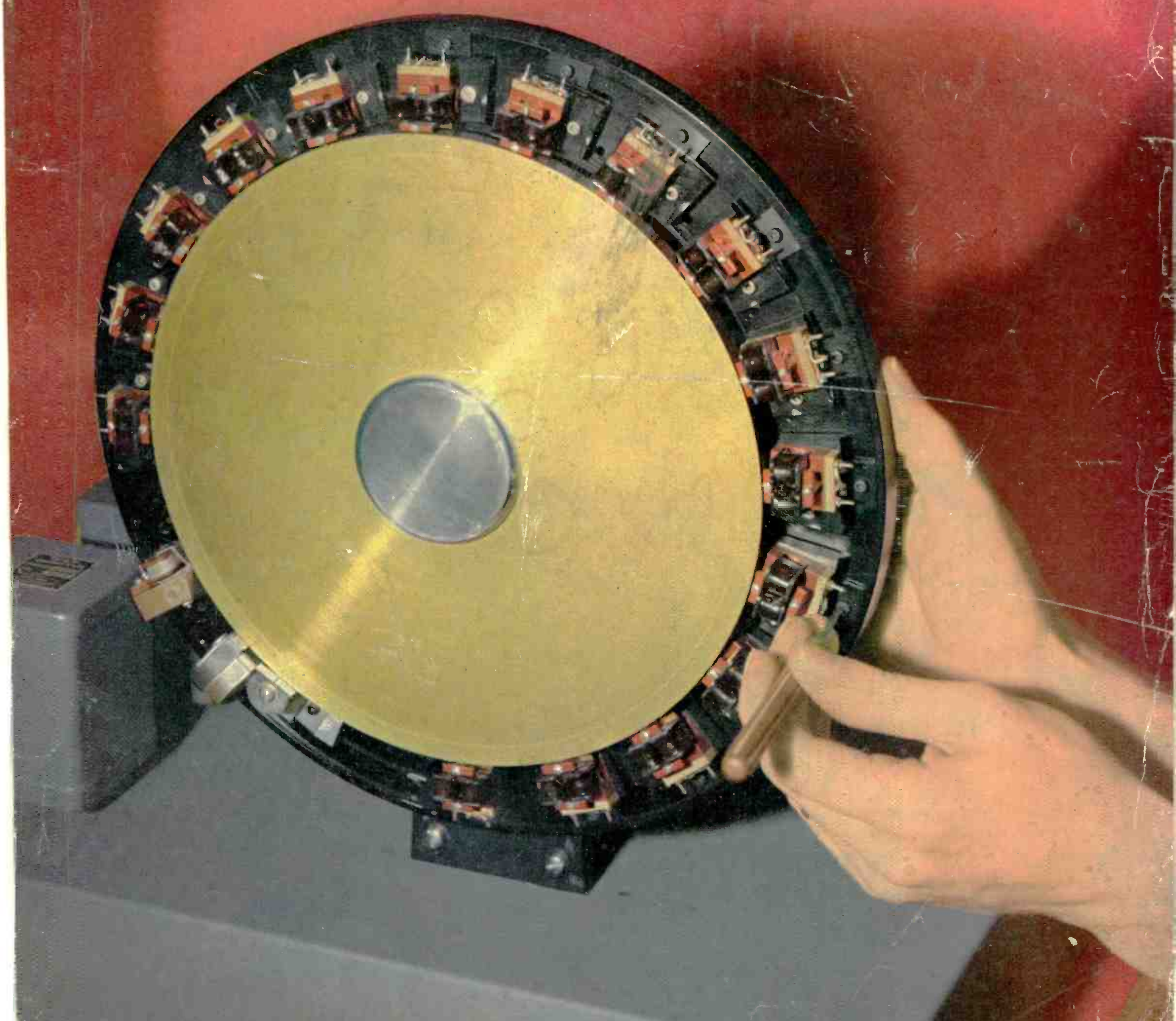
APRIL 1952
PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION



MAGNETIC RECORDING DELAY LINE

PRECISION IN PRODUCTION

Many people realize and take advantage of the fact that "the tough ones go to UTC." Many of these "tough ones," while requiring laboratory precision, are actually production in quantity. To take care of such special requirements, the UTC Laboratories have a special section which develops and produces production test equipment of laboratory accuracy. The few illustrations below indicate some of these tests as applied to a group of units used by one of our customers in one production item of equipment:

The component being checked here is a dual saturable reactor where the test and adjusting conditions necessitate uniformity of the complete *slope* of the saturation curve. The precision of this equipment permits measuring five widely separated points on the saturation curve with saturating DC controllable to .5% and inductance to .5%.

Servomechanisms and similar apparatus depend, to a considerable degree, on phase angle operation. The transformer adjusted in this operation requires an accuracy of .05 degrees phase angle calibration under the resonant condition of application. With wide change in voltage and temperature range from −40 to +85 degrees C., the phase angle deviation cannot exceed .2 degree. To effect this type of stability, specific temperature cycling and aging methods have been developed so that permanent stability is effected.

This test position involves two practical problems in a precision inductor. The unit shown is adjusted to an inductance accuracy of .3%, with precise (high) Q limits. It is then oriented in its case, using a test setup which simulates the actual final equipment so that minimum inductive coupling will result when installed in the final equipment.

The hermetic sealing of transformers involves considerable precision in manufacturing processes and materials. To assure consistent performance, continuous sampling of production is run through fully automatic temperature and humidity cycling apparatus. It is this type of continual production check that brings the bulk of hermetic sealed transformers to UTC.

United Transformer Co.

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MAGNETIC RECORDING DELAY LINE—Oxide-coated drum edge carrying signal recorded by new Engineering Research Associates boundary-displacement method (See p 116) rotates past playback pickups..........COVER

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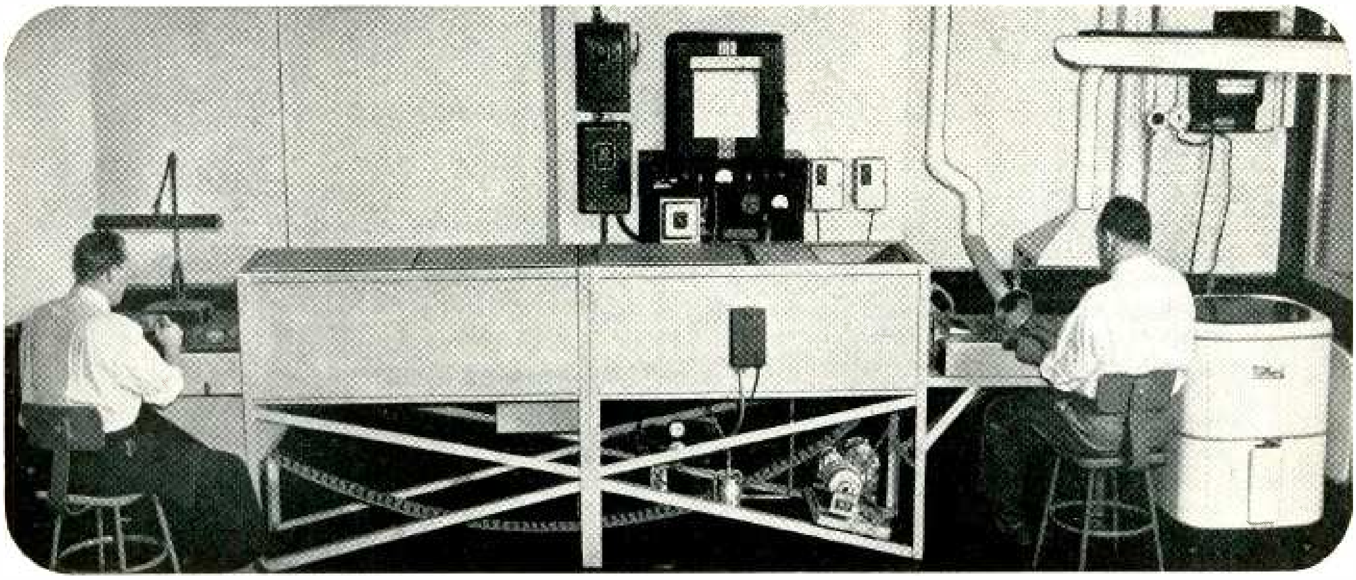
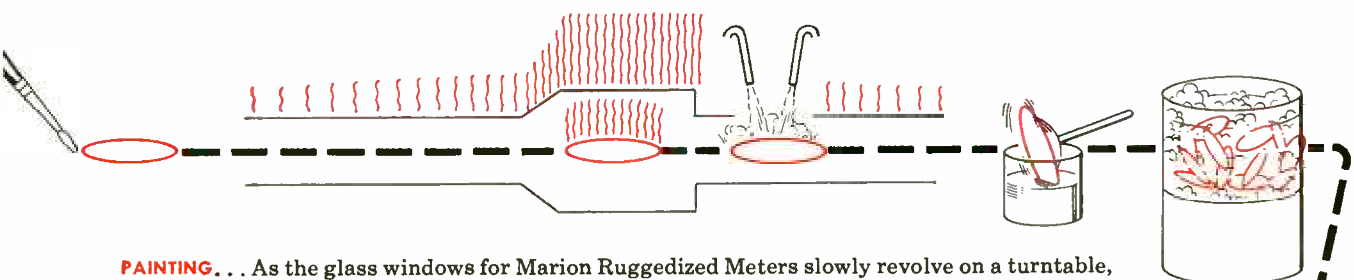
marion methods

make better hermetic seals for Ruggedized instruments





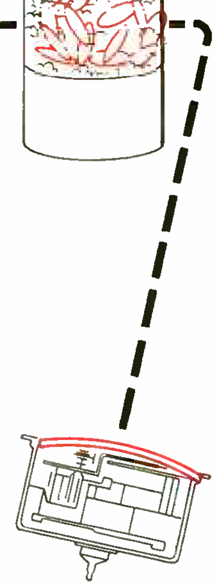
PAINTING. . . As the glass windows for Marion Ruggedized Meters slowly revolve on a turntable, their edges are coated with Hanovia Chemical #130A platinum alloy.

FIRING. . . The glass is then fired at a closely controlled temperature of 1150°. A stainless steel conveyor belt carries windows through the oven at a rate of three inches per minute.

TEMPERING. . . Windows are semi-tempered by a blast of compressed air, triggered by a photo-cell. The duration and pressure of the blast are controlled, according to the size of the glass window.

TINNING. . . Windows are then tinned, using a conventional solder pot. #63/37 tin lead solder is used, with 1% ammonium chloride in glycerin as a flux. Glass enters the tinning operation at approximately the same temperature as the solder pot, which is closely controlled at 500°.

WASHING. . . After tinning, the glass is allowed to cool. Windows are then racked in a modified dishwasher and washed thoroughly in order to neutralize and remove flux and to provide optically clear surfaces.



OTHER MARION METHODS. Current demands on industry by the mobilization program accentuate the importance of efficient production methods. Marion's method of metalizing and tinning glass has helped us to get better seals, to lower our costs and to increase production.

This is only one of a number of methods which Marion is presenting in the hope that some of them will help you as they have helped us. We will be pleased to furnish you with more detailed information if desired.

MARION ELECTRICAL INSTRUMENT CO., 401 CANAL ST., MANCHESTER, N. H.

marion meters

MANUFACTURERS OF MARION *Ruggedized* PANEL METERS

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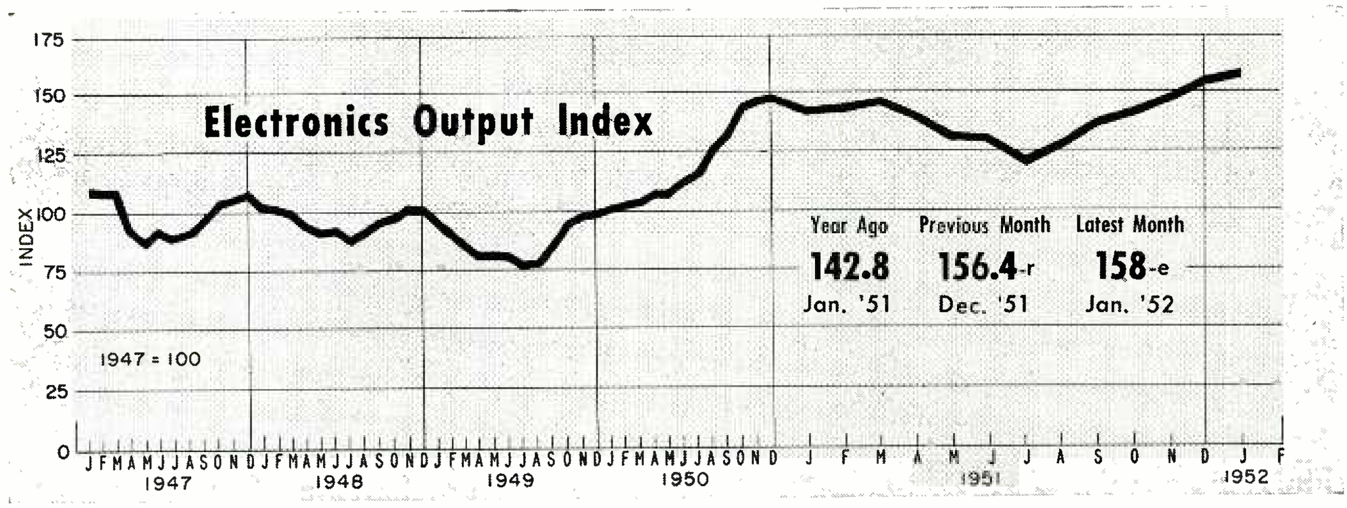


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago Jan '51	Previous Month Dec '51	Latest Month Jan '52
Television sets	645,716	467,108-r	404,933-p
Home Radio sets	750,289	567,929-r	368,875-p
Portable sets	75,294	78,056-r	68,433-p
Auto sets	346,799	222,115-r	195,147-p

RECEIVER SALES

(Source: Licensee figures)	Dec '50	Nov '51	Dec '51
Television sets, units	696,914	559,923	384,112
Electric radio sets, units	796,232	519,888	498,140
Battery sets, units	98,785	69,599	92,533
Auto sets, units	417,250	238,275	212,417
Television sets, value	$136,179,031	$95,055,472	$62,450,714
Electric radio sets, value	$19,722,466	$11,287,914	$9,830,047
Battery sets, value	$1,819,895	$1,320,649	$1,711,553
Auto sets, value	$10,984,002	$7,340,214	$6,191,627

RECEIVING TUBE SALES

(Source: RTMA)	Dec '50	Nov '51	Dec '51
Receiv. tubes, total units	38,723,601	32,710,369	28,000,471
Receiving tubes, new sets	30,278,479	20,405,712	16,176,537
Rec. tubes, replacement	7,122,502	8,539,275	7,117,041
Receiving tubes gov't	165,142	1,371,886	1,699,914
Receiving tubes, export	1,157,478	2,393,496	3,006,979
Picture tubes, to mfrs.	686,815	460,566	371,751

BROADCAST STATIONS

(Source: FCC)	Feb '51	Jan '52	Feb '52
TV Stations on Air	107	108	108
TV Stns CPs—not on air	2	0	0
TV Stns—Applications	385	488	506
AM Stations on Air	2,237	2,331	2,336
AM Stns CPs—not on air	116	75	74
AM Stns—Applications	273	311	313
FM Stations on Air	665	635	636
FM Stns CPs—not on air	18	13	14
FM Stns—Applications	12	7	8

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	Dec '50	Nov '51	Dec '51
AM/FM—ABC	$2,898,508	$3,220,760	$3,300,219
AM/FM—CBS	$6,544,490	$5,257,454	$5,278,508
AM/FM—MBS	$1,312,393	$1,583,291	$1,697,014
AM/FM—NBC	$5,077,740	$4,315,646	$4,343,307
TV—ABC	$1,298,616	$1,911,243	$1,980,145
TV—CBS	$2,304,602	$4,605,506	$4,736,368
TV—Dumont	Not avail.	$847,373	$937,875
TV—NBC	$3,274,757	$6,535,907-r	$6,592,673

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Feb '51	Previous Month Jan '52	Latest Month Feb '52
Sets in Use—total	11,142,500	15,777,000	16,129,300
Sets in Use—New York	9,442,400	14,931,100	15,262,600
Sets in Use—Los Angeles	2,145,000	2,800,000	2,840,000
Sets in Use—Chicago	835,000	1,090,000	1,100,000
Sets in Use—netw'k conn.	840,000	1,090,000	1,093,000

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Jan '51	Dec '51	Jan '52
Aeronautical	29,496	30,370	31,076
Marine	28,402	33,914	34,310
Police, fire, etc.	8,512	10,161	10,292
Industrial	8,013	11,449	11,859
Land Transportation	4,103	4,653	4,700
Amateur	90,964	100,922	103,570
Citizens Radio	422	749	792
Disaster	0	26	26
Experimental	475	452	425
Common carrier	832	835	877

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Dec '50	Nov '51	Dec '51
Prod. workers, electronic	278,300	266,500-r	270,200-p
Prod. wkrs., radio, etc.	190,300	166,700-r	169,400-p
Av. wkly. earnings, elect.	$59.76	$64.72-r	$64.83-p
Av. wkly. earnings, radio	$56.96	$61.25-r	$60.88-p
Av. weekly hours, elect.	41.5	42.0 -r	42.4-p
Av. weekly hours, radio	41.1	41.5	41.7-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Feb '51	Jan '52	Feb '52
Radio—TV & Electronics	223.7	270.9	276.2
Radio Broadcasters	202.4	261.4	268.8

INDUSTRIAL EQUIPMENT ORDERS

	Quarterly Figures		
(Source: NEMA)	Year Ago 3rd '50	Previous Quarter 2nd '51	Latest Quarter 3rd '51
Dielectric Heating	$300,000	$600,000	$210,000
Induction Heating	$1,100,000	$2,300,000	$1,900,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	3rd '50	2nd '51	3rd '51
Vacuum (non-receiving)	$3,370,000	$7,750,000	$8,420,000
Gas or vapor	$1,660,000	$2,700,000	$2,620,000
Phototubes	$230,000	$360,000	$275,000
Magnetrons and velocity modulation tubes	$2,050,000	$4,130,000	$3,750,000

p—provisional; r—revised; e—estimated

INDUSTRY REPORT

electronics—APRIL • 1952

Users of R-F Heating Equipment Face Radiation Checkup

FCC 1947 ruling bares teeth June 30. Welding deadline postponed

AFTER June 30, 1952, all radio-frequency heating devices used by industry are required to have certificates showing compliance with minimum radiation rules laid down in 1947 by the Federal Communications Commission. Users of such units are frantically working in two directions, (1) to meet the deadline and, (2) to convince the FCC that the deadline should be extended.

Written statements by qualified engineers that radiation of r-f energy at a distance of one mile from the installation is within prescribed limits are required, the object being to reduce interference with television and other communications services.

▶ **Apparatus Affected**—dielectric-heating apparatus is used for such things as setting the glue in the manufacture of plywood; induction-heating apparatus is commonly used for hardening metals. Old equipment used for both purposes often radiates considerable energy outside the building in which it is used. Even modern equipment may radiate under some conditions of installation and operation.

R-F welding equipment has caused interference to aviation communications and instrument landing devices. But, because of its strategic importance in defense work, enforcement of radiation limitation will be withheld until January 31, 1954.

▶ **Preventive Measures**—Reduction of radiation may require anything from simple shielding and filtering to complete redesign of equipment. One large tube manufacturing plant reports that $500,000 will be spent in curing radiation of equipment used on sealing machines. In this case much old equipment is being replaced.

Paul Godley, Jr., consultant in Upper Montclair, N. J., tells us that a certification measurement job (measurement and certificate only—no preventive work) will take from three to six engineering days on the average, at about $100 per day, where several radiating units are involved.

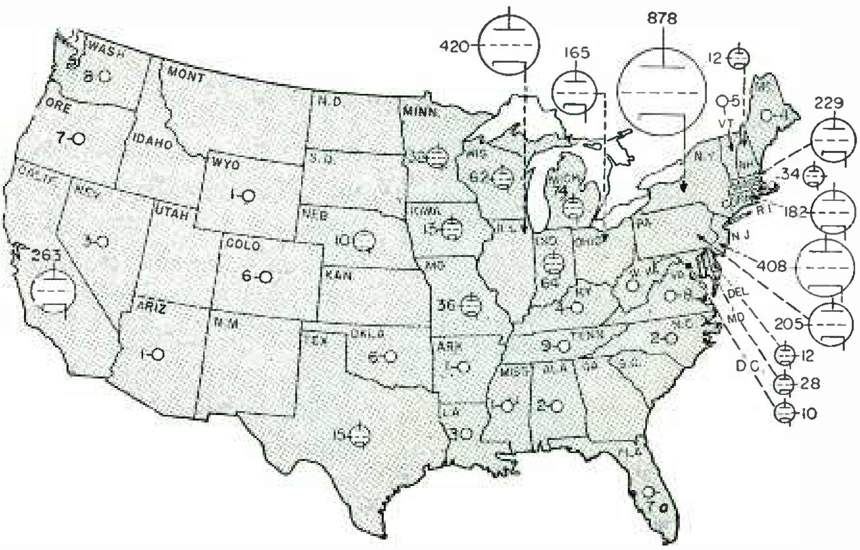
IRE Breaks All Records

MOSTLY on expense accounts, a grand total of over 29,000 engineers and executives paid their dollar apiece ($3 for nonmembers) to see an all-time-high of 357 different commercial exhibits filling four floors of New York's Grand Central Palace to saturation. In addition, uncounted scores of satellite exhibits and engineer-hiring setups in hotel suites further broadened the scope of the four-day mid-March electronic Mecca.

Nearby hotels were used by firms unable to get space in the main show, along with those who found peace and quiet more conducive to successful selling. To get people into these satellite exhibits, salesmen scouted the Palace for hot prospects and lured them over by mentioning a hot new item or a cool drink.

▶ **Job Opportunities**—Over 125 firms had cards posted on the fourth floor of the Palace listing the jobs they had open for electronic engineers and giving hotel room numbers for those interested in interviews. In addition, the New York City newspapers carried columns of engineer-wanted ads

Where Electronic Equipment Makers are Located



Concentration of companies is greatest in the northeast, with the north-central area in sizeable second place and the west coast coming up fast. Latest count of manufacturers in the field of electronics is 3,233 throughout the show days. All sections of the country were equally represented, but last year West-coast ads predominated.

A survey of representative hiring suites revealed that all were getting promising nibbles, but hiring was at a much slower tempo than last year. Inducements to change jobs were on a more rational basis, with salary-upping offers generally under $500 a year. Many firms were finding that young engineers could be coaxed back to their own home territory with little or no salary inducement if the boys happened to be homesick. Moving expenses were negotiated by most firms, generally on a share-the-cost basis; only a few, in the higher-salary brackets, were able to get the cat and dog moved free along with the family and furniture.

▶ **Jammed Sessions**—Every one of the 43 technical sessions and symposia drew a full house. At the Monday symposium on transistors, doors had to be locked after some 700 jammed the hall long before starting time. The overflow crowd here was so great that the session was repeated Thursday morning for 600 more.

An engineer who attended the full 20 hours of speeches had 23 hours left for exhibits, for an average of 3.86 minutes per exhibit. If he skipped all the papers, he still had only 7.22 minutes per exhibit during the 43 hours they were open. But he got no lunch or dinner while doing it.

Distributors Prepare For Unfreeze

DISTRIBUTORS across the country are already moving in on the potential business in tv equipment when the momentarily-expected lifting of the freeze occurs. A typical example is Graybar Electric, which late last month announced the signing of an agreement with Federal Telecommunication Laboratories, covering national distribution, by Graybar's 102 offices, of Federal's tv broadcasting equipment.

The agreement is aimed at supplying approximately 2,000 new stations eventually to be assigned in the uhf and vhf bands, says J. W. La Marque, sales manager.

FCC Staff Realignment Gives Walker a New Broom

Reshuffling of assignments and creation of new bureaus speeds work of the Commission

EFFECTIVE early in March, the Federal Communications Commission took the final step in its 'self-initiated' shakeup to streamline operations. It reassigned men and jobs as shown in the accompanying box.

Not a part of FCC's internal reorganization plan was Wayne Coy's sudden resignation to accept direction of the *Time-Life-Fortune* television enterprises. President Truman quickly elevated vice-chairman Paul A. Walker to the top post and tapped long-time Commission aspirant Robert T. Bartley for the empty seat.

Chairman Walker, 71, is serving out his regular term that expires June 30, 1953, under an executive order exempting him from compulsory retirement. His familiarity with current business is heartwarming to an industry long chilled by the television freeze. Delays in the final tv decision because of the change in leadership have been forecast as taking only an additional couple of weeks.

▶ **Walker's Record**—Walker does not make enemies, either within the Commission or on the Hill. He consistently votes with the majority. Believing his own and the Commission's decisions should speak for themselves, he is not in-

(Continued on page 8)

Federal Communications Commission

PAUL A. WALKER
Chairman (Dem.)

ROBERT T. BARTLEY (Dem.)	**ROSEL H. HYDE** Vice-Chairman (Rep.)	**GEORGE E. STERLING** (Rep.)
FRIEDA B. HENNOCK (Dem.)	**ROBERT F. JONES** (Rep.)	**EDWARD M. WEBSTER** (Ind.)

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OFFICE OF INFORMATION, George O. Gillingham, *Director*
OFFICE OF CHIEF ENGINEER, Edward W. Allen, Jr., *Chief Engineer*
OFFICE OF GENERAL COUNSEL, Benedict P. Cottone, *General Counsel*
COMMON CARRIER BUREAU, Jack Werner, *Chief*
BROADCAST BUREAU, Curtis B. Plummer, *Chief*
OFFICE OF OPINIONS AND REVIEW, Sylvia D. Kessler, *Chief*
OFFICE OF HEARING EXAMINERS, *Vacancy*
OFFICE OF CHIEF ACCOUNTANT, William J. Norfleet, *Chief Accountant*
OFFICE OF SECRETARY, Thomas J. Slowie, *Secretary*
SAFETY AND SPECIAL RADIO SERVICES, Edwin L. White, *Chief*
FIELD ENGINEERING AND MONITORING, George S. Turner, *Chief*

FCC Chairman Walker

New Commissioner Bartley

clined to explain or apologize. As a devout and active churchman, he has sometimes urged religious and educational groups to make more use of tv and radio. He gets jobs done and keeps discussions short and to the point. His particular interest has been telephone and telegraph regulation.

▶ **Bartley's Record**—Director of FCC's Telegraph Division from 1934 to 1937, Bob Bartley, 43, entered private industry and rose to vice-president of New England's Yankee Network.

He joined the NAB back in 1943 as director of war activities. Since 1948, he has been administrative assistant to his uncle, House Speaker Sam Rayburn. Besides his impeccable political connections, Bartley made a good personal impression upon the Senate, which confirmed his term to July 1, 1958.

Bell System Circuits Will Cost $60 Million

Additional television, telephone and telegraph facilities authorized by FCC

MICROWAVE radio-relay construction costing an estimated $32.5 million in 1952 will provide brand-new Bell System circuits between Albany and Buffalo, N. Y., Washington, D. C. and Atlanta, Kansas City and Dallas, and Los Angeles and San Diego.

Balance of the $60 million expenditure planned by Bell this year will go into coaxial cables and terminal equipment. Coax will be laid between Orlando and Tampa, Knoxville and Chattanooga, Memphis and Little Rock. New television circuits will extend service to Miami, New Orleans, Dallas, Fort Worth and Houston and to Oklahoma City.

Facilities for the circuits totaling more than 8 million channel miles are included.

S. A. Television Market Expanding

Government control may be handicap to receiver exports from U. S.

DESPITE OPTIMISM expressed in the United States, tv will not fully capture the South American market for at least another four years. This is the opinion of Ernest Marx, General Manager, Sales Division, DuMont, who has just returned from a tour.

In a verbal recap of his trip, Marx pointed out to an ELECTRONICS reporter that of six countries having or contemplating tv, four face some sort of government control.

▶ **Stations Operating**—Sao Paulo, Brazil, leads the South American tv race, with two stations already operating and three contemplated. Brazil's government is considering establishment of licensed plants where native industry would assemble receivers under supervision of United States technicians.

Argentina faces a political stumbling block in tv. The Peronist government will not allow receivers to be imported. Interested manufacturers must obtain a 'Peron Permit' to establish an assembly plant. At the present time, permits are very scarce.

Two other countries in S. A. face either full or partial government control. The governments at Lima, Peru, and Bogota, Colombia, feel that the present low standard-of-living may make it feasible for them to provide, by loan or outright gift, receivers for people who cannot afford them.

▶ **What About UHF?**—"There is no use for uhf in South America now or any time," Marx said, "due to the great distance between cities." From Sao Paulo to Rio

Twelve cities in South America have, or plan soon to have television. Eight are located along the coast. Distance between Sao Paulo and Rio is 250 miles

de Janeiro, Brazil, the distance is 250 miles, (approximately the same as from New York to Washington) which is the shortest distance between any two large cities

(Continued on page 10)

NEW! SPRAGUE *Blue Jacket*☆ wire-wound RESISTORS

WITHSTAND SEVERE HUMIDITY!

MEET JAN-R-26A!

Designed to withstand the rigid Characteristic G humidity tests of the most stringent specification of them all—JAN-R-26A—Sprague's new Blue Jacket Wire-Wound Resistors give trouble-free service in military electronic and electrical equipment exposed to extremely damp climates!

These outstanding new members of the Sprague resistor family are now available in tab terminal styles RW29 through RW39 in wattage ratings up to 166 watts.

You'll find the complete Blue Jacket Story with performance specifications in Engineering Bulletin 110, just off the press. Get your copy without delay.

YOU'LL KNOW THESE REMARKABLE RESISTORS BY THEIR VITREOUS ENAMEL BRIGHT BLUE JACKETS

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

☆ Trademark

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASSACHUSETTS in all South America.

Pointing out the distance from one end of the continent to the other is 11,954 miles, Marx said there obviously would be no congestion of stations.

▶ **Standards Being Used** — The table at right shows the standards now in use or being contemplated by new stations:

	Standard Lines	Standard Fields
Sao Paulo, Brazil	525	60
Montevideo, Uruguay	525	60
Buenos Aires, Argentina	625	50
Rio de Janeiro, Brazil	625	50
Santiago, Chile	625	50

Everyman's Radio Now Works Two Ways

Citizens Band has over 700 authorizations and a new control frequency

BLUEPRINTED by FCC for non-technical mass use of two-way radio communication, the Citizens Radio Service was launched in 1947 (ELECTRONICS, p 81, Nov. 1947).

The proposal envisioned simple licensing of commercial 'type-approved' transmitter-receivers that would allow the man in the street to talk from here to there. Although several designs were approved for radiophone use, manufacturers never produced equipment.

▶ **Growing Business** — Authorizations until recently in the hands of just a piddling few experimenters have now grown to a startling 700-odd. Who is using Citizen Radio, and how? No detailed breakdown is available from FCC because a statement of use is not required when the station license is obtained. It is known, however, that the band is being used in two different ways:

Modified uhf taxi equipment is beginning to be employed by people who can't qualify for other classes of radiotelephone service. Most of them are interested in communication with moving vehicles, like newspaper, maintenance or laundry and dry-cleaning trucks. Taxis, police and commercial ventures might obtain authorizations, provided they were willing to take the chance of severe interference. A complete station of this type costs about $600, requires no licensed operator, but must be installed and serviced by one. Because it has a Class A rating it can operate in regions of slightly less interference.

The other general use is for remote-control devices. Several equipments with Class B approval are in production. All Class B gear must operate in the center of the band where interference may be worst. They include garage-door openers and controls for model aircraft or boats. Suitable transmitters and receivers for models cost, respectively, about $40 and $30. Transmitters must not be tampered with but no operator license is required.

▶ **Bright Prospects**—FCC has supplied a fillip to the business by issuing a new 'Class C' authorization for remote control only. This assignment allows use of frequencies between 27,230 and 27,280 kilocycles rather than the regular Citizens band centered at 465,000 kc. Equipment for this lower frequency will be simpler to construct and just as easy to license.

Noble Experiment Is Noncompetitive

Radio message service will provide information on split channels

DAN NOBLE, pioneer of mobile f-m communications, recently dispatched personal letters to all operators of Miscellaneous Common Carrier systems, assuring them that Motorola (of which he is v. p.) is no competitor.

Noble recently set up Phoenix Radio Message Service, in Arizona, as a means of field testing new two-way communications equipment used between a telephone-answering switchboard and moving subscribers' cars.

Technical data collected will be turned over to the Joint Technical Advisory Committee (JTAC) for formulating industry recommendations to FCC on so-called 'split-channel' allocations. Usual channels require a width of 60 kilocycles. The Phoenix service narrows the channel to 20 kc.

Although tariffs of existing message services are a matter of public record on file with the Commission, a clear picture of operating costs is not always easy to arrive at. The Phoenix experiment is expected to furnish a typical set of cost figures, too.

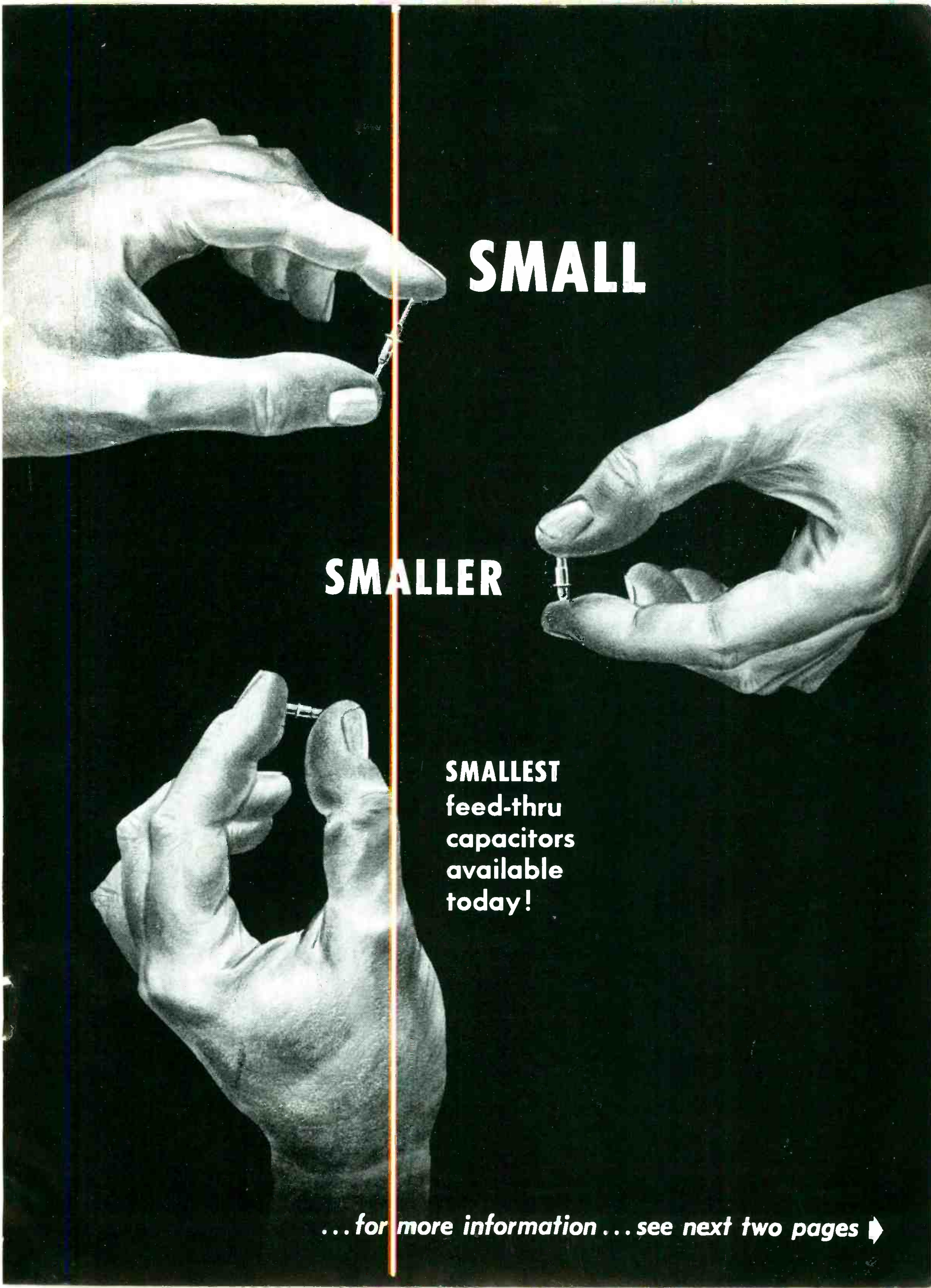
Printed Parts Ease Microwave Component Bottleneck

A REVOLUTIONARY technique for producing complicated microwave components in minutes rather than months was announced by engineers of Federal Telecommunication Labs, research associate of IT&T, at the 1952 IRE National Convention. The new foil-coated plastic equivalents of complicated plumbing units promise to ease the present bottleneck in production of electronic equipment for guided missiles and jet planes.

Two examples are illustrated: the 5,000-mc magic T weighing 15 pounds and costing around $700 can now be replaced by a two-inch-long plastic strip costing less than a dollar and weighing only a few ounces, and the 5,000-mc flap attenuator can be replaced with a three-inch plastic strip having only a simple riveted plastic flap.

▶ **Materials Not Critical**—Raw material for printed microwave components is sheet polystyrene, Teflon or a similar dielectric material about one-eighth inch thick,

(Continued on page 14)



SMALL
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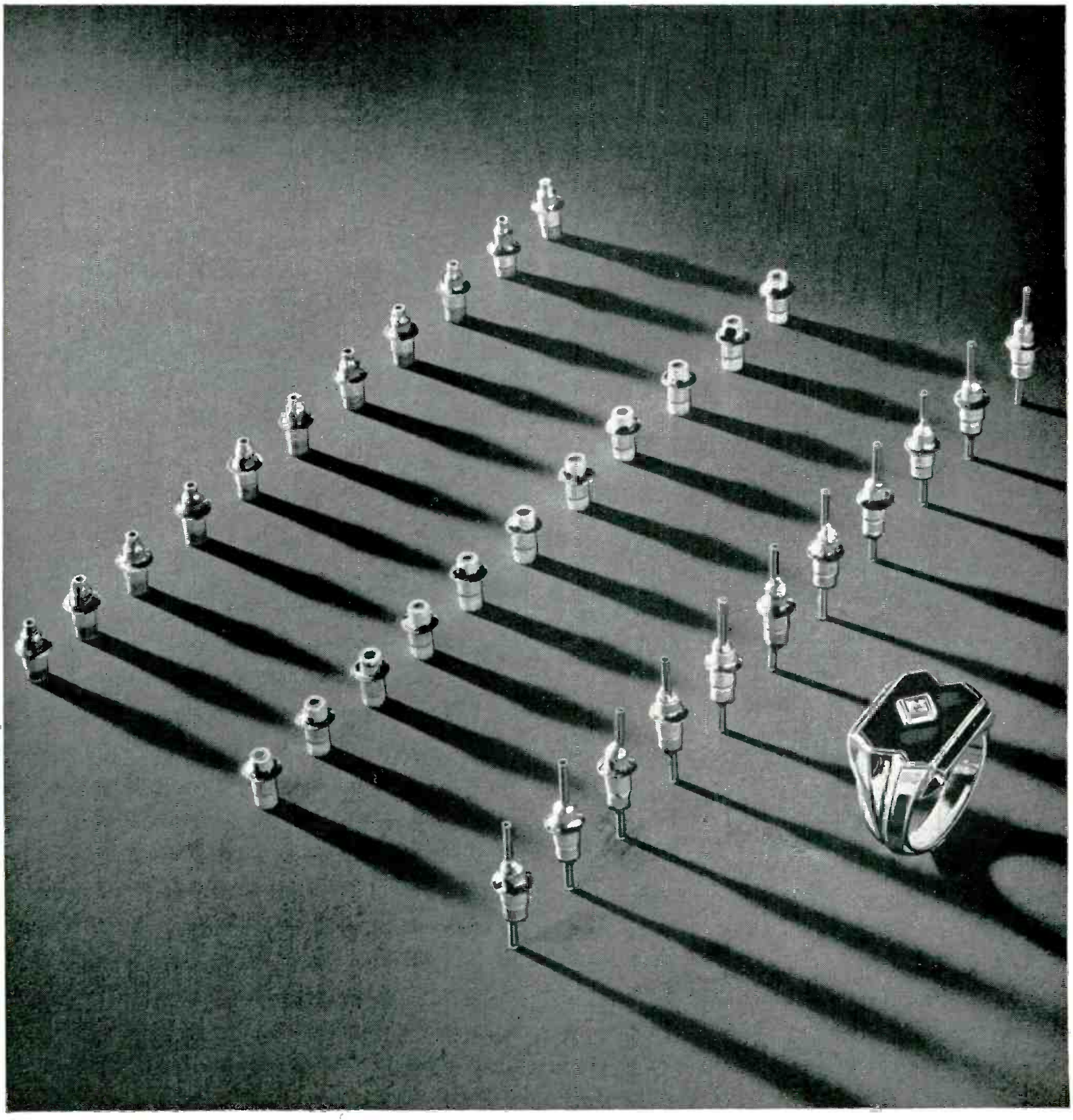
feed-thru
capacitors
available
today!
...for more information...see next two pages

Use the smallest capacitors on widest line available . . . with



EYELET-MOUNTED FEED-THROUGH CERAMIC CAPACITORS are now available in a new wider line — better engineered than ever before. These are the smallest feed-through capacitors made. Available in the widest capacitor range on the market. Can be tin dipped for ease of soldering — and furnished with general temperature compensating characteristics. Capacities range from 10 to 3000 mmf. Voltage rating 500 V.D.C.W. For complete information — write for Bulletin EP-15.

the market...choose from the Centralab Ceramic Capacitors

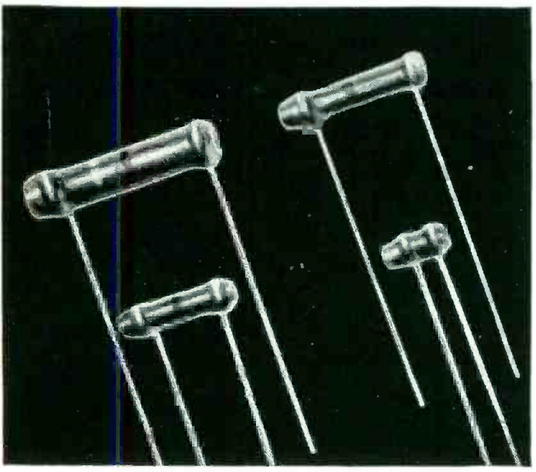
You will find Centralab Ceramic Capacitors the most permanent type yet developed — available in the smallest sizes on the market today. More, with Centralab you get the widest choice of voltage and accuracy requirements that you can get anywhere — at any price.

After testing hundreds of different ceramic combinations, Centralab developed Ceramic X with non-hygroscopic properties. Moisture absorption is held to .007% or less — this ultimate in reliability under severe humidity makes it ideal for tropical climates. In addition, capacity tolerances are maintained up to temperatures of 85° C — higher than generally encountered in most electrical apparatus.

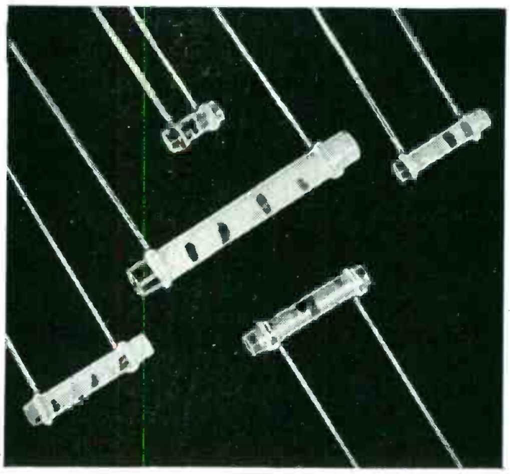
Today, when size is so important, Centralab offers the smallest capacitors available — about ½ the size of ordinary capacitors of mica or paper construction.

Compare with all others — and note the advantages in standardizing on Centralab Ceramic Capacitors—for highest efficiency, smallest size, low power factors, high voltage and accuracy requirements, and true permanence.

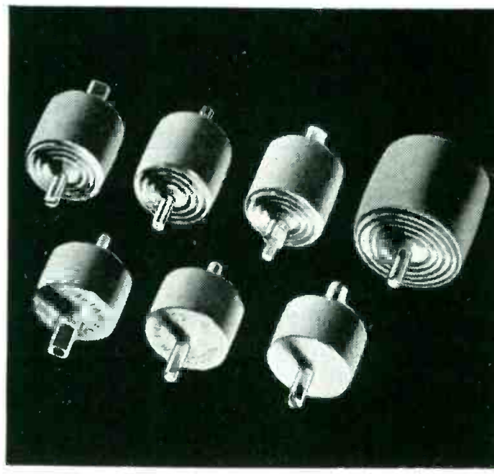
All Centralab capacitors are made to applicable portions of JAN specifications.



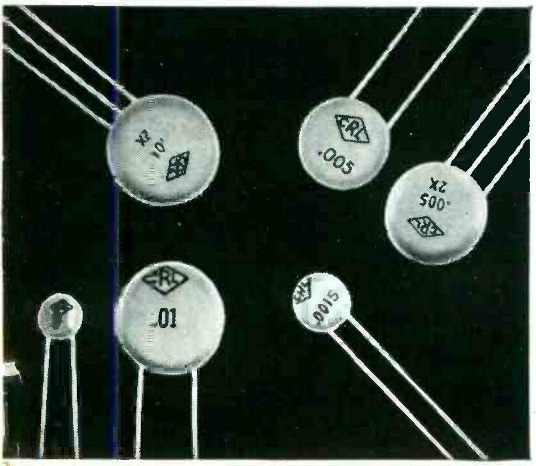
BC HI-KAP TUBULAR CERAMIC CAPACITORS available from 1 mmf. to 10,000 mmf. Ideal for use in r.f. by-pass and audio-coupling applications. For details, write for Bulletin 42-3.



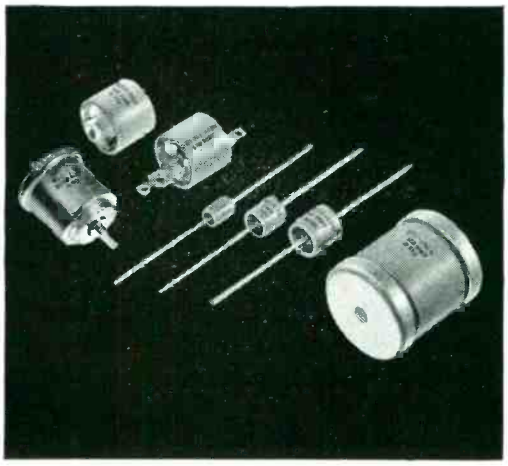
TUBULAR CERAMIC CAPACITORS — type TCZ show no capacitance change over wide temperature range. Type TCN special ceramic body varies capacitance with temperature. Write for Bulletin 42-18.



TV HI-VO-KAPS are the standard high voltage capacitors for the TV industry. Capacitance: 500 mmf., 10 KV, 20 KV and 30 KV D.C. working. Write for Bulletin 42-10R.



CERAMIC DISC HI-KAP CAPACITORS hold thickness to a minimum. Make possible very high capacity in extremely small size. Used in HF by-pass and coupling. For details, write for Bulletin 42-4R.



HIGH VOLTAGE CERAMIC CAPACITORS. Capacitance: 5 to 500 mmf., 5 KV to 40 KV D.C. working. Ideal for portable or mobile equipment and high voltage, high frequency gear. Bulletin 42-102.

MINIATURE CERAMIC TRIMMERS can be mounted to chassis or terminal mounted to coil or terminal board. Available in various trimming ranges. For details, write for Bulletin EP-16.

For complete information on Centralab ceramic capacitors and other electronic components . . . switches, controls and printed electronic circuits . . . write for technical bulletins listed and latest Centralab catalog.

CENTRALAB 30th Anniversary A Div. of GLOBE-UNION, Inc. 1922 CRL 1952

Centralab

A Division of Globe-Union Inc.

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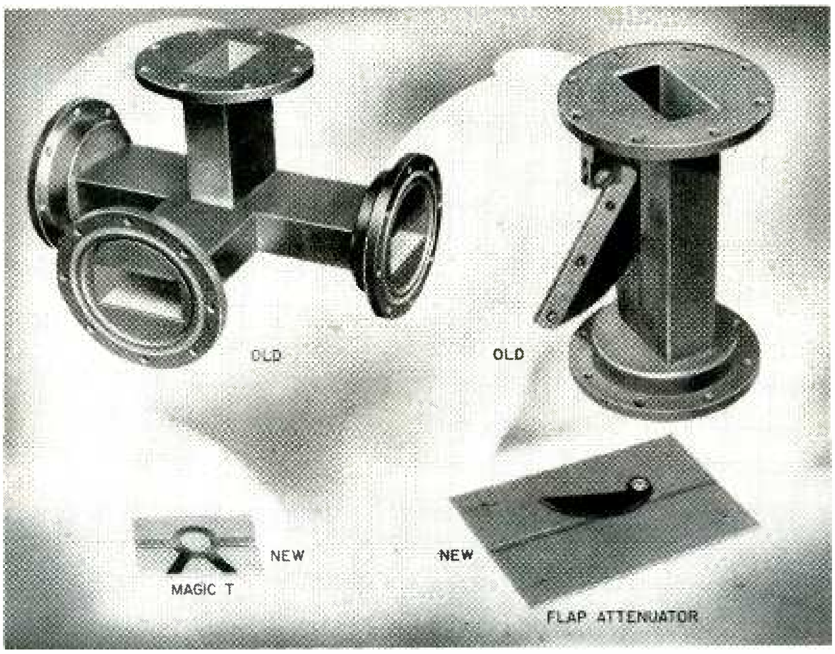


Relative sizes of old and new components for 5,000-mc microwave receiver. The magic T is a type of transformer used for mixing two signals together. The flap attenuator provides a convenient means for varying strength of microwave signals

with 0.001-inch copper foil cemented to both sides. One side is left untouched to serve as an electrical reflecting mirror; the other is etched by printed-circuit techniques to give the required pattern, without costly machine tools.

Offering tremendous savings in cost, weight, space, production time and manpower, the new components are expected to have far-reaching effects on the design and production of military and commercial microwave equipment. In particular, they open tremendous market potentialities for low-cost radio communication systems operating above 1,000 mc.

Magnetic Amplifiers Vie With Tubes For Development Dollars

New materials and military research contracts rapidly expand 'tubeless' branch of industry

TAKING a large bite out of today's defense dollar is a group of companies, some old and some new, specializing in the transformer-like magnetic amplifier.

In action, the magnetic amplifier serves as an electrical valve in the same way that the tube does, but with the advantages of extreme reliability, virtual indestructibility, high available power gains and high efficiency. The main limitation is speed of response, but this is not a serious defect in many applications.

Two or three years ago, the magnetic amplifier was known to few and understood by even fewer. Then along came the threat of another international scientific foot race. The military handed out challenging orders for years-ahead electronic devices for doing fabulous things under fantastic conditions. Many of these jobs were naturals for the long-neglected magnetic amplifier, and the seed was planted.

▶ **Who and How Big**—Today the mushrooming continues. One-time loft operations have bonanzaed into profitable workings. The military continues to be number-one customer, but techniques being developed show great promise for peace-time applications.

Typical comments from the twenty odd companies known to be in the magnetic amplifier business give graphic proof of prosperity. One company's average monthly income in 1951 was $3,000. The same figure for 1952 will be around $8,000, an increase of over 250 percent.

Another company tells of doubling its engineering staff inside of one year and increasing floor space by 500 percent to make room for more production.

Magnetic amplifiers are not alone in this contest for jobs as tube substitutes—transistors are also in there swinging. They do, however, enjoy a backlog of valuable experience and information, whereas transistors are still in the development stage. The business has been reborn of necessity and shows promise of an abundant and prosperous life.

New Law Will Up Sound Recorder Sales

Pharmacist Edward Liebson of New York records a doctor's prescription-refill order

THE Durham-Humphrey Act, which goes into effect April 26, will swell the national market for sound recorders. It requires pharmacists to furnish proof that a physician has authorized refill of every prescription in certain categories. A recording of the doctor's voice may be acceptable in some instances.

Over 50,000 drugstores in the

(Continued on page 16)

U. S. have prescription departments. The Sound-Scriber Corp. of New Haven reports that it has already sold recorders to many of them, notably the Shulte and Liggett chains, for experimental use.

▶ **Legal Questions**—The legality of telephone recordings varies with the state and this question has not yet been fully resolved. Telephone company requirements regarding direct recordings also vary throughout the country and must still be clearly defined.

So far as the FCC is concerned, this federal body has already ruled that recorded conversations must be preceded by a warning 'beep' signal in the case of interstate communications. That the beep need not be used on intrastate telephone lines remains to be seen.

Educational Television Stands at the Crossroads

Top school leaders meet to discuss use in their fields

MORE than 60 college presidents and other educational top brass will meet on the campus of Pennsylvania State College during the week of April 21-26 to study, for the first time, means for integrating television into the country's educational system.

Under the title of Educational Television Program Institute, directed by Carroll V. Newsom of New York State Education Dept., the group will consult with technical, financial and operations experts in the commercial field. A closed-circuit tv system will be set up for demonstration. Art Hungerford of General Precision Laboratory, previously training-aids technical expert for the Navy, will serve as assistant director.

Some $70,000 necessary to underwrite the Institute have been chiefly provided by the Fund for Adult Education (Ford Foundation). The group also has the backing of the Payne Fund, Sloan Foundation and others.

▶ **Timing**—With FCC expected to lift the tv freeze by the time of the meeting, the college presidents will have some firm frequency allocations upon which to base their thinking. In its proposed allocations plan, the Commission provided 209 educational, noncommercial tv channels. Of these, 127 were uhf and 82 vhf. However, FCC has been swamped by some 838 petitions from colleges and school systems.

Weightiest arguments for more channels came from New Jersey (which had been left entirely out in the cold) as well as Connecticut, New York and Wisconsin, all of which have extensive educational-tv plans at the state level. Ralph Steetle, executive director of Joint Committee on Educational Television, is confident that the final channels provided will be "more than 209".

▶ **Competition**—Some commercial broadcasters tend to swell up and turn red when educational tv is mentioned. Aside from the reservation of valuable channels, which can't be laughed off lightly in this spectrum-hungry world, commercial tv probably has little to fear from etv. Some systems will be so highly geared in with the school program as to offer little popular fare.

Many tv problems are common to both types of service, like networking and distribution of kinerecordings. But in the educational system greater reliance may have to be placed on privately owned and operated microwave links when off-the-air relaying is impossible.

Commercial tv stations in many places, says Director Steetle, are doing a fine job with educational programs of their own. They should be encouraged to continue. Particularly in communities and sections where the economy will not support an educational station, the commercial outlet will have to carry the whole load.

Hotel TV Comes of Age

Rugged, simple sets with hidden controls are needed

MAJOR CHANGES in the guest-television policy of hotels have recently taken place.

In the beginning, larger hotels were equipped with video distribution systems. 'Slave' units were brought to a guest's room upon request. The charge was so much extra per day. The smaller hotels had no tv facilities.

▶ **Current Practice**—Today, master antenna systems are taking over, with indoor antennas running a close second. Video distribution systems are fast becoming passé. Portable sets take their place. Average screen size is about 14 inches, with many 20-inch sets permanently installed in large hotels.

Nearly every hotel in New York City has tv facilities of one kind or other. For permanent installations, the charge is hidden in the regular price of the room. Smaller hotels charge from one to three dollars per day.

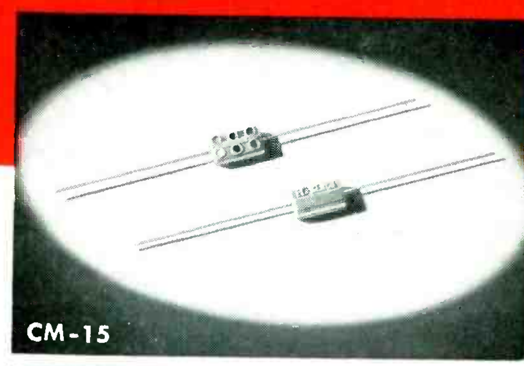
▶ **Type of Set Needed**—Hotels require tv sets that stand up under all kinds of abuse and are simple to operate, with most controls hidden. Because many hotel guests have never operated a tv set, too many controls on the front panel increase maintenance problems.

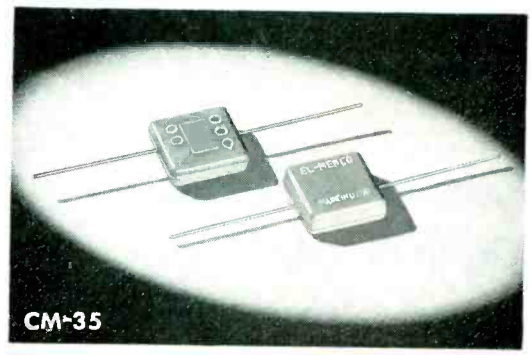
Lockheed Starts Training Program

FACED with a continued shortage of electronic technicians and the growing demand for aircraft even more heavily equipped with electronic devices, Lockheed has started an earn-while-you-learn training program.

The program is geared to turn out 600 technicians in 1952. In the first class, 25 are studying, with pay, on a regular factory shift from

(Continued on page 18)





- Every El-Menco Capacitor is factory-tested at more than *double* its working voltage, thus assuring a wide margin of safety, regardless of the nature of the application.

- From the midget CM-15 (2-525 mmf. cap.) to the mighty CM-35 (3,300 - 10,000 mmf. cap.) dependability is a predetermined certainty. That is why El-Menco's have won such universal acclaim in both military and civilian services.

Jobbers, Retailers, Distributors—For information communicate direct with Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

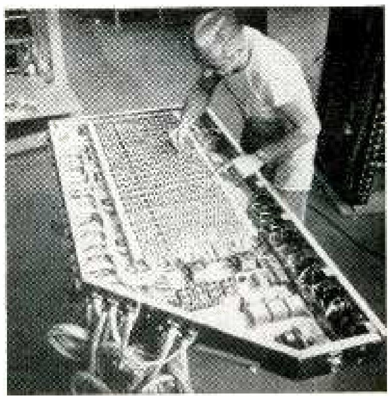
Write on your business letterhead for catalog and samples.

MOLDED MICA El-Menco **MICA TRIMMER**

CAPACITORS

Radio and Television Manufacturers, Domestic and Foreign, Communicate Direct With Factory—

THE ELECTRO MOTIVE MFG. CO., INC. **WILLIMANTIC, CONNECTICUT**



Radio terminal board of the new Super-Constellation transport has 1,500 connections, is assembled outside the airplane

8 am to 4:45 pm.

Even technicians with five to six years of electronic experience will get a 12-week refresher course familiarizing them with Lockheed's current needs. Less experienced trainees will take a 27-week course in fundamentals plus up to 14 weeks of specialized work.

▶ **Program Going Well**—Response to the program has been good and there is already a backlog of applicants. So far, 20 percent of those accepted for training have been company employees. The remaining 80 percent have responded to ads in newspapers.

A similar program has gone into effect at Lockheed Service. An initial class of 50 is now in training.

First-Quarter Checks Go to Stockholders

JUDGING from figures reported by leading companies in the electronics industry on net profits and dividends paid, 1951 was a good year financially.

First-quarter dividends for 1952, now in the mails, range from 15 cents per share being paid by Aerovox, to Raytheon's 60 cents. Admiral and Philco are paying 40 cents per share; Sprague is paying 50 cents.

During 1951, Magnavox earned 77 cents a share for common stock, Stromberg-Carlson earned $1.66 per share and is paying a regular dividend of 50 cents for preferred and 25 cents for common stock for first quarter. RCA paid $1.00 per share in 1951.

▶ **Nets & Grosses**—Although industry gross income was higher, net profits were generally lower than 1950 due to increased federal taxes. RCA's $598 million gross income netted the company $31 million after taxes. Though grossing $12 million more than in 1950, the company netted $15 million less.

General Electric also showed less net profit compared with 1950, due to taxes. With almost $2½ billion in gross income, the net for GE was $138 million. In 1950, a gross of nearly $2 billion gave a net profit of $173 million.

The Canadian Admiral Corp., Ltd., netted $217 thousand after a gross of over $5 million. Western Electric made a net profit of $45 million after taxes from a gross of $805 million. Olympic Radio-TV Corp. grossed $11½ million and put just over a quarter million dollars 'in the kitty'. Sylvania hit a new high by netting $8,253,973 while grossing $202 million, a record level. In 1950, the company paid nearly $4 million to stockholders.

What's Behind the Figures—
Licensee Radio—TV Set Sales

Second of a series explaining basis of statistics reported on *Figures of the Month* page

THE SECOND division of the statistical round-up which appears each month on page 4, labeled Receiver Sales, gives the monthly totals of radio and tv sets sold, in units and in dollar value. The figures given are those reported by licensees who pay royalties under patents controlling the design and production of all classes of domestic receivers.

The editors are not permitted to disclose the source of these figures, but it can be stated that they represent the sales of all major manufacturers except one. The totals are, therefore, representative of better than 90 percent, possibly 95 percent of the overall industry picture.

▶ **Set Breakdown**—The listings have the following significance: *Television sets* include table models, consoles, radio-phono-tv combinations and converters. Both direct-view and projection models are included. *Electric radio sets* include am, fm and am-fm table models and consoles as well as radio-phono table and console sets, but omit any type of set intended to be operated by batteries. *Battery sets* include table and console models as well as portables having provision for ac-dc and battery operation.

The dollar values published are the manufacturer's billing price, less excise tax. Latest month is the month during which the sales were actually billed. However, all reports are not received from manufacturers until the middle of the second month following. This accounts for the delay in publishing the figures (December sales published in the April issue).

Space on the Figures page does not permit a complete breakdown of the licensee sale figures, but the following typical data are available: In the electric radio set category, table models having a billing price over $12.50 accounted in December 1951 for about 80 percent of the units and about 65 percent of the dollar value in that category, compared with 3 percent of the units and 14 percent of the value represented by all radio and radio-phono consoles. Among battery sets, ac-dc portables account for 98 percent of the units; only 3 battery consoles were reported sold in that month.

(Continued on page 20)

NEW! High-level, direct-reading portable test sets simplify laboratory and field SHF work

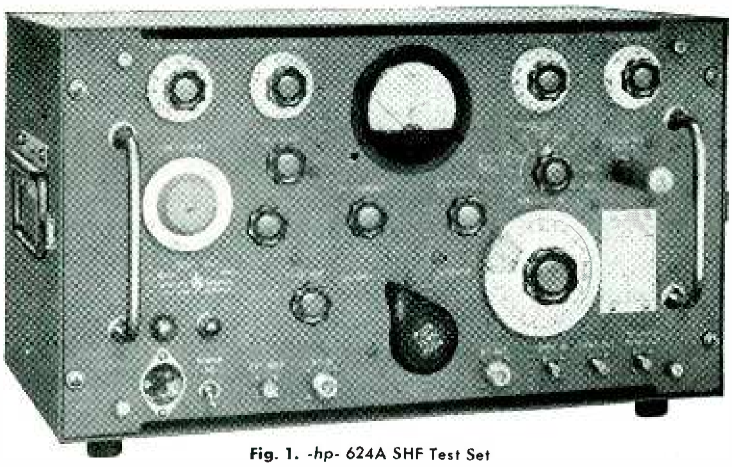


Fig. 1. *-hp-* 624A SHF Test Set

.223 v. maximum rf output
Direct tuning, reading
Pulse and fm modulated
Stable, accurate 100 db attenuator
Measures external rf power
Measures external frequency
Compact, sturdy, portable

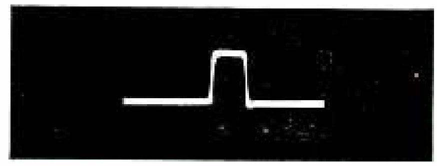


Fig. 3. Typical rf pulse, 0.25 μsec.

SPECIFICATIONS

-hp- 624A SHF Test Set

RANGE: 8,500 to 10,000 mc.

OUTPUT: 0 dbm (1 mw) to —100 dbm into 50-ohm load. Type N jack.

OUTPUT ACCURACY: Within 2 db, —10 to —100 dbm into matched load.

INTERNAL MODULATION: Pulsed or fm.

PULSE MODULATION: Length variable from approx. .25 to 10 μsec. Rise and fall times, each, 0.05 μsec. Rate variable 35 to 3,500 pps.

EXTERNAL SYNC: Internal pulser operates free-running or in sync with external 5-v. peak pulse, pos. or neg., or 5-v. rms. sine waves. May be externally square-wave modulated. BNC jack.

FM: Internal fm at power line frequency. ±7.5 mc deviation max. Also fm modulation by external 35 to 3,500 cps voltages.

TRIGGER PULSES: (a) Coincident with start of output rf pulse; (b) 3 to 250 μsec ahead of output rf pulse.

POWER METER: 2 mw full scale. Accurate within 1 db.

FREQUENCY METER: Full range, accurate within 0.03% at 25°C ambient.

PRICE: $2,250.00 f.o.b. factory.

-hp- 623B SHF Test Set

TOTAL FREQUENCY RANGE: 5,925 to 7,725 mc.

INDIVIDUAL KLYSTRON RANGES:

5,925—6,225	6,575—6,875	7,125—7,425
6,125—6,425	6,850—7,150	7,425—7,725

OUTPUT: 0 dbm (1 mw) to —70 dbm into 50-ohm load. Direct-reading control.

OUTPUT ACCURACY: Within 2 db, 0 to —70 db, into matched load.

INTERNAL MODULATION: FM from 1,000 cps internal source; phase, deviation adjustable; max. deviation ±15 mc.

EXTERNAL MODULATION: FM, 50 cps to 10 kc. May be pulsed or square-waved externally.

DETECTOR OUTPUT: Xtal detector to provide rectified output when fm or pulsed power applied.

(Other specifications similar to 624A)

PRICE: $1,500.00 f.o.b. factory.

Data subject to change without notice

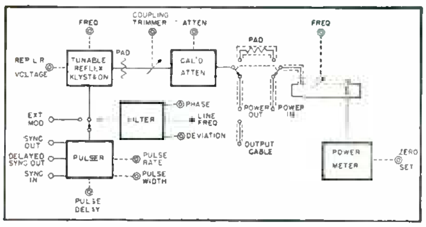


Fig. 2. Simplified circuit, *-hp-* 624A

-hp- 624A SHF Test Set is a high-level, accurate, multi-purpose instrument designed to speed and simplify a wide variety of tests between 8,500 and 10,000 mc. It is an ideal one-piece unit for measuring receiver sensitivity or selectivity, transmitter tuning or power level, and is particularly adapted to testing complete radar or gunfire control systems or beacon equipment. The instrument includes pulsing circuitry providing a variety of high-quality rf pulses.

-hp- 624A consists of a signal generator and a power and frequency meter section. The generator includes a modern klystron generator with excellent frequency stability and an output attenuator of the waveguide-beyond-cutoff type, insuring high accuracy and stability. The attenuator is not subject to temperature, humidity or age changes. The power and frequency meter section can be used to adjust the signal generator's frequency and level as well as measure external rf energy. The instrument employs 50-ohm Type N coaxial connectors, but for maximum versatility includes adaptors for waveguide connection.

-hp- 623B Test Set is designed for operation at frequencies between 5,925 mc and 7,725 mc. This overall frequency range is covered in six bands, each of which is a full 300 mc wide. Bands are selected by installation of the proper klystron tube (see specifications). The instrument is particularly useful in field-testing SHF radio relay stations and communications equipment as well as general tests involving fm modulated equipment. It includes a 1,000 cps modulator and may also be square-waved or pulsed by external sources with frequencies ranging from 60 cps to 100 kc.

Both *-hp-* 624A and 623B weigh less than 60 pounds, are of extra-sturdy construction and are equipped with carrying handles and snap-on cover. Sets also fit standard relay racks.

See your -hp- engineer-salesman or write direct for complete data.

ELECTRONIC MEASURING INSTRUMENTS

HEWLETT-PACKARD COMPANY 2444-A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
Export: Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

Sales of television sets in the latest month were about evenly divided between consoles and table models. Among the consoles only one in 8 tv sets sold was equipped for phonograph reproduction. Direct-view sets far outdistanced projection models; only 142 projection sets were sold in December, out of the total of 384,000 tv sets of all types.

▶ **1951 Recap**—Totals for the 12 months of 1951 reveal a sale of 5,032,942 tv sets with a value of $894,476,000, nearly 5 million auto sets, over a million battery sets and 5,868,570 electric radio sets having a value of just under $139 million. The average manufacturer's billing price for tv sets was $178, for electric radio sets $23.75.

Small British Business Under Big Pressure

BRITISH electronics industry had more than $212 million outstanding in orders at the end of 1951, according to a survey made by London's *Financial Times.* Nine months earlier the figure was less than $120 million.

Delivery of equipment now being ordered isn't expected much before 1954. New British fighters and bombers now being delivered to the RAF are missing much important electronic equipment.

Many military orders are in the research and development category.

The British electronics industry exported $61 million of equipment last year; an increase of $7.2 million over 1950.

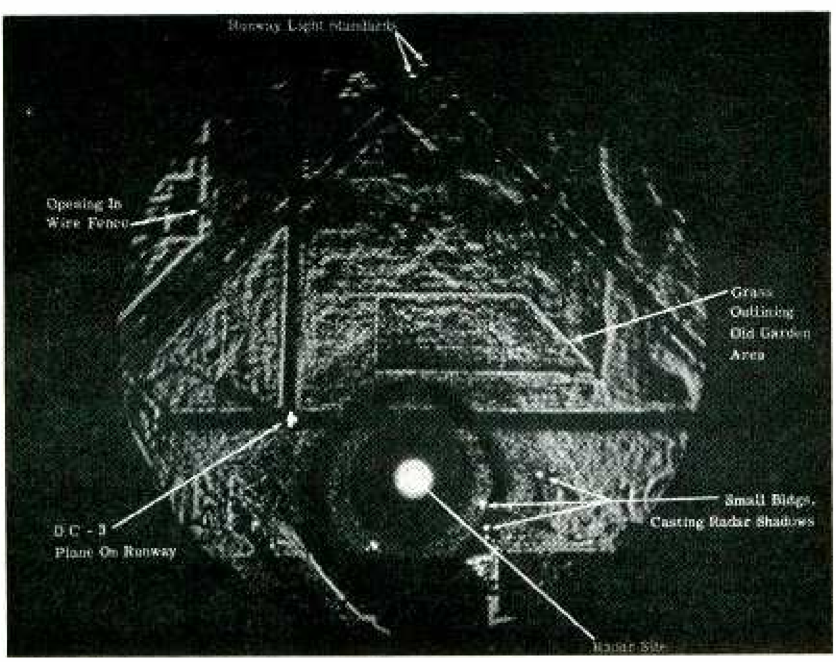
Why GCA Costs So

Bulky components using critical materials blamed

FAMILIAR excuse given by the Air Force for high cost of modern planes is the need for complex electronic gear. However, the high cost of ground-controlled approach radar (GCA) is explained in terms of critical materials.

The table shows how many pounds are used in three Air-Force procured GCA sets. The first column refers to a new, mobile, air-transportable job costing $617,295. The other two are not identified.

Material	*Set 1*	*Set 2*	*Set 3*
Carbon steel....	4,031	54,600	2,452
Alloy steel.....	732	358	580
Stainless steel..	3,459	918	400
Copper alloy....	3,453	331	296
Copper wire....	5,517	2,095	3,449
Copper casting..	0	232	116
Aluminum	11,654	6,619	4,061
Nickel	412	0	0
Chrome	630	0	0



HIGH RESOLUTION—HIGH COST: Airport surface detection radar (ASDR) equipment could be used in conjunction with ground-controlled approach radar (GCA) to see aircraft and vehicles on runways. Housed in a trailer, with an antenna on a 30-foot temporary tower, this ASDR will pick off crows on a runway or a man a mile away.

TV Service Goes on COD Basis

$750 million will be spent this year on service calls to keep tv sets running

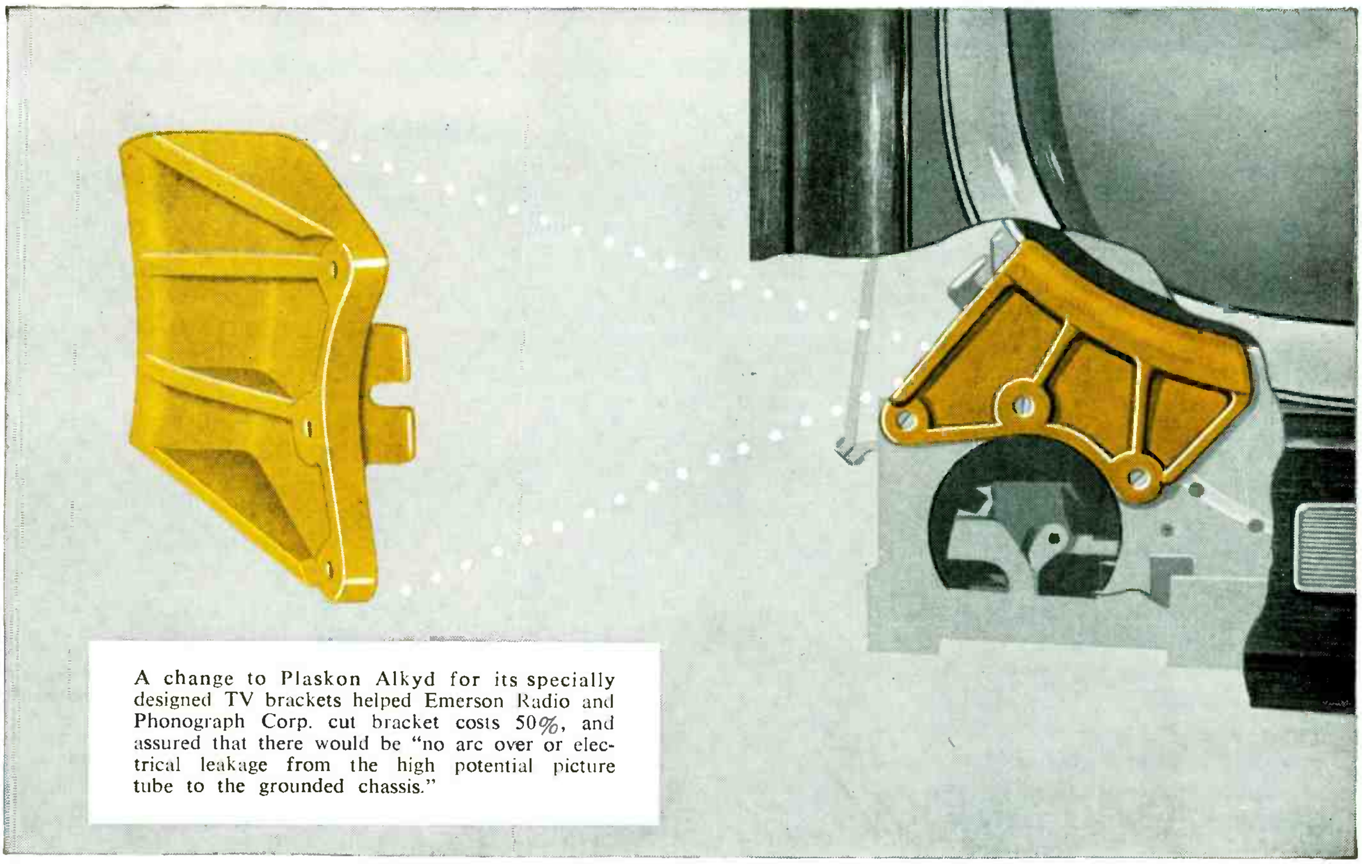
THERE HAVE been many changes, some good and some bad, in the tv servicing picture since publication in July 1950 of the ELECTRONICS survey: *Why Television Receivers Fail in Service.* These changes are important, because tv servicing is rapidly approaching a billion-dollar-a-year business that may overshadow even new-receiver sales figures.

On the credit side, manufacturers are making more reliable sets and the public is becoming more tolerant of minor defects in pictures, with the result that paying calls have dropped to an average of 3.5 per year as compared to 5.5 for 1950. At an average of $12.50 per call including parts and with an estimated average of 17.5 million sets in use in 1952, this means that a minimum of three-quarters of a billion dollars will be spent this year on repairs.

▶ **Contracts**—Less than 5 percent of the tv sets in use are under service contracts today. On existing contracts the human factor still governs, so that calls per year are unchanged from the 5.5 figure of two years ago.

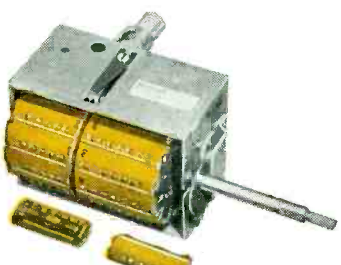
Dealers who handle all makes of sets are selling contracts with only about 10 percent of their new sets, but this figure can run as high as 30 percent for brands where the manufacturer has his own well-

(Continued on page 22)

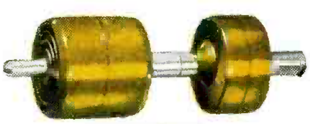


A change to Plaskon Alkyd for its specially designed TV brackets helped Emerson Radio and Phonograph Corp. cut bracket costs 50%, and assured that there would be "no arc over or electrical leakage from the high potential picture tube to the grounded chassis."

TV parts that resist high heat and arcing . . . hold precise dimensions!



TUNERS



CONDENSERS

When your TV parts are molded of Plaskon Alkyd, you can meet the extremely close tolerances demanded in television assemblies. That's because Plaskon Alkyd has exceptional dimensional stability with no after-shrinkage.

And the high heat resistance prevents parts molded of Plaskon Alkyd from breaking down, even under short-time contact with molten solder when connections are made.

What's more, Plaskon Alkyd combines a number of outstanding properties so essential for superior electrical insulating parts: high dielectric strength, superior arc resistance, excellent resistivity. In addition, it can be molded faster and at lower temperatures, giving increased production and greater savings.

Before you redesign, look into the advantages Plaskon Alkyd can offer. Write today for full information on television and electronic uses.

Plaskon Mobile Demonstration Trailer

Fully equipped with molding presses and complete testing equipment. Plaskon technicians will demonstrate right at your door the superiority of parts molded from Plaskon Alkyd over parts you may be using now. Inquire today.

INSIST ON
PLASKON®
ALKYD
FOR SUPERIOR ELECTRICAL PARTS

PLASKON DIVISION
Libbey • Owens • Ford Glass Company
Toledo 6, Ohio
Branch Offices:
Boston • Chicago • Los Angeles • New York
Manufacturers of Molding Compounds, Resin Glues, Coating Resins
In Canada:
Canadian Industries, Ltd. • Montreal, P.Q.

established service organization serving the public.

▶ **Repairs**—Troubles found in tv sets have changed considerably from two years ago.

Tube replacements predominate as quality of components and quality of assembly work improves in factories. Antenna calls go down because people either fix the antennas themselves or let them rot away. False calls, when nothing is found to be wrong, remain the same as ever because people still knock plugs out of wall outlets and still call about interference or transmitter troubles. Capacitor troubles stay low except for certain deep-South humid localities.

The breakdown on service calls now is: picture tubes—5 per cent; other tubes—40; antenna troubles—3; back-of-set controls—15; deficiency in circuit design—2 (same as before); false calls—8; capacitors—7; resistors—7; tuners—6; other components—4; soldered joints—1; realignment—2.

Robots to Control Robots?

TOMORROW'S INDUSTRIAL NEEDS will require robots to control robots . . . machines designed to maintain other elaborate and highly automatic machines. So, at least, thinks J. R. Churchill, Aluminum Company of America official.

The Analytical Division Chief of ALCOA told members of the Scientific Apparatus Makers Association that as electronic and other automatic features are added, new industrial equipment becomes harder to service. Thus still other features that tend to indicate developing faults in advance of failure, and perhaps even correct them, may be needed.

▶ **Reliable Parts Essential**—Churchill said that as the trend toward automatic apparatus develops, makers of industrial gear must refrain from even the occasional use of cheap component parts. Parts designed to stand the gaff of factory use rather than those primarily intended for use in home-entertainment equipment are recommended.

MEETINGS

APRIL 5: Connecticut Valley Section, IRE, University of Connecticut, Storrs, Conn.

APRIL 7–9: Radio Component Show, Grosvenor House, Park Lane, London, W1, England.

APRIL 15–17: AIEE, Southwest District Engineers, Jefferson Hotel, St. Louis, Mo.

APRIL 16–18: Audio-to-Microwaves Symposium, Engineering Societies Building, 33 West 39th St., N. Y., N. Y.

APRIL 19: Cincinnati Section, IRE Spring Technical Meeting, University of Cincinnati, Cincinnati, Ohio.

APRIL 21–24: National Committee of URSI-IRE, National Bureau of Standards, Washington, D. C.

APRIL 23–MAY 3: Ninth Annual British Components Exhibition, Radio-TV Show, Manchester, England.

MAY 2–3: Association for Computing Machinery, Pittsburgh, Pa.

MAY 5–7: Second Government-Industry Conference, sponsored by RTMA, NEMA, AIEE, at National Bureau of Standards, Washington, D. C.

MAY 5–16: British Industries Fair, Earls Court and Olympia, London, England, and Castle Bromwich, Birmingham, England.

MAY 12–14: National Conference on Airborne Electronics, Biltmore Hotel, Dayton, Ohio.

MAY 13: RADIO CLUB of America, Room 502, Engineering Societies Building, New York.

MAY 16–17: Fourth Southwest IRE Conference and Radio Engineering Show, Rice Hotel, Houston, Tex.

MAY 19–22: 1952 Electronics Parts Shows, Exhibition Hall, Stevens Hotel, Chicago, Ill.

MAY 22–24: Electronics Section, Quality Control Convention, Syracuse, N. Y.

MAY 23–24: 1952 Audio Fair, Conrad Hilton Hotel, Chicago.

JUNE 8–12: National Association Electrical Distributors, Ambassador Hotel, Atlantic City, N. J.

JUNE 23–27: AIEE Summer General Meeting, Hotel Nicole, Minneapolis, Minn.

AUG. 12–15: 1952 APCO Conference, Hotel Whitcomb, San Francisco, Calif.

AUG. 27–29: Western Electronic Show and Convention, Municipal Auditorium, Long Beach, Calif.

SEPT. 8–12: National Instrument Conference and Exhibit, Cleveland, Ohio.

OCT. 20–22: Radio Fall Meeting, RTMA Engineering Department, Hotel Syracuse, Syracuse, N. Y.

NOV. 10–30: International Radio and Electronics Exhibition, Bombay, India.

Business Briefs

▶ **Aeronautical Radio Inc.**, widely known for its work on tube reliability for commercial airlines is now working on a government contract to improve the performance and reliability of military tubes. The military, admitting significant early results, are not, yet, however, ready to give out details.

▶ **Small-Boat** radiophone potential is good, with total of 464,000 craft in US and only 28,000 equipped for communication. But even with proposed new allocations between 2 and 3.5 mc, frequency congestion will still restrict the market.

▶ **Business Opportunity** is great for the firm that comes up with a better design for military aircraft 'radomes', the exposed housings that protect warplane radars.

Radomes must not materially affect aircraft performance because of their size, shape, weight or position, nor reduce radar effectiveness because of their electrical characteristics. Above 350 miles per hour certain untreated laminated plastics are damaged by heavy rain in less than a minute. Over 600 mph even more rugged radomes rapidly disintegrate.

▶ **A Contract** for $30 million has been awarded to the New York Shipbuilding Corp., Camden, N. J., by the Navy, to convert two former heavy cruisers, the USS Boston and USS Canberra, into guided missile ships.

▶ **Radio-Frequency** power used by industrial and allied apparatus exceeds the total transmitter power required by all forms of electrical communications, according to FCC statistics.

Speed up analysis with these Brush instruments

Direct-coupled Amplifier
Model BL-932

AMPLIFIES VERY LOW VOLTAGES. The Brush Direct-coupled Amplifier features high sensitivity and low drift. When used in conjunction with the Brush Magnetic Oscillograph, it gives one chart millimeter deflection per millivolt input. Design features reduce effects of power line fluctuation. Zero signal drift not more than one chart millimeter per hour. Frequency response essentially uniform from d-c to 100 cycles.

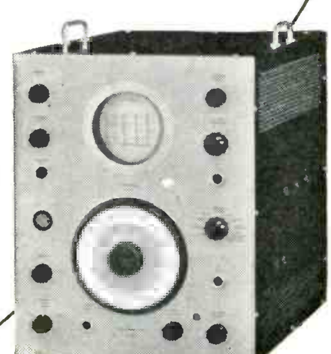
When used with the Brush Magnetic Oscillograph, the Amplifier can be used to record phenomena previously requiring the use of complicated intermediate equipment. Analysis of static or dynamic conditions involving either high or low signal strength is simplified and speeded with this equipment. Below, it is shown recording time constants of a reactor to provide a saturation curve.

PROVIDES IMMEDIATE RECORDING. The Brush Magnetic Oscillograph, used with the proper Brush Amplifier, makes a direct chart recording of physical phenomena which is immediately available. Either direct inking or electric stylus models available. Gear shift provides chart speeds of 5, 25, and 125 mm per second. An auxiliary chart drive is available for speeds of 50, 250, and 1250 mm per hour. Accessory equipment provides event markers where an accurate time base is required, or where it is desirable to correlate events. Photo shows two-channel model for recording of two phenomena simultaneously.

Direct-writing Two-Channel
Magnetic Oscillograph Model BL-202

CHECKS FREQUENCY RESPONSE QUICKLY. The Frequency Response Tracer permits visual examination of frequency response characteristics of radio receivers, amplifiers, transmission lines, filters. Electro-acoustic investigation of loudspeakers, microphones, and telephones can be made. Frequency range is 20 to 20,000 cycles, logarithmic scale. Continuous motor drive scans entire frequency range in 8 seconds.

Write for free copy of Bulletin 618 giving details on these Brush instruments. The Brush Development Company, Dept. K-24, 3405 Perkins Ave., Cleveland 14, Ohio. In Canada: A. C. Wickman Limited, Box 9, Station N, Toronto.



Frequency Response
Tracer Model
BL-4703

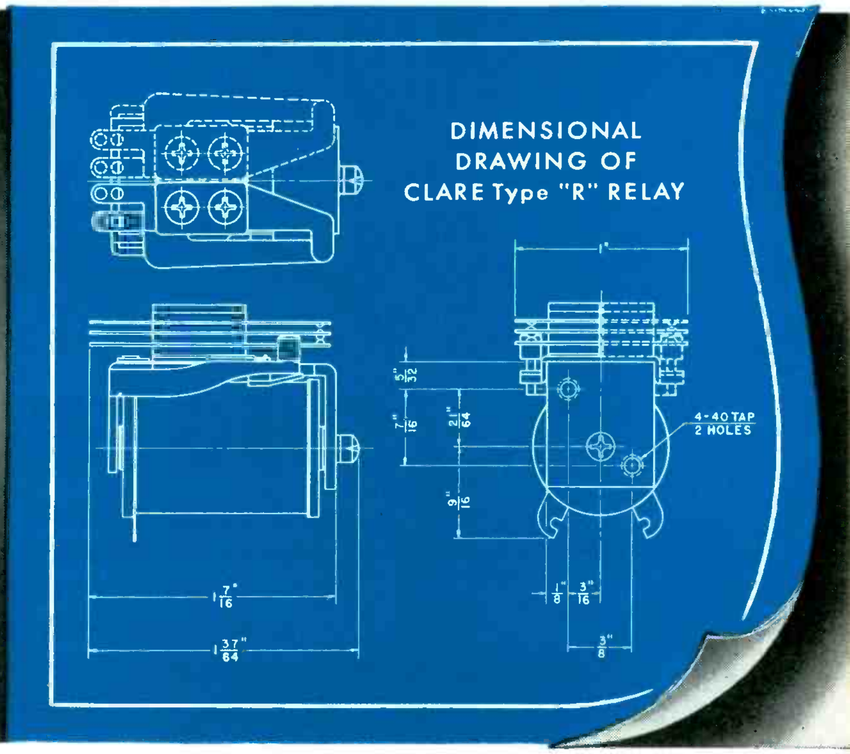
PUT IT IN WRITING WITH A BRUSH RECORDING ANALYZER

THE Brush DEVELOPMENT CO.

PIEZOELECTRIC CRYSTALS AND CERAMICS • MAGNETIC RECORDING
ACOUSTIC DEVICES • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS

A NEW CLARE RELAY...

the Type "R" combines extremely small size with unusual sensitivity and long life



SPECIFICATIONS

SIZE
Length: 1 7/16"—Height: 1 3/64"—Width: 1"

WEIGHT
Approximately 2 ounces

COIL
Single or double-wound

OPERATING VOLTAGE
Up to 230 volts d-c

ARMATURE
Single or double arm

CONTACT ASSEMBLY
Form A to C. Maximum of 10 springs in each pileup.

MOUNTING
Two #4-40 tapped holes in end of heelpiece

This new CLARE Type "R" d-c Relay embodies many features of the famous CLARE Type "K" Relay, which was the first to combine the advantages of a telephone-type relay with the small size, light weight and resistance to vibration required to meet the rigid demands of aircraft service.

In appearance, the Type "R" resembles the Type "K", but, through hardly noticeable structural differences, CLARE has given the new Type "R" even greater sensitivity and operating range. Both relays use the same contact springs, but the Type "R" coil is longer and of larger diameter, to provide greater winding space. Life expectancy of the new relay has been not only increased but multiplied.

The CLARE Type "R" Relay retains in an improved form the reed armature suspension which discerning engineers have come to recognize as one of the subtler reasons for the superior performance of CLARE Type "K" Relays over other relays of comparable size and somewhat similar appearance.

The Type "R" is available as either an open or hermetically sealed relay. Clare sales engineers are located in principal cities to give you firsthand information on this new relay and to cooperate with you on any complex relay problem. Call them or write to C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Write for CLARE Bulletin No. 115

CLARE RELAYS

First in the Industrial Field

FROM GROUND TO AIR OR POINT TO POINT

versatile

Multi-channel -- telegraph Al or telephone A3.

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-13.5 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3 AM. Stability .003% using CR-7 (or HC-6U) crystals. Operates in ambient 0° to + 45° C using mercury rectifiers;-35° to + 45° C using gas filled rectifiers. Power supply, 200-250 volts, 50/60 cycles, single phase. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446 . . . 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

Reg. U. S. Pat. Off.

Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.

Rigid quality control insures same standards in every Multicore reel

Total % flux to solder less than many single cored solders

Thin wall 3-core construction assures flux continuity . . . prevents "dry" joints

Perfect joints on difficult metals & alloys even if oxidized

Contains only Virgin tin & lead Tin—99.75% pure Lead—97.97% pure

Leaves only pure rosin after soldering

Only Multicore has Ersin Flux—high grade water-white rosin, homogeneously activated

Vigorous fluxing action

Non-corrosive even after long exposure to humidity

Conforms with QQ-S-571-b and all other pertinent Federal Specifications.

Wets metal rapidly due to reduced surface tension

Too often in these urgent days, little things like "dry" joints waste precious hours and cause unnecessary rejects.

Ersin Multicore Solder increases the efficiency of your plant, the dependability of your product and the profit in your pocket!

SAVE TIME • SAVE MONEY • PRODUCE MORE
with
MULTICORE—WORLD'S FINEST CORED SOLDER

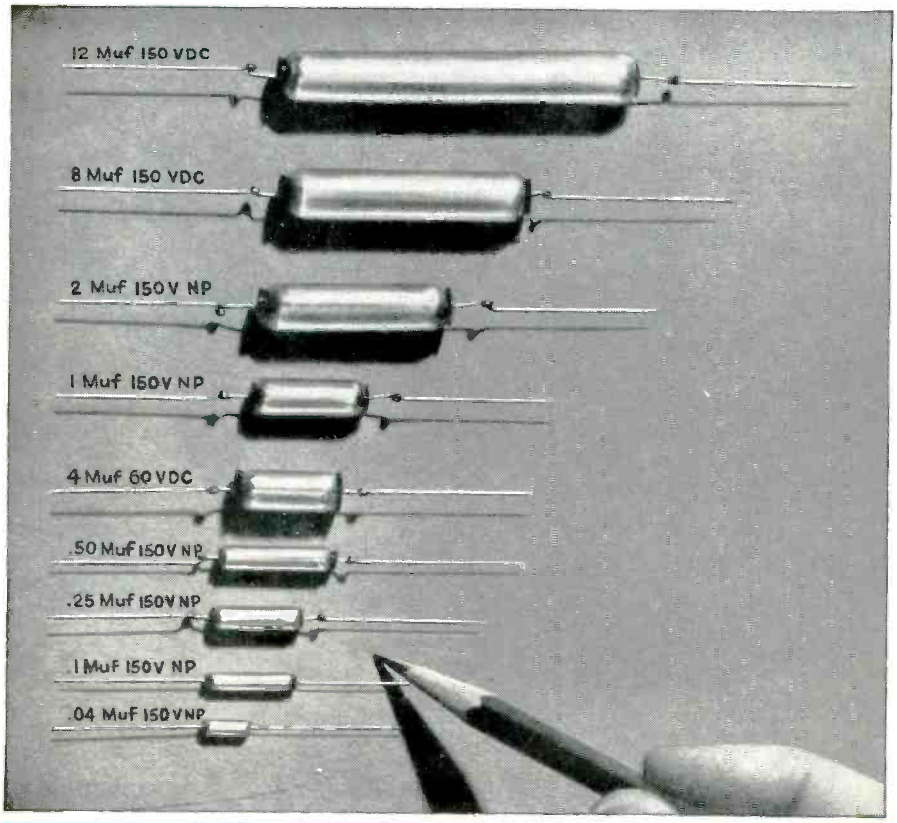
New Edition! FREE—
Valuable booklet "Modern Solders" and testing samples available on request.

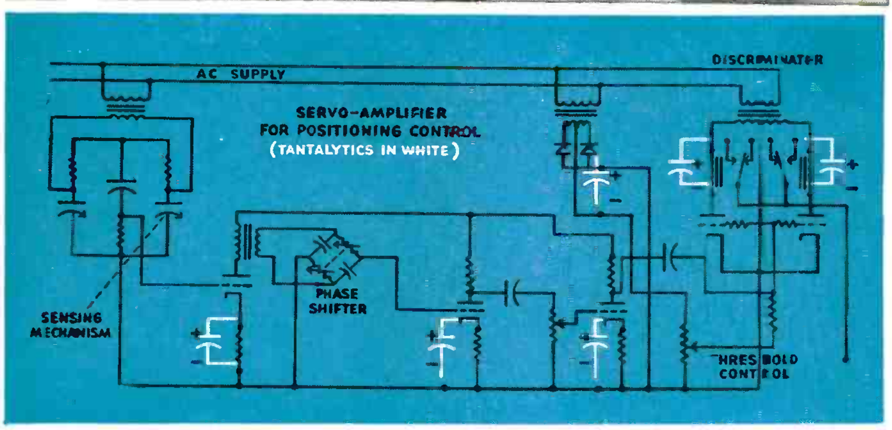
Address U. S. A. and Canadian inquiries to
MULTICORE SALES CORP.
164 Duane Street • New York 13, N. Y.

Inquiries regarding other territories to
MULTICORE SOLDERS LTD.
Maylands Ave. • Hemel Hempstead, Herts., England

DESIGNER'S

FOR SMALL SIZE, SUPERIOR PERFORMANCE IT'S G-E TANTALYTIC CAPACITORS





NEW tantalum-electrolyte units offer excellent low-temperature properties

Superior performance and large capacitance per unit volume make new General Electric Tantalytic capacitors valuable wherever miniaturization is a "must." Designed for low-voltage, direct-current applications, these capacitors excel in low-temperature properties and shock resistance.

Other advantages: Long shelf life • Exceedingly low leakage current • Hermetic sealing • Good stability • Chemically-neutral electrolyte

Operating temperatures range from −55C to +85C, ratings from .02 muf to 12 muf at 150 volts d-c. For further data, send coupon for Bulletin GEA-5753. For specific applications, list temperature range, leakage resistance values, and operating voltage and write *Capacitor Sales Division, General Electric Co., Hudson Falls, N. Y.*

For example: on this gun control system—

Design specifications for the circuit of a gun control servo-amplifier system required capacitors with great stability over a wide temperature range. Airborne equipment was involved, so size and weight were also extremely important. G-E Application Engineers were called in while the design was still on the board. Tantalytic capacitors were recommended because they are small, light, chemically stable. Result: a finished design that meets every requirement.

GENERAL ELECTRIC

667-19

DIGEST

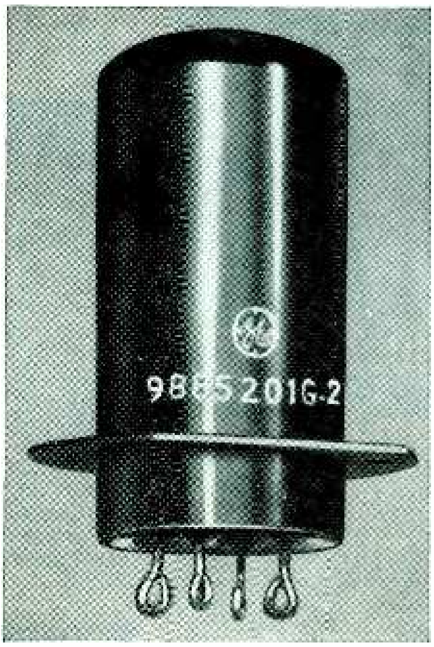
TIMELY HIGHLIGHTS ON G-E COMPONENTS

FOR RELIABLE DC TO AC AMPLIFICATION

NEW Second Harmonic Converter

The new G-E second harmonic converter is a magnetic-amplifier-type unit which converts low-level d-c error signals (such as those generated by thermocouples) to double-frequency AC. Developed for exhaust gas temperature control of jet engines, it's also applicable to control approach systems, industrial measurements, computing devices, and numerous servo mechanisms and electronic control systems.

Designed for use on 400-cycle power (800-cycle output) the converter can be adapted for use on other frequencies by selecting the proper external capacitance. Reliability and long life result from these features: hermetic sealing, static operation, low temperature rise. Write now for full details in Bulletin GEC-832. Then, if you have an application, contact your General Electric Apparatus Representative.



(Actual Size)

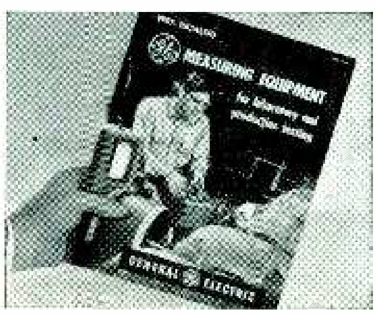
ANTI-BREAKDOWN PROTECTION

NEW Hermetically-Sealed Relay

General Electric's new hermetically-sealed aircraft relay for operation in exposed locations features extra protection against permanent breakdown due to voltage surges. Special polyster compound used to mold contact arms into the stack insulation is non-tracking, provides greater arc resistance. More powerful magnet structure yields higher tip pressures for surety of make. Rated 28 volts d-c, 3 amp. See Bulletin GEA-5729.

125 DEVICES DESCRIBED

NEW Measuring Equipment Catalog



G-E's complete line of measuring equipment for laboratory and production testing is concisely described in this new 80-page reference catalog. Measuring and testing devices include photovoltaic cells, time meters, the current-limited high-potential tester, and dozens of other products. Prices, application information, and condensed tables of important characteristics are all given in this illustrated booklet. Check Bulletin GEC-1016.

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

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

Components

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

Development and Production Equipment

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

Reg. Trade-mark of General Electric Co.

General Electric Company, Section C667-19
Schenectady 5, New York

Please send me the following bulletins:

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

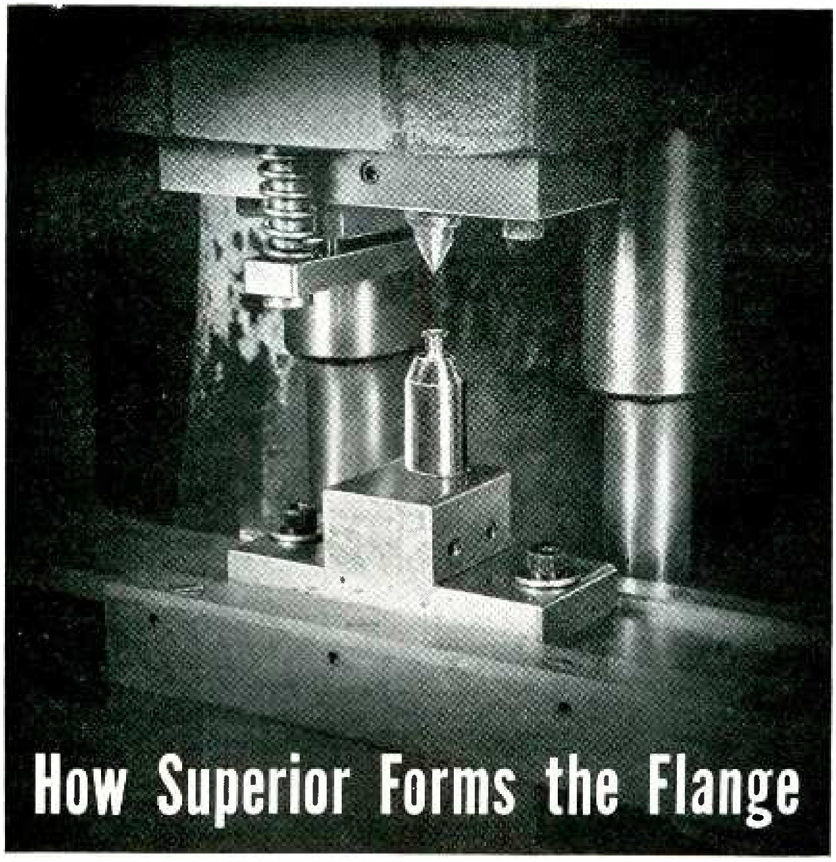
( ) GEA-5729 Hermetically Sealed Relays
( ) GEA-5753 Tantalytic Capacitors
( ) GEC-832 Second Harmonic Converters
( ) GEC-1016 Measuring Equipment

Name ....

Company ....

Address ....

City .... State ....



How Superior Forms the Flange

to give you better tube performance

● What do you expect when you order a tubular part with a flare or flange at one or both ends?

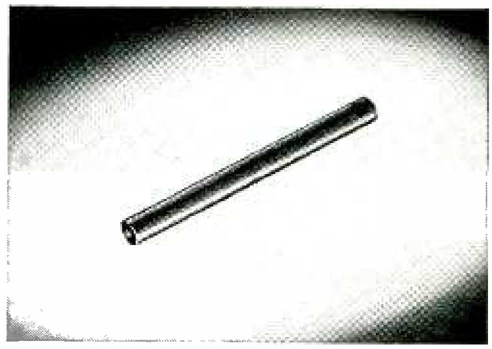
Certainly you expect that the over-all dimensions of the part will be within certain close tolerances. You expect that the flange or flare will be the only distortion in the tube. You want the flange dimensions and the flare angle to be within the limits established in your specification. You must be assured that the worked areas will be free from cracks, pits and breaks. You probably hope that the working has not set up unrelieved stresses to result in premature failure of the part.

When Superior supplies the part, you get all you expect, want and hope for.

This isn't a matter for boasting. The ability to deliver flared and flanged parts to meet these basic requirements is just a part of our job, made possible by our long experience and extensive, highly-developed equipment for performing just such operations.

The rest of our job is in the field of advice, research and development assistance and careful problem analysis to make sure that you have the right metal or alloy for your purpose.

If you are a manufacturer or experimenter in electronics and have need for a tubular part, whether it be a simple cut and tumbled tube, a flared or flanged part, rolled or bent, machined at either or both ends or drilled in one or more places, tell us about it. We can probably help you and we're always glad to do so. Write Superior Tube Company, 2500 Germantown Ave., Norristown, Penna.



Cut and Annealed. Extensive cutting equipment, hand cutting jigs, electronically controlled annealers and other equipment, much of it developed within our own organization, results in high speed, precision production of parts.

Flanging. Automatic flaring and flanging machines are combined in Superior's Electronics Division with carefully trained production and inspection personnel who know how to do a job right and take the time to be sure.

Expanded. Here is a part almost ready for delivery. Simple as it looks, it may well have been the subject of a score of operations and at every stage the prime consideration has been the *quality* of the finished part.

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

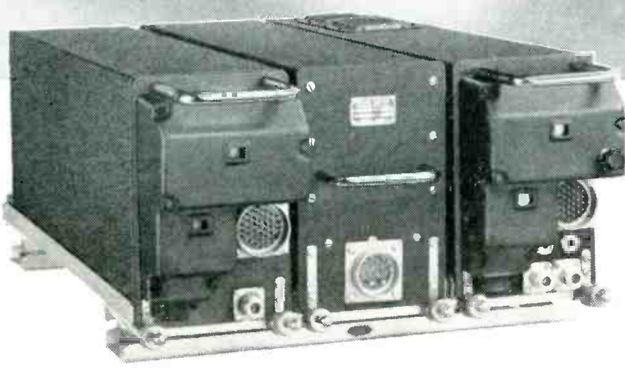
NICKEL ALLOYS FOR OXIDE-COATED CATHODES: This reprint describes the manufacturing of the cathode sleeve from the refining of the base metal; includes the action of the small percentage impurities upon the vapor pressure, sublimation rate of the nickel base; also future trends of cathode materials are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

Superior

THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) Up to 1⅝" O.D.

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



WILCOX ...Choice of EASTERN Air Lines

180 Channel WILCOX Communications System Chosen for Eastern's Entire Fleet of SUPER CONSTELLATIONS and MARTIN 4-0-4's

Eastern Air Lines demanded the finest communications equipment available to match the advanced, efficient operation of their modern new fleet. No greater compliment could be paid to Wilcox radio equipment than to be selected for this challenging assignment.

The Wilcox 440A VHF Communications System covers all channels in the 118-136 Mc. band. It is light in weight, small in size, and easy to maintain.

UNIT CONSTRUCTION FOR EASY HANDLING

The 50-watt transmitter, high sensitivity receiver, and compact power supply are each contained in a separate JAN AI-D case. Any unit may be instantly removed from the common mount.

FINGER-TIP REMOTE CONTROL

All transmitter and receiver functions are available by remote control. A new channel selector system assures positive operation and minimum maintenance.

DEPENDABILITY AND EASY MAINTENANCE

Simple, conventional circuits minimize the number and types of tubes and require no special training, techniques, or test equipment.

Write Today FOR COMPLETE INFORMATION ON THE WILCOX 440A 180 CHANNEL VHF COMMUNICATIONS SYSTEM

WILCOX ELECTRIC COMPANY

FOURTEENTH AND CHESTNUT — KANSAS CITY 1, MISSOURI, U.S.A.

Let's analyze the three R's of the
ELECTRONICS BUYERS' GUIDE

Over a period of many years the "GUIDE" has built the value of these three R's, both to users and advertisers. Designed originally to meet the exacting needs of this science industry, it has, through years of experience and penetration in the field, approached an unparalleled accuracy in meeting those needs. In the proof that only wide and accepted usage gives, the validity and value of these three R's have been established.

Reliability...

TO USERS OF THE "GUIDE"

To busy engineers, designers and countless other men of varied titles, the "GUIDE" quickly and accurately serves their needs for product source and data. Time and time again through the years they have used it and have learned to rely on it as an unvaryingly accurate source to meet their highly specialized needs.

TO ADVERTISERS

This reliance on the part of subscribers (more than 31,000) brings to the advertiser an assurance of readership that can be achieved in no other way. Usage* of a directory is the only measure of its value as an advertising medium. Advertising pages of the "GUIDE" are constantly referred to for the detailed product information they contain. Advertising dollars do a year-round job in the "GUIDE".

**Unbiased, outside surveys consistently prove industry wide usage of the ELECTRONICS BUYERS' GUIDE. Details gladly supplied upon request.*

Recognition...

The "GUIDE" has justly earned its place on electronic bread boards and in general industry wherever electronic circuitry plays its important part. It has earned this place through recognition of its accuracy and completeness – through its method of product listing that saves precious time – through the complete verification process every product goes through before it can be listed. Its authenticity is thoroughly recognized and engineers just naturally reach for it to find the information they need.

This recognition is a valuable asset to every advertiser within its pages. It means a great deal more than an individual company's recognition or product recognition – that is one of the inherent qualities of "GUIDE" listings. To the individual company, this recognition means readership of its product story by keyed reference to advertising pages in the listings. And in addition to product recognition, it brings product selection – and that invariably means a sale.

Results...

Depending upon the users' requirements, be he engineer, designer, purchasing agent, maintenance or production man, the results are direct information on the most complete and verified source of supply, or if detailed data are necessary, they are quickly found in the advertising section. Those are the sure results – and the reasons why the "GUIDE" is universally used throughout the electronic industry and by those utilizing industrial electronic equipment.

To the advertiser, there is only one result we want to talk about – and that is sales – and more sales. Sure, there is recognition to be gained, both company and product-wise, but they, however important, are intangible. We are talking about the hard, solid stuff. *Increased sales* – the sort of thing that pays off. You get them by advertising in the "GUIDE". Ask any of the hundreds who have consistently used its pages, and you will get the answer . . .
INCREASED SALES – NEW CUSTOMERS.

electronics

ANNUAL BUYERS' GUIDE ISSUE

--the reference book

THROUGHOUT INDUSTRY WHEREVER ELECTRONIC

THE ONLY *Completely Verified* LISTING OF MANUFACTURERS OF ELECTRONIC AND ALLIED PRODUCTS

V

the symbol that served its purpose

TO BE OMITTED IN THE 1952 ISSUE

For the past two years the above symbol was used with listings when manufacturers had, by the proof they submitted, earned this verification.

As a result, 94% of the 1951 listings were verified. This year the symbol will be omitted, as *all* products will be verified before listing. The same proof will be required and only those companies furnishing it will have their products listed. The symbol served its purpose well and opened the way to a 1952 Completely Verified ELECTRONICS BUYERS' GUIDE.

Ordinary methods of questionnairing for product listings in a directory are quite often misconstrued and lead to inaccuracy which, although not intentional, are nevertheless extremely annoying to users.

Two years ago, the ELECTRONICS BUYERS' GUIDE created this verification symbol to clear up any confusion. Listings, in order to receive this symbol had to submit proof of product availability and unrestricted use. The idea met with approval by both advertisers and users, and in last year's issue the listings were 94% verified — definite proof that at last the "GUIDE" was approaching complete accuracy.

This year's issue will be completely verified, but without use of the symbol. The same proof will be required and no company's products will be listed without it. The listings will, therefore, provide users with the ultimate that a directory can achieve . . . a completely verified source of supply with the largest number of products listed (almost 400% greater than available in any other directory).

Consider these valuable "exclusives" in the "GUIDE"

ELECTRONICS CUMULATIVE INDEX

Lists by title, subject and author all articles published in ELECTRONICS from January 1940 to December 1949. The first 10 years were published in last year's issue. Reprints of entire 20 years soon available.

TRADE NAME LISTING

Contains 3,223 trade names, also the manufacturers', as an aid to users who know trade names, but not manufacturers.

DISTRIBUTORS LISTING

The only list of distributors that is broken down by states. Contains 843 firms for quick and easy reference.

EASY-TO-FIND LISTINGS

As simple as a telephone book — all in one section, alphabetically arranged, and amply cross-sectioned to include all known terminology.

THEY'RE BUYING
when
THEY'RE DESIGNING
and that's when the
BUYERS' GUIDE
DOES YOUR SELLING

Electronics, because of its exacting nature, necessitates every piece of equipment, from an electron tube to a fastener, being specified by manufacturer, type and number. Substitutes, if any, can only be made on consultation with the design engineer, who again becomes the determining factor. Though purchase orders emanate from various sources, the engineers are, in fact, the originators of all purchases. And they must be reached at the right time — when they are at work designing and specifying.

ABC · A McGRAW-HILL PUBLICATION • 330 W. 42nd ST., NEW YORK 36, N. Y. · ABP

COMPONENTS EQUIPMENT AND ALLIED PRODUCTS ARE USED

CONDENSED DATA ON THE 1952-1953 ELECTRONICS BUYERS' GUIDE

CIRCULATION: The ELECTRONICS Buyers' Guide will have the same large and selective circulation as the regular issues of ELECTRONICS. According to the June 1951 ABC Statement ELECTRONICS Total Net Paid Circulation was 30,974. In addition there's a pass-on readership of approximately 120,000. No other publication in the electronic field begins to approach this full coverage of the men who buy and influence the purchase of electronic components, equipment, and allied products.

PENETRATION INTO INDUSTRY: The large, selective circulation of the Buyers' Guide means industry penetration that can't be equalled in the field . . . penetration on a wide industry front giving complete horizontal coverage, as well as deep penetration to the men who influence and buy in every major company. Ask an ELECTRONICS representative to show you "Examples of ELECTRONICS' PENETRATION THROUGHOUT INDUSTRY" for complete proof that you'll reach the men you want to influence in the Buyers' Guide.

PRODUCTS ADVERTISED: Products advertised include a full line of communication equipment, industrial electronic equipment, components, measuring equipment, and allied products . . . the same products for which we list product sources in our comprehensive Index. Electronic engineers design-in many products which are not, strictly speaking, "electronic" but which are, nevertheless, essential parts of complete circuits. These engineers use the Buyers' Guide for sources and specifications of all products entering into the design of electronic circuits.

RATES: Advertisers will be entitled to the rate earned in 12 regular issues of ELECTRONICS or to the rate they earn in the Buyers' Guide, whichever is most advantageous. Space used in the Buyers' Guide will not help earn a rate in the regular issues of ELECTRONICS. But the rate earned in the regular issues will determine the rate for the Buyers' Guide issue.

MECHANICAL REQUIREMENTS

	Width	Depth	Width	Depth
1 page	7	10	....	....
2/3 page	4-9/16	10	....	....
1/3 page	4-9/16	4-7/8	2-3/16	10
1/6 page	4-9/16	2-5/16	2-3/16	4-7/8

Page is 3 columns, each column 2 3/16 inches wide.
Composition—no charge.
Halftone screens—all halftones should be 100-110 line screen. They should be etched to the depth of .003 of an inch in the highlights, .002 of an inch in the middle tones, and .0015 of an inch in the shadows. Typographical rights reserved.

COLOR AND BLEED: A A A A standard colors: yellow, orange, red, blue, and green, $110 per page for any one color. Special matched color $130 per page for any one color. Rates for metallic inks and more than one extra color quoted on request.

Bleed pages: per page, extra $85.00. Plate size 8 3/8 inches by 11 1/2 inches, which allows 1/8 inch additional at top, bottom, and outer edge for trim. Keep essential elements 3/8 inch within plate size. Trim size 8 1/4 inches by 11 1/4 inches.

INSERTS (Letter Press): Regular space rates apply on complete inserts which are ready for binding when received. Before making plates or ordering printing please check with your local ELECTRONICS representative as to number of pages, quantity required, trim size. Maximum acceptable weight 100 lb. coated 25 inches by 38 inches basis, or equivalent. See closing dates below.

INSERTS (Offset): Inserts prepared by our Copy Service Department can be produced by photo offset at a saving in production costs to the advertiser. If the advertiser desires reprints of his advertisement, the offset method will have the additional advantage of permitting us to supply him with preprints rather than reprints. See closing dates below.

REPRINTS: Regular run of book stock will be used unless special stock is supplied by the advertiser. For information on the cost of reprints consult your local ELECTRONICS representative.

COPY SERVICE: Copy and layout service by specialists in the catalog type of presentation best adapted to this type of issue is available at a moderate cost to all advertisers and advertising agencies. Complete details including all product data, availability of photographs, cuts, choice of color, if color is being used, etc. should be in our nearest district office not later than March 10th. It is to the distinct advantage of each advertiser to get all the information in the hands of our copy department as soon as possible in order that careful and individual attention can be given to the presentation of his advertisements.

CLOSING DATES

Copy to prepare: All details must be in our New York Office not later than March 15th. Layout and copy sent to the advertiser for his OK and also final proofs.

Copy to set . . . April 1st. If no proof required . . . April 10th
Complete plates . . . . May 1st
Inserts . . . . May 25th

ADVERTISERS' NAMES BOLDFACED IN DIRECTORY SECTION: Advertisers in the Buyers' Guide will have their names boldfaced in the product listing section and reference will also be made to the page number(s) on which their advertisements appear. This permits the engineer seeking product information the two vitally important elements of the Guide — namely, 1. Where he can buy it. and 2. Technical data, when he turns to the page to which he is referred. And that is all he needs in order to specify or buy. The non-advertiser doesn't get this opportunity to sell his products.

FOR FURTHER DETAILS WRITE OR PHONE YOUR NEAREST McGRAW-HILL REPRESENTATIVE

NEW YORK
Donald H. Miller – James Girdwood
330 W. 42nd St., Longacre 4-3000

LOS ANGELES
Carl W. Dysinger
1111 Wilshire Blvd., Madison 6-4323

CHICAGO
Charles D. Wardner
520 North Michigan Ave., Whitehall 4-7900

DALLAS
James H. Cash
First Nat'l Bank Bldg., Prospect 7-5064

NEW ENGLAND
William S. Hodgkinson
1427 Statler Bldg.,
Boston 16, Hubbard 2-4911

SOUTH
Ralph C. Maultsby
1311 Rhodes-Haverty Bldg.
Atlanta 3, Ga., Walnut 5778

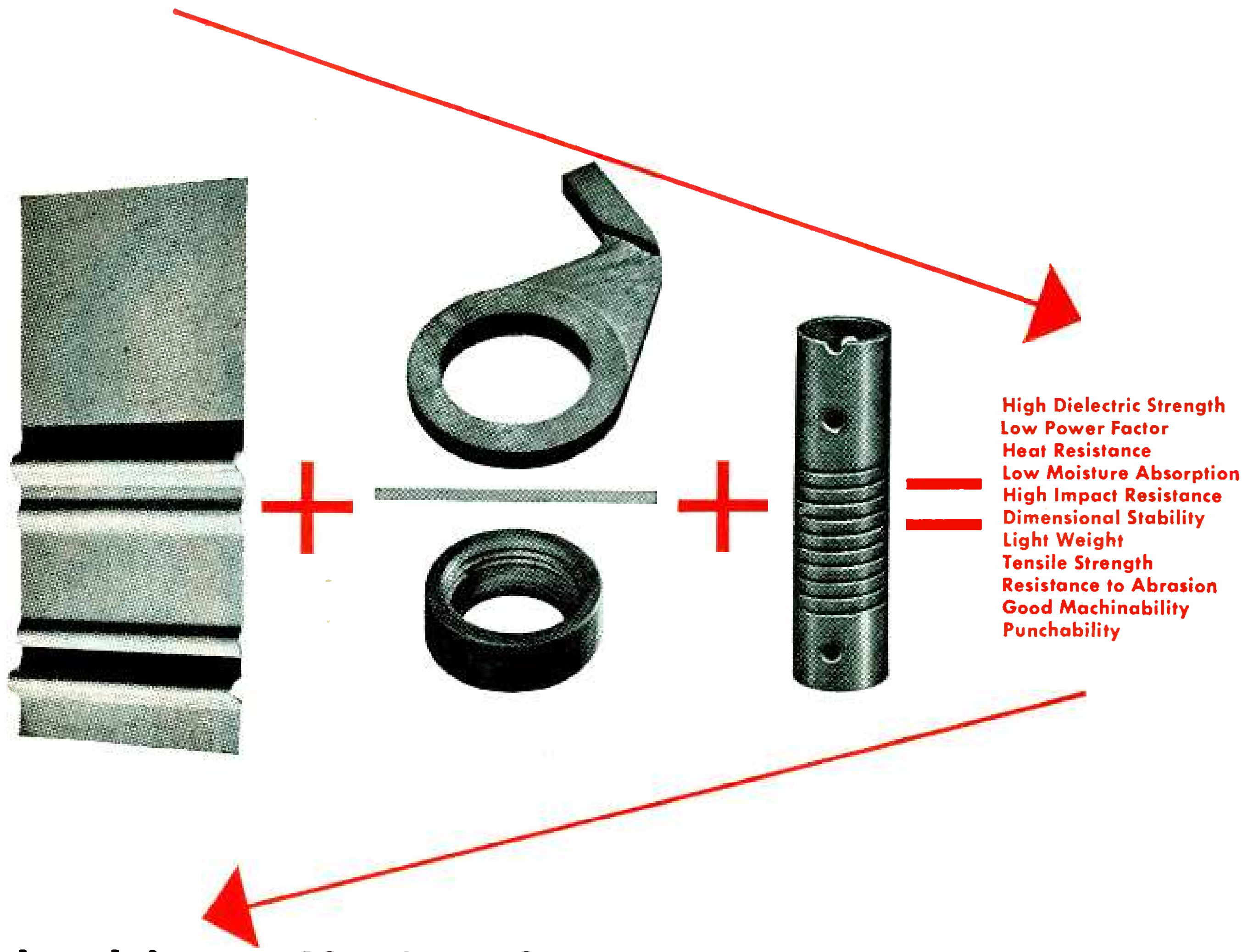
CLEVELAND
James L. Phillips
1510 Hanna Bldg., Superior 1-7000

SAN FRANCISCO
T. H. Carmody—R. C. Alcorn
68 Post St., Douglas 2-4600

PHILADELPHIA
Warren W. Shew
Architects Bldg., 17th and Sansom Sts.
Rittenhouse 6-0670

electronics

ABC • A McGRAW-HILL PUBLICATION • 330 WEST 42nd STREET, NEW YORK 36, N. Y. • ABP



the right combination of properties can be "custom-built" with Lamicoid®

LAMICOID (a thermosetting plastic laminate) is remarkably versatile and adaptable. Almost any characteristic, in any combination, can be built into LAMICOID by the use of fillers such as glass, nylon, fabric, paper, etc., with a variety of synthetic resins.

This versatility and adaptability has been proved in such products as tube socket supports, coil forms, dials, name-plates, antenna parts, motor and transformer parts, and switch gear and relay parts. In thousands of cases, LAMICOID is providing the practical solution to material shortages . . . and bringing about savings and product improvement, too.

Take advantage of LAMICOID's "custom-built" personality. Investigate the advantages it offers *your* product. LAMICOID can be supplied in standard sheets, rods and tubes or fabricated into parts to your specifications. Our 58 years of experience in developing and producing electrical insulating materials is at your service. Send your blueprints and specifications today for a prompt quotation.

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

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

Achievement!

a NEW Eimac tube

4PR60A

Pulse Modulator Tetrode

ACTUAL SIZE

THIS IS THE EIMAC 4PR60A!

Powerful . . . rugged . . . compact . . .

designed and built for outstanding performance in pulse-modulators, including airborne and marine radar. The 4PR60A is a power tube in every respect. It will handle up to 360 kilowatts and withstand 200G shock and strong vibration . . . physically no larger but more powerful than the 715C and 5D21 which it unilaterally replaces.

NEW concepts in tube design and manufacture have made the 4PR60A another Eimac achievement in the field of electronics. Cylindrical electrodes integrally mounted on a rugged moulded-glass header provide mechanical stability never equalled in older designs. The unique cathode with its reserve emission capabilities, the Pyrovac plate, freedom from gas . . . all these features make this new Eimac tube outstanding among pulse-modulator types.

Remember . . . Characteristics of Eimac tubes are firmly established by exhaustive testing under rigorous conditions in our laboratory.

- *Maximum ratings and other operational characteristics for this new tetrode are available from the Eimac Field Engineering Department.*

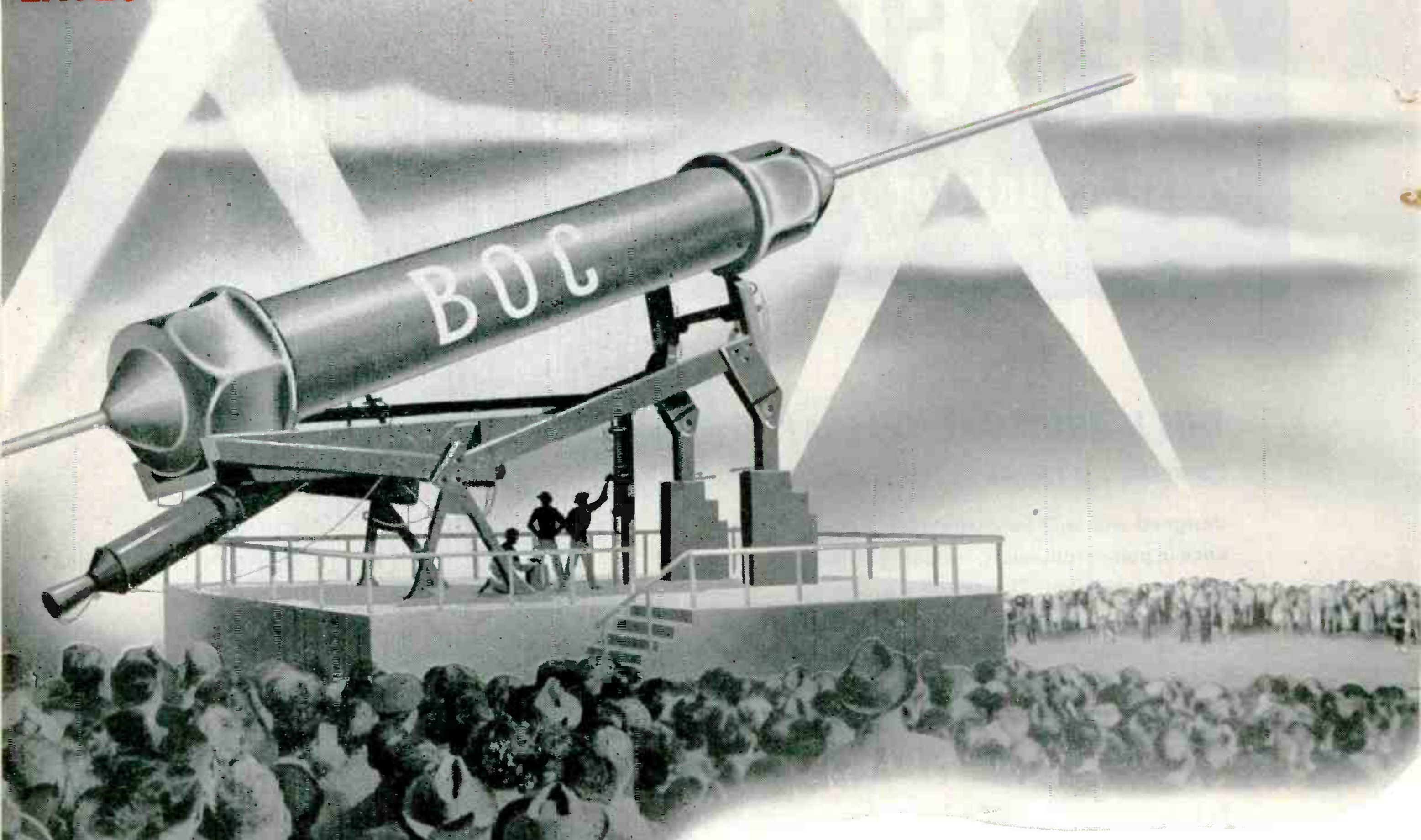
Follow the Leaders to Eimac Tubes

311

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

New developments are essential in resistors, too!

IRC LAUNCHES NEW BORON-CARBON RESISTOR (Type BOC)
LATEST DEVELOPMENT IN STABLE FILM-TYPE RESISTORS



- Reduces temperature-coefficient of conventional deposited carbon resistors . . .
- Provides high accuracy *and* long-time stability...
- Replaces high value wire wound precisions at savings in space and cost!

NO LONGER A LABORATORY ITEM. NOW FULLY AVAILABLE THROUGH IRC'S MASS PRODUCTION TECHNIQUES AND QUALITY CONTROL.

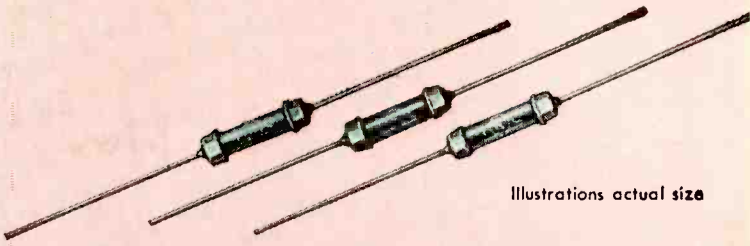
Here's a completely new tool for electronic and avionic engineers — one that's going to make possible higher stability circuits with smaller components. IRC's new Type BOC Boron-Carbon Resistor promises tremendous advantages in military electronic equipment such as gunfire control, radar, communications, telemetering, computing and service instruments. Heretofore strictly a laboratory item, Type BOC is now available to equipment manufacturers. Be sure you get full details.

TYPE BOC BORON-CARBON ½-WATT RESISTOR

Stability and high accuracy under widely varying temperatures make Type BOC Boron-Carbon Resistors ideal for a host of critical circuitry needs. Greatly improved temperature coefficients of resistance permit its use in place of costlier wire wound precisions in many applications. Small size makes it invaluable where limited space is a problem. And lower capacitive and inductive reactance allows it to be used in many circuits where the characteristic of wire wounds cannot be tolerated.

The characteristics of Type BOC have been designed to meet Signal Corps Specification MIL-R-10509.

IRC Boron-Carbon Resistors are particularly recommended for:—Amplifiers and computer circuits requiring better resistance-temperature characteristic and stability than those of carbon compositions or deposited carbons . . . Voltmeter multipliers, divider circuits, bridge circuits, decade boxes, requiring unusual accuracy and stability **with** economy . . . High frequency tuned circuit loading resistors, terminating resistors, etc., requiring wire wound resistor stability **without** undesirable high inductive and capacitive reactance.

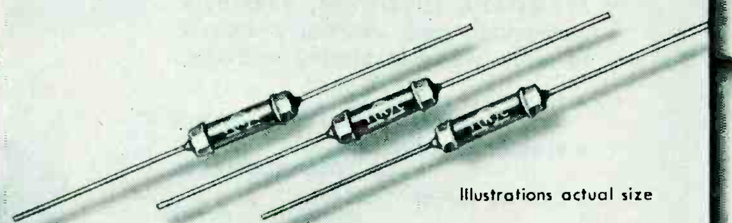


Illustrations actual size

Tolerance—1%, 2% and 5%. **Resistance values**—10 ohms to ½ megohm. Full technical data contained in Catalog Data Bulletin B-6. Mail coupon for your copy.

Parts per Million Change in Resistance per °C temperature				
Resistance Value	Type BOC	Type DCC	Nichrome	Advance Karma Evenohm
10 ohms	50	—	170	20
100 ohms	80	280	170	20
1000 ohms	100	310	170	20
10,000 ohms	100	330	170	20
.1 megohm	150	350	170	20
1.0 megohm	200	400	170	20

Latest small size addition to IRC's famous Deposited Carbon PRECISTOR line



Illustrations actual size

IRC TYPE DCC (DEPOSITED CARBON) HIGH-STABILITY RESISTORS

The ultimate in non-wire-wound accurate resistors, Type DCC has been developed to meet the latest needs of modern electrical and electronic circuits. Conservatively rated at ½-watt, it combines accuracy and economy with high stability, low voltage coefficient, and low capacitive and inductive reactance in high frequency applications.

Especially recommended for: — Circuits in which characteristics of carbon compositions are unsuitable and wire wound precisions are too large or too expensive . . . Metering and voltage divider circuits requiring high stability and close tolerance . . . High frequency circuits demanding accuracy and stability, but where wire wound resistors are unacceptable. **Tolerance**—1%, 2%, 5%. **Resistance values**—100 ohms to 2 megohms. Designed to meet Signal Corps Specification MIL-R-10509. Send coupon for complete technical information in Catalog Bulletin B-7.

Type DCC ½ Watt • Type DCF 1 Watt • Type DCH 2 Watts • Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes

IRC

Wherever the Circuit Says —\/\/\/

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad Street, Philadelphia 8, Pa.

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

INTERNATIONAL RESISTANCE COMPANY
403 N. Broad St., Philadelphia 8, Pa.

Please send me complete information on items checked below:—

☐ Type BOC Boron-Carbon Resistors
☐ Type DCC Deposited Carbon Resistors

NAME____________________
TITLE____________________
COMPANY____________________
ADDRESS____________________
CITY__________ZONE________STATE________

improve your product with –

MYCALEX

THE OUTSTANDING
LOW LOSS
HIGH FREQUENCY
INSULATION
FOR OVER
A QUARTER OF
A CENTURY

MYCALEX is a highly developed glass-bonded mica insulation backed by a quarter-century of continued research and successful performance. Both pioneer and leader in low-loss, high frequency insulation, MYCALEX offers designers and manufacturers an economical means of attaining new efficiencies, improved performance. The unique combination of characteristics that have made MYCALEX the choice of leading electronic manufacturers are typified in the table for MYCALEX grade 410 shown below. Complete data on all grades will be sent promptly on request.

MYCALEX is efficient, adaptable, mechanically and electrically superior to more costly insulating materials

- PRECISION MOLDS TO EXTREMELY CLOSE TOLERANCE
- READILY MACHINEABLE TO CLOSE TOLERANCE
- CAN BE TAPPED THREADED, GROUND, SLOTTED
- ELECTRODES, METAL INSERTS CAN BE MOLDED-IN
- ADAPTABLE TO PRACTICALLY ANY SIZE OR SHAPE

MYCALEX is available in many grades to exactly meet specific requirements

CHARACTERISTICS OF
MYCALEX GRADE 410

Meets all the requirements for Grade L-4A, and is fully approved as Grade L-4B under Joint Army-Navy Specification JAN-I-10

Power factor, 1 megacycle	0.0015
Dielectric constant, 1 megacycle	9.2
Loss factor, 1 megacycle	0.014
Dielectric strength, volts/mil	400
Volume resistivity, ohm-cm	1×10^{15}
Arc resistance, seconds	250
Impact strength, Izod, ft.-lb/in. of notch	0.7
Maximum safe operating temperature, °C	350
Maximum safe operating temperature, °F	650
Water absorption % in 24 hours	nil
Coefficient of linear expansion, °C	11×10^{-6}
Tensile strength, psi	6000

MYCALEX is specified by the leading manufacturers in almost every electronic category

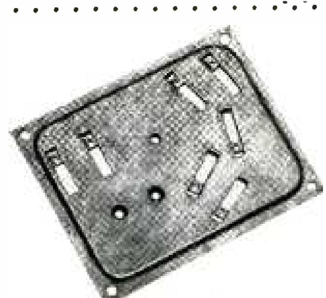
Mycalex 410
Tuning Coil Form

Mycalex 410
Tuning Switch Plate

Mycalex 410 Terminal Base
and Cap Assembly for
Fire Detection Equipment

Mycalex 410
Rotary Switch Stator

Mycalex 410
Solenoid Type Coil Form



Mycalex 410
Tuning Stator Plate

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG US PAT OFF

MYCALEX CORPORATION OF AMERICA

Owners of 'MYCALEX' Patents and Trade-Marks

Executive Offices: 30 ROCKEFELLER PLAZA, NEW YORK 20 — Plant & General Offices: CLIFTON, N.J.

"This extra r-f stage that gives quality reception... how can we have it economically in our new TV set?"

Good news

FOR COST-HARRIED U-H-F DESIGNERS

NOW . . . a brand-new r-f amplifier for ultra-high reception at *one-sixth* the cost of other suitable tubes for the purpose! And G.E.'s 6AJ4 saves you still more! Single-ended construction slashes circuit expense, compared with the coaxial circuits for other u-h-f types.

FOR THE FIRST TIME at a mass-production figure, you can build into your new u-h-f receiver the deluxe features of (1) low noise level, with freedom from snow, (2) minimum radiation interference with other television sets, (3) high selectivity. You can pioneer a u-h-f receiver that will sell and SELL in fringe areas!

PROOF lies in the 6AJ4's high signal gain (see ratings), its improved noise factor over crystal mixer alone, and the 30-db-and-up attenuation which the tube adds between oscillator and antenna.

JUST OFF THE PRESS: descriptive bulletin ETD-520. Wire or write for it today! *Tube Department, Section 13, General Electric Company, Schenectady 5, New York.*

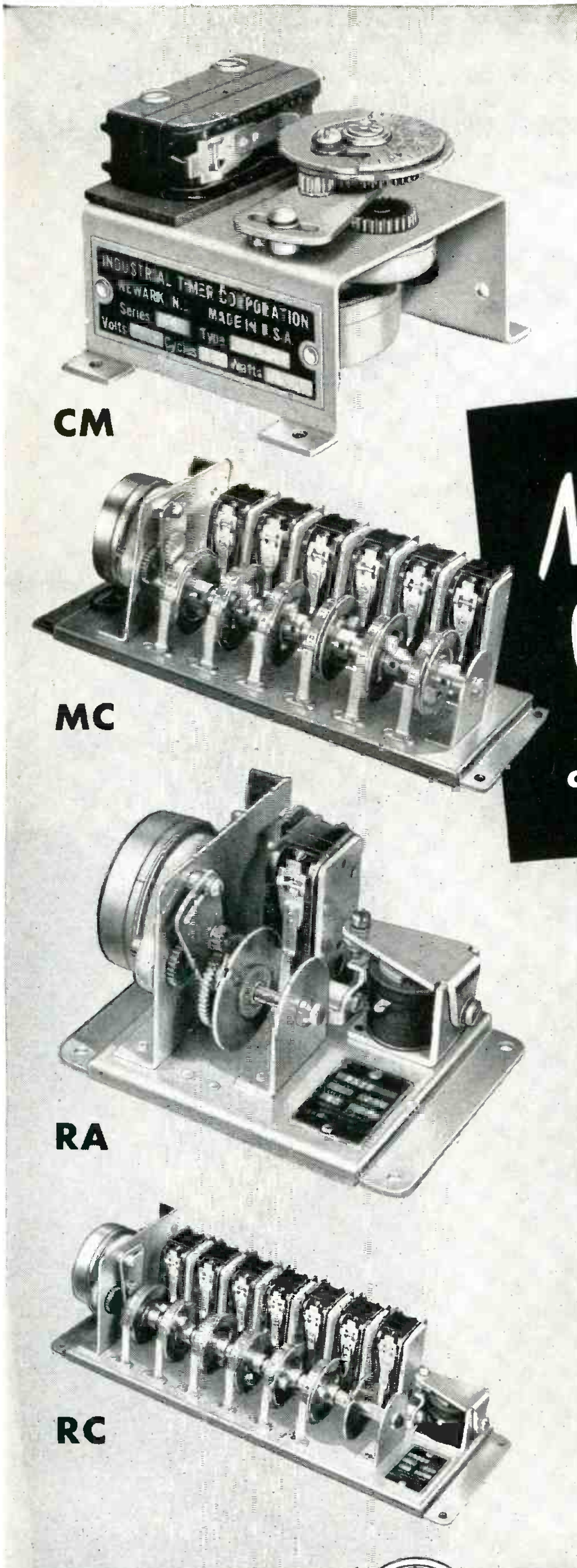
6AJ4

9-pin miniature u-h-f r-f amplifier

Amplification factor	45
Transconductance	10,000 micromhos
Plate current	15 ma
Power gain at 900 mc, for 10-mc band width	7 db
Noise factor at 900 mc	15 db

GENERAL ELECTRIC

162-1A2



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

OUTSTANDING FEATURES ARE:

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

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

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

New! Synchronous Motor Driven CAM TIMERS

for single cycle and continuous recycling applications

Series CM CAM RECYCLING TIMERS

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

Series MC MULTI-CAM TIMERS

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

Series RA SINGLE CYCLE CAM TIMERS

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

Series RC SINGLE CYCLE MULTI-CAM TIMERS

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

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

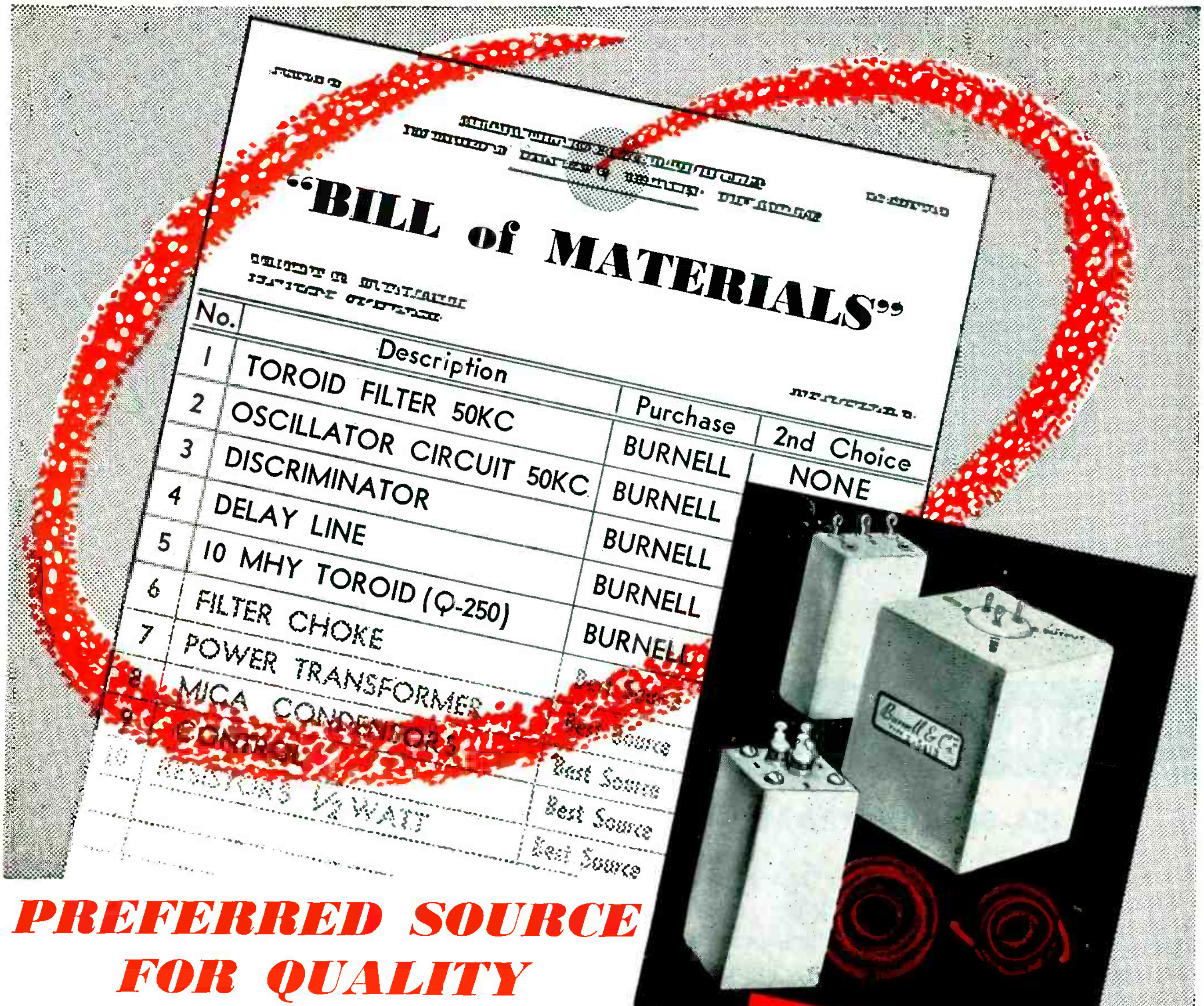
MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY— Time Delay Timers • Manual Set Timers • Tandem Automatic Recycling Timers • Running Time Meters • Instantaneous Reset Timers

Timers that Control the Pulse-Beat of Industry

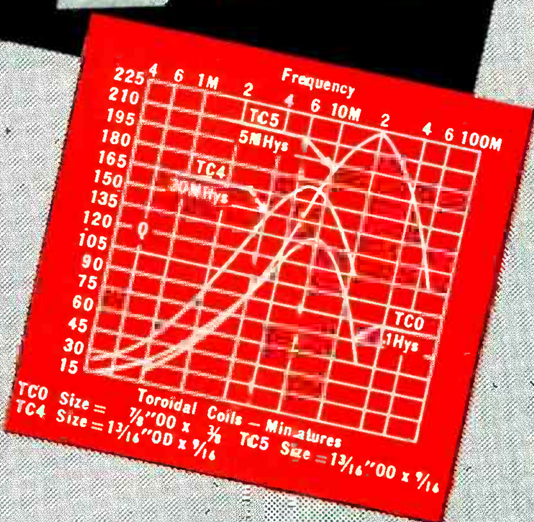
INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION

115 EDISON PLACE, NEWARK 5, N. J.



PREFERRED SOURCE FOR QUALITY TOROIDS & FILTERS



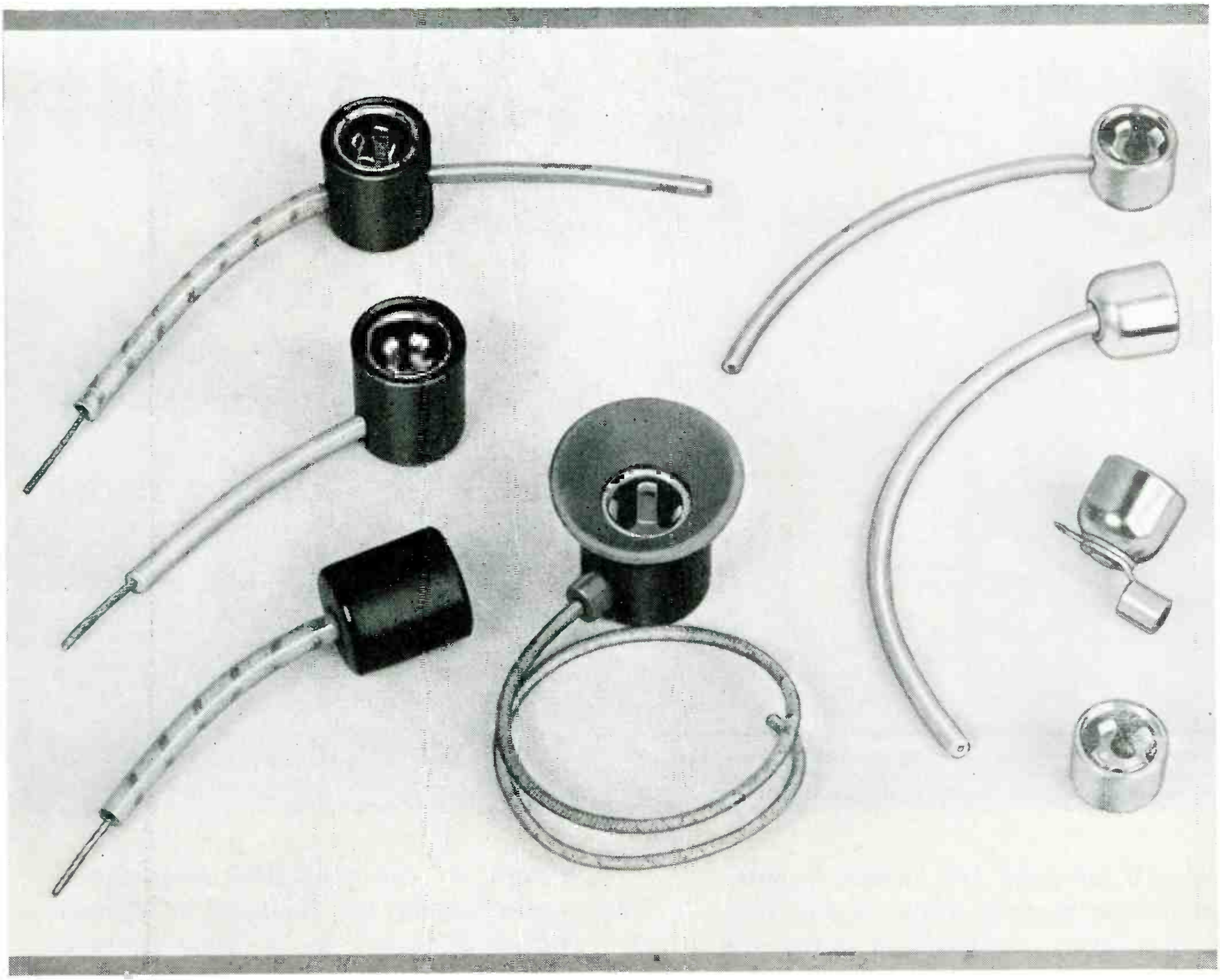
For every "Burnell" toroid or filter specified in the bill of materials for Electronic equipment, we chalk up another credit for our "Burnell Customer Service."

In this highly specialized and technical field, individual attention to the customer's problem assures him of obtaining the best filter for his application. It is the job of our engineering sales department to thrash out every detail of the customer's problem until it is sure that the specifications will guarantee correct performance.

The next step would be to choose from our file of thousands of designs, one which meets the requirements. In many instances, of course, it is necessary to create an original design but *at no extra cost to the customer*. In either case, we can state unequivocally, that the result is invariably one of customer satisfaction. This is why Burnell has been the "preferred source" with so many engineers.

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"



Tube Caps... TO YOUR SPECIFICATIONS

Basic cap available in two sizes — 1/4" and 3/8". Outer shell curled for resistance to corona at high voltage . . . spring clip made of resilient carbon steel, withstands repeated insertions. Entire assembly firmly eyeletted together.

Special caps available . . . with lug for strain relief or assembly to shaft of capacitor . . . top openings or single and double side openings. Color, coding, size and length of wire to customer's specifications.

Also available . . . caps insulated with shell of general purpose phenolic. Special design for critical military applications has reinforced spring and silicon rubber jacket for high altitude, high voltage conditions.

* * * *

Complete engineering and volume production facilities for all types of metal stampings, including the facilities for the assembly of metal to plastic or ceramic components.

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

The UCINITE CO.

Newtonville 60, Mass.

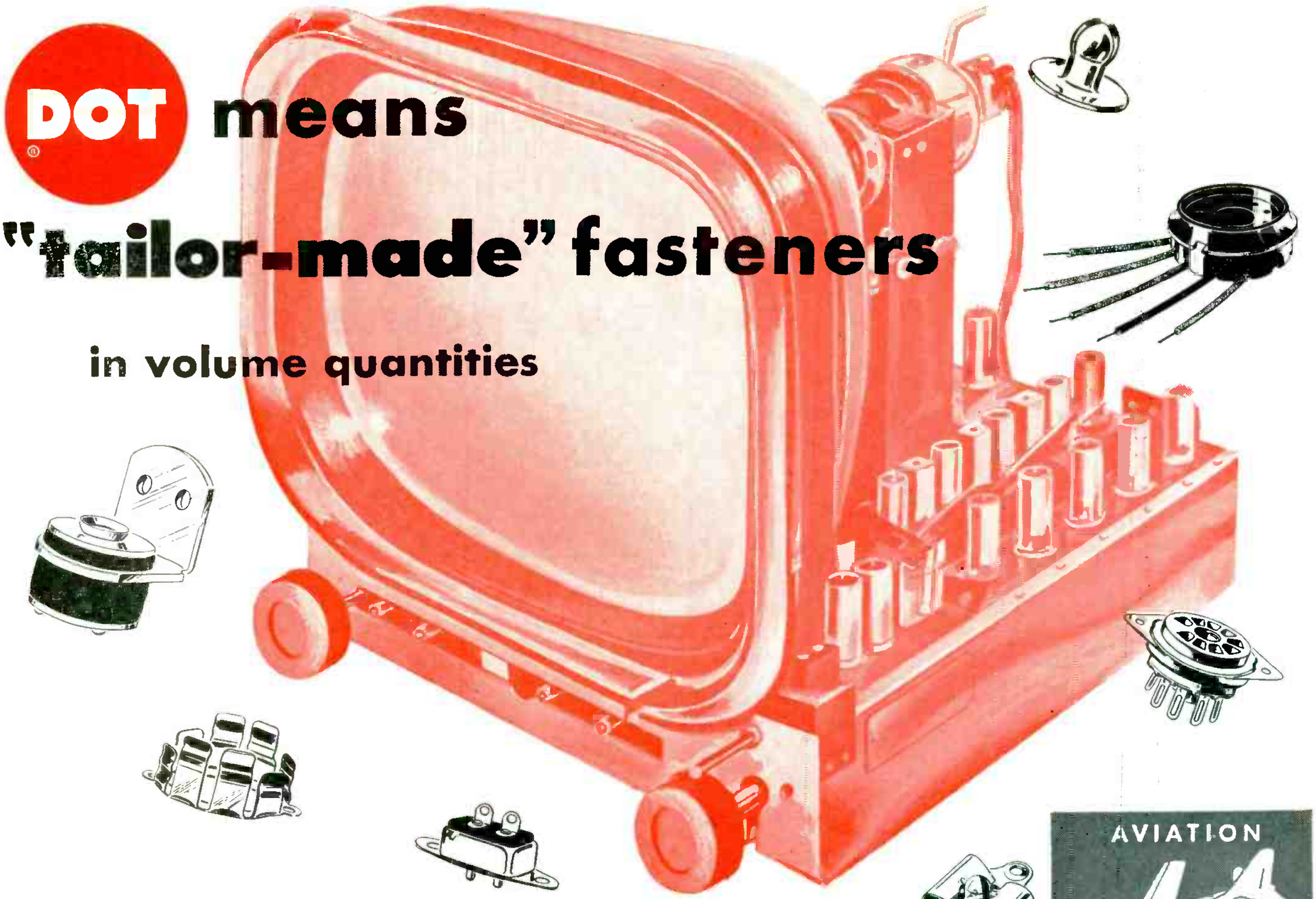
Division of United-Carr Fastener Corp.

Specialists in

ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

DOT means "tailor-made" fasteners

in volume quantities



SPECIALIZED FASTENERS

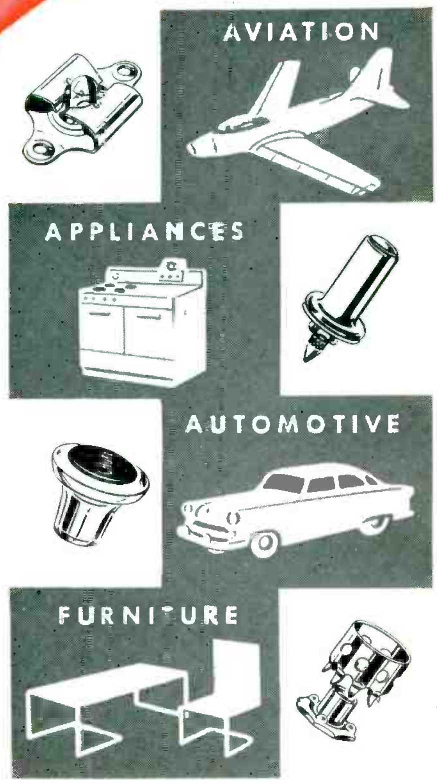
Illustrated above are a few of the hundreds of different fasteners and allied devices designed and produced *in volume* by United-Carr for the leading manufacturers in the electronics industry. Modern electronic devices use hundreds of these and similar parts, each *tailor-made* to speed assembly, lower costs or increase operating efficiency.

COMPLETE ENGINEERING SERVICE

United-Carr and its subsidiaries serve not only the electronics industry but the automotive, aviation, appliance and furniture industries, too. Each division of the company provides a reservoir of special knowledge for the others. It is this variety of skills and experience that makes our highly integrated organization uniquely valuable.

YOUR SPECIAL PROBLEMS

. . . may have fairly simple solutions or they may require close collaboration between your engineering staff and ours. In either case, we believe you will find it pays to consult United-Carr—FIRST IN FASTENERS.



UNITED-CARR

MAKERS OF DOT FASTENERS

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

Gulf Research

uses the new Electro-Chemograph to analyze engine deposits

- *It's fast*
- *It's accurate*
- *It's convenient*

GULF Research and Development Co., Pittsburgh . . . central research organization for the Gulf Oil Companies . . . speeds up routine chemical analysis with their new Type E Electro-Chemograph. Typical time-saving task for this "automatic chemist" is the analysis of minute amounts of internal combustion engine deposits left on valve stems and similar surfaces. Gulf Research has set up routine procedures to determine for lead, copper, nickel, zinc, and other metals.

Gulf men have streamlined the operation to a point where they can now do 9 determinations in 45 minutes. The Electro-Chemograph tells them what metals . . . and how much of each . . . are in the test sample. Controls are conveniently grouped on the console to provide easy selection of range and damping to meet just about all analytical requirements. The whole test procedure is so simple, as a matter of fact, that direction plate instructions on the console prove ample for 90% of routine work.

The new Electro-Chemograph gives you polarographic analysis at its best. Applications are broad. Proved superior for research work as well as routine analysis, the instrument is being used effectively by production and test labs in detecting small quantities of minor additives such as catalysts, plasticizers, oxidizing agents . . . for most common wet analyses on steel and non-ferrous materials . . . in trace analyses for poisons . . . in assaying hormones and vitamins . . . and in many other applications in manufacturing, research, and testing fields.

THE PEAK IN POLAROGRAPHY–

Meticulous attention to detail has produced in the new Type E Electro-Chemograph and associated apparatus modern instrumentation for accurate polarographic analysis. The equipment meets the most advanced needs of polarographic research; yet it's simple enough in operation for any technician to use in rapid routine analysis.

A built-in Speedomax Microampere Recorder measures maximum diffusion current so accurately in the undamped condition, that the envelope of peak current values (the distance from bottom to top of the large Electro-Chemograph curve pictured here) can be used directly as a basis of precise quantitative analysis. This permits more absolute quantitative determinations employing standard diffusion current constants for measuring various substances.

Send for information . . .

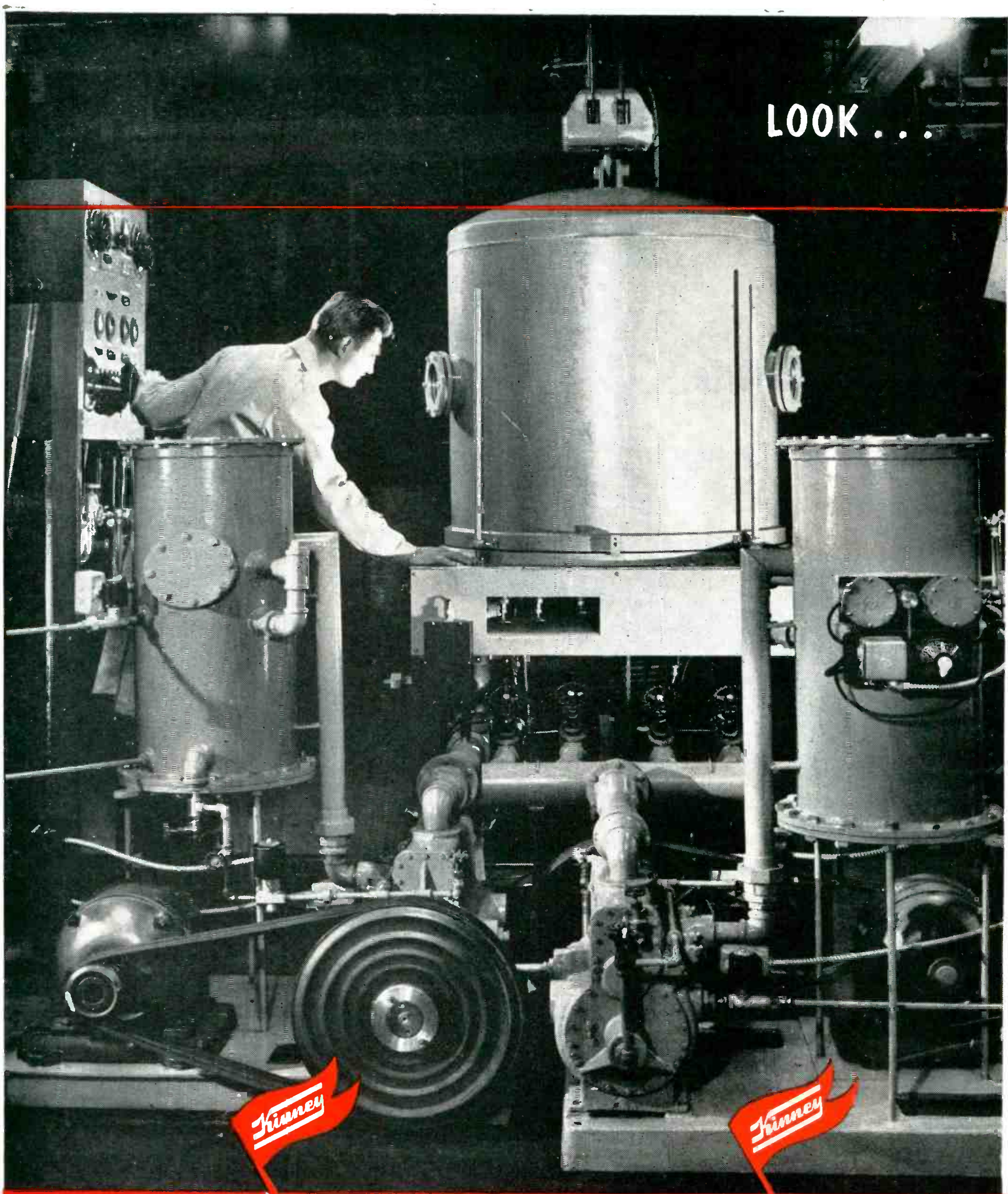
Our new Cat. EM9-90 tells all about the new Type E Electro-Chemograph. *Also*—our bibliography on polarographic analysis has recently been revised to include every paper published between 1903 and 1949 which we've been able to discover. Write our nearest office, or 4979 Stenton Ave., Phila. 44, Pa.

MEASURING INSTRUMENTS TELEMETERS AUTOMATIC CONTROLS HEAT TREATING FURNACES

LN LEEDS & NORTHRUP CO.

Jrl. Ad EM9-90(2)

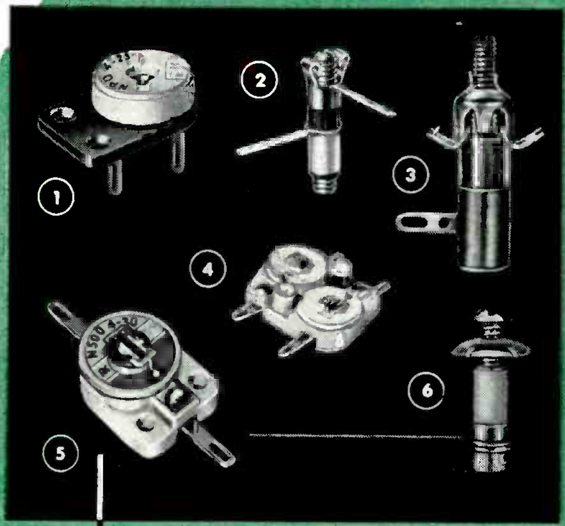
Use "dag"
Colloidal Graphite...
the Ideal CRT Wall Coating
"Dag" Exterior Wall Coating, developed by Acheson Colloids specifically for use on CRT glass envelopes, resists scratching and the loosening action of water. It requires no baking . . . is easy to apply . . . economical to use.
The smooth, uniform conductive black film obtained with "dag" Exterior Wall Coating adheres tenaciously to all CRT walls regardless of the glass to which it is applied.
Apply this specially processed electric-furnace graphite by spraying. The coating dries so rapidly that tubes can be handled in 2 or 3 minutes. Maximum adhesion is obtained by drying at room temperature for 24 hours or by infra-red drying for ½ hr. at 100° C.
The new and complete booklet "Dag" Colloidal Graphite for Electronic and Electrical Applications gives full data on "dag" Exterior Wall Coating and other "dag" dispersions. Write TODAY for Bulletin No. 433-5D.
dag DISPERSIONS®
Acheson Colloids Company, Port Huron, Mich.
...also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND
Units of Acheson Industries, Inc.

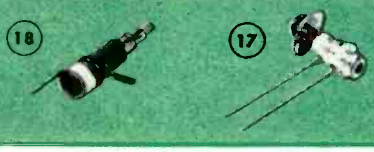


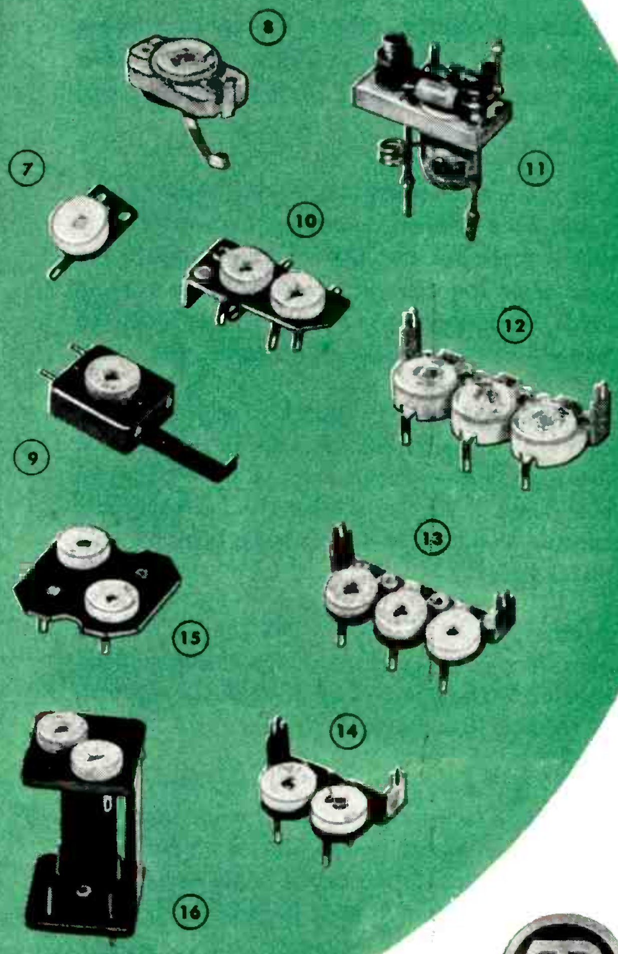
A compact vacuum coating system made by Distillation Products Industries. In such equipment are produced many of the items created by today's leading industrial designers: auto horn buttons, lenses, refrigerator nameplates, decorative novelties, costume jewelry, toys, and many other non-metallic products which depend on a micro-thin film of metal for their eye-appeal and utility. Kinney High Vacuum Pumps are used for speedy evacuation of the vaporizing chamber and for backing diffusion pumps during the metallizing operation. Note the Kinney Pumps in foreground.

HOW TO MAKE
OLD THINGS
BETTER

ERIE has the trimmer you want... or will *design* it for you







1. Standard Style 557 ceramic dielectric trimmer.
2. Standard Style 535 miniature tubular plastic dielectric trimmer.
3. Standard Style 531 tubular plastic dielectric trimmer.
4. Standard Style TD2A dual ceramic dielectric trimmer.
5. Standard Style TS2A single ceramic dielectric trimmer.
6. Standard Style 3139 tubular ceramic dielectric trimmer.
7. Standard Erie Style 557 Trimmer with special bent rotor terminal.
8. Special ribbon type terminals on standard Style TS2B Trimmer for direct connection to other components.
9. A compact pluggable assembly for mounting a trimmer in parallel with a plug-in crystal.
10. Special bracket and terminal arrangements on dual trimmer unit.
11. Compact Trimmer — Capacitor — Resistor — Coil Design. A complete oscillator unit.

12, 13, 14. Where special mounting is desired, standard Erie Style TS2A and Style 557 Trimmers can be supplied mounted on brackets.

15, 16. Two trimmer elements become an integral part of this coil form and I.F. top section.

17. Special steatite tubular dual trimmer.
18. Special tubular ceramic trimmer and variable inductance with molded phenolic case, having one common terminal.

ERIE RESISTOR provides a large and versatile family of trimmers . . . compact, rugged, economical . . . with excellent stability, high maximum to minimum ratios, and time-saving installation features.

ERIE has furnished manufacturers with many custom designed trimmers which incorporate the elements of Erie Disc and Tubular Ceramicon Trimmers for simplification of assembly and saving of space in specific applications.

Send your Trimmer problems to ERIE RESISTOR

Electronics Division

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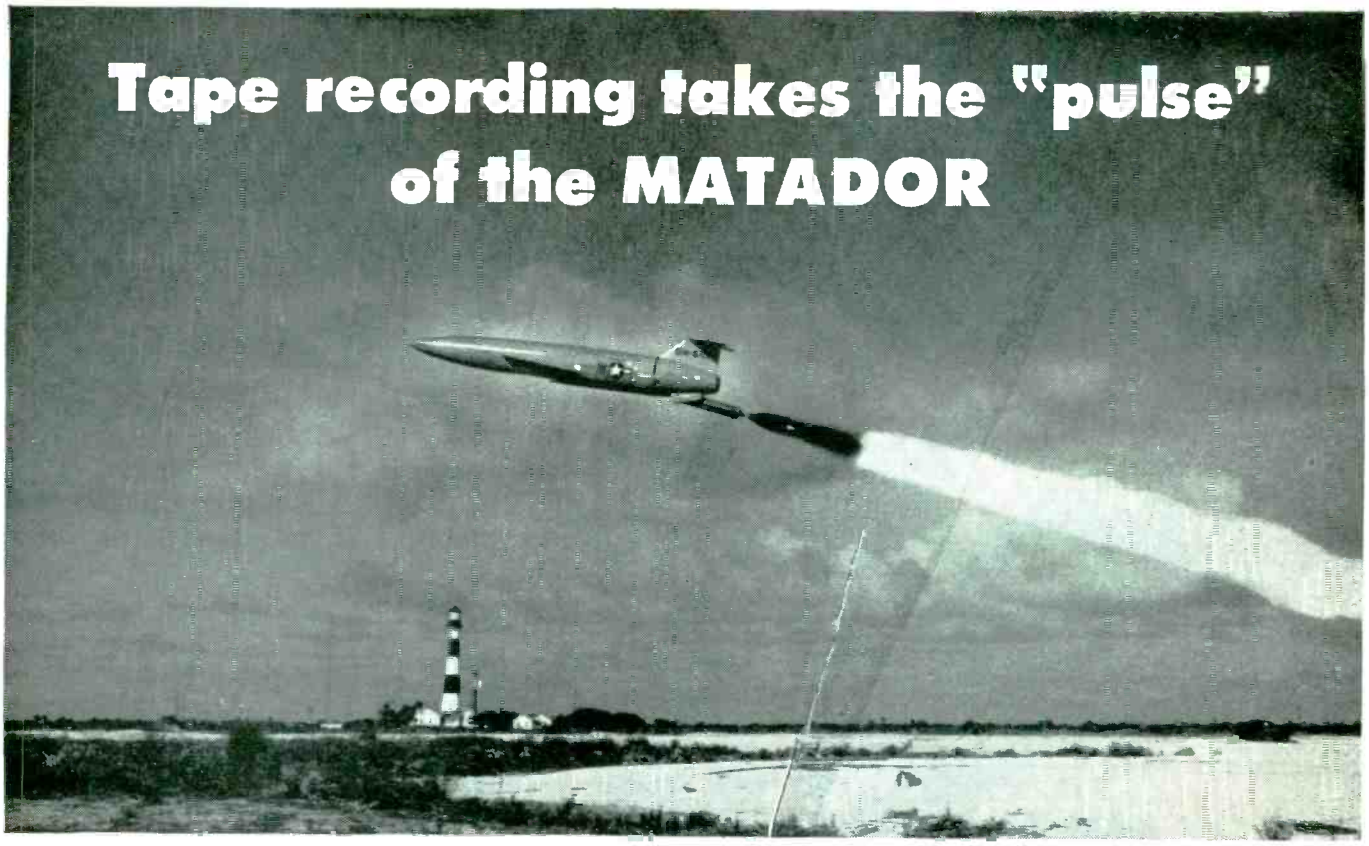
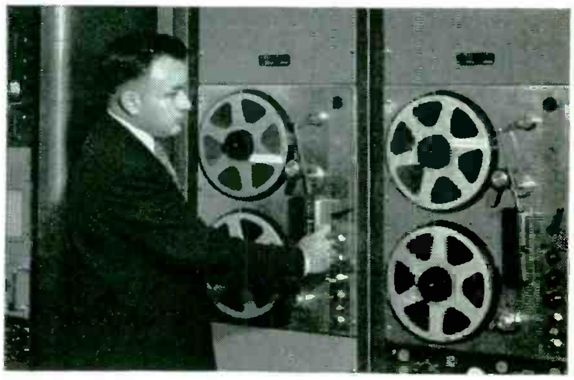
Tape recording takes the "pulse" of the MATADOR



TESTING OF GUIDED MISSILES like the famous "Matador" (above) involves a complicated job of telemetering. At the Air Force Missile Test Center in Florida, a series of down-range telemetry stations pick up pulsations transmitted by the missiles in flight. These signals are recorded on tape for later decoding.

"Scotch" Sound Recording Tape captures every impulse, reproduces it with unequaled fidelity. This gives engineers a dependable, lasting record of valuable engineering measurements—stress, strain, temperature, etc.



TAPE RECORDINGS of telemetered missile flights are gathered at a central point for study and analysis. By playing back the recordings, engineers can re-create each flight in its entirety.

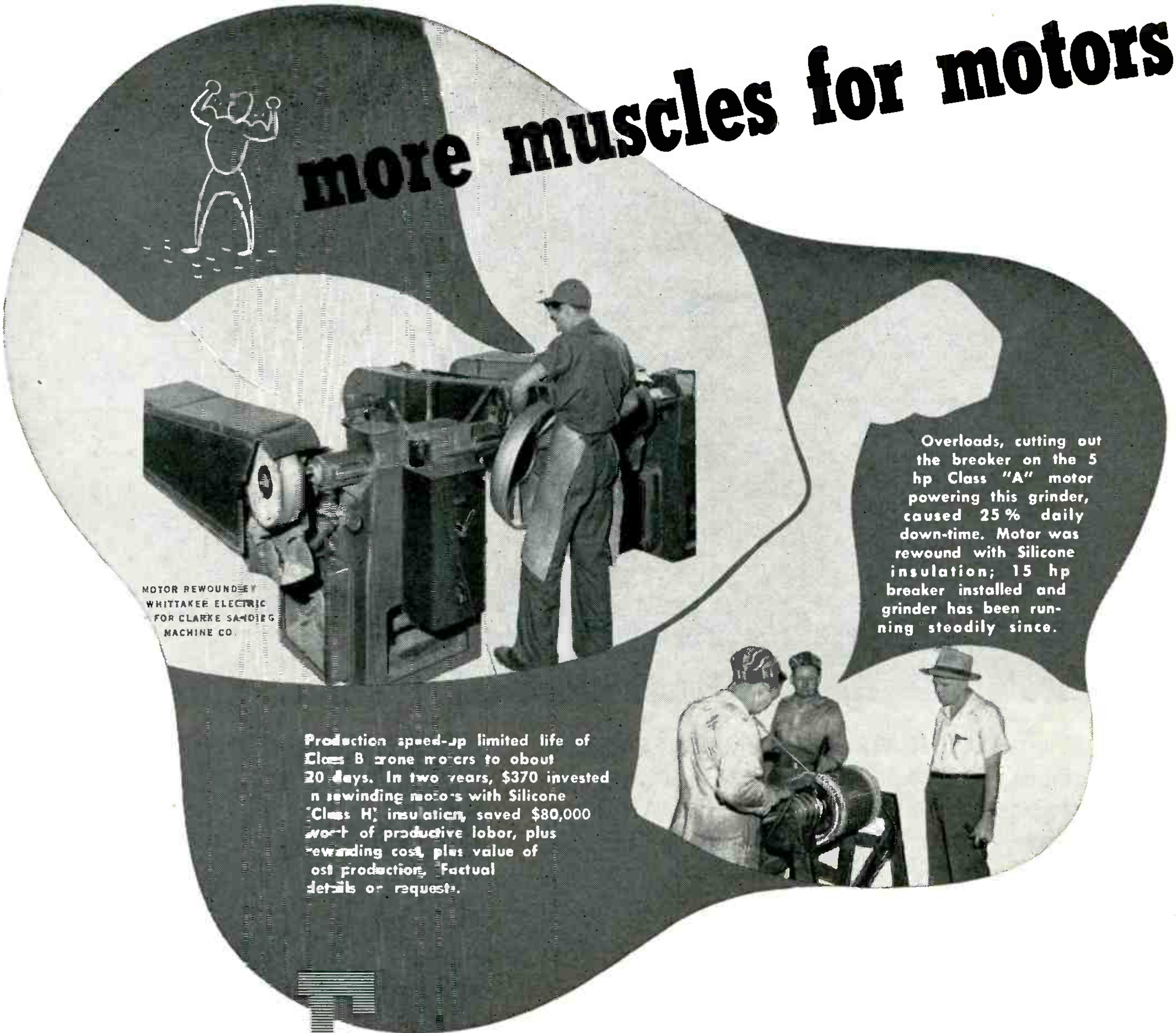
TECHNICAL ASSISTANCE on every phase of sound recording is yours for the asking from your local 3M Service Representative. Backed by the extensive facilities of the 3M Laboratories, he's ready to help with problems, show you new techniques, assist in selection of equipment. Call him today . . . or write us direct: Dept. E-42, Minnesota Mining & Mfg. Co., St. Paul 6, Minnesota.

Here's why recording engineers use more "SCOTCH" Sound Recording Tape than all other brands combined:

- Lower noise level than any other tape
- Greater output sensitivity than any other tape
- Better reel-to-reel uniformity than any other tape
- Erases cleaner than any other tape
- No curling or cupping—always lies flat on head
- Lubricated for longer tape life

FIFTIETH ANNIVERSARY 3M COMPANY 1902 1952

The term "SCOTCH" and the plaid design are registered trademarks for Sound Recording Tape made in U.S.A. by MINNESOTA MINING & MFG. CO., St. Paul 6, Minn.—also makers of "Scotch" Brand Pressure-sensitive Tapes, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: 270 Park Avenue, New York 17, N. Y. In Canada: London, Ont., Can.



ELECTRICAL Engineers and Production Men can save thousands of dollars* by using Dow Corning Silicone (Class H) Insulation to up-rate standard frame motors of all sizes. Class H Insulation permits higher operating temperatures and heavy overloads for sustained periods, at the same time multiplying motor life—reliability—overload capacity—moisture resistance—and productivity.

Furthermore, at name plate rating, there is no appreciable difference in power factor and efficiency between a Silicone insulated and a Class "A" insulated motor.

If speeded up production schedules are one of your problems, why not add more muscle to your motors by changing over to Class "H" insulated equipment? Most of the leading rewind shops now offer Class "H" Insulation made with Dow Corning Silicones. Talk to the people who rebuild your motors — or call our nearest branch office. There's a specialist in Silicone Insulation there to help you.

***WANT PROOF?** *Write for Dow Corning Data Sheet BE-16*

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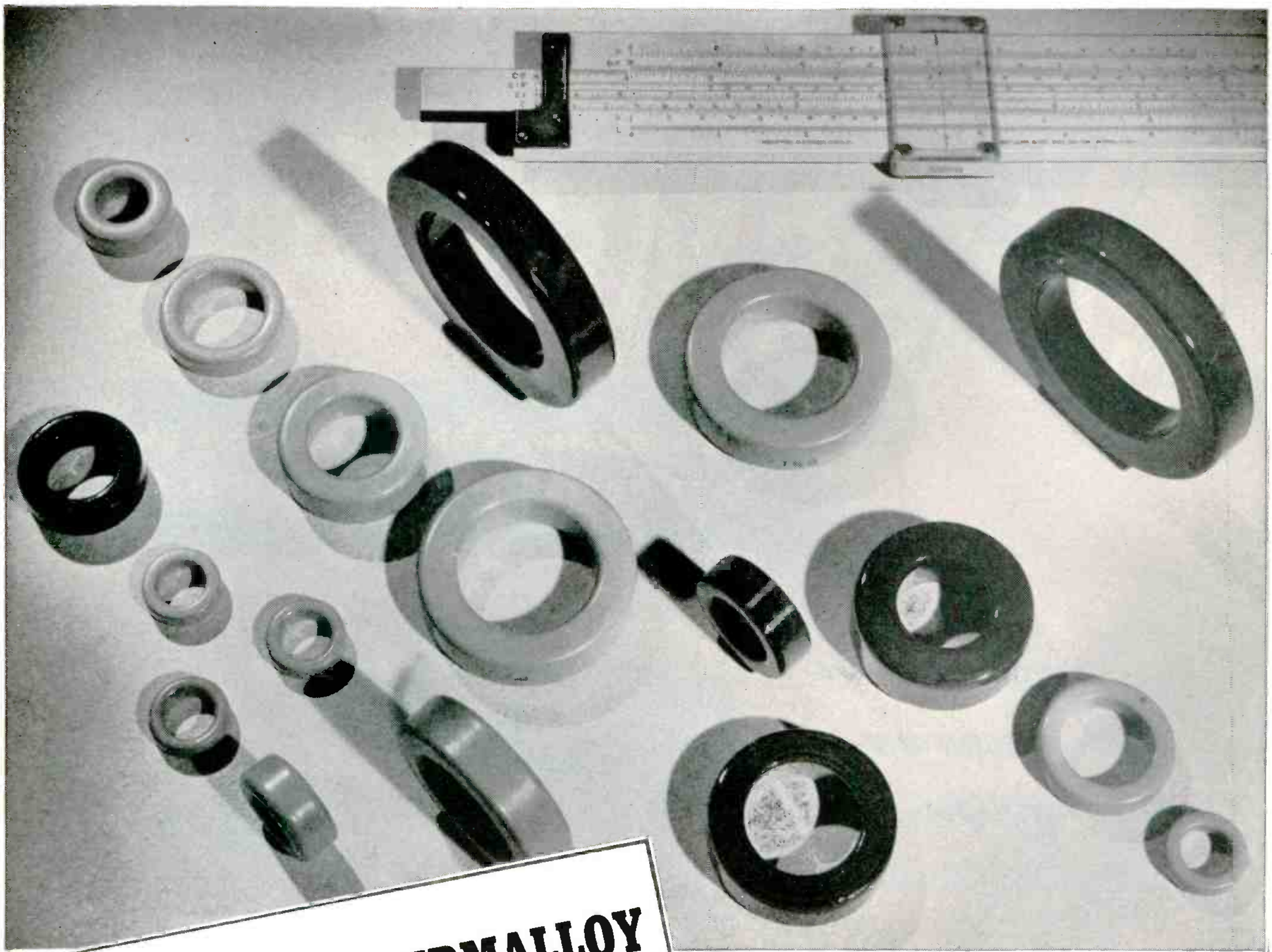


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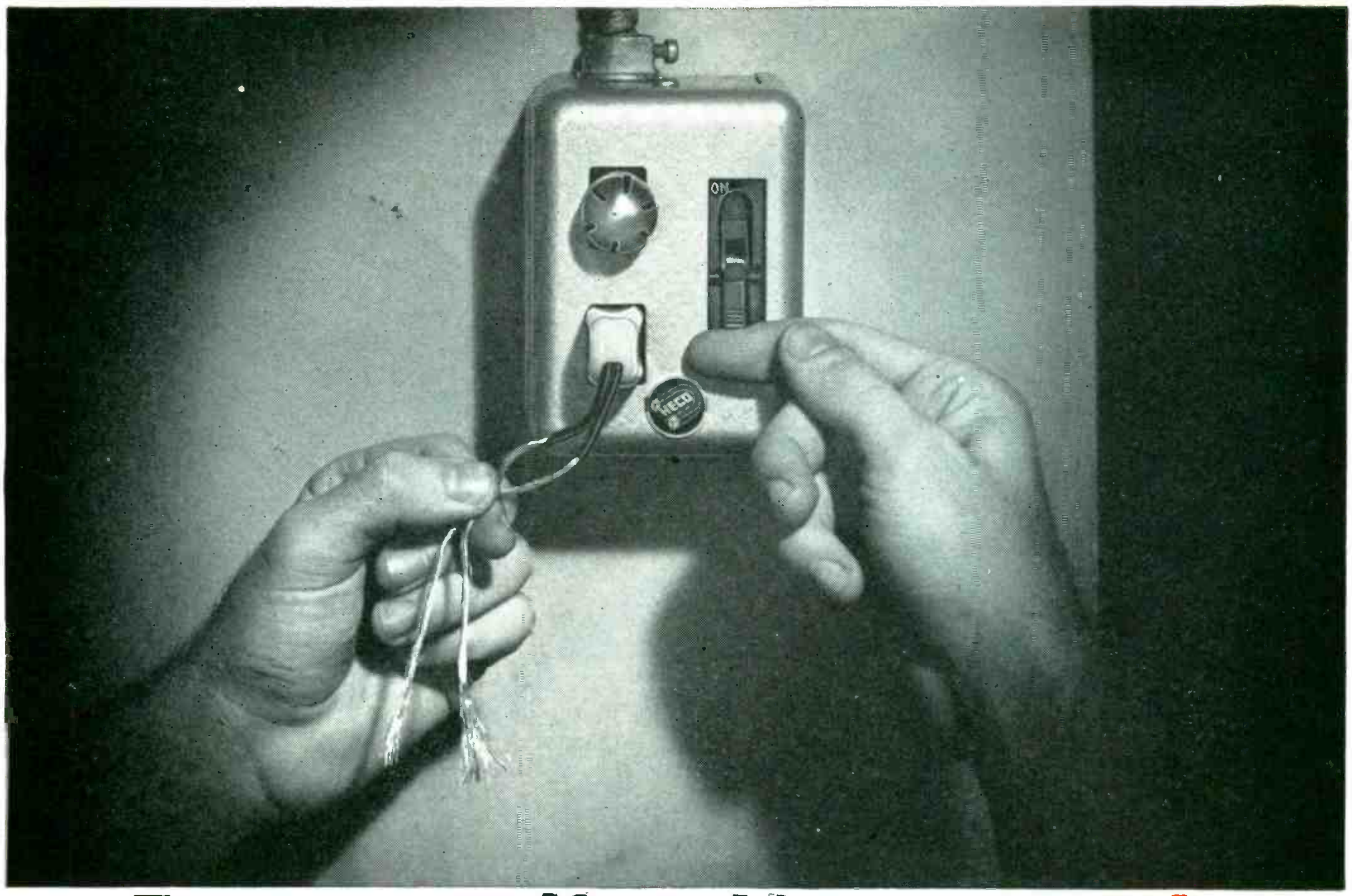
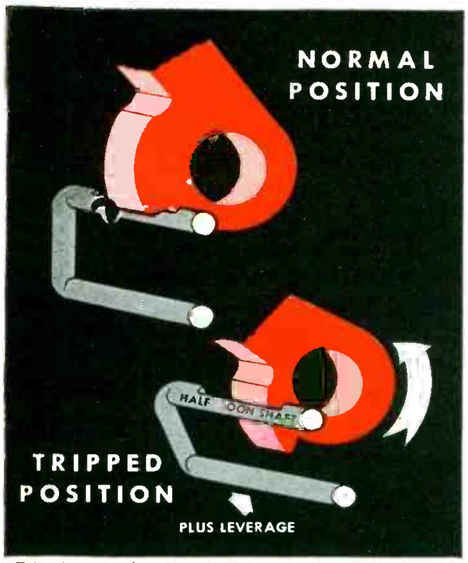


Trust yourself to this test . . . only with HEINEMANN CIRCUIT BREAKERS



Tripping mechanism design provides fastest action with least amount of friction . . . but never nuisance tripping. HEINEMANN Circuit Breakers have no confusing "reset" position . . . only "On" and "Off." After tripping, this can be turned "On" immediately if the fault has been corrected.

This man is holding a short circuit in his bare fingers. He might receive a bad burn . . . except that this circuit is protected by HEINEMANN Circuit Breakers.

With slower circuit protection, wires heat, insulation breaks down . . . and service troubles get their start. However, HEINEMANN Circuit Breakers don't use heat for actuation . . . they have no thermal elements. On short circuits, tripping is always instantaneous, in fact, so fast that wires in motor windings and other equipment are completely safe. On momentary overloads a proportioned time delay is provided . . . being shorter for large overloads . . . and longer for small ones.

Performance to this extent explains why most equipment manufacturers use HEINEMANN Circuit Breakers in their products.

Send for complete literature. HEINEMANN ELECTRIC COMPANY, 97 Plum Street, Trenton 2, N.J.

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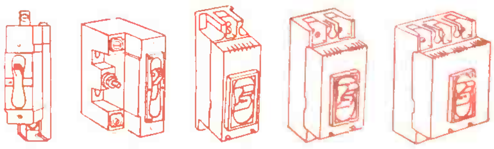
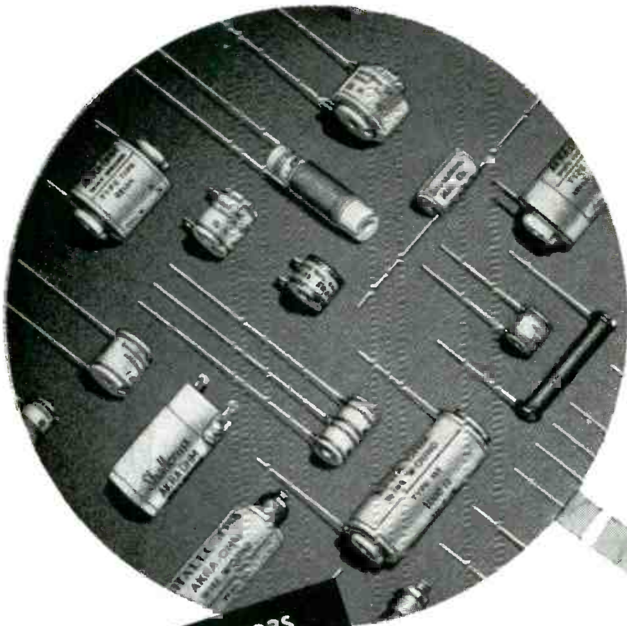
EST. 1888



HEINEMANN Circuit Breakers . . One, two and three pole . . 10 milliamps to 100 amperes

HEINEMANN *Circuit breakers*



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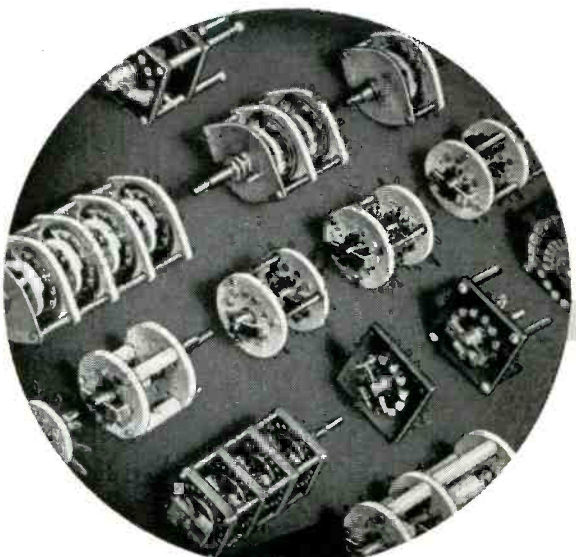

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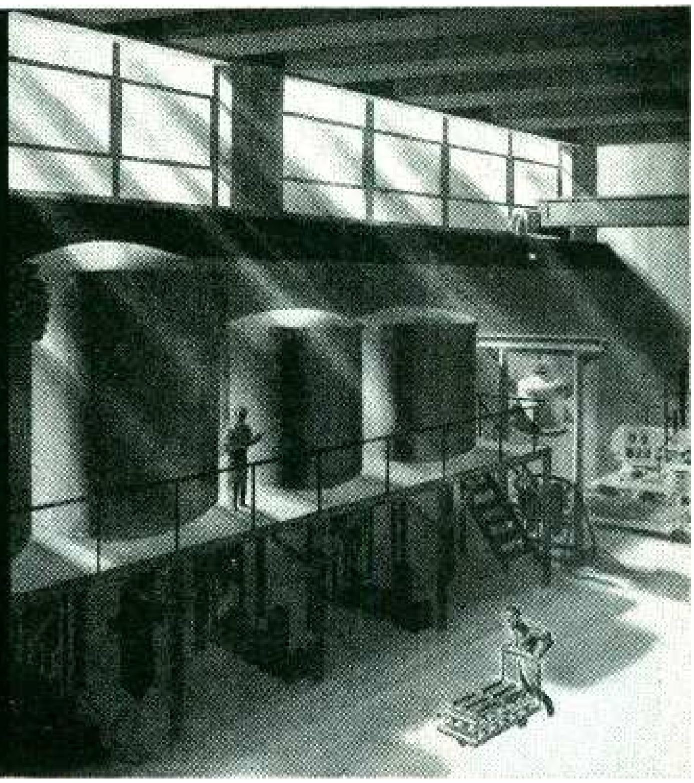

Vacuum Metals Corporation has been formed to supply specialty metals and alloys for applications of high performance in terms of physical, chemical or electrical properties.

Vacuum melting techniques developed by National Research are used to produce metals of higher purity and alloys held to closer composition tolerances than ever before achieved commercially.

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The unique properties of vacuum melted pure metals and alloys are particularly useful in applications such as electronic and electrical parts, magnetic materials, bearing materials, diaphragms, instrument components, laboratory standards and Atomic Energy projects.

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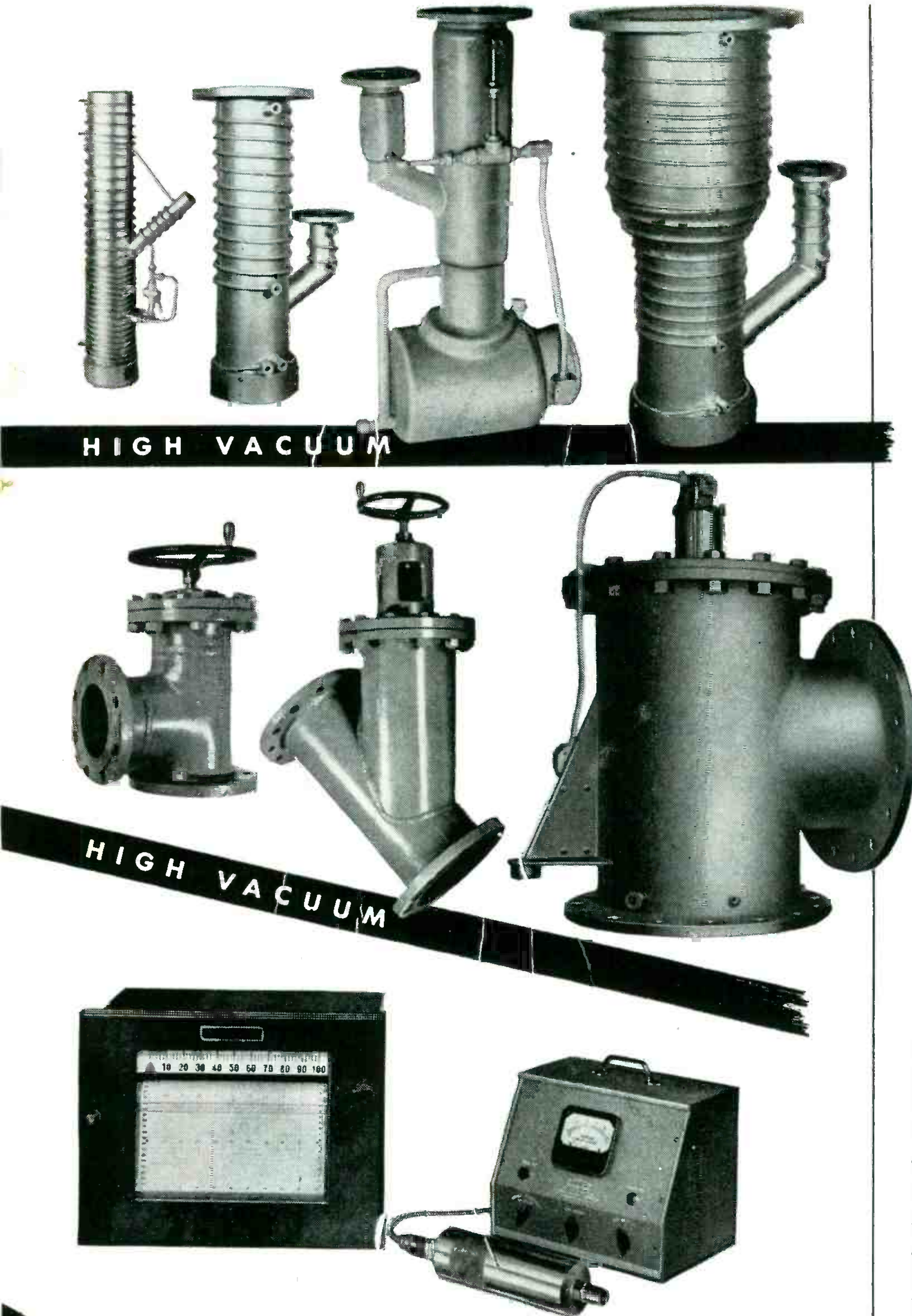

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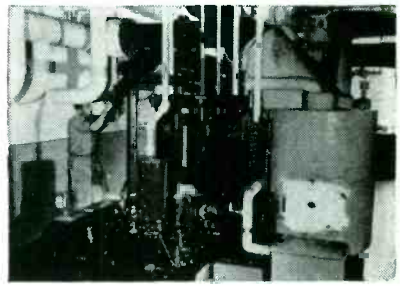
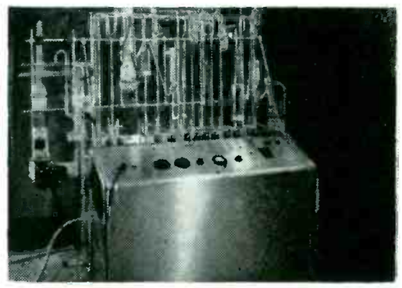


V25D Rotary Condenser. A typical processing unit in a large, high vacuum plant which we designed and built.



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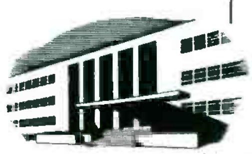

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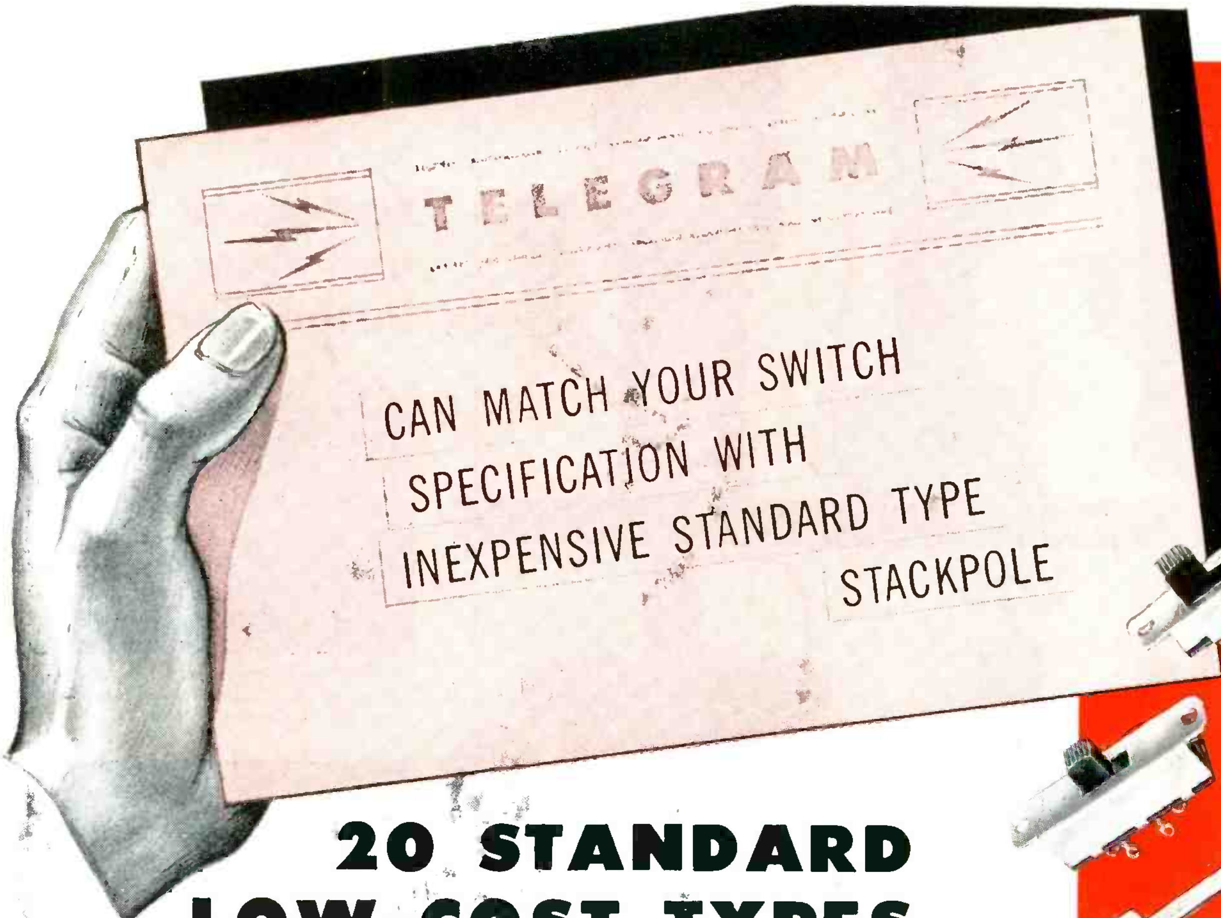

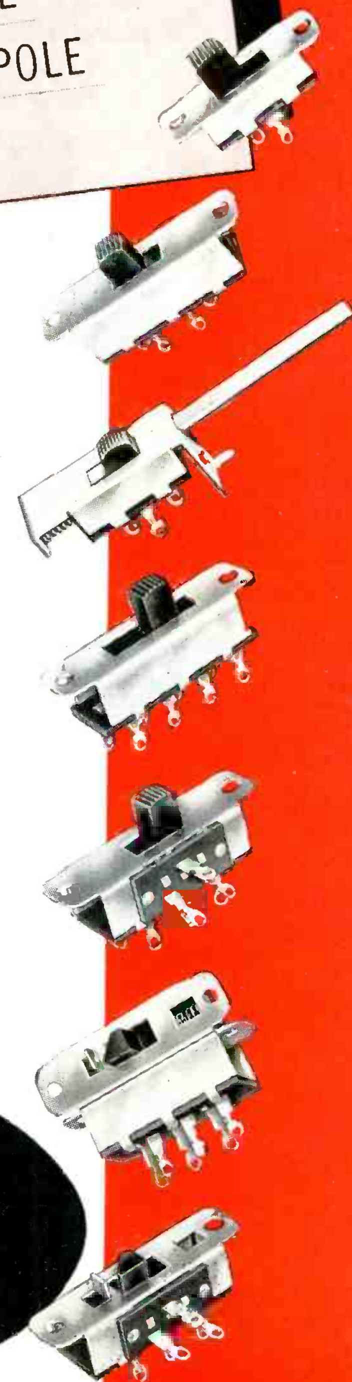

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POINTING the WAY To Continuing Prosperity

The set of figures in the middle of this page is news of high importance to every American.

In effect, it says that there is no basis in fact for all this talk about a collapse of capital expenditures plunging us into a depression following the industrial build-up for defense.

Such talk assumes that without defense orders business would spend relatively little for new industrial plant and equipment. The figures below show that that assumption is not justified.

BUSINESS PLANS FOR NEW PLANTS AND EQUIPMENT (Millions of Dollars)

	Actual Spending 1950*	Actual Spending 1951*	McGraw-Hill Survey: Planned 1952	McGraw-Hill Survey: Preliminary Plans 1953	Preliminary Plans 1954	Preliminary Plans 1955
Manufacturing	7,491	11,141	12,921	10,028	8,525	8,194
Mining	684	806	943	415	321	358
Railroads	1,136	1,564	1,642	1,248	1,117	1,002
Electric & Gas Utilities**	3,298	3,676	3,948	3,360	3,204	2,748
Other Transportation & Communications	1,392	1,592	1,721	1,671	1,943	1,839
ALL INDUSTRY	14,001	18,779	21,175	16,722	15,110	14,141

*U. S. Department of Commerce
***Electrical World* (A McGraw-Hill publication) and American Gas Association.

The figures come from the fifth annual McGraw-Hill survey of business plans for new plant and equipment. Companies were asked to report through that survey not only their plans for 1952, but plans they now have in hand for capital expenditures in 1953, 1954 and 1955, provided the money to carry them out can be obtained.

A Record in '52

As was expected, their plans call for another record-breaking volume of capital expenditures by business in 1952. But, as many did not expect, the McGraw-Hill survey also discloses plans for very heavy capital expenditures in each of the three years following. Expenditures now planned for those years are, to be sure, lower than those planned for 1952. But the significant fact is not that they are lower. Experience shows that plans made several years ahead always overlook many expenditures that are needed later.

The significant fact is that the expenditures already planned for 1953-55 are so high. For example, those now planned for 1955 would be higher than those of 1950, which, at that time, were second highest in our history.

If these plans are carried out we shall have an essential element of continuing prosperity. Sustained expenditures for capital expansion and betterment account directly for a large share of our employment and consumer income. Moreover, consistent modernization of industrial plant raises production efficiency and brings more and better goods and services within reach of more consumers.

It is not to be expected, of course, that we can come down from the peak of the defense boom without readjustments in some sectors of business. But if capital expenditures by business are carried out on the scale now planned, we shall be able to take any necessary readjustments in our stride, and continue to increase our industrial strength.

From V-J Day to the end of this year, manufacturing industries will have spent over $60 billion for new industrial plant and equipment. This is more than the value of all the plant and equipment these industries had on their books at the end of World War II. It is this heavy outlay that causes some, assuming most postwar plans for industrial expansion and modernization will be completed, to fear a collapse of capital expenditure.

Plans to Go Ahead

But American industry still has plans to go right ahead expanding and improving its facilities. This was the most striking single finding of this year's survey.* It disclosed also that after 1952:

— 83 per cent of the companies answering the survey are planning substantial further modernization.

— 48 per cent will need more capacity to make their present products.

— 33 per cent plan additional capacity to make new products.

It cannot be too strongly emphasized, however, that these plans represent what American industry *wants* to do. They are a concrete expression of hope and aspiration. As such they are extremely important, for they dispose of the idea that business considers the job of expanding and improving its facilities as finished, or anywhere near finished.

But the plans carry no guarantee of accomplishment. If they are to be realized, business must have the funds to carry them out. There is no assurance that the money will be available if the present level of corporation taxes is continued. Eight out of ten companies, according to the McGraw-Hill survey, will rely entirely on profits and reserves to finance their 1953-55 programs. So, in calculating their programs for these years, the companies were asked to assume relief from "excess profits" taxation.

Federal taxes now take at least 52 per cent of a corporation's profits, and 82 per cent of any profits in the so-called "excess profits" bracket. Despite this drain on their funds, companies are able to finance their 1952 programs because (1) they are borrowing heavily, and (2) many of them are getting government loans or special tax concessions on new facilities installed for defense purposes. But these are emergency aids.

Only Two Ways

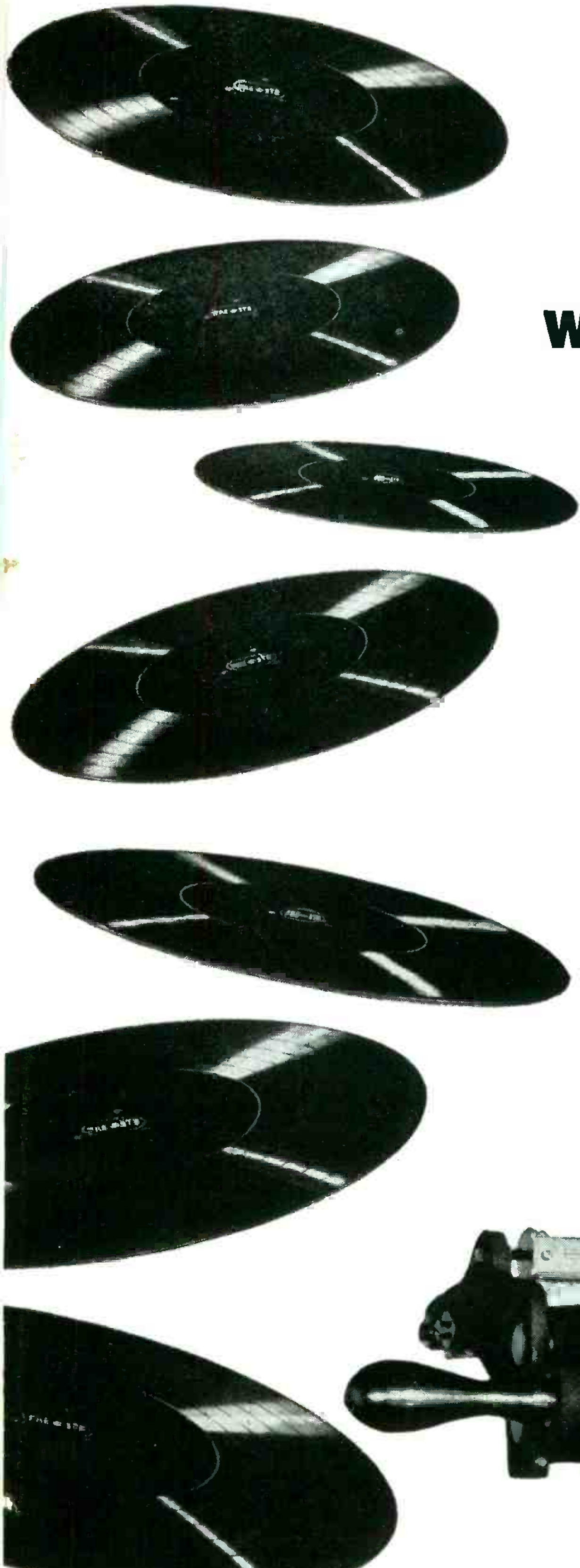
When the present defense program tapers off, there will be only two ways by which business can possibly increase its principal source of funds for new plant and equipment. One way is to make more profits before the tax collector takes his cut. And the only way many companies, already operating at capacity and high efficiency, can do that quickly is by raising their prices. That is an unpopular method. Also, with the return to more competitive markets, it might be self-defeating.

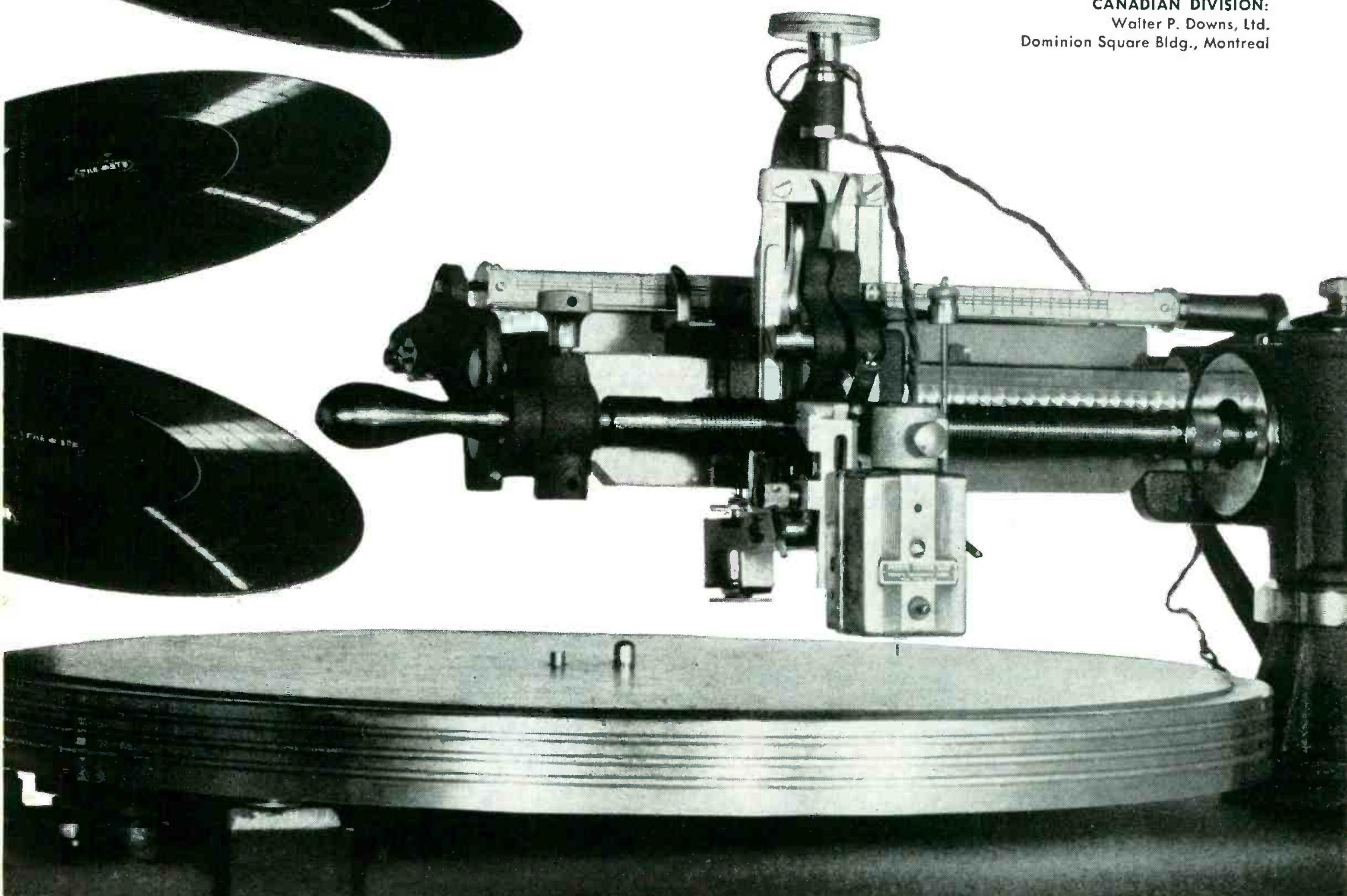
The other way is for the federal government to release its strangle hold on business profits. The so-called "excess profits" tax—the 82 per cent tax which is really a tax on business growth — should be repealed, effective January 1, 1953. And a cut in the basic tax of 52 per cent on all corporate profits should come not much later. That is by all odds the most important single step toward assuring that business plans already made for capital investment in 1953, 1954 and 1955 are carried out. It is the most important single step toward sustaining our present prosperity.

Through its plans for continued expansion and improvement of its facilities, American business clearly points the way to avoid the depression that so many have feared — and the Communists have so ardently hoped — would follow the peak of defense mobilization. It will be a tragedy for our country and for Americans in every walk of life if we do not insist that business get the chance to follow this wise and constructive course.

McGraw-Hill Publishing Company, Inc.

*Note — A copy of the full report of this survey can be obtained by addressing: Department of Economics, McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York 36, N. Y.





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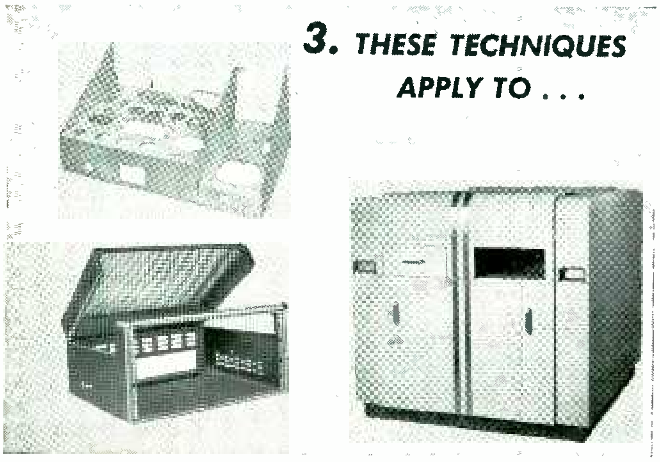

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General Electric has similar data for most of its JAN units, showing how each may be operated under a variety of conditions. For information on how these standard G-E capacitors may be applied in your circuits, consult your Apparatus Sales Office, or write to Specialty Capacitor Sales, General Electric Company, Hudson Falls, N. Y.

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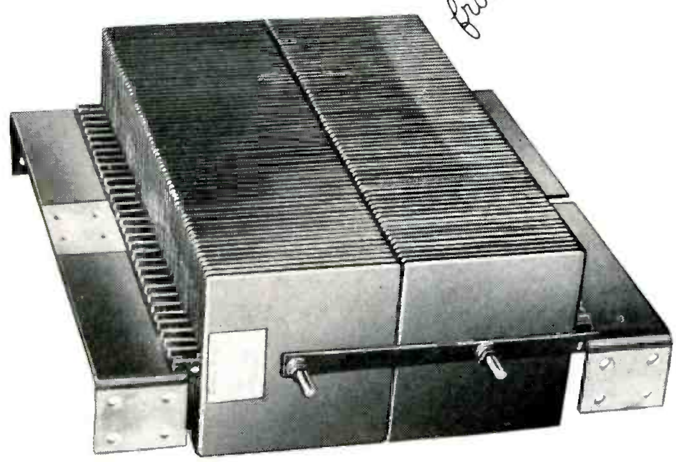

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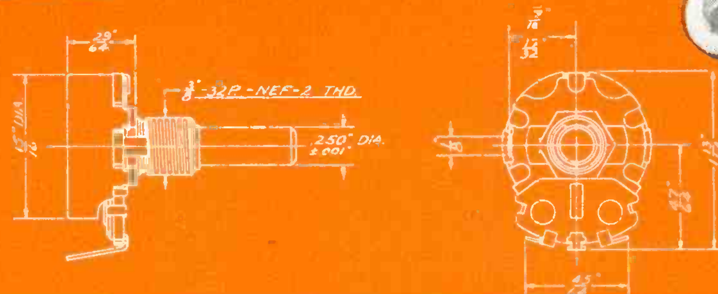
Cincinnati	Indianapolis	New Orleans	St. Louis	office only)

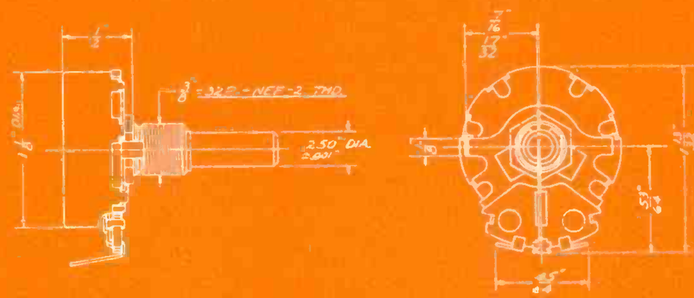
A Complete Line that

TYPE 45
(JAN-R-94, Type RV2)



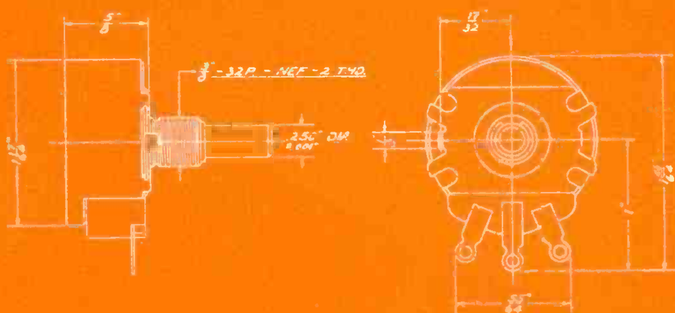
¼ watt, 1⁵⁄₁₆" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

TYPE 35
(JAN-R-94, Type RV3)



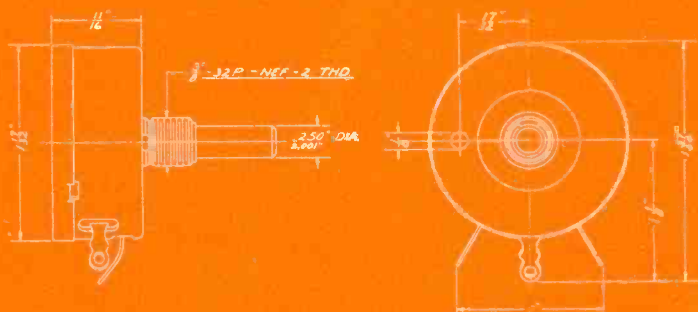
½ watt, 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

TYPE 252
(JAN-R-19, Type RA20)



2 watt, 1¹⁷⁄₆₄" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

TYPE 25
(JAN-R-19, Type RA30)



4 watt, 1¹⁷⁄₃₂" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

For additional information on these 7 controls, write for Data Sheet No. 160

EXCEPTIONALLY GOOD DELIVERY CYCLE on military orders due to enormous mass production facilities . . . *Immediate delivery from stock* on more than 170 different types and resistance values . . . Please give complete details on your requirements when writing or phoning for further information.

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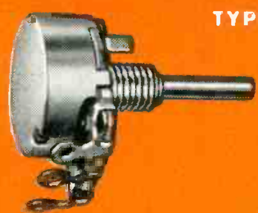
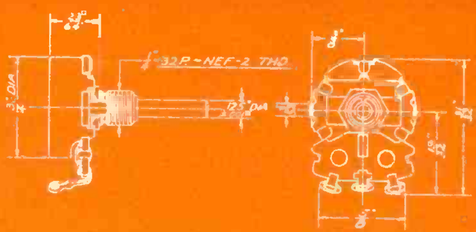
# of Variable Resistors

MEETS MILITARY SPECIFICATIONS

—55°C to +150°C . . . complete aridity to saturation . . . are the unprecedented temperature and humidity range of Types 65, 90 and 95. These controls are used in military equipment subjected to extreme temperature and humidity.

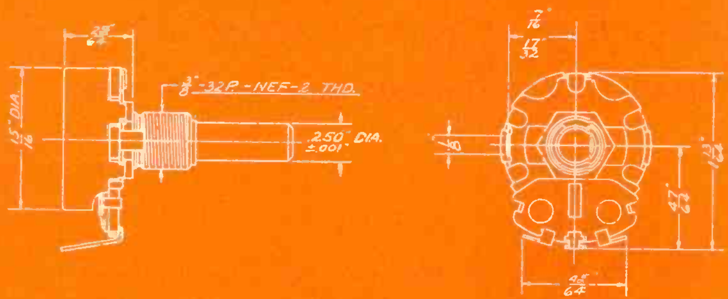


TYPE 65

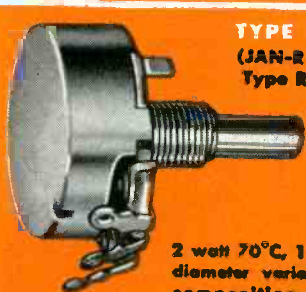


½ watt 70°C, ⅝" diameter miniaturized variable composition resistor.

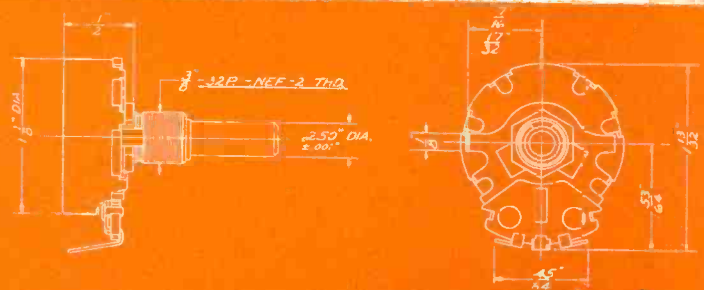
TYPE 90



1 watt 70°C, 1⁵⁄₁₆" diameter variable composition resistor. Attached Switch can be supplied.



TYPE 95 (JAN-R-94, Type RV4)



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

Specialists in Precision Mass Production of Variable Resistors

FOUNDED 1896

CTS

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Phone: Walnut 2-5369

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IN CANADA
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EFFICIENT IN TEMPERATURES ... FROM −85° TO 500° F.

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Electrical Insulating Tubing and Sleeving

MEETS MIL-I-3190 CLASS "H" SPECIFICATIONS

A combination of *Varglas* Sleeving made with continuous filament glass yarns and *Silicone High Temperature Resin.* Varglas Silicone is the only Class "H" insulation with these features:

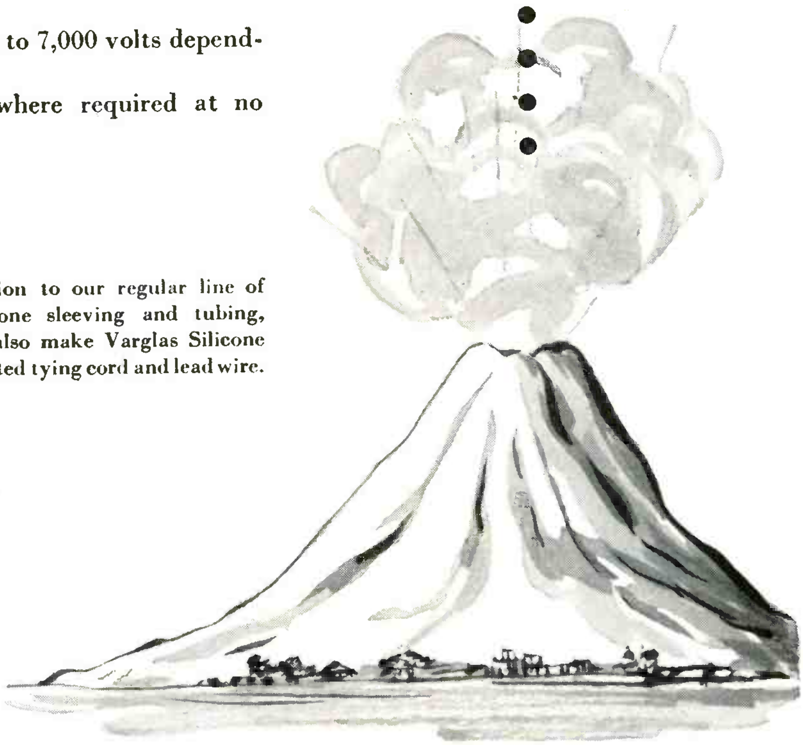
FLEXIBLE from 500° to —85° F in some grades.

RESISTANT to flame, moisture and fungus, abrasion, acids, mild alkalies.

DIELECTRIC PROTECTION up to 7,000 volts depending on grade.

AVAILABLE IN 10 COLORS, where required at no extra cost.

In addition to our regular line of Silicone sleeving and tubing, we also make Varglas Silicone treated tying cord and lead wire.

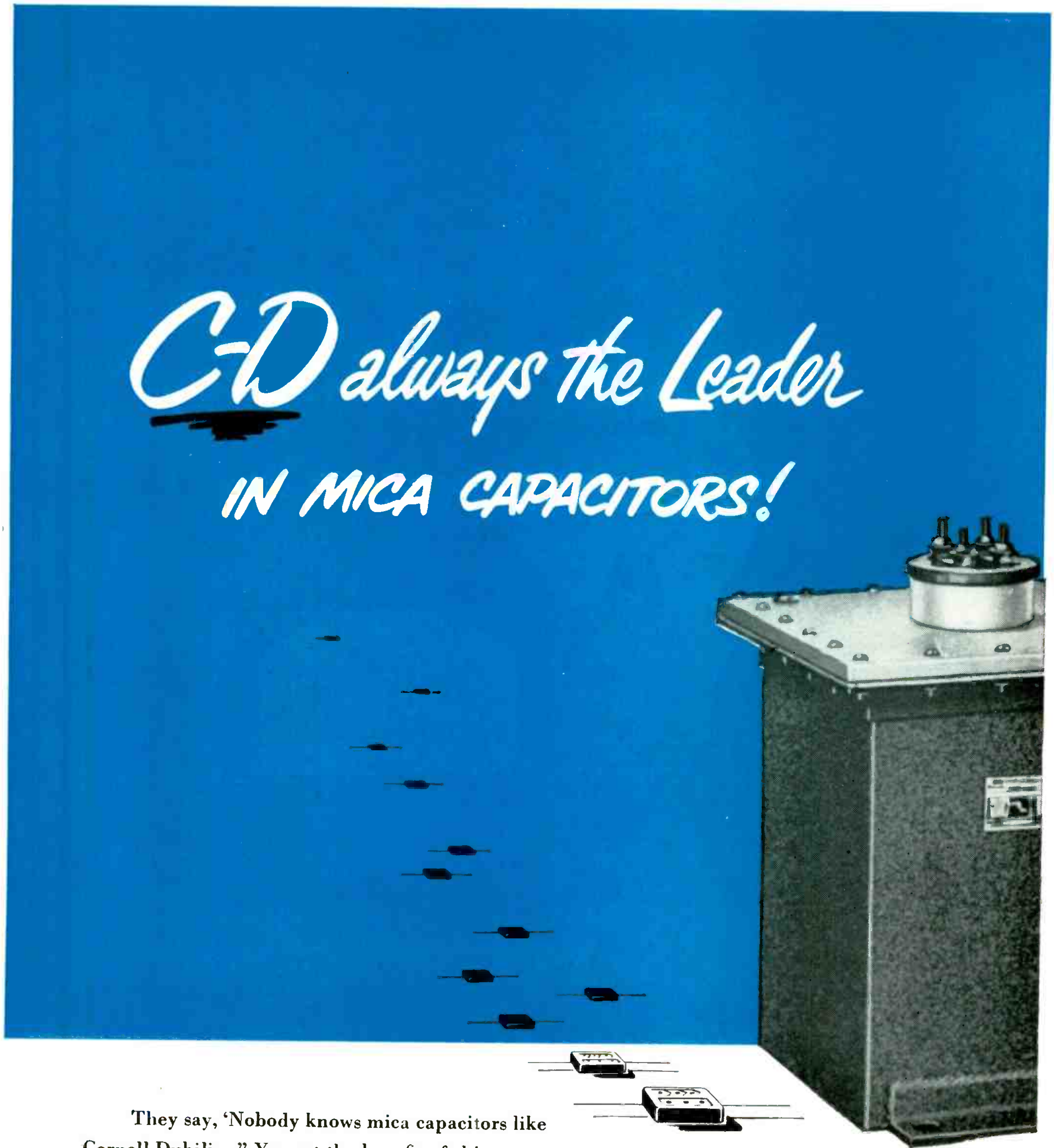


Varflex CORPORATION

Makers of Electrical Insulating Tubing and Sleeving

VARFLEX *Sales Co., Inc.*

308 N. Jay St., Rome, N. Y.



They say, 'Nobody knows mica capacitors like Cornell-Dubilier." You get the benefit of this mastery of mica whether you're using C-D's tiny Silver Mike, or C-D's famous commercial transmitter mica capacitor, or something in-between!

Send for Catalog No. 420. Dept. K42

Cornell-Dubilier Electric Corp., South Plainfield, N. J.

CORNELL-DUBILIER 1910-1951 CAPACITORS

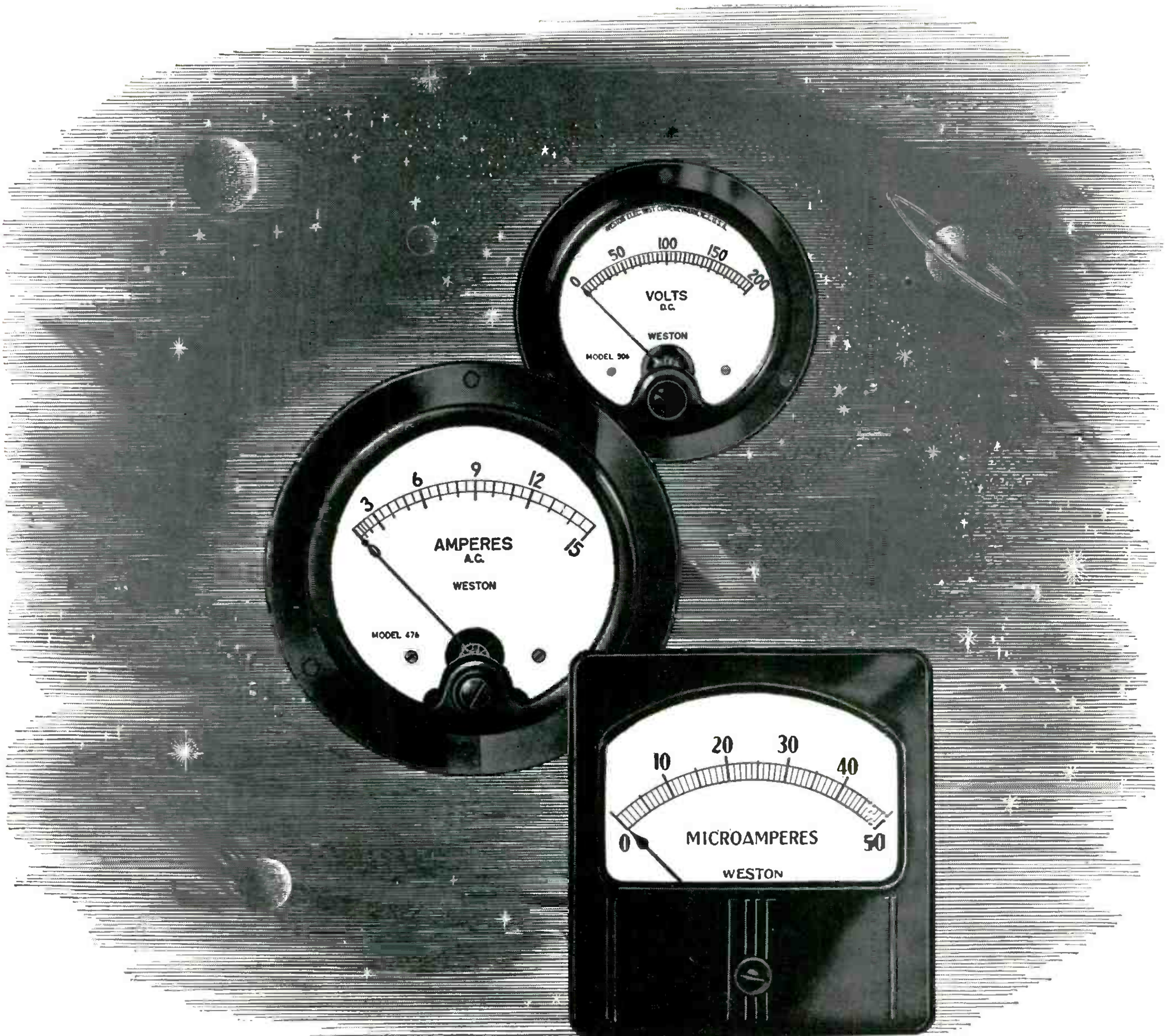
RADIART SUBSIDIARY

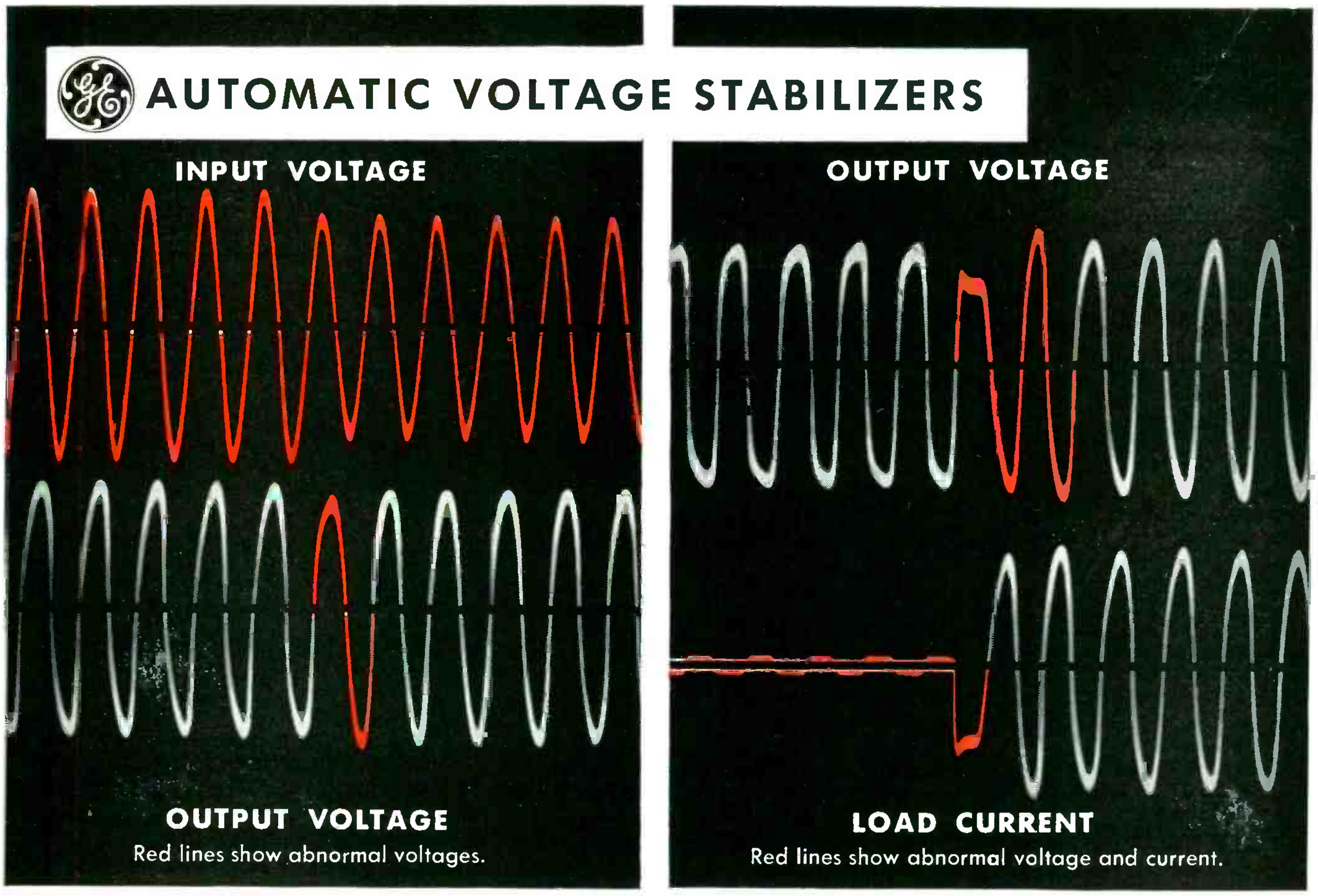
CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER

CAPACITORS

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


0 50 100 150 200
VOLTS
D.C.
WESTON
MODEL 506
3 6 9 12 15
AMPERES
A.C.
WESTON
MODEL 476
0 10 20 30 40 50
MICROAMPERES
WESTON



Output voltage stabilized in less than one and one-half cycles as input drops from 130 to 100 volts.

Output voltage stabilized within two cycles as load current jumps from 0 to full load.

Split-cycle action of G-E Stabilizers assures top performance of your product

A common cause of substandard performance of electrical equipment is fluctuating a-c voltage supply. The simplest way to prevent local voltage conditions from affecting your product performance is to use G-E Automatic Voltage Stabilizers.

MADE TO FIT ANY APPLICATION

Light, compact, standard models are now made in sizes 15 to 5000 va. These models can easily be used in a wide variety of applications: laboratory and factory testing equipment, signal and alarm systems, and many others. To do specific jobs, special designs are available or can be made.

CORRECTS WIDE RANGE OF VOLTAGES

Standard G-E Voltage Stabilizers correct for all fluctuations between 95 and 130 volts, or 190 to 260 volts, delivering a stable 115 or 230 volts to your product within $\pm 1\%$. Special models can stabilize to an even closer degree.

EASY TO INSTALL; NO MAINTENANCE

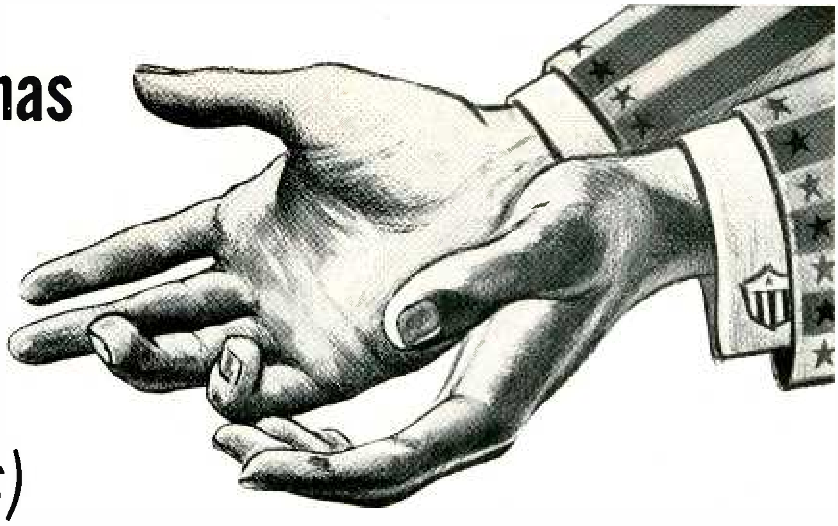
Only two sets of terminals to connect: one for supply and one for the load. Since there are no moving parts or electronic components, need for replacement parts, adjustments or any other maintenance is virtually non-existent. Operation is completely automatic. *General Electric Co., Schenectady 5, N. Y.*

SENSITIVE EQUIPMENT, such as this Type H Leak Detector, functions accurately only when voltage is properly stabilized. G-E voltage stabilizers perform this stabilizing function.

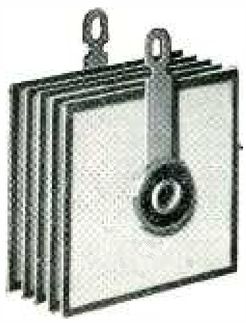
GENERAL ELECTRIC

411-99

If the government has tossed a problem in your lap . . . *(having to do with rectification, that is)*



. . . we'd like to assist you!

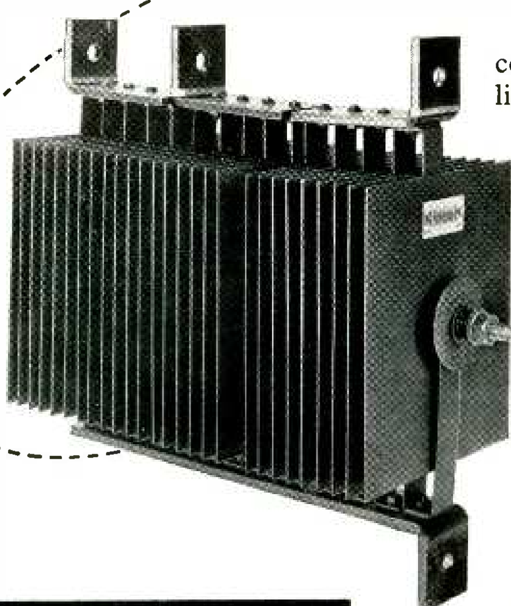


We've made *millions* of SELETRON selenium rectifiers in all sizes and shapes — tiny ones and whoppers — standard commercial ones, and those designed especially to meet government's rigid specifications. That includes hermetically sealed jobs as well as stacks built to withstand salt spray and high humidity tests.

We've sold a whale of a lot of 'em to the various branches of government including the armed services and their contractors, and thus have learned a great deal about rectifier idiosyncrasies and their application.

All this accumulated rectifier wisdom we'll share with engineers and technical men who have U.S. Government induced problems . . . and no strings attached!

State that problem, please. You'll receive a detailed, constructive answer promptly. Or if you wish our general literature on the subject, ask us for bulletin No. 104-D-3.



Do you have your copy of this instructive 24 page booklet? If not, send for Booklet No. 117-

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

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RADIO RECEPTOR COMPANY, INC.

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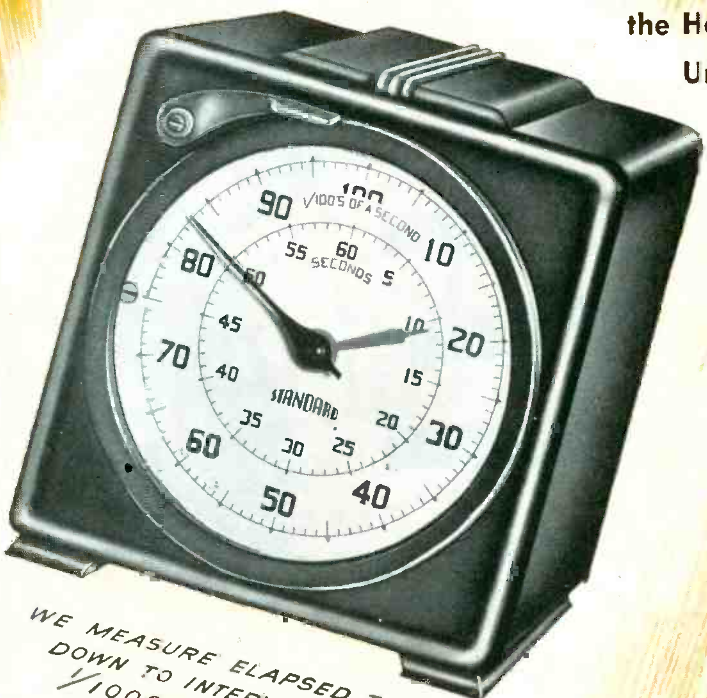
THE MOST Accurate and MOST Rugged
TIME-MEASURING INSTRUMENT IN GENERAL USE
IN THE WORLD!

The STANDARD PRECISION TIMER

It's There — in the "Clutch"
the Heart of STANDARD'S
Uncanny Precision
Performance



WE MEASURE ELAPSED TIME DOWN TO INTERVALS OF 1/1000th SECOND

Available in 12 Models

Manually and Electrically Operated

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Portable Cases or Panel Mounting

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Optional Changes to Conform to Customers' Requirements

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Let our Engineers help you with Your Special Timing Problems

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THE STANDARD ELECTRIC TIME COMPANY

97 Logan Street, Springfield 2, Massachusetts

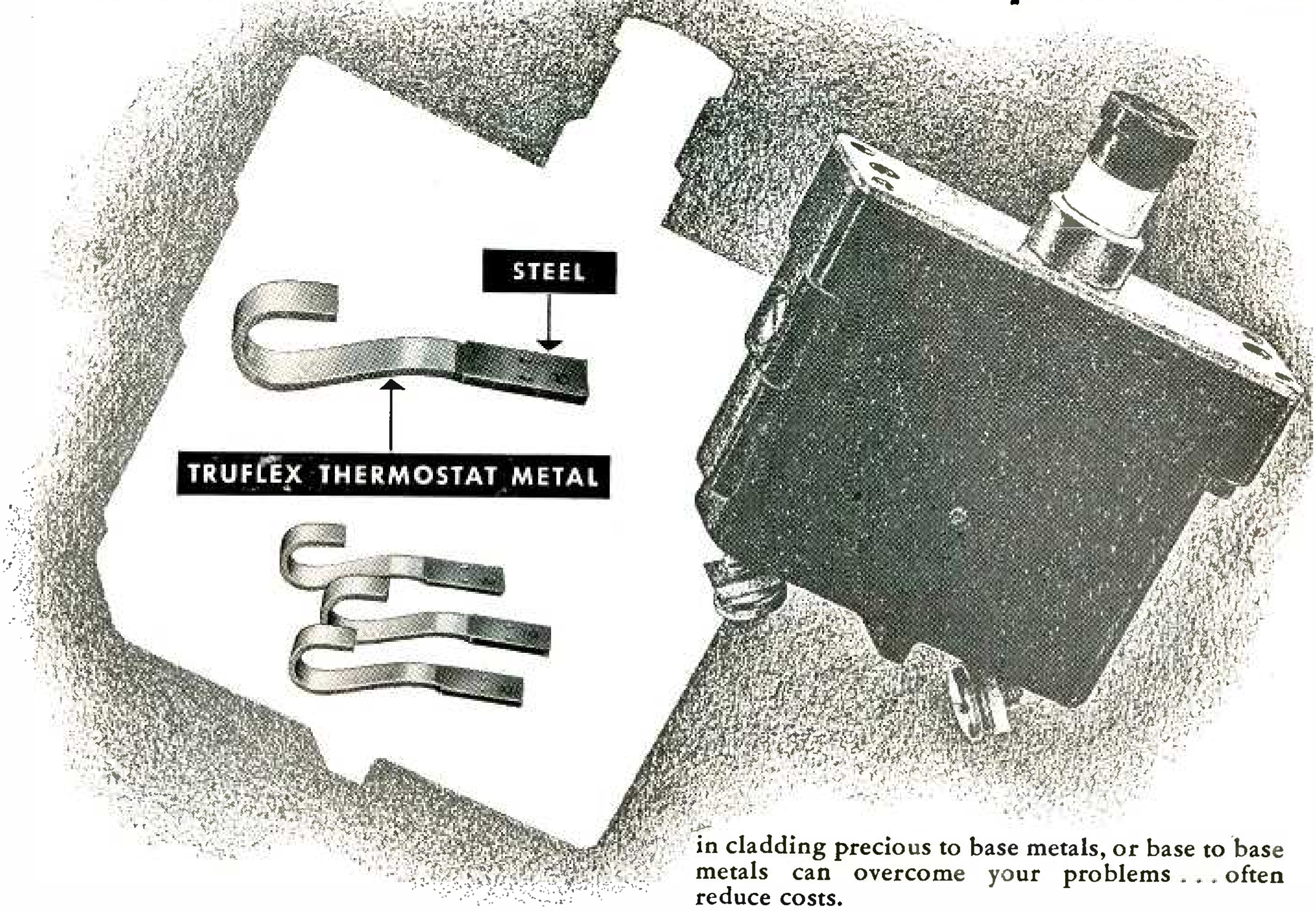
TIMERS AND CHRONO-TACHOMETERS
LABORATORY PANELS
PROGRAM CLOCK SYSTEMS **PIPELINE ANALYZERS**

Problem:

How to obtain controlled weld area and reduce costly fabrication of end to end welded circuit breaker parts

General Plate

Provided the solution with Steel edgebonded to TRUFLEX® thermostat metal – a Composite Metal



A leading manufacturer of circuit breakers had the problem of bonding a steel armature to a thermostat metal element. Individual butt welding of the small pieces was impractical due to the high cost of flash removal, and need of numerous inspections.

The problem was submitted to General Plate whose engineers quickly provided the solution by edge bonding steel to a Truflex thermostat metal ingot and then rolling the combination down to the proper size. As illustrated in the photograph, the result was a composite metal that was easily fabricated, gave the performance required and reduced costs considerably.

No matter what your problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals, or base to base metals can overcome your problems . . . often reduce costs.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, silver solders, composite contacts, buttons and rivets, Truflex® thermostat metals, Alcuplate®, platinum fabrication and refining, age-hardenable, #720 manganese alloy. Write for information.

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

GENERAL PLATE

Division of Metals & Controls Corporation

34 FOREST STREET, ATTLEBORO, MASS.

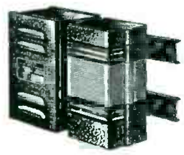
WIDEST

range of voltage regulator ratings and types available from stock

STANDARD TYPE "CV" UNITS:
15 VA to 10,000 VA

Most voltage regulating requirements can be met from these "stock" voltage regulating transformers. Regulation is ±1% or less with a total primary voltage variation as great as 30%. This is the static-magnetic voltage regulator that has become the "Standard of the World."

STANDARD SPECIALIZED TYPES:
Available from regular production stock:



HARMONIC NEUTRALIZED
. . . less than 3% harmonic distortion . . . ±1% regulation.

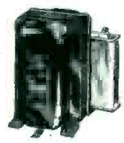
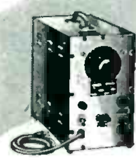
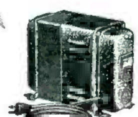


PLATE AND FILAMENT
. . . ±3% regulation or less . . . single, compact voltage source.



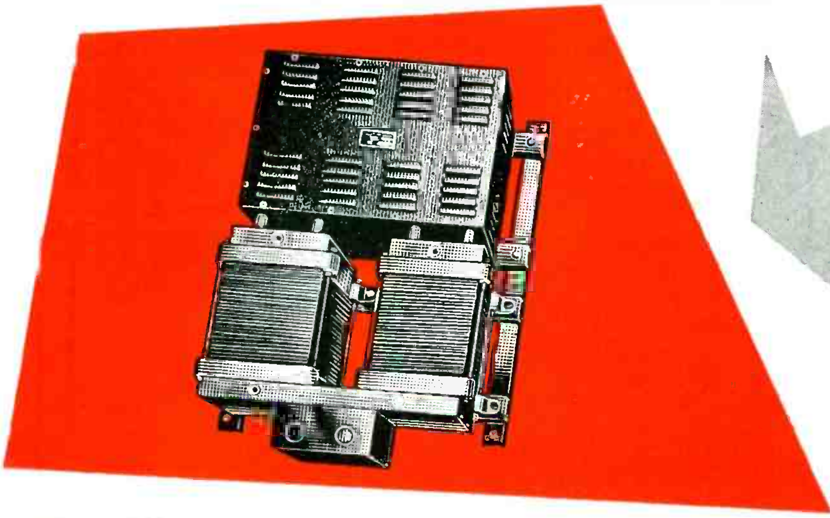
VARIABLE AC VOLTAGE SUPPLY
. . . less than 3% harmonic distortion . . . ±1% regulation.



TELEVISION ACCESSORY REGULATOR
. . . ±3% regulation . . . inexpensive . . . plug-in type.

CUSTOM DESIGNED UNITS: 1 VA to 25,000 VA

The wide flexibility of the SOLA Constant Voltage principle makes possible special designs to meet your specific requirements. Often, time and money can be saved by direct use or modification of a regulator from the several hundred special designs on file. Custom designs can include: SPECIAL VOLTAGE RATIOS, SPECIAL FREQUENCIES, COMPENSATION FOR FREQUENCY VARIATION, MULTIPLE OUTPUT VOLTAGES, THREE-PHASE SERVICE, and MILITARY SPECIFICATIONS.



New Catalog . . .

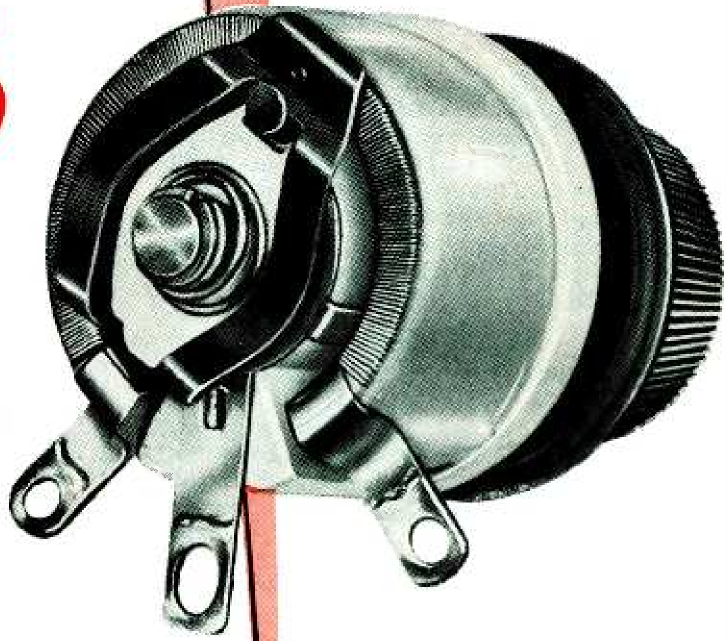
Write on your letterhead for our new Constant Voltage Catalog. It gives complete specifications, and operating data on SOLA Constant Voltage Transformers, including special units. Request Bulletin DCV-142.

SOLA *Constant Voltage* **TRANSFORMERS**

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois

The NEW rugged A-25

" Built to take it "



TYPE A-25 (25 WATT)

Tests show that our new A-25 rheostat is so rugged that it will stand up under the most adverse conditions!

It gives maximum wattage dissipation for its size; and the added safety factor made possible by our new high temperature blue-gray enamel.

The terminals, made of strong corrosion resistant alloy, are permanently welded to the winding form. The finest quality wire—made to our own specifications—is wound evenly on a toroidal ceramic form, and then securely bonded to eliminate troublesome connections.

The wound ring is made an integral part of the refractory base by vitreous enamel. The phosphor bronze actuating arm, to which is attached a graphite brush, gives perfectly smooth action, with excellent electrical control. And the shafts are insulated from all live parts by a strong shaft insulator.

Our A-25 units are equipped with three terminals to permit either potentiometer or rheostat use.

Send for new A-25 bulletin.

HARDWICK, HINDLE, INC.

Rheostats and Resistors

Subsidiary of

THE NATIONAL LOCK WASHER COMPANY

Established 1886 — NEWARK 5, N. J., U.S.A.

The mark of quality for more than half a century

JOHNSON *types* C and D CAPACITORS

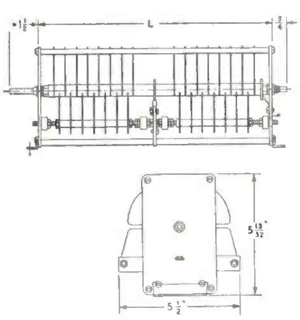
WE'RE PROUD of our C and D capacitors! They're rugged, reliable and simple. Their functional design permits rapid, accurate assembly which results in lower cost to the user. Materials are appropriate for the application and the finest available today. If you're building medium powered radio frequency equipment it will pay you to use JOHNSON C and D capacitors.

CONSTRUCTION

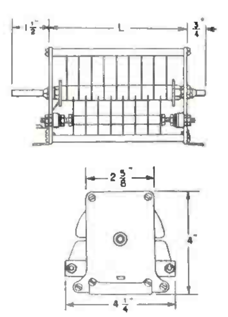
Heavy aluminum end frames, .051" plates and 5/16" tie rods assure extreme rigidity. Rotor contacts are laminated phosphor bronze. Dual models have center rotor contact for electrical symmetry. Low-loss Steatite insulators are located outside the most intense RF fields and used solely to support stator assemblies. Shafts are ¼" diameter, cadmium plated with ¾" rear extensions. Mounting brackets furnished for normal or inverted mounting. End frames drilled and tapped for panel mounting, special brackets or mounting of accessory components.

SPECIAL TYPES

Variations from standards such as special capacitances, ball bearings, dynamically balanced rotors, stainless steel shafts and right angle drive duals can be furnished in production quantities.

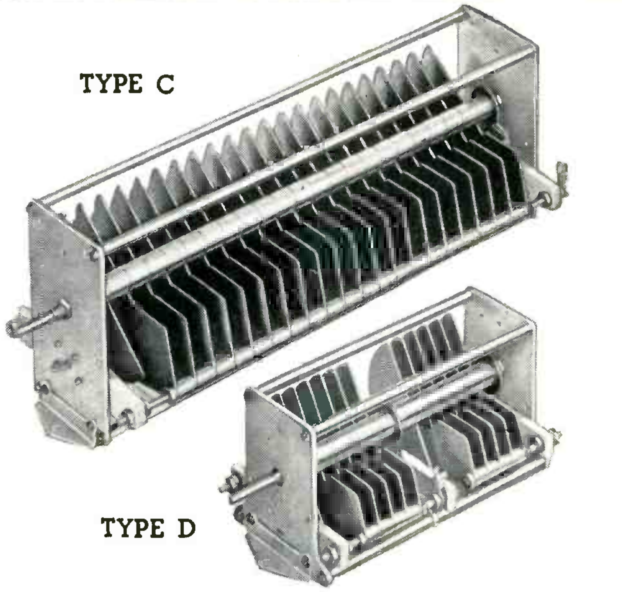


TYPE C DUAL



TYPE D SINGLE

Do you have our newest General Products Catalog 972? Most of this diverse line of electronic material can still be furnished with reasonable delivery. Here, perhaps, are the answers to some of your current production problems.



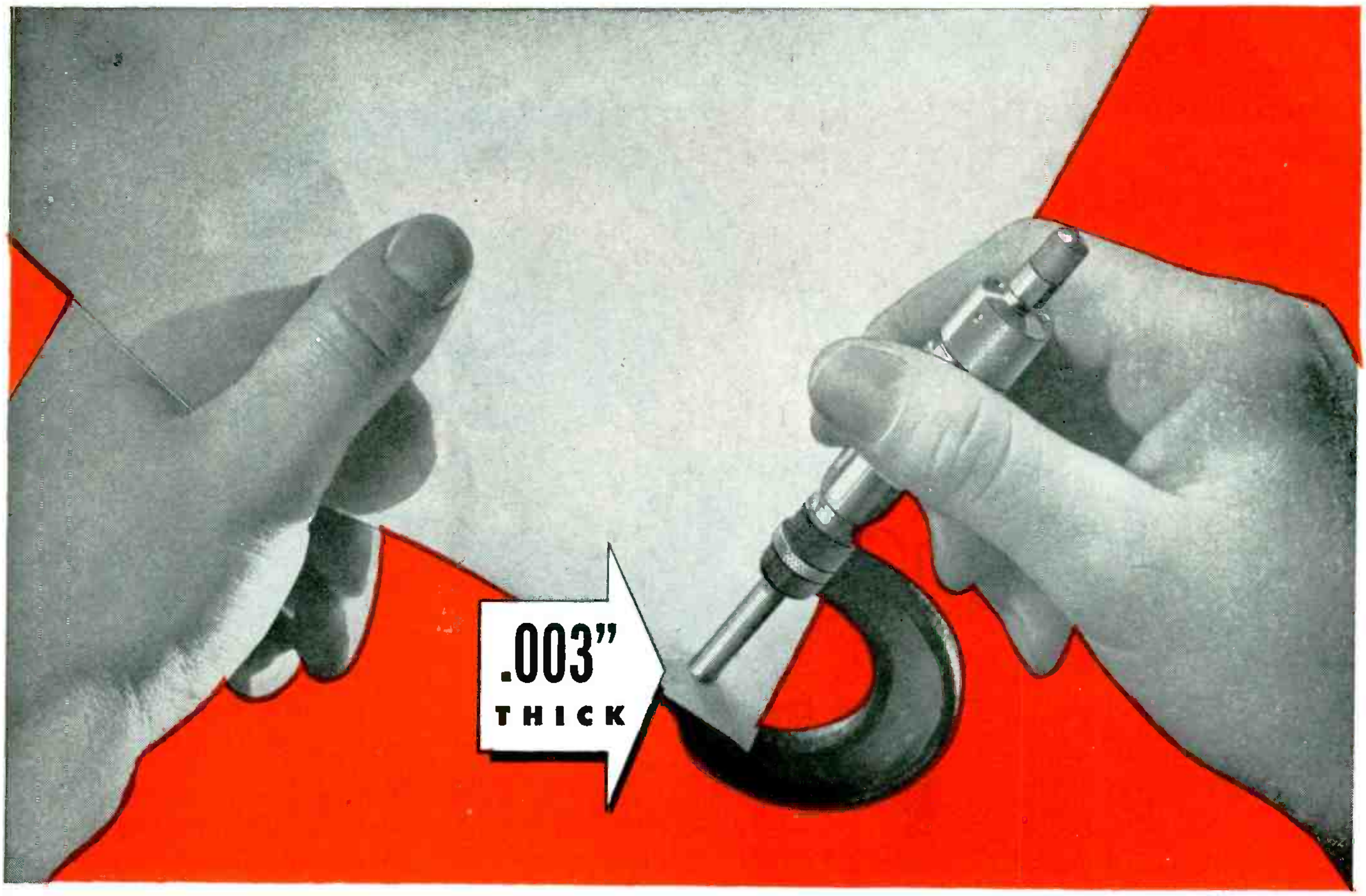
TYPE C SINGLE SECTION

*Cap. per Sect.

Cat. No.	Max.	Min.	Spacing	Plates Per Sec.	L
250C70	252	34	.175"	24	6 13/16
500C70	496	56	.175"	47	12 3/16
250C90	245	45	.250"	31	12 3/16
350C90	337	63	.250"	43	14 27/32
50C110	51	19	.350"	8	4 23/32
100C110	103	30	.350"	17	8 19/32
250C110	251	66	.350"	41	18 9/32
50C130	51	24	.500"	10	7 11/16
100C130	102	42	.500"	21	13 11/32
TYPE C DUAL SECTION					
200CD45	204	21	.125"	15	8 19/32
300CD45	290	26	.125"	21	10 5/16
200CD70	198	27	.175"	19	12 3/16
300CD70	305	37	.175"	29	16 25/32
150CD90	147	30	.250"	19	14 27/32
50CD110	50	18	.350"	8	10 5/16
100CD110	103	32	.350"	17	16 25/32
50CD130	51	24	.500"	10	14 27/32
TYPE D SINGLE SECTION					
100D35	99	14	.080"	8	2 29/32
250D35	252	24	.080"	20	4 25/32
500D35	496	36	.080"	39	6 25/32
100D45	104	19	.125"	12	4 25/32
150D45	146	23	.125"	17	4 25/32
50D70	51	17	.175"	7	2 29/32
70D70	72	18	.175"	11	4 25/32
100D70	98	23	.175"	15	4 25/32
150D70	151	31	.175"	23	6 13/16
250D70	244	45	.175"	37	10 5/16
350D70	351	62	.175"	53	13 11/32
50D90	53	20	.250"	10	4 25/32
70D90	73	25	.250"	14	5 13/16
100D90	99	30	.250"	19	7 11/16
150D90	149	43	.250"	29	10 1/16
TYPE D DUAL SECTION					
100DD35	95	13	.080"	8	4 25/32
150DD35	147	15	.080"	12	5 13/16
200DD35	202	19	.080"	16	7 11/16
300DD35	291	24	.080"	23	9 15/32
500DD35	496	38	.080"	39	13 11/32
150DD45	155	24	.125"	18	9 15/32
200DD45	198	27	.125"	23	12 3/16
50DD70	52	15	.175"	8	5 13/16
70DD70	72	17	.175"	11	7 11/16
100DD70	97	22	.175"	15	9 15/32
150DD70	151	31	.175"	23	13 11/32
50DD90	52	19	.250"	10	9 15/32
100DD90	97	30	.250"	19	14 27/32

*Nominal Values

E. F. JOHNSON COMPANY WASECA, MINNESOTA



Here's a new thin Class "H" insulation . . .
IRVINGTON Silicone-Coated Novabestos

Only .0025" to .003" thick—suitable for continuous operation at 180° C —offering excellent electrical and good physical properties—Irvington Silicone-Coated Novabestos is ideally suited for any application requiring a thin high-temperature insulation.

Irvington Silicone-Coated Novabestos consists of a special grade of very thin, very pure long-fiber asbestos formed into continuous-length rolls, and completely saturated and coated with silicone resin.

Silicone-Coated Novabestos is a *two-way* space-saver in the design of electrical and electronic equipment. Since it meets all Class "H" requirements, it allows windings to run at higher temperatures, and thus permits more compact construction. Its exceptional thinness cuts down the space needed for insulation—effecting savings in weight as well as in size.

If you've been looking for a thin Class "H" insulation, you'll certainly want to know about this new product of Irvington insulation leadership. Just send the coupon for technical data sheet.

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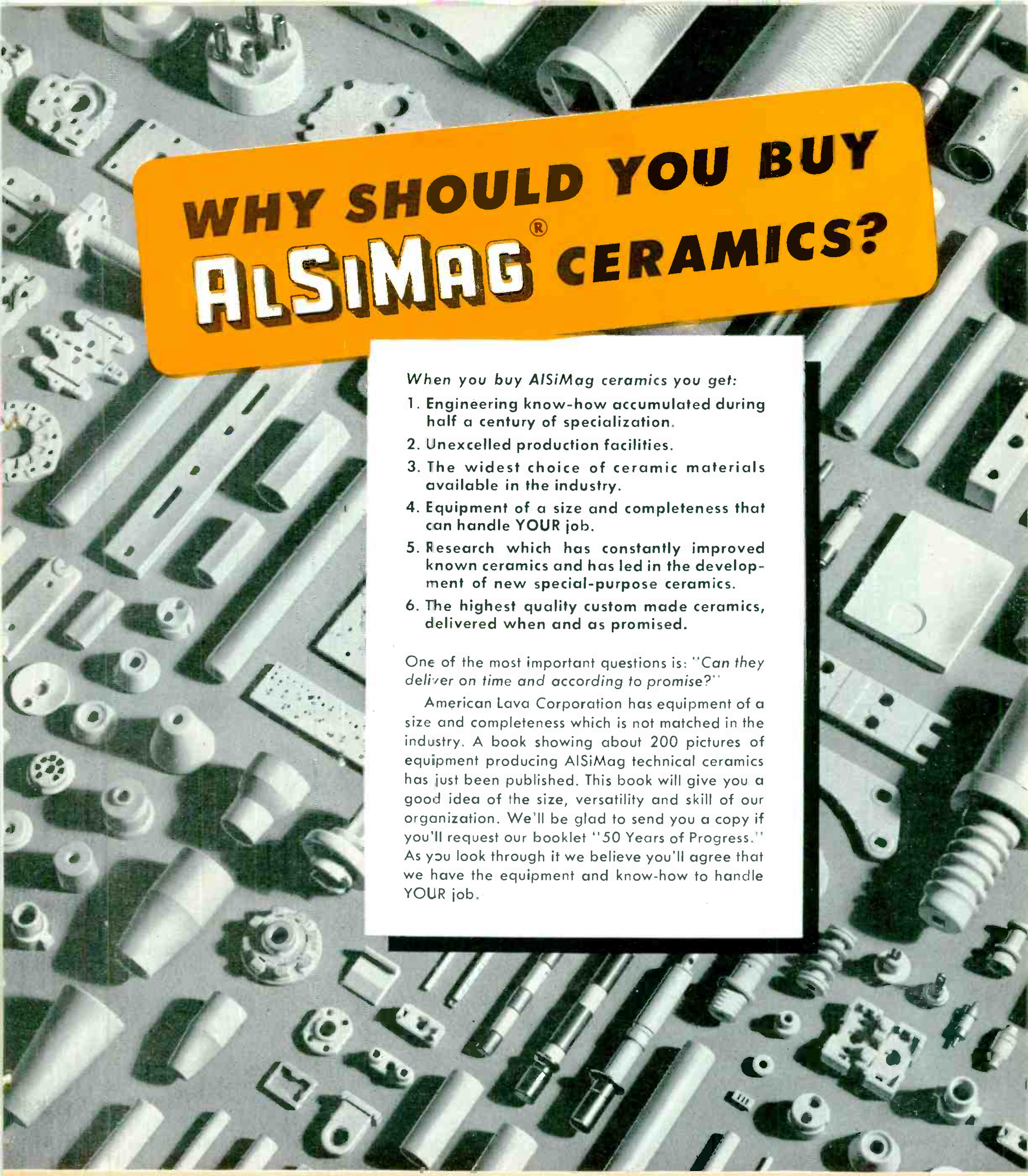
For Further Information, Consult pages 92-93 in the 1951-1952 Electronics Buyers' Guide



WHY SHOULD YOU BUY ALSIMAG® CERAMICS?

When you buy AlSiMag ceramics you get:

1. Engineering know-how accumulated during half a century of specialization.
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6. The highest quality custom made ceramics, delivered when and as promised.

One of the most important questions is: *"Can they deliver on time and according to promise?"*

American Lava Corporation has equipment of a size and completeness which is not matched in the industry. A book showing about 200 pictures of equipment producing AlSiMag technical ceramics has just been published. This book will give you a good idea of the size, versatility and skill of our organization. We'll be glad to send you a copy if you'll request our booklet "50 Years of Progress." As you look through it we believe you'll agree that we have the equipment and know-how to handle YOUR job.

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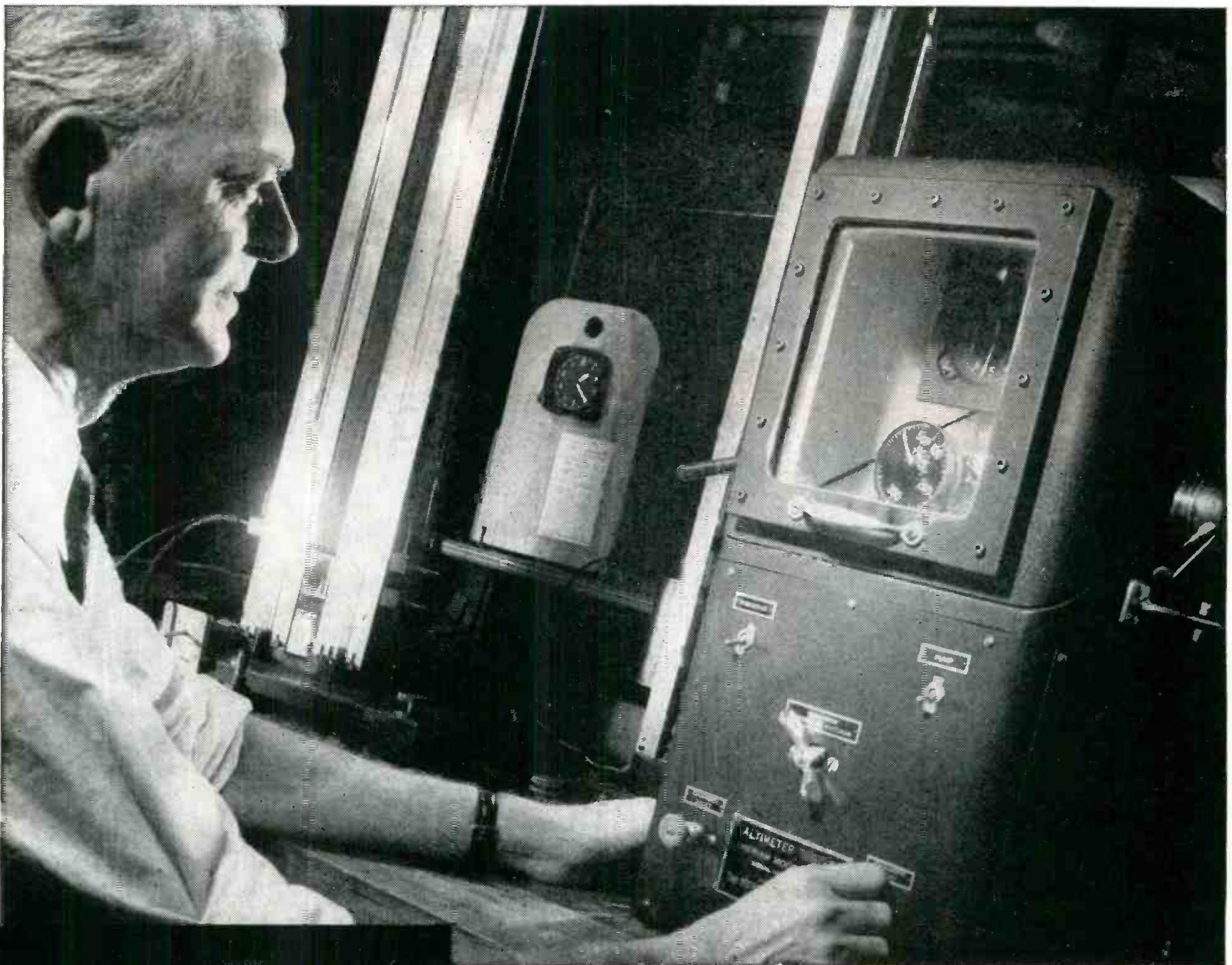


TIME SAVERS IN THREE SIZES

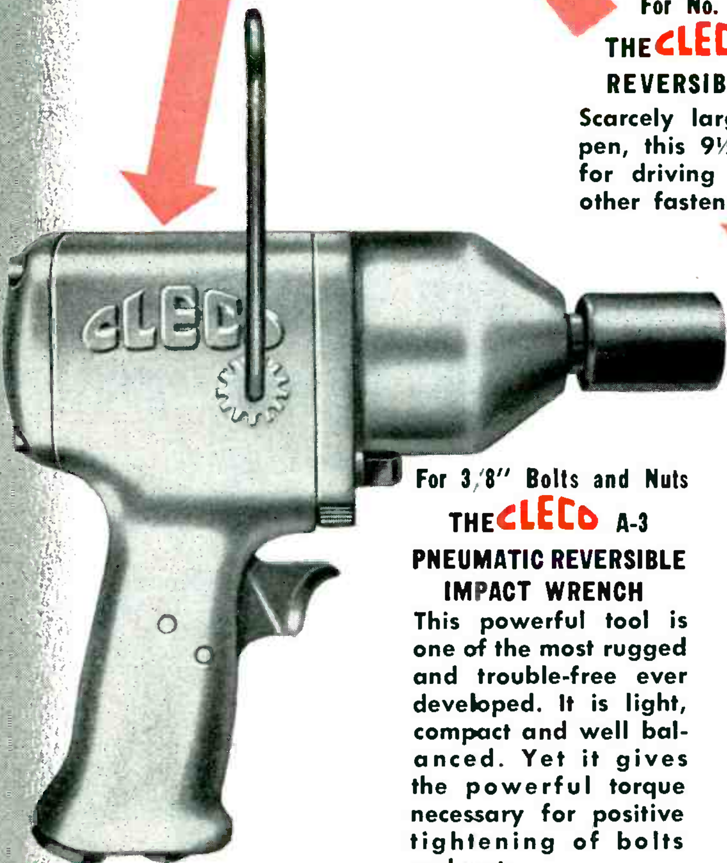
CLECO AIR-OPERATED SCREW DRIVERS AND NUT RUNNERS

One of these air-operated tools can cut your assembly costs by driving screws or running nuts faster. Each tool is tailored to the requirements of the job, each is light and easy to handle. Ask your Cleco Field Engineer for a demonstration.

For No. 8 Machine Screws

THE CLECO A-1 PNEUMATIC REVERSIBLE SCREW DRIVER

Scarcely larger than a fountain pen, this 9½-ounce tool is ideal for driving small screws and other fasteners.



For 3/8" Bolts and Nuts

THE CLECO A-3 PNEUMATIC REVERSIBLE IMPACT WRENCH

This powerful tool is one of the most rugged and trouble-free ever developed. It is light, compact and well balanced. Yet it gives the powerful torque necessary for positive tightening of bolts and nuts.

For 1/4" Bolts and Screws

THE CLECO 9RSPC REVERSIBLE SCREW DRIVER

This production tool features the new Cleco adjustable clutch with sturdy slip-impact action for final tightening. Finders and bits are easily changed without dismantling any part of the tool.

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THE LITTLE INDIAN SAYS.

Sangamo can furnish

SILVERED MICA BUTTON CAPACITORS for any requirement

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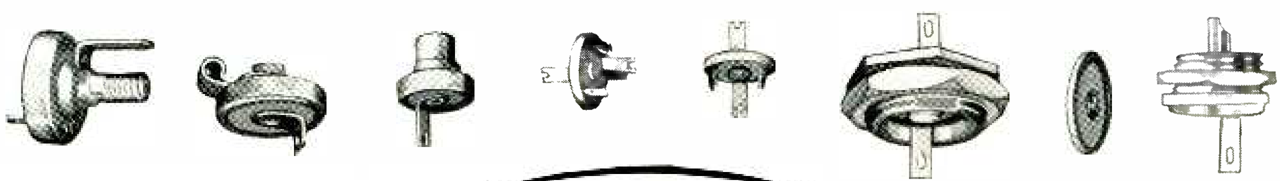
You can count on Sangamo whenever you need small sized, light weight button capacitors that are electrically and mechanically stable.

Sangamo Silvered Mica Button Capacitors meet all requirements of components for V. H. F. and U. H. F. applications. They have extremely low series inductance—ideal for application in high frequency circuits. Button capacitors with temperature coefficients and drift characteristics up to and including "E" of JAN-C-5 specification can be furnished. These capacitors are encased in silver plated, corrosion resistant brass. The case serves both as a shield and as the low potential terminal.

Sangamo Buttons are stable over a normal operating range from minus 50° C to plus 85° C. Higher operating temperature requirements will be considered and may be negotiated with our engineering department.



Those who know ... *choose Sangamo*

The SANGAMO Tribe

PAPER·MICA·SILVER·ELECTROLYTIC CAPACITORS

SANGAMO ELECTRIC COMPANY

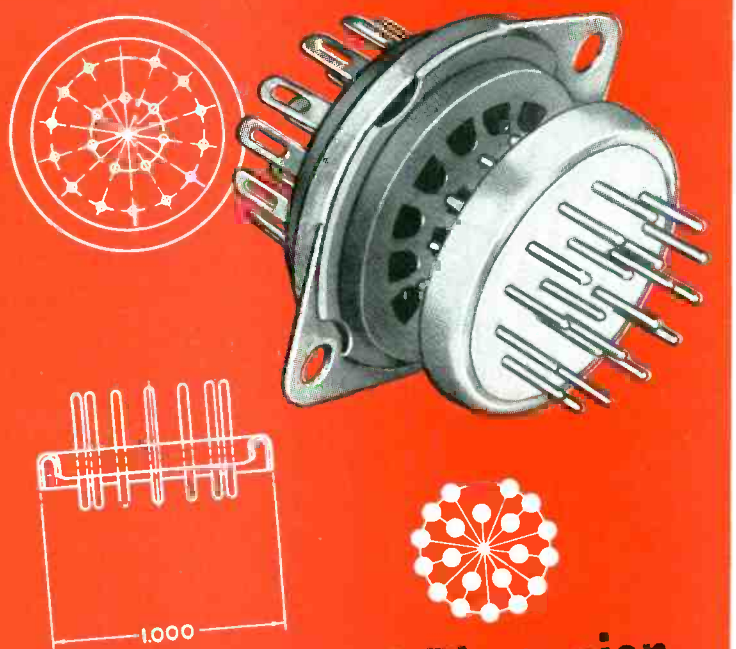
MARION, ILLINOIS

SC52-4

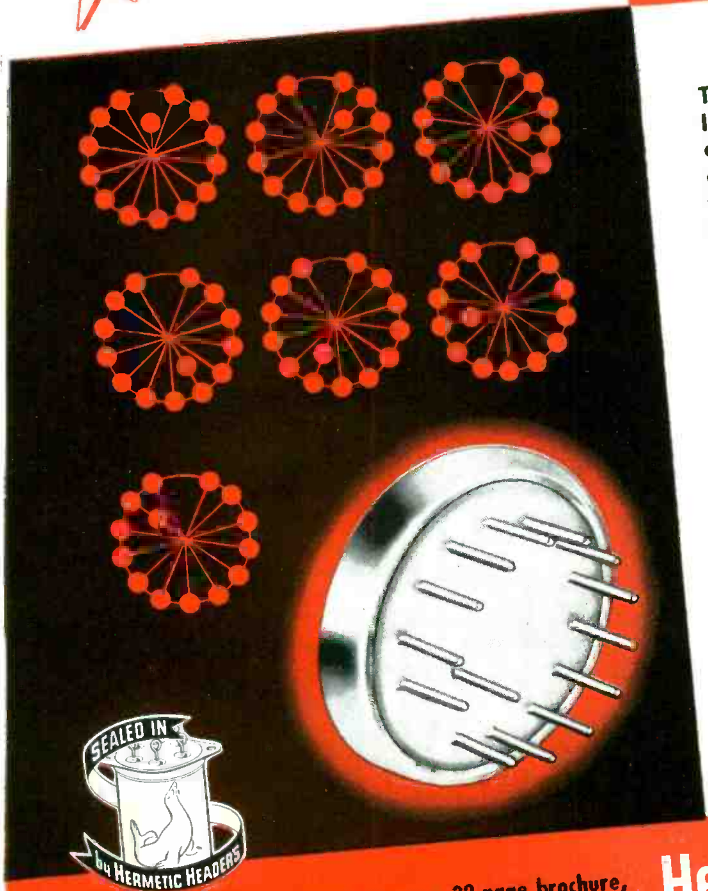
IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

Another Great *Hermetic* FIRST in MINIATURIZATION

The socket shown below was made by the Cinch Manufacturing Co., of Chicago, Illinois.



★ 20-Terminal, Plug-In Header In 1″ Dimension



The Electro-Seal Corporation of Des Plaines, Illinois, is an acknowledged leader in the field of hermetically sealed electronic components of exceptional quality. It was natural, therefore, that it should single out HERMETIC SEAL PRODUCTS CO. to develop a needed, polarized 20-terminal, plug-in header in a 1″ maximum dimension. It knew that only HERMETIC, with its vast experience, equipment and engineering staff could design and develop such a plug . . . one that would be able to withstand the mass spectrometer tests to which it would be subjected for leaks and cracks. Each and every component is thoroughly tested in Electro-Seal's efforts to maintain the quality standard for which it has become famous.

● The 20-terminal, ceramic-metal plug has 7 terminals on the inside circle and 13 in the outer circle. It is also available for other applications as a 14-terminal plug-in with 7 different polarized positions as shown on the print.

Submit your own problems in this highly exacting field to our specialist-engineers. They are eager to be of help.

Write for your copy of our new 32-page brochure, the most complete and informative presentation ever made on hermetic seals.

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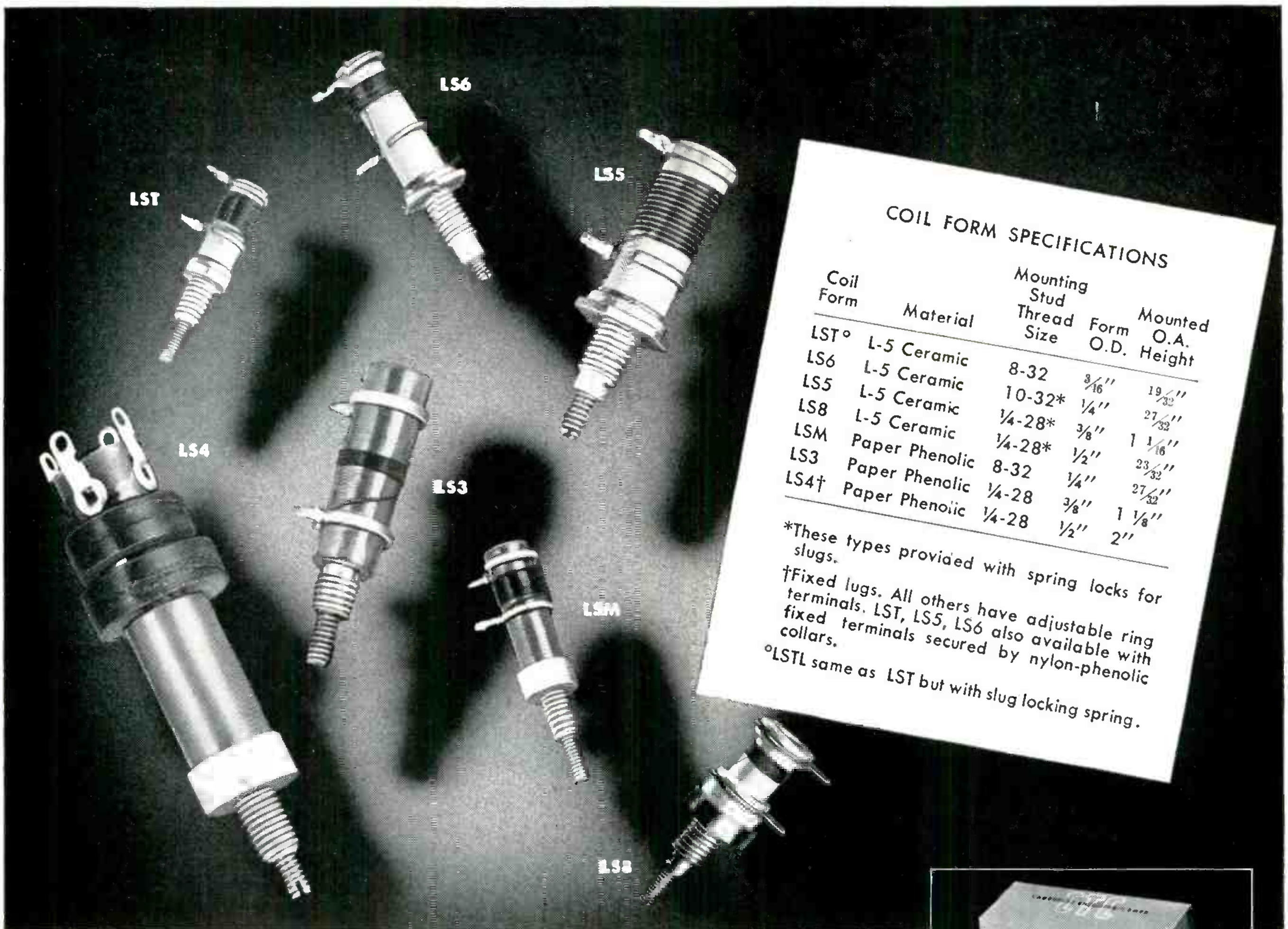


COIL FORM SPECIFICATIONS

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*	1/2″	23/32″
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″

*These types provided with spring locks for slugs.

†Fixed lugs. All others have adjustable ring terminals. LST, LS5, LS6 also available with fixed terminals secured by nylon-phenolic collars.

°LSTL same as LST but with slug locking spring.

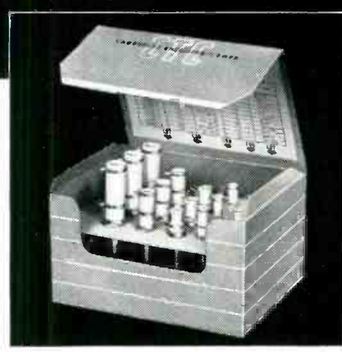
Here are the coils you want
...*the way you want them!*

Take advantage of one of C.T.C.'s most popular and useful services . . . the winding of slug tuned coils to exact specifications. Single layer or pie types furnished. You can be sure your specs — military or personal — will be faithfully followed to the last detail of materials and methods, and with expert workmanship.

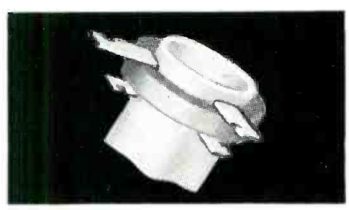
C.T.C. coil forms are made of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting bushings are cadmium plated brass and ring type terminals are silver plated brass. Terminal retaining collars of nylon-phenolic also available in types LST, LS5, LS6.

Wound units can be coated with durable resin varnish, wax or lacquer. Both coils and coil forms are furnished with slugs and mounting hardware — and are obtainable in large or small production quantities. Be sure to send complete specifications for specially wound coils.

All C.T.C. materials, methods, and processes meet applicable government specifications. For further information on coils, coil forms or C.T.C.'s special consulting service, write us direct. *This service is available to you without extra cost.* Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers, contact: E. V. Roberts, 5014 Venice Blvd., Los Angeles, and 988 Market Street, San Francisco, California.



NEW CERAMIC COIL FORM KIT. Helps you spark ideas in designing electronic equipment or developing prototypes and pilot models. Contains 3 each of the following 5 C.T.C. ceramic coil form types: LST, LS5, LS6, LS7, LS8. Color-coded chart simplifies slug-identification and gives approximate frequency ranges and specifications. Nylon-phenolic collars to replace metallic rings available with kit for all ceramic coil forms except LS7 and LS8.



NEW NYLON-PHENOLIC COLLARS. Terminals held securely; soldering spaces doubled; excellent for both bifilar and single pie windings. Show an increase in Q and many new benefits over metallic rings — without impairing in any way the moisture- and fungus-resistant qualities of coil form assemblies.

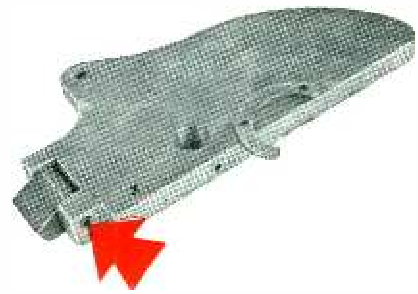
CAMBRIDGE THERMIONIC CORPORATION

custom or standard . . . the guaranteed components

See our listing in Electronics Buyers' Guide

AS A SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

AS A DOWEL . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.



AS A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application above is with the plate of a home workshop tool.

AS A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than usual assemblies.

AS A STOP PIN . . . in this application, Rollpin is shown in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.

AS A SIMPLE FASTENER . . . Rollpin replaces a set screw in pinning a gear to a shaft. Assembly time is shorter, service life longer. Vibration-proof flush fit. Easily removable.

YOUR IMPORTANT FASTENING JOBS

are cheaper . . . faster, with ROLLPIN

TRADE MARK

Rollpin is a pressed-fit pin with chamfered ends. It drives easily into holes drilled to normal tolerances, compressing as driven. No reaming, no tapering, no extra assembly steps required. Rollpin fits flush, *locked* in place by the constant pressure it exerts against the hole walls. Can be inserted with automatic press, or by hand—removable with a drift or pin punch.

Rollpin is reusable again and again.

Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA

MAIL COUPON TODAY. If your present operations or plans include the above applications—or set screws, rivets, hinge pins, cotter pins, pivot pins, taper pins—you can't afford to be without complete details on Rollpin. Write now—find out how much faster and cheaper Rollpin can do the job.

Section R1-421, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, N. J.

Please send me the following free information on ESNA self-locking fasteners:

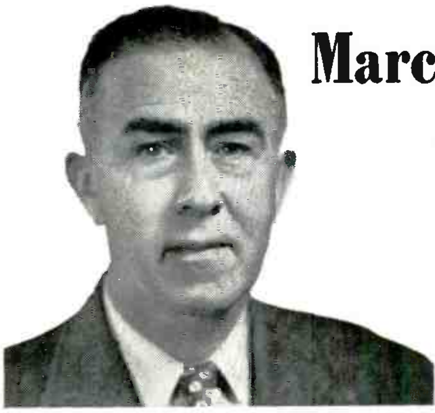
- ☐ Rollpin bulletin and sample Rollpins
- ☐ AN-ESNA conversion chart
- ☐ Elastic Stop Nut Bulletin
- ☐ Here is a drawing of our product. What fastener do you recommend?

Name__________ Title__________

Firm__________

Street__________

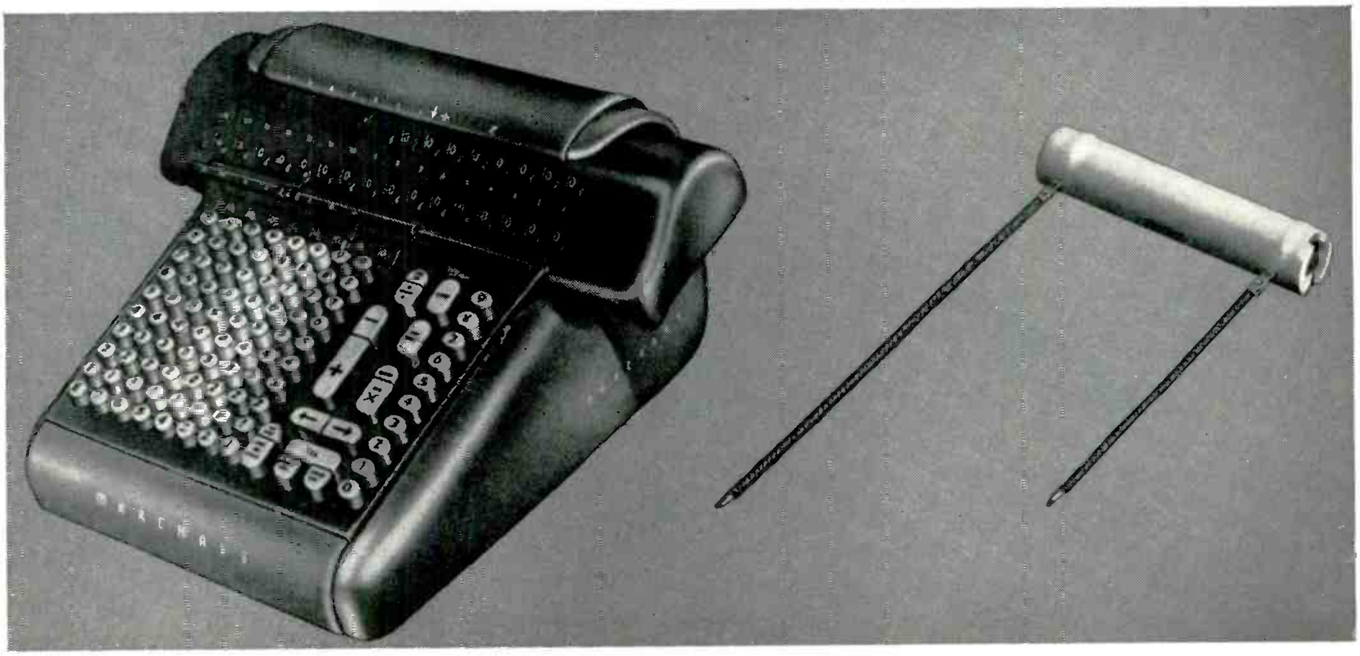
City__________ Zone_____ State_____



Marchant Calculating Machine Company

"They make no mistake in figuring resistor costs"

says L. F. Church, L. F. Church Company, San Francisco, representative for Ward Leonard Electric Company



It's *cost in terms of performance* that counts with the makers of Marchant calculators.

A lot of arithmetic would be delayed if resistors failed to work in these push-button multiplication calculators. That's why Marchant insists upon quality resistors, rather than taking a chance with bargains.

How do you *tell* a quality resistor?

It's true that most resistors look alike. A resistor is a simple piece of equipment—really nothing more than a piece of ceramic tubing . . . a couple of terminals . . . a piece of resistance wire . . . and a protective coating.

But there the similarity ends, because in the *important* things that really count, resistors are miles apart! And the biggest difference is that all of the resistor is actually *made* by the company that sells it.

The only way to be sure that all components will react the same to changes in temperature is to balance their thermal characteristics.

Take the tube. Companies like Marchant are depending on that high-density, non-porous, high-dielectric strength, perfectly cylindrical Ward Leonard ceramic core, with smooth surface and straight ends.

They also know the terminals are made of the right alloy to permit proper expansion . . . and that they're securely, rigidly, clamped to the core.

They know the wire is drawn especially for their type of resistor . . . is capable of withstanding great overloads . . . has uniformly low coefficient of resistivity. They also know the coating provides a complete hermetic seal, highly resistant to thermal shock and to high humidity, acids, alkalies, electrolysis.

You can be sure of quality, by buying your resistors from the *one* manufacturer who manufactures, not just assembles, all the components that go into resistors. Play it safe and sound—insist upon VITROHM resistors.

WARD LEONARD

WARD LEONARD ELECTRIC COMPANY

MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

CERAMIC CORES are made by extruding refractory material from hydraulic presses such as this in Ward Leonard's plant.

RESISTANCE WIRE sample is being processed in the combustion furnace to insure accuracy of alloy formula.

VITREOUS ENAMEL for coating is fritted, then ground to exact fineness in these revolving "ball mills."

VITROHM vitreous enamel is measured by interferometer for coefficient of thermal expansion, melting and annealing points.

Uniform Quality—Matched Thermal Characteristics—Long Service Life of VITROHM Resistors—Result From Unified Manufacture

All components of a VITROHM resistor are made by Ward Leonard, the only manufacturer who *makes*, not just assembles, all parts.

Vitreous enamel coating and ceramic cores are formulated and made by Ward Leonard—wire is drawn to their specifications.

This means that all parts are uniform in quality, balanced in respect to thermal coefficient of expansion.

There's no loosening, no failure, due to unbalance of thermal characteristics, heat affects all parts the same way, which in turn means longer life.

VITROHM resistors will stay on the job under the most adverse operating conditions where a less carefully made resistor would break down. Thermal shock, vibration, corrosive atmosphere, overloads, even prolonged exposure to humidity and electrolysis will not affect their performance.

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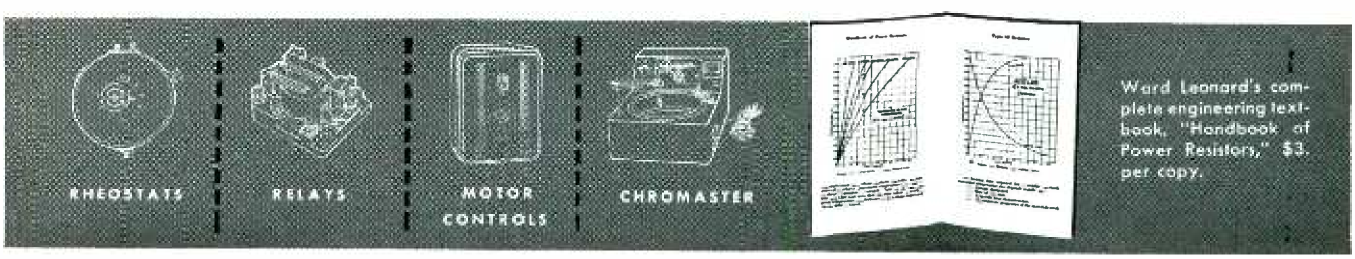
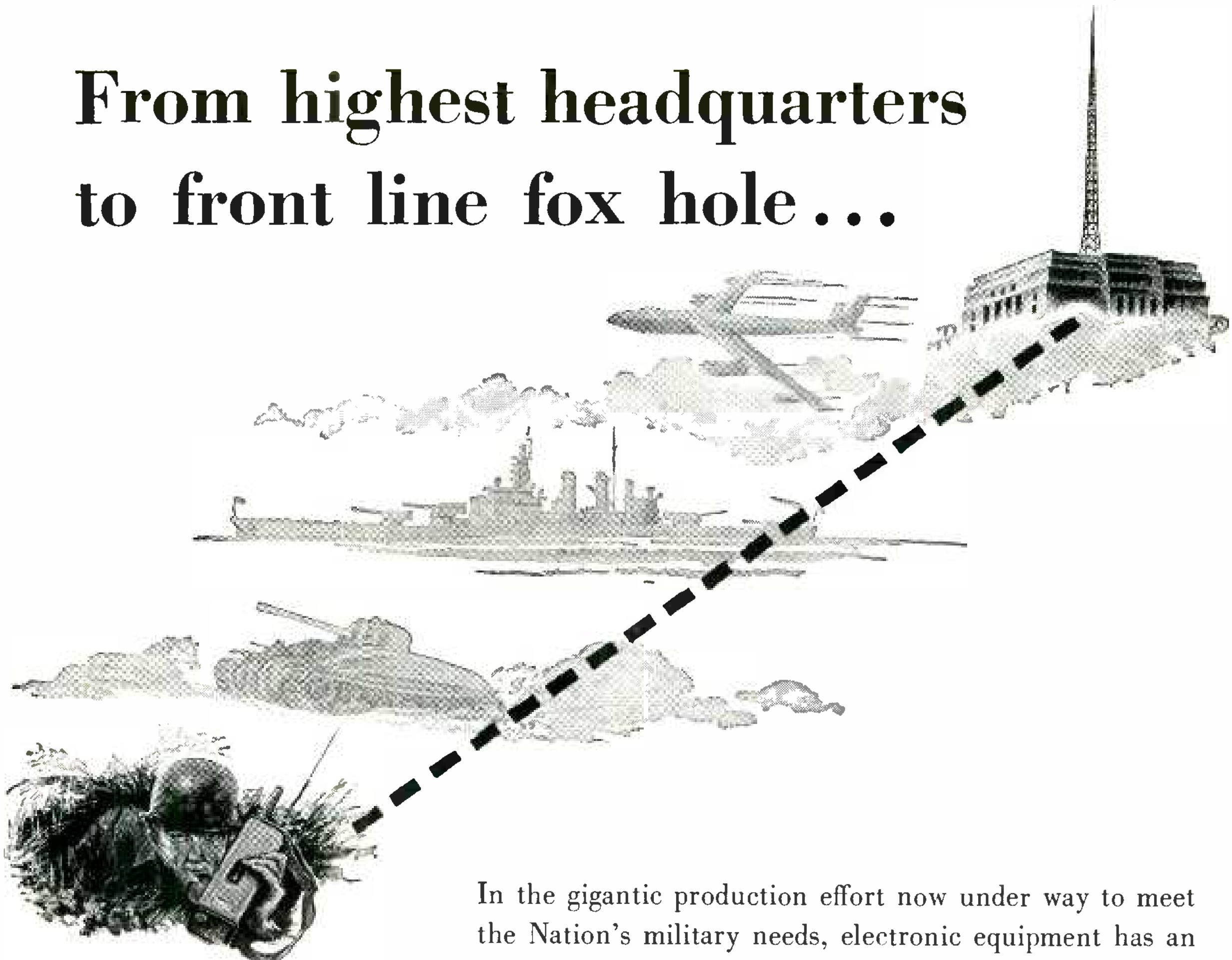


From highest headquarters to front line fox hole...



In the gigantic production effort now under way to meet the Nation's military needs, electronic equipment has an increasingly responsible role.

At every level, from highest headquarters to front line fox hole, military personnel and equipment depend on electronic devices. And no electronic equipment can operate without capacitors.

To assure dependable performance of their equipment, many manufacturers rely on Mallory capacitors.

They know Mallory produced the first high voltage dry electrolytic capacitor . . . pioneered electrolytic capacitor miniaturization . . . developed designs providing long shelf life and wide temperature range characteristics. They know Mallory offers unique facilities, personnel and products.

It will pay you to use Mallory capacitors in your electronic equipment . . . to consult Mallory on any problem involving the application of standard capacitors, the development of special types, or the simplification of related circuits.

Key to Subminiaturization

Timely example of Mallory capacitor know-how is the new Tantalum capacitor, developed by Mallory for the Armed Forces subminiaturization program. It is remarkably efficient from —60°C. to +200°C.

P.R. MALLORY & CO. Inc.
MALLORY

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CROSS TALK

► **AGIN NATURE** . . . The current conjecture is that the FCC plan for defreezing television stations will allow radiated power of 100 kw on channels 2 to 6, 200 kw on channels 7 to 13, and 1,000 kw (or possibly unlimited power) on the uhf channels 14–83. This looks like rather rank discrimination against the pioneering television stations, who ran up the red ink during the early years of tv broadcasting, most of which sit on channels 2 through 6. It also looks, less obviously, like some fairly ripe discrimination against a potfull of potential televiewers in remote areas.

The reasoning behind it has a bureaucratic ring. Seems like everyone is now agreed that stations on uhf channels will have a tough time competing with vhf stations, since nature has arranged that vhf signals carry farther, for given power and antenna height, than do uhf signals. The Commission is understandably anxious to have the uhf spectrum occupied, despite this disadvantage, and is accordingly doing everything in its power to augment uhf coverage by allowing higher power to be used. This is known as legislating a fact of nature into oblivion.

We predict the differential in allowed power won't last long, for the following reasons: Whatever power can be economically radiated on uhf channels, more power can be radiated for the same cost on the vhf channels. This is true because efficiencies are higher in vhf tubes and circuits. It is also true that whatever coverage you can get on uhf channels with high power, you can get more coverage on vhf channels with the same high power. This follows from the fact of nature cited above.

So, if you hold down vhf powers to 100 or 200 kw while allowing uhf stations 1,000 kw, you cut off service to those who live just beyond the range of either class of station, service which could be rendered only if the vhf stations were allowed higher power. These marginal viewers may not seem important right now, but lots of 'em are members of the grange, and we predict they'll be heard, and loud, just as soon as the rural Congressmen find out that the lack of service has been legislated, not imposed by nature. Then the power restriction on vhf stations will most certainly be abandoned, at least in those localities where interference levels permit increases in power without detriment to the existing service.

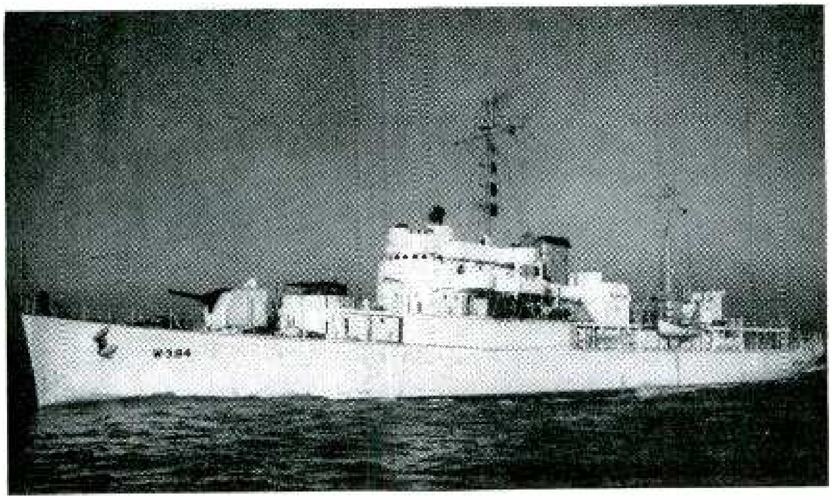
Some government engineers are muttering that the proposed differential in power is justified by the fact that coverage limitations on uhf channels will also restrict interference. But that's wishful cogitation in our book. A megawatt may create more interference but it will also serve more people than 200 kw. The interference pattern remains constant when all stations on the same and adjacent channels continue to operate with equal power, no matter what the absolute level of that power.

► **FIGURES** . . . To those who haven't yet studied our statistics page "Figures of the Month" (p 4 each issue) we recommend at least a cursory glance. We're amazed every time we read the proofs. Last month, for example, the number of amateur station licenses exceeded 100,000 for the first time. The figure this month is 103,570! Know how many receiving tubes are sold a month? Something like 30 million, 20 million of which go into new tv and radio sets. The current factory value of tv sets is about 9 times that of electric radio sets. The value of induction-heating equipment currently ordered is about 9 times that of dielectric ditto. The tv set population in Chicago and Los Angeles is a standoff. There are 506 applications for tv stations pending before the FCC. Advertisers spent \$28.4 million with the major tv and radio networks in the month of December 1951.

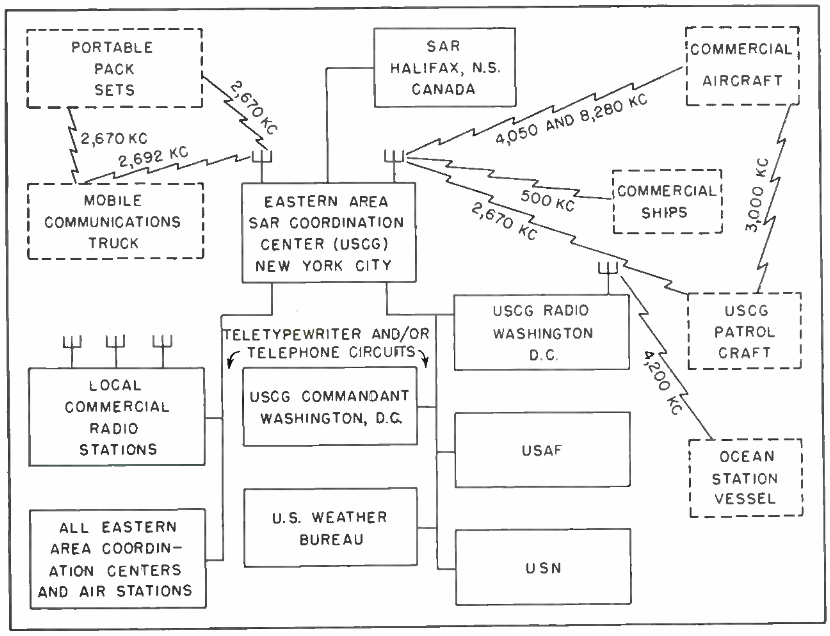
The FOM page is meant for browsing; so browse away. We dare you not to be impressed with the length and breadth of this electronics business of ours.

Electronics in SEARCH and RESCUE

Communications networks quickly coordinate land, sea and air transport for rescue of disabled-aircraft and ship personnel. Weather instruments, navigational aids and signals using vacuum-tube techniques are exemplified on floating islands in the Atlantic Ocean



USCG cutter "Cook Inlet" is typical Ocean Station Vessel engaged in weather and rescue service in the North Atlantic under ICAO agreement with other countries



Teletypewriter, telephone and radio-circuit connections from a representative Search and Rescue Coordination Center to cooperating agencies, aircraft and ships. There are many other possible interconnections among the various mobile units

SEARCH AND RESCUE (SAR) is an international civil service to insure greater safety of life at sea and in the air. Although of primary importance on or near the ocean, its charter provides for service to overland flights and in disasters such as floods.

The Department of Commerce, through CAA, is responsible for developing and integrating plans for civil aviation search and rescue on land of United States jurisdiction and acts as the coordinating agency in areas not otherwise covered by the Treasury Department. The Department of Defense makes its facilities available for civil needs when called upon by a coordinating agency. The Weather Bureau (Department of Commerce), Civil Aeronautics Board and the Federal Communications Commission also participate.

Role of Coast Guard

The Treasury Department, through the United States Coast Guard, is responsible for search and rescue facilities on and over the high seas, bodies of water and the land areas adjacent. For this reason, the role of the Coast Guard has been more romantic and varied than that of any other one agency.

The electronic equipment controlled by Commander, Eastern Area SAR Coordination Center (USCG) in New York City is representative of that used in other areas. It indicates the utter dependence of safety measures upon

By A. R. DaCOSTA

Chief Radioman, USCG
Cape May Court House
New Jersey

Typical radiobeacons useful to ocean vessels and over-sea aircraft. Conventional d-f equipment is used with first five in list

several modern electronic techniques.

The following description lists only equipment and operations of an unclassified nature not affecting the military or naval security of the United States. Details of all offshore aids to navigation and pilotage are likewise beyond the scope of this article.

Not illustrated is the Primary Radio Station common to each Coast Guard district. These stations handle all offshore radio traffic for the district besides guarding 500 kc (international distress frequency), 2,670 kc (CG calling and small-boat distress frequency) and 8,280 kc (interim U. S. h-f safety and distress frequency). These stations are also equipped to take m-f direction-finder bearings.

Each district maintains at least one cutter in constant communication with the shore and equipped with loran, radar and conventional direction-finding equipment. Cutter and Ocean Station Vessels crews are trained to pick up survivors from aircraft that are forced to ditch in the area that they are guarding. Such craft may sink within seconds or a few minutes of hitting the water.

The Search and Rescue coordinator may have to call upon FCC monitoring stations for assistance in obtaining long-range fixes on lost or disabled air and seacraft. The Commission operates the only monitoring and direction-finding net of its kind in the United States. There are sixteen stations interconnected by communications circuits on the

TYPICAL RADIOBEACONS

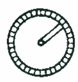
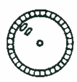
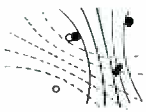
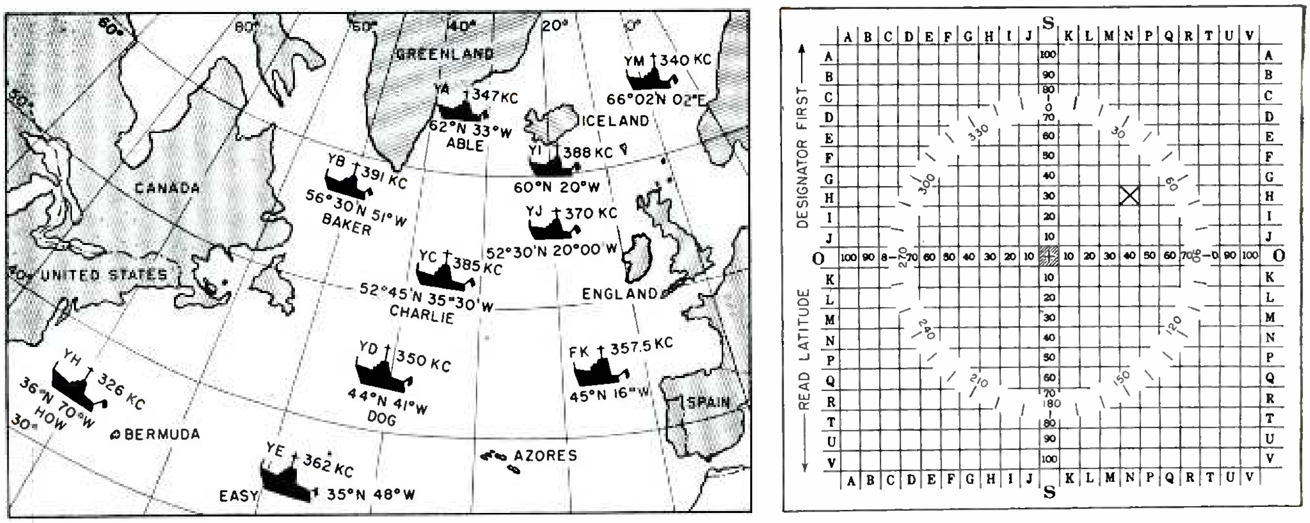
	Lighted Buoy Marker	Low-power radio marker beacon for harbor entrances and channels where shore installation impracticable.
	Manasquan Inlet (see explanation) 312 kc	10-mile range, marker. Continuously sends 0.5-second mcw dashes for 13.5 sec; silent 1.5 sec.
	Scotland Lightship —•—• 294 kc	20-mile range, omnidirectional, continuous carrier with 1,000-cps code superimposed.
	Barnegat Lightship — — — 286 kc Simultaneous Fog-horn Signal	100-mile range, omnidirectional, on 1, off 2 minutes during low visibility; on from 20 to 30 minutes past and 50 to 60 minutes past each hour in fair weather. Fog horn sounds simultaneous with mcw radio signal. Time delay indicates distance.
	Cape Cod (shore) — — • — 302 kc	200-mile range, omnidirectional, carrier on 1, off 2 minutes with 1,000-cps code superimposed. Most powerful type of radiobeacon. Like all those above, can be used to take direction-finder bearings.
	Corner Reflectors	Radar corner reflectors mounted on standard lighted buoy give strong reflection for ship radar.
	Ramark Presentation on PPI	Ship radar is detuned slightly to pick up Ramark beacon signal. All other targets disappear. Only azimuth of Ramark is shown on PPI.
	Racon Presentation on PPI	Racon transmits a coded signal when triggered by signal from ship or other radar transmitter. Azimuth, range (pip nearest center) and coding on PPI.
	Loran	Crossing of electronic lines of position from two pairs of Loran pulse transmitters provide fix to vessel equipped with Loran indicator and charts of region.

Table I—Partial OSV Equipment

Type	*Frequency Range*	*Emission*	*Power (watts)*
Beacon Transmitters			
(*VFO or Crystal*)	275–510 kc	A2	750
Transmitters	0.2–400 mc	A1,A2,A3	25–500
(*Portable*)	2–5 mc	A1	10
	2–5	A3	3
(*Mobile*)	2–3 mc	A3	1
Receivers	0.2–400 mc	A1,A2,A3	—
(*Portable*)	2–8 mc	A1,A2,A3	—
(*Mobile*, same as *Communication Trucks*, see Table II)			
Radar (*surface search*)	9 kmc	P1	300 kw peak
(*general search*)	200 mc	P1	500 kw peak
Direction Finder (scope)	250–1,500 kc	A1,A2,A3	—
Loran Receiver	1,750–1,950 kc	P1	—
Echo Sounder	18 kc	—	200
Radiosonde	82 mc	A2	1
Rawinsonde (*Radar reflector attached to free balloon followed by radar*)			



Ocean Station Vessels are manned, equipped and operated to provide all search and rescue functions as well as obtain meteorological and other scientific observations. Vessel is on station at center of 210-mile square (at right) and so indicates by beacon transmissions "OS". Ship at square marked would, instead, send "HN"

continent, with an additional one in Hawaii and one in Alaska. During fiscal 1950, the net handled 116 cases and in 1951, 168 cases.

Combined Operations

As an example of the unusual combinations of facilities often required in Search and Rescue, the well-publicized and completely successful rescue of crew and passengers of the seaplane, "Bermuda Queen" might be cited. This craft, flying westward with 69 persons aboard, passed Ocean Station Charlie. Two hours later, the pilot decided he would be unable to reach Gander, Newfoundland, and reversed his course to ditch alongside Coast Guard cutter "Bibb" on station Charlie.

Because of abnormal sunspot activity, communications between the craft and both Gander and the "Bibb" were impossible. Those between the "Bibb" and shore stations were badly impaired. However, a Trans-Canada plane attempting to relay between the "Bermuda Queen" and Gander was heard in Port Lyautey on the northwest coast of Africa.

From there, information was relayed to CAA in New York City via the Azores. Details of the ditching were available in New York in less than two minutes, despite the 5,000-mile roundabout circuit. It is estimated that in this operation, some $567,000 worth of electronic equipment alone was employed.

Table II—Representative SAR Equipment

SEAPLANES AND LAND PLANES WITH DROPPABLE BOAT

Type	*Frequency Range*	*Emission*	*Power (watts)*
Transmitters	300–600 kc	A1	125
	3–18.1 mc	A1	125
	200–1,500 kc	A1,A2,A3	100
	2–18 mc	A1,A2,A3	100
Receivers	200–500 kc	A1,A2,A3	—
	2–18 mc	A1,A2,A3	—
Trans-Rec Comb	0.55–9.1 mc	A2,A3	15
	100–150 mc	A3	8
	100–150 mc	A3	6
Automatic Direction Finder	100–1,750 kc	A1,A2,A3	—
	100–150 mc	A1,A2,A3	—
Radio Altimeter	420 mc	P1	—
Radar	9 kmc	P1	—
Loran Receiver	1,750–1,950 kc	P1	—

COMMUNICATION TRUCKS

Transmitters	300–600 kc	A1,A2,A3	100
(VFO)	2–13 mc	A1,A2,A3	100
Receivers	100–400 kc	A1,A2,A3	—
	0.48–30 mc	A1,A2,A3	—
	0.5–14 mc	A2,A3	—
Transceivers (Crystal)	2–3.5 mc	A3	10

Auxiliary equipment includes handie-talkie sets, gas-driven generator, extra batteries, provisions for operations enroute

PATROL BOATS

Trans-Rec Comb	2–3.5 mc	A3	25
Direction finder	220–1,600 kc	A1,A2,A3	—
Radar	3 kmc	P1	—

Rating New Test Methods

New statistical sampling technique reduces time and money spent in assembling products that are foredoomed to be rejects. Basis is simple *J*-index for evaluating different methods of testing component parts before assembly

By EUGENE D. GODDESS

Sylvania Electric Products Inc.
Boston, Mass.

WITH FIXED-FREQUENCY magnetrons valued at $1,000, the frequency-determining anode element can cost about $100. If measurement of the raw anode frequency makes possible evaluation of the final tube frequency, then use of anodes which would fail to make an acceptable unit can be avoided. In short, it is less expensive to use a diagnostic test for rejecting magnetron anodes than to reject finished magnetrons.

Germanium diode-type crystal rectifiers commonly used in television receivers should be able to withstand the effects of humid atmosphere. By the use of a humidity chamber, the behavior of the final product under special conditions is used to forecast the behavior of the final product under some future condition. If the humidity test is too severe, however, many crystals would be rejected that would be perfectly acceptable. If the test is not severe enough, crystals which should be rejected will be sent out into the field. In the first case, consumer costs go up, which is always undesirable; the alternative is that consumer quality goes down, also undesirable.

To avoid being caught on the horns of this dilemma, we seek a test that will pass the most good crystals and reject the most bad crystals, thereby reducing waste to the advantage of both producer and consumer. If too many defective units get out, highly valued and carefully developed customer relations are seriously endangered.

As a result of long acquaintance with just such problems as these, the medical profession has developed methods for evaluating simplified new diagnostic procedures that replace well-established but time-consuming laborious methods. In the balance of this paper one of these rating methods, known as the *J*-index, is discussed.

The *J*-index provides an objective method of choice between diagnostic tests when more than one such test is available. It is used to determine which test has a greater probability of accepting good parts and rejecting bad ones. It is the average of the abilities of the test to separate the good from the known good and the bad from the known bad.

Magnetron Test Problem

Suppose the present method of ascertaining the final frequency of a magnetron is to measure the resonance of its anode before assembly. This is a satisfactory diagnostic measurement; most of the anodes that it classifies as good result in tubes which are likewise classified as good.

A suggestion is made that since the resonant frequency is a function of the anode geometry, a resonance measurement with the anode at operating temperature would be a better diagnostic test, since the elevated temperature might alter the anode geometery by expansion, resulting in frequency shift.

Two tests are available for making a diagnosis: Method A, the cold resonance test, and method B, the hot resonance test. Failure to use the best test possible will result in the above-mentioned costly inefficiency. Consequently, one seeks an objective method of test rating, wherein these tests are rated against some test of known merit applied to a reasonably large number of units.

Use of the J-Index

Sometimes the best test from the point of view of ratings is not necessarily the best test from the viewpoint of the economics of the situation. For example, if it costs more dollars to make an error in rejecting good tubes than it does in passing bad tubes, we might elect to make a least costly error. The *J* test ratings, however, are based on the assumption that both errors are equally undesirable.

In the example, the comparison of the cold-resonance diagnosis to the completed tube classification as determined at final test is summed up in an index figure, called the *J*-index. Likewise, the elevated-temperature resonance diagnosis is summed up in the same manner, giving rise to a *J*-index value for that test. These two indices are compared; the higher the absolute value, the better the diagnostic test.

The *J*-index offers ease of computation. The data is set up in tabular form, then multiplication, subtraction and division provide an excellent objective measurement of diagnostic efficiency.

Without the *J* test, conclusions

drawn which are based on a visual inspection of the data can often lead one astray. Fortunately, there is an extremely simple method of evaluating tests which should find great use among engineers because of the ease of computation.

Recently, Dr. W. J. Youden of the National Bureau of Standards published a paper in the Jan. 1950 issue of the magazine *Cancer* which pointed the way to an elegant solution in dealing with this problem. Engineers can learn much from biostatisticians about maximizing the information obtained from a minimum of data.

Errors

Two kinds of errors can be made in a diagnostic test. Units may be classified as good which are actually bad, and units may be classified as bad which are actually good. Those errors of diagnosis are called false bads and false goods, respectively, as shown in Table I.

No false bads and no false goods, that is, no mistakes in judgment characterize the perfect diagnostic test.

To compare two diagnostic tests, we must determine whether the differences in the experimental data are due to chance or due to real differences.

Meaning of J-Index

In a diagnostic test we seek to differentiate between the good and the bad. If a and b of Table I are equal, then the test has no ability to differentiate whether the known good are good or bad. Consequently, since $a/(a+b)$ is the fraction of correct diagnoses, and $b/(a+b)$ is the proportion of incorrect diagnoses of the known goods, then the difference between these fractions, $(a-b)/(a+b)$, is a measure of the ability of the test to separate out the known goods. In the same vein, $(d-c)/(d+c)$ is a measure of the discriminatory ability of the test on known bads. The averages of these two abilities is J:

$$J = \frac{1}{2}\left[\frac{a-b}{a+b} + \frac{d-c}{d+c}\right] = \frac{ad-bc}{(a+b)(d+c)}$$

The J-index varies in numerical value from -1 to $+1$. A J-index of -1 simply means that perfect misclassification has been accomplished; in other words, the reaction one thought was characteristic of bad units was, instead, characteristic of the good. Thus one can always choose classifications so that the J-index varies from 0 to $+1$. When neither false goods nor false bads are present, the J-index is unity.

A negative J indicates that the known bad tubes are not as likely to be diagnosed as bad as were known good tubes. This contradiction to one's expectations is revealed as a negative number.

Accuracy of J

To compute the error in J, we assume a universe binomially distributed in which the standard deviation σ of the fraction defective in a sample from the mean number of defectives is given as

$$\sigma = \sqrt{PQ/N}$$

where P is the fraction defective, $Q = 1 - P$ and N is the sample size taken in the evaluation of P.

Consider the universe of known goods:

$$P = \frac{a}{a+b}$$

$$Q = 1 - P = 1 - \frac{a}{a+b} = \frac{b}{a+b}$$

$$N = a + b$$

Consequently, the standard deviation of the known goods is:

$$\sigma_{(+)} = \sqrt{\frac{PQ}{N}} = \sqrt{\frac{\frac{a}{a+b}\;\frac{b}{a+b}}{a+b}} = \sqrt{\frac{ab}{(a+b)^3}}$$

Similarly, for the standard deviation of known bads we obtain:

$$\sigma_{(-)} = \sqrt{\frac{cd}{(c+d)^3}}$$

Since independent standard deviations add as the square root of the sums of the squares, the standard error of the J-index is:

$$\sigma_J = \sqrt{\sigma_{(+)}^2 + \sigma_{(-)}^2} = \sqrt{\frac{ab}{(a+b)^3} + \frac{cd}{(c+d)^3}}$$

Thus we have defined the J-index and derived its standard error.

Confidence Level

The standard deviation of the difference between the two indices is used as a yardstick for objectively evaluating the difference between two J-indices. The statistic

$$t = \frac{J_1 - J_2}{\sigma_{diff}}$$

is approximately normally distributed. In this equation, J_1 is the J-index of the first test, J_2 is the index of the second test, and σ_{diff} is the standard deviation of the difference between the two J's and is equal to

$$\sigma_{diff} = \sqrt{\sigma_{J1}^2 + \sigma_{J2}^2}$$

If the two tests were identical, then t will have a mean of zero but, due to random fluctuations of sampling, would vary between ± 3 for 99.97 percent of the time. If the tests were really identical, larger values of t would be rare and would be taken as evidence of a real difference between the two tests.

The confidence level is determined by the value of t. Returning to the case of the magnetrons, assume that failure to determine whether a magnetron is defective involves an expensive error. To reduce costs, it is proposed to reduce the shrinkage by testing the anodes at operating temperatures.

Example

Suppose 150 anodes are to be assembled. To avoid making mag-

Table I—Classification of Errors in Diagnostic Tests

Basis of Classification	Classification	TEST		Total
		Good	Bad	
KNOWN	(Good)	a	b (False Goods)	a + b
	(Bad)	c (False Goods)	d	c + d
	Total	a + c	b + d	a+b+c+d

netrons from initially defective anodes a search is made for an improved diagnostic test compared to the present cold resonance method (test A).

It is suggested that if the resonance is measured at an elevated temperature (test B), a better diagnostic test will result. To test this suggestion, all 150 anodes are measured cold and hot. Finally, they are completed and the product tested. The results are shown in Table II, in comparison to the diagnoses made by each of the methods.

Based solely on this data, is test A a better diagnostic test than test B? Of 55 known bad tubes, test A detected 63 percent of the total while test B detected only 36 percent of the total.

This seems to indicate that test A is better than test B. On the other hand, of the known 125 good tubes, test A classified only 60 percent correctly, whereas test B classified 68 percent correctly. Which of these two comparisons should be given greater consideration?

To evaluate and compare these diagnostic tests, we compute indices J_A for test A and J_B for test B:

$$J_A = \frac{ad - bc}{(a+b)\ (c+d)}$$

$$= \frac{(35 \times 75) - (20 \times 50)}{55 \times 125} = 0.236$$

$$\sigma_{JA} = \sqrt{\frac{(20)\quad(35)}{(20+35)^3} + \frac{(50)\quad(75)}{(50+75)^3}} = 0.0782$$

$$3\sigma_{JA} = 0.235$$

The 3σ limits are therefore 0.236 $\pm$0.235, or 0.001 and 0.471. Three times the standard deviation is used since this will include 99.73 percent of the cases. Any values outside of the 3 σ limits can be assumed to be due to an assignable cause rather than chance.

$$J_B = \frac{ad - bc}{(a+b)\ (c+d)}$$

$$= \frac{(20 \times 85) - (35 \times 40)}{55 \times 125} = 0.0291$$

$$\sigma_{JB} = \sqrt{\frac{(20)\quad(35)}{(20+35)^3} + \frac{(85)\quad(40)}{(85+40)^3}} = 0.0771$$

$$3\sigma_{JB} = 0.2313.$$

The 3σ limits here are 0.0291$\pm$ 0.2313, or -0.202 and 0.260.

On first glance one might conclude that test A is a better diagnostic test than test B, since $J_A > J_B$. Of what statistical significance, if any, are the differences in the data, or can they be explained as chance variations due to random sampling? If the three-sigma limits of the two J distributions did not overlap, we might conclude that the J's are significantly different. Since they do overlap, however, it is necessary to determine (at some level of assurance) whether the overlap is fortuitous or significant.

To test the significance of the difference of two indices, proceed as follows:

First, note that even if the two tests were identical, the difference between two indices would vary from experiment to experiment because of pure random chance fluctuations.

Second, arbitrarily select a critical value for t, so that if the tests were identical, only rarely would this critical value be exceeded. In this case we shall regard a value of t that would be exceeded only ten percent of the time by chance as evidence of a real difference in the tests; thus, we choose 1.64 as the critical value of t.

Third, compute t:

$$t = \frac{J_1 - J_2}{J_{diff}} = \frac{0.236 - 0.029}{\sqrt{(0.078)^2 + (0.077)^2}}$$

$$= \frac{0.207}{0.110} = 1.88$$

It should be noted that the t-test is suitable for use only when the sample in each group is fairly large, that is, something of the order of 25 to 30. When we have smaller numbers to deal with, special statistical techniques are required. However, as a generalization, it is undesirable to attempt to make a differential diagnosis based on small numbers.

Fourth, interpret the value of t obtained. Consultation with any table of areas of the normal curve will show that when t = 1.88 there is a 6-percent probability that two samples selected from a single universe could show differences this great or greater, due to chance.

Fifth is the conclusion: In this instance at the 10-percent level (t = 1.64) there is evidence of a real difference between the two tests and they should therefore be considered as definitely different. Consequently, these variations in data could not be due solely to chance and test A is a real improvement over the other.

To obtain greater assurance, the procedure would be to obtain a sufficiently large amount of data so that σ_{diff} will be reduced and t will get larger. This is true providing the ratios remain approximately the same.

A test as simple as the J-index has an almost unlimited field of industrial application. Ease of computation and ease of interpretation make it extremely utilitarian.

Acknowledgement is herewith given to Dr. W. J. Youden and to J. M. Cameron of the National Bureau of Standards and to many unnamed associates at Sylvania whose discussions and suggestions helped bring this paper into its present form.

Table II—Comparison of Results Obtained From Two Test Methods

Test Method	Diagnostic Classification → / Final Test Classification ↓	Amount Test Calls Bad	Amount Test Calls Good	Total
A	Known Bad	$a=35$	$b=20$	55
	Known Good	$c=50$	$d=75$	125
	Total	85	95	180
B	Known Bad	$a=20$	$b=35$	55
	Known Good	$c=40$	$d=85$	125
	Total	60	120	180

Ultrasonic System

Volumes up to 20,000 cubic feet can be protected by single system of one transmitter and one receiver. Motion of an object within space changes frequency of energy reflected from object, setting off alarm

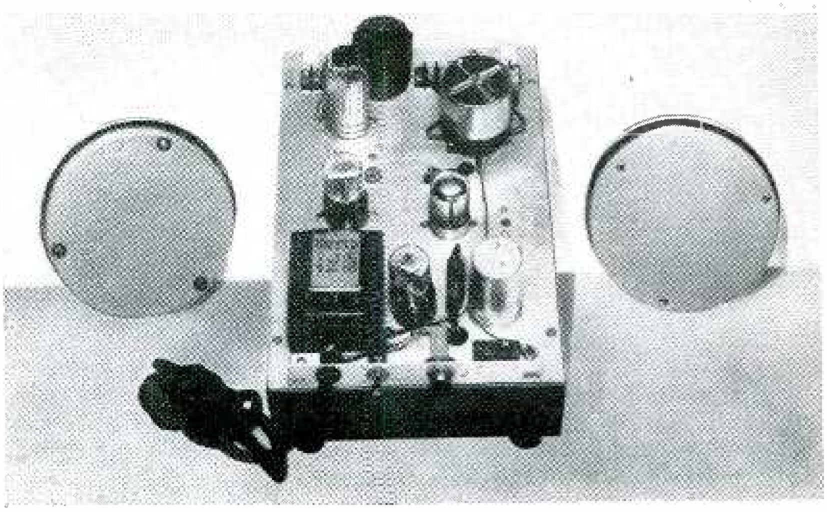
By **STANLEY KEMPNER**

North Rockville Center, N. Y.

MOTION OF AN INTRUDER within a confined space may be detected by the ultrasonic burglar alarm system developed by the Alertronic Protective Corporation of New York. The system does away with customary protective forms such as foil, dowel screens, electric linings, and open wiring.

The equipment operates on the Doppler principle. It consists of an ultrasonic oscillator, transmitting and receiving transducers and a receiver tuned to the frequency of the transmitted wave. For each transmitter there is one receiver. The transmitter and receiver are contained within the master control unit shown in the photograph. The transducers are connected to the control unit by shielded cables.

The space to be protected is filled with sound energy of a frequency slightly above the audible range. This energy is radiated constantly in all directions and the frequency of the received energy is constant. Some of the energy is received directly from the transmitter and some is received in the form of multiple reflections from surfaces within the space. As long as there is no movement within the enclosure, a stable standing-wave pattern is established and the received frequency remains constant. However, when movement of any object occurs, the frequency of energy reflected from the object increases or decreases as the object approaches or recedes. This difference in pitch is picked up by the receiver, amplified and used to set off the alarm.



Transmitter and receiver circuits are contained within master control unit. Transmitting and receiving transducers are shown alongside chassis

The equipment also detects the presence of a flame. Because of the low density of the hot air composing a flame, ultrasonic energy is reflected exactly as with a solid object. The flickering flame and the hot cone of air above it, behave like a moving intruder, and set off the alarm. In general, the size of the flame that the instrument will detect depends upon its sensitivity setting. For any given sensitivity, it will detect a flame about one-quarter the size of the minimum detectable intruder.

Circuit Design

Figure 1 is a schematic diagram of the ultrasonic transmitter and receiver. The transmitter consists of a Hartley oscillator driving a magnetostriction transducer. Transmitter stability characteristics are shown in Fig. 2.

The pick-up transducer also operates on the magnetostriction principle. Extraneous noise is minimized by the use of linear detection in the presence of the local oscillator signal rather than by sharp tuning. A crystal diode is included in the grid circuit of the relay control tube. The alarm relay is normally energized and its contacts are connected in series with the line to the central office. An open view of the master control unit chassis is shown in the photograph.

All units are equipped with tamper switches, so that if an attempt is made to disable the system the alarm relay will be released.

Detects Intruders

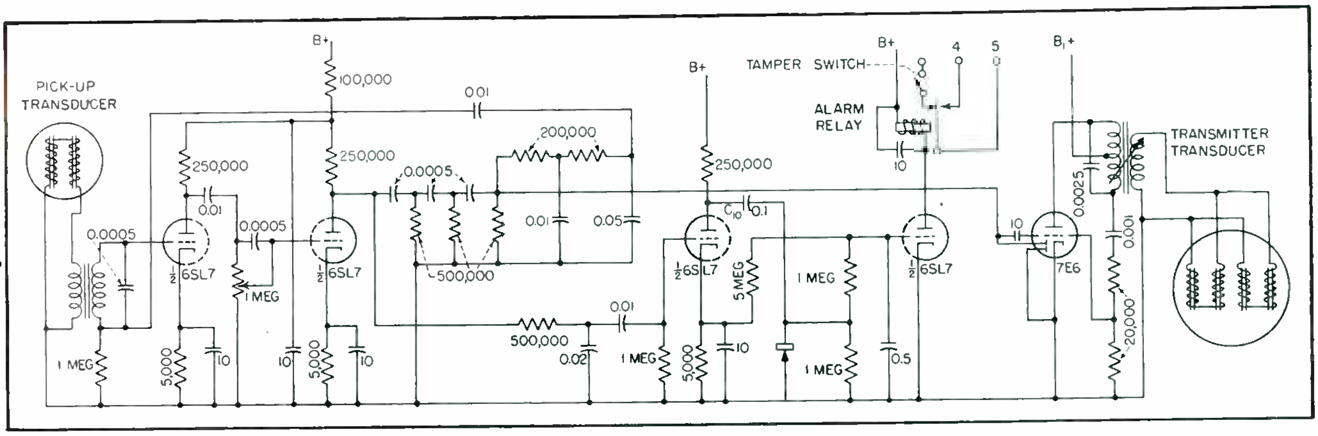


FIG. 1—Schematic diagram of the control-unit amplifier and oscillator. Reduced signal due to change of frequency when motion is present in protected area releases alarm relay

The tamper switch in the master control unit is in series with the rear contacts of the alarm relay.

Test Procedure

A small motor-driven vane built into each transmitter unit when actuated causes operation of the system for test purposes. This test may be conducted at will from the central station.

The procedure provides for an overall test of the system. The motor-driven vane at the transmitter tends to break up the standing-wave pattern thereby creating a frequency difference which is detected by the receiver resulting in operation of the alarm relay. The test is accomplished by opening the central station subscriber's circuit which releases the test relay at the premises. The central station circuit then restores in time to receive the alarm thus initiated. The test circuit is shown schematically in Fig. 3.

Scope of Operation

In general a single system of this type can protect a volume of up to 20,000 cubic feet; the exact capacity depending on the contents of the enclosure. For example, if a large percentage of the wall area is occupied with sound-absorbing material, the range of coverage will be reduced. However, rugs along the floor or fabric along one wall only will not reduce the range appreciably.

If greater coverage of a single enclosure is desired, the use of several units is recommended rather than just one.

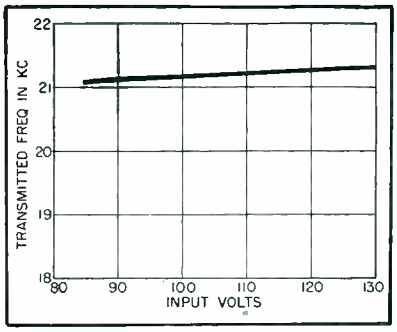


FIG. 2—Variation of frequency with voltage showing reasonably good stability

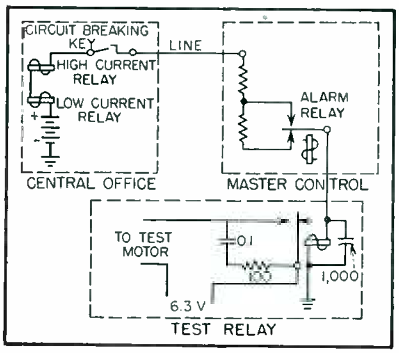


FIG. 3—Test of overall alarm system performance can be initiated at will by central station operator with circuitry shown

In theory, when the system is set up and operating within an enclosure, a very definite and stable standing-wave pattern exists within the protected area. However in practice this wave pattern is influenced by normal variations of temperature and barometric pressure.

This results in a pattern of areas of high and low intensity which tend to creep so that what may be a particularly sensitive area at one moment may become somewhat less sensitive the next.

The inherent creeping characteristic of the system renders it almost impossible to predict the degree of sensitivity within any given area of the enclosure. However the intruder cannot determine which areas are covered by the radiation pattern.

Equipment sensitivity varies with both temperature and relative humidity, but to a greater extent with the latter.

Applications

A study of the equipment has been made by the Underwriters' Laboratories, Inc. It was concluded that this system is practicable to install, to operate and maintain, is stable in normal and reasonably abnormal operating circumstances.

It is claimed by the manufacturer that the extent of coverage provided far surpasses that given by existing systems.

Several central station operating companies have been using this equipment during the past year. Other users include the Atomic Energy Commission, the Canadian Government and the Department of Defense.

Printed Circuits Used

By K. H. BARNEY and **S. MACHLIN***

Armament Radar Dept.
Sperry Gyroscope Co.
Great Neck, N. Y.

Communications Engineering
Kollsman Instrument Corp.
Elmhurst, N. Y.

WIRING THE UNIT ASSEMBLY

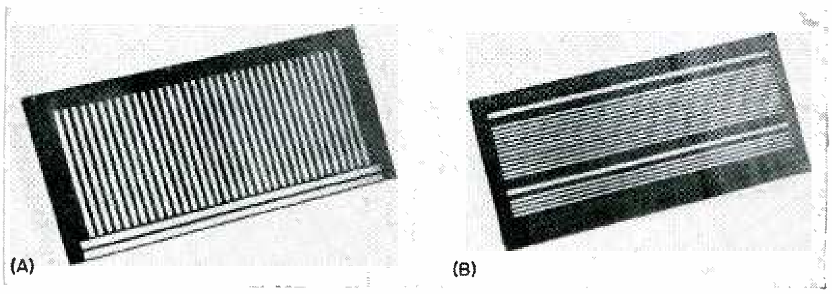


FIG. 1—Two sides of a cross-grid wiring card prior to preparation for a pulse or video circuit. Connections can be made to the metal strips on either side. Cross connections require a hole pierced through the insulating card as well as the metal strips. A wire or a component lead is soldered to each side

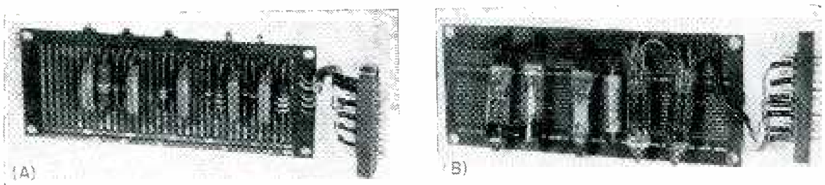


FIG. 2—Components are usually attached to one side (A) and tubes to the other (B). The short length of metal strip between the connections to a component are cut with a sharp tool and removed in the developmental stage. Previously prepared cards are used for production units. Heater, plate-supply, input and output connections are brought to a plug

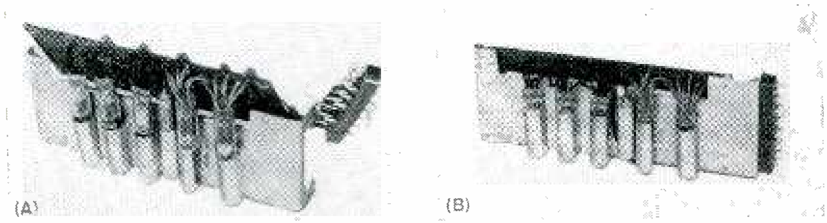


FIG. 3—When the wiring has been dip-soldered, the tubes are slipped into the metal cylinders (A) that hold them solidly and also act as shielding. The wiring card is fastened to a metal frame (B) along with the terminating plug. The metal frame serves as shielding and also helps dissipate heat from the tubes

IN ELECTRONIC chassis where compactness and ease of manufacturing are important, the use of printed wiring to replace the usual harness of hookup wire offers many advantages. Difficulty is often encountered, however, in transferring the circuit from the haywire breadboard form to the production mockup or the actual product in a reasonable length of time during an accelerated development program. Consequently, a method has been developed that uses printed wires to replace the chassis wiring harness. At the same time, it retains the flexibility of the hookup wire harness.

Unit Development

The development of radar and computer electronic units usually passes through several stages. The electronic circuits are first tested on a breadboard chassis that bears little mechanical resemblance to the finished product, but allows the components to be easily changed. When the development of the circuit has advanced to the point where the number of components is fairly well known, layout studies of the product may be started.

Frequently in the case of complicated circuitry, especially when subminiaturizing techniques are used, several layouts must be tested by constructing various mockups before the mechanical layout and the circuit functioning are both satisfactory. During this period the circuit connections and the exact number of components are often revised many times, necessitating corresponding changes in layout. Furthermore, if the placement of

* Formerly with Sperry Gyroscope Co.

in Development Models

Difficulties encountered in transferring circuitry from developmental breadboard to production model are eliminated by starting with simple, inexpensive cross-grid wiring cards similar to finished assembly. Connections are dip-soldered to improve product and save time

the wiring is at all critical, as in high-gain video and pulse circuits, the layout must take into account the location of the harnesses. In developing such units the use of printed wiring is frequently avoided owing to the complexity of the available processes, since the time and cost to develop the final unit may be prohibitive if each new component, circuit, or layout change requires a new printed wiring pattern.

Available Processes

At present four general processes for forming the printed wires are in use. One process consists in printing strips of silver paint on the surface of a ceramic base to form the interconnections between the various components. These strips are then fired to fuse the silver.

A second method uses sheets of insulating material to which copper foil has been cemented. The wiring pattern is printed on the foil with an acid resisting paint after which the unwanted copper is etched away leaving only the desired pattern.

Another technique involves spraying metal through a stencil on a plastic sheet to form the conductors.

In the fourth process the wiring harness consists of a stamped metal pattern that is bonded to an insulating surface. This usually involves the use of dies and for this reason is considered more a production method than a development one.

It is evident that the repetition of all of the steps in any of these four methods to accommodate the frequent changes in the development of complicated circuitry would require too much time for an accelerated program. A hookup wire harness cannot be directly converted to printed wiring at the last stage in the development of a preproduction model since the solution of the layout problems and new difficulties arising from the electrical characteristics of the printed wiring harness may require extensive redesign of the unit. Thus, the time spent in developing these circuits with hookup wire in mock-up form may be wasted.

If the production advantages of printed wiring are to be effectively realized in a reasonable development time, the manner of using the available printed wiring techniques is most important. First, to permit a minimum of redesign, printed wiring should be used as early in the experimental phase as possible. Consequently, it is essential that the type of printed wiring to be used must have a high degree of flexibility to accommodate the numerous changes in layout and components during development.

Ceramic-Base Circuits

From this standpoint, painted conductors seem to offer certain advantages as they can be applied directly by brush or pen. However, the need for firing means that the circuit is not immediately available for use. A more serious disadvantage is the fragility of the conductors that causes numerous open circuits following the repeated solderings and unsolderings in the laboratory. Furthermore, even slight flexing of the ceramic base can produce minute breaks in the circuit that are often extremely difficult to locate.

The etched circuit on the other hand has been found sufficiently rugged to withstand frequent soldering and considerable flexing, making it ideal for development work. To avoid re-etching the circuit each time a circuit change is made, the cross-grid pattern, a familiar device in the field of power distribution, has been found a satisfactory interconnecting means that provides complete flexibility.

Cross-Grid Cards

The grid consists of two layers of parallel conductors, all insulated from each other, with those in one layer arranged at right angles to those in the other. By making connections between the two layers and removing unwanted conductors any desired point-to-point paths may be established. Wide lines are provided for the filament circuit.

A cross-grid pattern that has been satisfactory in general video and pulse-circuit development is shown in Fig. 1. Here subminiature tubes and standard components are used. All components that may be mechanically mounted on their own leads, such as ½ to 2 watt resistors and small mica capacitors, are attached directly to the card, as shown in Fig. 2. A cross connection through the card at a crossover point is made by punching or drilling a hole through the conductor and plastic and inserting a wire pin, which is then soldered to both conductors. Unwanted connections are opened by simply cutting through the copper strip. In this manner all circuit connections are made.

The card is mounted on one side of a metal plate. On the other side the subminiature tubes are mounted in clips along with the larger circuit components. The tube leads pass through a notch in the plate and fasten directly to the wiring card as do the leads of the components mounted next to the tubes.

In addition to supporting the card, connector and tubes, the metal plate helps dissipate the heat of the tubes by conducting it to the frame on which the plates may be mounted, transferring the heat to the air, or radiating it directly. Space is left for the tube leads to connect to the conductors running across the card on the other side. All external connections are made through a plug that is attached with hook up wire to the end of the card. The entire chassis is assembled as shown in Fig. 3.

A mockup chassis to test the layout studies is constructed using this printed wiring card immediately following the breadboard stage of development. While the development continues, the circuit may be altered by utilizing the unused cross conductors to form new circuit connections, or by patching one conductor to another by means of bus wire without the necessity of reconstructing the entire chassis.

When a completely new layout is required because of a large number of changes there is little loss of time involved in connecting a new card, and since the crossgrid cards may be stocked in quantity the expense is negligible. Laboratory experience with this particular form of subunit assembly has shown that a technician can lay out and wire the chassis with the standard card faster than by using hookup wire to perform the same job.

Materials

Several types of insulating boards are now in use. Among them are XXXP Bakelite, Teflon-impregnated and silicone-impregnated glass-cloth laminates. Sheets of this material $\frac{1}{16}$ inch thick with a 0.0027-inch thick copper foil bonded to each side are supplied by the manufacturer. A silk screen stencil of the cross grid pattern is made by photographing an ink drawing of the pattern usually three or four times full scale. Conductors $\frac{1}{32}$-inch wide separated by $\frac{1}{32}$ inch are convenient.

As previously mentioned, a most important characteristic of the etched-copper process is the ruggedness of the wiring pattern. A cross section of the pattern is shown in Fig. 4. Component leads, tube leads, and bus wire may be directly soldered to this foil by ordinary means without the danger of causing an open circuit. Although the conductors may be only $\frac{1}{32}$-inch wide, their adhesion to the insulating board is satisfactory if the application of a direct stress on the foil is avoided. This stress is prevented by making all external connections to the foil from the opposite side of the insulating board through holes as shown in Fig. 4.

Manufacturing

The interconnection grid of the manufactured product is copied directly from the mockup card. Those portions of the cross-grid that are

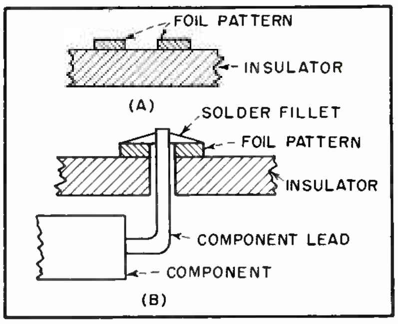


FIG. 4—Magnified cross-section of foil pattern on insulating card (A) and method of dip-soldering to avoid strain on the foil (B)

not actually used in the finished circuit may be eliminated at this time. The remainder of the cross-grid is reproduced on the production version of the card to give an exact electrical and mechanical duplicate of the circuit layout as developed. Furthermore, the other printed wiring processes may be utilized in the production model with the assurance that the electrical characteristics will be similar to those of the mockup card.

The mass-production advantages of printed wiring are now available. For example, when the etched wiring process is used many duplicate patterns can be reproduced on a large sheet. After etching, the sheets are sheared into separate cards. Because holes are drilled or punched for the component leads and cross-connection pins to form the chassis interconnections, the function of the wireman is replaced by more or less routine mechanical operations. The orderly arrangement of the card layout allows the resistors, capacitors, tubes and other components to be easily assembled to the card and permits rapid inspection.

Dip Soldering

An important process that may be used in the assembly of the card is dip soldering. Since all component leads come through the card in the same direction, the face of the card away from the components may be immersed in a solder bath soldering all the connections on that face simultaneously. Likewise the cross-connection pins, tube leads, and the external connection wires may be soldered to the grid by several dipping and assembling steps in the proper sequence. In this way all hand soldering operations can be eliminated.

The advantages of printed wiring as a production technique are becoming increasingly apparent. Experience with the cross-grid method of developing the chassis and wiring layout has shown that the transition from breadboard to production model need not be difficult. By introducing printed wiring at the earliest stages of circuit development the problems peculiar to its use may be solved from the start.

Furthermore, development costs are decreased by the saving in wiring time. The layout of the card utilizing conductors on both sides results in efficient use of space in addition to the simplification of the fabrication techniques. Consequently, it is felt that the use of the cross-grid pattern represents one step toward making mass production printed wiring processes available to experimental and developmental fields in which they have previously been infeasible.

BIBLIOGRAPHY

W. W. MacDonald, Stamped Wiring, ELECTRONICS, p 82, June 1947.

New Advances in Printed Circuits, U. S. Department of Commerce, National Bureau of Standards, Publication 192, Nov. 22, 1948.

Robert L. Swiggett, Printed Circuits on Foil Clad Plastics, *Plastics Engineering*, Aug. 1951.

Mass Production Die Stamping of Wired Circuits, Franklin Airloop Corp. 1950.

Constant Input-Impedance TV Second Detector

Performance of receiver using new detector circuit is superior to that of an equivalent receiver with a diode detector, particularly in respect to transient response. Intercarrier sound gain of 20 is byproduct of detector arrangement

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IN TELEVISION RECEIVERS, the video detector should be a device which, when supplied with a modulated input, delivers an output which is directly proportional to the modulation envelope of the input.

The detector should possess excellent amplitude linearity for accurate gray scale rendition in monochrome, and for acceptable color reproduction. In addition, it is necessary not only that the detector transient response be low in overshoot and adequately fast, but that the detector operation not deteriorate the transient response of associated circuits, such as the last i-f stage and the first video amplifier. As a matter of efficient receiver design, the detector should produce an output which is as large as possible compared to the input.

In two of these requirements the diode detector excels. Except at low levels, its amplitude linearity is excellent and it possesses a high rectification efficiency. However, it very seriously interacts with associated circuitry. The input impedance is low in magnitude and not a constant, particularly when the effect of the first video amplifier is considered. As a result of this varying input impedance, the amplitude-frequency response of the last i-f amplifier is altered, with a change in transient response.

This article is based on a paper presented at the 1951 National Electronics Conference. The conference paper will be printed in the *NEC Proceedings*.

As shown by Kilgour and Glessner,[1] the effective input resistance of a typical diode detector, which is approximately square law at low levels, is

$$R_E = \frac{\pi R d}{E_1 [\frac{2}{3}\sqrt{1 - D^2}\,(D^2 + 2) - 2D \operatorname{Cos}^{-1} D]} \quad (1)$$

Where D is detection efficiency

$$D = \frac{E_o - E_2}{E_1} \quad (2)$$

and R_d = conduction R of diode, E_o = voltage at which conduction begins, E_1 = input voltage, and E_2 = output voltage.

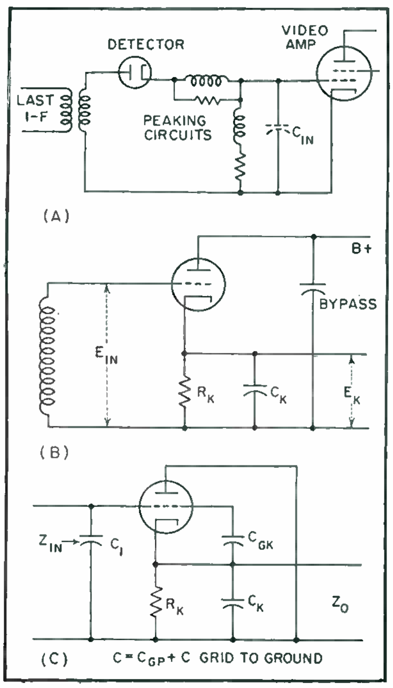


FIG. 1—Conventional diode detector circuit is shown in (A). Revised circuit and its equivalent are shown in (B) and (C)

From Eq. 1 and 2, the input impedance depends on the input level as well as on several parameters which in this idealized case have been considered constants. In actuality neither R_d nor D are constants at low levels. The situation is further complicated by consideration of the diode detector when connected to a typical video amplifier (Fig. 1A).

With the type tubes often used as video amplifiers, the input impedance is prodominately capacitive, principally because of Miller effect. Unfortunately, such capacitance will not be a constant, but will vary with the bias level of the video amplifier. This impedance variation in the load circuit of the detector will produce a variation in the detector input impedance. By applying the approach of Wheeler,[2] it can be shown that this variation assumes sizable proportions when the video amplifier capacitance variation is large.

The effect of any impedance variation on the last i-f amplifier stage is to change its response characteristics and produce poor definition and overshoot in a reproduced picture. For example, receivers, which have satisfactory i-f response curves when measured with standard sweep frequency techniques, often produce greater overshoot and poorer rise times than would be expected. Although this is partly due to the use of sweep frequency rather than pulse measurement techniques, it is also due to the fact that the i-f response is a function of the input signal.

In addition to these difficulties, the diode second detector poses extremely difficult problems when accurate design of detector video peaking circuits is considered. As the driving voltage for the peaking circuits is obtained from a nonlinear source (the detector), it is a ponderous if workable problem to calculate the transient response of such a circuit. As a result, the design formulas for video detectors are usually either highly idealized or highly empirical.

Triode Circuit

A useful, familiar circuit is shown in Fig. 1B. A triode is operated with a large cathode resistor so that it is self-biased nearly to cutoff. Detection is then obtained by means of the non-linearity of the grid-plate characteristic in the cut-off region. Such a circuit has been used occasionally in radio receivers under the misnomer of an "infinite impedance" detector, although the circuit possesses a finite input impedance.

The cathode follower has been thoroughly analyzed in many different applications.[3,4] However, when used as a detector it is necessary to obtain not only the input and output impedance as a function of frequency, but these impedances as a function of input voltage. The demodulation transfer function is also desirable.

Referring to the equivalent circuit of Fig. 1C, the input impedance is:

$$Z_{in} = \frac{-\left[\dfrac{1+G_mR_k}{R_k} + j\omega\,(C_k + C_{gk})\right]}{\omega^2[\,C_1\,(C_{gk}+C_k) + C_{gk}C_k] - j\omega\,(C_{gk}+C_1)\left(\dfrac{1+G_mR_k}{R_k}\right)} \quad (3)$$

If C_{gk} is small compared to C_1, then:

$$Z_{in} \approx \frac{-j}{\omega C_1} \quad (4)$$

Therefore, if a tube with low grid-cathode capacitance is used, the input impedance is a constant at any given frequency, and for all frequencies is the same as a typical i-f amplifier with the same input capacitance. However, this does not include transit time effects at high frequencies.

The output impedance of this circuit is

$$Z_o = \frac{R_k}{(1+G_mR_k) + j\omega R_kC_k} \quad C_{gk} < C_k \quad (5)$$

Here the only simplifying assumption was that C_{gk} was very small compared to C_k. From Eq. 5, the output impedance will be a function of g_m. However, g_m is a function of the input voltage e_g. To plot a family of curves for Z_o as a function of frequency at different values of e_{gk}, it is necessary to select a tube type and a typical value of R_k. Such a family of curves was plotted for a 6AU6, triode-connected, with a plate supply of 150 volts and R_k of 10,000 ohms. Figure 2 shows the magnitude of Z_o as a function of FC_k, for e_{gk} from -1 to -5 volts. Figure 2 shows also the phase angle of Z_o.

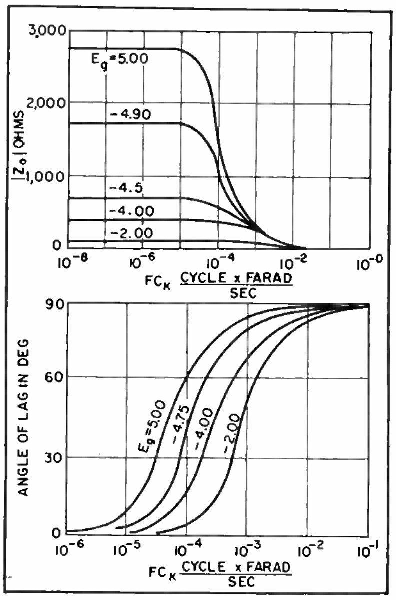


FIG. 2—Curves show magnitude and phase angle of output impedance of equivalent circuit shown in Fig. 1C

Attractive Bandwidth

Even with a high value of C_k, such as 100 μμf, the bandwidth of the output circuit is still of the order of 10 megacycles at an e_{gk} of -4.75 volts. Because of feedback, a very large change in input level is required to produce even a small change in e_{gk}.

This means that over the normal operating region of the detector, the output circuit is of sufficiently low impedance that even with a video amplifier having high input capacitance, excellent transient response can be obtained without recourse to any peaking circuits.

In addition to the input and output impedances, it is desirable to know the amplitude transfer characteristic of the circuit. A general analytical solution to the circuit was attempted. Such a solution requires representation of the tube characteristic, either by assuming it to be a linear device with g_m a constant, or by writing g_m as a function of e_{gk}. By assuming the tube to be linear, an unrealistic and rather useless solution is obtained. Therefore, if information of any practical value is to be obtained, the circuit must be treated as involving a nonlinear element.

Although this is a rather simple feedback circuit, the difficulty in obtaining the amplitude transfer characteristic, when g_m is a function of e_{gk}, as it is in this case, is enormous. Essentially it is necessary to solve a rather complicated differential equation involving the nonlinear quantity g_m. The fact that the circuit operates with negative feedback considerably complicates the situation. Although several approaches were attempted, no useful solution was obtained.

It was our feeling that in view of the difficulties involved, a general solution for this particular circuit was not justified, assuming a solution to be possible at this time.

The amplitude transfer charac-

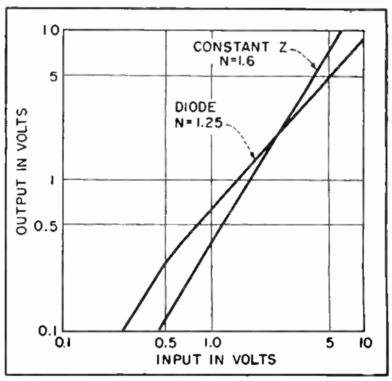


FIG. 3—Amplitude transfer characteristic of 6AU6 detector. Note close proximity to straight line having slope of 1.6

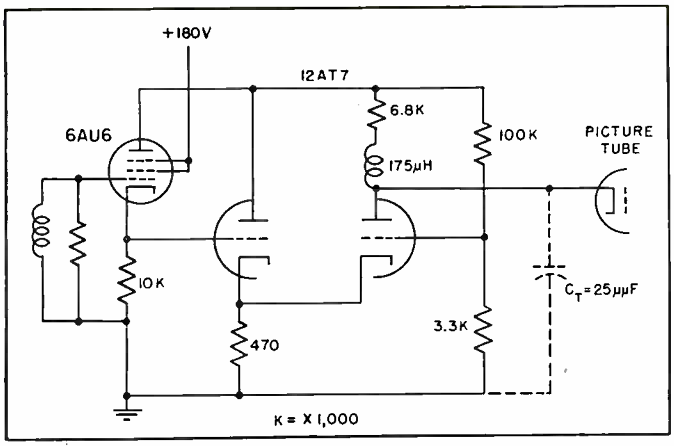


FIG. 4—Direct-coupled video amplifier designed for use with detector circuit described

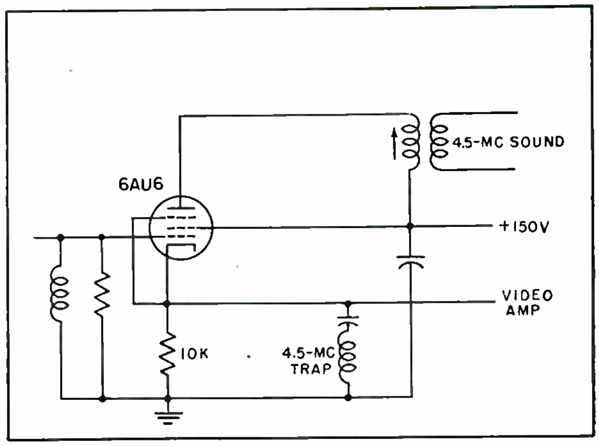


FIG. 5—Use of 6AU6 pentode detector provides intercarrier sound gain of about 20

teristic of the circuit using a 6AU6 was measured and is shown in Fig. 3.

It can be seen that this characteristic very closely approximates a straight line, on log log paper, with a slope of 1.6. As the video signal is polarized such that an increasing input decreases the display brightness, the gradient and gamma of the detector are 1/1.6 or 0.625. A plot of a diode detector is also shown; its gamma is 1/1.25 or 0.8. It can be seen that the constant input impedance detector is not as linear as the diode detector, and when the overall receiver gradient is determined, the effect of the detector must be included.

Circuit Application

When this detector is employed in a receiver, several circuit problems arise in connection with the output signal polarity and the d-c component. The output signal is polarized black positive, which requires an even number of video amplifier stages to drive the cathode of the picture tube, or an odd number to drive the grid. This situation is a disadvantage from one standpoint.

It has become common practice to use a single video amplifier with a black negative input to drive the cathode of the picture tube. This arrangement affords the possibility of obtaining considerable impulse noise limiting in the video amplifier. When the constant-input impedance detector is used, either two stages can be used, with limiting in one stage, or a single stage driving the picture tube grid can be used. In the latter case, noise limiting is somewhat less satisfactory but can be obtained by other methods.

If a direct-coupled amplifier is used to retain the d-c component available at the detector output, some difficulty may be encountered as the white level d-c voltage across the detector output resistor is of the order of 4 or 5 volts. Since the detector output is black positive, any signal above white level will raise the value of the cathode voltage.

A direct-coupled video amplifier particularly adapted to this detector is shown in Fig. 4.

The measured performance of this circuit with the constants shown is given below:

rise time=0.09 μ sec
overshoot=less than 10 percent
gain (detector K to crt K) =14 ×
peak to peak output=60 volts
with slight sync compression=110 volts
total B supply=11 ma at 180 volts

If still higher output is desired, it is possible to insert a load resistor in the plate circuit of the first video stage and apply the voltage developed to the grid of the picture tube.

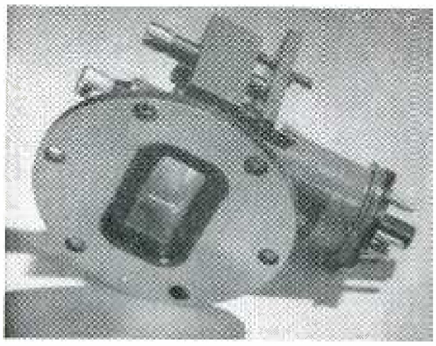
When a pentode, such as the 6AU6, is used as the detector, it is possible to obtain considerable intercarrier sound gain in the detector circuit. This is shown in Fig. 5. The 4.5-mc gain is of the order of 20 in this circuit. One of the advantages of this arrangement is that it avoids some of the complications involved in inserting satisfactory sound take-off circuits in the detector or video amplifier stages.

This detector has been included in several conventional receivers. It has been found that discrepancies between i-f sweep measurement and expected transient response are greatly reduced. The last i-f stage can be designed exactly like the other i-f stages. In addition, the removal of peaking requirements in the detector circuit simplifies the circuit and noticeably improves the transient response as compared to typical diode detector circuits.

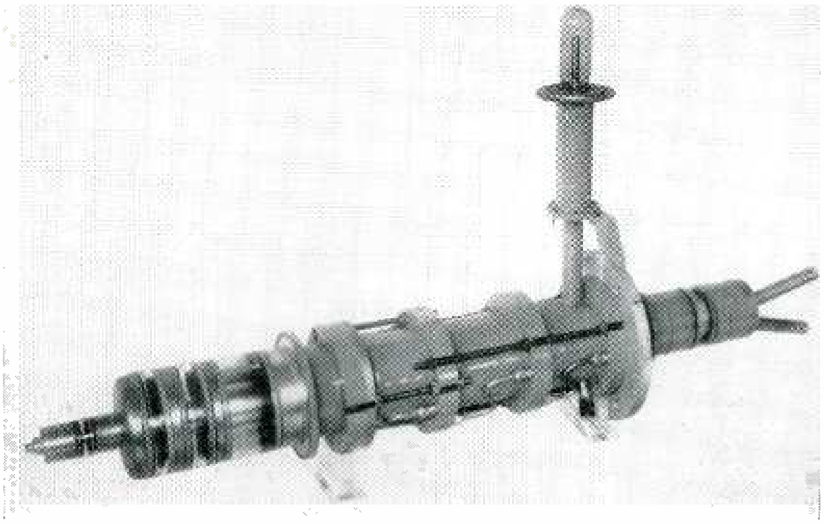
In summary, it can be stated that the constant input impedance detector meets the requirements of the detector as an integrated circuit element in the television receiver. It overcomes some of the inherent weaknesses of the diode detector, although its amplitude linearity is somewhat inferior. Complete and rigorous analysis of the detector is exceedingly difficult because of its non-linear operation. When the detector is employed in a receiver with video and i-f circuits designed to take advantage of it, performance is superior to an equivalent receiver with a diode detector, particularly in respect to transient response.

References

(1) C. E. Kilgour and J. M. Glessner, Diode Detection Analysis, *Proc. IRE*, 21, No. 7, p 930, June 1937.
(2) H. A. Wheeler, Design Formulas for Diode Detectors, *Proc. IRE*, 26, No. 6, p 745, June 1938.
(3) K. Schlesinger, Cathode Follower Circuits, *Proc. IRE*, 33, p 845, Dec. 1945.
(4) H. J. Reich, Input Admittance of Cathode-Follower Amplifiers, *Proc. IRE*, 35, p 573, June 1947.



One of the klystrons in the series of reflex oscillators covering from 5,925 to 8,200 mc. Each klystron has a tuning range of 300 mc. Designed for wide-band transmitter in local oscillator of television relay service



Klystron linear amplifier with 5-kw c-w output at 1,000 mc

Recent Developments

Television transmitters, phase-coherent radars, multiplexed relay systems and induction heaters are some of the expanding applications of klystrons. Renewed development work promises to bring widespread usage of klystrons in other untapped fields

ALMOST IMMEDIATELY after the development of the klystron, it was realized that this tube was capable of performing most of the functions performed by conventional tubes at lower frequencies. Within a year, designs had been worked out for oscillators, amplifiers (including multicavity cascade amplifiers), f-m and a-m modulators and demodulators, multipliers, tubes capable of large power output and means for improving klystron efficiency. This can probably put the klystron into the magnetron class as regards efficiency.

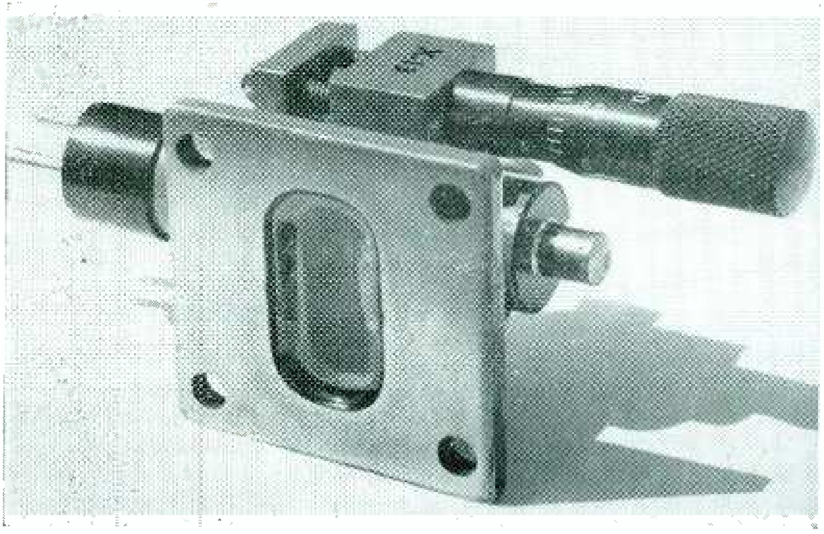
With such a fast start, it may appear strange that during the war the klystron was used as a local oscillator and very little else. There was really nothing strange about it. It turned out that the British had been pushing radar much more vigorously than we during a short period before war broke out. During this period they developed the slotted magnetron into a practical instrument but they did not have a satisfactory local oscillator until they got the klystron. When the United States and Great Britain pooled their development resources, the decision was made to follow the British concept and push primarily for immediately useful equipment.

This decision paid off with a tremendous radar victory for the Allies. The result was greatly weighted in our favor, however, by the Nazis' decision to standardize their equipment a rung or two below us on the research ladder, at a point where radar could only be a minor weapon.

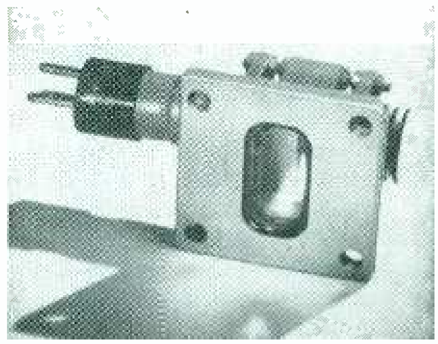
We finished the war with a large crop of young men who would normally be capable of new ideas, and most of them were absorbed into postwar work. But few were in a position to develop the new ideas they might have had. Military appropriations were cut drastically, leaving rather inadequate funds for postwar radar. Such funds as there were, were almost entirely devoted to procurement of service equipment or the refinement of existing equipment. The klystron art was almost at a standstill. Klystron engineers dreamed of commercial applications, but no one who held the purse-strings had enough faith in these new applications to provide enough money for new commercial development. Perhaps the only exception in the microwave field was the traveling-wave tube which did make considerable progress, principally under private support.

10-Megawatt Klystron

The first major progress in klystrons came because a group at Stanford University, supported by the Office of Naval Research, wanted to produce super-voltage electrons by means of a linear accelerator. This group defined the driver that it needed and, since no such tube existed, developed and made one. The resulting tube was



Tunable reflex klystron operating between 8,200 and 12,400 mc



Two-resonator klystron oscillator designed for fixed-frequency transmitter operation between 9,100 and 11,000 mc. Tube supplies a minimum of 4 c-w watts output power at a frequency of 10,000 mc

in KLYSTRONS

By RUSSELL H. VARIAN

President
Varian Associates
San Carlos, Calif.

a multimegawatt klystron amplifier which runs very consistently at 10 megawatts at 3,000 mc.

Although it occurred two and a half years ago, only recently has any serious effort been made to make use of this development in other applications. As an indication of the direction of thinking, most of the inquiries about such tubes have been slanted toward curing shortcomings of magnetrons rather than utilizing the inherent properties of klystrons.

With the untapped klystron potentialities which have been proved possible or will be proved possible in the near future, the imaginative engineer who is not bound by the habits of the past ten years again has a virgin field in which to work. His efforts, inquiries and requests will greatly stimulate the development of the tubes he needs. Development of high-power klystrons along with other postwar klystron work fits into a rather coherent pattern which, in conjunction with traveling-wave-tube developments, can usher in a new era in the microwave art.

The combination of high-power, high-gain klystron amplifiers with reasonably broad band and with crystal control provides the means for creating a wide variety of systems ranging from television transmitters to phase-coherent radars.

Reflex Klystrons

The reflex klystrons with very small harmonic distortion make possible multiplexed relay systems with a large number of links. In addition, the grid-controlled klystrons create the possibility of crystal-controlled channels spaced very close together which can be easily amplitude modulated. The linearity of the amplitude modulation has not been studied in detail, but it appears to be about as good as any triode.

There is a great challenge in this communication field, for it appears possible eventually to replace all long wire lines and, perhaps, to reduce the cost of long-distance communication to a point where the whole country can be as tightly knit by communications as a single city is today.

Another commercial application for the high-power c-w klystron is in electronic heating. The plastics industry, for example, is badly in need of a method of internal heating for large masses of thermosetting resins which avoids over-cooking on the outside.

Another interesting possibility is the explosion of grains or other solid particles during a free-fall passage through a resonator. An oscillator is usually too load-sensitive for such service but an amplifier can meet the requirements. Still better is a klystron amplifier with a space-charge grid on the beam holding the output voltage constant over a wide range of loads.

Radar Application

Radar applications are predominantly military, although there is a large commercial field in air navigation control, marine protective and, perhaps, railroad radar.

The klystron can certainly offer more power than a magnetron since the first attempt resulted in more power than magnetrons have attained after long development. This is of minor importance, however, since increased radar range is difficult to achieve merely by increasing power and also because there is always a limit to the power which can be supplied to a radar set. Increased range is even harder to achieve by improving tube efficiency.

In general, radar systems put a

number of pulses on a target. If these pulses are incoherent with each other, the energy per pulse is constant and usual display methods are used, sensitivity is proportional to $\sqrt{N}$ where N is the number of pulses per target per scan. Range is then proportional to the fourth root of the peak power, if the number of pulses remains constant, or to the eighth root of the peak power if the energy per pulse remains constant. It can also be readily shown that full utilization of the coherence between pulses will yield an equivalent power increase over the incoherent system equal to $\sqrt{N}$.

The majority of targets of interest to a radar system are moving targets. The existence of a coherent source of power greatly expands the possibility for moving-target-indicator systems, which could be made simple and dependable.

The pulsed high-power klystrons have been described elsewhere[1] so only a brief description will be given here. The tubes as now built are three-resonator cascade amplifiers operating at a very high voltage. Cathode emission density is very conservative for pulse work. Efficiency is in the neighborhood of 30 percent and can probably be considerably improved even without electron recovery. Because of the great dielectric strength of oil under pulsed conditions, the high voltage is not the great handicap that might be expected.

As mentioned, these tubes are spectacular in the minds of most people because of their power. However, the fact that these tubes are the equivalent of class-A amplifiers of very high gain and low noise level should become the most important feature in the long run. There is no reason why more cavities cannot be used to obtain still higher gain. The limit on gain is established by back coupling by high-speed electrons but most of this effect can be eliminated by proper design. Gain of 30 db is easily obtained and it should not be difficult to go beyond 40 db. Gains as high as 60 db may perhaps be possible. This gives the imaginative systems engineer a new challenge to make full use of the potential coherence and gain, as well as power, that this tube offers.

The high-power c-w klystron is in many ways similar to the pulsed klystron. Average power capacity is similar but operating voltage is much lower. One typical example is the high-power klystron developed by Varian Associates for a GE television transmitter[2]. This tube is a three-resonator tube delivering 5 kw power output at 22 db gain with a bandwidth suitable for television. Again there is nothing to prevent the use of more cavities to increase the gain-bandwidth product to achieve 40 or 50 db and the power output can readily be increased many fold.

A similar tube has been developed in France and another tube of the same design is now operating on Cheyenne Mountain for the Bureau of Standards' Tropospheric Laboratory. The system of which this latter tube is a part is the best operating demonstration of signal coherence obtainable from a klystron amplifier. The frequency stability of this system is as good as the crystal oscillator which drives the klystron through a multiplier chain—about 5 parts in 10^8. It is unmodulated and puts nearly all its power into a 20-cycle band at 1,000 mc. Here is proof for anyone who may doubt that high-signal coherence can be obtained.

Floating-Drift Tube

The floating-drift-tube klystron was first built at Stanford University before the war but no serious attempt has been made until recently to perfect this design. Fundamentally, the design consists of a drift tube suspended in a resonator in such a way as to provide two gaps in which the resonator field interacts with the electron stream. The first gap accomplishes the bunching; the second absorbs the energy from the beam. This tube combines many of the good features of the reflex klystron and the two-resonator klystron. The principal reason why the floating-drift tube has not been developed sooner is that its design is much more difficult because fewer parameters are subject to adjustment after the tube is made.

Much progress has been made in ruggedization of klystrons with the result that some klystrons can now withstand very high impact and can operate successfully under conditions of the most extreme noise and vibration. In addition, altitude has a negligible effect on the frequency of these tubes.

A great deal of work aimed at the improvement of existing klystron types has resulted in much more usable tubes than were available a few years ago. Improved efficiency of power klystrons is a project which has been in the minds of many since before the war, but until very recently little work has been done. Some work on efficiency improvement, however, is now being done at Stanford University.

Klystron Efficiency

There are two general ways, other than refinement of existing design, in which klystron efficiency can be improved. One method is by using two bunchers to improve the shape of the bunch entering the catcher. The high-power pulsed klystrons

OUTSTANDING RECENT DEVELOPMENTS

(1) High-power c-w klystrons for uhf applications, especially tv, are now a reality

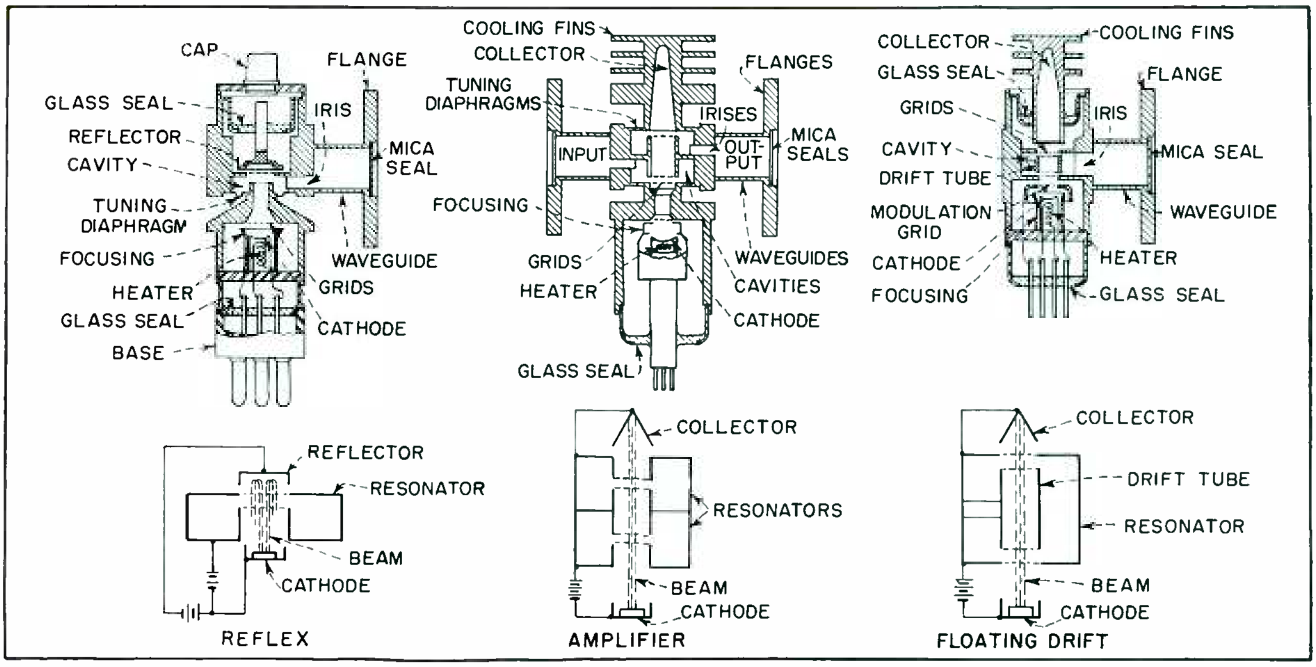
(2) Measurements on a reflex klystron under development prove that f-m harmonic distortion can be 60 db below the carrier with a $\pm$2-mc frequency swing

(3) The floating-drift klystron can combine the high efficiency and predictability of a two-resonator tube with the tuning ease and simplicity of f-m of the reflex klystron

(4) A space-charge grid may be inserted in a klystron to control beam current, transforming a klystron amplifier into a modulator with as much as 20-db gain and 10-mc bandwidth

(5) Improved frequency multipliers facilitate crystal control at microwave frequencies

(6) Klystrons have now been specifically designed for microwave-relay link service in communications



Sectional and schematic diagrams of the reflex, amplifier and floating-drift klystrons

developed at Stanford are designed to take some advantage of this method. However, it is doubtful whether the full benefits have been obtained. The other method of improvement is segregation of the electrons passing through the catcher resonator into groups according to velocity and returning one or more of these groups to the power supply. The simplest system would segregate the electrons which pass through the catcher resonator with greater than the initial beam velocity and return these to the cathode.

Somewhat greater improvement in efficiency may be had by segregating three groups of electrons: one of electrons of greater than cathode velocity; another of those with normal velocity and a third group of electrons with less than cathode velocity. By returning these various electron groups to appropriate taps on the pulse transformer which drives the klystron, a considerable over-all improvement of efficiency could be achieved. By proper use of these methods, it should be possible to obtain klystron efficiencies which are comparable to those obtained with magnetrons.

Another improvement stemming from prewar days is the use of the electrons passing through the last resonator of a klystron receiver for purposes of detecting the signal. It is relatively simple to put a velocity sorter in the path of these electrons and segregate them into high- and low-velocity groups. The d-c component of current in either of these groups is sensitive to the amplitude of the r-f signal.

Klystron detectors of this sort were built in the early days of klystron work before any crystal detectors were available. They were quite sensitive, but for low-frequency detection were extremely noisy and microphonic. It is quite probable that, by using a low-noise klystron or traveling-wave-tube amplifier before detection and then heterodyning to an intermediate frequency in the usual range, noise levels may be had comparable to those obtained in the laboratory with crystal detectors. Such systems should be much less temperamental than the usual crystal-detector system and be immune to over-voltage in the r-f and, therefore, should be considerably superior to crystals in field operation.

Low-Noise Klystrons

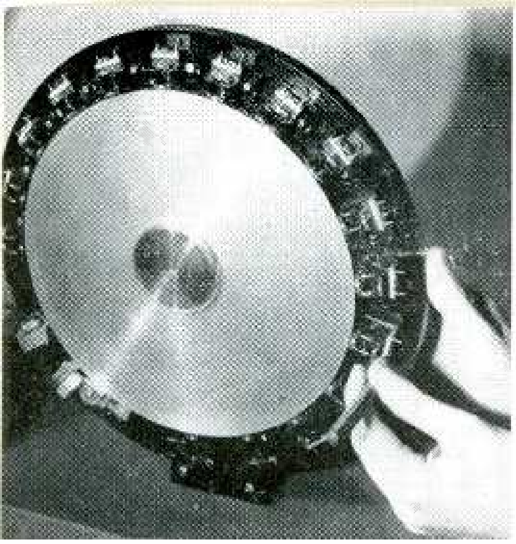
Considerable work has been done in producing low-noise traveling-wave tubes since the war but little has been done to produce low-noise klystrons. In the case of traveling-wave tubes, noise levels of 12 to 13 db have been obtained and it is probable that klystron noise figures at least as good may be had.

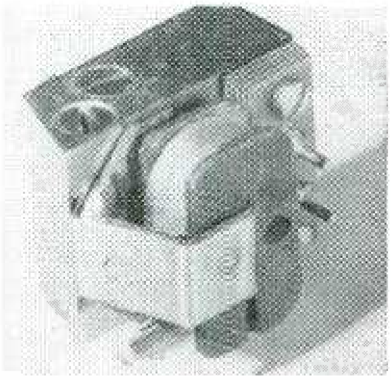
Another type of klystron which might be of considerable military value would be a tube capable of extremely short pulses which could give range information sufficiently accurate for artillery use against ground targets. Klystron control grids, described earlier, should be capable of gating the current in extremely short bursts. The buncher can operate continuously or on longer pulses. The catcher has a low Q and the output bursts are as short as the input bursts. To maintain high average-power output, such a tube would require high-voltage operation[1] but it has already been shown that such voltages are entirely feasible.

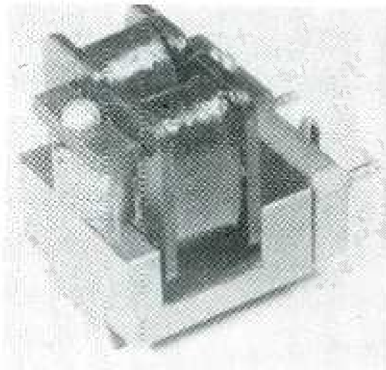
Money for development of klystrons is now much more plentiful than it was two or three years ago, and it is now possible to interest the Armed Services in projects sufficiently difficult that unorthodox methods must be used to solve them, which is one good method of getting advanced work done. However, the great pressure is on the delivery of tubes for specific purposes on a shorter-range basis.

REFERENCES

(1) M. Chodorow, E. L. Ginzton, I. Neilsen and S. Sonkin, Development of 10-Cm High-Power Pulsed Klystron, *Proc. IRE*, 38, p 208, Feb. 1950.
(2) H. M. Crosby, Five-Kw Klystron UHF Television Transmitter, ELECTRONICS, 24, p 108, June 1951.







THE FRONT COVER

Delay line comprising boundary-displacement magnetic recording head (near transformer at left) and sixteen ordinary playback heads arranged around periphery of aluminum drum coated with magnetic oxides. Extra head below recording head on drum is for erasing. Close-up views of recording head and playback head are shown at top center and right respectively

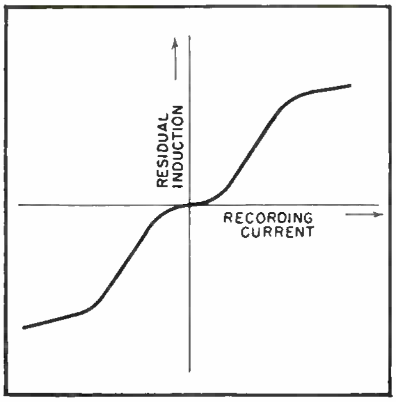


FIG. 1—**Typical playback remanence curve for conventional tape recording**

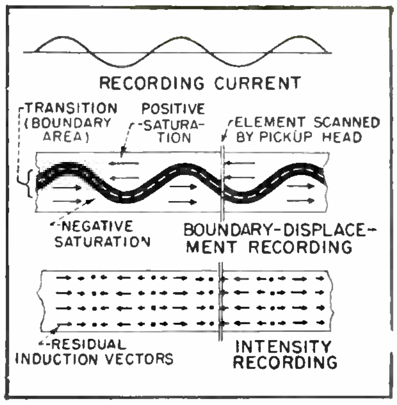


FIG. 2—**Comparison of new technique with conventional intensity recording**

Boundary-Displacement

First published description of a new method of magnetic tape and drum recording that is analogous to variable-area sound-on-film recording. Initial application is for analysis of transient waveforms up to 100,000 cps. Audio uses look promising

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THE newly-developed technique of boundary-displacement magnetic tape recording is characterized by a high degree of amplitude linearity with no dependence on the magnetization curve of the medium and with no critical adjustments.

To date, development effort has been concentrated mainly on recording for instrumentation purposes. The equipments developed have employed noncontact recording on drum surfaces coated with magnetizable materials, and have served for the most part as components in special-purpose systems for the analysis of transient waveforms. Frequencies involved have ranged in the various units from 1 cps to 100,000 cps, with appropriate adjustments in drum speed.

It would hardly be possible to avoid interest in possible application to audio recording. It has been possible to divert a small amount of effort to the construction of an audio tape-recording system, with results that are sufficiently promising to justify intensive future investigation.

The boundary-displacement system has also been applied experimentally to the production of visible oscillographic records of the recording signal, with no mechanical motion involved other than the constant velocity of the tape itself.

Conventional Tape Systems

About a decade ago, the performance of magnetic tape recording systems was so inferior as to be hardly competitive in quality with the results obtained by disc and photographic film methods. In recent years, however, this gap has closed rapidly. Improvement in the

HOW IT WORKS

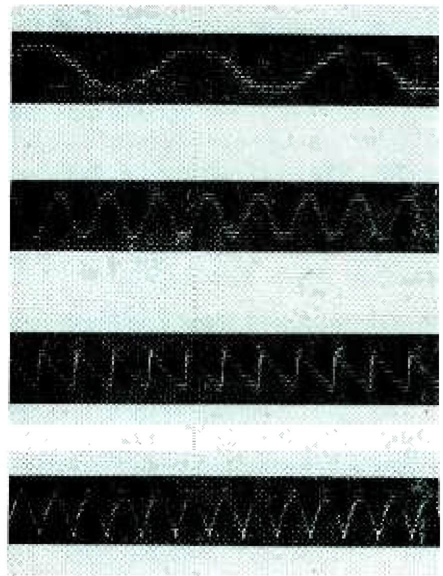
Ordinary magnetic tape is used, but is magnetized to saturation at all times.

With no modulation on the tape, one half of the tape has one polarity and the other half has opposite magnetic polarity. An unmagnetized boundary strip running down the middle of the tape separates the regions of opposite polarity.

A conventional magnetic tape pickup head is used for playback. With no signal on the tape, the equal-width opposite-polarity fields cancel in the pickup and there is no output signal.

With modulation on the tapes the unmagnetized boundary weaves back and forth according to the waveform of the signal. The net flux acting on the pickup head varies correspondingly, because sidewise movements of the boundary reduce the width of the magnetized region for one polarity and increase it for the other polarity.

A special recording head is needed to produce boundary-displacement recordings on tape or on drums coated with magnetic powder.



Boundary regions in four examples of boundary-displacement recordings on standard 1/4-inch magnetic tape, made visible by immersing tape in suspension of carbonyl iron powder in alcohol. Powder adheres to the regions of magnetic saturation. Fine lines in boundary region are due to nonmagnetic spacers in lamination stack of recording head

Magnetic Recording

quality of the recording media has reduced noise level and improved frequency response. The advent of a-c bias and erase techniques has led to mastery in large measure of the distortion resulting from the nonlinear remanence properties which are unfortunately characteristic of recording media.

The boundary-displacement recording system was initially concerned with the question of amplitude linearity. A typical playback remanence curve obtained by recording a strip of tape with a conventional ringform head is shown in Fig. 1. If an attempt is made to produce in the recording gap a field strength proportional to the recording signal, the remanent flux is an extremely nonlinear function of the recording current. One can, of course, apply to the recording head a d-c bias field[1] following a d-c saturation wipe of the medium such that the linearity of the remanence curve is vastly improved. An even more linear relationship can be achieved by the careful insertion of an a-c bias field[2,3] across the recording gap.

New Method

The boundary-displacement method attacks the problem of intensity nonlinearity from a different angle, by producing a magnetic record in such form that a continuous range of magnetization is not involved. A strip of tape recorded by this technique is effectively left in only one state—the relatively invariant state of residual magnetic saturation.

Figure 2 compares a section of tape recorded by a conventional intensity method with a similar recording produced by the boundary-displacement system. In the intensity recording, the intensity of magnetization increases or decreases along the length of the tape as the recording signal rises and falls in amplitude. In the boundary-displacement recording a small region of transition, which separates areas of oppositely polarized saturation, is displaced transversely from the center line of the tape by an amount proportional to the instantaneous signal intensity.

In playback, the boundary-displacement recording is read by a conventional type of pickup head whose gap spans the entire range of displacement of the boundary. The net flux in the pickup head is closely proportional to the difference between the elemental areas of positive and negative saturation scanned by the gap, and hence to the displacement of the region of transition, or boundary, from the center line.

Two properties are peculiar to the

boundary-displacement system. Linearity of recording is dependent not upon the remanence curve of the medium, but rather upon the geometry of the recording and pickup heads, and the full energy-storing capacity of the medium is available, since the limits of swing of the boundary correspond to full positive and negative saturation.

Recording Field Configuration

Several successful recording head designs have been evolved based on the principle represented in Fig. 3A. The upper diagram shows the longitudinal field pattern across the recording gap in the absence of signal, and the lower diagram illustrates the manner in which the signal to be recorded modifies this pattern. The horizontal coordinate represents points along the width dimension of the tape.

The zero-signal diagram portrays the static bias field across the recording-head gap. The intensity of this field is a function of position along the gap, varying linearly from an arbitrary positive value H_o at one edge of the tape to an equal negative value at the other edge, and zero at the midpoint.

In the presence of signal, a uniform signal field component h_s, which is proportional to the instantaneous signal amplitude, is superimposed upon the bias field to produce a vertical displacement of the resultant field intensity curve as indicated. A transverse displacement of the zero-field point away from the midpoint of the gap results. This displacement is proportional to the recording-signal amplitude under the conditions stated, so long as h_s does not exceed H_o.

The manner in which such a field produces a boundary-displacement recording is indicated in Fig. 3B, which represents the residual magnetization of the tape as it leaves the gap. If the saturation field intensity H_m of the tape is small compared to H_o, the tape is divided into two regions of opposite longitudinal saturation which are separated by a region of transition. The transition region is displaced from the center-line in accordance with the signal intensity, and the amplitude d is a fraction h_s/H_o of the width of the tape.

The width of the transition region is proportional to H_m/H_o. Limitations of magnetic materials and driving amplifiers impose a practical limit on how narrow a boundary region may thus be achieved. Since the form of this region does not change with transverse displacement, it contributes nothing to the played-back signal so long as it does not intersect the edge of the tape. Failure to achieve an abrupt transition between the areas of opposite saturation results only in a minor reduction of the maximum amplitude of swing. The relations between bias, signal and boundary width are indicated in Fig. 4.

Head Structure

A recording head structure which produces the necessary field configuration for boundary-displacement recording is shown in Fig. 5. The bias field is derived from the transverse magnetomotive force drop across a series of stacked silicon-steel laminations whose plane is parallel to the direction of motion of the tape. The source of bias flux is a permanent magnet coupled to the ends of the stack by means of soft iron yokes.

The recording gap is formed by one edge of the lamination stack in conjunction with the mating edge of a homogeneously permeable signal-flux member, whose section is in the form of a trapezoid open on one side. Because of the uniform reluctance of the gaps separating the signal-flux member from the lamination stack, the former adopts a magnetic potential midway between the potentials at the extremes of the latter. Thus the longitudinal field across the gap follows the zero-signal configuration of Fig. 3A. Current in the signal coil superimposes on the bias field a signal field which is uniform along the gap and achieves the desired transverse shift of the boundary. The relation-

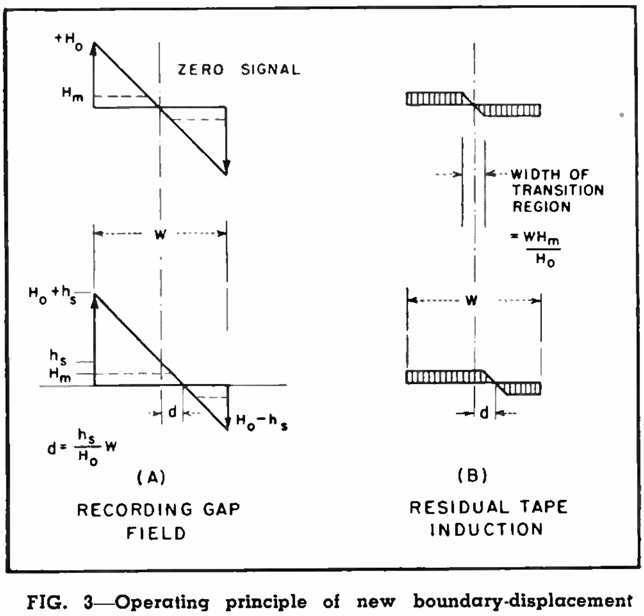


FIG. 3—Operating principle of new boundary-displacement recording head

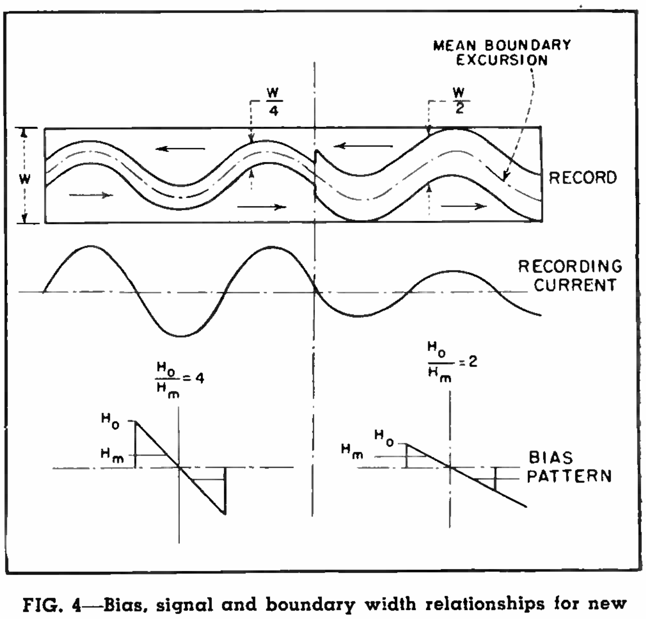


FIG. 4—Bias, signal and boundary width relationships for new method

ship of the reluctances and fields is given in Fig. 6.

The recording head structure is directional, so that the tape must be drawn across the gap from the lamination stack toward the signal flux member. If the direction of motion is reversed, the final field which acts on the tape is the strong transverse field from which the longitudinal bias is derived, and this causes partial erasure of the longitudinal recording.

Design of Recording Head

In designing the recording head, the transverse reluctance of the lamination stack must be made sufficiently high to absorb a major part of the magnetomotive force produced by the bias magnet. To insure linearity of the bias field, the total transverse flux into the lamination stack must be large compared to the active bias flux across the recording gap. The gaps between the signal flux member and the lamination stack and the distance of separation between the permeable laminations should be as uniform as possible to maintain linearity between the boundary displacement and the recording current.

Adjustment of the recording gap to suit the application is desirable. For contact recording a minimum gap is desired, and best high-frequency performance is achieved simply by butting the signal flux member against the lamination stack to yield an effective gap of a few tenths of a mil. For noncontact applications, in which a space of a mil or more must be maintained between the recording gap and the surface of the recording medium, a nonmagnetic shim of 3 to 5 mils thickness may be inserted in the gap without serious loss of high-frequency response.

The pickup head for boundary-displacement recording is entirely conventional in form. To avoid noise due to irregularities of the tape edge, the width of the pickup head is ordinarily made slightly less than the width of the tape.

Frequency Response

Limitations of the high-frequency response in a boundary-displacement system stem from the same

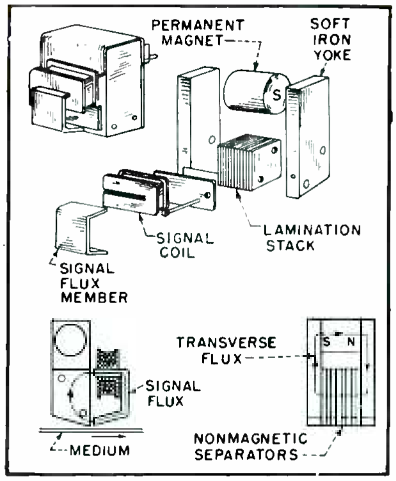


FIG. 5—New recording head structure

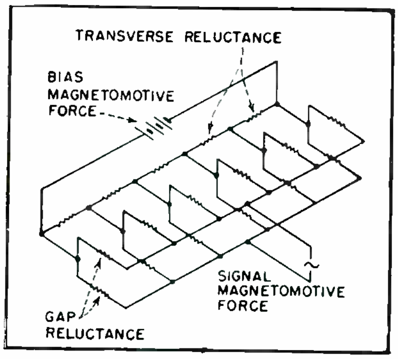


FIG. 6—Equivalent electrical circuit for new recording head

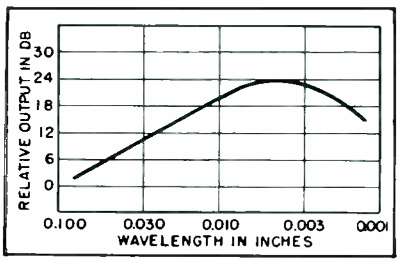


FIG. 7—Example of response curve for boundary-displacement contact recording

sources as in a conventional intensity-recording system[2]. These are the short-wavelength demagnetizing effects which are a property of the recording medium, and the inability of the recording and pickup head gaps to resolve wavelengths which are not large compared to the gaps themselves.

It has been shown experimentally that the frequency-response curve for a boundary-displacement system corresponds closely to the response derived from a d-c bias intensity recording system. A typical curve for standard red-oxide acoustic recording tape under contact conditions is given in Fig. 7.

In the absence of recording signal, the noise played back from the recording medium in a boundary-displacement system is equivalent to that produced by a d-c saturation wipe of tape. As a consequence, the absolute noise output corresponds closely to that derived from a d-c erase-and-bias intensity-recording system.

The maximum undistorted signal swing, on the other hand, is considerably greater than that derived from the intensity system. As a result, a dynamic range in excess of 40 db is readily achieved with presently available recording media. Since the recording gap applies a saturating d-c field, the difference between a-c erase and d-c saturation erase of the medium prior to recording is unimportant.

A second type of noise, which is largely avoided by the boundary-displacement recording method, appears as an unwanted modulation of the recorded signal produced by minute surface irregularities in the medium and by variations in spacing between the recording-head gap and the medium. The latter effect is principally a matter of dirt in the case of contact recording and of drum eccentricity in the case of noncontact recording.

In boundary-displacement recording, a moderate increase in spacing between the recording gap and the medium merely diminishes the value of H_o in the medium without altering the linear form of the field pattern. The result is an increase in width of the boundary region; this is of no consequence, since the mean displacement of the boundary region remains unchanged, and the pickup head sees the same difference between areas of positive and negative saturated magnetization.

Figure 8 presents oscillograms comparing a boundary-displacement recording on the magnetizable periphery of a drum with a d-c bias recording on the same drum. The drum, the medium, the frequency of the recording signal and the pickup head are identical in both cases. The drum used for this comparison was deliberately constructed to provide an overall eccentricity of two mils, together with a series of relatively short-period surface irregularities. The effect of the boundary-displacement recording in reducing modulation effects is quite evident.

As has been pointed out, the distortion produced by a boundary-displacement recording is not a function of the magnetization curve of the medium, but rather of the geometrical precision of the recording head. Experimental results have fully confirmed this prediction. Thus far, no attempt has been made to construct heads to a maximum degree of precision, yet the units have consistently yielded exceedingly low values of amplitude distortion—in some cases as low as two percent.

Audio Applications

Development of the boundary-displacement technique has been aimed largely toward instrumentation applications. Early in the development, a few brief and incomplete tests were made of an audio recording system based on this technique. Despite a relatively crude recording head, the system compared surprisingly well with a supersonic-bias system of good quality, both as regards dynamic range and distortion. The audio recording potentialities of the technique are undergoing further investigation.

Both the a-c bias and the boundary-displacement techniques are characterized by low-amplitude distortion. The achievement of a sufficiently intense a-c bias field in the medium becomes an increasingly difficult problem as signal frequencies are increased above the audio range, particularly under noncontact conditions. The a-c bias frequency must be several times the highest signal frequency, and the iron losses in the recording head under these conditions commonly lead to prohibitive power requirements and excessive heating of the head structure.

Visible Records

By immersing a boundary-displacement recording in a suspension of carbonyl iron powder in alcohol, a visible display of the recording current can be obtained because the boundary region then shows clearly. Visible records of this kind have been produced at frequencies up to several kilocycles. The principal limitation on frequency appears to be the rate at which the tape may be pulled across the gap.

Records of this sort were of initial interest primarily as a tool in the investigation of recording-head design. Beyond this, it appears that the method is applicable in general to problems of oscillography. That oscillograms of this kind can ever equal the definition and legibility of a photographic record is improbable. On the other hand, the relative simplicity and compactness of equipment, the ease and certainty of operation, and the avoidance of photographic processing are immensely attractive features.

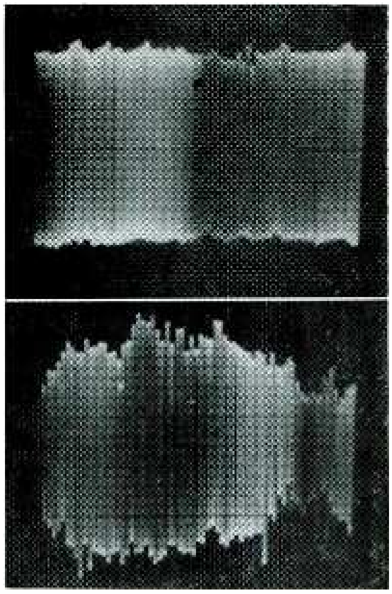


FIG. 8—Oscillogram showing modulation due to drum eccentricity for boundary-displacement recording, with corresponding oscillogram for d-c bias recording on same drum shown below for comparison

Both the recording and processing materials are inexpensive and readily available. It is possible to process a reel of tape by running it continuously through a processing bath, thus giving a visible record a few seconds after recording. The tape may be wiped clean of iron powder and reprocessed at will, or the powder may be fixed permanently by adding a suitable binder to the processing bath. In any case, the record may be replayed magnetically whenever desired for electrical reproduction; the presence of the iron powder has negligible effect on the played-back signal.

To summarize, the boundary-displacement system of magnetic tape recording is distinguished by the following characteristics, as compared with intensity magnetic-recording systems.

(1) A high degree of amplitude linearity is achieved which is wholly independent of the magnetization remanence curve of the medium.

(2) Maximum signal output corresponds to full tape saturation magnetization.

(3) Zero-signal noise output is comparable to that produced by a d-c saturation wipe of the tape.

(4) As a result of (2) and (3), the dynamic range is superior to that available from a d-c bias system, although perhaps somewhat inferior to that of a high-quality supersonic bias system.

(5) Performance is not critically dependent upon bias level.

(6) Recorded signal modulations due to inhomogeneities of the medium and to variations in gap-medium spacing are minimized.

(7) Problems attending the production of a high-frequency bias field in the medium are entirely avoided (of particular importance when the frequencies to be recorded are high, and when noncontact recording is involved).

(8) Under some conditions the recording may be processed very simply to yield an oscillographic display of the recording signal.

Development of the system has involved a number of persons. In particular, among the writer's associates, credit is due to S. M. Rubens as coauthor of the concept of the boundary-displacement magnetic record, and to J. W. Hogan and C. W. Fritze, who have contributed heavily to the reduction of the method to working form. In addition, acknowledgement is due to R. Herr and W. W. Wetzel of Minnesota Mining and Manufacturing Co. for advice and assistance in evaluating the initial attempt at an audio version of the boundary-displacement system.

REFERENCES

(1) S. J. Begun, "Magnetic Recording," Murray Hill Books, Inc., New York.

(2) R. Herr, B. F. Murphey and W. W. Wetzel, Some Distinctive Properties of Magnetic Recording Media, *Journ. SMPE*, p 77, Jan. 1949.

(3) L. C. Holmes and D. L. Clark, Supersonic Bias for Magnetic Recording, ELECTRONICS, p 126, July 1945.

FERRORESONANT FLIP-FLOPS

Carrier-frequency system permits count rates up to 100,000 per second with 2-mc carrier. Power consumption of decade with neon indicators and no tubes and no diodes is only one watt due to reactive nature of elements

By CARL ISBORN

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Computer Research Corporation
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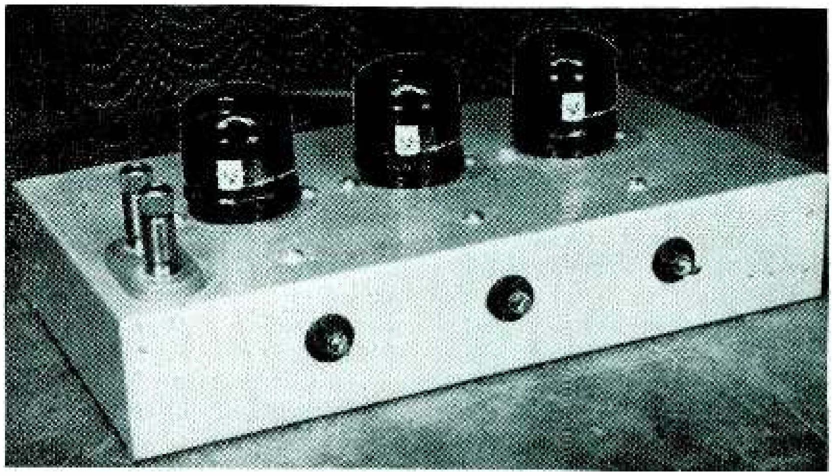


Ferroresonant flip-flops mounted on octal-base plugs are shown in complete three-stage counter with neon indicators

OVERALL RELIABILITY in an automatic computing system is equal to the product of the individual reliabilities of all of the components involved. This is due to the fact that all of the elements are effectively in series. Thus a chain of ten elements, each of which has 90 percent reliability, produces an overall reliability of about 35 percent. This chain is not nearly as strong as its weakest link.

Statistics show that the weakest link in a high-speed automatic computing system is invariably the vacuum tube. For this reason a major part of the research effort here is being directed toward reducing to an absolute minimum the number of vacuum tubes required for each computer.

Diode gating has been utilized to such an extent that virtually all multiple control grid gating tubes have been eliminated. An analysis of each individual computer, however, shows a required number of basic stable states. In practically all high-speed computers these stable states are supplied by vacuum-tube flip-flops. These flip-flops must not only maintain their stable states, but must also be able to deliver sustained power to their respective diode networks.

Research has shown the possibility of eliminating even these last few remaining vacuum tubes from computers, at least in the medium-speed field. One device which has made this possible is the Ferroresonant Flip-Flop.

Ferroresonance

It is first necessary to examine the phenomenon of ferroresonance. Consider the circuit of Fig. 1A. If the frequency and the voltage of the generator are properly chosen, the circuit is bistable; that is, it has two stable conditions either of which it can maintain indefinitely.

To explain this bistability refer to Fig. 1B. Remember that L is an iron-cored inductor and as such will suffer a-c saturation over at least a part of the cycle if subjected to a sufficiently strong magnetomotive force. This saturation results in a reduction in the effective inductance of L. In fact, changes of 20 to 1 are quite common if the inductor is properly constructed.

A certain capacitance C has been

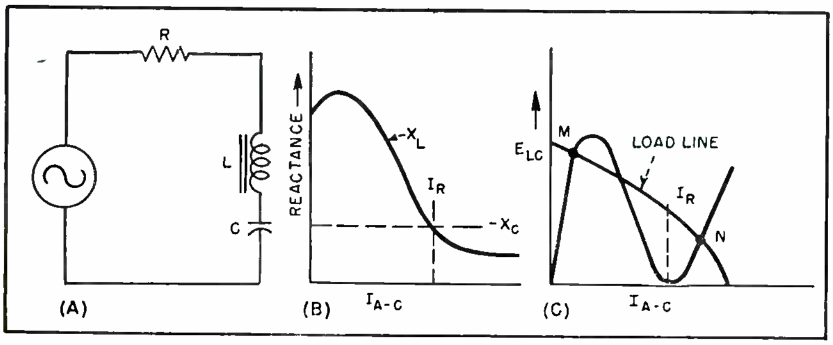


FIG. 1—Basic circuit and curves illustrate operating principle of ferroresonant flip-flop

chosen and minus X_c has been plotted on the same graph scale. Now at point I_R the values of X_L and X_c are equal in magnitude and opposite in sign so that the circuit is in series resonance for this particular value of alternating current. This condition has been named ferroresonance because of the ferroelectric nature of the inductor involved, and is not to be confused with ferromagnetic resonance which occurs in magnetic materials when subjected to magnetomotive force which alternates at several thousand megacycles.

If this nonlinear L and the linear C are connected in series as shown in Fig. 1A and the alternating current is increased, the E-I curve of Fig. 1C will be obtained. The voltage across L and C will first rise, reach a maximum, then decrease to a value near zero at a current I_R. The nearness with which it approaches zero is dependent on the losses in L and C. After I_R is exceeded, the voltage across L and C rises in a normal fashion. It should be noted that before I_R is reached, the circuit is inductive, after I_R it is capacitive.

Note also that the curve shows a negative-resistance region. Thus if the proper operating voltage is chosen and the value of R is small enough, there exists two possible stable values of I_{A-C}, one at M characterized by low current and high inductive resistance, and one at N where the current is high and the circuit is slightly capacitively reactive.

If a second winding were applied to the core of inductor L in Fig. 1A, it should be possible to raise the current in the circuit from point M to point N by the application of a d-c trigger pulse which temporarily reduces the inductance of L and allows the current to jump to point N where the current holds since the device is self latching. Notice that the trigger pulse could be of either polarity since either could accomplish a temporary reduction in L.

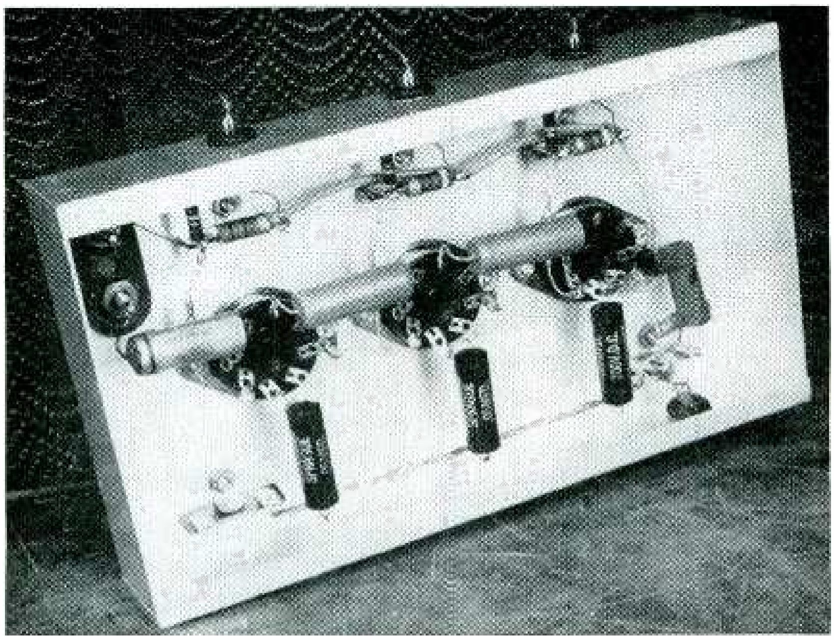
Note also that successive pulses applied to the same winding will not return the current to point M since the alternating current flowing is sufficient to hold L in saturation. Thus, whereas the simple L-C circuit of Fig. 1A possesses the bistability necessary for flip-flop applications it lacks the ability to change its state with each successive applied trigger pulse. For greater flexibility it is necessary to resort to the circuit of Fig. 2.

Useful Circuit

In this circuit the reactance of C_c is so chosen that one and only one L-C combination can be in resonance at a time. If both should try to go into resonance, the voltage at point P would fall so low due to the added voltage drop across C_c that neither L_1C_1, nor L_2C_2 could have sufficient voltage across them to maintain resonance. On the other hand if L_1C_1 and L_2C_2 should both try to go out of resonance, the voltage at point P would rise to such a value that one or the other should be forced to break down and go into resonance.

When connected in this way, these elements are somewhat analogous to a pair of gas tubes connected in parallel through a high impedance to a high d-c voltage. When the voltage is applied, the voltage across the gas tubes rises till one of them breaks down. Once this happens the other tube will not fire because its striking voltage is greater than the operating voltage of the tube already lit.

Getting back to Fig. 2 it is obvious that this circuit has several advantages over that of Fig. 1. It is a device which in many ways resembles its vacuum-tube counterpart. It has two inputs and two outputs, one output being always opposite in phase to the other. It is a balanced system in that it always draws the same current from the a-c supply.



Bottom view of three-stage binary counter employing ferroresonant flip-flops illustrates extreme simplicity

Photograph shows relative size of flip-flop and vacuum-tube equivalent

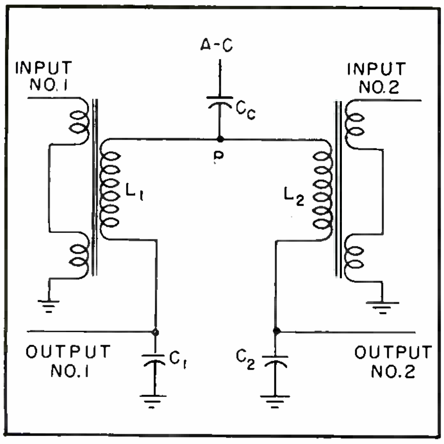


FIG. 2—More flexible circuit employs two separate cores

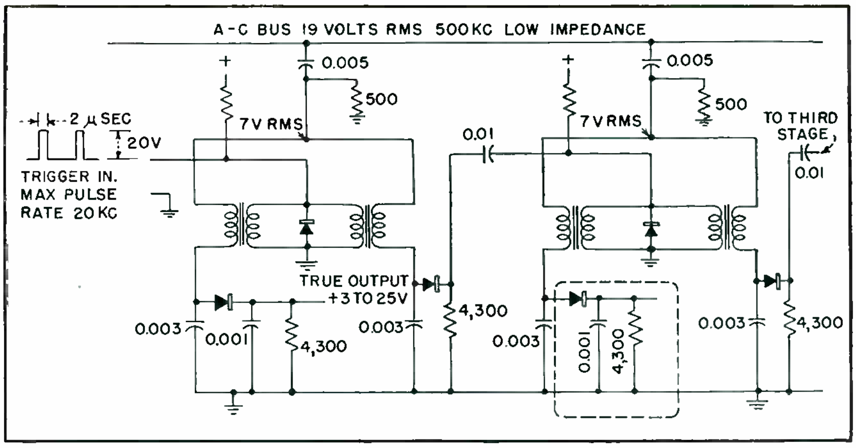


FIG. 3—Complete circuit shows two stages appropriately coupled for binary operation. Ferroresonance phenomenon is adaptable to ring counter circuits

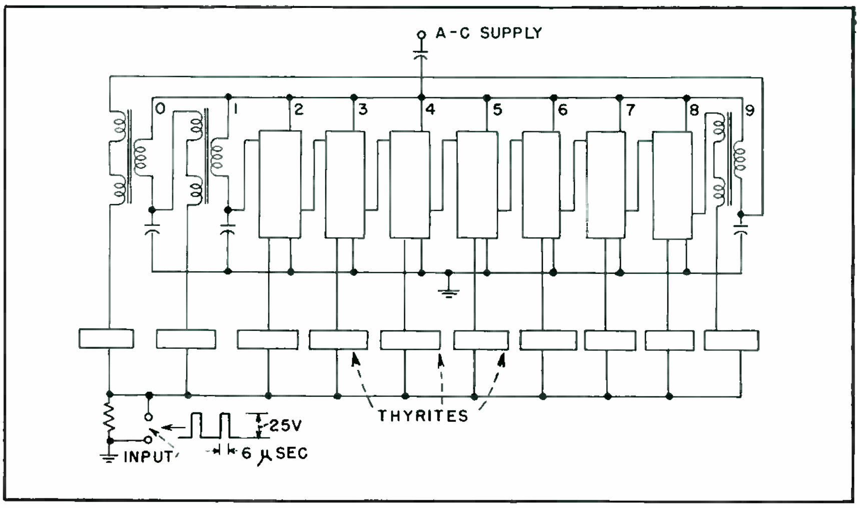


FIG. 4—Decade unit uses no tubes. Diodes are replaced with nonlinear thyrite elements

Assuming that L_1C_1 of Fig. 2 is in resonance, a pulse applied to input No. 2 will cause the voltage at P to drop; this causes L_1C_1 to go out of resonance and L_2C_2 to go into resonance. Now a pulse at input No. 1 causes the reverse action to take place. This type of flip-flop is well adopted to parallel-gated binary-counting systems, since each element is capable of considerable power gain and one flip-flop can drive several others through diode gates without drivers being necessary. Such flip-flops are capable of performing as binary counters, ring counters and stepping registers, by using suitable diode gating.

If a single-input flip-flop is desired, inputs 1 and 2 of Fig. 2 may be tied together and pulsed simultaneously. When this is done, successive trigger pulses will cause the flip-flop to change its state. To explain the reason for this, assume that L_1C_1 is resonant. The applied trigger pulse tends to drive L_2C_2 into the high-current condition resulting in a drop in voltage at point P Fig. 2. This causes the current in L_1C_1 to start to decrease.

At the end of the trigger pulse the voltage at P increases due to the fact that neither L_1C_1 nor L_2C_2 is in true resonance at this instant. This rise in voltage forces either L_1C_1 or L_2C_2 to go into resonance. Since L_1C_1 was decreasing in current at the instant the trigger pulse ended and L_2C_2 was increasing, the regenerative nature of the circuits assures that this trend be continued and that L_2C_2 go into resonance and that L_1C_1 go out of resonance.

This whole action takes place in a period equal to about 5 cycles of the applied power frequency. This circuit, like all single-input flip-flop circuits, is more critical to pulse width than the parallel gated system. It is not however as critical as might be thought from the above description. Typical limits for reliable triggering are from 1 microsecond to 4 microseconds in one unit tested. This was with a square pulse of 30 volts amplitude.

Interstage Coupling

Figure 3 shows a typical circuit for a two-stage carry-type binary counter wherein the output from the first stage is rectified and differentiated to form a trigger pulse for the second stage. The advantage of this type of counter over a parallel-gated counter is that it requires less components.

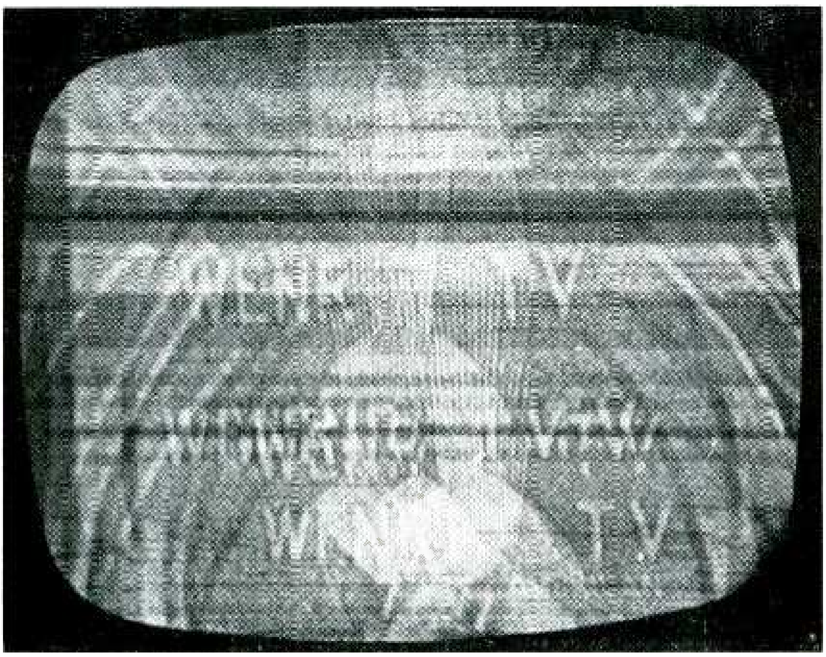
The ferroresonance phenomenon is very readily adapted to ring counters with as many as 20 or more elements if desired. Thus an input pulse stream may be divided by any integer 1 through 20 or more by connecting the proper number of elements in the ring. Figure 4 shows a typical decade ring which requires no vacuum tubes and no diodes. The nonlinear properties of thyrite resistors perform the logical gating.

This decade lights neon lights to indicate the count and requires a total a-c power input of about 1 watt.

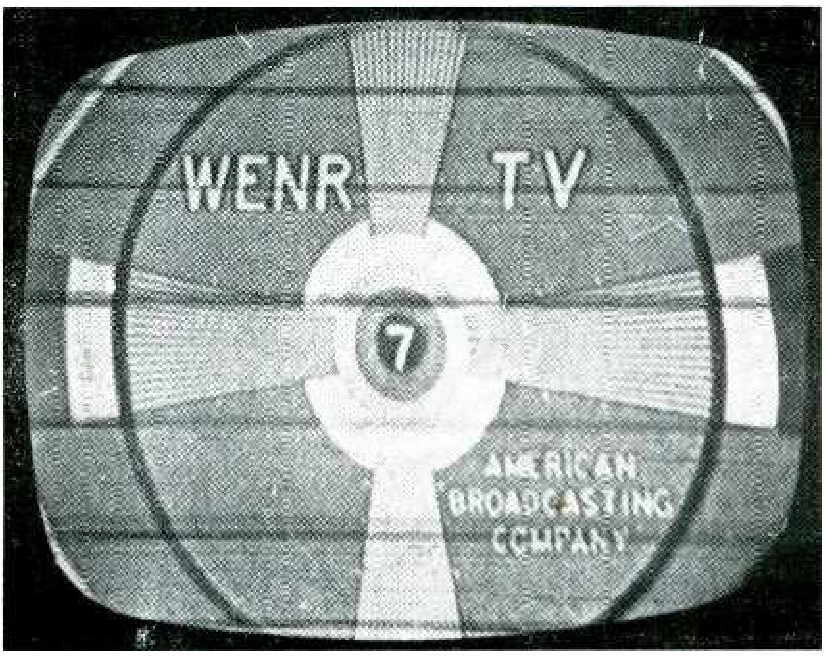
The low power consumption of the ferroresonant flip-flops is due to the fact that almost all of the components are reactive components and therefore do not consume power. The major part of the power consumed is due to the copper loss in the coil.

Noise-Immune

Impulse noise strong enough to disturb most synchronizing circuits is rendered innocuous by a single-tube sync clipper. Noise pulses, distinguishable from desired signals by their higher peak amplitude, produce no output and no residual charge



Test pattern received with the fringe lock control set for minimum protection. The noise source was a d-c operated buzzer inductively coupled to the antenna terminals through an attenuator



Improvement of test pattern achieved with control set for maximum noise protection. For both settings of the control with the noise source turned off, the picture did not move

ONE of the main weaknesses of television receivers today is poor synchronization of the picture, especially in fringe areas.

The main source of trouble lies in the design of the sync clipper that separates the synchronizing information from the rest of the detected signal. But this task becomes exceedingly difficult when the antenna also picks up local interference which may be many times stronger than the signals of the distant station.

Engineers have been increasing the number of tubes assigned to do the sync-clipping job in an effort to make the circuit intelligent enough to reject this extraneous interference and accept only the legitimate sync information. But with the pressure of lowering costs, simpler and more effective methods have been eagerly sought.

This paper describes circuits capable of salvaging a maximum of sync information under severe noise conditions, using no additional tubes and only a few judiciously placed resistors.

Sync Clipper Troubles

It will be necessary to touch briefly on the design considerations of a conventional sync clipper to understand why the output goes to pieces under strong impulse noise conditions. As an example of a typical sync clipper, the 6BN6 gated beam tube[1] will be used because it will pave the way for a better comprehension of the inner workings of the noise-immune sync clippers to be described. Practically all conventional sync clippers are subject to the same troubles and for the same reasons.

Figure 1 shows the 6BN6 as a conventional sync clipper. The out-

Sync Separator

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put of the video detector has an amplitude of around 2 volts peak, with negative polarity. If the video amplifier has a sync gain of 20, the composite video at its plate will be 40 volts peak, with the syncs positive. The syncs are located in the upper quarter of the composite video signal and may be separated by taking a slice out of this quarter.

The plate of the video amplifier is coupled to grid 1 of the sync clipper through a coupling capacitor and grid leak. The values of these two components are carefully chosen to fulfill two requirements. The lower clipping point is established by the resistor and the duty cycle of the normal signal, and the capacitor must be large enough to insure the transfer of the vertical sync information with a minimum of distortion.

Figure 2 shows how the 6BN6 operates as a conventional sync clipper. The upper quarter of the 40-volt video amplifier output is shown. The upper and lower slicing points are shown dotted. This illustrates the first basic fault of the conventional sync clipper—noise pulses are treated exactly the same way as sync pulses. They are sliced top and bottom, and their full cross section appears in the sync output.

One additional fact pertains particularly to the 6BN6 tube—the curves for both grid and plate current are sharply cut off and become saturated immediately. In contrast to this, the corresponding grid current curve for an ordinary triode or pentode will continue to increase in the positive grid region. It was because of this internal grid current-limiting characteristic that the 6BN6 was used as a sync clipper in Zenith television receivers for over two years.

The second basic trouble with which almost all conventional sync clippers are afflicted is illustrated in Fig. 3. This condition is known as charging up of the coupling capacitor whenever noise pulses are strong enough and occur frequently. Here the 40-volt positive-going signal is applied to grid 1 through the large coupling capacitor.

The upper and lower clipping levels are shown together with their behavior during and following noise pulses. After the first noise pulse, the clipping level increases because the capacitor-charging grid current lasts several times longer than a horizontal sync pulse. No damage is noticed the first time, but after the second noise pulse, the clipping level has increased enough to cut the sync output in half. After the third noise pulse, the syncs are stripped for quite a few horizontal periods. When stripped syncs are fed to the horizontal sweep system of a television receiver the result will usually be a tearing in portions of the picture or a squirming motion—depending upon the time constants and circuits used for automatic frequency control.

A triode or pentode sync clipper reacts much more violently to extraneous noise pulses than the 6BN6 because of the rising grid current characteristic of such tubes.

In addition to the damage done by sync stripping, the output of practically all conventional sync clippers contains the noise pulses themselves in full strength. Such pulses are likely to cause rolling and bouncing of the picture since they readily penetrate the integrator and can trigger the vertical sweep generator prematurely.

Noise-Immune Circuits

Figure 4 shows a sync clipper which offers a great improvement in performance over conventional sync clippers. This circuit is essentially the same as that shown in Fig. 1, except for the addition of a diode, a few resistors and a negative bias source. The object here is to separate all noise pulses whose amplitude is greater than that of the sync tips, and then to apply these separated pulses to the second control grid of the conventional sync clipper just described. This grid has limiting characteristics similar to those of the first control grid, and is available as a gating grid.

If the separated negative-polarity noise pulses are applied to the gat-

This article is based on a paper, presented at the 1951 National Electronics Conference, which will appear in the *NEC Proceedings*.

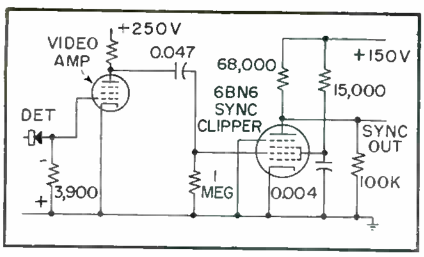


FIG. 1—Conventional type sync clipper using 6BN6 gated-beam tube

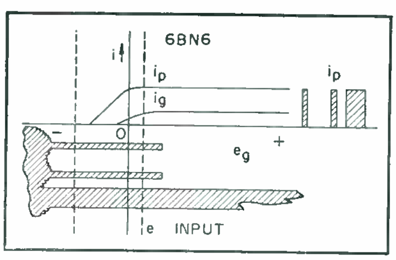


FIG. 2—Operating characteristics of the circuit in Fig. 1

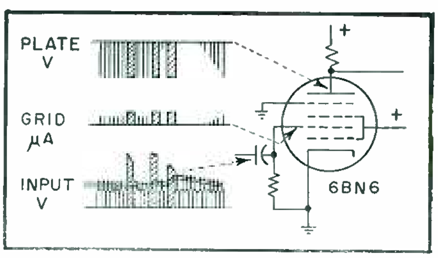


FIG. 3—Behavior of the conventional circuit burdened with impulse noise

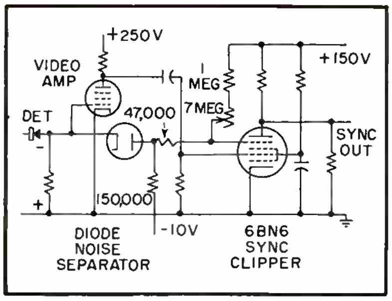


FIG. 4—Noise-immune sync clipper using diode noise separator

ing grid, the output current is cut off as long as the noise pulse amplitude exceeds that of the sync tips by a sufficient margin. The undesired noise pulses therefore disappear from the sync output.

The plate of the diode has a delay bias equal to the sync tip amplitude, so the diode will conduct only when its cathode goes more strongly negative than the sync tips. When this happens, negative-going pulses appear at the plate and are passed directly to the gating grid.

This circuit is very effective in avoiding one of the two basic troubles of conventional sync clippers: Its output contains no false sync information, and if the receiver has stable horizontal and vertical sweep systems, this improved sync clipper will give very good service. However, the second basic trouble, charging up of the coupling capacitor, still remains.

It is possible to eliminate the diode noise separator from the circuit just described without any sacrifice of noise immunity by shorting the diode, and removing the negative bias source together with its series feed resistor. In this case, the second control grid is biased positively to place the sync tips at the upper knee of the plate current curve so that the composite video will fall into the saturated region. This compresses the video and sync tips, but noise pulses of greater amplitude than the sync tips cut off the plate current and thus suppress the output for the duration of the noise pulse, just as in the previous circuit.

Improved Circuit

Figure 5 shows an improved version of the noise-immune sync clipper which retains all advantages of the circuits previously described, but which also overcomes the second trouble of most sync clippers: charging up of the coupling capacitor on extraneous noise pulses is prevented. This circuit is of great practical interest.

The main difference between this circuit and the preceding one appears to be that the connections to the two control grids have been interchanged. It has been known for some time that very good sync clipping is possible with either control grid of the 6BN6 gated beam tube, but the change has a profound effect.

Figure 6 shows how each element of the sync clipper helps to achieve the desired noise immunity. Grid 2, the gating grid, is biased positively so that the sync tips fall at the knee of its plate current curve. Space current is cut off by any noise pulse of sufficient amplitude.

In the absence of noise pulses, the electron beam reaches the second control grid. Normally, when this second grid goes positive during sync pulses, some electrons flow into the coupling capacitor to recharge it and maintain normal bias. But with noise gating applied to the first grid, a neat hole is cut into the beam current for the duration of each noise pulse and the supply of electrons available for charging the second grid is denied it every time a damaging noise pulse arrives at the video detector.

Thus we see that this circuit eliminates the noise pulses from the sync-clipper output, and at the same time, prevents the coupling capacitor from charging up on noise pulses and stripping the syncs. The improvement made by the substitution of this circuit over conventional sync clippers is really impressive, especially under the most adverse conditions of impulse noise and signal strength. With such a sync clipper the picture just stands still.

Operating Characteristic

The video amplifier forms an integral part of this noise-immune sync clipper, and a composite operating characteristic of the entire system proves instructive. The curves given in Fig. 7 show the sync-clipper plate current plotted against the video detector output. If it seems odd to have a negative-going signal producing plate current in a tube, it should be remembered that the detector output is amplified in the video stage and reversed in polarity before being applied to the second grid of the sync clipper.

Let us follow a noise pulse and trace out the composite operating characteristic. At the starting point the detector output is zero, grid one is biased positively, say two volts, and the beam current is maximum, but the plate current is zero because grid two is biased beyond cutoff. As the pulse applied to grid one increases in the negative

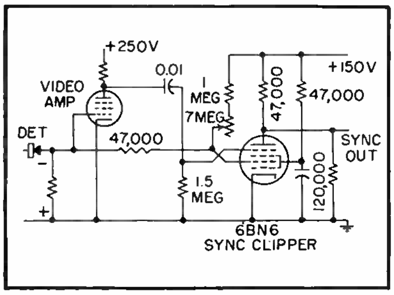


FIG. 5—Improved version of the noise-immune sync clipper

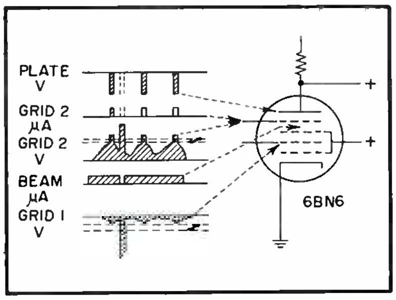


FIG. 6—Behavior of the circuit in Fig. 5 burdened with impulse noise

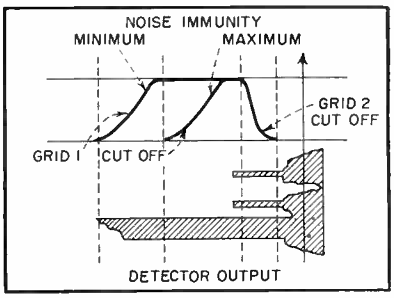


FIG. 7—Composite operating characteristic of the noise-immune circuit

direction, the amplified pulse applied to grid two increases more rapidly in the positive direction.

As these grid potentials continue to increase in their respective directions, the plate current will suddenly go to saturation as it describes the portion of the characteristic labeled "grid 2 cut off" in Fig. 7. The pulse continues to move in the negative direction for another volt or so and then the plate current again suddenly falls to zero after the "grid 1 cut off" portion of the characteristic is reached. For the on time of the rest of the pulse, there is no plate current until the pulse, on its way down, crosses first the same "grid 1 cut off" curve and flashes through the saturated plate current region, and past the "grid 2 cut off" curve.

The bias adjustment on the first control grid controls the flat, saturated portion of the composite characteristic. When this adjustment is set for minimum noise immunity, the gating grid must be biased sufficiently positive that even the largest noise pulses hardly reach the "grid 1 cut off" curve. This adjustment is made by turning the series rheostat (Fig. 5) to zero, thus leaving only the series limiting resistor from plus 150 volts to the gating grid. The resistance of the rheostat may now be increased until one of two things happen. Either adequate noise protection is achieved, or the flat, saturated portion of the curve is reduced to the point where the sync tips poke into the "grid 1 cut off" curve and thereby cause a reduction in the amplitude of the sync output.

This composite characteristic of the noise-immune sync clipper shows how the amplitude of the signal at the video detector determines whether or not an output pulse is produced—if the video signal extends only into the flat portion, normal sync output obtains. But, if the amplitude is sufficiently larger, the output is withheld. An operating characteristic of this sort has been called an aperture characteristic. In principle it is not new to the art. But none of the older circuits seem to approach the economy and effectiveness of the circuits described in this paper.

Preferred Tube

In searching for the most economical tube to use for the noise-immune sync clipper without any sacrifice in performance, the 6BE6 (pentagrid) was examined. This tube has a first control grid characteristic altogether different from that of the gated beam tube. The grid current keeps increasing as the grid goes more positive; it does not saturate at low positive potentials like the 6BN6. Therefore, another means must be used to compress the video and sync tips in the signal applied to the first control grid.

Good compression may be obtained by means of a series resistor in the grid circuit, because for positive grid potentials the grid current increases so rapidly. For the negative portions of the applied signal where no grid current flows, there is no compression and the space current is cut off almost as abruptly as for the gated beam tube. An idea of the degree of compression which may be obtained by this means is shown in Fig. 8. Here the operation without a grid limiting resistor is represented by the straight line while the curve represents operation with the resistor inserted. When the first control grid is positively biased so the sync tips are placed at the onset of grid current, the compression of the video and sync tips is nearly as complete as with the 6BN6 tube.

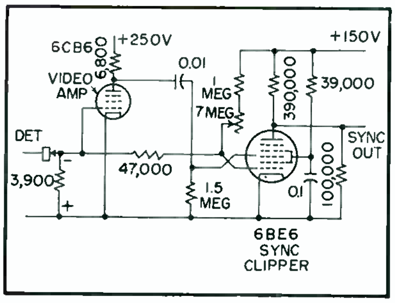


FIG. 10—Fringelock circuit using 6BE6 pentagrid

Figure 9 shows plots of the relative compression characteristics of the 6BN6 gated beam tube, the 6BE6 pentagrid type tube, and the 6AS6 pentode. Each small division of the abscissa is one volt, and it is apparent that for the grid series and plate load resistors given, the 6BN6 and the 6AS6 tubes have about twice as sharp a cut off in the first grid as the 6BE6—one volt versus two volts. However, the performance of the 6BE6 in a television set is so close to that obtained with the 6BN6 that when impulse noise is applied it is difficult to distinguish between the two tubes. The more economical 6BE6 is therefore used in the noise-immune sync clipper.

This circuit, known as the Fringelock and used in the current production of Zenith television receivers, is shown in Fig. 10. The sync pulses appearing at the output are of negative polarity and have an amplitude of approximately 25 volts. They are used without further amplification to synchronize the horizontal and vertical sweep systems of the receiver.

The Fringelock system was conceived and developed jointly by Robert Adler and the author in the Research Laboratories of Zenith Radio Corporation. Thanks are due to J. C. Spindler, W. J. Stroh, and L. J. Metevier, who conducted numerous field tests and assisted in adapting the system for use in production.

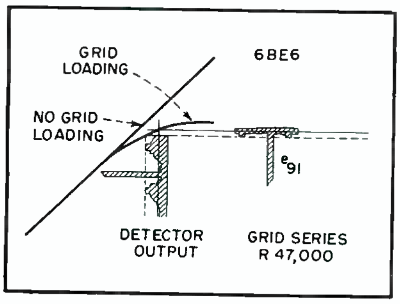


FIG. 8—Compression of video portion of detector output by grid series resistor

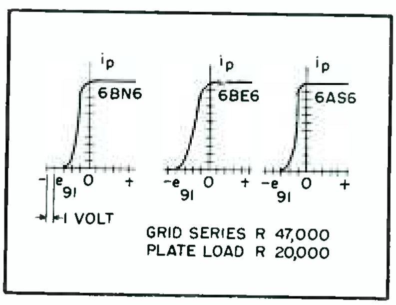


FIG. 9—Compression characteristics of three tube types

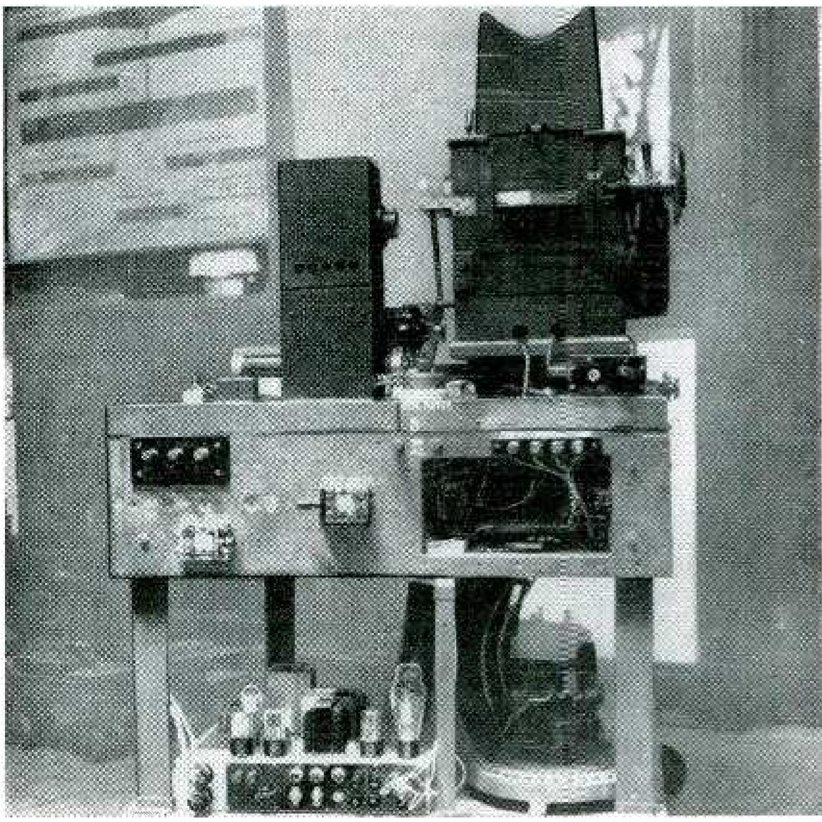
REFERENCE

(1) R. Adler, A Gated Beam Tube, ELECTRONICS, p 82, Feb. 1950.

SERVO DRIVE

By H. R. HOLSINGER
Westinghouse Electric Corp.
East Pittsburgh, Pa.

and C. E. SMITH
Cutler-Hammer Co.
Milwaukee, Wis.



End view of GE oscillograph showing servo drive chassis on shelf

IN VIBRATING-REED oscillographs, a mirror assembly (either of the oscillating or the rotating type) must be operated in synchronism with the input signal to view the wave shape of this signal on a ground-glass screen. The mirror assembly must be driven at a constant speed so that the motion of the light beam imparted by it can be synchronized with the motion of the light beam due to the galvanometer mirror movement.

Ordinarily, a-c motors are used to drive such mirror assemblies, and are designed to operate at speeds corresponding to frequencies of one-half, one-fourth, or some lesser fraction of the input signal, allowing the viewing of one, two, or more complete cycles of the signal.

In the modification of a galvanometer of the oscillating mirror type, it was desired to operate the mirror assembly over a two-to-one speed range, with gradual adjustment of motor speed. The original oscillograph motor, an a-c type operating at 1,800 rpm only, was equipped with a semicircular shutter to block out the light source for half of each revolution. It was also coupled to the mirror assembly to impart a linear sweep to the light beam, the shutter serving to block out the return sweep.

The requirement of variable speed suggested that a d-c motor be used in this modification, but such a motor does not run at absolutely constant speed even though motor voltage is held constant. Slight variations in friction, heating and windage cause the motor speed to change gradually and continuously, preventing synchronization. However, if the motor field voltage is held constant, the motor is highly sensitive to changes in armature current. Therefore a servomechanism was required that would have as its error signal the discrepancy between actual speed and desired (synchronous) speed.

Shutter Modulation

As indicated, the oscillograph was provided with a vibrating-mirror assembly, and equipped with a shutter to block out the light beam during the return sweep. In later models a rotating mirror is used, making the shutter unnecessary. In this modification, the shutter can be used advantageously for another purpose. A phototube is placed within the housing of the oscillograph, and is struck by the light beam during the half-revolution that the shutter allows light to enter the housing.

The output of this phototube is a square wave having a frequency f_m identical with the speed of the shutter. The differentiation of this square wave produces a pulse voltage, alternately positive and negative, and having this same frequency.

Since the frequency of the input signal to be observed dictates the true, or synchronous, speed at which the motor should operate, the pulse voltage should be made to have a frequency exactly one-half that of the input signal voltage. This situation is then analogous to the original conditions of 30 cps for the motor and line frequency of 60 cps for the input signal.

The input signal is used to trigger a sawtooth oscillator, producing one sawtooth wave per cycle of input signal voltage, both having a frequency f_i. The positive and negative pulses produced by the differentiation of the phototube output are added to this sawtooth voltage. If the motor is operating at its synchronous speed, this addition will superimpose a positive pulse on alternate sawtooth waves, and a negative pulse will appear on the remaining sawtooth waves, every pulse appearing at the same

This work was done as an undergraduate thesis project at the University of Cincinnati.

for Oscillograph Motor

Direct-current drive motor is held at constant speed when error-signal spikes superimposed on sawtooth pulses remain fixed. Principle used to extend useful range of mirror oscillograph between 50 and 250 cps can be applied to other industrial control problems

point on the sawtooth slope. Considering only the positive pulses and the sawtooth wave, it can be seen that, as long as the motor speed remains constant, the peak value of the sum will also remain constant, as shown in Fig. 1A.

On the other hand, if the motor speed begins to decrease, because of variations in source voltage or any of the other factors that tend to prevent a d-c motor from running at absolutely constant speed, the pulses will begin to spread apart at the instant of speed change. The first positive pulse appearing after the speed change commences will be at a different instant during the sawtooth cycle, and will be forced to appear higher on the slope.

The second positive pulse will appear even higher, the third higher still, and so on. Furthermore, the more extreme the speed change, the more rapid will be the increase in the peak value.

Conversely, if the motor speed begins to increase, the pulses will begin to appear closer together. The second positive pulse will appear lower on the slope, the third lower still, and so on, causing the peak value to decrease. This action can be readily understood by referring to Fig. 1B for motor speed increase, and Fig. 1C for motor speed decrease. In Fig. 1 the discrepancy has been exaggerated in order to emphasize the change in peak value. Thus there is produced a control voltage (V_c, the peak value of sawtooth plus positive pulse) which varies immediately with any discrepancy in motor speed.

Motor Control

Shown schematically in Fig. 2 is the motor-control circuit, which is patterned after a voltage-regulated power-supply circuit. The d-c motor used in this modification was a 40-volt, 1/90 hp type, requiring 100 to 150 ma of armature current for the range desired. For controlling this current a 6AS7 is used with both triodes in parallel. The grid voltage on the 6AS7 is produced by the current in a 150K resistor, the plate resistor of half a 6SL7 acting as an amplifier. The remaining half of this tube serves as a cathode follower.

As the control voltage V_c rises

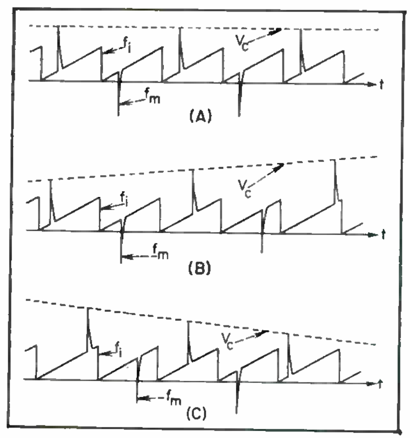


FIG. 1—At (A) the frequency of the sawtooth f_i produced by the input signal is exactly double the frequency f_m of the shutter. The resultant control voltage V_c is constant. At (B) f_i is more than double f_m; V_c is increasing. At (C) f_i is less than double f_m, causing V_c to decrease

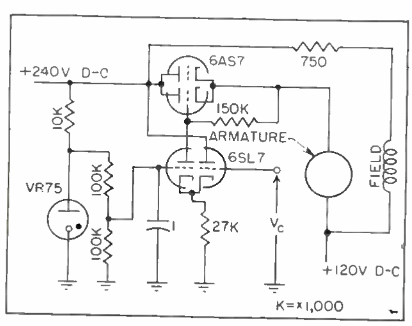


FIG. 2—Basic motor-control circuit is similar to voltage-regulated power supply

owing to slight decrease in motor speed, the cathodes of both halves of the 6SL7 also rise, due to cathode-follower action.

However, the grid of the amplifier half of this tube is held at a constant potential of 37.5 volts by the VR75 tube and the voltage-divider network (two 100K resistors and one 1-μf capacitor). When the cathode of this half rises, there is less plate current in the 150K resistor. The grid voltage of the 6AS7 decreases (becomes more positive), and more current flows into the armature, returning its speed to the proper value.

Should the motor speed exceed this value, V_c then begins to decrease, reversing the steps outlined above, and allowing less current to reach the armature. Hence, by utilization of the sawtooth voltage, the pulse voltage, and the circuit of Fig. 2, an extremely sensitive servomechanism is provided to return the motor speed to its true or synchronous value.

Moreover, by this means of motor-speed control, if the frequency of the input signal is changed, the frequency of the sawtooth voltage is also changed, and the motor speed is corrected to the new synchronous value.

Practical Control Unit

The actual means of utilizing the principles outlined above can be understood by reference to Fig. 3, a complete schematic diagram of the servomechanism circuit. The input signal is applied to one grid of a 6SL7, which provides two stages of amplification, the first a cathode-bias amplifier, the second an overdriven zero-bias amplifier.

These two stages provide a large positive pulse across the 330K resistor regardless of the wave shape of the input signal. This pulse is next applied to the grid of a 2050 thyratron, biased by a divider network supplied from B+. The plate of the 2050 is fed by another divider network from B+, and the tube acts as a relaxation sawtooth oscillator, producing a sawtooth voltage of input signal frequency across the 0.25-μf capacitor.

The phototube that provides the motor speed intelligence is a 929 high-vacuum type mounted inside the oscillograph housing. The output appearing across the 1-megohm resistor is a square wave having the frequency of the rotation of the shutter.

This square wave is fed into two stages of amplication, performing as outlined in the preceding paragraph, except that the tube used is a 6SN7. The positive pulses appearing across the 5K resistor are clipped to a constant value by means of half a 6H6 (B). No clipping bias is required, since the tube resistance is sufficient to yield a suitable peak value of the positive pulses and to assure a relatively constant peak value at any frequency.

These positive pulses are then applied to the primary side of a 1-to-3 audio interstage transformer, with the sawtooth voltage placed in series with the secondary winding. The combination of the sawtooth and pulses are then coupled, by means of a 6J5 cathode follower stage, to the plate of the second half of the 6H6 (A). This half acts as a peak-sensitive rectifier, charging the 0.12 (or the 0.12 plus 0.05) μf capacitor to the peak value of the combination, thus producing the control voltage V_c described earlier.

It will be noted that a multiposition range switch is used in several parts of the circuit. In the input signal stage, this switch has one position that is connected directly to an available filament winding of the power transformer of the power-supply circuit. This furnishes an internal signal of line frequency and permits the control circuit to function at this one frequency without the use of an external voltage source. For other frequencies within the appropriate ranges provided by the different positions, the external voltage source applied to the galvanometer input terminals must also be applied to the input signal terminals.

In the sawtooth output stage, this range switch adjusts the amplitude of the generated sawtooth voltage to the optimum value for most satisfactory operation. One position, with suitable values of resistance, must be used for the lower frequencies, while the other positions can be used with a second set of resistors.

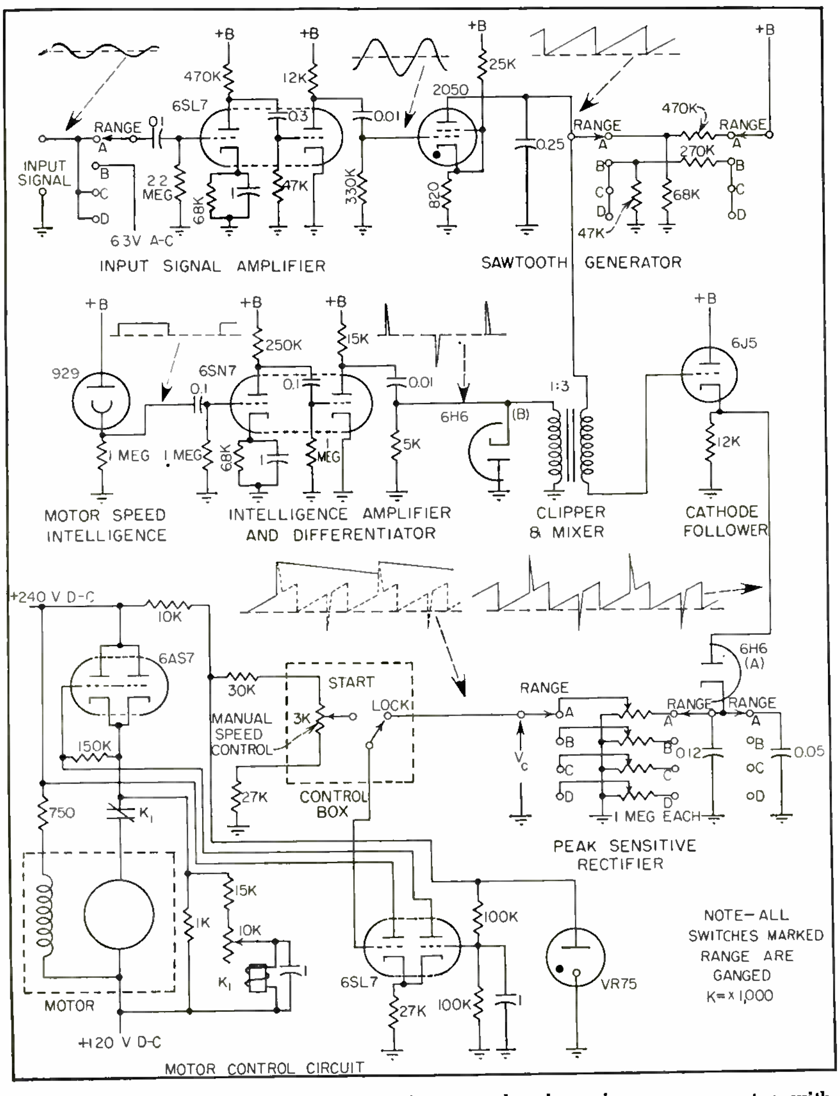


FIG. 3—Complete servomechanism used to synchronize mirror-sweep motor with input signal continuously from 50 to 100 cps. Operation is also possible from 100 to 250 cps

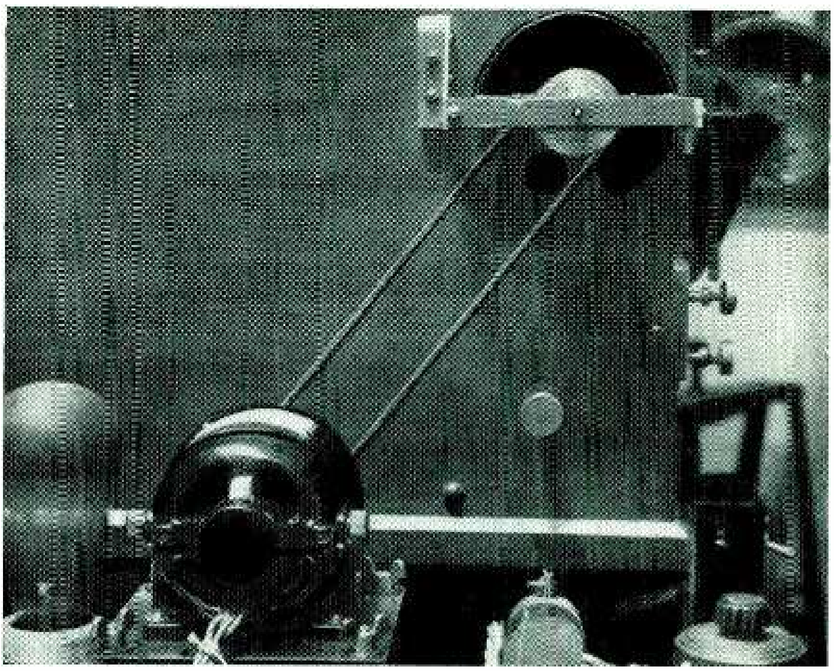
Optimum Capacitance

In the peak-sensitive rectifier stage, this range switch performs a dual function. It switches in the optimum value of capacitance required to produce the proper time constant in the R-C circuit of the diode cathode, thus allowing the capacitor to charge quickly enough to respond to very minor discrepancies in motor speed, but not so quickly that the motor becomes unstable.

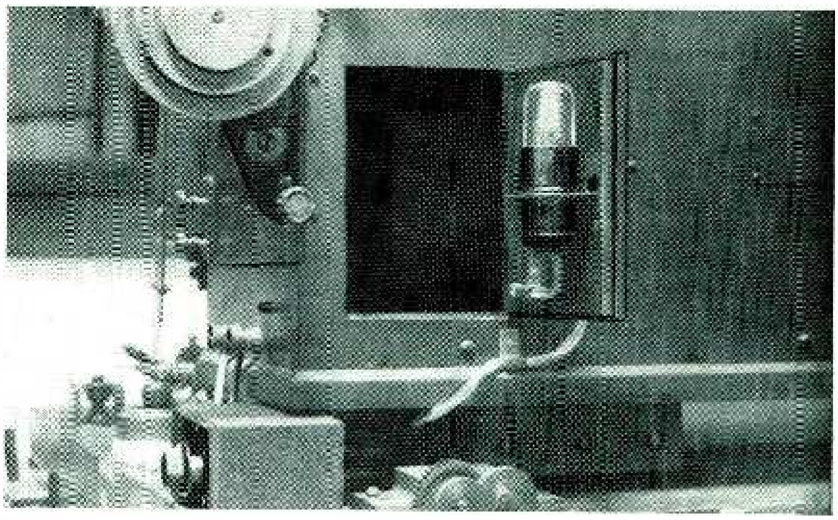
The range switch also connects in four different 1-megohm potentiometers, allowing individual adjustment of the output value of V_c. The pulses that represent motor-speed intelligence have a constant amplitude, but, because of the design of the sawtooth generator, the sawtooth waves do not. At low frequencies, these waves have a relatively high amplitude that diminishes at the higher frequencies, since the 0.25-μf capacitor has less and less time during which to charge. Thus the output—the peak value of the combination—must be diminished at the lower frequencies for satisfactory results.

The operation of this oscillograph requires a d-c bus for energizing the field of the galvanometer. Rather than supply the current for motor operation by electronic means, the d-c bus is used to provide current for both motor armature and motor field. A 750-ohm resistor in series with 120 volts provides the proper value of current to the motor field, while a 10K resistor provides the necessary drop from 240 volts to 75 volts required across the VR75 tube. Two 100K resistors and a 1.0-μf capacitor form a divider network to hold the grid of the amplifier half of the 6SL7 at a constant 37.5 volts.

The motor must be operated at the correct speed long enough for the control voltage to become a constant. A portion of this control voltage is provided by the rotation of the motor. With the motor at standstill, some separate starting means is necessary. Such means is provided by the resistor-potentiometer combination that is supplied by the regulated potential of the VR75 tube. The 3K potentiometer in this portion of the circuit is contained in a conveniently located control box, containing also a spdt switch. With this switch in the start position, an auxiliary voltage V_c is available that can be easily varied to such value that the remainder of the series-control circuit will cause the motor to run exactly at synchronous speed. The detection of the true synchronous speed may appear difficult, but in reality is not.



Belt drive couples motor to semicircular shutter and to mirror cam



Phototube mounting on door that gives access to the oscillograph prisms

Synchronous Operation

With the galvanometer suitably energized, the shutter turning, and the mirror assembly vibrating, the operator of the oscillograph observes a variety of patterns on the ground-glass screen that resemble those on a cathode-ray oscilloscope screen. When the motor reaches synchronous speed, these patterns resolve into one single cycle of the input signal. At this moment, the operator knows that the pulses have a frequency exactly one-half that of the sawtooth wave. Consequently the peak value of the combination that determines the control voltage V_c is a constant. The operator then switches the spdt switch to the lock position and allows the servomechanism to assume control of the motor speed.

The motor armature is provided with two more features that should be explained. A 1K resistor connected directly across the armature terminals provides dynamic braking action, smoothing out the instability that results when the armature current is abruptly decreased, as it is when the motor speed has momentarily surged ahead. Tripping voltage for overvoltage contactor K_1 is adjusted to prevent the motor from running at excessive speeds.

The B+ circuit is of the conventional full-wave rectifier type, using a choke-input filter. The use of d-c bus voltages for the high-current requirements diminishes the current required from this circuit.

By the use of this servomechanism circuit, the modified oscillograph can be used for observing the wave shapes of input signal voltages that are not of line frequency or that may be changing continuously. Satisfactory operation was achieved for signals between 50 and 100 cps, using one cycle for observation. Using multiple cycles, satisfactory operation was achieved between 100 and 250 cps.

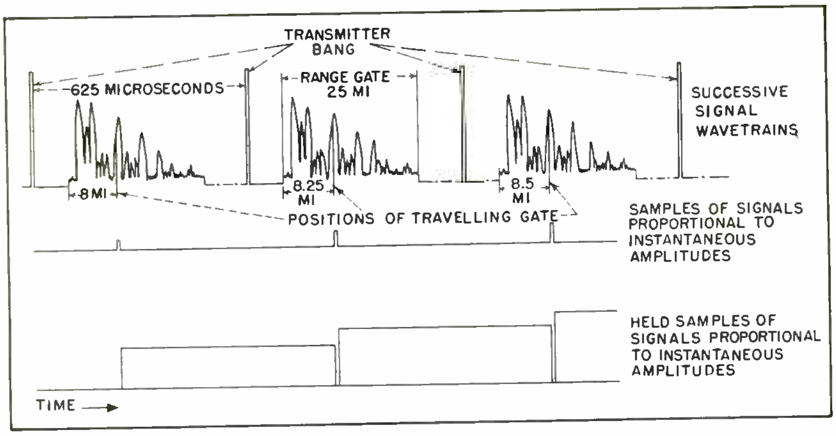
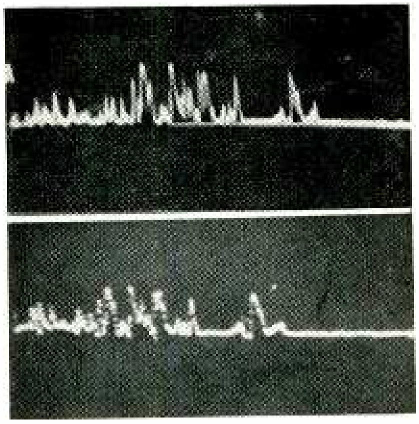


FIG. 1—Action of sampling gate and holding circuit on typical radar signal. Held samples form the desired low-frequency signal that is easily transmitted over wire lines or low-frequency radio communication links. When the received signal is applied to the intensity grid circuits of a cathode-ray indicator, it gives a ppi radar picture having the essential characteristics of the original



Example of normal A-scope radar presentation (above), and sampled and synthesized version (below) of an identical video signal. Scopes used here differed slightly in gains and sweep speeds

Radar Signal Sampler

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TRANSMISSION of video information which has a frequency spectrum of several megacycles requires carrier frequencies whose propagation characteristics limit the reliable maximum range to line-of-sight. If it is desired to relay video information directly over distances greater than line-of-sight, means must be provided to compress the video-frequency spectrum so that it may be efficiently transmitted and received over a low-frequency link.

The method and techniques involved in the signal sampler and synthesizer may have applications to such problems. For example, the frequency spectrum occupied by the video information applied to a normal radar plan position indicator may be compressed into a bandwidth which may be recorded or transmitted by communications-type equipment. Though the bandwidth is compressed, most of the useful resolvable information presented by a normal ppi indicator may be preserved.

A principal requirement for a straightforward application of signal sampling and synthesizing techniques is that the high-frequency waveshape may be satisfactorily resolved by f_H/f_L points, where f_H and f_L are the high and low recurrent rates respectively.

If the high-frequency waveshape is not repeated exactly every cycle, an additional requirement is that the general high-frequency waveshape does not change significantly during one low-frequency period.

Required inputs to the system, in addition to the high-frequency signal, are a synchronizing pulse recurring at the high-frequency repetition rate and a linear sawtooth (or other shaped wave for particular applications) recurring at the desired low-frequency repetition rate. The output of the system is a low-recurrent-rate waveshape having the same general amplitude characteristics as the high-frequency signal.

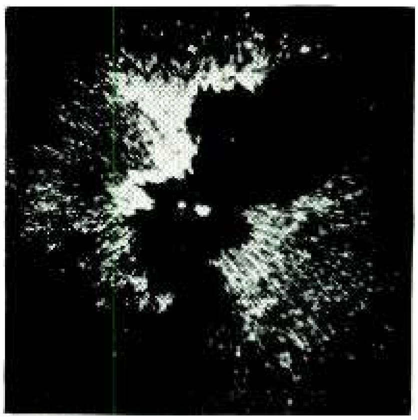
Essentially, the operation performed is that of frequency division, all the frequency components of the high-frequency signal being divided by the factor f_H/f_L. A further significant reduction in the bandwidth required to transmit the data is feasible since useless high-frequency components of the sampled and synthesized signal may be discarded.

Radar Picture Analysis

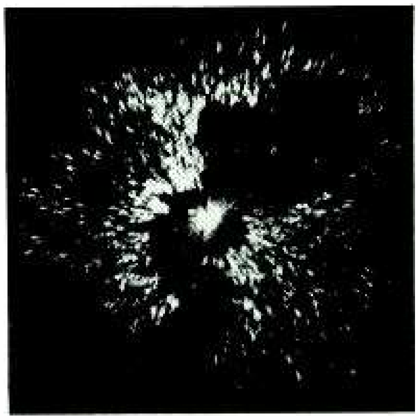
A radar ppi presentation is not a continuous picture but is generated by an electron beam acting on the face of a cathode-ray tube. As the radar antenna and the indicator's deflection coils are rotated, the action of the electron beam generates radial lines on the face of the cathode-ray tube, each line being intensity-modulated in accordance with a received signal wavetrain. The number of intensity-modulated lines per second is equal to the repetition rate of the radar.

The signal sampling and synthesizing method of bandwidth reduction as applied to such radar returns takes advantage of the assumption that there is little or no significant change in the character of successive wavetrain returns during the time it takes the radar antenna to move one beam width. Somewhat less than this time is chosen as the period of the system's low-frequency linear sawtooth voltage.

Figure 1 represents pictorially several successive received video wavetrains, each wavetrain corresponding to successive radar returns up to a 25-mile range. Each wavetrain is sampled by a narrow range gate which continuously moves out in range to maximum range, then flies back and starts over again at zero range. The position of the sampling gate for several successive



Normal ppi radar presentation, using 1.6-deg antenna beamwidth, 1-microsecond pulse width, 1,600-cps radar repetition rate, 12.5-sec antenna scan rate and 25-mile range setting



Typical example of result obtained by sampling and synthesizing video signal of pattern at left to compress bandwidth for long-distance radio relaying. Major outlines are still clear

In addition to radar relaying, potential applications of this signal sampler and synthesizer include missile guidance, reconnaissance, early warning, strip mapping and antijamming

Compresses Bandwidth

Permits relaying ppi radar presentations from planes to points far beyond line of sight, by sampling the video signal and synthesizing into a similar waveshape having a sufficiently low recurrence frequency for handling by conventional low-frequency radio links

radar repetition rate periods is also indicated in Fig. 1.

Traveling Range Gate

The relatively slowly traveling narrow range gate samples the instantaneous amplitude at zero range of the first of a series of essentially recurrent video wavetrains. When a second wavetrain is received, the range gate has advanced an incremental distance along the second line, this distance corresponding to a range increment of approximately 0.25 mile. This sampling process continues, with the range gate advancing 0.25 mile on each successive line, until on the 250th wavetrain the gate has advanced to a point where it samples a narrow increment of range corresponding to 25 miles.

During this sampling process, each sampled amplitude of the 250 successive wavetrains is applied as a narrow pulse to a holding circuit which maintains the amplitude of each sampled amplitude until the next arriving sampled amplitude determines a new amplitude of the held voltage. Thus the 250 successive sampled amplitudes are held and form a low-frequency signal having the essential amplitude characteristics of the original essentially recurrent video wavetrains.

If the linear sweep voltage of the system is applied to the sweep circuits of a ppi indicator which is rotated in synchronism with the normal indicator and if the held sampled and synthesized signal is applied to the indicator's intensity grid circuits, a ppi picture will be seen which has the essential characteristics of the normal ppi picture.

Complete System

The block diagram of a circuit which will sample a recurrent video wave shape and synthesize the samples into a similar wave shape recurring at a desired rate is shown in Fig. 2, and the circuit itself is shown in Fig. 3.

A synchronizing pulse recurring at the rate of the video signal input is applied to a delay multivibrator negative range gate generator V_1, whose gate width, for a particular application, was made approximately 25 radar miles. This negative range gate is applied to the grid of a start-stop sweep generator triode V_{2A}. This tube normally draws saturation plate current through its plate load resistor, since its grid is returned to the positive end of the power supply.

The negative gate from the gate generator drives the grid to cutoff, causing the capacitor in the plate circuit to begin to charge through the plate load resistor. The charging rate of this capacitor, voltage against time, is employed in succeeding circuits to produce the effect of pulse delay. When the negative gate is complete, the start-stop sweep generator tube returns to its normally saturated condition.

Action of Delay Diode

Cathode follower V_{2B} is used to couple the start-stop sweep generator to the plate of delay diode V_3. The cathode of V_3 is coupled by cathode follower V_{13} to a linear sawtooth generator, consisting of blocking oscillator V_{12A}, with output taken from the grid circuit, and a conventional triode amplifier V_{12B}.

Optionally, an external sawtooth may be applied to the SLOW SWEEP IN terminal, with the SWEEP SELECT switch in the EXT position. The amplitude of the sawtooth and the d-c level at the cathode of the cathode follower may be individually controlled by the SWEEP AMPLITUDE control and the GATE POSITION MANUAL control. The time constant of the circuit between the diode cathode and the succeeding clipper amplifier is such that the sawtooth sweep, composed of relatively low-frequency components, is highly discriminated against.

When the amplitude of the start-stop sweep voltage applied to the diode plate exceeds the amplitude of the d-c plus sawtooth sweep voltage applied to the diode cathode, so as to make the diode plate positive with respect to its cathode, delay diode V_3 conducts. The signal from the delay diode, which consists of the portion of the start-stop sweep which remains after the diode begins to conduct, is applied to the grid of clipper amplifier pentode V_4.

Little discrimination because of the intervening coupling capacitor is experienced by this signal, since it is composed of relatively high frequency components. The start of this signal is delayed from the synchronizing pulse by the time interval between the start of the charging of the capacitor in start-stop sweep generator V_1 and the instant diode V_3 begins to conduct.

The signal from the delay diode is positive in direction and of greater amplitude than the clipper amplifier pentode's bias, resulting in clipping of the top of the start-stop sweep. The clipped wave, which appears as a square wave with a sloping leading edge, is amplified and inverted by the pentode and appears across its plate load resistor. An additional triode V_5 amplifies and reinverts the square wave, sharpening its leading edge.

Gate Width Control

The square wave from the triode amplifier is differentiated and is applied to the grid of a variable-width pulse-shaper pentode V_6, which is normally biased beyond cutoff. The positive pulse which occurs because of the differentiation of the leading edge of the square wave has sufficient amplitude to drive the grid from beyond cutoff to the conducting region, resulting in a clipped pulse. Upon amplification by V_6 and gate generator triode V_{7B} this becomes a steep-sided flat-topped pulse whose width is determined by a differentiating time constant GATE WIDTH control in the pulse shaper pentode's grid circuit.

The time interval between this pulse and the synchronizing pulse is determined by the setting of the GATE POSITION MANUAL control. The range this pulse sweeps is determined by the SWEEP AMPLITUDE control; thus, a traveling gate is produced, the center of travel of which may be adjusted, and whose sweep range may be varied. The rate at which the range is swept is determined by the frequency of the internal sawtooth sweep or optionally by an external SLOW SWEEP IN.

The traveling gate is supplied to a gated video amplifier circuit (V_7 and V_8) to which is also applied the recurrent video signal which is to be sampled and synthesized. Thus the video signal is sampled once during each cycle of the synchronizing input pulses.

The range over which sampling takes place is adjustable and the recurrence rate of the sampling is the same as that of the start-stop sweep. The output of the gated video amplifier consists of video sample pulses caused by sampling by the traveling gate; the amplitudes of the samples are proportional to the amplitude of the video signal at the instant of sampling. The time interval between these pulses is approximately equal to the reciprocal of the repetition rate of the synchronizing pulse.

If the output of the video amplifier were connected to the vertical deflection plates of an oscilloscope whose horizontal sawtooth sweeps were synchronized with the sawtooth sweeps, a series of widely spaced pulses would be seen. If the SWEEP AMPLITUDE and GATE POSITION MANUAL controls were set so that the traveling gate travels the entire recurrent video signal input, the envelope of the amplitude modulation on these pulses will be similar in waveform to the recurrent video waveform as seen on an A-type scope presentation.

Holding Action

Holding circuit V_{10} minimizes the spaces between sample pulses so that a more continuous waveform may be seen. Saturation-level gating pulses, occurring at the same time as the video amplifier gating pulses, are applied by gate generator triode V_{11A} to the grid of V_{10B} which is biased beyond cutoff. The sample pulses resulting from the gated video signal are applied to the grid of triode V_{10A}.

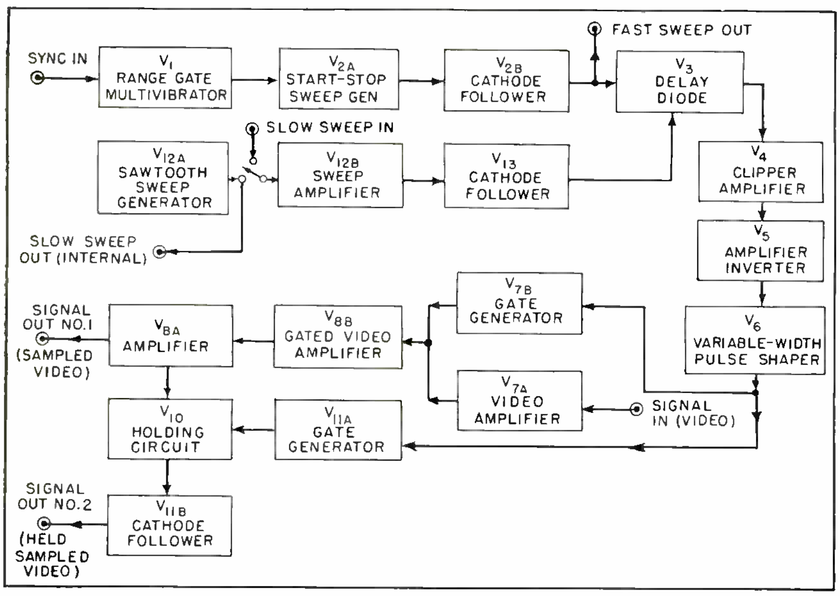


FIG. 2—Arrangement of stages in signal sampler and synthesizer

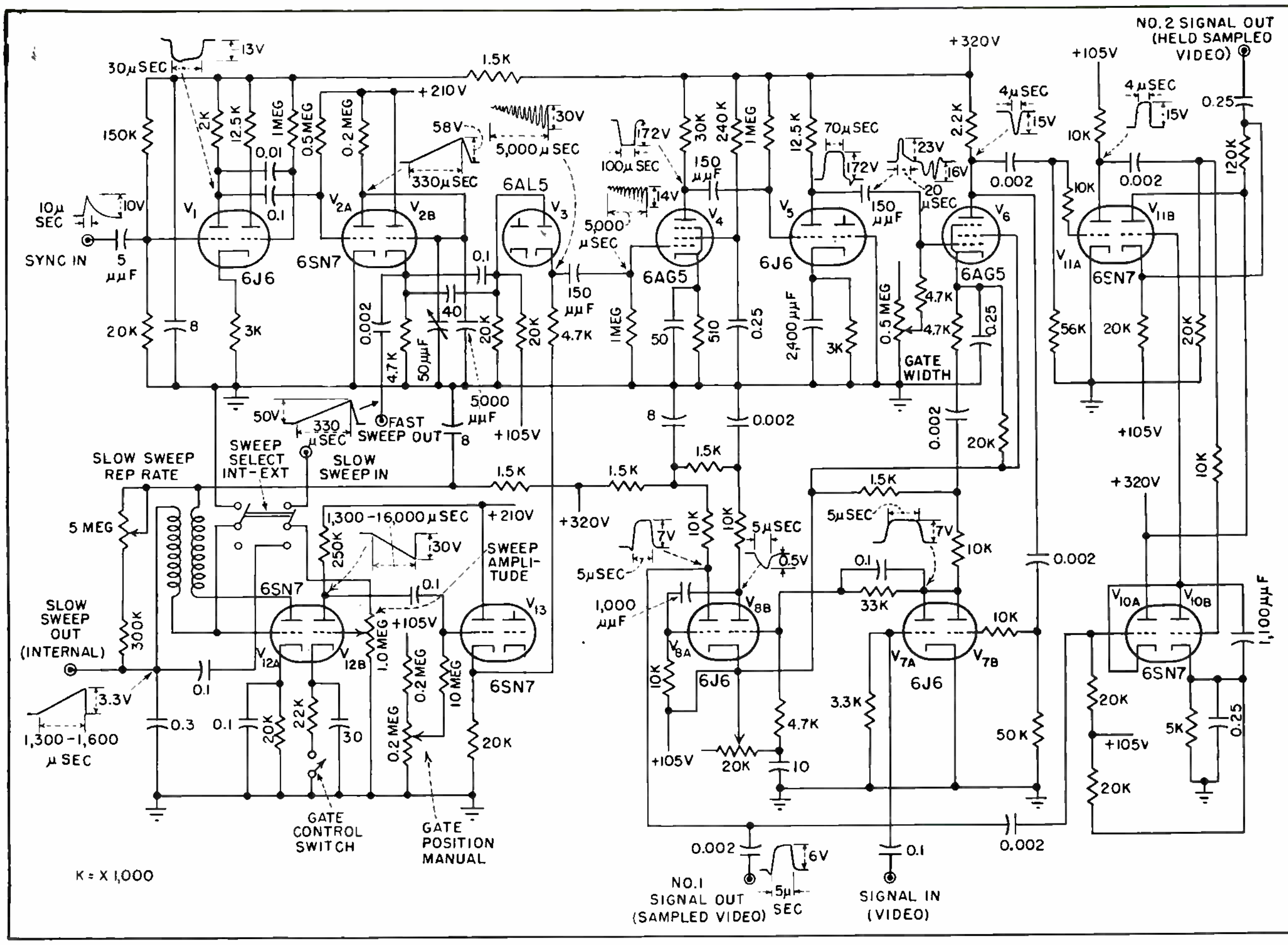


FIG. 3—Complete circuit of signal sampler and synthesizer except for power supply, which is a conventional 5Y3G full-wave rectifier arrangement with two VR105 tubes in series across the output to stabilize 210 volts

The width of the gating pulses is slightly less than that of the sample pulses. The difference in width between these pulses is the actual effective gating pulse width. Upon simultaneous application of both sets of pulses, V_{10B} acts as a cathode load resistor for V_{10A} acting as a cathode follower.

The capacitor connected from the junction of grid, plate and cathode to effective ground rapidly assumes a potential proportional to the amplitude of input to the grid of V_{10A}. The pulse to the grid of V_{10B} drops to zero and the tube is cut off, but the capacitor holds a charge since no discharge path is present. The magnitude of the held charge is proportional to the amplitude of the sample pulse. The preceding operation is repeated at the rate of the synchronizing frequency.

The final tube in the circuit is cathode follower V_{11B}, used to couple from the held pulses to a load. An oscilloscope connected to this point would show a series of flat-topped steps, the outline of which approximates the original video wave form.

Potential Applications

Video data for strip maps, obtained by mounting a radar antenna rigidly on the side of an airplane, can be relayed over greater than line-of-sight distances by compressing the video signal. The sampler and synthesizer unit samples from the radar receiver's output only those signals corresponding to targets within a narrow increment of range. The position of the increment is continuously varied at a low-frequency linear rate from zero range to maximum range, or over any desired range between these extremes. The sampled signals are held and reassembled at the low-frequency rate for transmission over a low-frequency link for remote recording or for direct recording. If the recording facsimile paper or film speed is properly synchronized with the speed of the aircraft and a straight course is maintained, a strip map of the terrain over which the aircraft passes will be produced.

The basic nature of the technique of signal sampling and synthesizing may, in addition to video applications, be employed for the generation of low-frequency waveshapes. For example, if the inputs to the system were a 1,000-cps sine wave, a 1,000-cps reference pulse and a 1-cps sawtooth, the output would be a 1,000-point approximation of a 1-cps sine wave. If two systems were employed, with the inputs to the second system being the same 1,000-cps reference pulse and 1-cps sawtooth as previously, but the 1,000-cps sine wave being applied through an adjustable phase shifter from the common source, then a phase difference of ø degrees between the two 1,000-cps inputs will cause a difference of ø degrees between the two 1-cps outputs.

Direct-Reading Instrument

Four-tube circuit provides rapid and accurate determination of tube noise resistance in single operation that can be performed by unskilled personnel. Auxiliary controls and meters permit plotting of tube characteristics as concomitant application

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WHERE large quantities of low-noise tubes must be used, it is convenient to have a simple but accurate means for determining the noise resistance of a tube quickly with nontechnical workers. This is important, since tubes having unusually high noise resistance may not show any other undesirable characteristics and they may pass various quality control inspections at the factory.

The apparatus shown in the photograph and in the circuit diagram of Fig. 1 is capable of making such measurements. The noise resistance R_n of a tube is measured by comparing the noise of the tube to the thermal noise of a known resistance R. This is achieved by using the tube as the first stage of a sensitive, linear, tuned amplifier, having the resistance R in its grid circuit. The output noise power is measured with a quadratic detector such as a bolometer, a thermocouple or a crystal diode.

Measurement Theory

According to Nyquist's theorem the noise of a resistance R can be described by a noise emf e in series with R such that

$$\overline{e^2} = 4kTRB \qquad (1)$$

In the equation k is Boltzmann's constant (1.38×10^{-23} Joule per degree), T is the absolute room temperature and B the bandwidth of the receiver. The noise resistance R_n of a tube is defined such that if a resistance R_n is inserted in the grid circuit of the tube it produces as much noise as the tube itself. This means that the tube noise can be described by a noise emf e_n in series with the input such that

$$\overline{e^2_n} = 4kTR_nB \qquad (2)$$

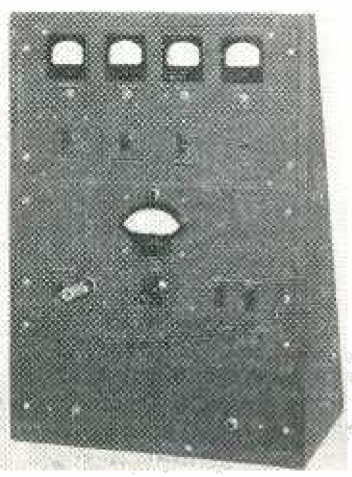
The noise output power of the amplifier due to the first tube and its input circuit is proportional to $4kT\,(R + R_n)B$, whereas the noise output power due to the first tube *only* is proportional to $4kTR_nB$. Let M_1 be the reading of the output meter in the first case and M_2 the reading of the output power meter in the second case, then

$$\frac{M_1}{M_2} = \frac{4kT(R + R_n)B}{4kTR_nB}$$

$$\text{or } R_n = \frac{M_2}{M_1 - M_2}\,R \qquad (3)$$

so that the value of the bandwidth B does not enter into the final result.

The circuit diagram of the apparatus is shown in Fig. 1. In making measurements, SW is set to the desired range of R and the amplifier gain is set so that M_1 coincides with the full deflection of the output meter. When SW is moved to the short circuit position the output meter reading shows M_2. The meter is calibrated directly in terms of noise resistance.



Octal socket on front of tube noise resistance may be used with adapters for most tube types

Though one can evaluate R_n from Eq. 3 for the whole range $0 < R_n < \infty$ for each value of R, the measurement is most accurate in the range $0.1R < R_n < 5R$. For measuring tubes with widely different values of R_n one should use various values of R. The three values of R shown give overlapping ranges and any noise resistances between 50 and 50,000 ohms can be measured rapidly and accurately. This is sufficient for all practical triodes and pentodes.

The circuit has to be modified for the measurement of the noise resistance of mixer tubes because an untuned input circuit not only generates a noise band of the input frequency (which is converted to i-f noise in the mixing process) but it also generates i-f noise directly.

Circuit Design

The instrument is a four-stage linear amplifier. The bandwidth is a few thousand cycles; if it is much lower, the output meter reading will show fluctuations unless the time constant of the meter is large. A tuning frequency of 120 kc is used mainly because 120-kc band-pass filters are available commercially, otherwise it would be better to choose a lower tuning frequency.

The choice of the tuning frequency is important. For low tuning frequencies, tube noise increases due to Flicker effect. For high tuning frequencies the input capacitance C of the stage (tube

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Measures Tube Noise

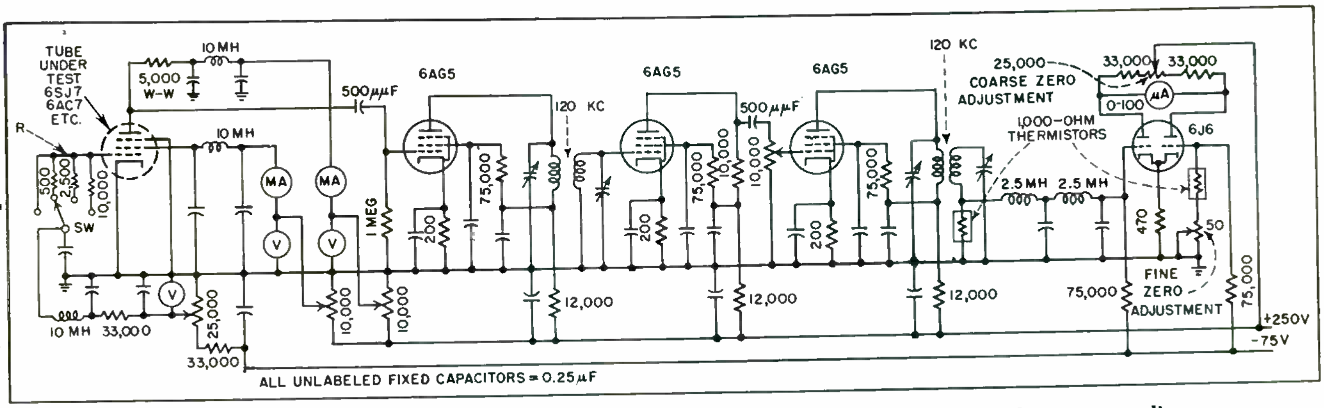

FIG. 1—Complete circuit diagram of tube noise resistance-measuring circuit less regulated power supplies

and wiring) shunts the resistance R whereas the feedback through the anode-grid capacitance C_{ag} also becomes important.

Flicker noise gives a noise output power which varies as $1/f$, so that it becomes unimportant for sufficiently large f ($>$20 kc). Due to the capacitance C the mean square value of the noise voltage at the grid of the first stage of the amplifier is not $4kTRB$ but

$$\frac{4kTRB}{1+\omega^2C^2R^2} \tag{4}$$

The capacitance C thus gives rise to an error of 1 percent if $\omega CR = 0.1$. Taking $R = 10^4$ ohms and $f = 120$ kc we find that this occurs if $C = 14$ $\mu\mu$f. This means that the error is unimportant at 120 kc even for the highest R_n scale of the instrument.

The load resistance of the test circuit is sufficiently low that feedback through the anode-grid capacitance is small even for triodes. The main effect of this feedback is a change in input capacitance (Miller effect). This change in capacitance may be quite large for triodes with a high g_m, but those tubes have a low noise resistance (a few hundred ohms) so that they can be measured on the lowest R_n scale, where this change in capacitance has little effect especially because of the low tuning frequency.

The 8-pin socket for the test tube is mounted at the front panel. It is wired such that 6SJ7, 6AC7 and similarly based tubes can be tested directly. For other tubes one has to wire adapter sockets. Input and output are well-screened for the 8-pin socket in order to avoid capacitive feedback and similar precautions should be taken for the adapter sockets if possible.

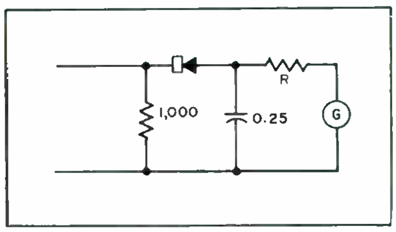

FIG. 2—Alternate bridge arrangement which eliminates zero drift but requires more sensitive indicating instrument

Quadratic Detector

A thermistor is used as a quadratic detector for the measurement of the noise output power of the amplifier. A change in resistance of the thermistor measuring the output power is measured in a thermistor bridge using a 6J6 and a 100-μa meter in a balanced circuit. A filter section keeps the output noise voltage away from the grid of the 6J6. Zero drift is eliminated to a large extent by using equal thermistors in both arms of the bridge and mounting them close together so that they have comparable thermal environments.

It is also possible to replace the thermistor by a 1,000-ohm resistor and to measure the noise voltage across the resistor with a crystal diode as shown in Fig. 2. At low signal levels (up to a few μa rectified current) the crystal diode is a quadratic detector. Silicon detectors seem to be quadratic over a wider range than germanium diodes. The quadratic range can be extended by inserting a resistance R of the proper value in series with the galvanometer measuring the rectified current.

Use of a crystal diode rectifier has the advantage that the zero drift is eliminated completely, but a more expensive galvanometer is required.

Test Results

The results of a large number of measurements showed that the 6J4 and 6AG5 tubes have noise resistance values close to the theoretical value with very few exceptions. The 6AC7's were moderately good though there was a larger percentage of noisy tubes than for 6AG5. The 6J6 and 6AK5 were found to be rather poor; up to 50 percent or more of the tubes had a noise resistance of more than twice the theoretical value and there was a considerable spread in noise resistance. No marked difference was found between 6AK5's made by different manufacturers.

The work described in this article was performed under contract with the Defense Research Board of Canada and the author wishes to express his thanks to that Board for permission to publish the results and to R. B. Tomlinson who built the equipment.

Flexible Selectivity For

Single-tube circuit employs electronic Q multiplication to attain i-f selectivity equivalent to that obtainable with quartz crystal filter. Also provides increased flexibility and choice of null or boost to peak desired signal or eliminate interference

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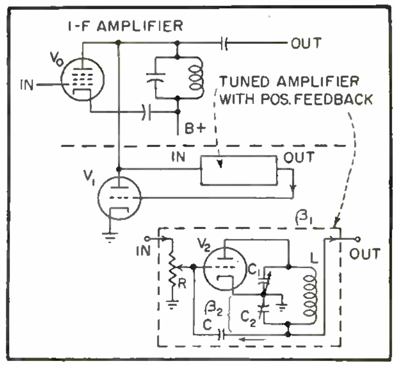

FIG. 1—Simplified circuit for null in existing i-f amplifier response using electronic Q multiplication

AN INDISPENSABLE COMPONENT of modern communications receivers is the variable-selectivity crystal filter, useful in both phone and c-w reception. Design of these filters has remained essentially unchanged since their introduction in the early nineteen thirties. Present crowding of the h-f bands suggests the desirability of improvement, particularly in respect to flexibility.

Electronic Crystal

A tunable electronic circuit can perform most of the functions of an i-f crystal filter—and more besides—and may be connected to existing receivers or amplifiers without wiring modification or noticeable loss in gain. The circuit may also be used for exalted-carrier double-sideband or single-sideband reception in a particularly simple manner. It should prove valuable for bandwidth control and interference elimination in a number of laboratory and other applications.

These objectives may be achieved by means of an L-C resonant circuit with electronic Q multiplication by positive feedback.[1] The equivalent Q of 465-kc i-f crystal filters is roughly 4,000. Resonant circuits have values of Q between 100 and 200 at this frequency; hence multiplications of 20 to 40 times suffice. While stability of circuits with positive feedback is not that of a passive element, occasional minor readjustment is not believed to be a serious disadvantage since operators tend frequently to alter filter settings to suit changing conditions.

The incorporation of an additional crystal filter in existing receivers requires major rebuilding. An electronic selective circuit, on the other hand, may be designed to provide a variable impedance which may be connected between the plate (or grid) of one of the existing tubes in an amplifier chain, and ground.[2] This impedance may take form of a tube whose effective plate resistance is modified by feedback. Thus, a high-r_p tube given strong negative voltage feedback at the frequency to be eliminated, represents a very low impedance at that frequency and a relatively high one at other frequencies where the feedback is negligible.

A simplified diagram of the connection for obtaining a null similar to a crystal rejection slot is shown in Fig. 1. Tuned circuits used in i-f tuned amplifiers have parallel resonant impedances varying between 250,000 and 25,000 ohms, with the higher values the most common. Thus if V_1 is one-half of a dual triode such as the 12AX7, insertion loss due to its plate resistance r_p will not be serious.

The box connecting plate and grid of this tube contains a tuned amplifier with Q multiplication obtained by positive feedback. The connection polarity in this box is such that the through phase shift at resonance is zero. Thus, V_1 has strong negative feedback at resonance.

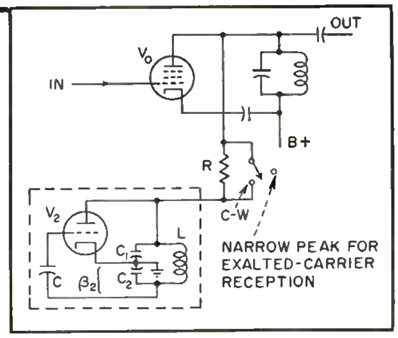

FIG. 2—Circuit shown produces sharp peak in i-f selectivity curve

Theoretical Analysis

It may be shown that Z, the effective plate resistance of V_1, is given by

$$Z = \frac{r_{p1}(1 - A_2\beta_2)}{1 - A_2\beta_2 + k A_1 A_2} \qquad (1)$$

where A_1 and A_2 are the no-feedback gains of V_1 and V_2 respectively, β_2 the feedback fraction of V_2, and k an attenuation constant controlling the magnitude of β_1.

Thus Z becomes zero when $A_2\beta_2 = 1$. This is the condition for oscillation of the amplifier in the box, if V_1 were not connected. However, the path through V_1 represents negative feedback, and oscil-

Communications Receivers

Two units containing elements shown in Fig. 3 may be used together to provide an extremely flexible arrangement with a choice of two nulls, two peaks, or one of each for separating desired and interfering signals

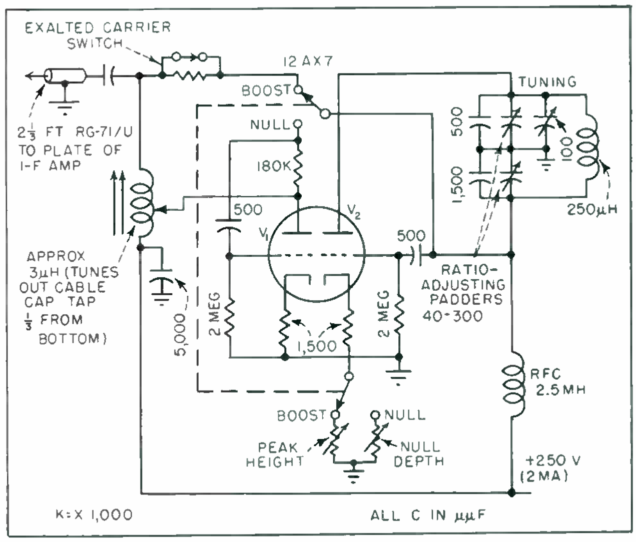

FIG. 3—A double-pole double-throw switch permits operator to choose between null and peak operation. In use, the peak may be moved across i-f amplifier pass-band for fine tuning without changing the pitch of signals coming through

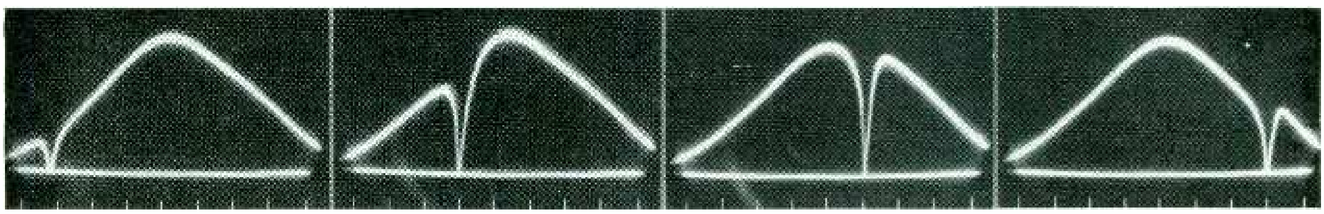

FIG. 4—Actual oscillograms made on typical communications receiver shows remarkable performance obtainable with external circuit set in null position

lation will not occur even though $A_2\beta_2$ is equal to unity and the null is perfect. Oscillation will occur, however, when $A_2\beta_2$ is increased until it equals $(1 + kA_1A_2)$.

The amplifier A_2 has in effect two voltage feedback loops; one positive (β_2) and one negative (kA_1), and the net positive feedback, which multiplies the intrinsic Q of the tuned circuit, is the difference of these two. The effective Q of the tuned circuit is

$$Q_{eff} = Q \frac{1}{1 - A_2\beta_2 + kA_1A_2} \qquad (2)$$

Since $(1 - A_2\beta_2)$ is always set to zero to give a perfect null, the effective coil Q is controllable simply by varying k.

To the extent that $A_1\beta_1$ (see Fig. 1) is large compared to unity at resonance, the variation of Z with frequency is essentially the inverse of the variation of the quantity β_1, with frequency.

It is important that the magnitude of β_2 at resonance be as nearly independent of tuning as possible, to preserve the depth of the null. Since V_2 in Fig. 1 is essentially a constant-current generator, and the parallel-resonant impedance in its plate circuit (without feedback) is proportional to ωLQ, A_2 will vary directly with frequency if the total capacitance is varied for tuning. Even though the required percent tuning variation is small and the change in $A_2\beta_2$ small, the change in $(1 - A_2\beta_2)$ will nevertheless be noticeable. It can be greatly reduced by proper choice of the ratio C_1/C_2, and by tuning with one capacitor alone.

One may express $A_2\beta_2$ in the following form:

$$A_2\beta_2 = g_m LQ \frac{(C_2C_1)^{1/2}}{(C_2 + C_1)^{3/2}} \qquad (5)$$

where g_m is the mutual conductance of V_2. Since Q may be regarded as constant over the narrow frequency range under consideration, the problem is to minimize the change in the right-hand side of Eq. 5 when C_1 is varied. A minimum occurs when $C_2 = 2C_1$. For small variations about this value of C_1, $(1 - A_2\beta_2)$ will be substantially constant.

To achieve a selective peak similar to that obtainable with a quartz crystal, the circuit may be modified as shown in Fig. 2. Assume that the switch is closed. The impedance level of the tuned circuit LC_1C_2 inside the box is made low compared with that of the plate circuit of the amplifier V_o. The response of the circuit in the box will then control the overall frequency response. Insertion loss, when LC_1C_2 is off tune, is high. However, when resonance is approached, and the Q of this circuit is multiplied by V_2, its parallel resonant impedance becomes large and the gain of V_o

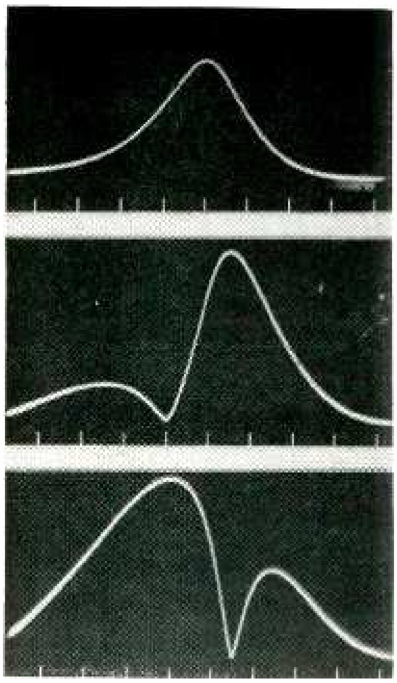

FIG. 5—Typical crystal filter characteristic

may equal (or even exceed) the normal value. (Excessive positive feedback in V_2 will make the entire circuit oscillate). In this way the selective response characteristics of a crystal filter with the holder capacitance neutralized, may be closely approximated.

Exalted-Carrier Reception

Another type of overall response that may be obtained is the normal amplifier gain-versus-frequency characteristic with a sharp peak superimposed on top. Such a characteristic is useful for exalted-carrier reception of a-m signals, or for reception of reduced-carrier single-sideband transmissions. The peak may be made narrow enough so that only the carrier receives extra amplification, all sidebands of significance being handled at the receiver's normal gain level.

This characteristic is quite useful with relatively stable receivers having bandspread tuning and S meters, since the tuning may be done by maximizing the meter indication in the usual way. The increased carrier-to-sideband ratio requires a noticeable increase in audio gain-control setting. For reception of reduced-carrier single-sideband signals, the response peak may be tuned. Symmetry of the resulting peak with respect to the normal passband is affected by tuning the resonant circuit in the receiver to which the unit is connected, and may be restored by a slight change in the tuning of this circuit when the superimposed peak is set to either side of passband center.

This response is readily obtained by decoupling the high-Q resonant circuit LC_1C_2 from the amplifier by means of the resistance R. The insertion loss otherwise caused by LC_1C_2 is greatly reduced; nevertheless, at the resonant frequency of LC_1C_2 a narrow peak appears on the transmission characteristic of V_o. Assuming that the height of this peak is to have some convenient value (say 10 db), its bandwidth is determined by the combination of positive feedback and R required to give this particular height. The larger R is made, the greater the positive feedback required, and the narrower the resulting bandwidth.

The selective arrangements shown in Fig. 1. and 2 are readily combined in one device, with the desired function selectable by means of a switch. Figure 3 is a schematic of a practical circuit designed for a frequency of 465 kc. Connection to the plate of the amplifier tube is made through a shielded cable, whose capacitance is tuned out by a slug-tuned inductance.

Since positive feedback is used, it is desirable that the plate supply be regulated. Total plate drain is about two milliamperes at 250 volts.

Feedback is controlled by two potentiometers in the cathode of V_2. Capacitors C_1 and C_2 are adjustable padders whose ratio may be set to minimize variations in feedback with tuning. It is desirable that the circuit as a whole be connected to low-level stages in a given amplifier chain, to avoid the possibility of overloading on strong signals. Insertion loss in the null position, even when the amplifier incorporates low-C tuned circuits, is of the order of 3 db.

The performance of the device is illustrated vividly in Fig. 4 and 5. These oscillograms were made with a typical communications receiver, and the transmission scale is logarithmic. When the notch of the electronic circuit (Fig. 4) is tuned from one side of the response curve to the other, (leaving all other controls set) the width of the overall response remains constant. The depth of the null likewise remains substantially constant, being better than 40 db down from the normal response. In the case of the crystal filter (Fig. 5), considerable broadening occurs, particularly near the desired signal.

C-W Reception

The peak response curve for c-w reception closely resembles that of regular crystal filters. This peak, it should be pointed out, may be tuned through the receiver passband without appreciable change in height—thus providing flexibility not possessed by a crystal. Separating c-w stations by tuning the selective circuit rather than the receiver local oscillator, is believed to be more logical and normal than the conventional method, for changes in tuning do not then affect the pitch of the signal being received. If the operator is concentrating on a particular weak signal in the presence of several others, it is easy to become confused by the change in pitch of all signals when tuning a conventional receiver to center the desired signal in the crystal passband.

In phone reception, it is convenient to set the two electronic nulls at each side of the receiver passband, and let the completely-neutralized crystal determine how wide the passband will be. The nulls steepen the sides of the passband (much as in the case of m-derived filters) and can be set on top of any specific interfering signal that ventures near the frequency of the desired signal.

This work is an outgrowth of research supported by contract W28-099-ac131 between Stanford University and the Rome Air Development Center.

REFERENCES

(1) H. E. Harris, Simplified Q Multiplier, ELECTRONICS, p 130, May 1951.
(2) O. G. Villard, Jr., Tunable Shunt Selector-Rejector for Audio Amplifiers, *Rev. Sci. Instr.*, 22, No. 10, p 726, Oct. 1951.
(3) D. K. Oram, Full-Range Selectivity with 455-Kc Quartz Crystal Filters, *QST*, p 33, Dec. 1938.

2-Channel Rectangular Pulse Generator

Battery-operated generator delivers rectangular voltage pulses from two main output channels. Pulses from each channel are adjustable in amplitude from 0 to 80 volts in three decade ranges and adjustable in time duration from 25 microseconds to 7.5 milliseconds in three ranges

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A STIMULATOR is described which delivers rectangular voltage pulses from two main output channels. The voltage pulses from each channel are independently adjustable in amplitude and time duration. The pulses delivered from the second channel are delayed by an adjustable time from those delivered from the first.

Pulses are delivered from each channel at the same pulse repetition rate which is adjustable continuously over three decade ranges. This type of stimulator is necessary for certain studies in neuromuscular physiology and may be used also as an excellent general purpose stimulator.

Overall Characteristics

The equipment is a completely shielded self-contained battery-operated unit which may be used satisfactorily in a shielded laboratory room. It has two main output channels and a synchronizing pulse channel. The synchronizing channel delivers rectangular voltage pulses of approximately 20 μsec duration adjustable in amplitude from zero to 120 volts in two decade ranges. The pulses from this channel may be used for synchronizing the sweep of an external monitor oscilloscope or for initiating the sweep of a recording oscillograph.

Each main output channel delivers rectangular voltage pulses adjustable in amplitude from zero to 80 volts in three decade ranges and adjustable in time duration from 25 μsec to 7.5 milliseconds in three ranges. The output impedance of the two main channels depends upon the voltage-control dial setting but does not exceed 3,200 ohms resistance for maximum output voltage.

The voltage pulses of the synchronizing pulse channel are advanced in time from those of the first main output channel by an amount adjustable from 0.04 to 1.64 milliseconds in two ranges. Likewise the voltage pulses of the second main output channel are delayed in time from those of the first main output channel by an amount adjustable from 0.04 to 1.64 milliseconds in two ranges.

All of the operating adjustments of the stimulator are independent of each other and are calibrated. Changing one adjustment does not change any of the others.

The stimulator normally delivers repeating pulses from each channel. The pulse repetition rate is adjustable from 0.5 to 500 pulses per second in three decade ranges. Pulses always are delivered from all three channels at the same rate.

Provision is made for a d-c output for marking work and for a single-pulse output for special work. The single pulse is initiated by an external shielded switch which plugs into a jack on the stimulator panel. When this switch is operated, a single pulse is produced in each channel output. The synchronizing pulse appears first, the pulse from the first main channel second and then the pulse from the second main channel.

Circuit Operation

The schematic of the stimulator is shown in Fig. 1. The complete circuit consists essentially of multivibrators and switch tubes. The multivibrators are similar to those used in radar systems and have been chosen because of their good operating characteristics and reliability features.

The oscillator which provides the timing for the repeating pulses consists of V_1 and V_2 and the associated circuits with switch S_3 on the middle position. It is a conventional free-running multivibrator with full positive bias on the grids of the tubes. The output signal is taken from the plate of V_2. The amplitude of the signal is independent of the frequency.

A 30-μf filter capacitor is connected across the plate supply of the oscillator to stabilize the plate voltage and to minimize interference in the operation of other stages of the stimulator caused by battery-voltage fluctuations during the oscillator cycle. To stabilize the frequency of the oscillator, a separate battery is used to supply the filaments of the oscillator tubes.

The oscillator output signal is applied to the grid of V_3 through a short-time-constant differentiating circuit. The tube acts as a clipping stage and operates at positive bias in order that clipping will occur on the negative part of the input grid signal. A positive rectangular voltage pulse appears at the plate of

V_8. The width of this pulse depends upon where the input grid signal is clipped, which in turn depends upon the setting of potentiometer R_2. Tube V_3 is direct coupled to the power output tube V_4 which raises the power level of the signal and provides additional clipping for better wave form. The output voltage controls consist of the two potentiometers R_4 and R_5. The 2,000-ohm resistor in series with the output terminal protects the tube in case the output terminals are short circuited accidentally.

Delayed Pulses

The synchronizing pulse advance circuit which consists of V_5 and V_6 delays the output pulses of channel 1 from the output pulses of the synchronizing channel. In effect this is the same as advancing the pulses of the synchronizing channel when channel 1 is taken as the reference. The circuit is a monostable multivibrator in which the screen of the normally nonconducting tube V_5 is used as a plate. The free plate of V_6 which provides the output signal may be loaded without affecting the timing of the multivibrator. This circuit produces a voltage pulse having a very sharp trailing edge.

The adjustment of timing of the multivibrator is obtained by varying the resistance in the screen circuit of V_5. Since the screen current is not greatly dependent upon the screen resistance, the voltage signal which appears at the screen and which is transferred to the grid of V_6 will vary with the value of screen resistance. This in turn will vary the time required for the grid of V_6 to return to the value which will allow the tube to conduct after the multivibrator has been fired. This method of varying the timing gives a calibration curve which is nearly linear.

The rectangular pulse signal from V_5 is differentiated by means of separate circuits to obtain voltage pips for driving the pulse-width control circuit of channel-1 and the channel-2 delay circuit. The positive pips are used since they are the ones delayed by an adjustable time from the output pulses of the synchronizing channel.

The pulse-width control circuit for channel 1 consists of V_7, V_8 and V_9. Tube V_7 removes the negative voltage pip in the signal from the previous stage and converts the positive pip into a negative pip necessary to drive the multivibrator proper, V_8 and V_9. This is a monostable circuit with plate-to-grid coupling one way and cathode coupling the other. Both tubes operate at fixed bias voltages obtained from a bleeder. The grid of V_9 is connected to the bleeder through a 1N63 germanium diode to shorten the reset time of the multivibrator after it has completed its timing cycle. The bias adjustment R_{11} on the grid of the normally nonconducting tube provides the means of adjusting the multibrator timing.

Isolation Methods

This circuit offers the advantage of a control adjustment which has a linear calibration. Three ranges of timing adjustment are obtained by switching the timing capacitor in the plate-to-grid coupling circuit. A separate battery must be used for the filaments of V_8 and V_9 because of the cathode coupling.

In order to eliminate cross-interference effects between different multivibrators, the filament circuit is switched with a relay to shorten the filament leads from the tube socket to the chassis terminals, the cathode resistor is made as small as practical and the leads to the filament battery as well as the battery itself are shielded. The plate-

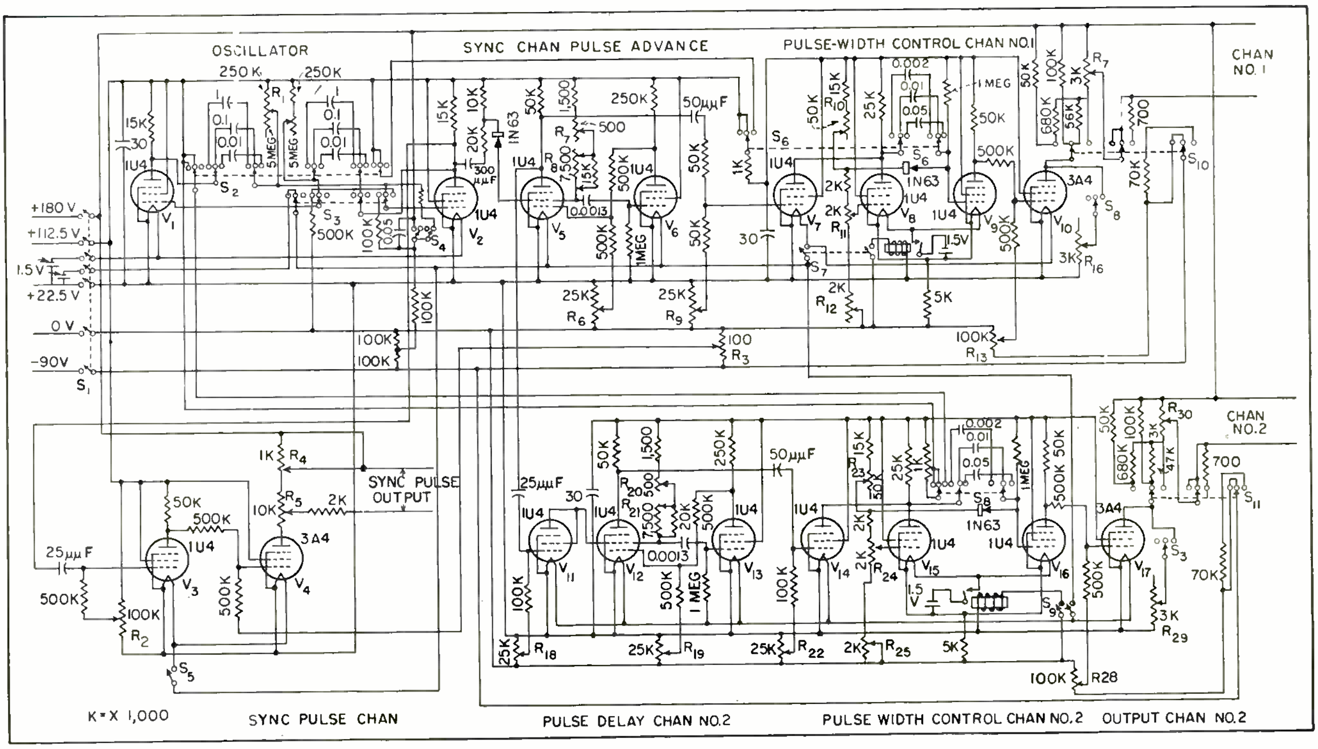


FIG. 1—Schematic diagram of the two-channel rectangular-pulse generator. The 3A4 tubes are selected for good cutoff characteristics

supply voltage for tubes V_7, V_8 and V_9 is passed through a filter consisting of a 1,000-ohm series resistor and a 30-μf shunt capacitor.

The output stage of channel 1 consists of V_{10} direct-coupled to the output from the pulse-width control circuit. This tube raises the power level of the signal and provides a small amount of clipping for better wave form.

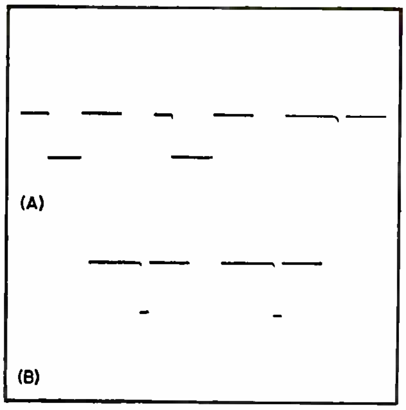
The output voltage controls consist of potentiometer R_{17} and switch S_{10}. On the high-voltage range, the potentiometer serves as the plate load resistor. A 700-ohm series resistor serves to protect the tube in case the output terminals should be short-circuited accidentally. On the two lower voltage ranges, the plate load resistance is increased to about 50,000 ohms to reduce the drain on the plate-supply battery.

The three resistors in the plate circuit are chosen so that the total voltage which appears across R_{17} is 1/10 and 1/100 that which appears on the high-voltage range. The quiescent plate voltage of the tube being lower on the two lower voltage ranges, the grid-bias adjustment is changed by switching out the 70,000-ohm resistor in series with R_{13} to keep the tube operating as a clipping stage. Since the tube is self-protecting against short circuits on the output terminals for these conditions, the 700-ohm series resistance is switched out of the circuit.

The circuits of channel 2 are essentially duplicates of the synchronizing-pulse advance circuit, the pulse-width control circuit and the output circuit of channel 1.

Single Pulse Train

For initiating a single voltage pulse in the output of each channel, circuit changes are made by the output-voltage waveform selector switch S_3. On position 1, this switch decouples the oscillator, connects the grid of V_1 to a large negative bias and connects the grid of V_2 to a separate network consisting of two resistors, a capacitor and a spdt switch S_4. When S_4 is in the normal position, V_2 is biased beyond cut off. When the switch is operated, the grid is raised to +180 volts and allows the tube to start conducting very rapidly. The output pulses from the differentiating circuits connected to the plate of V_2 are sufficient to generate the synchronizing pulse signal and to fire the first multivibrator consisting of V_5 and V_6. From that point on the operation is the same as for repeating pulses, except that the multivibrators fire only once.



Output voltage waveform (A) and constancy of wave shape of the output voltage pulse with respect to nerve loading on the stimulator (B)

The capacitor across S_4 prevents the circuit from resetting immediately when S_4 is released. This delay is introduced to prevent the multivibrators from firing more than once in case S_4 should chatter or make bad contact during the opening and closing operation.

D-C Output Circuits

When the output voltage waveform selector is switched to position 3, the multivibrators and output tubes are cut off and adjustable resistances R_{16} and R_{29} are connected in parallel with the output tubes of channels 1 and 2. Thus battery voltage is applied directly across the output-voltage control circuits and direct current is available at the output terminals. The resistances R_{16} and R_{29} are adjusted to match the apparent resistance of the output tubes when they are conducting so that the same voltage calibrations on the output-voltage control dials apply whether the stimulator is delivering direct current or rectangular voltage pulses.

Switching Provisions

Separate off-on switches are provided in each output channel to reduce battery drain when all channels are not being used. The switches are wired in the filament circuits and turn off all tubes which function only in the corresponding channel.

The pulse-repetition-rate range-selector switch S_2 is interlocked with the pulse-width range-selector switches S_6 and S_8 to turn off the pulse-width control circuits by switching off the plate supply voltage if both range selectors are set on the high ranges simultaneously. For long pulse widths at high pulse repetition rates, successive pulses would overlap and block the operation of the pulse-width control circuits.

The normally-closed contact on S_4 provides a means of starting and stopping the generation of output pulses. This switch plugs into the circuit through a phone plug and jack. When S_3 is in position 2 with S_4 plugged in, V_2 is biased sufficiently negative to block the oscillator. When S_4 is operated, positive bias is applied to V_2, the oscillator begins to function immediately and voltage pulses appear at the output terminals. When S_4 is released, the oscillator is blocked and the output pulses stop. Continuous pulsing operation is obtained by unplugging S_4.

The stimulator described in this paper was developed by the Bio-Mechanics Group, University of California, whose work is aided by a grant from the National Foundation of Infantile Paralysis, for use in neuromuscular research studies.

The stimulator has been in active use for over two years and has given excellent performance, both as a general-purpose stimulator and for supplying synchronized pulses from two main output channels.

BIBLIOGRAPHY

R. K. Combs and F. C. Walz, An Improved Electronic Stimulator, *Review Scien. Inst.*, 16, p 249, 1945.

A. C. Guyton, Versatile Square Wave Nerve Stimulator, *Review Scien. Inst.* 17, p 553, 1946.

W. L. Nastuk and H. L. Borison, A Versatile Electronic Stimulator for Nerve and Muscle, *Review Scien. Inst.*, 18, p 669, 1947.

R. L. Schoenfeld, Double Pulse Constant Current Stimulator, *Review Scien. Inst.*, 20, p 827, 1949.

H. V. Connerty and W. H. Johnson, *Proc. Soc. Experimental Biology and Medicine*, 49, p 223, 1942.

B. Chance et al, "Waveforms," McGraw-Hill Book Co., N. Y., 1949.

H. Goldberg, Synchronized Voltages for Bioelectric Research, ELECTRONICS, 14, p 30, Aug. 1941.

DRIFTLESS

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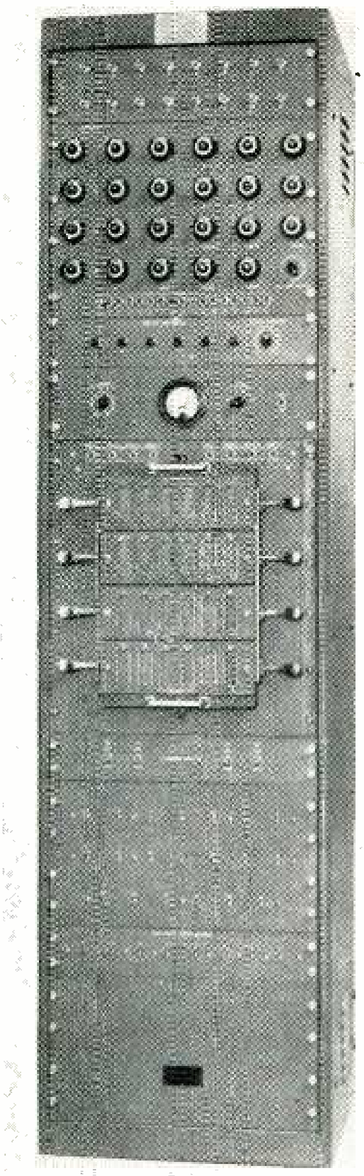


Reeves model A-105 computer uses sixteen driftless high-gain d-c amplifiers. Removable pre-patch board permits patching for problems away from computer, saving set-up time, permitting problem storage and making multiple-shift operation possible

THE REAC is a group of general-purpose analog computer equipments capable of solving nonlinear differential equations with a high degree of accuracy.[1] The newest version contains 16 high-gain driftless d-c amplifiers, 4 limiters of a new and extremely effective design, 6 automatic switching devices, and passive circuit elements which may be used in conjunction with the high-gain amplifiers to generate transfer functions.

Figure 1 shows a high-gain phase-inverting d-c amplifier connected to perform the operation of summation of variables. Integration with respect to time is achieved by substituting a capacitor for the feedback resistor. Three stages are used, providing the requisite phase inversion and an overall gain of approximately 30,000. The input stage is operated to draw essentially zero grid current, so that the current through the feedback resistor may be considered equal to the sum of the input currents, as indicated on the equivalent circuit.

The grid voltage has a varying component which drives the output voltage to a value dependent upon the input voltages, and a relatively steady component which is called the drift voltage because it is due to d-c amplifier drift after zero-balancing. The amplifier gain being high, the varying component of e_g changes only slightly (about 0.01 volt) as V_o varies over its full range (a swing of approximately 300 volts). The amplifier is balanced by adjusting the second-stage bias for zero output with the input points opened. Under these circumstances e_g is zero. This is the condition in which the amplifier is operated. With the amplifier properly balanced, $V_o = -(AV_1 + BV_2)$, which is the ideal performance equation of a summing amplifier.

Qualitatively the circuit of Fig. 1 is similar to a servo. Any error voltage at the input grid appears as a large voltage of opposite sign at the output where, by virtue of the voltage division across the input and feedback resistors from the output voltage to the various input voltages, it drives the input grid voltage back toward zero. The amplifier is thus a voltage servo which maintains a null at its input grid by virtue of current feedback. The input grid floats at a virtual ground. This, in effect, allows the various input circuits to be connected to the common point with no feed-through between them in the summing network. The high-precision values of commercially available passive components, particularly resistors, may then be used for accurate computation.

Grid Current

It is not possible to maintain zero grid current in a d-c coupled amplifier stage in which plate current is flowing; the grid current is a function of plate current and may be made relatively constant by operating at low plate current. Using a 6SL7 as an input tube in the circuit shown in Fig. 1, about 20×10^{-10} ampere of grid current flows. Because of the feedback arrangement, this current all flows through the 1-meg feedback resistor, producing an error of approximately 2 mv at the output.

To understand why grid current flows only through the feedback resistor, consider what happens if any grid current flows through the input resistor. The voltage across the resistor will change. Since the input end of the resistor is tied to a low-impedance source the voltage of which will not be affected by the small change in current, the voltage at the input grid will tend to change. The amplifier will oppose this action by driving the output voltage so as to buck this change.

All d-c amplifiers are inherently susceptible to drift because a slight change in grid-to-cathode voltage in the first stage (due to a slight variation in plate supply or heater voltage, resistor drift or input tube unbalance) is amplified in succeeding

D-C AMPLIFIER

Chopper and auxiliary a-c amplifier provide continuous balancing to counteract drift. Input current is zero because all input-stage grid current goes through feedback resistor. Two-page table gives input and output networks for use with amplifier to generate variety of complex transfer functions for summation operation in analog computers

stages, producing a large change in output voltage. Despite the drift problem, the use of d-c amplifiers for analog computation is highly desirable because d-c voltages may be operated on with simple RC networks. Equivalent networks for a-c carrier systems are complex and are sensitive to carrier frequency variation. A d-c amplifier with an input resistor and a feedback capacitor provides more accuracy over a wider range of integration than any other analog device.

Balancing

Various methods have been used to solve the drift problem, most of which resolve themselves into frequent setting of a voltage level. The original REAC computer used a servo balancing system in which the amplifier inputs were opened and the output voltage supplied as the error signal to a servo driving the potentiometer from which the balancing voltage was tapped. A stepping relay and clutching system switched the servo amplifier and motor to each of the 20 amplifiers in turn. This eliminated the drift voltage at the instant of adjustment. Frequent adjustment was necessary and the allowable problem running time was limited by the amplifier drift rate.

An all-electronic continuous-balancing system has been developed[2], using a chopper in conjunction with an auxiliary a-c amplifier. The circuit version used in the REAC is shown in Fig. 2. Any voltage existing at the input grid is chopped into a 60-cycle signal by the vibrator which grounds the junction of R_2 and C_2 on alternate half-cycles. Note that grounding the input in this manner draws negligible current because the input grid is always within 2 mv of ground and the resistance to ground through the vibrator is more than 2 meg.

The amplifier output is half-wave rectified by the vibrator, filtered by R_3 and C_3, and coupled to the second grid of the d-c amplifier input. The first stage of the input tube receives the input signal directly, while the other grid receives the output of the auxiliary amplifier. The auxiliary amplifier output is added to the direct-coupled signal by means of the common cathode resistor of the first stage.

The auxiliary amplifier has a d-c gain of about 1,000. Since it is in series with the basic amplifier, between the junction of the summing resistors and the basic amplifier, the combination has a d-c gain which is the product of the gains of the two amplifiers (about 30 × 10^6). Moreover, the auxiliary amplifier is drift-free so that the drift

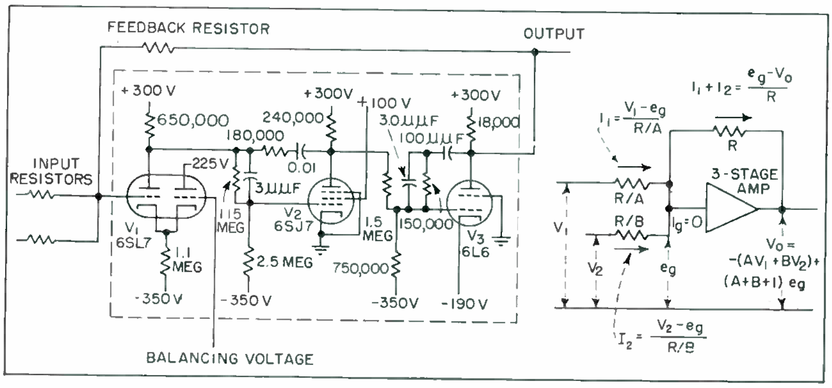


FIG. 1—Basic computing amplifier and equivalent circuit

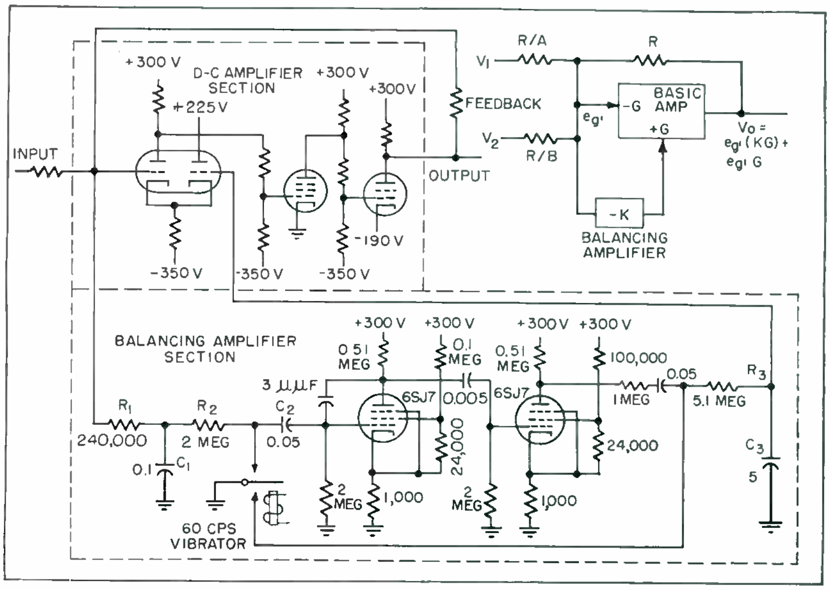


FIG. 2—Circuit used to counteract drift of d-c amplifier

voltage is less by a factor of about 1,000.

Stability

Certain stability problems arise when it is attempted to raise the loop-gain of a feedback system 60 db by the insertion of an additional amplifier in series. If the auxiliary amplifier, which provides the additional gain, has a bandwidth restricted to low frequencies so that the gain of the auxiliary amplifier falls to unity before the main amplifier gain is attenuated more than a small fraction of a db by the antising networks, and if the auxiliary amplifier is bypassed so that high-frequency components of the signal will pass directly through the primary amplifier, the combination may be made stable.

The gain-frequency characteristic of the amplifier is shown in Fig. 3. To satisfy the Nyquist-Bode stability requirements the characteristic curve should cross the unity gain (0 db) line at a slope of less than 12 db per octave. Each individual response curve satisfies this condition. With the series connection, however, if the sloping sections were to overlap, the combined attenuation would produce too steep a slope. It is thus necessary that the auxiliary amplifier frequency response be severely limited. Additionally, the auxiliary amplifier must be bypassed because the slope of its characteristic increases sharply below unity gain. Since the auxiliary amplifier is followed by a gain of roughly 30,000 the series combination would have unity gain at a gain of 1/30,000 for the auxiliary amplifier, at which point the slope of the characteristic is too steep.

Whenever there is a disturbance at the direct input, the balancing input must not be a larger disturbance because when coupled through the amplifier it would drive the direct input grid in the opposite direction past zero and oscillation would result.

A further stipulation is thus necessary for stability. The time constant of R_3 and C_3 at the output of the balancing amplifier must be equal to or greater than the time constant of R_1 and C_1 at the input multiplied by the gain of the balancing amplifier. In this fashion the amplified transient at the balancing amplifier output is attenuated so that the amplitude of the transient input to the balancing grid does not over-compensate and cause the input grid to be driven in the opposite direction. Filter network R_1—C_1 is required at the input of the two-stage amplifier to isolate the input grid of the 6SL7 from the vibrator signal.

It is necessary for stability that the vibrator have make-before-break contacts. If one of the vibrator contacts is momentarily ungrounded, the in-phase a-c coupled through the vibrator capacitance will cause the balancing amplifier to oscillate. If one contact is grounded at all times, most of the feed-through is eliminated and the balancing circuit is stable.

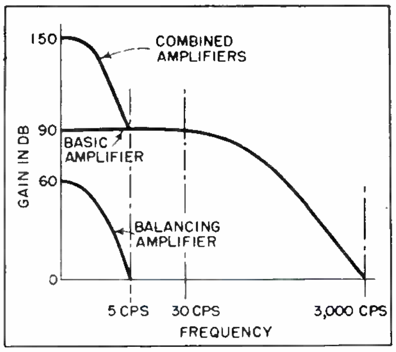


FIG. 3—Variation of gain with frequency for d-c amplifier

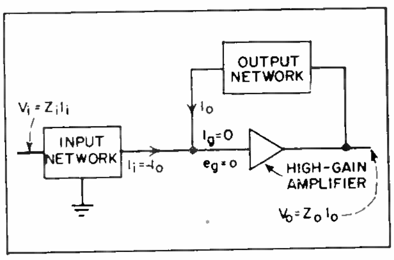


FIG. 4—Generalized block diagram of amplifier

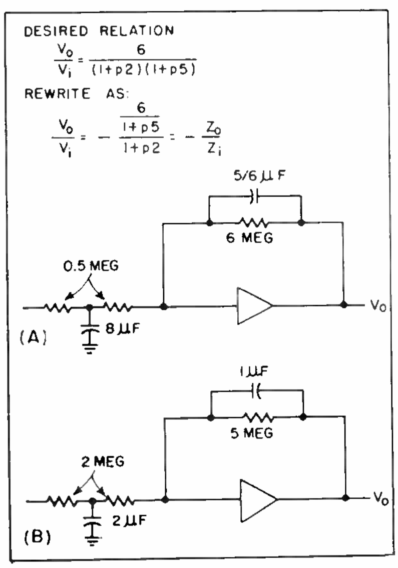


FIG. 5—Examples of transfer function networks

Transfer Functions

The use of d-c amplifiers in combination with passive networks to generate complex transfer functions is a generalization of summation (or integration). The equations in Fig. 4 hold when e_g is essentially zero and very small grid current flows. Here Z_i and Z_o are the short-circuit transfer impedances of the respective networks. The short-circuit transfer impedance is defined as input voltage divided by output current for output short-circuited, hence $(V_o/V_i) = (-Z_o/Z_i) = f(p)$ where $p = d/dt$ and $f(p)$ is a transfer relationship between output and input voltage dependent solely upon the networks (to the extent that e_g and I_g are close to zero).

An example is presented in Fig. 5, along with the networks that provide the desired transfer function. The input and output networks may be modified to adapt the component values available to the component values required by modifying the circuits individually without changing their time constant.

For example, the feedback network can be changed as shown in Fig. 5B. This actually changes the constant term 6 in the numerator but does not affect the differential terms. The reduction in feedback resistance value and increase in input resistance value drop the steady-state gain to 5/4. Originally the gain was 6. This factor can be picked up elsewhere in the computing loop.

The table of transfer functions was prepared by S. Godet of Reeves Instrument Corp.

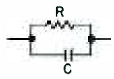
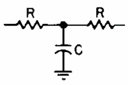
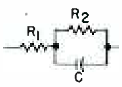
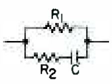
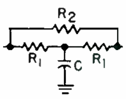
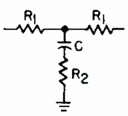
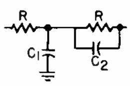
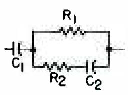
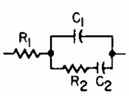
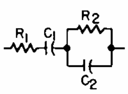
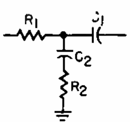
REFERENCES

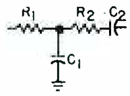
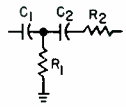
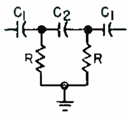
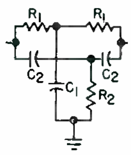
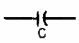
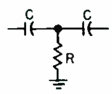
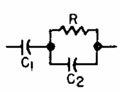
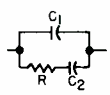
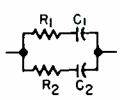
(1) Seymour Frost, An Office Size Electronic Computer, ELECTRONICS, p 116, July 1948.

(2) Edwin Goldberg, Stabilization of Wide-Band Direct-Current Amplifiers for Zero and Gain, *RCA Review*, p 296, June 1950.

Table I—Transfer Functions of R-C Input and Output Networks

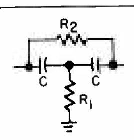
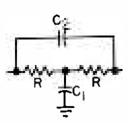
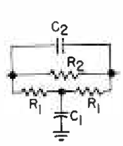
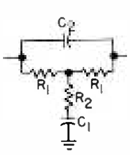
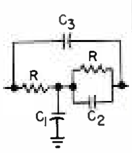
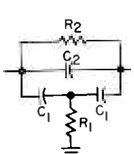
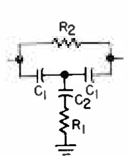
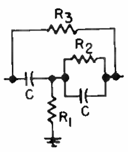
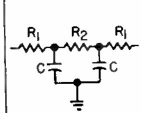
To generate a specific $f(p)$, rewrite $f(p)$ in the form Z_o/Z_i where Z_o and Z_i are each in a form corresponding to a function in the left-hand column. Choose input and output networks in accordance with the diagrams and relations adjacent to the function representing Z_i and Z_o respectively.

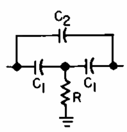
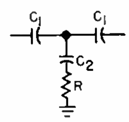
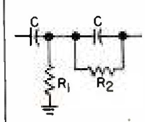
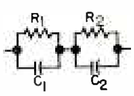
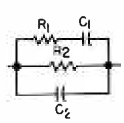
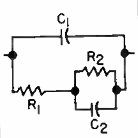
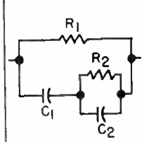
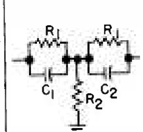
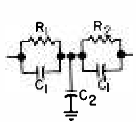
TRANSFER IMPEDANCE FUNCTION	NETWORK	RELATIONS	INVERSE RELATIONS
A		$A = R$	$R = A$
$\frac{A}{1+pT}$		$A = R$ $T = RC$	$R = A$ $C = \frac{T}{A}$
$A(1+pT)$		$A = 2R$ $T = \frac{RC}{2}$	$R = \frac{A}{2}$ $C = \frac{4T}{A}$
$A\left(\frac{1+p\theta T}{1+pT}\right)$ $\theta < 1$		$A = R_1+R_2$ $T = R_2C$ $\theta = \frac{R_1}{R_1+R_2}$	$R_1 = A\theta$ $R_2 = A(1-\theta)$ $C = \frac{T}{A(1-\theta)}$
		$A = R_1$ $T = (R_1+R_2)C$ $\theta = \frac{R_2}{R_1+R_2}$	$R_1 = A$ $R_2 = \frac{A\theta}{1-\theta}$ $C = \frac{T(1-\theta)}{A}$
$A\left(\frac{1+pT}{1+p\theta T}\right)$ $\theta < 1$		$A = \frac{2R_1R_2}{2R_1+R_2}$ $T = \frac{R_1C}{2}$ $\theta = \frac{2R_1}{2R_1+R_2}$	$R_1 = \frac{A}{2(1-\theta)}$ $R_2 = \frac{A}{\theta}$ $C = \frac{4T(1-\theta)}{A}$
		$A = 2R_1$ $T = \left(R_2+\frac{R_1}{2}\right)C$ $\theta = \frac{2R_2}{2R_2+R_1}$	$R_1 = \frac{A}{2}$ $R_2 = \frac{A\theta}{4(1-\theta)}$ $C = \frac{4T(1-\theta)}{A}$
		$A = 2R$ $T = \frac{R}{2}(C_1+C_2)$ $\theta = \frac{2C_2}{C_1+C_2}$	$R = \frac{A}{2}$ $C_1 = \frac{2T(2-\theta)}{A}$ $C_2 = \frac{2T\theta}{A}$
$\frac{1}{pB}\left[\frac{(1+pT_1)(1+pT_3)}{1+pT_2}\right]$ $T_1 < T_2 < T_3$		$B = C_1$ $T_2 = (R_1+R_2)C_2$ $T_1T_3 = R_1R_2C_1C_2$ $T_1+T_3 = R_1C_1+R_2C_2+R_1C_2$	$R_1 = \frac{T_1+T_3-T_2}{B}$ $R_2 = \frac{T_1T_3(T_1+T_3-T_2)}{B(T_3-T_2)(T_2-T_1)}$ $C_1 = B$ $C_2 = \frac{B(T_3-T_2)(T_2-T_1)}{(T_1+T_3-T_2)^2}$
		$B = C_1+C_2$ $T_2 = R_2\left(\frac{C_1C_2}{C_1+C_2}\right)$ $T_1T_3 = R_1R_2C_1C_2$ $T_1+T_3 = R_1C_1+R_2C_2+R_1C_2$	$R_1 = \frac{T_1T_3}{BT_2}$ $R_2 = \frac{(T_1T_2+T_2T_3-T_1T_3)^2}{BT_2(T_3-T_2)(T_2-T_1)}$ $C_1 = \frac{BT_2^2}{T_1T_2+T_2T_3-T_1T_3}$ $C_2 = \frac{B(T_3-T_2)(T_2-T_1)}{T_1T_2+T_2T_3-T_1T_3}$
		$B = C_1$ $T_2 = R_2C_2$ $T_1T_3 = R_1R_2C_1C_2$ $T_1+T_3 = R_1C_1+R_2C_2+R_2C_1$	$R_1 = \frac{T_1T_3}{BT_2}$ $R_2 = \frac{(T_3-T_2)(T_2-T_1)}{BT_2}$ $C_1 = B$ $C_2 = \frac{BT_2^2}{(T_3-T_2)(T_2-T_1)}$
		$B = C_1$ $T_2 = R_2C_2$ $T_1T_3 = R_1R_2C_1C_2$ $T_1+T_3 = R_1C_1+R_2C_2+R_1C_2$	$R_1 = \frac{T_1T_3}{BT_2}$ $R_2 = \frac{T_1T_2T_3}{B(T_3-T_2)(T_2-T_1)}$ $C_1 = B$ $C_2 = \frac{B(T_3-T_2)(T_2-T_1)}{T_1T_3}$

TRANSFER IMPEDANCE FUNCTION	NETWORK	RELATIONS	INVERSE RELATIONS
$\frac{1}{pB}(1+pT_1)(1+pT_2)$ $T_1 \neq T_2$		$B = C_2$ $T_1T_2 = R_1R_2C_1C_2$ $T_1+T_2 = R_1C_1+R_2C_2+R_1C_2$	$R_1 = \frac{(\sqrt{T_1}-\sqrt{T_2})^2}{B}$ $R_2 = \frac{\sqrt{T_1T_2}}{B}$ $C_1 = \frac{B\sqrt{T_1T_2}}{(\sqrt{T_1}-\sqrt{T_2})^2}$ $C_2 = B$
$\frac{1}{pB}\left[\frac{(1+pT_1)(1+pT_2)}{p\sqrt{T_1T_2}}\right]$ $T_1 \neq T_2$		$B = C_2$ $T_1T_2 = R_1R_2C_1C_2$ $T_1+T_2 = R_1C_1+R_2C_2+R_1C_2$	$R = \frac{(\sqrt{T_1}-\sqrt{T_2})^2}{B}$ $R_2 = \frac{\sqrt{T_1T_2}}{B}$ $C_1 = \frac{B\sqrt{T_1T_2}}{(\sqrt{T_1}-\sqrt{T_2})^2}$ $C_2 = B$
$\frac{1}{pB}\left[\frac{(1+pT_1)(1+pT_2)}{p^2T_1T_2}\right]$ $T_1 < T_2$		$B = \frac{C_1C_2}{C_1+2C_2}$ $T_1 = RC_1$ $T_2 = R(C_1+2C_2)$	$R = \frac{T_1(T_2-T_1)}{2BT_2}$ $C_1 = \frac{2BT_2}{T_2-T_1}$ $C_2 = \frac{BT_2}{T_1}$
$A\left(\frac{1+pT_1}{1+p^2T_1T_2}\right)$	 $R_1C_1 = 4R_2C_2$	$A = 2R_1$ $T_1 = \frac{R_1C_1}{2} = 2R_2C_2$ $T_2 = R_1C_2$	$R_1 = \frac{A}{2}$ $R_2 = \frac{AT_1}{4T_2}$ $C_1 = \frac{4T_1}{A}$ $C_2 = \frac{2T_2}{A}$
$\frac{1}{pB}$		$B = C$	$C = B$
$\frac{1}{pB}(1+pT)$		$B = C$ $T = RC$	$R = \frac{T}{B}$ $C = B$
$\frac{1}{pB}\left(\frac{1+pT}{pT}\right)$		$B = \frac{C}{2}$ $T = 2RC$	$R = \frac{T}{4B}$ $C = 2B$
$\frac{1}{pB}\left(\frac{1+pT}{1+p\theta T}\right)$ $\theta < 1$		$B = C_1$ $T = R(C_1+C_2)$ $\theta = \frac{C_2}{C_1+C_2}$	$R = \frac{T(1-\theta)}{B}$ $C_1 = B$ $C_2 = \frac{B\theta}{1-\theta}$
		$B = C_1+C_2$ $T = RC_2$ $\theta = \frac{C_1}{C_1+C_2}$	$R = \frac{T}{B(1-\theta)}$ $C_1 = B\theta$ $C_2 = B(1-\theta)$
$\frac{1}{pB}\left[\frac{(1+pT_1)(1+pT_3)}{1+pT_2}\right]$ $T_1 < T_2 < T_3$		$B = C_1+C_2$ $T_1 = R_1C_1$ $T_2 = (R_1+R_2)\left(\frac{C_1C_2}{C_1+C_2}\right)$ $T_3 = R_2C_2$	$R_1 = \frac{T_1(T_3-T_1)}{B(T_2-T_1)}$ $R_2 = \frac{T_3(T_3-T_1)}{B(T_3-T_2)}$ $C_1 = \frac{B(T_2-T_1)}{T_3-T_1}$ $C_2 = \frac{B(T_3-T_2)}{T_3-T_1}$

(Continued on page 148)

Table I (continued)—Transfer Functions of R-C Input and Output Networks

TRANSFER IMPEDANCE FUNCTION	NETWORK	RELATIONS	INVERSE RELATIONS
$A\left(\frac{1+pT_1}{1+pT_1+p^2T_1T_2}\right)$		$A=R_2$ $T_1=2R_1C$ $T_2=\frac{R_2C}{2}$	$R_1=\frac{AT_1}{4T_2}$ $R_2=A$ $C=\frac{2T_2}{A}$
$A\left(\frac{1+pT_2}{1+pT_1+p^2T_1T_2}\right)$		$A=2R$ $T_1=2RC_2$ $T_2=\frac{RC_1}{2}$	$R=\frac{A}{2}$ $C_1=\frac{4T_2}{A}$ $C_2=\frac{T_1}{A}$
$A\left[\frac{1+pT_3}{1+pT_1+p^2T_1T_2}\right]$ $T_2>\frac{T_1}{4}$ (Complex roots) $T_3>T_2$		$A=\frac{2R_1R_2}{(2R_1+R_2)}$ $T_1=\frac{R_1(R_1C_1+2R_2C_2)}{2R_1+R_2}$ $T_2=\frac{R_1R_2C_1C_2}{R_1C_1+2R_2C_2}$ $T_3=\frac{R_1C_1}{2}$	$R_1=\frac{AT_3^2}{2[T_3^2-T_1(T_3-T_2)]}$ $R_2=\frac{AT_3^2}{T_1(T_3-T_2)}$ $C_1=\frac{4[T_3^2-T_1(T_3-T_2)]}{AT_3}$ $C_2=\frac{T_1T_2}{AT_3}$
		$A=2R_1$ $T_1=R_2C_1+2R_1C_2$ $T_2=\frac{R_1(R_1+2R_2)C_1C_2}{R_2C_1+2R_1C_2}$ $T_3=\left(R_2+\frac{R_1}{2}\right)C_1$	$R_1=\frac{A}{2}$ $R_2=\frac{AT_1(T_3-T_2)}{4[T_3^2-T_1(T_3-T_2)]}$ $C_1=\frac{4[T_3^2-T_1(T_3-T_2)]}{AT_3}$ $C_2=\frac{T_1T_2}{AT_3}$
		$A=2R$ $T_1=R(C_2+2C_3)$ $T_2=\frac{RC_3(C_1+C_2)}{C_2+2C_3}$ $T_3=\frac{R}{2}(C_1+C_2)$	$R=\frac{A}{2}$ $C_1=\frac{2[2T_3^2-T_1(T_3-T_2)]}{AT_3}$ $C_2=\frac{2T_1(T_3-T_2)}{AT_3}$ $C_3=\frac{T_1T_2}{AT_3}$
$A\left[\frac{1+pT_3}{1+pT_1+p^2T_1T_2}\right]$ $T_2>\frac{T_1}{4}$ (Complex roots) $T_3<T_1$		$A=R_2$ $T_1=2R_1C_1+R_2C_2$ $T_2=\frac{R_1R_2C_1(C_1+2C_2)}{2R_1C_1+R_2C_2}$ $T_3=2R_1C_1$	$R_1=\frac{AT_3^2}{4[T_1T_2-T_3(T_1-T_3)]}$ $R_2=A$ $C_1=\frac{2[T_1T_2-T_3(T_1-T_3)]}{AT_3}$ $C_2=\frac{(T_1-T_3)}{A}$
		$A=R_2$ $T_1=\frac{C_1(2R_1C_2+R_2C_1)}{2C_1+C_2}$ $T_2=\frac{R_1R_2C_1C_2}{2R_1C_2+R_2C_1}$ $T_3=\frac{2R_1C_1C_2}{(2C_1+C_2)}$	$R_1=\frac{AT_3^2}{4[T_1T_2-T_3(T_1-T_3)]}$ $R_2=A$ $C_1=\frac{2T_1T_2}{AT_3}$ $C_2=\frac{4T_1T_2[T_1T_2-T_3(T_1-T_3)]}{AT_3^2(T_1-T_3)}$
		$A=R_3$ $T_1=\frac{R_1(2R_2+R_3)C}{R_1+R_2}$ $T_2=\frac{R_2R_3C}{(2R_2+R_3)}$ $T_3=\frac{2R_1R_2C}{(R_1+R_2)}$	$R_1=\frac{AT_3^2}{2[2T_1T_2-T_3(T_1-T_3)]}$ $R_2=\frac{AT_3}{2(T_1-T_3)}$ $R_3=A$ $C=\frac{2T_1T_2}{AT_3}$
$A(1+pT_1)(1+pT_2)$ $T_1<T_2$		$A=2R_1+R_2$ $T_1=\left(\frac{R_1R_2}{2R_1+R_2}\right)C$ $T_2=R_1C$	$R_1=A\left(\frac{T_2-T_1}{2T_2}\right)$ $R_2=A\frac{T_1}{T_2}$ $C=\frac{2T_2^2}{A(T_2-T_1)}$

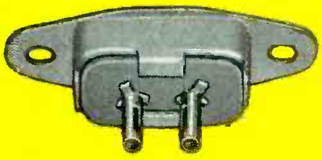
TRANSFER IMPEDANCE FUNCTION	NETWORK	RELATIONS	INVERSE RELATIONS
$\frac{1}{pB}\left(\frac{1+p\theta T}{1+pT}\right)$ $\theta<1$		$B=C_2$ $T=RC_1\left(\frac{2C_2+C_1}{C_2}\right)$ $\theta=\frac{2C_2}{2C_2+C_1}$	$R=\frac{T\theta^2}{4B(1-\theta)}$ $C_1=\frac{2B(1-\theta)}{\theta}$ $C_2=B$
		$B=\frac{C_1^2}{2C_1+C_2}$ $T=RC_2$ $\theta=\frac{2C_1}{2C_1+C_2}$	$R=\frac{T\theta^2}{4B(1-\theta)}$ $C_1=\frac{2B}{\theta}$ $C_2=\frac{4B(1-\theta)}{\theta^2}$
		$B=\left(\frac{R_1}{R_1+R_2}\right)C$ $T=R_2C$ $\theta=\frac{2R_1}{R_1+R_2}$	$R_1=\frac{T\theta^2}{2B(2-\theta)}$ $R_2=\frac{T\theta}{2B}$ $C=\frac{2B}{\theta}$
$A\left[\frac{1+pT_2}{(1+pT_1)(1+pT_3)}\right]$ $T_1<T_2<T_3$		$A=R_1+R_2$ $T_1=R_1C_1$ $T_2=\left(\frac{R_1R_2}{R_1+R_2}\right)(C_1+C_2)$ $T_3=R_2C_2$	$R_1=\frac{A(T_2-T_1)}{T_3-T_1}$ $R_2=\frac{A(T_3-T_2)}{T_3-T_1}$ $C_1=\frac{T_1(T_3-T_1)}{A(T_2-T_1)}$ $C_2=\frac{T_3(T_3-T_1)}{A(T_3-T_2)}$
		$A=R_2$ $T_2=R_1C_1$ $T_1T_3=R_1R_2C_1C_2$ $T_1+T_3=R_1C_1+R_2C_2+R_2C_1$	$R_1=\frac{AT_2^2}{(T_3-T_2)(T_2-T_1)}$ $R_2=A$ $C_1=\frac{(T_3-T_2)(T_2-T_1)}{AT_2}$ $C_2=\frac{T_1T_3}{AT_2}$
		$A=R_1+R_2$ $T_2=\left(\frac{R_1R_2}{R_1+R_2}\right)C_2$ $T_1T_3=R_1R_2C_1C_2$ $T_1+T_3=R_1C_1+R_2C_2+R_2C_1$	$R_1=\frac{AT_2^2}{T_1T_2+T_2T_3-T_1T_3}$ $R_2=\frac{A(T_3-T_2)(T_2-T_1)}{T_1T_2+T_2T_3-T_1T_3}$ $C_1=\frac{T_1T_3}{AT_2}$ $C_2=\frac{(T_1T_2+T_2T_3-T_1T_3)^2}{AT_2(T_3-T_2)(T_2-T_1)}$
		$A=R_1$ $T_2=R_2(C_1+C_2)$ $T_1T_3=R_1R_2C_1C_2$ $T_1+T_3=R_1C_1+R_2C_2+R_2C_1$	$R_1=A$ $R_2=\frac{A(T_3-T_2)(T_2-T_1)}{(T_1+T_3-T_2)^2}$ $C_1=\frac{T_1+T_3-T_2}{A}$ $C_2=\frac{T_1T_3(T_1+T_3-T_2)}{A(T_3-T_2)(T_2-T_1)}$
$A\left[\frac{1+pT_2}{(1+pT_1)(1+pT_3)}\right]$ $T_2<T_1<T_3$		$A=2R_1+\frac{R_1^2}{R_2}$ $T_1=R_1C_1$ $T_2=\left(\frac{R_1R_2}{R_1+2R_2}\right)(C_1+C_2)$ $T_3=R_1C_2$	$R_1=\frac{AT_2}{(T_1+T_3)}$ $R_2=\frac{AT_2^2}{(T_1+T_3)(T_1+T_3-2T_2)}$ $C_1=\frac{T_1(T_1+T_3)}{AT_2}$ $C_2=\frac{T_3(T_1+T_3)}{AT_2}$
$A\left[\frac{1+pT_2}{(1+pT_1)(1+pT_3)}\right]$ $T_1<T_3<T_2$		$A=R_1+R_2$ $T_1=R_1C_1$ $T_2=\frac{R_1R_2}{R_1+R_2}(2C_1+C_2)$ $T_3=R_2C_1$	$R_1=\frac{AT_1}{(T_1+T_3)}$ $R_2=\frac{AT_3}{(T_1+T_3)}$ $C_1=\frac{(T_1+T_3)}{A}$ $C_2=\frac{(T_1+T_3)}{A}\left(\frac{T_2}{T_3}+\frac{T_2}{T_1}-2\right)$

Cinch
ELECTRONIC COMPONENTS

TV 110 VOLT DISCONNECT PLUG
No. 15 M-14684

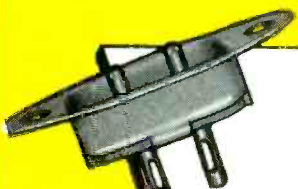
PATENT PENDING

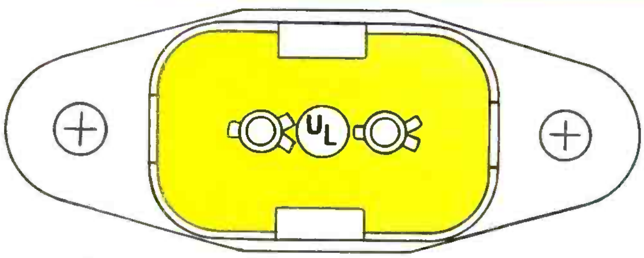
TV 110 VOLT DISCONNECT PLUG



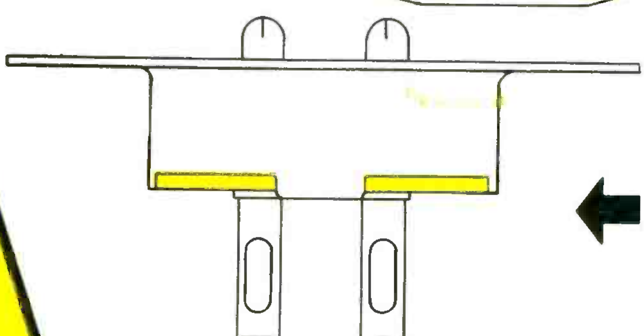
The new CINCH one piece pin with solder tail is featured in the re-designed CINCH 110 Volt TV lead in. Underwriters approved, this improved disconnect is a contribution of CINCH engineering to the industry's programs of material conservation and design simplification.

CONSULT CINCH.





ELIMINATES INTERMITTENTS. The new one piece pin with solder tail insures positive electrical flow through plug to set by eliminating old style pin-lug riveted joint.



SAVES scarce materials . . . eliminates one piece of insulation and two soldering lugs.

SAVES solder and soldering operations of lugs to pins.

Cinch
ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass

New one piece pin with solder tail can be used in other conventional pin plug applications and assemblies.

Choosing Pentodes for Broad-Band Amplifiers

Gain-bandwidth products for pentodes are easy to calculate individually, but a graphic comparison of these broad-band amplifier-tube figures of merit yields a wealth of interesting and useful information. Such a comparison is shown in chart form below

By JOHN R. WHYTE

Radio Valve Company of Canada Ltd.
Toronto, Ontario

There are many tubes now available for use in broad-band amplifiers. Pentodes are generally preferred to other types because of their relatively low grid-to-plate capacitance values. The chart below shows at a glance the relative suitability of 100 typical pentodes for use in broad-band amplifier circuits.

The important features of a pentode in this application are its transconductance or g_m, and the total capacitance to ground C, which is equal to the input plus the output capacitance. The plate resistance is much larger than the load resistance R and is usually neglected.

At normal frequencies the gain of the tube is $g_m R$. At high frequencies, if no compensation is used, the gain falls to 70 percent at the frequency where the reactance of C is equal to R. If this frequency

$$f = \frac{1}{2\pi R C}$$

is taken as the bandwidth, then

$$\text{gain} \times \text{bandwidth} = \frac{g_m}{2\pi C}$$

and depends on the tube characteristics rather than on the external circuit. More complicated coupling networks will extend the bandwidth, but the gain-bandwidth product will still depend on the ratio of g_m to C.

Transconductance and total capacitance are used as coordinates. Different envelope styles are shown by different symbols. Using logarithmic scales, the contours of constant gain-bandwidth product are lines sloping upwards at 45 degrees. The most desirable tube for this service is towards the lower right corner of the chart.

One use of this chart is to indicate tubes that are electrically similar, such as the 6AU6 and 6BH6.

The chart also shows that an improved tube can be obtained either by increasing the g_m, as shown by types 6AG5 and 6BC5, or by decreasing the capacitance, as shown by types 6AG5 and 6AK5.

Other similarities and differences are shown by tubes on the same diagonal line. For example, types 6AK5, 6CB6 and 6AH6 have the same gain-bandwidth product, with different values of transconductance and capacitance.

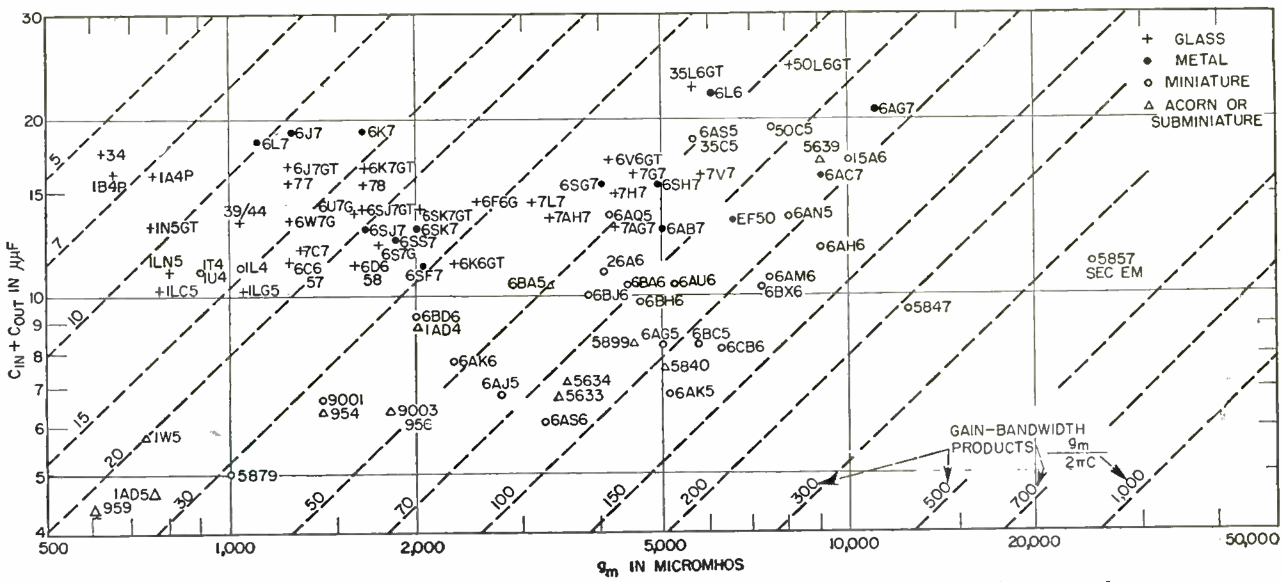
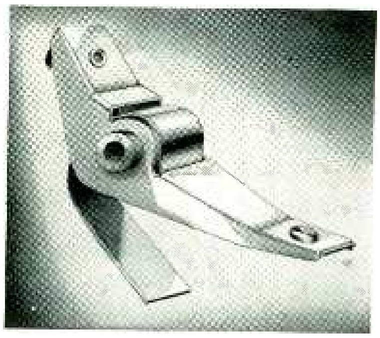
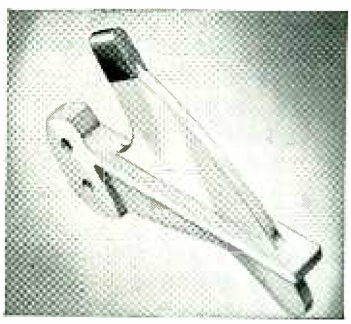
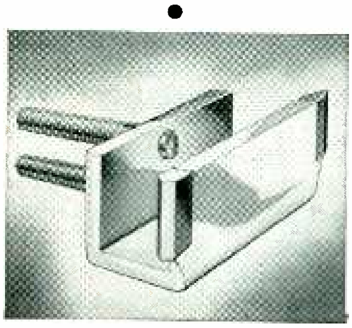


Chart enables designer to compare broad-band amplifier performance of various pentodes at a glance

Don't let contact assembly problems "sidetrack" your engineers... your production facilities!







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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

OTHER DEPARTMENTS featured in this issue:

Parallel-Output Push-Pull Circuit

By John W. Flowers
Associate Professor of Physics
University of Florida
Gainesville, Florida

A NEW and interesting push-pull output circuit has recently been described by Arnold Peterson and D. B. Sinclair of the General Radio Company.[1] With this circuit, each tube in a push-pull pair delivers an output signal voltage and current which combine in parallel in the primary of the output transformer. In the usual push-pull circuit the output voltages combine in series with an output impedance which is four times larger than the parallel output circuit.

A modification of the General Radio circuit is presented in Fig. 1. The experimental circuit of Fig. 1 provides the simplifications of self biasing and perhaps more conventional circuitry in the driving and inverter stages for power outputs near 20 watts. The power-handling characteristics of this circuit as determined by observations of wave shape show no significant difference from the usual push-pull circuit with equivalent operating potentials. For the 6L6 output tubes indicated, somewhat excessive cathode potentials are developed at the higher levels for the cathode of V_1. Other output tubes are available, however, that operate within rated values of heater-cathode potentials.

Self-biasing potential is developed across the cathode resistor R_1 which carries the current of both V_1 and V_2. Only part of this potential is used to bias V_1 since V_1 is partially self biased by the d-c drop in the transformer primary winding contained in its cathode circuit. The potentiometer R_2 serves to balance tube currents and compensate for the drop in the transformer winding. By-passing of the cathode resistor R_1 is not necessary.

In the parallel output circuit it is necessary to drive the upper output tube V_1 by a signal developed between the cathode and grid of V_1. Since the cathode of V_1 contains the output signal voltage it becomes necessary to compensate the signal developed by the driver V_3 which is in turn driven with respect to ground. This is accomplished[1] by deriving the plate-supply potential of V_3 from the plate of V_2 which contains the same a-c component as the cathode of V_1.

To a first approximation, and disregarding any self-adjusting effects that occur, the introduction of the a-c signal component in the plate supply of V_3 best compensates for the same a-c component existing at the cathode of V_1 when the driver V_3 is chosen to be a pentode operating with a constant screen voltage.

With a pentode driver, the a-c component in its plate supply does not develop any appreciable component across its output load. The only appreciable output component developed across the output load of the driver V_3 is due to the signal that appears at its grid with respect to ground. Thus the only appreciable signal presented between the grid and cathode of V_1 is derived from the grid-to-ground signal of V_3.

With the exception of the plate supply of V_3, the drivers are symmetrical and are preceded by a conventional phase inverter and coupling stage. The variable plate supply of V_3 produces negligible

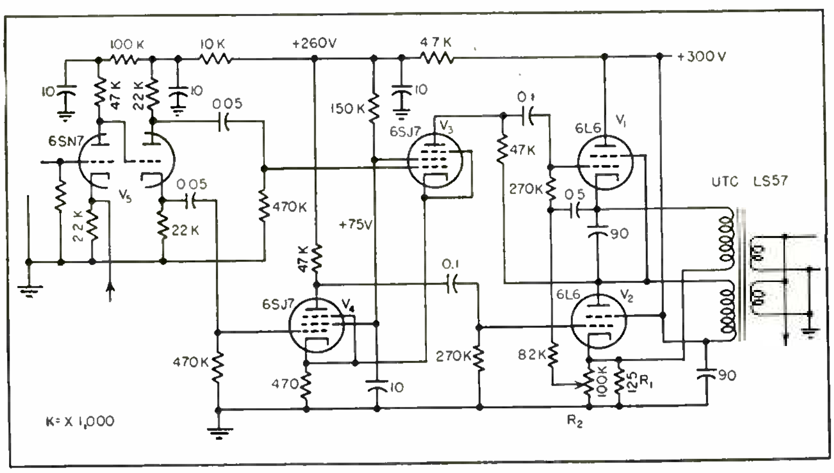
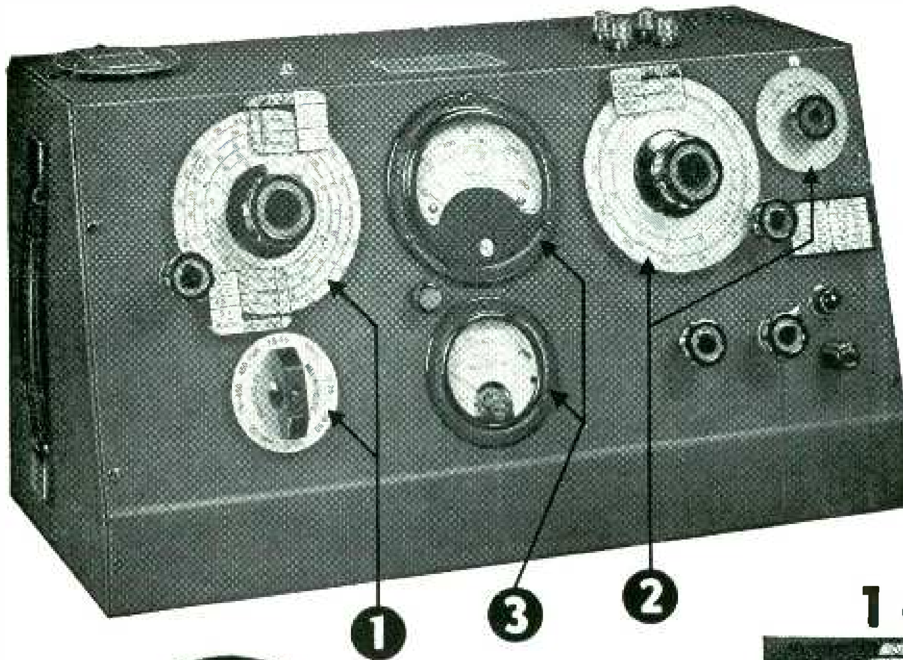


FIG. 1—Self-biased parallel-output push-pull circuit using pentode drivers. Power output is from 15 to 18 watts



EXAMINE THESE *Direct Reading Features* WHICH SIMPLIFY ACCURATE MEASUREMENTS

The Q METER

TYPE 160-A

50 kc. to 75 mc.

Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

With the 160-A Q-Meter, as with other Boonton Radio Corporation instruments, the keynote in design is to embody accurate *direct reading* features which save time and simplify operation.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.

Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

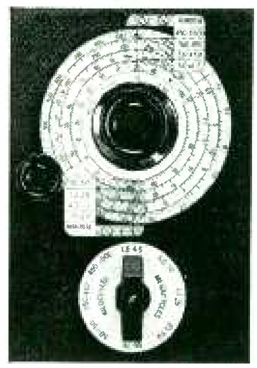
Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero, —3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

Price: $625.00 F.O.B. Boonton, N. J.

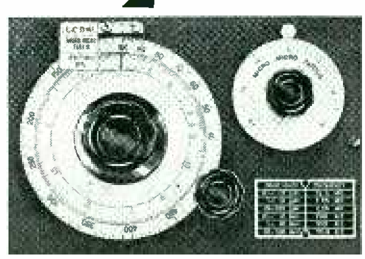
Write for further information

1 OSCILLATOR FREQUENCY DIAL.



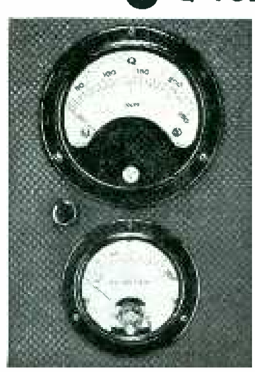
This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated *directly* in kilocycles or megacycles, with scales conveniently divided for maximum readability. A vernier dial drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

2 Q-TUNING CAPACITANCE DIALS.



L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance *directly* in MMF, and (2) providing an effective inductance scale which also becomes *direct* reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from +3 MMF through zero to —3 MMF, accurate to ±0.1 MMF.

3 Q-VOLTMETER AND MULTIPLIER METER.



For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated *directly* in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1.5 in 0.1 steps, X2, and X2.5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermocouple element for maximum accuracy.

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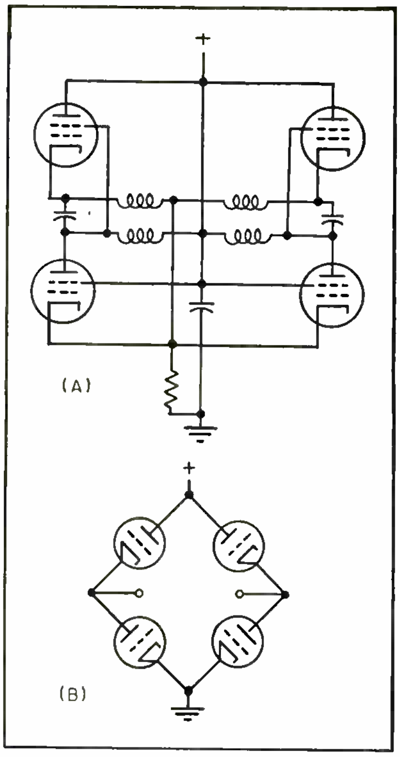


FIG. 2—Push-pull output bridge (A) with only primary windings shown. Vertical division yields two parallel-type circuits; horizontal division yields two series-type push-pull circuits. Balanced output without a transformer (B)

departure from symmetry for a pentode as compared with triodes. The relative performance with respect to distortions however, remains to be determined.

Feedback is obtained from the voice coil to the cathode of the input stage. Feedback from the primary of the output transformer is more difficult. The phase relations are not proper for feedback to the cathode or plate of the input triode.

It appears likely that the usual series push-pull circuit and the parallel push-pull circuit may be combined to form a quadruplet push-pull stage of even greater symmetry than either alone. Such a suggested circuit is indicated in Fig. 2. It would require four drivers as well as a pair of center-tapped primary windings on the output transformer. Only one phase inverter would be required, however. Each push-pull type would then appear to be only a part of the circuit of Fig. 2.

Inspection of the circuit of Fig. 2 reveals two series push-pull circuits connected in parallel or two parallel push-pull circuits connected in series. The output impedance should be twice that of the parallel circuit alone or half that of the series circuit alone. The quadruplet stage provides a balanced-to-ground or double-ended termination while the parallel circuit alone is single ended.

REFERENCES

(1) Arnold Peterson and D. B. Sinclair, *General Radio Experimenter*, **26**, Oct., 1951.

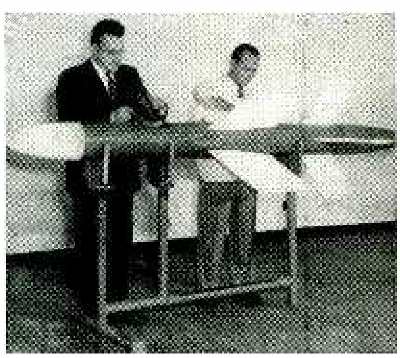
Packaged Radar for Aircraft

RADAR STATIONS for use in advanced-type aircraft are being built experimentally in packages almost small enough to fit in a brief case or handbag by the Ryan Aeronautical Company.

The complete equipment consists of an intelligence head, main circuits and a power supply. The intelligence head contains the transmitter and receiver. Reflected energy is received by a midget antenna. The received information is then amplified and analyzed.

The information in the reflected energy is channeled to two places after it is extracted by the electronic circuits. One channel is used to determine the navigation required and the second is used to determine what adjustments are necessary to the controls of the aircraft in order to guide it.

Five-tube subminiature radar amplifier circuit compared with a package of cigarettes



Ryan "Firebird" air-to-air guided missile which contains complete radar equipment

Automatic VSWR Measurement Equipment

By L. M. BARKER and W. T. CHAPIN

Ship Radar Section
General Electric Co.
Electronics Park
Syracuse, New York

MANUAL methods of measuring voltage standing-wave ratios are tedious, time-consuming and necessarily painstaking. The equipment shown in the photograph (p 156) was designed to facilitate such measurements with considerable economy of time, and to make permanent records of the results.

The operation of the instrument is illustrated by the simplified block diagram of Fig. 1. The modulated

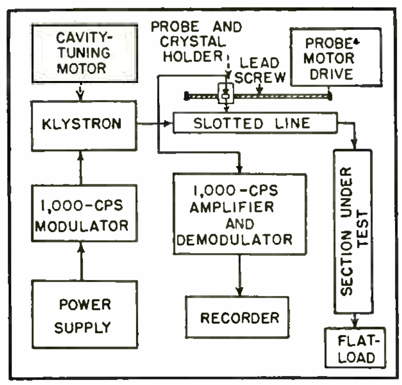
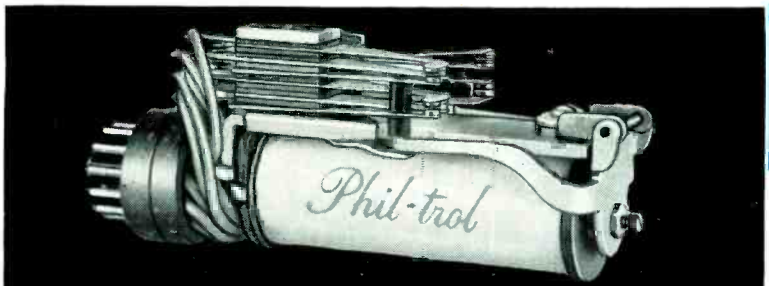


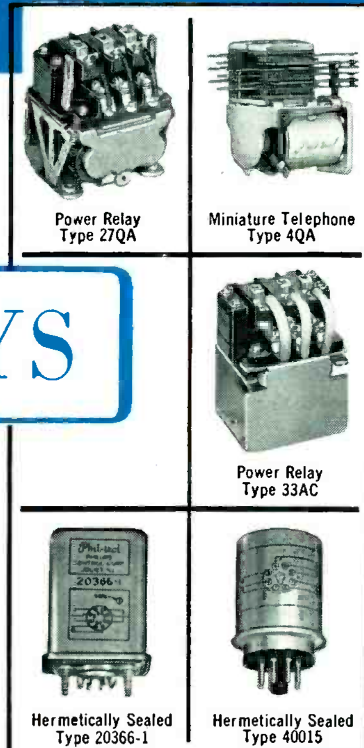
FIG. 1—Basic block diagram of automatic vswr system. Automatic gain control and frequency calibration marker cavities are not shown

output of the 10-cm klystron is fed through a slotted-line section to the device being tested, and a flat load is connected to the other end of the device under test.

A reversing motor operates a lead screw to drive an electromagnetic pickup probe back and forth in the slot of the slotted-line section. The probe picks up an r-f voltage proportional to the electric field within the guide. The ratio of the maxi-



Telephone Type 2QA



Power Relay Type 27QA

Miniature Telephone Type 4QA

Power Relay Type 33AC

Hermetically Sealed Type 20366-1

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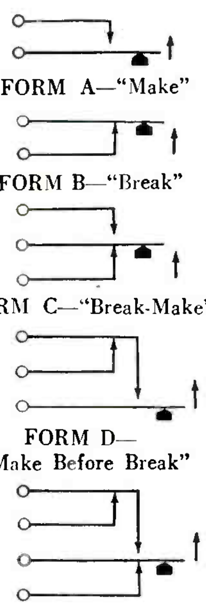

FORM A—"Make"

FORM B—"Break"

FORM C—"Break-Make"

FORM D—"Make Before Break"

FORM E—"Break-Make Before Break"

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mum to minimum voltages picked up as the probe moves along the slot, vswr, is indicative of the mismatch introduced by the section being tested. The position of the minimum voltage along the line together with the vswr is indicative of the impedance of the device under test.

A crystal in the probe assembly detects the r-f voltage picked up by the probe. The detected signal is in the form of square-wave pulses having a repetition rate of about 1,000 cps modulated by the variations in voltage picked up as the probe moves along its slot. This signal is amplified, demodulated and applied to a magnetic pen recorder. The actual vswr may be read from a calibration curve. The klystron cavity is automatically swept across a band of frequencies 200 mc wide in the 10-cm band. Repeller voltage tracking is provided by a geared potentiometer.

Three high-Q absorption cavities produce frequency calibration marks on the vswr record. Signals from the audio amplifier are also applied to a detector having a very long time constant, such that its output is not affected by the standing wave envelope, but is affected by slow changes in radio frequency output of the klystron oscillator

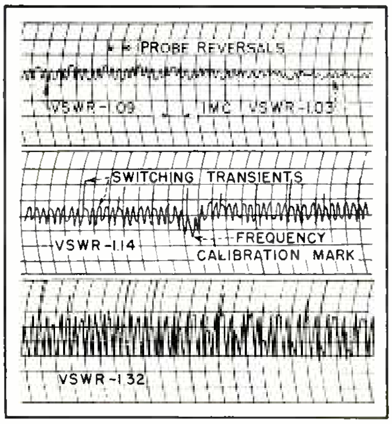
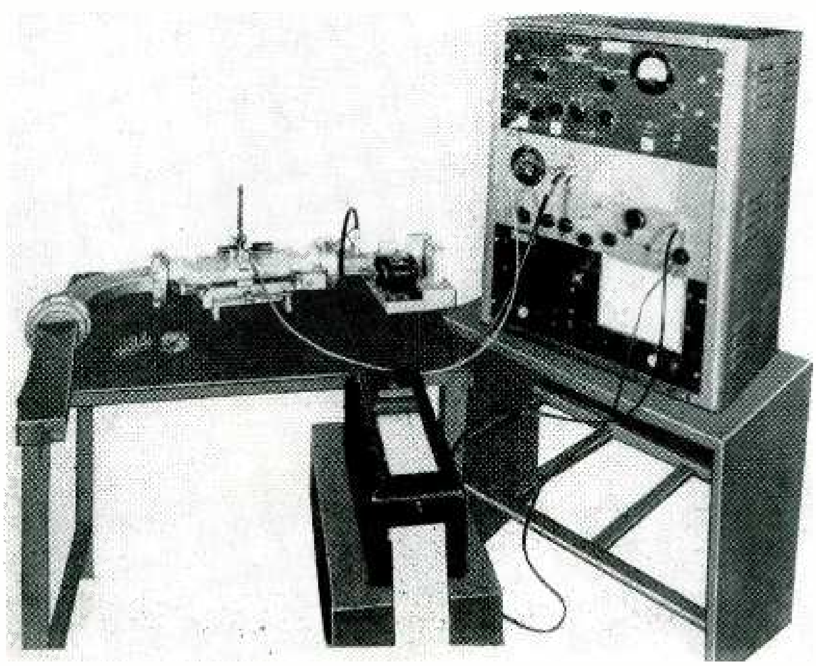


FIG. 2—Sections of typical recordings made with automatic vswr equipment

as the oscillator is driven automatically across the band. Its output provides agc for the audio amplifier, whose gain is set initially at a value such that under steady-state conditions (no probe movement) the meter on the amplifier reads that value (about 0.9 full-scale reading) at which the pen motor was calibrated. As an aid in this adjustment, a switch is provided for reducing the time constant of the agc detector. This same switch may be used to disconnect the agc circuit for manual measurements or checks.

Figure 2 shows a portion of three typical vswr records. The high spikes are switching transients and indicate where the probe motor reversed. Some of the transients are higher than others; some are missing entirely. This is due to the fact that different instantaneous voltages exist in the 60-cycle power each time the probe drive motor reverses. The vswr may be read between these reversals. It is read by noting the peak to peak deflection on the record and by translating it into vswr by means of a calibration curve. The calibration curve is made originally by inserting known vswr values and noting the recorder pen deflection. The final record may be read with approximately the same degree of accuracy as readings made using manual methods and similar equipment.



Complete equipment for measuring vswr of waveguide sections over 200-mc band at 10 cm

R-F Current Transformers

By T. J. Douma*

San Carlos, California

A RECENT article by Lawrence Fleming (Current Transformers for Audio Measurements, ELECTRONICS, p 188, Jul. 1951) pointed out the usefulness of current transformers in making measurements at audio frequencies. This technique can be extended to radio frequencies if certain precautions are taken to avoid resonance effects.

The problem that stimulated research along these lines was to construct a current meter which could be used from about 10 kc upwards.

The circuit used to make experimental measurements is sketched in Fig. 1. In the primary was placed a common r-f meter (Weston thermocouple instrument). The current in the primary was held constant at 100 ma and the d-c current on the secondary side was measured as a function of frequency.

At low frequencies the circuit behaves as indicated in the formulas given by Fleming. At low frequencies the germanium diodes have more resistance at small current than at higher current so that the error is greatest at low currents. At the higher frequencies the upper frequency limit for the instrument

* Work described done by author while in employ of Philips Research Laboratories at Eindhoven, Holland.

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was not set by the shunt capacitance of the germanium diodes but by resonance effects of the secondary of the transformer.

Obviously Fleming had the same experience. However by winding the transformer in a different way it is possible to suppress the first and second resonances sufficiently to get an instrument (for 100 ma) good from 10 kc to 50 mc.

For a certain experimental case, a primary of one turn and a secondary between 80 and 90 turns was used. The d-c meter was a 1-ma instrument shunted until full deflection corresponds to 100 ma r-f on the primary side. The secondary was a single-layer winding on a Ferroxcube core. The primary turn was first located at about the center of the secondary. Capacitances were kept low by using thin wire for the secondary and keeping some distance (0.5 to 1 mm) between primary and secondary.

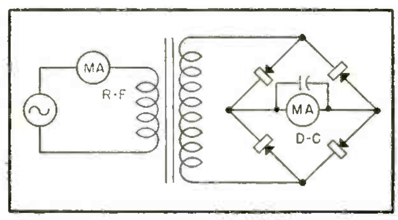
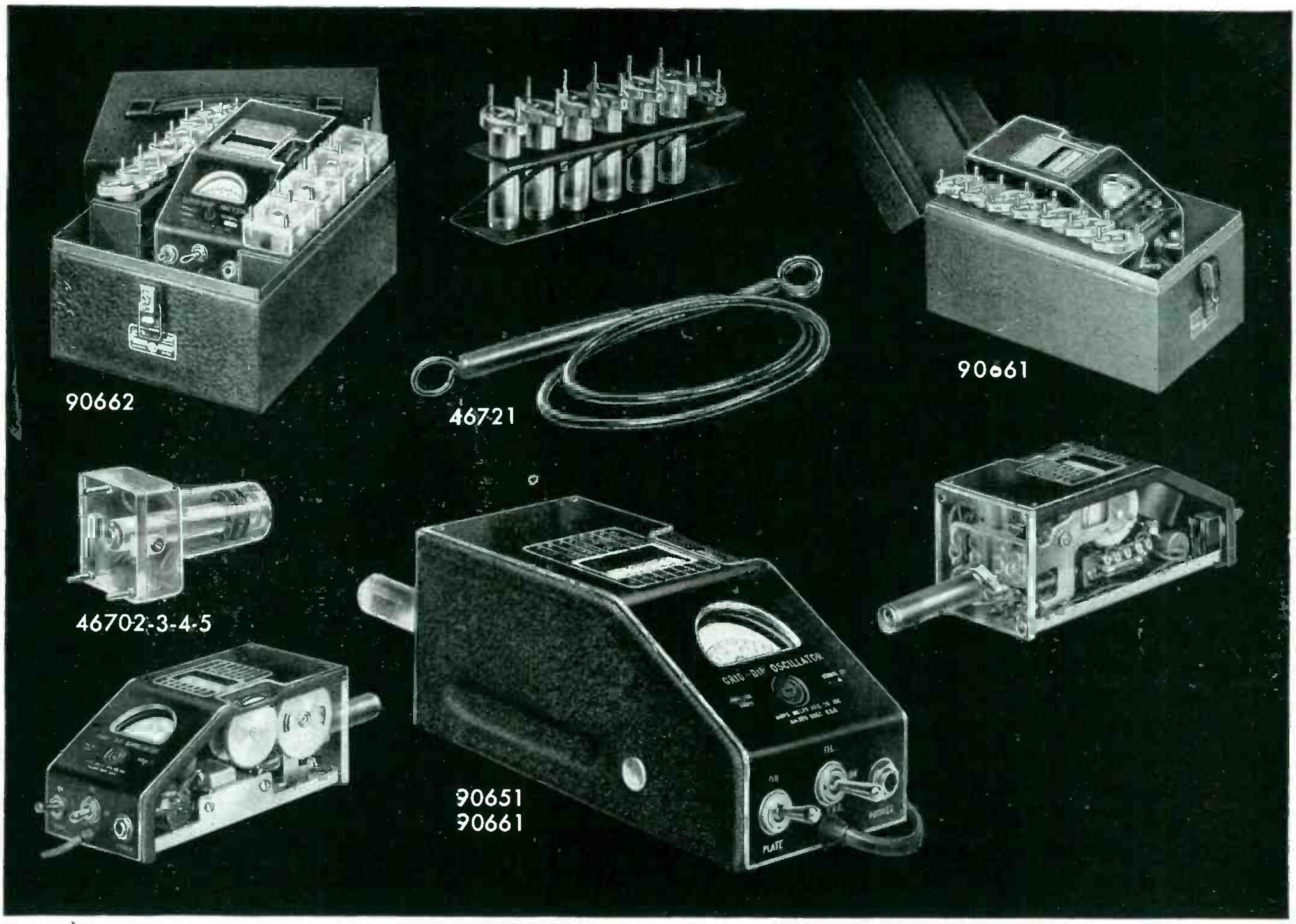


FIG. 1—Circuit used to make experimental measurements

The first resonance effect occurred between 20 and 30 mc. A voltage maximum occurred at the center of the secondary and touching by hand or with a piece of metal changed the secondary current. The standing-wave picture is indicated in Fig. 2. The voltage is taken zero between both ends of the secondary, because at these high frequencies the diodes are practically a short circuit. The resonance current flows at both ends inwards or outwards, which means we should expect the picture shown in Fig. 2B instead of Fig. 2A (current zero at both ends; voltage taken zero at both ends). However the current at the extremities is not quite zero for this resonance due to the capacitance of the crystal diodes and attached d-c instrument.

The second resonance effect is much stronger and has its maximum at around 50 mc. The standing-



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Grid Dip Meters

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use with a range from 225 kc. to 300 mc. incorporates features desired for both industrial and laboratory application, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range of 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe.

These instruments are complete with a built-in transformer type A.C. power supply and interminal terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 270° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Grid Dip Meters may be used as:

1. A Grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

Size of Grid Dip Meter only (less probe): 7 in. x 3$\frac{5}{16}$ in. x 3$\frac{5}{8}$ in.

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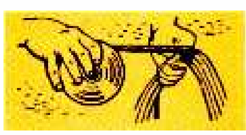

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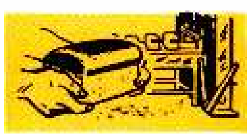

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wave picture is now as shown in Fig. 2C. The current flows from one end of the coil to the other. Also there is a current maximum in the center of the coil just where the primary turn is located. This means that this resonance is heavily excited. (An absolutely symmetrical secondary, a toroid, should have both resonance frequencies the same.)

The first resonance mode will theoretically not be excited when the primary is exactly at the current node. Experimentally it proved to be easier to split the primary into two turns located symmetrically (to point M in Fig. 2A) and fed in parallel. With some mechani-

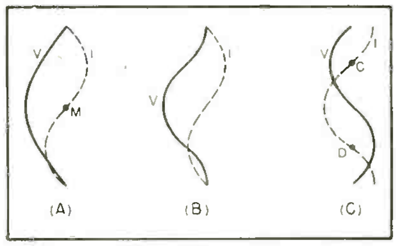
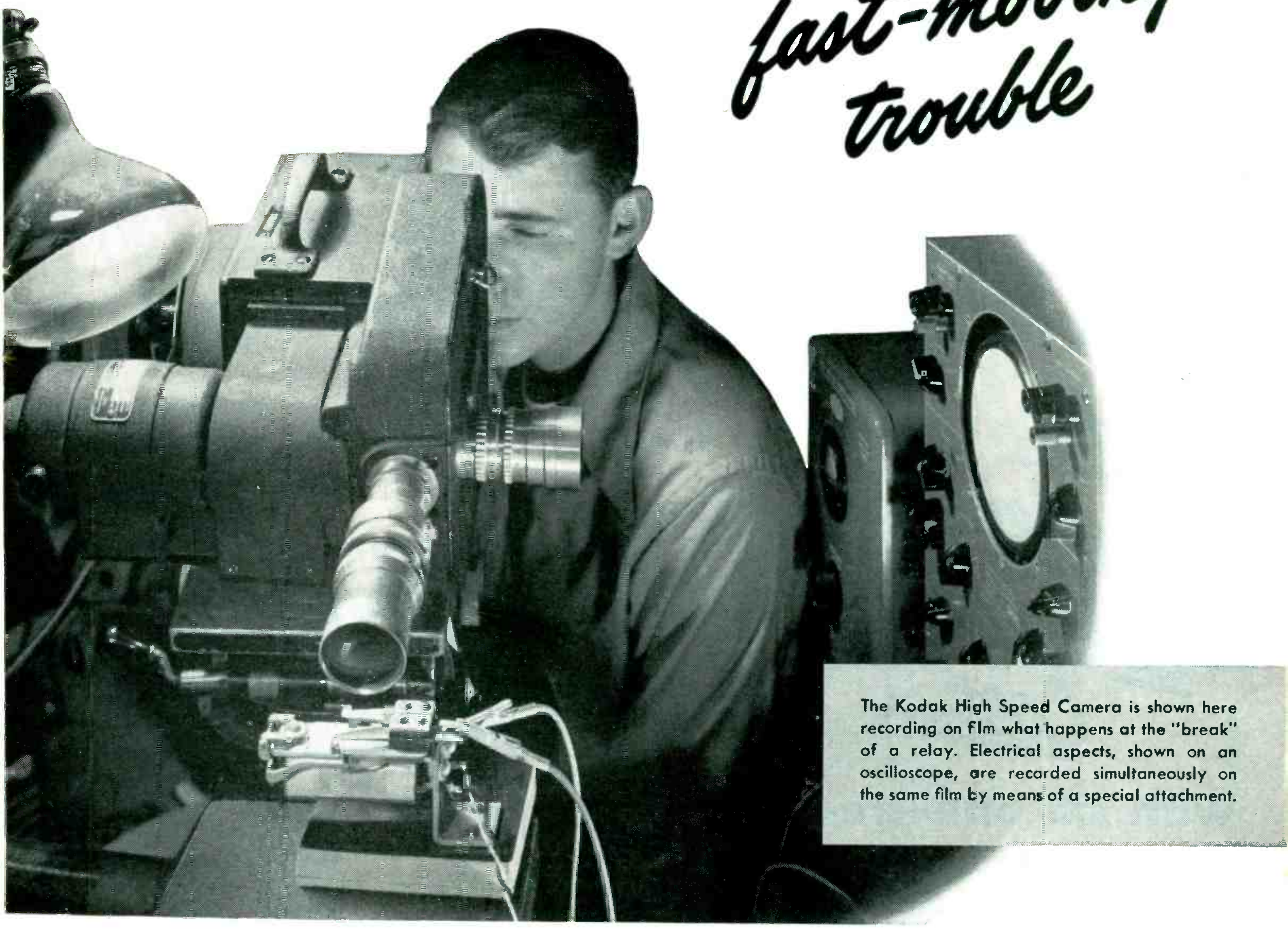


FIG. 2—Standing wave picture

cal adjustment of one of these turns the first resonance could be suppressed. This is clear from Fig. 2A because with the turns at the right places (at C and D in Fig. 2C) the second resonance can also be suppressed at least theoretically. Practically it proved to be rather difficult to get complete suppression of the second resonance even by splitting the primary into four parallel turns, two symmetrical to C and the other two to D. However, with some care it was possible to build a meter sufficiently straight from 10 kc to 50 mc.

There are several other modifications in winding the primary so that the first resonance will be suppressed. The iron core plays no important role in these resonance effects (except for increasing capacitance) because the resonance currents flow in both directions so that there is no resulting megnetomotive force. This means that the coupling between primary and the different turns of the secondary is not the same. The case is between a receiving antenna (where there is the same emf working at

This eye spots *fast-moving trouble*



The Kodak High Speed Camera is shown here recording on film what happens at the "break" of a relay. Electrical aspects, shown on an oscilloscope, are recorded simultaneously on the same film by means of a special attachment.

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This high speed "eye" is daily solving complex problems of design, production, and product performance—problems where usual methods of analysis would be slow and costly. One manufacturer projects high speed movies within two hours after they are taken—the solution to a problem is on the drawing board the same morning it is discovered. We'd be glad to send you, with our compliments, a folder showing how this company uses the Kodak High Speed Camera so effectively. Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.

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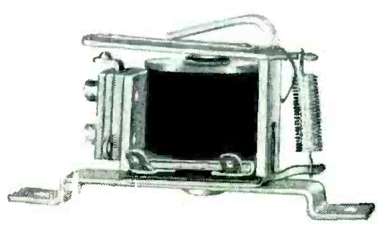
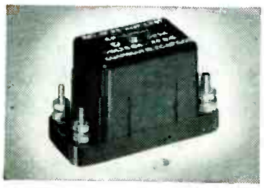
This unit tabs 900 or more overlapping cars per minute at split-second contact. As car wheels hit a pneumatic tube stretched across traffic lanes the compression closes an electrical contact on a diaphragm, operating a Guardian Series 125 D.C. relay. The relay responds to every impulse but the counter unit registers only every other impulse to compensate for rear wheel contact.

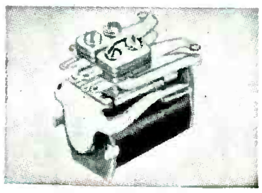


SERIES 125 D.C. RELAY



AN-3320-1 D.C.

AN-3324-1 D.C.



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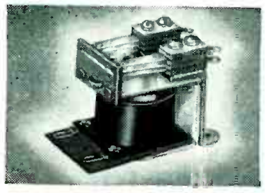

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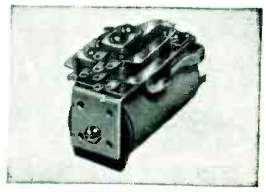

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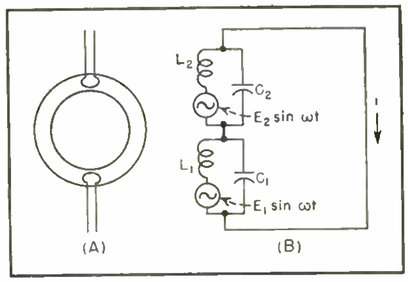

FIG. 3—Resonant-mode suppression with cavities and lines

each point) and the transmitting antenna (with a concentrated emf at the center or at one end).

The same type of suppression of certain resonance modes can be done with resonant lines or cavities. In Fig. 3A if we excite at both loops in phase, the first mode will be suppressed, the second strongly excited. Exciting in opposite phases favors the first and suppresses the second. The case of two parallel circuits in series each with an induced emf (Fig. 3B) has some resemblance with the lowest resonance frequency of the transformer as indicated in Fig. 2A and 2B. The current i in Fig. 3B is independent of C_1 and C_2 and equal to

$$i = \frac{(E_1 + E_2) \sin \omega t}{\omega (L_1 + L_2)}$$

when $L_1C_1 = L_2C_2$. With E_1 and E_2 proportional to frequency the current becomes frequency independent. However if $L_1C_1 \neq L_2C_2$ we get strong resonance effects in i unless $E_1 = E_2$ and $L_1 = L_2$.

In Fig. 4 are indicated (qualitatively) some standing-wave patterns on a resonating cylindrical coil. Voltage now is taken zero in current maximums. Fig. 4A gives patterns for an open-ended coil into four half waves on the coil. The current and voltage nodes are not equidistant when there are more than two on the coil. We can understand that somewhat, by considering the third mode. The middle half wave has a different coupling with the rest of the coil than the upper or lower half wave.

From the voltage patterns we see that the coil can be shorted when there are an even number of half waves on it.

For the shorted coil (Fig. 4B and 4C) the *A* modes have about the same resonance frequencies as the corresponding case on the open

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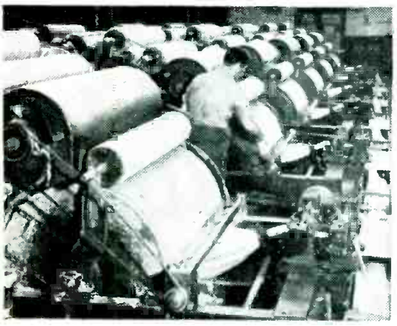

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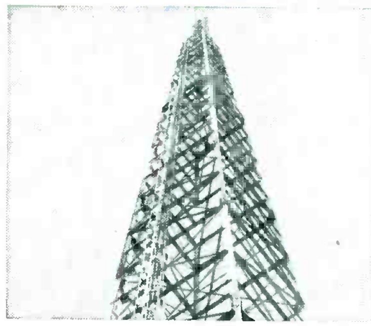

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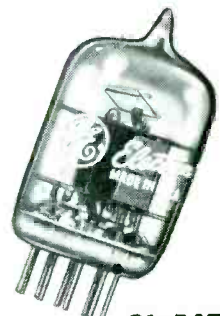

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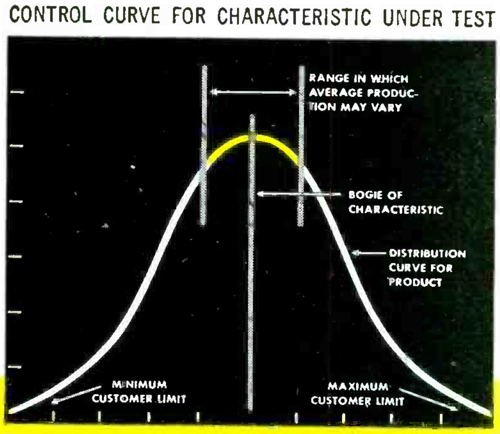

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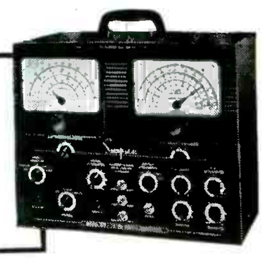

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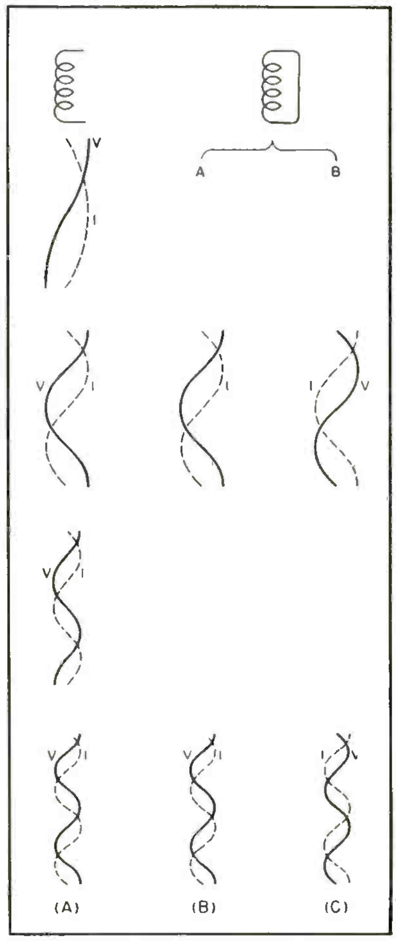

FIG. 4—Standing-wave patterns on a resonating cylindrical coil

coil. Actually these frequencies are somewhat lower because the shorting lead adds some capacitance.

On the shorted coil, we find another group of resonances here indicated as *B* modes in Fig. 4C. These differ from the *A* modes in that voltage and current patterns have been reversed. The frequencies are higher than for the corresponding *A* cases. This is undoubtedly caused by the fact that we don't have a circular symmetrical coil. With a shorted toroid coil we may expect the same frequencies in the *A* and *B* case. This proved to be true. Then the distances between modes are equal. The ends of the open coil and the ends of the shorted coil resonant in the *A* mode are sensitive. Touching by hand or with a piece of metal lowers the resonance frequency.

The ends and the center of the shorted coil when resonant in *B* mode are absolutely cold (no electrical field between adjacent turns). No change in frequency occurs when touching these points, also

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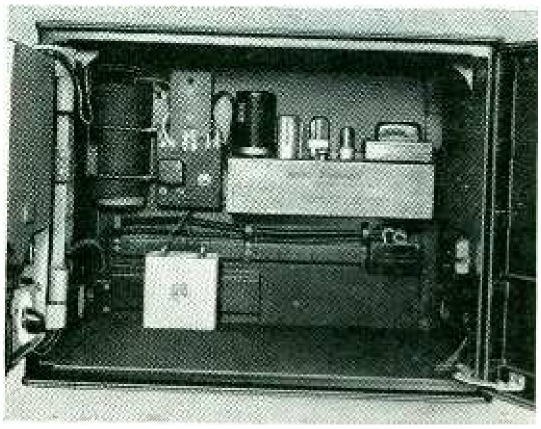
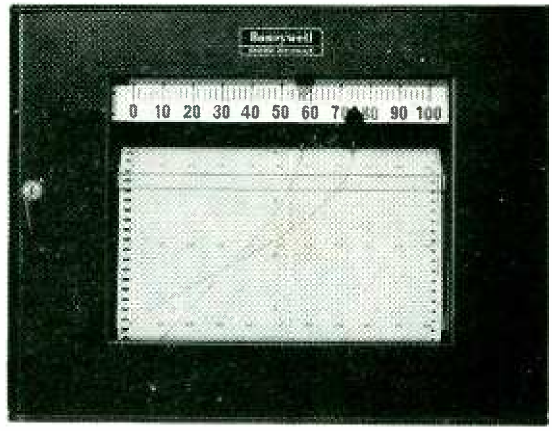


Internal view showing amplifier and damping circuit components.



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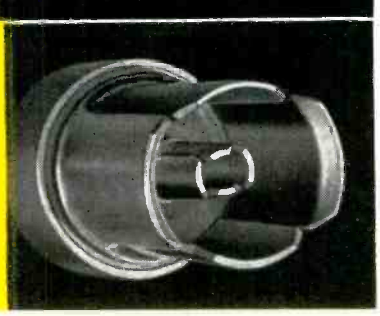

an open-ended toroid will probably show some difference between even and odd resonances. With an odd number of half waves on the coil, the voltages at the ends are in counterphase so that there will be some capacitive current between the ends tending to lower the resonance frequency and so to give unequal distance between modes. This is not so with an even number of half waves. We did not check this. In the iron core transformer case the open coil resonances with an odd number of half waves will be radically changed because there is a resulting mmf.

The shorted coil resonances may appear in pulse transformers especially when the windings are not quite symmetrical. A practical application of coil resonance may be an antenna in the form of an open-ended coil resonant in the first (half-wave) mode. The advantage above an antenna mask of the same length is that the current maximum (and so also the vertical component of the current) can be brought well above ground. Varying pitch can adjust the current distribution.

British Commercial Radar

By MARVIN HOBBS

Electronics Advisor to the Chairman Munitions Board, Dept. of Defense Washington, D. C.

IN ENGLAND today at least five manufacturers produce commercial radar for use aboard nonmilitary vessels, ranging from passenger liners to tugboats and whalers. British ships of these classes are being equipped with radar at the rate of one per day and the total number of such ships, British and foreign, so equipped is approximately 1,500.

Marine-Radar Specifications

Some of the principal requirements for marine radar which are set forth in the Ministry of Transport specifications are as follows. Maximum range (surface objects): 7 miles on tramp steamers of 5,000 gross rated tons, 2 miles on 2nd class buoys and 3 miles on 30-ft fishing vessels. Minimum range is 50 yards. Range accuracy is ±5 percent of maximum range obtainable on scale in use. Range discrimination requires the set to indicate clearly on the largest scale the presence of two small objects in line when these are 100 yards apart. Bearing accuracy calls for a maximum error of one deg at the edge of the PPI display. Bearing discrimination should be such that the set shall indicate clearly the presence of two objects at the same range when the gap between them subtends an angle of 3 deg provided the distance between them is greater than 200 ft.

The performance characteristics of all of the sets which have the Ministry of Transport Certificate of Approval either equal or exceed these specifications in performance. Several of the characteristics of the latest sets are shown in the Table I.

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As early as 1940, a member of the Thomas-Houston engineering staff considered the use of the nonlinear properties of ferromagnetic materials as the basis for developing switching elements capable of handling high power levels at very high switching rates. However, no materials with the required characteristics were available at that time.

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Table I—Marine Radar Characteristics

	Decca	Thomson-Houston	Kelvin-Hughes	Marconi	Cossor
Peak power (kw)	7	40	7	30	22
Pulse length (μsec)	0.11–0.12, 0.17–0.20	0.25	0.20	0.20	0.20 0.60
Pulse rate (pps)	1,000	1,500	2,000	1,500	1,500 500
Scan rate (rpm)	24	25	30	30	28
Max. range (mi.)	25	25	25	30	30
Min. range (yd.)	<25	50	40	30	<50
Horiz. beam width (deg)	1.6	1.2	1.6	2.0	1.3
Vert. beam width (deg)	23	24	27	40	20
PPI tube dia. (in.)	5 12	9	12	9	9

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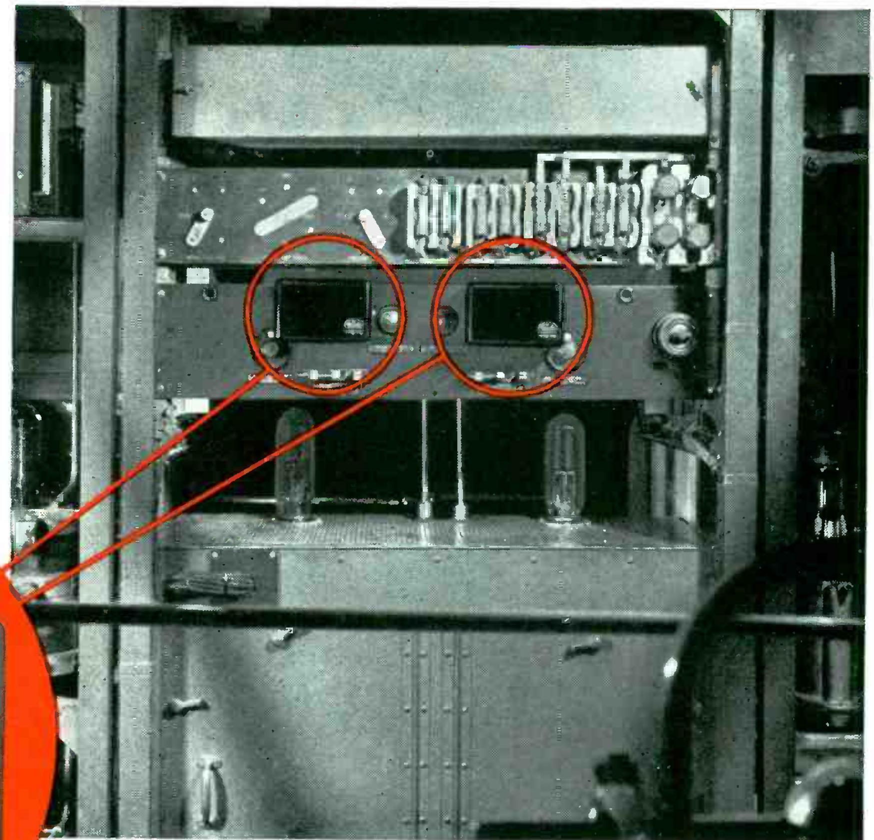

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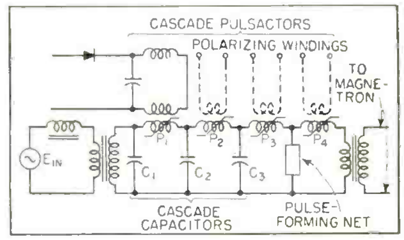
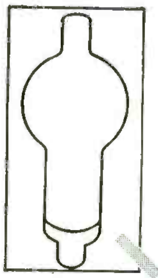


FIG. 1—Single-phase four-stage cascade pulsactor circuit

was determined that a specially heat treated and grain oriented 50/50 nickel-iron known as 5000Z had been developed and manufactured by an organization in Germany. This material had properties suitable to meet the requirements for the reactive elements of such a circuit. Early in 1948, the British equivalent of 5,000Z, known as HCR metal, became available. Although its thickness was too great for use in the later stages of a cascade magnetic modulator, it made possible the large flux swing and the high rate of change of permeability which is essential for the first stage. It was found that a complete cascade system could be developed by utilizing heat-treated toroidal cores of thin-strip Mumetal for the element of the later stages.

The circuit of Fig. 1 shows a magnetic modulator having four of the saturable reactive switching elements in cascade. Saturable reactors of this modulator are called pulsactors to differentiate from saturable reactors for more orthodox applications, such as magnetic amplifiers. In brief, a pulsactor is defined as a saturable reactor having properties which, in appropriate circuits, are suitable for the functions of a discharge device. The open condition or the electronic switch is established by the high impedance of the pulsactor when the core material is unsaturated. Saturation of the core provides the closed or low-impedance condition.

To simulate an electronic switch it is necessary for the pulsactor to change from high to low impedance with extreme rapidity. A cascade arrangement of pulsactors and capacitors is necessary to achieve the high rate of switching necessary to modulate a magnetron with rectangular pulses of quarter microsecond duration. Such rapid switching can



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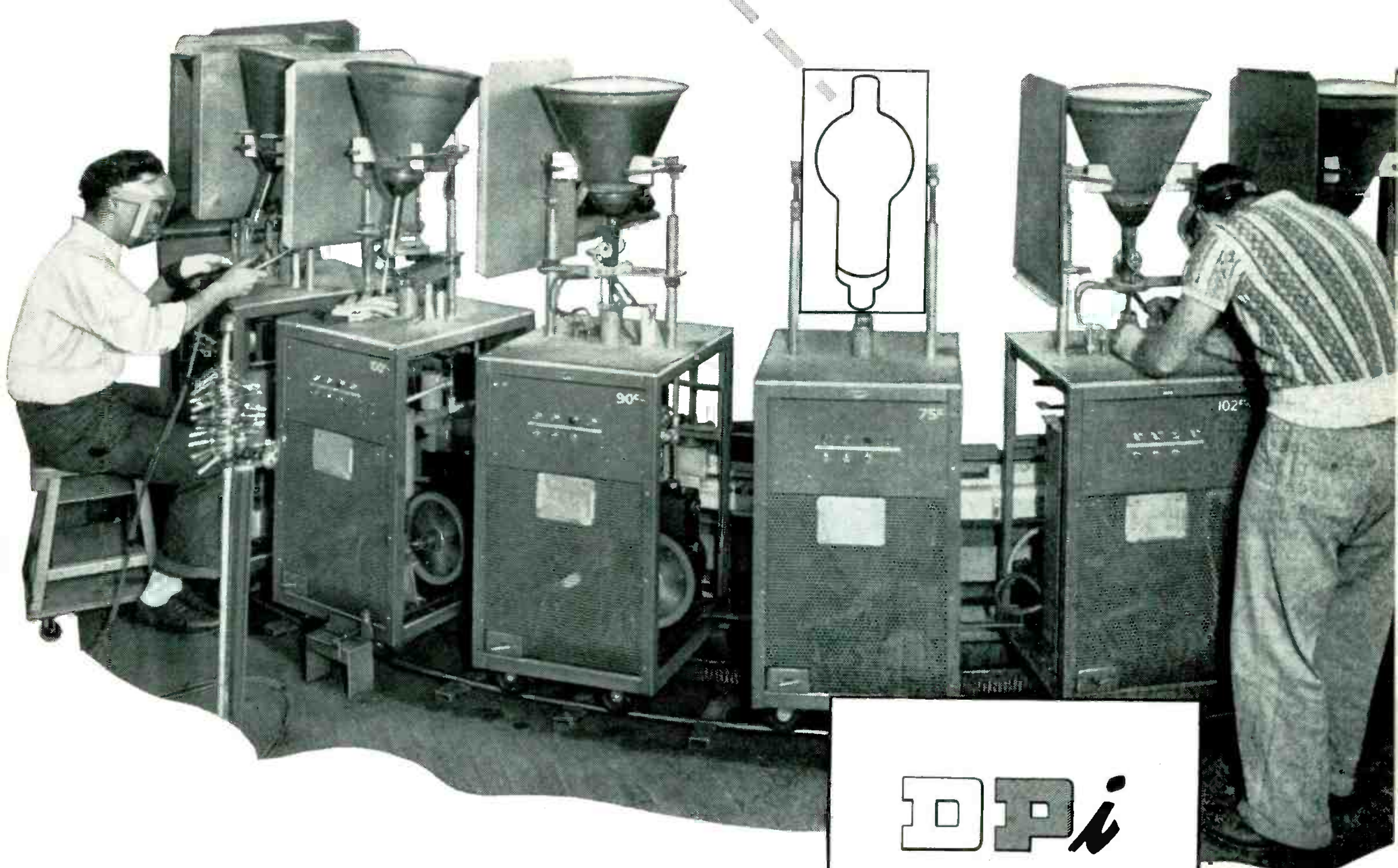

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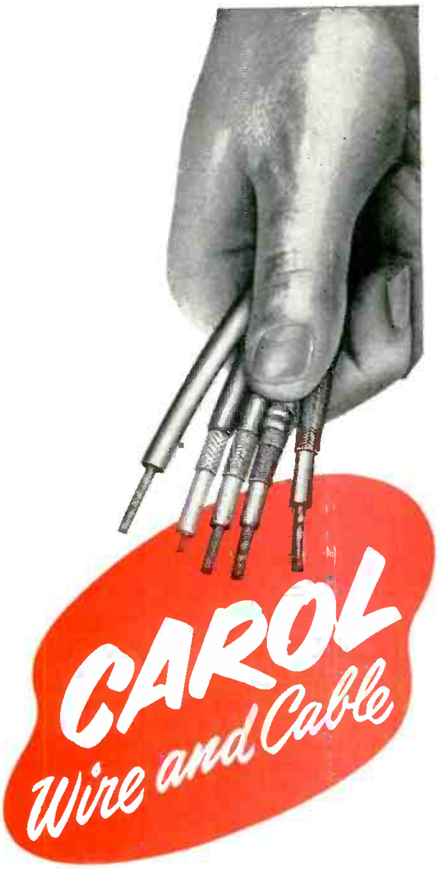

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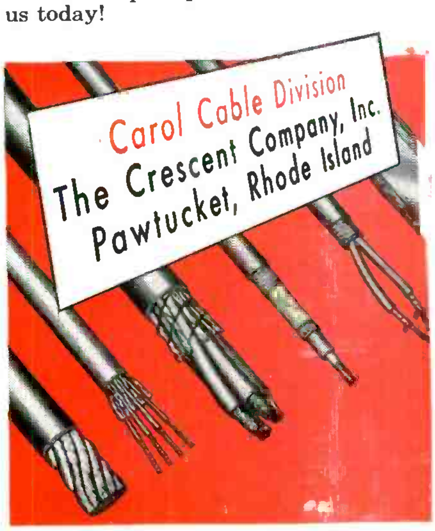

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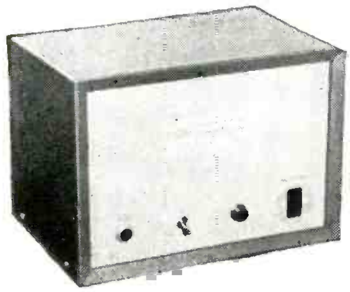

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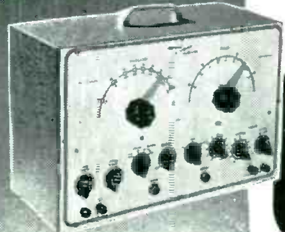

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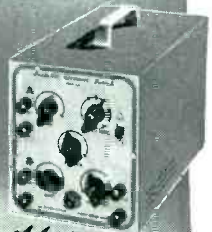

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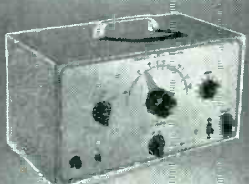

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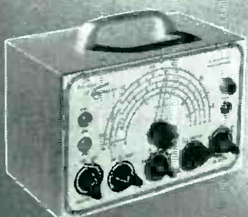

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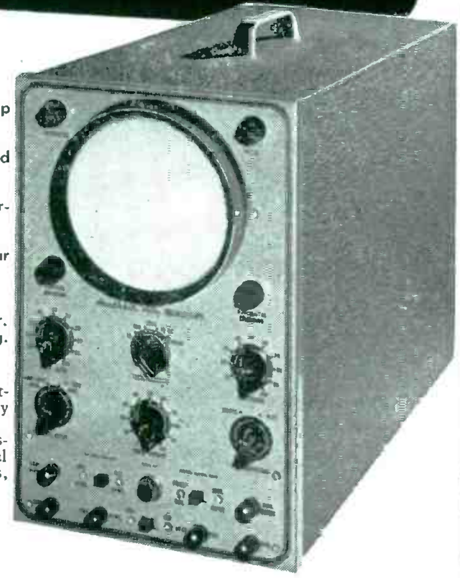

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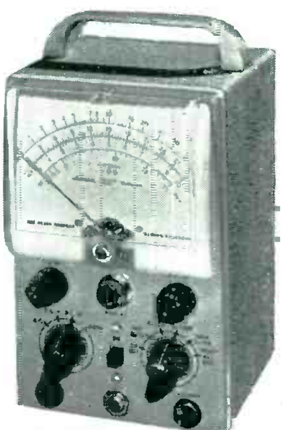

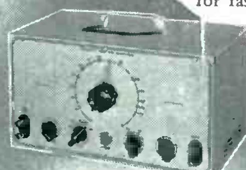

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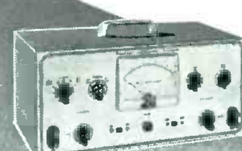

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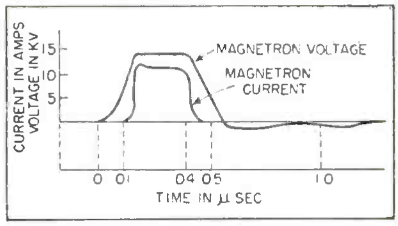


FIG. 2—Typical waveforms of magnetron voltage and current developed by the magnetic pulse modulator

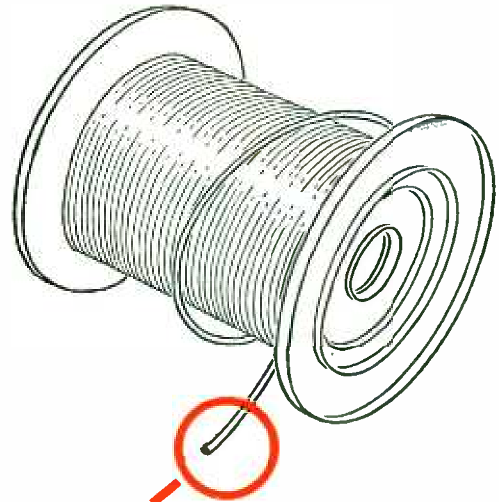
not be achieved with a single stage.

In the circuit of Fig. 1 the charge developed across the cascade capacitors is transferred from one to another via each succeeding pulsactor to build up the high switching rate required for the desired operation. In a laboratory model of the modulator, the supply to the step-up transformer at the input was 80 v rms at 1,500 cps. The voltage was stepped up to about 9,000 volts at C_1 through the resonating inductance and the transformer. Polarizing circuits are associated with the pulsactors to achieve single-phase operation.

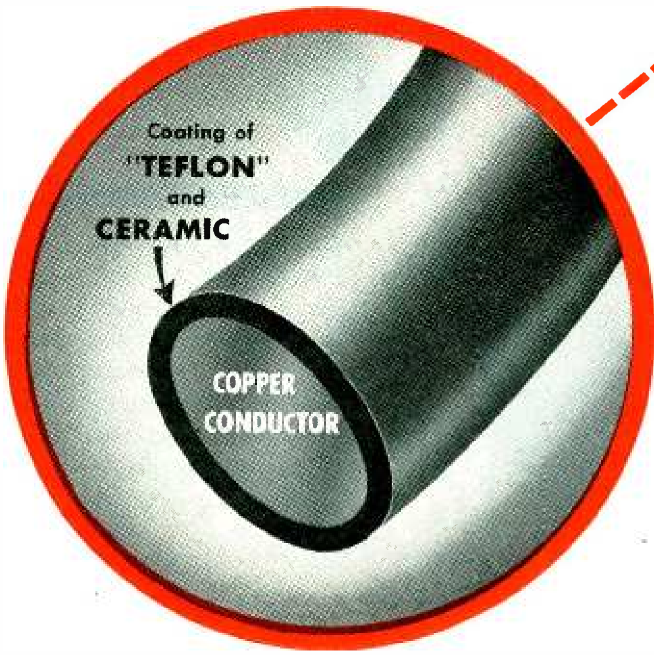
The output pulse at the primary winding of the pulse transformer was 4,000 v and was transformed to 13,000 v to give the magnetron waveforms shown in Fig. 2. The characteristics of the marine radar modulator are as follows: peak power (150 kw), pulse voltage (13 kv), pulse current (12.5 amp), pulse duration (0.25 μsec) and pulse rate (1,500 pps).

The following advantages are claimed for the magnetic pulse modulator: long and trouble-free life, instantaneous operability, simple auxiliary circuits, a wide range of operational applicability, freedom from radiated interference and self-protection against overvoltages. The disadvantages are said to be that the cascade system required added space, that the completely magnetic system operates on a-c only and that the pulsactors require special and expensive core materials.

The magnetic modulator is expected to result in negligible maintenance costs for that portion of the system and to offer advantages which outweigh by a considerable margin the disadvantages listed above. Furthermore, as development progresses it is to be



High temperature magnet wire coated with Du Pont "Teflon"



Magnified cross-section of magnet wire manufactured by Sprague Electric Company, North Adams, Mass.

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After extensive testing, such a wire was developed by coating a copper conductor with ceramic and then impregnating the ceramic with a dispersion of Du Pont "Teflon"* tetrafluoroethylene resin. This combined the excellent heat and solvent resistance of "Teflon" with the high temperature nature of the ceramic. According to the manufacturer, the wire will operate continuously up to 250° C.

"Teflon" is tough and elastic—permits the wire to be stretched 20% and wound around its own diameter without cracking the insulation. "Teflon" has outstanding dielectric characteristics, and the ability to maintain its electrical properties under moist conditions. These and other unusual properties make it widely applicable wherever high frequencies, high voltages and/or high temperatures are encountered.

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LITTON INDUSTRIES NEWS

Litton Model 3900 Thermopile

LITTON THERMOPILE WITH STANDARD METER FORMS ACCURATE, LOW COST INDICATOR FOR SMALL DIFFERENTIAL TEMPERATURES

Engineers in increasing numbers are using Litton Model 3900 Thermopile in conjunction with microwave water loads to measure rf power, and in cooling systems to monitor temperature changes.

The Thermopile has 30 pairs of copper-constantan junctions, tapped at 10 and 20 pairs. Junctions protrude into a fluid flow channel milled in a plastic block to which water fittings are mechanically attached. The plastic block is encased in a cast aluminum housing. Binding posts are provided for electrical connection, and ¼″ Uniflare fittings for water connection. Internal resistance is approximately 6 ohms.

With rf water loads using appropriate water flow, meter sensitivity and number of junctions, average powers from 10 watts to several kilowatts can be measured conveniently and accurately. For lower power levels, several thermopiles can be used in series.

The 30-junction thermopile generates approximately 1 millivolt per °C differential temperature. To determine water flow rate and indicating meter, the following formula is useful:

(P = power dissipated in watts; Q = water flow in gals. per minute; R = meter internal resistance in ohms; M = meter sensitivity in millivolts for full-scale deflection.)

For full-scale meter deflection, approximately:

$$250M\,\frac{(R+6)}{R} = \frac{P}{Q}$$

Also, to avoid excessive heat losses, differential temperature should not exceed 20°C, where for pure water

$$T = \frac{P}{246Q}$$

(T being temperature differential in °C.)

Because of stray losses in plumbing and the load, the system is best calibrated by direct dissipation of metered power in a water-cooled resistor in series with the water load.

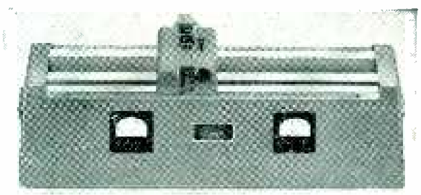
Time of response in minutes is determined by the volume of the system V in gallons divided by Q. (Time constant of thermopile is negligible.) For a typical installation of Litton Model 4000 U-Line, Model 4100 Water Load and Model 3900 Thermopile, operating at the kilowatt level, using a meter with M = 7 millivolts, R = 71 ohms, time of response is approximately 20 seconds. Litton Model 3900 Thermopile, price $75.

WATER LOAD

Litton Model 4100 Water Load is a termination for 1⅝″, 50-ohm coaxial lines, and is particularly useful in high-power applications where power output must be accurately measured. The Load is conservatively rated at 2 kilowatts capacity, 950 to 3,000 mc/sec. VSWR is less than 1.2 over full range, less than 1.1 above 2,000 mc/sec. The equipment includes two adjustable-depth probes for sampling rf power. Model 3900 Thermopile is recommended for use with this load. Model 4100 Water Load, price $425.

U-LINE AND STUB COMBINATION

Litton Model 4000 U-Line offers convenience and accuracy in quickly determining VSWR in high- or low-power coaxial lines. The equipment transduces power from a 1⅝″ coaxial line to a U-shaped configuration with a rigid central and outer conductor. A traveling probe moves on a precision carriage through the open end of the "U." A 500-millimeter scale with vernier indicates probe position.



Litton Model 4000 U-Line

Model 4000 U-Line offers continuous frequency coverage from 450 to 2,750 mc/sec. with insertion VSWR of less than 1.05. Teflon bead supports permit a CW power rating of 2 kilowatts. Mounting holes are provided for meters. Price $700.

STUB

For use with Model 4000 U-Line. Permits rapid insertion, variation of phase position and withdrawal of mismatch of known VSWR in the U-Line. Calibrated scale permits insertion of known VSWR up to 2.0, at frequencies 950 to 2,750 mc/sec. Thus, equipment may be used as a calibrated mismatch or matching device.

Insertion at any phase position is possible with relative phase readable on millimeter scale on the U-Line.

Model 4200 Stub is a metallically-loaded Teflon rod contoured to fit the U-Line. The stub is suspended from a carriage riding on the U-Line. Price, $100.

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expected that the disadvantages will be minimized. In this circuit the only tubes, which are two diodes and a protective spark gap and relay, are associated with the magnetron and do not perform any switching functions.

Superregenerative Reflex Receiver Circuit

MINIATURIZATION of communications equipment has made rapid progress in recent years, both in size of components and in modifications of circuits and improvement of performance of components that result in the cutting down of size and weight. Such progress has been brought about by circuit research, among other things, and in the course of this circuit research, many old techniques have been restudied and show promise for wide application in future developments.

As an example, Harry E. Stockman of Waltham, Massachusetts, radio and electronics consultant, has recently devised a scheme for increasing the gain of a superregenerative receiver.* The technique provides this increased gain without adding to the weight, size or complexity of that of a conventional superregenerator and low-frequency amplifier combination.

Briefly, this is accomplished by redesigning the filter associated with the rectifying means coupled to or forming part of the superregenerative amplifier to pass the quench frequency. Then, a train of direct-current pulses corresponding to the train of high-frequency pulses produced by the superregenerative amplifier appears in the output of the rectifier rather than a current corresponding to the average value of these direct current pulses and representing the modulation on the received carrier as in the conventional receiver.

At the same time, the low-frequency amplifier is redesigned along the lines of a reflex amplifier. The high-frequency channel of the reflex circuit then amplifies the above-mentioned train of pulses. The low-frequency channel of the reflex amplifier amplifies the recti-

* U. S. Patent Appl. NR 151, 253.

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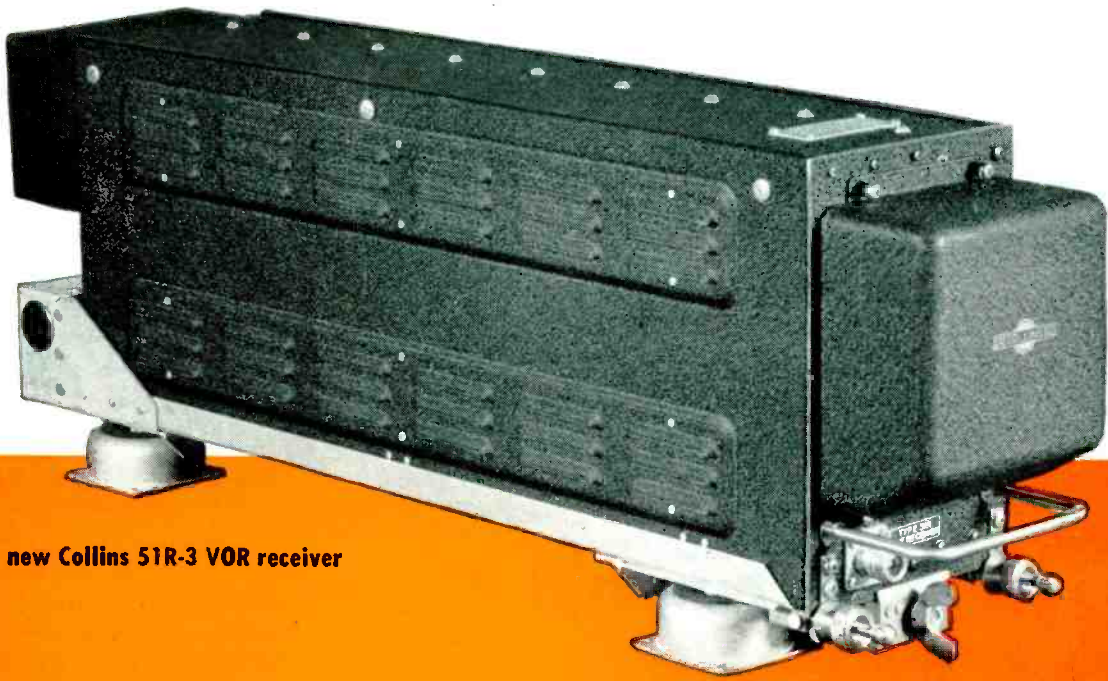

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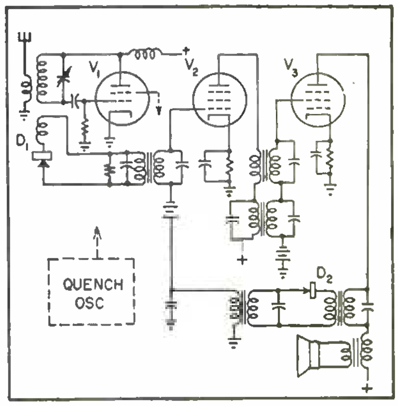

FIG. 1—Circuit diagram of improved reflex superregenerative receiver

fied output of the high-frequency channel representing the received carrier modulation, which may be an audio or video frequency.

A circuit of a superregenerative receiver employing this technique is shown in Fig. 1. For self-quenched operation the time constant of the grid circuit of V_1 is chosen to cause intermittent action of the oscillator in normal fashion, and the quench oscillator is not used. The resulting train of high-frequency constant-amplitude pulses of varying repetition rate is rectified by diode D_1 and applied to the primary winding of a transformer. By proper choice of time constant this circuit filters out the r-f oscillations, but passes the pulse repetition frequency. The resulting output is a train of d-c pulses of constant amplitude and having a prr that varies with the modulation on the received carrier.

The remaining tubes in the circuit form a reflex amplifier having high and low-frequency channels. The output of the high-frequency channel is rectified by D_2 to recover the audio (or video) and return it to the start of the low-frequency channel.

Since the d-c pulses applied to the reflex amplifier are of constant amplitude and varying repetition rate, it will be apparent that the fundamental frequency thereof, or a higher harmonic, will be a sine wave of constant amplitude and varying frequency, or in other words, a frequency-modulated wave. To detect such a wave it is necessary that the output of the detector vary as the frequency of the applied wave, such detectors usually being re-

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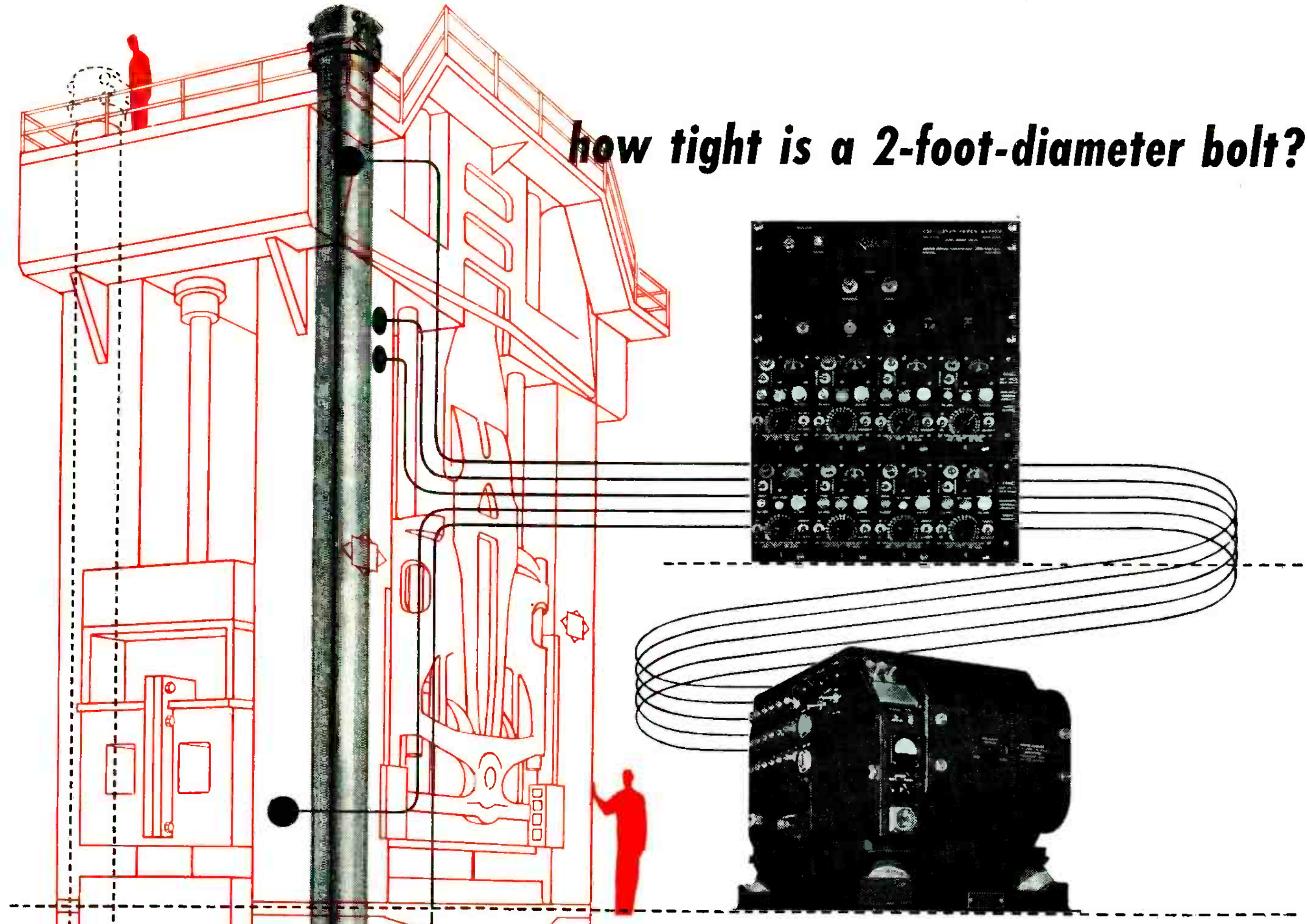

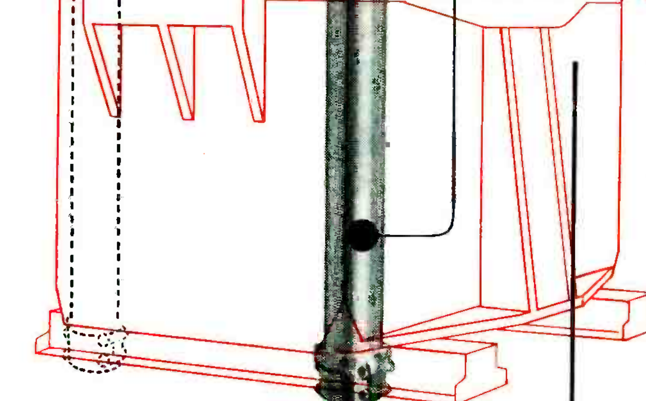

Four bolts, each nearly 50 feet long and 2 feet in diameter, hold Lockheed Aircraft's new 8,000-ton hydro press together. Built by Birdsboro Steel Foundry and Machine Co., the mammoth machine required not only special installation techniques, (the building was erected *around* it) but also novel testing procedures.

To adjust and equalize tightness, strain gages and leads were attached to each bolt before installation. Then, during assembly, tightness was measured as a function of strain by means of Consolidated Bridge Balance Units. When gage outputs were equal it was known that all bolts had been tightened to the same degree. Later, the press was tested *dynamically* during actual trial runs and the momentary stresses, speed of operation, and other performance data recorded by a 5-114 Recording Oscillograph. The *complete* performance picture, with all forces in their true relationship, gave Birdsboro and Lockheed engineers all information needed for the final adjustments necessary for optimum operation before actual production work started.

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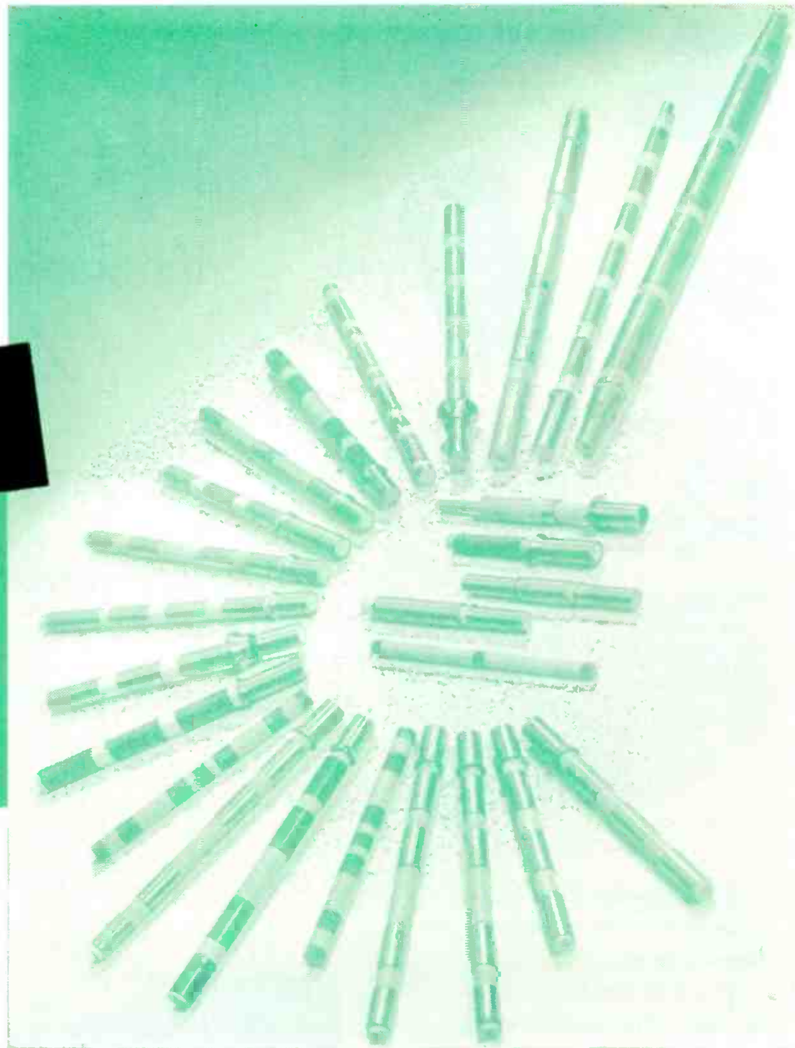

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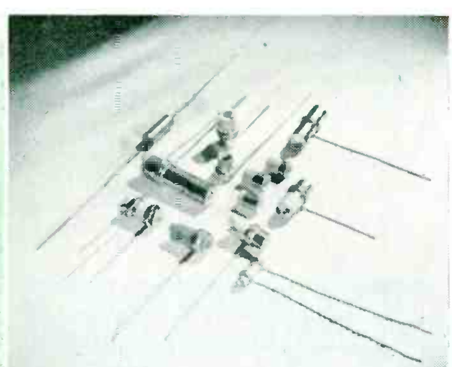

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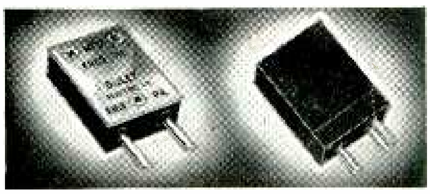

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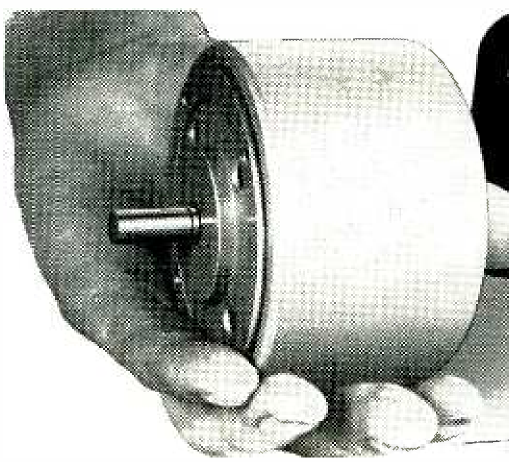

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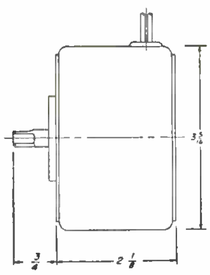

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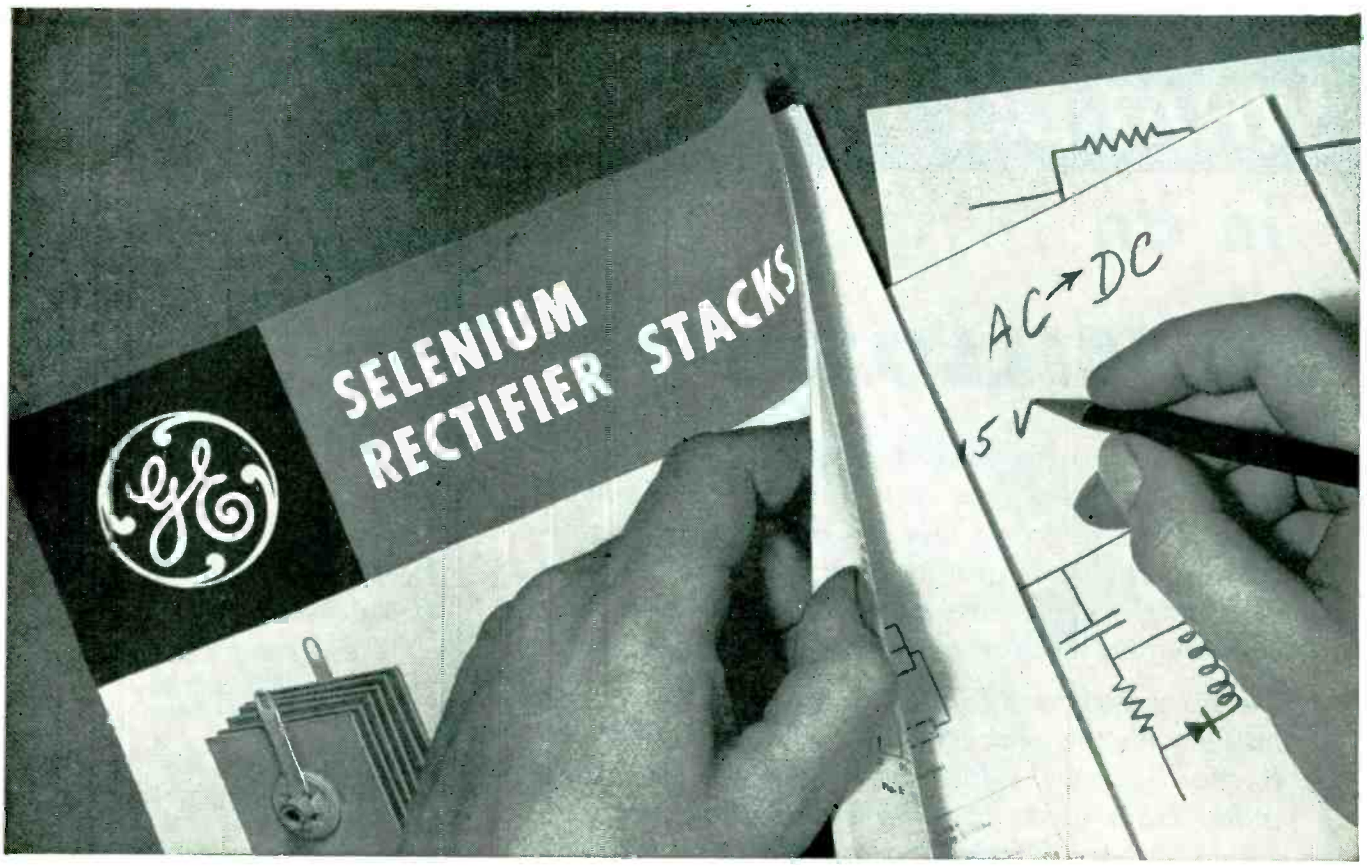

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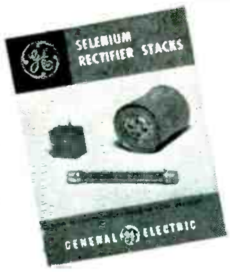

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Presetting a Tape for Broadcasting

By KENNETH J. DOLAN

Chief Engineer
Radio Station WARA
Attleboro, Mass.

IN MANY SMALL radio stations where announcers are required to operate the console, turntables, do some program patching and operate tape recorders for both recording and playing back program material, production and program quality are quite apt to suffer.

At WARA, the same situation had to be faced. A great many of the man-on-the-street interviews and other special events are done via tape recordings. Due to the amount of equipment in the studio control room the location of the tape machine was not within an arms reach of the announcer-operator. If for example, a tape was to be played back on the air directly following some program or announcement, the announcer-operator would have to get up from the control desk to reach the switch starting the tape machine. At times the microphone switch would be left on, by mistake, and there would be the noise of a man getting up, chair squeaking and then the final clunk of the tape starting switch, as it was thrown. Many times there would be long periods of silence between programs.

In order to eliminate this situation a remote tape starting switch, of the mercury type, was installed on the control desk well within an easy reach of the announcer-operator, thus eliminating all of the above inefficiencies and faults. At WARA the Magnecord PT6-AH is

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POWER SUPPLY: The instrument is entirely self-contained and operates on 100-125 volts 50-60 cycles. Total consumption 40 Watts.
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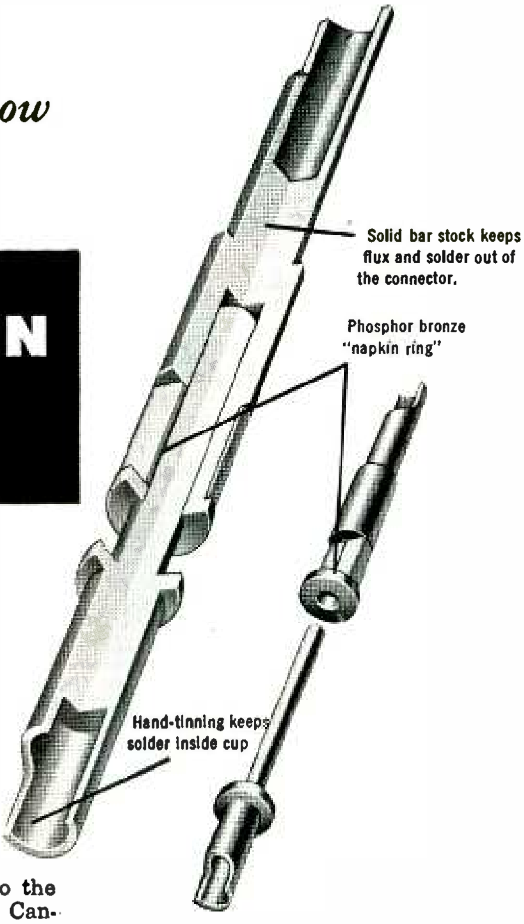
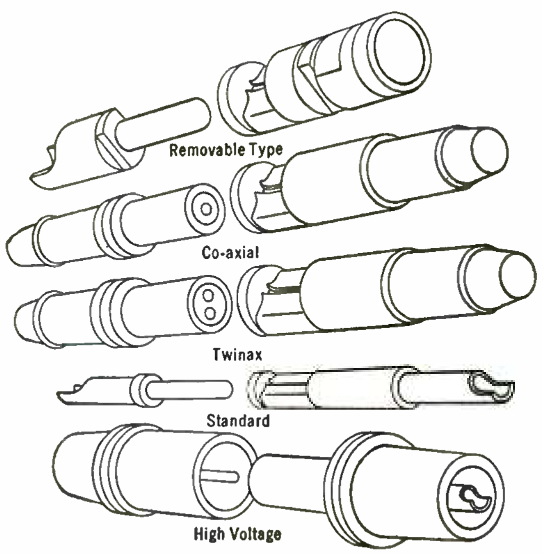
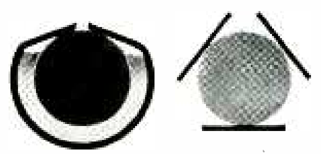


Because the contact is the key to the success of any electric connector, Cannon has always applied the highest order of skill and care to this all-important detail. Cannon pin and socket contacts are all precision machined from solid bar stock. Silver or gold plating maintains high conductivity after years of constant use. Phosphor bronze "napkin ring" of the socket keeps pressure on large areas of heavy metal, preventing current loss. There are no thin metal tangent contact points in Cannon contacts. (See below). Solder cups are carefully tinned by hand to keep the solder inside the cup. Cannon socket contacts are full floating to assure perfect alignment. **You'll find these design features throughout the great variety of precision contacts used in all Cannon connectors. For real value demand Cannon.**





Cannon design (above left) makes contact on large, heavy metal surfaces. Current is not carried through spring section. In Cannon Connectors there are no thin metal tangent contact points, like the design shown at right.

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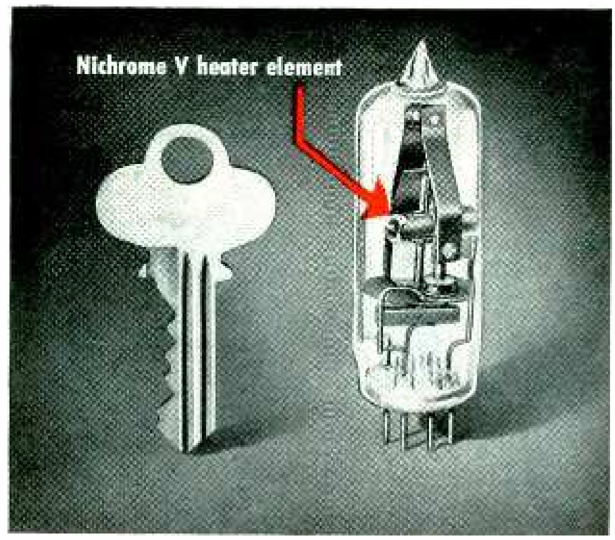

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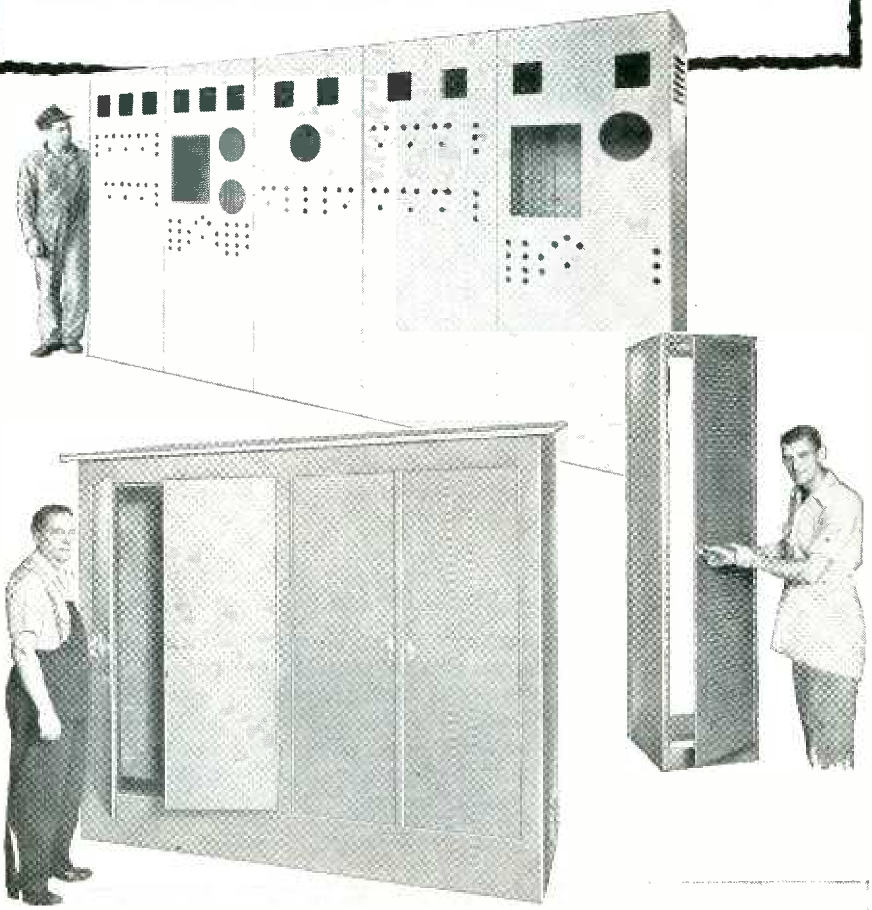


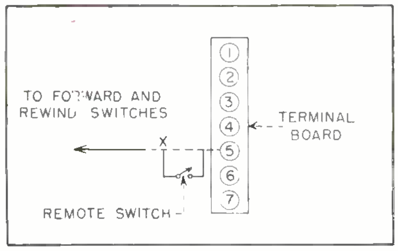


FIG. 1—Switching arrangement for tape recordings

used. Inside the motor section of this tape machine there is a terminal board to which the different switches, etc., connect. Disconnect the lead going to terminal No. 5 on this terminal board at point x and connect the remote switch in series with it, returning the other side of the remote switch back to terminal No. 5. As the No. 5 terminal is the common lead between the forward and rewind switches, both rewind and forward control of the tape machine are accomplished with one remote switch.

The announcer-operator can put a tape on the machine at his own convenience and set the regular tape-control switch to the proper position and then without having to leave the control desk, operate the tape machine with the remote switch, with no effort, at the proper time. This could be called presetting.

Rewinding after the tape has been played is accomplished in the same way only the tape control switch on the machine has to be switched to its rewind position. The tape machine can now be operated from either the control desk or the machine itself, as long as the remote switch is in the ON position.

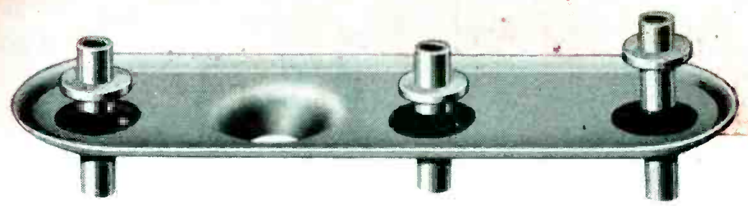
Variable-Gain Amplifier

By G. W. HOLBROOK (Lt. Col.)
Dept. of Electrical Engineering
Royal Military College of Canada
Kingston, Ontario, Canada

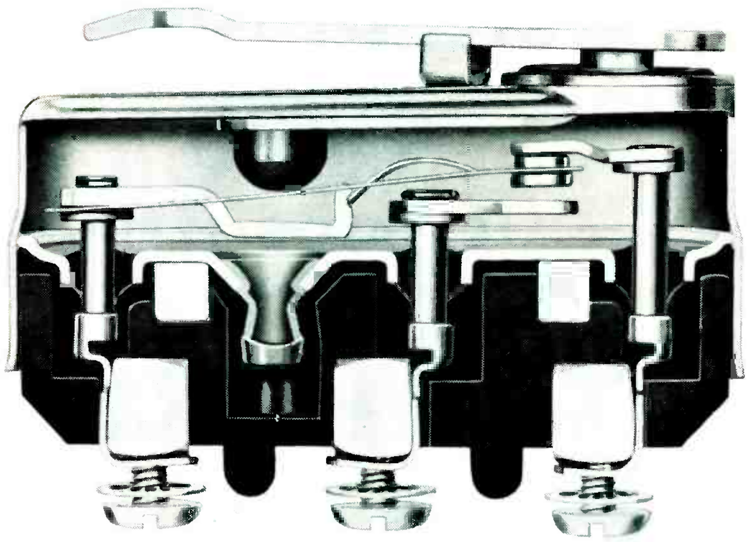
A VARIABLE-GAIN amplifier that is to be used as a conventional compressor or expandor must have a continuously variable gain over its control range. This gain must be controlled by a voltage which is a function of either the input or output level of the device.

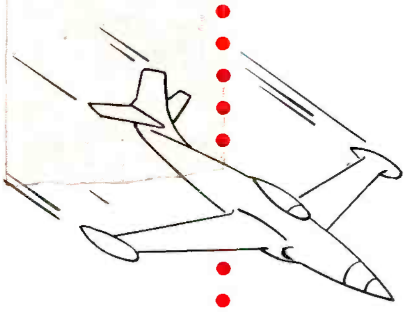
One of the most common forms

Here's the "*inside*" story



on the MICRO Hermetically Sealed Switch





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of control is that employed in avc circuits of radio receivers and which functions by virtue of a variable-μ tube. The system normally employed in telephone compressors and expandors is that of an attenuation pad made up of varistors whose a-c resistance can be altered by a variable bias voltage.

Both of these systems require comparatively high control voltages in order to achieve reasonable changes of overall gain. Stewart[1] has employed the variable anode impedance of a pentode tube as a feedback element in a negative feedback amplifier to achieve gain control in limiter circuits. This method has been modified by the author by employing a network of varistors as a feedback element in a similar amplifier.

Figure 1 shows one of many possible arrangements of this principle of gain control. If the control voltage is such that point A is made positive with respect to B, the impedance of the varistors W_1 and W_2 is reduced to a low value and the gain of the amplifier is a maximum owing to the fact that the feedback resistor R is almost completely shunted. If A is made negative with respect to B, then the impedance of the varistors becomes high and the full effect of the feedback resistor is achieved resulting in a very low value of gain.

The gain-voltage characteristic of the amplifier depicted in Fig. 1 is shown in Figure 2. It will be noted that a range of nearly 30 db of gain is achieved for a bias change of two volts, with a gain of 5 db at zero bias.

Bias Circuits

In order to take advantage of the characteristic described, an ade-

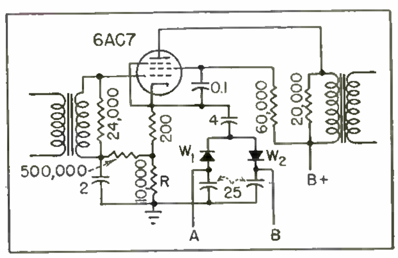

FIG. 1—Circuit using pentode as feedback element in a negative feedback amplifier

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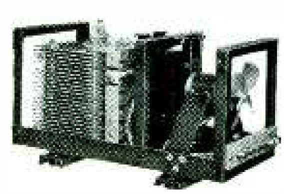

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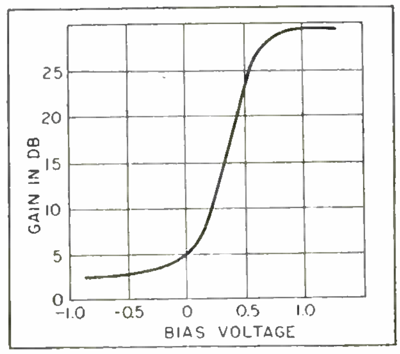

FIG. 2—Gain-voltage characteristic of the amplifier shown in Fig. 1

quate bias system must be established. Figure 3 shows a block diagram of an arrangement of hybrid coils and variable-gain amplifiers, with associated bias circuits, which achieves the result desired. It represents, basically, a two-wire repeater, but the same arrangement can equally well be applied to four-wire and radio-telephone circuits.

Signal voltages for operating the bias circuit are obtained from an additional winding in each hybrid transformer. This winding is, effectively, in parallel with the winding carrying the output power of each amplifier. Thus the voltage delivered to the bias circuit from either amplifier is directly proportional to the output level of that amplifier. Each of these voltages is rectified as shown in Fig. 4 and the rectified voltages are added to each other in opposition across the resistances R_1 and R_2. The resultant voltage divides equally across the resistors R_3 and R_4 and produces bias of opposing polarity on the grids of the two triode tubes. Under quiescent conditions the voltage developed across the points XY is zero but with signal voltages appearing across the windings of the hybrid coils, a bias, its polarity depending on the relative amplitudes of these signal voltages, will be generated at these points. Amplifiers shown

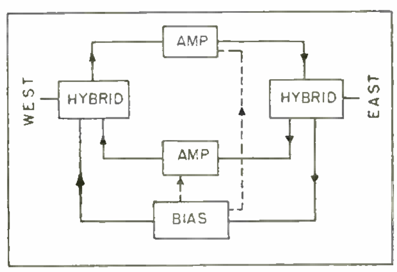

FIG. 3—Block diagram of an arrangement of hybrid coils and variable-gain amplifiers

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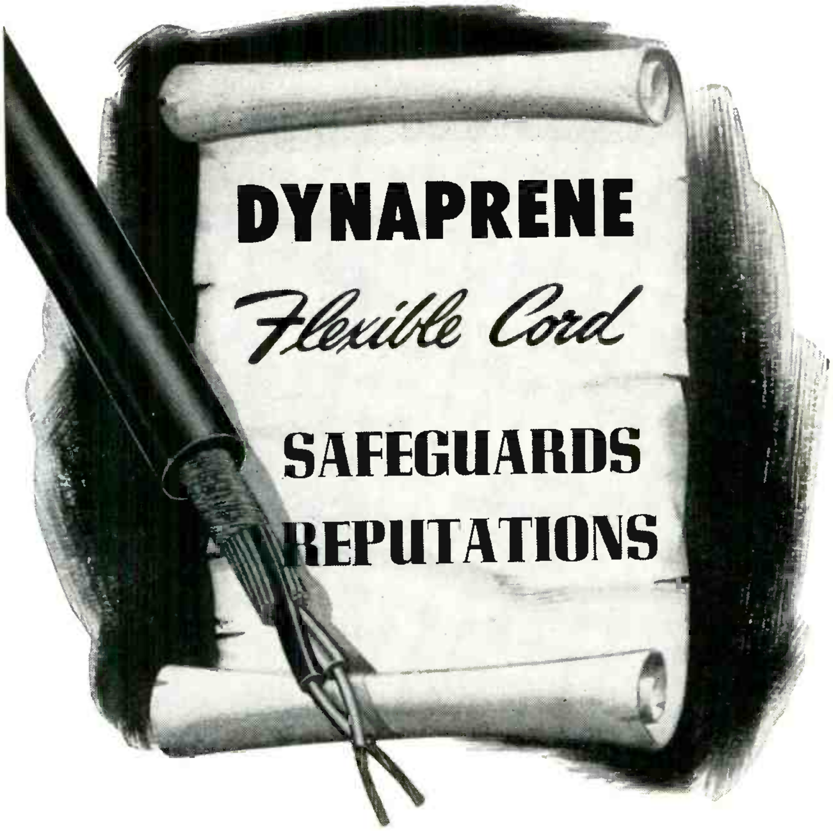

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COIL—2200 OHMS CONTACTS—SPDT
OPERATES AT 4.5 MA PRICE—$4.00 ea.

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3)	6500 ohms	3A	4.0 MA	3.00 ea.
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1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	5 MA	2.50 ea.
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TS-33/AP
TS-34/AP
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TS-35/AP
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TS-24/APM-3
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TS-47/APR
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I-95/A
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I-122
I-130A
I-145
I-177
I-178
I-208/A

I-212
I-222/A
I-225
I-233
IE-21/A
IE-36
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IS-185
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BC-221(*)
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BC-906/D
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BC-1203
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50	SIMPSON 55, 3½" round..........@	9.30
120	WESTINGHOUSE NA-35, 3½" round * 3 A..........@	5.50
250	SIMPSON 55, 3½ round * 5 A..........@	8.10
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C–60	R–17–A–5725	60 AMP	G.E.
C–60	R–17–A–5725	60 AMP	Weston
		50–0– 50 AMP	Weston
D–60	R–17–A–5745	60–0– 60 AMP	W.H.
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C–120	R–17–A–5730	120 AMP	G.E.
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2 conductor AWG 12	2 conductor AWG 18
7 conductor AWG 14	7 conductor AWG 16
14 conductor AWG 16	6 conductor AWG 20
11 cond. shielded AWG 20	10 conductor AWG 16
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Shielded cable with terminal lug each end 100' and 150' lengths

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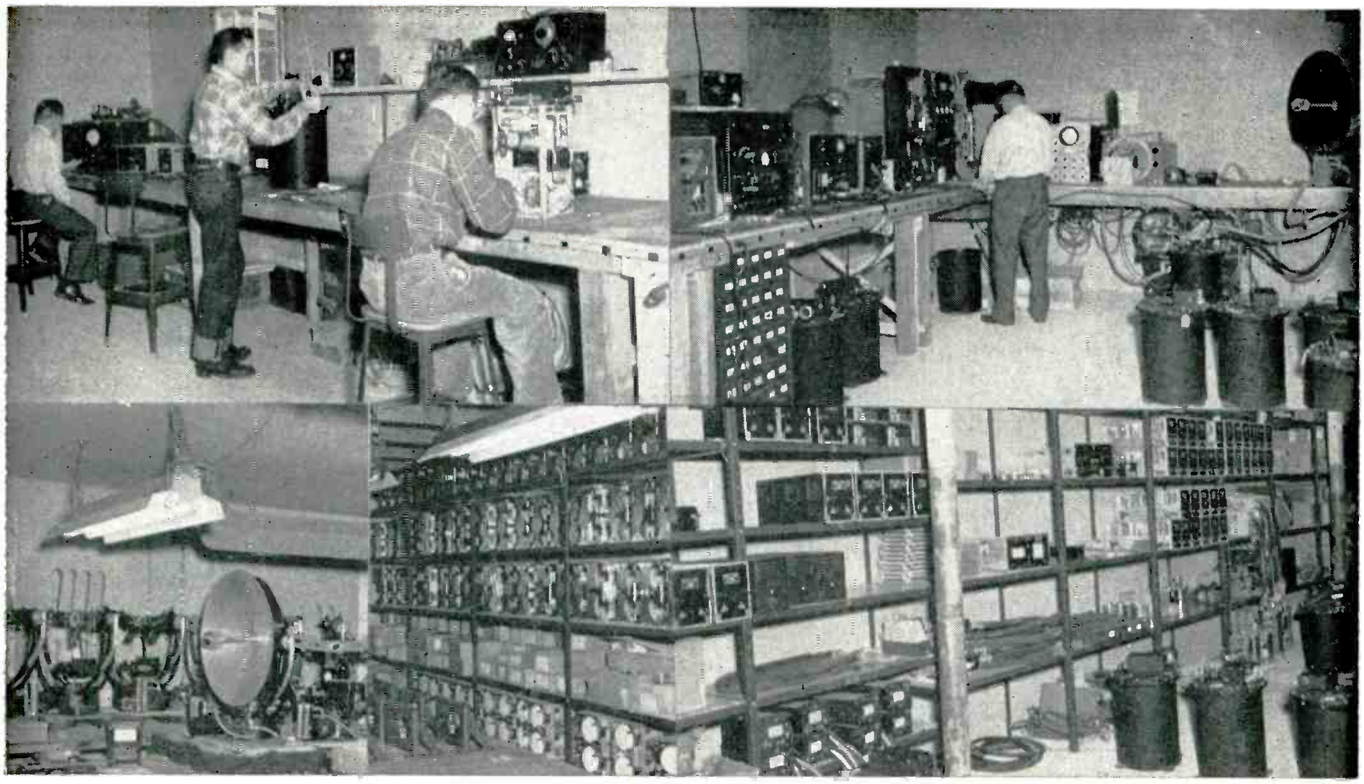

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2C43	24.50
2C44	1.19
2C51	5.75
2C52	4.50
2D21	1.49
2D21W	2.49
2E25A	4.50
2E26	3.25
2E30	1.98
2J21	8.95
2J22	7.95
2J26	19.95
2J27	19.95
2J31	29.50
2J32	29.50
2J33	29.50
2J34	29.50
2J36	99.50
2J48	22.95
2J56	169.50
2J61	32.95
2J62	32.95
2K22	
2K25	28.50
2K25/723A/B	29.50
2K26	65.00
2K39	99.50
3A4	.79
3A5	1.39
3A8GT	1.39
3AP1	10.95
3PB1	6.95
3B7/1291	.59
3B24	4.95
3B26	3.50

3C23	9 95
3C24/24G	1.75
3C27	3.95
3C33	12.50
3D6/1299	.59
3DP1	3.95
3FP7	1.69
3GP1	3.95
3Q4	.69
3Q5GT	1.15
3S4	.69
4B24	7.50
4C22/HF100	9.95
4C27/CV92	8.95
4C35	34.50
4E27/HK257B	16.50
4J21	129.50
4J22	129.50
4J23	129.50
4J26	129.50
4J27	129.50
4J28	129.50
4J29	149.50
4J30	249.50
4J31	99.50
4J33	99.50
4J35	99.50
4J41	99.50
4J52	299.50
4X150A	35.00
5BP1	4.50
5BP4	4.50
5D21	19.95
5FP7	3.95
5FP14	16.95
5GP1	4.50
5JP1	24.50
5JP5	24.50
5J23	59.50
5J26	89.50
5J30	5.95
5R4GY	2.00

5V4G	1.10
523	.99
6A3	1.69
6AB7/1853	1.29
6AC7	.99
6AG7	1.39
6ZJ5	2.49
6AK5	1.45
6AK6	1.10
6AN5	5.50
6AS6	3.30
6AS7G	4.50
6B8	1.00
6BL6	64.50
6BL7GT	1.10

12SQ7GT	.79
15E	.98
15R	.69
FG-17	4.50
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25L6GT	.69
FG-27A	6.95
FG-32	12.95
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RK48A	8.95
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6J4	6.95
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6L6GA	1.39
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6SN7WGT	1.98
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7B4	.89
9LP7	7.95
12AH7GT	1.29
12C8	.98
12DP7	16.50
12GP7	16.50
12H6	.89
12HP7	16.50
12SF5	.79
12SJ7	.89
12SN7GT	.89

RK60/1641	2.25
RKR72	.69
RKR73	.69
75TL	6.50
FG81A	3.75
83	1.29
83V	1.10
98R	5.95
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114B	.75
VT-127A	3.75
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250TH	22.00
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307A/RK75	4.25
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371B	.75
374B	3.95
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WL530	19.95
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702A	2.75
703A	4.95
705A	1.95
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706CY	29.50
706FY	49.50
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707A	7.95
707B	14.95
708A	3.95
713A	1.00
714AY	4.50
715A	1.95
715B	8.95
715C	22.95
717A	1.10
720BY	59.50
720CY	59.50
721A	1.95
722A	1.95

723A/B	16.95
724A	4.50
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725A	6.95
726A	5.90
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803	3.75
807	1.59
808	2.95
809	2.95
810	9.50
813	8.50
814	3.85
815	2.90
829	9.95
829B	12.50
832A	9.95
833A	39.50
836	3.95
837	1.45
838	2.95
845	3.95
851	49.50
852	19.95
860	4.95
861	29.50
865	1.10
866A	1.49
872A	2.75
874	.89
876	.59
884	1.75
889RA	149.50
921	1.75
923	1.00
931A	6.50
954	.39
955	.49
956	.49
957	.49
958A	.59
991	.39

1005	.69
1006	2.75
1007	.89
1613	.98
1616	.90
1619	.39
1624	1.75
1625	.39
1626	.39
1629	.39
1632	.69
1644	.89
2051	1.19
5560	17.95
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5647	4.50
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5676	3.35
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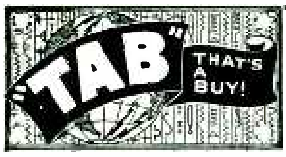

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0.607	240	820	2095	7500	27500	186600
0.7	245	850	2141	7700	28000	190000
1.03	245.4	854	2142	7717	28430	198000
1.3	250	899	2145	7900	28500	200000
1.75	260	900	2150	7930	29000	201000
2.5	270	910	2160	7950	29500	205000
3	271	917	2180	8000	29990	210000
3.83	275	946	2187	8094	30000	215000
4	280	978	2195	8200	31000	220000
5	286	1000	2200	8250	31500	225000
5.025	289	1030	2250	8500	32000	229000
6.25	299	1056	2300	8700	33000	230000
6.5	300	1059	2400	8770	35000	235500
7	310	1067	2450	9000	36000	238000
7.8	311.5	1100	2463	9100	37000	240000
7.9	320	1110	2485	9445	38140	245000
8	325	1150	2490	9500	38500	250000
10.38	330	1155	2500	9710	39000	265000
11.25	340	1162	2525	9800	39500	268000
13.52	350	1200	2600	9900	40000	270000
14.2	360	1225	2625	9902	41400	275000
14.5	365	1250	2635	10000	42000	294000
15	370	1260	2700	10430	43000	300000
16	375	1350	2750	10500	45000	307500
17	380	1355	2860	10600	47000	311000
19.5	389	1400	2870	10900	47500	314000
19.2	390	1488	2900	10936	48000	316000
20	400	1495	3000	11000	48660	325000
22	410	1500	3100	11400	49000	330000
23	414.3	1510	3163	11500	50000	333500
24	418.8	1518	3259	11690	51000	350000
25	425	1600	3290	12000	52000	353500
27	426	1640	3300	12500	55000	375000
28	427	1646	3333	12800	56000	380000
30	430	1650	3384	13100	57065	390000
31.	440	1670	3500	13500	58333	400000
37	450	1680	3509	13550	60000	402000
48	452	1710	3600	13600	61430	420000
50	460	1712	3700	14000	62000	422000
51.78	470	1740	3730	14250	64000	425000
55	475	1770	3760	14400	65000	430000
56.7	478	1800	3900	14500	66650	450000
60	480	1818	4000	14550	66650	458000
63	487	1830	4030	14600	67500	470000
68	500	1850	4200	15000	68000	472000
74	510	1865	4220	16000	70000	478000
75	520	1892	4280	16500	72000	500000
80	525	1894	4300	16800	73500	510000
18.4	540	1895	4314	17000	75000	520000
88	550	1896	4440	17500	80000	521000
95	560	1897	4444	17977	82000	525000
100	575	1898	4500	18000	84000	543000
101	580	1899	4720	18300	85000	550000
103.2	588	1900	4750	18380	85750	560000
105	600	1901	4850	18500	88000	570000
105.7	612	1902	4885	18800	90000	575000
107	620	1903	4900	19000	91000	600000
130	625	1904	5000	19500	93000	620000
120	633	1905	5100	20000	95000	650000
121.2	640	1906	5210	20441	10000	654000
125	641	1907	5235	20500	110000	660000
130	645	1908	5270	21000	115000	680000
135	649	1909	5300	21500	116667	690000
147.	650	1910	5500	22000	120000	700000
150	657	1911	5600	22500	130000	750000
160	665	1912	5730	22990	135000	761300
165	670	1913	5770	23000	140000	800000
170	673	1914	5910	23150	141000	813000
175	675	1915	6000	23325	145000	820000
179	680	1916	6100	23400	147000	850000
180	681	1917	6125	23500	150000	860000
182	684	1918	6140	24000	155000	900000
182.4	689	1919	6200	24600	160000	910000
200	697	1922	6300	25000	165000	930000
209.4	699	1924	6495	25200	166780	950000
210	700	1926	6500	25400	167000	
216	711	1960	6800	5833	169200	
220	733	1980	6840	26000	175000	
220.4	740					

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1.	1.57	2.2	.3	4.5	7	9.5
1.1	1.579	2.25	3.5	5	7.5	10
1.2	1.65	2.5	3.673	5.1	7.62	11.55
1.25	1.75	2.7	3.75	5.5	7.74	12
1.3	1.8	2.75	3.9	6	8	12.83
1.35	1.9	2.8	4	6.5	8.02	13
1.39	2	2.855	4.23	6.6	8.5	13'
1.4	2.11	[illegible]	4.25	6.7	9.05	30.85
.5						

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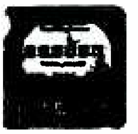

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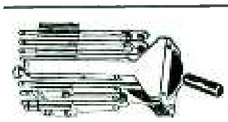

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BC638	TS61	RT19/ARC4
BC1287	TS89	RT48/TPX
BC1277	TS92	RT73/UPN
1-83G	TS131	RT10/APS3
1-86A	TS159	AN/APT4
1-114	TS170	APS4
1-183	TS184	TS51
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CLoverdale 2-2411 BRyant 9-1220, 1221

LABORATORY EQUIPMENT

3 Boonton FM signal generators, mod 202B
3 Philco visual alignment generators, type 7008
1 RCA oscilloscope, model WO 79A
1 Rawson electrostatic voltmeter, mod 518
1 Weston output meter, type 695
1 Weston AC voltmeter
1 General Radio precision condenser, mod 722D
1 Kay Electric megasweep

All of this equipment in excellent condition

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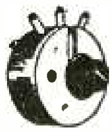
SURPLUS EQUIPMENT

POWER RHEOSTATS



Standard Brands: 5 Ohms: 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.

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G. E. MOTOR AMPLIDYNE

Mod. 5AM45DB15. Input: 115 volts, single phase, 60 cycle, 4.5 amp. Output: 250 volts DC, .6 amps, 3450 RPMS........**$79.00 ea.**

PIONEER TORQUE UNITS

TYPE 12604-3-A: Contains CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1 **$70.00 ea.**

TYPE 12606-1-A: Same as 12604-3-A except it has a 30:1 ratio between output shaft and follow-up Autosyn....**$70.00 ea.**

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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.**

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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.**

TACHOMETER INDICATOR SINGLE

Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer. **$9.95 ea.**

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Tachometer Indicator and Generator (above) ....Both **$33.50**

420 CYCLE GENERATOR

General Electric #5AB324A7: 115 Volts, single phase, 7.5 KVA, 3480 rpm, equipped with triple V-belt pulley. Cycle and voltage may be varied by varying speed. New price......**$525.00**

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General Electric-Type 5BA10AJ37; 27 volts, DC; .5 amps, 8 oz inches torque; 250 RPM; shunt wound; 4 leads; reversible **$12.50 ea.**

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General Electric-Type 5BA10AJ52C; 27 volts, DC; .5 amps, 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$12.50 ea.**

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Pioneer Part #1556-2K-A Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required..**$12.95 ea.**

PIONEER GYRO FLUX GATE AMPLIFIER

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G.E. MOTOR GENERATOR

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SERVO MOTOR 10047-2-A: 2 Phase; 400 Cycle; with 40-1 Reduction Gear $10.00 ea.

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Ultra-Violet Fluorescence

Now . . . build your own black light lamp equipment at a new low cost with these easy - to - assemble components. Kit contains: Ultra-Violet tube brackets, ballast, starter, wire, plug and wiring diagram.
4-Watt Kit—5½" tube)............ **$3.00**
8-Watt Kit—(12" tube)............ **$4.00**

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AIRESEARCH: 115V; 400 CPS; Single phase; 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03.................. **$10.00 ea.**

EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles; 6000 RPM .... **$12.50 ea.**

EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle, Single Phase. **$12.50 ea.**

PIONEER, CK-2, 400 cycle 2-phase, 115 volt .... **$20.00 ea.**

INVERTERS

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.**

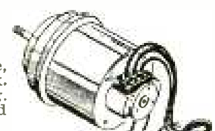
MG 153 HOLTZER-CABOT
Input: 24 V, DC, 52 amps; Output. 115 volts—400 cycles, 3-phase, 750 VA, and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated .... **$95.00 ea.**

12116-2-A PIONEER
Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC 5 amp...**$90.00 ea.**

10563 LELAND ELECTRIC
Output: 115 VAC; 400 cycle; 3-Phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp. .... **$80.00 ea.**

16486 LELAND ELECTRIC
Output: 115 VAC; 400 Cycle; 3-Phase; 175 VA; 80 PF. **Input:** 27.5 DC 12.5 amp; Cont. duty .... **$90.00 ea.**

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Deihl and Bendix.

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TRANSMITTERS .... **$15.00 ea.**

SYNCHROS

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5G Generator (115/90 volt—60 cyc.) **$50.00 ea.**

5SDG Differential Generator (90/90 volts —400 cyc.) .... **$30.00 ea.**

5DG Differential Generator (90/90 volts 60 cycle) .... **$50.00 ea.**

TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle .... **$25.00 ea.**

REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle .... **$37.50 ea.**

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FREQUENCY, 57-63 cycles per second, 125 volts, mfg. Aero mod. 7007. 3-inch round **$8.95 ea.**

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X Band, 1¼" x ⅝" guide, choke or plain flange, dissipates 350 watts average power continuously in still air, VSWR less than 1.15 between 7 and 10 KMC, weight 5¼ pounds.

X Band, ½" x 1" guide, choke flange, dissipates 250 Watts average power continuously in still air, VSWR less than 1.15 between 8.2 x 12.4 KMC, weight 3¼ pounds.

X Band, 1¼" x ⅝" guide, plain flange, dissipates 200 watts average power continuously in still air, VSWR less than 1.15 between 7-10 KMC, weight 3¼ pounds.

X Band, 1¼" x ⅝" guide, plain flange, dissipates 150 watts average power continuously in still air, weight 2 pounds 4 ounces.

S Band, 1½" x 3" guide dissipates 1000 watts average power in still air, VSWR less than 1.15 between 2.5 to 3.7 KMC, choke flange, weight 13 pounds.

TS-36, X Band Power Meter, measures 1 milliwatt to 1 watt of X Band average power for ⅝" x 1¼" wave guide,—$200.00.

TS-155 S Band Signal Generator and Power Meter.

X Band Power and Frequency Meter for 8,500 to 9,600 megacycles measures 1 to 1,000 milliwatts average power. The frequency meter is direct reading within 25 megacycles and within 4 megacycles with correction chart; commercial equivalent of TS-230 B/AP.

TS-110/AP S Band Echo Box,—$150.00.

TS-89 Voltage Divider,—$30.00.

TS-12/AP (Unit 2) X Band slotted line with adapters and probes,—$175.00.

TS-100 Synchroscope.

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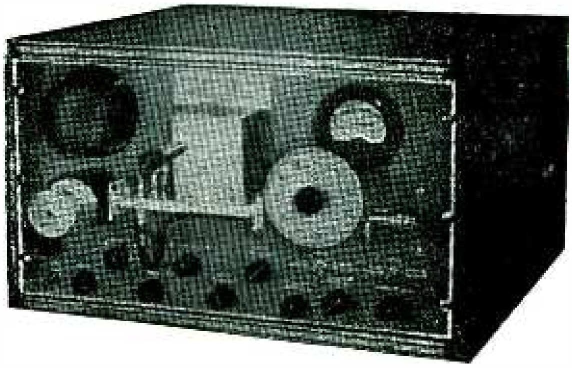
Waveguide Below Cut-Off Attenuator L 101-A, U. H. F. Connectors at each end calibration 30-100 db,—$25.00.

Amplifier Strip AM-SSA/SPR-2 contains I. F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 band-width 10 megacycles, center frequency 30 megacycles, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2, 600 cps 1.3 amps. Send for schematic,—$65.00 less tubes.

Tuning Units for APR-4 Receiver—TN 16 30-80 megacycles, TN 17 80-300 megacycles, TN 18 300-1,000 megacycles, TN 19 1,000-2,200 megacycles, TN 54 2,200-4,000 megacycles.

S Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages over-all gain 125 db., reg. power supply.

S Band Spectrum Analyzer 2700-3900 Mc., similar to above.



ELECTRO IMPULSE LABORATORY

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SEARCH RECEIVER — ARD-2

Frequency range 80 to 3000 Mcs.

Measures RF signals from 80 to 3000 Mcs and pulse rates from 50 to 8000 cycles.

The ARD-2 can be used as a Direction Finder to locate signals, or as a frequency meter, by VISUAL and AURAL indicators, provide Originally designed and used by USN aircraft. Ideally suited for military, laboratory and general purpose use.

Equipment consists of the following:

Antenna Detector-CMD-66AFH — Has variable length antennas, diode detector and silver plated tuning stub with calibrated scale.

AMPLIFIER CMD-50ADC—has three stage pulse amplifier, a trigger circuit, a pulse rate counter circuit and audio amplifier, visual signal indicator, rectifier power supply which is operative on 115 Volts AC 60 to 2400 cycles current, regulated.

Test OSCILLATOR-CD-60ABG—Has cavity frequency of 400 cycles with selection of four pulse repetition rates.

ALL CABLES AND FITTINGS, ACCESSORIES AND SHOCK MOUNTED RACK for immediate instalation, plus two Technical Manuals.

SPARE PARTS—Steel chest includes spares for components and two extra sets spare tubes.

Guaranteed NEW

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All Merchandise Fully Guaranteed

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IN21B	$3.25	IN23B	$3.75
IN23	1.45	IN26	7.75
IN23A	2.75	IN34	.65

Transmitting Tubes New-Jans

CE1C	$2.25	954	$ .45
C6J	5.95	955	.50
F123A	7.75	957	.55
F127A	17.75	958A	.65
RK72	1.50	991-NE16	.35
VR105	1.25	1005	.69
1B29	4.75	1006	3.25
2X2	.65	1616	.90
3B24	4.75	1619	.29
6AR6	2.75	1625	.45
10Y	.45	1626	.45
211	.50	1629	.45
310A	6.75	2051	1.10
814	3.25	9001	1.25
815	1.75	9005	1.75

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YOU NAME IT   WE HAVE THEM

DELIVERY FROM STOCK   FACTORY CLEAN CONDITION

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UPRIGHT TYPES—CP40, 41 • CP61 with universal brackets • CP70 series
BATHTUB TYPES—CP53 side term. CP54 top term. CP55 bot. terminals
CHANNELS & BATHTUB TYPES AVAILABLE IN SINGLE, DUAL OR TRIPLE UNITS
CAPACITY VALUES—.01-.02-.05-.1-.25-.5-1.0-2-4-6-8-10-15 MFD
VOLTAGES AVAILABLE—50-100-200-400-600-1000-1500-2000-2500-3000 etc.

MOST TYPES IN VERY LARGE QUANTITIES • LET US QUOTE ON YOUR REQUIREMENTS

Look! BEEN SEARCHING FOR THIS ITEM?

Brand New OUTPUT TRANSFORMER ES-691027

Used in SCR-274 & other aircraft receivers

SUITABLE FOR USE IN NEW DESIGNS

Manufacturing Quantities Available

Electrical specifications: Plate winding/power pentode. Sec. high & low imped. headphones

Has Mounting For Neon Noise Suppressor

SPECIAL NOISE SUPPRESSION CAPACITORS

CA-442 CA-445 CA-481 CA-209 CA-275 CA-177A CA-106 and many other types

MUMETAL***LAMINATIONS***4750 & AUDIO

Partial listing of types available

F-12 EI-312 EI-21 EE-24-25 EE-26-27 L-12

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RADIO TELETYPE Selective Audio Filters
MARK & SPACE freq. set of 4 .... $23.75
SPECIAL SELECTIVE AUDIO FILTERS to order

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Warehouses at Imeson Airport

COLUMBIA ELECTRONICS LTD.

R-4/ARR-2 RECEIVER

34-58 mcs. Brand new, COMPLETE WITH RACK AND CONTROL BOX.

HEADSETS

HS-38 & HS-33 BRAND NEW

AN/CRT-3

EMERGENCY RADIO TRANSMITTER. T-74/CRT-3 DUAL FREQUENCY OPERATED TRANSMITTER. Operates on both 8280 kc. and 500 kc. Power output 2½ W. on 500 kc and 2 W. on 8280 Kc. BRAND NEW. COMPLETE WITH PARACHUTE, KITES, LAMP, BALLOON and GENERATOR.

RC-184 IFF EQUIPMENT

Complete. Brand new.

MG-19A BRAND NEW

MODULATOR UNIT BC-1203-A

With Coupling Heads BC—1201 & BC-1202

APS-4 Complete Radar
Mark 16 Complete Radar
APS-6 Complete

SCR-615 PARTS

LP 21 LOOPS

Models LM, AM, A
Excellent Condition

RECEIVERS

APR-4 APR-5

TELEVISION CAMERA

350 line resolution. Easily converted to present RMA standards. Circuits available with camera. Complete, like new.

MK-20A/UP
Brand new. Individually boxed.

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Complete Line!

DuMont 224-A Oscilloscope
1-77 Hickok Tube Checker
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IE-36 (New)	TS-100/AP
I-122	TS-111/CP
I-139-METER	TS-126
I-212	TS-127/U
I-222	TS-170/ARN-5
TS-3/AP	TS-182/UP
TS-10B/APN	TS-184A/AP
TS-19/APQ-5	TS-204/AP
TS-24A/APR-2	UPM-1 (Complete)
TS-34/AP	WE 1 193
TS-36/AP	Range Calibrator 1-146
TS-61/AP	
TS-62/AP	
SL-1 Slotted LineTest Set	

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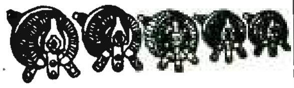
POWER RHEOSTATS



Ohms	Watt	Ea.	Ohms	Watt	Ea.
.5	25	1.98	250	25	2.23
.5	50	2.81	250	50	2.53
.5	150	5.93	300	50	2.53
1	50	2.81	300	75	3.90
2	50	2.81	300	100	4.40
2	100	4.68	300	150	5.04
2	300	8.42	350	25	2.25
3	100	4.67	350	100	4.40
3	225	6.58	370	25	2.23
4	225	6.60	378	150	6.59
5	25	1.97	400	25	2.23
5	50	2.53	400	75	3.90
5	100	4.68	500	25	2.23
6	25	2.23	500	50	2.53
6	50	2.53	500	75	3.95
6	75	3.90	500	100	4.50
7	25	1.98	500	150	5.15
7.5	75	3.95	500	300	9.49
8	50	2.53	585	150	6.59
10	25	2.23	750	25	2.23
10	50	2.53	750	150	5.46
10	100	4.37	1000	25	2.53
12	25	2.23	1000	50	2.66
12	50	2.53	1200	225	7.20
15	25	1.98	1200	300	8.40
15	75	3.90	1250	50	2.66
15	100	4.38	1250	150	6.10
20	50	2.53	1500	25	2.53
22	50	2.53	1500	50	2.66
25	25	2.23	1600	50	2.66
50	25	1.98	1800	150	6.19
50	50	2.53	2000	25	2.53
75	25	1.98	2000	50	2.66
75	75	3.90	2250	150	6.24
80	50	2.53	2500	50	2.66
80	500	12.46	2500	100	4.68
100	25	1.98	2500	150	6.24
100	50	2.53	3000	25	2.66
100	100	4.39	3000	100	4.95
125	25	2.23	5000	25	2.66
150	50	2.53	5000	50	2.90
175	25	2.23	7500	50	2.90
185	25	2.23	7500	100	5.32
200	25	2.23	10000	50	2.99
200	100	4.40	10000	100	5.51
200	150	5.04	15000	25	3.25
225	50	2.53	20000	150	8.75

OTHERS

Dual	1.3	25	4.95
Dual	10	25	4.49
Dual	13.2	300	15.95
Dual	100	25	4.49
Dual	200	50	4.95
Dual	300	50	4.95
Dual	378–585	150	12.75
Dual	500	25	4.49
Dual	1375	25	4.49
Triple	3	300	24.95

Specify Type Shaft Required "SS" or "Knob"

"AN" CONNECTORS

Large Variety Available At Great Savings

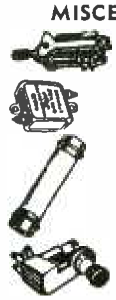
Send your specs and let us quote

BIRTCHER TUBE CLAMPS

#926-A	FROM	#926-C5
#926-A1	**35c**	#926-C10
#926-A14		#926-C24
#926-B		#929-1
#926-B1		#930-12
#926-B7		#930-18
#926-B22		#930-19
#926-C		#930-21

MICROSWITCHES

MISCELLANEOUS



A. MOSSMAN LEVER SWITCHES
B. NOISE FILTERS
C. GLASS FERRULE RESISTORS
D. MALLORY SERIES 2000 PUSH SWITCHES
E. WE-I—PRECISION RESISTORS

See Dec. Issue for Complete Listings of above.

OIL CAPACITORS RECTANGULAR

.00025		25KV
.0025		1500
.004		10KV
.0075		7KV
		10KV
.03	AC	500
.05		2500
.1		6KV
.25		2000
		3000
		3500
		4000
		5000
.5		600
		1500
		3000
.75		1000
1.0	AC	250
	AC	330
		600
		1000
		1500
		2000
		5000
		6000
1.5	AC	400
2.0	AC	220
	AC	250
	AC	330
		400
		600
	AC	660
		1000
		1500
		2000
		2500
		4000
3.0	AC	240
4.0	AC	220
		600
		700
		1000
		1500
5.0		600
6.0		400

BATHTUBS

.02	600
.033	600
.05	200
	400
	600
.1	200
	400
	600
	1000
.15	600
.2	600
.25	200
	400
	600
	1000
.35	400
.5	200
	400
	600
	1000
.75	600
1.0	50
	100
	200
	300
	400
	600
	1000
2.0	400
	600
4.0	50
	100
5.00	50
8.0	500
10.0	50
	150
15.0	200
16.0	450
20.0	25
	50
	75
40.0	25
	40
	100
50.0	25
100.0	15
200.0	12
300.0	6

CHANNEL

.01	600		600
	1000	4.0	600
.02	400	.01–.1	400
.025	600	.02–.1	600
.05	400	.035–.2	
	600		600
	1000	.05–.05	
.1	400		400
	500		600
	600	.1–.1	400
	1000		600
.15	600	.25–.25	
.25	400		200
	600		400
	1000		600
.31	600		1000
.42	600	.5–.5	300
.5	400		400
	500		600
	600	.02–.05–.02	400
	1000		
.7	600	.1–.1–.1	
1.0	400		400
	500		600
	600		1000
2.0	200	.25–.25–.25	600
	400		

(Top—Bottom Univ. Term.)

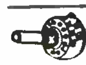
HIGH POWER TR. MICA

G-1 TYPE		G-2 TYPE			
.0001	5KV	.0001	10KV	.0011	20KV
.00015	5KV	.00015	10KV	.00124	15KV
.0002	6KV	.0002	10KV	.004	12KV
.0008	6KV	.000247	12KV	.25	1.6KV
.0047	6KV	.0003	10KV	.25	6KV
.005	5KV	.000375	10KV	.001	20KV
.01	4KV	.0004	5KV	.00047	20KV
.032	2KV	.0005	10KV	.015	3KV
.04	1KV	.00065	10KV	.0012	20KV
.08	1.5KV	.001	6KV	**G-4 TYPE**	
.09	1.5KV	.003	8KV	.0002	30KV
		G-3 TYPE		.0025	25KV
		.0001	20KV	.005	8KV
		.003	20KV	.01	15KV
		.0004	20KV	**TYPE #56**	
		.00045	15KV	.000155	30KV
		.0005	20KV	.000533	30KV
		.001	20KV	.0004	30KV
				.001	30KV

TRANSMITTING MICAS

.00001	.0002	.0015	.0082
.000025	.00022	.00162	.0009
.00003	.00024	.00175	.01
.00004	.00025	.0018	.012
.000047	.00027	.002	.0135
.00005	.0003	.0022	.0142
.000051	.00033	.0024	.015
.000056	.00039	.0025	.016
.000068	.0004	.003	.018
.00007	.00047	.0039	.02
.000075	.0005	.004	.022
.00008	.00051	.0043	.024
.0001	.0006	.0047	.025
.00011	.0007	.005	.027
.00015	.00075	.0051	.03
.000152	.0008	.006	.033
.00016	.0009	.0062	.04
.000175	.001	.007	.043
.00018	.0013	.008	.05

TYPE "J" POTENTIOMETERS



Type "J"		
65	25k	150k–150k
75	30k	250k–250k
300	50k	300k–300k
400	75k	350k–350k
500	80k	2.meg–2.meg
600	100k	4.meg–4.meg
650	120k	2k–50k
750	125k	2.2k–24k
1000	150k	6k–45k
1400	250k	10k25k
1500	500k	20k–2k
2000	1.meg	25k-10k
4000	2.meg	35k–5k
6500	3.meg	800k–75k
9000	**Type "JJ"**	350k–5k
10k	500–500	700k–7k
12k	600–600	350k–25k
15k	1500–1500	1.meg–500k
20k	2000–2000	
	130k–130k	

Type "JJJ"

700k–700k–700k	1.meg–1.meg–1.meg
750k–750k–750k	20k–200k–20k
800k–800k–800k	45k–27k–2500

JONES CONNECTORS

JONES Connectors

Jones BARRIER STRIPS

Jones Plugs		
"300"	315-EB	504-CE
P-101-1/4	315-AB	506-CE
101-3/8	315-FHT	506-DB
306-AB	315-CCT	508-CE
306-CCTL	315-LAB	510-CE
308-FHTL	318-AB	512-CE
310-LAB	321-CCE	S-502-DB
310-FHT	321-CCEL	504-DB
310-CCT	330-AB	504-CE
310-AB	330-SB	506-DB
312-LAB	330-CCT	506-CE
312-CCTL	"400"	**Jones Barrier Strips**
312-CCT	P-402-SB	2-140-3/4W
312-AB	404-DB	2-140-Y
315-FHT	406-AB	3-140
315-CCE	406-FHE	4-140
315-CCT	406-CCE	6-140
315-FHE	408-LAB	10-140-3/4W
315-EB	408-DB	10-240
318-CCE	410-CCE	11-240
321-AB	412-DB	17-240
321-DB	412-CCE	18-240
324-EB	S-404-AB	20-160R
324-FHT	404-DB	3-141
324-CCT	406-CCT	4-141-W
324-AB	408-LAB	4-141-3/4W
330-SB	408-CCT	6-141
330-FHT	410-CCE	7-141-Y
330-CCT	410-AB	10-141-Y Mel
333-CCT	412-DB	13-141
Jones Sockets	"2400"	20-141-3/4W Mel
S-101-D Mod	P-2410-CCE	20-161-AR
201	2410-SB	2-142-Y
202-B	2410-FHE	4-142-Y
302-CCT	2412-SB	12-142
302-AB	2412-CCE	3-150
304-CCT	S-2406-CCE	4-150-Y
306-LAB	2408-LAB	4-152
306-FHT	2408-SB	6-22
306-FHTL	2410-LAB	8-6
306-CCT	2412-LAB	8-54
308-AB	2412-FHE	2002
308-FHTL	2412-CCE	2008
308-CCTL	"500"	2013
310-LAB	P-502-DB	
	504-DB	

ALEXANDER MOGULL COMPANY

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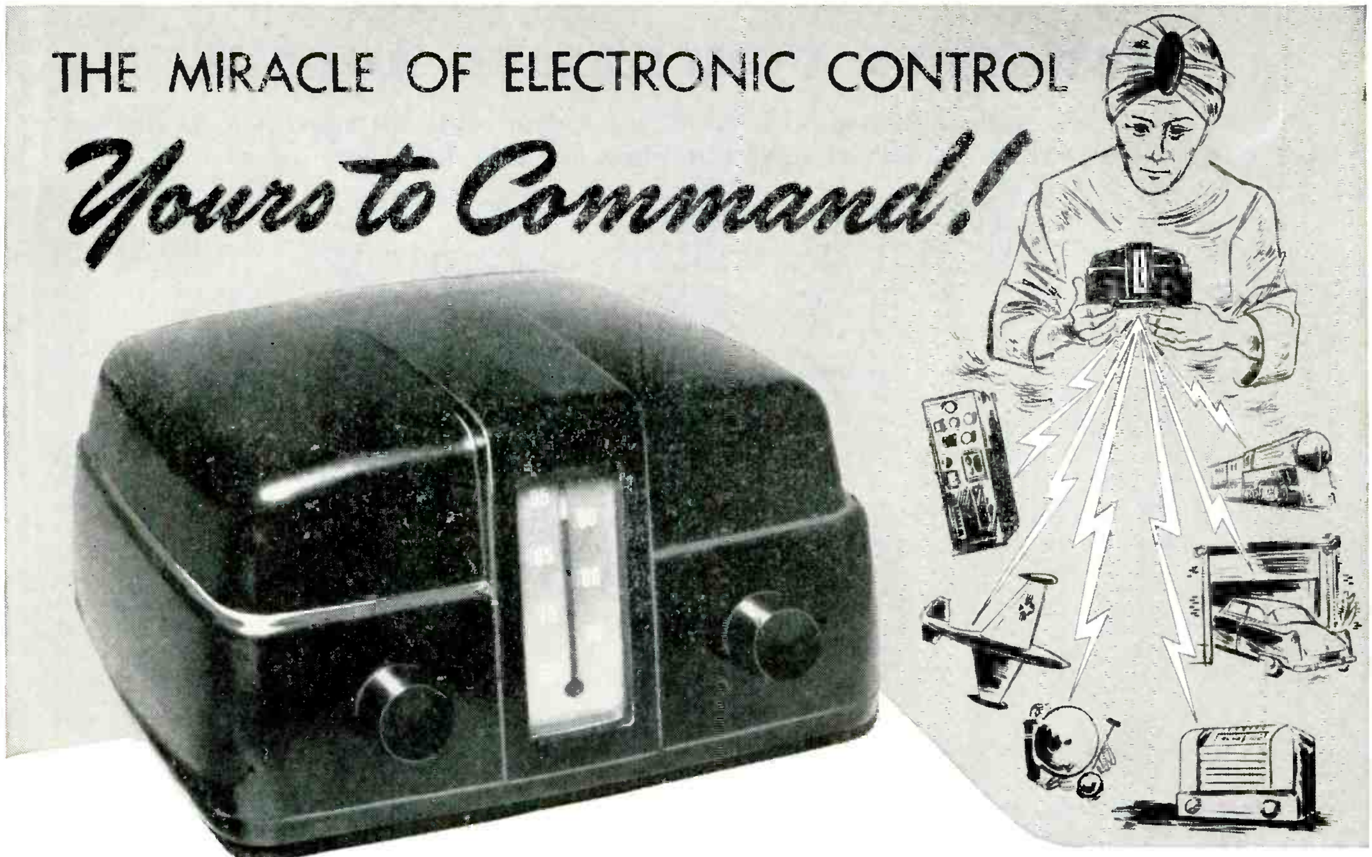

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Here's the chance of a lifetime to own a genuine Thyratron Electronic Remote Control of your own at a fraction of its regular price! This mighty handful (only 5¾x5x3¼") of miracle control can be made to perform hundreds of practical, fascinating feats of remote control.

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These amazing Thyratron precision thermostatic controls can easily and quickly be modified by you for electronic remote control of: Transmitters; Turn Radio and TV on and off; Open and Close Garage Doors from your car; Remote Control of Appliances, Machinery, Power Tools; Remote Controls for Model Railroads, Planes, Boats, Trucks; Burglar, Fire, Temperature and Rain Alarm Systems; Poultry Brooder Controls, etc., etc.

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Each control unit contains a highly sensitive plate circuit trigger relay, a 110 volt 60 cycle AC filament transformer, many condensors and resistors (including 1% precisions) and a host of other valuable parts worth twice or more our low, low bargain price. No matter how you use it it's a great buy!

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All 3 *plus* Bakelite Cabinet—only $4.95
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- Open and Close Garage Doors From Inside Your Car
- Model Railroads, Boats, Planes, Cars, Trucks
- ON-OFF for Appliances, Machinery, Power Tools
- Burglar, Fire, Temperature or Rain Alarm Systems
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—CONVERTORS
—DYNAMOTORS
—INVERTERS
—POWER SUPPLIES
—RECTIFIERS

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• RADAR

MARINE, GROUND & AIRBORNE

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APS-3	SL	SG
APS-4	SN	SL
APS-6		SCR-545
APS-13	SO	SCR-720
APS-15	SQ	
	SJ	

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800W—(400 watt phone) Western Electric 10-channel automatic dial selection, 2.0-20.0 mcs. with 220 volt, 1 ph, 50-60c, power supply. SAME TRANSMITTER AS USED ON S.S. "QUEEN MARY"—Brand New. Price $4,000.00.

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★ *All equipment new or reconditioned, checked in our laboratory and ready for operation.*

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Portable and Stationary Switchboards and Supplies

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TBL—Navy all-wave transmitter; 350 watts output; CW and phone. Supplied complete with m/g and starter for d.c. or a.c. operation.

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SCR-284—the famous mobile and ground station for field use. Large quantity of complete sets available.

MAG—10 cm. portable link radar transmitter receivers. 6-volt operation.

and TUBES—MAGNETRONS, KLYSTRONS, SPECIAL PURPOSE and TRANSMITTING TYPES

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
O1A	——	2J33	$100.00	4C28	$35.00	307A	$5.00	723A/B	$25.00	2x2/879	$1.75
OC3	$1.60	2J36	100.00	4E27	17.50	371B	2.50	724B	6.50	954	1.00
OD3	1.50	2J38	17.50	4J33	190.00	388A	2.75	725A	——	955	1.00
C1A	6.00	2J39	17.50	4J52	350.00	446A	2.00	730A	——	956	1.00
C1B	7.00	2J42	150.00	5J23	——	446B	4.00	803	7.00	1616	2.75
C6A	——	2J50	75.00	5J26	350.00	450TH	45.00	807	1.65	1619	.75
C6F	12.50	2J61	75.00	6C21	29.50	450TL	45.00	813	9.00	1624	2.00
C6J	——	2J62	75.00	10Y	1.25	464A	9.50	829A	12.00	1625	.65
1B22	3.95	2K22	——	100TH	9.00	705A	3.50	832A	10.00	1626	.75
1B23	10.00	2K25	35.00	204A	60.00	706A-GY	45.00	836	4.75	1629	.65
1B24	——	2K26	150.00	211	1.00	707B	25.00	837	2.75	1636	3.00
2B22	4.95	2K29	35.00	250TH	20.00	714AY	17.50	843	——	1642	3.50
2B26	3.75	2K41	150.00	250TL	20.00	715B	17.50	849	50.00	2050	2.00
2C40	18.00	2K45	140.00	304TH	15.00	720	——	851	80.00	8012	4.25
2C43	25.00	2K54	150.00	304TL	15.00	721A	3.75	860	5.00	8020	3.50
2D21	1.70	2K55	150.00					861	40.00	8025	7.00
2E22	3.75	3B24	6.50					865	1.40	9001	1.65
2J21	17.50	3B27	10.00					872A	3.85	9002	1.50
2J22	17.50	3B28	10.00					874	1.50	9003	1.75
2J26	27.50	3C31	5.75					889R	195.00	9004	1.75
2J27	27.50	3E29	15.00					891R	250.00	9005	1.90
2J31	27.50	4C27	25.00					892R	250.00	9006	.50
2J32	65.00										

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BATHTUB CONDENSERS CP53B1FF504K .5MFD—600V. ....$.64

Round 1 MFD. 1000 VDC screw Type 1 Lug 2¾" High ....50¢ ea.

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TYPE J 150 ohm 50 Watt #5381.......$1.89 each
TYPE K 100 Watt 25 Ohm...............$2.96
TYPE H 25 Watt 15 Ohm................$1.67

PACKET SWITCHES made by A&H&H Type 80989 25 amp. size 2PDT and 3DPT....$7.95 ea.

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721A	$3.50	2J36	105.00
815	2.80	4J37	175.00
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830B	3.95	9002	1.35
832	6.95	9003	1.70
832A	9.00	9006	0.40
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3B24	4.95	6D6	0.75
		SX3	0.75

LINE CORD AC manufactured by G.E. molded rubber plug, 12' lengths.........$25 per 100 pcs.

RAYTHEON BENCH WELDPOWER #516 Miniature Model 115VAC less welding head. Has ability to Weld Difficult material. More Information on request. Price....................$85.00

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UG 352U ....$6.00 EACH
UG 9/U ....95 EACH

HAYDON SYNCHRONOUS MOTOR

110 V.A.C.
½ R.P.M.
3.6 Watts
$2.47 each

Haydon, 2.2 watt 1-120 RPM.............$1.68 complete with coin arrangement for 25¢ pc..$2.49 minimum order 5 pcs. on synchronous motor.

MICA TRANSMITTING CAPACITORS Type G3 .0001 Mfd 25KV ....$48.00 ea. Type G2-50, .0001 mfd, .0002 mfd, .0005 mfd. 10KV $19.00

ATTENUATOR DAVEN TYPE T-994-2 7500/3900-2DBStep ....$4.25 Type TA-1000-2 7500/3900 Ohm.......$5.25 ea.

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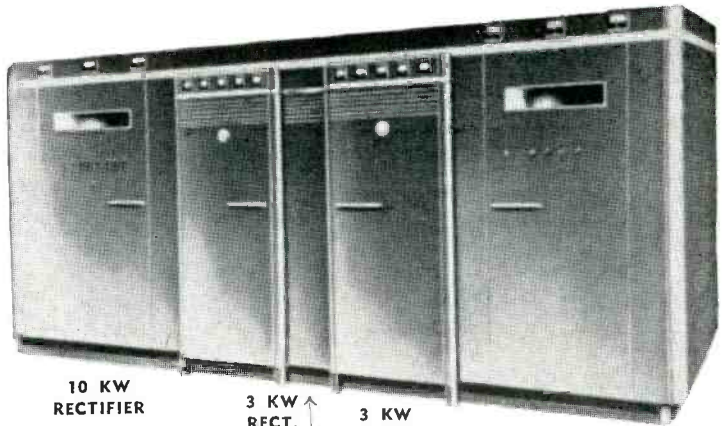
NEW GE 1 KW, 3 KW, AND 10 KW–RF AMPLIFIERS!!

1 KW P.A.



10 KW RECTIFIER

3 KW RECT.

3 KW P.A.

10 KW POWER AMP.

Above G.E. Transmitting Equipment of recent design, NOT WAR SURPLUS, all NEW and export cased—at tremendous reduction from original price! Available, *in quantity:* Type BF-1-A, 1 KW Power Amplifier and Power Supply: BF-2-A, 3 KW Power Amplifier with separate matching Rectifier-Power Supply: BF-3-A, 10 KW Power Amplifier with separate matching Rectifier-Power Supply. This equipment is designed for 88-108 MC FM Broadcasting application, beautifully engineered and constructed. (250 Watt FM Exciter or Driver NOT AVAILABLE) Conversion to lower frequencies (2 to 24 mc, or other frequencies) can be accomplished at very low cost. Our factory will be glad to quote on conversion to specified frequencies. All units designed for 208/230 volts, 50/60 cycles operation; 3 KW and 10 KW units require 3-phase. All incorporate internal blower systems for forced air-cooling, and use latest G.E. hi-efficiency tubes. Quantities sufficient to interest manufacturers—to convert for other applications. Ideal for FM Broadcasters, communication companies, Schools, Labs! Available as separate units, or complete.

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BC-221, I-222-A Signal Generator, 100-156 MC, with crystal calibrator, for 115 V. 60 cycles AC.

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RT-3/ARN-1 Radio Receivers, New. **Model ZB-3, Aircraft Homing Adapters,** with plugs and accessories. New Eqpt.

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Wilcox 36A Rectifier-Power Supply, for 3 KW modulated transmitter. Designed for use with 4 or more 96C 3 KW Transmitters and 50A Modulator. New, Unused. **WRITE FOR PRICE.**

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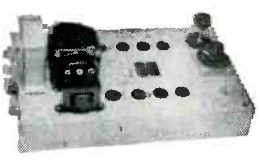
BC-163 Radio Beacon Eqpt., designed for use with SCR-508 / 608 / 528 / 628 / 510 / 610 Transmitter-Receivers, 20 to 40 mc. Complete, export-packed, NEW equipment.

GENERAL ELECTRIC VOLTAGE REGULATOR & POWER SUPPLY MODEL 3GVD14B3



Output 750 volts up to 100 ma; complete power supply using 8 tubes, with selector switch for regulating or non-regulating. Operates from 110 V., 60 cycles AC. NEW units, less tubes, with operational data and diagram. **EACH** $24.50

ECLIPSE PIONEER TYPE C-14 MAGNESYN UNIT

Per W.E. Spec., KS-5899-L01 excitation 26 volts 400 C.P.S. current drawn 200 to 500 MA. Shaft locking arrangement overall dim. 2¼" dia. 2¼" long. .812" x 2.562" Mtg. centers. NEW Units.

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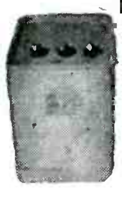
Syncro—Capacitor



50-50-50 mfd., Standard Brand Delta connected, 90 V. AC, 60 cps. All NEW, packaged capacitors. For power-factor correction on 115 V. 3 phase AC. etc. Large quantity available. **EACH** $7.00

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T4/FRC, with Modulator
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RCA-ET 4332 and 4336.
TDE, TBK, 8010, 8003, for Ships.
ATD, for Aircraft.
BC-319, BC-604, BC-684, etc.
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TDQ Transmitters, 100-156 MC, 45 watts AM output. Reconditioned to like new.
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Jefferson Travis, Model 350-A, Transmitter-Receiver, 50 W. output, 1.5 to 12.0 mc, 5 channels operation—1 VFO and 4 X'tal—both transmitter and receiver. **Power Supply** operates from either 12/24/32/115 V.D.C., or 115 V. AC, 60 cycles. **With** Ant. Loading Coil unit, handset, key, & instruction book. Complete.

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Beachmaster 250 W.; Western Elec. Model HLAS—500W.; RCA 25W. (12V.) Mobile; RCA MI-2817-E Amplifier, 1,000 Watts (2—500 Watt Channels); **W.E. Speaker Units** D-173246, (25-30 **Watts**) **and** D-173232A (50-60 Watts), considerable quantity available.

Immediate Delivery from Stock — All Prices F.O.B. N.Y.C. — All Material Offered Subject to Prior Sale

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$1.79

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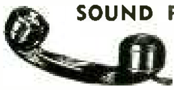
100 small assorted gears. Most are stainless steel or brass. Experimenter's dream! ....Only $6.50

VERNIER DIAL or DRUM (From BC-221)

DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks ....either 85¢



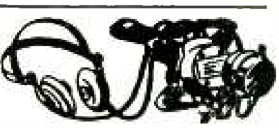
SOUND POWER HANDSET

BRAND NEW

Includes 6 ft. cord.—No batteries or external power source used. $17.60 pr

AC LINE CORDS—4 ft. long with molded rubber plug 10¢

Sound Powered Chest Set RCA—With 24 Ft. Cord
Per Pair
USED $17.60
NEW $26.40



400 CYCLE INVERTERS

Leeland Electric Co.

#10890 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF....................$24.95

3AG FUSES

Amp	Per 100	Amp	Per 100	Amp	Per 100
1/8	$4.00	3/4	$4.00	6	$3.00
3/8	4.00	4	3.00	10	3.00
1/2	4.00	8	3.00	15	3.00

DELAY NETWORK—ALL 1400Ω

T 114—Approx. 2.2 micro sec. delay.................. 95¢
T 115 Similar to T 114 with tap brought out........ each

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Mfg. No.	ID	OD	Thickness	Price
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MRC7026-1	5 5/64	6 15/64	9/16	3.50
Timken 37625	4 5/16	6 1/4	29/32	4.25
MRC-7021-200	4 1/8	5 9/32	23/64	2.95
MRC 106 M2	1 17/64	2 7/16	25/64	1.75
MRC 106 M1	1 13/64	2 7/16	25/64	1.60
Federal LS 11	1 1/8	2 1/2	5/8	1.75
Norma S 11 R	1 1/8	2 1/8	3/8	1.25
Fafnir B 541	1 1/16	1 1/2	9/32	.55
Hoover 7203	5/8	1 9/16	7/16	.90
Norma 203S	5/8	1 9/16	7/16	.90
SCHATZ	3/4	1 3/4	9/16	1.00
N5 5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	1 5/32	11/32	.55
Norma S 3R	3/8	7/8	7/32	.45
MRC 39 R1	11/32	1 1/32	5/16	.45
MRC 38 R3	5/16	55/64	9/32	.45

NEEDLE BEARINGS

TORRINGTON B108 ½" wide ⅝" 13'16" 30¢

Brand New Meters—Guaranteed

0-10 ma. D.C. 3½"...3.95 0-80 Amp. D.C. 2½"..$2.25
0-1 ma. D.C. 3½" DeJur...Scale Reads 0-4 KV....$5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V....................$1.79
Half Wave 100 MA 115V.................... .91

SPAGHETTI SLEEVING—assortment—99 feet.....$1.00

TYPE "J" POTENTIOMETERS

100	S.S.*	1,000	9/16	10K	5/8	200K	5/8
150	S.S.	1,500	1/4S.S.	15K	1/4	200K	S.S.*
300	S.S.	2,000	1/4	15K	S.S.*	250K	5/8
400	S.S.*	2,000	S.S.*	25K	S.S.*	250K	S.S.*
500	3/8	2,500	S.S.	70K	S.S.	500K	S.S.*
1,000	3/8	3,000	3/8	80K	S.S.	1Meg	S.S.
		4,000	3/8	100K	7/16		
		5,000	3/4*	100K	S.S.*		

*SPLIT LOCKING BUSHING $1.50 EACH

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	3-141W	.24	3-142	$0.21
3-140¾W	.19	4-141W	$0.30	2-150	.39
6-140	.25	5-141	.26	3-150	.54
10-140W	.53	5-141¾W	.37	1-141¾W	.51
10-140¾W	.53	8-141¾W	.58		
3-141¾W	.24	9-141Y	.64		

TIME DELAY RELAY

Eagle Signal Corp., Moline, Illinois
1 Min. Delay. 115 V., 60 Cycle
2½ second recycling time spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully Cased
ONLY $6.50

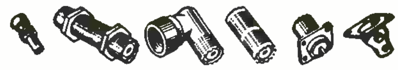
AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

NEW COAXIAL CABLES

	Price per 1000 Ft.		Price per 1,000 Ft
RG 5/U*	$140.00	RG 22A/U	$285.00
RG 6	180.00	RG 24	675.00
RG 7*	85.00	RG 26	475.00
RG 8*	120.00	RG 29*	50.00
RG 9*	250.00	RG 34	300.00
RG 9A/U	275.00	RG 35	900.00
RG 10	240.00	RG 41*	295.00
RG 11*	120.00	RG 54A/U	97.00
RG 12	240.00	RG 55*	110.00
RG 13*	216.00	RG 57*	325.00
RG 17	650.00	RG 58*	60.00
RG 18	900.00	RG 58A/U*	65.00
RG 19	1250.00	RG 59*	60.00
RG 20	1450.00	RG 62*	75.00
RG 21	220.00	RG 77*	100.00
RG 22/U*	150.00		

Add 25% for orders less than 500 feet.
*No minimum order—others 250' minimum.

COAXIAL CABLE CONNECTORS



15¢	$1.30	30¢	80¢	40¢	12¢
UG 175/U	83-1F	83-1AP	83-1J	SO-329	HOOD

83-1AC	$ .42	UG 13/U	$1.75	UG 87/U	$1.60
83-1AP	.30	UG 21/U	1.20	UG 88/U	1.35
83-1F	1.30	UG 21B/U	1.45	UG 167/U	4.85
83-1H	.12	UG 22/U	1.30	UG 175/U	.15
83-1J	.80	UG 22A/U	1.65	UG 176/U	.15
83-1R	.40	UG 24/U	1.30	UG 224/U	1.40
83-1SP	.60	UG 25/U	1.25	UG 255/U	2.45
83-1SPN	.60	UG 27/U	1.30	UG 260/U	1.35
83-1T	1.30	UG 30/U	2.50	UG 290/U	1.35
83-2AP	1.95	UH 57/U	2.30	UG 306/U	2.95
83-2J	2.10	UG 58/U	.80	UG 499/U	1.25
83-22AP	1.10	UG 59A/U	2.25	UG 23/BU	1.70
83-22SP	1.15	UG 60/U	2.40		
83-22R	.68	UG 85/U	1.75		

DIFFERENTIAL

115 V., 60 Cyc. #C78249 **$3.95 ea.**

3⅜" dia. x 5⅝" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)..........$4.50
Mounting Brackets — Bakelite for selsyns, and differentials shown above ....35¢ pair

2J1G1 SELSYNS

400 CYCLE BRAND NEW

POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd
7	23	47	82	180	500	800	.001625	.0056
7.5	24	51	90	220	510	820	.002	.006
	25	56	100	240	560	.001	.0027	.0062
8.2	26	60	110	250	580	.0011	.003	.0065
10	30	62	120	350	600	.0012	.0033	.0068
15	33	68	125	370	620	.0013	.0035	.0082
18	39	70	150	390	650	.00136	.0036	.01
20	40	75	160	400	680	.0015	.004	
22	43	80	175	470	750	.0016	.0044	

Price Schedule

8.2 mmf to 910 mmf....................5¢
.001 mmf to .001625....................8¢
.002 mfd to .0082 mfd....................15¢
.01 mfd ....28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
8	50	82	155	275	466	800	.0022	.0033
10	51	100	170	325	470	.0011	.0023	.0039
18	56	110	180	350	500	.0013	.0024	.005
22	60	115	208	360	510	.0015	.0025	.0051
24	62	120	225	370	525	.0016	.0026	.0056
27	66	125	240	390	560	.001625	.0027	.006
30	68	130	250	400	570	.0018	.00282	.0068
39	75	135	260	410	680	.002	.002826	.0082
40		150	270	430	700		.003	.01

Price Schedule

10 mmf to 875 mfd....................10¢
.0011 mfd to .0025 mfd....................20¢
.0026 mfd to .0082 mfd....................50¢
.01 mfd $1.00

PULSE TRANSFORMERS

UTAH—9262 9278 9280 9340
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9365, KS9565, KS9800, KS9862, KS13161
GENERAL ELECTRIC—K2731 80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

PRECISION RESISTORS—¼ WATT—30¢

2	10.48	12.32	14.98	62.54	147.5	705
2.5	10.84	13.02	15.8	79.81	220.4	2,193
3.5	11.25	13.52	16.37	105.8	301.8	3,500
5	11.74	13.89		123.8	366.6	
6.68				125	414.3	59,148

PRECISION RESISTORS—½ WATT—35¢

.25	13.15	75	400	6,500	16,000	36,000
.334	13.3	87	723.1	7,000	16,700	37,000
.444	15	97.8	855	7,300	17,000	45,000
.502	25	125	970	7,500	19,860	47,000
.557	45	178	1,500	8,000	20,150	50,000
.627	46	179.5	2,500	8,500	21,300	56,000
.76		180	2,850	8,800	25,000	59,000
1.01	52	200	3,995	10,000	26,667	59,905
1.53	55.1	210	4,000	12,000	30,000	68,900
2.04	60	240	4,285	14,825	32,700	70,000
3.25	61	260	4,300	15,000	32,888	79,012
5.26	65	270	4,451	15,750	33,000	92,000
5.89	66.6	290	5,714	15,755	33,300	100,000
10.58	69	298.3	5,900	15,810	35,888	180,000
11.1						

PRECISION RESISTORS—1 WATT—45¢

.1	2.55	15	80			55,000
.11	2.58	18	125		8,250	56,000
.2	2.6	28	250	2,215	9,000	65,000
.21	2.66	30	270	2,250	10,000	68,000
.861	3.1	38	312	3,300	12,000	70,000
1.01	3.39	45.5	420	5,000	12,420	84,000
1.166	4.29	54.25	425	5,221		
	5.21	60	1,530	7,000	50,000	95,000

PRECISION RESISTORS—1 WATT—60¢

100,000	166,100	320,000	399,000	590,000
105,000	240,000		413,000	600,000
120,000	260,000	348,000	520,000	645,000
128,000	270,000		522,000	650,000
130,000	296,000	376,000		700,000
132,000	310,000			876,457
149,500				
150,000				

MEGOHM 1 WATT 1%—$1.50—5%—60¢

PRECISION RESISTORS—2 WATT—75¢

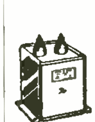
4,385 5,000 6,000 10,000 19,917 23,000

UNIVERSAL JOINTS ALUMINUM

3/16" hole x ⅜ O.D. 1-⅛" long—**50¢**
¼" hole x ½ O.D. 1-⅛" long—**75¢**

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.125	35,000	$39.95	4	1,000	$2.25
.125	27,000	29.95	3	1,000	1.75
.25	20,000	19.95	2	1,000	.95
.15-.15	8,000	2.95	1	1,000	.75
.1	7,500	2.25	1	800	.60
.03	7,500	1.95	10	600	2.95
.1-.1	7,000	2.25	8-8	600	1.79
.1	7,000	1.95	8	600	2.05
.02-.03	7,000	1.65	4	600	1.63
.1	6,000	1.75	4 x 3	600	1.95
.01-.03	6,000	1.45	2	600	.79
2	4,000	6.95	2 x 2	600	1.35
3 x .2	4,000	2.50	8	500	1.50
.06	4,000	1.40	4	500	.98
.25	3,500	2.25			
8	2,000	7.95			
3	2,000	3.75			
.5-.1	2,000	1.95			
.5	2,000	1.95			
.3	2,000	1.75			
.1-.1	2,000	1.65			
.02	2,000	.89			
4	1,500	2.50			
1	1,500	1.50			



8 MFD. 2000 V.D.C. $7.95

OIL FILLED A.C. CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
.2	750	$ .69	30	330	$8.50
8	660	7.50	25	330	7.50
6	660	5.95	20	330	6.75
5	660	5.45	10	330	4.95
4	660	4.95	6	330	3.25
2	660	3.95	4	330	2.25
1	660	2.95	3	330	1.45
15	440	6.25	20	220	4.95
6	440	3.95	10	220	2.95
5-3	440	3.95	7.5	220	2.00
4.4	375	2.15			

1N34 Crystal Diode....................79¢

300 Twin Lead..............02½ per ft. $18.95 per M.

Dynamotor DM 33A ....$3.75 ea.

Chokes: 30 Hy. 80MA @....$1.29; 6HY, 80MA @..79¢

Power Tap Switch—OHMITE (#312-5 Taps) non-shorting 25A 150 V, A.C....................$3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A. C. Fully cased Plugs into octal socket $6.50

Just received—Quantity of used BC 221 parts.
Send us your requirements.

Mike Connector Amphenol 80-81 Interchangeable with Amphenol 80-M cad plated....................25¢

Send Us Your Name For FREE Mailings

Hardware Assortment
Screws, Nuts, Washers, Lugs, Etc. Mostly Brass 3 Lbs. $1

Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

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A LEADING SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY -- FULLY GUARANTEED

A C MOTORS

TELECHRON SYNCHRONOUS MOTOR, Type B3, 110 V., 60 Cy., 4 W., 2 RPM. PRICE $5.00 EA.

TELECHRON SYNCHRONOUS MOTOR Type BC, 110 V., 60 Cy., 6 W., 60 RPM. PRICE $4.00 EA.

EASTERN AIR DEVICES, Type J33, Synchronous, 115 V., 400 Cy., 3ϕ, 8000 RPM. PRICE $15.00 EA.

HAYDON TIMING MOTORS 110 V., 60 CY.

Type 1600, 2.2 W., 4/5 RPM. PRICE $3.00 EA.

TPE 1600, 2.2 W., 1/240 RPM. PRICE $3.00 EA.

TYPE 1600, 2.3 W., 1 RPM. PRICE $3.00 EA.

TYPE 1600, 2.2 W., 1-1/5 RPM. PRICE $3.00 EA.

TYPE 1600, 3.5 W., 1 RPM., With shift unit automatic engaging and disengaging shaft. PRICE $3.75 EA.

TYPE 1600, 2.2 W., 1/60 RPM. PRICE $3.00 EA.

SERVO MOTORS

CK1, PIONEER, 2 ϕ 400 Cy. PRICE $10.00 EA.

CK2, PIONEER, 2 ϕ, 400 Cy. PRICE $14.00 EA.

CK2, PIONEER, 2 ϕ, 400 Cy., with 40:1 reduction gear. PRICE $15.50 EA.

10047-2-A, PIONEER, 2 ϕ, 400 Cy., with 40:1 reduction gear PRICE $10.00 EA.

MINNEAPOLIS HONEYWELL Type B, Part No. G303AY, 115 V., 400 Cy., 2 ϕ, built-in reduction gear, 50 lbs. in torque. PRICE $10.00 EA.

MINNEAPOLIS HONEYWELL Amplifier Type G403, 115 V., 400 Cy., Used with above motor. PRICE $10.00 EA. WITH TUBES

REMOTE INDICATING COMPASSES 26 V., 400 CY.

PIONEER TYPE AN5730-2 Indicator and AN5730-3 Transmitter. PRICE $40.00 PER SET

KOLLSMAN TPE 680K-03 Indicator and 679-01 Transmitter. PRICE $15.00 PER SET

D C MOTORS

DELCO MOTOR, TYPE 5068750, 27 V., D.C., 160 R.P.M., with Brake. Price $22.50 EA.

JAEGER WATCH CO. TYPE 44K-2 Contactor Motor, 3 to 4.5 V. Makes one contact per second. PRICE $3.50 EA.

GENERAL ELECTRIC TYPE 5BA10AJ37, 27 V., 0.5 amps., 8 oz. in torque, 250 RPM. PRICE $10.00 EA.

BARBER-COLMAN CONTROL MOTOR, Type AYLC 5091, 27 V., 0.7 Amps., 1 RPM. Contains 2 adj. limit switches. 500 in. lbs. torque. PRICE $9.50 EA.

WHITE RODGERS ELECTRIC CO., Type 6905 No. 3, 12 V., 1.3 Amps., 1½ RPM, torque 75 in. lbs. PRICE $10.50 EA.

ENGINE HOUR METER

John W. Hobbs Model MI-277. Records running time up 1000 hours. 20 to 30 volts D.C. PRICE $15.50 EA.

INVERTERS

WINCHARGER CORP. PU-16/AP, MG750. Input 24 V. D.C., 60 Amps. Output 115 V., 400 Cy., 1 ϕ, 6.5 Amps. PRICE $100.00 EA.

HOLTZER CABOT TYPE 149F, Input 24 V. D.C. at 36 Amps., Output 26 V. at 250 V.A., 400 Cy., and 115 V., 400 Cy., at 500 V.A., 1 ϕ. PRICE $75.00 EA.

PIONEER TYPE 12117. Input 12 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.

PIONEER TYPE 12117. Input 24 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.

PIONEER TYPE 12116-2-A. Input 24 V. D.C., at 5 Amps. Output 115 V., 400 Cy., 1 ϕ at 45 watts. PRICE $100.00 EA.

GENERAL ELECTRIC TYPE 5D21NJ3A. Input 24 V. D.C. at 35 Amps. Output 115V., 400 Cy., 485 V.A., 1 ϕ. PRICE $35.00 EA.

LELAND PE 218. Input 24 V. D.C. at 90 Amps. Output 115 V., 400 Cy., 1 ϕ at 1.5 K.V.A. PRICE $47.50 EA.

PIONEER AUTOSYNS

TYPE AY1, 26 V., 400 Cy. PRICE $8.50 EA.

TYPE AY5, 26 V., 400 Cy. PRICE $8.50 EA.

TYPE AY14G, 26 V., 400 Cy. PRICE $15.00 EA.

TYPE AY 14D, 26 V., 400 Cy. PRICE $15.00 EA.

TYPE AY54D, 26 V., 400 Cy. PRICE $10.00 EA.

TYPE AY131D Precision Autosyn. PRICE $35.00 EA.

PIONEER AUTOSYN POSITION INDICATORS & TRANSMITTERS

TYPE 5907-17. Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $30.00 EA.

TYPE 6007-39. Dual Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $50.00 EA.

TYPE 4550-2-A Transmitter, 26 V., 400 Cy., 2:1 gear ratio. PRICE $20.00 EA.

VOLTAGE REGULATORS

LELAND ELECTRIC CO. TYPE B, Carbon Pile type. Input 21 to 30 V. D.C. Regulated output 18.25 at 5 Amps. PRICE $6.50 EA.

WESTERN ELECTRIC TRANSTAT VOLTAGE REGULATOR Spec. No. V-122855, Load K.V.A. 0.5. Input 115 V., 400 Cy. Output adjustable from 92 to 115 V PRICE $10.50 EA.

RATE OR TACHOMETER GENERATORS

ELECTRIC INDICATOR CO. TYPE B68 Rotation Indicator, 110 V., 60 Cy., 1 ϕ. PRICE $14.00 EA.

GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-1. Variable frequency, 3 ϕ output. PRICE $25.00 EA.

GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-2. Variable frequency, 3 ϕ output. PRICE $30.00 EA.

ALL PRICES F. O. B. GREAT NECK N. Y.

SYNCHROS

1F SPECIAL REPEATER, 115 V., 400 Cy. PRICE $20.00 EA.

2J1F3 GENERATOR, 115 V., 400 Cy. PRICE $10.00 EA.

2J1G1 CONTROL TRANSFORMER, 57.5/57.5 V., 400 Cy PRICE $10.00 EA.

2J1F1 GENERATOR, 115 V., 400 Cy. PRICE $10.00 EA.

2J1H1 DIFFERENTIAL GENERATOR 57.5/57.5 V., 400 Cy. PRICE $10.00 EA.

5SDG DIFFERENTIAL GENERATOR, 90/90 V., 400 Cy. PRICE $20.00 EA.

5G GENERATOR, 115 V., 60 Cy. PRICE $50.00 EA.

W. E. KS-5950-L2 Size 5G, 115 V, 400 Cy. PRICE $10.00 EA.

D C ALNICO FIELD MOTORS

DIEHL TYPE S.S. FD6-23, 27 V., 10,000 RPM. PRICE $10.00 EA.

DELCO TYPE 5069370, 27 V., 10,000 RPM. PRICE $15.00 EA.

DELCO TYPE 5072400, 27 V., 10,000 RPM. PRICE $15.00 EA.

BLOWER ASSEMBLIES

JOHN OSTER TYPE MX215/APG, 28 V. D.C., 7,000 RPM, 1/100 H.P. PRICE $10.00

WESTINGHOUSE TYPE FL, 115 V., 400 Cy., 6,700 RPM, Airflow 17 C.F.M. PRICE $10.00 EA.

DELCO TYPE 5068571 Motor and Blower Assembly, P.M. Motor, 27 V., 10,000 RPM. PRICE $15.00 EA.

GENERAL ELECTRIC D C SELSYNS

8TJ9-PAB, TRANSMITTER, 24 V. PRICE $4.50 EA.

8DJ11-PCY, INDICATOR, 24 V. Dial marked −10° to +65°. PRICE $6.00 EA.

8DJ11-PCY, INDICATOR, 24 V. Dial marked 0 to 360°. PRICE $7.50 EA.

RECTIFIER POWER SUPPLY

Hammett Electric Mfg. Co., Model SPS-130, Input Voltage AC 208 or 230, 60 cycle, 3 phase, 21 amps. Output 28 Volts, 130 amps, continuous duty. 37" high, 22½" wide, 21" deep. Contains DC Volt meter, DC amp meter and 8 point tap switch for variable output voltage. Brand new. Price $350.00.

MISCELLANEOUS

PIONEER MAGNETIC AMPLIFIER ASSEMBLY Saturable reactor type output transformer. Designed to supply 1 of 400 cycle motor such as the Pioneer CK-5 or CK-2 from the plate of a 6SN7 tube. PRICE $15.00 ea.

SPERRY A5 CONTROL UNIT, Part No. 644836. PRICE $7.50 EA.

SPERRY A5 AZIMUTH FOLLOW-UP AMPLIFIER, Part No. 656030, with tubes. PRICE $5.50 EA.

SPERRY A5 DIRECTIONAL GYRO, Part No. 656029, 115 V., 400 Cy., 3 ϕ. PRICE $25.00 EA.

PIONEER TYPE 12800-1 GYRO SERVO UNIT. 115 V., 400 Cy., 3 ϕ. PRICE $20.00 EA.

ALLEN CALCULATOR TYPE C1 TURN & BANK INDICATOR, Part No. 21500, 28 V. D.C. PRICE $15.00 EA.

TYPE C1 AUTO-PILOT FORMATION STICK, Part No. G1080A3. PRICE $15.00 EA.

PIONEER GYRO FLUX GATE AMPLIFIER Type 12076-1-A, 115 V., 400 Cy. PRICE $40.00 EA.

INSTRUMENT ASSOCIATES

363 GREAT NECK ROAD, GREAT NECK, N. Y.
Telephone GReat Neck 4-1147

Write for Catalog NE100

U. S. Export License-2140

Western Union address: WUX Great Neck, N. Y.

EQUIPMENT CO.

AUDIO TRANSFORMERS

AT501 Hi-Fi Special: PRI: 3000 ohms P-P/Sec: 4/16/12/50/200 ohms 60-10,000 CY.—1 db 50W. $3.49
AT152 Hi-Fi Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db. $1.49
AT063 Output to H.S. or line PRI: 14,200 ohms SEC: 8000/600 ohms $1.19
AT449 Hi-Fi Driver (5000 ohms) to P.P. output grids (4,000 ohms) 100-10,000 CY. 10 W. 6V6 to PP 805's $2.39
AT666 Intercon Input: Spkr (-4-8 ohms) to grid ($250,-000 ohms) $0.69
AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY $1.95
AT858 Plate (10,000 ohms C.T.) to line V.C. (500/125130 ohms) HI-FI—50 W. $6.95
AT070 Mike-or-Line (250 ohms) to grid (250,000 ohms C.T.) $1.20
AT765 Mike-or-Line (600 ohms) to grid (50,000 ohms C.T.) $0.89
AT-871 Universal Output—10W Hi-Fi
PRI: 20,000 Ohms P-P/16,000 Ohms P-P also 5000/4000 ohms. Single End.
SEC. 500/15/7.5/3.75/1.25 ohms. Response Flat P.M. 1 d.b. 30-20,000 Cycles. $4.75
AT-694 Hi-Fi Output: 3 Watts. 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db. $1.49
AT4-A1: Mike (35 ohm Carbon) to Line 600 ohm/200 ohm $1.19
AT 649: Line (500 ohms) to Grid (75K ohms) .... .89¢
AT-448: Line (600 ohms) to V.C. (6 ohms) 17 d.b. Level $1.19
AT 631: Mike-or-Line (200 ohms) To Single or P-P Grids (50K Ohms) .59¢
AT 718 Line (300 ohms) to Line (600/30 Ohm) Response 50-20KC P.M. 1 db. .49¢

TUBES! VACUUM TUBES TUBES!

O1A	.66	12HP7	14.65	723A	9.75
2C21	.66	12SK7	.79	723A/B	17.95
2C22	.54	12SR7	.79	724B	3.15
2J21A	14.95	15E	.98	725A	7.95
2J22	14.95	15R	.75	726A	6.75
2J26	24.50	23D4	.42	730A	37.50
2J27	21.50	35/51	.74	800	1.45
2J31	29.75	38	.54	801-A	.44
2J32	38.75	39/44	.52	809	2.35
2J38		45S	.32	837	1.65
2J39	47.50	227A	4.39	838	3.25
2J49	59.50	5C27	4.39	860	
2J61	54.50	255A	14.00	861	23.50
2J62	48.50	417A	8.75	876	1.45
3B24W	5.25	532	3.49	932	.75
3BP1	4.95	559	.98	1619	.28
3CP1	2.25	615	.44	1625	.39
3C23	9.95	700-A	23.50	1626	.39
3C30		700-B	23.50	1629	.35
3DP1	3.95	700-C	23.50	1961	4.75
3EP1	3.95	703-A	6.75	8013A	4.85
3FP7	2.19	704-A	.89	9004	.49
3J31	85.00	705-A	2.45	9006	.27
4C27	9.75	706-AY	42.50	GL697	
4J38	87.50	706BY	37.50	NR74	.27
5FP7	7.95	706CY	37.50	QK60	85.00
5GP1	4.75	706EY	44.50	QK61	85.00
5J23	12.75	715B	15.95	QK62	85.00
5J30	24.50	717A	1.25	VR91	1.45
6U5/6U5G	.89	718DY	44.50	WL530	9.95
10Y	.42	719A	24.50		

IE-12
SCR 522 TEST SET-UP
CONTAINS SIG. GEN. 1-96, F.S. METER 1-95, RCVR.-XMTR. SCR 522, ALSO, CONTROL BOXES, CABLES, ALL CRYSTALS, DYNAMOTOR, TOOLSET, INSTRUCTION MANUAL, ETC. BRAND NEW, COMPLETE $1295.

SPECIALS

SA-4A/APA-1-MOTOR DRIVEN ANT. SWITCH—NEW $14.95
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 Antennae $8.50
2 Meter Choke, 1000 MA, 20-144 8/$1.00
Supersonic Crystal Head, MI-2, 22-27KC HI-2 $27.45
Underwater Microphone, Model JR, Z=50ω $24.50
Dynamic Mike & Headset Combo. B-19. New $3.75
HS-30 Inserts, M-300 $3.50 per M
Motors, 3 RPM—115V, 60 Cy $1.85
AN/ARC-4 VHF Trans-Rcvr $75.00
IE 36 Test Set. New $37.50
SCR 274 Test Set, I-104 $42.25
Time Delay Relay—45 Sec. 115VAC-DC 10A $2.29
Carbon Pile Reg., 18V-.5V #35X025
ART-13 Driver Trans. 6V6 to P-P 811's $1.29
DM 34 Dynamotor, 14V In. 220V, 80 MA out
Sens. Relay: 3.5MA, 13K ohms, 2PST, 2A $1.29
Klixon Breaker: Thermal, 35A .69
T-30 Carbon Mikes. New .89
Screen Mod. Trans. for 807's $1.19
3-4 MC Coils for ARC-5 #6029, #7247 Set $2.79
400 Cy Volt Reg. RH Transtat. In: 115V, 400 Cy. Out: 75-120V, 6A $12.75
BC 1203 Pulse Test Set for SCR 535 $175.00

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps input

CT-07	760VCT	.300A	5V/3A, 6.3VCT/7A	$5.95
CT-15A	550VCT	.085A	6.3V/.6A, 6.3V/1.8A	2.35
CT-164	4200V/.002A/12KV Test, 5VCT/3A/12KV Test, 6.3V/0.6A/5400V Test			12.95
CT-341	1050V/10 MA, —625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A			22.50
CR-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V	.160	2.5/12, 30/.100	9.95
CT-15A	350VCT	.070	6.3/.6, 6.3/1.8, 3 lbs	2.95
CT-071	110V	.200	33/.200, 5V/10, 2.5/10	4.95
CT-378	2300V	4 MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.010	6.3/1A, 2.5VCT/7A.	3.25
CT-403	350VCT	.026 MA	5V/3A	2.75
CT-931	585VCT	.036	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002 MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026 MA	5V/3A	2.75
CT-866	330V	.065	6.3V/1.2, 6.3V/600 MA	1.75
CT-456	390VCT	30 MA	6.3V/1.3A, 5V/3A	3.45
CT-160	800 VCT	100 MA	6.3V/1.2A, 5V/3A	4.95
CT-931	585VCT	86 MA	5V/3A, 6.3V/6A	4.95
CT-442	525VCT	75 MA	5V/2A, 10VCT/2A, 50V/200 MA	3.85

Filament Transformers—115V/50-60 cps input.

Item	Rating	Each
FT-674	8.1V/1.5A	$1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	17.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	12.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A TAP 2.5V/2.5A 16KV TEST	18.95
FT-340	2x2.5V/3A, 7V/7A—23KV TEST	24.95
FT-038	6.3V/500A WELD	29.45
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5V/.5A, 7V/7A	2.19

Plate Transformers—115V/50-60 cps input.

Item	Rating	Each
PT-919	1200—0—1200 200 MA	$8.95
PT-976	Auto: 120VCT/10 MA	.69
PT-31A	2x300V/5 MA	.79
PT-403	Auto: 70V/4A	2.29
PT-160	1120VCT/770 MA, 590VCT/82 MA, 25 lbs.	24.95
PT-170	Auto: 156/146/137/128—.71A	3.29
PT-31A	2x300V/5 MA	.79
PT-976	120VCT/10 MA	.79
PT-446	185V/3.5A	3.59
PT-699	2x300VCT @ 50MA	1.59

TRANSTAT: TYPE TH45BG: IN: 130 or 260V. Max. OUT: 0-260V, 45A, 11.7KVA 60 Cy. 1 Phase —Ex. Cond. Write for further details.

Special Filament Transformers

Item	Pri.	Output	Price
STF-05A	115/230	2 x 5V/7.57" H x 7" x 5" D.	4.25
STF-682	220	30-25-20V/1 MA	.69
STF-370	220/440	3 x 2.5V/57, 2.5V/15A, 5½ x 5 x 4½	5.25
STF-11A	220	2 x 40V/.05/2 x 5V/6A, 12.6/1A	2.95
STF-631	230	2 x 5V/27A 2 x 5V/9A	24.95
STF-96B	230	2.5/6.5A	1.95
STF-370	220/440V	3 x 2.5V/5A, 2.5V/15A	9.95
STF-085	220/440V	2.5V/60 ACT	15.95
STF-083	220/440V	5VCT/30A, 3000 V TEST	17.50
STF-619	110/220V	2.5V/500A	19.95

115 V—400 CY XFMRS

Stock	Ratings	Price
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	2.75
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/.01A	4.29
UX8355C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65 MA, 5VCT/3A	3.59
T-48852	700VCT/80 MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300VCT, 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, 6.3V/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
302433-A	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	6.4V/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/1.75A	17.95

TRANSTAT; IN: 115V, 400 CY. OUT: 75-120V, 6.0 Amps 12.95

FILTER CHOKES

Stock	Description	Price
CH-250	SWING. 2.5-24H/.4-.05A 10KV Test	$7.95
CH-8-19	SWING. .006H/5A-.035H/.5A .032 ohs DCR. 1KV TEST	3.95
CH-776	1.28 H/130 MA/75 ohms	2.25
CH-344	1.5 H/145MA/1200V Test	2.35
CH-43A	10 HY/15MA—850 ohms DCR	1.75

POWER RESISTORS

120W—WW—5% Tol.
1⅛" Ferrule, 9½" Long

Res.-Ohms	Price	Res.-Ohms	Price
2.5*	55¢	198*	35¢
25*	35¢	225	30¢
30	45¢	250	45¢
32.5	35¢	300*	35¢
40	30¢	450	65¢
50*	45¢	500*	40¢
70*	45¢	630*	55¢
100	70¢	4500	50¢
125	35¢	8000	90¢
125*	45¢	160,000	65¢

* Tapped to give 10 equal sections with 9 tabs.

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 II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
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-E: Input: 25 28 vdc, 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. Dim. 17"x6½"x10". New $34.50
PE-218-H: Same as above except size: 16½"x6"x10". New $34.50
PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5½"x10½". New $22.50
MG 149F. Input: 24 vdc. 36A. Output: 26 v @ 250 va. 400 cy, and 115 v @ 400 cy—500 va 1 phase $75.00

SELENIUM RECTIFIERS

UP TO 18 VAC IN—UP TO 14 VDC OUT

2A	$2.50
4A	4.00
6A	6.00
10A	7.50
12A	9.00
24A	18.00

UP TO 36 VAC IN—UP TO 28VDC OUT

1A	$3.00
2A	4.00
4A	8.00
10A	14.50
12A	18.00
24A	36.00

UP TO 54 VAC IN—UP TO 42 VDC OUT

2A	$6.50
4A	8.50

UP TO 120 VAC IN—UP TO 100 VDC OUT

2A	$11.00
10A	48.00
12A	60.00

Special Rectifiers On Request

Hi-Current Chokes
.1 HY—12Amp—0.46 Ohms $14.95
.01 HY—2.5 Amp—Cased $2.25

LO-VOLT. XFMRS
Primaries 115v, 60 Cycle

36V-40V at 3.5 amps	$3.75
24v-1.5A	1.95
8v-1.5A	.98
16v-5A	3.75
12v-5A	3.75

HI CAP. FILTER CONDENSERS

Cap.	WVDC	Price
800	15	$1.35
2000	6	1.85
500	200	2.00
250	150	1.45

PRECISION RESISTORS 1%

OHMS	OHMS	OHMS
5	150	7,500
5.05	250	10,000
10	430	12,000
18	468	17,000
82	800	20,000
120	920	30,000
125	1100	35,000
128	4300	84,000

30c EACH.....10 FOR $2.50
100K 120K 150K 220K
40c EACH.....10 FOR $3.50
1 MEGOHM......EACH 75c

MAGNETRONS

Tube	
2J27	2J62
2J31	3J31
2J21-A	5J30
2J22	718DY
2J26	720BY
2J32	725-A
2J38 Pkg.	730-A
2J39 Pkg.	QK 62
2J49	QK 59
2J61	QK 61
	QK 60

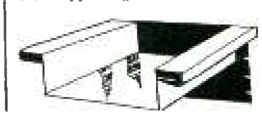
700 A, B, C, D
706 AY, BY, DY, EY, FY, GY

UNIVERSAL POWER TRANSFORMER

Pri: Vibrator Input @ 6/12/24/110 VDC, AC Input: 110/220 V. @ 60 CY.
Sec: 230-0-230 V — 40 MA
6.3V — 1.8A.
E $1.49

TYPEWRITER WELL

Heavy Duty Standard Panel, 19" x 10½"W x ⅛", tough steel supporting metal desk well 20" x 15" wide x 4½" deep. Ideal for that new, compact rig. Space saving panel may be used to support extra equipment. Attractive gray finish. New. Only a few left $4.95



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COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. MR. CHAS. ROSEN **Dept. E-4.** **Phone Main 4-8373**

COMMUNICATIONS

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER. Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio. .001 max. Pulse duration: 5. 1.0, 2.0 microsec. Input voltage: 115 v 400 to 2400 cps. Uses: 1-715B. 4-829-B, 3-'72's, 1-'73. New $110.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk Pwr. out 35 KW Energy 0.018 Joules $49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS, 1.5 microsec, pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

APS-4C MODULATOR DECK. Complete, less tubes $75.00

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec 400 PPS, 50 ohms imp. $22.50

G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS, 50 ohms impedance $6.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 84 Microsec. 810 PPS. 50 ohms imp.: Unit 2, 8 Sections, 2.24 microsec. 405 PPS, 50 ohms imp. $6.50

7.5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec 200 PPS, 67 ohms impedance, 3 sections $7.50

7.5E4-16-60, 67P, 7.5 KV, "E" Circuit, 4 sections 16 microsec, 60 PPS. 67 ohms impedance $15.00

7.5E3-3-200-6FT, 7.5 KV, "E" Circuit, 3 microsec, 200 PPS, 67 ohms imp. 3 sections $12.50

Multi Section Pulse Network: All ratings 8KV

Z=50 ohms

Pulse Length Msec	PRR	Sections
.25	1600	2
.50	800	2
2.6	400	4
5.20	200	4+4

Physical Size: 2" x 10⅝" x 5⅝" $47.50

PULSE TRANSFORMERS

G.E.K.-2745 ...... $39.50

G.E.K.-2744-A. 11.5 KV High Voltage. 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec, or 1/microsec. @ 600 PPS $39.50

W.E.-KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1 and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s., Permalloy core $6.00

W.E. #D169271 Hi Volt input pulse Transformer $27.50

G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G. E. $34.50

G.E. K2748A. Pulse Input line to magnetron $36.00

Ray UX 7896—Pulse Output Pri. 5v. sec. 41v $7.50

Ray UX 8442—Pulse inversion—40v + 40v $7.50

Ray UX 7361 ...... $5.00

PHILCO #352-7250, 352-7251.

UTAH #9262, 9332, 9278.

MICROWAVE TEST EQUIPMENT

X BAND POWER METER

Consists of thermistor mount and bridge, microammeter, rough attenuator. X-Band Waveguide thruout. For power measurements anywhere in the 9000 MC band $225.00

BROADBAND TEST OSCILLATOR

Freq. coverage 50-3000 MC. By direct calibration and interpolation anti-backlash gear drive; compact, portable. Operates from any 115V source or battery source. New, with all tubes $425.00

TS-56A/AP	I-158	TS 47/APR	TS 226
CW60-ABM	I-222	TS 36/AP	TS 89
LU-1	I-185	TS 12 UNIT 2	I-203-A
LU-3	TS 268/U	Q. METER	TS 11/AP
TS 159	TS 102/AP	TS 69/AP	BC 438
CS60-ABW			

SEND FOR FURTHER INFORMATION AND PRICES

MICROWAVE ANTENNA EQUIPMENT

3 CM ANTENNA WITH DISH 14" Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanisms. Complete. New as shown $125.00

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½ x 3'. New $75.00

Dipole for above $12.00

TDY "Jam" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New $150.00

10 CM Horn, Rectangular-to square-to circular RF assembly ending in horn, radiating circularly polarized beam. Waveguide input. Complete with flange $50.00

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 (as shown) $4.50

140-600 DIRECTIONAL ANTENNA

140-310mc cone and 300-600 mc cone, each consisting of 2 end fed half wave conical sections with enclosed matching stub for reactance changes with changing frequency.

New: complete with mast, guys, cables, carrying chest $49.50

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L X 4'W X 3'H. Unused $250.00

Gov't Cost—$4500.00

DBM ANTENNA. Dual back-to-back parabolas with dipoles. Freq. coverage 1,000-4500 mc. No drive mechanism $65.00

RADAR SETS

APS-2, Airborne, 10 CM, Major Units, New.

APS-4, Airborne, 3 CM Compl.

APS-15, Airborne, 3 CM, Major Units. New.

SD-4, Submarine, 200 MC, Compl. New.

SE, Shipboard, 10 CM, Compl. New.

SF-1, Shipboard, 10 CM, Compl., New.

SJ-1. Submarine, 10 CM, Compl., Used.

SL-4, Shipboard, 10 CM, Compl., Used.

SN, Portable, 10 CM, Compl., Used.

SQ, Portable, 10 CM, Compl., Used.

SO-1, Shipboard, 10 CM, Compl., Used.

SO-7, Portable, 10 CM, Assault.

SO-8. Shipboard, 10 CM, Compl., Used.

10 CM RESEARCH EQUIPMENT

COAXIAL WAVEMETER, W.E. Transmission type, using type "N" fittings. Calibrated between 3400-4500 MC $99.50

LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $49.50

BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice ...... each $47.50

MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated $45.00

SIGNAL GENERATOR, using 417A klystron, 2700-3300 mc. Output approx. 50 mw. 115 vac power supply. With tubes, new $425.00

REGULATED POWER SUPPLY for GL 446 type lighthouse tubes (2C40, etc.) 115 vac, 60 cycles. Panel Mounting. Less tubes $32.50

RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR cavity, compl. recvr. & 30 MC IF strip using 6AK5 (2C40, 2C43, 1B27 lineup) w/Tubes.

721A TR BOX complete with tube and tuning plungers $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28. Three types available $4.00

TS 268 CRYSTAL CHECKER $35.00

F 29/SPR-2 FILTERS, type "N" input and output $12.50

WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50

AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees ...... per set, $75.00

AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

S BAND SIGNAL GENERATOR, complete with calibrated attenuator, W. E. coax. wavemeter, McNally Klystron Cavity. Regulated power supply operates from 115 V.A.C., 50-1200 Cycles. Manufactured by W. E. $650.00

OAJ ECHO BOX, 10 CM, TUNABLE $22.50

⅞" RIGID COAX—⅜" I. C.

RIGHT ANGLE BEND, with flexible coax output pickup loop $8.00

SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00

RIGID COAX to flex coax connector $8.50

STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00

RT. ANGLES for above $2.50

RT. ANGLE BEND 15" L. OA $3.50

FLEXIBLE SECTION, 15" L. Male to female $4.25

FLEX COAX SECT. Approx. 30 ft. $16.50

⅞" RIGID COAX. BULKHEAD FEED-THRU $14.00

3 CM Research Equipment

1" x ½" Waveguide

1" x ½" waveguide in 5' lengths. UG 39 flange to UG40 cover ...... per length, $7.50

Rotating Joints supplied either with or without deck mounting. With UG40 flanges ...... each, $17.50

2J42 Magnetron Pulse Modulator. 14kw max. rating 7kw min. Plate voltage pulsed 5.5kv 6.5 Amp. .001 duty cycles. 2.5 usec pulse length max. filament 6.3V .5 Amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24. New $75.00

TS 268 Crystal Checker $35.00

Bulkhead Feed-Thru Assembly $15.00

Pressure Gauge Section 15 lb. gauge and press nipple $10.00

Pressure Gauge, 15 lbs. $2.50

Dual Oscillator-Beacon Mount. P/O APS 10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields $42.50

Dual Oscillator, Mount. (Back to back) with crystal mount, tunable termination attenuating slugs $18.50

Directional Coupler. UG-40/U Take off 20 db $17.50

2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount. Iris coupling and choke coupling to TR $22.50

TR-ATR Duplexer section for above $8.50

CU 105/APS 31 Direction Coupler 25 db $25.00

723AB Mixer—Beacon dual Osc. Mnt. w/xtal holder $12.00

Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50

Twist 90 deg. 5" choke to cover w/press nipple $6.50

Waveguide Sections 2½ ft. long silver plated with choke flange $5.75

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90 dgeree elbows, "E" or "H" plane 2½" radius $12.50

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40KW X BAND Radar, complete as described and illustrated in July 1951 PROC IRE

APS-4 Under Belly Assembly, less tubes $375.00

1¼" x ⅝" WAVEGUIDE

Mitered Elbow H Plane UG51-UG52 ...... $12.00

6" St. sect. choke to choke $3.50

CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD $10.00

X Band Wave GD. 1¼" x ⅝" O.D. 1/16" wall aluminum ...... per ft., 75¢

Slug Tuner Attenuator W.E. guide. Gold plated $6.50

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Bi-Directional Coupler, UG-52, Takeoff 25 db. coupling $24.95

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1.25 CM RESEARCH EQUIPMENT

Shunt Tee $35.00

Waveguide Lengths, 2" to 6" long, gold plated with circular flanges and coupling nuts ...... per inch, $2.25

APS-34 Rotating Joint $49.50

Right Angle Bend E or H Plane, specify combination of couplings desired $12.00

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Feedback to Parabola Horn with pressurized window $27.50

90° Twist $10.00

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OA3	1.50	2J26	27.75	5BP1	6.95	311A	7.95	724A	4.95	869BX	35.00
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OD3	1.50	2J32	69.95	5D21	27.50	327A	3.95	726A	6.95	884	1.95
C1A	4.95	2J36	105.00	5JP1	27.50	328A	9.95	726B	56.00	885	1.75
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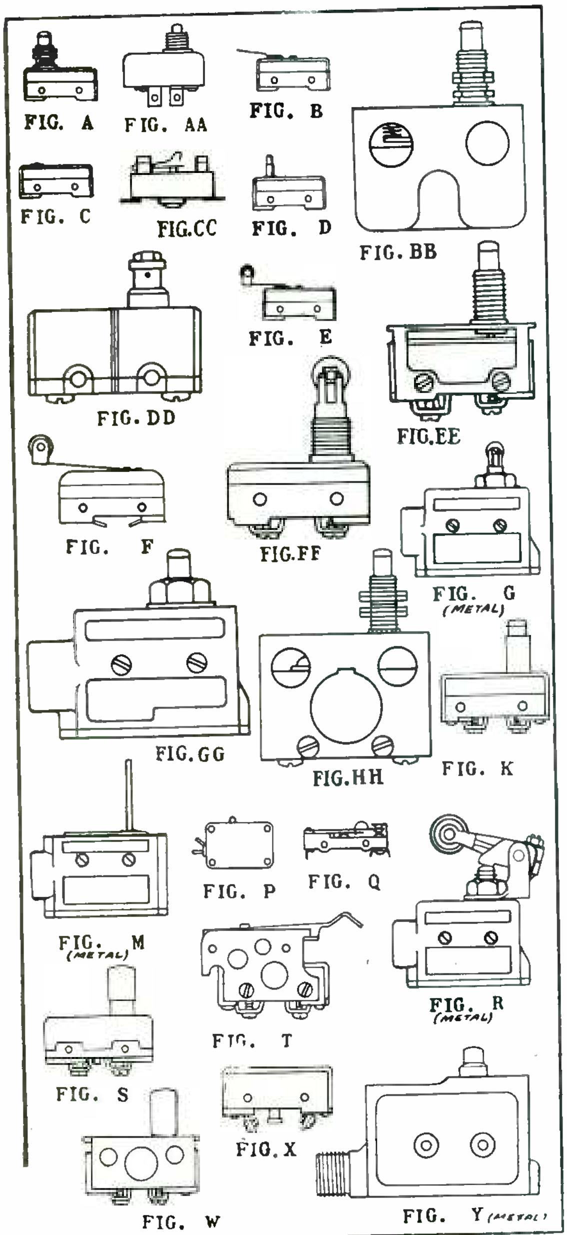

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4MM2	MU	ACZ101BB	SPDT	W	.85	4MD16	MICRO	WZ7R	NC	C	.55
4MC17	MICRO	B-1	NC	Y	1.45	4MC15	MICRO	WZ7RQT2	NC	A	.70
4MC16	MICRO	B-1T	NC	DD	.90	4MD36	MICRO	WZ7RST	NC	D	.55
4MC7	MICRO	B-14	NO	HH	1.70	4MC23	MICRO	WZE7RQTN	NC	R	3.75
4MD62	MICRO	B-R	SPDT	C	.70	4MD54	MICRO	WZR8X	NC	X	.80
4MD63	MICRO	B-RS36	SPDT	D	.80	4MC9	MICRO	WZR31	NC	C	.65
4MD23	MICRO	BD-RL32	SPDT	B	.95	4MD57	MICRO	WZR31	NC	T	.70
4C51	MICRO	BZ2FTC1	SPDT	C	.75	4MD31	MICRO	WZRD	NC	C	55
4ML4	MICRO	BZRQ41	SPDT	W	.85	4MD19	MICRO	WZRL8	NC	B	.70
4MD51	MICRD	BZ-R37	SPDT	C	.70	4ML3	MICRO	WZRQ41	NC	W	.65
4MD2	MICRO	BZE7RQT2	SPDT	GG	1.70	4ML2	MICRO	WZV7RQ9T1	NC	G	2.25
4MD21	MICRD	BZ-7RST	SPDT	D	.80	4MC21	MICRO	X757	NC	C	.55
4MD38	MICRO	BZE2RQ9TN1	SPDT	G	2.65	4MD37	ACRO	XC1A	NC	C	.55
4MD6	MU	CUM 24155	NO	E	.80	4MC5	ACRO	XD45L	SPDT	B	.95
4ML1	MU	D	NO	BB	1.50	4MD4	MICRO	YZ	NO	C	.75
4MC12	MICRD	D in case	NC	Y	1.45	4MD40	MICRO	YA2RLE4D13	NO	B	.70
4MD60	MICRO	G-RL	NO	B	.80	4MD24	MICRO	YZ2YLTC1	SPDT	B	.95
4MC11	MICRO	G-RL 5	NO	B	.80	4MC1	MICRO	YZ2YST	SPDT	D	.60
4MD61	MICRO	G-RL35	NO	B	.80	4MD13	MICRO	YZ3R3	NO	C	.60
4MC32	ACRO	HRO 7.1P2TSP1	NO	K	.65	4MD56	MICRO	YZ3RLTC2	NO	B	.80
4MC19	ACRO	HRO7.4P2T	NO	S	.60	4D79	MICRO	YZ3RT	NC	C	.60
4MD8	ACRO	HRRC 7.1A	NC	C	.55	4D127	MICRO	YZ3RW2	NC	F	.80
4MD27	ACRO	HRRO 7.1A	NO	C	.60	4MC14	MICRO	YZ3RW2T	NO	F	.90
4MC31	MICRO	LN-11 HO3	SPDT	M	1.70	4MD49	MICRO	YZ7RQ9T6	NO	FF	.85
4MC18	MU	MLB 321	SPDT	B	.95	4MD32	MICRO	YZ7RST	NO	D	.60
4MD1	MU	MLR 643	NC	B	.70	4MC13	MICRO	YZ7RA6	NO	EE	1.00
4MD55	PHAO	PS 2000	SPDT	C	.85	4C116	MICRO	YZRE4	NO	C	.65
4MC28	ACRO	RC71P2T	NC	A	.70	4MC20	MICRO	YZRQ4	NO	S	.60
4D129	ACRO	RD71AT2	SPDT	C	.75	4MC22	MU	Z	NC	Y	1.45
4MD22	ACRO	RD2M	NO	E	.80	4MD52	MU	Blue Dot	SPDT	E	.90
4MC28	ACRO	RO2M12T	ND	E	.80	4C73	MU	Blue Dot	SPDT	D	.80
4D87	ACRD	RD7 8586	NO	K	.70	4MC8	MU	Red Dot	NC	C	.65
4MC25	MICRD	R-RS	NC	D	.50	4MD18	MICRO	Open Type	SPDT	Q	50
4MD9	MICRO	SW-186	NC	D	.50	4MD39	MU	Green Dot	NO	B	.80
4MC10	MICRO	WP3M5	NC	AA	.50	4MC29	MU	Green Dot	NO	D	.55
4MC4	MICRO	WP5M3	NC	AA	.50	4D84	MU	Green Dot	NO	B	.80
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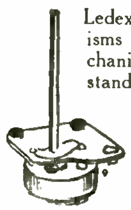

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68–115	1.10	168–195	1.35

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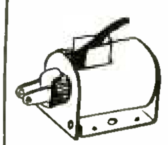

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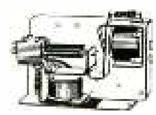

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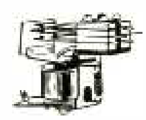

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GUARDIAN: 24 VAC, 48 ohm relay, Makes 2 Breaks 2............**$1.49 ea. $125/C**

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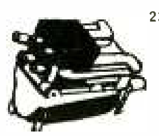

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23012-0 RBM, 24VDC, SPDT, 250 ohms, #R172..**$1.25**
7251 ARC, 24VDC, SPDT, 300 ohm, #R406......**$1.25**
7252 ARC, 24VDC, DPST, n.o. (2As) 300 ohm, Anti-Capacity Arms, Ceramic Insulation, #R354.....**$1.25**

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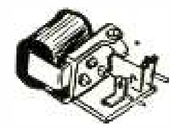

RBM 23025 6 ma., SPDT, 8000 ohm, #R428 **$1.50**
W.E. (Whelock) KS9665 9 ma., 1A, 1B, 1C, 2000 ohm, #R426..............**$4.95**
Kurman Midget 12 ma., SPDT, 1500 ohm, #R427 ....**$.98**
Clare Type J (K102) 6 ma., SPDT, 3500 ohm, #R30 ....**$3.50**
Dumont 5 ma., 1A, 5000 ohm #R230.. **$.98**
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Cooke Type C 4 ma., 1A, 6500 ohm, #R596 **$3.50**
Claire B11613 (K101) 2 ma., SPDT, 6500 ohm, #R588 ....**$4.95**
Clare A8053 8 ma., 3A, 6500 ohm, #R408 **$3.95**
Potter-Brumfield; 9 ma; 2500 ohm, SPDT; 5 Amp Contacts; #R364..........**$1.25**
Potter-Brumfield; 5 ma; 5000 ohm; SPDT; 5 Amp Contacts; #684............**$1.50**
RBM 452-1041; 4 ma; 12,000 ohm; DPDT; Telephone Type; #R685..........**$4.95**

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State quantity and price.

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DYNAMOTORS • SELSYNS • AUTOSYNS • INVERTERS • TRANSMITTERS
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Please send list stating condition and lowest price.

No Quantity Too Small or Too Large!

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We want to buy all types of surplus electronic equipment. We are one of the largest buyers in U. S. We buy more because we give every seller top prices and a fair deal. TELL US WHAT YOU HAVE. USE COUPON BELOW—*AND MAIL TODAY!*

Use following numbers to indicate conditions: N-1, brand new; N-2, used, like new; N-3, used.

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Name ....

Address ....

SEE COLUMBIA ELECTRONICS AD ON PAGE 373

ELECTRONIC ENGINEERS

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Small electronic research and development laboratory, located 8 miles outside of Washington, D. C., has several openings for junior and senior electronic engineers. Degree essential. Varied projects include analog computers, servo mechanisms, special test equipment, etc. All Defense work. Liberal salaries dependent upon experience.

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in Radar, Guided Missiles, Servos, Computers, Receivers, Solid State Physics, Image Converters, Pulse and Timing Techniques, Special Purpose Tubes, Networks and Systems Design, Light and Electron Optics, Storage-Type Tubes, Photo-Electric Pickup Tubes, and Related Equipment.

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With Particular Opportunities In Analytical Treatment Of Problems Including

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These positions are permanent.
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Knowledge of organs as well as musical-acoustics, essential.
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To properly fit into our organization, this man must have a burning desire to work with electronic organs. *Write:* President,

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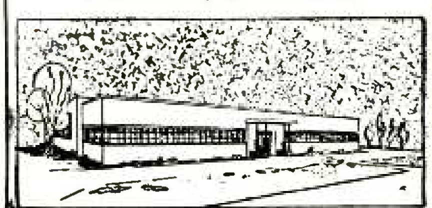

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Electronic Engineers qualified by design experience on DC and wide band amplifiers, low power pulse circuitry, computers, telemetering or allied fields, should contact Tracerlab, Inc.

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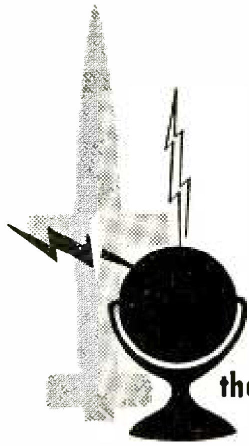
Industrial Relations Department

TRACERLAB, INC.
130 High Street Boston 10, Mass.



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Unusual opportunities for those experienced in the design and analysis of Radar and Missile Guidance Systems.

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Please send me ***FREE*** booklets describing the Convair Opportunity for me and my Convair Application Form.

My name ____________________

Occupation ____________________

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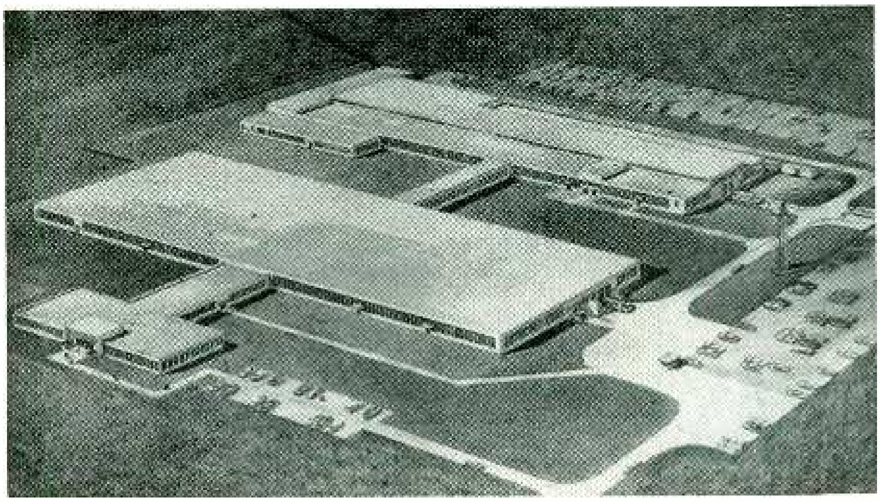
City ____________ State ____________



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Minimum requirement is a B.S. Advanced degrees are even better, but experience to back up the degree is really best. We pay industrial salaries. Other tangible advantages here (for example, our self-sponsored internal research policy) should be of particular interest to men with intelligence, ingenuity, and initiative. Send us your resume; all inquiries are strictly confidential. Promising candidates will be invited to Buffalo for interviews at Laboratory expense.

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VICE-PRESIDENT in Charge of Industrial Sales, Heavy Market Research Background.....$30,000
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SALARIED PERSONNEL, $3,000-$25,000. This confidential service established 1920, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. L, 241 Orange St., New Haven, Conn.

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EE GRADUATE with twenty years broad experience in the radio-communications manufacturing field seeks a position on the executive or administrative level with a manufacturer or laboratory requiring a man of initiative, integrity, and adaptability. Well rounded experience includes sales, research and development, and product design both on a personal and leadership basis. Salary at least $9,000. PW-3621, Electronics.

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Two Swiss, high quality, winding machines will be used according to your specifications on relay or random type coils. Now in position for 24 hour usage. Send print and quantity for quotation.

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An advertising inch is measured 7/8" vertically on one column. 3 columns—30 inches—to a page.

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The publisher cannot accept advertising in the Searchlight Section which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

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WE CARRY A WORKING INVENTORY of some metals for prompt service. Send us your order for one pound or a thousand—or write for catalog of products and services.

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ELECTRONICS

Must have mechanical aptitude and be able to plan and build own equipment and parts. Applicant must be interested in the research field where immediate results are not always forthcoming. An excellent opportunity to work in the modern research laboratory of our progressive Engineering Department.*

** Write Employment Mgr. giving full details of qualifications and background.*

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supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

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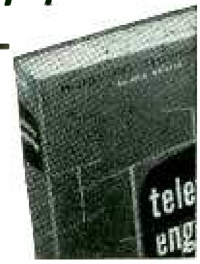

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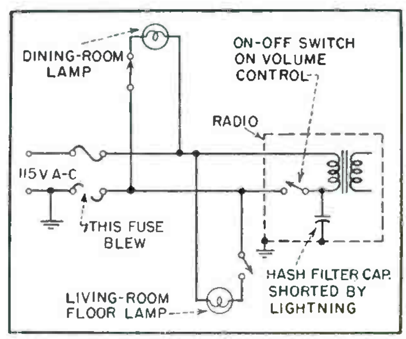
that as long as we could not study in darkness, we might as well listen to the radio. I turned the volume control knob, and as I did so, the light in the dining room came on. When one of the other students pulled the chain to try the lamp beside the radio, a loud woosh came from the radio along with a cloud of smoke, the house was plunged into total darkness, and the radio went off.

"I then replaced the fuse at the power meter in the basement and came back to find all lights on, but the radio was turned off with a large sign across it, "Out of Order DO NOT TURN ON". I calmly removed the sign, turned on the radio and thus proved it in normal working condition."

Solution

A circuit of the wiring involved is shown below. The receiver had a good ground from chassis to a



water pipe. The on-off switch (on the volume control) was in the normally-grounded side of the power line, and an r-f hash filter capacitor was on the transformer side of the switch to chassis.

The lightning flash blew only the line fuse in the normally-grounded side of the line and simultaneously popped the line filter capacitor thus giving the transformer a connection to ground as effective as though the switch had been turned on. Turning the volume control actually closed the on-off switch, thereby giving the dining-room study lamp a ground return. The added load of the floor lamp fused the capacitor resulting in a burst of smoke and flame. Other circuits in the receiver were unharmed and being in a quiet location no change in performance could be noticed, when the fuse was replaced.

Bureau, some important information was omitted, and this omission effectively changed the meaning of several of the paragraphs.

In particular, on page 170, paragraph 2, line 4 should read . . . "of a superheterodyne *mixer* as negative feedback." It would be another story to take the difference frequency from the output of a superheterodyne rather than from the mixer.

In the first paragraph on page 174, reference is made to the gain variation with 26db of feedback and a plate supply of 100 volts. Here again, the deletion of the parenthetical statement (300 volts normal) gave a misleading indication of the actual operating conditions under which the variation was made.

The second paragraph on page 174 describes a figure labeled Fig. 2 but actually refers to a photograph that was not included with the report. It is rather obvious from the figure that the feedback voltage is *not* returned to the cathode. However, the material included in the last paragraph does refer to your Fig. 2.

Finally, on page 175, a word was deleted from line 3 of the last paragraph, which should read . . . "gain-bandwidth product . . . " which has meaning while "gain-bandwidth" does not.

GAIL E. BOGGS
Central Radio Propagation Laboratory
National Bureau of Standards

Electronics Quiz

LAST MONTH we printed a quiz problem story describing a freak chain of events that was actually witnessed by Elliot M. Barr, of Rochester, New York. The original problem and its solution are as follows:

"During a particularly energetic thunderstorm, a group of students were studying in the dining room of a fraternity house at midwestern university. A loud crash of thunder and flash of lighting plunged the house into darkness except for the pilot light and tube filaments in the radio in the adjoining living room, which had not been turned on before the crash.

"Playing a hunch, I suggested

BACKTALK

More Figures

DEAR SIRS:

. . . Although many of us are familiar with certain of the figures contained in your new Figures of the Month page, I am sure that, like myself, many engineers are surprised at the magnitude of others. One of the most important factors in the magnitude of engineering effort and employment is the work on government research contracts handled by universities and industry. Is there any way that this could be shown, such as new research contracts granted or renewed?

W. C. WHITE
Research Laboratory
General Electric Company
Schenectady, New York

(Editor's Note: At Bill White's suggestion, we are investigating possible sources of such information and studying the possibility of adding it to the Figures page.)

DEAR SIRS:

. . . I am particularly pleased with "Industry Report" and I hope it long endures. I want to see the likes of page 8 (Figures of the Month) in every issue. . . . While I am at present engaged as a development engineer I feel a need to be kept up to date on the business aspects of the industry and I don't think I should have to go to the *Wall Street Journal* to get them.

ELLIOT L. GRUENBERG
Brooklyn, New York

(Editor's Note: Present plans insure a solid future for IR, including Figures of the Month. In each issue, as in February, an added section will be devoted to interpretive writings on late happenings in the field, as they affect the business end of the industry. Any suggestions are appreciated—in fact, encouraged.)

Gain Stabilized Mixer

DEAR SIRS:

IN THE February, 1952 issue of ELECTRONICS you carried an article entitled, Gain-Stabilized Mixer, describing the work I am doing here at NBS. Unfortunately, in editing the material you received from the

from the 1940 first edition include expansion of the single chapter on electronics into two chapters, expansion of material on artificial radioactivity and additional material on radiological protection.

SERVICING TV IN THE CUSTOMER'S HOME. By Milton S. Kiver, 1951, Howard W. Sams & Co., Inc., Indianapolis, 96 pages, $1.50. First half describes present-day receivers and their operation; second half deals with judging set performance and adjustment techniques.

TUBES ELECTRONIQUES PAR MODULATION DE VITESSE. By R. Warnecke and P. Guenard. Gauthier-Villars, 55 Quai des Grands-Augustins, Paris 6, France. 1951. An 800-page text in French on tubes of the velocity-modulation type and circuits thereof.

RECEIVING TUBE SUBSTITUTION GUIDE BOOK, First Supplement, by H. A. Middleton. John F. Rider Publisher, Inc., New York, 48 pages, 99¢. Lists in numerical sequence additional possible substitutions for tubes not available, plus discussion of tube substitution problems in television receivers.

METAL FINISHING GUIDEBOOK-DIRECTORY, 19th Edition. Finishing Publications Inc., 11 W. 42nd St., New York, 488 pages, $2.50. Treats mechanical and chemical surface preparation, plating solutions and procedures, special anodizing and other surface treatments and much other data applicable to metal finishing problems of the electronic industry.

MANUAL OF WELDING DESIGN AND ENGINEERING, 4th Edition. Eutectic Welding Alloys Corp., Flushing 58, N. Y., 72 pages, no charge. Application and how-to-do-it data, corrosion factors and other data applicable to all types of welding of ferrous and nonferrous metals.

ZEIT- UND KURZZEITMESSUNGEN MIT ELEKTRONENSTRAHL-OSZILLOGRAPHEN. By Paul E. Klein. Weidmannsche Verlagsbuchhandlung, Berlin, 60 pages, DM 3.90. Methods of portraying waveforms in various coordinates, with circuits, mathematics and discussion. In German.

1950 SUPPLEMENT TO SCREW-THREAD STANDARDS FOR FEDERAL SERVICES 1944. 113 pages, 1951, 50¢ U. S. Government Printing Office, Washington, D. C. Replaces and augments supplement issued in June 15, 1949; revision of entire handbook to come later. Includes standards for thread form for coarse-thread series from ¼ to 4 inches, inclusive, and for fine-thread series from ¼ to 1½ inches inclusive; Unified special threads and American National diameter-pitch combinations. Tables of tolerances, allowances and other thread data for threads of special diameters, pitches and lengths of engagement.

ASA GRAPHICAL SYMBOLS FOR SINGLE (ONE) LINE ELECTRICAL ENGINEERING DIAGRAMS. Contains 81 sections covering symbols for almost all electrical engineering work in the fields of power and communication. Each term is accompanied by drawing agreed upon by electric, telephone and telegraph, radio and public utility industries and government. Examples of the use of simplified one-line diagrams using the symbols are given.

THE EDISON EFFECT. By Vice Admiral Harold G. Bowen. Second in a series of case histories on the great inventor's principal inventions and their development into major American industries. Intended for general education purposes, particularly high school students, the booklet of some 70 pages is most attractively got up, and interesting to read. Available from the Thomas Alva Edison Foundation, Inc., West Orange, N. J., at 50¢ per copy.

TABLE OF DIELECTRIC CONSTANTS OF PURE LIQUIDS. By Arthur A. Maryott and Edgar R. Smith, National Bureau of Standards. Circular 514, August 10, 1951, Superintendent of Documents, U. S. Government Printing Office, 50¢. Static, or low-frequency, values for more than 800 substances divided into standard liquids, inorganic liquids and organic liquids. In many cases the temperature coefficient of dielectric constant is included.

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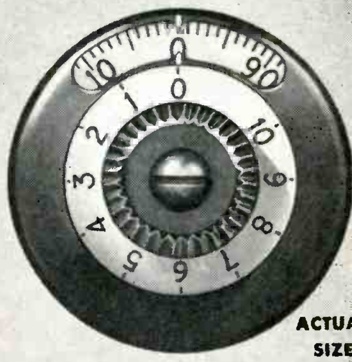

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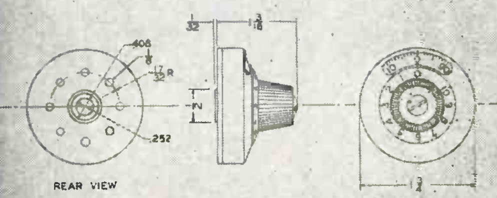

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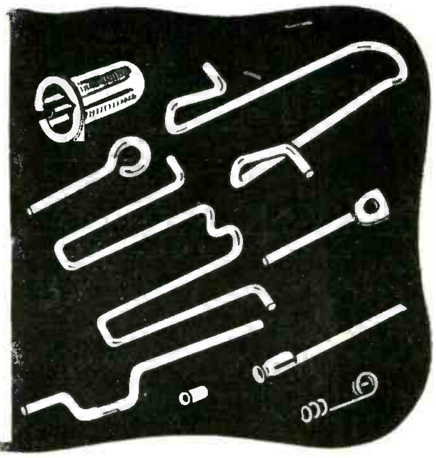

ture. Major portion of book deals with magnetic electron microscopes, but last chapter covers electrostatic and other types and gives advantages and drawbacks of each. Experimental approach, with minimum math, makes book of maximum value to those actually working with the instruments.

TRAINING BY TELEVISION. Office of Technical Services, U. S. Dept. of Commerce, Washington, 24 pages, $.75. Navy Special Devices Center report on comparative effectiveness of live television, recorded tv and standard classroom training procedures. Results show superiority of tv for rapid training of large groups.

INTRODUCTION TO LIGHTING. By Howard M. Sharp. Prentice-Hall, Inc., New York, 1951, 337 pages, $6.65. Student text suitable for formal college courses in illumination and for industry training programs. All types of gas discharge lamps are covered, along with their radio interference problems. A 25-page chapter covers procedures for planning and installing effective lighting in factories.

ALMOST SINUSOIDAL OSCILLATIONS IN NONLINEAR SYSTEMS. Part I: Introduction—Simultaneous Oscillations. By Johannes S. Schaffner. Univ. of Illinois Bulletin Series No. 395, Engineering Experiment Station, Univ. of Illinois, Urbana, Ill., 1951, 64 pages, $.60. First of a series of three bulletins, the other two of which will cover synchronization problems and transient phenomena. Mathematical analysis is based on replacement of nonlinear element by an equivalent linear impedance whose value is chosen so that, in the first approximation, the behavior of the oscillatory system will remain the same.

THE HANDBOOK OF MEASUREMENT AND CONTROL. Edited by M. F. Behar. The Instruments Pub. Co., Inc., 921 Ridge Ave., Pittsburgh 12, Pa., 1951, 181 pages plus ads, $4.00. Sixteen chapters written by fourteen experts give broad survey-type coverage of each type of measurement and control, including all basic pneumatic, hydraulic, electronic and electric sensing and control instruments. Many tables of classifications, instrument operating ranges, percent accuracies and recommended procedures add to reference value.

INSPECTION AND GAGING. By C. W. Kennedy. The Industrial Press, 148 Lafayette St., New York 13, N. Y., 1951, 502 pages, $7.50. Training and reference manual giving basic procedures that can readily be applied to electronic equipment and components manufacturing. Emphasis is on importance of psychology in inspecting, and on relationship of process inspection to other phases of manufacturing. Rejections can mean personnel trouble unless the inspector is a bit of a diplomat, for few men like criticism of their work.

TENSOR ANALYSIS. By I. S. Sokolnikoff, Prof. of Math., Univ. of Calif. John Wiley & Sons, Inc., New York, 1951, 335 pages, $6.00. Theory of linear transformations and matrices is developed first, followed by applications to geometry, mechanics, relativity, elasticity and fluid dynamics. Book is outgrowth of lectures given to graduate students interested in applications of mathematics.

EQUIVALENT CIRCUITS OF ELECTRIC MACHINERY. By Gabriel Kron, Consulting Engineer, GE. John Wiley & Sons, Inc., New York, 1951, 278 pages, $10.00. Develops stationary equivalent circuits for all rotating machines by means of a unified physical picture, without mathematical analysis. In General Electric series, written for advancement of engineering knowledge.

RADIO TUBE FUNDAMENTALS. By George J. Christ, Transmission Engineer, New York Telephone Co. Gernsback Library. Radcraft Publications, Inc., 25 W. Broadway, New York, 1951, 96 pages, $1.00. Design differences in tubes, written for practical radiomen.

RADIOLOGIC PHYSICS. By Charles Weyl and S. Reid Warren, Jr. Charles C. Thomas, Publisher, Springfield, Ill., Second Edition, 1951, 491 pages, $10.50. Primarily intended to serve as text for courses in theoretical and applied radiation physics for medical students and graduate radiologists. Major changes comprehensive and useful summary in Vol. 10 of the Radiation Laboratory Series. The engineer or physicist who wishes to derive his own formulas will find Lewin's book invaluable.

The reader should be familiar with many topics of advanced mathematics, such as functions of a complex variable, integral equations, variational calculus, and the like. Having this familiarity, he will find the various topics developed with great clarity. For example, many of the complex developments are followed by a brief summary, outlining the steps in the development. These summaries are of great assistance in providing a guide through the maze of mathematics.

Some of the techniques used are those of Schwinger and his cohorts in America, but many of the developments have originated with the author and others in England. These are sufficiently novel and advanced to merit considerable study by students of advanced waveguide techniques in this country.

The value of the book is enhanced by an extensive bibliography on waveguide techniques and related topics, occupying 22 pages. This bibliography has been compiled from the abstracts and references published in *Wireless Engineer* from January, 1941 to June, 1951, inclusive—THEODORE MORENO, *Varian Associates, San Carlos, Calif.*

THUMBNAIL REVIEWS

MANUAL FOR THE ILLUMINATING ENGINEER ON LARGE-SIZE PERFECT DIFFUSORS. By H. Zijll, Philips Lighting Service Dept., Eindhoven, Netherlands. Philips Technical Library. Available in U. S. from Elsevier Press Co. Inc., 402 Lovett Blvd., Houston, Texas, 1951, 196 pages, $4.25. In English. Gives basic formulas having application to diffuse lighting of television studios and to new Sylvania large-area light sources made from sheet glass.

AUDIO AMPLIFIERS AND ASSOCIATED EQUIPMENT, Vol. 3. Howard W. Sams & Co., Inc., Indianapolis, 1951, 352 pages, $3.95. Detailed analysis of 50 audio amplifiers and 22 f-m and a-m tuners not in previous volumes, including circuit and design data.

PRACTICAL ELECTION MICROSCOPY. By V. E. Gosslett, Cavendish Laboratory, Cambridge, England. Academic Press Inc., 125 E. 23rd St., New York, 1951, 299 pages, $5.50. Textbook covering principles and specimen preparation methods, with 290 references to significant literaactivated oxide coating in equilibrium, the electron emission equations are derived and considerable attention is given to the meaning of the work function with this complex emitter.

Following the treatment of pure barium oxide in equilibrium, the performance of mixed alkaline earths is given as well as a review of investigations on oxides of other materials. In the final chapter a number of phenomena of considerable technical importance are treated under the heading of "Variations in equilibrium of oxide coatings". These include, in addition to the activation process itself, decay of emission on drawing current, deactivating effects and phenomena traceable to the interface layer.—W. E. DANFORTH, *Bartol Research Foundation, Swarthmore, Penna.*

Advanced Theory of Waveguides

By L. LEWIN. *Iliffe & Sons, London, 1951, 192 pages, 30 shillings.*

THE AUTHOR of this book assumes that the reader is already familiar with the essentials of waveguide theory and practice. The book deals with selected topics in advanced waveguide theory.

The first chapter is a summary of the essentials of electromagnetic theory as applied to waveguides, and the remaining chapters consider a number of topics in waveguide analysis. Among the topics considered are cylindrical posts in waveguides, diaphragms in waveguides, tuned posts and tuned windows, waveguide steps, junctions and tapers, radiation from waveguides, and propagation in loaded waveguides. This is a substantial though not comprehensive list of topics, but it has not been the aim of the author to summarize existing information. His aim is, rather, to present the principles and methods of analysis used in solving the theoretical problems that arise in waveguide work. The theoretical analyses have been carried through to produce formulas that may be utilized by engineers, but the engineer who wants only to use the resulting formulas will find a more

tions are eliminated by introducing the Fermi distribution without derivation. The Fermi level is defined as the undetermined energy parameter which appears in that distribution; its thermodynamic interpretation and the concept of free energy are not dealt with. Happily (to this reviewer), the concept of "X-associated energy" is not introduced.

The theoretical calculations of thermionic emission are carried out entirely "from inside". The distribution of electron momenta within the material is assigned and the rate at which electrons surmount the surface barrier is computed. This approach is preferred by many because of its qualities of directness and concreteness. However, in omitting the equilibrium treatment of thermionic emission, the treatment in which the solid is visualized in equilibrium with an electron gas outside, a degree of generality is necessarily sacrificed. This generality is sometimes useful.

The foregoing remarks are not intended as adverse criticism of the book as regards its intended function. Primarily, it is a highly useful work in which a vast amount of experimental and theoretical material pertinent to the cathode field is brought together in a harmonious and illuminating manner.

After presenting the basic considerations regarding thermionic emission from metals, a general critical discussion is presented of various experimental methods for determining values of work function. These include, besides the common "Richardson line", the calorimetric method, contact potential, photoelectric effect and field emission.

Following this, material especially basic to oxide cathodes is presented in a chapter entitled "Phenomena in Ionic Solids." The term "interference level" is used instead of the common "impurity level" because of some illogicalness of the latter term where the "impurity" is an element of the compound, e.g., barium impurity in barium oxide. Ionic conduction is treated briefly, with the theory of an excess semiconductor presented in some detail. In the next chapter, dealing with an

NEW BOOKS

Electronics

BY P. PARKER, *Northampton Polytechnic, London. Edward Arnold & Co., London*, 1951, 1,050 *pages*, $10.00.

A THOROUGH-GOING text on the theory, design and use of tubes and tube circuits, understandable to anyone with some collegiate background and a knowledge of alternating currents.

Although written primarily for physicists who must understand and, perhaps, employ tubes in their work, this large book should be an excellent possession of anyone with an interest in electronics. Naturally the text must cover much that is in other books, but a cursory perusal of its contents will indicate that one will find here much that is found in only few and scattered books of similar title. Every chapter concludes with a good bibliography (mostly of English books) and a series of notes and references which point up the previous text matter and give additional information. A series of useful problems is part of each chapter.

The first eight chapters deal with tubes themselves, and the remainder of the 18 chapters cover the tube as a linear and nonlinear circuit element, oscillators, rectifiers, detectors, mixers, gas discharge tubes and phototubes plus seven appendices dealing with the kinetic theory of gases, thermodynamics of electron emission, magnetron and klystron theory, etc., some 20 pages of experiments and a final section of tabular matter.—K.H.

The Oxide-Coated Cathode

BY G. HERRMANN AND S. WAGENER. *Chapman & Hall, London*, 1951, 311 *pages*, 42 *shillings*.

THIS work is unquestionably one which any engineer or physicist concerned with thermionic cathodes should have at hand.

The authors first develop the theoretical ideas for pure metals and, in later sections, expand these concepts to handle more complex emitters, such as films or metals and oxide coatings.

Quantum mechanical demonstrations are almost entirely avoided. Also the basic statistical demonstra-

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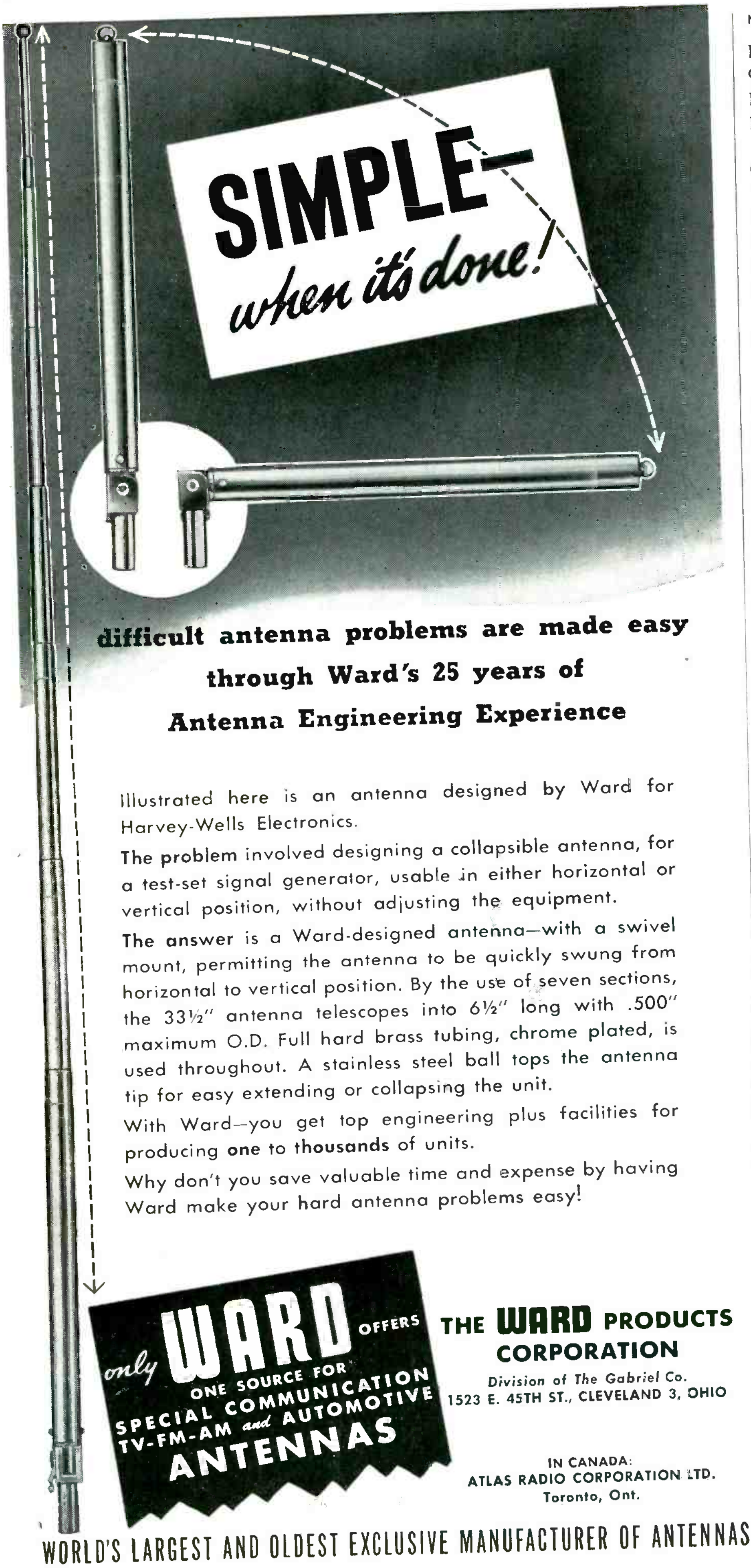


plicant to have at least a bachelor of science degree, plus work experience to qualify for the higher-paying jobs.

Electrical engineers, electronics engineers or electronics scientists (titles of position as listed in booklet), interested in employment with the government should apply to the nearest Civil Service Commission office.

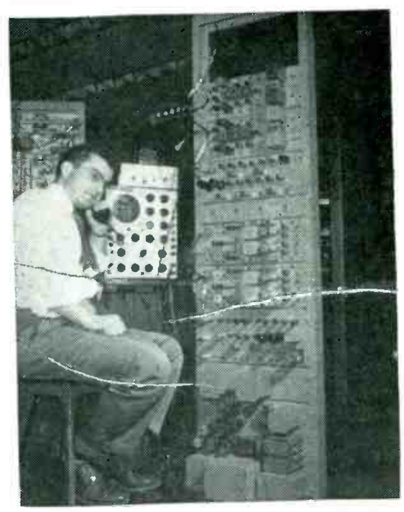
Guided Missile Courses

A SERIES of special courses in guided missile engineering has been started by North American Aviation, Inc., Los Angeles, to train engineers for its aerophysics and electro-mechanical departments.

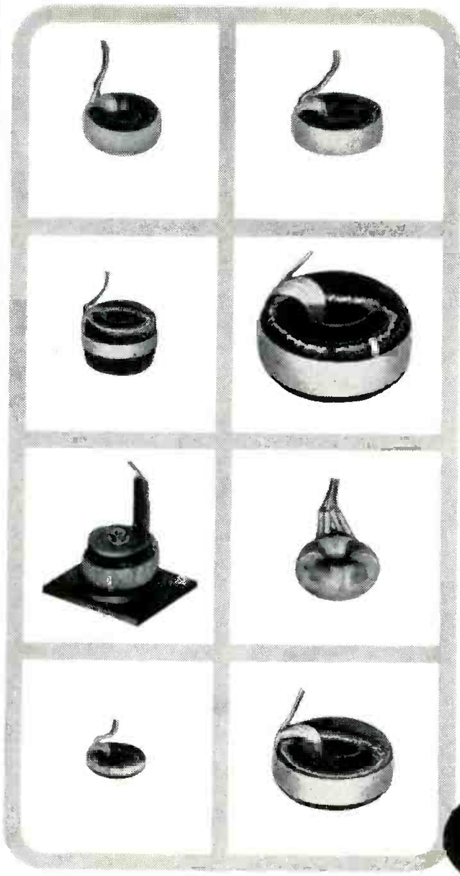
Purpose of the courses, each of which will last from one to three weeks, is to provide a larger number of engineers with the specialized knowledge needed for work on the company's advanced research projects.

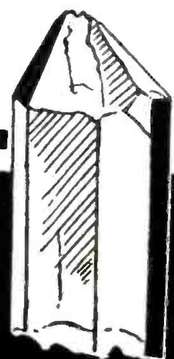
North American has leased 6,250 sq ft of classroom facilities at Downey, Calif., where its research and development work in atomic energy, aerophysics and electro-mechanics is centered.

TALKING TO ONESELF



This GE engineer talks to himself via a 30-mile microwave radio relay system which General Electric is operating experimentally between Electronics Park at Syracuse and DeRuyter, N. Y. Signals are beamed to a relay station near Pompey, N. Y., which passes them to the DeRuyter station. There they are automatically placed on another channel, sent back to the Park via the Pompey station and fed into a loudspeaker in the laboratory. The 60-mile round trip takes only about three ten-thousandths of a second





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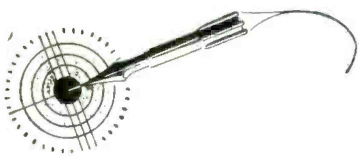

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A NEW "Littel Plug" and "Extension Jax" have been added to the ever-expanding SWITCHCRAFT line.

No. 440—"Littel Plug" (PJ-055B) features a one piece tip rod which together with the sleeve are assembled into the mold as inserts; providing a finished plug with complete continuity of thermoplastic insulation between this tip rod and the sleeve of the plug. Design and material strictly in accordance with specification JAN-P-642. Also available in types PJ-055R and PJ-055M.

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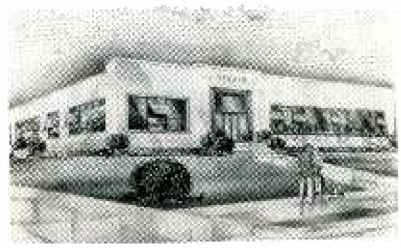
CANADIAN REPRESENTATIVE: Atlas Radio Corporation Ltd., 560 King Street, W., Toronto 2B, Canada. Phone Waverly 4761.

tracts have made the expansion necessary.

Increased activity in the development, design and production of electronic computers, control systems and special devices has led *The Austin Co.* to establish new headquarters for its growing Special Devices Division in the Port of New York Authority Building at 76 Ninth Ave., New York City.

The Staver Co., Inc., has completed a new plant at 41-51 North Saxon Ave., Bay Shore, Long Island, N. Y., thus expanding facilities for production of electro-mechanical parts and component assemblies.



New Staver Co. plant

Titeflex Inc. of Newark, N. J., manufacturers of flexible metal tubing and aircraft ignition harnesses, announce the establishment of an Electronics Division to co-ordinate the manufacture and sale of flexible and rigid waveguides, electronic parts and special equipment, due to the increased demand for these items.

Dow Corning Corp. will invest over $13,000,000 in a major expansion of plant capacity for its silicone products. Construction is already under way and the program is scheduled for completion by 1954.

Establishment of a Mobile Radio Communications Department in its newly acquired plant in Passaic, N. J., has been announced by *Federal Telephone and Radio Corp.*, Clifton, N. J. The new facilities will add approximately 13,000 sq ft of space to the more than a million now provided by Federal's Clifton plant.

Help to Broadcasters

EQUIPMENT shortages are reflected in a recent FCC decision to exempt broadcasters from paper work upon failure of frequency and modulation monitors, plate ammeter or

SOLID ultra-sonic DELAY LINES

Spurious signals −40 db or better . . . Wide length range . . . Completely cased with BNC connectors or to customer's specs . . . Maximum precision and stability . . . Complete facilities for ultrasonic research and development.

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STANDARD RANGE
1000 OHMS TO 9 MEGOHMS

Used extensively in commercial equipment including radio, telephone, telegraph, sound pictures, television, etc. Also in a variety of U. S. Navy equipment.

SEND FOR BULLETIN 4906

It gives details of both the Standard and High Value resistors, including construction, characteristics, dimensions, etc. Copy with Price List mailed on request.

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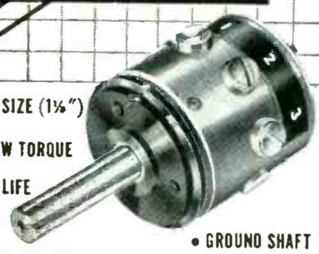

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Giannini, standard with the leaders, develops this small ballbearing potentiometer with a variety of unique features to meet the latest computer requirements. Runout and concentricity within .001 in. Total resistance up to 100,000 ohms, torque less than 0.2 inch ounces.

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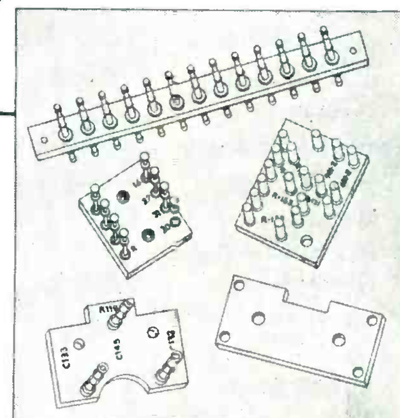

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voltmeter, base-current or common-point meter for a-m stations and transmission-line meter for f-m and tv stations.

Heretofore, informal application to FCC, Washington, was necessary to permit legal operation without, or with substitute equipment. Now, a log entry and notification to Engineer in Charge of the radio district legalizes operation for 60 days.

If the emergency exists beyond this time, a letter or telegram must be sent to the Engineer in Charge stating reasons for the continued nonstandard operation.

Informal requests for authority to operate without phase monitors must still be submitted to Washington.

Radio Welding Rules

THE Federal Communications Commission has postponed the enforcement of its rules applying to welding equipment using radio-frequency energy until January 31, 1954. Although there have been many complaints of interference to air-to-ground communications, instrument-landing devices and other important radio communications, the Commission has decided that use of this type of welding equipment is vital to the national defense effort.

However, FCC feels that the two-year period of grace should be ample for the development of interference-free r-f welders and also that existing equipment can generally be operated so as to cut down much of the present radiated energy. If existing equipment is shown to interfere, the owner must take immediate steps to correct the trouble.

Naval Research Seeks 400 Engineers

NAVY DEPARTMENT'S Office of Naval Research has issued a booklet containing available positions open for scientists in all fields. The electronics field has over 400 vacancies, with salaries starting at $3,410 per year and going up to $10,800.

These openings, located in all parts of the United States and in Yokohama, Japan, require each ap-nature are expected to strengthen Britain's defense effort and help meet her military needs with a minimum of Mutual Security dollar expenditures for end-use items.

Plant Expansions Continue

COMPANY activities in the electronics field indicate that the trend toward expanded facilities is still on the upgrade. Here are some examples:

Lear Inc., aircraft electronics manufacturer, has begun construction of a new 70,000-sq ft building in Los Angeles. Approximately 21,000 sq ft of the new plant will be devoted to executive offices, general offices, engineering, drafting and experimental laboratories, the remainder to manufacturing.

The Beckman group of precision instrument and electronics manufacturers has acquired a 40-acre site in the Fullerton-La Habra area, south of Los Angeles, to centralize the activities now housed in 14 different facilities in the Pasadena area. The Beckman organization, which started out 12 years ago with 50 employees, now employs more than 1,100.

Raytheon Mfg. Co., Waltham, Mass., has bought an additional building in that city to house sections of the firm's expanding research.

The electronics division of *Sylvania Electric Products, Inc.*, has purchased a one-story building in Newton, Mass., at which some 200 persons will be employed in the manufacture of magnetrons and associated microwave tubes for radar systems.

The new electronics test equipment plant of *General Radio Corp.*, in West Concord, Mass., is expected to be ready for occupancy in June. Employment will run between 125 and 200.

The Gray Mfg. Co., Hartford, Conn., has leased 23,000 sq ft of manufacturing space in the former Hilliard Mill in Manchester, Conn., to provide additional operating space for its wholly-owned subsidiary, the Gray Research and Development Co. Current and expected orders for specialized tv and electronics equipment and defense con-

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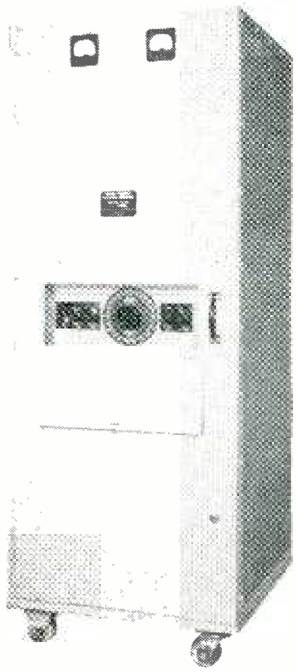
CML Model 1435

VARIABLE FREQUENCY ELECTRONIC GENERATOR.



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- Power input 208–220V 50–60 cycles single phase 5KVA
- Frequency range 50–6000 cycles in four ranges: 50–180, 170–600, 540–1800, 1700–6000
- Frequency stability better than 1%
- Distortion less than 7% at full 2.2 KVA load with unity power factor
- Output voltage regulation from no load to full load 1%
- Nominal output voltage 120V RMS

Write for the new CML Catalog describing the Model 1435 Generator and other CML products.

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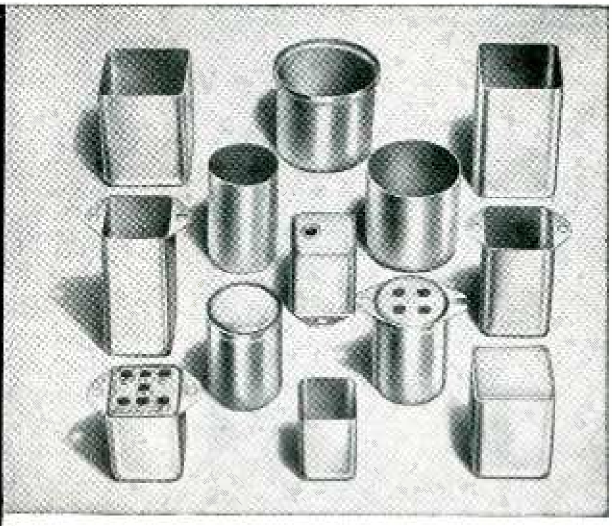

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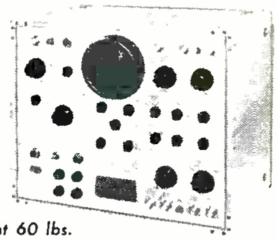

Weight 60 lbs.
13" x 16" x 14"

Another Waterman first, a compact, portable wide band pass laboratory oscilloscope with markers that are triggered in synchronism with the incoming signal. Ideal for pulse measurements, such as shape, amplitude, duration and time displacement. S-5-A LAB PULSESCOPE is adaptable to all kinds of electronic work where knowledge of circuit performance is essential. Built in Video delay permits observation of leading edge of triggering pulse. Precision means of amplitude calibration are provided. Sweep can be either repetitive or trigger with 10 to 1 expansion when desired. Internally generated markers, together with Video calibration, provide quantitative data of amplitude, shape, duration and time displacement of pulses. The oscilloscope thus is truly a PULSESCOPE, another Waterman first.

Video amplifier up to 11 mc . . . Video Delay 0.55 μs . . . Pulse rise and fall time better than 0.1 μs . . . Video sensitivity 0.1v p to p/in. . . . Sweep 1.2 μs to 120,000 μs with 10 to 1 sweep expansion . . . Sweep triggered or repetitive . . . Internal markers synchronized with sweep from 0.2 μs to 500 μs . . . Trigger generator with output available externally . . . Built in precision amplitude calibrator . . . Combination case . . . Operates on 50 to 1000 cycles at 115V AC.

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S-14-B WIDE BAND	POCKETSCOPE
S-15-A TWIN TUBE	POCKETSCOPE

Also RAKSCOPES, RAYONIC
Cathode Ray Tubes
and other equipment

WATERMAN PRODUCTS

ing of amateur licenses will also be handled in this bureau.

Among other responsibilities will be determinations as to whether proposed antenna structures constitute a hazard to air navigation and the problems of interference arising from industrial, scientific and medical devices.

Britain Receives MSA Technical Aid

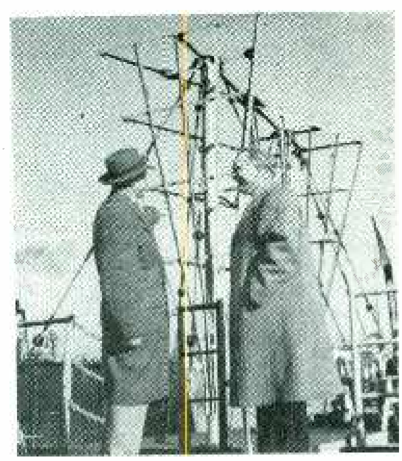
THE MUTUAL SECURITY AGENCY is putting American technical aid to work in Great Britain to modernize World War II radar landing equipment which would cost approximately $16 million to replace.

To save the sets and enormous funds, three American radar engineers of Bendix Aviation Corp.—C. W. Hicks, F. L. Koch and J. C. Fritz—have been sent to London to work with British electronic engineers. Bendix had built the GCA sets Britain acquired under lend-lease.

The Americans will remain in England for three months to make a survey of aircraft landing sets on commercial and military airfields and to advise British engineers on the substitution of British-made spare parts.

Future projects of a similar

FLOATING RADIO STATION



Jean Seymour (left) project engineer, points out construction features of the broad-band broadcast antenna to George Q. Herrick, (right) Chief of Planning and Development for the Voice of America. Two such pairs of inverted pyramids are mounted on the deck of the Coast Guard cutter *Courier* for mobile relay broadcasting behind the Iron Curtain

in electronic ordnance.

William H. Happe, Jr., previously associated with Federal Radio and Telephone Corp., Clifton, N. J., as director of the Vacuum Tube Division, was recently appointed works manager of the Electronics Division, Curtiss-Wright Corp., Carlstadt, N. J.

Hans U. Hjermstad, in charge of engineering development for Sola Electric Co., Chicago, Ill., since 1948 as assistant to the president, has been named vice-president in charge of engineering.

Jacob Millman, formerly associate professor of electrical engineering at the College of the City of New York, has been appointed professor of electrical engineering at Columbia University. He will teach courses and conduct research in the field of electronic circuits, pulse circuit techniques and radar.

James M. Moran, for the past six years in charge of the electronics department of Barkley & Dexter, consulting engineers, has been appointed executive vice-president of Barkley & Dexter Laboratories Inc., Boston, Mass.

Ferdinand W. Schor, formerly with Hallicrafters Co., was recently named chief engineer in charge of military engineering at Motorola Inc., Chicago, Ill.

J. A. Milling has become director of the Electronics Division, National Production Authority, U. S. Department of Commerce, succeeding **E. T. Morris, Jr.,** who left to return to Westinghouse Electric Corp. He also succeeds Mr. Morris as chairman of the Electronics Production Board, Defense Production Administration.

Carl Blaker, formerly associated with Lear Radio, Inc. and with Wood & Cies, has been appointed chief engineer in charge of production for National Electronics Mfg. Co., Los Angeles, Calif.

Albert Axelrod, connected with Loral Electronics Corp. for three years as project engineer, has joined the Advanced Development Laboratories of CBS-Columbia Inc. as senior engineer.

William S. Parsons, vice-president of Globe-Union Inc., has been elected president of Centralab Division of Globe-Union Inc., Milwaukee, Wisconsin.

French Industrialists Want More U. S. Equipment

THIRTEEN representatives of the French electronics industry recently made a five week tour of the United States studying methods of increasing output, lowering production costs and improving quality standards which might be applied to French defense plants.

Jean Thibier, manager of the Establessment Jacquet in Paris, says that with the help of the Marshall Plan, France has rebuilt its industries and is well on the way to recovery. Defense production is under way but material shortages have already developed in such scarce items as copper.

Thibier hopes that French industry may be able to buy much-needed equipment and supplies from the United States. He is impressed with American developments in the field of television. Predicting rapid growth of tv in France, he says that at the present time the industry is confined to the Paris area, where "there are a few sets in use."

French industrialists on tour of Bogue Electric Company, one plant in their five week study of American methods of production

Overseas Positions for Radio Engineers

THE DEPARTMENT OF STATE is looking for radio engineers for its Voice of America program at relay bases overseas.

Salaries are from $4,719 to $6,807 plus a tax-free allowance for rent, heat, light, fuel and electricity. In addition, there is a variable allowance to adjust for living costs at posts where the cost of living has been determined to exceed that prevailing in Washington, D. C., and a differential is also paid to employees serving at posts which are considered to have exceptionally difficult living conditions.

Interested American citizens of at least five years' standing, who are willing to serve at any post abroad for a continuous period of not less than two years, may obtain further information by writing a resume of their qualifications to the Division of Foreign Service Personnel, 1734 New York Ave. NW, Washington, D. C.

FCC Field Activities

RECENTLY established under a reorganization of FCC activities is the Field Engineering and Monitoring Bureau headed by George S. Turner. Mr. Turner, a veteran since 1924 in government radio supervision, will have charge of such aspects of the Commission's activities as station inspections, surveys, monitoring, direction finding, signal measurement and investigations.

His group will also develop rules and regulations for commercial radio operators and issue licenses. Amateur examinations and upgrad-

News From The Field

Edited by WILLIAM P. O'BRIEN

Network Symposium Scheduled

MODERN NETWORK SYNTHESIS (Audio to Microwaves) is the subject of a symposium to be held on April 16, 17 and 18, 1952 at the Engineering Societies Building Auditorium, 33 W. 39th St., New York, N. Y. This symposium, jointly sponsored by the Polytechnic Institute of Brooklyn and the Office of Naval Research, will summarize the progress to date in the various fields of network synthesis and highlight new developments of current interest to engineers and physicists. American and European authorities who have made original contributions to the art will participate.

There is no registration fee for admission to the symposium. Proceedings of the Modern Network Synthesis Symposium will be published by Sept. 1952 at $4 per copy.

Copies of the detailed program, hotel information and registration forms are available on request. All correspondence should be addressed to: Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N. Y.

Thirty Personnel Changes

THIS MONTH'S review of people in the news involves a combination of thirty new promotions and transfers.

Positions reported changing hands at Sylvania Electric Products Inc. are four: **Walter A. Weiss** moves from manager of the Radio Tube Division's plant in Burlington, Iowa, to general manufacturing manager of the Division. **Albert Lederman,** for the past five years secretary of the Panel on Electron Tubes, Research and Development Board, OSD, is now a technical representative of Sylvania Government Relations Dept. in Washington. **Matthew D. Burns,** formerly general manufacturing

M. D. Burns

C. A. Haines

manager, has been promoted to general manager of the Radio Tube Division. **C. A. Haines,** company vice-president since December 1950, was recently placed in charge of a new executive department as director of Facilities Planning.

Recent additions to the Sprague Electric Co. are the following: **John H. Harley,** previously electrical design engineer with Douglas Aircraft Co., is the newest member of the radio interference filter group at the Culver City, Calif., application engineering laboratory. **Frederick W. Reynolds, Jr.,** formerly with the Allen B. DuMont Laboratories, has been appointed to the application engineering staff of the Sprague New York office.

Promotion of five top members of the Instrument Division, Allen B. DuMont Laboratories, Inc., to new key posts within the division has been announced. The appointees and their new posts are as follows: **P. S. Christaldi,** formerly engineering manager, is now assistant division manager. **G. Robert Mezger** moves from technical sales manager to engineering manager. **Emil G. Nichols** has been promoted from assistant technical sales manager to technical sales manager. **Melvin B. Kline,** former head of the Special Projects Section of the Instrument Engineering Department, and **William G. Fockler,** former head of the Development Section of the same department, have been appointed assistant engineering managers.

General Electric Co. reports three recent promotions. **Homer R. Oldfield, Jr.,** has been appointed resident manager of the company's Advanced Electronics Center at Cornell University. Up to now he had been manager of sales for all Government Department sales. **Lawrence R. Cohen** has been advanced from project manager in the Army Equipment section to sales manager for army equipment in the Government Sales Department of GE's Electronics Division. **George C. Trotter** was appointed sales manager for Air Force Equipment in the same department. He was formerly assistant manager of the Air Force section.

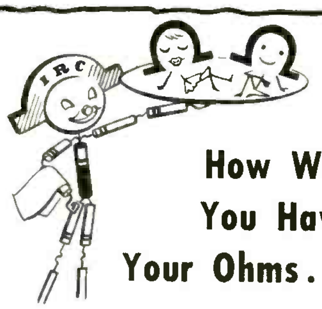
Radio Corporation of America also announces three appointments. **Thomas D. Meola,** for the past three years manager of public offices and sales of RCA Communications, Inc., has been elected a vice-president of that organization. **Hugh P. McTeigue,** manager of training for the RCA Service Co. for the past three and a half years, has been appointed to direct the company's accelerated military electronics training program. **S. D. Conley,** engaged up to now in RCA Victor engineering and sales activities, was recently named merchandise manager of the company's new air conditioner department.

Several other important personnel changes recently reported are as follows:

Charles H. Wirth, formerly sales engineer for Rangertone, Inc., has been appointed engineering representative for the Audio & Video Products Corp., New York, N. Y.

Air Associates, Inc., Teterboro, N. J., has promoted **C. K. Krause** from factory manager to division manager of its Electronic Products Division.

Merril F. Distad, formerly of the Naval Research Laboratory, has joined the staff of the Ordnance Development Division of the National Bureau of Standards to work



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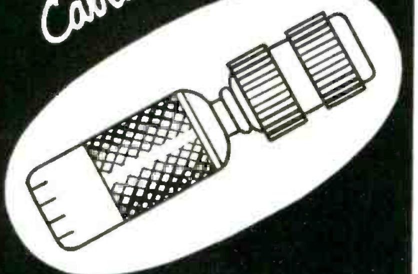

WORKSHOP provides a complete line of solderless cable fittings for RG-59/U, RG-11/U and RG-8/U coaxial cables—all in current production and available in large quantities. Pictured above is the W-50 male cable connector, silver plated and specially slotted to withstand strain. Write for catalog and complete specifications.

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Size: Panel 8¾x19. Overall 8¾x19x12.

For Complete Information Write for Catalog "A"

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E/M

motors designed to meet the needs of the military services. Construction and application in formation, performance characteristics and dimensions of representative examples of the company's motor, blower and fan line are given.

Rheostats and Resistors. Rex Rheostat Co., 3 Foxhurst Road, Baldwin, L. I., N. Y. Catalog No. 5 is a 16-page booklet covering the following: a standard line of tubular slide-wire rheostats and a new rheostat for extremely fine adjustment; a new type of double rheostat; a noninductive rheostat; tapered-wound rheostats and resistors; miniature slide-wire rheostats; and tubular rotary drive rheostats. Illustrations and technical data are included.

Precision Equipment. American Measuring Instruments Corp., 21–25 44th Avenue, Long Island City 1, N. Y., offers a 4-page folder illustrating and describing a line of precision units, subassemblies and components parts. The devices covered are applied on aviation products, communication equipment, signal devices, telegraph and telephone apparatus, and electrical and electronic equipment. The company's manufacturing services are also listed.

Permanent Magnets. Carboloy Dept. of General Electric Co., Detroit 32, Mich. Bulletin PM-100 includes a complete listing of stocked sizes and shapes of Alnico permanent magnets. The 20-page illustrated catalog contains pull curve and size information in tabular form. It contains a list of available patterns for various sizes of cast Alnico bars, blocks, rods, rings and sleeves. Also described are three types of permanent magnet magnetizers.

Servo System. Kalbfell Laboratories, Inc., P. O. Box 1578, San Diego 10, Calif. A recent mailing piece illustrates and describes three different elements in a servo system. Chief features, applications,, specifications and prices are included for the twin-T servo stabilizer, the twin-T filter and the twin-T peaked amplifier.

miniature component wiring. The booklet contains complete technical data, detailed specifications, soldering procedures, diagrammed construction details, prices and ordering information plus samples of the product.

Continuous Sampling Monitor. General Electric Co., Schenectady 5, N. Y. Booklet GEA-5738 is a 4-page, two-color bulletin on the continuous sampling monitor, a new device to simplify quality control. The publication contains photographs and diagrams of the equipment and explains the continuous sampling monitor's operation, construction and range. It is designed to complement the company's bulletin GEA-5627 on quality control instrumentation.

X-Ray Diffraction. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y., has available an 8-page booklet titled "What is X-Ray Diffraction." The booklet points out how this nondestructive analysis method is helping to speed the defense program in identifying components or raw materials to assure uniformity, in identifying unknown materials and constituents of mixtures and in identifying impurities. Also covered are the uses in production for selection of raw materials, for production analysis and control, for tracing physical or chemical changes during technological processes and for checking quality of finished products.

Tube Testers. The Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio. Form TT5 is a 4-page folder illustrating and describing the latest 10-model selection of dynamic mutual conductance tube testers. The instruments described feature tube gas test, tube noise test and calibration in micromhos. Complete technical data for each model are included.

Precision Designed Motors. Air Marine Motors Inc., 2183 Jackson Ave., Seaford, L. I., N. Y. A recent loose-leaf perforated folder covers a line of small precision-built subfractional horsepower electric

contents is divided into seven sections covering the following types of equipment: aeronautical, broadcasting, communications, maritime, navigational aids, crystals and electronic tubes, and miscellaneous. Under the last category are treated antenna equipment, sound reproduction, pressurized h-v variable capacitors and test and measuring instruments.

Technical Ceramics. American Lava Corp., Chattanooga 5, Tenn., presents on its 50th anniversary a detailed story on the custom manufacture of technical ceramics. This detailed presentation in pictures and diagrams should be of great value to any designer, engineer or purchasing agent dealing with technical ceramics. Also included is a property chart which details the characteristics of some of the most frequently used ceramic compositions. Individual technical bulletins on the different types are also available for the writing.

General Products. E. F. Johnson Co., Waseca, Minn. The latest general products catalog 972 is now ready for distribution. Products listed for the first time are the Viking 1 transmitter, Viking vfo, Faraday shield for Johnson plug-in links, the 229–201 rotary inductor, the 126–105 crystal socket and the company's new knob and dial line.

Saturable Transformers. Magnetic Amplifiers, Inc., 11–54 44th Drive, Long Island City 1, N. Y., announces a new bulletin describing a standard line of saturable transformers. Power output of the units discussed is phase reversible a-c with output levels of 1 w to 1 kw, both 60 and 400 cps. The bulletin lists applications and gives typical circuits with actual component values.

Small Gage Copper Wire. The Rex Corp., 51 Lansdowne St., Cambridge 39, Mass., announces publication of a new technical booklet on Nonstrip wire. It describes 125C microwall, insulated, multicolor-coded, small-gage copper wire utilized in both military and commercial services for aircraft, radio, instrument, telephone and

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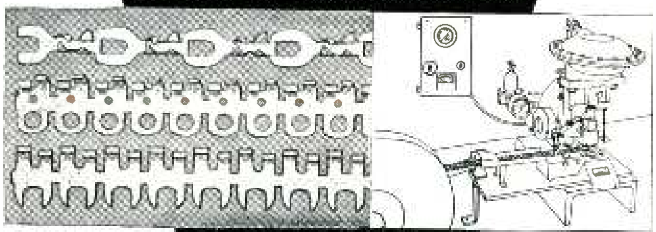

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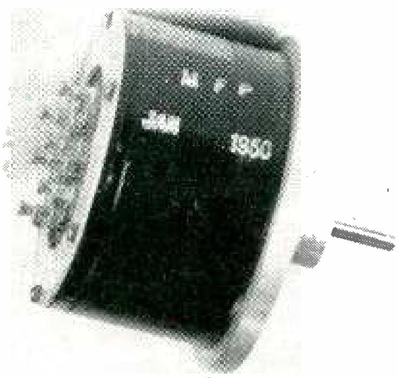

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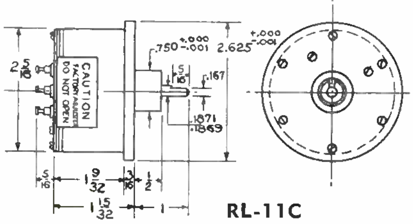

RL-11C

CONDENSED SPECIFICATIONS

	RL 11-C	RL 14-MS
Total resistance	16,000 ± 10%	35,400 ± 1%
Percent resistance within brush circle	Approx. 85%	99 ± ¼%
Angle of rotation	360°	360°
Weight	4.75 oz.	1.8 lbs.
Torque (Approximate)	¾ oz. in.	2 oz. in.
Wire	80 Ni 20 Cr	80 Ni 20 Cr
Resolution	.4°	.2°
Angular accuracy	±.6°	±.5°
Amplitude accuracy	±.8%	±.6%
Maximum volts across winding	150	350
Maximum speed	60 rpm	60 rpm
Expected Life	350,000 cycles	200,000 cycles

Illustration shows RL-11C unit, RL-14MS unit is approximately twice as large. Minor variations of these standard designs, available on special order, permit operation at high rotational speeds with some loss of accuracy but, with a substantial increase in expected life. Sine and cosine voltages are produced simultaneously. Resistances other than those shown above are available within certain limits.

FOR COMPLETE DETAILS SEND FOR BULLETIN F-68-A

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HERMETICALLY SEALED RELAYS

Meet AN Standards or Armed Services Applications

Compact, multiple contact... vibration and shock proof. Built to meet rigid specifications and severe operating conditions.

Unique pile up arrangement reduces over-all space compared with conventional relays.

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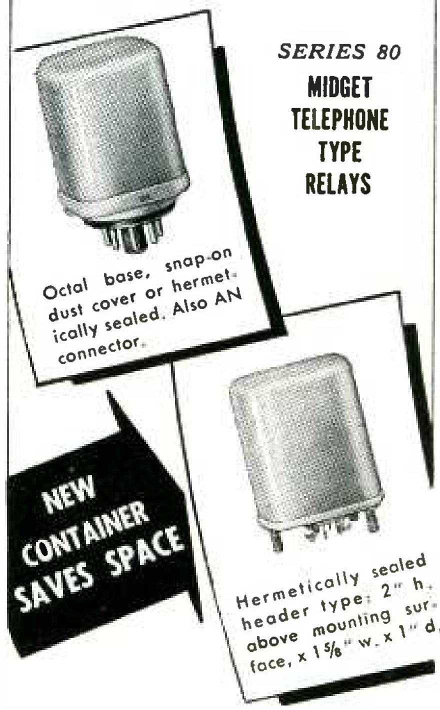

Write for Bulletin MTR-6

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plete descriptive information and technical data on a line of products for insulating all types of electrical and electronic equipment. The catalog incorporates six bulletins on various products. Included are No. 499 which describes methods, materials and applications for fabricated insulators; No. 499A which discusses requirements, styles and materials for motor slot insulators; No. 489, giving information on dispenser-packaged cuffed motor slot paper; No. 443, providing data on the hard vulcanized washer assortment; No. 280, describing hard maple wood motor slot wedges; and No. 441, discussing curve-formed fibre motor slot wedges.

Crystal Diode Replacements. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A recent wall chart lists 68 different types of crystal diodes. Next to each is shown its construction, description, manufacturer and the Sylvania type replacement. Illustrations are included.

Pulse Generator. Carlson & Nicholson, Inc., 497 Maynard Drive, Buffalo 21, N. Y. A four-page folder illustrates and describes the model 7 pulse generator, an instrument designed for laboratory use, that generates video pulses from approximately 0.2 μsec to 2,000 μsec. Technical specifications, ordering information and a warranty notice are given.

Terminal Assemblies. Lundey Associates, Waltham, Mass., has prepared a folder made up of 17 loose-leaf pages illustrating and giving engineering data and method of assembly for a line of terminal assemblies for hermetic sealing. Dimensional drawings and much tabular material on inserts, insulators, conductors and cushioning washers are included.

Radio Equipment. Marconi's Wireless Telegraph Co. Ltd., Marconi House, Chelmsford, Essex, England, has published a 405-page catalog showing a complete range of the company's radio equipment. The publication is heavily illustrated and well indexed. Table of

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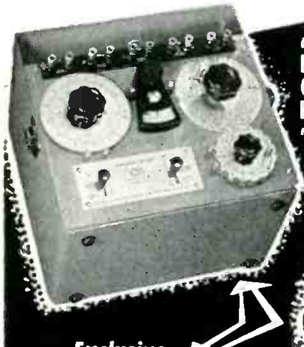

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ELECTRICAL COMPARISON between Grayburne and Conventional RF Chokes proves Grayburne superiority (both chokes valued at 2.5 mh, 125 ma).

GRAYBURNE	FERRI-CHOKE	CONVENTIONAL RF CHOKE
L	2.5 mh	2.5 mh
R	10.5 ohms	40.0 ohms
Cd	1.7 uuf	2.8 uuf
Q	110	45
Wire length	30.0 ft.*	96.0 ft.
Core	Ferrite	Isolantite
Size	1" long x 3/8" diam.	2 1/2" long x 1/2" diam.
Wt.	4.5 grams	13.5 grams

*NOTE: *COPPER SAVINGS OVER 200%*

Grayburne Vari-Chokes: variable over a wide range of inductance, in many cases as high as 10-1 ratio.

Grayburne Ferri-Chokes and Vari-Chokes can be supplied in the inductance, mounting and type of winding you specify.

Grayburne Ferrite Core Kits of 27 various-sized cores, fixed and variable, are available for your development and research purposes. Net. $2.25.

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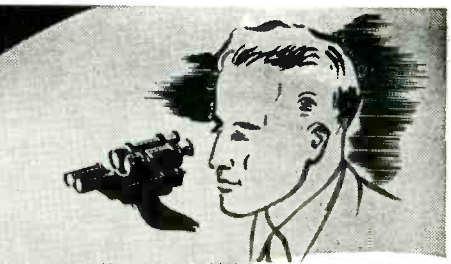

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on the company's complete line of instrument transformers. The fully illustrated, 94-page publication, GEA-4626E, gives ratings, ASA accuracy classifications and prices of indoor and outdoor potential and current transformers, metering outfits and potential and current portable transformers. Listings of ratio and phase-angle tests, together with tables covering the mechanical and thermal limits of current transformers are also included.

X-Ray Diffraction & Spectrometers. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y., has released a 60-page catalog on x-ray diffraction and Geiger-counter x-ray spectrometric equipment. The catalog also covers such components and accessories as tubes, rectifiers and cameras. A number of pages is devoted to wide-range goniometers, fluorescence analysis, universal working arrangements, Geiger tubes, electronic circuit panels and table model spectrometers. Considerable space is given to the electron microscope. Information is also provided on applications for x-ray instruments along with typical charts which show how specimens differ when analyzed by this powerful laboratory and production control equipment.

Audio Equipment. University Loudspeakers Inc., 80 S. Kensico Ave., White Plains, N. Y. Containing a wealth of concise and practical technical data, the Technilog, a new 28-page general catalog will be of special value to everyone interested in public-address and high-fidelity equipment. Product and application information are presented in simple language. Scores of curves, tables, charts, typical circuitry and practical discussions on such subjects as overload protection of loudspeakers, impedance matching speaker baffles, phasing and reverberation are included.

Electrical Insulation. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. A 24-page catalog contains com-

fications for solderless cable connectors are given on a new catalog sheet, form WA54-164. Describing the models W-50, W-60, W-80 and W-100 for RG-8/U, RG-11/U and RG-59/U cable, the sheet gives dimensions and electrical characteristics.

High-Mu Power Triode. Lewis and Kaufman, Inc., Los Gatos, Calif. A new technical data sheet describes the type 100TH high-mu power triode. The tube is illustrated and described with dimensions, operating curves and electrical characteristics. Typical operation and maximum ratings are given for the tube in service as a Class AB audio-frequency power amplifier and modulator and as a Class-C power amplifier and oscillator.

Analog Transducers. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J., has made a compilation that fills the long established need for an easy-to-use reference of transducers for use with c-r oscillographs. The compilation contains over 500 different types of analog transducers arranged alphabetically according to their functions. By using the publication one may find the model, manufacturer, and mechanical and electrical characteristics of the transducer required. For radiation studies a special section tabulating G-M tubes is included. A transducer accessory listing is also given. Price of the complete compilation is 50 cents.

Transformers and Reactors. Southwestern Industrial Electronics Co., 2831 Post Oak Road, Houston 19, Texas. A single-page bulletin announces a new line of miniature, hermetically-sealed, low-frequency transformers and reactors. The components described are characterized by their high performance, light weight, close electrical tolerances and excellent shielding. Complete technical data are given.

Instrument Transformers. General Electric Co., Schenectady 5, N. Y. The 1952 edition of the Instrument Transformer Buyer's Guide contains basic, up-to-date information

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Proven Quality
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PLUGS & SOCKETS

P-306-CCT — Plug, Cable Clamp in cap.

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Made in 2 to 33 contacts for 45 volts, 5 amps, for cap or panel mounting. Higher ratings where circuits permit. All plugs and sockets polarized. Knife switch socket contacts phosphor bronze, cadmium plated. Engage both sides of flat plug—double contact area. Bar type plug contacts hard brass cadmium plated. Body molded bakelite.

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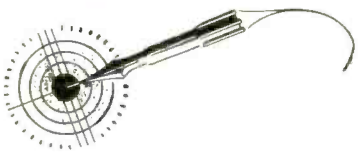

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laboratory applications in addition to its broad use in the telemetering field. The instrument described features automatic frequency control, automatic gain control and regulated voltage sources for critical stages.

Carbonyl Iron Powders. Antara Chemicals, Division of General Dyestuff Corp., 435 Hudson St., New York 14, N. Y., recently issued a 32-page booklet presenting basic information on carbonyl iron powders now widely used in high-frequency cores for radio, telephone, tv and radar. Contents include unique features, electromagnetic data, design data, stability information, use in closed magnetic circuits, formulas frequently used and a bibliography of pertinent publications.

Seamless Tubing. Uniform Tubes, Level Road, Collegeville 2, Pa., has published a new 4-page catalog covering its complete line of fine seamless tubing available in sizes from 0.010 in. o.d. to $\frac{5}{8}$ in. o.d. and in metal of almost any desired analysis. One page is devoted to Pointer tubing (some of it finer than a human hair) that is used as the indicating needle in sensitive measuring instruments. The balance of the catalog is devoted to all larger tubing up to $\frac{5}{8}$ in. and covers details of drawing and annealing operations, working tolerances and metals available.

Military Capacitors. Sprague Electric Co., North Adams, Mass., has released a new catalog on military-grade paper dielectric capacitors made in accordance with the requirements of specification JAN-C-25. Catalog 21 is intended to serve as a ready reference guide for engineering and purchasing agents in specifying and buying capacitors to meet stringent performance requirements for various branches and agencies of the Dept. of Defense. The 24-page, 2-color brochure is available on business letterhead request only.

Solderless Cable Connectors. The Workshop Associates, Division of The Gabriel Co., 135 Crescent St., Needham, Mass. Complete speci-

15,000 rpm; full load speed, 7,500 rpm.

Audio Oscillator

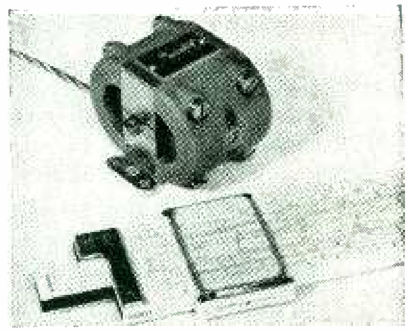
WAVEFORMS, INC., 333 Sixth Ave., New York 14, N. Y. Model 510-B extended-range audio oscillator is a miniature precision instrument measuring 6 in. high × 4¼ in. wide × 5¼ in. deep. Frequency range is 18 cycles to 1.2 mc in five overlapping ranges. Other features are: distortion less than 0.2 percent over most of the useful range; constant output of ±0.5 db from 18 cycles to 100 kc; 300-deg vernier-drive dial; accuracy and stability ±2 percent ±1 cycle for all conditions of line voltage variation (±10 v) to 210 kc.

Literature

Microwave Equipment. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. Booklet B-5448 deals with type FB-1 microwave equipment. The 8-page booklet describes equipment designed to provide reliable communication channels for telemetering, supervisory control, voice communication, protective relaying, teletyping, facsimile and load control. The transmitter and receiver are block diagrammed with tube types indicated, and complete specifications for the equipment are presented.

F-M Receiver. Raymond Rosen Engineering Products, Inc., 32nd & Walnut Sts. Philadelphia 4, Pa., has available a specification sheet on its 842-C f-m receiver, a unit which will fulfill a variety of

frequencies up to 10,000,000 cps. It eliminates the need for harmonic amplifiers, transfer oscillators, multivibrators and oscilloscopes in frequency work. The exact frequency of each unknown measured is presented instantly and directly on the instrument's front panel. For determination of frequencies above 300 cps the equipment counts and displays the unknown directly on the front panel. For low-frequency work the instrument measures the period or duration of a cycle in microseconds. Price of the unit is $2,000.



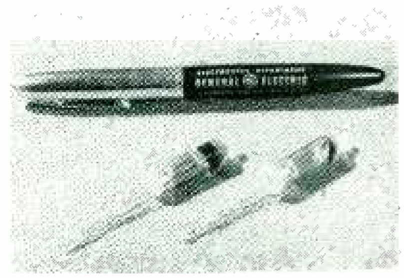
Torque Motor

MIDWESTERN GEOPHYSICAL LABORATORY, Tulsa, Okla. Model 8 electromechanical actuator was designed primarily to stroke hydraulic servovalve pistons. It is usually driven from a servoamplifier utilizing two output tubes in push-pull. This actuator produces over 5 inch-pounds of torque at a radius of 0.906 in. with 40 ma differential current in its two coils (2,900 ohms each). It has a maximum stroke of ±0.020 in. and less than 2 percent hysteresis. The motor weighs 18 ounces, and has a no-load natural frequency of 425 cps.

Universal Motor

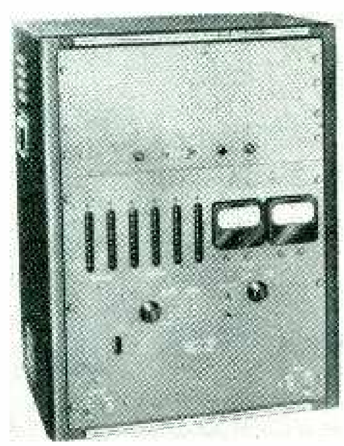
HOWARD INDUSTRIES, INC., Racine, Wisconsin, has announced a new universal motor, EMC model 1120, rated 1/40 to 1/12 horsepower. It was developed for laboratory equipment and similar applications where gear units are not used. Housing is ventilated. Bearings are porous bronze sleeve bearing with felt oil reservoir. Internal fan is standard. Weight is 2 lb. No load speed is

especially for high-frequency inductors. The laminations have exceptionally high permeabilities, with correspondingly low core losses. Orthosil is oriented to provide directional magnetic characteristics and was developed primarily for frequencies of from 400 to 2,000 cycles. It is also readily adaptable to the audio ranges.



Subminiature Receiving Tubes

GENERAL ELECTRIC Co., Syracuse, N. Y., has developed two new subminiature receiving tubes for military aircraft service. Type GL-5797 is a semiremote-cutoff pentode designed for use as a r-f amplifier. The GL-5798 is a medium-mu twin triode designed for use as an oscillator mixer. Both are rated for use at frequencies of up to 400 mc and are particularly suited for applications in which the supply voltage for heater and plates is about 26.5 v.



Frequency Counter

HEWLETT-PACKARD Co., 395 Page Mill Road, Palo Alto, Calif. Model 524A frequency counter is the first single-unit commercial equipment capable of instantly measuring and displaying low, medium and higher

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Bird's engineering staff has the answers to your Jewel Bearing needs. Jewels of any size can be furnished to exact tolerances . . . either unset or set in screws or bushings of your design, ready for assembly into your product without further inspection. Shown below are just two of the many types of Jewel Bearings — precision manufactured by Bird — outlining dimensions needed for ordering. A simple sketch incorporating these specifications will help us to furnish . . . more quickly . . . more accurately, a quotation and delivery of the *right* Jewel Bearing to help you build quality into your product.

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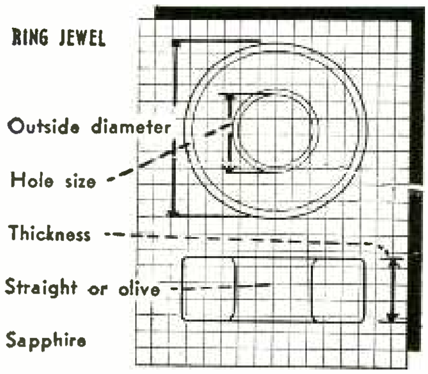

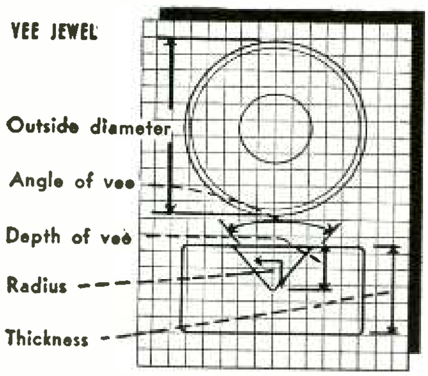

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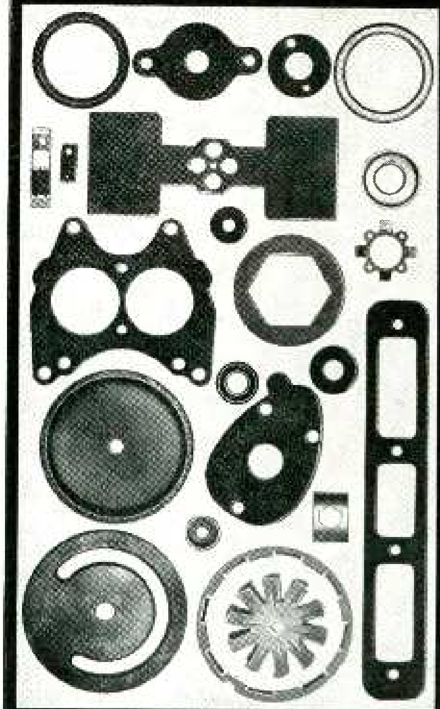

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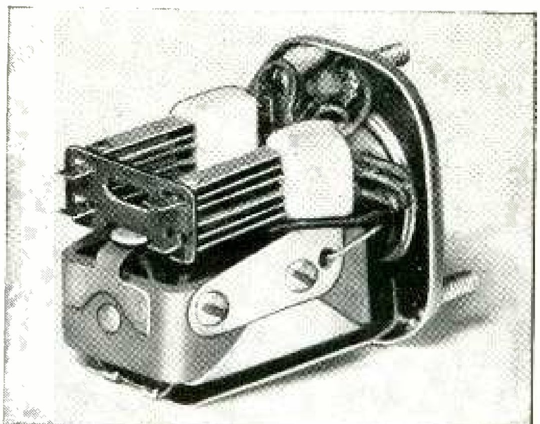
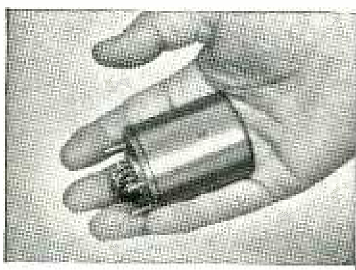
New G-E Hermetically-Sealed Relay Protected from Breakdowns

Cuts Down on Relay Replacements

General Electric's new aircraft relay is more highly arc-resistant, has non-tracking stack insulation, because of a revolutionary technique for directly molding contact arms into a polyester compound.





Rated at 28 volts d.c., the relay withstands surges up to 1500 volts.

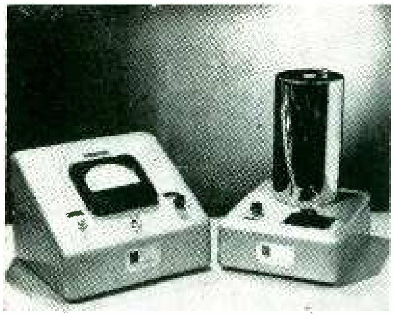
A more powerful magnet structure yields a higher tip pressure, adds to the surety of making contacts. And the relay is available for quick shipment. Write Section 730-38 for Bulletin GEA-5729.

General Electric Co., Schenectady 5, N. Y.

730-38

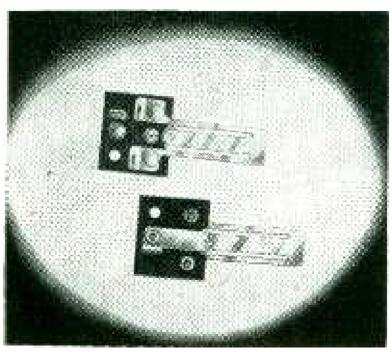
GENERAL ELECTRIC

ranges, with an accuracy of 5 percent of full scale, is incorporated in the instrument.



Gammometer

THE OHMART CORP., 2347 Ferguson Road, Cincinnati 38, Ohio. Model AH-1 gammometer is an instrument designed for the analytical measurement of microcurie quantities of gamma activity. It uses the Ohmart Cell (in which radioactive energy is converted directly into electrical energy) as the radioactive element, thus eliminating need for a h-v power supply. Ranges are from as low as 0.1 microcurie to 10,000 microcuries full scale, calibrated in terms of Radium (standard), Iodine-131 or Cobalt-60. For measurement of ambient field intensity the units are available calibrated in milliroentgen per hour from 0.1 to 10,000 mr per hour full scale.

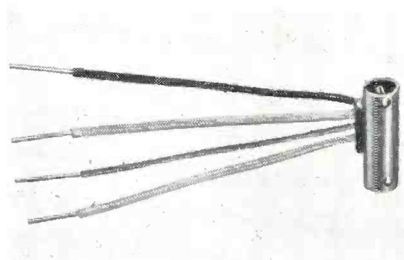


Thermal Switch

THE LAPOINTE PLASCOMOLD CORP., Windsor Locks, Conn., has available the model SW-T-1 thermal switch for remote on-off control of auxiliary electrical circuits. It eliminates special wiring and switching equipment. Design features include small, compact size, easy installation, rugged construction, fast self-recycling, pure silver-to-silver contact and mechanical stability. Maximum load is 50 w; actuating load minimum, 100 w at 117 v; and actuating load maximum, 500 w at 117 v.

All-Glass Kinescope

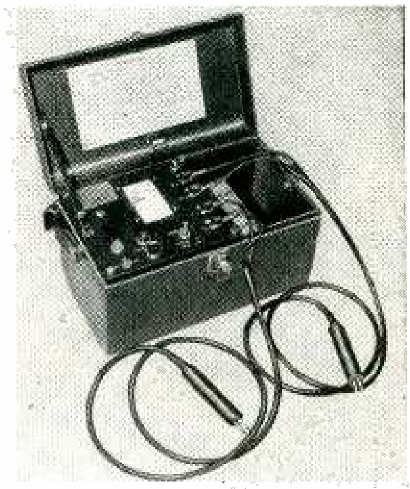
RADIO CORP. OF AMERICA, Harrison, N.J. The 17HP4 is a 17-in. all-glass rectangular picture tube with low-voltage electrostatic focus. The focusing electrode features its own base-pin terminal to permit designers a choice of focusing voltage for best results. The tube has a Filterglass faceplate, an external conductive bulb coating and an ion trap gun. Its picture screen measures $14\frac{3}{8} \times 11\frac{5}{16}$ in.



Instrument Rectifiers

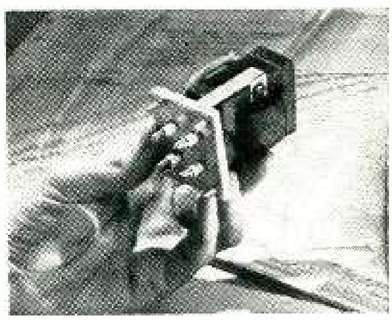
ELECTRONIC DEVICES, INC., 429 12th St., Brooklyn, N.Y. Minisel instrument rectifiers using selenium rectifier cells are made possible by a special plate-stabilizing process and by matching the characteristics of the individual cells to give excellent uniformity within and between units. They are manufactured in all standard configurations: half-wave, center-tap, doubler, $\frac{3}{4}$ bridge and bridge. The individual cells are rated at 10 v a-c input and 5 ma d-c output, but can be had in input ratings up to 26 v a-c and output

current ratings up to 10 ma d-c for special applications.



Low Resistance Ohmmeter

JAMES G. BIDDLE CO., 1316 Arch St., Philadelphia 7, Pa. The Megger low-resistance ohmmeter is self-contained with a compartment for storing leads and hand spikes. It is supplied in two models, both having the same ranges of 0 to 1,000 and 0 to 10,000 μohms. Model 1B is a battery-powered set that employs 2 Burgess 4 FH dry cells or equivalent. Model 1R has a built-in rectifier that can be plugged in to any ordinary lighting circuit outlet. Each complete unit weighs about 19 lb. Ranges of the instrument cover applications such as routine tests on circuit-breaker contacts, relays, switches, bonds, connections and joints, and bar-to-bar tests on commutator-type armatures.



Laminating Material

THOMAS & SKINNER STEEL PRODUCTS CO., 1120 E. 23rd St., Indianapolis, Ind., recently introduced Orthosil, a new, 4-mil iron-silicon material for laminations, designed

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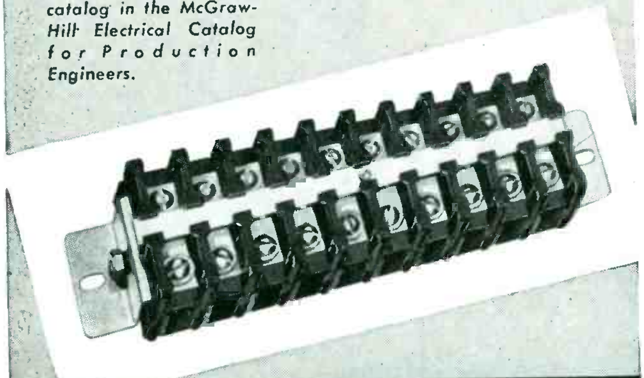
CURTIS TYPE "CDM" BLOCKS

TYPE:
Factory assembled. Your choice of 1 to 50 terminals.

RATED:
750 Volts between terminals of opposite polarity and to ground. 30 Amps. (Conservative).

MARKER:
White marker strip for circuit identification.

Write for Bulletin DS-116. For quick reference consult our condensed catalog in the McGraw-Hill Electrical Catalog for Production Engineers.



CURTIS DEVELOPMENT & MFG. CO.
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Measurements Corporation
MODEL 31

INTERMODULATION METER

- *Completely Self-Contained*
- *Direct Reading For Rapid, Accurate Measurements*

To insure peak performance from all audio systems; for correct adjustment and maintenance of AM and FM receivers and transmitters; checking linearity of film and disc recordings and reproductions; checking phonograph pickups and recording styli; adjusting bias in tape recordings, etc.

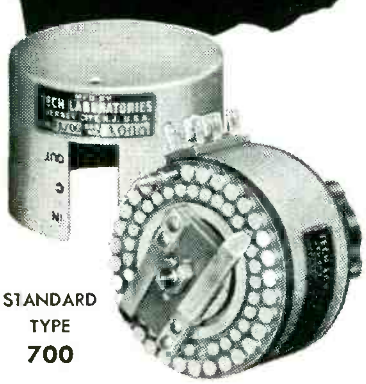
The generator section produces the mixed low and high frequency signal required for intermodulation testing. A direct-reading meter measures the input to the analyzer section and indicates the percentage of intermodulation.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

ATTENUATORS by TECH LABS

MIDGET TYPE **600**

"Midget" model is especially designed for crowded apparatus or portable equipment.



STANDARD TYPE **700**

- Solid silver contacts and stainless silver alloy wiper arms.
- Rotor hub pinned to shaft prevents unauthorized tampering and keeps wiper arms in perfect adjustment.
- Can be furnished in any practical impedance and db. loss per step upon request.
- TECH LABS can furnish a unit for every purpose.
- Write for bulletin No. 431.

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Measurements Corporation
MODEL 58

UHF RADIO NOISE & FIELD STRENGTH METER

Frequency Range
15 Mc. to 150 Mc.

FREQUENCY ACCURACY: ±2%. Individually calibrated dial.

SENSITIVITY RANGE: 1 to 100,000 microvolts. Direct reading dial.

POWER SUPPLY: Built-in supply, 117 volts AC, 6 volts DC.

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

ratios have been combined in the compact type 942-A output transformer. In addition to its use in regular audio amplifiers, the transformer is well adapted for use in high-power modulators; and in amplifiers for electronic musical instruments, industrial uses and constant-voltage audio distribution systems. Eighteen impedance ratios can be obtained covering a wide range of values. The unit has a continuous power rating of 90 w and can handle peak powers of more than 100 w. At the continuous power rating, the transformer distortion is 1 percent or less above 30 cycles under normal operating conditions. Upper frequency limit is between 50 and 100 kc.

Wide-Band Oscilloscope

TEKTRONIX, INC., P.O. Box 831, Portland 7, Oregon. Type 517 wideband h-v cro is designed primarily for the observation and photographic recording of very fast-rising waveforms having a low duty cycle. A quantitative instrument, it has all critical voltages electronically controlled to preserve the accuracy of the sweep and vertical-amplitude calibrations. The amplitude calibrator provides continuously variable output voltages in six ranges, from 0.15 v to 50 v full scale, with an accuracy better than 4 percent of full scale. Distributed-type vertical amplifiers provide a rise time of 0.007 μsec with maximum sensitivity of 0.1 v per cm. A continuously variable trigger-rate generator operating from 15 to 15,000 cps in three

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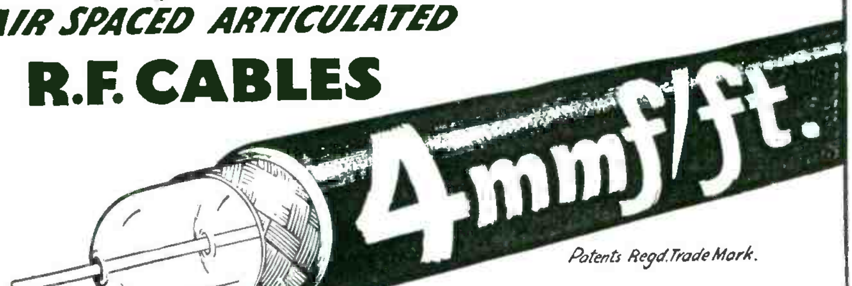

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Billed in dollars Settlement by your check.

LOW ATTEN. Types.	IMPED. Ohms.	ATTEN. db100ft. of 100Mcs.	LOADG. K.W.	O.D."	
A.1.	74	1.7	0.11	0.36	
A 2	74	1.3	0.24	0.44	HIGH POWER FLEXIBLE
A 34	73	0.6	1.5	0.88	

LOW CAPAC. Types	CAPAC. mmf/ft.	IMPED. Ohms.	ATTEN. db100ft 100Mc/s.	O.D."	
C 1	7.3	150	2.5	0.36	
PC 1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C 22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C 33	4.8	220	2.4	0.64	VERY LOW CAPACITANCE
C 44	4.1	252	2.1	1.03	

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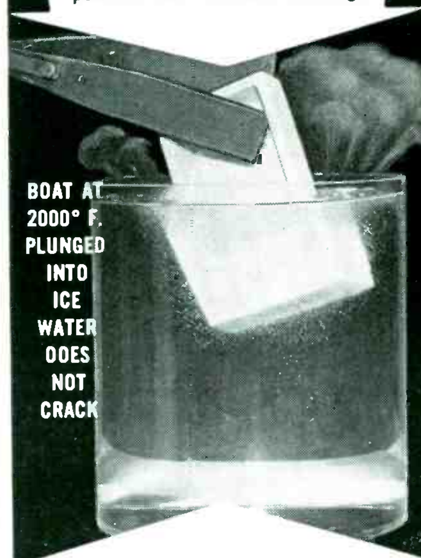

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- Clean . . . will not rub off on hands and work pieces
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Available in stock forms of boats or slabs. Special shapes made to your individual specifications.

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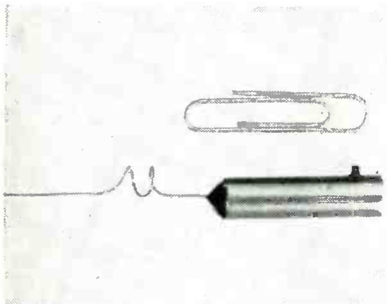
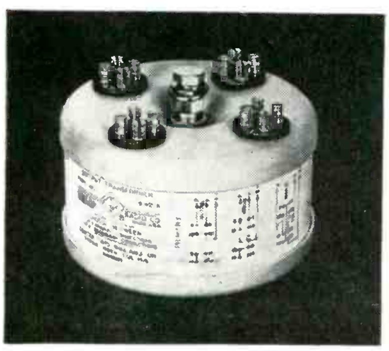
fast rise time with a minimum decay providing a good waveform for specific pulse techniques. Standard frequency response is from 100 kc to 30 mc. The transformers may be built of class H materials for continuous operation at 200 C.



Miniature Thermostat

THOMAS A. EDISON, INC., West Orange, N.J. A miniature, adjustable, metal-enclosed thermostat designed for long-term stability and accuracy has been announced. It has a temperature range from −50 to 350 F and is adjustable ±60 F from its original factory setting. Sustained stability is achieved by the use of a ceramic bushing to anchor the bimetal and by a separate phosphor bronze spring which carries the moving contact. The separate contact spring prevents the bimetal from taking a set or becoming overstressed by extreme contact pressure. Contacts are rated at 1 ampere, 115 v a-c or 0.5 ampere, 115 v d-c. Overall shell length is $1\frac{1}{4}$ in. and diameter approximately $\frac{5}{16}$ in.



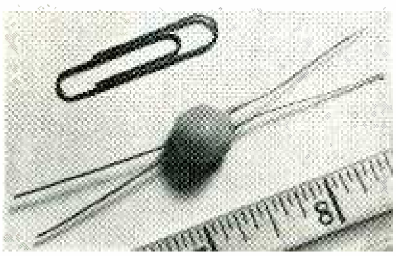
Output Transformer

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Excellent frequency response, low distortion, high power-handling capacity and flexibility of impedance

maximum attenuation. The feedthrough insertion loss is less than 0.5 db at 250 mc. The attenuator is available in two models: the A-72 for use with RG-59/U cable at a dealer price of $54.50; the A-72X for use with RG-11/U cable, priced at $59.50.

Signal Generators

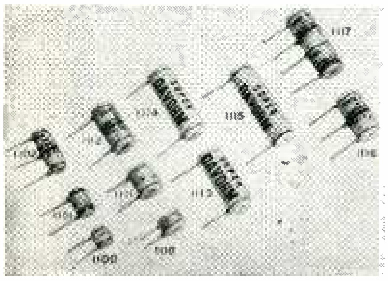
DECADE INSTRUMENT CO., Caldwell, N. J. Model 10–100 Decalator, a signal generator developed for the 10-kc to 10-mc range, consists of a series of decade-switched oscillators. Decalators feature direct readings for 9,000 separate steps of frequency; excellent short term stability, ±2 cycles, at all frequencies; high accuracy, ±0.05 percent, at maximum frequency. Price is $795.



Subminiature Pulse Transformers

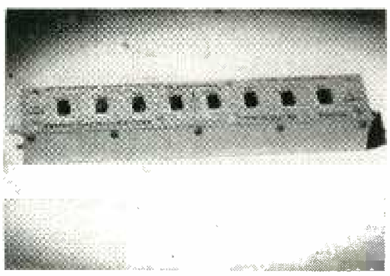
PCA ELECTRONICS INC., 6368 DeLongpre Ave., Hollywood 28, Calif., has available pulse transformers designed for low-power application and for use where space is at a premium. Size reduction is $\frac{7}{16}$ in. × $\frac{7}{16}$ in. × $\frac{3}{8}$ in., with weight less than 0.1 oz. The transformers are built in a range from 0.2-μsec to over 5-μsec pulse widths when used as a blocking oscillator. Two, three and four-winding units with and without center taps are obtainable to fit particular circuit requirements. Special features are

to cover the 10-meter band. The vfo kit uses a 6AU6 electron-coupled oscillator and an OA2 regulator. All voltage requirements are supplied from the vfo supply socket on the Viking 1 transmitter. If the vfo is used without the transmitter, power supply requirements are 250 to 300 v, unregulated at 15 ma and 6.3 v at 0.3 ampere, a-c or d-c.



Subminiature Resistors

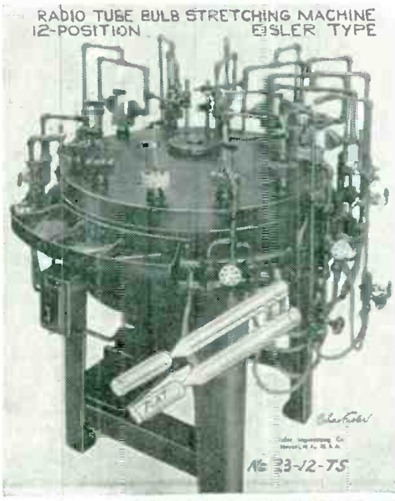
DAVEN Co., 191 Central Avenue, Newark, N. J., has introduced a new series of small resistors to meet the miniaturization program of the armed forces, aircraft and electronic industries. Resistance values from 20,000 ohms to 2 megohms are available in sizes from $\frac{1}{4}$ in. in diameter × $1\frac{3}{8}$ in. long. Maximum values of resistance may be obtained by use of various types and sizes of wire.



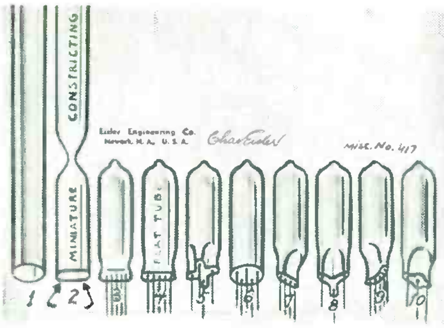
R-F Attenuator

JERROLD ELECTRONICS CORP., N. E. Cor. 26th & Dickinson Sts., Philadelphia 46, Pa., has introduced a versatile new r-f attenuator with wide usefulness for tv and radio engineers, technicians and servicemen. Designed for 72-ohm input and output matching of the 0 to 250-mc range, it provides precise attenuation in any value from 0 to 82 db by a simple in and out switching arrangement. The attenuator is accurate within 1 percent at the

ELECTRONIC GLASS WORKING EQUIPMENT for RADIO, TELEVISION TUBES, INCANDESCENT LAMPS, GLASS LATHES for TELEVISION TUBE REPAIR. We make Transformers, Spot and Wire Butt Welders, Wire Cutting Machines and 500 other items, indispensable in your production. Eisler Engineers are constantly developing New Equipment. If you prefer your own designs, let us build them for you. Write to Charles Eisler who has served The Industry over 30 years.



Machines for small Radio Tubes of all kinds; 24 Head Stem, 24-Head Sealing and 24-Head Exhaust Machines, Spot Welders, etc.



EISLER ENGINEERING CO., Inc. 751 So. 13th St. Newark 3, N. J.

PRECISION-MADE PORCELAINS for Electronic Applications

The high quality porcelain insulators you need are assured by Louthan's careful workmanship and close inspection. Louthan specializes in Vitrified, Refractory, and low-loss Steatite porcelain insulating parts, with the clean, smooth surfaces, the good mechanical strength, the specified electrical properties, and the dimensional accuracy your applications demand.

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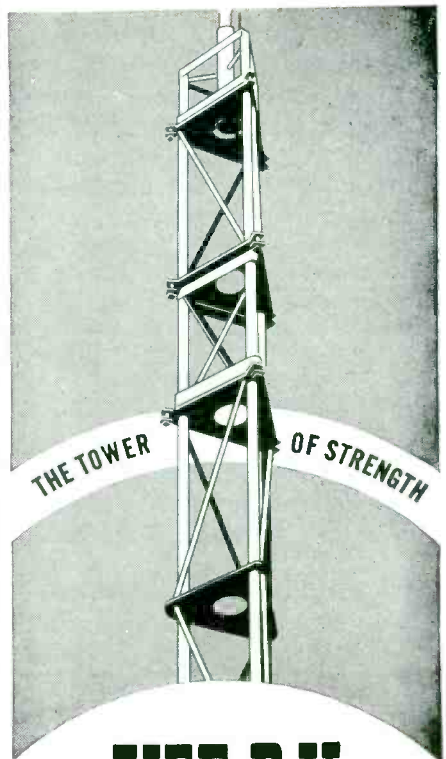
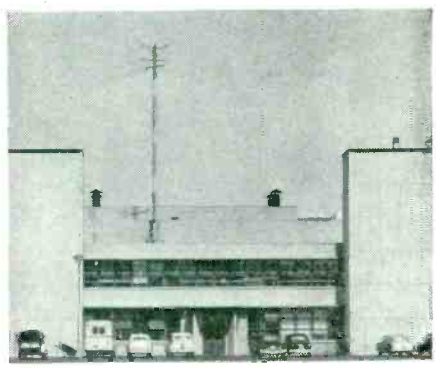
A Subsidiary of Harbison-Walker Refractories Co.
EAST LIVERPOOL, OHIO



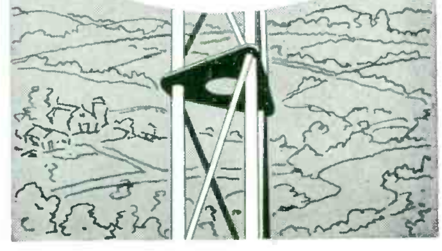
VEE-D-X Sectional Tower

MOST ECONOMICAL FOR MICROWAVE · FM · TV COMMUNICATIONS · RADAR



Pan American World Airways installation at Idlewild. Tower carries one 40 mc ground-plane antenna, six half-wave vertical 100 mc antennas, two weather instruments and a full set of obstruction lights.

THE LaPOINTE-PLASCOMOLD CORP.
WINDSOR LOCKS, CONN.



a plotting board and exploratory stylus, d-c power supply operated from 115 v a-c, a high accuracy multiturn voltage divider, sensitive microammeter with specially designed overload protection, and a supply of conducting paper and silver paint. An instruction book accompanies the plotter.

Sonic Oscillator

RAYTHEON MFG. CO., Waltham 54, Mass., is offering a magnetostriction oscillator that furnishes a reliable sound source for scientific and industrial research. With this oscillator almost any industrial laboratory can conduct its own research into the effects of sound waves on living organisms and chemical mixtures. The devices are available in two sizes. The small unit, operating at 9,000 cycles, has a recommended capacity of 25 cc and delivers approximately 50 watts to the magnetostriction rod. The larger unit has a capacity of 50 cc and delivers 200 watts at a frequency of 10,000 cycles.

VFO Kit

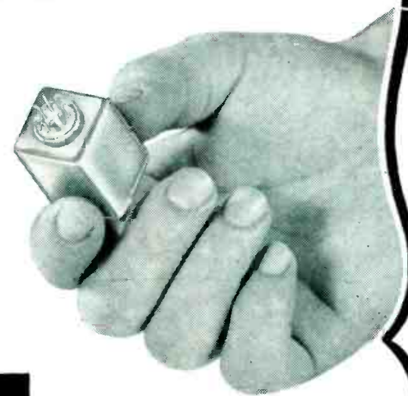
E. F. JOHNSON CO., Waseca, Minn. A new vfo kit provides more than adequate vfo output to drive transmitters to full excitation on all bands, 10 through 160 meters. Keying can be done in three ways: with vfo alone, with transmitter alone, or with both together, the last method providing perfect break-in operation on all bands. The use of two separate oscillator tank circuits, temperature compensated, provides maximum frequency calibration spread and accuracy and minimum frequency drift with a frequency multiplication of only four needed

COULD THIS BE THE HOME FOR YOUR

New Relay ?

Transformer ?

Choke Coil ?



Ideally suited for use where space is at a premium, this standard Hermaseal unit meets Mil-T-27 and JAN specifications, and has many possible applications.

DETAILS

1" x 1" can, depth variable to your requirements.

Supplied with cover pierced for individual terminals, or pierced and embossed for a .600 O.D. sealed header with up to eight terminals (as shown). Equipped with mounting studs, if desired.

Furnished with either dry air fill or vacuum-pumped and pressure-filled with dry nitrogen.

STILL DOESN'T SUIT YOU?

Tell us what you *do* need; perhaps one of our other standard units will fill the bill. Or, we'll be glad to design a special unit for you (as we've done for many others.) Write today for our new catalog and quotes.

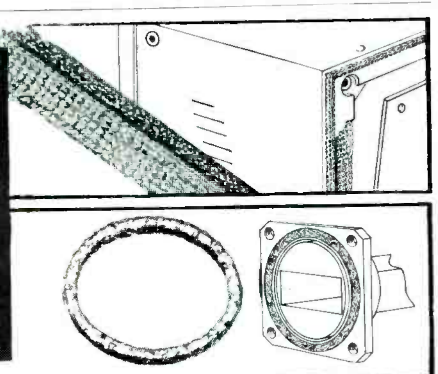
Hermaseal **THE HERMASEAL CO, Inc.** **Elkhart 12, Indiana**

SHIELDING PROBLEMS

effectively and economically solved with

METEX

electronic "Weather Strips"



Resilient . . . Conductive . . . Compressible . . . Cohesive

From closures for cabinets to gaskets for waveguide couplings, Metex Electronic Shielding assures *lasting* metal-to-metal contact to prevent leakage, without the need for costly machining to secure precise surface-to-surface contacts. Metal wire — *knitted,* not woven or braided — gives Metex Electronic Strips and Gaskets that combination of conductivity and resiliency which makes them so effective and economical for shielding.

For a more detailed picture of the scope of utility of Metex Electronic Products, write for free copy of "Metex Electronic Weather Strips." Or outline your specific shielding problem—it will receive immediate attention.

METAL TEXTILE CORPORATION

KNITTERS OF WIRE MESH FOR MORE THAN A QUARTER CENTURY

METEX

641 East First Avenue **Roselle, N. J.**

INFORMATION on positions at NORTHROP

Northrop Aircraft, Inc. is engaged in the most absorbing work of a long career devoted to scientific and engineering development, as well as aircraft production. This includes new, long-range projects of the utmost importance and interest. Exceptional opportunities await qualified individuals.

The most responsible positions will go to top-caliber engineers and scientists. However, a number of excellent positions exist for capable, but less experienced, engineers. Some examples of the types of positions now open are:

ELECTRONIC PROJECT ENGINEERS . . . ELECTRONIC INSTRUMENTATION ENGINEERS . . . RADAR ENGINEERS . . . FLIGHT-TEST ENGINEERS . . . STRESS ENGINEERS . . . AERO- AND THERMODYNAMICISTS . . . SERVO-MECHANISTS . . . POWER-PLANT INSTALLATION DESIGNERS . . . STRUCTURAL DESIGNERS . . . ELECTRO-MECHANICAL DESIGNERS . . . ELECTRICAL INSTALLATION DESIGNERS.

Qualified engineers and scientists who wish to locate permanently in Southern California are invited to write for further information regarding these interesting, long-range positions. Please include an outline of your experience and training.

Allowance for travel expenses.

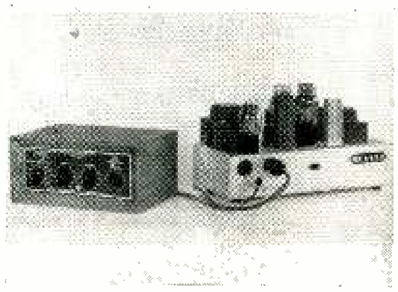
Address correspondence to Director of Engineering,

NORTHROP AIRCRAFT, INC.

1009 E. BROADWAY
HAWTHORNE, CALIFORNIA

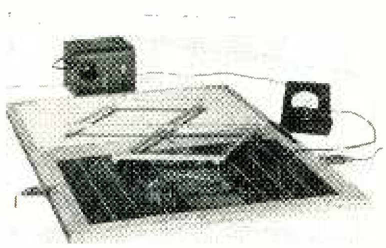
5P6

mometers, cathode cells, meters and gages of all types.



Remote-Control Amplifier

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 214-A amplifier has control and compensating features that improve music fidelity and simplify operation and installation. Remote control can be placed up to 25 ft from the power amplifier. An 8-position record-compensator adjusts for any recording characteristic. Individual 3-channel continuously-variable tone controls each have control range from 6 db per octave boost, through flat response, to 6 db octave attenuation. Frequency response is flat from 18 to 22,000 cps; output, 20 w; hum, 84 db below full output; harmonic distortion, less than 0.5 percent at full output.



Analog Field Plotter

GENERAL ELECTRIC CO., Schenectady 5, N.Y., has introduced the portable analog field plotter, a versatile tool for rapid solution of complex two-dimensional field problems. It sets up electrical field patterns in a thin conducting-paper surface on the plotting board. Analogy between the electric field in the paper and the related field problems — such as might exist in electrostatics, electromagnetics, thermal and fluid flow—allows an easy solution to a broad range of problems. It consists basically of

Exclusives in the coming (Mid-June) electronics

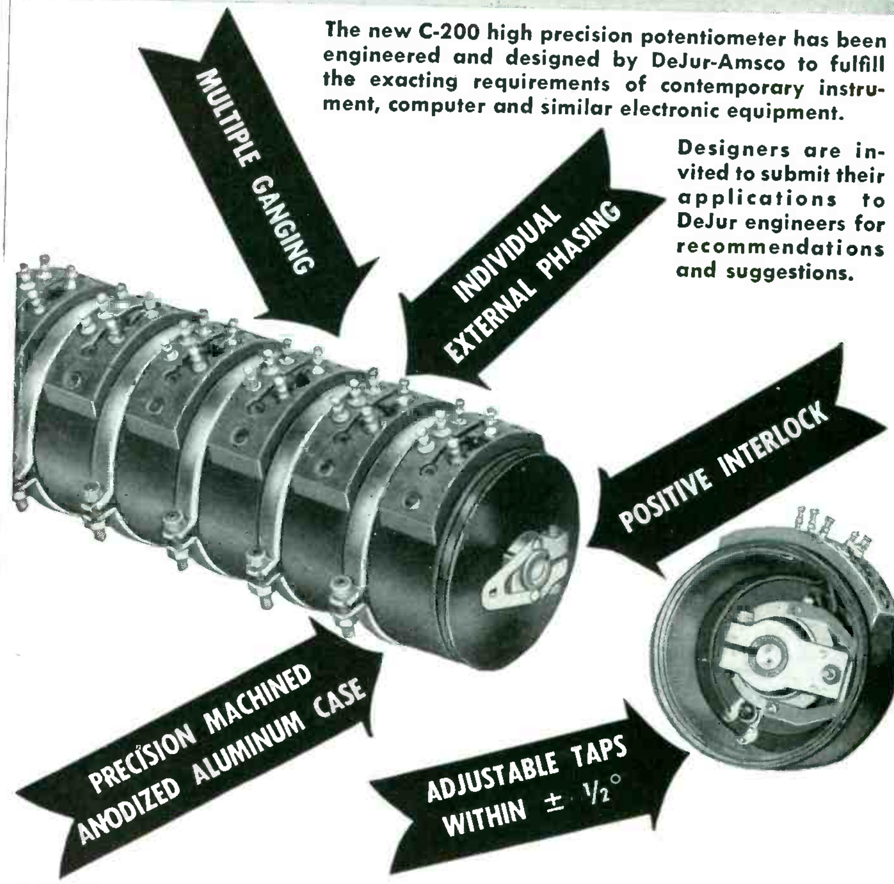
BUYERS' GUIDE

include:

- a cumulative editorial index to ELECTRONICS, 1940-1949 inclusive
- extensive trade name listings
- geographical listings of distributors
- simple telephone book type product listings

Announcing THE NEW **C-200**

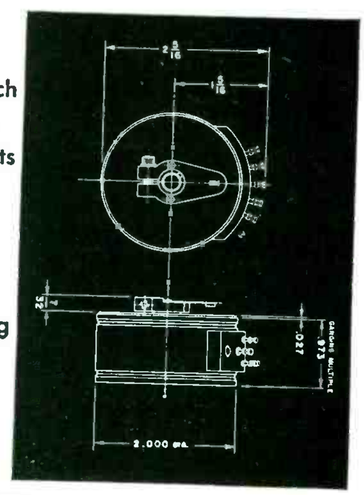
DeJUR External Phasing Potentiometer



The new C-200 high precision potentiometer has been engineered and designed by DeJur-Amsco to fulfill the exacting requirements of contemporary instrument, computer and similar electronic equipment.

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



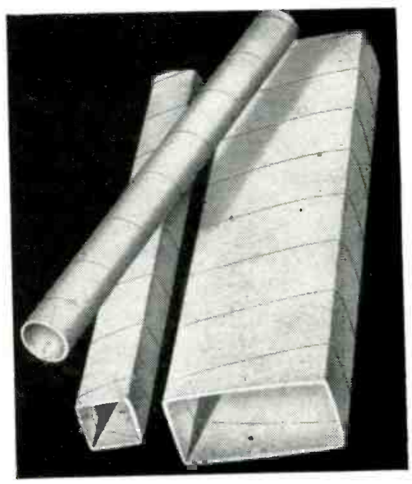
WRITE FOR BULLETIN 100-E

DeJUR AMSCO CORPORATION
45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.
MANUFACTURERS OF SCIENTIFIC PRECISION EQUIPMENT FOR OVER A QUARTER ...
• CAMERAS • PROJECTORS • ENLARGERS • EXPOSURE METERS •

ture in both cases. The skirt and metal base has been eliminated and the pin connections in the Amperex types pass directly through the powdered glass seal base. This means that free circulation of air around the base pins is permitted. In operation the types 6155 and 6156 run considerably cooler at the base areas and the removal of the unnecessary external structures also permits a more economical space arrangement in the circuit construction.

P-A Amplifier

ALLIED RADIO CORP., 833 W. Jackson Blvd., Chicago 7, Ill. The Knight 80-watt public-address amplifier was designed for such industrial applications as high-power paging and music distribution throughout entire plants. Technical specifications include: power output, 80 watts; hum 76 db down; 4 inputs for microphone and phono; outputs, 5, from 4 to 500 ohms, plus new RTMA 70-volt and special 600-ohm low-level ungrounded output for connection to phone lines or additional amplifiers for extra power; response, ±2 db, 30 to 20,000 cps (on all channels); power drain, 127 watts at no signal and 300 watts at rated output. Operation is from 110 or 130 v, 50 or 60 cycle a-c, with transformer taps at 117 and 130 v. Price is $129.75.

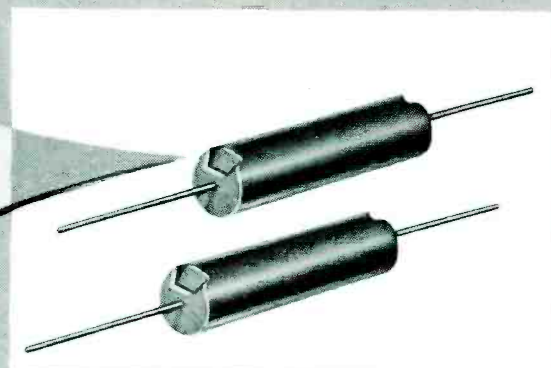


Asbestos Tubing

ACCURATE PAPER TUBE CO., 848 N. Noble St., Chicago, Ill., has de-

Only Speer has this patented notch

...to anchor windings securely



Want coil forms that practically guarantee your leads will be anchored securely?

Try Speer. Their rugged, well-made coil forms possess patented notches at both ends. These notches are designed so that the leads of the coil may be wound around and then fastened securely, with a minimum of time and labor.

Speer coil forms are molded from mineral filled material, iron powder, or metallic oxides, and have from two to six terminals. Their effectiveness has been proved by actual performance in hundreds of circuits, under all types of operating conditions.

See what they can do for you...

Write today for information on specifications

SPEER Resistor Corp.

St. Marys, Pennsylvania
A Subsidiary of Speer Carbon Co.
OTHER SUBSIDIARIES: Jeffers Electronics, Inc.
International Graphite & Electrode Corp.

Other Speer Products for the Electronics Industry

anodes · contacts · fixed carbon resistors
iron cores · discs · brushes · battery carbon
graphite plates and rods

also

R. F. coils · ceramic capacitors · capristors
highvoltage condensers · disccapacitors · chokes

made by

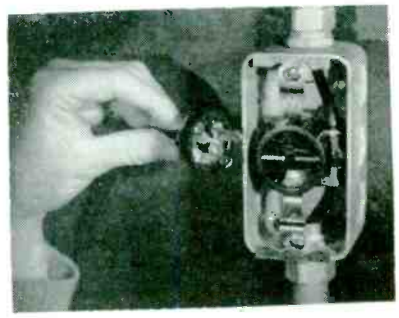
Jeffers Electronics, Inc.

SPEER RESISTOR

veloped an asbestos tubing for coils and transformers. This tubing, made from either of two types of Johns Manville purified asbestos (Quinterra or Quinorgo), was developed for use on Class B and Class H transformers. Tests made with transformers using these asbestos tubes with secondaries short circuited have shown breakdown resistance of 1,250 v to ground even after windings have burned out. Identical transformers using Class A insulation and given the same test shorted out at 117 v. Development of this tubing will permit manufacturers to reduce the size of their transformers without fear of the resultant higher temperatures. It also will eliminate the costly extra step of fabricating their own cores when high temperatures are involved.

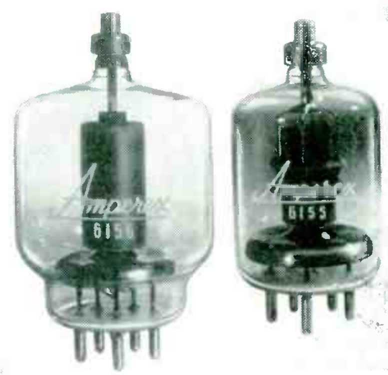
Instrument Mercury

THE BETHLEHEM APPARATUS CO., INC., Hellertown, Pa., is now processing and marketing mercury specifically for use in instruments requiring a high degree of accuracy. An unbreakable 5-lb polyethylene bottle with a flexible dispensing tip delivers the mercury directly to the instruments from the dust-proof chamber in which it has been purified of all contaminants. This instrument mercury goes beyond the standard chemical tests that are adequate for reagent mercury, and meets much more exacting physical tests, remaining bright indefinitely in storage and in instruments. It is suitable for use in manometers, polarographs, therpipe-line, forestry, utility and state police fields.



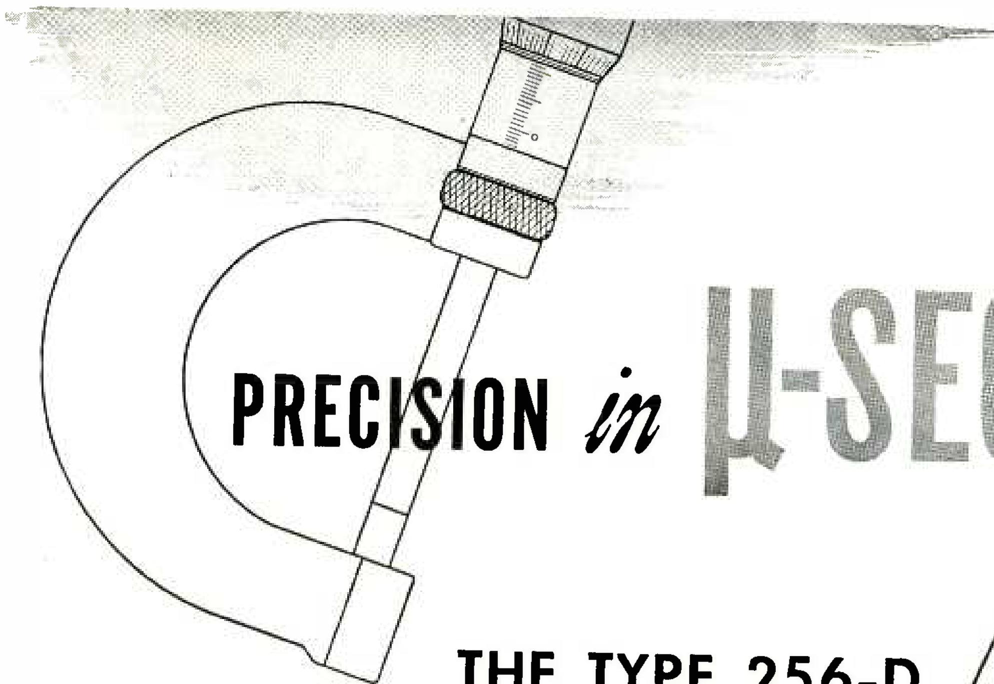
TV Coupler

TECHNICAL APPLIANCE CORP., Sherburne, N. Y., has available a master tv antenna system coupler for use in conduit installations in new-construction work. It is designed to fill the need for a tap-off device along the main transmission lines housed in conduits. The Tacoplex Catalog 1582, as a tap-off device, provides the necessary isolation between receivers and at the same time provides proper attenuation to maintain a constant level of signal strength throughout the system. By means of three resistors wired in parallel the proper attenuation is obtained by clipping out one or two of the resistors. Complete instructions accompany the unit.



Improved Tube Types

AMPEREX ELECTRONIC CORP., 25 Washington St., Brooklyn 1, N.Y., announces availability of two new tube types, 6155 and 6156, which are improved versions of the types 4D21 and 5D22 respectively. Although they fit into the same sockets and are completely interchangeable with the latter types, considerable improvement has been made on the external tube struc-



PRECISION *in* µ-SECS

THE TYPE 256-D

and

for PRECISION IN YARDS

THE TYPE 256-E

A high-precision time-measuring device designed for general-purpose functions in laboratory work.

The calibrated sweep delay of the Type 256-D will measure time intervals up to 1000 microseconds with an accuracy of ±0.1% of the full scale ranges of 100 µ-secs. or 1000 µ-secs. A movable marker indicates the portion of the sweep which is expanded on shorter delayed sweeps. Delayed sweeps are of 4-, 10-, and 25-microsecond durations. Undelayed sweeps are available in six ranges from 4- to 4500-microseconds.

Response of the video amplifier is within ± 1 db at 20 cps; down less than 3 db at 8 mc, no more than 6 db at 11 mc. Sensitivity is 0.7 peak-to-peak volt per inch. Pulse response is such that a rise time of 0.01 microsecond will be reproduced as a rise time of 0.04 microsecond or less.

Crystal-controlled timing markers calibrate the delay circuits. Delayed and undelayed sweeps may be started by external trigger pulses of either polarity or by built-in trigger generator providing 1 microsecond pulses of either polarity, having a rise time of 0.3 microsecond and amplitude greater than 100 volts. Trigger repetition rates up to 2000 P. P. S. are available.

Electrically similar to the Type 256-D. Calibrations in yards instead of microseconds. Designed especially as test equipment for electronic ranging systems, or as an accessory unit for radar systems.

Provides undelayed sweeps of 800, 2000, 4000, 20,000 and 200,000 yards in addition to a 4500-microsecond sweep. Delayed sweeps of 800, 2000 and 4000 yards may also be selected.

DU MONT

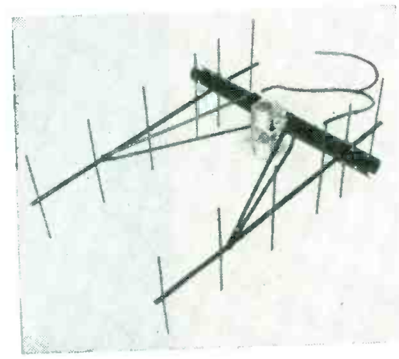
for Oscillography

Instrument Division, **ALLEN B. DU MONT LABORATORIES, Inc.,** 1500 Main Ave., Clifton, N. J.

0.2 percent at 15 ips and less than 0.25 percent at 7½ ips.

Metal-Clad Laminates

THE RICHARDSON CO., 2765 Lake St., Melrose Park, Ill. Two well-known grades of Insurok laminated phenolic—T-725 and T-812—are now being offered as copper-clad and aluminum-clad sheets. These metal-clad laminates can be printed and etched to produce printed circuits for use in radio, tv and many other electrical assemblies. The metal foil is bonded to the laminate under heat and pressure and provides unusually high bond strength for this class of material. Sheets are available in 36 in. × 42 in. sizes, in thicknesses from $\frac{1}{32}$ in. to $\frac{3}{32}$ in. inclusive. Nominal thicknesses of metal foils available from stock are 1½ and 3 mils. Sheets can be furnished with metal covering on one side or both sides.

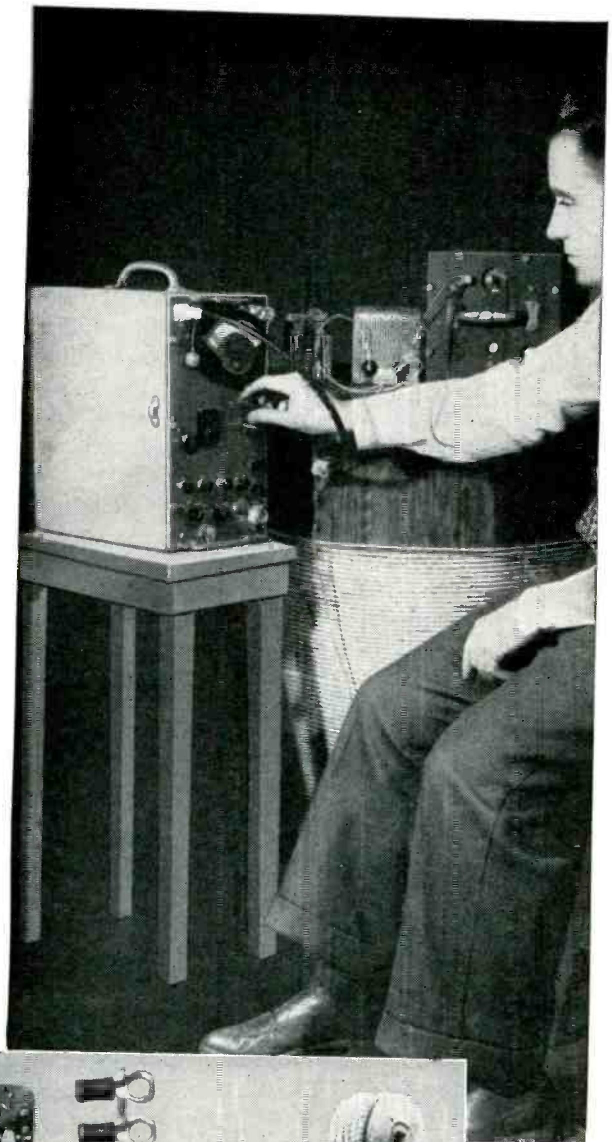


Directional Antennas

WARD PRODUCTS CORP., DIVISION OF THE GABRIEL CO., 1523 E. 45th St., Cleveland 3, Ohio. High gain and rugged construction are features of two new directional antennas for the 450 to 470-mc band. Model SPP-161, illustrated, is a 12-element Yagi type with a gain of 11 db. It is vertically polarized for commercial communications, (with provision for horizontal polarization where necessary), matches 52 ohms with vswr of less than 2 to 1, and can handle up to 250 w of power. Model SPP-172 is a 24-element Yagi of similar construction, with a forward gain of 14.5 db. They are designed for point-to-point communications in the broadcasting, railroad, petroleum-

NOISE!

WE DEFY ANYONE TO DETECT ANY DIFFERENCE IN NOISE LEVEL BETWEEN AN AMP SOLDERLESS CONNECTION AND A PERFECT SOLDERED JOINT!



During recent years three laboratories, employing DIFFERENT test methods and the finest equipment yet developed, agree: THERE IS NO MEASURABLE NOISE IN THESE AMP SOLDERLESS CONNECTIONS!

TEST #1 AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

AMP terminal connections (which had been subjected to salt spray) were placed in series with the input of a high gain, wide band pass amplifier (originally developed for checking thermal noise in R.F. input circuits). Dr. Wiesner's results, after testing AMP terminals, substantiate "the unlikelihood that metal-to-metal contact as it exists in crimped solderless connections would be expected to develop noise"

TEST #2 AT AN ARMED FORCES TEST LAB

Since a terminal has but a few milliohms resistance, this test required a special transformer to match this low impedance to the input of the amplifier, sensitive to levels of 0.2 micro volt. 60 AMP solderless terminals crimped to short lengths of wire in series, a similar number of carefully soldered joints, and a single piece of solid wire of equivalent R, were compared.

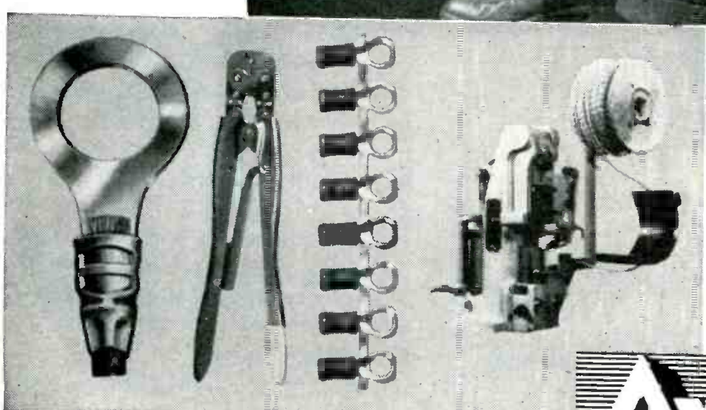
No noise difference was detectable between any of the three.

TEST #3 AT A PROMINENT UNIVERSITY LAB

7,000 AMP solderless connectors were crimped to short lengths of wire in series making a chain of terminals 340 feet long (see illustration). After aging for two years in an unfavorable atmosphere these 14,000 connections in series were tested at radio frequencies up to 20 megacycles.

AGAIN — Noise measurements were down to thermal magnitude.

(Copies of all test results available on request to our ELECTRONIC DIVISION.)



CHECK THESE RESULTS YOURSELF! Use the Appropriate AMP Connection In ANY Circuit, Be It Low or High Level, DC or High Frequency!

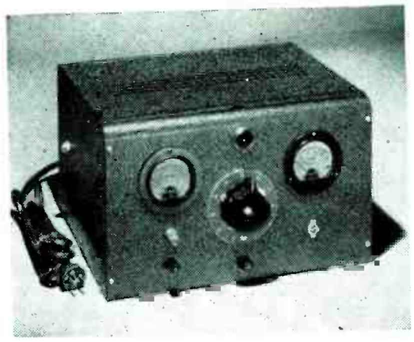
AMP precision tools produce these uniform quality connections at production rates up to 4,000 terminations per hour!

AIRCRAFT-MARINE PRODUCTS, INC.

10 Paxton Street Harrisburg, Pa.

AMP Trade-Mark Reg. U.S. Pat. Off.

may be inserted on planchets, filter paper on rings or disks, and ashing dishes. Price is $225 fob, Philadelphia.

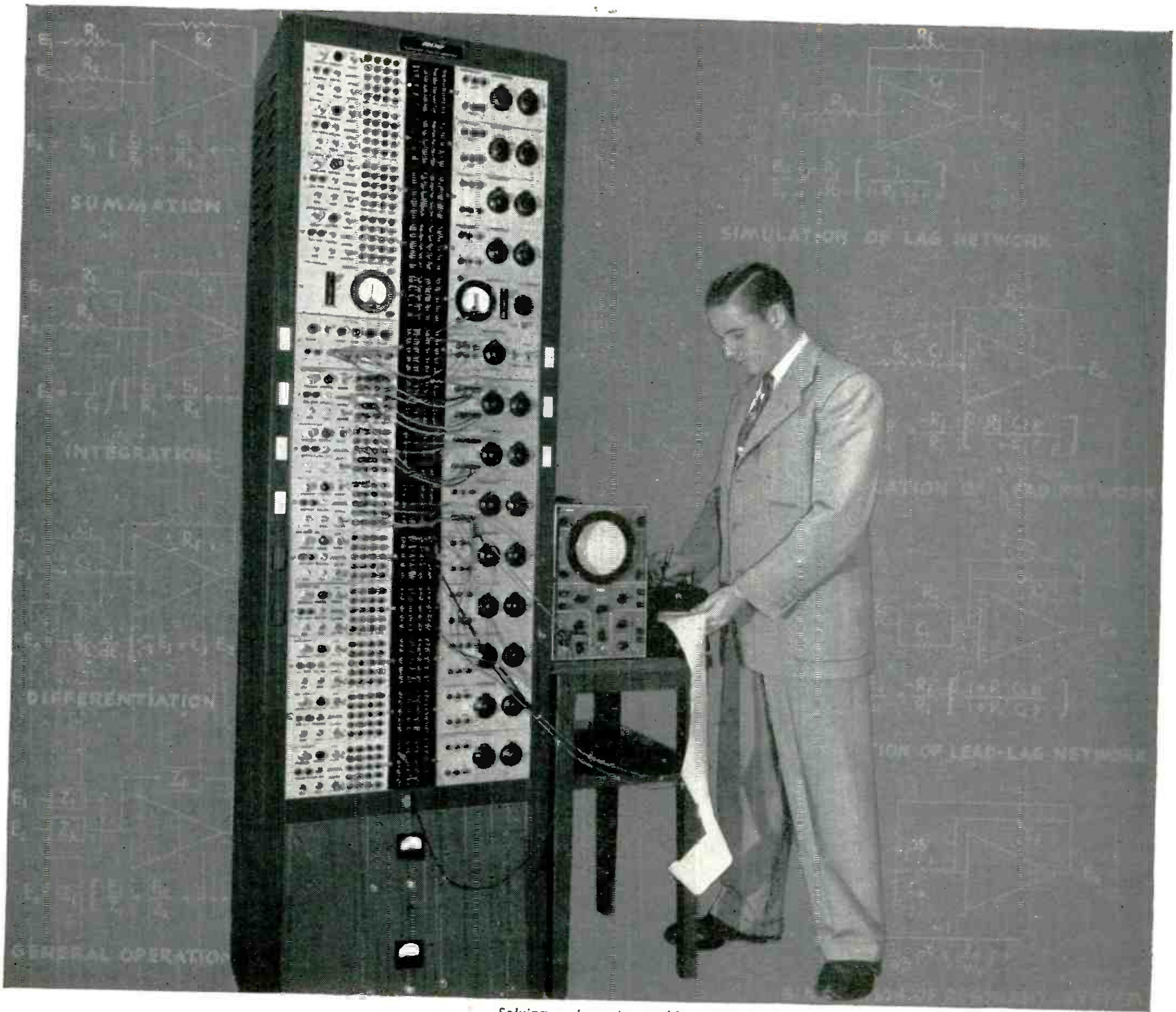


Bench Power Supply

INDUSTRIAL RECTIFIER Co., 120 Cedar St., New York 6, N. Y., has announced the model 1028 bench power supply for laboratory and production use. Continuously variable from 0 to 28 v d-c, it is rated for 10 amperes continuous duty. Other models can be supplied to order. These power supplies feature custom-built selenium stacks individually tested for peak performance.

Tape Recorder

AMPEX ELECTRIC CORP., Redwood City, Calif., has announced the model 400-A tape recorder for audio recording. It offers push-button operation in a tape recorder recording up to 15,000 cps at a tape speed of 7½ in. per sec. It has a frequency response down no more than 4 db at 30 and 15,000 cps at 7½-ips tape speed. At the 15-ips speed the response is ±2 db, 50 to 15,000 cps. Noise level is 55 db below the 2 percent total harmonic distortion level. Wow and flutter are less than



Solving a dynamics problem with the Boeing Computer; oscilloscope at right shows result.

What's it like to be a Boeing engineer?

Boeing engineers enjoy many advantages – among them the finest research facilities in the industry. These include such advanced aids as the Boeing-designed, Boeing-built Electronic Analog Computer shown above.

This is part of the stimulating background that helps Boeing men maintain the leadership and prestige of an Engineering Division that's been growing steadily for 35 years.

If you measure up to Boeing standards, you can share that prestige. And you'll work with renowned engineers on such vital projects as guided missiles, the still-classified B-52, the record-shattering six-jet B-47, and other outstanding developments.

There are excellent opportunities, right now, for experienced and junior engineers for aircraft

- **DESIGN**
- **RESEARCH**
- **DEVELOPMENT**
- **PRODUCTION**
- **TOOLING**

also for servo-mechanism and electronics designers and analysts and for physicists and mathematicians with advanced degrees.

You can work in Seattle, in the Pacific Northwest, or in Wichita, Kansas. You will receive a generous moving and travel expense allowance. And as a Boeing engineer, you'll enjoy pay that is good and grows with you.

You'll be proud to say, "I'm a *Boeing* engineer!"

Write today to the address below, or use the convenient coupon.

JOHN C. SANDERS, Staff Engineer—Personnel
Dept. H-4
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

Name ______________________

Address ______________________

City and State ______________________

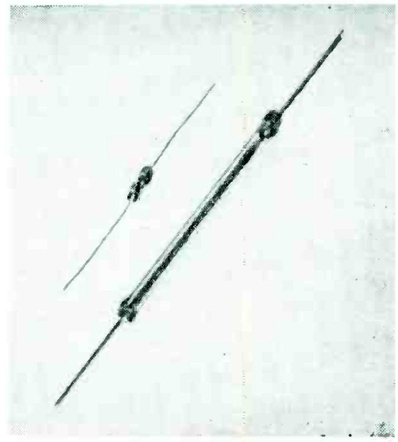
BOEING

wire lines and cables used in carrier communication may be achieved through the use of newly available toroidal loading coils. Coils are wound on high-stability iron-powder toroidal cores. Applicable to circuits using carrier frequencies of 3 to 35 kc, these coils in particular combinations form a tuned loading system that provides a substantially flat nonreactive impedance characteristic throughout most of the range. Three different basic coils are available with inductances of 4.3, 2.6 and 4.1 millihenries. Inductance of the coils is held within 0.02 mh of nominal value while the two windings on each coil are balanced to 0.1 percent of inductance value from 200 cps to 35 kc. Maximum resistance unbalance is 0.03 ohm, current rating is 300 ma, and insulation between the windings withstands 3,500 volts rms.

Radioactive-Sample Changer

El-Tronics, Inc., 2647 N. Howard St., Philadelphia, Pa., has announced model LSC shielded radioactive sample changes for use in radiology departments of hospitals, physical and chemical research laboratories and graduate schools. A sliding sample drawer contains two inches of lead at front and rear of the sample, so that when the sample is placed, actually two inches of lead completely enclose it, as well as a two-in. lead shield around the Geiger tube. To facilitate decontamination and prevent back-scattering the slide is made of aluminum. Four slide positions offer fast counting of large numbers of radioactive samples, which

tained. Mounting faces may be made to hanger all common servo motors, synchros, potentiometers and other electro-mechanical components.



Selenium Rectifiers

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., has introduced its hermetically sealed selenium rectifiers with cell sizes as small as 0.060 in. diameter. Known as the Microstak line, these miniature units are available in a wide range of current and voltage ratings. Illustrated is the 36 v to 4,500 v peak inverse rating unit. Actual measurement of the 4,500-v unit is $2\frac{3}{4}$ in. long $\times$ $\frac{7}{32}$ in. diameter. Technical data bulletin SR-1 is available from the manufacturer.

Toroidal Loading Inductors

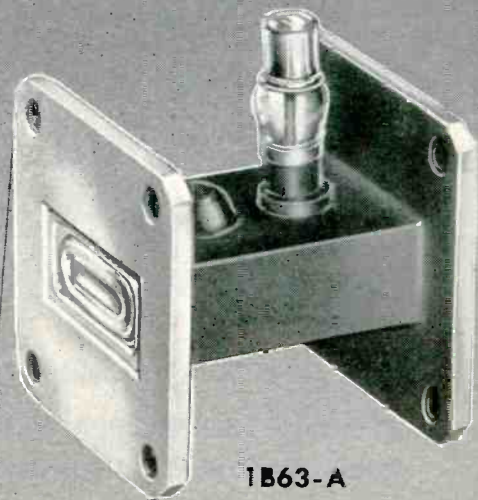
LENKURT ELECTRIC CO., 1105 County Road, San Carlos, Calif. Impedance matching between open

NOW in Production...

For X Band users, Bomac is now producing the 1B63-A Band Pass TR Tube. This addition complements the line of Band Pass TR Tubes already available in K and S Bands.

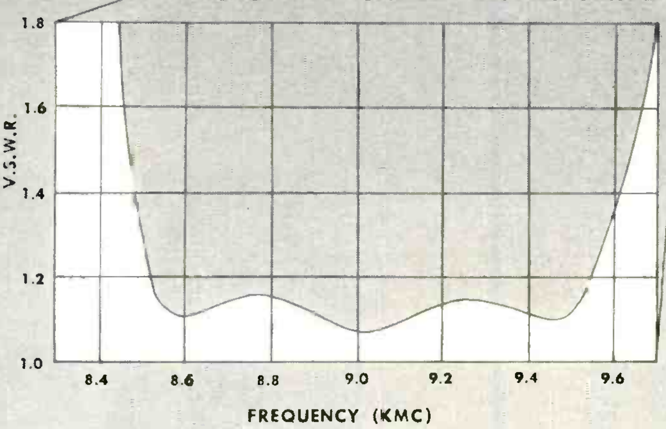
The 1B63-A is a 4-element tunable gap type, factory adjusted to produce a usable band width from 8490 to 9578 mc.

Bomac produces a complete line of Gas Switching Tubes. This includes TR, ATR, Pre TR and Attenuator Tubes for all microwave frequency bands.



1B63-A

1B63-A TYPICAL BAND PASS CURVE



1B63-A CHARACTERISTICS

Insertion Loss	0.7 db., max.
Flat Leakage Power, 40 KW.	40 mw., max.
Spike Leakage Energy, 40 KW.	0.2 erg, max.
Recovery Time, 40 KW.	4.0 μ sec., max.
Arc Loss	0.8 db., max.

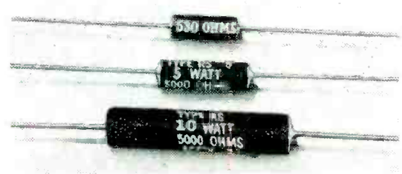
We invite your inquiries regarding

- ENGINEERING
- DEVELOPMENT
- PRODUCTION

Bomac Laboratories
INCORPORATED
BEVERLY, MASSACHUSETTS

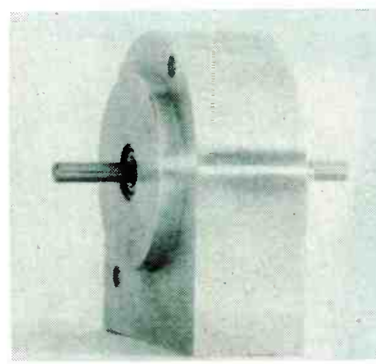
Catalog on request. Write (on your company letterhead) Dept. C, Bomac Laboratories, Inc., Beverly, Mass.

circuits are also available. Write the company for engineering and application data.



Tiny Power Resistors

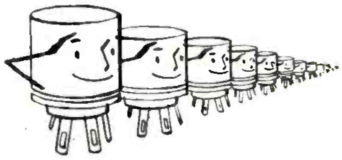
DALE PRODUCTS, INC., Columbus, Nebraska, has available miniature power-resistors in two, five and ten-watt sizes. They offer completely welded construction from terminal to terminal for trouble-free performance. A special silicone material seals the resistance element making it impervious to moisture. Standard tolerance is 1 percent but tolerances as high as 0.05 percent can be furnished if necessary. Temperature coefficient is practically flat. Resistance shift is less than 0.00002 percent per deg C. Illustrated price sheets are available on request.



Precision Gear Trains

BOWMAR INSTRUMENT CORP., 4214 Leo Road, Fort Wayne, Ind., announces a new line of precision gear trains for instrument applications. They are available in ratios up to 15,000 to 1 in the same general case dimensions. Shaft height from the mounting surface and shaft diameter are standard for use with conventional laboratory servomechanisms breadboards and components. Precision hobbed gears and bearings are used exclusively with the result that maximum efficiency, uniform torque and absolute minimum backlash are ob-

SYLVANIA SOCKETS...



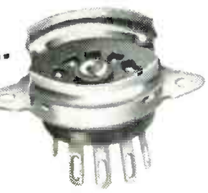
report for Active Duty!

Sylvania's full line of high quality sockets meets rigid military and civilian requirements

JAN 7-Pin Miniature Socket
(Shield Base Type)

For active military duty, Sylvania produces the JAN 7- and 9-Pin miniature sockets. These are available in Low Loss Phenolic and Steatite with Beryllium Copper Silver Plated contacts. The contacts and center shield tab are hot tin dipped after complete assembly.

1.


2.


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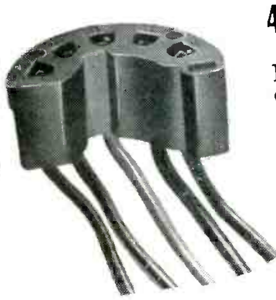
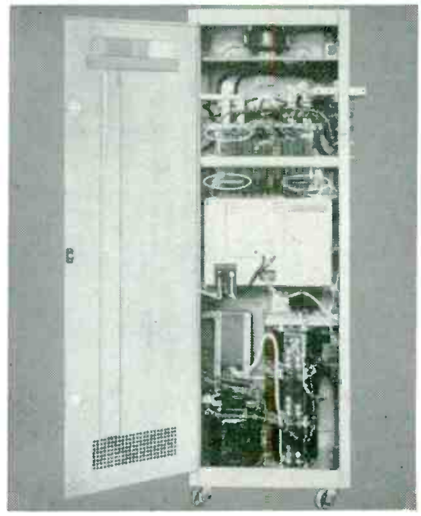


1. **7-Pin Miniature Socket (Bottom Mounting)**
2. **RMA 9-Pin Miniature Socket (Shield Base Type)**
3. **Octal Socket (Top Mounting)**
4. **Duo-Decal Cathode Ray Tube Socket**

For regular commercial use, Sylvania makes RMA 7- and 9-Pin Miniature, Turret, Octal, Duo-Decal, etc., sockets. Available in General Purpose and Low Loss Phenolics with any combination of contact materials. Write for new illustrated catalog giving complete descriptions: Sylvania Electric Products Inc., Dept. A-1004, Parts Sales Division, Warren, Pa.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS: PHOTOLAMPS: TELEVISION SETS at 500 v d-c, capacitance values of the units range up to 100 μμf.

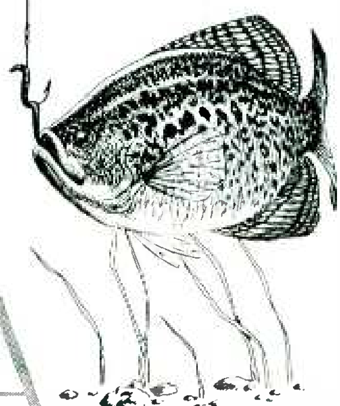


Rectifier Protection

FENWAL, INC., Ashland, Mass. Thermostat control on high-current selenium rectifier stacks is accomplished by building-in special thermoswitch units that turn off main power before chance overheating can destroy the selenium layer on the rectifier plates that compose the stack. The thermal switch circled at right is used to sound visual and audible alarms.

Selenium Rectifiers

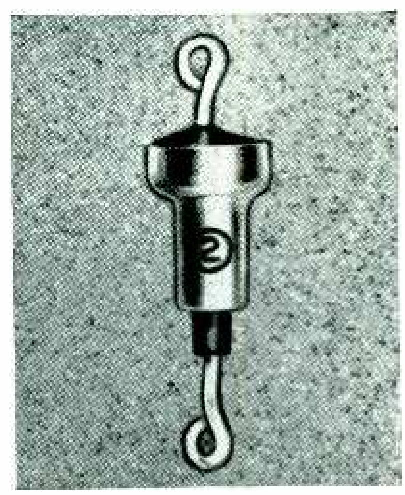
INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., announces a new line of hermetically sealed selenium rectifiers in metal cases filled with inert gas and provided with standard tube terminals to fit standard sockets. All standard tube mountings are available. The unit illustrated, No. W15CM, is rated at 390 v rms input; 550 v peak inverse; 120 ma, 160 v d-c output at 35 C ambient. Half-wave and bridge



repetition rate of 1,000 pps, and a pulse width of 0.5 μsec, at 9,300 mc. The tube can be used in equipment having a maximum transmitting power of 100 kw.

Parabolic Antenna

THE WORKSHOP ASSOCIATES, DIVISION OF THE GABRIEL CO., 135 Crescent Road, Needham Heights 94, Mass. Faced with the requirement for an antenna to use with a completely pressurized system, the company has redesigned its standard 2,000-mc models to maintain a pressure of 8 to 10 lb per sq in. Solving the problem of increased radome density, vswr has been held under 1.25-to-1 for the dipole style feed. The new feed is designed to mate with $\frac{7}{8}$ in. Teflon flexible copper air line, having 0.045-in. wall and $\frac{11}{32}$-in. conductor. However, it can be simply adapted to brass line where desirable.



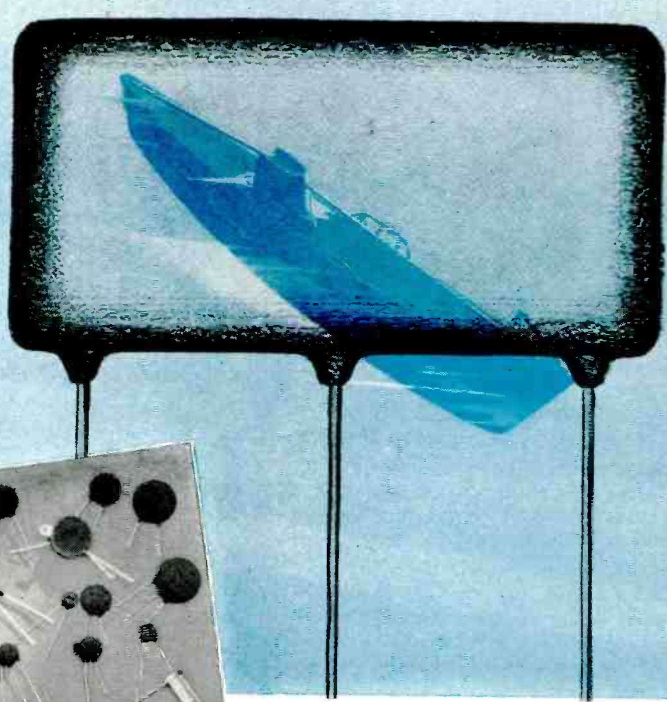
Small Ceramic Capacitor

SPRAGUE ELECTRIC CO., North Adams, Mass. Use of the type 503C, a small feedthrough ceramic capacitor for filtering leads passing through a chassis, paves the way to marked efficiencies in the design and production of tv equipment. For protection against humidity the small ceramic disk element is resin-sealed in a recessed cup at the top of the metal ferrule. The through lead passes through a hole in the center of the dielectric disk. Thus there is equal radial distribution to the grounded outer shell of all high frequencies being bypassed. Rated

HI-Q SERVES NATIONAL DEFENSE

Whenever Electronics Lend Ears to the Fleet

● Among the countless contributions which electronic engineers are making to our armed services, high importance must be placed on long-range eyes and ears for the fleet... ...not only in increasing the deadliness of its own undersea craft, but equally in protecting its surface vessels from enemy submarines. And throughout the field of electronics, high importance is likewise placed on the dependable long life and rigid adherance to specifications found in **HI-Q** components. Among the countless ceramic units carrying the **HI-Q** trademark, you'll find disc capacitors of by-pass and temperature compensating types ...tubulars, plates and plate assemblies ...new high voltage capacitors in many styles...trimmers, wire-wound resistors and chokes. You'll find, too, that **HI-Q** engineers are your best source for specially designed components to meet your specialized, individual needs.



HI-Q PLATES AND PLATE ASSEMBLIES

HI-Q Plate Capacitors can be produced in single and multiple units in an unlimited range of capacities up to guaranteed minimum values of 33,000 mmf per square inch. The number of capacities on a multiple unit is limited only by the K of the material and the physical size. In **HI-Q** Plate Assemblies (printed circuits) the number of combinations of condensors and resistors which can be incorporated on a single unit is virtually endless...again, limited only by the K of the material and physical size.

HI-Q* DIVISION

AEROVOX CORPORATION

OLEAN, NEW YORK, U. S. A.

*HI-Q is a registered trademark

Export: 41 E. 32nd 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.

SALES OFFICES IN ALL PRINCIPAL CITIES

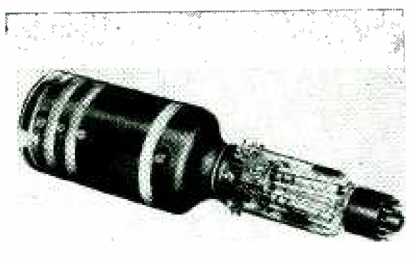
copper-oxide or selenium stacks. Models being produced include those in single-phase, half-wave ratings of 12 v, 0.4 ampere; 21 v, 0.4 ampere; 27 v, 0.4 ampere; and 6 v, 6 amperes. They are designed for power conversion in intricate computing machines, radar devices, and other applications where size and weight requirements are at a premium. Operation tests at the rated voltage over a 5,000-hour period indicate no change in forward resistance and reverse leakage.

Small C-R Tube

VACUUM TUBE PRODUCTS, 506 South Cleveland St., Oceanside, Calif. The large tube illustrated is the standard 5CP type of c-r tube. The small one is a miniaturized version called the VTP 5ESP type. This tube is approximately electrically interchangeable and is excellent for such applications as miniature radars for airborne use. It is made in screens of P1 through the company's recently registered P-19, an extremely long-persistence orange phosphor.

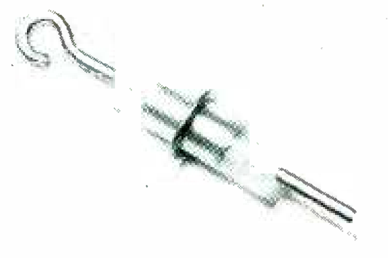
Servo Amplifiers

SERVOMECHANISMS INC., Post and Stewart Aves., Westbury, Long Island, N. Y., has available two new servo amplifiers featuring a hermetically-sealed, oil-filled packaging technique. The packaging design provides for greater heat dissipation and elimination of hot spots, longer tube life, greater resistance to vibration and shock, and a great saving in space. Designated as types SA104H (illustrated) and SA112H, they supply outputs of 9 w at 115 v and 3 w at 30 v, respectively. Type SA104H was primarily designed for use in high-performance servo loops and incorporates a derivative control network. The SA112H is intended for use in analog computer servo loops and is designed for velocity damping, furnished by a tachometer generator. The amplifiers are designed as miniaturized, plug-in units, in which all the electronic elements required for one function in a control system are packaged together.



Two-Gun C-R Tube

ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 19, Pa. Type 52HAP7 two-gun multipost accelerator band c-r tube is similar to RTMA type 5SP7 except for being designed for operation at considerably higher accelerating voltages. A maximum of 25,000 v d-c can be applied to the final post accelerator anode. In addition, a new type aluminized screen permits greater luminous efficiency in tubes designed to operate at accelerating voltages above 5,000 v. Under typical conditions with the final anode operating at 10,000 v, the second anode potential maintained at 2,000 v (with the interim post accelerator anodes being fed from a series of 25-megohm bleeder sections) the focusing anode potential will be between 362 and 695 v with control grid cutoff between −30 and −90 v.



Terminal

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., has available the type HS-1 solder-seal type terminal with a molded Polytrifluoromonochloroethylene resin insulating the solder seal ring from the center terminal rod. The Kel-F molded body is chemically inert to organic solvents, acids and fumes. It is unaffected by high humidity, has zero water absorption and high resistance to thermal shock (-70 to +190 C). Overall length is $1\frac{1}{8}$ in.; dielectric strength, 5,000 v (rms) 60 cps; corona starting voltage, over 2,000 v (rms) 60 cps.

Gas Switching Tube

GENERAL ELECTRIC CO., Schenectady, N.Y. Type 6038 small broadband gas switching tube that resembles a miniature cigarette lighter was designed for viewing objects at close range on radar screens. The tube acts as a switch to decouple the transmitter from a common transmitting and receiving antenna to allow the antenna to receive the return signal after a radar signal has been transmitted. It cuts recovery time to only 8 μsec at a power of 50 kw, with a pulse

RAYTHEON

Ready for YOU now!

. . . this reliable source of Reliable Tubes

CK 5654 the high Gm RF pentode

CK 5686 the all purpose power output tube, good from audio to 150 mc.

CK 5725 the gating or mixer pentode (dual control grids)

CK 5726 the high perveance twin diode

CK 5749 the remote-cutoff RF amplifier pentode

CK 5751 the high Mu dual triode

CK 5814 the medium Mu dual triode

This great, new plant at Quincy, Mass.— bringing the total Receiving Tube Division manufacturing area to 400,000 square feet — is devoted exclusively to the production of Raytheon quality tubes. It is now operating full blast to meet, *and meet promptly,* the tremendous demand for Raytheon Reliable Miniatures.*

***RAYTHEON WAS THE FIRST...** to develop ARINC Reliable Tubes and produce them in quantity. CK5654, the first ARINC type, was initially shipped in October 1947.

Close to 400 Raytheon distributors are at your service on these tubes. Application information is yours for the asking from Raytheon at Newton, Chicago, Los Angeles.

RAYTHEON ®

RAYTHEON MANUFACTURING COMPANY
Receiving Tube Division
Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

Excellence in Electronics

RELIABLE SUBMINIATURE AND MINIATURE TUBES • GERMANIUM DIODES AND TRANSISTORS • RADIAC TUBES • RECEIVING AND PICTURE TUBES • MICROWAVE TUBES

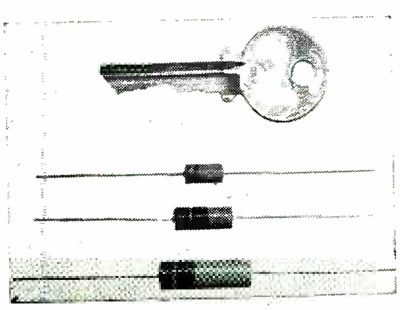
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Miniature Tubes And Components Still in Spotlight . . . Insulating Materials Find Wider Use In Ruggedization Program . . . Industry Literature Briefed For Busy Engineers (see p 301)

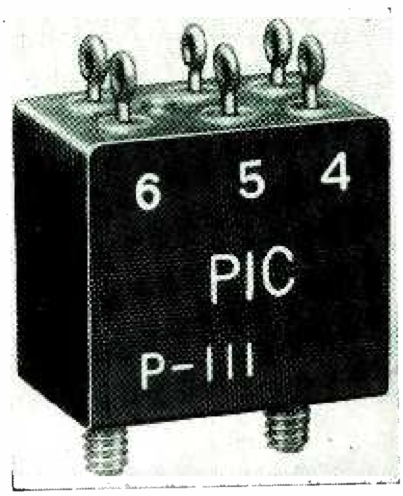
A-M/F-M Tuner

ALTEC LANSING CORP., 9356 Santa Monica Blvd., Beverly Hills, Calif. Model 303A a-m/f-m tuner, which includes a built-in power supply and multistage audio circuit, was designed for use in home music systems but is also adaptable for industrial and broadcast applications. The a-m section is a superheterodyne type, designed to provide a broad-band flat-top curve. The f-m circuit employs two ground grid r-f stages, a separate oscillator and triode mixer stage, two stages of i-f amplification and a ratio detector. The cathode follower output stage of the amplifier enables the tuner to be connected to any power amplifier with a high-impedance input. Separation may be as great as fifty feet.



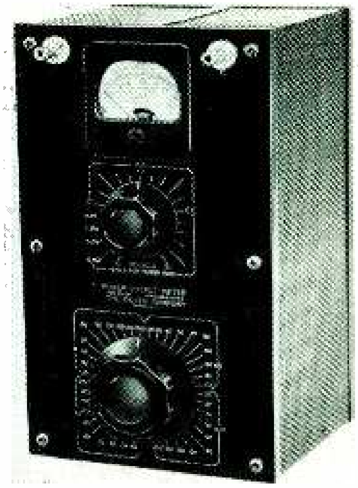
R-F Choke Coils

JEFFERS ELECTRONICS, INC., Dubois, Pa., is manufacturing a new series of radio-frequency choke coils featuring smaller size and extremely wide range of inductance. Made with insulated copper wire, the coils have a rugged molded jacket made of a mineral-filled thermosetting compound that permits use under the most severe service conditions. The coils, made in types 101, 102 and 104, have no shorted end turns and the windings are soldered to the leads.



Ferrite Pulse Transformer

POLYPHASE INSTRUMENT CO., Bryn Mawr, Pa., is introducing a new line of pulse transformers taking advantage of the high-frequency magnetic qualities of ferrite core materials. Due to the high resistivity of ferrites, eddy currents are almost negligible and extremely short rise times are possible. A 1-μsec blocking oscillator transformer built to MIL-T-27 specifications is illustrated. Other ferrite transformers can be designed and manufactured to customer circuits or specifications for application as blocking oscillator, isolation, impedance matching, line driving, and wideband input and output transformers.



Output Power Meter

DAVEN CO., 191 Central Ave., Newark, N. J. Type OP-961, a 50-watt output power meter has been especially designed to read power or impedance accurately at all impedances over the a-f range. With an impedance adjustable over a range of 40 steps from 2.5 ohms to 20,000 ohms, the instrument will measure 50 w in steps of 0.1 mw. It is also calibrated to measure decibels from -10 db to +47 db. Over a range of 20 to 15,000 cycles the readings can be relied upon within 2 percent. This may be attributed to the characteristics of the impedance-changing network, which remains essentially resistive at audio frequencies, and the meter-multiplier network, which has a constant impedance at all frequencies.

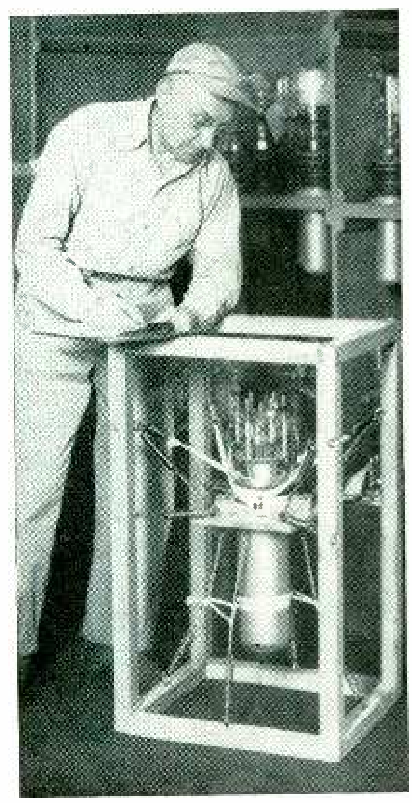
Industrial Germanium Rectifiers

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has developed a line of germanium industrial rectifiers that can operate at current densities up to 1,000 times greater than existing

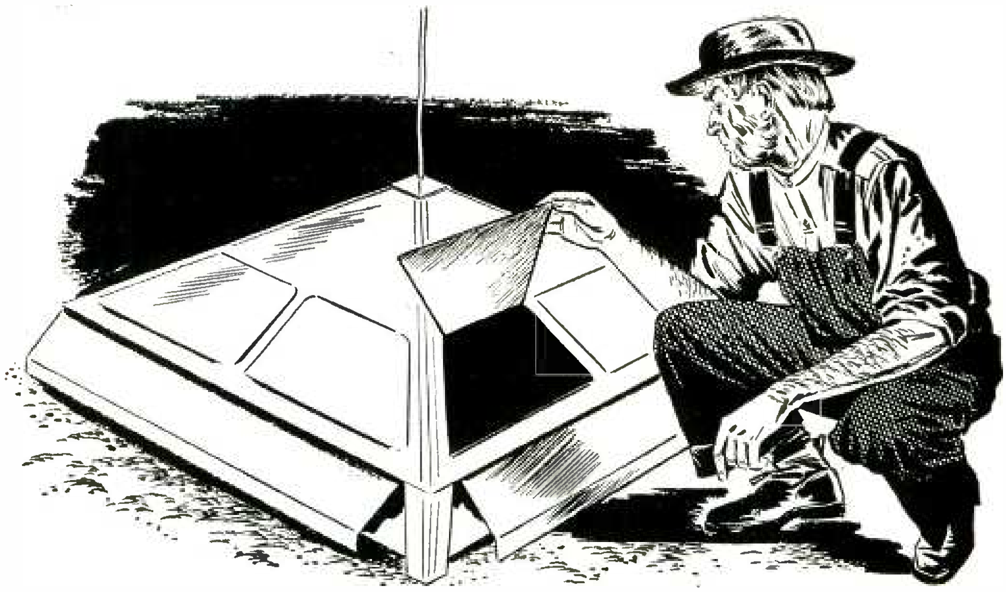
bomber by using Remington 36T mobile coolers. These are trailer-mounted air-conditioning units that can be moved from plane to plane. Air with a cooling power of 39,000 btu per hour is blown into the plane through a flexible 25-foot duct that is entirely retractable into a schnorkel atop the trailer. Construction of the duct is much like that of a child's jack-in-the-box.

Transmitter Tube Packaging

SPRINGS and chains support the F-5918 high-frequency triode within a wood framework devised at Federal Telephone and Radio Corporation's Clifton, N. J. plant to prevent damage during shipping. Plywood pieces clamped around an anode flange provide anchor points for the supporting chains. Woven cotton strips limit movement of the tube, so it cannot strike the sides of the container when dropped from any position. In shipping, a cardboard carton is slipped over the wood framework.



Sixteen stiff coil springs support and position this heavy transmitting triode within its wood shipping frame



GOING . . . GOING . . . Gone . . .

'Twas a balmy evening in March after one of those days when you are sure Spring is here — but know all too well it is still around the corner. As Eleazer Yoder crossed the yard, after putting his week-old turkey poults "to bed," he felt the wind change. Well — no need to worry. That new electric brooder would take care of any temperature change. Those poults were Eleazer's pride and joy. Were is right, for in the morning they were "all." During the night the temperature dropped, but the brooder didn't respond . . . the electrical insulation had failed. That particular manufacturer's name went down on Eleazer's black-list and sales in the area dropped sharply.

You can't afford to take chances on product breakdown and loss of customer good-will through inferior electrical insulation. Here's where BH Fiberglas can help you, with a sleeving or tubing for every electrical application.

There's BH Extra Flexible Fiberglas Sleeving for instance, a primary insulation for low voltages where heat resistance and flexibility are important. Made without hardening varnish or lacquer it is permanently flexible through a temperature range of –67°F. to 1200°F. Color stability to 300°F. BH Extra Flexible spreads to cover knobs, terminals, irregular objects, and through a patented process, plus an organic saturant, it will not fray or ravel.

As a supplementary insulation, BH Extra Flexible fully meets Underwriters' specifications. Permanently rounded, it handles easily – slips on quickly and is a definite time-saver over old-fashioned hand-wrapping methods.

BH Extra Flexible Fiberglas Sleeving is one of a family of electrical insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements – product, temperatures, voltages – we will gladly send free samples for testing purposes.

Address Dept. E-4

Bentley, Harris Manufacturing Co.
Conshohocken, Pa.

BH Fiberglas* SLEEVINGS

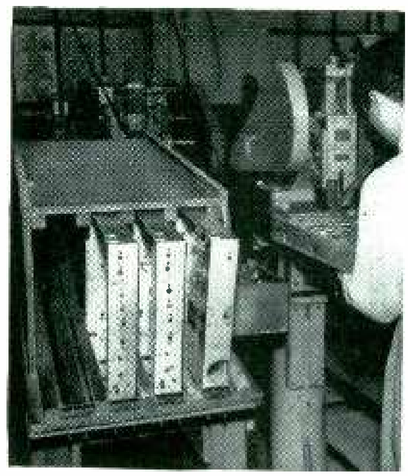
*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

former soldering and unsoldering operations.

Included in the total saving is 2 cents gained by salvaging the cutoff wire. This wire costs 4 cents to restrip for use elsewhere in production, but is then worth 6 cents.

Chassis Chutes

AN EASILY-CONSTRUCTED plywood chute extending across the ends of two punchpress lines permits transfer of chassis units by gravity, eliminating trucking or carrying by hand in the riveting department of the CBS-Columbia television plant in Brooklyn, N. Y. Four slides each hold three units, giving a storage capacity of twelve. Wood strips form the bottoms and sides of the slides, and a metal angle bracket at the bottom serves as a stop. The angle of the slide is determined by trial.



Chassis units coming off punchpress at left rear are put into plywood chute, and slide within easy reach of operator on second line of presses

Cooling Technicians in Sun-Baked Airplanes

PLANES exposed to the sun on ramps at aircraft plants can develop interior temperatures exceeding 130 F. Time is then lost in production because personnel doing final electronic assembly work and testing cannot stay in the plane.

The Wichita Division of Boeing Airplane Co. solved this problem in connection with the B-47 Stratojet

ber and name of the missing component in the Camden plant of RCA's Engineering Products Department. These signs aid assemblers in spotting equipment awaiting critical components, prevent units from being placed in stock incomplete and show dramatically to executive or other visitors the reason why production is stalled.

Long Leads Cut Cost

A TOTAL saving of 21.8 cents per unit is achieved in Emerson's Jersey City plant by making the leads for a certain military component much longer than is necessary for the final product. Previously, a special final test of the unit inside a chamber made it necessary to solder on extra wires temporarily with lap joints to bring connections out of the chamber. In the new technique, the leads are made long enough initially for the test, and are cut to correct length afterward. It is then necessary to strip the ends of the leads by hand with notched sidecutting pliers, but this takes far less time than did the

STORING REPAIR PARTS

Holes in corrugated cardboard provide convenient storage for a large variety of small parts needed at television receiver troubleshooting and repair positions in Teletone's Elizabeth, N. J. plant

It's Tung-Sol for radio and tv

Quality -that keeps pace with the growth of the electronic industry
-that meets fully the performance requirements of all radio and tv set manufacturers
-that safeguards dealer service work

TUNG-SOL
RADIO, TV TUBES, DIAL LAMPS

TUNG-SOL ELECTRIC INC., Newark 4, N. J. — Sales Offices: Atlanta • Chicago • Culver City • Dallas • Denver • Detroit • Newark
Tung-Sol makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes

carton. The width dimension of the carton is just right for bringing the set up to working height, hence cartons go through on their sides. The carton also serves in lieu of the wood pallet otherwise required for moving cabinets on roller conveyor lines.

Blueprint Hanger

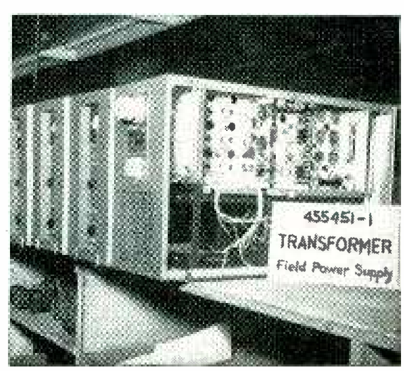
LARGE blueprints used in assembling small quantities of an electronic unit are mounted on sheets of corrugated cardboard suspended by ropes going over ceiling pulleys, at DuMont's Television Transmitter Division plant in Clifton, N. J.

The print for the particular job of the day is lowered until it just touches the bench top, where it is upright facing the operator yet much more protected from damage than a print laid out on the bench surface or propped up without the protective backing. Masking tape is used to fasten the print to the carboard. A $\frac{1}{2} \times \frac{3}{4}$-inch wood strip across the top provides rigid anchor points for the ropes.

When work with a print is completed, it is pulled up to the ceiling for storage if likely to be needed again within a few weeks, or taken off the cardboard for conventional storage if no further production of that item is contemplated in the near future.

Missing-Part Signs

WHEN units are held on an assembly line awaiting a missing part, a hand-lettered sign is propped against the end unit, giving num-



Sign shows at glance that missing power transformer is holding up production of these power supply units for field television cameras

LENZ ELECTRIC MANUFACTURING CO.

1751 North Western Avenue • Chicago 47, Illinois

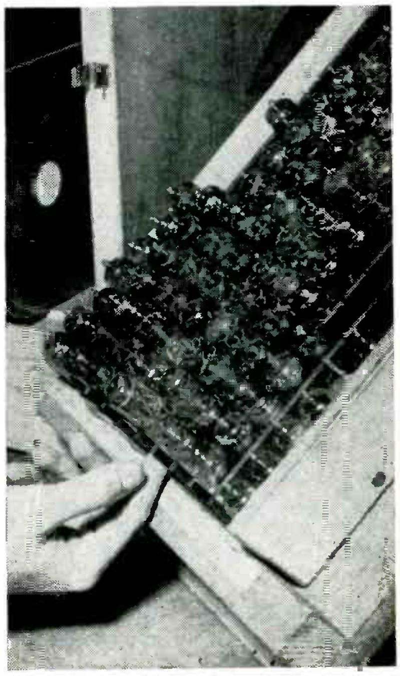
IN BUSINESS SINCE 1904

Angle brackets hook over side of chassis to hold spacer block

subjects the chassis to a desirable vibration during the ride down the steel rollers, accelerating the failure of defective joints and components so that they are caught in final test.

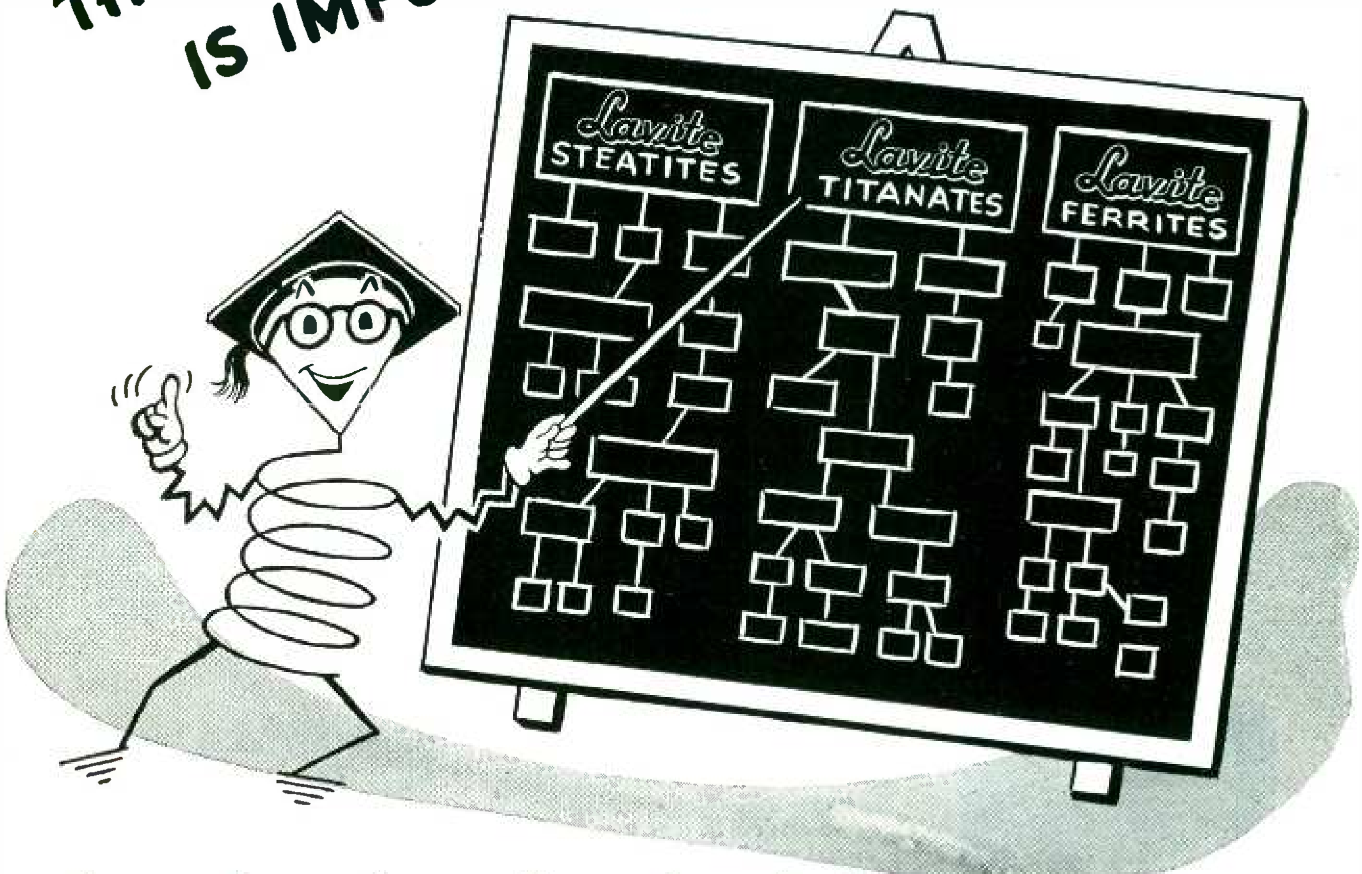
Racks for Spare Parts

A WOOD tray propped at an angle and partitioned with Masonite strips provides convenient storage for spare miniature tubes at repair positions for military radio communication equipment at Federal Telephone and Radio Corp., Clifton,



Easily-made slide for keeping variety of spare miniature tubes within reach

THIS 75 YEARS OF 'KNOW-HOW' IS IMPORTANT TO YOU!



In service • In quality • In selection

In service — 75 years of "Know-How" can prove unbeatable when it comes to satisfying your requirements promptly and accurately.

In quality — 75 years of "Know-How" packs a lot of accomplishments — in research, development and manufacture — to provide a dependable standard in all Lavite Ceramics equal to your most stringent specifications.

In selection — 75 years of "Know-How" has produced three main groups of technical ceramics (Lavite Steatites, Lavite Ferrites and Lavite Titanates), each of which offers unlimited selection in combination of characteristics.

In short — I invite you to profit by these 75 years of Ceramic "Know-How" on both defense and industrial needs. Steward's engineers will be happy to work with and for you — send them your specifications!

Ask for general characteristic data on all Lavite Technical Ceramics.

Remember —

There are non-critical Ferrites for non-critical uses.

D. M. STEWARD MANUFACTURING CO.

3604 Jerome Ave. • Chattanooga, Tennessee

Sales Offices in Principal Cities

Handy corrugated-cardboard holder for small parts

N. J. (an IT&T associate). Each time a tube is removed from the bottom of the row, the others in that row slide down so that one tube is always within easy reach.

In the same plant, strips of corrugated cardboard are taped together to form a holder for the variety of spare resistors and capacitors needed at repair positions. The cardboard is cut so that openings in the corrugations face upward to serve as receptacles for the leads.

Using Cartons as Pallets

ROLLER conveyor lines in the final test section of the CBS-Columbia television plant are positioned at the optimum height for working on consoles yet serve equally well for table-model sets. This dual-purpose use is achieved by placing each table-model set on its own empty

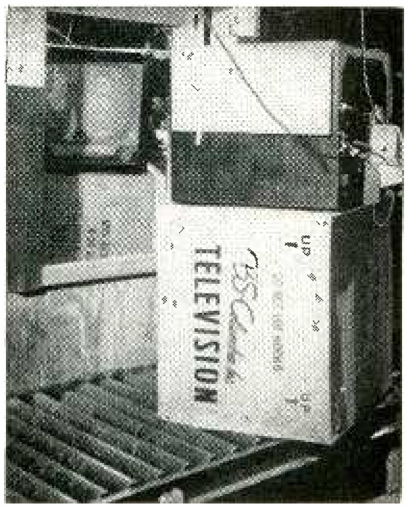


Table-model set rides through final test booth on its own carton. Sponge rubber strip around frame of mirror protects cabinets from scratches

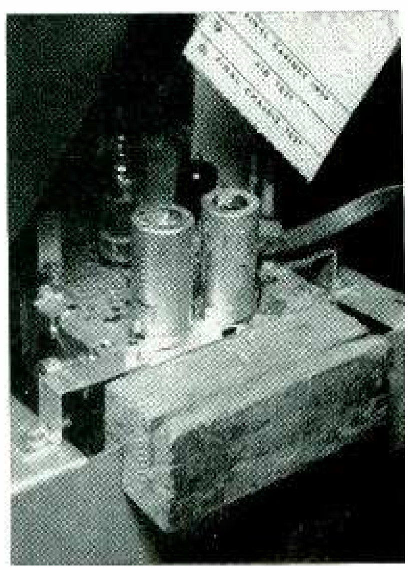
Method of storing mica spacers for type 4B32 xenon rectifier tubes

out, the glassblower breaks the vacuum at the tubulation, then heats the other end and blows out glass to form a wide opening. The bulb can be used over and over again.

Anti-Collision Blocks

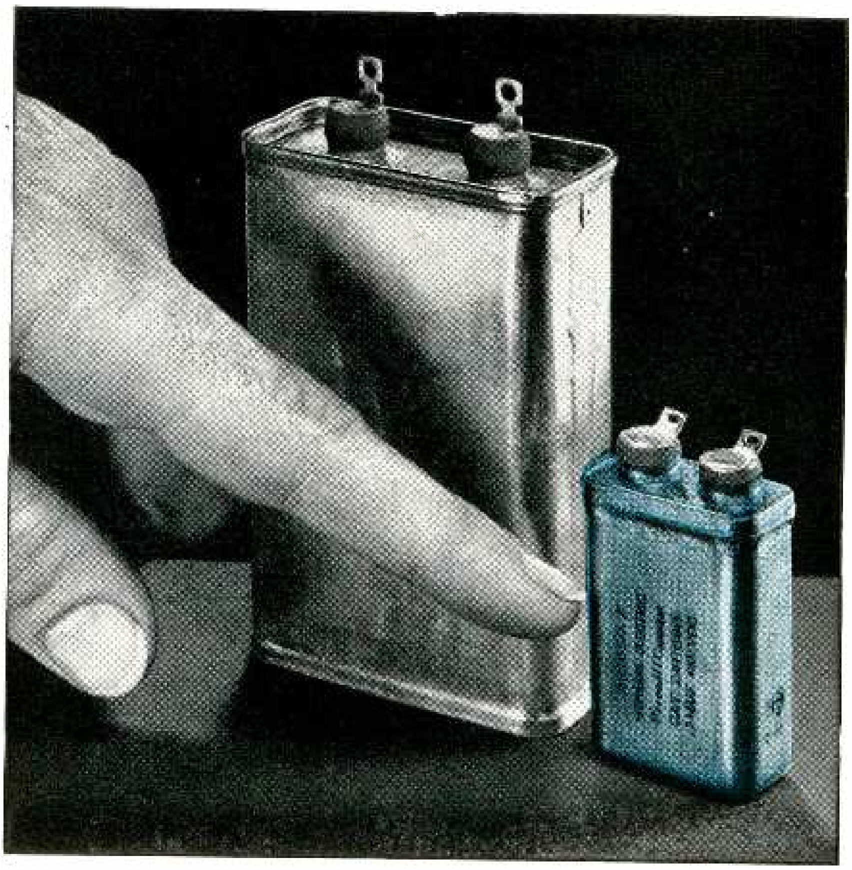
To PREVENT television chassis units from bumping each other and perhaps breaking picture tubes when the units are sent down a roller conveyor line without pallets, CBS-Columbia uses easily-attached wood blocks as separators. For one type of chassis an inch of separation was found adequate; here a short length of 2″×2″ wood was slit on a circular saw so it could be dropped over the side of the chassis as shown. Another chassis required six-inch separation for protection; here angle brackets were screwed to a 6-inch length of 2″×6″ wood. The brackets hook over the edge of the chassis.

In addition to saving money, omission of conventional pallets



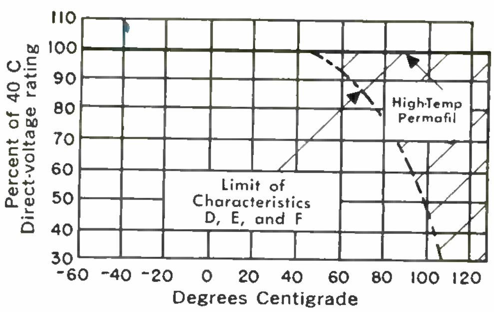
Slotted wood spacer block is easily attached and removed

Reduce space and weight requirements as much as 80%...



G-E Permafil d-c capacitors designed to operate in high ambients—up to 125 C—without derating

Why you gain by using Permafil capacitors for high-temperature operation



Comparison of operating voltages for JAN-C-25 characteristics D (vegetable oil), E (mineral oil), and F (synthetic insulating liquids) with Permafil impregnated capacitors—crosshatched area reveals advantages of Permafil over other impregnants in the high-temperature range above 40 C.

For ambient temperatures above 40 C, most liquid-filled paper-dielectric capacitors require considerable derating. This increases both space and weight requirements.

G-E Permafil capacitors, however, operate in high ambients—*up to 125 C*—for 10,000 hours, at full rated voltage. They average about 1/5 the size and weight of liquid-filled capacitors that will operate at 125 C—a saving of 80%. They're suitable for all blocking, by-pass, filtering, and many coupling and timing applications.

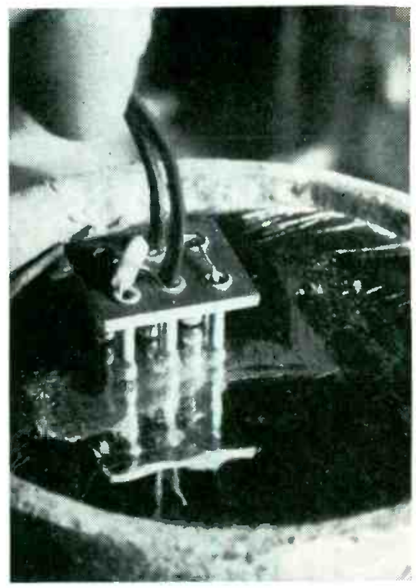
Permafil capacitors stand up in elevated temperatures because the paper dielectric is impregnated with a *solid* plastic compound that retains its electrical stability at *both* high and low temperatures. And since the impregnant is a solid, it can't leak. With proper derating or where short life characteristics are permissible, Permafil capacitors can be used in temperatures as high as 150 C. They can also be used in high altitudes and where extreme cold is encountered. Other characteristics include high insulation resistance and comparatively constant capacitance with temperature changes.

G-E Permafil capacitors can be obtained in case styles CP53 and CP61, as covered by specification JAN-C-25—in ratings of .05 to 1.0 muf, 400 volts DC. They are housed in metallic containers and hermetically sealed with G-E long-life all-silicone bushings.

For full information on Permafil capacitors, see your local G-E representative. Or write Section 407-310. Ask for Bulletin GEC-811. *General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

407-310

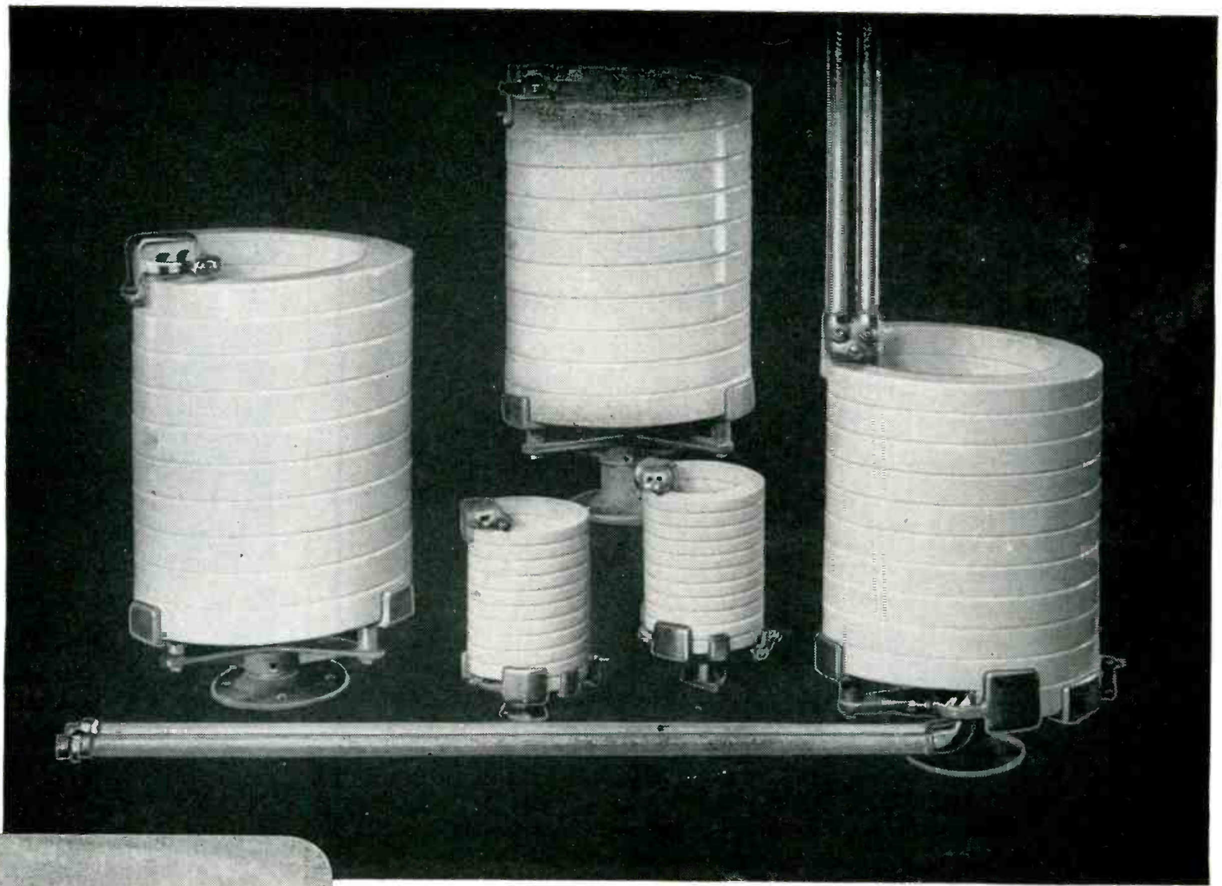


Dip-soldering television twin-lead plug. Normal twist and bends in stripped twin-lead ends are sufficient to hold plug on end of line during dipping

on an insulating base material, use of a wax in the liquid flux gives a solder-repelling wax coating on the insulating base, thereby preventing formation of short-circuiting bridges of solder between terminals or between wires. A formulation recommended for this purpose by Signal Corps Engineering Laboratories is 1 part Glyco Wax No. S932 made by Glyco Corp., Brooklyn, N. Y.; 1 part Kester No. 1015 activated rosin in alcohol flux, made by Kester Solder Co., Newark, N. J.; 1 part or more of toluene. Keep the flux bath warm (about 110 F) during use.

Storing Cleaned Mica

MICA spacers for tube electrodes are stored under vacuum in spare tube bulbs at Chatham Electronics Corp. in Newark, N. J. to keep the parts perfectly clean until needed on tube production lines. The spacers are punched, washed and degreased, then packed into a tube envelope that is open at one end and has a pumping-off tubulation at the other end. The large end is then closed by a glassblower, and the tubulation is fused to a vacuum line in a baking oven. The spacers are baked under vacuum for about 15 minutes, then sealed off and removed for storage. To get them



Lapp PORCELAIN WATER COILS

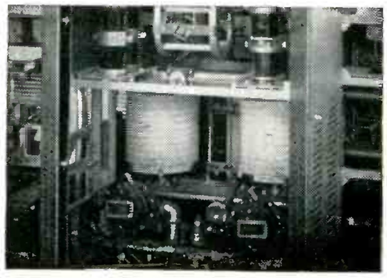
for tube-cooling water . . .

2 gals. per min. . . .

or 90 gals. per min.

Lapp porcelain water coils are now available in twin-hole types (for water supply and return) and single-hole models in a variety of standardized sizes. Of pure white, completely vitrified, non-porous, low-loss chemical porcelain, they provide for positive cooling and long tube life, because they are permanently non-deteriorating and non-sludging. They permit no water contamination, so avoid need for frequent inspection and water changing, eliminate possibility of electrolytic attack on fittings with consequent leakage. Compact, too—a 29-foot coil of porcelain pipe with two holes of size equivalent to ¾″ pipe, and capable of carrying 35 gallons per minute both ways, at 25 pounds water pressure, measures only 12″ outside diameter by 18″ overall height including base mount.

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



Lapp

the solder pot fits between the pins and the aligning key, and prevents the solder from touching the key.

All connections to a six-pin antenna plug for television receivers are soldered in one dipping operation after twin-lead ends and interconnecting wires are inserted, at the CBS-Columbia plant in Brooklyn, N. Y. The pins are dipped into Kester 115 liquid soldering flux before dipping into the molten 50-50 solder.

For success in dip-soldering, solder temperature should be held in the range of 400 to 450 F. Surface sludge should be skimmed regularly when soldering pins, for sludge can easily plug the hole in a pin and prevent solder from getting in. At CBS-Columbia, the pot is skimmed after about every six dipping operations.

Tube pins should be held in the solder for about two seconds to insure that the pins themselves reach solder temperature; this is essential to prevent solder from cooling prematurely and forming blobs on the pins as they are withdrawn. When faster cooling is desired after parts are withdrawn from the solder, the parts are dipped into carbon tetrachloride; this also serves to clean off surplus flux.

When dip-soldering terminals or etched wires that are closely spaced

Dip-soldering the pins of a ruggedized 5R4WGY tube in one operation. Thermostatic control for solder pot is at upper right. In right foreground is tool operated by foot lever, for cutting all projecting inner leads flush with ends of pins in one operation

Announcing

The new RCA WV-87A *Master* VoltOhmyst*

$112^{50} Suggested User Price

Measures . . . (Full-scale ranges)

DC VOLTAGE: 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
PEAK-TO-PEAK VOLTAGE: 0 to 4, 14, 42, 140, 420, 1400, 4200 volts
RMS VOLTAGE: 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
RESISTANCE: 0 to 1000 megohms in seven overlapping ranges
DC CURRENT: 0 to 0.5, 1.5, 5, 15, 50, 150, 500 milliamperes; 0 to 1.5, 15 amperes

Sold Complete—with the following Probes and Cables

- Direct Probe and Cable
- DC Probe
- Ohms Cable and Probe
- + Current Cable (Red)
- — Current Cable (Black)
- Ground (Case) Cable

Accessory Probes Available on Separate Order

√ WG-264 Crystal-Diode Probe for measuring ac voltages at frequencies up to 250 Mc.

√ WG-289 High-Voltage Probe, with WG-206 Multiplier Resistor, for increasing dc-voltage range to 50,000 volts and input resistance to 1100 megohms.

FEATURING an 8½" meter, the new WV-87A Master VoltOhmyst is really the master of every testing application. Its peak-to-peak scales are particularly useful for television, radar, and other types of pulse work.

The WV-87A measures dc voltages accurately in high-impedance circuits, even with ac present. It also reads rms values of sine waves and the peak-to-peak values of complex waves or recurrent pulses, even in the presence of dc.

Like all RCA VoltOhmysts, the WV-87A features ±1% multiplier and shunt resistors, a ±2% meter movement, high-input resistance, zero-center scale adjustment for discriminator alignment, dc polarity-reversing switch, and a sturdy metal case for good rf shielding.

On direct-current measurements, extremely low-meter resistance gives an average voltage drop of only 0.3 volt for full-scale readings on all ranges. Nine overlapping ranges provide dc readings from 10 microamperes to 15 amperes.

An outstanding feature is its usefulness as a television signal tracer . . . made possible by its high ac input resistance, wide frequency range, and direct reading of peak-to-peak voltages.

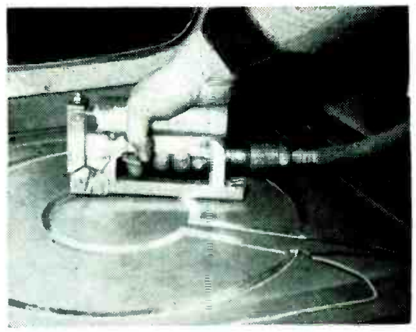
The RCA WV-87A *Master* VoltOhmyst has the accuracy and stability for laboratory work. Its large, easy-to-read meter also makes it especially desirable as a permanently mounted instrument in the factory and repair shop.

For complete information on the WV-87A, see your RCA Test Equipment Distributor or write RCA, Commercial Engineering, Section DX-46, Harrison, New Jersey.

*Reg. U. S. Pat. Off.

Get complete details today from your RCA Test Equipment Distributor.

RADIO CORPORATION of AMERICA
TEST EQUIPMENT HARRISON, N. J.



Fastening loop to cabinet with air-actuated stapler

fastening the loops to the inside of the cabinet. There is no noticeable difference in the performance of the three different sizes of double-loop antennas when used in high-signal-strength localities.

Picture-Tube Holder

To PREVENT scratching of the glass screen when putting plastic boots and rims on metal-wall picture tubes, the tube is placed face-down on a felt-covered wood doughnut at Emerson's Jersey City plant.

Felt-padded ring supports metal-wall tube while plastic dress is put on

Dip-Soldering Techniques

BASE PINS of ruggedized 5R4WGY rectifier tubes are all soldered cleanly in one dipping operation at the Chatham Electronics plant in Newark, N.J. Consistently reliable flow of solder inside the pins is achieved by use of a Robertshaw Thermostat for automatic control of solder temperature. A small pipe projecting up out of the center of

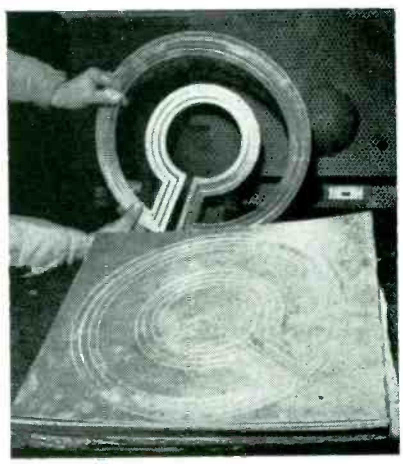
Spraying masked i-f transformers for tropicalization. Two-shelf conveyor in background carries other sprayed units into baking oven near ceiling

ing through openings, preventing it from curling around and depositing on the front of the housing.

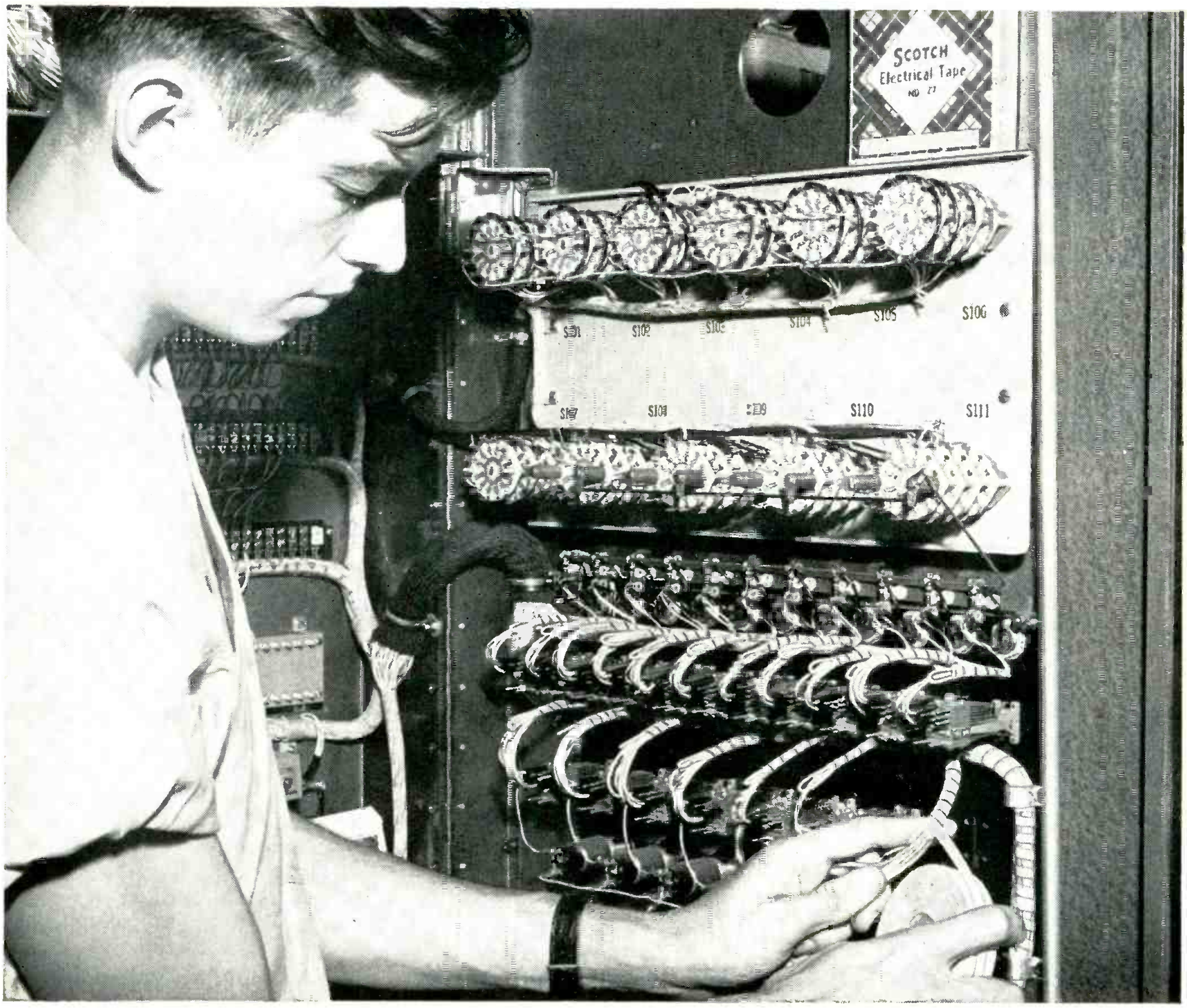
Die-Cut Television Antennas

A UNIQUE double-loop design for a built-in television antenna permits die-cutting three antennas at a time out of a single sheet of foil-coated cardboard. For protection and for convenience in shipping, loops are delivered by the outside vendor with waste cardboard still attached loosely. In the CBS-Columbia plant using these, the first operation is poking out the scraps and separating the loops. A short length of twin-lead is then riveted to the ends of the outer loop and an insulated wire stub is soldered to one twin-lead terminal to improve matching.

An air-actuated stapler made by Tener Corp. in Chicago is used for



Loops before and after removal of scrap cardboard

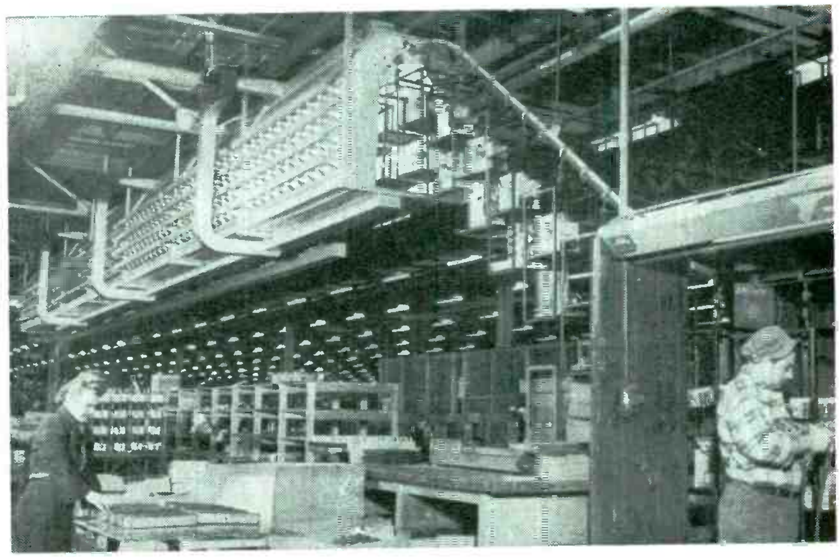


Fungus-resistant plastic tape harnesses wiring on this D.O.

Insulation rot is no problem on this Defense Order at The Austin Company's Special Devices Division, New York, N. Y. "Scotch" Electrical Tape No. 20 meets all military specifications for this special harnessing job—doesn't cause "cold flow" of the plastic jacketed wires like ordinary harnessing materials. And this tough plastic tape resists oil, moisture and acids, too.

Dozens of different "Scotch" Electrical Tapes are now available to help *you* meet D.O. specifications, or to solve practically any insulating or harnessing problem. There are tapes with thermosetting adhesives, high temperature tapes and films; tapes for high frequency insulation—you name it!

For complete information write Minnesota Mining & Mfg. Co., Dept ES-42,St. Paul 6, Minn. Do it today!



Infrared baking oven near ceiling saves floor space. Conveyor carries parts into it from spray booth at right

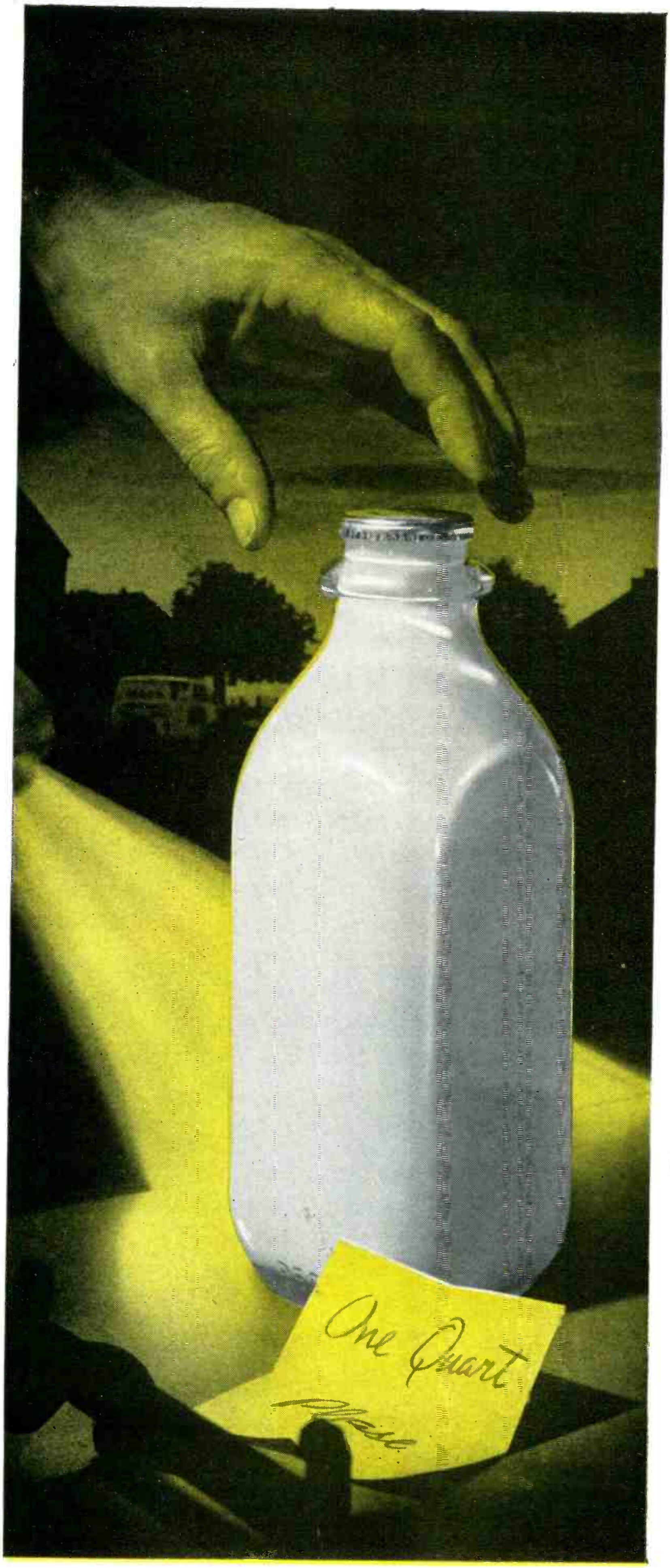
ing of costs, along with appreciable saving of valuable floor space.

To protect the terminals of plug-in electrolytic capacitors during spraying, the units are placed in large drilled holes in strips of wood. The strips serve also as convenient carrying racks and holders for handling the parts. Similar strips with smaller drilled holes protect the mounting screws, terminals and the movable slugs of i-f transformers during spraying.

At the present time, come-clean adhesive paper disks are used for plugging some of the holes in housings when metal masks have large openings. Plans call for changing to corks for these holes in the future. Some holes can be successfully masked with metal disks supported by wires welded to the metal mask.

A continual waterfall down the rear of the spray booth creates a back draft that attracts spray com-

Re-usable terminal masks for plug-in electrolytics. Those in background have wood-dowel corner posts to permit stacking for air drying after spraying



5 a.m.

A bottle of milk is the last scene in the last act of the cow-to-cup drama.

The real stars in this drama are milking machines, pasteurizers, bottle washers, homogenizers, and delivery trucks. Synthane—a laminated plastic—plays an unseen but essential part in these and other kinds of electrical and mechanical dairy equipment.

The dairy industry appreciates, as you may, the fact that Synthane is strong, light in weight, chemical-resistant, easily machined, and a good electrical insulator—all rolled into one. And that it is available in sheets, rods, tubes, and fabricated parts.

Try Synthane laminated plastics yourself. There is an interesting 26-page catalog of its properties and possibilities waiting for you. Synthane Corporation, 6 River Road, Oaks, Pennsylvania.

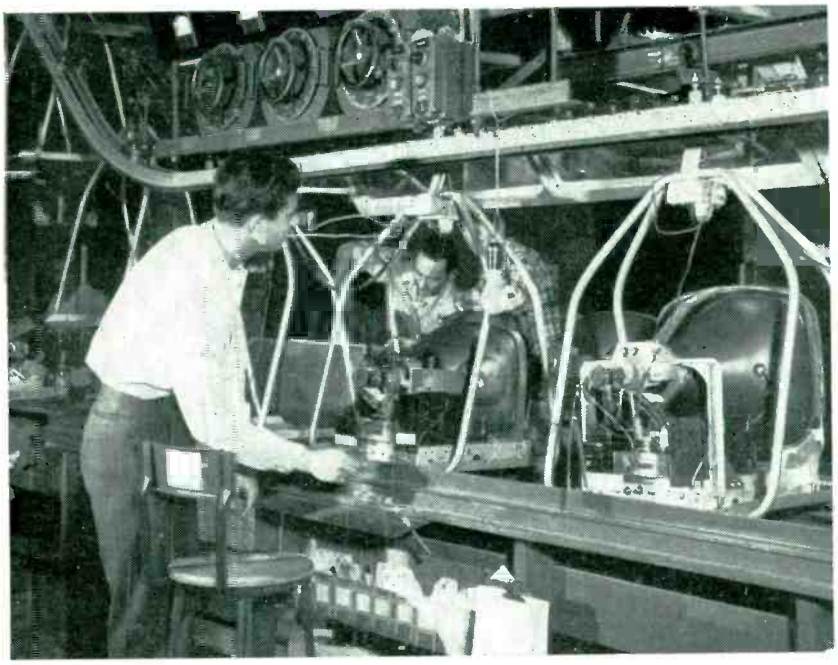
AIRCRAFT electronics system part, made from Grade LE Synthane. Application requires good electrical properties, resistance to moisture, retention of size and shape at elevated temperatures.

Synthane-one of industry's unseen essentials

SYNTHANE

S

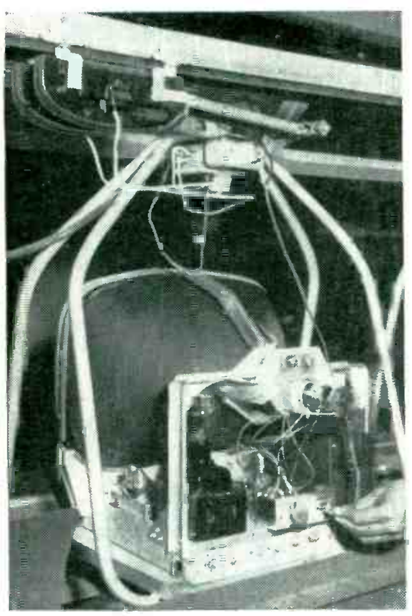
LAMINATED PLASTICS



Half-way point in aging conveyor, with operator adjusting a rear control while watching screen in overhead mirror set at 45-degree angle. Inoperative sets are tagged, then pushed onto bench on other side of line for repair

parts. At the halfway point, the conveyor dips down to an inspection position where sets that have failed can be pushed off for repair before completing their aging.

The outlet box on each chassis carrier has a fuse receptacle and a pair of outlets, one being a spare. A cheater cord is plugged in one of the outlets at all times. The socket at the other end of the cord takes the most punishment since it is used on each set in turn, but this cord is easily replaced when worn. The receivers operate without antenna, hence give only a raster on the screen during aging.



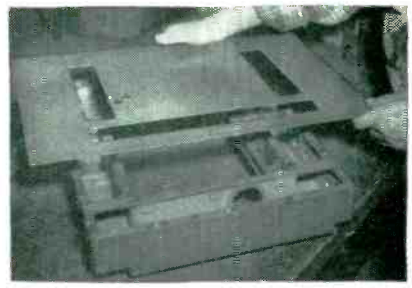
Closeup of chassis-carrier, showing method of mounting power outlet and pulling Benbow power collector

Outlet boxes of each group of ten chassis-carriers are connected in parallel by means of zip-cord that hangs loosely between the carriers. Power for the group is obtained with a Benbow caterpillar-tread connector riding on a power rail paralleling the conveyor. The connector is pulled by a spring attached to one of the carriers.

Three - phase constant - voltage power for the aging system is obtained from large voltage regulators mounted near the ceiling. Each phase energizes one-third of the length of the power rail; gaps between the three rails give a five-minute off cycle for each set three times during its two-hour aging.

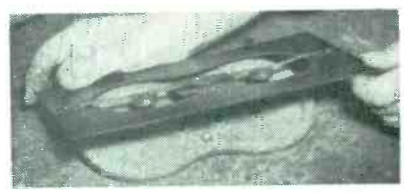
Tropicalizing Techniques for Military Radios

METAL and wood masks are used in place of masking tape for protecting openings, gasket surfaces and threaded portions of housings and components for military radio equipment during spraying for tropicalization and fungi-proofing at the Clifton, N. J. plant of Federal Telephone and Radio Corp., an IT&T associate. Use of an overhead conveyor to take sprayed parts through a baking oven suspended just under the ceiling gives further speed-up of production and lower-

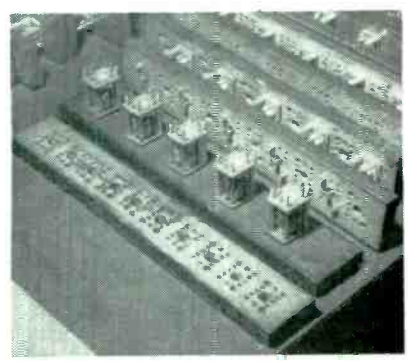


Simplest metal mask, for protecting gasket surfaces when spraying interior of housing for Signal Corps ground radio control set

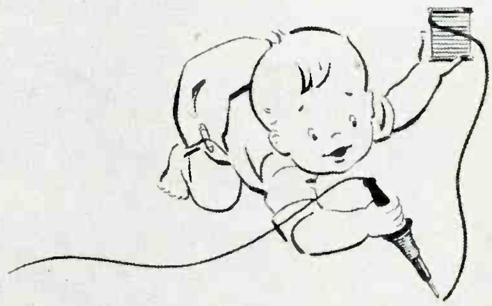
Mask using metal disks and shaped inserts to block out openings



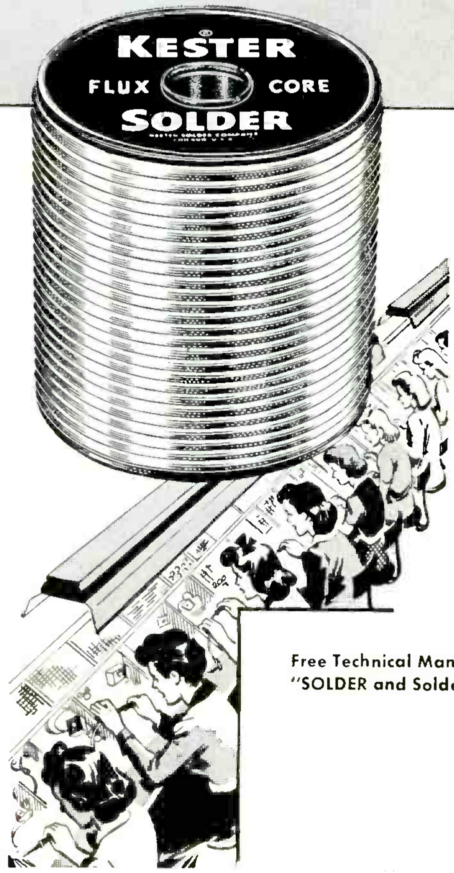
Use of stiff wire to support hole-blocking pieces in large opening in metal mask



Wood-strip masks for i-f transformers, used in pairs to protect both ends of units while spraying the coil and small components



SO SIMPLE...



KESTER FLUX-CORE SOLDER

SO SIMPLE... to solve that Soldering Problem when Kester Solder and Kester's Engineering Service "arrive on the scene."

Flux Control, more or less Flux, the exact predetermined flux-content, is *only* available with Kester's *seven* different Core Sizes (openings) in the solder-strand.

This exclusive Kester feature may be had in eight Flux-Core Solders including the widely accepted "44" Resin, "Resin-Five" and Plastic Rosin, also diameters ranging from nine-thousandths (.009") to one-quarter inch (.250"), and any alloy.

Kester, the "engineered" Flux-Core Solder, meets all applicable Government and Federal Specifications.

Free Technical Manual—write for your copy of "SOLDER and Soldering Technique."

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Production Techniques

Edited by JOHN MARKUS

THIS department presents techniques for expediting the production of military and commercial electronic equipment and components.

Here, production and methods engineers will see how problems comparable to theirs are solved in other plants.

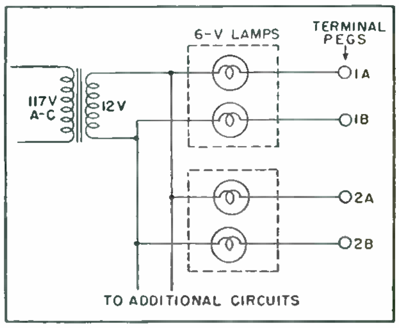
Topics covered range from the jigs and test setups of incoming inspection to the tricks of final packaging, all showing how to boost output, simplify an operation, reduce rejects, improve quality or cut costs

Lamps Indicate Errors in Cable Harness Assembly

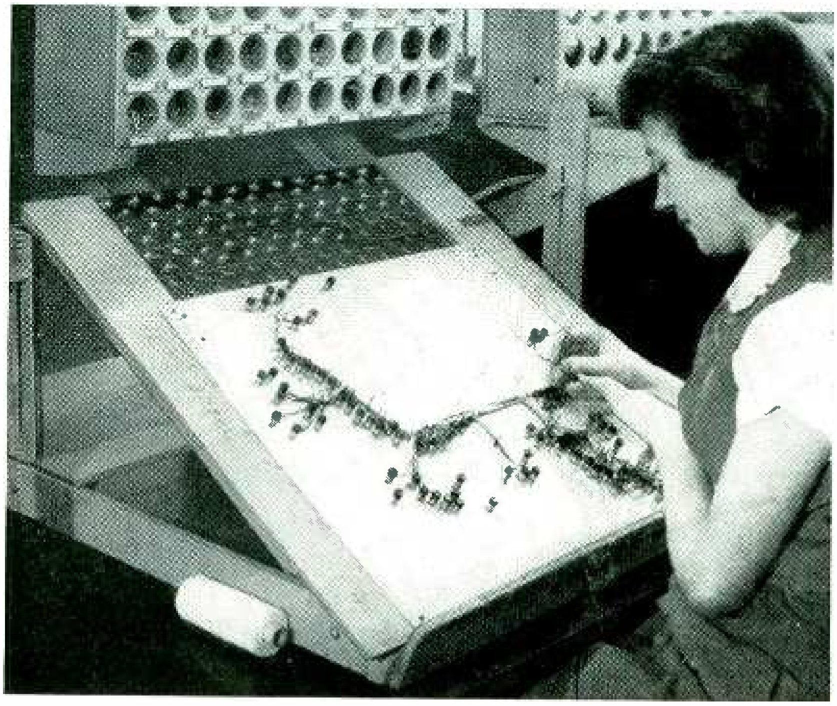
A COMPOSITE assembly and test fixture developed by the Crosley Division of Avco Mfg. Corp. enables an operator to build wire harnesses and simultaneously test them. The cable board is of standard design using nails for delineating the routing of leads, except that push-type binding posts serve as terminal pegs for each wire-end in the cable.

Electrical circuitry under the cable board connects the terminal pegs to an indicating-lamp panel. For each wire in the cable there are two 6-volt panel lamps, connected as in the diagram so that both lamps for a given wire will light only when the wire is connected between the correct terminals.

As the wires of the cable are correctly added to the board one by one in numbered sequence, the corresponding pairs of numbered lamps light. If a wire is connected improperly, either the two lamps that light will be the wrong lamps (as for a wire from 1A to 2B) or no lamps will light (as for a wire from 1A to 2A). Either effect will be immediately noticed by the operator since the lamps are almost directly in her line of vision, hence the mistake will be corrected before another wire is put in. When all wires have been installed, all the lamps will be on to indicate a perfect cable, and the operator can begin lacing.



Circuit used for error-indicating lamps

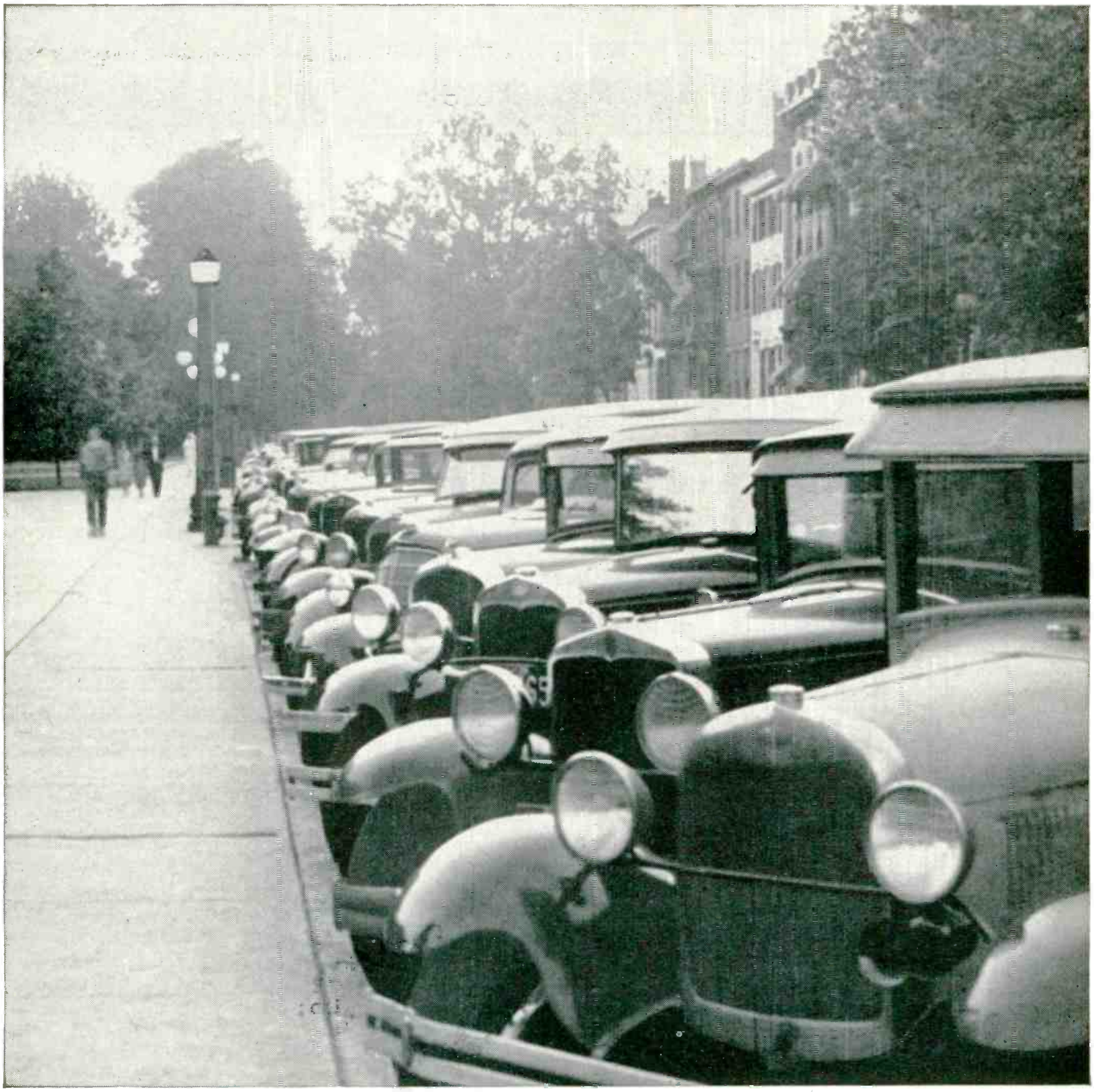


Lamps come on in paired sequence when wires of harness are put in correct terminal pegs according to predetermined schedule on card in front of operator

Cardboard-tube holders for the individual wires are arranged in sequence and numbered the same as the pairs of lamps, to aid the operator in spotting the next wire needed. Each tube is cut to the proper length so that all wires protrude the same distance from the front, permitting prompt detection of wires incorrectly inserted by stock boys.

Conveyor Gives TV Sets Two-Hour Aging

AN OVERHEAD conveyor installation having an a-c power outlet on each suspended chassis-carrier permits operating completed television receivers for two hours in otherwise unused space up near the ceiling of the CBS-Columbia plant in Brooklyn, N. Y. Power is interrupted three times during the ride to accelerate the breakdown of weak



Most popular 1952 models!

This year, three out of four cars on U.S. roads will be old models!

39% will be three to nine years old—their major repair age. No wonder motor experts say this is the year of repair!

To thousands of auto service dealers, hundreds of miles from factories and parts depots, this great demand for repair parts will pose a problem.

That's why, in sales meetings with dealers, motor car companies advise: "For faster turnover, lower inventory, more good-will; order repair parts via . . . Air Express!"

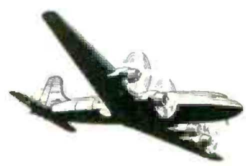
Air Express speed cuts days from repair time, builds dollar business at a cost of pennies. Whatever your need, you can profit from regular use of Air Express. Here's why:

IT'S FASTEST — Air Express gets *top priority* of all commercial shipping services — gives the fastest, most complete door-to-door pickup and delivery service in all cities and principal towns at *no extra cost.*

IT'S DEPENDABLE — Air Express provides one-carrier responsibility all the way and gets a *receipt upon delivery.*

IT'S PROFITABLE — Air Express service costs less than you think, gives you many profit-making opportunities.

New parcel post regulations affect you? Call your local agent of Air Express Division, Railway Express Agency.



AIR EXPRESS

GETS THERE FIRST

also be utilized to vary the repetition frequency as well as the amplitude of the square wave. For operation, the grid potential at the tube must be lower than its cathode potential when its capacitor is fully charged, otherwise the action fails. Therefore, if R_5 or R_6 has a large value compared with the internal impedance of the tube, the value of the cathode resistor R_1 or R_2 should be greater than or equal to that of the grid resistor R_7 or R_8 for satisfactory operation.

Frequency may range from a few cycles to about 100,000 cycles. If C_1 and C_2 are chosen to be about 150 $\mu\mu$f, they will charge quickly and the cathode will follow the variations of the grid. The drop at the plate of the tube will not be able to drive the other grid beyond cutoff. The circuit then becomes an ordinary positive-feedback oscillator producing a sinusoidal shape.

Crack-Detector for Wire Threads

By JOHN H. JUPE
Middlesex, England

A NEW CRACK DETECTOR of French origin has many applications in connection with the manufacture of radio tubes, picture tubes and electric lights because it can be used for thin wires. Diameters from 0.8 to 32 mm can be handled irrespective of whether they are insulated or are nonmagnetic.

The device is particularly valuable for use with molybdenum or tungsten wires and can effect substantial savings because 20 percent or more of the thin wires from these two metals may be unsuitable for lights or electron tubes.

The wire to be examined is slipped through the axis of a solenoid, thus constituting its core. A high-frequency current is passed through the solenoid and eddy currents are induced in the wire.

Distribution of the eddy currents is disturbed by the presence of a crack in the wire and the amount of disturbance varies with the position and size of the flaw. It also affects the electrical characteristics of the solenoid, which can be measured and presented on a crt so that deflection of the trace is a measure of the flaw existing in the wire.

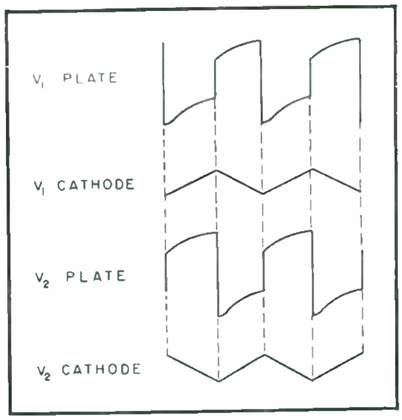


FIG. 2—Voltage waveforms produced by free-running multivibrator

currents in both tubes will then be decreased.

Perfect balance of the circuit is impossible as there must be a little difference between the charging rates of the two capacitors. If C_2 is charging faster, V_2 will reach its negative bias region earlier than V_1. When this happens, the plate current of V_2 decreases more, its plate voltage rises and brings the grid voltage of V_1 with it. The amount of plate rise of V_2 is large enough to cause V_1 to draw more current although its cathode voltage is increasing. This action is also due to the fast rate of grid rise for V_1 as compared to its cathode potential.

Next, the plate voltage of V_1 drops and plate current of V_2 decreases further. By cumulative action, V_1 conducts and V_2 is cut off. However, C_1 still charges to bring the cathode of V_1 up. While V_2 is conducting, C_2 will discharge through R_2. When V_2 starts to draw current, the circuit is switched over, V_2 conducts and V_1 cuts off. Then, C_2 charges again to bring the cathode of V_2 up and C_1 discharges through R_1 until the conducting point of V_1 is reached. The circuit is then switched over again. The operation is repeated in a similar manner.

Coarse control for repetition frequency is provided by arranging different values for capacitors. Changing the position of the tap on voltage divider R_5 and R_6 or R_6 and R_7 will result in an increase in the drop beyond cutoff and will reduce the repetition frequency. Any one of these resistors can be used as a fine control.

The plate loads R_3 and R_4 may

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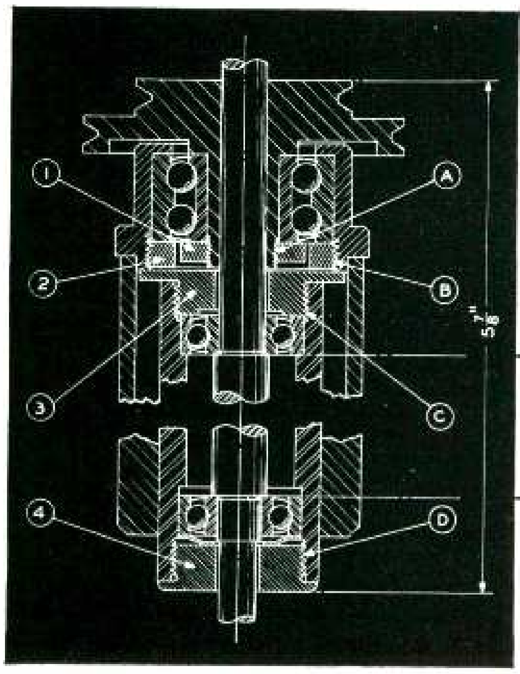
save $3.50 per unit in redesign of miniature Spindle Assembly

BEFORE. 4 threaded retainers required to hold parts of drill press assembly together. Machining of threads was slow, costly...required skilled labor. Threaded retainers took up much space.



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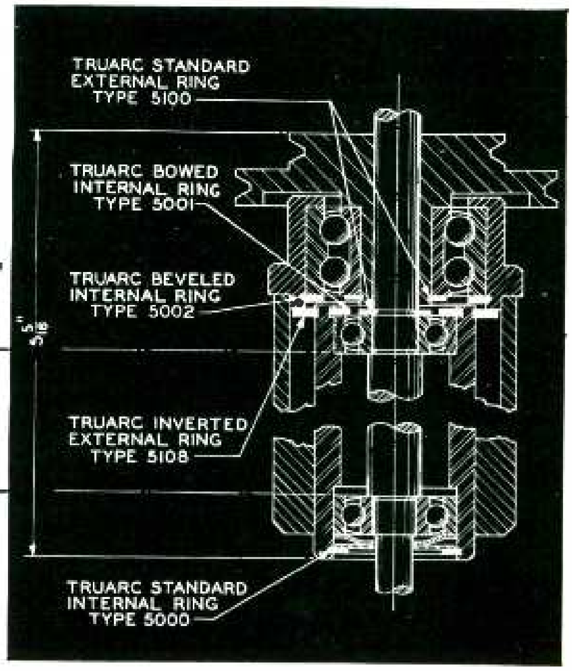

In Philips & Hiss Company's new Miniature Drill Press, tolerances are critical . . . compactness, important. By using 6 Truarc Retaining Rings, they cut the length of the spindle assembly 9/16". The machine is more securely assembled, smaller, lighter. What's more—Truarc Rings eliminated threaded retainers and mating threads, saving 68 minutes of machining and skilled assembly time, or a saving of $3.50 per unit.

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Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. E-044

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
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venting. After the pressure is relieved, the top reseats itself on the grommet, sealing the cell. This cycle of venting and resealing can be repeated continuously.

A somewhat longer cell (1.95 in. long) has a 3,600 mah rating, and can furnish up to 200 ma. The curves of Fig. 2 show life characteristics of both types.

REFERENCE

(1) Samuel Ruben, Balanced Alkaline Dry Cells, *Trans. Electrochemical Soc.*, 92, 1947.

Modified Free-Running Multivibrator

By LT. COL. CHANG SING
Communications School
Chinese Air Force
Taiwan, (Formosa) China

THE PLATE-COUPLED or cathode-coupled multivibrator is a popular free-running circuit. The new free-running multivibrator circuit to be described has novel arrangement of components.

Figure 1 shows the circuit. It consists of two self-biased amplifiers cross-connected with d-c coupling. With special choice of the cathode component values, the multivibrator action will be produced by the charge and discharge of two cathode capacitors.

When $B+$ is first applied, both tubes have positive grid potential which causes heavy current flow. The capacitors C_1 and C_2 charge up and the drops across the cathode resistors R_1 and R_2 increase. By using large values for R_1 and R_2, the cathode potentials can be made positive with respect to the grids as the capacitors fully charge. The

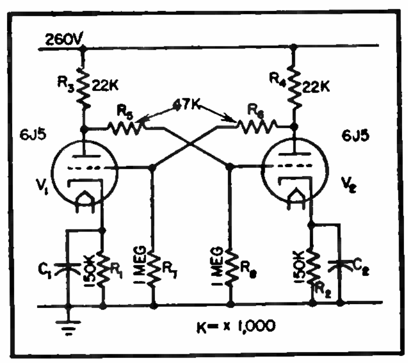

FIG. 1—Schematic diagram of the free-running multivibrator. Valves for C_1 and C_2 may be in the range from 2,200 μf to 4 μf

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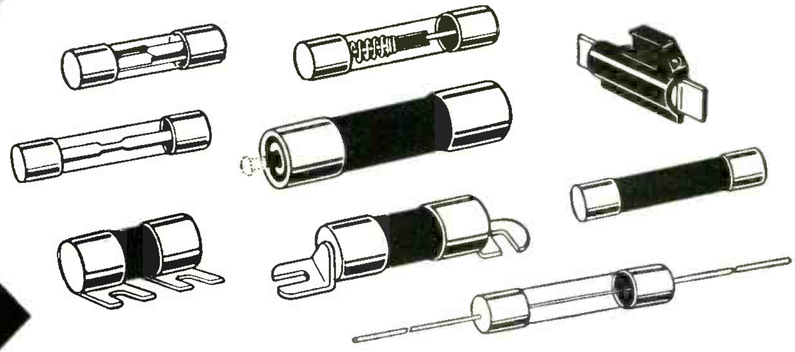

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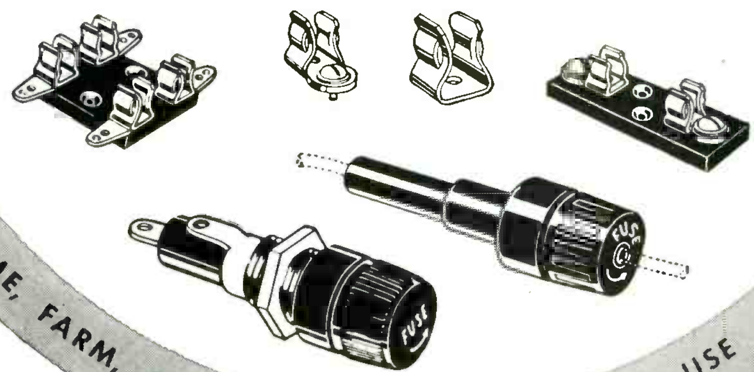

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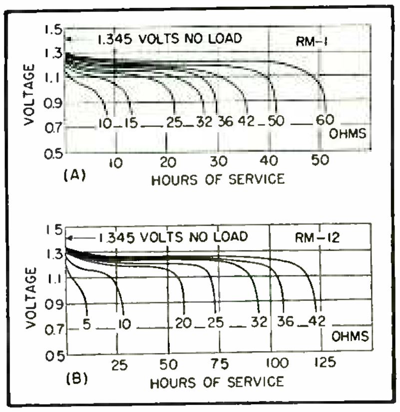


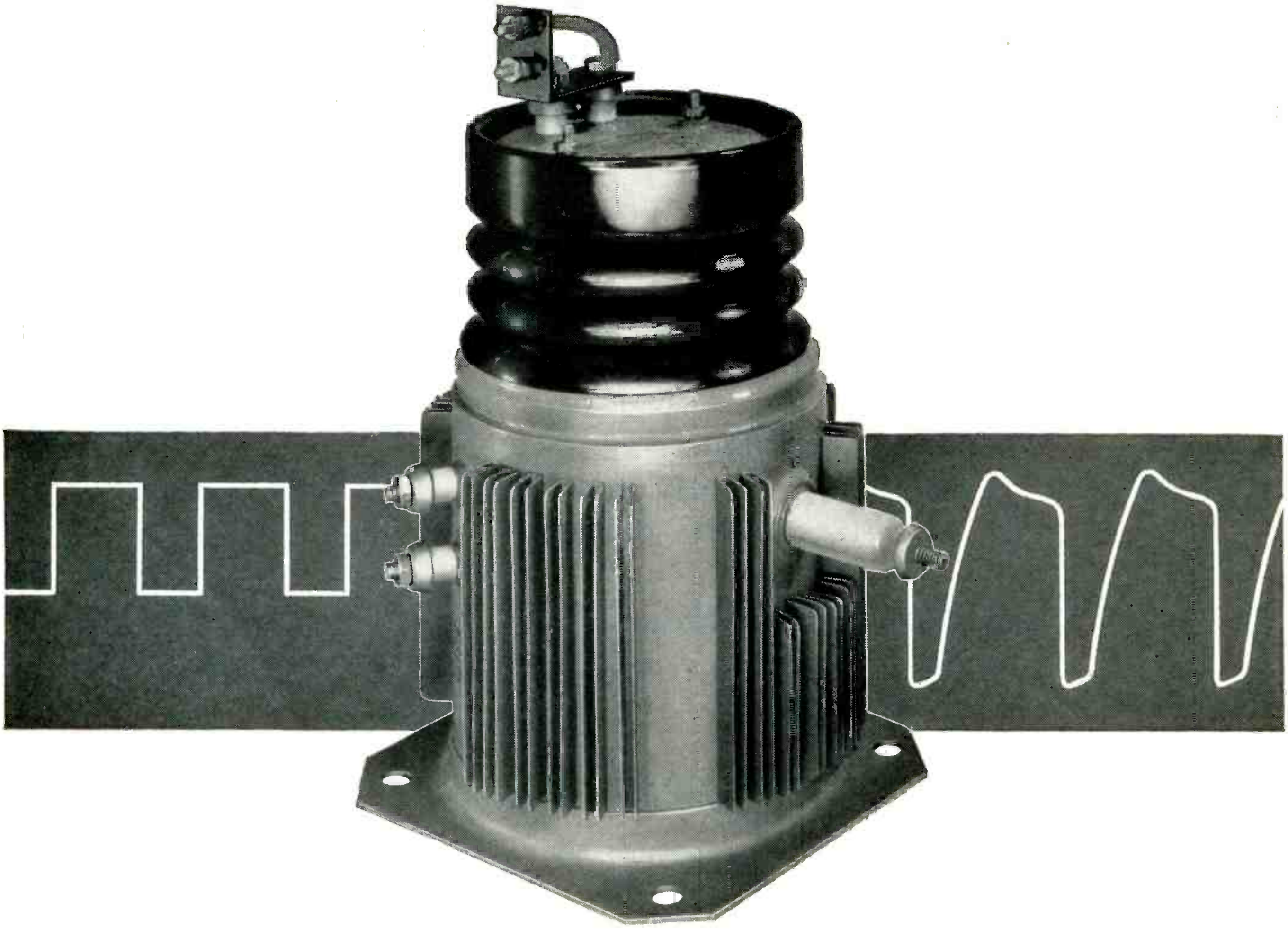
FIG. 2—Curves show life of two cell types for various loads

100 ma and has a flash current of 1 ampere. Its component parts are a nickel-plated steel outer can which is the external positive contact, an absorbent paper tube, a nickel-plated steel inner can that is in contact with a pressed cylindrical cathode of mercuric oxide and micronized graphite, a polystyrene disc that insulates the anode from the steel can, a cotton disc that absorbs electrolyte and holds the anode against the top, a combination paper tube that absorbs and holds electrolyte and acts as barrier, appropriately spacing the zinc from the depolarizer, a pressed cylindrical anode of zinc-mercury amalgam in contact with a tin-plated steel top which is the external negative contact, and a polyethylene grommet that insulates the electrode and provides an air-tight seal when the cell is properly crimped. A cross section of the cell is shown in Fig. 1.

The electrolyte used consisted of 100 g of 85 percent KOH, 13.3 g of ZnO and 100 g water. The cell is balanced[1] by the use of an excess of mercuric oxide.

Two of the requirements of an application where a cell is to be used individually are that the cell be free of leakage and mechanical deformation.

Leakage and mechanical deformation are prevented since any gas pressure developed inside the cell will force the top away from the grommet which rests on the flange of the inner can and allows the gas to escape between the cans and through the hole in the bottom of the outer can. The paper tube between cans absorbs any electrolyte that might be forced out during



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If size, weight, performance or quantity production have any bearing on your transformer problem call your Westinghouse representative. For many applications, standardized designs are available at substantial savings. Westinghouse Electric Corporation, Specialty Transformer Department, Sharon, Pa. J-70611

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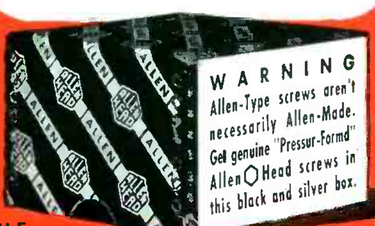

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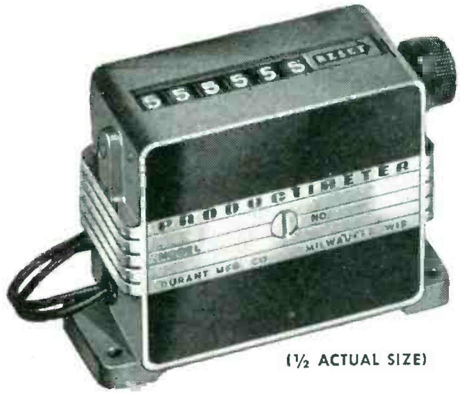

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not clipped prior to operation. The slow release ensures that the circuit does not release during slight pauses between syllables.

REFERENCE

(1) H. H. Stewart and H. S. Pollock, Compression with Feedback, ELECTRONICS, p 19, Feb. 1940.

Miniature High-Capacity Battery Cells

By RICHARD R. CLUNE
Product Engineer
P. R. Mallory Co.
North Tarrytown, N. Y.

DURING the Second World War there arose a need for a power source to operate portable equipment requiring a high ratio of ampere hour capacity to volume at relatively high current densities. The development of a new dry cell to meet these conditions was undertaken and resulted in the RM* type cell.

Since that time considerable improvements have been made and new cells developed to meet requirements of military and civilian ap-

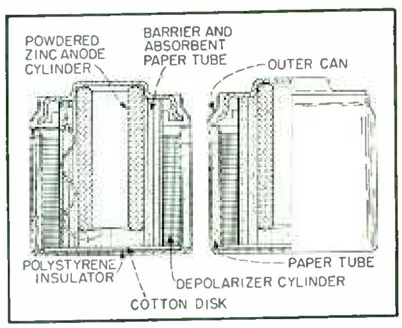
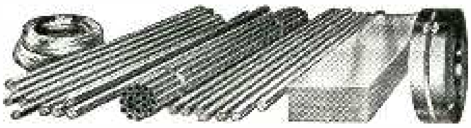


FIG. 1—Cross section of cell shows self-venting principle that prevents mechanical deformation and leakage

plications. Two of the more important of these applications are hearing aids and miniature radios; with their development towards smaller size, more compact battery structures were required which in turn required more capacity per unit volume.

The RM-1 is nominally 0.625 in. in diameter and 0.650 in. high, weighs 0.43 ounce and is rated at 1,000 mah which is 5 ampere hours per cubic inch. It will operate efficiently at current drains up to

*The designation RM was originally suggested by the Signal Corps and is derived from the names of the inventor of the cell, Samuel Ruben, and P. R. Mallory Co. which developed and first commercially produced the cell.



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Electronic Link Eliminates Time Lag in Control Instruments

Measurement and control of such variables as temperature and pressure in chemical and power plants, oil refineries and other process industries must not only be accurate but instantaneous.

The more removed the control center is from the operation being monitored, the greater the time lag of mechanical devices due to friction, resistance, compressibility and other factors.

Time Lag Eliminated

Because of this time lag factor, the illustrated system has been devised in which an electronic link changes pneumatic pressure into direct current, carries it to the recording and control point and reconverts it back to proportional pneumatic pressure. Since only two electrical lines run from the operation point, high pressure lines are eliminated and inflammable liquids and other corrosive media are kept at the source.

Copper and its alloys are used in the electronic section in the form of terminals, wire and other connectors.

Corrosion Resistance Important

In the mechanical or pneumatic section of the system, copper-base alloys are almost universally used to combat the corrosiveness of the moisture which is generally present in the compressed air.

Ease of working and machinability are main factors looked for in materials used for making the valves and fittings in the system.

Since accurate machining is necessary in valve blocks and fittings, free turning brass rod is used (61% copper, 3.4% lead and remainder zinc). This alloy has the highest machinability of all the copper-base materials, has good corrosion resistance to water and finishes are easily obtained.

High Ductility Needed

Depending on whether high or low pressures are involved, either a Bourdon tube or bellows is used.

For the Bourdon tube, a brass with 80% copper, 1% tin and the remainder zinc is usually specified. This alloy has good fatigue as well as corrosion resistance, plus high strength.

The bellows is generally made from a brass containing 80% copper and 20% zinc. This material has high ductility to form the bellows and work-hardens sufficiently to give excellent temper, which in turn gives adequate spring characteristics. For more severe service conditions phosphor bronze (95% copper, 5% tin) is specified.

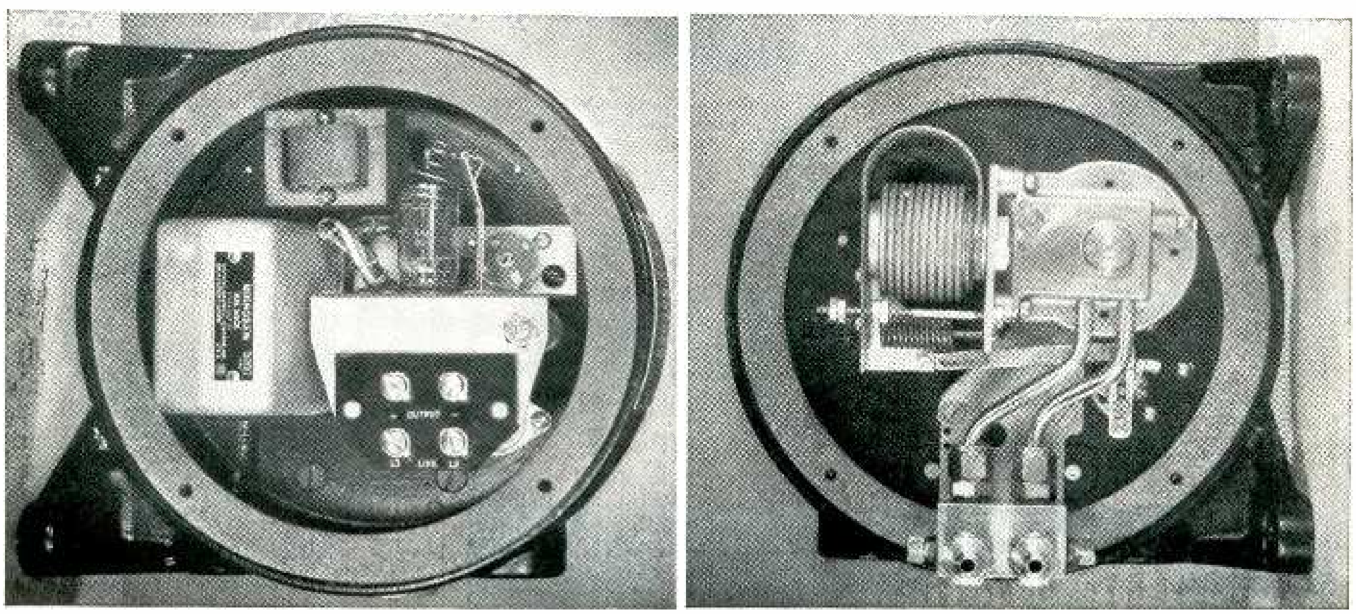
Copper tube is used for the air connectors in the unit.

Phosphor Bronze Used

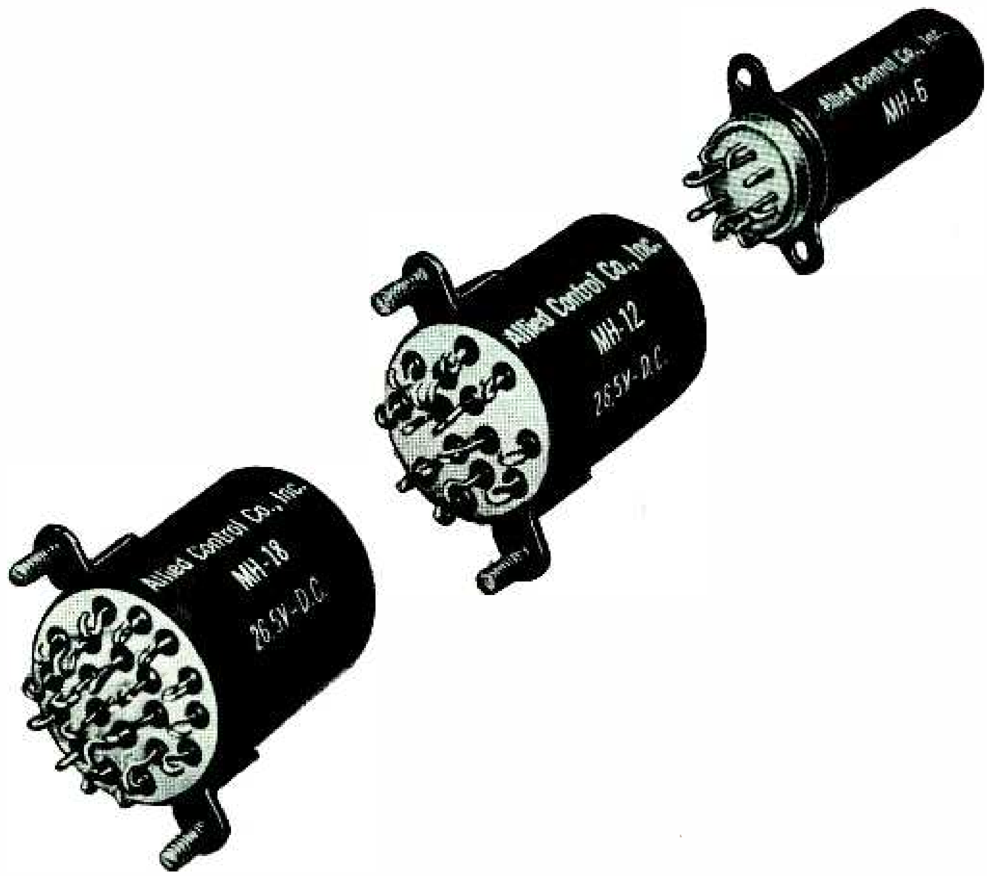
The metal diaphragm is made from phosphor bronze since this alloy has dependable spring properties, high fatigue resistance and good strength.

Locations of the instruments are often conducive to corrosion, especially where steam and other gases are present. The copper-base alloys resist corrosion from many different gases.

For information about alloys and advice on them for your product, write or call our nearest district office. Our laboratory has compiled much information which may prove helpful in your work. (7982)



Transmitter and receiving transducer for remote control. The covers are removed to show the electronic and pneumatic amplifiers.
Courtesy Manning, Maxwell & Moore, Inc., Stratford, Connecticut.



ALLIED'S NEW 50G SUB-MINIATURE RELAYS

Developed specifically to meet the rigid requirements of U.S.A.F. Spec. MIL-R-5757A, the new Allied line of sub-miniature double throw relays includes the MH-18 (6-pole), the MH-12 (4-pole), and the MH-6 (2-pole) will follow.

Contacts are rated at 2 amps resistive or 1 amp inductive at 28 volts D.C.

The high performance of these relays has been achieved in an extremely compact, unitized construction and parallels the most recent advances in airborne equipment design.

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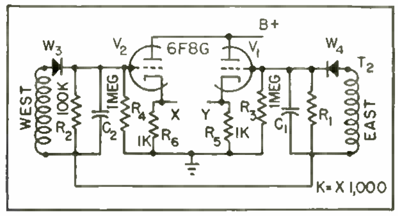

FIG. 4—Bias circuit

in the block diagram of Fig. 3 are both identical to that depicted in Figure 1. The points *AB* of these amplifiers are connected directly to the points *XY* of the bias circuit Fig. 4, but are so arranged that point *A* of the West-to-East amplifier is connected to point *B* of the East-to-West amplifier and point *Y* of the bias circuit. Thus, assuming that under quiescent conditions a signal arrives from the West line, the voltage developed across R_1 will be greater than that across R_2, due to the slight amplification of the West-to-East amplifier. This will result in a positive increment to the grid voltage of V_1 and a negative increment in V_2. Point *Y* will become positive with respect to *X* resulting in an increase in the gain of the West-to-East amplifier and a decrease in gain of the East-to-West. This effect is cumulative, resulting in the production of maximum gain in the former amplifier and minimum gain in the latter. As soon as the signal is removed from the West line the bias developed across *XY* will disappear and quiescent conditions will again be assumed.

With this arrangement, a low overall gain around the singing path is maintained at all times and only a compromise balance in each hybrid coil is required. The speed of operation of the bias circuit is controlled by the *CR* constant of the rectifier circuits. The attack time is governed by the *CR* constant made up from the value of capacitors C_1 and C_2 and the forward resistance of the varistors W_3 and W_4. The release time is controlled by the *CR* values of C_1 and C_2 and the resistors R_1 and R_2 each in parallel with the backward resistances of W_1 and W_2 and is therefore much longer than the attack time. This is desirable in that a quick attack time is needed so that the first syllables of speech are

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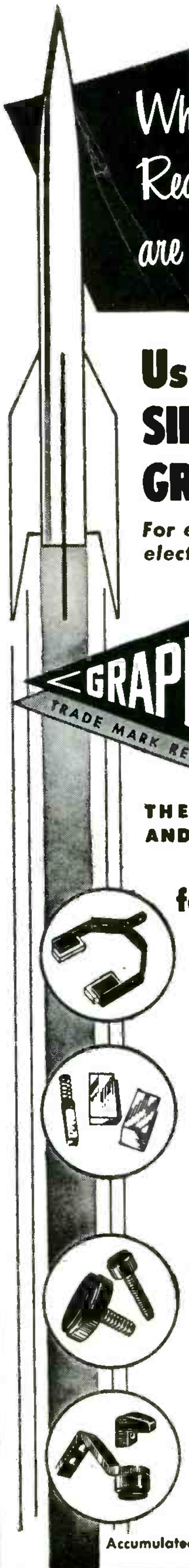

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501R	2 Kw.	Up to 150 Mc.	100.00
5924/AX-9904 R	5.0 Kw.	Up to 220 Mc.	225.00
5604	22.5 Kw.	Up to 25 Mc.	540.00
880	40 Kw.	Up to 25 Mc.	510.00
6077/AX9906	108 Kw.	Up to 30 Mc.	1700.00

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RCA-6166

(Typical Operation in Class B or Grid-Modulated Class C Television Service, Grid-Drive Circuit, 54 to 216 Mc)

DC Plate Voltage	5800 volts
DC Grid-No. 2 Voltage	1200 volts
DC Grid-No. 1 Voltage*	–130 volts
Peak RF Grid-No. 1 Voltage	375 volts
DC Plate Current*	3.45 amp
Driver Power Output (Approx.)*	800 watts
Power Output (Approx.)*	12,000 watts

RCA-6181

(Typical Operation in Class B or Bias-Modulated Class C Television Service, Cathode-Drive Circuit at 900 Mc)

DC Plate Voltage	1800 volts
DC Grid-No. 2 Voltage	475 volts
DC Cathode-to-Grid-No. 1 Voltage*	75 volts
Peak RF Grid-No. 1 Voltage	120 volts
DC Plate Current*	1.7 amp
Driver Power Output (Approx.)*	200 watts
Useful Power Output (Approx.)*	1200 watts

*At synchronizing level

RCA-6181

NEW forced-air-cooled *TV* power tetrodes

THE new RCA-6166 and 6181 . . . developed for TV and radio services . . . represent the successful application of forced-air cooling to power tetrodes designed to operate at high efficiency at the higher frequencies. The use of forced-air cooling simplifies transmitter design and effects substantial operating economies.

Both tubes feature coaxial-electrode structures, and are particularly suited to operation in circuits of the coaxial-cylinder type.

The RCA-6166 VHF tetrode uses a time-proved thoriated-tungsten filament that permits substantial savings in filament power.

The RCA-6181 UHF tetrode has an indirectly heated, low-temperature, coated cathode of the matrix type for long serviceability. Further, it features seals between a low-loss ceramic and a high-conductivity metal to provide high-efficiency uhf performance.

For complete technical data on these or any other RCA tubes, write RCA, Commercial Engineering, Section DR42, Harrison, New Jersey . . . or contact your nearest RCA Field Office . . .

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