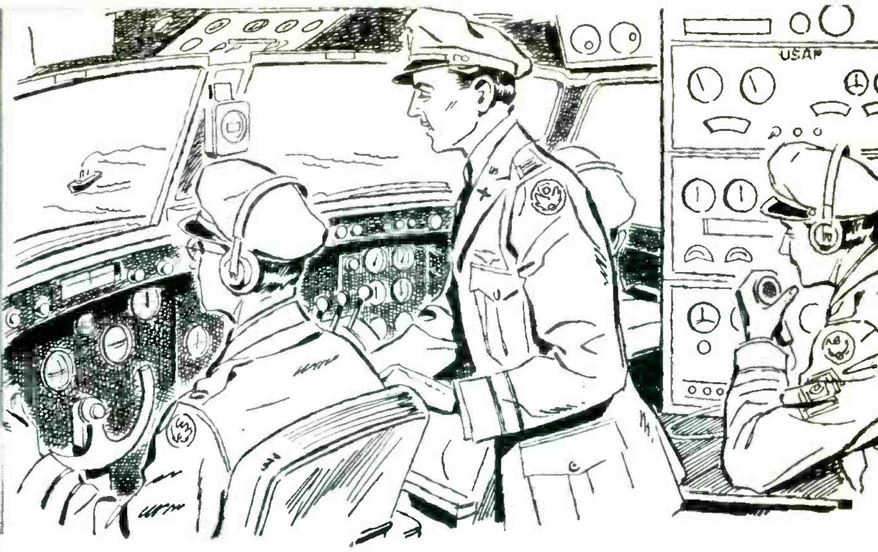
Wire-Stripping Pliers

DURING ASSEMBLY of military electronic equipment in one of DuMont's plants, it was impossible to push a wire through a chassis grommet after stripping, because of bunch-

Method of holding tools for stripping insulation close to chassis



Courtesy Lear, Inc.



in instruments where reliability is imperative

SILASTIC* works

where other materials fail

To assure maximum service life and accuracy, engineers at Lear, Incorporated, planned to protect their new vertical gyro-mechanism from corrosion by housing it in a completely inert and dehydrated atmosphere.

Sealing the housing, however, proved to be more easily said than done. Despite the most elaborate precautions, solder and flux fumes often penetrated the joint and contaminated the delicate mechanism. Once sealed, it was impossible to reopen the case without loss of the expensive cover and harness.

To both of these problems a simple and ingenious solution was found. A thin O-ring of Silastic molded to fit snugly under the cover flange is used to exclude the corrosive fumes generated in soldering a metal strip over the entire joint. The Dow Corning silicone rubber O-ring is not damaged by soldering temperatures. And, the gyro-mechanism is just as accessible for repairs as the contents of a hermetically sealed can of coffee.

Lear also uses a large ring washer of Silastic at each end of the housing to serve as resilient, shock-absorbing cushions for the apparatus at stratospheric temperatures.

And that's just one of hundreds of examples of how Silastic is used to improve the performance of products ranging from cable to traction motors, from domestic steam irons to aircraft.

*T. M. Reg. U. S. Pat. Off.

For more information about the properties or fabricators of Silastic, mail this coupon today or phone our nearest branch office.

Dow Corning Corporation, Dept. BE-3, Midland, Mich.

Please send me:

- ☐ Silastic Facts 10a with new data on properties and applications of all Silastic stocks and pastes.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

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Long-nose pliers as modified for wire stripping

ing of the loosened insulation. The wire was too short to permit use of ordinary wire strippers after threading the unstripped wire through the grommet.

The problem was solved by developing a special stripping tool made from long-nose pliers. Stripping jaws were fastened onto the ends of the plier jaws with machine screws, and a hole was drilled and tapped through one jaw for a spacer screw that could be adjusted for cutting insulation on various sizes of wire without damaging the wire.

In the final technique used, the wire was stripped at one end, and this was soldered to its tube socket terminal under the chassis. The unstripped end of the wire was then pushed up through the grommet and held near the chassis with a pair of ordinary long-nose pliers. The stripping tool was now clamped over the end of the wire to cut the insulation, and pulled upward to strip off the insulation. The tool permits stripping as close as a quarter inch from the chassis.

Optical Thermometer for Induction Heating

A NEW heat detector permits full control of induction heating directly from work temperature even though the available target area is extremely small and the time cycle for heating is only a few seconds. A high-sensitivity thermopile provides high speed of response to all radiation from infrared to ultraviolet and focuses all wavelengths

AMERICAN LAVA CORPORATION... SPOTLIGHTS ALSIMAG® METAL-CERAMIC COMBINATIONS

Lead-Through Hermetic Terminals

(Designed for soft-soldering)

Superior ceramic terminals for hermetic seals are now available in an AlSiMag Alumina Body which meets L5A Requirements of JAN-I-10 specifications.

Some sizes and styles are carried in stock . . . or they can be custom made for your specific requirements. *STOCK ITEMS ARE SHOWN IN BULLETIN NO. 524, SENT ON REQUEST.*

Our broad experience in metal-ceramic combinations is available to you on your request.

51ST YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

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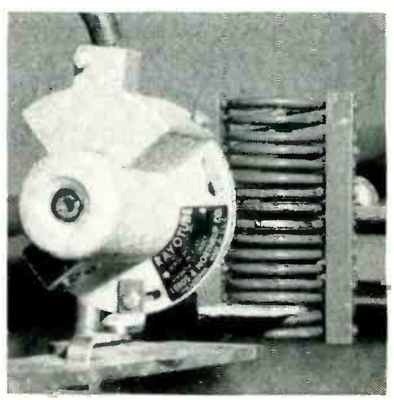
Experimental setup of optical thermometer, here aimed between turns of work coil to measure heat of test sample inside

at the same point. Radiation outside the sharply defined target area does not reach the thermopile.

A double-mirror optical system permits sighting through a very small opening to spot the target area, which may even be as small as a pinhole. This means that the instrument can be aimed between the turns of the work coil for successful pickup of heat from the glowing part inside. The minimum object diameter is 0.1 inch at a 4-inch object distance and response time is 0.6 second to 99 percent of change. Ambient temperature may be as high as 350F.

The detector, made by Leeds and Northrup Co. and designated as type 8891-C Rayotube, may be used either with a recorder or controller. Measuring ranges start from 800F,



Closeup view of detector and work coil of induction heating unit

for Real Uniformity, specify STACKPOLE *Ceramag*® ferrite cores!

Most ferrite core users have learned by costly experience, that it's one thing to obtain satisfactory samples—but quite another thing to have these sample cores reproduced in production quantities. *But not at Stackpole!*

Stackpole Ceramag ferrite cores are outstandingly uniform in every physical and electrical respect. The production unit is exactly like the sample. Each production unit is exactly like the other.

In short, Stackpole has perfected control of the complicated problems involved in handling ferrite materials. The result spells cores of outstanding uniformity in their electrical characteristics, highly accurate physical tolerances and with the ability to withstand exceptionally high temperatures without permeability change for many specific uses.

Write for Stackpole Ceramag Bulletin

Have you investigated these potential NEW Ceramag core uses?

HIGHER TEMPERATURE OPERATION IN NITROGEN ATMOSPHERES

New equipment designed and sealed in nitrogen, due to high ambient temperatures imposed by miniaturization, poses a real temperature problem for permeability tuning cores as well as for I-F transformer and R-F cores. This is solved handily by Stackpole Ceramag cores thanks to the fact that they stand higher temperatures and show less drift than high-permeability iron cores.

SUPERSONIC FREQUENCY APPLICATIONS

Ceramag cores assure high permeability with low losses in the supersonic-frequency range.

CENTER CORES FOR POWDERED IRON POT CORES

Used as center cores in powdered iron pot cores operating at less than 1 megacycle, Ceramag increases L by approximately 100% and increases Q on the order of 50%.

INCREMENTAL PERMEABILITY APPLICATIONS

Because Ceramag is more easily saturated than conventional core materials, it is ideally suited for pulse generation, magnetic amplifying and incremental permeability tuning.

HASH AND INTERFERENCE SUPPRESSION

Recent experience indicates that the unique characteristics of Stackpole Ceramag help materially in minimizing "hash" and interference when the cores are used in the filter systems of electrical equipment and tools. Inquiries are invited.

- ✓ lower losses
- ✓ higher efficiency
- ✓ lower operating temperatures
- ✓ lighter weight—smaller sizes
- ✓ less corona effect

FIXED AND VARIABLE RESISTORS—LINE & SLIDE SWITCHES
CERAMAG® ferrite CORES
IRON CORES
(Side-molded, sleeve, cup, choke coil, threaded and conventional types)
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corresponding to ¼ millivolt, and can go up to 2600 F or higher depending on the recorder and controller ranges selected.

With this new aid to induction heating, reproducible results are possible regardless of variations in power input or other variables. Because final temperature is accurately measured, depth of hardness can be readily adjusted by varying power input. Initial setup is also expedited.

Measuring Small R-F Chokes

By T. L. Snowdon

Engineering Department
Jeffers Electronics Division
Speer Carbon Co., DuBois, Pa.

The measurement of small values of inductance has always been a problem, especially with regard to correlation. The nomenclature used to describe the inductance has varied, depending on the measurement method used. Such measurements are of increasing importance with the very small inductances used in uhf equipment.

During efforts to establish a standard line of small r-f choke

Testing small choke coils by using calibrated terminals on top of Q meter

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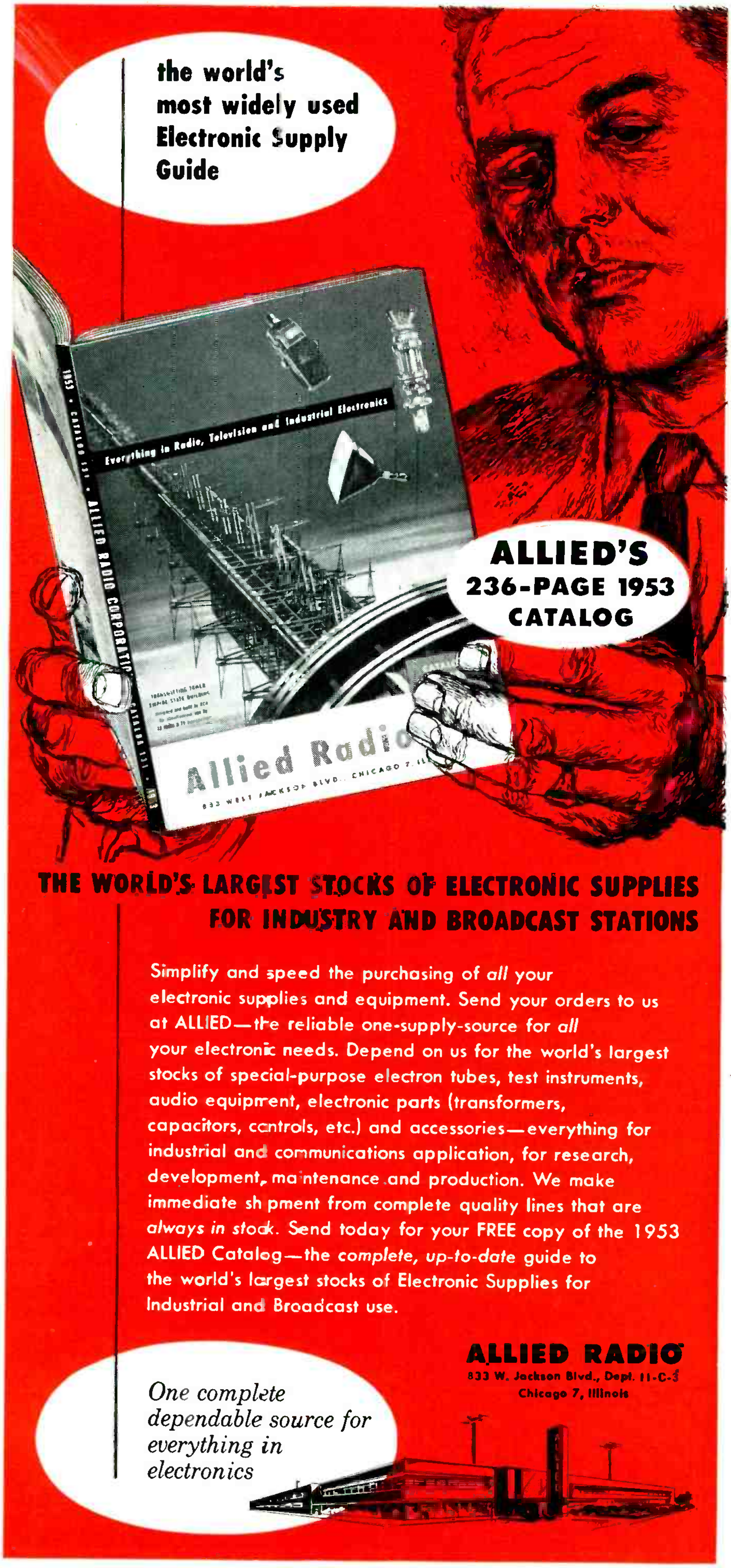


coils ranging from 0.15 to 120 microhenrys, it was realized that some simple, easily-reproduced inductance-measuring method should be used so that anyone with ordinary equipment could be assured of close correlation.

For values where the inductance is large, so that the instrument calibration is fine enough to be a very small part of the tolerance, the common 1,000-cycle inductance bridge (such as General Radio No. 667) may be conveniently used. These readings are easily reproduced and correlation is good. For coils of less than 10 microhenrys, however, the smallest inductance increment on such a bridge is too great a percentage of the total to be useful. It has been a common practice to use for such coils the Boonton Q meter and prepare the specification in terms of capacitance limits. Here it is difficult to name the coil inductance in coil terms; instead, each coil drawing specifies a different capacitance or frequency test.

The instrument chosen for production-line measurement of these small inductances is the Q meter because of its already widespread usage and flexibility. The Boonton 160A Q meter is now equipped with a capacitance dial calibrated in microhenrys, and by proper choice of frequency, this dial can be read directly; however, the choice of connection method will radically alter the reading so that some standard holder is required. When this is done the inductance of the holder must be considered, as well as the internal inductance of the meter, due to its connections to the terminals. The inductance *B-C* shown in Fig. 1 is the internal plug jig inductance.

By establishing a standardized

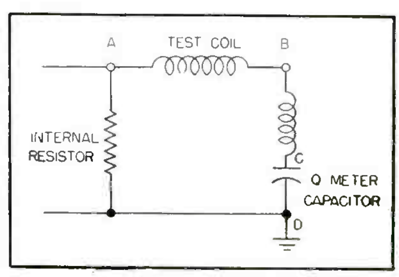
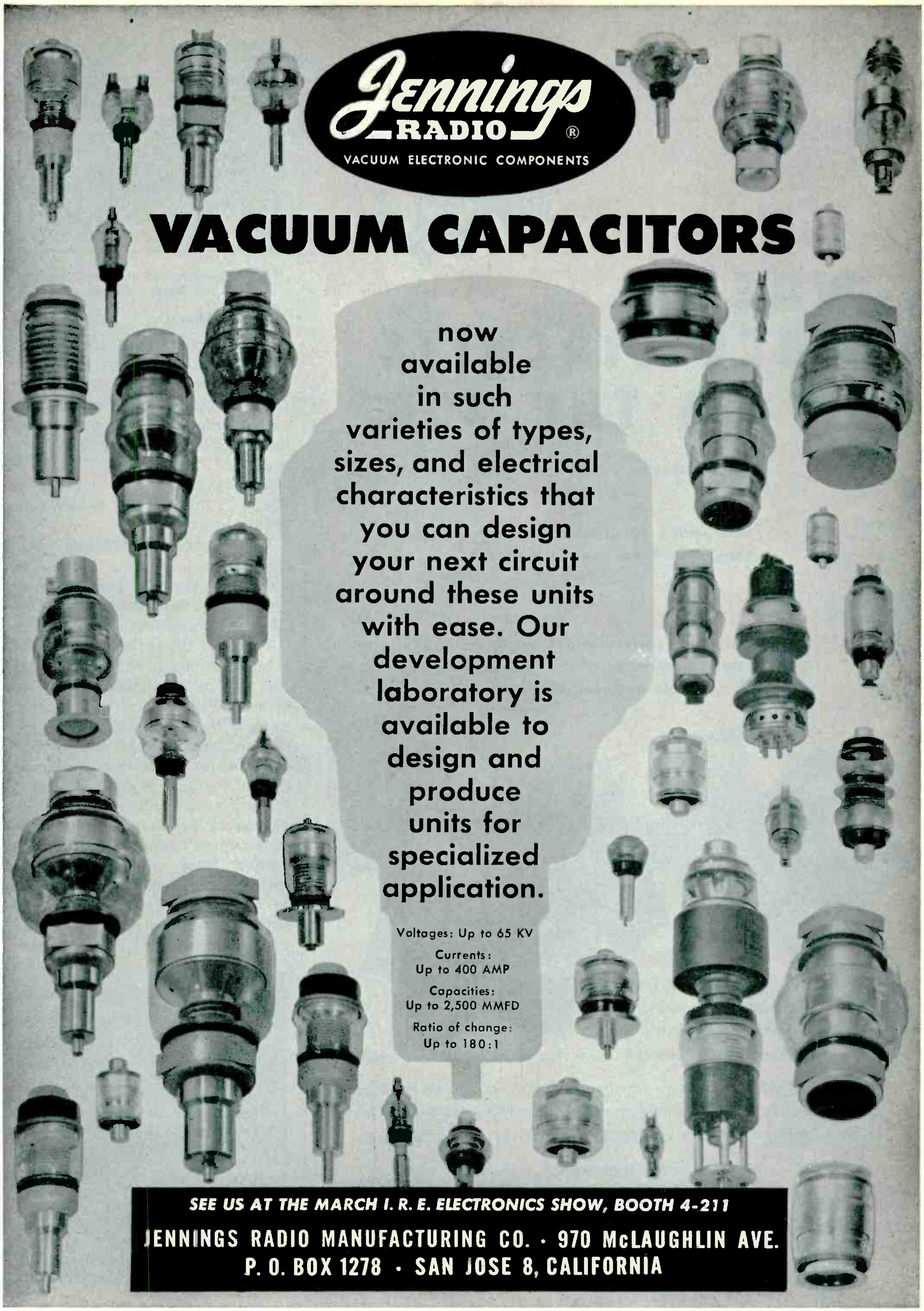


FIG. 1—Output circuit of Q meter



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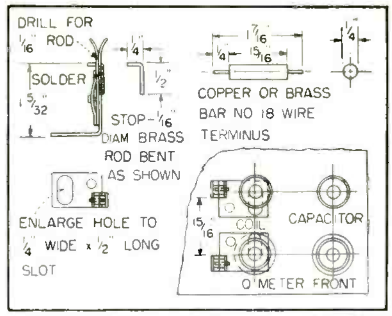
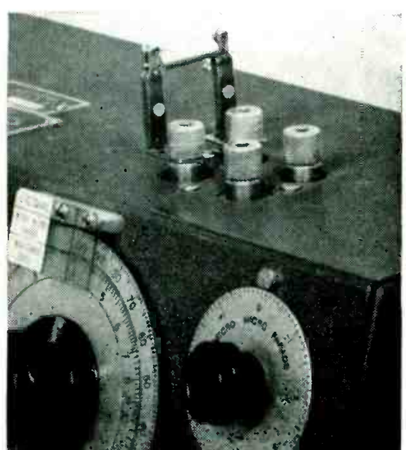


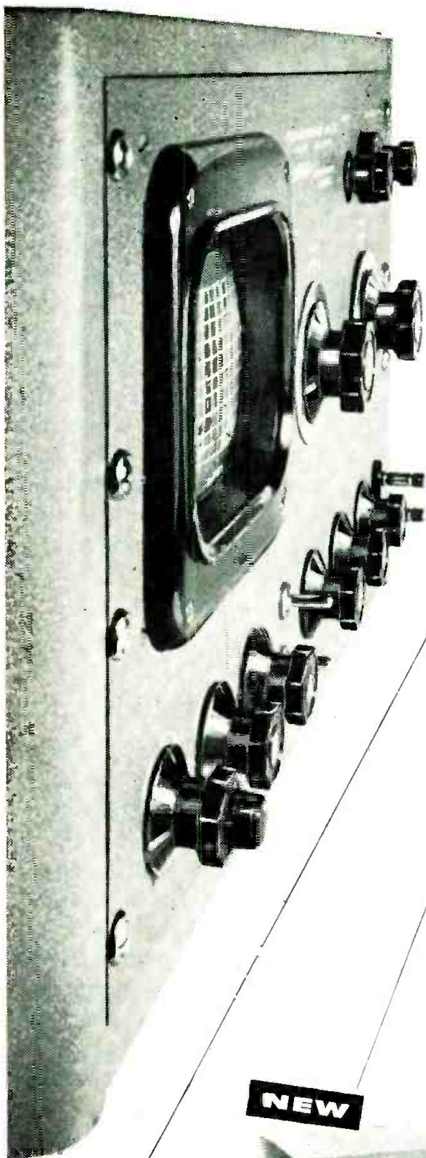
FIG. 2—Construction of special terminal clips and brass calibrating bar

terminal which is easily operated, and properly accounting for the stray inductance thus added, it should be possible to make accurate, reproducible measurements of coils on the order of tenths of a microhenry. This was done by re-working a pair of "Rapid Test Clips" and equipping them with stops as in Fig. 2 so that the coil location will always be constant.

To evaluate the clip and meter internal inductance, a heavy low-inductance shorting bar was made up and its inductance calculated. Then by a measurement of the inductance of the entire combination, Q meter, clips and shorting bar, the clip and meter inductance can be defined. With this calibration, as it were, of the individual Q meter and clip combination, the dial reading of the Q meter becomes rather accurate for any inductance value. For one such combination, the correction to be considered is 0.028 microhenry. The subtraction of this amount from any reading made with the same combination will give an inductance figure which represents the coil alone. Of course, where this amount is small com-



Calibrating bar in place on Q meter



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ULTRASONIC RESPONSE INDICATOR—MODEL G-3

Used as an adjunct to the Model SB-7 Panoramic Ultrasonic Analyzer, the G-3 permits visual inspection of amplitude versus frequency characteristics of networks and devices between 2KC and 300 KC. Direct readings of frequency and amplitude. Indicates fundamental response only.

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Designed specifically for applications requiring extreme resolution or demanding measurement of levels of signals spaced very closely in frequency or widely divergent in amplitude.

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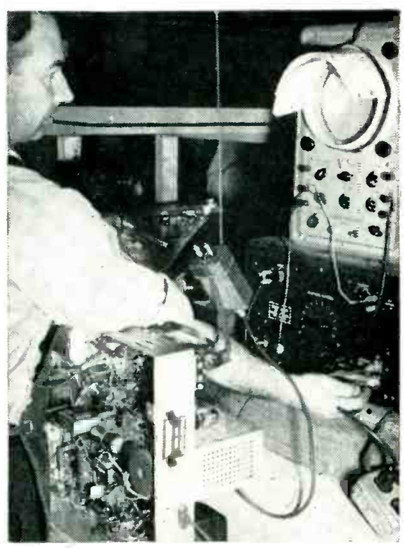
pared to the tolerance of the unit under test, no consideration need be given. For a 0.10 microhenry coil, disregarding it can cause serious error.

This method is not as precise as might be desired for some laboratory work due to the tolerances on Q meter frequency and calibration and the distributed capacitance of the coil. It is possible to improve the precision by use of frequency standards and closer dial calibration. However, it does suffice for the majority of common ±10 percent to ±20 percent small coils, and makes possible the convenient specifications and actual naming of the inductance in microhenrys, instead of indirectly in terms of capacitance or frequency.

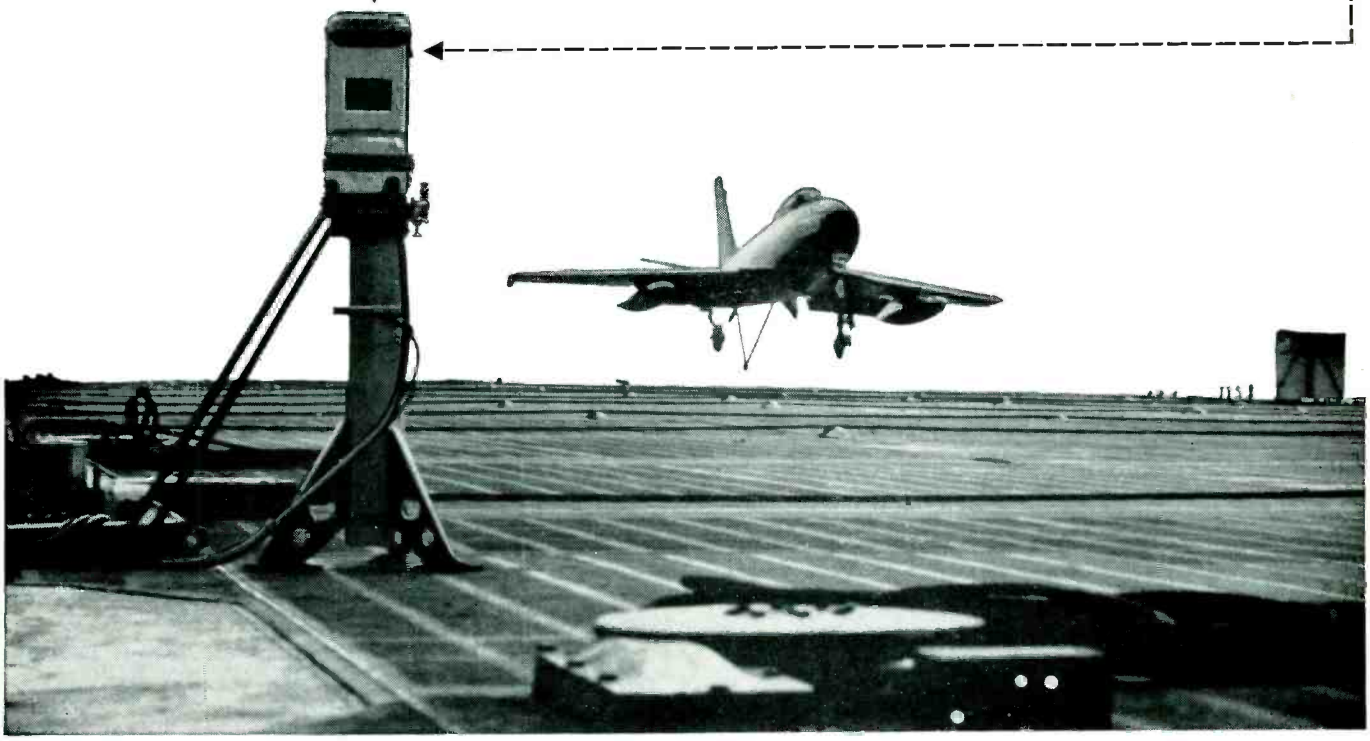
TV Alignment Techniques

A LONG SPRING suspended from the ceiling supports the isolation transformer above the test bench in the television receiver alignment section of Olympic's plant. Input to the transformer is by coaxial cable from a sweeping oscillator, and output goes to a short length of twin-lead having a clothespin-type connector that snaps over the lugs of the antenna terminals on the chassis. When not in use, the transformer moves up far enough to be out of the way when bringing



Operating tape-covered attenuator switches. Spring-supported isolation transformer, above forearm, is fed by output of sweeping oscillator

BRIGHT MINDS CONJURE UP ELECTRONIC MENTAL GIANTS



AT NORTH AMERICAN AVIATION

An airplane's rate of descent used to be painstakingly computed from photographs which took several days to evaluate. Then North American's electro-mechanical engineers developed TRODI (above) for the Navy for carrier suitability tests.

TRODI is an electro-optical Touchdown Rate of Descent Indicator that watches the airplane descend, measures its rate, and electronically readies its information so it's available the minute the pilot lands. TRODI's electronic brain saves untold time, men and money for the Navy.

TRODI is just one ingenious example of the challenging electronic and electro-mechanical work being pioneered at North American by some of the nation's best scientific minds, using the most advanced facilities.

If you like theory, you may find an exciting and secure future at North American in the field of operations analysis, advanced dynamics, kinematics, noise, error or information theory, systems engineering, statistical quality control or servo analysis.

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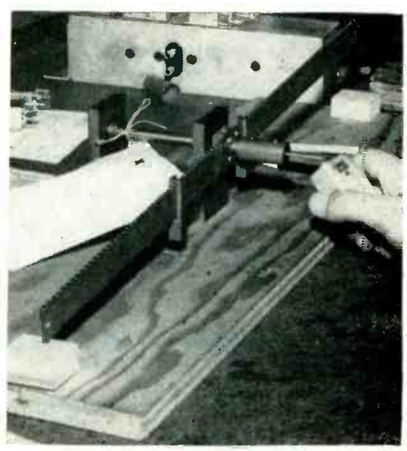
a new chassis on the bench.

To speed up the setting of attenuator switches on the Kay Electric Co. Marka-Sweep instrument when adjusting sound r-f transformers, television tester Simon Cohen has wound adhesive tape around the group of five toggle switches. With this, he can move the entire bank of five switches in one movement yet still move individual switches at either end of the group as desired.

Checking Torque of Adjusting Screws

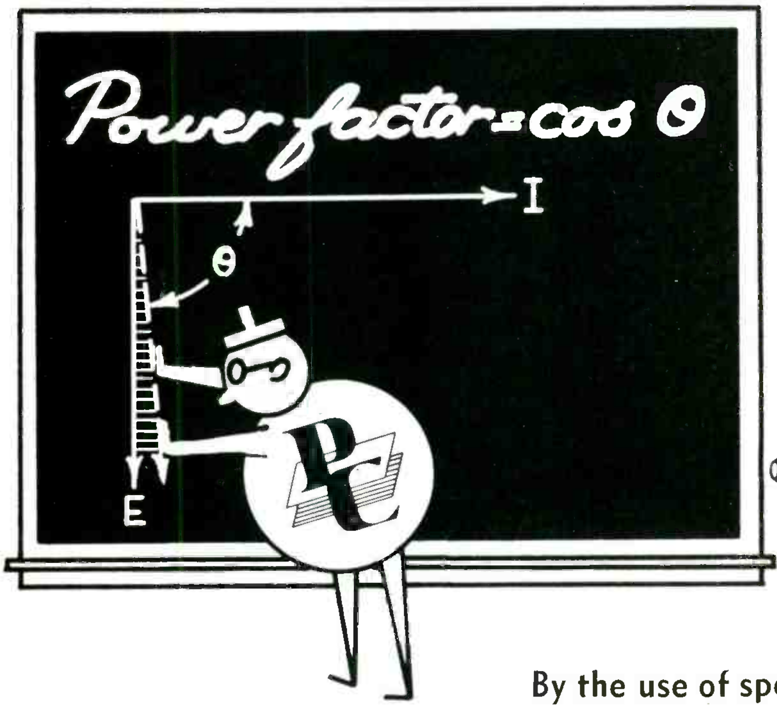
THE TORQUE in ounces needed to turn each adjusting screw of an i-f transformer in both directions is measured with a simple balance setup in DuMont's incoming inspection department. The balance arm is a notched metal strip on which sliding weights can be hung. The arm is pivoted on ball bearings at its center and a screwdriver bit is clamped onto the front end of the shaft.

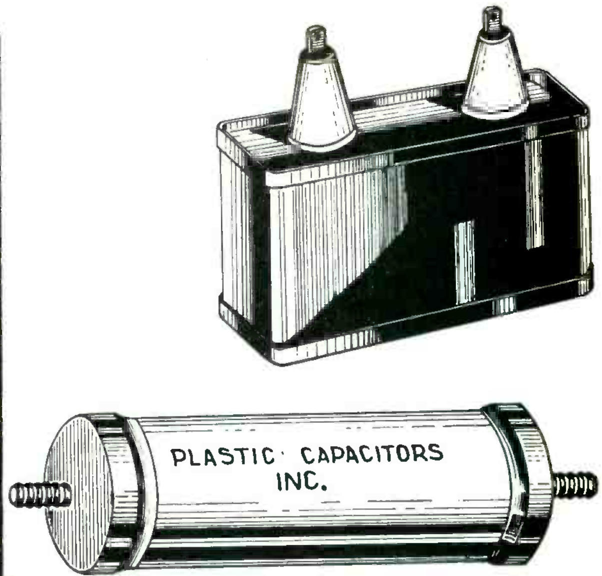
In use, a transformer is held up to the screwdriver bit so that an adjusting screw engages with the bit, and the transformer is turned. With one weight close to the pivot, the transformer is held so that the other arm is up on the air, and its weight is moved out until it is just far enough to turn the screw of the ferrite core. Next, this weight is moved in to the center and the other weight is moved out step by step to check the torque needed to loosen the screw in the other direction.



Bringing an i-f transformer up to the screwdriver bit on the shaft of the balance arm for checking turning torque

LOW POWER FACTOR





By the use of specially selected and processed plastic films for the dielectric and painstaking and meticulous craftsmanship in their fabrication, P-C Capacitors are available with extremely low power factors.

Capacitance stability and low dielectric absorption, coupled with high resistance and low temperature coefficient characteristics result in units of almost pure capacitance.

As a consequence, power factor is available as low as .01% to .02% in the audio range. Comparable Q values may be had up to 100 kc.

If your capacitor requirements call for low power factor, specify P-C Capacitors.

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NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Forty-Three Trade Bulletins Reviewed

OTHER DEPARTMENTS
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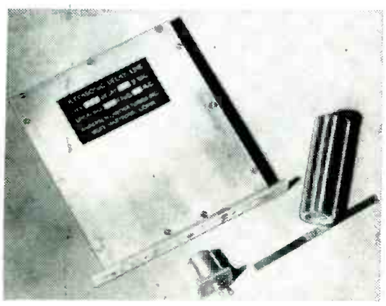
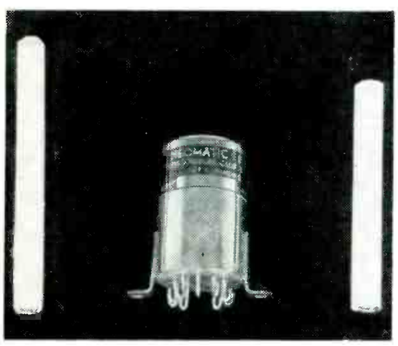


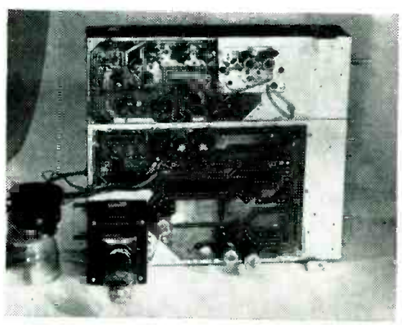
Ultrasonic Delay Lines

ANDERSEN LABORATORIES, INC., West Hartford, Conn., has developed a series of fused quartz ultrasonic delay lines for radar and electronic computer applications. These solid delay lines are available in bandwidths of 12 mc or greater and feature an extremely low ratio of spurious to desired signals. This can be held as low as −50 db for special requirements. Insertion losses are also kept to a minimum, 34 to 50 db being characteristic depending on the terminating impedance necessary.



Subminiature Relay

NEOMATIC, INC., 9010 Bellanca Ave., Los Angeles 45, Calif., in announcing its new dpdt relay, calls attention to its small size by this comparison shot with both standard and king-sized cigarettes. It is obtainable in the range from 50 to 1,000 cycles, operating on an input of 115 v. Two models are offered: Model 10220, with a contact rating of 1 ampere, noninductive; and model 10320, with a contact rating of 4 amperes, noninductive. All units are hermetically sealed with dry air or inert gas to withstand severe environmental conditions and insure long life. Optimum operation is in the temperature range from −55 C to ±85 C. Weight is 1.51 oz; diameter, 1.0 in.; and length, 1.71 in. It connects with 9-hook or 9-pin header. The a-c relay is especially suited to aircraft applications but may be used for remote control mechanisms in almost all military or industrial applications.



Printed Circuit

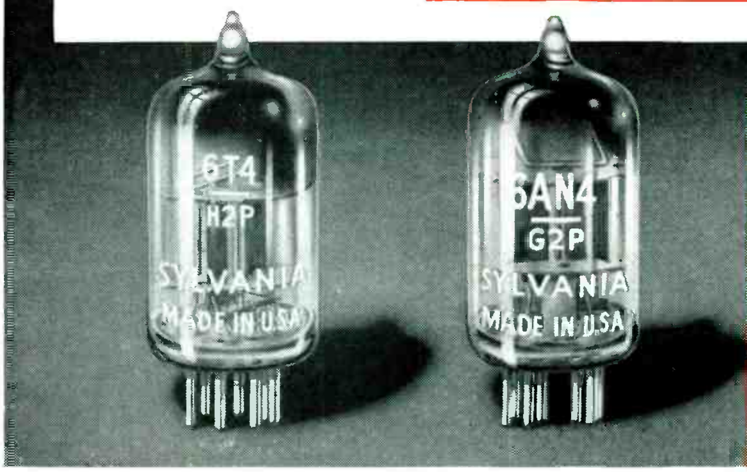
CIRCUITRON, INC., 400 Ninth St., Hoboken, N. J. The Circuitron is a new type of printed circuit using a radically different method of bonding the pattern to the insulating base. The conductive pattern can be run from one side of the base material to the other by plating through holes, maintaining circuit continuity without the need for eyelets or other hardware. This permits crossovers, greater design flexibility, and easy adaptation to single-dip soldering. Copper, silver and other metals in any specified thickness can be used for the conductive circuit. The pattern can be overplated with nickel, silver, rhodium or gold. The conductive pattern can be applied to such base materials as phenolics, melamines, silicones, polystyrene, polyesters and Teflon. Circuitrons can be custom-engineered and produced in quantity for a wide variety of electrical and electronic applications.

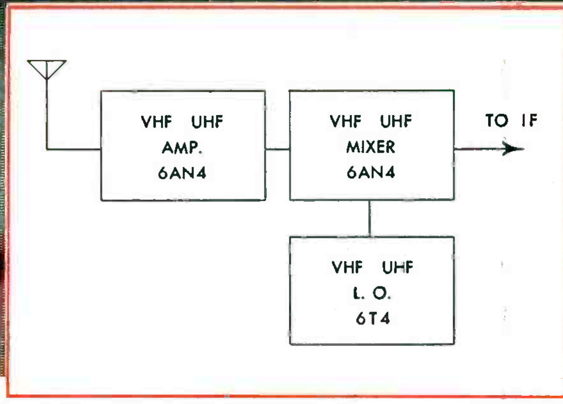
Miniature C-R Tube

BEAM INSTRUMENTS CORP., 350 Fifth Ave., New York, N. Y. The Cossor type 1CP1 is a miniature cathode-ray tube with a lock-in (B8G) base. The focusing of the beam is automatic and only one anode potential is required. For simple display purposes the grid bias is most easily developed by inserting a resistance of about 10,000 ohms in the cathode line of the tube; thus the excitation of the tube is exceedingly simple. Also, the

Make your UHF circuits as simple as VHF designs...

Use these two New Sylvania Tubes in tuners and converters





Representative block diagram of combination VHF-UHF tuner using the new Sylvania 6AN4 as rf amplifier and mixer, and the 6T4 as local oscillator.

Equipment Manufacturers! Simplify design of combination VHF-UHF tuners, UHF converters for TV! Two new Sylvania-developed tubes permit adaptation of conventional amplifier-mixer-local oscillator circuit to the new frequency bands—completely eliminate complicated switching arrangements or stage duplication. Leading Tuner Manufacturers have adopted these types for current tuner production.

- Short Bulb T-5½ 7-pin miniature construction
- Requires no special socketry
- Designed for use at frequencies up to 1000 mc
- Double plate and grid leads
- Uniformity at high frequency means lower cost and better availability

THE SYLVANIA 6T4 is designed for use as a local oscillator at frequencies up to 1000 mc. Used as the companion tube to the 6AN4, it makes possible the design of extremely simple combination tuners and UHF converters.

THE SYLVANIA 6AN4 can be used both as an rf amplifier and as a mixer. Its performance in the VHF band is equal to or better than previously existing types of tubes, and in UHF tuners it gives comparable performance to VHF tuners.

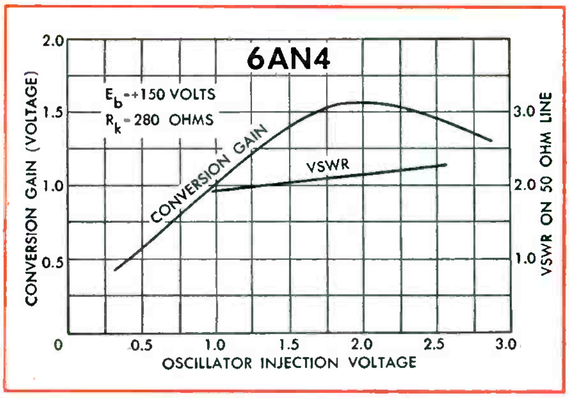
The 6AN4 is designed for both high g_m and high mu. Under representative operating conditions as a Class A amplifier, the transconductance is 10,000 micromhos and the amplification factor is 70.

When used as a mixer, the 6AN4 offers the advantages of a conversion gain and of relatively low oscillator drive requirements.

Complete technical information on operating characteristics, including performance curves, is included in the manual, "Sylvania's UHF Story." A copy is yours for the asking. Write to: Sylvania Electric Products Inc., Dept. 3R-1003, 1740 Broadway, New York 19, N. Y.

COMPARATIVE PERFORMANCE OF THE 6AN4 AT VHF AND UHF

CONDITIONS		VOLTAGE GAIN	NOISE FIGURE
Single tube in Channel 13 booster	VHF	5	9.2 db
Two tubes in cascode in Channel 13 booster	VHF	11.1	8 db
Single tube in open half-wave tuned amplifier at 450 mc.	UHF	12 db	13 db
Single tube in open half-wave tuned amplifier at 900 mc.	UHF	10 db	15 db



Curve shows representative relationships between conversion gain and input VSWR of the 6AN4 when used in mixer service, plotted against oscillator injection voltage.

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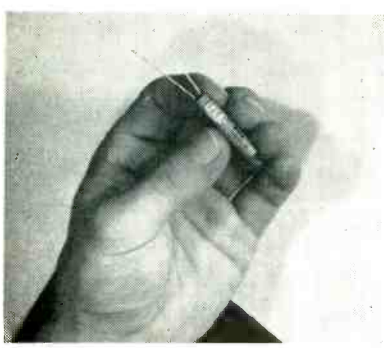
heater cathode insulation is such that up to 250 v may be applied between them and this simplifies the derivation of the heater voltage. This tube is intended to be incorporated for monitoring purposes in a wide variety of electronic equipment to permit the observation of waveforms in various stages of complex circuits.

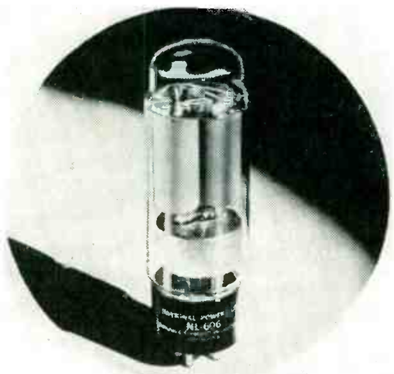
Harmonic Generator

COMPUTING DEVICES OF CANADA LTD., 338 Queen St., Ottawa, Canada. Type C020 harmonic generator is a new instrument designed to produce electronically a sine waveform with a frequency of 400 cps and the 2nd, 3rd, 4th, 5th and 7th harmonics of this frequency. The phase of each harmonic voltage is independently adjustable over a range of 360 deg with respect to the fundamental. This generator is designed as a piece of demonstration equipment to be used in conjunction with a cathode-ray oscilloscope for the production and analysis of complex waveforms.



Pulse Forming Network

PCA ELECTRONICS, INC., 6368 De-Longpre Ave., Hollywood 28, Calif. The PFN 7030 B pulse forming network, presently being used on radar, missile and computer applications, measures only $\frac{7}{16}$ in. in diameter and $1\frac{7}{16}$ in. in length. Its small size plus two convenient $1\frac{1}{4}$-in. No. 22 solid copper-tinned leads make mounting easier, especially when used in miniaturized circuits. It has an impedance of 1,050 ohms and forms a 0.15-μsec pulse when used in a suitable circuit. They are also available with pulse widths from 0.02 to 20 μsec. They will operate satisfactorily in ambient temperatures that vary from −65 to +105 C.



Full-Wave Rectifier Tube

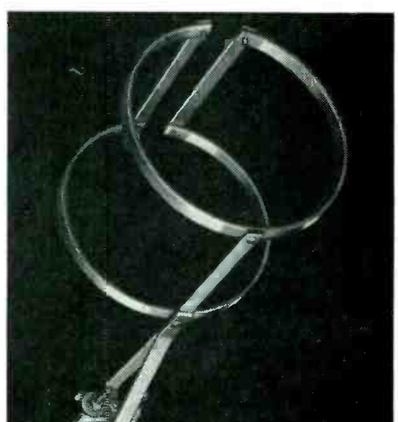
NATIONAL ELECTRONICS, INC., Geneva, Ill., has announced a new high-current full-wave rectifier. This tube, designated as the NL-606, carries 6.4 amperes d-c and 25.6 amperes peak rating. It was designed especially for industrial power rectifier applications requiring higher voltages up to 900 v peak inverse or 250 v d-c. The NL-606 is gas and mercury filled for quick-starting, long-life, and high peak inverse within wide temperature limits. Other ratings are: filament voltage, 25 v; filament current, 17 amperes; and peak inverse voltage, 900 v.

General Purpose Speakers

JAMES B. LANSING SOUND, INC., Los Angeles, Calif., is now producing the D-130-15 in., D-131-12 in. and D-208-8 in. general purpose speakers. Power output for D-130 is 25 w; for D-131, 20 w; and for D-208-12 w. Impedance for the D-208 is 8 ohms; and for the D-130 and D-131, 16 ohms. Voice coil diameter is 2 in. for the D-208 and 4 in. for the D-130 and D-131. A new principle of magnetic structure design has been incorporated in the units. It utilizes a special pure iron high-intensity casting structure, producing a greater usable flux density.

Sensitivity Tester

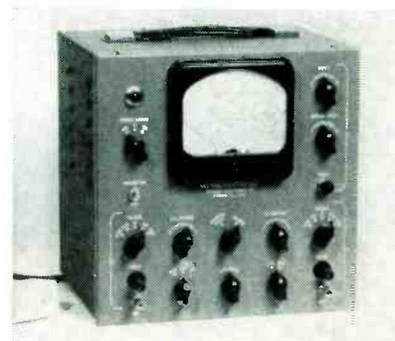
SERVICE INSTRUMENTS CO., 422 South Dearborn St., Chicago 5, Ill. The SensiMeter is a tester that accurately measures the sensitivity of any tv receiver in microvolts. Its scale is divided into very sensitive receiver, medium sensitivity and insensitive receiver, to enable the serviceman to quickly determine the condition of the receiver. Checking receivers from antenna terminals to picture tube, it is an excellent method of determining the cause of bad pictures in fringe areas.



UHF Antenna

RYTEL ELECTRONICS MFG. CO., 9820 Irwin Ave., Inglewood, Calif., has

announced the Double-O uhf antenna. Circular construction means greater directivity along a horizontal plane, a 1-db gain over single dipole, a low pickup response in vertical directions and effective reduction of ghosts, because noise, multipath and other signals which arrive at an angle other than perpendicular to the plane of the circle cancel out at the terminals. With the two circle antennas fed 90 deg out of phase, an additional gain of 3.8 db for each circle of antenna is obtained. This, plus the 1-db gain over the single dipole for each circle, yields an overall gain in the forward direction of 5.8 db. Since the dielectric of the Double-O is air (no fragile or expensive insulators), and since the unit is supported at a current node (ground potential), there can be no mechanical or electrical breakdown.



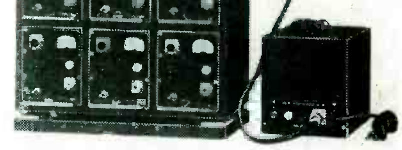
Vectorlyzer

ADVANCE ELECTRONICS CO., P. O. Box 394, Passaic, N. J. Type 202 Vectorlyzer is based on a new fundamental circuit that permits unusual speed and accuracy for measuring vector relations of alternating voltages. It may be used to measure vector sum or difference of two voltages, phase angle between two voltages, imaginary and real components of an unknown voltage in terms of reference voltage. Frequency range is 8 cps to 2 mc through panel binding post, 20 kc to 500 mc through probe. Input impedance at the probe is 2.5 μμf shunted by 100,000 ohms; at the panel binding post, 14 μμf shunted by 1.0 megohm. Voltage range through post is 0.06, 0.6, 6 60, or 600 v full scale; through probe, 0.6, 6 or 60 v full scale. Accuracy of the instrument is ±2 percent

through panel binding post, and ±1 db through probe.

Base Station Antennas

MARK PRODUCTS CO., 3547 Montrose Ave., Chicago 18, Ill., has available a line of omnidirectional vertically polarized high-gain base station antennas for the communications services in the 150 and 450-mc regions. Based upon a new colinear stacking and feed design that permits high gain and excellent bandwidth performance at low cost, the units are available as standard production items for the 148 to 174-mc and 450 to 470-mc bands. Both three element and seven-element arrays are in production providing a 4 db and 7.2 db gain over a half-wavelength dipole. They are designed to withstand 100-mph wind velocity with ½-in. radial ice load.



Amplifier Unit

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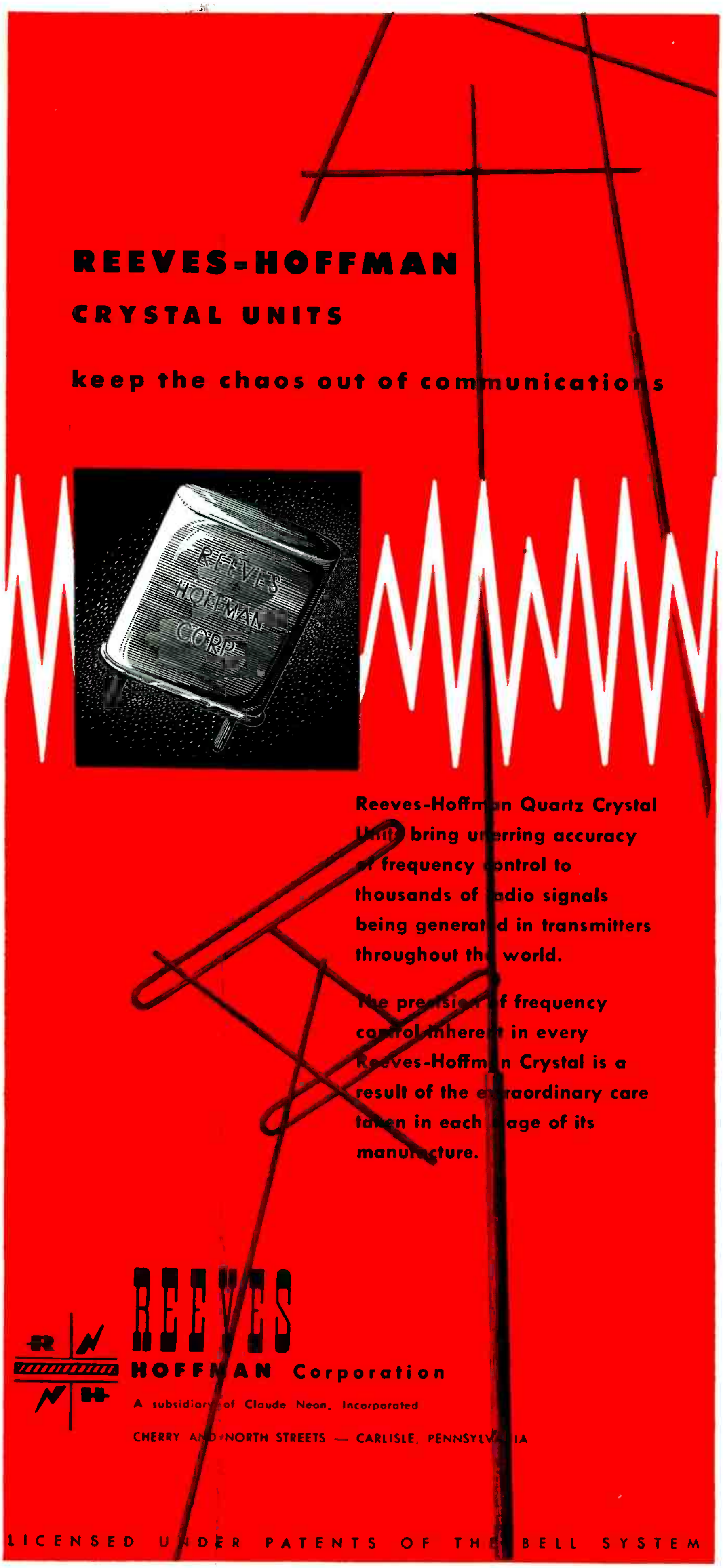
TÉL. : MOLITOR 73-91, 92 et 93 FRANCE



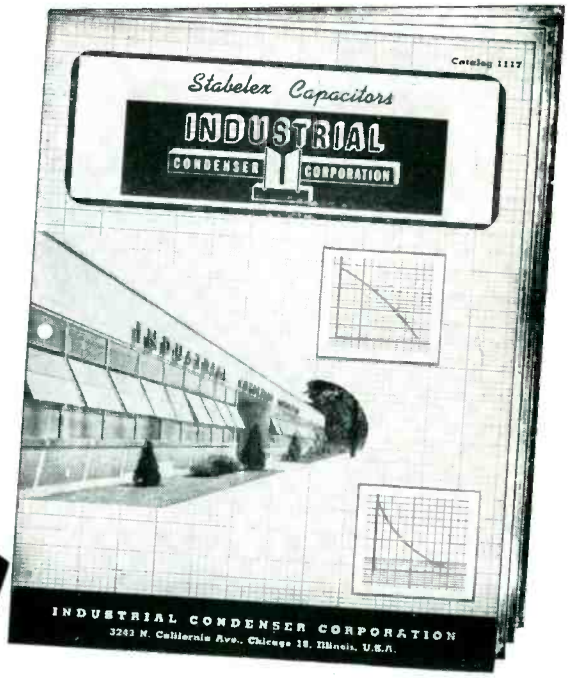
Ohio. Model 201-A six-channel amplifier unit is a portable, (69 lb complete with power supply), self-contained system used primarily for the accurate measurement of such physical phenomena as strain, pressure, acceleration, vibratory displacement and velocity. It consists of six individually excited, three-stage, single-channel amplifiers, with output metering and overload indicating circuits and with linear and integrated amplification employed to provide for the use of a wide variety of pickup devices; a separate electronically regulated power supply providing both a-c and d-c power to all channels; a shock mounted cabinet with power plugs for inserting the single channel amplifier units and the necessary power and test cable assemblies. Recording of the amplifier output is usually accomplished by a recording oscillograph, a tape recording device or similar recording instruments.

Infrared Meter

General Electric Co., Schenectady 5, N. Y., has developed a new infrared meter designed to measure radiant-energy intensities up to 10 watts psi. Designated as type DW-69, the meter is especially suited for determining in a matter of seconds the intensity of high range, radiant energy sources and for studies of infrared radiation effects concerning absorption and transmission properties of materials. The pocket-sized instrument's operation is simplified because no separate thermopile or other accessory equipment is needed. Accuracy is ±5

Sensational Advancements In Science & Industry

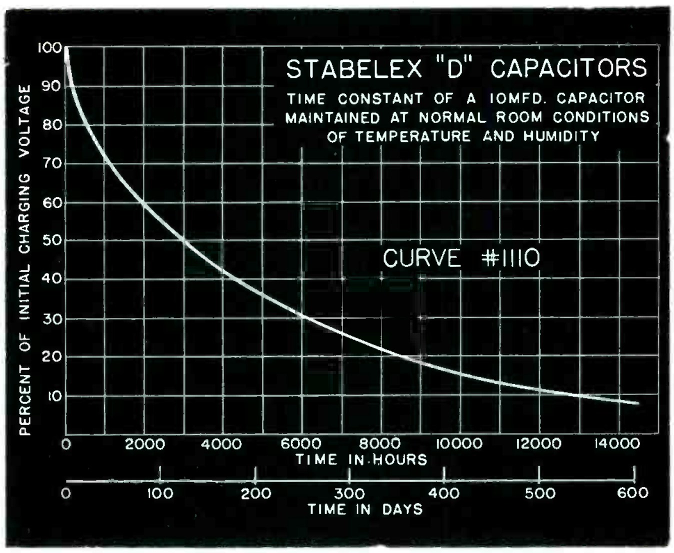
Created the Need for THE NEW *Stabelex* "D" CAPACITORS



YOUR FREE
INDUSTRIAL CONDENSER CORPORATION
Stabelex "D" Capacitor Catalog
may prove to be the most important
new single piece of literature for
you this year!

Curve #1110, shown at right, is of particular interest and illustrates the long self time constant of Stabelex "D". The time constant of the 10 MFD capacitor illustrated on this curve is 200 days, or 4800 hours. This curve represents measurements on capacitors allowed to stand at normal room conditions of temperature and humidity. This, therefore, represents the time constant of these capacitors under normal conditions of operation.

Performance curves illustrating various characteristics of the Stabelex "D" Capacitor will appear in this magazine each month.



OUTSTANDING FEATURES

INSULATION RESISTANCE AT 20° C. AFTER THREE MINUTES CHARGE—900,000 megohm microfarads
INSULATION RESISTANCE AT 75° C.—78,000 megohm microfarads
INSULATION RESISTANCE AT—75° C.—In excess of 5 million megohm microfarads
CHANGE IN CAPACITANCE FROM 25° C. TO —80° C; +0.76%
SELF TIME CONSTANT OF 10 MFD CAPACITOR—4800 hours
Q AT 50 KILOCYCLES—10,000
POWER FACTOR AT 1 KC—0.00025

SEND FOR CATALOG 1117 TODAY

After a long period of research, Industrial Condenser Corporation now offers to industry for the first time the first of their family of Stabelex capacitors, stabelex "D", which has been produced for special applications for some time.

Complete information performance curves, characteristics, and suggested applications of the various types now available will be found in this catalog.

INDUSTRIAL CONDENSER CORPORATION

3244 N. California Avenue
Chicago 18, Illinois, U.S.A.

Please send me my FREE copy of your new Catalog 1117 on Stabelex "D" Capacitors.

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Company .... Position ....
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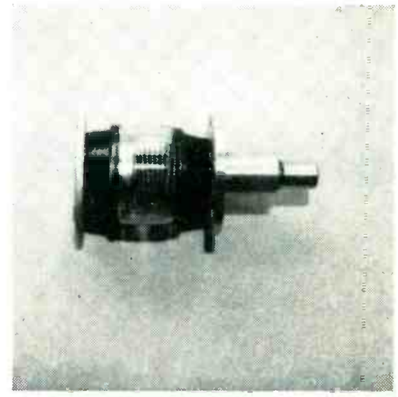
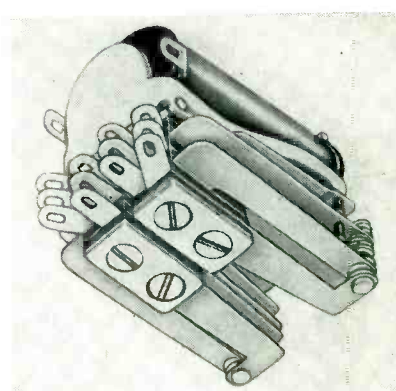
percent of full-scale value over a response range of 300 to 3,500 millimicrons (3,000 to 35,000 angstroms).



Miniature Vacuum Capacitors

JENNINGS RADIO MFG. Co., 970 McLaughlin Ave., San Jose 8, Calif. A full line of miniature vacuum capacitors is now available in both fixed and variable types. These new low-voltage units, rated at 3 kv and 5 kv, are characterized by small physical size, negligible power factor and extremely wide capacitance ranges. For example, one variable unit has a capacitance range of 5.5 $\mu\mu f$ to 1,000 $\mu\mu f$. Another has a range of 4 $\mu\mu f$ to 250 $\mu\mu f$ and is only 4 in. long. The fixed JCSL series and the variable UCSL series are both available in capacitances ranging up to 2,000 $\mu\mu f$.



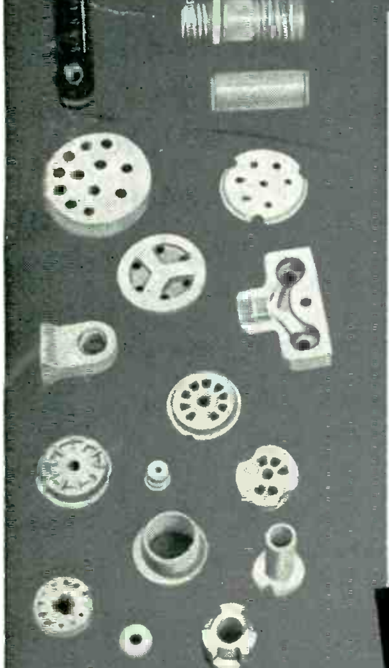
Telephone Type Relays

POTTER & BRUMFIELD, Princeton, Ind. Newly developed MJ series miniature telephone type relays, available open or hermetically sealed, have been announced. The

General Ceramics' *engineered* STEATITE* INSULATORS

Specified with Confidence for—

RADIO
TELEVISION
UHF CIRCUITS
ELECTRONICS
AND ELECTRICAL
MANUFACTURING



Pressed and Extruded Shapes to Close Tolerances

Engineered Steatite by General Ceramics offers the designer and engineer both excellent electrical and mechanical advantages and the economies of standard catalog body types. Offers low loss factor, zero moisture absorption, high surface and volume resistivity, high tensile and great compressive strength. Steatite insulators can be produced to countless sizes and shapes for practically all requirements.

Standard Shapes AVAILABLE:

PILLAR INSULATORS
LEAD-IN BUSHINGS
ENTRANCE BUSHINGS
COAXIAL CABLE INSULATORS
LEAD-IN INSULATORS
SPREADER INSULATORS
STRAIN INSULATORS
COIL FORMS
SUPPORT BARS
COUPLING INSULATORS

"STEATITE-BONDED-TO-METAL" COMBINATIONS
Steatite bonded to metal by the Solder-Seal method produces a permanent hermetic seal. Also recommended for re-inforcing steatite where exceptional mechanical strength is required.

FOR UHF CIRCUITS, SPECIAL G-C STEATITE
General Ceramics Special Steatite developed for UHF service. An engineered insulation with extremely low loss factor. Recommendations made on specific applications without obligation.

CUSTOM DESIGNS TO SPECIFICATION—
Special steatite insulators can be produced in any size or shape by pressing, extruding, casting or machining. Experienced engineers are available for consultation.

BOOTH #1-506
FIRST FLOOR
AT THE I.R.E. SHOW

*FULLY CONFORMS TO THE REQUIREMENTS OF GRADE L-4A IN ACCORDANCE WITH JAN-I-10.

IF YOU HAVE A PROBLEM—
For complete information on General Ceramics Steatite Insulators, request the new illustrated catalog; for engineering assistance on specific problems, contact a General Ceramics Sales Engineer.

GENERAL CERAMICS AND STEATITE CORPORATION — STEATITE INSULATORS

General CERAMICS and STEATITE CORP.
Perth Amboy 4-5100
GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, FERRAMICS, LIGHT DUTY REFRACTORIES, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE AND FERRAMIC MAGNETIC CORES

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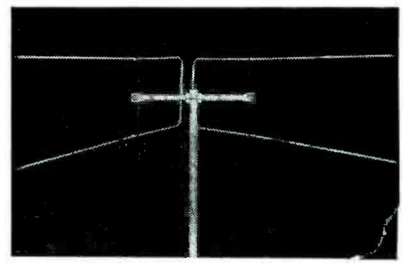
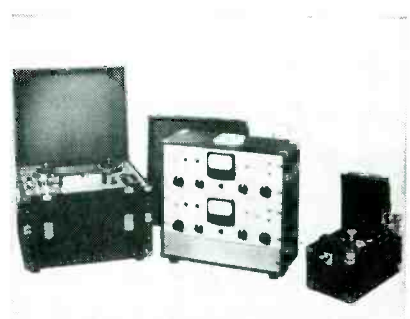
new construction features longer, more flexible contact arms resulting in a lower spring load rate. This combination permits wider contact gap, more overtravel, improvement in sensitivity, faster action and longer life. The MJ series is available with a maximum of 4 Form C contacts for either d-c or 60 cycle a-c operation. Coils are furnished up to a maximum resistance of 22,000 ohms. Insulation resistance is better than 1,000 megohms and breakdown is tested at 500 v rms. The open relay measures 1 in. wide, 1$\frac{17}{32}$ in. long, by 1$\frac{3}{16}$ in. high.



UHF-VHF Antenna

THE BRACH MFG. CORP., Division of General Bronze Corp., 200 Central Ave., Newark, N. J., announces the No. 481 Dual -V antenna designed for both uhf and vhf areas. The construction features perfect balance at the mast point for minimum strain and maximum life. Elements are made of high-strength aluminum with resilient plastic insulators to prevent breakage from wind gusts. The antenna has a gain of approximately 8 db at uhf and a directional pattern at uhf which is like that of a 6-element conical at vhf. On vhf the pattern is nondirectional and the efficiency averages about that of a dipole.



Stereophonic Recorder

AMPEX ELECTRIC CORP., 934 Charter St., Redwood City, Calif., has in-

If longer service life from vacuum tubes

is <u>your</u> problem,

remember . . . from

Peanuts to Power

. . . tubes perform better with *NICKEL*

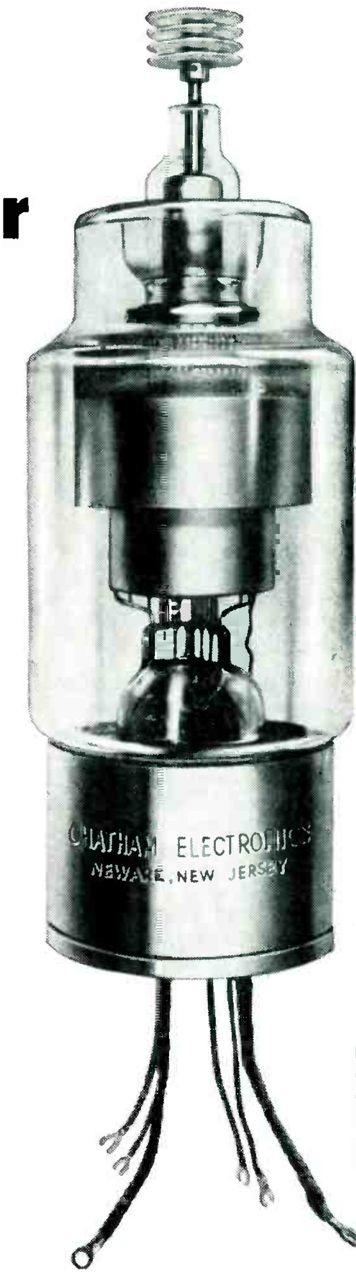
From the tiny peanut tube in hearing aids to the tremendous power producer in transmitting equipment . . . in almost every tube . . . electronics manufacturers turn to Nickel to improve performance.

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.

10 Reasons Why Nickel Improves Tube Life

- 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 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.

The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

INCO

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
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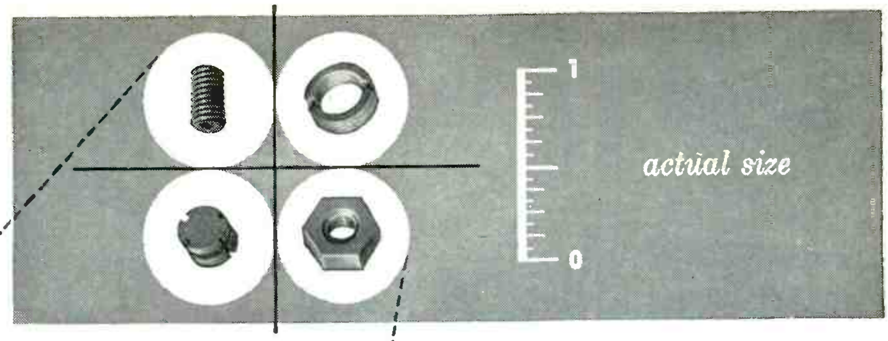
troduced a stereophonic recorder having the same performance characteristics as the model 403 magnetic tape audio recorder. The new model, known as the 403-2, employs a dual track head assembly that records or plays back two separate channels simultaneously. Thus, material recorded by two properly placed microphones may be played back through two similarly spaced loudspeakers to give sound a directional effect. This third dimension of sound provides a realism comparable to the visual realism obtained from stereoscopic photography. The two-speed machine is supplied as a three-case portable or for rack mounting. Performance characteristics include $7\frac{1}{2}$ and 15 in. per second tape speeds; solenoid control of all pushbuttons, permitting full remote control; built-in preamplifiers for microphone and bridging low level lines; frequency response to 15,000 cycles at $7\frac{1}{2}$-in. tape speed and signal-to-noise ratio over 55 db as defined by NARTB standards.

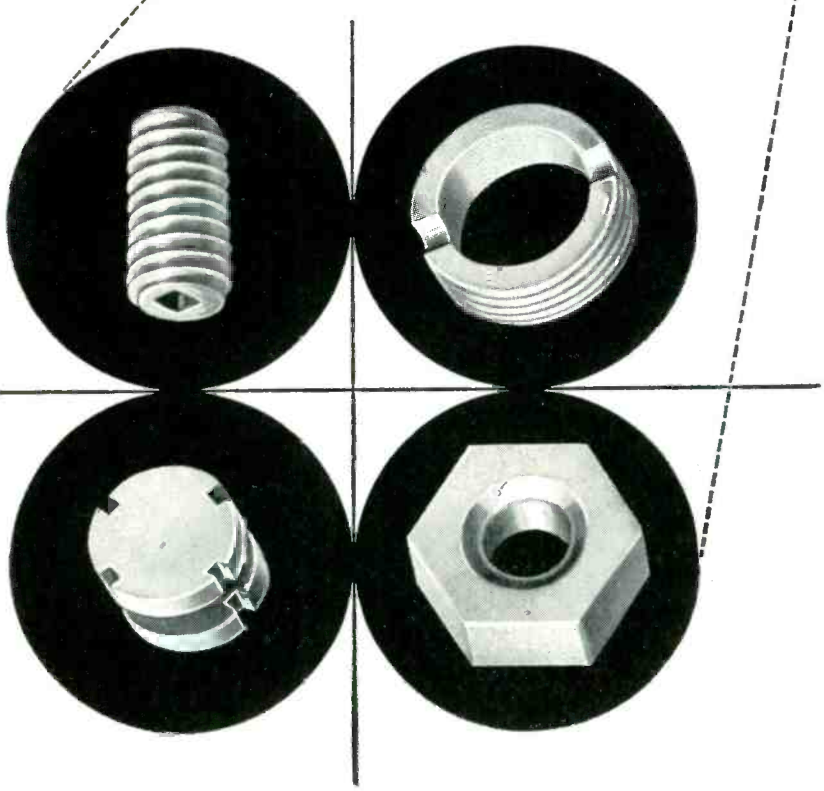
Beam Power Tube

RADIO CORP. OF AMERICA, Harrison, N. J. The 12V6-GT is a beam power tube of the heater-cathode type intended primarily for use in the output amplifier of automobile radio receivers operating from a 12-v storage battery. A single 12V6-GT operated with a plate and screen voltage of 250 v can deliver a maximum-signal power output of 4.5 w with a driving voltage of only about 12 v. These features together with the relatively low plate-current drain make the tube especially suit-



pyroferric

iron cores



PYROFERRIC IRON CORES are scientifically manufactured, under strictest quality controls and rigid maintenance of close electrical and mechanical tolerances.

PYROFERRIC services are available for the engineering of your core production requirements . . . your letterhead request for Catalog 22B will bring you complete information including the manufacture of iron cores, their electrical properties, materials, design considerations, standardization data, uses and other helpful information.

PYROFERRIC

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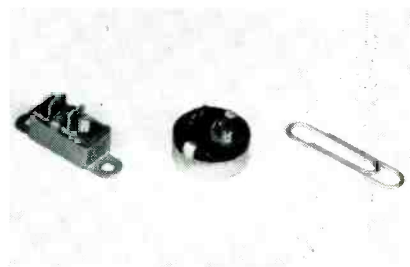
able for use in the output stage of automobile receivers.

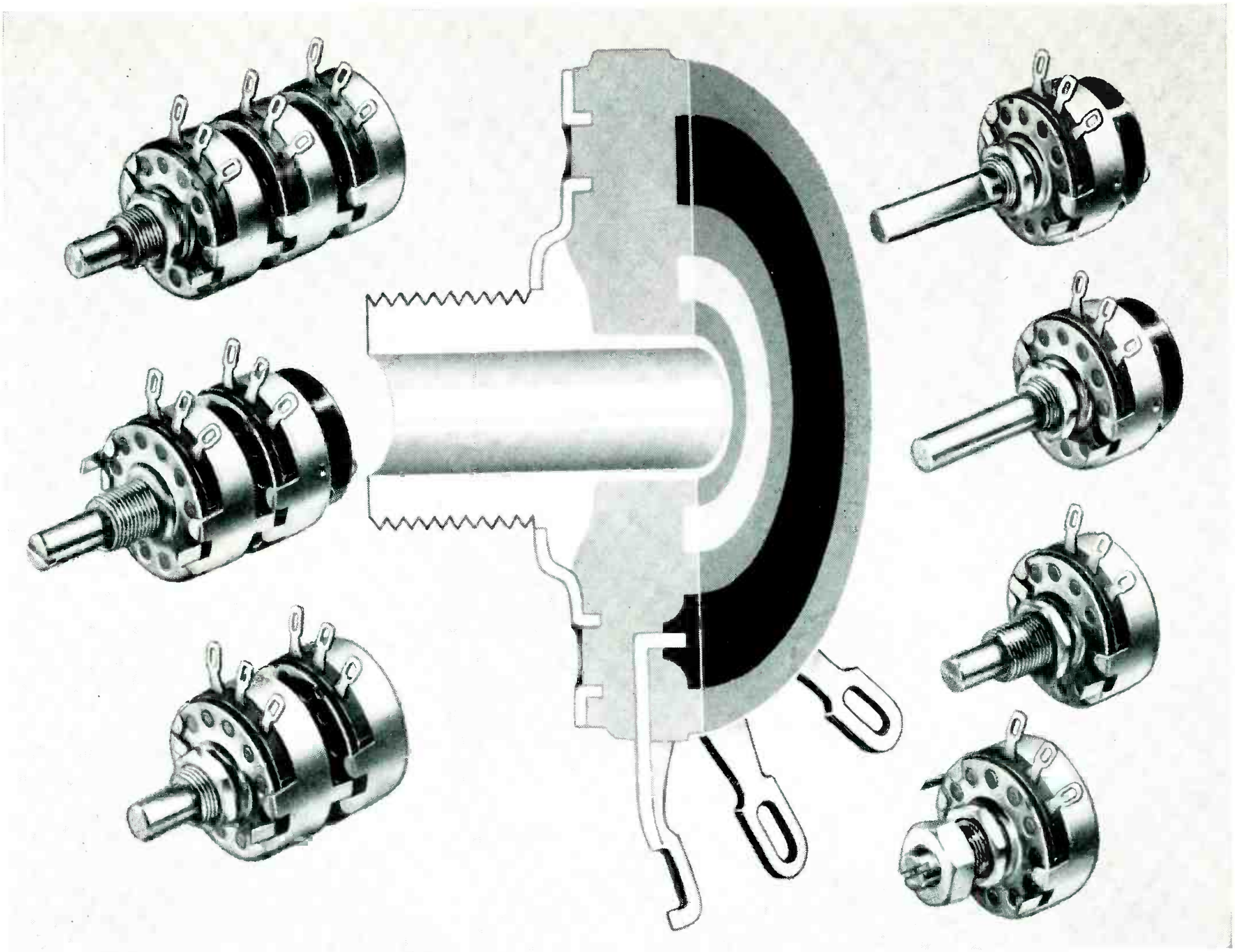
Two-Way Radio Packset

INDUSTRIAL RADIO CORP., 428 N. Parkside Ave., Chicago 44, Ill., has introduced a portable two-way radio packset for industrial, police, fire, utility and conservation department applications. The Pak-Fone, consisting of a powerful 8-tube transmitter and a sensitive 15-tube receiver, is completely self powered. It conforms with FCC licensing regulations and is designed to provide dependable two-way radio-telephone communication between other portable stations, mobile or fixed stations. Optional power supplies permit the unit to be used also as a mobile station with a 6-v automobile battery as the power source or as a fixed station using 115 v a-c for power. The Pak-Fone is designed to operate in either the 25 to 50-mc or the 152 to 174-mc bands.

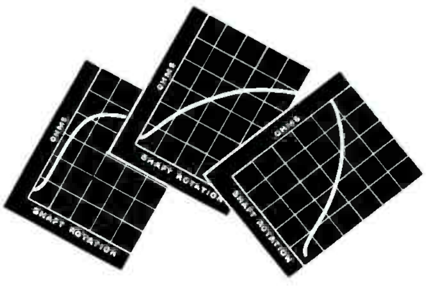


Miniature Thermostat

FENWAL INC., Ashland, Mass. A tiny thermoswitch, available in both rectangular and cylindrical models, has been designed for precise temperature control and overheat detection in instruments and precision mechanisms where minimum volume and weight are important. Depending on the thermal and electrical characteristics of the particular system, temperature control to within 1 deg F is readily attainable, since the inherent thermostat sensitivity is actually less than 1 deg. F. Either model may be set at any temperature in the range from 0 deg to 200 deg F by turning an adjusting screw. A high resistance to vibration permits the miniature units to maintain accurate control under vibration conditions of 5 g's



Quality ADJUSTABLE RESISTORS FOR CRITICAL ELECTRONIC REQUIREMENTS



ANY RESISTANCE-ROTATION CURVE

Prior to molding, the composition of the resistor ring may be varied to produce any resistance-rotation curve. After molding, the resistance is permanently fixed. There are no soldered connections. Shaft, faceplate, and other ferrous parts are stainless steel.

If your electronic circuits require a noiseless, adjustable resistor with long life and permanent characteristics . . . if you need a rheostat or potentiometer which is unaffected by heat, cold, moisture, or hard use . . . the Allen-Bradley Type J Bradleyometer is the logical answer.

It is not a film or paint type resistor. The molded resistor does not become noisy with age. The carbon contact brush actually improves with use. Type J Bradleyometers are available in single, dual, and triple unit assemblies.

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

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at 50 to 500 cps. Both models are rated at 2.5 amperes at 115 v a-c or 2 amperes at 28 v d-c.

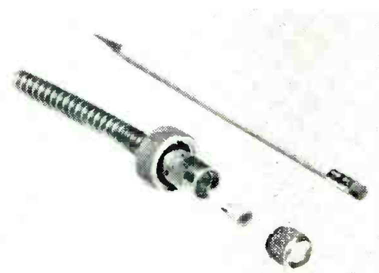
VTVOM

ALLIED RADIO CORP., 833 W. Jackson Blvd., Chicago 7, Ill., announces a new, Knight vtvom kit. Designed for maximum versatility, the unit has 6 ranges for measuring a-c peak-to-peak volts. It also includes 6 ma ranges and 5 capacitance ranges—29 ranges in all. Frequency response is as high as 2.5 mc, adequate for servicing tv circuits as well as audio units. Complete instructions include schematic pictorial diagrams for easy assembly and wiring. The unit reads up to 1,000 v d-c and 2,800 v a-c; to 1,000 megohms and 5,000 μf. Stability is assured by use of one zero setting for all d-c ranges. Special probes are available for extending the d-c range to 30,000 v and for extending the a-c range to read r-f to 200 mc.

Miniature Delay Line

ADVANCE ELECTRONICS CO., P. O. Box 394, Passaic, N. J. Type 507 was developed to meet the increas-

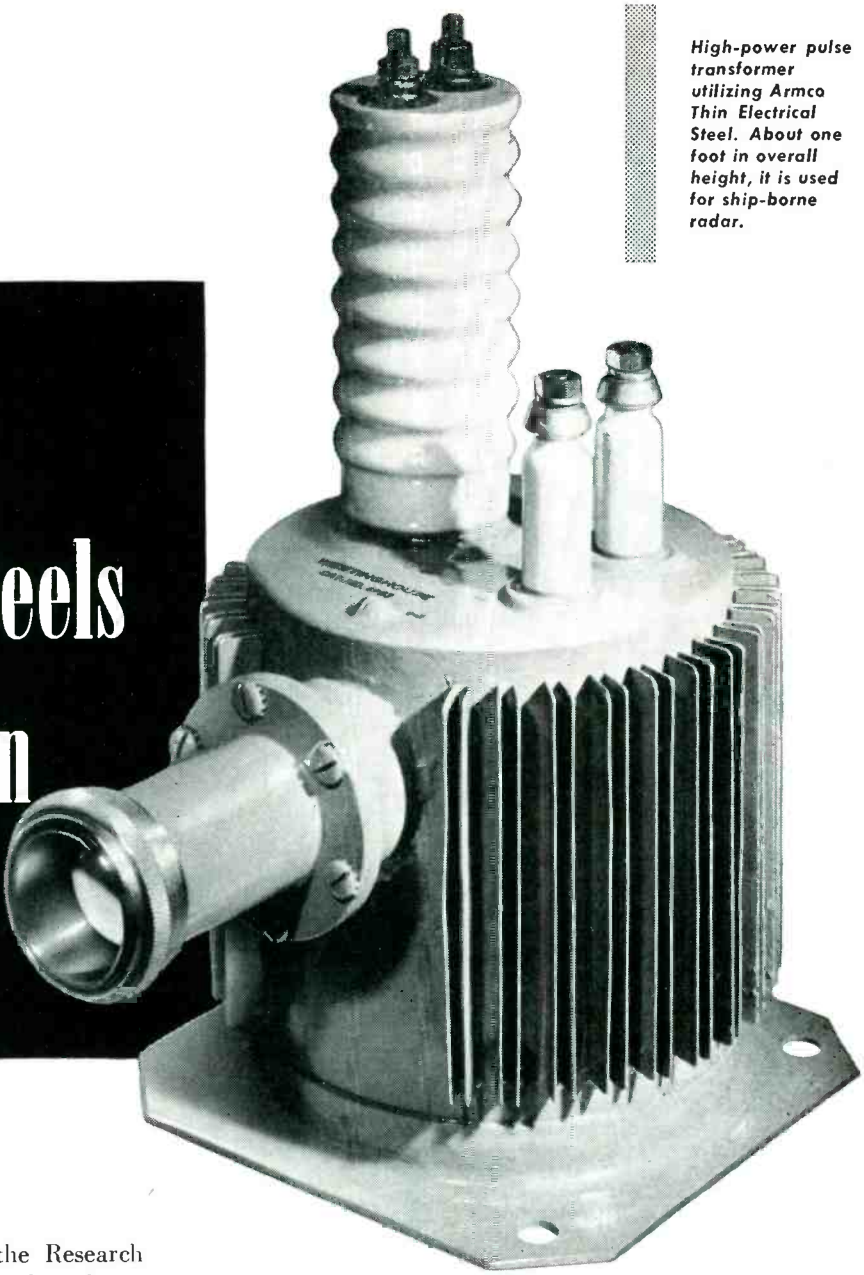
ing need of miniature delay line capable of providing continuously variable time delay from zero to several hundreds of millimicroseconds. By means of a novel mathematical method the amount of equalization was made exactly equal to its correct optimum value. The miniature continuously variable delay line is essentially a condensed r-f cable with one conductor changed into a long thin coil and the other conductor spaced closely to the first, thus producing a large amount of time delay yet maintaining low attenuation at high frequencies. Time delay is continuously variable from 0 to 0.8 μsec. Characteristic impedance is 390 ohms nominal. Attenuation in db per 100 millimicroseconds delay is essentially zero below 3 mc, 0.5 at 8 mc, 1 at 15 mc. Size of the unit is 1 in. deep, 4 in. long and 4 in. high.



Flame Failure Safeguard

COMBUSTION CONTROL CORP., 720 Beacon St., Boston 15, Mass. The Firetron scanner type 48PT1 provides flame failure protection for gas, oil, pulverized coal or combination fuel burner installations. It is used in conjunction with control type 26SJ5 for the protection of manually ignited burners and with programming control type 26RJ8 for the protection of automatically fired installations. The eye of the scanner is the Firetron, a photoconductive cell highly responsive to infrared. With its associated electronic circuits it distinguishes between the infrared of a flame and that of other sources of infrared. The tiny cell, hardly bigger than a pencil eraser, is plugged into the scanner unit that consists of a mounting for the cell and a length of cable for electrical connections. The single scanner views both the pilot and main flames and replaces

Armco Thin Electrical Steels in production NOW



High-power pulse transformer utilizing Armco Thin Electrical Steel. About one foot in overall height, it is used for ship-borne radar.

THEY'RE ON THEIR OWN

Armco Thin Electrical Steels are out of the Research Laboratory. They are now being produced in a brand-new production department of their own. Like other Armco Special-Purpose Steels, they now need Research attention only to plan improvements.

THE NEW SET-UP

The making of these steels is much different from producing ordinary electrical steels. Personnel in the new department work on Thin Electrical Steels alone. They have specialized rolling, annealing, slitting and testing equipment, used exclusively for Thin Electrical Steels.

RELIABLE DELIVERY

You can specify these grades of thin magnetic materials with confidence because they are production items:

TRAN-COR T in 7 and 5 mil thicknesses with good permeability in all directions; TRAN-COR T-O, in 4, 2 and 1 mil thicknesses, an "oriented" grade with best permeability exhibited in the rolling direction; and TRAN-COR T-O-S, in 4 mil thickness only, a super-oriented grade.

THE CATALOG TELLS THE STORY

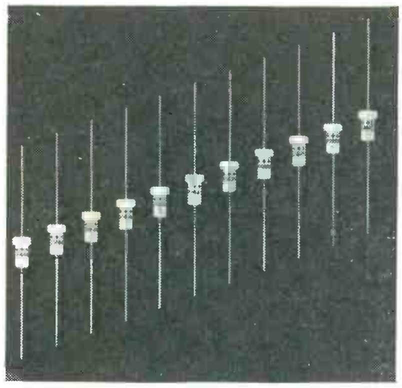
If you are interested in the advantages of reduced core losses and smaller core dimensions at frequencies of 400 to 200,000 cycles, write for the 32-page booklet, "Armco Thin Electrical Steels." It has complete information and graphical data on the 6 Armco Thin Electrical Steels.

ARMCO STEEL CORPORATION

1683 Curtis St., Middletown, Ohio • Export: The Armco International Corporation

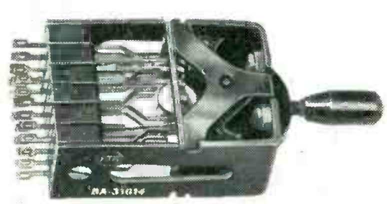
ARMCO

both flame rod and photocell flame detectors.



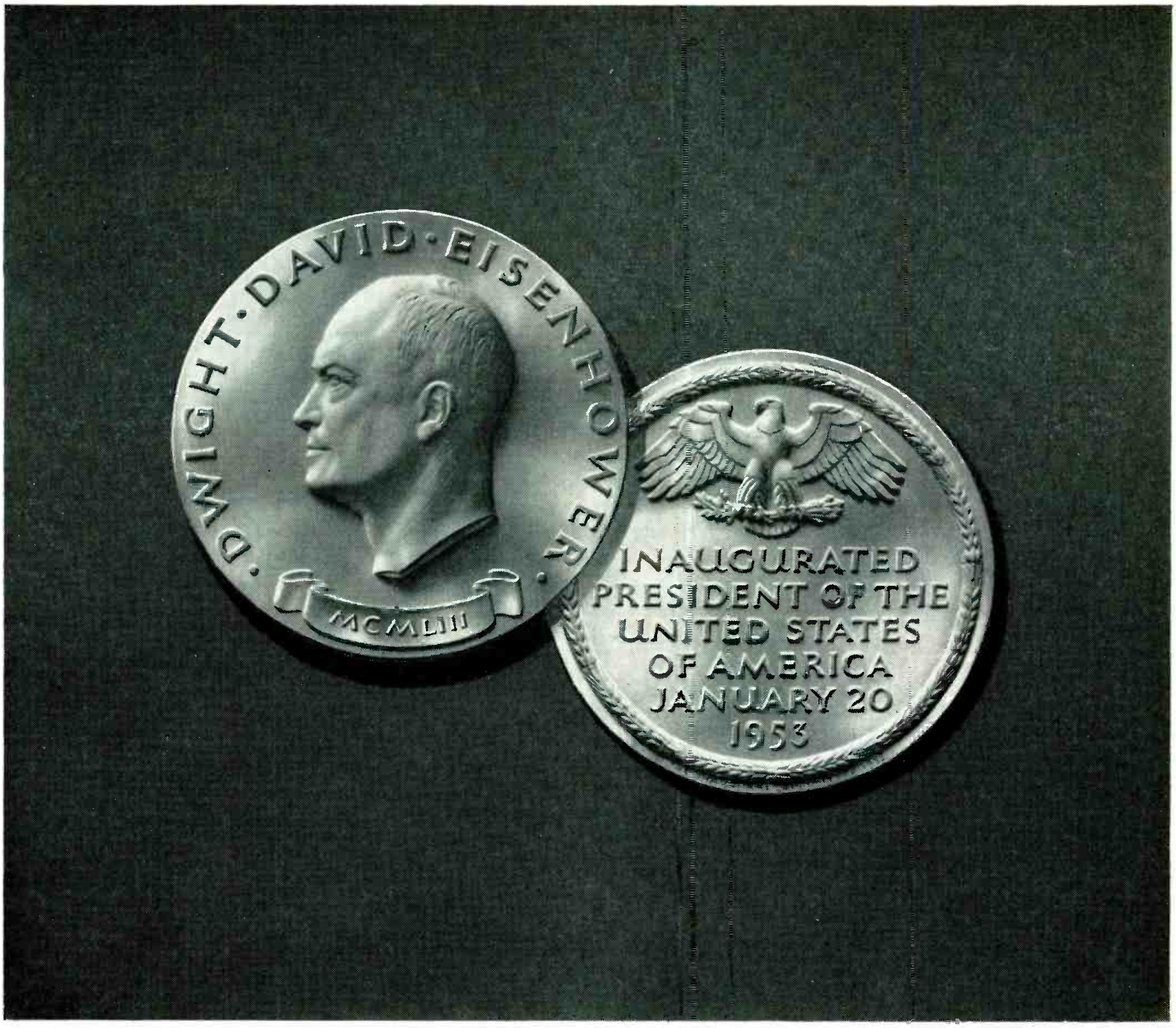
Tantalum Capacitors

FANSTEEL METALLURGICAL CORP., 2200 Sheridan Rd., North Chicago, Ill., has available a line of electrolytic capacitors that employ porous tantalum anodes. They range from 1.5 to 30 μf with working voltages up to 125 v d-c. The normal temperature range at rated working voltage is from −55 to +85 C. Excluding connection leads, the capacitors occupy less than 1/10 of a cubic inch. They are intended for applications where unusually stable characteristics are required and space is at a premium.



Switching Key

FEDERAL TELEPHONE AND RADIO CORP., Clifton, N. J., has announced a new miniature anticapacitance switching key that weighs only 2⅛ oz and combines compactness with increased reliability and long life. Designed to meet military requirements, the new key is ideal for use in airborne and other types of equipment where compactness and light weight are prime factors. The unit consists of four sets of transfer contacts on each side. The key is nonlocking in both directions. It is mounted on an aluminum frame



The Eisenhower Inaugural Medal

is made of Lasting Bronze

WE ARE PROUD to announce that one of our customers is executing the official 1953 Presidential Inaugural Medal. The striking of over 10,000 replicas by the Medallic Art Company of New York City marks the return of this commission to private enterprise after many years of government manufacture. Walker Hancock, well-known American sculptor, prepared the original model from which the medal for General Eisenhower and the replicas were reproduced.

This memorable medal may be obtained for $3.00 from the Inaugural Committee, 1420 Pennsylvania Avenue N. W., Washington 25, D. C.

A special alloy of bronze, carefully prepared to exacting specifications, is being supplied for this medal from our mill here in Bristol.

The **BRISTOL BRASS CORPORATION**

makers of Brass since 1850 in Bristol, Conn.

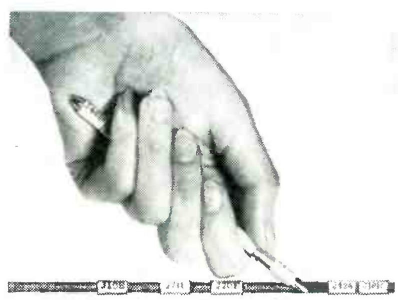
Offices or warehouses in

Boston, Chicago, Cleveland, Dayton, Detroit, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Providence, Rochester

with four screws and can be easily removed from the key frame for inspection and adjustment. Other features include a molded spring nest and a special restoring spring heat-treated for maximum life and endurance.

Insulation

Irvington Varnish and Insulator Co., 6 Argyle Terrace, Irvington 11, N. J. Irv-O-Bestos, a new class B insulation consisting of Mylar polyester film bonded to Quinterra asbestos papers in duplex and triplex combinations, has been announced. This new type of insulation not only has high tensile and tear strength, but exceptional dielectric strength as well. For example, the 0.003-in. duplex construction has a dielectric strength of 1,900 vpm with ¼-in. electrodes, and 1,500 vpm with 2-in. electrodes. Suggested applications for this high dielectric strength material might be as motor and dry-type transformer insulation, magnet wire insulation, coil and relay insulation, sheet insulation, or as primary cable insulation.



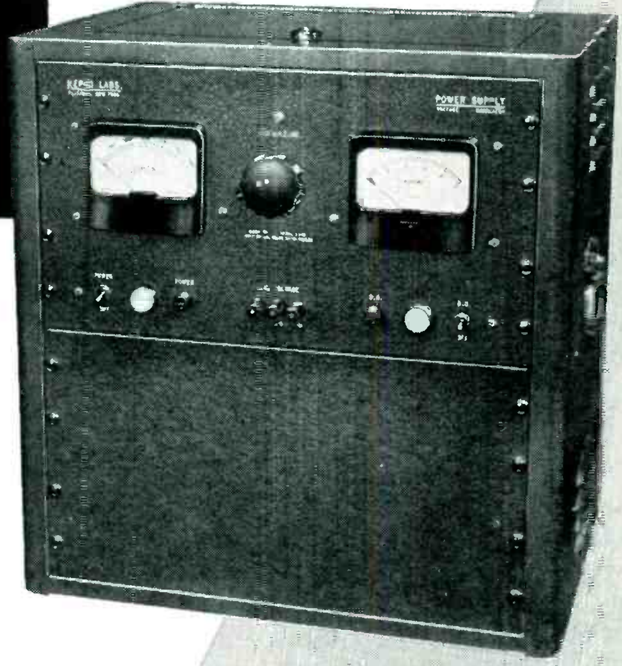
Split-Sleeve Tagging

Duramark, Inc., 2 Secatoag Ave., Port Washington, N. Y., has available a line of split-sleeve laminated tags made of vinylite. Only a light pressure on the tag is required for application to wire, cable or tube. A unique method of packing the tags permits direct, quick loading of a number of tags on an applicator and a fast continuous tagging operation. Because of a protective laminated overlay the tags are impervious to abrasion, corrosion, erasure, water, oil, acids and gases. Application is simple. The marker

VOLTAGE REGULATED POWER SUPPLIES

For Industrial and Research Use

MODEL 1520



THE KEPCO MODEL 1520 FEATURES A REGULATED HIGH VOLTAGE POWER SUPPLY WITH EXCELLENT REGULATION, LOW RIPPLE CONTENT AND LOW OUTPUT IMPEDANCE.

SPECIFICATIONS

OUTPUT VOLTAGE DC: 0-1500 volts continuously variable.

OUTPUT CURRENT DC: 0-200 milliamperes continuous duty.

REGULATION: In the range 30-1500 volts the output voltage variation is less than ½% for both line fluctuation from 105-125 volts and load variation from minimum to maximum current.

RIPPLE VOLTAGE: Less than 20 millivolts.

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

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

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

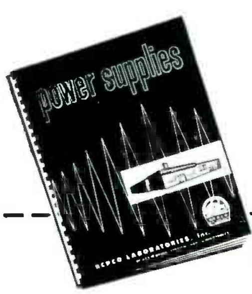
METERS: Voltmeter: 0-1500 volts, 4" rectangular. Milliameter: 0-200 milliamperes, 4" rectangular.

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

CONTROLS: Power on-off switch, HV on-off switch, HV control.

KEPCO

RESEARCH • MANUFACTURING
KEPCO Laboratories

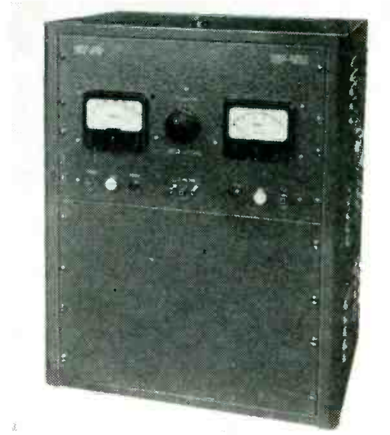


KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, NEW YORK

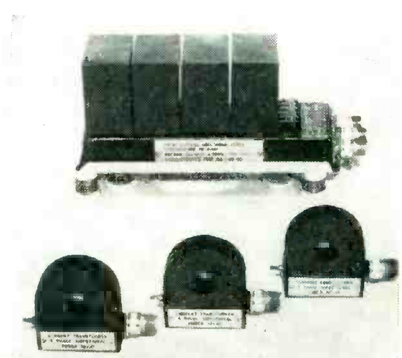
Complete catalogue available upon request . . . write dept. A

VISIT KEPCO BOOTH NOS. 4-406 and 4-408 AT THE I.R.E. SHOW is slipped over an applicator tool and slid into position. Once in position the tag grips tightly and remains permanently. Applicator tools are available for every size tag. A four-page descriptive bulletin is available.



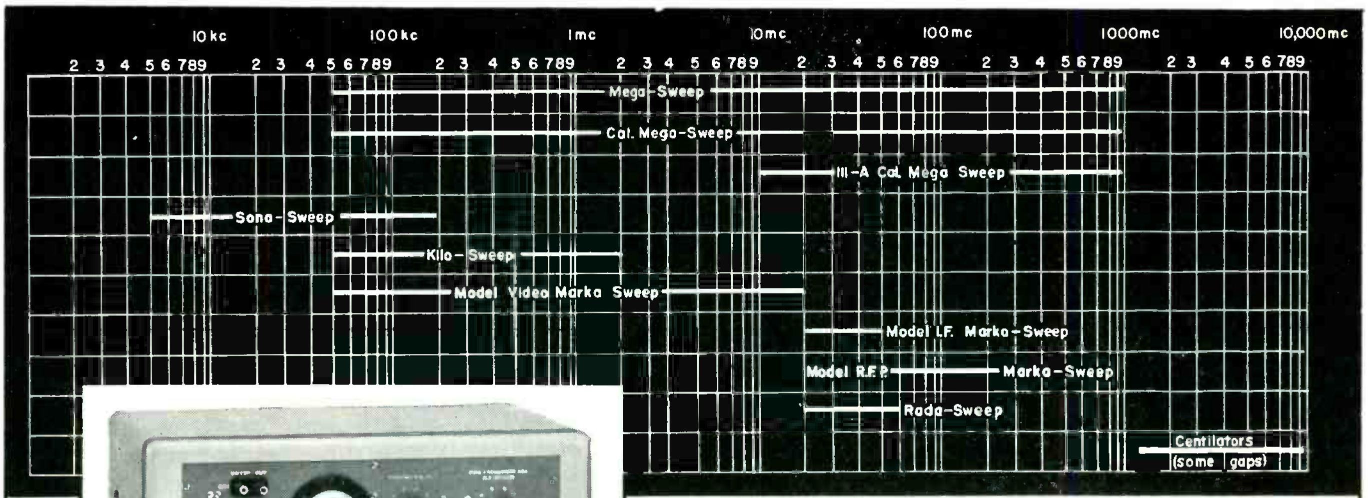
Voltage-Regulated Power Supplies

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y. Model 700 power supply features one regulated d-c voltage supply with excellent regulation, low ripple content and low output impedance. The high voltage supply is continuously variable from 0 to 350 v and delivers from 0 to 750 ma. In the 30 to 350-v range the output voltage variation is less than 0.5 percent for both line fluctuations from 105 to 125 v and load variation from minimum to maximum current. The ripple voltage is less than 10 mv peak to peak. Cabinet height is 22¾ in., width 21¾ in. and depth 15¼ in.



Power Relay

GENERAL AVIATION CORP., 540 E. 80th St., New York 21, N. Y., has



NEED SWEEPING OSCILLATORS

FOR RAPID and ACCURATE VISUAL MEASUREMENTS?

	Frequency Range	Tuning	Maximum Sweep Width	Markers	Output (Open Circuit)	Price* f.o.b. factory
Mega-Sweep	50 kc - 1000 mc	Continuous	30 mc	None	0.1 volt	**$395.00**
Calibrated Mega-Sweep	50 kc - 950 mc	Continuous	30 mc	None	0.1 volt	**425.00**
111-A Calibrated Mega-Sweep	10 mc - 950 mc 450 mc - 900 mc	Continuous	40 mc	None	0.3 volt, 70 ohms 0.6 volt, 300 ohms	**575.00**
Sona-Sweep	5 kc - 200 kc	Continuous	20 kc	Up to six crystal positions	1.0 volt	**525.00**
Kilo-Sweep	50 kc - 2 mc	Continuous	100 kc	Up to six crystal positions	1.0 volt	**525.00**
Model Video Marka-Sweep	50 kc - 20 mc	Three Ranges 50 kc - 5 mc 50 kc - 10 mc 50 kc - 20 mc	Complete Range	Up to six crystal positions	0.6 volt	**495.00**
Model IF Marka-Sweep	20 mc - 50 mc	Four Ranges	500 kc (Narrow) 15 mc (Wide)	Up to nine crystal positions	0.5 volt	**295.00**
Model RF-P Marka-Sweep	All 12 channels, VHF TV Range	Switchable	15 mc	Pix and Sound crystal positions	0.5 volt, 70 ohms 1.0 volt, 300 ohms	**795.00**
Rada-Sweep	30 & 60mc centers; Others, special	Switchable	3 mc (Narrow) 20 mc (Wide)	Up to nine crystal positions	0.5 volt	**395.00**
No. 1214 Centilator	1245 mc - 1460 mc	Continuous	5 mc	None	134 mw	**595.00**
No. 3439 Centilator	3400 mc - 3960 mc	Continuous	40 mc	None	106 mw	**495.00**
No. 4249 Centilator	4240 mc - 4910 mc	Continuous	35 mc	None	115 mw	**450.00**
No. 6274 Centilator	6250 mc - 7425 mc	Continuous	50 mc	None	110 mw	**450.00**
No. 8596 Centilator	8500 mc - 9660 mc	Continuous	60 mc	None	30 mw	**395.00**

In some cases small extra charge for crystal substitutions or additions

SEE OUR NEW INSTRUMENTS

BOOTH 1-401
NY IRE SHOW

REQUEST NEW 1952-1953 CATALOG FOR FULL DETAILS

KAY

KAY ELECTRIC COMPANY

14 Maple Avenue — Phone CAldwell 6-4000 — Pine Brook, New Jersey

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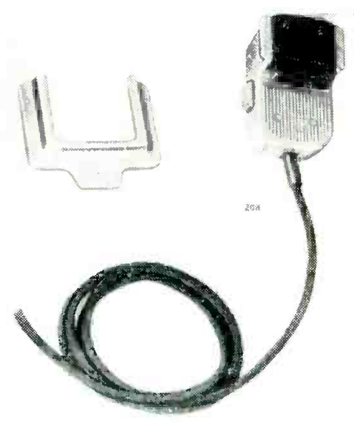
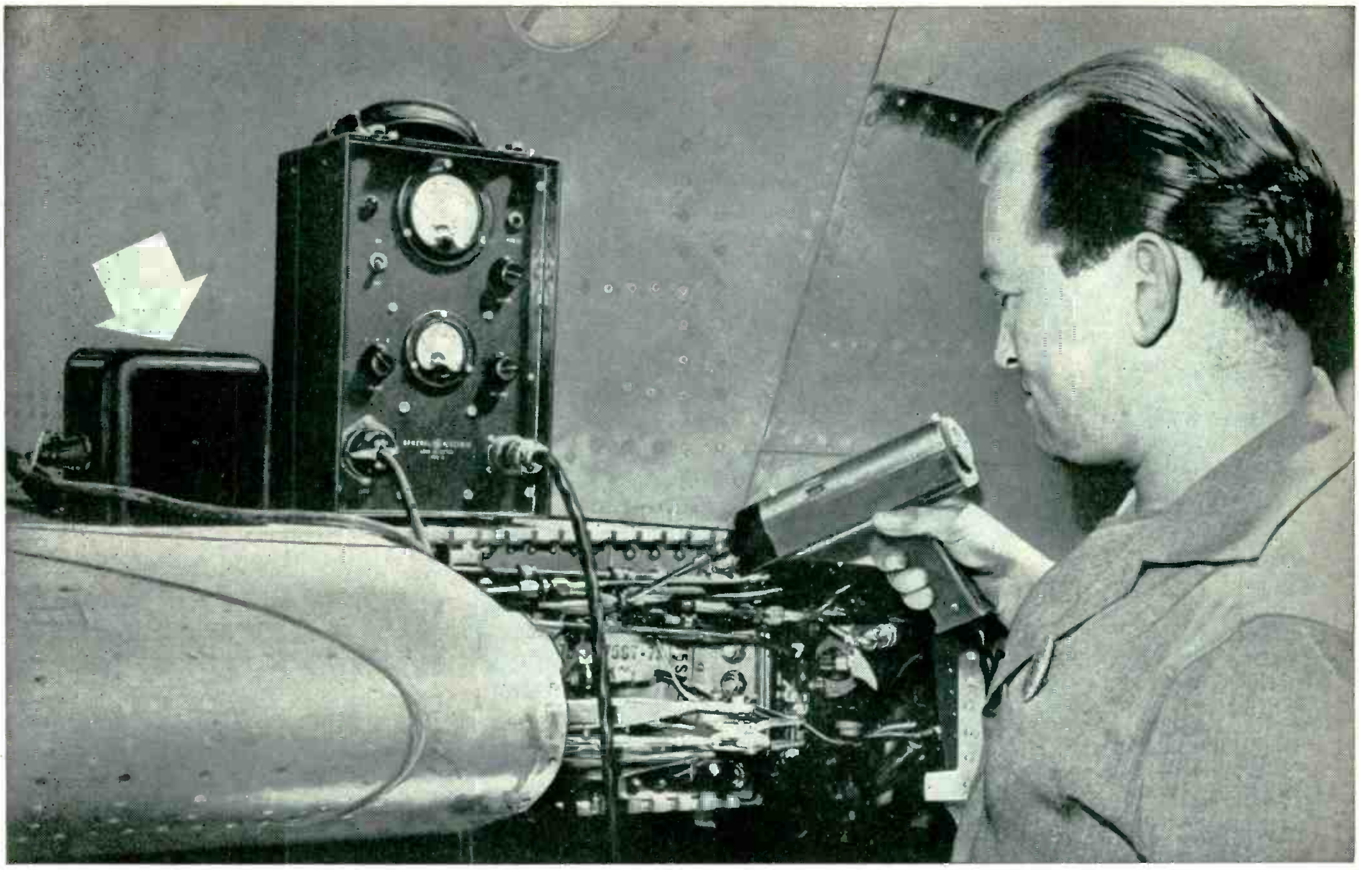
developed an a-c current sensing and cutoff system to protect aircraft alternators hooked up in parallel from reverse current and overvoltage. It can also be used for d-c overvoltage protection. The equipment is a three-phase directional power relay. It provides a more precise trigger point action and is less sensitive that other d-c equipment. The unit weighs 3 lb and is 100-percent hermetically sealed. The set consists of four small boxes. Three of these are individual sensing units, one for each phase of current, in which are contained the trigger tubes and master relays. Current conditions in the main alternator circuits are telegraphed to these sensing units by three doughnut-shaped current transformers that impress on the sensing circuits a voltage proportioned to line current. A reverse power flow of 2,000 w or overvoltage in any phase will cause the master relay of the respective sensing unit to be triggered, which in turn operates a slave relay. The slave relay in turn shuts down the alternator.



Carbon Microphone

ELECTRIC-VOICE, INC., Buchanan, Mich. A new model 208 hand-held differential type noise cancelling, high-output, single-button carbon microphone is now being produced. It is designed for convenient close-talking and maximum intelligibility in mobile communications and similar applications. Articulation is at least 97 percent under quiet conditions, 88 percent under 115 db of ambient noise. Frequency response to sounds of close origin is sub-



PRECISE INSTRUMENT DETECTS LEAKS AS SMALL AS 1/100 OUNCE A YEAR, USES G-E VOLTAGE STABILIZER.

For Precision Performance Use G-E Voltage Stabilizers

Accurate to within ±1% in standard models, G-E Automatic Voltage Stabilizers correct voltage fluctuations between 95 and 130, or 190 and 260 volts, delivering a stable 115 or 230 volts to your product.

AUTOMATIC OPERATION: Compact standard models are now made in sizes 15 to 5000va. Special designs are available for specific applications, and others can be engineered for your purpose. Operation on all G-E Voltage Stabilizers is completely automatic. Whatever your varying voltage problem, G-E experience will provide the answer.

SIMPLE INSTALLATION: G-E Automatic Voltage Stabilizers have only two sets of terminals to connect—one for supply, one for load.

NO MAINTENANCE: Since there are no moving parts or electronic components, there is virtually no need for replacement parts, adjustments, or any other maintenance. General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

MORE HELPFUL INFORMATION

The "why" and "how" of stabilization, including specific details on operating characteristics, uses, and application information, is explained in a new bulletin number GEA-5754. To get your free copy of this practical, helpful manual on voltage stabilization, fill in and mail the coupon below.

General Electric Company
Section A411-108
Schenectady 5, New York

Please send me, without charge, Manual GEA-5754 on Automatic Voltage Stabilization.

For immediate project ________. For reference only ________.

NAME________________________TITLE______________

COMPANY____

ADDRESS______________CITY__________STATE__________

Product or type of product for which stabilizers are to be used, if not confidential:________________________________

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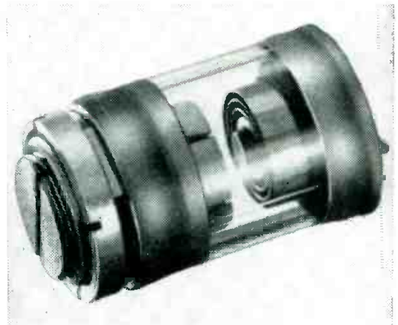
stantially flat from 100 to 4,000 cps. Output is −50 db. Temperature range is from −40 to +185F.



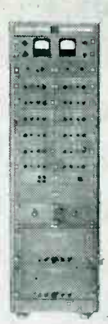
High-Ratio Capacitor

THE JOHANSON MFG. CORP., Boonton, N. J., has developed a new concentric high ratio capacitor with a maximum capacitance of 35 $\mu\mu$f and a minimum of 1 $\mu\mu$f. Because of the ratio of capacitance it has many applications in electronic equipment where capacitive adjustments need to be made over a wide range with great accuracy. It is being used in 10-channel transceivers with very good results. Because of its construction of silver-plated brass and Pyrex glass, it has excellent performance characteristics at the higher frequencies. It is a high Q capacitor at and above 200 mc.

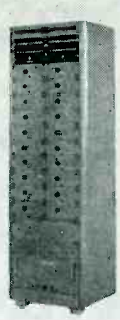
Connector Compound

BURNDY ENGINEERING CO. INC., Norwalk, Conn. For easy on-the-job application of Penetrox A, this oxide-penetrating, corrosion-inhibiting compound for all electrical connections involving aluminum now comes in a sturdy 5-oz tube. Each tube is individually packaged in a strong cardboard carton to prevent crushing or leakage, with full directions printed on both tube and carton. The protruding spout facilitates application of the compound neatly and quickly in all in-

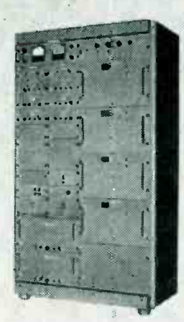
Preview of a New Precision Analog Computer for Solving Problems in Dynamics . . .



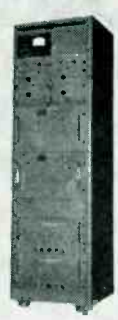
Amplifier Group Type 16-31B 24 contact-stabilized d-c amplifiers.



Multiplier Group Type 16-31A 20 multiplying channels.



Resolver Group Type 16-31D 4 resolving channels, 6 amplifier channels.



Servo Group Type 16-31G 2 resolving channels. 4 multiplying channels.

True, you'll find many analog computer systems on the market. However, we have spent a great deal of time developing a system which we feel does a more effective, more efficient job with the highest degree of accuracy. Here are the reasons:

New 20-channel servo-mechanical multiplier in which several channels may be used as incremental function generators.

New centralized control from operating console for greater flexibility.

New automatic select and set keyboard-operated attenuator system for ease of operation.

New controlled environment to insure maximum accuracy at all times.

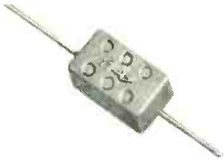
New grounded metal problem board eliminates errors due to leakages between terminals.

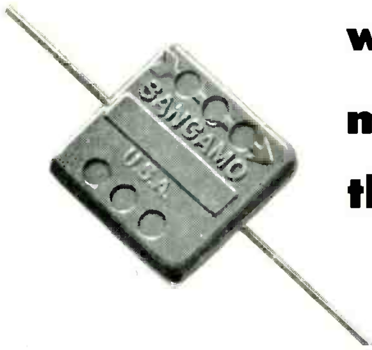
For more information on this system, write for our Components Book. Address inquiries to:

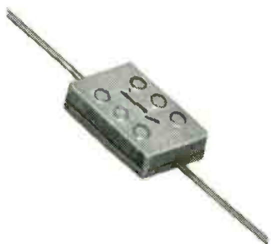
ELECTRONIC ASSOCIATES, INCORPORATED
COMMERCIAL SALES DEPARTMENT
100 LONG BRANCH AVENUE
LONG BRANCH, NEW JERSEY

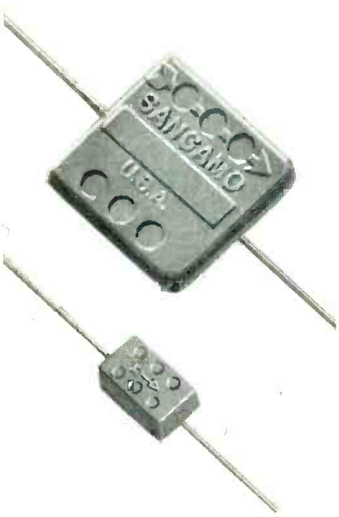
See this new system at Booths 1-114, 1-115—I.R.E. Show, Grand Central Palace

ELECTRONIC ASSOCIATES *Incorporated*





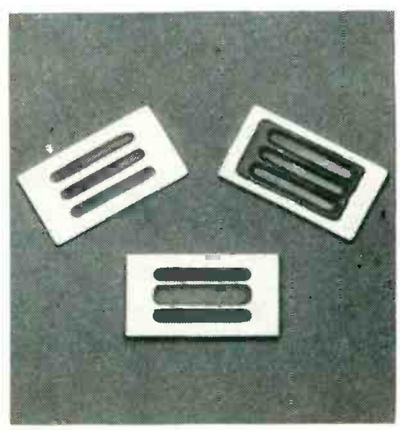




stallations. The compound is also available in pint, quart and gallon cans.

Rapid Scanning System

TIGERMAN ENGINEERING CO., 4332 No. Western Ave., Chicago 18, Ill., has announced a new rapid scanning system known as the Telescan. This Metrotype system of numerical recording and telemetering makes printed records of process data directly from the primary information. Readings are presented in numerical form tabulated for convenient use and on a single page for easy handling and storage. It reads voltage, current, power, temperature, flow or anything else that can be translated to an electrical indication with a suitable transducer. Telescan also sets up an alarm for any abnormal condition.



Wide-Band Microwave Window

MICROWAVE ASSOCIATES INC., 22 Cummington St., Boston 15, Mass. The glass-metal window illustrated

covers a bandwidth of 40 percent in the frequency range of 8,200 to 12,500 mc at a vswr less than 1.25. The vswr frequency characteristic behaves like a single resonant circuit with a minimum value of 1.03 in the neighborhood of 9,800 mc. The doubly loaded Q of the unit is approximately 0.25. The window blank consists of three parallel slots stamped in a thin blank of Kovar 0.600 in. × 1.100 in. o.d. to which is sealed a rectangular blank of low-loss glass. The windows are copper and silver plated and may be soft soldered into a UG-39/U flat flange. It is necessary to mill out the flange to accommodate the window dimension and to break the inside edges of the waveguide at the flange connection to avoid cracking the glass in the seal. The windows may be used in pressurizing applications and will withstand pressures up to 30 lb psi absolute.

Restorer

CHEMICAL ELECTRONICS CORP., Irvington, N. Y., has announced an improved combination solvent, lubricator, restorer and silencer for all electrical and electronic controls and contacts. The new solution has proved to be entirely safe even for critical uhf circuits. It does not affect inductance, capacitance or resistance, and is wholly nonreactive to heat, cold, oil or corrosives. It is a special hydrocarbon colloidal suspension of a highly refined vegetable gum. Its hypercapillary action forces it into the ordinarily inaccessible places where it cleans instantly and forms a durable non-

Of this we are sure: you made us what we are today. You demanded so many of our seamless nickel cathodes that we had to add capacity. We did. We built another plant—this time at Wapakoneta, Ohio—increasing our seamless nickel cathode output by 50%.

Other familiar characteristics of Superior service remain—the desire to help you with your problems, the experience of skilled tube-fabricators, and quality-controlled manufacture.

Take advantage of Superior service and capacity now.

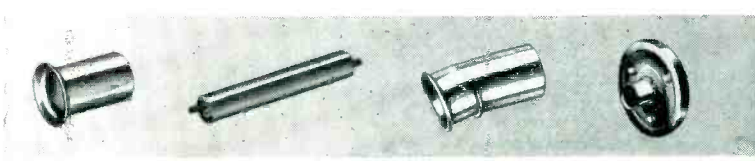
*Main Superior Tube plant at Norristown, Pa.
**NEW Superior Tube plant at Wapakoneta, Ohio

SEAMLESS NICKEL CATHODES

Representative size and shape specifications in current production

Type	Bead	O.D.	Wall Thickness	Length
ROUND	None	.015″	.002″	25.4 mm
ROUND	None	.121″	.0035″	8.0 mm
ROUND	Single	.045″	.002″	27 mm
ROUND	Double	.025″	.002″	28.5 mm
OVAL	Double	.025″x.048″	.003″	12 mm
OVAL	Single	.045″x.149″	.002″	31 mm
OVAL	Single	.025″x.048″	.003″	12 mm
ELLIPTICAL	Double	.025″x.048″	.003″	11 mm
RECTANGLE	Single	.030″x.0975″	.002″	11 mm
RECTANGLE	Double	.040″x.132″	.004″	33.4 mm

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



Superior
THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.

Certain analyses (.035″ Max. wall) up to 1⅝″ O.D.

Seamless Nickel Cathode—Round, flanged one end. .115″ O.D. x .105″ I.D. .180″ long.

Lockseam† Nickel Cathode Plate, .170″ O.D. x .005″ wall. 1″ long.

Weldrawn‡ 305 Stainless Steel Anode Rolled and Bent 10°. .499″ I.D. x .010″ wall x 1.050″ long.

Disc Cathode .121″ O.D. .312″ long.

† Manufactured under U.S. Patents
‡ Trademark Reg. U.S. Pat. Off.

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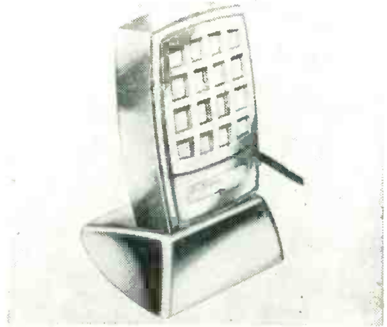
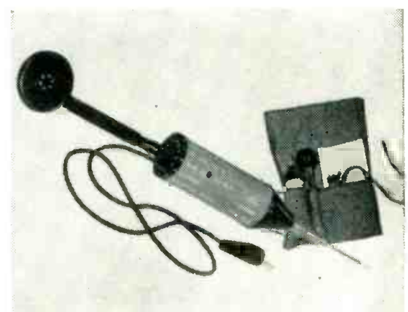
greasy, nonsticky hard-bonded lubricating surface.



Ceramic Microphone

ELECTRO-VOICE, INC., Buchanan, Mich. The model 715 Century microphone has a moisture-proof ceramic generating element and unusually high output (−55 db). Dependable and long-lasting service in extremely hot, humid climates is assured. The microphone is essentially nondirectional, becoming directive at higher frequencies. It is a-c/d-c insulated, features high impedance, has a 5-ft cable, measures 3 in. × $2\frac{3}{16}$ in. × 1 in., and weighs 6 oz.

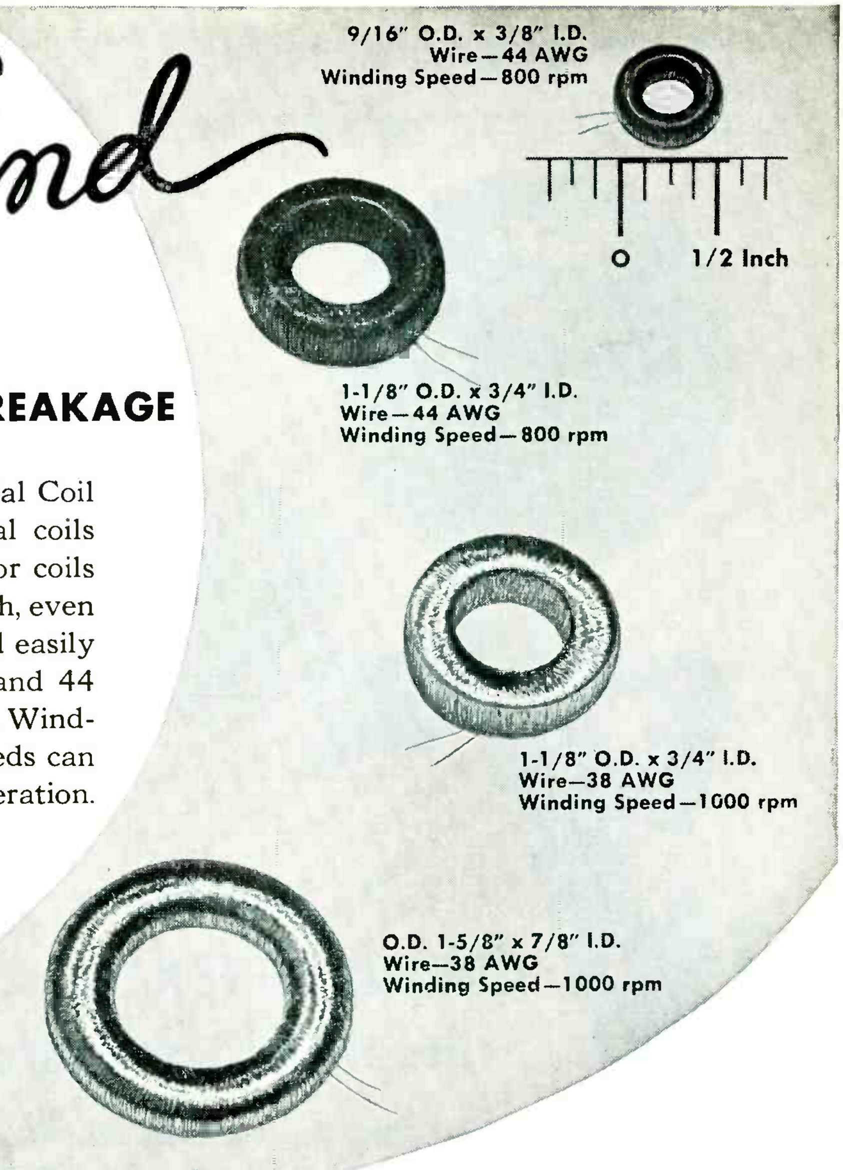


Circuit Analyzer

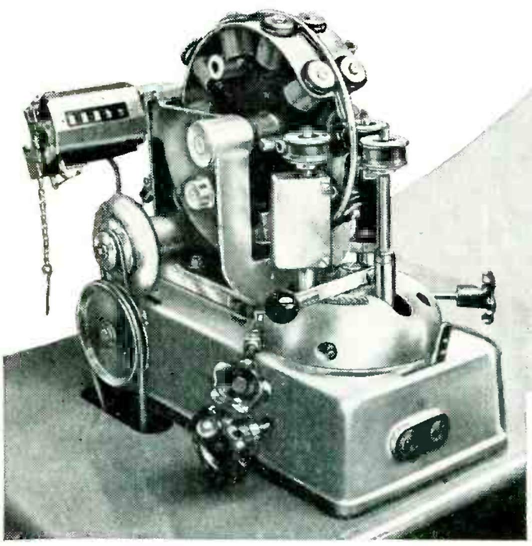
LEE ELECTRONIC LABS, INC., 233 Dudley St., Roxbury 19, Mass. Model E-C dynamic Serviset is a complete portable test lab in itself. It is designed for field or bench servicing of radio, tv, radar and communications equipment. Among its many uses are: r-f and a-f signal tracer, r-f and a-f signal injector, a-c and d-c voltage indicator, d-c polarity indicator, low ohms continuity and short indicator, high ohms continuity and leakage checker. Accessories, besides phone, extension cord, insulated extension tip, tv high-voltage adapter and test lead, include a complete instruction

EVENLY *Wind*

SMALL TOROIDAL COILS AT HIGH SPEEDS WITH MINIMUM WIRE BREAKAGE



The MICAFIL Model RW-0 Toroidal Coil Winder automatically winds toroidal coils continuously around 360° and sector coils from 30° to 270°. To produce smooth, even layers of wire, the winder is adjusted easily to wind any wire size between 26 and 44 AWG and to obtain the proper pitch. Winding direction can be changed and feeds can be adjusted while machine is in operation.



CAPACITY

Coil Sizes
- Minimum finished I.D. . . . . ¼"
- Maximum finished O.D. . . . . 2"
- Minimum finished O.D. . . . . ½"

Wire Sizes . . . . 26 to 44 AWG

Winding Speed—
according to wire size. . up to 1000 rpm

Shuttle Capacity—
according to wire size . . . 60 to 800 feet

MICAFIL Toroidal Coil Winders are made in three larger sizes for winding coils up to 8" O.D. and with 10 AWG Wire.

SPIRALING DEVICE—Device winds spirals for shuttle loads—in advance . . . Newly developed to permit continuous operation of Coil Winder . . . Winds to predetermined lengths.

SHUTTLES—Made in four different ring diameters to accommodate range of spiraled wire sizes . . . Larger wire capacities . . . *More than one coil can be wound with single loading* . . . Changed within 30 seconds . . . Loaded in less than a minute.

ACCURATE TURNS COUNTER—Preset for required number of turns . . . Automatically stops winder when turn count is reached.

WHILE IN NEW YORK

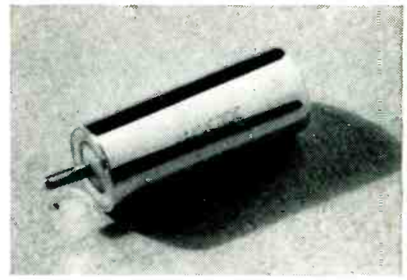
See this RW-O and other Micafil Coil Winders. COSA is in the CHRYSLER BLDG.—4 blocks from the IRE SHOW. Telephone: ORegon 9-3560.

COSA CORPORATION

405 Lexington Ave., New York 17

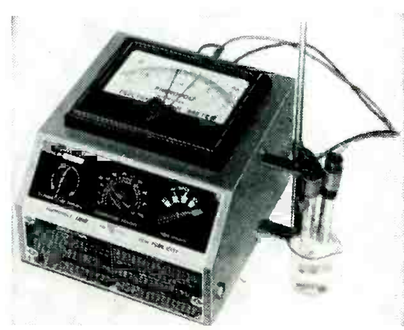
IN DETROIT AREA contact DETROIT-COSA CORPORATION, 16923 James Couzens Highway, Detroit 35, Mich.
IN CANADA contact COSA CORPORATION OF CANADA, LTD. • 40 Front Street, West, Toronto 1, Ontario

manual showing application and latest tv trouble-shooting techniques.



Miniature Thermostat

VALVERDE LABORATORIES, 252 Lafayette St., New York 12, N. Y. The VAL90 is a miniature hermetically sealed thermostat measuring $\frac{3}{8}$ in. in diameter and $1\frac{3}{8}$ in. in length. One terminal is the pin of an eyelet thermetic header; the other, the cylindrical brass capsule. The bimetal is friction couple snap action, and both the temperature and differential are adjustable. The thermostat can be used without the capsule for on-the-job adjustment. It holds its setting permanently. At 85 C setting tolerance can be ± 2 C, differential, less than 3 C.



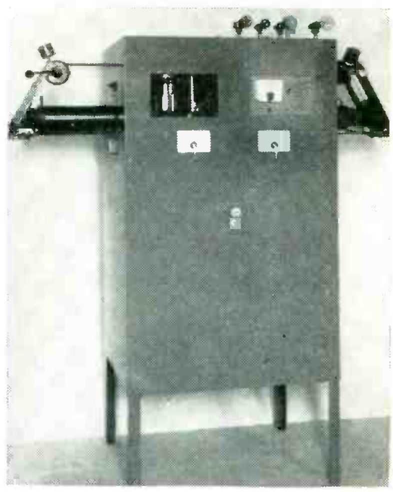
Portable pH Meter

PHOTOVOLT CORP., 95 Madison Ave., New York 16, N. Y. Model 125 portable pH meter is powered by only three ordinary radio batteries that give 2,000 hours of service. Reading accuracy is 0.03 pH. All electronic components are contained in a single plug-in unit that can be exchanged as easily as a tube of a radio set. The readings are taken on a single 0-14 scale without switching of ranges. While primarily intended for battery operation, a stabilized power supply unit can be furnished to operate the pH

meter from the a-c power line without the use of batteries.

H-V Selenium Rectifiers

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Two high-voltage selenium rectifiers, types V-75HF and V-100HF, have been developed for use in tv equipment in which long life and reliability are of prime importance. The units are designed with ferrule terminals for insertion into standard 30-ampere fuse clips. Diameter of the rectifiers is 9/16 in. Type V-75HF is 3 1/4 in. long; and the V-100HF, 4 5/32 in. long. Both are designed to deliver 5 ma into a capacitive load at a d-c output voltage of 1,500 and 2,000 v respectively.



Controlled Atmosphere Furnace

STEWART ENGINEERING CO., Box 145, Soquel, Calif. The model 3 controlled atmosphere furnace was developed for hydrogen firing and brazing operations in the laboratory where its fast heating and fast cooling cycle are advantageous in sav-

ing time. An Inconel tube is used as the furnace muffle and is heated to a high temperature in a short period of time by passing current from a low-voltage high-current transformer directly through the muffle, which serves as the heating element. The heating time, unloaded, from room temperature to 1,000 C is about 5 minutes. A high volume, quiet operating blower is built into the unit, and allows cooling in about the same period of time. Temperature is regulated by a thermocouple and Simplytrol pyrometer. One of its many uses is for deoxidizing and cleaning certain metals such as nickel and Kovar for use in vacuum tubes. Most of the occluded or absorbed gases are replaced by hydrogen, which is easily removed during evacuation. When used with a dry nitrogen atmosphere it is useful for the annealing of glass joined to metal or annealing of complete vacuum tubes before evacuation.

General-Purpose Power Supplies

OPAD-GREEN CO., 71 Warren St., New York 7, N. Y., has available general-purpose power supplies that are designed to furnish an adjustable source of unfiltered d-c from single phase 50 or 60-cycle a-c power lines. A unique feature is their stepless control of the d-c output voltage that permits them to serve as power sources for a wide variety of electrical equipment and electrochemical processes. The secondary of a two-winding step-down transformer, whose primary is fed by a variable autotransformer, supplies power to a full-wave selenium rectifier. The step-down transformer is provided with taps to

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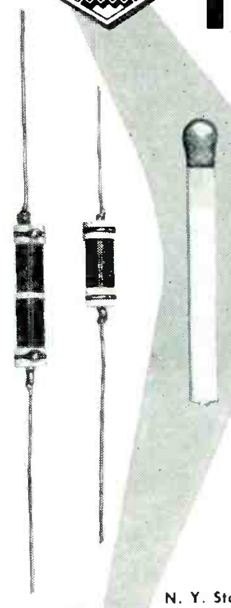
PRECISION-FIXED WIREWOUND

resistors



Forty-two types in all, from 1/4 Watt to 10 Watts. Three wire alloys. Accuracies to .025%. Resistance range from .1 Ohm to 15 megohms. All receive aging treatment for assured stability. A variety of impregnation treatments and installation mountings to meet your requirements. Shown actual size (left) are the new 412 HE and 413 HE types designed for direct replacement of carbon composition resistors where space is at a premium.

Write for Complete Catalog

N. Y. Stock:
Audio & Video Products Corp. • 730 Fifth Ave. PLaza 7-3091

CINEMA ENGINEERING COMPANY
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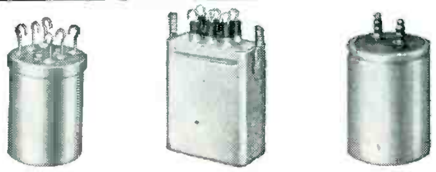
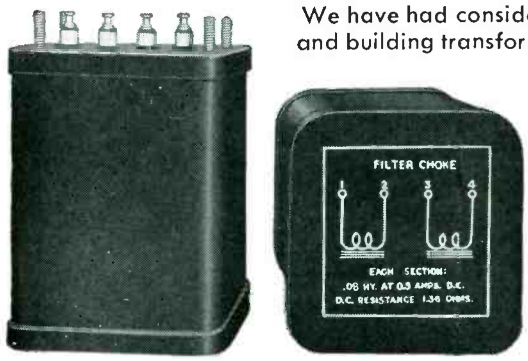


TRANSFORMERS

built to MIL-T-27 specifications



We have had considerable experience in designing and building transformers to MIL-T-27 specifications. Our testing equipment includes facilities to test over a temperature range from minus 50°C to plus 85°C. In addition, Corona test equipment, hot, cold, salt water bath equipment, and vacuum equipment to conduct impregnation tests and assimulate high altitude conditions are available.

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Acme Electric

A. E. C. GENERATOR insulated by BIGGEST MYKROY Moldings ever made

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The Atomic Energy Commission chose MYKROY *above all other materials* as insulator for its generator. The 4-ft. diameter of the rings was only one of many reasons.

CHECK THESE FEATURES

- can be machined or molded to closest tolerances
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- won't warp; keeps its shape
- low-loss factor at sub-zero or 1000° F.
- bonds with most metals

Surely, MYKROY, the perfect glass bonded mica, can solve your insulating problems. Supplied in sheets and rods . . . machined or molded to specifications. We'll be glad to quote on your requirements. Write today for MYKROY Brochure #203. Made exclusively by

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compensate for line voltage variations and rectifier aging. Panel controls include a power switch, a-c line fuse, voltage control knob, two 3-in., 2-percent-accurate D'Arsonval meters and two binding posts for d-c load connections. A 6-ft line cord is furnished for a-c input.

High-Fidelity Amplifier

PRECISION ELECTRONICS, 9101 King Ave., Franklin Park, Ill. Model 100BA is designed as a basic amplifier for the average high-fidelity home system. Features include full-range reproduction with low distortion. Power output is 10 w, 20 w peak. Distortion at 10 w is 1.0 percent harmonic, and 2.0 percent intermodulation. Frequency response at 3 w ± 0.5 db is 20 to 50,000 cps. Frequency response at 10 w, ± 1.0 db is 30 to 20,000 cps.

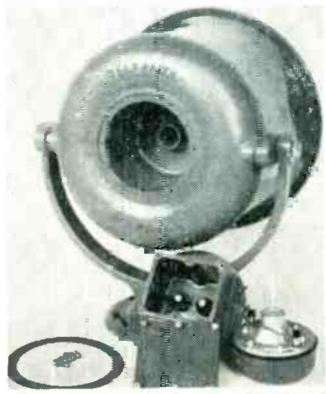
Magnetic Heads

THE BRUSH DEVELOPMENT CO., 3405 Perkins Ave., Cleveland 14, Ohio, announces two new magnetic heads. One is a record-reproduce head, BK-1090; the other, its erase head companion, is a BK-1110. The BK-1090 is intended for dual track recording and distinguishes itself by very high resolution and uniformity. The most outstanding feature

GALBRAITH OUTDOOR SPEAKERS

All bronze housings, complete with mounting brackets 15" horn diameter, double re-entrant type. Frequency response from 400 to over 6000 cycles. Thoroughly weatherproof. Powered with Alnico-V-Plus driver unit, U. S. Coast Guard approved made by specialists in the manufacture of Marine equipment and Controls, Emergency Loudspeaker Systems, Public Address Systems, Music Broadcast Systems and Docking and Navigating Systems.

Weatherproof, E-27, 544
Front and Back View, showing assembly details



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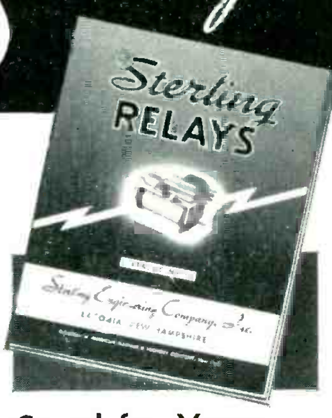

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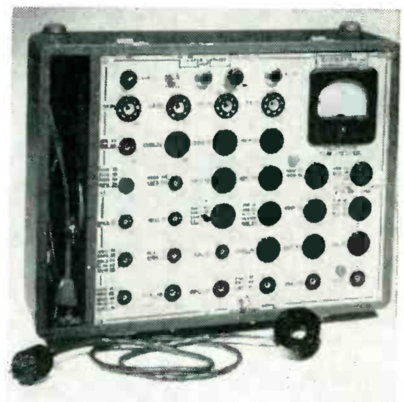
of the BK-1110 is its low power consumption of less than ½ volt-ampere. These units are cast into a block of specially selected synthetic resin which makes them extremely uniform, moisture proof, nonmicrophonic, and allows operation throughout a wide temperature range. The low-loss core structure is made from thin molybdenum permalloy laminations carefully annealed and cemented together permitting the use of high bias and erase frequencies. These components are enclosed in a mu-metal shield to provide optimum shielding from extraneous magnetic fields.



TV Tube Tester

ANKO MFG. CO., INC., 7311 W. Burleigh St., Milwaukee 10, Wisc. Teletest is a new dynamic performance tv tube tester that reduces tube testing time. Application is intended primarily for the tv service trade but it will also lend itself to positive faster tube testing in tube and set manufacturing plants. Further use is predicted among tv broadcast station technicians engaged in daily studio maintenance routine operations. Many of the time consuming switching and selecting operations, together with the usual tube selector charts, have been eliminated. Only one meter with a single scale positively indicates good or bad tube condition. Picture tubes can be tested through a single adapter cord and plug while in the receiver chassis.

Level Control

GREYLOR CO., 605 W. Washington Blvd., Chicago 6, Ill., has developed

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BG BAGS, CW BAGS, CLIP BAGS, TOOL ROLLS, BAGS & CASES for ordnance, radio, electronic and radar equipment.

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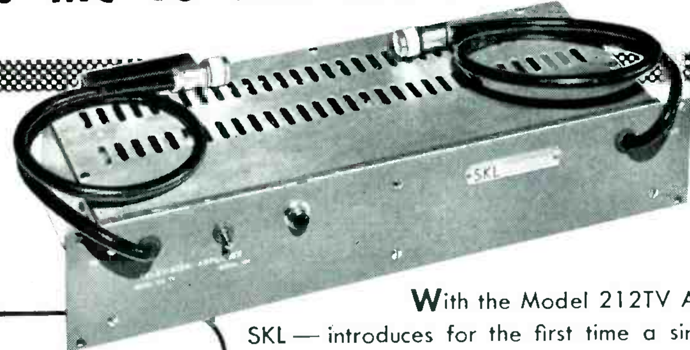
40 MC TO 225 MC TV AMPLIFIERS



With the Model 212TV Amplifier — SKL — introduces for the first time a single broad band chain amplifier type booster capable of amplifying all 13 television channels simultaneously. Because of its stability and reliability — a tube failure means only a slight loss of gain, not amplifier failure — the Model 212TV Amplifier can be safely left unattended for long periods of time. Its low noise level, high output, and low impedance make the Model 212TV Chain Amplifier ideal for television distribution systems in hotels, apartment houses, sales rooms, television stations, cities and towns.

SPECIFICATIONS

- BANDWIDTH
  40 MC — 225 MC
- IMPEDANCE
  180, 52 and 72 ohm unbalanced, 300 ohm balanced
- GAIN .... 21 db
- OUTPUT VOLTAGE
  6 volts peak maximum
- RESPONSE
  ± 2 db over bandwidth
- POWER SUPPLY
  117V, 60 cps, 55 watts

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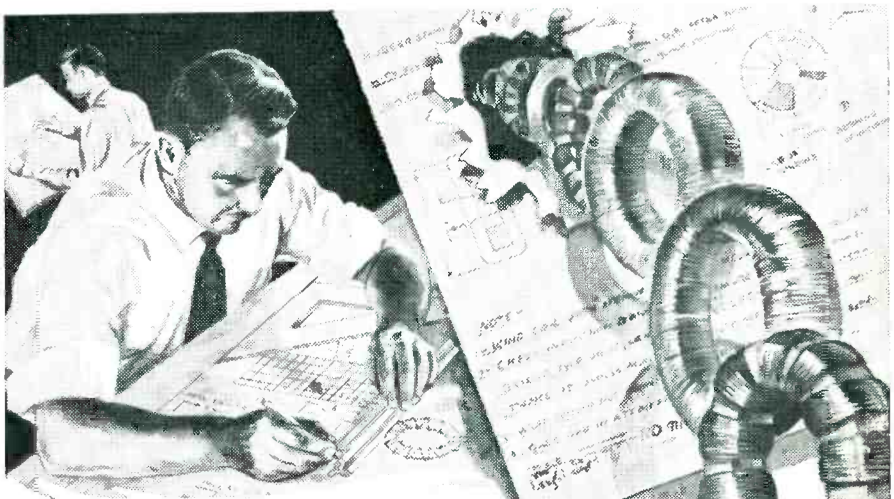

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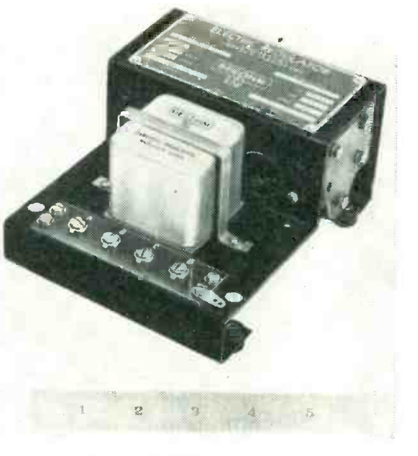
a new electronic level control for nonconductive materials ranging from condensed gases to semisolids. It has proved extremely valuable for precise level control, particularly in the high temperature and high pressure ranges where exacting level controls are desired. The Ktrol is a compact unit with plug-in, sealed housing containing all components. The plug-in unit can be replaced in a matter of seconds. Exchangeable sealed component units are available for insertion in control without disturbing or removing equipment from tank or vat. It is so designed that the electronic circuit will maintain level control from $\pm\frac{1}{16}$ in. and up. Custom-built noncorrosive probes are available for the material to be controlled and the kind and size of tank or container to be used. It is available in an oil-filled housing making it acceptable for explosion-proof installation.



Streamlined Chassis

ELECTRIC REGULATOR CORP., Norwalk, Conn., has designed a new, streamlined steel chassis for mounting the Regohm and associated resistor elements. The Regohm mentioned is an electric circuit controller that has found wide application in the precise control of voltage current, speed and servos. The chassis, built in accordance with military specifications, has overall dimensions of 5 in. × 6 in. × $3\frac{1}{4}$ in., and weighs about 2 lb complete with plug-in Regohm controller. Its sturdy construction, including built-in vibration mounts, permits efficient operation under *from*

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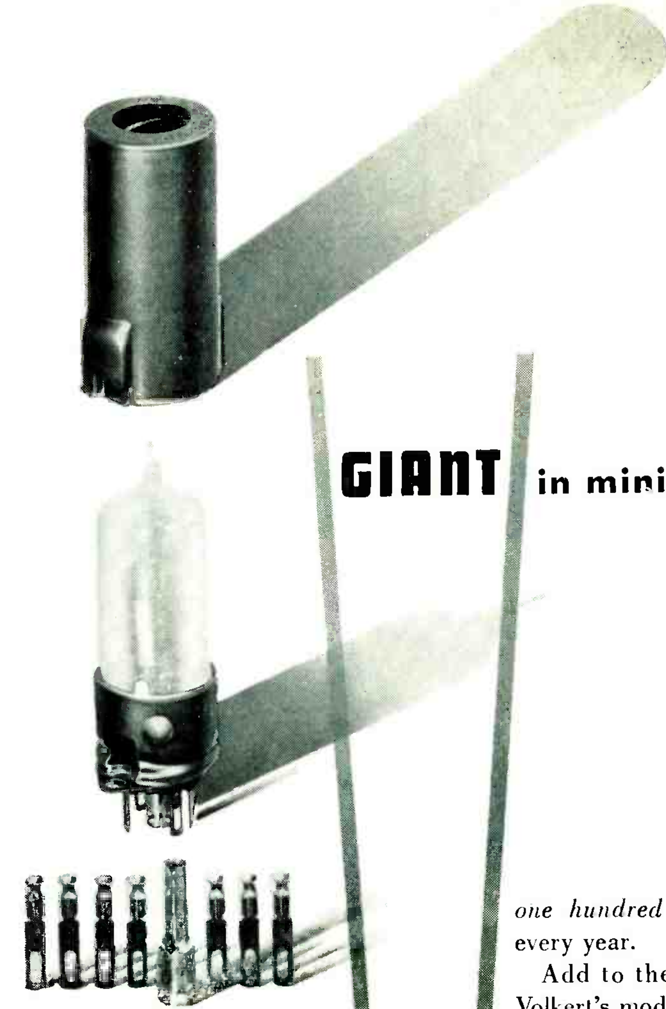

GIANT in miniatures

The inevitable process of "separating the men from the boys" is still going on in the comparatively new electronics industry. Yet Volkert has already established itself as the leading independent supplier of stamped components for miniature tube sockets, and other precision stampings.

Volkert was the *first* to produce shield bases for sockets on a progressive die in a one-press setup. Through Volkert's creative die engineering, a cost-saving method was initiated to stamp the tiny contacts *two at a time.* And now Volkert turns out over *one hundred million* contacts every year.

Add to these achievements Volkert's modern production facilities, its ability to work with all types of specialty metals, and its emphasis on precision *plus* automaticity—and you have the reasons why Volkert is your *best* source for *all* precision stampings at low cost.

Volkert's outstanding facilities for design engineering, tooling, production, assembly and inspection—all combined under a single roof—are described in a 16-page booklet, "3-Way Facilities for Precision Stampings." Write for your copy.

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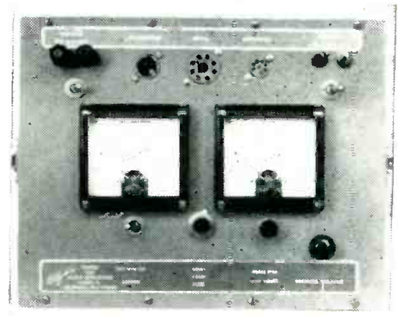


Regulator Tube & Selenium Rectifier Tester

LLOYD'S ENTERPRISES, Box 313, Altadena, Calif., has available a regulator tube and selenium rectifier tester. It measures the voltage regulation under the minimum and maximum currents as shown in the manufacturers' data sheets, and permits the matching or selection into groups of tubes to be used in critical applications. The test for selenium rectifiers permits several tests to be made such as the forward current, back current or creepage if present. The tester could also be used as a variable voltage 50-ma power supply when not being used as a tester. A complete set of instructions is included with the tester.

Electrical Resolvers

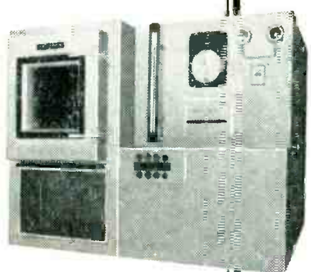
FORD INSTRUMENT CO., Division of the Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y. An electrical resolver system, capable of operating with accuracy over a wide environmental range, has been developed for use in computers and computing systems. The system is composed of a resolver, a high-gain amplifier and a summing network box. The network box suitably combines its inputs for introduction into the high-gain amplifier; the amplifier feeds the resolver, either the basic resolver or the vector solver type; and the outputs of the resolver are the desired functions. The system, designed originally for the armed services, operates accurately at temperatures from −60 to +160 F; moreover, it is standardized thereby allowing interchangeability without upsetting the system of which it is a part. Flexibility is provided through a choice of network boxes and amplifiers; in this way, many different type problems may be solved by minor equipment substitutions. Brochure R1-11-52-4M, now available, gives typical ratings and technical data.

Oscillograph Trace Reader

BENSON-LEHNER CORP., 2340 Sawtelle Blvd., Los Angeles 64, Calif. The Oscar Model C oscillograph trace reader is designed to expedite the analysis of continuous trace records, 35 mm to 12 in. in width, presented either on film or paper. In one operation it applies nonlinear calibrations, scales, zero corrections, logs and squares, as well as interpolating time. It produces instantaneous records in the form of tabulations, plots, or punched cards as required. Accuracy of the amplitude measuring system is in the order of ±0.1 percent of full scale movement. Only one person is required to operate the equipment and produces approximately 20 points of final data per minute temperatures! atmospheres! pressures!

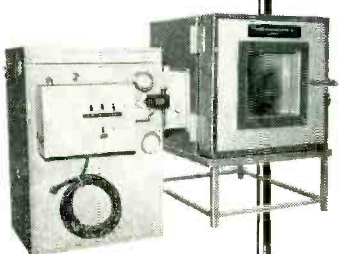
For ACCURACY TEST WITH Tenney

. . . for Tenney Test Chambers are precision-engineered for maximum efficiency and can be designed to simulate the complete range of temperature, atmospheric or pressure conditions found anywhere on earth—or above it to altitudes of 120,000 ft. plus! They attain sub-zero temperatures quickly, maintain them efficiently and provide full instrumentation for accurate evaluation of complete test data.



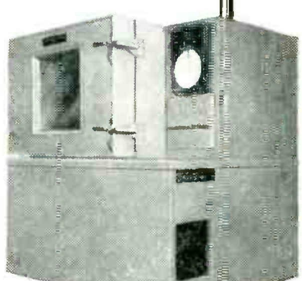
TENNEYZPHERE ALTITUDE CHAMBERS

Designed to withstand atmospheric pressure and to simulate global conditions of pressures, temperatures and humidities. Altitudes from sea level to approx. 80,000 ft. Temperature range from plus 200°F to minus 100°F. Also simulates desired (20% to 95%) relative humidity.



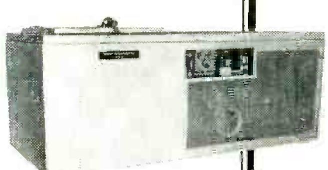
TENNEY SERVO UNIT

Portable air conditioning unit which may easily be attached to various types of laboratory enclosures–impact machines; tension machines; torsion testers; cold boxes and similar equipment. Through its use, articles undergoing testing, aging or weathering can be subjected to wide variations of humidity, heat and cold. Photo shows servo attached to companion chamber.



TENNEY TEMPERATURE AND HUMIDITY CHAMBER

Designed for positive control of temperature, humidity and air circulation. Permits the accurate checking of physical quality, fragility, tension and other factors. Also built to incorporate extreme low temperatures, to −100°F.



TENNEY SUB-ARCTIC INDUSTRIAL CABINETS

Designed for low-temperature testing of metals, radios, instruments, plastics, liquids, chemicals and pharmaceuticals. Temperature ranges of −40°F, −60°F, −95°F and −150°F are standard for each size.

For further information on these and other Tenney test equipment, write to Tenney Engineering, Inc., Dept. A, 26 Avenue B, Newark 5, New Jersey.

Tenney

Engineers and Manufacturers of Automatic Environmental Test Equipment

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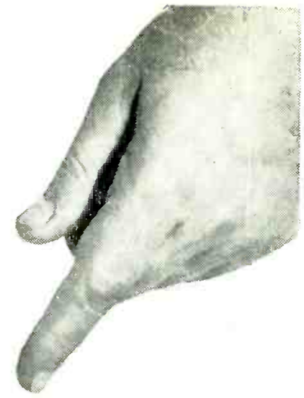

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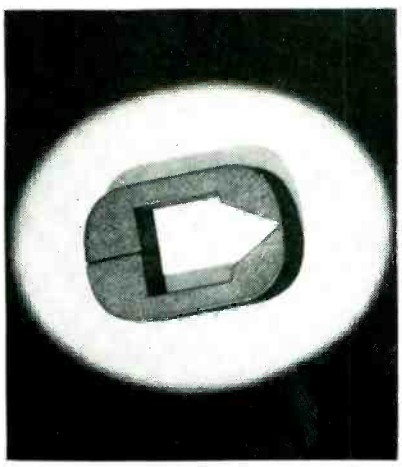
with no additional equipment required.

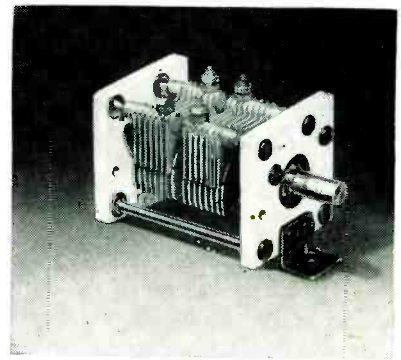
Subminiature Filters

ASTRON CORP., 255 Grant Ave., E. Newark, N. J., is currently effecting reductions of from 40 to 50 percent in the size of r-f interference filters through the use of metallized paper capacitor elements and inductances made with special windings on high permeability core materials. Standard or specially designed r-f interference filters are available in single or multiple-filter sections for suppressing conducted and radiated noise on one or more power lines and for noise attenuation from 14 kc to 1,000 mc. The units conform to all existing government specifications.



Ferrite Recording Heads

FERROXCUBE CORP. OF AMERICA, 35 Marshall St., North Adams, Mass. Increasing use of nonmetallic ferromagnetic cores for recording heads in various types of magnetic recorders has resulted from the introduction of a new material—type 1-90-1—developed especially for this purpose. The new material is very homogeneous and more nearly free from voids and cracks than most commercially available ferrites. Technical information on the new material is available in bulletin FC-5103 upon letterhead request.

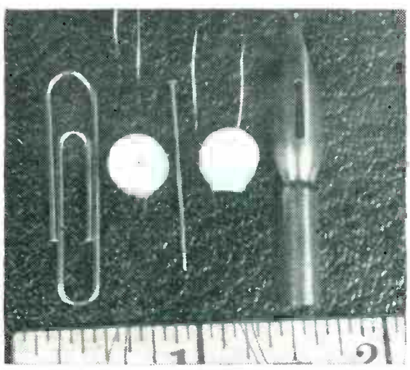


VHF/UHF Capacitor

HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y., has introduced a vhf-uhf variable capacitor specifically designed for use in tuned circuits that operate at frequencies from 50 mc to 500 mc. This 'VU' capacitor incorporates a unique design that places two capacitor sections in series and eliminates the need for contacts to the rotor. The rotor is completely isolated by the use of pyrex-glass ball bearings. As a result of this construction, contact and bearing noise is completely eliminated.

Casting Resins and Potting Compounds

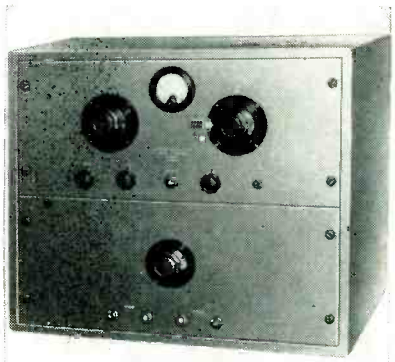
CARL H. BIGGS CO., 11616 W. Pico Blvd., Los Angeles 24, Calif., has announced a new line of casting resins and potting compounds to meet today's needs of military and civilian users. When used for cast-resin embedments of circuits and components, Helix potting compounds provide hermetic sealing protection against moisture, fungus and fumes, and offer rugged protection against shock and vibration with considerable elimination of mounting hardware and consequent reduction of labor time and costs since bare point-to-point wiring may be used. These resins have a shrinkage of less than 1 percent, with excellent adherence to metal leads and other elements. Corrosive effects are nil. Supplied in liquid form, Helix resins are poured cold and will cure at room temperature. They are 100 percent resin solids compounds that give an nonporous casting with a temperature range from −100 F to +400 F with very slight changes in their electrical or physical properties. Moisture absorption is less than 0.01 percent and excellent humidity chamber tests have been recorded.



Subminiature Pulse Transformers

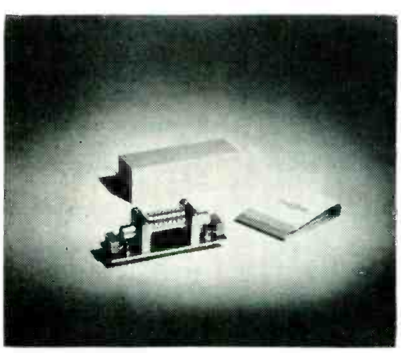
THE JACOBS INSTRUMENT CO., 4718 Bethesda Ave., Bethesda 14, Md., has developed a new line of potted pulse transformers. They are cylindrical in shape, the cylinder being $\frac{5}{16}$ in. in diameter and $\frac{1}{8}$ in. high. They weigh 1/100 oz each when potted in a thermoplastic capsule. A novel mounting means, comprising a pin passing axially through the transformer, is provided. This pin may be used to fasten the transformer to a mounting panel. A standard transformer with a 1 to 1 turns ratio is offered, and in addition transformers with special windings can be supplied on special order. These subminiature transformers should be very valuable in

accelerating the trend toward smaller size and increased reliability in modern electronic equipment.



Master Oscillators

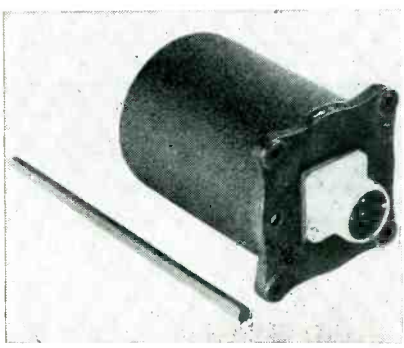
WUNDERLICH RADIO Co., 2 Fifth Ave., New York 11, N. Y., has announced a series of high stability master oscillators for use in the laboratory or as a frequency source for radio transmitters and receivers. There are three models covering the following ranges: 200 to 600 kc, 500 to 1,640 kc and 1 to 16 mc. A stability of 5 parts per million is attainable and a resettability of the same order is featured, thus making it unnecessary to reference the frequency against a master standard. Power output of 2 to 5 w across a 75-ohm load is provided, which permits full excitation of most radio transmitters. The oscillators are mounted on standard width relay rack panels and are supplied with a cabinet for table top mounting. Primary power source is 115 v, 50 to 60 cycles.



Mechanical Filter

COLLINS RADIO Co., Cedar Rapids, Iowa. The mechanical filter illustrated is a magnetostrictively

driven unit for intermediate frequency application and is composed of three sections: the input transducer, the resonant section and the output transducer. Input and output sections are identical and function to convert the electrical signal to a mechanical form and vice versa. In the resonant section, disks composed of special alloy metal have a very sharp resonance and excellent frequency stability. By means of magnetostrictive action, mechanical vibrations are converted into a varying magnetic field. A coil intercepts this field and supplies the output voltage. The entire unit is housed in a hermetically sealed case smaller in size than a normal intermediate transformer. The unusual selectivity of this filter and its miniature size make it readily applicable to both military and commercial transmitter and receiver designs.



Oil-Filled Accelerometer Unit

G. M. GIANNINI & Co., INC., Pasadena 1, Calif., announces the 24133 accelerometer designed to fit in an oil-filled case. It utilizes a potentiometer resistance with a large output, requiring no amplifying unit in most cases. Instrument ranges may be obtained up to 30G while standard resistance ranges are 2,000 or 5,000 ohms. The potentiometer element safely carries current up to 15 ma. The unit has good resolution with 0.25 percent minimum offered on the standard instrument. The 24133 is a 1.0-percent instrument in performance. It is designed to operate in temperatures between −54 C and +71 C. Damping is 0.5 ± 0.075 of critical for a 7.5 G instrument as a typical case. It is designed for applications

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MINIATURE Insulated Standoff

Terminals

Molded Melamine Insulation
in accordance with latest revisions of
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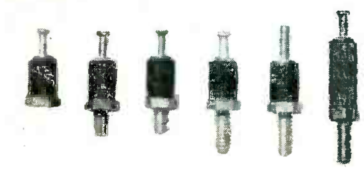

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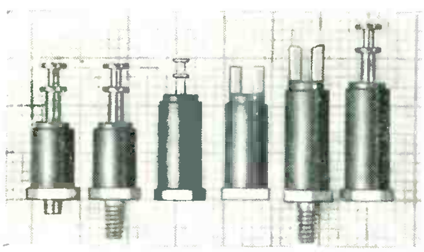

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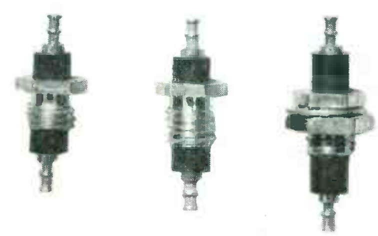

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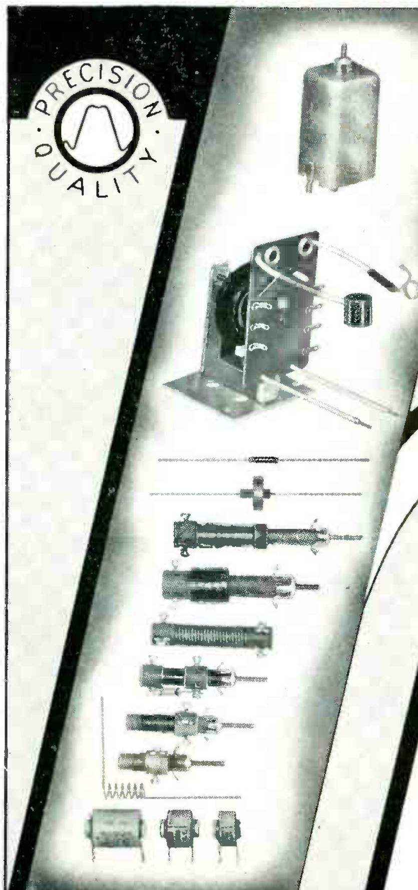

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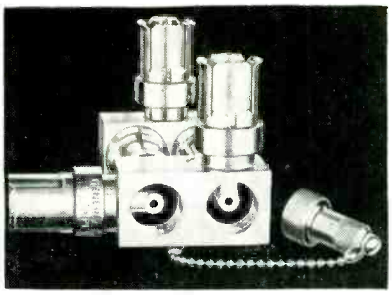

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General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Accurate measurements of balanced impedances in the frequency range from 50 to 1,000 mc can be made with the help of the type 874-UB balun. The balun, a tunable semiartificial half-wave line, acts as a transformer and makes it possible to connect a balance impedance to an unbalanced coaxial system such as is used on high-frequency measuring instruments. The balun has two important advantages over a conventional transformer—it can be tuned over a wide frequency range and has very low losses. The unbalanced end of the balun is a type 874 coax connector, and thus it can be used directly with any of the company's measuring equipment. New adaptors are available to connect to any of the other commonly used connector systems.

Literature

Electronic Level Control. Fielden Instrument Division, Robertshaw-Fulton Controls Co., 2920 North 4th St., Philadelphia 33, Pa. Brochure No. F-101 deals with the Tektor level control. This 8-page, 2-color publication describes the product, outlines applications, stresses its outstanding features (such as no moving parts or diaphragms to get out of order), and lists the various types of electrodes available. Ordering information is included.

Power Tetrode. Lewis and Kaufman, Ltd., 50 El Rancho Ave., Los Gatos, Calif. A new technical data

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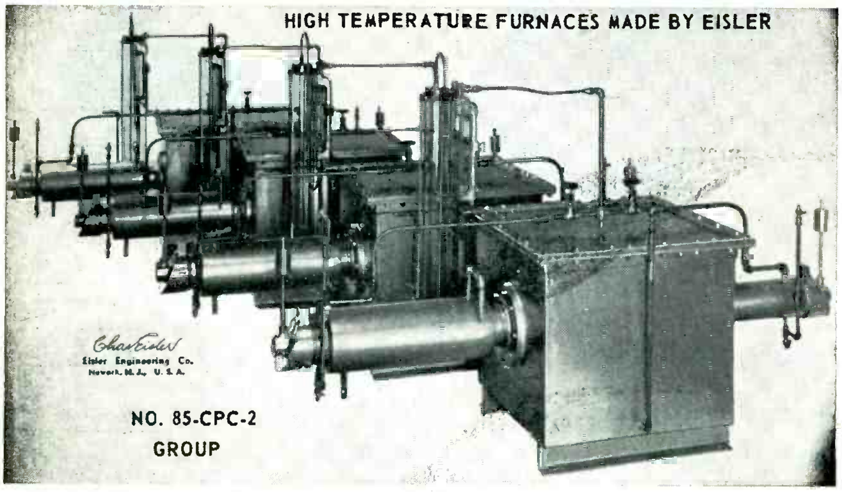

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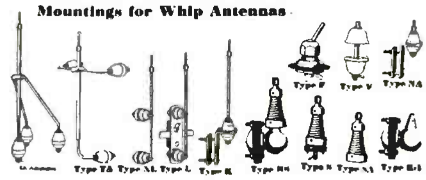

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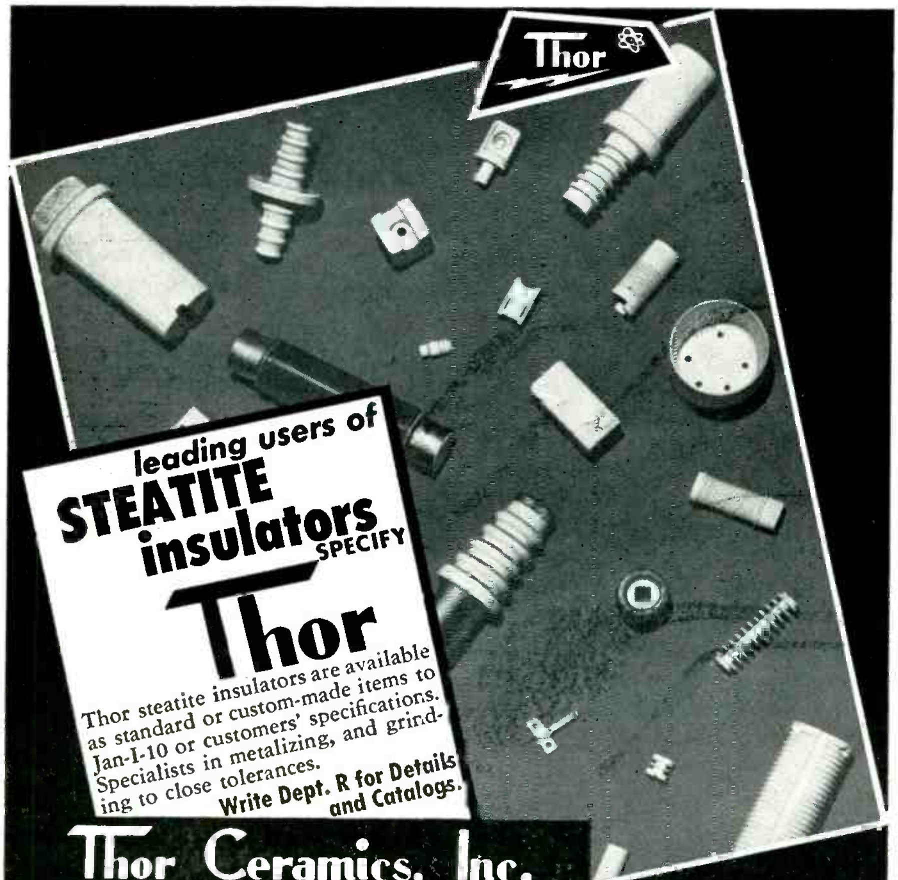

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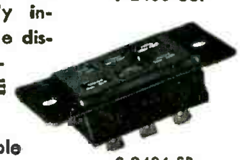

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sheet on the Los Gatos brand 4D21 power tetrode illustrates the tube, gives dimensional data, general electrical characteristics and constant current curves for 350 screen volts. Maximum ratings and typical operation figures are provided for: Class-AB_1 audio-frequency power amplifier and modulator, class-AB_2 audio-frequency power amplifier and modulator, class-C r-f power amplifier and oscillator (unmodulated) and class-C r-f high level modulator-amplifier.

Test Chambers. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet 11.0-7, "Test Chamber by Bowser," presents basic instrumentation data on all types of test chambers including those for relative humidity, low temperature, altitude, flight similitude and environmental tests. Also included in the literature are engineering data and general specifications for the company's standard reach-in and walk-in test chambers.

Infrared Photo Resistance. J. W. Bootz, 1009 Prinsengracht, Amsterdam, Holland, has available a leaflet illustrating and describing the Eletro-Cell, a lead-sulfide infrared photo resistance of great sensitivity. The unit discussed, featuring specially small construction, can be used for infrared measuring and directional apparatus as well as for many other scientific and technical purposes.

Teflon Products. Raybestos-Manhattan, Inc., Manheim, Pa., has issued a new, attractive 8-page bulletin featuring the company's Teflon products. Included in the line described are gaskets, rings in irregular shapes, sheets, tubes, rods, tape, braided and plastic packings, packings for stuffing boxes and valve stems, and Vee-Flex packing rings. The products covered are ideal for use against acids, solvents and alkalies, because no known industrial acids or caustic will attack Teflon.

Portable Power Megaphone. Austin-Lee Inc., 1624 Eye St., N.W., Washington 6, D. C., has avail-

able a 4-page bulletin describing the Little Bull portable, self-contained power megaphone that operates on a magnetic amplifier without any electronic amplifier or vacuum tubes. The unit discussed features instant trigger action, has a range that is effective up to ¼ mile, and weighs 5½ lb complete. Some of the many possible uses of the megaphone are listed.

Electronic Track Scales. Cox and Stevens Aircraft Corp., P.O. Box 30, Mineola, N. Y. Electronic track scales for motion and stationary weighing of freight cars are described and illustrated in this new catalog. Data are given on accuracies, installation, operation and maintenance.

Bobbin Winder & Dereeling Tension. Geo. Stevens Mfg. Co., Inc., Chicago, Ill. A new catalog sheet illustrates and describes the model 119-A bobbin winder and model T-102 dereeling tension for extremely fine wire. Among the features of model 119-A described are types of windings, coil sizes, wire sizes-tension equipment, economy box-type cam, gears, winding speeds, setup time, motor equipment, automatic stop, automatic counter, mounting and other features. Model T-102 tension's descriptive features include wire sizes handled, size of spools, description of operation and other features.

Mass Spectrometer. Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Calif. Bulletin CEC-1800 B discusses mass spectrometry and its uses for control analyses, complex mixture analyses, exploratory analyses, purity determinations and research investigations. It describes and illustrates the model 21-103A analytical mass spectrometer, an integrated assembly of precision units. Performance characteristics, specifications and information on accessories are included.

Miniature Metal-Cased Capacitors. Aerovox Corp., New Bedford, Mass., has published a bulletin announcing a wide choice of foil-paper capacitors housed in compact tubular metal cases with vitreous-

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ceramic terminal end seals to meet high-temperature and miniaturized space requirements of present-day electronic equipment. Depending on the impregnant used, the capacitors described operate in temperature ranges from −40 to +85 C, and from −55 to +125 C. The bulletin contains standard listings, specifications, drawings, how-to-order and other pertinent data. It includes several variations from the plain grounded-to-case design, such as an insulated-from-case unit, the plastic insulating sleeve, the threaded terminal and the tangential mounting bracket.

Motors and Timers. Amglo Corp., 2037 W. Division St., Chicago 22, Ill., has available a mailing piece on its reed-controlled d-c motors and timers that feature self-starting, constant speed and light weight. Included are technical specifications and two pages of performance curves.

Certified Alloys. Cannon-Muskegon Corp., 2875 Lincoln St., Muskegon, Mich. A brochure describing a new service whereby precision casting foundries can quickly and for the first time obtain stainless, super stainless and alloyed tool steels specifically developed for remelting purposes is now available. The publication illustrates a new model plant, designed and built specifically for producing master heats of alloys in shot and ingot form. Shown are laboratories, melting equipment of latest design and other equipment to produce and guarantee quality alloys.

Nut Clip Fastener. Prestole Corp., Toledo, Ohio. Catalog sheet 751-A contains complete engineering and application data on the company's new heavy duty nut clip fastener that features (1) assembly ease of a nut clip unit; (2) security and holding power of a multiple thread fastener; a spring steel lead tongue that provides (3) ease in clipping fastener onto panel edge and acts as (4) a lock washer when assembly is in a fixed position.

Cold Drawn Steel Tubing. Pacific Tube Co., 5710 Smithway St., Los Angeles 22, Calif. Steel tubing and

cold finished rods and bars are described in bulletin No. 10. The six-page folder gives standard manufacturing tolerances on outside diameter, inside diameter, wall thickness and commercial lengths for various sizes of tubing; also, size ranges for standard production of cold drawn carbon steel and alloy steel tubing, electric resistance welded steel tubing, stainless welded and drawn tubing, cold finished bars and precision shafting. A table lists average physical properties of various tubing analyses regularly produced. Included in the folder are illustrations of plant facilities, useful information for users of tubing and information on mill practices.

Insulation Handbook. Mycalex Corp. of America, Clifton Blvd., Clifton, N. J. A 24-page engineers' handbook and catalog contains important data on the ideal insulation for all frequencies. Included are the product's outstanding properties, a listing of the company's new developments, a table showing a comparison of glass-bonded mica with other insulating materials, and an illustrated description of different grades of Mycalex. The catalog also contains information on a line of switches, commutator plates and tube sockets.

High-Vacuum Apparatus. Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill. An interesting and informative 56-page booklet on high-vacuum apparatus, recently revised to include new type vacuum connectors and couplings, has just been published. It contains detailed information on planning the high-vacuum system together with many valuable tables and charts. Also included in bulletin 10E is a complete description of the various types of high-vacuum apparatus and accessories.

Power Measurement Transducers. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Bulletin 15-16 contains technical data on the application of power measurement transducers to process control. Application data on all subjects such as salt operation, pulverizing, clay

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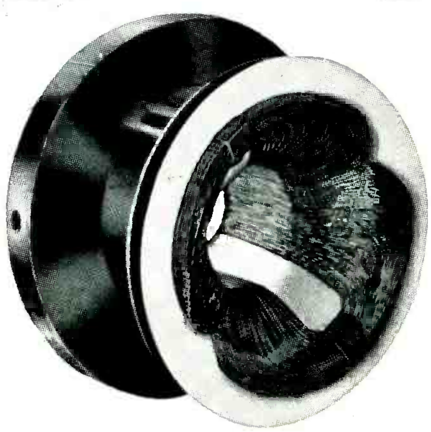

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Radio Equipment. Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, England. The 1953 catalog of radio equipment is a 432-page hard-covered book giving an overall picture of the extensive range of the company's products. It is divided into seven sections: aeronautical, broadcasting, communications, maritime navigational aids, crystals and electronic tubes, and miscellaneous. The last-named section covers antenna equipment, sound reproduction equipment and test and measuring instruments. By the aid of a comprehensive index at the end, the reader may immediately turn to the pages covering those items in which he is particularly interested. Also, each of the seven sections mentioned has its own contents page that indicates the broad classification of equipments within that section.

Information on Magnets. Eriez Mfg. Co., 1945 Grove Drive, Erie, Pa. A new chart, "What Makes A Magnet?", describes the natural forces causing magnetism and how they are harnessed to create a useful tool for industry and the home. The chart, made up of diagrams and drawings with explanatory captions, describes the potential magnetic forces found in a ferromagnetic atom. How these natural forces are organized by the application of an external magnetic field is also shown.

Test Chambers. International Radiant Corp., 40 Matinecock Ave., Port Washington, N. Y., has issued a 4-page bulletin giving an illustrated technical description of the following testing equipment: A

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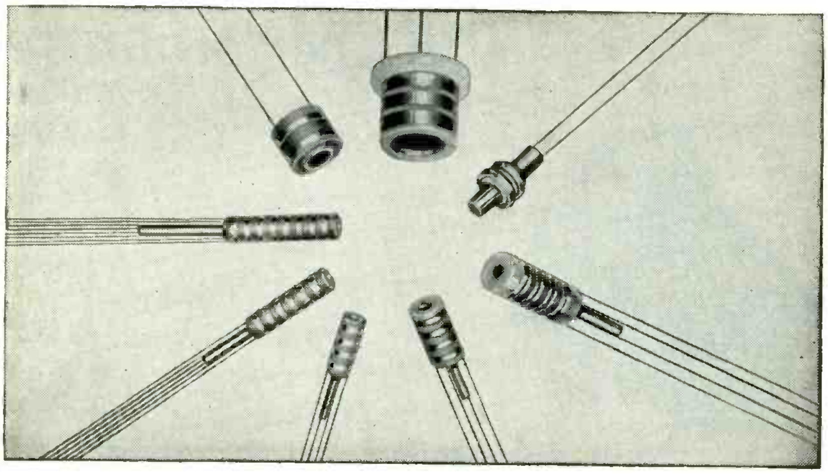

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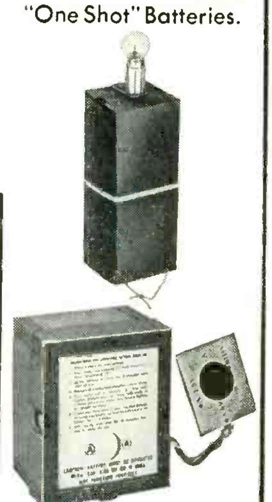

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House Organ. John Volkert Metal Stampings, Inc., 222-34 96th Ave., Queens Village 8, L. I., N. Y. A new quarterly publication featuring precision metal stamping case histories was recently issued. The first issue of the highly-illustrated publication, called "The Volkert View," contains a story on how precision stampings shoot the picture onto the tv screen. Another highlight is a round-up story on the recent plant expansion program that has brought about a 20-percent increase in capacity for this leading supplier of precision stampings and assemblies. Those interested in having their names added to the mailing list should write to the company.

Recorders and Indicators. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Catalog 1520 covers a broad line of ElectroniK recorders and indicators. Illustrations, general specifications, various models and ordering information are given for strip chart recorders, circular chart recorders and precision indicators. Measuring circuits and scale ranges are included.

Geiger and Scintillation Probe Monitor. Measurement Engineering Ltd., Arnprior, Ontario, Canada. A single catalog sheet covers the model AEP 19035 Geiger and scintillation probe monitor, a portable mains operated instrument capable of measuring low values of alpha, beta and gamma radiation with a probe at distances up to 100 ft. Electrical and mechanical features, uses, circuit design and operation are given.

Plastic Insulated Wires. Sequoia Process Corp., 881 Douglas Ave., Redwood City, Calif., presents a compilation of technical information to aid users of plastic insulated wires in determining wire requirements. The purpose of the catalog is to provide data on the various

characteristics of each component used in plastic insulated wire so that the best combination for each specific use can be determined. In addition, a brief listing is included of the properties of the more common wires manufactured.

Timing Relays. Allen-Bradley Co., Milwaukee, Wisc., is offering a 16-page bulletin featuring its complete line of timing relays. Fluid dashpot, pneumatic and electronic timers are fully described. It also contains complete operation and engineering data. Applications are clearly stated. Timers are shown in a wide variety of standard enclosures. A selector chart is provided along with suggestions in choosing a timing relay for a particular application.

Master TV Systems. Blonder-Tongue Laboratories, Inc., 526 North Ave., Westfield, N. J., has issued a new installation manual giving complete technical data on all types of master tv systems. It describes the characteristics and functions of each of the company's units and accessories. Picture diagrams offer convincing evidence of the great flexibility and ease of installation of low-cost master tv systems. There is complete information regarding the layout of a master system, including the type of transmission line to use, location and installation of the various units, and elimination of ghosts and other interference.

Products Catalog. JAN Hardware Mfg. Co., 25-30 163rd St., Flushing, N. Y. A new four-page catalog introduces the company's line of electronic hardware. Included are illustrations, description and use, chief features and specifications for an insulated coupling assembly, a panel bearing and shaft assembly, a shaft lock, an offset extension shaft coupler, a jack cover and a bushing extender.

Parabolic Reflectors. Workshop Associates Division, The Gabriel Co., Endicott St., Norwood, Mass., has prepared a catalog sheet listing over 100 different parabolic reflectors. Describing stock reflectors, the sheet covers a wide

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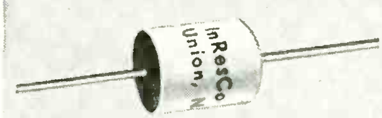

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Pulse Generator. Rutherford Electronics Co., 3707 South Robertson Blvd., Culver City, Calif., has available a six-page, two-color brochure on the model B-2 pulse generator. The instrument described and fully illustrated is a general purpose unit having high repetition rates, fast rise times and narrow pulse widths. Chief features and complete technical specifications are included.

Soldering Information. Wasserlein Mfg. Co., Inc., 126 W. Cass St., Joliet, Ill., has announced bulletin No. 105-D, entitled "The New Way to Solder." This illustrated brochure explains resistance soldering and outlines its many uses for production and maintenance in industry. The publication also contains concise operating instructions for using the Wassco Glo-Melt resistance soldering unit and its many labor-saving accessories.

Miniaturized Tubulars. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin NB-147 deals with the Demicon miniaturized tubular metal-cased paper capacitors. All 12 types of the capacitor series described will comply with applicable parts of specifications JAN-C-25 and MIL-C25A. The bulletin includes illustrations, technical characteristics and dimensional diagrams.

Multichannel Sampling Switches. Applied Science Corp. of Princeton P. O. Box 44, Princeton, N. J. A recent four-page brochure gives a representative cross section of highspeed multichannel rotary sampling switches. Switch plates with as many as 240 contacts and switch assemblies with 1,500 contacts are covered. The switches described and illustrated are being used for industrial and airborne telemetering, drift compensation a d-c amplifiers displaying parameters such as input-output char-

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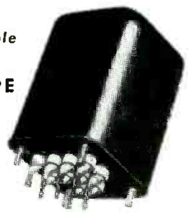

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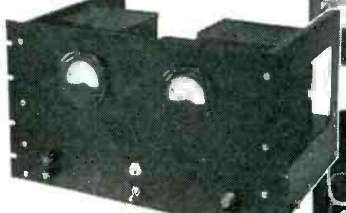

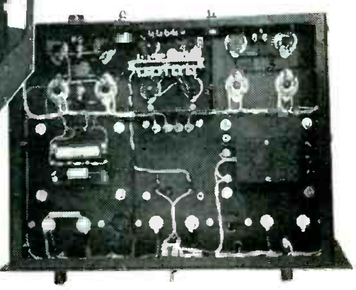

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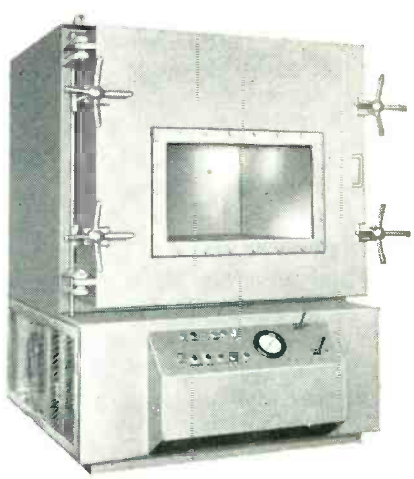

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acter of electrical components for multichannel voltage comparison, for sampling many thermocouples with a single alarm, for generating pulse trains and many other uses.

Klystron Power Supplies. Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill. A four-page folder presents the models 910 and 2310 electronically regulated klystron power supplies for precise microwave measurements. It gives illustrated descriptions of the units along with chief features and complete technical specifications. The units described feature high stability, good regulation and low ripple.

Direct-Writing Recording Systems. Sanborn Co., 38 Osborn St., Cambridge 39, Mass. A new 6-page bulletin explains the scope of application of the company's equipment for the recording of a wide variety of electrical and mechanical phenomena. The bulletin includes a chart of various phenomena that can be recorded with these direct-writing recorders together with transducer data and examples and comments. It also features complete performance data and specifications.

L-F Transformers and Reactors. Magg Transformer Co., 419 Bedford Ave., Brooklyn, N. Y. A recent company bulletin announces a new line of hermetically-sealed low-frequency transformers and reactors. The components described are characterized by their high performance, light weight, excellent shielding and close electrical tolerances.

Optical Gaging. Eastman Kodak Co., 343 State St., Rochester 4, N. Y. A new 12-page booklet describes advanced methods of optical gaging to cut inspection and tool-room costs. The booklet illustrates the uses of special fixtures and charts to inspect to close tolerances, large parts, complex shapes, and blind holes and recesses using contour projection. Profusely illustrated, it shows how optical gaging may be adapted to a wide variety of parts for faster, more economical checking. Specifica-

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4 Awards Totaling $250.00

1st prize	**$100.00**
2nd prize	**75.00**
3rd prize	**50.00**
4th prize	**25.00**

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1. Each entry must state a specific and existing industrial problem.

2. The solution of this problem must be arrived at by the use of a radioactive source and any instrument or circuit, which utilizes for detection a Geiger Counter Tube, an Integrator Tube or any similar device.

3. Simple, clear, illustrative sketches plus adequate descriptions will be acceptable.

4. It is not necessary for you to be an expert in the nuclear field. If through your knowledge of industrial problems you are able to describe a solution based on the use of a radioactive source and a detection device—you may submit your entry in a non-technical form. Your entry must include your name, home address and occupation.

5. The judges' decision in all cases will be based on practicality of the suggested applications. In the event of a tie duplicate awards will be made.

6. All entries must be postmarked no later than midnight June 15, 1953. Winners will be notified on or before July 15, 1953.

7. No entry will be returned and all entries will become the property of the Anton Electronic Laboratories, Inc. Brooklyn, New York. The decision of the judges will be final. No employee, previous employee, of the Anton Electronic Laboratories, Inc. or relative of either shall be eligible to enter this contest.

8. Judges will be named by Anton Electronic Laboratories, Inc.

9. All entries must be addressed:

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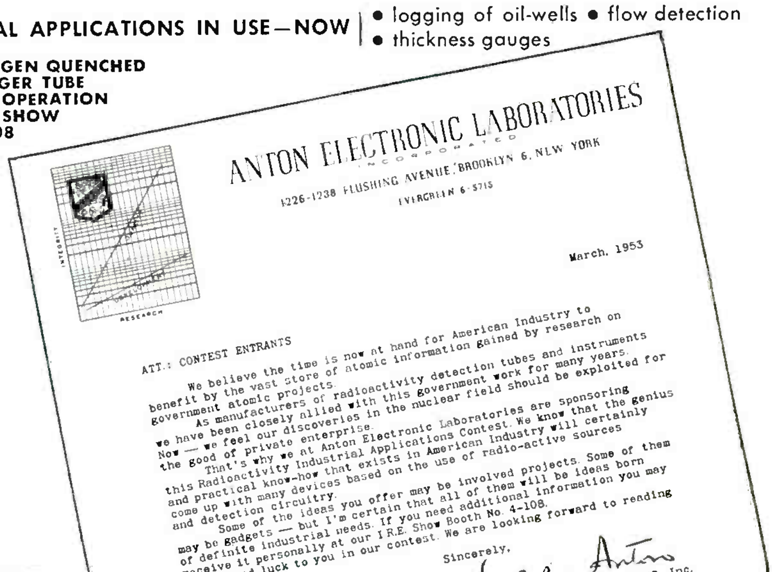
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March, 1953

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That's why we at Anton Electronic Laboratories are sponsoring this Radioactivity Industrial Applications Contest. We know that the genius and practical know-how that exists in American Industry will certainly come up with many devices based on the use of radio-active sources and detection circuitry.

Some of the ideas you offer may be involved projects. Some of them may be gadgets — but I'm certain that all of them will be ideas born of definite industrial needs. If you need additional information you may receive it personally at our I.R.E. Show Booth No. 4-108.

Good luck to you in our contest. We are looking forward to reading your entry.

Sincerely,

Nicholas Anton

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tions and features of both models 2A and 3 contour projectors are described and illustrated.

Adjustable-Speed Drive. General Electric Co., Schenectady 5, N. Y. Thy-mo-trol (thyratron motor control) drive, what it consists of and how it operates are described in two new four-page bulletins. A simplified drive for ¾ to 3-hp applications is discussed in bulletin GEA-5829. Photos and diagrams are used to explain the system that is designed for use on testing equipment, conveyors and many other applications. A precision-controlled drive for ¾ to 10-hp applications is described in bulletin GEA-5827. The packaged adjustable-speed drive described is intended for application on machine tools, reeling and processing equipment, textile machines and other uses.

Fasteners. Simmons Fastener Corp., North Broadway, Albany 1, N. Y. Catalog 1252 covers a complete expanded line of fasteners that are suited for widely divergent applications. The 36-page, highly-illustrated booklet introduces the company's new Dual-Lock, a high-load, positive-locking structural fastener. The new catalog, which features an illustrated table of contents, contains dimensional drawings, engineering data, installation details and instructions for ordering. Numerous applications of each fastener type are pictured and described.

Motor Catalog. Gleason-Avery, Inc., 45 Aurelius Ave., Auburn, N. Y., has available a new catalog of products and services. The catalog includes specifications and illustrations of all the company's synchronous and nonsynchronous instrument motors, series 500 gear reduction motors and temperature controls, complete with rating charts and mounting dimensions. Also included to aid manufacturers is a list of possible applications of the motors.

Variable Resistors. Chicago Telephone Supply Corp., Elkhart, Ind. A complete civilian line and a com-

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plete military line of variable resistors are pictured and described in data sheet No. 164. Attached switches for the civilian line are illustrated as well as a variety of concentric shaft tandem constructions with panel and rear sections operating separately from concentric shafts. Also shown is the new miniaturized type 70 civilian control designed for use in new radio and tv sets. Military resistors covered include JAN-R-19 and JAN-R-94 types and special composition controls specifically designed for military communications equipment subject to extreme temperature and humidity ranges.

Small Precision Metal Parts. The Torrington Co., 500 Field St., Torrington, Conn., has available a catalog listing the small precision metal parts now being made by the company. Some of the many parts described and illustrated are special pins and pivots; screw driver blades; all types of rotary swaged rods, wires and tubing in practically all kinds of metals; mandrels for grinding wheels, abrasive points and polishing wheels; perforating punches in straight carbon or alloy steels; and tapered or pointed wires and rods.

Hermetically-Sealed Resistors. Shallcross Mfg. Co., Collingdale, Pa. Bulletin L-27 with supplement 1 covers a complete line of precision wirewound resistors that meet every requirement of specification JAN-R-93, characteristic A. The resistors described are hermetically sealed in ceramic for extremely stable performance under wide temperature variations and high humidity—even total salt water immersion.

Radio Kits. Stockman Electronics Research Co., 543 Lexington St., Waltham, Mass., has a series of circuit diagrams, parts, kits and circuit display boards for school laboratories and lecture rooms. The items covered are vtvm's, signal generators, amplifiers and other test instruments, transceivers and new type radio receivers. A formula booklet reviewing circuit theory completes the series.

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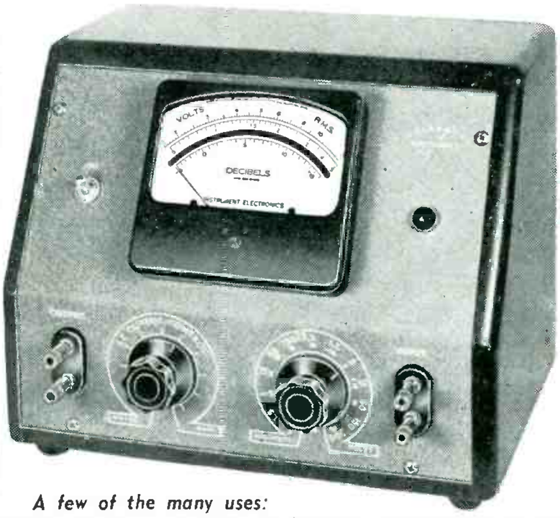

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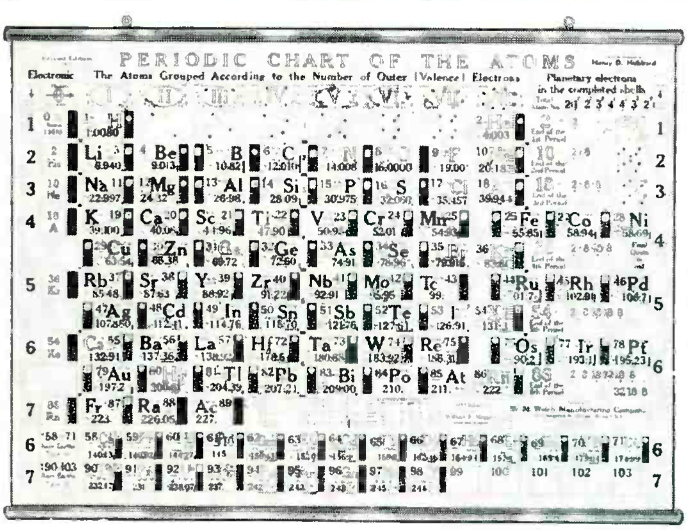

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A comprehensive, 48-page, key booklet is furnished with each chart. It contains a brief discourse on the atom and the periodic law, a bibliography, a detailed explanation of the chart data, numerous tables and graphs, and a large black and white reproduction of the chart.

No. 4854. Chart of The Atoms, 1953 Edition. With formed-metal chart molding at top and bottom with eyelets for hanging, non-glare protective coating and key booklet.
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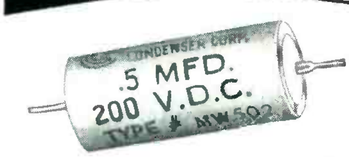

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

OTHER DEPARTMENTS featured for this issue:

Pye And General Precision Sign Research Agreement

AN AGREEMENT has been signed by Pye Limited of Cambridge, England, and General Precision Laboratory, Inc., New York, providing for an expanded program of joint research and development in the field of industrial and broadcast television cameras and studio equipment. The two companies have been associated for 3 years under an agreement which provided for the development of the items of studio equipment currently marketed by GPL.

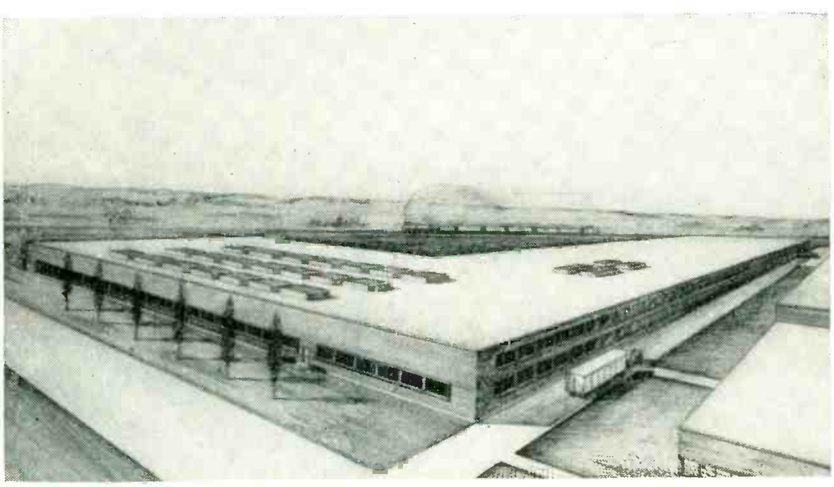
Pye will manufacture cameras and associated studio items in England and General Precision will do the same in the U. S. for independent sale through their respective marketing organizations. The combined engineering knowledge of the two firms, reflecting world-wide operations, will be pooled.

In addition to the television broadcast cameras of the image orthicon and photocon types, a new miniature camera has been announced, chiefly for use in industrial and military applications. This is based on a new type of camera tube developed by Pye engineers, the details of which have not yet been announced.

The unit together with the Pye-GPL remote pan and tilt pedestal (ELECTRONICS, Sept. 1952, p. 22) will permit remote viewing with complete control of focus, iris, lens and turret.

The Pye-GPL agreement mainly covers television cameras but it is reported that the two firms are also working closely on theater television and are planning a similar co-operation in other industrial fields.

Raytheon To Build Picture Tube Plant



Plans for the erection of a new plant in Quincy, Mass., were recently announced by C. F. Adams, Jr., president of Raytheon Manufacturing Co. When completed, the plant, shown in the architect's sketch, will provide 100,000 sq ft of space which will be devoted exclusively to the manufacture and warehousing of television picture tubes, especially the new large sizes such as the 24-inch and 27-inch rectangular tubes. The plant is expected to be in operation next summer. It will employ 350 workers.

IRE Appoints Officers And Directors For 1953

THE BOARD of directors of the Institute of Radio Engineers, at its annual meeting in New York City, appointed 6 officers and directors for the year 1953. Haraden Pratt, telecommunications advisor to former President Truman, was reappointed secretary of the Institute, a post he has held since 1943.

W. R. G. Baker, vice-president of the General Electric Co., was appointed treasurer for the third successive year.

Alfred N. Goldsmith, consulting engineer, was appointed editor, an office he has held since the IRE was founded in 1912.

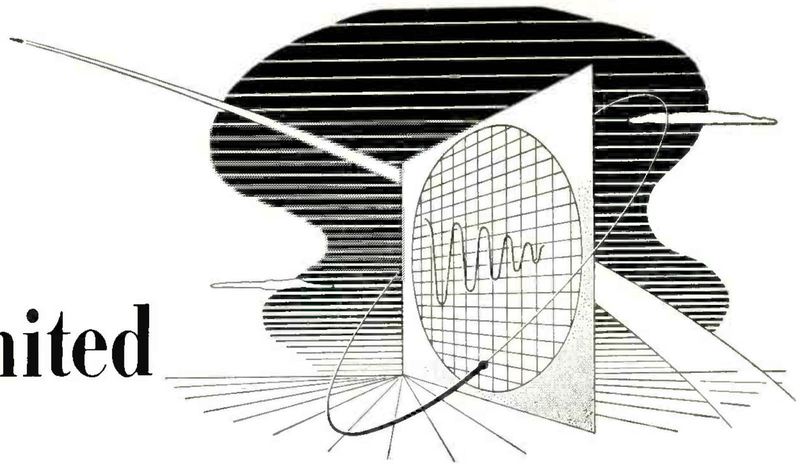
Appointed as directors for 1953 were Ralph D. Bennett, technical director of the U. S. Naval Ordnance Laboratory; William R. Hewlett, vice-president of Hewlett Packard Co. and Arthur V. Loughren, vice-president in charge of research at Hazeltine Electronics Corp.

General Instrument Elects Cohen President

MONTE COHEN, veteran of 37 years in the radio-electronics field, has been elected president of General Instruments Corp., it was announced by Abraham Blumenkrantz, chairman of the board and chief executive officer.

Mr. Cohen has been executive vice-president of the company since 1951, and president of the F. W. Sickles Division of General Instru-

horizons unlimited



Inhibitions must be stifled if creative development is to have full freedom of expression. Only with a young, imaginative, "of course it can be done" attitude are the great advances of this modern era accomplished.

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ment since that year. He started his career in radio in 1916 with the old Marconi Company. He has helped design and manufacture numerous electronic, radio and television components which are widely used today in military and civilian products.

Black Receives Research Corp. Annual Award

Harold S. Black

HAROLD S. BLACK, transmission engineer at the Bell Telephone Laboratories, received the Research Corporation Annual Award for Contribution to Science. This is the foundation's 17th annual award.

Mr. Black, who joined the laboratories in 1921, was chosen as the 1952 recipient of the award in recognition of his invention and development of the negative feedback principle and for his general record of contribution in the field of communications. The negative feedback amplifier has been widely utilized wherever freedom from distortion and a high degree of perfection is required.

A native of Leominster, Mass., Mr. Black received a B.S. degree in electrical engineering from Worcester Polytechnic Institute. In 1940 he was honored by the NAM as a modern pioneer, in recognition of distinguished achievement in the field of science and invention. He also holds the John Price Wetherill medal of the Franklin Institute for his technical contribution to the efficiency of modern long distance telephony.

New Officers Elected By WCEMA For 1953

NORMAN H. MOORE, chief engineer of Litton Industries, San Carlos, Calif., became the 1953 president of the West Coast Electronics Manufacturer's Association as a result of his election to the post of chairman of the San Francisco council. Moore, who served as vice-chairman of the Northern California group in 1952, has long been active in WCEMA activities, having served in various other capacities during the past years.

Vice-president of the association for the new year is Ed Grigsby, sales manager of the western division of Altec-Lansing Corp., Beverly Hills. Grigsby was elected chairman of the Southern California council for 1953, succeeding Leon B. Ungar.

Secretary is Don Larson, advertising director of Hoffman Radio Corp., Los Angeles. Treasurer for 1953, representing the Northern California council, is H. Myrl Stearns, vice-president and general manager of Varian Associates, San Carlos.

New WCEMA 1953 directors elected include: Hugh P. Moore, president of Acme Electronics, Inc.; Paul H. Tartak, president of Tartak-Stolle Electronics, Inc.; E. P. Gertsch, president of Gertsch Products, Inc.; Noel E. Porter, production manager for Hewlett-Packard Co.; William Heflin, Lenkurt Electric Co.; Winfield Wagener, Eitel-McCullough, Inc.; and M. J. Murdock, general manager of Tektronix, Inc. This brings the directors to 14 members, including the immediate past president, Leon B. Ungar, Los Angeles, who automatically joins the board. The organization sponsors the annual Western Electronic Show and Convention. This year it will be held in the San Francisco civic auditorium August 19-21.

Motorola Elects Officers

ELECTION of two new officers of Motorola, Inc. was announced by Paul V. Galvin, president. Walter Scott, formerly works manager, became vice-president in charge of manufacturing, consumer product division. John Silver, general manager of the communications and electronics division, was named vice-president in charge of operations, communications and electronics division.

Mr. Scott has been with the electronics firm since 1946. For five years prior to that he was assistant to the production head of the J. I. Case Company.

John Silver

Mr. Silver came to Motorola in 1944 and was appointed general manager of the communications and electronics division in 1949. Prior affiliations included 12 years in engineering with Crosley Radio Corp., and several years as chief production engineer for Collins Radio.

Teal Joins Texas Firm As Research Head

GORDON K. TEAL, well-recognized for his work in the semiconductor field, has joined Texas Instruments Inc. of Dallas as assistant vice-president and director of the materials and components research department of the engineering division.

He has been prominently associated with several recent advances in electronics. He and his former associates at Bell Telephone Labs are credited with the introduction of single-crystal germanium and silicon into the transistor field. He is also co-developer of the n-p-n junction transistor and of the borocarbon resistor. He had been with

Want more information? Use post card on last page.

Gordon K. Teal

Bell Labs since 1930 and has been responsible for about 45 patents in his field.

Railroads Select New Communications Officers

C. O. Ellis, general superintendent of communications of the Chicago, Rock Island and Pacific Railway, has been selected as chairman of the communications section of the Association of American Railroads for the two-year term ending December 31, 1954.

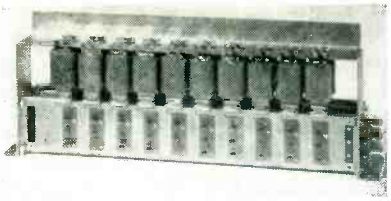
R. A. Hendrie, general superintendent of communications of the Missouri Pacific Railroad has been selected as vice-chairman of the section for the same term.

RCA Honors Engineers

Among the 20 employees of RCA Victor who received the company's top citation, the RCA Victor Award of Merit, were M. John Heffernan, field engineer, John D. Callaghan, senior engineer and Clarence A. Gunther, assistant chief engineer.

Mr. Heffernan was honored for unusual ingenuity and initiative which resulted in the development of an antenna-detector device that makes possible vastly improved air-weather station communications for the U. S. Air Force. It eliminates the need for long and expensive antenna arrays, and the necessity for heavy investment by the government in purchase of land, antenna towers and other associated equipment.

Mr. Callaghan received the award for his role in the development of



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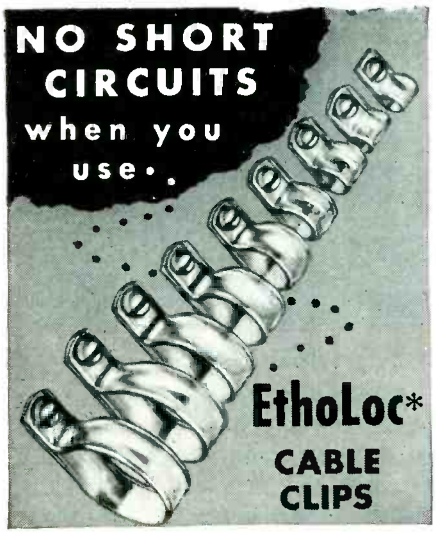
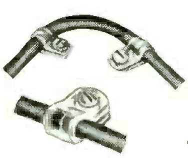


*TRADE MARK PAT. PEND.



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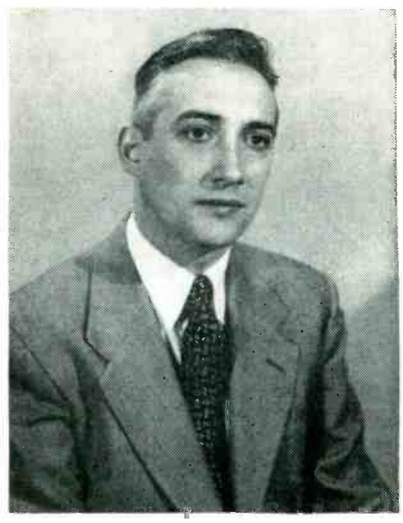
antennas, transmission lines and other equipment that helped make possible the introduction of uhf tv service to the public.

Mr. Gunther was cited for invaluable counsel on the selection of government projects best suited to the company's facilities and type of production. His analysis of electronic equipment while visiting Korea enabled him to make recommendations of the greatest importance to the armed forces.

Ford Instrument Promotes McKenney to Chief Engineer

HENRY F. MCKENNEY has been appointed chief engineer of the Ford Instrument Company, division of the Sperry Corp., Raymond F. Jahn, president of the company announced. He will be responsible to William H. Newell, vice-president for engineering.



Henry F. McKenney

Mr. McKenney, a graduate of the University of Cincinnati, came to Ford Instrument eleven years ago as a test engineer. He entered the design engineering department shortly thereafter, specialized in airborne equipment, and has been assistant chief engineer for the past two years.

He holds four patents with eight more pending on magnetic amplifiers, servo-mechanisms and electronic equipment.

Cotton Returns To Philco

RICHARD W. COTTON, on leave from Philco since June 16, has resigned as director of NPA Electronics Di-

vision to return to his position as assistant to the president of Philco, William Balderston. He has agreed to remain as head of the electronics board on a part time basis until the new director takes over. Deputy Director Donald S. Parris will become director of the Electronics Division.

Ryder Named President Of '53 NEC

J. D. RYDER, head of the electrical engineering department, University of Illinois, has been named president of the 1953 National Electronics Conference Inc. C. E. Barthel, Jr., Illinois Institute of Technology, was named chairman of the board.

The ninth annual conference will be held September 28, 29 and 30, 1953 at the Hotel Sherman in Chicago.

Other officers are: executive vice-president, R. M. Soria of American Phenolic Corp.; executive secretary, Karl Kramer of Jensen Radio Co.; secretary, J. M. Cage of Purdue University; treasurer, G. E. Fostor of Metrotype Corp.

The conference is sponsored by the AIEE, IRE, Illinois Institute of Technology, Northwestern University and the University of Illinois, with participation by Purdue University and the University of Wisconsin.

Wright Advanced To V-P at Capehart-Farnsworth

THE PROMOTION of Anthony Wright to vice-president in charge of the commercial products division of the Capehart-Farnsworth Corp. was recently announced by Fred D. Wilson, president.

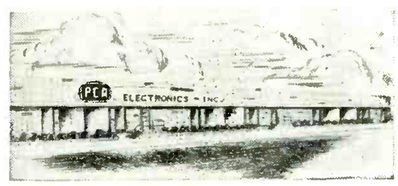
Mr. Wright, who joined Capehart early in 1950 as chief engineer, became vice-president in charge of engineering for the consumer products division in February of that year. A pioneer in the radio and television industry, Mr. Wright was chief engineer for the Magnavox Corp. immediately prior to joining Capehart. From 1929 to 1947 he was with the RCA Victor Division of RCA and was responsible for many of the advances in radio, phonograph, and television engineering at RCA. As chief engineer

for the home instrument department, television section, he was responsible for the development of RCA's first postwar television receivers; he was also in charge of the development of airborne television equipment. While vice-president in charge of engineering at Capehart he has designed many highly successful television chassis, including the CX-37 now in production.

In addition to his work in radio and television engineering, Mr. Wright has spent much time in the radio retailing field. A native of England, he was educated at Oxford University.

PCA Moves Into New Plant

PCA ELECTRONICS, INC., manufacturers of miniature pulse transformers and delay lines used in computers, guided missiles and radar equipment, recently moved into a new building in Santa Monica, Calif.



New PCA Plant

The new building has more than 5 times the floor area of the previous plant, increasing production facilities and providing room for the expanding research and development departments of the company.

Sylvania In Canada Elects New Officers

THE ELECTION of four new top-ranking officers of Sylvania Electric (Canada) Ltd., wholly owned manufacturing subsidiary of Sylvania Electric Products Inc., was announced by the Canadian corporation's board of directors.

Ralph E. Niedringhaus, a member of the Sylvania staff in the United States since 1938, becomes president of the Canadian subsidiary under the new organization. Other officers elected by the directors are: W. Benton Harrison, treasurer; William B. O'Keefe, vice-president in charge of manufactur-

Want more information? Use post card on last page.

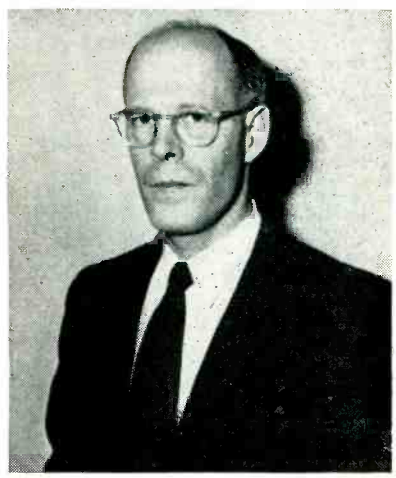
ing; and Guy Therien, secretary.

Mr. Niedringhaus has been sales manager of Sylvania's lighting division in the Cleveland, Ohio district since 1947. Mr. Harrison also is treasurer of Sylvania Electric Products Inc. Mr. O'Keefe has been plant manager at Drummondville since 1949 and Mr. Therien joined the Canadian corporation in the same year as supervisor of plant accounting, becoming office manager in 1951.

The company is now building a large new plant in Drummondville, Canada to produce electronic devices for Canadian defense purposes.

Law Joins CBS-Hytron As Assistant to V-P

CHARLES F. STROMEYER, vice-president in charge of manufacturing and engineering of Hytron Radio & Electronics Co., announced the appointment of Dr. Russell R. Law as his assistant. He will advise Mr. Stromeyer on special technological problems.

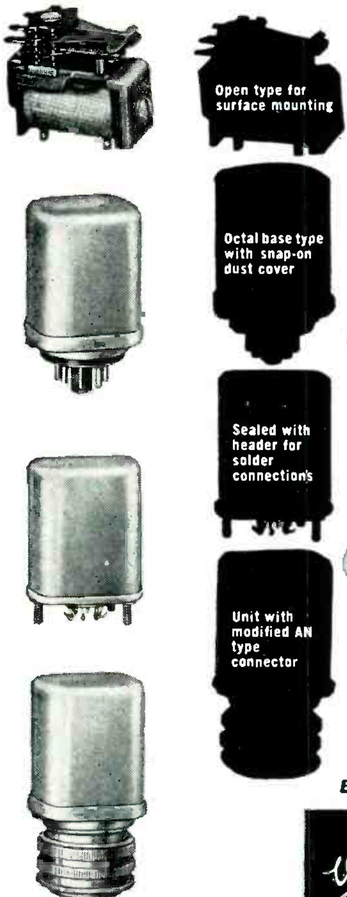


Russell R. Law

During the last eighteen years, Dr. Law has been with RCA in Harrison and Princeton. Among his contributions are improvements in electron optics, projection screens and tri-color picture tubes. More recently, he has devoted his efforts to color television and semiconductors.

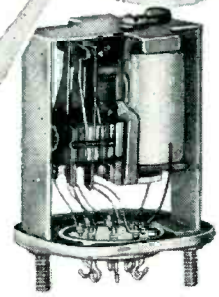
Sarkes Tarzian Expands

THE RECTIFIER DIVISION of Sarkes Tarzian, Inc., is expanding its facilities by adding a two-story struc-



a rugged little space saver...

MIDGET TELEPHONE TYPE RELAYS SERIES (80)—OPEN TYPE FOR SURFACE MOUNTING, OR IN HERMETICALLY SEALED CONTAINERS.



This vibration and shock-proof Midget Type Relay is the answer to numerous applications where unfailing operation is necessary. In fact, it is built to meet rigid Army and Navy specifications. This "rugged little space saver" is a compact, multiple contact relay which has been developed over years of specialized engineering in the field by Signal Engineering and Mfg. Co., manufacturers of a comprehensive line of relays and signals of various designs and sizes.

Write for Bulletin MTR-6

Engineering Representatives in Principal Cities.

Wheelock RELAYS
SIGNAL
ENGINEERING & MFG. CO.
154 WEST 14TH ST NEW YORK 11 NY

ELECTRONICS SALES AND APPLICATION ENGINEERS

High-Frequency Heating, Microwave Communication, V.H.F. Communication, Power-Line Carrier and Military Communication and Radar Equipment

The expanding Electronics Division of Westinghouse has a number of desirable sales and application engineering positions open for men well qualified in one or more of the above fields. These openings require technical graduates with good personalities and business sense, men who like to meet people and work with them on a broad range of equipment application problems rather than specializing in a narrow field of design. Previous technical sales experience is desirable but not necessary.

Permanent positions are available at Headquarters (Baltimore) as well as in various sales offices throughout the country. The latter positions generally require training at Headquarters for a period depending on previous experience.

All these positions offer top pay, commensurate with ability and experience, with excellent opportunity for advancement on merit. They carry the usual generous employe benefits offered by Westinghouse—low-cost group life and hospitalization insurance, an excellent retirement plan, graduate study opportunities and paid vacations. Re-location allowances will be made by the Company.

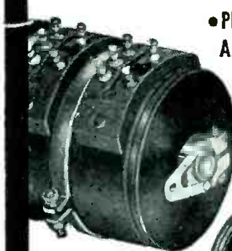
Send resume of qualifications to:

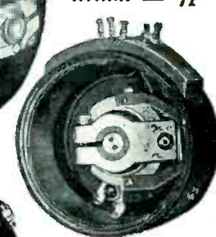
Manager, Industrial Relations, Dept. CK
Westinghouse Electric Corporation
41 Hopkins Place
Baltimore 1, Md.

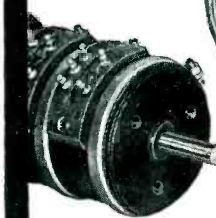
DeJUR

EXTERNAL PHASING C-200 *Potentiometers*

- MULTIPLE GANGING
- INDIVIDUAL EXTERNAL PHASING
- POSITIVE INTERLOCK
- PRECISION MACHINED ANODIZED ALUMINUM CASE
- ADJUSTABLE TAPS WITHIN ± 1/2°







Designers are invited to submit their applications to DeJur engineers for recommendations and suggestions.

- 2" Diameter
- 4 Watts Fully Enclosed
- 10 to 200,000 Ohms Accuracy up to 1%
- Linearity up to 0.3%
- Non Linear Windings
- 360° (Continuous) Mechanical Rotation
- 320° Electrical Rotation
- Taps as Required
- High Resolution 1,000,000 Cycles Operational Life
- Precious Metal Contacts
- Low Torque 1 oz. inch
- Centerless Ground Stainless Steel Shafts
- Ball Bearings to Special Order
- Single or Ganged Units
- Servo Type Mounting or Single Hole Threaded Bushing
- Numerous Shaft Designs

WRITE FOR BULLETIN E-3

ELECTRONIC DeJUR U.S.A. INSTRUMENTS
DeJUR AMSCO CORPORATION
45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.

ture to the present plant. It will contain approximately 20,000 sq ft of floor space. This additional space will be used to make more rectifiers for the radio and television industries and to take care of increased government requirements. When this building is completed the production output can be doubled.

Guided Missiles And Atomic Energy Appointments Made

WALTER G. WHITMAN, chairman of the Research and Development Board of the Department of Defense, announced two appointments on the RDB Committees on Guided Missiles and on Atomic Energy.

James C. Starks, who is on leave from the Sandia Corp., has been named executive director of the Atomic Energy Committee of RDB.

Allen E. Puckett, head of the aerodynamics section of the Hughes Aircraft Company, has been appointed to the Committee on Guided Missiles.

Beacon Plans To Open Plants In Australia

BEACON CORP. of Chicago is planning to open factories in Sydney and Adelaide, Australia, to manufacture television receivers and antennas. The firm is negotiating with the Australian Federal Government for permission to do so. If permission is granted, a subsidiary company with some Australian participation would be created. A standard tv receiver would cost $225 and smaller ones about $160 in the country.

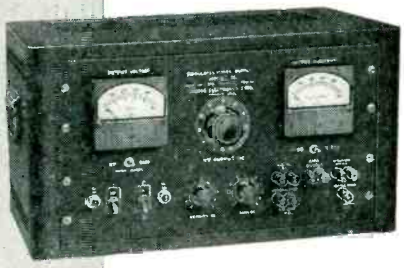
At least 4 Australian manufacturers of wireless equipment have also advanced plans for the local production of tv sets and equipment.

Consolidated Engineering Names Nunan V-P

J. KNEELAND NUNAN has been elected vice-president in charge of sales of Consolidated Engineering Corp. and executive vice-president of CEC Instruments, Inc., a wholly-owned subsidiary. Phillip S. Fogg, president of Consolidated, made the announcement.

The Pasadena firm's recent purchase of the vacuum equipment department of Eastman Kodak Co.'s

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES



BENCH MODEL 50

• STABLE • DEPENDABLE • MODERATELY PRICED •

ALSO AVAILABLE STANDARD RACK MOUNTING
MODEL 50-R
PANEL SIZE 10½" x 19"
DEPTH 14¼"

- **INPUT:** 105-125 VAC, 50-60c
- **OUTPUT #1:** 0-500 VDC at 500 ma regulated
- **OUTPUT #2:** 0-50 VDC, 0-200 VDC Bias Output.
- **OUTPUT #3:** 6.3 VAC at 5A unregulated
- **OUTPUT #4:** 6.3 VAC at 5A unregulated
- **RIPPLE OUTPUT:** Less than 8 millivolts rms

For complete information write for Bulletin 50S

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES

BENCH MODEL 25

• STABLE • DEPENDABLE • MODERATELY PRICED •

WIDTH 14"
DEPTH 6"
HEIGHT 8"
WT: 17 LBS.

- **INPUT:** 105 to 125 VAC. 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin E-5S

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES

RACK MODEL 32

• STABLE • DEPENDABLE • MODERATELY PRICED •

STANDARD RACK MOUNTING
PANEL SIZE 10½" x 19"
DEPTH 9"
WEIGHT 38 LBS

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 VDC at 300 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 5A unregulated
- **OUTPUT #3:** 6.3 Volts AC CT at 5A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin E-2S

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES

• STABLE • DEPENDABLE • MODERATELY PRICED •

MODEL 28
STANDARD RACK MOUNTING
PANEL SIZE 5¼" x 19"
WEIGHT 16 LBS.

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin E-8S

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

ELECTRONICALLY REGULATED
LABORATORY POWER SUPPLIES

RACK MODEL 33

• STABLE • DEPENDABLE • MODERATELY PRICED •

STANDARD RACK MOUNTING
PANEL SIZE 10½" x 19"
DEPTH 9"
WEIGHT 38 LBS

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 100 to 200 VDC at 300 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 5A unregulated
- **OUTPUT #3:** 6.3 Volts AC CT at 5A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin E-3S

LAMBDA ELECTRONICS
CORPORATION
CORONA NEW YORK

Want more information? Use post card on last page.

Distillation Products Industries is expected to boost its annual sales volume, currently running between $8 million and $8.5 million, to approximately $15 million by the end of 1953. An immediate responsibility of Nunan's will be to coordinate and administer this sales expansion.

New Company To Make UHF Equipment

GRANCO PRODUCTS, INC., a new company in the electronics field, has been organized to design, manufacture and distribute uhf converters and uhf measuring instruments. Production will begin at a 10,000 sq ft plant in Long Island City, N. Y. The new company was formed to meet the increasing demand for uhf converters.

Henry Fogel, formerly manager

Henry Fogel

of commercial products division of the Radio Receptor Co., Inc., has been appointed president of the new firm. As manager at Radio Receptor he directed the development and production of uhf tuners and industrial tv devices.

RTMA Makes Staff Changes

Two promotions and a staff addition at RTMA headquarters were announced recently by executive vice-president James D. Secrest.

Peter H. Cousins, who has been information director of RTMA for several years, has been appointed special assistant to Mr. Secrest and staff assistant to the technical

Want more information? Use post card on last page.

products division.

Tyler Nourse, who served as assistant information director under Mr. Cousins, has been promoted to the position of editorial director in charge of RTMA publications.

Herbert F. Hodge, Jr., formerly in government information service, has joined RTMA headquarters staff as an editorial assistant to Mr. Nourse.

The staff reorganization was effected following the resignation of R. M. Haarlander, who has served as staff assistant to the technical products division for the past five years. Mr. Haarlander resigned to take a position in private industry.

Carpenter Forms Summit Engineering Co.

Douglas H. Carpenter, president, announced the establishment of Summit Engineering Co., Hartford, Conn., for the manufacture of television antennas and electronic equipment.

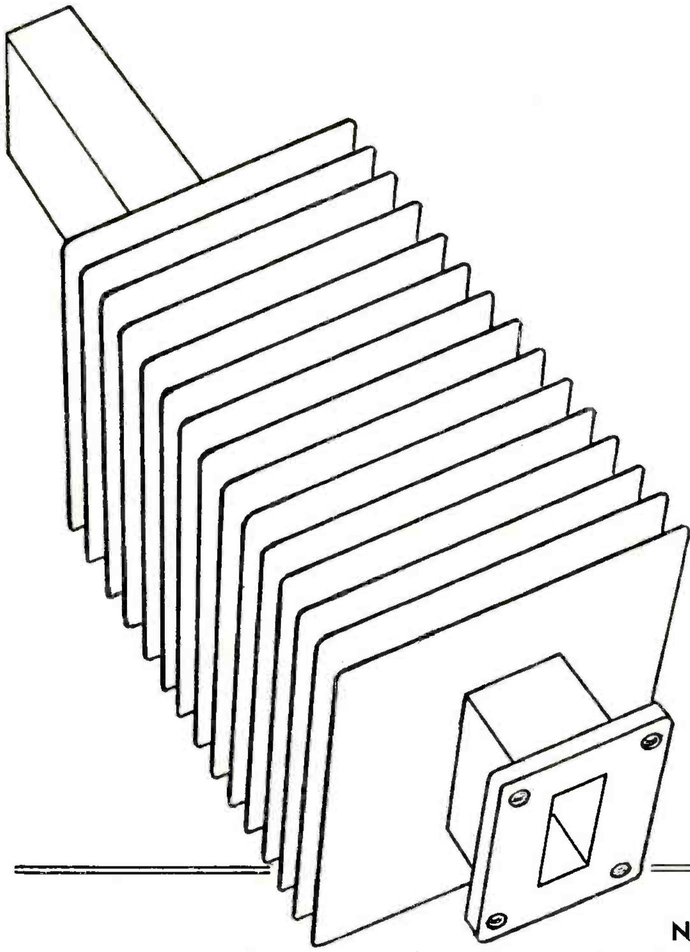
Douglas H. Carpenter

Mr. Carpenter holds many basic patents in antenna design and electronics circuitry. His business experience includes 5 years as chief engineer of the McMurdo Silver Co. and several years in a similar capacity with the LaPointe-Plascomold Corp.

ERCO Apoints Greene V-P And General Manager

Board of directors of the Engineering and Research Corp. announced the appointment of William L. Greene as vice-president of engineering, and general manager.

As chief engineer, Mr. Greene assumed the leadership in organiz-



New Ceramic Lossy Material Stable Up to 2000°F Means Greater Efficiency in These Waveguide, High Power Terminations, and Attenuators

"Eilex", a new ceramic lossy material, is now available in waveguide, high power terminations and attenuators from Electro-Impulse Laboratory.

This new material is extremely durable, provides a strong adhesive bond to waveguide walls, withstands temperatures up to 2000°F, and handles the thermal shock efficiently.

Eilex is stable up to 2000°F (doesn't emit steam or water, characteristic of dummy loads using a Portland cement and graphite mixture for the lossy material.)

The waveguide loads use walls that are poor conductors, which means a more efficient removal of the heat generated in the load, and less tendency toward pulsepower breakdown (arcing) as may occur in designs which use filling material in the waveguide.

New construction shortens path between inner surface of lossy guide to heat conducting material.

Hot spots have been eliminated.

Attenuators are accurately calibrated and may be used as a termination and power measuring device in conjunction with a thermister bridge.

For details, write Department "E".

Type	Freq Range KMC	Waveguide in inches	Nominal* Average Power Dissipation	Maximum V.W.S.R.	Size in inches	Weight	Flange
			DUMMY LOADS				
HPTK100	18-26.50	½ x ¼	60 W.	1.15	8 long	2 lbs.	UG425/U
DA22/U	8.2-12.4	1.2 x 1	175 W.	1.15	11 x 2.5 x 2.5	3 lbs.	UG39/U
HPTXS250	8.2-12.4	½ x 1	250 W.	1.15	11 x 3.5 x 3.5	3¼ lbs.	UG39/U
HPTXS150	8.2-12.4	½ x 1	150 W.	1.15	11 x 2.5 x 2.5	3 lbs.	UG39/U
HPTXS75	8.2-12.4	½ x 1	75 W.	1.15	11 long	2½ lbs.	UG39/U
DA21/U	7-10	1¼ x ⅝	280 W.	1.15	11.5 x 3.5 x 3.5	6 lbs.	UG51/U
HPTXL250	7-10	1¼ x ⅝	250 W.	1.15	12 x 3.5 x 3.5	3¼ lbs.	UG51/U
HPTXL200	7-10	1¼ x ⅝	200 W.	1.15	11.25 x 2.75 x 2.75	2 lbs. 4 oz.	UG138/U
HPTXL100	7-10	1¼ x ⅝	100 W.	1.15	10 long	2 lbs.	UG51/U
HPTXL500	7-10	1¼ x ⅝	450 W.	1.15	11.25 x 4.5 x 4.5	5¼ lbs.	UG51/U
HPTX600	5.85-8.20	1½ x ¾	600 W.	1.15	14 long	8 lbs.	UG344/U
HPTX800	3.95-5.85	2.00 x 1.00	800 W.	1.15	14 long	12 lbs.	UG149A/U
TS 338	2.4-3.7	1.5 x 3	700 W.	1.1	24 x 5.4 x 5.4	13 lbs.	UG438/U
HPTS1500	2.60-3.95	3.00 x 1.50	1500 W.	1.15	25 long	13 lbs.	UG438/U
HPTL1500	1.70-2.60	4.46 x 2.31	1500 W.	1.15	15 long	20 lbs.	UG435/U
HPTL2000	1.12-1.70	6.66 x 3.41	2000 W.	1.15	32 long	24 lbs.	UG417/U
			ATTENUATORS				
HPAXS	8.2-12.4	1.2 x 1.00	250 W.	1.15	Attenuation 2-60 decibels (fixed)		UG39/U
HPAXL	7.00-10	1¼ x ⅝	450 W.	1.15	Attenuation 2-60 decibels (fixed)		UG51/U

* Without the use of water or forced air cooling.

ELECTRO IMPULSE Laboratory

62 WHITE STREET • RED BANK, N.J.
RED BANK 6-0404

ing and equipping the company for its entry into the electronic flight simulator field. Following the successful completion of the first Flightronic simulators, Mr. Greene was appointed vice-president of engineering. He began his career with ERCO more than fifteen years ago as an aeronautical engineer.

Norde Joins Hammarlund As Chief Receiver Engineer

LESLIE NORDE has joined the Hammarlund Manufacturing Co., Inc. as chief receiver engineer after nearly 5 years at the Northern Radio Corp. where he was senior project engineer, it has been announced by S. H. Van Wambeck, chief engineer of Hammarlund.

Leslie Nord

In his new position Norde is supervisor and technical consultant for the design of Hammarlund commercial and amateur radio receivers. At Northern Radio he supervised the designing of space diversity receivers and carrier shift radio teletype transmitting equipment.

Mallory Forms Electronic Equipment Department

TO MEET increasing demand for electronic products by both the consumer and the military, P. R. Mallory & Co. Inc., Indianapolis has created a new electronic equipment department to manufacture special assemblies, including complete electronic systems.

Named as manager of the new department is Joseph C. Rah, for-

merly manager of the firm's switch division. Mr. Rah has been with the Mallory firm for 16 years, serving in engineering capacities throughout the company.

Dyson of Erie Resistor Honored By England

A. A. DYSON, managing director of Erie Resistor Ltd., has been included in Queen Elizabeth's New Years Honors List to receive the Order of British Empire, which is presented to civilians of the British Empire that have performed outstanding service to the Empire.

Mr. Dyson has been active during and since World War II on many British Government electronics planning and production boards.

Electronic Company Formed By Universal Match Corp.

A NEW electronic company, Unitronics, Inc., has been formed by Universal Match Corp. to replace Precision Engraving Company, also a subsidiary company.

Phillip Gilbert, director of graphic art research and development, and Theodore Hommel, chief electronic engineer, have been named vice-presidents of Unitronics . Mr. Hommel will be the company's general manager and Mr. Gilber will be in charge of engineering and production.

The new company is manufacturing electronic light-integrating instruments and plans to introduce a new line of industrial electronic equipment later this year.

O'Neill Heads New Plant

WILLIAM O'NEILL JR. has been appointed plant manager of the new $2 million battery factory of Sonotone Corp. at Cold Spring, N. Y.

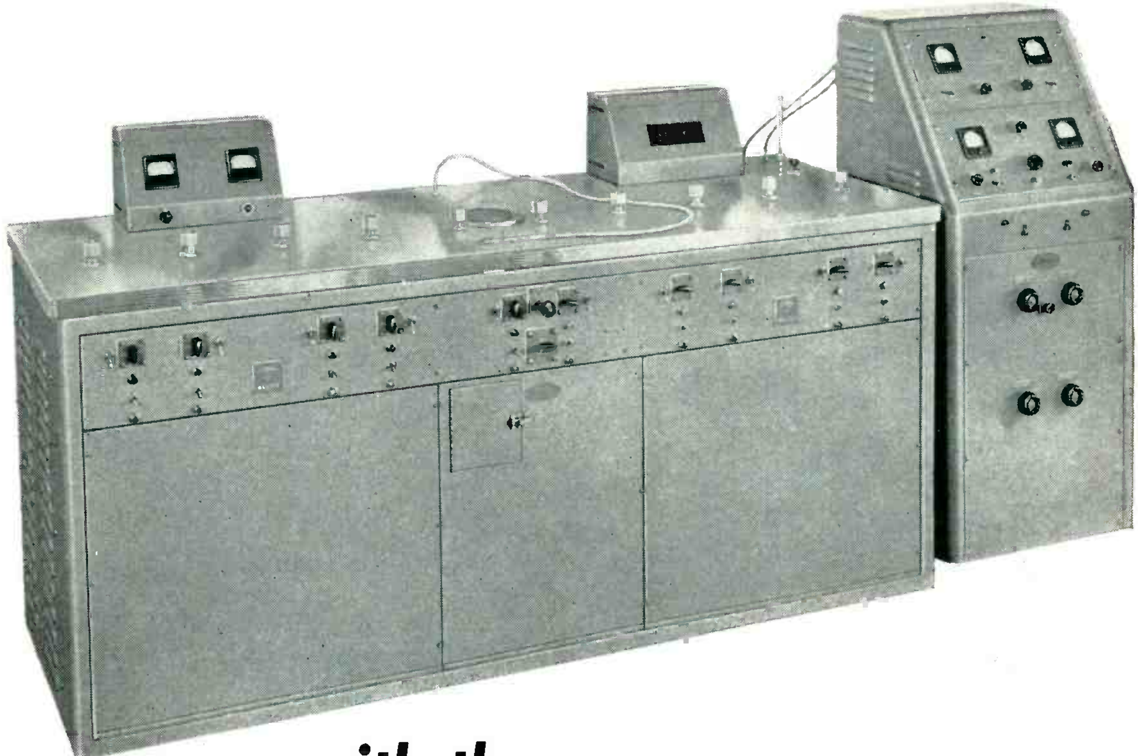
Hickok Opens Plants

OFFICIAL opening of a new assembly plant of the Hickok Electric Instrument Co. in Cleveland recently took place. The $200,000, one-floor modern factory houses assembly operations for electronic

Want more information? Use post card on last page.

LEAK-TIGHT

HERMETIC SEALING



with the Veeco ten-port manifold and leak detector

The equipment pictured above is a complete unit for evacuating, leak-testing, and back-filling hermetically sealed components such as relays, switches, amplifiers, electronic tubes, gyros and aircraft instruments.

The manifold simultaneously evacuates ten components; first with a rough pump, then a high vacuum diffusion pump. The vacuum process is monitored by self-contained gauges. If any leakage exists it is immediately located by the Veeco Leak Detector, proven to have the highest, constant sensitivity. After leak checking, components are filled with a suitable gas through separate filling lines.

Veeco Solenoid Vacuum Valves control pumping and filling operations. The valves are energized by switches on the front panel. The standard manifold has both local and master control, giving greatest flexibility. Each port can be operated by its own switch, or any number of ports can be controlled at one time with a master switch.

Both smaller and larger manifolds are available, built to your special requirements, if necessary.

Write for bulletin EM-3.

VACUUM-ELECTRONIC ENGINEERING CO.

86 Denton Avenue, New Hyde Park, Long Island, N. Y.

test equipment. Designing, engineering and meter manufacturing continue in an older building.

Gray Research Names Smith

NEWLAND F. SMITH, formerly director of general engineering for the Mutual Broadcasting System and WOR, has been appointed assistant general manager for Gray Research and Development Co., Inc.

Harrison Named Wilcox V-P

ARTHUR E. HARRISON, formerly chief engineer of Air Associates electronics division, is now vice-president and chief engineer of Wilcox Electric Co., Kansas City, Mo.

Maxson Assigns Personnel

THE W. L. MAXSON CORP. announced several personnel assignments. S. Merrill Skeist has been elected vice-president and is now in charge of the Contracts Division.

Other appointments with the Contracts Division are: J. W. Bjorkman, executive assistant to the vice-president and manager of the planning department; J. L. Comer, staff assistant to the vice-president and manager of the administrative department; W. P. McNally, manager of the Air Force contracts department; J. J. Ryan, manager of the Navy contracts department; A. J. Colton, manager of the Army contracts department.

OTHER NEWS

Hazeltine Gets Navy's "Basic" Agreement

NAVY'S first basic contract agreement has been signed with Hazeltine Electronics Corp. This is an experiment that the Navy is trying out with a few large contractors to speed up the work with company negotiators and attorneys.

It is a master-type agreement in which the Navy and a contractor agree to general provisions to be included in all future contracts. It is not a contract but it allows all applicable general conditions in future contracts to be included

Want more information? Use post card on last page.

merely by reference to the clauses contained in the basic agreement. The only matters left for negotiation will be quantities, prices, specifications and delivery dates.

The general conditions agreed upon fall into two categories. They are mandatory provisions required by the armed services procurement regulation executive orders and other applicable statutes which are used in specific procurements.

Since it will be necessary to send copies of each basic agreement to every Navy purchasing office, inspection office and other interested governmental agencies, it is not considered economical to sign basic agreements with companies making only a few contracts each year.

The Air Force has used basic agreements successfully under its centralized purchasing office at Wright-Patterson Air Force Base.

Tentative Program Set For '53 IRE National Convention

AN ESTIMATED 30,000 radio engineers and scientists will convene on March 23-26 at the Waldorf-Astoria Hotel and Grand Central Palace in New York City for the 1953 IRE National Convention. The program of 220 technical papers and 400 engineering exhibits will be keynoted by the theme "Radio-Electronics, A Preview of Progress." The 43-session technical program will be highlighted by an all-day seminar on "Acoustics for the Radio Engineer" and nine symposia organized by Professional Groups of IRE. The complete tentative program follows:

MONDAY, MARCH 23, 1953—2:30 P.M.

Session 1: Antennas I—General

The Measurement of Highly Directive Antenna Patterns and Over-All Sensitivity of a Receiving System by Solar and Cosmic Noise by Jules Aarons of Air Force Cambridge Research Center, Cambridge, Mass.
Radiation Patterns for Aperture Antennas with Non-Linear Phase Distributions by Charles C. Allen of General Electric Co., Schenectady, N. Y.
Factors Affecting Radiation Patterns of Corrugated Surface Antennas by M. Ehrlich and L. Newkirk of Hughes Aircraft Co., Culver City, Calif.
A Microwave Anechoic Chamber for Antenna Pattern Measurements by Alan H. Simmons of Naval Research Lab., Washington, D. C.
Wide-Frequency-Range Tuned Circuits and Antennas by A. G. Kandoian and William Sichak of Federal Telecommunications Labs., Nutley, N. J.

Session 2: Television I

Theory of Synchronization Applied to NTSC Television by Donald Richman of Hazeltine Corp., Little Neck, N. Y.
Color Synchronization in the NTSC Color

Reeves ®
INSTRUMENT CORPORATION

HIGHLY ADAPTABLE ELECTRONIC DIFFERENTIAL ANALYZING EQUIPMENT

REAC®

(REEVES ELECTRONIC ANALOG COMPUTER)

SIMULATOR • COMPUTER • TESTER

THE REAC FAMILY of electronic and electro-mechanical units continues to grow in number and capability. The Electronic Function Generator and the Electronic Multiplier were recently introduced for real time applications requiring high speed response, where mechanical methods with their inherent frequency limitations were unsatisfactory.

NOW A NEW SIX CHANNEL RECORDER is available featuring, convenient table top recording, interchangeable electric or ink styli and simplified paper loading. Low drift amplifiers, absence of paper weave, and good power regulation combine to make this unit highly accurate.

A ONE CABINET INSTALLATION will soon be in production. The Reeves Electronic Analog Computer C-202 Mod O will contain, in addition to the computing components, four servos and the required power supplies.

PRECISION RESOLVERS

TYPES R-600, R-602

For 60, 400 or 1000 cycle operation; network or winding compensated for high precision trigonometric applications and winding compensated for additional sweep circuit usage. The winding compensated resolvers type R-602 are capable of operation within a frequency range of 10 to 40,000 cps.

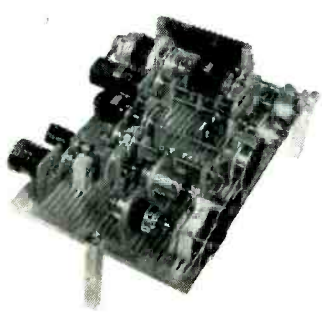
TYPES R-150, R-151

A new miniature resolver in a Navord size 15 case featuring very high input impedance (17,500 ohms when tuned at 400 cps) and a large dynamic range of operation. The unit can withstand better than 50G shock or vibration and operates perfectly above altitudes of 50,000 feet. Type R-151 is winding compensated.

STANDARD AND MINIATURE BREADBOARD INSTRUMENTATION PARTS

STANDARD INSTRUMENTATION PARTS

Reeves Instrument Corporation manufactures a complete line of precision breadboard parts in standard sizes for economical construction of experimental servos and computers including precision gears, component hangers, slotted mounting plates, etc. A shaft diameter of 1/4" is used.



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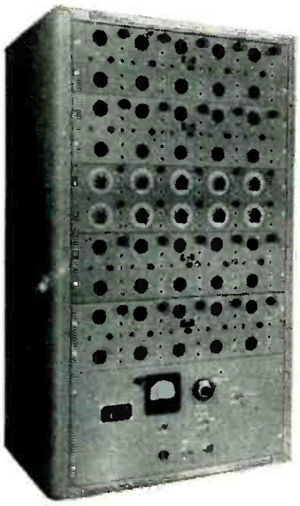

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PLANTS AND PEOPLE (continued)

Television Receiver by Means of the Crystal Filter by W. E. Good of General Electric Co., Syracuse, N. Y.
Automatic-Phase-Control Color Synchronization for NTSC Color Television by Donald Richman of Hazeltine Corp., Little Neck, N. Y.
Transient Response In a Color Carrier Channel With Vestigial Side Band Transmission by J. S. S. Kerr of General Electric Co., Syracuse, N. Y.
Transients in Color Television by P. W. Howells of General Electric Co., Syracuse, N. Y.

Session 3: Circuits I—Network Theory

A General RLC Synthesis Procedure by L. Weinberg of Hughes Aircraft Co., Culver City, Calif.
A General Theory of Wide-band Matching by H. J. Carlin and R. LaRosa of Polytechnic Institute of Brooklyn, Bklyn., N. Y.
Synthesis of Electric Filters With Arbitrary Phase Characteristics by B. J. Bennett of Stanford University, Stanford, Calif.
Wide-Band Filter Amplifiers at Ultra-High-Frequencies by J. M. Pettit and W. A. Christopherson and D. O. Pederson of Stanford Univ., Stanford, Calif.
Network Analysis With the Aid of Generating Polynomials by H. Kurss of Polytechnic Institute of Brooklyn, Bklyn., N. Y.
Two New Equations for the Design of Filters by M. Dishalf Federal Telecommunication Labs., Nutley, N. J.

Session 4: Electronic Computers I

Multichannel Analog Input-Output Conversion System for Digital Computer by P. A. Adamson and M. L. MacKnight of Hughes Aircraft Company, Culver City, Calif.
An Analog to Digital Converter With an Improved Linear Sweep Generator by D. W. Slaughter of California Institute of Technology, Pasadena, Calif.
Dynamic Binary Counter With Analog Read-Out by L. Packer of Columbia Univ., New York, N. Y.
Life and Reliability Experience With Transistors in a High Speed Digital Computer by J. J. Scanlon of Bell Telephone Labs., Whippany, N. J.
Engineering Experience in the Design and Operation of a Large Scale Electrostatic Memory by J. Logue, A. Brennemann and A. Koelsch of IBM Corp., Poughkeepsie, N. Y.

Session 5: Symposium: Instrumentation I—Automatic

A New Method for Measuring Noise Figure and Gain of a Radar Receiver by R. J. Parent and V. C. Rideout of Univ. of Wisconsin, Madison, Wis.
Automatic Instrumentation for Continuous Monitoring of Systems Performance by M. V. Ratynski, M. Kant and H. Webb of Rome Air Development Center, Rome, N. Y.
Automatic One-Shot Methods for Bandwidth Measurement by J. B. Woodford, Jr. and E. M. Williams of Carnegie Institute of Technology, Pittsburgh, Pa.
Microwave Power Meter with Automatic Zero Setting and Telemetering by L. A. Rosenthal and G. M. Badoyannis of Rutgers Univ., New Brunswick, N. J.
Monitoring of Errors in Synchro Servo Systems by G. Quazza of Polytechnic Institute of Brooklyn, Bklyn, N. Y.

Session 6: Radio Location, Navigation and Airborne Electronics

The Technique of Monopulse Radar by W. Hausz of General Electric Co., Syracuse, N. Y.
Reducing Sky Wave Errors in CW Tracking Systems by Marvin S. Friedland of Patrick Air Force Base, Fla. and Nathan Marchand of Electronics Lab. Greenwich, Conn.
An Application of Integrator Type Signal Enhancer to Direction Finding Equipments by C. A. Strom and J. A. Fantoni of Rome Air Development Center, Rome, N. Y.
A Theory of Target Glint or Angular Scintillation in Radar Tracking by Richard H. Delano of Hughes Aircraft Co., Culver City, Calif.
Automatic Dead Reckoning Navigation Computers for Aircraft by James L. Dennis of Wright Air Development Center, Dayton, Ohio.

TUESDAY, MARCH 24, 1953—10:00 A.M.

Session 7: Antennas II—Microwave

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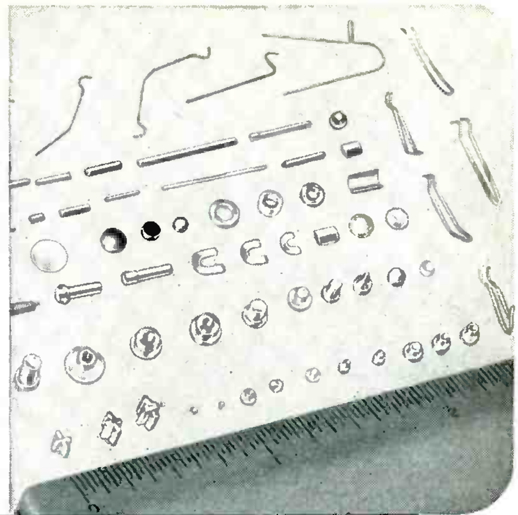

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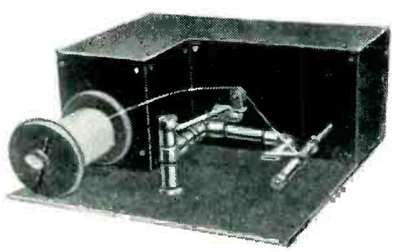

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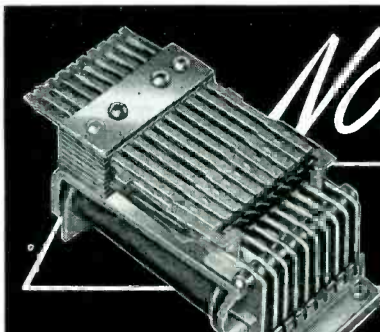

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Arrays of Flush Mounted Travelling Wave Antennas by J. N. Hines, V. H. Rumsey and T. E. Tice of The Ohio State University, Columbus, Ohio.
Transient Build-Up of the Antenna Pattern in End-Fed Linear Arrays by Norman H. Enenstein of Hughes Aircraft Company, Culver City, Calif.
A New Microwave Reflector by K. S. Kelleher of Naval Research Lab., Washington, D. C.
Crosstalk in Radio Relay Systems Caused by Foreground Reflections" by H. W. Evans of Bell Telephone Labs., New York, N. Y.
Low Side Lobes in Pencil-Beam Antennas by E. M. T. Jones of Stanford Research Institute, Stanford, Calif.

Session 8: Television II

Probability Distribution Measurements of Television Signals by W. F. Schreiber, Cruft Lab. of Harvard University, Cambridge, Mass.
Colorimetric Properties of Gamma-Corrected Color Television Systems by D. C. Livingston of Sylvania Electric Products, Inc., Bayside, N. Y.
Phase Measurements at Subcarrier Frequency in Color Television by A. P. Stern of General Electric Company, Syracuse, N. Y.
A Precision Line Selector for Television Use by I. C. Abrahams and R. C. Thor of General Electric Company, Syracuse, N. Y.
A Monitoring System for NTSC Color Television Signals by C. E. Page of Hazeltine Corp., Little Neck, N. Y.

Session 9: Circuits II—Symposium: Panel Discussion on Wideband Amplifiers

Conventional Amplifiers by W. Bradley of Philco Corp., Philadelphia, Pa.
Feedback Amplifiers by H. N. Beveridge of Raytheon Mfg. Co., Newton, Mass.
Transistor Amplifiers by R. L. Wallace of Bell Telephone Labs.
Distributed Amplifiers by W. G. Tuller and E. H. Bradley of Melpar Electronics Alexandria, Va.
Traveling Wave Tube Amplifiers by L. Field of Stanford Univ., Stanford, Calif.

Session 10: Electronic Computers II

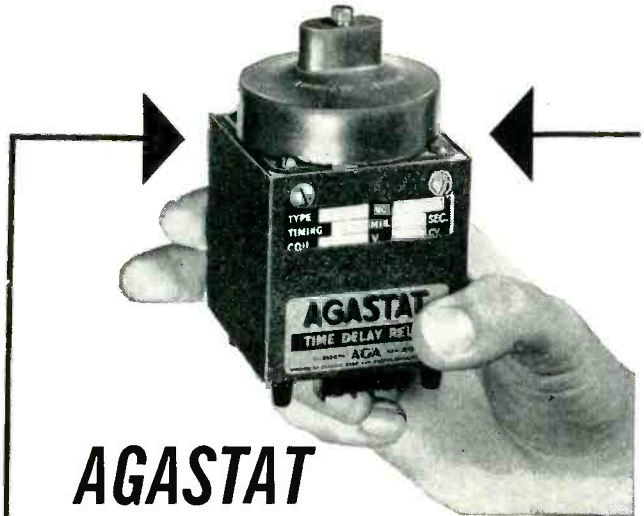
Analog Computing with Magnetic Amplifiers Using Multi-Phase A-C Voltages by J. E. Richardson of Huges Aircraft Company, Culver City, Calif.
Some Recent Developments in Logical 'Or-and-Or' Pyramids for Digital Computers by C. Leondes of University of Pennsylvania, Philadelphia, Pa.
Magnetic Core Switches as Logical Elements in Computers by Eugene A. Sands of Magnetics Research Co., Chappaqua, N. Y.
Magnetic Shift Register Using One Core Per Bit by R. D. Kodis, S. Ruhman and W. D. Woo of Raytheon Mfg. Co., Waltham, Mass.
Simple Computer for Automatically Plotting Correlation Functions by A. H. Schooley of Naval Research Lab., Washington, D. C.

Session 11: Instrumentation II—Symposium: Transistor Measurements

Transistor Metrology by D. A. Alsberg of Bell Telephone Labs., Murray Hill, N. J.
Measurement of Transistor Parameters by CRO and Other Methods by W. E. Morrow, Jr., MIT of Cambridge, Mass.
Transistor Static Characteristics Obtained by Pulse Techniques by D. R. Fewer of Bell Telephone Labs., Murray Hill, N. J.
Bridges for Measuring Junction Transistor Admittance Parameters by L. J. Giacoletto of RCA Labs., Princeton, N. J.
A Transistor Alpha Sweeper by H. G. Follingstad of Bell Telephone Labs., Murray Hill, N. J.
Rapid Tracing of Transistor Characteristics by Oscillographic Methods by V. Mathis of General Electric Co., Syracuse, N. Y.

Session 12: Significant Trends in Airborne Equipment

Some Systems Considerations in Flight Control Servomechanism Design by Robert J. Bibbero and Roland Grandgent of Republic Aviation Corp., New York, N. Y.
Faired-In ADF Antennas by Louis E. Raburn of Electronics Research Inc., Evansville, Ind.
Magnetic Amplifiers for Airborne Appli-



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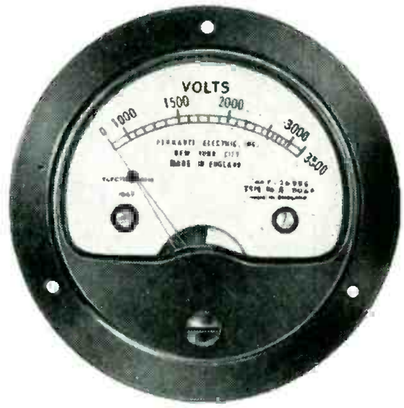

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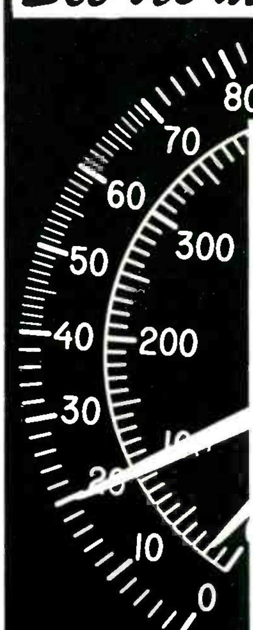

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cations by J. K. McKendry of General Precision Labs., Pleasantville, N. Y.
Aircraft Electrical Power by J. C. Dieffenderfer and George W. Sherman of Wright Air Development Center, Dayton, Ohio.
The Effects of Electronic Equipment Standardization on Aircraft Performance by George C. Sumner of Consolidated Vultee Co., Fort Worth, Texas.

TUESDAY, MARCH 24, 1953—2:30 P.M.

Session 13: Antennas III—Propagation

Notes on Propagation by L. A. Byam, Jr. of The Western Union Telegraph Co., New York, N. Y.
Tropospheric Propagation in Horizontally Stratified Media over Rough Terrain by H. M. Swarm, R. N. Ghose, G. H. Keitel of University of Washington, Seattle, Wash.
Radio Wave Scattering in Tropospheric Propagation by J. W. Herbstreit, K. A. Norton, P. L. Rice and G. E. Schafer of National Bureau of Standards, Boulder, Col.
Extended-Range Radio Transmission by Oblique Reflection from Meteoric Ionization by O. G. Villard, Jr., A. M. Peterson, L. A. Manning and Von R. Eshleman of Electronics Research Lab., Stanford University, Stanford, Calif.
An Interpretation of Vertical Incidence Equivalent Height versus Time Recordings on 150 Kc/s by Rune Lindquist of Ionosphere Research Lab. The Pennsylvania State College, State College, Pa.

Session 14: Symposium: Diagnostic Programs and Marginal Checking for Large Scale Digital Computers.

(Program to be announced)

Session 15: Circuits III—Time Domain Networks—Delay Lines

Continuously Variable Delay Line by C. Berkley of Allen B. Du Mont Labs. Inc., Clifton, N. J.
General Transmission Theory of Distributed Helical Delay Lines with Bridging Capacitance by M. J. DiToro of Du Mont Labs., Inc., Passaic, N. J.
Distributed Constant Delay Lines with Characteristic Impedances Higher Than 5000 OHMS by W. S. Carley of U. S. Naval Ordnance Lab., Silver Spring, Md.
Helical Winding Exponential-Line Pulse Transformers for Millimicrosecond Service by J. Kukel and E. M. Williams of Carnegie Institute of Technology, Pittsburgh, Pa.
Time Domain Approximation by Use of Pade Approximants by R. D. Teasdale of RCA, Camden, N. J.
Frequency Transients in Idealized Linear Systems by B. Gold of Hughes Aircraft Co., Culver City, Calif.

Session 16: Electron Devices I—Transistors

The Negative Resistance Diode by I. A. Lesk and Vernon P. Mathis of General Electric Co., Syracuse, N. Y.
Reliability of Transitors by W. R. Sittner of Bell Telephone Labs., Allentown, Pa., and R. M. Ryder of Bell Telephone Labs., Murray Hill, N. J.
Characteristics of the M-1768 Transitor by L. B. Valdes of Bell Telephone Labs., Murray Hill, N. J.
Developmental High Frequency Alloy Transitors by C. W. Mueller and J. I. Pankove of RCA Labs. Div., Princeton, N. J.
Behavior of Germanium Junction Transistors at Elevated Temperatures and Power Transitors Design by L. D. Armstrong of RCA Labs Div., Princeton, N. J.

Session 17: Instrumentation III—Electronics

The Response of a Panoramic Receiver to CW and Pulse Signals by H. W. Batten, R. A. Jorgensen, A. B. Macnee and W. W. Peterson of University of Michigan, Ann Arbor, Mich.
A VHF Impedance Meter by J. H. Mennie of Boonton Radio Corp., Boonton, N. J.
Simplified Measurement of Incremental Pulse Time Jitter by W. T. Pope of Griffiss Air Force Base, Rome, N. Y.
Wide-Band Wave Analyzer by O. Kummer of Bell Telephone Labs., Murray Hill, N. J.
Ultra-Low Frequency, Three-Phase Oscillator by G. Smiley of General Radio Co., Cambridge, Mass.

Session 18: Symposium: Trends in Mo-

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bile Communications

The Effects of Selectivity, Sensitivity and Linearity in Radio Circuits on Communications Reliability and Coverage by J. G. Schermerhorn of Rome Air Development Center, Rome, N. Y.
Single Sideband for Mobile Communications by A. Brown and R. H. Levine of Coles Signal Lab., Ft. Monmouth, N. J.
Major Factors in Mobile Equipment Design with Emphasis on 460 MC Mobile Equipment Characteristics by John Byrne and A. A. Macdonald of Motorola, Inc., Chicago, Ill.
Field Experience with 450 MC Mobile Systems by P. H. Bellingham and J. Q. Montrese of Bell-Mont Communications Service Corp., Englewood, N. J.

TUESDAY, MARCH 24, 1953—8:30 P.M.

Session 19: (to be announced)
WEDNESDAY, MARCH 25, 1953—10:00 A.M.

Session 20: Electron Devices II—Electron Tubes

Gas Pressure Effects on Ionization Phenomena in High-Speed Hydrogen Thyratrons by William C. Dean of Odessa, Texas and G. W. Penney and J. B. Woodford, Jr. of Carnegie Institute of Technology, Pittsburgh, Pa.
Low Noise, Hot Cathode, Gas Tubes by E. O. Johnson, W. M. Webster and J. B. Zirker of RCA Labs. Div., Princeton, N. J.
New Dispenser Type Thermionic Cathode by R. Levi.
Multi Output Beam Switching Tubes for Computers and General Purpose Use by Saul Kuchinsky of Burroughs Adding Machine Co., Philadelphia, Pa.
An Equivalence Principle in High Frequency Tubes by Robert Adler of Zenith Radio Corp., Chicago, Ill.

Session 21: Circuits IV—Active Networks—Transitors

Transient Analysis of Junction Transitor Amplifiers by J. J. Suran and W. F. Chow of General Electric Co., Syracuse, N. Y.
The Grounded-Collector Transitor Amplifier at Carrier Frequencies by F. R. Stansel of Bell Telephone Labs., Murray Hill, N. J.
Symmetrical Properties of Transitors and Their Application by G. C. Sziklai, RCA Labs. Div. of Princeton, N. J.
A Study of Transitor Circuits for Television by G. C. Sziklai, R. D. Lohman and G. B. Herzog of RCA Labs. Div., Princeton, N. J.
Conductance Curve Design of Relaxation Circuits by K. A. Pullen of Ballistic Research Labs., Aberdeen Proving Ground, Md.
Transitor Relaxation Oscillators by S. I. Kramer of Fairchild Guided Missiles Div., Wyandanch, N. Y.

Session 22: Noise and Modulation

Noise Problems of Theoretical and Practical Interest by Bernard Gold of Hughes Aircraft Co., Culver City, Calif.
A Note on Receivers for Use in Studies of Signal Statistics by R. Deutsch and H. V. Hance of Hughes Aircraft Co., Culver City, Calif.
Amplitude Modulation by Plate Modulation of CW Magnetrons by J. S. Donal, Jr., and K. K. N. Chang of RCA Labs. Div., Princeton, N. J.
Comparison of Modulation Methods by R. M. Page of Naval Research Lab., Washington, D. C.
A Technique of Intermodulation Interference Determination by A. J. Beauchamp of Rome Air Development Center, Rome, N. Y.

Session 23: Symposium: Television Broadcasting

The Design of Speech Input Consoles for Television by Robert H. Tanner of Northern Electric Co., Ltd., Belleville, Canada.
Building TV Broadcast Facilities for Growth, Flexibility and Economy by Allen R. Kramer and Edwin R. Kramer of Kramer, Winner and Kramer, New York, N. Y.
Fashions in TV Transmitting Antennas by Frank G. Kear of Kear and Kennedy, Washington, D. C., and John G. Preston of American Broadcasting Co., New York, N. Y.
High Gain Amplifiers for High Power Television Transmitters by John Ruston of DuMont Labs., Inc., Clifton, N. J.
Optimum Utilization of the Radio Frequency Channel for Color TV by Ray D.

Kell and A. C. Schroeder of RCA Labs., Princeton, N. J.

Session 24: Quality Control Methods Applied to Electron Tube and Electronic Equipment Design

Use of Statistical Tolerances to Obtain Wider Limits on Tube Component Dimensions by E. V. Space of RCA, Harrison, N. J.
Tolerance Considerations in Electronic Product Design by Raymond C. Miles of Airborne Instruments Lab., Mineola, N. Y.
Distribution Patterns for the Attributes of Electronic Circuitry by R. F. Rollman and E. D. Karmiol of DuMont Labs., East Paterson, N. J.
The Application of Statistics to Field Surveillance of Product Performance by R. Herd of Aeronautical Radio, Inc., Washington, D. C.
Reliability of Electron Tubes in Military Applications by E. F. Jahr of Aeronautical Radio, Inc., Washington, D. C.
Dynamic Environment Testing by D. T. Geiser of Boeing Airplane Co., Wichita, Kansas.

Session 25: Seminar: Acoustics for the Radio Engineer—I

Fundamental Theory by Leo L. Beranek of MIT, Cambridge, Mass.
Microphones by Harry F. Olson, RCA of Princeton, N. J.
Loudspeakers by Hugh S. Knowles of Industrial Research Products, Inc., Franklin Park, Ill.

WEDNESDAY, MARCH 25, 1953—2:30 P.M.

Session 26: Electron Devices III—Microwave Tubes

High Power Traveling Wave Tube Amplifiers by M. Ettenberg of Sperry Gyroscope Co., Great Neck, N. Y.
Operation of the Traveling-Wave Tube in the Dispersive Region by L. A. Roberts and S. F. Kaisel of Electronics Research Lab., Stanford Univ., Stanford, Calif.
A Traveling-Wave Electron Buncher by R. B. Neal of Stanford Univ., Stanford, Calif.
Some Properties of Periodically Loaded Structures Suitable for Pulsed Traveling Wave Tube Operation by Marvin Chodorow and Ervin J. Nalos of Microwave Lab., Stanford Univ., Stanford, Calif.
Experiments on Millimeter Wave and Light Generation by H. Motz, W. Thon and R. N. Whitehurst of Stanford Univ., Stanford, Calif.

Session 27: Information Theory I—Recent Advances

Recent Advances in Information Theory by Louis DeRosa of Federal Telecommunication Labs., Inc., Nutley, N. J.
Radar Problems and Information Theory by Harry Davis of Airmaterial Command, Redbank, N. J.
Analysis of Multiplexing and Signal Detection by Function Theory by Nathan Marchand of Marchand Electronic Labs., Greenwich, Conn.
Optimum Nonlinear Filters for the Extraction and Detection of Signals by L. A. Zadeh of Columbia University, New York, N. Y.
Detection of Information by Moments by J. J. Slade, Jr., S. Fich, D. A. Molony of Rutgers University, New Brunswick, N. J.

Session 28: Communications Systems

Automatic-Tuning Communications Transmitter by M. C. Dettman of Federal Telecommunication Labs., Nutley, N. J.
Doubling of Channel Capacity of Single Sideband Systems by Clifford D. May of the Office of Chief Signal Officer, Washington, D. C.
Performance of Space and Frequency Diversity Receiving Systems by R. E. Lacy of Fort Monmouth, N. J., M. Acker of Fort Monmouth, N. J. and J. L. Glaser of Bell Telephone Labs., New York, N. Y.
Effect of Hits in Telephotography by P. Mertz and K. W. Pfleger of Bell Telephone Labs., New York, N. Y.
Reliability of Military Electronic Equipment and Our Ability to Maintain it for War by A. S. Brown of Stanford Research Institute, Stanford, California.

Session 29: Symposium: Television Broadcasting and UHF

A Flexible TV Studio Intercommunication System by R. D. Chipp and R. F. Bigwood

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of DuMont Television Network, New York, N. Y.
CBS Television's Hollywood TV City: Video, Audio and Intercommunication Facilities by Richard O'Brien, Robert Monroe and Price Fish of Columbia Broadcasting System, New York, N. Y.
An Experimental Study of Wave Propagation at 850-MC by Jess Epstein and Donald W. Peterson of RCA Labs., Princeton, N. J.
A Typical UHF Installation by W. H. Sayer, Jr. of DuMont Labs., Passaic, N. J.
High Power UHF Klystron Application by A. E. Rankin of General Electric Co., Schenectady, N. Y.
High Power UHF Klystron Amplifier Design by N. P. Hiestand of Varian Associates, San Carlos, Calif.
High Power UHF Television Broadcasting Systems by H. M. Crosby of General Electric Co., Syracuse, N. Y.

Session 30: Microwaves I—Symposium: Manufacture of Microwave Equipment

How to Design Microwave Components for Ease of Assembly by F. Neukirch of N. R. K. Manufacturing & Engineering Co., Chicago, Ill.
The Design of Microwave Components for Production by Henry J. Riblet of Microwave Development Labs., Waltham, Mass.
Fabrication of Microwave Components Employing the Dip Brazing Process by William J. Rudolph of The Glenn L. Martin Co., Baltimore, Maryland.
Electroforming with Copper, Nickel and Other Metals by C. L. Duncan of Chamblee, Ga.
Manufacturing Microstrip Printed Circuit Components by H. F. Engelman (probable speaker) of Federal Telecommunication Labs., Nutley, N. J.

Session 31: Seminar: Acoustics for the Radio Engineer—II

Phonograph Reproducers by Benjamin B. Bauer of Shure Brothers, Inc., Chicago, Ill.
Tape Recording by Marvin Camras of Armour Research Foundation, Chicago, Ill.
Studio Acoustics by Hale J. Sabine of Celotex Co., Chicago, Ill.

THURSDAY, MARCH 26, 1953—10:00 A.M.

Session 32: Symposium: Nucleonics

Servomechanism for Remote Manipulation by Raymond C. Geortz of Argonne National Lab., Chicago, Ill.
The Applications of Secondary Emission Multiplier to Nuclear Particle Measurements by George Morton of RCA Labs., Div., Princeton, N. J.
Electronic Circuitry for Nuclear Reactors (speaker to be announced)
Billion-electron-volt Accelerators by Kenneth Green of Brookhaven National Lab., Upton, L. I., N. Y.
Instrumentation Developments in Fast Neutron Dosimetry by G. S. Hurst and R. H. Ritchie of Oak Ridge National Lab., Oak Ridge, Tenn.

Session 33: Information Theory II—Theoretical

Error Probabilities of Binary Data Transmission Systems in the Presence of Random Noise by S. H. Reiger of Air Force Cambridge Research Center, Cambridge, Mass.
Statistical Properties of the Output of Certain Frequency Sensitive Devices by G. R. Arthur of Sperry Gyroscope Co., Great Neck, N. Y.
Cross-Correlation Applied to Automatic Frequency Control by M. J. Stateman of Sylvania Electric Products, Inc., Bayside, N. Y.
Approximate Probability Density Function of First Level Crossing for Linearly Increasing Signal Plus Noise by G. Preston and R. Gardner of Philco Corp., Philadelphia, Pa.
A Design Criteria for the Optimum Demodulation of Generalized Modulated Signals by F. W. Lehan of California Institute of Technology, Pasadena, Calif.

Session 34: Medical Electronics

Electric Photograph by K. S. Lion, MIT, Cambridge, Mass.
Concerning the Use of High Energy Particles and Quanta in the Determination of the Structure of Living Organisms by R. J. Moon of University of Chicago, Chicago, Ill.
Possible Medical and Industrial Application of Linear Electron Accelerators by

W. C. Barber of Stanford University, Stanford, California.
Capacity and Conductivity of Body Tissues at Ultra High Frequencies by Herman P. Schwan and Kam Li of University of Pennsylvania, Philadelphia, Pa.
The Problem of Application of Electronics to Medicine by Robert S. Schwab of Mass. General Hospital, Boston, Mass.
Progress Report in Electronic Mapping of the Electrical Activity of the Heart by Stanford Goldman, W. D. Spence, Mary Rizika and Silvan Lidovitch of Syracuse Univ., East Syracuse, N. Y.

Session 35: Broadcast and Television Receivers—I

Gain Stable Mixers and Amplifiers with Current Feedback by Gail E. Boggs of National Bureau of Standards, Washington, D. C.
Video Amplifiers with Instantaneous Automatic Gain Control by William E. Ayer of Stanford University, Stanford, Calif.
An Automatic Level-Setting Sync and AGC System by E. O. Keizer of RCA Labs., Princeton, N. J. and M. G. Kroger of Motorola, Inc., Chicago, Ill.
Packaged Adjacent Channel Attenuation for Television Receivers by John P. Van Duyne of DuMont Labs, Inc., Clifton, N. J.
Methods of Matrixing in an NTSC Color Television Receiver by Will M. Quinn of General Electric Co., Syracuse, N. Y.

Session 36: Microwaves II—Discontinuities and Transitions

R-F Measurements on Metallic Delay Media by Seymour B. Cohn of Sperry Gyroscope Co., Great Neck, N. Y.
Impedance Measurement in a Circular Waveguide with TE_{01} Excitation by Leonard S. Sheingold of Sylvania Electric Products Inc., Boston, Mass.
Experimental Determination of the Properties of Microstrip Components by M. Arditi of Federal Telecommunication Labs., Inc., Nutley, N. J.
A Wideband Transition Between Waveguide and Coaxial Line by Ned A. Spencer and Harold A. Wheeler of Wheeler Labs., Great Neck, N. Y.
A Contribution to the Ridge Guide Problem by Bela A. Lengyel of Hughes Aircraft Co., Culver City, Calif.

Session 37: Radio Telemetry

Telemetering Requirements for Upper Air Rocket Research Experiments by Marcus O'Day of Air Force Cambridge Research Center, Cambridge, Mass.
Telemetering—Broad Band on Short Order by Thomas F. Jones, Jr., of General Electronic Labs., Inc., Boston, Mass.
Flutter Compensation for FM/FM Telemetering Recorder by John T. Mullin of Bing Crosby Enterprises, Inc., Los Angeles, Calif.
A Magnetic Tape Recording System for Precision Data by Louis L. Fisher of Ampex Electric Corp., Redwood City, Calif.
An Improved FM/FM Decommutator Ground Station by Foster N. Reynolds of The Ralph M. Parsons Co., Pasadena, Calif.
Some Industrial Applications of Telemetry by F. N. Stephens of Midwest Research Institute, Kansas City, Mo. and Lee Bergren of Great Lakes Pipe Line Co., Kansas City, Mo.

THURSDAY, MARCH 26, 1953—2:30 P.M.

Session 38: Audio

Sound Reinforcement System, General Assembly, United Nations by Leo L. Beranek of MIT, Cambridge, Mass. and C. W. Goyder of United Nations, Telecommunications Div., New York, N. Y.
A Variable Time Delay by Kenneth Goff of Acoustics Lab., MIT, Cambridge, Mass.
A Flux Sensitive Head for Magnetic Recording Play Back by David E. Wiegand of Armour Research Foundation, Chicago, Ill.
Uniaxial Microphone by Harry F. Olson, John Preston and John C. Bleazey of RCA Labs., Princeton, New Jersey.
Sound Pressure Measurement Between 50 and 220 BD by J. K. Hilliard of Altec Lansing Corp., Beverly Hills, Calif.

Session 39: Engineering Management

Report of Year's Activities by the Chairman of the Professional Group on Engineering Management by Ralph I. Cole

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22CR	3-26 KV	2 ma. @ 18 KV	.5%
22M	3-26 KV	3 ma. @ 20 KV	
22MR	3-26 KV	3 ma. @ 20 KV	.5%
23C	5-40 KV	1.3 ma. @ 25 KV	
23CR	5-40 KV	1.3 ma. @ 25 KV	.5%
23M	5-45 KV	1.5 ma. @ 30 KV	
23MR	5-45 KV	1.5 ma. @ 30 KV	.5%
24C	5-50 KV	1 ma. @ 35 KV	

MODEL No.	VOLTAGE RANGE	CURRENT RANGE	REGU-LATION
24CR	5-50 KV	1 ma. @ 35 KV	.5%
24M	5-55 KV	2 ma. @ 30 KV	
24MR	5-55 KV	2 ma. @ 30 KV	.5%
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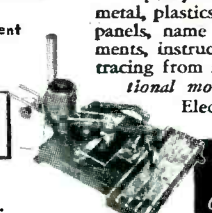

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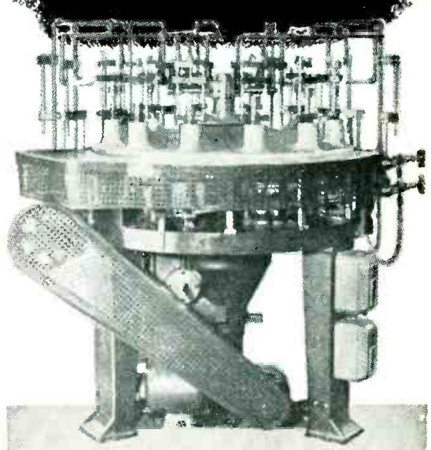

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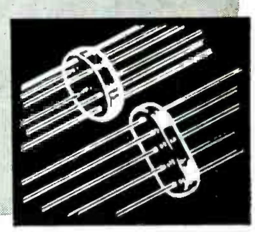

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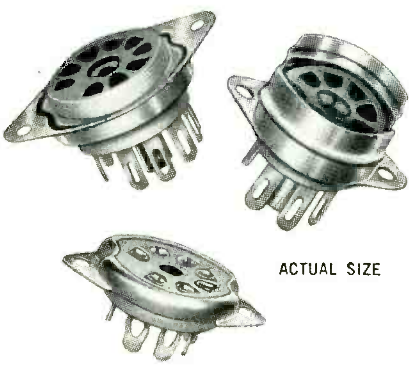

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of Rome Air Development Center, Rome, N. Y.

General Problems of Engineering Management Facing the Electronics Industry by Haraden Pratt, Telecommunications Advisor to the President, Washington, D. C.

Research and Development Problems of Engineering Management in the Electronics Industry by M. J. Kelly of Bell Telephone Labs., Inc., New York, N. Y.

Production Aspects of Engineering Management in the Electronics Industry by W. A. McDonald of Hazeltine Electronics Corp., Little Neck, N. Y.

What the Military Services Expect from Engineering Management of the Electronics Industry by Donald L. Putt of Air Research and Development Command, Baltimore, Md .

Session 40: Information Theory III—Coding

A Necessary and Sufficient Condition for Unique Decomposition of Coded Messages by A. A. Sardinas and G. W. Patterson of Burroughs Adding Machine Co., Philadelphia, Pa.

A Systematic Survey of Coders and Decoders by B. Lippel of Fort Monmouth, N. J.

Method for Time or Frequency Compression—Expansion of Speech by G. Fairbanks, W. L. Everitt and R. Po. Jaeger of University of Illinois, Urbana, Ill.

A New Coding System for Pulse Code Modulation by A. G. Fitzpatrick of Burroughs Adding Machine Co., Philadelphia, Pa.

Coincidence Detectors for Binary Pulses by Clarence Gates of California Institute of Technology, Pasadena, California.

Session 41: Broadcast and Television Receivers—II

Factors Affecting the Design of VHF-UHF Tuners by E. H. Boden of Sylvania Electric Products Inc., Emporium, Pa.

Theory of A.F.C. Synchronization by Wolf J. Gruen of General Electric Co., Syracuse, N. Y.

Standardization of Printed Circuit Materials for Mechanized Radio Assembly by W. Hannahs, J. Caffiaux and N. Stein of Sylvania Electric Products, Bayside, L. I., N. Y.

A Color TV Receiver for the NTSC System by Kenneth E. Farr of Westinghouse Electric Corporation, Metuchen, N. J.

A Simple Pickup Camera Attachment for Television Receivers by V. K. Zworykin, L. E. Flory and W. S. Pike of RCA Labs. Div., Princeton, N. J.

Session 42: Microwaves III—Ferrites and Detectors

Space Charge Detector for Microwaves by A. B. Bronwell, John May, Charles Nitz, T. C. Wang, and Hilliard Wachowski of American Society for Engineering Education, Evanston, Ill.

Low Level Synchronous Mixing by M. E. Brodwin, C. M. Johnson of The Johns Hopkins University, Baltimore, Md. and W. M. Waters of Bendix Radio, Towson, Md.

Guided Wave Propagation Through Ferrites and Electron Gases in Magnetic Fields by L. Goldstein, M. Gilden, and J. Etter of University of Illinois, Urbana, Ill.

Cavities with Complex Media by A. D. Berk and Benjamin Lax of MIT, Cambridge, Mass.

Resonance in Cavities with Complex Media by Benjamin Lax and A. D. Berk of MIT, Cambridge, Mass.

Session 43: Remote Control Systems

The Organization of a Digital Real Time Simulator by H. J. Gray, Jr. of University of Pennsylvania, Philadelphia, Pa.

Control System Engineering Applied to Suspension Systems by C. J. Martin, R. Jeska and E. B. Therkelsen of University of Michigan, Ypsilanti, Mich.

Experimental Evaluatoin of Control Systems by Random-Signal Measurements by William W. Seifert of MIT, Cambridge, Mass.

Extension of Conventional Techniques to the Design of Sampled-Data Systems by W. K. Linvill and R. W. Sittler of MIT, Cambridge, Mass.

Generalized Servomechanism Evaluation by W. P. Caywood and William Kaufman of Carnegie Institute of Technology, Pittsburgh, Pa.

Method for Reducing the Forced Dynamic Error of Closed-Loop Systems by L. H. King of MIT, Cambridge, Mass.

NEW BOOKS

Electrical Fundamentals of Communication

BY A. E. ALBERT. *2nd Edition, McGraw-Hill Book Co., Inc., New York,* 1952, 531 *pages,* $7.00.

PROFESSOR Albert's first edition of "Electrical Fundamentals of Communication" appeared in 1942 as a text designed for the individual interested in familiarizing himself with simplified laws of electrical communication. The book was designed for the student with only a limited background in physics and mathematics. The main topics discussed were d-c and a-c circuit constants, networks and measurements of electrical quantities, electron tubes and circuits, transmission of electromagnetic waves and electro-acoustics.

The second edition is a replica of the first with minor changes in symbolisms and terminology. The format of the original edition has been retained. Each chapter terminates with a summary, review questions on the theory, and problems requiring numerical computations which involve a knowledge of simple algebra and trigonometry. These features are well integrated.

Inductors, capacitors, filters, rectifiers and oscillators are prematurely introduced for the sole purpose of acclimating the reader to a new language. Later on, attempts are made to clarify these terms with descriptions and illustrations which are adequate.

The quantitative aspects relate to the application of Kirchhoff's laws to simple circuits. The concept of a-c impedance is delved into as a complex quantity and effective measurable quantities, such as current, voltage and power, are defined. Examples illustrate the importance of phase angles and their influence on instantaneous variations of current and voltage in circuits containing combinations of resistance, inductance and capacitance. The importance of matching networks is considered for the realization of maximum power transfer from a source to a terminating load.

Electromagnetic waves are discussed very qualitatively. Attempts are made to describe the sig-

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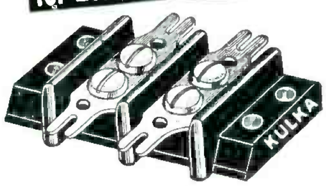

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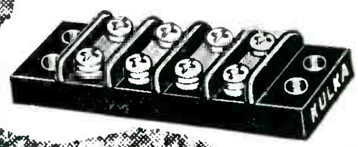

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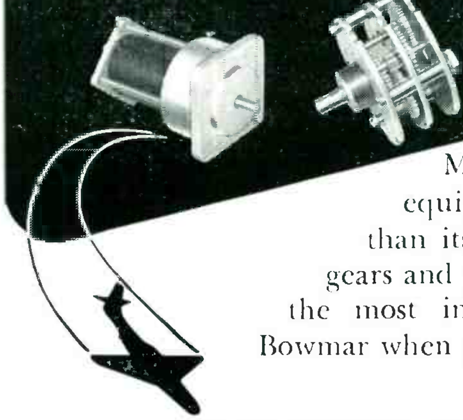

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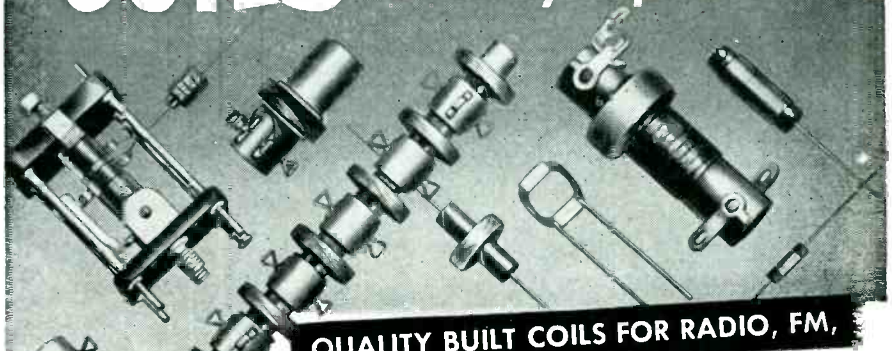

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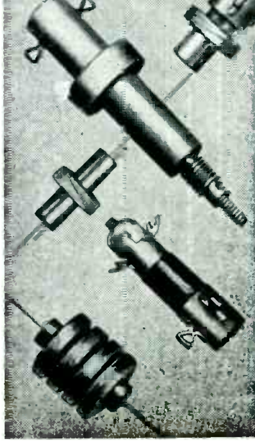

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nificance of propagation along transmission lines and in the atmosphere. The phenomena of reflected waves as a function of terminating impedances are mentioned.

The book is elementary in its approach. The fullest intent is to present a panoramic view of the field aimed toward initiating the beginner into its folds. It creates an atmosphere which may either satisfy the reader or stimulate him toward higher plateaus of learning.

There are sixteen chapters in all. The material is well selected. The author has avoided the matter of how these fundamentals are applied in practice. The text is quite suitable for self-study. However, it is not intended to be a royal guide to learning since its scope is rather limited.—ANTHONY B. GIORDANO, *Polytechnic Institute of Brooklyn.*

Strain Gauges: Theory and Application

PUBLISHED BY N. V. PHILIPS, *Eindhoven, Holland,* 95 *pages,* $2.75, 1952.

PART of Philips Technical Library, this small book presents a great deal of information on strain gauges that is not usually found in books on industrial electronics and measurements.

The material has been divided into six sections written separately by five scientists of the Netherlands Industrial Organization for Applied Scientific Research, Section for Research of Stress and Vibration, Delft, and Philips Industries, Eindhoven, Holland.

A particularly interesting section is the one on how to make and apply strain gauges. Complete step-by-step instructions are included along with excellent photographs illustrating each step. This section might be useful to engineers faced with a problem that could not, for some reason, be solved by use of commercially available gauges.

A separate chapter is devoted entirely to the theoretical aspects of stresses. The usual bridge circuits are described with various schemes of compensating for errors. One chapter tells how resistance strain gauges may be used in instruments with suitable coupling devices to permit measurement of such phenomena as weight, pressure, thickness, vibration, rate of flow and so on.

One shortcoming of the book is its lack of good circuit information between the actual gauge circuit to the recording pen or oscilloscope. Only circuits of commercial Philips instruments are given, and these are without component parts values.

The book should provide an excellent background for any engineer who is confronted with a strain gauge problem.—J. F.

Storage Tubes

BY M. KNOLL AND B. KAZAN, *Princeton University and RCA Laboratories, John Wiley and Sons, Inc., New York, N. Y.*, 1952, 143 *pages*, $3.00.

THIS is the first book published on storage tubes. It is essentially descriptive and is designed to explain the fundamental operation of the many different types of electronic storage tubes and to provide this information in an easily accessible manner. The book should be useful to physicists, electronic engineers, and teachers interested in the general subject of storage and television-camera tubes.

In addition to describing the many tubes under development in this country, the book acquaints us with past developments in Germany through the wide experience of Professor Knoll who was a leader in this field in Germany and is continuing his work at RCA Laboratories and Princeton University.

A substantial portion of the text was initially prepared for the U. S. Army Signal Corps in the form of a report, and Parts I, II, III, and VIII of the book have appeared in a paper by the authors in *RCA Review*, Vol. XII, p. 702, December, 1951.

Part I of the book begins with a description of the equilibrium potentials acquired by an insulating surface under electron bombardment and the action of light. Part II defines terms used in connection with storage tubes. Part III of the book gives a descriptive outline of the different methods of writing and reading. This outline serves as

a complete account of the fundamental processes of writing and reading involved in present-day storage tubes. Parts IV through VII are concise descriptions of the different types of storage and television-camera tubes. The tubes are classified first as to application and then as to reading and writing processes. Part IV is assigned to signal converter tubes having electrical input and output. Part V is a description of direct-viewing storage tubes which have electrical input but visual output. An account of digital computer storage tubes is given in Part VI. An up-to-date description of modern television-camera tubes is included in Part VII.

Part VIII consists of a fairly complete bibliography with a short abstract of many of the papers. To the tube engineer this bibliography by itself is worth the price of the book.

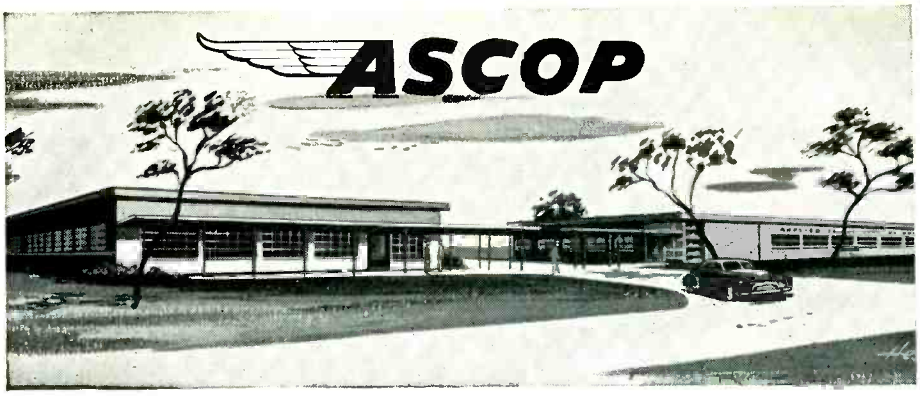
It is the opinion of the reviewer that the diagrams and notation in Part I are unnecessarily complicated. For this reason it is suggested that the reader introduce himself to the book by first referring to the descriptions of the tubes that interest him before attempting to absorb the contents of Part I.

The book leaves one with a strong desire for more quantitative data such as performance comparisons, measurements of redistribution effects, and construction techniques. It is hoped that the authors will supply this information in later editions as progress is made in the storage tube field.—S. T. SMITH, *Hughes Aircraft Company*

Airborne Radio Equipment Symposium

International Air Transport Association, International Aviation Building, Montreal 3, Canada; 252 *pages plus appendices,* $3.00, 1952.

THIS is an edited version of the verbatim transcript of part of the Fifth IATA International Conference held in Copenhagen in May 1952 and attended by experts of 23 member airlines and some 45 manufacturers of aircraft radio equipment, government agencies and research laboratories. Among the appendices are papers on aircraft



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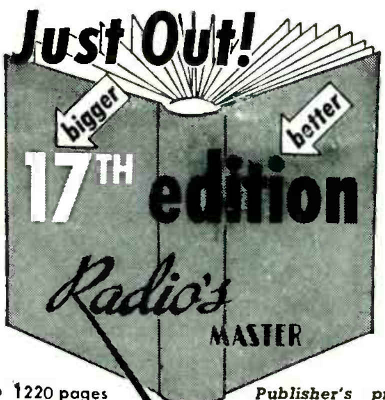

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antenna problems, radar systems, instrument presentation and suppressed carrier single-sideband transmission.

It is a remarkable document since it gives the day by day discussion by men of all degrees of knowledge and interest in the very important problem of communication between aircraft and ground; it shows how far from ideal presentday apparatus is; how very difficult it is to get agreement among those involved; and how the problem will not ease but will get worse as the number of planes in the air and their speed increase. Not the least interesting aspect revealed by a reading of this report is the tremendous contrast between the old and the new concepts and instrumentation employed today—the necessity of using the old carbon microphone side by side with the elegant methods of getting a plane out of the air safely to ground (ILS, GCA.)

The extraordinary complexity of the communication-navigation-control problem of the modern airways system is made very clear in this report; and the reader must inevitably come to the conclusion that a new approach to the overall problem is necessary. Those now in the thick of the situation seem to be too close to it, have too much knowledge of the past, and of the prejudices and biases so inextricably interwoven with the realization that something must be done.

For when you get all through, the airplane, unlike any other vehicle, cannot stop and wait until the weather clears or until it gets definite instructions what to do. It must keep moving—and fast.—K.H.

Physical Foundations of Radiology

BY GLASSER, QUIMBY, TAYLOR, AND WEATHERWAX. *Paul B. Hoeber, Inc., Second Edition*, 1952, 581 *pages*, $6.50.

HERE is the long awaited, revised, and expanded second edition of a basic and yet practical book on radiation physics, written primarily for the radiologist and the medical student by a team of authors outstanding for their teaching and re-

search in medical physics. That the first edition—whose title and quartet of authors is a trade expression in the radiological field—has gone through eight printings since its appearance in 1944 is owing as much to the simplicity and clarity of the presentation as to the thoughtful inclusion of a broad background of material ranging from basic concepts of matter and radiation and their interaction to a wealth of pratical data for diagnostic and therapeutic use.

A primary purpose of the little volume—5 x 8 inches—is to give the interested physician an authoritative though simplified understanding of the basic principles involved in the production, measurement, and use of all forms of ionizing radiation. In this objective it succeeds remarkably well, though the medical reader still will often need the help of his physicist associate to clarify the more difficult pages and fill in the occasionally scanty detail. The book fits in admirably as a text in radiation physics for residents in radiology and is an interesting guide even for the beginner in physics who plans to specialize in the medical field. It is well illustrated, some 70 illustrations having been added and many others made more descriptive. An adequate bibliography is found at the end of each chapter. The number of equations has been kept close to the minimum and illustrative computations are included with commendable frequency justified by years of working with the medical student.

Two new chapters on radioactive isotopes covering measurements and dosage considerations have been added as well as one on high energy accelerators and supervoltage generators. Of particular value is the improved and expanded presentation of radium dosage information, including new Quimby dosage tables for linear radium sources and a generous supply of Patterson and Parker charts for the quick determination of surface and volume dose in radium therapy. This presentation will now serve not only to teach the method of quantitative radium therapy, but is sufficient to meet the ordinary needs

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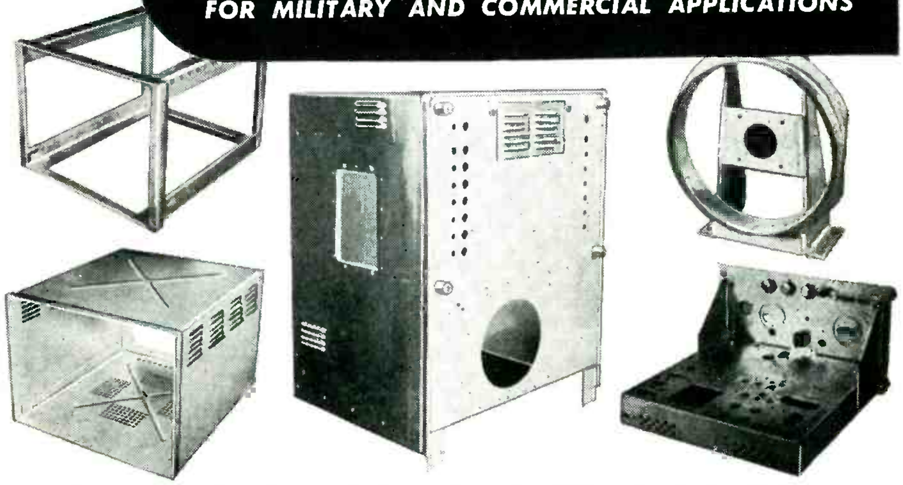

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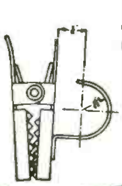

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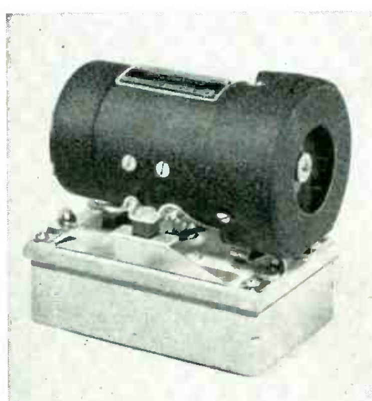

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of the practicing therapist. There likewise has been a real improvement in the chapter on X-ray dosage calculations; the depth dose tables in the appendix cover X-ray qualities from half-value-layer (HVL) of 1mm Al to 8mm Cu. It is some slight regret that this range did not reach the quality produced by 2.0 mev X-ray sources, not only because such accelerators are coming into general use, but also because 2.0 mev X-rays are close in their physical and biological properties to the gamma rays from Radium and Cobalt 60.

Perhaps the most comprehensive revision has been done on the chapter on Protection in Radiology, which was rewritten to include the latest international agreements on protection. This chapter contains much practical data for the attainment of adequate personnel protection in the diagnostic research and therapeutic use of X-rays, radium, and isotopes.

While "Physical Foundations of Radiology" will not serve every need of the radiologist, it is bound to be one of his most useful references.—JOHN G. TRUMP, *High-voltage Research Laboratory, MIT*

Statistical Quality Control

BY EUGENE L. GRANT. *2nd Edition, McGraw-Hill Book Co., Inc., New York,* 1952, 557 *pages*, $6.50.

THIS excellent volume is valuable to a far wider audience than the title indicates. Any engineer who has responsibility for development, design or production of any piece of equipment in which quality is of importance, (this covers 99.9 percent of everything manufactured) can benefit from a host of extremely important suggestions given throughout the book.

Professor Grant recognizes the human factors involved in quality control programs of all types. Though most of the book is devoted to the techniques and theory of statistical quality control, he does not hesitate to interject discussions relevant to the practical side of implementing the techniques, which, by the way, are not necessarily restricted to large-quantity productions, as the author points out in

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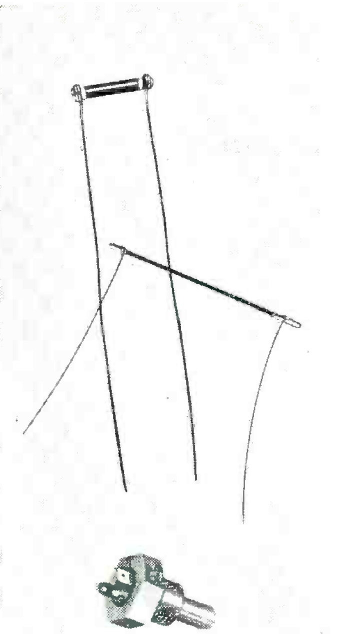

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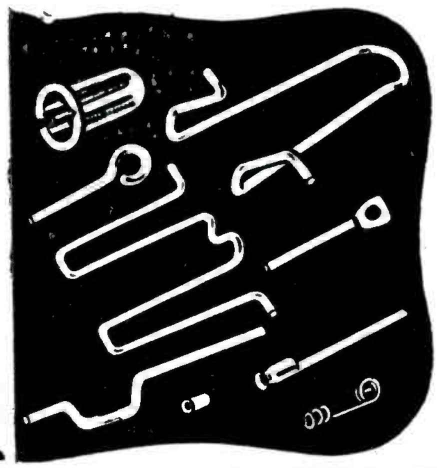

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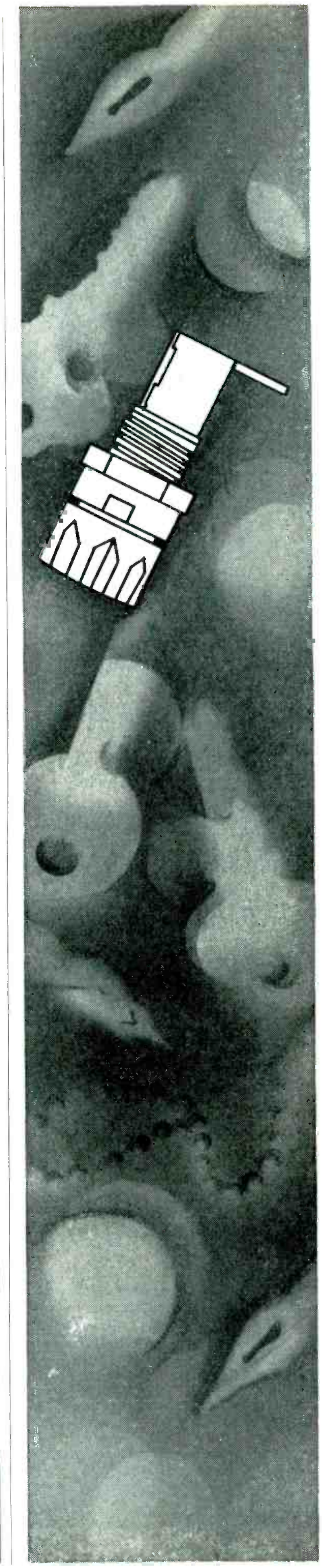

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The aim of quality control according to the author, is "better quality at lower cost." To this end the Shewhart control chart has been developed, and has proved itself of enormous value in effecting cost savings in all types of industrial applications. The book is essentially an elaboration of the problems and methods involved in the application of the Shewhart chart.

In the book are discussed the fallacies of such methods as 100-percent inspection where the fatigue factor of the inspector is not taken into account, or sampling procedures not based on the theory of probability. Thus, as a vivid example, Professor Grant shows that a sampling procedure calling for the inspection of five articles out of a lot of 50, with acceptance of the entire lot if no defectives are found and rejection of the entire lot if one or more defectives are found—a common-sense method—turns out to be not particularly sensible because, if on the average 4 percent are defective, a negligible improvement in quality is effected. If 4 percent were defective originally, 3.5 percent would still be defective after inspection. Yet, 18.5 percent of the submitted product is rejected to improve the outgoing quality from 4 percent defective to 3.6 percent defective.

The reviewer has been striving for years to train all engineering and test personnel to date and time all data, no matter how unimportant the data may seem. The reviewer is therefore particularly pleased to see on page 65 a special paragraph devoted to "importance of preserving the order of measurement." These and many other important hints in the book on how to take and record data for proper control of quality make the volume unusually valuable.

The most important changes from the first edition of this book are:

(1) The chapters dealing with acceptance sampling of attributes has been considerably expanded and rewritten. An objective of the rewriting was to improve the presentation of fundamental princi-

ples, so that newcomers to the field of quality control would appreciate the theory behind the systems.

(2) The chapter dealing with acceptance sampling by variables has been entirely rewritten.

(3) A treatment of the economic aspects of quality control decisions has been considerably expanded. (This is an extremely important aspect of all quality control, since management will often feel that quality control methods are unnecessary expenses. It is up to the engineer to prove that quality control techniques will result in lower costs, and better products in the end.)

(4) A large number of additional problems have been included, with a greater percentage of the problems having answers.

(5) Additional sampling tables have been included.

Since the basic contents of the second edition are similar in many respects to the first edition, it is not necessary to list a chapter-by-chapter breakdown here.

This reviewer wishes to emphasize again the excellent attitude of Professor Grant towards the human problem of quality control. Part 5 of the book, entitled "Making Statistical Quality Control Work," is a section that should be read by all people associated with production, whether they are engineers, technicians, or part of management. The fact that all industrial processes are subject to statistical variations and chance occurrences in the final product should be drummed home, as other wise vast amounts of money and time can be wasted.—VICTOR WOUK, *Beta Electric Corp., New York.*

High Speed Photography

BY GEORGE A. JONES. *John Wiley & Sons Inc., New York*, 1952, 112 *pages*, $6.50.

USEFUL to anyone interested in the history, equipment, techniques and applications of this fascinating avenue in photography. The eleven chapters plus appendices giving data on cameras, tubes, processing formulas, etc, cover the whole subject. Plentifully illustrated.

The history of the numerous

methods of making photographs or records in microseconds is very interesting in showing the difficulties encountered and the methods of solving them. Although written in England there are few language differences and they are easily understood here. The bibliographies are extensive and up to date.

Subjects covered are spark photography, high-intensity illumination methods, exposure determination, camera design, use of image dissectors, rotating mirror and multiple-lens cameras, etc. The two final chapters deal entirely with the scientific and industrial applications of the numerous methods of making high-speed still and moving-picture photographs.—K.H.

THUMBNAIL REVIEWS

ASTM STANDARDS ON METALLIC ELECTRICAL CONDUCTORS. American Society for Testing Materials, 1916 Race St., Philadelphia 1952, 262 pages, $3.00. New and revised standards, test methods, etc., on copper, aluminum, steel and non-ferrous bars, rods, conductors etc.

LES FILTRES ELECTRIQUES. By Pierre David. Gauthier-Villars, 55 quai des Grands-Augustins, Paris, VI, France. 192 pages, 1952, large format, 1952, 2,500 francs, $7.46. Third edition, completely revised. Covers simple and multielement filters of all types.

DESIGN FOR A BRAIN. By W. Ross Ashby, Director of Research, Barnwood House, Gloucester (England), John Wiley & Sons Inc., 1952, 260 pages, $6.00. A serious attempt determine the nervous system's unique ability to produce adaptive behavior—to determine what sort of mechanism it must be to behave so differently from any existing man-made machine.

DIRECT CURRENT MACHINES FOR CONTROL SYSTEMS. By A. Tustin, Professor of Electrial Engineering, University of Birmingham, England. Macmillan, 1952, 306 pages, $10.00. Explains common principles on which modern control machines such as the amplidyne, rototrol, torque motors, etc, depend. For engineers, designers and users of control apparatus.

THEORY OF ELECTRIC POLARIZATION. By C. J. F. Bottcher, Professor of Physical Chemistry, University of Leyden. Elsivier Press, Inc., 300 Park Ave., New York, 492 pages, 1952, $10.00. Theoretical, requiring adequate background in electrostatics and vector calculus.

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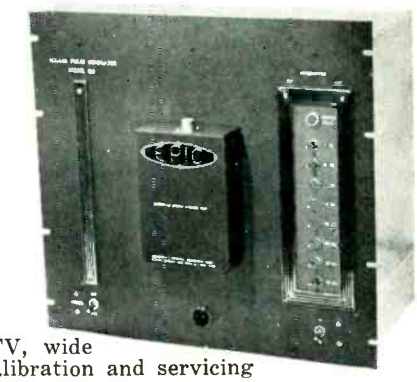

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BACKTALK

Community TV

DEAR SIRS:

I HAVE READ with interest your article in the December 1952 issue of ELECTRONICS entitled, "Community Antennas Bring TV to Fringe Areas" by John M. Carroll (p 106). While your article deals principally with community antenna and distribution systems I would like some additional information.

Geographically we are some 175 airline miles from the nearest tv station in Denver, Colorado. That rules out any use of a community antenna system. I have thought of possible use of a microwave relay system to bring the signal from a receiver located some 60 miles closer to the Denver tv stations. Then a distribution system would be used around our community to furnish service.

Are there any instances of this method at the present time? Is microwave equipment for this purpose available? Does the FCC approve microwave links for this purpose?

I would certainly appreciate an answer to these questions and any suggestions you might have. Kindly let me hear from you at your earliest convenience.

WILLIAM G. WALTER
Radio Station KOLT
Scottsbluff, Nebraska

(Editor's Note: J. E. Belknap & Assoc. of Poplar Bluff, Mo. considered building a microwave relay to deliver signals from KSD-TV, St. Louis and WMCT, Memphis to proposed community antenna systems in their area. Their proposal met opposition from several quarters and no permit has been granted in their case.)

W2TY de W9KQX

Amateur Radio Station W2TY
c/o Wm. W. MacDonald
Editor, ELECTRONICS
330 West 42nd Street
New York 36, N. Y.

DEAR MR. MACDONALD:

THIS LETTER is written by a ham reader of ELECTRONICS to a ham who happens to be Editor of the same magazine. ELECTRONICS is one of the four radio magazines I read regularly, and it occupies

its own unique position in the group. I have several comments from the ham point of view which may be of interest both to you as W2TY and as Editor.

With the introduction of printed circuits in domestic radio gear, it would seem that now is the time for manufacturers to start using "good engineering practice" in their designs.

My worst cases of broadcast interference from a 2-meter transmitter with an input of 40 watts arose from two combination receivers made by responsible manufacturers who *should* know better. In these receivers the designer took "calculated risks" in the design of the first audio stage. Use of high-gain triodes with 6 or 10-megohm grid resistors, with absolutely no shielding and no r-f filtering in order to save a few cents in manufacturing cost cannot be termed "good engineering."

Another gripe is the way in which advertising copy is presented by various manufacturers. For instance, some manufacturers use the space they buy to transmit some real information. This class includes the makers of test apparatus, antennas and specialties. As a rule, they are relatively small in unit production and dollar volume. These firms do not hesitate to give "catalog" information. Their ads are interesting, even though they may not be of immediate interest.

In contrast, take plugs for the 6AF4, 6AJ4, 6AM4 series of tubes. About all they say is, "They're the latest, the best." The copy must have been written by an ex-ad writer for a fur coat concern or perfume manufacturer. The art work did not even sneak in a base diagram. The pay-off is that the same type of copy was used in the ham magazines. The 6BK7 is one of the really good vhf tubes, yet its introduction was made in the same vague manner.

This business is, of course, not under the magazine's control, but I think you will agree that some of the advertisers do not use their space effectively. In the case of tubes, I would like to see the data presented as a tear sheet so that complete information would lead, rather than lag, the availability of

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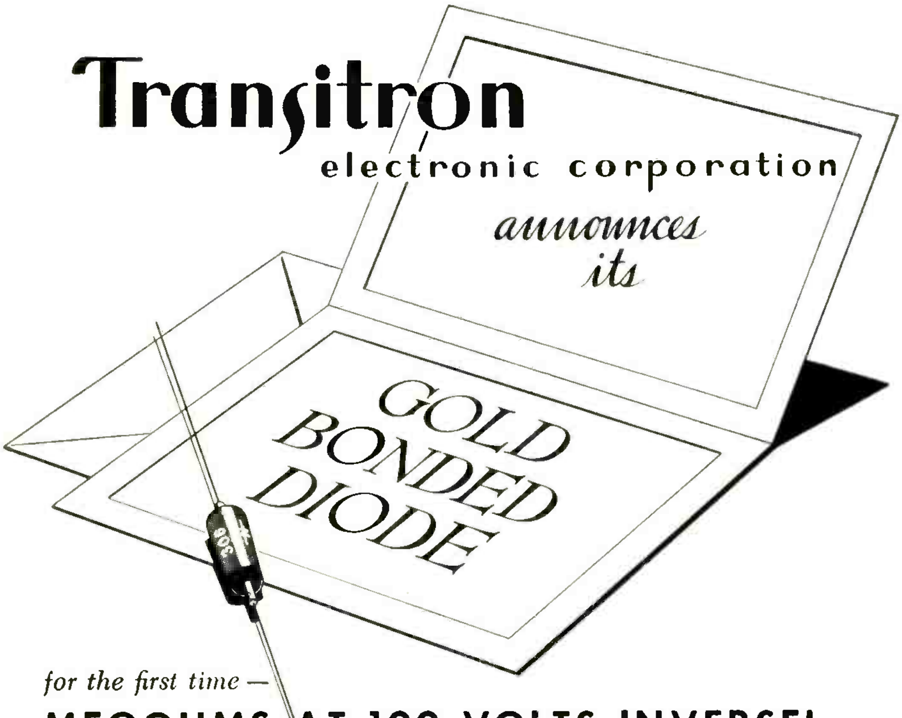

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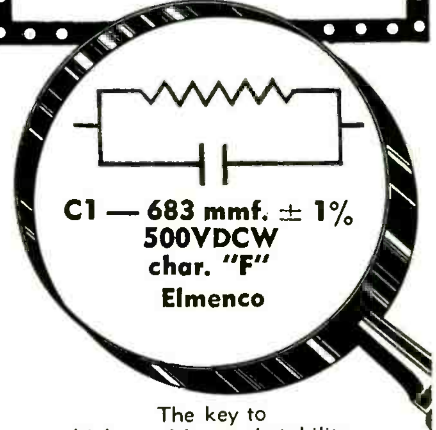

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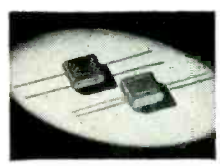

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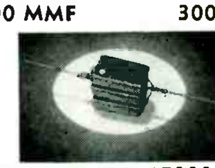

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a tube, or any other component.

You would be very much gratified at the reception by the ham readers of ELECTRONICS of articles that cover items of direct interest. Examples are Villard's selective amplifier; Morgan's horn antenna; articles on vhf; the development work by Hollis on the citizen's band equipment. This sort of material is really appreciated. Incidentally, I would make a small bet that amateurs constitute your largest single field of readers, because so many of the specialists in other phases of electronics are at the same time hams.

Thanks to you and your staff for putting out a swell magazine, serving many fields in ELECTRONICS.

F. D. WHITE, W9KQX
Springfield, Ill.

W9KQX de W2TY

DEAR MR. WHITE:

IT IS nice to hear from you on two counts, first because we like very much the things you say about ELECTRONICS and, secondly, because it is always good fun to correspond with another amateur.

We certainly agree with you that it is a tough job to get receiver designers to pay any attention to anything except cost. As an editor, and also an amateur, I certainly intend to keep trying.

We have been plugging for more informative advertising for some time in our promotion piece, *Electronic Markets*, which goes to most advertising managers and agencies. I think this has borne some fruit.

Your last point, about amateurs reading ELECTRONICS, is very gratifying indeed. We realize that many of our readers are in the industry but take a busman's holiday via amateur radio. We don't often address them directly, but we certainly do like to publish things that interest them indirectly.

W. W. MACDONALD, W2TY
Editor

Mobile Radio Sales

DEAR SIRS:

I TOO have been interested in your discussions of the mobile radio service question as discussed in

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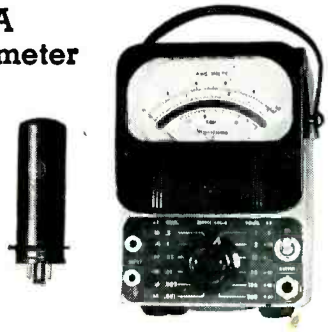

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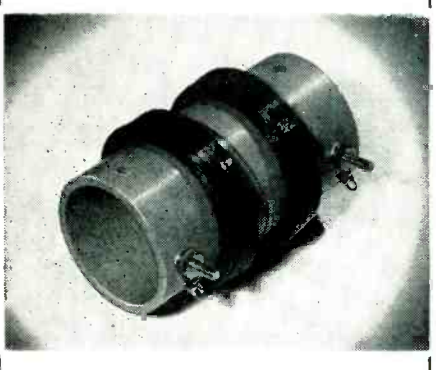

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your various articles and *Backtalk* letters in ELECTRONICS. We have service contracts with several of the largest suppliers of this type of equipment but feel that one aspect of the problem has not been touched upon.

To the best of my knowledge not one of the five leading manufacturers will set up a service shop so that it can solicit and profit directly from the sale of equipment. Some have a minute percent available for "sales assistance" but by no means enough to actually go out and sell equipment.

In contrast I wonder how many television sales and service establishments would continue operation if they were confined entirely to service, especially in areas where the volume of business cannot support a one man full time service set up.

Seventy-five percent of our gross business is in the marine field where we cater to yachts and commercial vessels of all sizes. Were it not for the substantial discount available through marine suppliers, we would certainly look to other sources for an income.

The mobile manufacturers reason that they have their own salesmen but a recent potential order made known to four or five manufacturers brought forth not one reply.

I feel sure that until this outdated system of merchandising is changed, there will be little to attract competent technicians to this field.

You have my full permission to publish this letter completely or in part in the hopes that it might help to change the situation.

EDWARD P. YORK
Stonington, Connecticut

Canadian CRT's

DEAR SIRS:

IN YOUR January 1953 issue on page 18, under the heading of "Television Sales Boom in Canada", you make the surprising statement that "cathode ray tubes . . . are not yet made in appreciable quantities in Canada". I feel that your reporter

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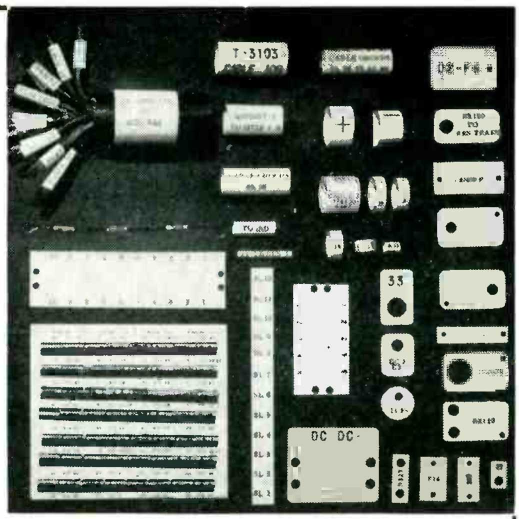

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slipped a cog on this one, as we have been manufacturing this type of tube in Canada since 1941.

One is led to believe that there is, and will be, a substantial shortage of cathode-ray tubes in the United States, very likely throughout 1953. The situation is also tight in Canada, but I know of no set manufacturer in Canada who has been forced to cut back his production for lack of tubes, and can assure you that this information would get to my desk rather quickly.

In 1942, when cathode-ray tubes were in short supply in the United States, we shipped substantial quantities to you. In 1948 and 1949, when you were again short, we shipped substantial quantities to you.

Last year, and currently, we have been buying some cathode-ray tubes in the United States to supplement our production. This would not have been necessary had the member companies of R.T.M.A. made more realistic estimates. (Sound familiar?).

I can assure you that the number of tubes imported is not too great in relation to the number made. We expanded last August, again in November, and will again in May. Further, we have very substantial and approved plans which we are confident will insure a complete supply of "Made in Canada" tubes for the trade.

Yours for more and better electronics!

W. E. DAVISON
President.
The Radio Valve Company
Toronto, Canada

Feedback

DEAR SIRS:

IN STUDYING the interesting article, "Effective Cathode Impedance," by W. Chater and N. Golden, on page 184 of the Dec. 1952 issue of ELECTRONICS, I think it will be found that to calculate $R_{eq} = \frac{R_k R_m}{R_k + R_m}$ and apply it as such to the feedback network will lead to extremely large errors in the feedback ratio calculations.

If the feedback voltage were the only voltage applied to this network

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the above would be true as presented in the original article. However, in addition there is a voltage generated on the cathode of the tube by the grid swing of that particular tube which is in phase with the feedback voltage.

If the feedback is around 20 db letting $R_{eq} = R_k$ will lead to errors of only a few percent and as the feedback is increased this error gets smaller. A small amplifier using 2 sections of a 12AX7 twin triode in cascade will demonstrate this fact very nicely. In this particular case the cathode resistors were 1,000 ohms and the feedback resistance a 100,000-ohm resistor. The measured gain was 100!

DONALD W. NELSON
Seattle, Washington

More on Nim

DEAR SIRS:

THIS LETTER refers to an article appearing in the November 1952 issue of ELECTRONICS, "Digital Computer Plays Nim" by Herbert Koppel.

I have been interested in machines of this type for several years and know something of their history. The first Nim machine was invented jointly by E. U. Condon, G. L. Tawney and W. A. Derr and is described by U. S. Patent No. 2,215,544. Condon's machine was built by Westinghouse and displayed at the New York World's Fair. Redheffer describes a machine that directs the correct play of Nim in the *American Math. Monthly*, 55, p. 343. In 1949, at Washington University, I built a relay operated Nim machine to be displayed at an "Engineer's Day" exhibition.

The omission of any reference to Condon's or Redheffer's work was undoubtedly an unintentional oversight on the part of Mr. Koppel.

As to the method of winning at Nim, Mr. Koppel does not discuss the exceptional case where it is the machine's turn to play and the field appears

XX
X
X

or in a similar configuration. Here,

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the machine's winning play is to leave an odd number of markers in a given column.

Another way of finding the correct play is to employ a radix four notation. First, we must introduce the concept of the "balanced set". A balanced set is defined as the set of numbers 1, 2, 3 or as an even number of like integers. The application of this method is best illustrated by an example. Let us say the markers on the field are

	Row
XXXX	I
XXXXXX	II
XXXXXXX	III
XXXXXXXX	IV

We can then make a table

	I	II	III	IV
4^0	0	2	3	0
4^1	1	1	1	2

showing the number of markers in each row in base 4 notation. Note that neither the 4^0 or the 4^1 columns constitute balanced sets. In order to win, one must leave the field such that a balanced set exists in each column. A winning move would be removing 3 markers from Column IV leaving the field

	I	II	III	IV
4^0	0	2	3	1
4^1	1	1	1	1

in which case both columns are balanced. I do not recall who first described this method.

Your readers may be interested in the generalized game of Nim described by E. H. Moore in 1910. In this game the play is not limited to one row at a time, but to an arbitrary number of rows agreed upon by the players at the outset. The general game is won by

1. Writing the number of markers in each row in binary notation.
2. Adding these columns *decimally.*
3. Examine each integer of the sum.

A winning position is obtained by adjusting the markers such that each integer of the sum is congruent to zero modulo $K + 1$, where K is the limit to the number of rows one may operate on in a given move.

HOWARD L. FUNK
Poughkeepsie, New York

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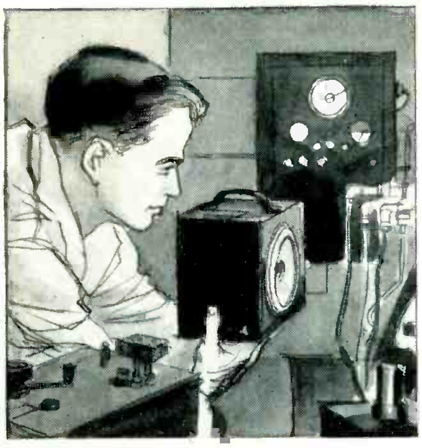

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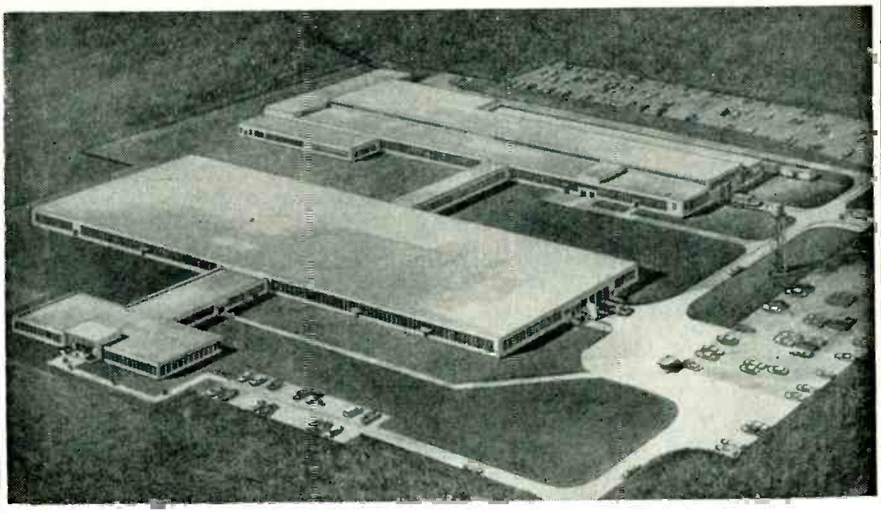

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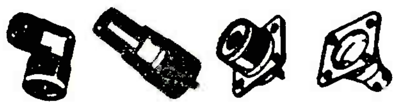

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RG-5/U	$140.00	RG-13/U	$216.00	RG-26/U	$475.00	RG-50/U	$325.00
RG-6/U	180.00	RG-17/U	650.00	RG-29/U	50.00	RG-58/U	60.00
RG-7/U	85.00	RG-18/U	900.00	RG-34/U	300.00	RG-58A/U	70.00
RG-8/U	100.00	RG-19/U	1250.00	RG-35/U	900.00	RG-59/U	60.00
RG-9/U	250.00	RG-20/U	1450.00	RG-54A/U	97.00	RG-62U	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.

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price
2	400	$ .55	.1	1500	$.69	1	6000	$9.95	1	25KV	$85.00
5-5	400	1.65	.5	1500	1.25	.1	7000 R'd	1.79	.001	50KV	24.50
1	600	.55	3	1500	2.50	.1-.1	7000	5.95	.025	50KV	42.50
2	600	.69	4	1500	2.95	.1	7500	2.85	.2	50KV	85.00
2	600 R'd	.69	.1-.5	2000	.95	.075-.075	8KV	6.50	.25	50KV	95.00
2-2	600 R'd	1.65	.25	2000	1.50	1	10KV	29.50	7.5	220VAC	1.95
3	600	.95	.3	2000	1.30	.1	12KV	8.95	1-3	330VAC	1.95
4	600	1.65	1	2000	1.95	1	15KV	45.00	10	330VAC	3.95
4	600 R'd	1.65	3	2000	3.75	.045	16KV	4.70	12.75	330VAC	4.10
5	600	1.75	12	2000	8.95	.05	16KV	4.95	15	330VAC	4.50
6	600	1.85	1	2500	2.75	.075	16KV	8.95	5	440VAC	3.10
8	600 R'd	1.85	1-1	2500	3.85	.25	20KV	19.95	2.9	660VAC	3.50
8-8	600	1.95	32	2500	15.80	1	20KV	54.00	7	660VAC	4.25
4-4-4	600	2.50	.5	3000	2.40				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	1000 R'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	5	5000	29.50						
1-1-1	1200	1.85	.01-.03	6000	1.65						

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

FILAMENT TRANSFORMERS

INPUT—115 V., 50/60 CYCLES

MFR	RATING	PRICE
UTC	5 V @ 1A.-Herm. Sealed	$1.20
GE	5 V.ct. @ 8A. and 5V. @ 8A insul. 750V.- Encl. Case	3.85
UTC	6.3 V. @ 6A.-Herm. Sealed	1.45
—	6.3 V. @ 1A.-Open frame	.89
GE	6.3 V. @ 20A.-Encl. Case	4.25
GE	6.3V. @ 1.2A; 6.3V. @ O.6A; 5V @ 2A.-Open Frame	1.60
Raytheon	6.3V.CT. @ 3A.; 6.3V. @ 5A. Insul. 1780 V RMS-Herm Sealed	2.30

INPUT—208/230 V., 50/60 CYCLES

MFR	RATING	PRICE
GE	2.5 V.CT. @ 10A., Insul.-5KV Encl. Case	2.10
GE	5V. CT. @ 7.5A; Insul.-1.5 KV Open Frame	3.45
GE	5 V. CT. @ 7.5A; Insul.- 7KV Open Frame	5.25
GE	5V.CT. @ 7.5A., Insul.-10 KV Encl. Frame	6.25
GE	INPUT 190.5V., 50/60 CYCLES; Sec.-4.3V. to 25.98V. by 6 taps Open Frame	7.95
GE	INPUT 220V 60 CYCLES; Sec.-5V.CT., @ 7.5A., Insul.-5KV-Open Frame	4.60

TEST EQUIPMENT

- Gen. Radio 475B Frequency Monitor $200.00
- Gen. Radio 681A Freq. Deviation Meter 87.50
- 1-72K Signal Generator 48.50
- Dumont 175A Oscilloscope 225.00
- Gen. Radio 757-P1 Power Supply 27.00
- A. W. Barber Labs. VM-25 VTVM 86.00
- TS-10A/APN Delay Line Test Set 45.00
- TS-19/APQ-5 Calibrator 185.00
- CW1-60AAG 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
- 1-138A Signal Generator—10 cm 185.00
- BC-221 Frequency meter 125.00
- CW—60ABM Frequency Meter—10 CM 97.50
- Weston Model 1 D.C. Milliameter 150/1500 MA with leather case 75.00

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

DUAL "J" POTS.—$2.95 ea.

50 SS	330 SS	2500 SS	2.5 meg SS
100 SS	500 SS	10K SS	5 meg SS
250 SS	1K SS	1 meg SS	1K/25K 3/8"

TRIPLE "JJJ" POTS.—$3.95 ea.

100K/100K/100K 3/8" 20K/150K/15K 3/8"

2 ϕ LOW INERTIA SERVO MOTORS

Diehl FPE-25-11—75V 60 cy. .11 Amp 4 Watts. Each $34.50
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 13 115 volt 400 cycle—includes damping signal generator (autosyn) $47.50

RELAYS

Sigma type 4AH—2000Ω 4 ma DC coil—SPDT contacts—hermetically sealed 5 pin plug-in base $3.30
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
Sigma type 5F—Coil 3500 ohms—pulls in @ 2.5MA out @ .5 MA—copper slug for slight time delay. Contacts—SPDT 2 Amp $3.95
Sigma type 5RLP—Dual coil 60 ohms each, pulls in @ 12MA out @ 10MA. Contacts—SPDT 2 Amp $3.75
Leach type 1521—Coil 115 VAC 60 cy—Contacts SPST NO Double Break 15 Amp.—Mycalex Insul. $3.25
Cramer Model 1C2H—110V 60 cy. motor. Interval timer—two SPST 15A contacts (on 1 hr. off 1 hr.) can be adjusted $2.95
Weston Model 813—1200 ohm moving coil; 50 microamp. Contacts 35 milliamp $16.50

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BA0
ANY TYPE—$14.88 EACH
TS-10 Type Handsets $9.25

TRANSFORMERS

Westinghouse—Hipersil—Pri—115V 60 cy.—¾ KVA—Sc #1—240V @ 1.56A.; Sec #2—240V @ 1.56 A $18.75
G.E.—Hi Voltage—Pri—115V 60 cy—Sec. 6250 V @ 80 MA.—12.5KV Insulation $18.50

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-AA. Output-30 Volts DC 15 Amps. Brand New-Original Packing $15.50
PE-109 Inverter—13.5 VDC to 115 VAC 400 cy 175 VA 1ϕ (new) $79.50
PE-218 Inverters 28 VDC to 115 VAC 400 cy 1500 VA. (New) $49.50
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 12121-1A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3ϕ 400 cy 250 VA 0.7 PF—(New) $225.00

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
5 amp. AC 4" R.—JBT	4.11
30 V DC 2½" R.—General Electric	3.95
3 amp. RF 3½" R.—Weston	6.00

SPARE PARTS FOR ARMY AND NAVY RADIO, RADAR & SONAR EQUIPMENT

AN/APS-2	AN/APN-4	AN/ARC-5	QCB
AN/APS-3	AN/APN-9	SF	QCJ
AN/APS-4	AN/ARC-1	SL	QCL
AN/APS-15	AN/ARC-3	SO	WEA
etc.	etc.	etc.	etc.

QUOTATIONS UPON REQUEST

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

CABLE ADDRESS - "LECTRONIC PHILADELPHIA"

GUARANTEED BRAND NEW

!!! NEW LOW PRICES !!!

TUBE SPECIALS

STANDARD BRANDS ONLY

Receiving Tubes

OOA	$1.50
O1A	.67
OZ4	.59
OZ4A	.63
1A3	.71
1A5GT	.72
1A6	.72
1A7GT	.79
1B3GT	.99
1B4P	.79
1B5	.74
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	.69
1H6G	.75
1H6GT	.79
1J5G	.74
1J6G	.69
1L4	.69
1LA4	.87
1LA6	.99
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.74
1N5GT	.83
1N6G	.75
1P5GT	.69
1Q5GT	.99
1R4	.69
1R5	.79
1S4	.71
1S5	.69
1T4	.71
1T5GT	.71
1U4	.73
1U5	.77
1V	.65
1X2	.93
2A3	1.28
2A5	.79
2A7	.79
2B7	.79
2E5	.94
2X2	.50
2X2A	1.85
3A4	.65
3A5	.95
3A8GT	1.50
3B7	.57
3C6	1.15
3D6	.57
3LF4	.91
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.79
5AZ4	.54
5R4GY	1.59
5T4	1.91
5U4G	.59
5V4G	.98
5W4	.82
5X4G	.79
5Y3GT	.47
5Y4G	.71
5Z3	.87
5Z4	1.40
6A6	.82
6A7	1.05
6A8	.95
6AB4	.83
6AB7	.98
6AC5GT	1.19
6AC7	.85
6AC7W	3.25
6AD6G	.98
6AD7G	1.29
6AE6G	.89
6AF6G	.89
6AG5	.79
6AG7	1.45
6AH6	1.29
6AJ5	1.95
6AK5	.84
WE-6AK5	1.85
6AK5W	2.95
6AK6	.99
6AL5	.59
6AL5W	2.65
6AQ5	.72
6AQ6	.79
6AR5	.79
6AS5	.99
6AS6	2.25
6AS7G	4.25
6AT6	.63
6AU5GT	1.21
6AU6	.65
6AV6	.55
6B4G	1.25
6B5	1.20
6B7	.95
6B8	.75
6B8G	.75
6BA6	.65
6BA7	1.20
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.85
6BE6	.65
6BF5	1.10
6BF6	.83
6BG6G	1.89
6BH6	.95
6BJ6	.95
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.55
6C5	.70
6CB6	.75
6C6	.73
6C8G	.96
6CD6G	2.21
6D6	.88
6D8G	.63
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.87
6F7	1.05
6F8G	.91
6G6G	.99
6H6	.66
6H6GT	.66
6J5	.59
6J5G	.64
6J5GT	.55
6J6	.95
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.65
6K7	.79
6K7G	.86
6L5G	1.06
6L6	1.87
6L6G	1.49
6L6GA	1.39
6L7	.99
6L7G	.85
6N7	.99
6N7GT	.89
6P5GT	.96
6Q7	.89
6R7	.79
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.71
6SA7GT	.67
6SB7Y	1.05
6SC7	.93
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.75
6SG7	.75
6SH7	.75
6SH7GT	.75
6SJ7	.71
6SJ7GT	.69
6SK7	.72
6SK7GT	.72
6SL7GT	.81
6SN7GT	.73
6SN7WGT	2.10
6SQ7	.65
6SQ7GT	.65
6SR7	.63
6SS7	.99
6ST7	1.05
6T7G	1.09
6T8	.98
6U5	.98
6U7G	.65
6V6	1.49
6V6G	.89
6V6GT	.67
6W4GT	.64
6W6GT	.88
6X4	.59
6X5GT	.59
6Y6G	.89
6ZY5G	.89
7A4	.76
7A5	.79
7A6	.75
7A7	.76
7A8	.78
7AD7	1.44
7AH7	1.08
7B4	.79
7B5	.79
7B6	.79
7B7	.79
7B8	.78
7C4	.45
7C5	.79
7C6	.79
7C7	.79
7E5	.79
7E6	.58
7E7	.83
7F7	.99
7F8	1.35
7G7	.89
7H7	.79
7J7	1.10
7K7	1.10
7L7	.97
7N7	.97
7Q7	.79
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.79
10	.39
12A	.65
12A6	.64
12A6GT	.64
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.79
12AT6	.55
12AT7	.99
12AU6	.71
12AU7	.86
12AV6	.54
12AV7	.99
12AW6	1.20
12AX7	.99
12BA6	.69
12BA7	.95
12BD6	.99
12BE6	.66
12C8	.65
12F5GT	.79
12H6	.69
12J5GT	.55
12K8	.70
12Q7GT	.67
12SA7GT	.69
12SF5	.79
12SF5GT	.79
12SF7	.85
12SG7	.85
12SH7	.73
12SJ7	.71
12SJ7GT	.65
12SK7	.69
12SL7GT	.93
12SN7GT	.89
12SQ7GT	.68
12SR7	.79
12SR7GT	.89
12X3	.89
12Z3	.89
14A4	.97
14A7	.74
14B6	.74
14B8	.89
14C5	1.10
14C7	.93
14E6	.99
14E7	1.09
14F7	.89
14H7	.89
14J7	.89
14N7	.89
14R7	.89
14S7	.89
14W7	.89
14X7	.89
19	.89
19T8	.99
22	1.16
24A	.89
25A6	1.16
25L6GT	.69
25Z5	.79
26	.79
27	.69
28D7	1.95
30	.70
30 Spec.	.45
31	.59
32	.69
32L7GT	.87
33	.69
34	.69
35/51	.59
35A5	.72
35B5	.75
35L6GT	.67
35W4	.55
35Y4	.72
35Z4GT	.69
35Z5GT	.55
36	.64
37	.69
38	.69
39/44	.59
41	.71
42	.79
43	.79
45	.79
45Z5GT	.89
46	.81
47	.99
50	1.09
50A5	.89
50B5	.69
50C5	.69
50L6GT	.63
50Y6GT	.92
53	.95
55	.99
L55B	.32
56	.69
57	.69
58	.69
59	1.24
70L7GT	1.29
71A	.79
75	.85
76	.69
77	.69
78	.69
79	.89
80	.59
81	1.41
82	1.19
83	1.11
83V	1.25
84/6Z4	.75
85	.79
89Y	.55
117N7GT	1.89
117P7GT	1.89
117Z3	.65
117Z6GT	.97
FM-1000	1.59

Transmitting and Special Purpose Tubes

OA2	.95
OA3	1.15
OA4G	1.25
OB2	1.10
OB3	1.19
OC3	1.10
OD3	.95
1B21A	2.65
1B22	2.50
1B23	9.60
1B24 West	12.95
1B24 SYLV.	18.95
1B24A	39.50
1B26	3.73
1B27	14.95
1B29	2.75
1B32	3.75
1B35	11.00
1B36	12.50
1B38	32.50
1B40	4.95
1B41	47.50
1B42	9.80
1B54	32.50
1H20	.88
1P21	35.00
1P23	4.10
1P24	1.27
1S21	9.50
1Z2	3.75
2A4G	1.22
2AP1	8.95
2AP5	8.95
2B4	2.10
2B22	2.20
2C21	.65
2C22	.45
2C26	.39
2C26A	.49
2C33	4.95
2C34	.49
2C39	22.00
2C4D	12.00
2C42	23.75
2C43	17.75
2C44	1.20
2C46	21.50
2C51	5.75
2D21	1.55
2E22	1.85
2E24	4.10
2E26	2.85
2J21/ 2J21A	8.75
2J22	8.95
2J26	24.75
2J27	22.95
2J31	27.00
2J32	36.50
2J33	39.50
2J34	27.00
2J37	13.70
2J38	17.50
2J39	36.50
2J40	34.50
2J48	49.50
2J49	65.00
2J50	39.50
2J56	148.50
2J61	45.25
2J66	165.00
2K23	37.50
2K25	28.50
2K26	105.00
2K28	29.50
2K29	27.50
2K33	265.00
2K33A	280.00
2K39	135.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/ EL-1C	2.60
3B23	4.75
3B24	5.20
3B24W	7.50
3B25	4.50
3B26	3.75
3B27	4.20
3B28	7.75
3BP1	5.75
3C23	9.65
3C24	1.85
3C27	6.95
3C31/ EL-C1B	3.95
3C37	32.50
3C45	12.95
3CP1	2.25
3D21	2.98
3DP1	4.85
3DP1A	6.75
3E29	13.75
3EP1	4.75
3FP7	2.90
3FP7A	6.95
3GP1	3.95
3HP7	3.95
3J31	115.00
4-125A	29.50
4A1	1.18
4AP10	4.40
4B22/ EL5B	8.95
4B24	5.75
4B25/ EL-6CFt	8.95
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	5.50
5BP4	5.50
5C22	47.75
5CP1	4.50
5CP7	9.50
5D21	19.50
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J29	18.50
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	21.75
5LP5	19.75
5MP1	10.50
6-8B	.85
C6A	6.75
6AN5	3.30
6AR6	3.25
6C21	27.50
6C24	52.50
6F4	5.95
C6J	9.95
6J4	6.85
7-7-11	1.19
7BP1	8.65
7BP7	6.50
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	11.75
9LP7	4.50
10BP4	17.95
10FP4	22.50
10T1	.88
10Y	.39
12DP7	14.50
12GP7	18.50
12HP7	14.75
13-4	.80
15E	1.95
15R	.65
FG-17/ 5557	4.95
REL-21	1.95
24G	1.85
HK-24	4.95
RK-25	3.82
FG32/ 5558	6.75
FG33	17.50
RK34	.49
35T	4.95
35T ION gauge	5.95
35TG	4.95
REL36	.45
T-40	3.75
FG-41	122.50
RK-47	4.92
EF-50	.79
VT-52	.35
53A	5.60
RK59	2.44
VT-62(Br.)	1.15
RK-63	22.50
FG-67	14.80
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	3.50
75T	5.80
VR-78	.64
FG-81A	3.95
91	14.80
FG-95/ 5560	25.00
VT-98 (Br.)	19.50
C100A	2.30
C100E	2.30
100R	2.90
100TH	9.95
WE-101F	3.62
WE-102F	2.85
FG-104/ 5561	24.60
FG-105	19.50
WE-113A	1.32
HY-114B	.75
WE-117A	.95
F-123A	7.75
WE-124A	3.80
F-127A	22.50
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AB-150	12.50
FG-166	48.50
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203A	7.40
203B	6.33
204A	47.50
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
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WE-231D	2.25
232CH	240.00
RX-233A	4.95
FG-235A/ 5552	94.50
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
FG-271/ 5551	62.50
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	8.75
304TL	8.75
307A	4.25
WE-309A	6.45
WE-310A	6.25
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
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368A	6.95
371A	.95
371B	.95
388A	2.95
393A	8.60
394A	4.50
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446A	1.95
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506AX	1.25
507AX	1.47
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532A	3.75
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559	2.20
561	3.50
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KU-623	39.50
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WL-654/ 659	82.00
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700C	24.50
700D	24.50
701A	6.95
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702B	4.25
703A	5.95
704A	.95
705A	2.25
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	7.95
707B	14.90
708A	4.75
709A	3.85
710A	1.70
713A	1.45
714AY	10.75
715A	6.25
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715C	19.50
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718AY	45.00
718BY	45.00
720DY	95.00
721A	3.95
722A	2.25
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
726B	45.00
726C	65.00
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731A	2.45
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788Y	1.40
800	1.75
801A	.45
803	4.95
805	4.50
806	24.50
807	1.65
808	2.65
809	2.95
810	10.95
811	3.60
813	10.50
814	3.95
815	2.95
816	1.45
826	1.25
828	11.25
829	9.95
829A	11.95
829B	12.95
830B	2.95
832	7.95
832A	9.95
833A	39.50
836	4.10
837	1.45
838	3.75
841	.49
843	.59
845	5.75
845W	6.75
849	29.50
851	67.00
852	19.50
860	4.95
861	22.50
864	.35
865	1.28
866A	1.48
872A	3.95
874	1.15
876	1.60
878	1.85
884	1.75
885	1.75
886	2.60
902P1	9.95
905	3.50
918	1.65
919	1.95
923	1.35
927	1.85
931A	5.00
954	.39
955	.55
956	.49
957	.49
958A	.69
959	2.25
991	.45
1003	.90
CK-1005	.69
CK-1006	3.30
E-1148	.35
1201	.79
1203	.45
1291	.57
1294	.69
1299	.57
1602	2.25
1613	.89
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.25
1624	1.90
1625	.39
1626	.30
1629	.30
1630	.95
16331	1.38
1632	.75
1636	3.10
1638	.70
1642	.65
1644	.95
1645	1.95
1655	1.90
1665	1.80
1904	14.80
1960	.70
2050	1.70
2051	1.10
5611	115.00
5651	2.75
5654	2.90
5691	8.55
5692	8.55
5693	6.95
UX-6653	.65
7193	.45
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.05
8020	1.25
8025	6.95
9001	1.50
9002	.95
9003	1.50
9004	.45
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

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1N21	1.19
1N21A	1.69
1N21B	3.00
1N22	1.25
1N23	1.95
1N23A	2.75
1N23B	3.45
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N39	6.10
1N40	8.50
1N41	9.85
1N42	18.00
1N45	.94
1N52	1.05
1N55	3.05
1N60	.55

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GENERAL ELECTRIC	ARMA
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1CT	5DG	6G	2J1F1	C-44968-6	C-78249
1DG	5F	7DG	2J1G1	C-56701	C-78254
1F	5G	7G	2J1H1	C-56776-1	C-78410
1G	5N	A	2J1M1	C-69405-2	C-78411
1HG	5SF	B	2J5A2	C-69406	C-78414
1SF	5SG	M	2J5D1	C-69406-1	C-78415
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5CT			2JD5A2		C-79331

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Full data on request

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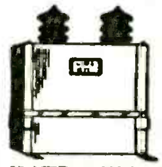
HIGH VOLTAGE OIL CAPACITORS



.001 MFD 50,000V DC..$37.50
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.135 MFD 7,500V DC..$6.95
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.25 MFD 15,000V DC....................$19.50
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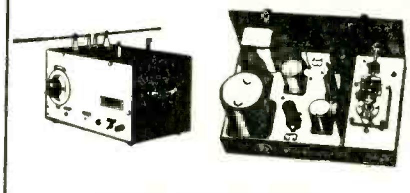

RADIO MODULATOR

Type BC-423-B, or tweeter, is a miniature keying unit, modulator and transmitter combined. A dipole mounted atop the tweeter case radiates a signal pulse at 205 megacycles modulated by pulses occurring at 4,098 CPS. Uses 2-6J7, 1-6F6, 1-955, 1-5W4 tubes. Operates from 115V. 60 cy. source. Brand new including tubes and instruction book....$29.50

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2.5 KVA Diehl Elec. Co. 120DC to 120AC, 60 cy., 1 Ph., Complete with Magnetic Controller, 2 Field Rheos and full set spare parts including spare armatures for generator and motor. New..$295.00
2 KVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph. Export Crated. New..........$195.00
MOTOR GENERATOR, TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Motor: 2 H.P., 230 V.D.C., 10 amps. Generator: 1800V. D.C., 0.4 A, 500V, D.C., 0.35A. 115 V.D.C., 1.5A, 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature..............................$365.00

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Onan M-G.-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26V DC at 4 amps. New..........$295.00
Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output: 80V, 800 cy. 1 Ph., 485VA. New..$22.50
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G.E. 5AS1315511A. Model 218J. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. Regulated. New....................................$89.50
Holtzer-Cabot M.G. 164. Input: 440, 3 Ph., 60 cy., Output: 70V, 146 cy. 3 Ph., 0.140KVA. New $67.50
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Dumore Co. type ELBG. 24VDC. 40-1 gear ratio. For type B-4 Intervalometer. New..........$8.50
G.E. Model 5BBY47AB12 250VDC Perm. Mag. ¼ H.P., 1725 RPM........................$23.50

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Armor. Synchro Differential Generator. Type 6DG. New $60.00
Hobart Mfg. Co. Synchro Differential Synchro Type XIX 115V. 60 cy. New......................$9.50

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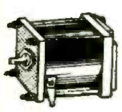
Leach type 1154A, SPDT, 115 A.C..........$2.35
Leach type 1054, BSN 20-28V D.C..........$2.35
Clare Plug-in base No. 30FMX 115 A.C.....$2.45
G.E. Plug-in base Sensitive K27J853........$3.25
Western Electric D-163781 Plug-in..........$4.95
Guardian Time Delay type B-9-SPDT.......$2.95

SWEEP GENERATOR CAPACITOR



High speed ball bearings. Split stator silver plated coaxial type 5/16 mmfd. Brand new

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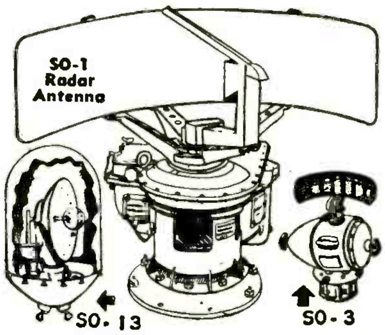
RADAR EQUIPMENT



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Type SO-1 (10CM) assembly with reflector, waveguide nozzle, drive motor. New..........$279.50
Type SO-3 (3 CM.) Surface Search type with reflector, drive motor, etc., but less plumbing. New in original cases $189.50
Type SO-13. (10CM.) Assembly with 24" dish, dipole, drive motor, gearing. New........$149.50
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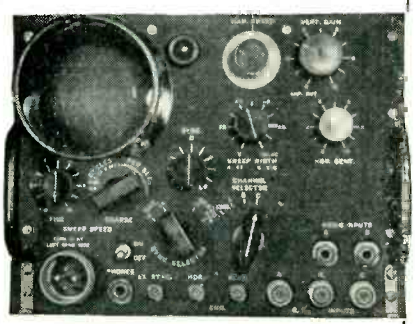

Provides 4 Types of Presentation:
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(3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
Price **$245.00**
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AN/APA-10 80 Page Tech Manual..........$2.75

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AUTO. 400 cy. G.E. Cat. No. 80G184. KVA .945S-520P Volts 460/345/200/115. New $4.50
FILAMENT—400/2600 CPS. Input—0/75/80/85/105/115/125V. Output—5V3A/5V3A/5V6A/6.3V 0.5A. No. 7249010—New $1.95
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PULSE WECO KS-9563 Supplies voltage peaks of 3500 from 807 tube. Tested at 2000 Pulses/sec and 5000 peak. Wdg. 1-2=18 ohms. Wdg. 1.3=72 ohms. L of Wdg. 1.3=082H at 100 cps........$3.95
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Western Electric—type CR-1A/AR in holders. ½" pin spacing. Ideal for net frequency operation. Available in quantities, 5910-6350-6370-6470-6510-6610-6670-6690-7270-7350-7380 - 7390 - 7480 - 7580-9720. All fundamentals in KC. Good multipliers to higher frequencies ....$1.25 each

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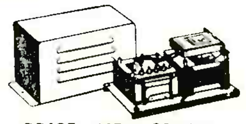
Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V. 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6½" H x 8¾" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.



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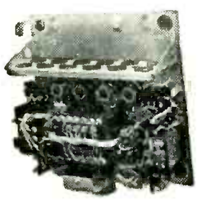
GE Servo type 2CV1C1 400 cycle
Constant Output Line RC-730C
Synchro Amplifiers for Radar
Intercommunication type BC-605

ANTENNAS
MR-162 Coast Guard 23½ ft. whips
AS-33 APT-2, AT-38A/APT, AS-62/APS-13
AS-125/APR for APR-5A
TDY RADAR JAMMER HORNS
PARABOLOIDS, MAGNESIUM DISHES 17½" dia.
SCR-623-A (part of RC-153-B Antenna)
CU 64/APT Antenna matching unit 50 ohm unbal. to 100 bal.

POTENTIOMETERS
W.E. KS-15138 Linear Sawtooth
W.E. KS-8732 for SCR547 Radar
W.E. KS-8801 Motor Driven



G. E. 400 CYCLE SERVO AMPLIFIERS
Type 2CV1C1

Brand New $29.50
Metal Dust Cover Included

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Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, P.E. 94CM dynamotor. Brand new equipment with instruction manuals.

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U. S. Instrument Co. No. A-260 Combination headset and chest microphone. Brand new, including 20 ft. of rubber covered cable.........$17.50 each

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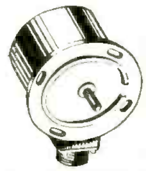
Switch Micro R-RL2T......................$.65
Switch Navy Rotary #647491...............$17.50
Contactor CRP-23AGO for SG-1 radar.....$24.75
Band-Switch assembly for AR-88 receiver.....$9.50
RT-7-AN/APN-1 Receivers
BC-423B Modulators
BC-1366M Jack Boxes—Large quantity

LINEAR SAWTOOTH POTENTIOMETER
W.E. No. KS 15138



The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding to which electric power is supplied through two fixed taps 180 degrees apart. Two rotating brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output voltage. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. The potentiometer is excited with 24-volt direct current, is arranged for panel or bracket mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 4¾ inches long, and has an approximate weight of one pound. External connections are made through a standard AN type connector.

Brand New $5.75

RADAR SETS
MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt, 60 cy., 1 Ph. "A", "B", and "PPI" presentation. Complete with tech manual and full set of operating spare parts.

MODEL SG-1. Consists of complete equipment including Radar Transmitter-Receiver CRP-43AAK-3, Range and Train Indicator CRP-55ABC-3, Control Amplifier CRP-50AAT-1, Motor Dynamo-Amplifier (Amplidyne) CG-21AAY and Antenna Assembly CRP-66ABJ-1.

MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC, Antenna Assembly CRP-ACZ, Mounting Base CPR-10ABE, etc.

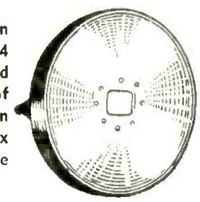
Spare Parts available for Model SQ and SG-1 Radar.

MISC. RADAR EQUIPMENT
Modulator Units for SO-11 (CUZ-50AGD)
Pulse Timer units for SD-5
Transmitter-Receiver units SO-13
Spare Parts for SG-1
Spare Parts for SQ
Marker Oscillator Crystals in holders 98.35KC
Bearing Control Units CRP-23AEK
Synchro Amplifiers—Bendix
90° Waveguide Bends 10CM Bronze
Signal Monitors CRP-60AAN
Repeater Amplifiers CBM-50AFO
Oscillator Tube Cavities for SO-1, 13 etc., RF303.
10CM Horns, 1½" x 3" waveguide, standard contact, flange input, circularly polarized horn output
Duplex Tees #2Z3005-17
APS-10 Modulator
Auxiliary Rectifier CABM-20237 (SO-2 Radar)
SO-1 (66AGE) Antenna R.F. Nozzle Assemblies (RF502)
SO-1 (66AGE) Antenna Reflector Assemblies (RF503)
SO-1 (6AGE) Antenna Waveguide Resonance Chamber Assemblies (RF515)
SO-1 RF Coupling Waveguide to Transmitter (Z304)
SO-1 RF System and duplexing cavity (RF301 with V309)

REPAIR PARTS FOR BC-348 RECEIVERS (H, K, L, R, Only)
Also BC 224 Models F. K., Coils for ant., r.f., det., osc., I.F., c.w. osc., xtal filters, 4 gang cond., front panels, dial assemblies, vol. conts., etc. Write for complete list and free diagram.

AUTO TRANSFORMER
G.E. 400 cy. Cat. No. 80G184 K.V.A. .945S—.520P Volts 460/345/230/115 New $4.50

PARABOLOIDS
17½" diameter, spun magnesium dishes, 4 inches deep. Reinforced perimeter. Two sets of mounting brackets on rear. Opening at apex for waveguide dipole assembly 1½ x 1⅝".



BRAND NEW . . . . PER PAIR $12.50

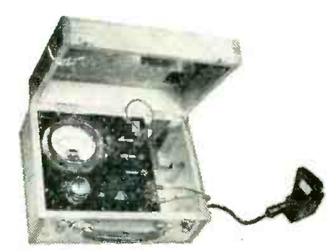
G. E. BATTERY CHARGER
Charges 54 cell battery at from 1 to 10 ampere rate

Input 115V., 60 cy. 1 Phase.
The model 6RC89F16 Copper Oxide battery charger consists of a transformer, a secondary reactor, a copper oxide rectifying element, a ventilating fan, control circuits and auxiliary equipment necessary for proper operations. Transformer tapped for various supply voltage. Eight secondary taps for adjusting changing rate. Built into metal cabinet. Metered.

Complete with spare fan and fuses. New in original packing cases. Shipping weight approx. 305 lbs.

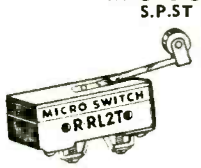
Price $255.00

SYNCHRO CAPACITORS
.6-.6-.6 mfd Mark 12, Mod. 2, type 1C......$1.75
10-10-10 mfd. Mark 1, Mod. 2, type 3C......$5.65
30-30-30 mfd. Mark 3, Mod. 2, type 9C......$6.50



FLUXMETER
Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at $29.50

MICRO-SWITCH
S.P.ST NORMALLY CLOSED



BRAND NEW $.85 EACH

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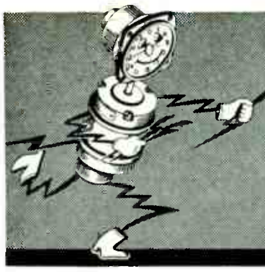
ELECTRONICRAFT INC
27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

24V DC SOLENOID
2 LB. PULL—¾" STROKE

BRAND NEW $1.45 Each

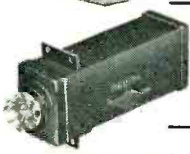


Available for IMMEDIATE DELIVERY!

SYNCHROS • DC MOTORS • AC MOTORS • INVERTERS
SERVO MOTORS • ACTUATORS • GEAR MOTORS • GENERATORS

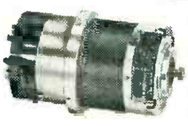
GUARANTEED TO MEET ORIGINAL MANUFACTURERS' SPECIFICATIONS

C-1 AUTOPILOT INVERTER — Eicor and Westinghouse. 24-28 volts d-c input, 45 va output @ 19 volts a-c, 105 cycles and 1.0 power factor. Filter in base. 7½" x 5¾" x 5¾". Wt. 9 lb. #SA-177 .... $24.50



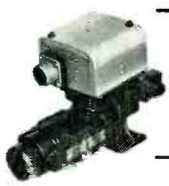
SERVO OUTPUT TRANSFORMER — Sperry #661824. Hermetically sealed saturable reactor type. 1" x 1¼" x 3¼" high. Wt. 9 oz. #SA- 266 .... $6.75

AIRESEARCH LINEAR ACTUATORS — 4 types available; AR-42, AR-46, AR-4017, and AR-63. 115 volts, 400 cycle single phase. Compression and tension 25-50 lb. static 200 lbs. Approx. 4" travel. Wt. 1.5 lb. #SA-326 .... $19.50



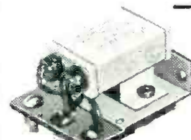
1SF NAVY SYNCHRO — 115 volts 400 cycles. May be used on 26 volts 60 cycle for industrial purposes. 3.625" x 2.25" diam. Large quantity available. Other Navy synchros in stock. Wt. 1.5 lb. #SA-29 .... $54.50

GEARHEAD SHUNT MOTOR — John Oster Type B-9-1, 27.5 volts d-c @ 7 amp. Motor speed 5600 rpm. Gearhead has dual output shafts upon which cams actuate roller lever arms. Reduction ratios 930: 1 and 230: 1. 7½" x 2¾" diam. Wt. 2 lb. #SA-335 .... $9.75
SA-46 also available with 12 volt motor.



ROTARY OIL COOLER FLAP ACTUATOR — Lear Model 156-W24 volts d-c @ 9.0 amp. Motor speed 10,000 rpm. Intermittent duty. Potentiometer follow-up and adjustable limit switches. 7½" x 3½" x 5½". Wt. 4 lb. #SA-343 .... $19.50

HIGH PRECISION AUTOSYN — Pioneer Type AY-201-3-B transmitter or control transformer for controlled servo circuits. Same as AY-200-3 and AY-202-3 except for shaft detail. 26 volts 400 cycle single phase. Max. error 15 min. Eclipse-Pioneer specification sheet available on request. Wt. 5 oz. max. #SA-365 .... $27.50



PHASE CHANGING TRANSFORMER — GE #70G23. 115 volt single phase 400 cycle input, providing 3 phase 115 volt 400 cycle output @ .048 kva and .33 power factor. Size 2¼" x 2⅝" x 2". Wt. ½ lb. #SA-364 .... $3.75

DC ROTARY ACTUATOR — White Rogers #6912X-4 Type 3. 24-volts d-c @ .4 amp. 50 in. lb. torque @ 1.5 rpm. 5½" x 4" x 4½". Wt. 3 lb. #SA-385 .... $12.50

DC ROTARY ACTUATOR — White Rogers #6913-3 Type 3 .24 volts d-c @ .65 amp. 150 in. lb. torque @ 2.5 rpm. 6½" x 4" 4½". Wt. 4 lb. #SA-391 .... $19.50

ELECTRIC TURN AND BANK — Army Type C-1. 24 volt d-c instrument size gyro in standard case 3¼" diam. x 6⅜" long. May be modified for signal take-offs. Wt. 1 lb. #SA-382 .... $24.50

GEARHEAD DC SERIES REVERSIBLE MOTOR — John Oster Type A-16B-26R. 26 volts d-c. Output shaft limited to two revolutions in either direction by cam operated G-E Switchettes. Pinion and worm gear used in gearhead. 4½" long x 1¾" high x 3" wide. Shaft extends from top of gearhead 7/16" and is ¼" diam. Wt. 1 lb. #SA- 328 .... $9.50

- **RADIO CONTROLLED SERVO UNIT** — Used in Glide Bomb, complete from receiver to actuators which move control surfaces. Contains the following major components: 1. Receiving set #AN/CRW-3 (BC-455) with DM-32A Dynamotor. Frequency range 6.0 to 9.1 mc. 2. Multichannel servo amplifier (Amplifier Selector AM-41/CRW-3) 3. Barber Colman 14 volt d-c rotary actuator. 4. White Rogers rotary actuator. 5. 24-volt d-c Gyro. 6. Heating unit. #SA-387A .... $175.
SA-387B As above but with BC-454 receiver. Frequency range 3 to 6 mc.
- **C-1 (M-7) SERVO MOTOR UNIT** — Manuf. Norden. Small size unit containing a 1/50 hp. 24 volt d-c motor which runs constantly @ 3000 rpm. Electric clutches and brakes engage motor to differential gear which turns a 1.15625" diam. cable drum @ 44 rpm. and @ 13.3" lb. torque. This type of arrangement permits almost instant start, stop, and reverse of output drum. Wt. 8 lb. #SA-372 .... $29.50
- **AERIAL CAMERA MOUNT** — Minneapolis-Honeywell #A-15B. 3-channel servo system with variable reluctance pendulous error sensing devices for deviation from vertical. Completely stabilized camera platform for roll and pitch with remote control of azimuth rotation. Packed in durable trunk type cases for semi-portable use. Supplied with all tubes, interconnecting cables, amplifier, power supply, and inverter for operation from 24 volts d-c. Only one available. Wt. 109 lb. #SA-9 .... $475.
- **CONVERSION TRANSMITTER** — Eclipse-Pioneer #PEX-29752. Consists of 2 major assemblies. One unit contains a complete magnetic amplifier assembly and 115 volt 400 cycle inverter. Other unit consists of 1F synchro, servo motor with integral rate generator, dial, plus gears and other components. Complete schematic available. #SA-40B .... $195.
- **MAGNETIC AMPLIFIER ASSEMBLY** — Removed from above Conversion Transmitter. Contains 12SN7 electron tube, magnetic amplifier, plus other transformers and components in shock-mounted case. #SA-407 .... $39.50

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Prices F.O.B. Hawthorne

Telephone: HAwthorne 7-3100

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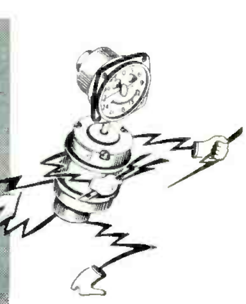

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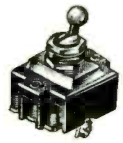
RECTIFIER POWER UNIT

PP35/ART. Sig. Corps No. 3H 4698-35 Input 115 Volts 400-2500 Cycles Note: P/O AN/ART5 to AN/ART11 complete with 2-836 H.V. Rectifiers.

Stock No. 6248A Price Each **$7.50**

HEAVY DUTY SWITCH



H&H 4 P. D. D. T. Toggle Switch. 5 AMP. @ 250 Volt. 10 Amp. @ 125 Volt. Single ¾" hole mount. Ball Handle

Stock No. 6203A Price Each **$1.95**

PULSE TRANSFORMER

For Navy I F F Responder. Jeff. Elec. No. 300362-1. Farnsworth No. 467-001-228. Navy No. N17-T 80105-2758. Available in large quantity.

Prices on request. PRICES BASED ON QUANTITY

D.C. GENERATORS

High voltage continuous duty fully enclosed D.C. Generator. Delivers 440 volts at 200 M.A. Motor driven by 3450 RPM motor (not furnished). Made to Navy Specs. for Collins Radio by Fractional Motors Co. Navy No. 211220-C, Collins No. 231-0002-00. Brand New.

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SIGNAL CORPS & NAVY TRANSFORMERS

Over 200,000 transformers, chokes etc. For Signal Corps and Navy Equipment. Send us your requirements, or ask for our catalog listing by Signal Corps Numbers, DON'T DELAY!

G. E. HEAVY DUTY SWITCH

Type SB-1. No. 6075 732-G1. 8 pole double throw. ¼" contacts. 10 AMP, 115 V 2¼" x 3" x 9" long. 3 hole panel mount. Moulded bakelite frame with heavy barriers between terminals.

Stock No. 6250A Price Each **$9.95**

ONAN GAS-DRIVEN GENERATOR
14 V-2500 WATT D.C. $225.00

GAS DRIVEN LIGHT PLANT
125V 3 Phase 3KVA 50-60 Cycle $395.00

SWITCHBOARD BD74

JAN TUBES

OB3/VR90	$.85	832A	$8.50
OC3/VR105	.85	836	3.00
3E29	12.95	GL8002R	95.00
6C21	12.95	9003	1.00
204A	75.00	3BP1	5.95
368AS	7.00	5FP4	3.95
371B	.75	12GP7	14.95

BASIC UNIT FOR RECEIVING SET

AN/CRW-2. Sig Corps No. 2Z-1508-2. Complete with 6 tubes and 28 volt dynamotor.

Stock No. 6249A Price Each **$10.00**

RADAR OSCILLATOR APR-5

Sig. Cr. Stk. No. 2C 2784. Used for tuning 1000-3100 Mg.

AN-109A ANTENNA

5' Whip with base in quantity. Per 100: $95.00; $1.25 EACH

POWER TRANSFORMER

Horizontal Double Half Shell Type. Pri.: 117 Volt—60 Cycle. Sec.: 265-0-265 V.A.C. & 40 Ma. Sec.: 6.3 V.A.C. @ 1.65 Amps. Mtg. Centers 2½" x 2". H.V. Center Tap is grounded to core.

Stock No. 6183 Price Each **$1.25**

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 Std Mtg. Bolts

Stock No. 5792A Price Each **$3.50**

HIGH CURRENT FILAMENT TRANSFORMER

Primary 115 VAC 60 Cycle. Secondary 1.25 VAC at 100 Amp.

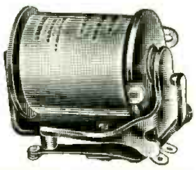
Stock No. 5783A Price Each **$5.00**

.01 MFD.—600 VOLT MICA CONDENSERS

Large quantities available in both CM-35 and CM-40 case sizes.

TOLERANCE	PRICE PER 1000
5%	$150.00
10%	125.00
20%	100.00

SENSITIVE RELAYS



MIDGET TYPE RELAYS

Automatic Electric Type R-45. 6500 ohm Coils. Normally open contacts except as noted.

Stock No.	Contacts	M. A.	Price Each
102152	S.P.S.T.	2.0	$1.25
102249	2.P.S.T.*	4.5	1.50
102264	3.P.S.T.	6.0	2.00

* 1 Norm. open-1 Norm. closed.

Same type and style as above, but has 24 V.A.C. coil. Intermittent duty. Will operate on 6 V.D.C. Continuous duty. Contacts: S.P.S.T.-N.O. and S.P.D.T.

Stock No. 102248A Price Each **$1.25**

RELAYS

LEACH TYPE 1204. D.P.S.T.

¼" Diam. Normally open contacts. Bakelite base. 24 V.D.C., 265 ohm Coil.

Stock No. 6169A Price Each **$1.95**

ALLIED CONTROL TYPE BOX 60

D.P.D.T. ¼" Diam. Contacts. One Pole makes before break. 9.6 V.D.C., 40 ohm Coil.

Stock No. 6170A Price Each **$1.25**

STRUTHERS-DUNN. TYPE 61AXX100. S.P.S.T.

Normally open contacts rated at 20 amps @ 24 V.D.C. 80 ohm, 24 V.D.C. Coil.

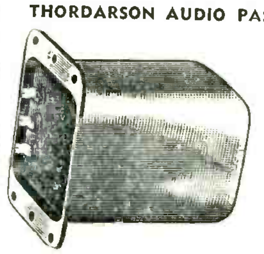
Stock No. 6171A Price Each **75¢**

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	.0001	1500	BE 15	.20¢
5498A	.004	2500	4	.20¢
5499A	.001	5000	F	.30¢
5600A	.0036	5000	A2	.60¢
5601A	.15	1000V	XS	$1.00
5602A	.00007	2500V	3	1.90
5603A	.00005	3000V	15L	.90¢
5604A	.0001	5000V	F2L	1.00
5605A	.0008	5000V	F2L	1.00
5606A	.000025	10,000	PL-34L	1.00
5607A**	.00015	10,000	PL-315	1.95
				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.

6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.4 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. ½" above Chassis. Soder Lug Terminals—All Terminals Marked.

Stock No. 5254A

Price Each **$2.65**

TERMS:

Open Accounts to rated or Acceptable reference accounts. Others Pre-payment of 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

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ALNICO FIELD MOTORS

(Approx. size overall) . . . 3¾" x 1¼" diameter) **Delco-Type** 5069230: 27.5 volts; DC; 145RPM **$19.95 ea.**

DELCO TYPE #5069600: 27.5 volts DC; 250 RPM **$19.95**

PM Motor, Delco Type #5069370: 27.5 volt; DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½", diameter 0.125" **$12.50**

PM Motor, Diehl Mfg. SS FD6-21; 27.5 volt; DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½", diameter 0.125" **$12.50**

AC CONTROL MOTOR

Diehl Mfg. Co., FPE-25-7, 20 Volts, 2 ph 1600 RPM, .85 amps **$15.00**

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 60; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝" .... **$15.00 ea.**

400 CYCLE MOTORS

PIONEER: TYPE CK5 2 Phase; 400 cycles **$35.00 ea.**

EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle .... **$17.50 ea.**

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.**

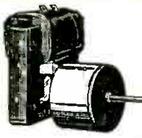
EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle. Single Phase **$12.50 ea.**

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**

Electric Motor: PNT—1400—A1—IA Serial No. 207, 208 V., 400 cycles, 3 phase Kearfott Co., Inc. .... **$17.50 ea.**

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle; with 40-1 Reduction Gear $17.50 ea.



TELECHRON SYNCHRONOUS TIMING MOTORS: 110 VAC; 6 cycle; 2 RPM and 4 RPM; approx. 2¼" square overall .... **$2.95 ea.**
In lots of 10 or more $2.50 ea.

SMALL DC MOTORS

DELCO #5068750: constant speed; 27 VDC; 160 RPM; built-in reduction gears and governor .... **$17.50 ea.**

J. OSTER: series, reversible motor; 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps;

SPERRY #806069; approx. size 1⅝" x 3½" **$7.50 ea.**

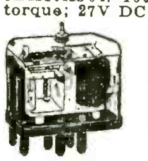
(Approx. size....4" long x 1¼" dial.)

General Electric Type 5AB10AJ37; 27 volts DC; .5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible **$15.00 ea.**

General Electric. Mod. 5BA10FJ33; 12 oz. inches torque, 12 V DC, 56 RPM, 1.02 amp. **$15.00 ea.**

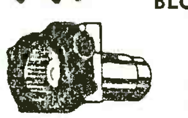
General Electric-Type 5BA10AJ52C; 27 volts. DC; .5 amps, 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$15.00 ea.**

GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64. 160 r.p.m.; 65 amp; 12 oz.-in. torque; 27V DC .... **$19.95 ea.**



WESTINGHOUSE OVER-CURRENT RELAY: Type MN, adjustable from .04-.16 amp. (1210991). External reset push button. Enclosed in glass case . . . hand calibrated. NEW LOW PRICE. **$14.95**

BLOWER



Eastern Air Devices, Type J31B; 115 volt; 400-1200 cycle; single phase; variable frequency; continuous duty; L & R #2 blower; approx. 22 cu. ft./min. **$15.00**

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL, 17CFM, complete with capacitor. **New** .... **$12.50 ea.**

SENSITIVE ALTIMETERS

Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required...**$12.95 ea.**

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp. .... **$80.00 ea.**

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. **Input:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5. **BRAND NEW** .... **$39.95 ea.**

MG 153 HOLTZER-CABOT

Input: 24 V, DC, 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated .... **$95.00 ea.**

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps, 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 18-12 amps. Voltage and frequency regulated .... **$89.50 ea.**

12116-2-A PIONEER

Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC 5 amp....**$90.00 ea.**

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF, and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps. cont. duty, 6000 RPM. Voltage and Frequency regulated...**$195.00**

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont. Duty .... **$90.00 ea.**

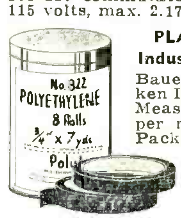
TRANSFORMERS

SOLA
One KVA, 210-270 Volts, 240 Sec., 3-Phase
#30663 .... $175.00

FILAMENT, Gen. Elec. #7455321: Primary 110/125 Volts. Secondary 11 Volts, 65 Amps, 975 KVA. Shipping wt. approx. 60 pounds. **$24.95**

FILAMENT, AMERTRAN #29048: Primary 115 Volts, 50/60 cycle. Secondary 5 volts, 190 amp. Shipping weight approx. 75 lbs. **$36.50**

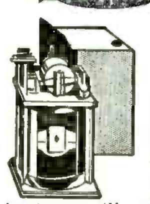
VARIABLE, AMERTRAN #29144: 250 VA. 103-126 commutator range, fixed windings, 115 volts, max. 2.17 amps **$19.95**



PLASTIC ADHESIVE TAPE
Industrial—High Voltage Type

Bauer & Black No. 822 Polyken Industrial Adhesive Tape. Measures ¾" wide—7 yards per roll. Rated 10,000 volts. Packed 8 rolls to the can **$3.50/can**

Ten cans or more **$3.00/can**



SCHWEIN REMOTE CONTROL DUAL GYRO

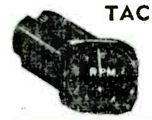
Free and rate gyro type 45600. Contains two 28 volt DC constant speed gyros . . . one operates horizontally, the other vertically. Vertical master gyro influences horizontal gyro position, which in turn will actuate a series of limiting switches controlling any number of electrical devices. Both gyros turn in excess of the 30,000 rpm. Size 8" x 4¼" x 4¼". Comes with metal cover .... **$22.50 ea.**

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

TACHOMETER INDICATOR
SINGLE



Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer **$9.95 ea.**

Tachometer Indicator and Generator (above) .... **Both $33.50**

TACHOMETER GENERATOR (MARK V) $25.50 ea.

G. E. GENERATORS

General Electric Type 5ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia. **$99.50 ea.**

SINE-COSINE GENERATORS
(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle .... **$30.00 ea.**

Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor .... **$25.00 ea.**

Arma Resolver Type 213014; equal in size to size 5 synchro; 55-60 cycle; single phase primary, 2 phase secondary **$79.50**

GENERATORS

Eclipse-Pioneer; 716-3A (Navy Model NEA-3A) OUTPUT: 115 VAC; 10.4 amps; 800 cycle; single phase; 28.6 VDC; 60 amps @ 2400 rpm; spline drive; self exciting; wt. 60#.
BRAND NEW in original box....**$39.95 ea.**

SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.
Quantities Available.

REPEATERS .... **$20.00 ea.**
TRANSMITTERS .... **$20.00 ea.**

SYNCHROS

IF Special Repeater (115V-400 Cycle) **$15.00 ea.**

2JIF 3 Generator (115-400 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.**

5/DG Differential Generator (90/90 volts —400 cyc.) .... **$30.00 ea.**

TRANSMITTER, BENDIX C-78248; 115 Volt, 60 Cycle .... **$25.00 ea.**

Differential—C-78249; 115 Volt; 60 Cycle **$5.00**

REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle .... **$37.50 ea.**

REPEATER, AC synchronous 115 V., 60 cycle. C-78863 .... **$15.00 ea.**

7G Synchro Generator (115/90 volt; 60 cycle) **$75.00**

6G Synchro Generator (115/90 volt; 60 cycle) **$60.00**

6DG Synchro Differential Generator (90/90 volt; 60 cycle) **$60.00**

2JF51 Selsyn Control Transformer: 105-55 Volts; 60 Cycle **$50.00**

2JD5J2 Selsyn Motor: 115-90 Volts; 60 cycle **$50.00**

5JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle **$50.00**

2JIF1 GENERATOR: 115—57.5 Volt; 400 cycle .... **$12.50 ea.**

2JIH1 DIFFERENTIAL GENERATOR: 57.5 —57.5 Volt; 400 cycle .... **$12.50 ea.**

2JIG1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle .... **$7.50 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.**

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 12602-1-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn .... **$70.00 ea.**

TYPE 12602-1-A: Same as 12606-1A except it has base mounting type cover for motor and gear train .... **$70.00 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.**

C and H Sales Company
BOX 356-X EAST PASADENA STATION • PASADENA 8 CALIFORNIA

Reliance Specials

GEAR ASSORTMENT

100 small assorted gears. Most are stainless or brass. Experimenter's dream! .... Only $6.50

HAYDON TIMING MOTOR

1 R.P.M., 115 V., 60 Cycle.......... $1.95

TIMING MOTOR

8 RPM 115V 60 cyc
E. Ingraham Co.

$1.79

400 CYCLE INVERTERS

Leland Electric Co.

#10800 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V, 400 Cyc. 1 phase, 1500 V.A. 90 PF.............. $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¢

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
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	S/16	55/64	13/32	.45

NEEDLE BEARINGS

TORRINGTON B108 ½" wide 5/8" 13'6"........ 30¢

Brand New Meters—Guaranteed

0-10 ma. D.C. 3½"..$3.95 0-80 Amp. D.C. 2½"..$2.50
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

SOUND POWER HANDSET

BRAND NEW

Includes 5 ft. cord.—Uses no batteries or external power source. $18.50 pr

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
10	40	70	125	240	400	680	.0016	.004
20	47	75	135	250	430	800	.002	.0044
22	50	80	150	270	470	820	.0027	.005
23	51	82	160	300	500	910	.0033	.006
24	56	90	175	330	510	.001	.0036	.0065
25	60	100	180	360	580	.0012		.0068
33	62	110	200	370	600	.0013		.0082
39		120	220	390	650	.0015		.01

Price Schedule

10 mmf to 820 mmf........................ 5¢
.001 mmf to .0016........................ 8¢
.002 mfd to .0082 mfd.................... 15¢
.01 mfd.................................. 28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
10	50	100	170	360	510	.001	.0024	.0047
18	51	110	180	370	525	.0011	.0025	.005
22	56	115	208	390	560	.0013	.0027	.0051
23	60	120	225	400	570	.0015	.0028	.0056
24	62	125	240	410	680	.0016	.003	.006
25	66	130	250	430	700	.0018	.0033	.0068
27	68	135	255	470	800	.0022	.0039	.0082
30	75	150	260	488	900	.0023	.004	
40	82	155	270	500				

Price Schedule

10 mmf to 700 mfd........................ 10¢
.0011 mfd to .002 mfd.................... 20¢
.0022 mfd to .0082 mfd................... 50¢

PULSE TRANSFORMERS

UTAH—9262 9278 9289 9318 9340 9350
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9800, KS9862, KS13161
GENERAL ELECTRIC—80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

AN CONNECTORS

See Our Ad February, 1953 Electronics
PHONE! WIRE! WRITE! YOUR NEEDS

COAXIAL CABLE CONNECTORS

14¢ UG175/U	$1.20 83-1F	30¢ 83-1AP	70¢ 83-1J	40¢ SO-239	12¢ HOOD
83-1AC	$0.42	PL-274	$1.10	UG-87/U	$1.50
83-1AP	.30	PL-275	1.90	UG-88/U	.90
83-1BC	.35	SO-239	.40	UG-89/U	1.10
83-1F	1.10	UG-13/U	1.70	UG-102/U	.80
83-1H	.12	UG-18B/U	1.10	UG-103/U	.68
83-1HP	.22	UG-20B/U	1.65	UG-104/U	1.40
83-1J	.70	UG-21/U	.95	UG-105/U	1.50
83-1RTY	.65	UG-21B/U	1.00	UG-106/U	.12
83-1SP	.45	UG-21C/U	1.05	UG-107B/U	2.75
83-1SPN	.53	UG-21D/U	1.45	UG-167/U	5.70
83-1T	1.30	UG-22/U	1.35	UG-146/U	2.00
83-2AP	1.95	UG-22A/U	1.60	UG-175/U	.14
83-2J	2.10	UG-22B/U	1.20	UG-176/U	.14
83-2R	1.65	UG-23/U	1.20	UG-185/U	.99
83-22AP	1.25	UG-23B/U	1.50	UG-196/U	1.65
83-22F	1.90	UG-23C/U	1.10	UG-203/U	.65
83-22J	1.50	UG-24/U	1.30	UG-224/U	1.15
83-22R	.68	UG-27/U	1.25	UG-255/U	1.98
83-22SP	.80	UG-27A/U	2.25	UG-260/U	.85
83-22T	1.65	UG-27B/U	2.95	UG-261/U	1.10
83-168	.14	UG-28A/U	2.95	UG-262/U	1.10
83-185	.14	UG-29B/U	1.65	UG-273/U	1.45
CW-123A/U	.45	UG-30/U	2.30	UG-274/U	2.30
M-358	1.30	UG-57B/U	1.70	UG-291/U	.95
M-359	.30	UG-58/U	.70	UG-306/U	2.65
M-359A	.65	UG-58A/U	.90	UG-414/U	1.95
PL-258	.75	UG-59A/U	1.90	UG-499/U	1.25
PL-259	.45	UG-83/U	1.75	UG-625/U	1.00
PL-259A	.53	UG-85/U	1.70		

NEW COAXIAL CABLES

	Price per 1000 ft.		Price per 1000 ft.
RG 5/U*	$140.00	RG 22/U*	$135.00
RG 6/U	180.00	RG 22A/U	285.00
RG 7/U*	80.00	RG 24/U	675.00
RG 8/U*	100.00	RG 26/U	475.00
RG 9/U*	250.00	RG 29/U	50.00
RG 9A/U	275.00	RG 34/U	300.00
RG 10/U	240.00	RG 35/U	900.00
RG 11/U	100.00	RG 41/U*	295.00
RG 11A/U*	150.00	RG 54A/U	97.00
RG 12/U	240.00	RG 55/U*	110.00
RG 13/U*	216.00	RG 57/U*	325.00
RG 17/U	650.00	RG 58/U*	60.00
RG 18/U	900.00	RG 58A/U*	65.00
RG 19/U	1250.00	RG 59/U*	55.00
RG 20/U	1450.00	RG 62/U*	70.00
RG 21/U*	220.00	RG 77/U*	100.00

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¢

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 — $1.25 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	$0.17	3—141W	$0.27	9—141Y	$0.71
3—140¾W	.21	4—141	.24	3—142	.24
6—140	.28	5—141	.29	2—150	.43
10—140W	.59	5—141¾W	.41	3—150	.60
10—140¾W	.59	7—141¾W	.56		
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 • Microswitch contact. 10A • Holds ON as long as power is applied • Fully Cased • ONLY $6.50

RADIO FREQUENCY GENERATOR

RCA 1KW 400 KC; Input: 220 V 60 cycle Needs minor repairs to water circulating system. Otherwise in good condition $295.00

PRECISION RESISTORS—¼ WATT—30¢

2	6.68	11.74	14.98	79.81	147.5	414.3
2.5	8.33	12.32	15.8	105.8	147.8	705
2.8	10.48	13.02	16.37	123.8	220.4	2,193
3.5	11	13.52	20	125	301.8	3,500
5	11.25	13.89	62.54	142	366.6	59,148

PRECISION RESISTORS—½ WATT—35¢

.25	11.1	66.6	298.3	4,000	14,825	33,300
.334	13.07	75	400	4,285	15,000	35,888
.444	13.15	87	723.1	4,300	15,750	36,000
.502	13.3	97.8	855	4,451	15,755	37,000
.557	15	97.85	970	5,900	15,810	45,000
.627	25	125	1,000	6,500	16,000	47,000
.76	30	178	1,500	6,650	16,700	50,000
1	35	180	1,800	6,670	17,000	56,000
1.01	46	200	2,250	7,000	20,000	59,000
1.53	50	210	2,280	7,300	20,150	59,905
2.04	52	213	2,500	7,500	25,000	68,000
4.35	54	235	2,850	8,000	30,000	79,012
5.26	55.1	260	3,427	8,500	32,700	100,000
5.89	61	270	3,700	8,800	32,888	150,000
10.48	65	273	3,995	10,000	33,000	180,000
		273.1		12,000		

PRECISION RESISTORS—1 WATT—45¢

.1	2.6	32	89.8	2,000	8,000	50,000
.11	2.66	35.7	125	2,200	8,250	52,525
.2	3.39	38	250	2,250	9,000	55,000
.31	5.21	45.1	270	2,550	9,700	56,000
.861	12	45.5	420	3,300	10,000	65,000
1.01	15	54.25	425	5,000	12,000	68,000
1.166	17.9	56.7	800	5,221	15,000	75,000
2.55	18	60	1,000	6,000	25,000	84,000
2.58	28	71.4	1,530	7,000	30,000	95,000
	28.5		1,750		45,000	

PRECISION RESISTORS—1 WATT—60¢

100,000	149,500	260,000	348,000	590,000
105,000	150,000	270,000	399,000	600,000
120,000	175,000	296,000	413,000	645,000
128,000	200,000	297,000	500,000	650,000
130,000	240,000	310,000	520,000	700,000
132,000	250,000	320,000	522,000	

1 MEGOHM 1 WATT 1%—$1.50; 5%—60¢

PRECISION RESISTORS—2 WATT—75¢

4,385	6,000	19,917	25,000	80,000
5,000	10,000	23,000	65,000	100,000

DIFFERENTIAL

Used $4.95
115 V., 60 Cycle
#C78249 New $9.95

3⅜" dia. x 5⅜" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted) $5.50
Mounting Brackets—Bakelite for selsyns, and differentials shown above .... 35¢ pair

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
5.2	50	$0.35	.25	3,000	$2.25
6	400	.85	1	3,600	3.95
3 x 3	400	1.00	3 x .2	4,000	2.50
4	500	.85	2	4,000	7.95
4-4	500	1.30	3	4,000	10.95
8	500	1.35	.01	5,000	.95
1	600	.45	.01-.03	6,000	1.40
.5-.5	600	.40	.03-.03	6,000	1.50
2	600	.80	1	6,000	9.95
4	600	1.63	.02-.02	7,000	1.55
8	600	2.05	.02-.03	7,000	1.60
10	600	2.95	.1	7,000	1.95
4 x 3	600	1.75	.1-.1	7,000	2.25
8-8	600	1.79	.1	7,500	2.25
1	800	.60	.3-.3	7,500	4.50
1	1,000	.75	.075-.075	8,000	1.85
2	1,000	.95	.15-.15	8,000	2.95
3	1,000	1.70	.25	20,000	19.95
6	1,000	2.75			
8	1,000	3.25			
1	1,500	1.45			
.02	2,000	.65			
.1-.1	2,000	1.30			
.1-.5	2,000	1.65			
3	2,000	3.75			
8	2,000	7.95			

1 mfd
6,000
V.D.C.
G.E.
$9.95

OIL FILLED A.C. CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
.2	750	$0.69	15	440	$6.25
8	660	7.50	4.4	375	2.15
6	660	5.95	25	330	7.50
5	660	5.45	20	330	6.75
4	660	4.95	4	330	2.25
3	660	4.45	3	330	1.45
2.9	660	4.35	1.75	330	.85
2	660	3.95	20	220	4.95
1	660	2.95	7.5	220	2.00

1N34 Crystal Diode .... 79¢

Dynamotor DM 33A.......................... $3.75 ea.

Chokes: 30 Hy. 80MA @...$1.29; 6HY, 80 MA @...79¢

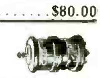
Power Tap Switch—OHMITE (#312-5 Taps) nonshorting 25A 150 V. A.C.......................... $3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A.C. Fully cased Plugs into octal socket $5.50

BC 221 FREQUENCY METER.................. $80.00

2J1G1 SELSYNS $8.95

400 CYCLE BRAND NEW



Minimum Orders $3 — All orders f.o.b. PHILA., PA.

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NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA2	$1.40	2J21A	17.95	4E27	17.50	RK-73	1.95	450TH	45.00	806	27.50	955	.55
OA3	1.10	2J22	17.95	4J25	199.00	100TH	9.95	450TL	45.00	807	1.69	956	.69
OB2	1.35	2J26	27.75	4J26	199.00	FG95	24.95	464A	9.95	808	3.50	957	.29
OC3	1.25	2J27	29.95	4J27	199.00	FG105	19.00	471A	2.75	810	11.00	958A	.69
OD3	1.25	2J31	29.95	4J31	199.00	203A	8.95	527	15.00	811A	3.95	991	.65
C1B	3.95	2J32	69.95	4J32	199.00	211	.95	WL530	3.50	813	9.95	F1148	.35
1B21A	2.75	2J36	105.00	4J33	199.00	217C	18.00	WL531	22.50	814	3.95	1280	1.25
1B22	3.95	2J38	17.95	4J37	199.00	242C	10.00	WL533	17.50	815	3.50	1611	1.95
1B23	9.95	2J39	12.50	4J38	89.00	244A	12.95	700A/D	25.00	816	1.45	1613	1.38
1B24	17.95	2J40	35.00	4J39	199.00	249C	4.95	701A	7.50	829	12.95	1616	2.95
1B26	2.95	2J42	200.00	4J41	199.00	250TH	22.50	703A	6.95	829A	13.95	1619	.89
1B27	13.50	2J49	109.00	C5B	3.95	250TL	19.95	705A	3.95	829B	15.95	1622	2.75
1B32	4.10	2J50	195.00	5BP1	6.95	274A	3.00	707A	17.95	830B	2.50	1624	2.00
1B38	33.00	2J61	45.00	5BP4	6.95	204B	3.00	707B		832	7.95	1625	.45
1B42	19.95	2J62	45.00	5CP1	6.95	304TH	10.00	714AY	17.95	832A	9.95	1851	1.85
1B51	9.95	2K25	29.50	5D21	21.00	304TL	10.00	715A	7.95	833A	49.95	2050	1.85
1B56	49.95	2K28	37.50	5JP1	27.50	307A	4.95	715B	12.00	834	7.95	2051	1.80
1B60	69.95	2K29	37.50	5JP2	19.50	310A	5.95	715C	25.00	836	4.95	8012	4.25
1N21	1.35	2K41	150.00	5JP4	27.50	311A	6.95	717A	1.95	837	2.95	8013	2.95
1N21A	1.75	2K45	149.50	WE6AK5	2.50	312A	3.95	718AY/EY	48.50	838	6.95	8013A	5.95
1N21B	4.25	2V3G	2.10	C6A	12.50	323A	15.00	719A	29.50	845	5.59	8019	1.75
1N22	1.75	3BP1	7.50	C6J	10.95	327A	3.95	721A	3.95	849	52.50	8020	3.50
1N23	2.00	3B24	5.50	7BP7	7.95	328A	6.95	722A	3.95	851	80.50	8025	6.95
1N23A	2.75	3B24W	7.50	7DP4	10.00	350A	6.95	723A/B	24.95	860	4.95	PD8365	89.00
1N23B	4.25	EL3C	5.95	12AP4	55.00	350B	5.95	724A	4.95	861	29.50	9001	1.75
1N34A	.96	3C22	120.00	15E	1.95	357A	20.00	724B	6.95	866A	1.79	9002	.95
1N43	2.50	3C24	1.95	15R	.95	368AS	6.95	725A	9.95	869B	57.50	9003	1.75
2B22	1.95	3C31	3.95	NE16	.66	371B	2.95	726A	24.00	869BX	35.00	9004	1.75
2B26	3.75	3DP1A	10.95	FG17	6.95	385A	4.95	726B	56.00	872A	3.95	9005	1.90
2C34	.35	3DP182	12.00	KY21A	8.75	388A	2.95	726C	69.00	878	1.95	9006	.35
2C40	10.00	3E29	15.50	FG33	12.95	394A	7.95	728AY	27.00	884	1.95		
2C43	20.00	3GP1	5.50	35T	4.95	MX408U	.75	730A	24.00	885	1.75		
2C44	.90	4A21	2.75	45 Special	.35	417A	17.95	801A	1.00	889R	199.50		
2D21	1.75	4B26	6.95	RK39	2.95	434A	19.95	802	4.25	914	75.00		
2E22	2.75	4C27	25.00	HF50	1.75	446A	1.95	803	7.95	931A	5.00		
2E30	2.75	4C28	35.00	VT52	.25	446B	5.40	805	5.95	954	.35		

Minimum Order

$25.00

MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Also available of new production TS239A Synchroscope.

Other test equipment, used checked out, surplus.

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS10/APN Altimeter Test Set
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS15/AP Flux Meter
TS16/AP Altimeter Test Set
TS19/APQ 5 Calibrator
TS33/AP X Band Power and Frequency Meter
TS/34AP Western El Synchroscope
TS34A/AP Western El. Synchroscope
TS35/AP X Band Signal Generator
TS36/AP X Band Power Meter
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP X Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS251 Range Calibrator APN9
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175 Signal Generator
TS226 Power Meter
TS239A Synchroscope

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APA10 Oscilloscope and panoramic receiver
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APT2 Radar Jamming Transmitter
APT5 Radar Jamming Transmitter

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25 Dollars

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Cables:
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SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
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Of special interest to American industry is the wide attention given inquiries for test equipment now no longer available. Our greatly expanded facilities, our library of original tech manuals and engineering notes, and our experienced personnel provide the medium for rapid delivery of recreated pieces of test equipment. S-Band, X-Band, and K-Band equipments are offered in packaged forms to interested laboratories. Some 20 pieces of equipment are now being manufactured in their entirety in our shops; the balance of material listed below is generally refurbished and recertified equipment, absolutely checked-out and sold with a money back guarantee.

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TS-8A/U	TS-56/AP	TS-148/UP*	TS-279	AN/APA-10	I-198A	BC-1060
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TS-11/AP	TS-65A/FM2-1	TS-159/TPX	TS-294/U	I-56	I-212	BC-1236/A
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TS-18	TS-100/AP	TS-184/AP	TS-419	I-106A	IE-21/A	AT-39/AP
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TS-27/TSM	TS-110	TS-205/AP	TS-465/U	I-135E	BC-221*	TSX-4SE
TS-32A/TRC-1	TS-111/CP	TS-210/MPM	TS-480/U	I-139A	BC-376	TSS-4SE
TS-33/AP	TS-117/GP	TS-220/TSM	TS-487	I-140A	BC-438	TVN-8SE
TS-34/AP	TS-118/AP	TS-233/TPN	TS-505/U	I-145	BC-638	
TS-36/AP	TS-125/AP*	TS-251/UP	TS-589/U	I-147	BC-906/D	
TS-39A/TSM-1	TS-127/U	TS-250/APM	TS-615/U	I-168	BC-918B	
TS-45/APN-3	TS-131/AP	TS-257/AWR	TS-617/U	I-177	BC-923A	
TS-47/APR	TS-144/TRC-6	TS-266A/AP	AN-5841	I-178	BC-949/A	

*Of new manufacture.

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WESTON 93, MASS.

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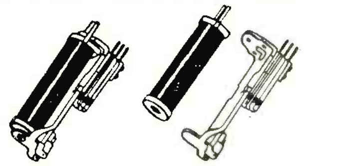
SEE OUR PREVIOUS ELECTRONICS ADS FOR LISTINGS OR WRITE FOR CIRCULARS

TELEPHONE TYPE RELAYS



These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

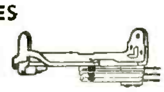
Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations.

107 COOK, 3-6VDC, 6 make, 1 break (5As. 1C), 12 ohm. Part of BC654, #R407........$ 3.95
CLARE, 6500 ohm, 8maDC, 3 makes (3As) R276 .... 4.25
5035A7 AUTOMATIC, 1300 ohm, 8maDC, SPST n.o. (1A), #103........ 1.75
CLARE K101, 6500 ohm, SPDT, 2 ma DC. Fast Action #175........ 4.25
A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug, Slow Release, SPDT, 200 ohm, Part of SCR 522, #R365........ 2.49
R5229A1 AUTOMATIC 6VDC. 3PST n.o. (3As), 75 ohms, Slow Release, #412........ 2.50
R5021A1 AUTOMATIC 1300 ohm, 20maDC, SPST n.c. (1B), #R413........ 2.95

FRAMES

(For Cost of Relay Add Price of Frame to Price of Coil)



Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	1.25	F111	1B, 2A	1.75
F102	2A	1.50	F114	1B, 3A	2.00
F103	3A	1.75	F108	1B, 1A, 1C	2.00
F104	4A	2.00	F107	2B, 1A	1.75
F105	5A	2.25	F112	2B, 2A, 2C	3.00
F106	1A, 1B	1.50	F118	2B, 5A, 1C	3.25
F107	1A, 2B	1.75	F113	5B, 2A	2.75
F108	1A, 1B, 1C	2.00	F121	5B, 1C	2.75
F109	1A, 1C	1.75	F122	1C	1.50
F110	1A, 2C	2.25	F123	2C	2.00
F111	2A, 1B	1.75	F109	1C, 1A	1.75
F112	2A, 2B, 2C	3.00	F116	1C, 4A	2.50
F113	2A, 5B	2.75	F117	1C, 5A	2.75
F114	3A, 1B	2.00	F121	1C, 5B	2.75
F115	3A, 2C	2.75	F110	2C, 1A	2.25
F116	4A, 1C	2.50	F115	2C, 3A	2.75
F117	5A, 1C	2.75	F108	1C, 1A, 1B	2.00
F118	5A, 2B, 1C	3.25	F118	1C, 5A, 2B	3.25
F120	1B	1.25	F112	2C, 2A, 2B	3.00
F106	1B, 1A	1.50			

FRAMES WITH MICROSWITCH

F125	1A, 1C (Microsw.)	1.75
F126	1A, 1A (Microsw.)	1.75

A = Normally Open; B = Normally Closed; C = Double Throw.

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

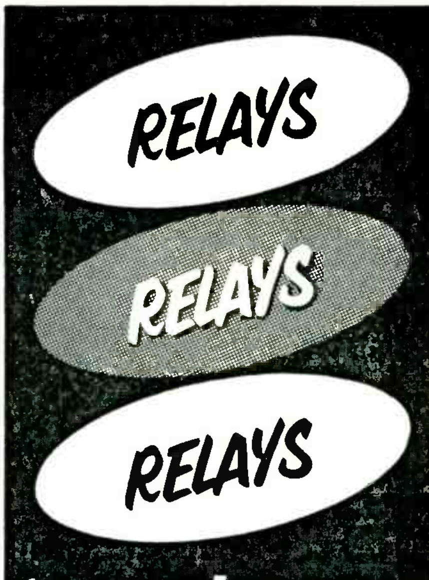
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	1.25	K106	1100/500 Dual	2.00
K102	12	1.25	K111	1300	1.75
K103	250	1.25	K112	2000	2.25
K104	450	1.50	K113	3000	2.50
K105	500	1.50	K115	4600	2.75
K106	500/1100 Dual	2.00	K116	6500	2.75
K107	750	1.50	K130	11,300	3.00
K108	900	1.75	K118	40,000	3.25
K109	1000	1.75			

A-C COILS

Stock No.	Voltage	Price each
K119	6V AC	1.75
K121	110V AC	2.50

SLOW ACTION COILS

Stock No.	Ohms	Slow Action	Price each
K122	33	Make	1.50
K123	75	Release	1.50
K124	200	Release	1.50
K125	300	Make	1.75
K126	2000	Make	2.00
K127	2500	Release	2.00

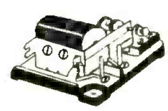


324 CANAL ST. (Near B'way) N. Y.—WA 5-9642

Universal general corp.

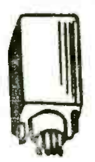
TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days. All others Remittance with Order. Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

ULTRA SENSITIVE RELAYS



KURMAN BK35 — Nominal Operating Characteristics, 11,000 Ohms. 0.4 Ma. 4V DC SPDT. Adjustable contacts and armature. #R277, 10 for $55.00. 100 for $475.00.

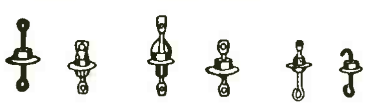
5.95 each



SIGMA 5RJ: 5000 ohms Hermetically sealed SPDT; 1.5 ma. DC, #R281

6.95 each

KOVAR GLASS TO METAL SEALS HIGH-VOLTAGE FEED THRU



Many types and sizes. Send us your blueprint or sample for our quote. Our prices are a fraction of original factory cost.

SAMPLE KIT 96 Seals (8 ea. 12 types)	5.00	postpaid in USA
LAB KIT 300 Seals (20 types)	15.00	postpaid in USA

H-F TIE POST

Low-loss Melamine Insulation, pictured actual size (4-40 Thread).....7.50/C $67.50/M

FERRULE AND OTHER WIRE WOUND RESISTORS

AT A FRACTION OF MANUFACTURERS' ORIGINAL COST!

IMMEDIATE DELIVERY

From Our Wide Assortment from 0.2 to 15 Megohms.

ENAMEL • GLASS
FIXED • ADJUSTABLE

New and in Perfect Condition. Nearly all made to JAN Specifications.

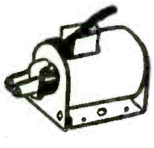
Send us your requirements. We have 250,000 wire wound resistors in a large variety of sizes in stock.

SELENIUM RECTIFIERS

Full-Wage Bridge Types

CURRENT (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.20	$3.60	$8.95
2 Amps.	2.20	5.60	6.50	10.50
2 U Amps.	.....	.....	.....	13.00
4 Amps.	3.75	6.75	8.75	.....
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	36.00
10 Amps.	6.75	12.00	20.00	45.00
12 Amps.	8.50	16.00	25.50	52.50
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	.....	.....
36 Amps.	25.50	45.00	.....	.....

A.C. SOLENOIDS



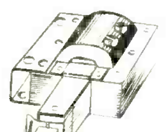
GUARDIAN No. 1: 24 VAC, 6 ohms ⅛ to ½" stroke, 6 oz.-in. #R 804 1.95

GUARDIAN No. 4: 115 VAC, 133 ohms ⅛ to 1⅛" stroke, 14 oz.-in. #R 805 3.95

GUARDIAN No. 4: 115 VAC, Intermittent Duty, 49 ohms ⅛" to 1⅛" Stroke, 3 lb.-in. 3.95

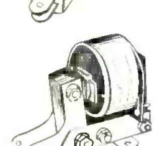
ALLEN BRADLEY BULLETIN 860, 110 VAC, ⅛ to 1" stroke, 2 lb-in pull; #R942 3.50

WARD LEONARD N83 CONTACTOR; 110 VAC, Heavy Duty. 8 lb-in stroke; #R233 10.95



UNIVERSAL 110V AC, 6-lb. pull, 2x2x2½", 1" thrust, #R176 ....$2.75

UNIVERSAL Type 1109, 110V AC, Intermittent duty, 12-lb. pull, 2½x2½x3", 1⅝" thrust, #R177 ....$7.95

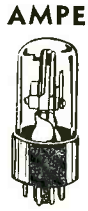


D. W. DAVIS MINIATURE 110V AC, Intermittent duty, 1⅜x1⅜x1½", ¾" stroke, 12 oz-in pull, #R178......$1.95

D. W. DAVIS MINIATURE 24V AC, 1⅜x1⅜x1½", ¾" stroke, 12 oz-in pull, #R179 $1.79

LEACH 980, 110V AC Intermittent duty, 1⅝x3⅛x2¼" Hinged type, #R180....$2.25

AMPERITE THERMOSTATIC DELAY RELAY



LIST
4.00 each
NET
2.40 each

Amperite Thermostatic Delay Relays are actuated by a heater . . . can therefore be used on AC, DC, or pulsating current. Being hermetically sealed, Amperite Relays are not affected by altitude, moisture, or other atmospheric conditions. At the present time only SPST is available — normally open or normally closed.

Available in voltage ratings of 2.5, 5, 6.3, 12, 26 and 115 volts. Delays in seconds are available as follows: 2, 3, 5, 10, 15, 20, 30, 45, 60, 75, 90 and 120 seconds. Most types from stock. When ordering specify: Voltage—Delay in Seconds—Open or Closed.

COMMUNICATIONS EQUIPMENT CO.

SHOCK MOUNT RACKS

FT-156	FT-265A	MT-62/ARC-5
FT-162	FT-338	MT-167-U
	FT-449	
FT-185	FT-487	MT-170A
FT-225	MT-5/ARR-2	MT-171A

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

COAX CABLE

RG8/U
RG9/U
RG34/U
RG37/U
RG57/U

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¢

MICA CAPACITORS

CM-45—2500 V. TEST

MFD.	Price	MFD.	Price	MFD.	Price
.01	$0.85	.0024	.60	.0075	.80
.015	.85	.0025	.60	.0076	.80
.02	.85	.0027	.60	.008	.80
.04	.85	.003	.60	.0085	.80
.001	.60	.004	.60	.0005	.60
.0015	.60	.005	.60	.00085	.60
.002	.60	.0056	.60	.00015	.60
.0022	.60	.006	.60	Write For Many Others	
.0023	.60	.0063	.60		

CM-55—2500 V. TEST

MFD.	Price	MFD.	Price	MFD.	Price
.00001	$0.29	.001	.35	.0075	1.79
.000025	.29	.0015	.35	.0076	1.79
.00003	.29	.0016	.35	.008	1.79
.00005	.29	.0017	.35	.01	1.10
.000075	.29	.002	.50	.015	1.10
.0001	.29	.0023	.50	.02	1.10
.00015	.29	.003	.50	.025	1.10
.00025	.29	.004	1.79	.027	1.10
.0003	.29	.005	1.79	.03	1.10
.0004	.29	.006	1.79		
.0005	.35	.0063	1.79	5000 V Test	
.00075	.35	.0069	1.79	.0015	1.75
.0008	.35	.007	1.79	.002	2.00

UNIVERSAL SUPPLY KIT

Delivers 230V @ 40MA DC. From 110/220VAC 60 CY. Kit Consists of 1-PWR Transformer, 1-5 HY @ 40MA Choke, 2-8 MFD @ 450V Filter Cond. 1-6x5 Tube. A great buy at only......... $3.95

INTERPHONE TRANSFORMER SET

Rig your own interphone. Kit consists of 1-Input Transformer (Matches 4 or 6 OHM SPKR to Grid) and 1-Output Transformer (Matches 50L6, 35L6, 25L6, etc., to 4 or 6 OHM Speaker Set of 2 XMRS. ONLY $1.00

12-14V SUPPLY KIT

Delivers 12-14VDC at 3.5A from 115V, 60 cy., Kit contains 1—Transformer Rated 18.5V, 4A, 1—Selenium Rectifier, F. W. Bridge..... $6.95

24 VOLT TRANSFORMERS

For operating surplus gear, toy trains, gadgets, etc. Operates from 115V, 60 cy., supplies 24 VAC at 1.2 Amp., herm. sealed and cased......... A Great Buy at Only $1.49

RECTIFIER TRANSFORMERS

Pri: 115V, 60 Cy. Sec: 28V/3.1A, 26V/8.4A 7.3V/14A $12.95
Pri. 210/215/220/225/230/235/240V, 60 Cy., 1 Phase Sec: 11/10/7.5/5VCT @ 35A.................$19.50
Pri: 115V 60 Cy: Sec: 8.1V @ 1.5A.........$1.39
Pri: 115V 60 Cy. Sec: 18.5V @ 5A.........$4.25

FLEXIBLE COUPLING SHAFTS

MC 215

(ALL LENGTHS IN INCHES)

34	163	260
135	186	

MC 124

(ALL LENGTHS SHOWN IN INCHES)

23	61	120	175
29	65	140	205
39	103	161	241
52	114	166	348

PRICE: MC 124 or MC 215

2¢ PER IN.

SELENIUM RECTIFIERS—Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.10	$3.60	$7.50
2 Amps.	2.20	3.60	6.50	10.50
2½ Amps.	.....	.....	.....	13.00
4 Amps.	3.75	.....	8.75	.....
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	33.00
10 Amps.	6.75	12.00	20.00	40.00
12 Amps.	8.50	16.00	25.50	50.00
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	.....	.....
36 Amps.	25.50	45.00	.....	.....

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	.050A	5VCT/3A	2.25
CT-99A	2x110VCT	.010A	6.3/1A, 2.5VCT/7A	3.25
CT-403	350VCT	.026A	5V/3A	2.75
CT-931	585VCT	.086A	5V/3A, 6.3V/6A	4.25
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	4.99
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—115V50-60 cps Input

ITEM	Rating	Each
FT-38A	6.3V/2.5A, 2.5V/7A, 2.5V/7A., 7500 VDC Test	$3.45
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-468	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 A 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

ITEM	Rating	Price
PT-699	300/150V/.05A, 300/150V/.05A	$2.79
PT-302	120-0-120V/350 MA	4.69
PT-108	17,600V/144 MA	120.00
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

Special Plate Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STP-613	230V	230/.05A 230V/.05A	$1.79
STP-409	220/440V	136VCT/3.5A	5.69
STP-815	240/440, 3ph	1310V/.67A, 6KV Test	27.50
STP-129	230V	3850V/3.12KVA	42.59
STP-823	137V	222VCT/.3A	2.35
STP-08B	50V	2x750V/.001A	1.79
STP-622	210/220/230	5000V/1A	59.75
STP-945	210/220/230	550-0-550V/.3A	5.95

Special Comb. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STC-16A	220V	260V/.03A, 100V/1A, 6.3V/4.2A	$4.69
STC-609	220V	220V/3A	6.95

CIRCUIT BREAKERS

AM 1614—80: 28VDC 80 AMP $1.59
AM 1614—100: 28VDC 100 AMP $1.69
KJ—600V. 115 AMPS, UP TO 1000% OVERLOAD RATING. TRIP ADJ. 10 MIN.—INST $21.95

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 376
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

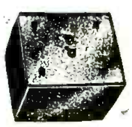
PE-218-H: Input: 25 28 VDC, 92 amp. Output: 115 v. 350 500 cy 1500 volt-amperes. New......................$44.50
PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5½"x10½". New..............$22.50
LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA, 400 CY 3 PHASE. EXC. COND........................$70.00

This Month's Special

PHASE-SHIFTING HELMHOLTZ COILS 0-360 DEGREES $3.95
BLEEDER RESISTOR, TYPE-HA. 3000 OHM—25W, 7500 OHM—5W, 23 OHM—1W, 23 OHM—1W WITH MTG. BRACK... .69¢
SA4A/APA-1 Motor Driven Coaxial Ant. Switch DPDT, Continuous Operation from 24VDC. Completely Enclosed $24.50
MP-22 MAST BASE Mobile Antenna Mount 4.59
SA1A/APN-1 Altitude Limit Switch for APN-1 Altimeter 7.95
ALTITUDE INDICATOR for APN-1.......... 12.50
C-387-D Final P.A. Coil for BC610 2-3.5 MC, Variable Link 4.89
RA-74 Power Supply for Super Pro.......... 69.50
J-17/ARC-5 Junction Box for ARC-5........ 7.95
J-22/ARC-5 Junction Box.................. 3.49
SUPERSONIC CRYSTALS, Rochelle salt.... .50 ea.
MOTOR, 24vdc. 3 HP 3800 rpm, New........ 75.00
TV LEAD-IN WIRE, 300 ohms, HI-Q, Lo-Loss.............................$17.50/M FT Roll
BC 306 ANTENNA TUNING UNIT, NEW 6.95
R9/APN-4, New, With Tubes............... 75.00
ID6/APN-4, New, With Tubes and Crystal.. 75.00
A-62 Phantom Antenna 8.50
2 Meter Choke, 1000 MA, 20-144 ....8/ 1.00
Supersonic Crystal Head, M-1, 22-27KC HI-2.................................... 27.45

FILTER CHOKES

Stock	Description	Price
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-8-35	2 / .5H/380 MA/25 Ohms	1.79



Stock	Description	Price
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-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	2 x .5H/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	15HY .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
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000V.T.	1.39
CH-170	2X0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5KV INS	39.95

INTERPHONE AMPLIFIER

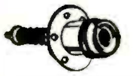
Easily converted to an ideal Inter-Communications set for office, home or factory. Original. New w/conversion diagram... $4.75

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.

131 Liberty St., New York 7, N. Y. Dept E-3 Chas. Rosen Phone: Digby 9-4124

COMMUNICATIONS EQUIPMENT CO.

PULSE EQUIPMENT



H/I-Volt Pulse Bulkhead. Feed-thru. Fits UG-36 Connector—as shown $15.00

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

PULSE TRANSFORMERS

G.E. # K2731 Repetition Rate: 635 PPS. Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28KV PK. Peak Output: 800 KW Bifiar 2.75 Amp. $65.00

U-10198 Pri: 4-5KV, 97A Pk Sec: 18KV, 26A, PRR-350-500 Cy. Duration 1.3 usec. $42.50

D-166173: Video. Ration = 50:900 Ohms 10KC—2MC $12.50

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. 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 100 KW 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 UX7361 .... $5.00

PHILCO 352-7250, 352-7251, 352-7287

UTAH 9332, 9278, 9341.

RAYTHEON: UX8693, UX5986 .... $5 ea.

W.E.: D-166310, D-16638, KS 9800, KS9948.

DELAY LINES

D-168184: 0.5 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

PULSE NETWORKS

G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS 50 ohms impedance $6.50

15A—1-400-50: 15 KV, "A" CKT. 1 microsec. 400 PPS. 50 ohms imp. $37.50

G.E. #3E (3-84-810) (8-2-24-405) 50P4T; 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms imp: Unit 2, 8 sections, 2.24 microsec. 405 PPS. 50 ohms imp. $6.50

7-5E3-1-200-67P. 7.5 KV. "E" Circuit, 1 microsec. 200 PPS. 67 ohms impedance 3 sections $7.50

7.5E3-3-200-6FT. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. 6 ohms imp. 3 sections $12.50

#755: 10KV. 2.2usec., 375 PPS. 50 ohms imp. $27.50

#754: 10KV. 0 85usec., 750 PPS. 50 ohms imp. $27.50

KS8865 Charging Choke: 115-150H @ .02A, 32-40H @ .08A, 30,700V Corona, 21KV Test $37.50

G.E. 25E5-1-350-50 P2T. "E" CKT, 1 Microsec. Pulse @ 350 PPS. 50 ohms impedance $69.50

TEST EQUIPMENT

● Signal Gen.	RCA 710A, 370-560 MC	350.00
● 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	Slotred Line, 500 MC	325.00
● TS 127/UP	Wavemeter, 300-700 MC	72.50
● TS 69/AP	Wavemeter, 340-1000 MC	72.50
● TS 70/AP	Pwr. Meter, 200-800 MC	
● TS 110/AP	Echo Box, 2400-2700 MC	

THERMISTORS

D167018	$1.50
D167332	1.50
D167613	1.50
D166228	1.50
D164699	2.50
D163903	1.95
D166792	2.15

VARISTORS

D171812	$1.50
D172155	1.50
D167176	1.50
D168687	1.50
D167208E, D171858	1.50
308A, 27-B	1.50
D168403	2.15

MICROWAVE COMPONENTS

S BAND—3″ x 1 1/2″ W.G. 10 CM.

DIRECTIONAL COUPLER. Broadband. 20 db. Coupling. Type "N" Takeoff. Complete with all Hardware. Navy # CABY-47AAN-2 .... $37.50

WAVEMETER 2700-3400 MC. Reaction Type with counter Dial—Mfg., W.E. $92.50

REACTION WAVEMETER. Mfg. G.E. 3000-3700 MC. Misc. Head $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 plated $45.00

RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr.-TR cavity, compl. recvr. & 30 MC IF strip using 6AK5 (2040, 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

F 29/SPR-2 FILTERS, type "N" input and output Hi-Pass Over 1000 MC $12.50

WAVEGUIDE TO ⅞″ RIGID COAX "DOORKNOB" adapter choke flange. Silver plated broad band $32.50

AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

OAJ ECHO BOX, 10 CM TUNABLE $22.50

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

"E" or "H" PLANE BENDS, 90 Deg. less flanges $7.50

COAXIAL FILTER, F3/APR-2, LO-PASS, BELOW 400 MC $32.50

7/8″ RIGID COAX—3/8″ I. C.

ROTARY JOINT, Stub-supported, UG 46/UG 45 fittings $27.50

10 CM STABILIZER Cavity, tunable, standard UG46/UG 45 fittings $45.00

RG 44/U RIGID COAX, stub support, 5 ft. sections, with UG46/UG45 connectors $12.50

RT. ANGLES for above $4.50

RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00

SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00

RIGID COAX to flex coax connector $3.50

RT. ANGLE BEND 15″ L. OA $3.50

FLEXIBLE SECTION, 15 L. Male to female $4.25

⅞″ RIGID COAX. BULKHEAD FEED-THRU $14.00

X BAND—1″ x 1/2″ W.G. 3 CM.

CROSS-GUIDE COUPLER. Main Section 7″ long with 90 deg. bend (E-Plane). 2½″ radius. Broadbanded coupling figure is 20 db. Individually calibrated $22.50

1″ x ½″ waveguide in 5′ lengths, UG 39 flange to UG40 cover $7.50

Rotating joints supplied either with or without deck mounting. With UG40 flanges .... each $17.50

Bulkhead Feed-thru Assembly (As Shown) $15.00

Pressure Gauge Section 15 lb. gauge and press nipple $10.00

Pressure Gauge, 15 lbs. $2.50

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/pres nipple $6.50

Waveguide Section 2½ ft. long silver plated with choke flange $5.75

Rotary joint choke to choke with deck mounting $17.50

3 cm. mitered elbow "E" plane $12.00

UG 39 Flanges .... $ .85

90 degree elbows. "E" or "H" plane 2½″ radius $12.50

45 degree twist $8.00

APS-4 Under Belly Assembly, less tubes $375.00

MICROWAVE RECEIVER, 3 CM.

SENSITIVITY: 10-13 MICROWATT COMPLETE WITH L.O. AND AFC MIXER AND WAVEGUIDE INPUT CIRCUITS. 6 I.F. STAGES GIVE APPROXIMATELY 120 DB GAIN AT A BANDWIDTH OF 1.7 MC. VIDEO BANDWIDTH: 2 MC. USES LATEST TYPE AFC CIRCUIT. COMPLETE WITH ALL TUBES, INCLUDING 723A/B LOCAL OSCILLATOR $175.00

K BAND—1/2″ x 1/4″ W.G. 1.25CM.

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

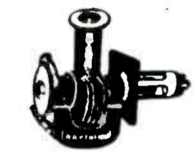
"S" Curve Choke to cover $4.50

Adapter, round to square cover $5.00

Feedback to Parabola Horn with pressurized window $27.50

90° Twist $10.00

MAGNETRONS



Tube	Tube	Tube
2J27	2J49	720BY
2J31	2J61	725-A
2J21	700	730-A
2J22	706	QK 62
2J26	2J62	QK 61
2J32	3J31	QK 60
2J37	5J30	2J56
2J38	718DY	2J32
2J39		

400 CYCLE TRANSFORMERS

(All Primaries 115V, 400 Cycles)

Stock	Ratings	Price
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V/6A, 5V/6A	$5.49
702724	9800/8600 @ 32MA	8.95
12033	4540V/250MA	17.50
K59584	5000V/290 MA, 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/CA	6.95
352-7070	2X2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/1000/75 OV @ .005A	7.45
352-7196	1140V/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2X6.3VCT/6A	4.75
RA6400-1	2.5V/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V/75MA, 100V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/80MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300 VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS 8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A	2.95
52C080	526VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4V/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
95-G-45	2000V/.002A, 465V/.6A, 44V/10A, 6.3V/23.5A, 6.3V/1.8A, 5V/9A, 2X2.5V/1.75	17.95
TRANSTAT	IN: 115V, 400 CY. OUT: 75-120V, 6.0 Amps.	12.95
M-7467886	2X140V/.014A, 120V/.012A, 1200VRMS Test, P/O MX-8/APG-2	4.95
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1 MA, 2.5V/1.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A P/O ID-39/APG-13	4.95

MICROWAVE ANTENNA EQUIPMENT

AT49A/APR—Broadband Conical, 300-3300 MC. Type N Feed. (AS SHOWN) $12.50

AS-31/APN-7: 10 cm Polyrod in Lucite Ball. Type N Fitting Coax Feed $22.50

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½″ x 3′. New $100.00

Dipole for above $12.00

TDY "JAM" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New $150.00

Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal 33 deg. in vertical planes $35.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50

AS14A/AP, 10 CM pick up dipole assy, complete w/length of coax and "N" connectors $3.50

AS46A/APG-4 Yagi Antenna, 5 element array $22.50

30″ Parabolic Reflector Spun Aluminum dish $4.85

RADAR ANTENNAS

AS-12/APS-3	AS-125/APR
AS-17/APS-2	AS-217/APG-15
AS-13/APG-2	AT49/APR
AS69/APT	AS-14/AP

30′ SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig. Corps No. 2A289-223-A. New .... $49.50 per set

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.

131 Liberty St., New York 7, N. Y. Dept E-3 Chas. Rosen Phone: Digby 9-4124

Wilgreen Industries

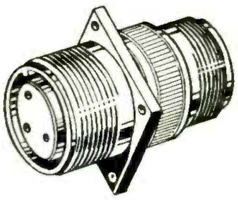
99 MURRAY ST., NEW YORK 7, N. Y.
WOrth 4-2490-1-2

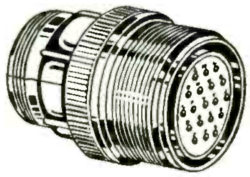
48 Hour Delivery on AN

PROMPT Service on UG

We carry a complete and diversified stock of "AN" connectors at all times and are in a position to make deliveries within 48 hours, thereby eliminating all unnecessary stoppages due to the lack of "AN" connectors.

Many manufacturers have come to depend upon our prompt deliveries of AN & UG connectors from stock, without delay.


AN 3100 A/B


AN 3101 A/B

"UG" CONNECTORS "UG"

TYPE	TYPE	TYPE	TYPE	TYPE
UG 9/U	UG 46/U	UG 115/U	UG 234/U	UG 348/U
UG 10/U	UG 49/U	UG 119 U/P	UG 235/U	UG 349/U
UG 11/U	UG 50/U	CW 123 A/U	UG 236/U	UG 352/U
UG 12/U	UG 57/U	UG 131/U	UG 237/U	M 358
UG 13/U	UG 57 B/U	UG 146/U	SO 239	M 359A
UG 14/U	UG 58/U	UG 148 A/U	UG 241/U	MT 412
UG 15/U	UG 58 A/U	UG 149 A/U	UG 242/U	UG 414/U
UG 16/U	UG 59/U	UG 154/U	UG 243/U	UG 419/U
UG 17/U	UG 59 A/U	CW 155/U	UG 244/U	UG 421/U
UG 18/U	UG 60/U	UG 155/U	UG 245/U	UG 422/U
UG 18 A/U	UG 60 A/U	UG 156/U	UG 246/U	UG 423/U
UG 18 B/U	UG 61/U	UG 157/U	UG 249/U	UG 478/U
UG 19/U	UG 61 A/U	UG 158/U	UG 250/U	UG 479/U
UG 19 A/U	UG 83/U	CW 159/U	UG 251/U	UG 482/U
UG 19 B/U	UG 85/U	UG 159 A/U	UG 252/U	UG 483/U
UG 20/U	UG 86/U	UG 160 A/U	UG 253/U	UG 484/U
UG 20 A/U	UG 87/U	UG 160 B/U	UG 254 A/U	UG 486/U
UG 20 B/U	UG 88/U	UG 166/U	UG 255/U	UG 487/U
UG 21/U	UG 88 B/U	UG 167/U	UG 256/U	UG 491/U
UG 21 A/U	UG 89/U	UG 167 A/U	UG 257/U	UG 492/U
UG 21 B/U	UG 90/U	UG 173/U	PL 258	UG 493/U
UG 21 C/U	UG 91/U	UG 174/U	PL 259	UG 494/U
UG 21 D/U	UG 91 A/U	UG 175/U	PL 259 A	UG 495/U
UG 22/U	UG 92/U	UG 176/U	UG 259/U	UG 496/U
UG 22 A/U	UG 92 A/U	UG 180 A/U	UG 260/U	UG 499/U
UG 22 B/U	UG 93/U	UG 181 A/U	UG 260 A/U	UG 503/U
UG 22 C/U	UG 93 A/U	UG 182 A/U	UG 261/U	MX 504
UG 23/U	UG 94/U	UG 185/U	UG 262/U	UG 505/U
UG 23 A/U	UG 94 A/U	UG 188/U	UG 266/U	UG 506/U
UG 23 B/U	UG 95/U	MX 195/U	UG 269/U	UG 507/U
UG 23 C/U	UG 95 A/U	UG 197/U	UG 270/U	UG 526/U
UG 27 A/U	UG 96/U	UG 201/U	UG 271/U	UG 530/U
UG 27 B/U	UG 96 A/U	UG 202/U	UG 272/U	UG 531/U
UG 28/U	UG 97/U	UG 203/U	UG 273/U	UG 532/U
UG 28 A/U	UG 97 A/U	UG 204 A/U	UG 274/U	UG 533/U
UG 28 B/U	UG 98/U	UG 206/U	PL 274	UG 535/U
UG 29/U	UG 98 A/U	UG 207/U	UG 275/U	UG 536/U
UG 29 A/U	UG 100/U	UG 208/U	UG 276/U	UG 541/U
UG 29 B/U	UG 100 A/U	UG 212 A/U	UG 279/U	MX 554/U
UG 30/U	UG 101/U	UG 213 A/U	UG 286/U	UG 557/U
UG 32/U	UG 101 A/U	UG 215/U	UG 287/U	MX 564/U
UG 33/U	UG 102/U	UG 216/U	UG 290/U	UG 568/U
UG 34/U	UG 106/U	UG 217/U	UG 291/U	UG 571/U
UG 35 A/U	UG 107 A/U	UG 218/U	UG 294/U	UG 572/U
UG 36/U	UG 107 B/U	UG 219/U	UG 299/U	UG 573/U
UG 37/U	UG 108/U	UG 220/U	UG 306/U	UG 625/U
UG 37 A/U	UG 108 A/U	UG 222/U	UG 309/U	UG 627/U
UG 38 A/U	UG 109/U	UG 223/U	UG 333/U	UG 628/U
UG 39/U	UG 109 A/U	UG 224/U	UG 334/U	UG 634/U
UG 40/U	UG 110/U	UG 231/U	UG 335/U	MX 913/U
UG 45/U	UG 114/U	UG 233/U	UG 347/U	

"AN" CONNECTORS "AN"

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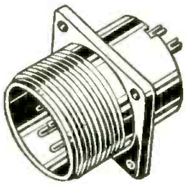
THE ABOVE INSERTS ARE AVAILABLE IN ALL TYPE SHELLS "AN-3055"—ADAPTERS "9760"—CAP & CHAINS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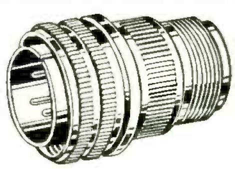
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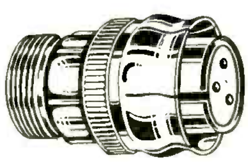
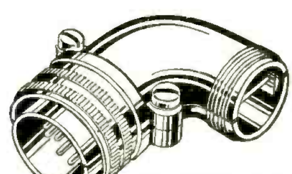
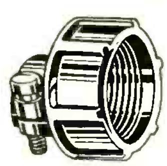

AN 3107 A/B


AN 3108 A/B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Recording Theodolite PHB-33

(Spotting Set PH-32)

ORIGINAL APPLICATION

To analyze effectiveness of anti-aircraft fire by accurate "three dimensional" determination of shell burst position with respect to the target.

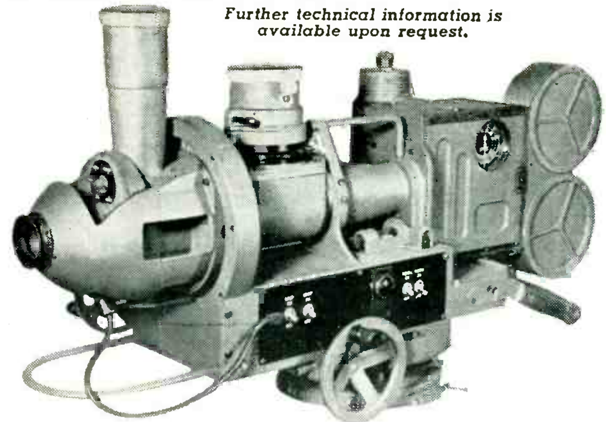
PRESENT APPLICATIONS

1. To determine accurate "landing and take-off" measurements in aircraft flight test work. By placing these units at points from 1,000 to 3,000 feet normal to the center line of a runway, this "photographic recording theodolite" provides an accurate film record of azimuth and elevation of the position of the airplane on both take-off and landing. Since the distance of the theodolite from the runway is a known factor, all other distances can then be computed by the method of triangulation.
2. The "recording theodolite" also provides a rapid method for measuring acceleration and deceleration of airplanes in acceleration and stop tests.
3. For tracking of missiles at relatively low altitudes up to 8,000 feet. By modification to a 20" lens, the "recording theodolite" may be used for tracking missiles or target planes from 20,000 feet to 25,000 feet.
4. If modified to a 20" lens, the theodolite may be used for photographing airplane spin tests at these same high altitudes.

DESCRIPTION

Each theodolite is a complete unit consisting of a built-in motion picture camera, camera magazine, sighting telescope, lamps, controls, gearing and associated mechanisms necessary for operation. Junction boxes, cords, timing interval devices, time interval multiplier, and time interval signal units are supplied with each theodolite.

Further technical information is available upon request.



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Output: 115 V—400 cycle—45 Watt—Single Phase — **$90.00**

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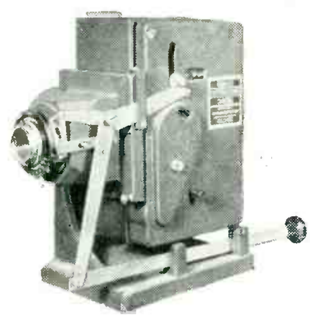

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TS24/ARR2	TS89/AP
TS26/TSM	TS100/AP
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IE21	I-130	I-223
IE36	I-139A	IS-185
IE45	I-145	BC-221
IE46	I-148	BC-376
IE57	I-155	BC-906
I-56	I-173	BC1066
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AND 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	2J33	100.00	4C27	25.00	304TH	9.75	813	9.00	1625	.65
OC3	$1.60	2J34	write	4C28	35.00	304TL	9.75	829A	12.00	1626	.75
OD3	1.50	2J36	100.00	4C35	27.50	307A	5.00	832A	10.00	1629	.65
C1A	6.00	2J38	49.50	4D32	write	339A	35.00	833A	42.50	1636	3.00
C1B	7.00	2J39	49.50	4E27	17.50	371B	2.50	836	4.75	1642	3.50
C6A	write	2J42	100.00	4J25	175.00	388A	2.75	837	2.75	2050	2.00
C6F	12.50	2J49	100.00	4J26	175.00	446A	2.00	843	write	8012	4.25
C6J	write	2J50	75.00	4J28	175.00	446B	3.75	849	50.00	8020	3.50
1B22	3.95	2J61	75.00	4J29	175.00	450TH	45.00	851	45.00	8025	7.00
1B23	10.00	2J62	75.00	4J30	write	450TL	45.00	860	5.00	9001	1.65
1B24	write	2K22	write	4J31	175.00	464A	9.50	861	write	9002	1.50
1B44	write	2K25	35.00	4J33	190.00	705A	3.25	865	.40	9003	1.75
2B22	4.95	2K26	150.00	4J52	350.00	706AGY	45.00	872A	3.85	9004	1.75
2B26	3.75	2K29	35.00	5C22	write	707B	12.50	874	1.50	9005	1.90
2C40	18.00	2K36	write	5J23	write	714AY	17.50	889R	195.00	9006	.50
2C43	25.00	2K41	150.00	5J26	350.00	715B	17.50	891R	250.00		
2D21	1.70	2K45	100.00	5J29	write	720	write	892	150.00		
2E22	3.75	2K54	150.00	6C21	29.50	721A	3.75	892R	250.00		
2J21	17.50	2K55	100.00	10Y	1.25	723A/B	25.00	2X2/879	1.75		
2J22	17.50	3B24	5.40	100TH	9.00	724B	6.50	K1069P7	write		
2J26	27.50	3B27	10.00	204A	60.00	725A	write	1614	write		
2J27	27.50	3B28	9.00	211	1.00	730A	45.00	1616	2.75		
2J31	27.50	3C31	5.75	250TH	30.00	803	7.00	1619	.75		
2J32	65.00	3E29	15.00	250TL	30.00	807	1.65	1624	2.00		

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Voltage regulator for above to regulate plus or minus 2 volts $125.00

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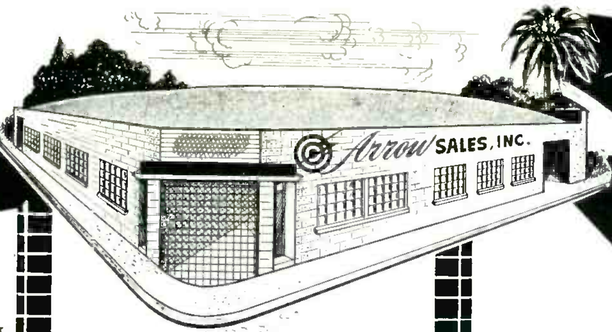

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Dynamotor powered, either 14 or 28 V. Shock mounted, remotely controlled, transceiver. Tunable receiver, range 108-160 M.C., 4-channel crystal controlled VHF transmitter, built-in provisions for omni. Weight, complete with plugs, less cable, 19 Lbs. Less crystal, new **$245.00**

Radar

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APR-5	APT-3	RC-224
APS-4 New, Complete	APT-4	RC-266
APS-6 New, Complete	Mark 16	RT34/APS13
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Part #	Item
Transmitter	T-47A/ART-13
564916	Barometric Switch
565027	4-Pile Ceramic, Variable Cap.
K7890443	6-Pile Ceramic, Variable Cap.
564605	4 Centralap-Type 843-003 Cap Assembly
Antenna Loading	CU-25

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1½ Kw. 110 V. 60 cps. Complete gas engine power supply. New, with spare parts. P.U.R.

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IE-36	TS-35/AP	TS204/AP
I-95	TS36/AP	TS-218
I-96-A	TS-45A/APM-3	TS251
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Specials

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R-4/ARR-2	BC-733-D	TA2J-24
ID-6/APN-4	R-57/ARN	R-89/ARN
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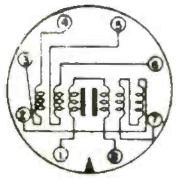
Tube base plug in type



TYPE UX 7350
Each Coil—50-T #36E
Max. DC Res. Ohms
1 & 8= 4.02Ω
2 & 7=4.542Ω
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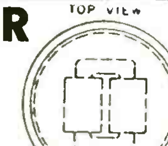

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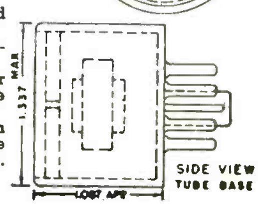

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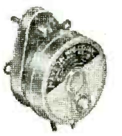

110 v. 60 cycle 30 RPM.... **$2.60**
110 v. 60 cycle 1/10 RPM.. **$2.35**
110 v. 60 cycle 1 RPM..... **$2.85**
110 v. 60 cycle 2 RPM..... **$2.00**
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ISOLATION TRANSFORMER

Step-Up or Step-Down 4½ lbs....... **$2.85**

230 volts to 115 volts
115 volts to 230 volts
115 volts to 57 volts

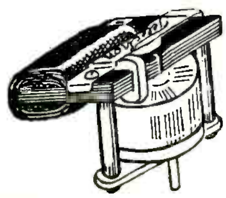
MARKTIME 5 HOUR SWITCH

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

REDMOND Powerful 5" Blower or Ventilator 115 volts AC 60 cycles 18 watts. For Kitchen — Laboratory. Heat or Cold or Chemicals...$7.50

Genuine TELECHRON Motors



2 RPM..... **$2.90**
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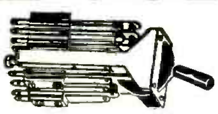
60 RPM.... **4.30**

One of each **$15.00**

Mossman Lever Switch $2.50



10 Amp. Heavy Duty Silver Contacts. Contacts can easily be re-stocked and changed to suit your needs. Now momentary OFF CENTER but can be changed by user to stay either side. Brand New.

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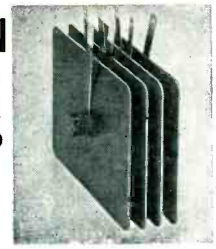

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Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$7.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	.....	.....	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	40.00
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20 Amps.	13.25	25.50	39.00	79.50
24 Amps.	16.25	32.50	45.00	90.00
30 Amps.	20.00	38.50	.....	.....
36 Amps.	25.00	48.50	.....	.....

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PRI: 115 V., 60 cycles in. SEC: 9, 12, 18, 24, and 36 volts Continuous Ratings
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4 Amps.—.07 Hy.—.6 ohm....................$7.95
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OB2	1.10	6CD6-G	1.60	117Z6	1.00
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1AE4	.85	6G6-G	.85	250-TH	17.00
1B3/8016	.80	6J5GT	.45	274A&B	2.95
1B23	8.00	6J6	.62	275-A(WE)	3.00
1B27	12.50	6J7	.70	304-TH	7.00
1L4	.60	6K4(Syl.)	3.50	304-TL	8.75
1LA6	.90	6K6GT	.59	310-A(WE)	5.95
1N21B	2.50	6K7 Metal	.70	311-A(WE)	6.50
1N21C	17.50	6L5-G	.49	328-A(WE)	5.00
1N23A	2.25	6L6-G	1.19	337-A(WE)	3.00
1N23B	3.49	6L6-GA	1.20	349-A(WE)	1.35
1N34A	.75	6L6-Metal	1.95	350-B(WE)	3.95
1N44/400B	1.21	6L7	.80	359-A(WE)	4.00
1N45/400C	1.39	6N7-Metal	.80	371-B	.85
1N48(GE)	.55	6Q7GT	.80	373-A(WE)	4.00
1N54(Syl.)	.77	6S7 Metal	.98	374-A(WE)	3.50
1X2A	.90	6SD7	.79	387-A(WE)	2.50
2C40	9.95	6SG7	.72	400-A(WE)	2.50
2C43(GE)	13.95	6SJ7	.69	403-B(WE)	7.50
2C52	5.50	6SK7GT(Syl.)	.62	407-A(WE)	5.00
2D21	1.25	6SL7GT	.60	408-A(WE)	2.75
2E24	2.50	6SN7GT	.70	421-A(WE)	3.50
2E30	1.95	6V6GT	.55	GL-559	1.00
2J22	6.50	6W4GT	.55	717-A	.88
2J32	29.95	6W6GT	.85	725-A	5.50
2J34	25.25	6Y6-G	.88	805	3.25
2J39	40.00	6X5GT	.55	807	1.59
2J48	24.25	7A7	.69	811-A	3.50
2K25	29.50	7A8	.69	812	2.70
3A4	.59	7C5	.69	812-A	3.50
3AP1	9.00	7C6	.69	816	1.10
3B28	7.50	7C30	85.00	832-A	8.50
3B29	9.95	7F7	.69	837	1.45
3BP1	5.75	7H7	.72	860	3.95
3BP11	9.50	12A6	.50	861	15.00
3C23(GE)	9.50	12AT7	.75	866A	
3C27	7.50	12AU7	.62	(Hytron)	1.55
3C33	9.00	12AV6	.49	872-A	3.95
3D6/1299	.50	12AX7	.79	959	2.75
3E29	9.95	12BA6	.57	1613	.75
3Q5GT/G	.99	12BD6	2.10	1616	.70
3S4	.80	12BE6	.57	1622(6L6M)	1.95
4C35	22.50	12BH7	1.15	1625(RCA)	.35
4E27	13.00	12SA7	.75	1631	.70
4-125A	22.00	12SF5	.70	1632	.70
4-250A	32.00	12SG7	.80	2050(RCA)	1.35
5D21(WE)	16.75	12SH7	.63	2051	1.10
5R4GY	1.25	12SJ7	.69	5514(Hytron)	4.50
5U4G	.55	12SK7	.70	5528/C6L	13.00
5V4G	.95	12SL7GT	.65	5608-A	3.95
6AB7	.98	12SN7GT	.70	5646(Syl)	8.25
6AC7	.77	12SQ7GT	.63	5654	1.75
6AG7	1.25	12SR7	.60	CK-5702	3.23
6AH6	1.00	14F7	.80	CK-5744	2.25
6AJ5	1.30	19AP4A		CK-5886	3.00
6AK5	.70	(GE)	44.00	5800(Vict.)	6.50
6AK5-W	.90	25AV5	1.25	5803(Vict.)	2.75
6AL5	.50	25BQ6GT	1.00	5814	2.95
6AN5	2.25	25L6GT	.65	5910	.75
6AT6	.60	25Z6	.67	5995	3.50
6AU6	.59	35B5	.40	8020	.98
6AV6	.49	35C5	.40	9001	1.35
6BE6	.55	35L6	.69	9002	.85
6BG6-G	1.35	35-T(EIM)	3.00	9003	1.50
6BH6	.60	35Z5GT	.49	9004	.35
6BQ6GT	1.20	42	.65	9006	.35
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Capacity	W. Voltage	Ea.
500 MFD.	50 V.	.98
500 MFD.	200 V.	2.50
1000 MFD	12 V.	.50
3000 MFD.	20 V.	2.25
5000 MFD.	50 V.	3.75

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• Choke to match above XFMR. New. Mfd by Western Electric $4.95

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First Quality in factory-sealed cartons. Full Year Warranty Card on each tube. Remember . . . no seconds; no rebuilts . . . Prices include Fed. Tax. C.R. Tubes via Express Collect.

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14CP4	24.00	17BP4A	24.75	21FP4A	36.00
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CO-122 3 conductor each #22 AWG neoprene jacket 550' lengths
CO-127 single #14 AWG braided and tinned copper braid shield

MULTI-CONDUCTOR

2 conductor AWG 12
7 conductor AWG 14
14 conductor AWG 16
11 conductor shielded AWG 20
2 conductor AWG 18
7 conductor AWG 16
19 conductor AWG 16
6 conductor AWG 20
10 conductor AWG 16
22 conductor AWG 16
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AMOUR

DRIA-23 DHFA-100 FRIA-4

SINGLE CONDUCTOR AWG 10

shielded cable with terminal lug each end 100' and 150' lengths

WIRE

AWG 18 copperweld
AWG 29 tinned copper
Resistance wire AWG 32
AWG 22 with nylon core plastic insulation

LINEAR WIRE WOUND POTENTIOMETERS

10 Ohm	25 Watt	$.90	15000 Ohm	25 Watt	$1.70
15	25	.95	20000	25	2.00
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25	25	.95	150w/switch	50	2.15
50	25	.95	200 w/switch	50	2.15
100	25	.95	10000	50	2.95
200	25	1.20	15	75	2.95
350	25	1.20	.5 Meg 1" Shaft	AB "J"	1.45
500	25	1.20	200,000 1/8 SD	AB "J"	1.40
1000	25	1.30	200 1/8 SD	AB "J"	1.40

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80-86 Crystal in Holder $2.50
Balloon with Hydrogen Generator $2.50
300 Feet Aerial Wire $2.00

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10 CM echo box CABV 14ABA-1 of OBU-3, frequency range 2890 MC — 3170 MCS. Direct reading micrometer head. Ring prediction scale plus 9% to minus 9% Type "N" input. Resonance indicator meter. With accessories, spares and 10 CM directional coupler. Brand New.

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2X2/879	.55	803	3.60	C5B	8.00
3B24	4.95	826	.65	CK 70	4.15
3C24	1.60	864	.25	E1148	.30
7C4/1203A	.70	931A	4.45	HY 615	.20
10Y	.35	955	.30	RK 73	.45
15R	.65	957	.35	5BP4	4.25
30 Spec	.40	CK 1005	.45	5FP7	1.75
39/44	.25	CK 1007	.90	1J6 G	.70
45 Spec	.35	1626	.35	1B3 GT	.80
WE 203A	6.75	1629	.25	3A4	.60
316A	.60	2051	1.10	5U4G	.57
WL 531	4.95	7193	.50	6K6GT	.60
713A	.90	8011	1.50	371B	.75

HI VOLTAGE FILTER CHOKES

.4 HY 4.5 Amp DC 3 ohms 1230 RMS to ground. New.
1 HY 3.2 Amp DC 3.5 ohm GE69G459. New.
1.7-3 HY 2 AMP DC 34,000 VDC GEY346A. New.

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Porcelain flanged bowl with brass rod, fittings and aluminum shield. Dimensions 4⅜" high, 6-5/16" OD at base. Brand new $4.50.

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24" Parabola in turret 360° span at 12 RPM DC, motor control and reversing switch New.

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Breaks Contact with increase in Temperature. New $1.35

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DPST 115 VAC "AB" #700 $5.95

RELAYS

12 VDC DPST Allied Control Box 32...$1.25
24 VDC DPDT Allied Control BID36....$1.45
24 VDC 3PDT 8 Amp................$1.50
110 VAC DPST 1 Amp Contacts Struthers Dunn CKA 1970..................$3.65
115 VAC DPST Struthers Dunn CXA 2997 ....$3.65
220 VDC DPDT Struthers Dunn CK 2122.$4.50
230 V 50 cycle DPDT G.E. 12HGA11A2..$4.00

OIL FILLED CONDENSERS

FD	VDC	Each	Ten	MFD	VDC	Each	Ten
1	600	.85	.80	.5	2000	2.00	1.90
2	600	.95	.95	.25	3000	2.85	2.80
4	600	1.40	1.40	.5	3000	2.95	2.90
5	600	1.65	1.60	.2	5000	4.50	4.25
1-8	600	2.50	2.35	.1	7500	3.95	3.95

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Portable 0-25 Amps AC Weston #433 Brand New $37.50
Switch Board Panel 0-100 Amps DC Weston #269 with 100 Amp Shunt Brand New $24.95

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Walkie-Talkies 2.3-4.6 MC
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DAB 3—Direction Finder
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MP-S-33 BASE—Insulated type with heavy coil spring and 5" dia. insulator. Requires 2" hole for mounting. Weight: 9 lbs. $5.95

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115 Volt 60 cycle BLOWER (pictured), approx. 100 CFM Dis. 2¼" intake; 2" outlet. Quiet running Motor size: 2½"x3¼". NEW — not Gov't surplus. Order No. 1C939 **$8.95**

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FLANGE TWIN—275 CFM. 4-½" Intake: 3-¾" x 3" Dis. Complete size: 11-¾" W x 9-⅜" H x 8-1/16" D. No. 2C069 .... $21.95

AERIAL WIRE—Phosphorous Bronze #16 Stranded. 200 lb. test. Weatherproof. 150 ft. on Reel. RL-3 with Clips $1.50

TELEPHONE WIRE—3 Cond. copper & steel, 525 ft. $4.75

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RADIO FREQUENCY AMPLIFIER AM-14/APT 100 W. Used to increase output Transmitting Equipment AN/APT-1. Input 80 or 115 V. AC 400 to 2600 Cycle 600 W. $59.50

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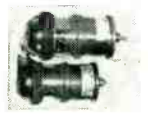

2J1G1 CONTROL TRANSFORMER WITH CAPS. 57.5 VOLT; 400 CYCLE. NEW; $5.95 Ea.

SELENIUM RECTIFIER UNITS

HEAVY DUTY—30 VOLT DC OUTPUT:

115/200 V. Three Phase 400 Cycle Input:
TYPE 143 w/Transformer & VR 100 Amp....$69.50
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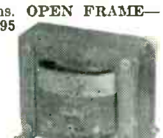

5 VOLT CT-25A—10,000 V. Ins. OPEN FRAME—6" x 5" x 4-½".......... $7.95
Sec. Two 12 V. 4 A. Windings—gives 12 V. 8 A. or 24 V. 4 A. $5.95
Sec. 24 Volt ½ Amp .$1.50
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Input	Output	Stock No.	Price
14 V. DC	600 V. 300 MA.	BD-36	$9.95
12 V. DC	220 V. 70 MA.	DM-24	6.95
12 V. DC	220 V. 100 MA.	DM-18	4.95
12 or 24 V. DC	440 V. 200 MA. & 220 V. 100 MA.	D-104	14.95
14 V. DC	375 V. 150 MA.	DM-375	8.95
14 V. DC	330 V. 135 MA.	DM-330	7.95
14 V. DC	500 V. 500 MA.	PE-59	14.95
12 or 24 V. DC	275 V. 110 MA.	USA/0516	3.95
12 or 24 V. DC	500 V. 50 MA.	USA/0515	3.95

ALSO—PE-73; PE-86; DM-53; DM-33; 5055; DM-416; PE-101, etc.

ADDRESS DEPT E ● All Prices Are F.O.B., Lima, Ohio ● 25% Deposit on C.O. Orders

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ARC—1's, ART—13's, RTA 1B's, BC348's AND COMPONENT PARTS FOR ABOVE

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WAREHOUSE CLEARANCE TUBE SALE

NEW, STANDARD MANUFACTURERS, IMMEDIATE DELIVERY

0B3/VR90	$ .99	6AC7	.95	721A	2.45	EL302.5/3B21	2.95
0C3/VR105	.99	6AG7	1.15	723AB	22.50	FG27A	6.50
0D3/VR150	.85	6AJ5	1.50	724A	2.95	FG90	4.95
1A3	.78	6AJ6	1.50	724B	3.95	GL316A	2.50
1A5GT	.62	6B6G	.75	725A	8.50	GL434A	22.50
1B22	2.50	6C6	.74	726A	14.95	GL446A	2.50
1B24	9.95	6C8G	.74	801	.85	GL605	49.95
1B27	17.50	6H6	.59	803	3.95	ML-531	14.50
1B32/532A	2.95	6K7	.63	804	10.50	QK59	65.00
1N21	1.00	6SC7	.97	805	3.95	QK60	65.00
1N22	1.19	6SH7GT	.79	807	1.65	QK61	65.00
1N23	1.19	6SH7	.79	810	10.95	QK72	65.00
1N27	1.65	7C4/1203A	.75	811	2.85	RK25	3.69
1P23	2.75	7E5/1201	.89	813	8.95	RK72/CRP72	1.95
1R4	.59	7E6	.55	814	2.79	RX233A/2C33	2.75
1T4	.59	10Y	1.30	815	3.40	VR90	.99
2A3	.95	12A6	.85	816	1.45	VR105	.99
2AP1	7.50	12C8	.89	826	1.39	VR150	.85
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2E22	2.75	14H7	.79	838	3.50	ZP653	65.00
2J21	7.95	14J7	.79	866A	1.10		
2J21A	8.50	15R	.75	872A	3.65		
2J22	9.50	23D4	.65	884	1.50		
2J27	14.95	30	.48	902P1	5.50		
2J34	29.95	45	.35	954	.45		
2J50	69.50	53A	2.50	957	.45		
2J55	84.50	71A	.69	1616	1.95		
2X2	.89	100TH	10.50	1619	.75		
2X2A	1.65	112A	.49	1624	1.45		
3A4	.85	211	1.25	1625	1.65		
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3C23	9.95	304TH	13.95	1846	95.00		
3C24/24G	1.95	304TL	19.50	2051	.95		
3DP1	3.50	350A	6.25	8005	5.85		
3D6/1299	.62	359A	1.85	8020	2.50		
3EP1	4.50	371B	2.95	9001	1.35		
3FP7	3.50	388A	2.95	9002	1.00		
3GP1	3.95	394A	4.25	9003	1.49		
3JP12	10.50	450TH	44.50	9004	1.00		
4B22/EL5B	6.50	450TL	44.50	9006	.75		
4B25/EL6CF	6.50	464A	8.95	CE22	1.00		
4J36	145.00	531	14.50	CK501X	1.00		
4J37	145.00	532A/1B32	2.95	CK1089	1.00		
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5D21	19.95	706AB	19.50	ELC5B	6.50		
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5JP2	19.50	707A	9.95	ELC6F	6.50		

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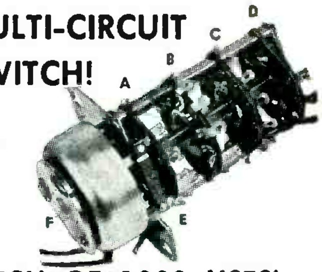
NEW! FOR REMOTE CONTROL! ROTARY, SOLENOID-OPERATED 6V DC MULTI-CIRCUIT WAFER SWITCH!



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THE SWITCH OF 1000 USES!

Wonder solenoid that obsoletes manual switching. Remote selection of crystals, band changing, audio circuits, antenna switching etc. Solenoid (F) produces a rotary motion (from 6V DC source), transmitting this motion to rotor shaft of 4 gang wafer switch by novel ratchet mechanism, advancing switch. Cam-operated interrupter switch (E) attached to wafer (A) opens when solenoid nears end of stroke, de-energizing solenoid. By combining E and A, either stepping or rotary selective action is achieved. Requires 6V DC @ 10A for .03 seconds. Control wafers: Decks A, B and C are 1 pole 6 pos. Deck D is DPST. Resistance 1/2 ohm DC. 25 degree rotary stroke; 8 lbs./in. torque. Size: 4½ x 2½ x 2½". Shipping weight 1 lb. Pictorial schematic circuits included.

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Press Wireless 981 3400 V 1.7 A	150
Wilcox 96-C 4000 V 3.0 A	300

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2	3000	3.50
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1	5000	4
1	6000	6
3	8000	35
5	10,000	50
1	15,000	30
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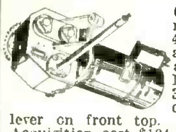
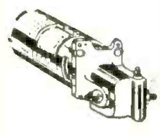
GEORGE WHITING, SOLE OWNER

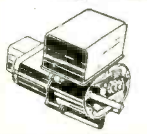
GEAR HEAD MOTORS



GENERAL ELECTRIC —DC motor #5BA50LJ22, ½ H.P. 4000 RPM. 60v-8.3a armature and 27v-2.9a field, reversible and has magnetic Brake. Gear Box #T8254252G1, with two 380 RPM take-offs. Throw-out type clutch actuated by lever on front top. Size 6x8x12". Wt. 14 lbs. Acquisition cost $194.00. Our Price NEW..$12.95

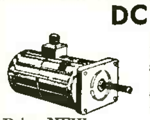


EMERSON ELECTRIC — DC motor type D44FZ-454-0417, 1 H. P. 5800 RPM, 27v-40a armature and 27v-2.5a field, reversible. Throw-out type clutch on gear box controls two 480 RPM take-offs. Ball-bearings. Size 6½x4½x11". Wt. 15½ lbs. Price NEW $12.95

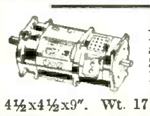


WHITE-ROGER SERVO MOTORS.—24 VDC. Torque 150 in.-lbs. Reversible. Control box on top has limit switches, relays, and selenium rectifiers (to block AC out of motor). Size 5x5x4". Can be supplied in Models 6904-5 RPM or 6904-3½ RPM. Price each NEW..$8.50

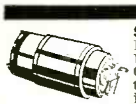
DC MOTORS



ELCOR.—Part No. 82706. ½ H.P. 4500 RPM, 60v-8.3a armature, 24v-2.3a field, reversible, ⅝" spline shaft 9/16" long. Comes with 3" long-spline adapter. Size 6x4½x7½. Wt. 9 lbs. Price NEW $7.45

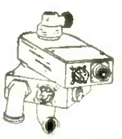


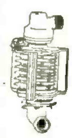
EMERSON ELECTRIC.—Type D44F0447-0417. Can be used as motor or generator. 1 H.P. 5400 RPM. 12 volts 100 amps. Double-end shaft ⅝" dia. by 1-3/16" length on each end. 4½x4½x9". Wt. 17 lbs. Price NEW..........$8.50



SYNCHO - DIFFERENTIAL. — Bendix #C78249. 115V 60 cycle. Used as a dampener between two C78248 Synchos. Easily converted to 3600 RMP motor (instructions included). Size 3-⅝x5-⅝". Price Brand New in original containers............$8.50

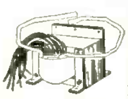
SLIP RING ASSEMBLY



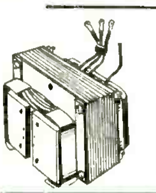


Emerson Electric—Part ET35300 (shown with and without housing). Used to transfer voltages between stationary and moving parts as in turrets or revolving displays. Full 360° rotation up to 15 RPM. Rating 12 conductors—ten 10 amp and two 100 amp at 28 VDC. Adaptable to higher voltages. Also has swivel plumbing designed to transfer oxygen at 15 P.S.I. Size 9x6x10". Wt. 10 lbs. Price complete NEW.........................$8.50

HEAVY DUTY TRANSFORMERS



#1221.—1.8 KVA. Input 120 volts 60 cycle. Output: 12.0, 14.5, 16.0, 17.0, 17.2, 17.8, 18.0 volts at 100 amps. Pri. leads 28" long. Sec. leads 17" long. Size 7x7x7". Wt. 26½ lbs. Price Brand NEW $23.50



GENERAL ELECTRIC. — #79G907. 2 KVA Intermittent duty. Input: 100/110/120 volts 60 cycle. Output 0.8 (eight-tenths) volt at 2,500 amps. Can be used for quick-heat applications, spot welders, testing, etc. Size 5¾ x 6¾ x 5". Wt. 27 lbs. Price NEW $12.50

WHOLESALE ONLY

AMPLIDYNES—General Electric #5AM31NJ9A. Input 27 VDC-44 amps. Output 60 VDC-8.8 amps. 530 Watts. Quantity 200 Brand NEW at $475.00 per 100.

VOLTAGE REGULATORS — Leece-Nevillle Co. #S-20686. 12 VDC. Precision adjustment vibrator type. Brand NEW in original cartons. Quantity 450 at ....$65.00 per 100.

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McNEAL ELECTRIC & EQUIPMENT CO.

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V&H

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New in original cartons. Complete. Consists of all accessories, plus AS-27A, R89B/ARN-5 and BC-733D. Modified to flag alarm.

BC-611 & BC-721 HANDIE TALKIES, Plus SPARE PARTS, Quantity available.
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AN/ARN-7 COMPLETE
SCR-269 COMPLETE
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AN/ARC-1 VHF EQUIPMENT
BC-348 RECEIVERS
BC-342 RECEIVERS

AN/ART-13 EQUIPMENT

ATC XMTR	T-47A/ART-13 XMTR
T-47/ART-13 XMTR	CU-24 ANT. LOAD
CU-25 ANT. LOAD	DY-11 & 12 Dynam't'r
MT-283 MOUNT	0-16 LFO
MT-284 MOUNT	ATC DYNAM'T'R
SA-22 ANT. LOAD	C-87 CONTROL BOX

AN/APG-13A RADAR

Absolutely complete, brand new

AN/APN-2	MG-153
SCR-729 New	APS-2, 3, & 15 Components
TA2J-24	AN/ARC-5 VHF
RTA-1B	SCR-274 & ARC-5 Command Equipm't
BC-1016	R-4/ARR-2 Receivers
APA-6 INDICATOR	BC-640 VHF XMTR
APA-11 INDICATOR	SCR-510
APA-17 RADAR	SCR-522
HS-33 HEAD SETS, NEW	MG-153
MG-149F & H	

SPARE PARTS

SCR-720	SCR-522
SO-7	AN/ART-13
AN/ARN-7	AN/ARC-1
SCR-269	BC-611

SCR-718 A, AM, B & C

Altimeter equipment—complete

To insure the finest of service and quality of merchandise, we have just recently put into operation our own reconditioning and function-testing plant, complete with all facilities.

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ART-13 BC-788
I-52 BC-348 Q & R
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COMBINATION SIGNAL GENERATOR AND FREQUENCY METER

Freq. range: 150-200 MC., crystal calibrated. Has separate 30MC signal output, crystal cal: 3-stage, AF amplifier. Power measurements by built-in VTVM circuit 0-1 MA. meter as 2-range voltmeter. Built-in 400 cps. voltage regulated power supply. New **$69.95**

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BUILD TV-FM-AM SWEEP GENERATOR

You can build "Versatile Sweep Frequency Generator" with APN-1 magnetic units... **$5.95**

RM 29 with the TS-13 handset
$14.95 ea. **2 for $27.50**

RL-42 Reversible Motor with antenna reel and clutch, used..................**$2.95**

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Complete with attenuator, indicators and 350 ft. of coaxial cable, Originally cost $300.00.. new condition ..ONLY $14.95

Plugs...large quantity available...write for prices!

166	171	MC277
167	172	ART13-U6U
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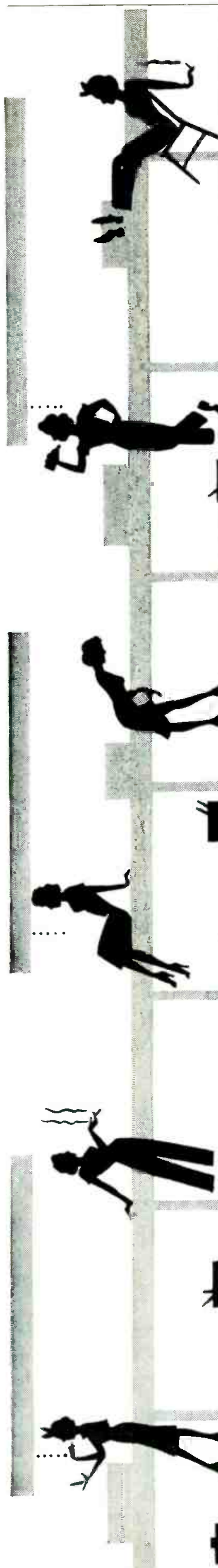

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5C22-SYL. new	48.95	CK-5702-RAYT	2.99

All Tubes listed below are fully guaranteed and in stock for immediate shipment.

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OD3/VR-150	.85	1N38-A	.74	2K23	45.00	3C23	10.50
1B21/471-A	2.49	1N40	7.50	2K25	32.50		
1B22	3.75	1N41	9.50	2K25/723A/B			
1B24	11.95	1N42	18.00	Sld. ctns.	24.95		
1B27	12.90	1N45/400C	1.25	2K26	159.00		
1B36	9.90	1N46	.59	2K28	31.95		
1B38	28.50	1P21	39.95	2K29	28.90		
1B41	48.90	1Q26 G.E.	79.50	2K33	290.00		
1B42	14.95	1R4/1294	.79	2K34 Sperry	225.00		
1B60	69.50	2C39	23.95	2K35 Sperry	390.00		
1D21/631P1	5.00	2C39A	30.00	2K39 Sperry	135.00	3C33	14.50
1N21	1.20	2C40 Jan	14.95	2K41	149.50	3C45	17.95
1N21A	1.70	2C42	25.95	2K42 Sperry	142.50	3E29	14.50
1N21B	2.95	2C43	17.95	2K43 Sperry	139.00	3K22 Sperry	325.00
1N21C	18.90	2C51	6.15	2K44 Sperry	139.50	3K23 Sperry	375.00
1N23	1.30	2D21 RCA	1.35	2K45 Sperry	145.00	4-125-A	24.95
1N23A	2.40	2E24 Jan	3.99	2K46 Sperry	349.50	4C28	24.00
1N23B	3.45	2E25/HY65	4.95	2K47 Sperry	475.50	4C33	60.00
1N25	5.15	2E26	3.00	2K48	125.00	4C35	26.50
1N26 (W. E.)	8.50	2E30	1.99	2K50	700.00	4C36	14.90
1N27	2.50	2E43	1.35	3B24	5.20	4J52	249.50

Highest Cash Prices Paid for Your Special Purpose Tubes! Any Quantity 1 to 1,000.

Type	Price	Type	Price	Type	Price	Type	Price
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5R4GY RCA	1.49	FG172	32.00	575A	14.90	1614-RCA	2.15
5T4	2.25	250-R	9.45	702A	3.00	1620	5.95
C6J	8.50	300-B	12.50	703A	5.90	1622	2.70
6AH6	1.19	307-A	3.95	705-A/8021	2.25	2050	1.49
6AK5	1.25	350-B	4.75	707-B	14.25	R-4340 Sylv.	Write
6AK5W	3.00	355-A	13.95	715-B	8.50	5651	2.95
6AN5	3.95	393-A	11.50	715-C	21.95	5654	2.75
6AR6	3.25	394-A	4.75	719-A	26.95	5656	6.75
6AS6	3.25	434-A	18.00	721A	2.25	5670	4.95
6AS7G	4.50	CK501DX	.75	723A/B	18.75	JRP 5676	1.35
6C21	24.50	CK509AX	1.75	724A	3.50	5687	5.40
6F4	6.00	CK522AX	1.25	724B	3.50	CK5697	4.95
6J4	6.85	CK526AX	1.45	726B	49.50	CK5702	5.95
6K4	4.90	CK528AX	1.62	726C	59.25	CK5703	1.49
6L6	2.19	CK531DX	1.95	804	12.95	CK5704	3.95
6L6G	1.25	CK532DX	1.95	807	1.60	5744	1.50
6L6 GAY	2.25	CK533AX	1.25	814	3.50	5814	3.50
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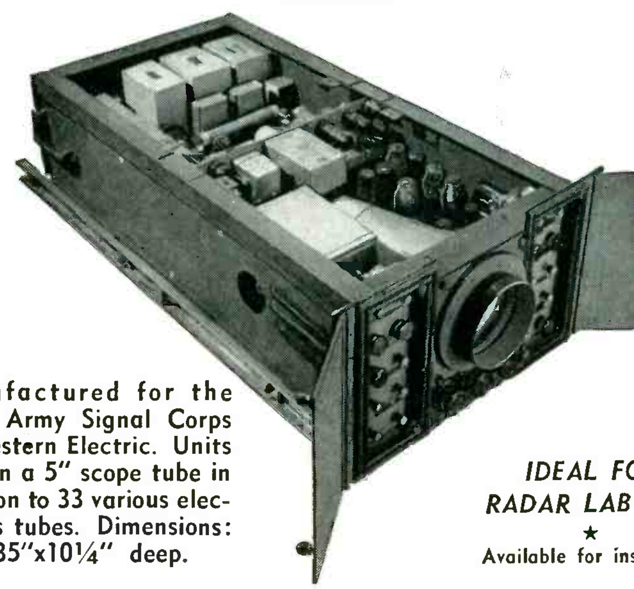

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INDEX
SEARCHLIGHT

March, 1953

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(Continued on opposite page)

TO THE ADVERTISERS

March, 1953

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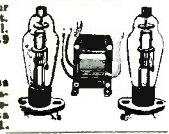

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300wvdc	
1.2	.29
400wvdc	
.1	.39
.5	.45
1	.69
4	.98
6	1.08
10	1.39
2x.1	.75
2x.5	.94
3x.1	.91
3x.25	.99
600wvdc	
.034	.30
.1	.35
.25	.39
.5	.42
1	.52
2	.65
4	1.60
5	2.25
6	2.59
7	2.89
10	3.10
2x.1	.59
2x.25	.78
2x.5	.89
2x1	1.05
2x2	1.25
2x8	3.25
3x.05	.75
3x.22	.85
3x.25	.98
700wvdc	
4	1.50
800wvdc	
.1	.69

Mfd	Each
1000wvdc	
.45	.59
1	.79
2	.85
5	2.98
15	4.98
1400wvdc	
.25	1.29
.5	1.39
1500wvdc	
.5	1.49
.75	1.69
1	1.79
2	3.49
8	3.98
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1	1.49
2x.1	1.69
1	1.75
2	3.98
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8	9.49
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.1	2.49
2	4.45
4	7.89
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2	4.49
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7000wvdc	
.002	1.69
.0075	1.98
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2.5	.90
2.8	.95
3	1.00
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10	6.98
16	7.98

2MFD/330VAC/1000WVDC "CD" RND CAN 3 for $1.00; 10 for $3.00; 100 for $25

METER SPECIALS

0-30VDC Aircraft Type "AN" as Illustrated.......$1.95; 3 for $5.25
0-25MA DC WESTON..............$6.98
0-60ADC "AN" $3.25; 3 for $9.
0-240ADC "AN" $3.49; 3 for $9.75
—20 +3VU Weston 301 Vol. Level Indicator..............$16.98

SELSYNS

2J1H1 GE Selsyns....................2 for $6.98
2J1F3 GE Brand New 115V/400 cy. ea.......9.75
C78248 Sync. Trans. 115/60 cy $39.95; 2 for 75.00
C78249 Sync. Diff. 115V/60 cy 12.95..2 for 25.00
Sync Trans. C-69405-2 Type I-I........2 for 90.00
Sync Repeater 115/60 cy Type 11-4...2 for 99.00
Bendix Autosyns AY1 & AY5..........2 for 4.95
Bendix AY20 New Orig Crtns..............12.98

DYNAMOTORS

INPT 6VDC, Output 200V/100ma, or 12/24V Output 500V/50ma P' Magnt. As Illustrated.. 6.95
Inpt 28VDC/1.4A Output 250V/60ma.............3.69
D104 Inpt 12 & 24V, Outpt 225V/100ma 440V/200ma. SPECIAL..............$11.98
DA3A 28V/10.5A out 300VDC/260ma 150VDC/10ma, 14.5vdc/5amp.........6.75
PE94 Plate Supp.. Uses DA3A (SCR522). 8.98
PE97 Plate Supp.. Less Tubes.............9.98

TELEVISION ANTENNAS

Conical antenna, sturdy prefab const. Versatile 72, 150 or 300 ohm match. 8 elements & 100 ft of all copper twinex, cross bar and hardware...........................$5.98
Double Vee all channel antenna. Hvy duty aluminum construction. Inclds mounting clamp & 100 ft of twinex..................$4.50
Window Antenna 4 element conical, all channel, sturdy construction. Easy to mount $3.95
5 Foot interlocking mast sections, hvy duty; painted, rustproof. Each.................95c

FUSES & HOLDER

3AG: 1/8, 1/4, 1/2 Amp. 5c; 100 for 3.98
3AG: 1, 1 1/2, 2, 3, 4, 15, 20 Amp. Each 3c; 20 for 50c; 100 for 2.49
3AG: Slo-Blo, 10, 20 Amp. 20 for 1.00
4AB: BUSS 10 Amp. 7c.......100 for 5.98
4AG: ¼, ½ Amp. 7c.........100 for 5.98
4AG: 2, 5, 10, 15 Amp. Ea. 5c:.......100 for 3.98
4AG: Slo-Blo 3, 10, 15, 20 Amp. Ea. 9c; 100/7.98
5AB: BUSS, Littlefuse, 5 Amp. Ea. 4c; 100/3.00
5AG: 35, 50 Amp. Ea 5c:..........100 for 3.98
7AG: 0.2 Amp. Littelfuse. Ea. 9c..........100 for 7.98
8AG: 1/32, 2/10, 1/2 Amp. Ea. 8c:.......100 for 6.98
HOLDER 1075 Littelfuse 20c:..............10 for 1.75

"TAB" THAT'S A BUY

PARTS CABINET

60 Draw Hvy Steel 34½"H/18"W/9"L/65 lbs Draws 3"W/3¼"H, 8"L..................$40.00
100 Draws as above. 135 lbs..................$65.00
27 Draw Hvy Steel 37"H/30¾"W/14¾"L/120 lbs. Draws 3"H/9"W/12"L..................$39.95

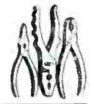
SPEED DRILLS 29 PIECE SET

Chrome Vanadium Speed Steel, machinists or tool makers drills, for all purpose use. Standard full length 1/16" to 1/2" by 64ths. With cased Huot drill index. Delivered Prepaid..............$9.98
12 piece set: 1/16 to 1/2 less drill index Delivered Prepaid..............$3.98

AUDIO AMPLIFIERS READY TO GO

Model 305MP 5 Watt Ampl. Features Mike & Phono Inpts. W/Sep. Gain Cntrls. Latest Compensated Tone Cntrl Design W/Tubes... $14.98
Model 200MO Mike OSC. Broadcasts Through Your Radio with No Direct Connection. W/Tubes..................$6.98
Model 100PO Phono OSC. Phonograph Broadcasts Through Your Radio. No Direct Hookup. W/Tube..................$4.98
Model 302PA 3 Tube Phono Ampl. Ideal for Building Your Phonograph. W/Tubes.......$4.98

PLIERS KIT



Pliers 6" Long Nose & Side Cutters..............$.89
Pliers 6" Side Cutters..............89
Pliers Linesmans 7" Hvy Dty .79
All (3) Pliers Listed Above.. 2.25
Drill Set 9 pcs. 1/16" to 1/4" Hardened Tempered Tool Steel. Plastic Case. 39c; 3 for $1

SOLDERING GUNS 115 VAC

"WELLER" 100 Watt & Lite..............$8.69
"WEN" 250 Watt & Lite..............8.69

SOLDERING IRONS 115V-AC & DC
Famous Make—Fully Guaranteed

55 Watt/ 3/8 Tip/11 1/2 Lng/.38 lbs.......$1.29
100 Watt/ 3/8 Tip/12" Lng/.5 Lbs..........2.69
Instrument Type 25 Watt/ 1/5" Tip..........3.29
American Beauty Type 100 Watt 3/8" Tip 5.29
Element for Amer. Beauty 100 Watt..........2.00
60 Watt/3/8 Tip/12" Lng/.38 Lbs..........2.29
130 Watt/1/2 Tip/12" Lng/.5 Lbs..........2.55

MICA CAPACITORS

Brand NEW Made to Rigid Gov't Specs.

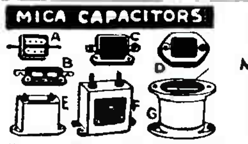


Fig. B. .001 mf. 10c; .006 mf. 23c; .01 mfd. 35c
Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	Each	Mfd.	Each
600 WV		600 WV	
.0001	$0.29	.03	1.19
.001	.42	1200 WV	
.002	.45	.002	.66
.004	.53	.004	.68
.005	.55	.005	.71
.006	.59	.01	.78
.008	.62	2500 WV	
.01	.66		
.02	.76	.00047	.59

Fig. D. Screw Term & Mtg.

Mfd.	Each	Mfd.	Each
600 WV		1200 WV	
.0001	$0.29	.01	$0.78
.00055	.37	.013	.89
.00085	.42	.03	1.89
.0012	.44	.033	2.39
.003	.49	2500 WV	
.005	.54	.0004	.59
.015	.71	.002	1.09
.02	.78	.0022	1.09
.03	1.19	.0024	1.13
.033	1.29	.0035	1.19
.039	1.38	.0036	1.19
.04	2.09	.0043	1.26
.05	2.39	.005	1.39
1200 WV		.006	1.55
.001	.61	.01	1.89
.002	.66	.015	2.19
.0051	.71	3000 WV	
.0068	.75	.005	1.65

Fig. E. Upright Xmtg Micas

Mfd.	Each	Mfd.	Each
250 VDC		.0001	$1.08
.05	$0.47	.0005	1.15
.2	2.59	.0007	1.19
1500 VDC		.0055	1.39
.04	.89	3000 VDC	
.05	1.08	.0055	1.35
2000 VDC		.005	1.79
.003	1.08	3500 VDC	
.005	1.19	.000033	.78
.006	1.25	5000 VDC	
.01	1.39	.000082	1.65
.015	1.68	.0001	1.79
.02	1.98	.00015	2.29
.03	2.35	.00018	2.39
2500 VDC		.0003	2.75
.0025	1.08	.00043	2.85
.006	1.65	.0006	3.59
3000 VDC		.001	3.89
.00005	.78	.01	4.79

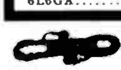
TUBE CLAMPS

926B-5, 926B-16, 926B, 929-1, 930-19, 926B-19, 926A-10..........5 for $1.00

"TABS" TUBE SPECIALS
BROKEN KEYS OR CRACKED BASE ELECTRICALLY PERFECT & GTD.

1B3GT, 6H6, 6K6GT, 6SN7GT 12SN7GT..............Each 50c; 5 for $2.00
6BG6G, 6BQ6GT, 12SG7, 19BG6, 6L6G 6L6GA..............Each 79c; 3 for $2.00

TEST CORDS



15 Foot Extension Cord Hvy Duty. Rubber Covered Insulation. As Illus.........$1.10
6 Foot Line Cord W/Plug Rubber Covered...55c
4 Foot Test Cord, Plug & (2) Alligator Clips Attached..............59c; 2 for 98c
4 Foot Instrument Test Leads, High Quality Red & Black..............59c; 2 for 98c

CIRCULAR SLIDE RULE

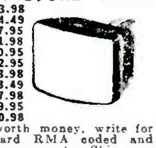
Equiv to 12"—Only 2½" Radius. LAMINATED—Print Stays On! Mult, Div, Sqs, Cubes & Roots, Log, Decimal Equiv. Case & Data..................98c
Parallel Rules. Precision Drafting Tool Mfr. BRUNING 6" wide. For Radiomen, Engineers, Students—Unsurpassed for Quick Ckt Diagrams. SPECIAL.... 39c; 3 for $1.00
Ball Pens Red & Blue. Rites Dry....5 for $1.00
Ball Pens Draftsman Black. Rites Dry.2 for $1.00

Infrared Snooperscope

Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 line/in. Complete data & tube, ea...$4.98; 2 for $9.49

SNOOPERSCOPE PWR SUPPLY
1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper.........$6.98

ONE YEAR GTD PICTURE TUBES



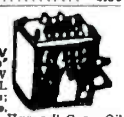
10BP4..................$13.98
10BP4A..................14.49
12 Inch Glass..............17.95
12 Inch Metal..............21.98
14 Inch Rectangular...... 20.95
16 Inch Glass..............22.95
16 Inch Metal..............23.98
17 Inch Rectangular...... 23.49
19 Inch Round..............27.98
20 Inch Rectangular...... 29.95
21 Inch Rectangular...... 30.98

Your old pict. tube is worth money, write for trade-in-allowance toward 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.

FILAMENT TRANS.

2.5V/2A @ 79c, 2 for $1.49, 10 for..........$6.49
2.5VCT/10A 5KVINS..........3.59
2.5VCT/20A/12KV INSUL CSD HSLD..........7.98
5VCT/10A, 4KV INSUL CSD HSLD..........5.95
5VCT/10A/12KV INSUL G.E..........8.25
5V/60AMP CSD KENYON. HVINS..........13.98
5V/115A CSD KENYON HVINS..........16.95
7.5VCT/12A CSD KENYON 15 KVINS..........10.95
12.6VCT/1.25A CSD HMSLD..........1.98
24V/1.25A CSD @ $1.98 Two for..........3.49
2X12V/2A or 24V/2A @ $3.89 Two for..........6.98
24V/6A CSD @ $4.98 Two for..........9.49
42.5V/2A SEL RECT TRANS..........4.85

TRANSFORMERS



All 115 V 60 Cyc Input TV & CR Pwr Xmfr Up to 20" Tubes. Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL Tubes. PL & FIL wndgs; 300 VDC/275Ma Full-Wave, 6.4V/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core. Oil Impreg. $6.49; Two for..........$12.49
2500V for CRT, 6.3V/.6A, 2.5V/1.75A CSD Kenyon Hvins. 4/BC412..........$7.98
1000VCT/45MA, 795VCT/80MA, 360VCT/55MA, 3X5V/3A, 6.3VCT/1A, 6.3VCT/3A CSD HVINS CAN BE USED 2X RATING RAYTHEON. HIPERSIL CORE..........$4.98
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A 10V/1.5A WESTERN ELECT..........$5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS..........$3.49
900V/3MA, 6.3V/2A, 2.5V/3A..........$2.98
840VCT/110MA, & 530VCT/21MA, 2X5V/3A, 6.3VCT/1A, 6.3VCT/.3A..........$4.98
770VCT/85MA, 5V/2A, 6.3V/3.5A..........$3.98
770V/2.5MA, 2.5V/3A HVINS HMSLD includes FILTER PARTS 4-econ..........$3.69
760VCT/120MA, 2.5VCT/10A, 6.3VCT/2A, 5V/3A, 10V/3.25A..........$6.98
720V/85MA, 5V/3.5A, 6.3V/3.5A..........$2.98
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price $3.98; Two for..........$7.25
500VCT/60MA, 6.3V/4A HSLD..........$2.98
480VCT/80MA, 6.3VCT/4A, 5V/3A..........$2.69
420VCT/90MA, 6.3V/1.9A W/INPUTS 6, 12, 24, 115VDC & 115 230 VAC @..........$1.98

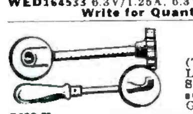
FILTER CHOKES

Dual 30 Hy/60ma Csd..........$.98
15Hy/40ma AC/DC sets, 3 for..........98
12 Hy/80ma/3KVins..........2.25
10 Hy/75ma..........1.25
10 Hy/125ma/UTC/Csd/H'Sld/1KVins..........1.69
50 Hy/125ma/Csd/H'Sld..........2.89
12 Hy/300ma/5KVins..........4.95
20 Hy/300ma or 15Hy/400ma/12KVins Kenyon..........8.95
13.5Hy/1Amp/17KVins/Raytheon..........39.95
Dual 2Hy/300ma USN...$1.25; 2 for..........1.98
6Hy 175ma 250 ohm..........1.49; 2 for 2.49
10 Hy 100ma Freed..........1.49

400 CYCLE XFMRS

WE KS9608 1233vct/350Ma, 1140vct/70Ma. 5.98
G-E M7472443P1 788V/200Ma, 210V/15Ma, 5V/2A..........4.95
G-E M7472469 6.3V/7A, 6.7V/.9A, 6.3V/.3A 3.98
WE KS9604 6.3V/4.65A, 6.3V/.3A..........3.49
WE KS9603 6.3V/3A, 5V/2A..........2.98
LANGEVIN 702556 6.3V/.6A..........1.49
FREED 11686 5V/10A..........4.95
WE KS9602 5V/4A..........2.98
FREED 11685 2.5vct/10A CSD..........4.95
LANGEVIN 702720 5V/6A, 13 KVINS..........4.98
WED164533 6.3V/1.25A, 6.3V/1.25A..........1.98
Write for Quantity Price

ALIGNMENT TOOL



(Top) Ideal NO-LOSS Alignment Screwdriver—long Insulated Shaft. Sure Grip Knurled Knob. ONLY..........49c; 3 for $1.25
(Bottom) RELAY Spring Adjuster & Switch Bd Tool Slot takes up to .022". WEC #293. 98c; 6 for $5.00
Precision feeler gauge TL147. Ideal for telephone & relay work, adj. Spark gaps. Removable gauges..........98c; 6 for $5.00

KITS AND COMPONENTS

ELECTROLYTICS Cndsrs Asst..........25 for $4.98
OIL CAPACITORS Asstd..........25 for 4.98
SPRGE CRP3 Vert Integrator Netwk 3 Res-3CNDSR only 3 LEADS 29c. 5 for 1.00
DISC CERAMIC 2X.004MFD/600V 6 for 1.00
50 PWR Magnifier & Condsr..69c; 4 for 2.00
Silver & Mica Cndsrs..........30 for 2.50
Controls, 50 ohm to 2 Meg..........10 for 2.50
Resistors, ½ & 1W, to 2 Megs..........100 for 1.98
Vitreous WW Resistors..........5 for .69
Sockets, Asstd. 8, 7, 5, 4P..........25 for 2.49
Rotary Switches, Asstd..........6 for 1.75
Coil Forms, Thd & Sm HF..........50 for 1.00
Iron Core Slub & Screw..........50 for 1.00
Knobs, Asstd. w/Insert..........10 for .98
Spaghetti Sleeving, Asstd..........75 ft. for 1.00
Ceramicon Cndsrs, Asstd..........12 for 1.00
Resistors, 2 W Asstd..........20 for 2.49
Tie-Point Lugs, Asstd..........35 for .98

PRECISION RESISTORS

Over 2½ Million In Stock

"TAB"—Specialists in Precision Resistors
No Mfrs Choice—We Ship Types in Stock

0.116	271	1225	3333	16500	110000
0.42	275	1250	3384	16800	115000
0.425	280	1260	3500	17000	116667
0.607	286	1300	3509	17500	120000
0.7	289	1350	3600	17977	130000
1.03	299	1355	3700	18000	135000
1.3	300	1400	3730	18300	140000
1.75	310	1488	3760	18380	141000
2.5	311.5	1495	3900	18500	145000
3	320	1500	4000	18800	147000
3.83	325	1510	4030	19000	150000
4	330	1518	4200	19500	155000
4.35	340	1600	4220	20000	160000
5	350	1640	4280	20441	165000
5.025	360	1646	4300	20500	166750
6.25	366.6	1650	4314	21000	167000
6.5	370	1670	4440	21500	169200
7	375	1680	4444	22000	175000
7.8	380	1710	4500	22500	180000
7.9	389	1712	4700	22990	180600
8	390	1740	4720	23000	185000
10.38	400	1770	4750	23150	186600
11.25	410	1800	4850	23325	190000
12	414.3	1818	4885	23400	198000
13.52	418.8	1830	4900	23500	200000
14.2	425	1850	5000	24000	201000
14.25	426.9	1865	5100	24600	205000
14.5	427	1892	5710	25000	210000
15	430	1894	5235	25200	215000
16	440	1895	5270	25400	220000
17	450	1896	5300	25833	225000
19	452	1897	5500	26000	229000
19.2	460	1898	5600	26500	230000
20	470	1899	5730	26600	235500
22	475	1900	5770	27000	238000
23	478	1901	5910	27500	240000
24	480	1902	6000	28000	245000
25	487	1903	6100	28430	250000
26	500	1904	6125	28500	265000
28	510	1905	6140	29000	268000
30	520	1906	6200	29500	270000
31.5	525	1907	6300	29990	275000
37	540	1908	6495	30000	294000
48	550	1909	6500	31000	300000
49	560	1910	6800	31500	307500
50	575	1911	6840	32000	311000
51.78	580	1912	6990	33000	314000
55	588	1913	7000	35000	316000
56.7	600	1914	7320	36000	325000
60	612	1915	7500	37000	330000
63	620	1916	7700	38140	333500
68	625	1917	7717	38500	350000
74	633	1918	7900	39000	353500
75	640	1919	7930	39500	375000
80	641	1922	7950	40000	380000
81.4	645	1924	8000	41400	390000
88	649	1926	8094	42000	400000
89.8	650	1960	8200	43000	402000
95	657	1980	8250	45000	420000
100	665	2000	8500	47000	422000
101	670	2045	8700	47500	425000
103.2	673	2080	8770	48000	430000
105	675	2095	9000	48660	450000
105.7	680	2141	9100	49000	458000
107	681	2142	9445	50000	470000
110	684	2145	9500	51000	472000
120	689	2150	9710	52000	478000
121.2	697	2160	9800	55000	500000
125	699	2180	9900	56000	510000
130	700	2187	9902	57065	520000
135	711	2195	10000	58333	521000
147.5	733	2200	10430	60000	525000
150	740	2250	10500	61430	543000
160	750	2300	10600	62000	550000
165	800	2400	10900	64000	560000
170	806	2450	10936	65000	570000
175	820	2463	11000	66600	575000
179	850	2485	11400	66650	600000
180	854	2490	11500	67500	620000
182	899	2500	11690	68000	650000
182.4	900	2525	12000	70000	654000
200	910	2600	12500	72000	660000
209.4	917	2625	12800	73500	680000
210	946	2635	13000	75000	690000
216	978	2700	13100	80000	700000
220	1000	2750	13500	82000	750000
220.4	1030	2850	13550	84000	761300
225	1056	2860	13600	85000	800000
230	1059	2870	14000	85750	813000
235	1067	2900	14250	88000	820000
240	1100	3000	14400	90000	850000
245	1110	3100	14500	91000	860000
245.4	1150	3163	14550	93000	900000
250	1155	3259	14600	93300	910000
260	1162	3290	15000	95000	930000
270	1200	3300	16000	100000	950000

Any Size Above, Each 35c; Ten for $3.29

MEGOHMS

1.	1.579	2.7	4	6.7	10
1.1	1.65	2.75	4.23	7	11.55
1.2	1.75	2.8	4.25	7.5	12
1.25	1.8	2.855	4.5	7.62	12.83
1.3	1.9	3	5	7.74	13
1.35	2	3.3	5.1	8	13.85
1.39	2.11	3.5	5.5	8.02	$1
1.4	2.2	3.673	6	8.5	
1.5	2.25	3.75	6.5	9.05	
1.57	2.5	3.9	6.6	9.5	

Any Size Above, Each 70c; Ten for $6.49

Vacuum Precision HiVolt Resistors

Megohms — .12/.25/.6/.75/.83/.09/1/1.5/2/3/3.75 ½% Accy....Ea. $1;..............Ten for $7.50

VARISTOR & AUDIO COMPONENTS

WE D-97966. Mfgrd to Rigid Western Electric Specs. Balanced Precision Full Wave Bridge Rectifier. Designed for Pulse Operation in Transmission Circuits. 6 Terminal, Csd. Rated 3V/15Ma Reverse Resistance 30,000 Ohms. Excellent Frequency Response. Ideal Bridge Rectifier for Computer & Robot Ckts. Also VU Meters. "TAB" Special $1.49..........4 for $5.00
Western Electric Push-Pull Pentode Output Transformer 197A. Rated 10 Watts for 6V6's or 6AQ5's. Excellent Freq Response, Flat 30 to 15,000 Cycles, Secondary 600 Ohm. "TAB" Special $4.49;..........2 for $7.98
With UTC Varimatch..........$5.49
UTC Varimatch 600 Ohm to VC's..........$1.98
XFMR HMT-SLD UTC Super Electric 3 Wdg. 600 Ohm Ct & 400 Tapped 250 & 150 Ohm. Can be Used Mike to Grid, Line to Line & Line to Grid. Special 49c; 10 for $4.49; 100 for $25.00

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 oz Designed Portable Equip. Models..98c 4 for $3
(4) 36V BATTERIES W/Acid..........3.35
2V/20AH Willard PLUS 2V. Vibrator..........2.98
2V/20AH Batt. W/Vib & Acid..........3.59
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10 Amp	6.75	$12.75	12.75	20.00	40.00
12 Amp	8.50		16.25	25.50	45.00
20 Amp	13.25	16.20	25.50	39.00	79.50
24 Amp	16.25		32.50	45.00	90.00
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Full Wave Rect & Trans. 115V/60cy inputs.
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0 to 12VDC/2 AMP Variable DC supply, uncased and completely built—inpt. 115v/60 cy. Usable LAB supply, filament D.C. plating, battery charging, model railroad, includes voltage or speed control and center off reversing sw. Ideal for two "HO" loco's $10.95; 2 for $20

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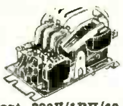
CONTACTOR



G. E. CR2811C22AQ. Heavy Duty Electric Starter, Transmitter or Motor Starter Switch. For Single or 2 or 3 Phase Appl. Rated 1 Phase 3HP/110V, 7½ HP/220V 10 HP/600V. Rated 2 or 3 Phase 7½ HP/110V, 15 HP/220V, 25 HP/600V. Control Inpt. 220V/1PH/60-Cy. Contacts rated 45 Amp Enclosed, 50 Amp Open. GE List $119. SPECIAL..$19; 2 for $36

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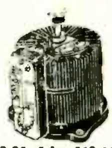

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100 ohm 50W Model K .... 2.25; 3 for 6.00
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SPDT 24VDC/5A CTS ....
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SPNO 115VAC/15A CTS B'Dunn $2.98
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DPDT Clare SK5010, Octal Base, 18-28V 2A Contacts, Nitrogen Sld. .... $1.49; 4 for $5.00
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OA3/VR75	1.04	2E32	1.49	6A4	1.89
OA4G	1.05	2E36	1.49	6A5G	2.07
OB2	1.37	2E41	1.54	6A6	.80
OB3/VR90	1.09	2E42	1.49	6A7	.85
OC3/VR105	1.15	2E43	1.49	6A8GT	.90
OD3/VR150	.90	2G21	1.49	6AB4	.79
OY4	2.53	2J21	8.75	6AB5/6N5	1.33
OZ4	.60	2J21A	8.90	6AB7/1853	.98
C1A/ELC1A	9.75	2J22	7.69	6AC5GT	1.00
O1A	.69	2J30	69.00	6AC6G	.95
VS-1	12.49	2J31	27.00	6AC7	.80
1A3	1.10	2J31A	79.95	6AD7G	1.29
1A4P	.79	2J32	37.00	6AG5	.79
1A5GT	.79	2J33	27.00	6AG7	1.39
1A6	1.49	2J34	27.00	6AH5G	1.49
1A7GT	.95	2J36	108.00	6AH6	1.22
1AD4	1.49	2J37	12.70	6AJ5	1.40
1AE4	1.80	2J38	11.75	6AK5	.74
ELC1B/3C31	3.45	2J39	44.00	6AK5W	2.98
1B3/8016	.81	2J42	187.00	6AK6	1.05
1B4P	.89	2J48	24.25	6AL5	.54
1B5/25S	.99	2J49	67.25	6AL7GT	1.29
1B7GT	.99	2J50	21.25	6AN5	2.90
1B21/471A	2.85	2J52	249.50	6AQ5	.55
1B22	2.20	2J55	85.00	6AQ5W	3.98
1B23	9.90	2J56	149.00	6AQ6	.81
1B24	9.45	2J61	49.95	6AQ7GT	1.29
1B26	2.45	2J62	49.45	6AR5	.79
1B27	12.75	2K22	49.95	6AR6	2.98
1B32/532A	3.90	2K23	29.00	6AS5	.79
1B35	11.25	2K25	39.95	6AS6	2.43
1B37	16.98	2K25/723AB	31.59	6AS6W	3.20
1B38	29.95	2K28	32.00	6AS7G	4.65
1B40	4.95	2K33	300.00	6AT6	.63
1B41	49.95	2K34	498.00	6AU5GT	1.10
1B42	18.00	2K35	398.00	6AU6	.59
1B46	1.98	2K39	130.00	6AV5GT	1.29
1B53	49.95	2K41	109.00	6AV6	.49
1B56	38.50	2K42	145.00	6AW6	1.89
1B58	175.00	2K43	135.00	6AX4/6U4	.79
1B60	69.75	2K44	108.00	6AX5GT	.79
1B63	50.00	2K45	108.00	6B4G	1.23
1B63A	75.00	2K48	118.00	6B5	1.19
EL1C	2.70	2K50	498.00	6B6G	1.05
1C5GT	.89	2V3G	.98	6B7	.95
1C6	.79	2W3GT	.98	6B8G	.60
1C7G	.89	2X2	.49	6BA6	.63
1D5GP	.99	2X2A	1.53	6BA7	1.27
1D7G	.89	3A4	.99	6BC5	.63
1D8GT	.89	3A5	.81	6BC7	1.23
1D21/631P1	3.89	3A8GT	1.59	6BD5GT	1.65
1E5	.99	3B4	2.69	6BD6	.83
1E7G	.99	3B5	.98	6BE6	.59
1F4	.69	3B7/1291	.69	6BF5	.98
1F5G	.79	3B22	2.70	6BF6	.65
1F6	.89	3B23/RK22	4.95	6BF7	2.55
1F7G	.89	3B24	5.40	6BG6G	1.39
1G4GT	.89	3B25	4.50	6BG7	1.98
1G5G	.89	3B26	3.70	6BH6	.63
1G6GT	.79	3B28	7.90	6BJ6	.69
1H4G	.89	3C22	77.00	6BK7	2.15
1H5GT	.72	3C23	9.90	6BL7GT	1.45
1H6GT	.79	3C31/C1B	3.45	6BN6	1.49
1J5G	1.20	3C33	14.98	6BN7	1.69
1J6GT	.79	3C34/HK24	5.49	6BQ6GT	1.20
1L4	.69	3C45	15.48	6BQ7	1.65
1L6	.98	3D6/1299	.69	6BY5G	1.45
1LA4	1.19	3D21A	4.98	EL6C/6C	16.98
1LA6	.99	3D22	13.95	6C4	.50
1LB4	1.29	3D23	4.90	6C5GT	.55
1LC5	.79	3E29	14.95	6C6	.57
1LC6	1.39	3J31	300.00	6C7	1.26
1LD5	.99	3K22	275.00	6C8G	.80
1LE3	.99	3K23	405.00	6C21	29.45
1LH4	.89	3K30	300.00	6CB6	.69
1LN5	.79	3Q4	.79	6CD6G	1.69
1N5GT	.72	3Q5GT	1.29	6D4	2.70
1P5GT	.79	3S4	.85	6D6	.89
1P42	5.60	3V4	.79	6D7G	.89
1Q5GT	.70	4-125A	29.00	6D8G	.85
1Q26	69.00	4-250A	40.00	6E5	.79
1R4/1294	1.29	4-400A	57.50	6E7	1.39
1R5	.79	4-1000A	108.50	6F4	6.20
1S4	1.19	4B23	16.98	6F5	.95
1S5	.79	4B27	4.98	6F6	.79
1S21	7.90	4B32	9.50	6F6GT	.79
1T4	.79	4C25/HK54	5.98	6F7	.85
1T5GT	.99	4C33	59.00	6F7G	1.29
1U4/5910	.73	4C35	27.25	6F8G	.85
1U5	.79	4C36	15.98	6G6G	.90
1V	.79	4E27/257	14.50	6H6	.60
1V2	.70	4J22	148.50	C6J/5C21	6.95
1X2	.95	4J31	98.00	6J4	6.66
1Y2	6.98	4J34	194.00	6J5GT	.47
1Z2	3.98	4J42/700	27.00	6J6	.63
2A3	1.78	4J47/720CY	300.00	6J7	.72
2A4G	1.19	4J47	485.00	6J8G	1.19
2A5	.69	4J52	350.00	6K4	5.15
2A6	.69	4J56	498.00	6K4A	6.45
2A7	.69	4X-150A	45.00	6K5GT	1.09
2AC15	4.98	4X-500F	85.00	6K6GT	.59
2AS15	4.98	5AX4GT	.54	6K7	.75
2B22	3.90	5AZ4	1.35	6K8GT	1.08
2C21/1642	.67	C5B/5C30	3.95	6L5G	.75
2C22/7193	.33	EL5BHD	16.98	6L6	2.09
2C26	.19	5C21/C6J	6.95	6L6G	1.35
2C33/RX233A	3.49	5C22	52.00	6L6GA	1.35
2C34/RK34	.69	5C30/C5B	3.95	6L6GAY	2.29
2C36	27.00	5D21	21.69	6L7	.80
2C39	21.00	5D23/RK65	36.50	6N4	2.39
2C39A	29.50	5J29	12.40	6N6G	1.69
2C40	7.29	5J23	59.00	6N7GT	.80
2C43	14.75	5R4GY	1.39	6P5GT	.89
2C43/464A	9.49	5R4GYW	1.75	6Q7	.89
2C44	1.20	5T4	2.49	6R7	.77
2C50	3.69	5U4G	.69	6R8	1.39
2C51	6.45	5V4G	1.10	6S4	.85
2C52	5.98	5W4	.89	6S7G	.83
2D21	1.26	5X4G	.79	6S8GT	.92
2E5	1.19	5Y3GT	.43	6SA7GT	.63
2E22	1.95	5Y4G	.79	6SA7GTY	3.37
2E24	4.69	5Z3	.99	6SB7Y	1.19
2E25/HY65	5.15	5Z4	1.49	6SC7	.90
2E26	2.88	C6A	6.75	6SD7GT	.80
2E30	1.95				

6SF5	.77	12BA6	.59	35C5	.69	F123A	7.90	CK538DX	.98
6SF7	.73	12BA7	.79	35L6GT	.79	T125	12.49	CK539DX	2.19
6SG7	.72	12BD6	1.23	35T	6.95	F127A	19.98	CK541DX	1.99
6SH7	.61	12BE6	.59	35TG	5.45	VT127A	3.90	CK542DX	.99
6SJ7	.70	12BF6	.85	35W4	.59	CV148	4.98	CK543DX	.99
6SK7GT	.69	12BH7	1.29	35Y4	.69	150T	14.50	CK544DX	.99
6SL7GT	.69	12BY7	1.35	35Z3	.79	FG166	49.00	CK546DX	1.99
6SN7GT	.70	12BZ7	1.25	35Z4GT	.69	FG172	29.00	CK547DX	1.98
6SN7WGT	2.25	12C8	.65	35Z5GT	.59	182B	1.20	550P1	19.95
6SQ7GT	.63	12F5GT	.65	REL36/6J4	.49	FG190	12.80	CK571AX/	
6SR7	.63	12H6	.65	36	.65	HF200	21.00	5886	2.49
6SS7	.75	12J5GT	.49	37	.69	T200	22.98	CK573AX/	
6ST7	.98	12J7GT	.75	38	.59	201A/CX301A	.98	6029	3.49
6SU7GTY	2.69	12K7GT	.89	RK39	2.89	203A	5.98	575A/975	15.95
6SZ7	1.05	12K8	.69	39/44	.59	205B/VT2	1.69	WL579	10.49
6T7G	.85	12Q7GT	.55	CRC40	.59	CE206	3.15	WL579B	12.98
6T8	.98	12S8GT	.98	T40	4.29	211/VT4C	1.25	601B	.19
6U5/6G5	.99	12SA7GT	.69	TZ40	3.98	CE215	8.98	HY615	.25
6U6GT	.83	12SC7	.80	40	1.09	RX215	9.95	616	37.00
6U7G	.55	12SF5GT	.72	HY40Z	3.75	WE215A	.18	KU627	18.00
6V3	1.89	12SF7GT	.49	41	.79	217C	8.75	WL652	65.00
6V6	1.39	12SG7	.83	42	.69	227A	4.98	WL670A	11.98
6V6GT	.57	12SH7	.63	43	.85	231	1.20	WL673	117.00
6V8	1.99	12SJ7GT	.59	45	.69	242C	3.95	WL676	39.95
6W4GT	.57	12SK7	.72	45S/VT52	.65	244A	4.15	WL686	35.00
6W6GT	.89	12SL7GT	.65	45Z3	.69	247A	9.95	701A	5.95
6W7G	.85	12SN7GT	.75	45Z5GT	.89	250R	18.95	702A	3.29
6X4	.59	12SQ7GT	.63	46	.89	250TH	22.25	702B	5.98
6X5GT	.59	12SR7	.63	47	.99	250TL	17.75	703A	4.75
6Y6G	.89	12X3	.90	48	1.17	HK254	14.49	704A	.98
6Y7G	.89	12Z3	.89	RK48A	6.85	262B	3.98	705A/8021	1.98
6Z7G	.89	14A4	.87	RK49	7.50	274B	3.45	707A	7.90
6ZY5G	.89	14A7/12B7	.75	49	.83	276A	9.89	707B	13.50
7A4/XXL	.73	14AF7/XXD	.83	50	1.19			710A/8011	.95
7A5	.73			50A5	1.19	300B	11.50	713A	.98
7A6	.73	14B6	.65	50B5	.79	T300	26.98	NL714	5.95

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7A7	.69	14B8	.89	50C5	.69	HF300	24.30	714AY	5.90
7A8	.69	14C5	1.07	50C6	1.49	304TH	8.90	715A	6.00
7AD7	1.49	14C7	.95	50L6GT	.69	304TL	8.90	715B	8.19
7AF7	.89	14E6	.99	50X6	.89	307A/RK75	4.20	715C	19.80
7AG7	1.00	14E7	1.09	50Y6GT	.79	310A	6.25	717A	.90
7AH7	1.19	14F7	.95	50Z7G	.98	311CH	10.95	718BY	48.45
7B4	.69	14F8	.83	52	.99	311CT	10.50	718CY	48.45
7B5	.73	14H7	.83	53		311T	10.50	719A	28.50
7B6	.73	14J7	.83	T55	8.79	313C	2.98	721A	2.49
7B7	.73	14N7	.87	55	1.06	316A	1.49	721B	12.50
7B8	.73	14Q7	.85	56	.69	323A	4.95	722A/287	2.45
7C4	.73	14R7	.80	57	.79	327A	4.95	723A	11.95
7C5	.69	14S7	.80	58	.75	5340	2.98	723A/B	25.00
7C6	.73	14W7	1.09	RK59	1.45	350A	6.50	724A	3.95
7C7	.69	14X7	1.23	59	1.78	350B	4.95	724B	3.45
7C23	72.00	15E	1.98	RK60/1641	3.95	353A	4.65	725A	8.49
7C29	69.95	15R	1.15	RK61	3.05	RK354	24.98	726A	16.45
7E5/1201	.65	FG17	3.95	T60	10.49	355A	14.15	726B	45.00
7E6	.73	18	.98	HY69	4.98	368AS	7.49	726C	79.95
7E7	.73	19	.79	70A7	1.59	371B	1.85	730A	24.50
7F7	.73	19BG6G	1.79	70L7GT	1.59	380A	.79	800	1.85
7F8	1.25	19T8	1.09	71A	.79	388A	1.49	801A	.29
7G7/1232	.89	19V8	1.62	CRP72	1.20	393A	8.90	803	3.89
7H7	.89	T20/1623	3.79	CRP73	1.49	394A	4.90	805	3.90
7J7	.89	TUF20	5.19	73	1.67	FP400	15.98	807	1.65
7K7	1.10	TZ20	3.79	NR74	.29	WE417/5842	18.50	808	3.49
7L7	.79	RK20A	8.95	HY75	4.59	WL434A	10.95	809	2.49
7N7	.79	RX21	3.75	75		GL434A	12.69	810	2.98
7Q7	.79	22	.99	76	.79	446A	1.05	811	2.90
7R7	.83	24	.85	77	.69	446B	1.89	811A	3.50
7S7	.92					450TH	45.00	812	2.70

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7T7	1.03	24A	1.10	78	1.05	450TL	52.00	813	12.49
7V7	.79	24G/3C24	1.90	79	1.69	460/HF200	15.95	814	2.97
7W7	.79	25A6	.98	80	.69		13.85	815	2.98
7X7/XXFM	.85	25A7	2.98	81	1.69	GL471A	2.69	816/866Jr	1.49
7Y4	.69	25AC5GT	1.59	FG81A	5.95	CK501X	1.26	826	.95
7Z4	.49	25AV5GT	1.29	82	1.19	CK501AX	2.20	828	11.29
8DC-15	4.98	25BQ6GT	1.19	83	1.39	GL502A	1.79	829	11.49
10Y	.35	25C6	1.18	83V	1.45	CK502AX	1.49	829B	12.45
CV11	5.25	25L6GT	.69	84/6Z4	.99	CK503AX	1.79	830	3.49
12A	.75	25W4GT	.89	85	.99	CK505AX	1.79	832	7.65
12A5	.35	25Y5	.79	89	.75	CK506AX	1.49	832A	9.65
12A6	.53	25Z5	.79	SVR92	24.85	RH507	9.98	833A	39.45
12A7	1.39	25Z6GT	.79	FG95/5560	24.85	CK509AX	1.79	834	5.95
12A8GT	.59			FG98	19.95	CK510AX	2.98	835	12.95
12AC7	.90					CK512AX	1.45	836	1.45
12AH7GT	1.45	FG27A	8.70	100TH	7.83	CK522AX	1.29	837	3.98
12AK5	1.98	HY27	10.95	102D	2.98	CK525AX	1.29	838	.39
12AK5W	2.98	RK28A	4.89	102G	2.98	CK526AX	1.49	843	5.95
12AL5	.75	28D7	1.95	FG104	37.98	CK527AX	2.69	845	29.45
12AT6	.52	30	.70	FG105	17.64	CK528AX	2.49	849	29.45
12AT7	.81	31	.59	VU111	1.45	CK529AX	1.79	851	19.98
12AU6	.72	HY31Z	2.75	HY114B	.79	GL530	22.00	860	4.90
12AU7	.63	32	.49	HY115/145	.79	CK531DX	1.89	861	23.95
12AV6	.49	FG32/5558	13.85	117L/M7GT	1.59	CK532DX	6.98	864	.39
12AV7	.96	32L7GT	1.49	117N7GT	1.79	WL532	3.98	865	1.29
12AW6	1.79	33	.59	117P7GT	1.79	CK533AX	1.29	866A	1.50
12AX4GT	1.20	34	.59	117Z3	.59	CK534AX	.99	868/CE1C	3.49
12AX7	.79	35/51	.89	117Z4GT	1.39	CK536AX	.99	869	36.95
12AY7	2.95	35A5	.79	117Z6GT	1.39			872A	3.29
12AZ7	1.49	35B5	.79	117Z7GT	1.49	CK537AX	3.04		

874	1.39	9002	1.50
878	.75	9004	.42
884/6Q5G	1.80	9006	.39
885	1.45	**C'Ray Tubes**	
893A	250.00	2AP1	9.70
917	2.59	3AP1	9.75
922	1.85	3AP1A	14.25
919	2.75	3AP5	18.00
923	1.00	3BP1	5.75
925	1.69	3BP1A	14.98
927/CE25	1.49	3BP5	18.00
930	1.20	3DP1	4.75
931A	6.25	3EP1/1806P1	4.85
954	.18	3FP7	.98
955	.39	3FP7A	14.98
956	.36	3GP1	4.20
957	.65	3GP4	16.50
958A	1.45	3HP7	3.40
967/FG17	3.95	3GP5	18.00
973	16.95	3HP14	14.98
991	.45	3GP7	18.00
FM1000	1.50	3JP7	12.50
CK1005	.85	3JP12	19.95
CK1006	3.49	3JP14	16.95
CK1007	.89	4AP10	4.40
CK1027	2.98	5BP1	4.89
CK1028	15.98	5BP4	4.25
CK1089	2.99	5CP1	4.50
CK1090	2.98	5CP1A	18.49
R1100	5.00	5CP7	11.75
R1130	12.00	5CP5	30.00
E1148	1.35	5FP4	40.00
HY1231Z	5.39	5FP7	1.49
1612	1.90	5HP1	5.70
1613	.89	5HP4	5.70
1616	2.45	5JP2	19.25
1619	.25	5JP4	26.75
1620	4.70	5JP5	35.00
1622	2.69	5JP7A	39.00
1624	1.90	5LP1	22.25
1625	.33	5LP2	27.50
1626	.33	5LP7	29.95
1629	.29	5LP4A	33.00
1630	.97	5MP1	10.50
1631	1.95	5SP7	100.00
1632	.77	5RP7A	89.50
1633	.73	7BP1	8.65
1634	.73	7BP7	6.50
1635	1.89	7EP4	17.98
1636	3.19	7JP4	18.39
1644	.95	9GP7	12.75
2000T	149.50	9LP7	2.98
2050	1.17	12DP7	16.89
2051	1.15	12DP7A	49.50
5516	5.98	12GP1	49.98
5517	3.39	12GP7	14.75
5594	6.65	12HP7	14.75
5608A	5.95	905	3.49
5636	3.50	912	89.98
5637	6.99	913	9.98
5638	12.64	914A	45.00
5647	8.35	**Xtal Diodes**	
5651	3.15	1N21	.93
5654	2.79	1N21A	1.55
5656	6.90	1N21B	2.89
RK5657	350.00	1N21C	21.50
5663	1.85	1N22	1.25
5670	5.30	1N23	1.35
CK5672	1.29	1N23A	2.20
CK5676	1.29	1N23B	3.49
CK5678	1.89	1N25	4.98
5684	14.98	1N26	8.75
5686	3.90	1N27	1.55
5687	5.49	1N29	3.50
5691	.85	1N32	23.75
5692	7.85	1N34	.64
5693	6.75	1N34A	.90
5694	3.65	1N35	1.65
CK5697	3.49	1N38	1.43
CK5702	3.49	1N38A	1.43
CK5703	10.15	1N39	4.15
CK5704	1.89	1N41	13.00
5718	10.15	1N42	17.50
5725	12.25	1N43	1.75
5726	1.79	1N44	1.24
GL5727	4.49	1N45	1.45
5744/CK619CX	1.69	1N46	.69
5749	1.98	1N47	4.00
5751	5.45	1N48	.55
5763	1.70	1N51	.45
CK5783	6.69	1N52	1.62
CK5784	6.98	1N54	.98
5812	2.99	1N54A	1.17
5814	3.64	1N55	2.35
CK5829	4.39	1N56	.89
5840	12.34	1N57	.89
CK5851	8.65	1N58	1.19
CK5875	1.69	1N60	.60
5881	2.69	1N61	2.10
X6030	4.49	1N63/K63	2.49
8002R	99.50	1N64	.69
8005	7.25	1N67	1.95
8008	6.49	1N69	1.9
8012	2.89	K34	3.5
8013	2.75	CK705	.77
8013A	.39	CK706	.54
8014A	28.95	CK707	1.80
8020	1.25		
8025A	4.75		
9001	1.55		
9002	.95		

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