electronics

DECEMBER · 1951

PRICE 75 CENTS

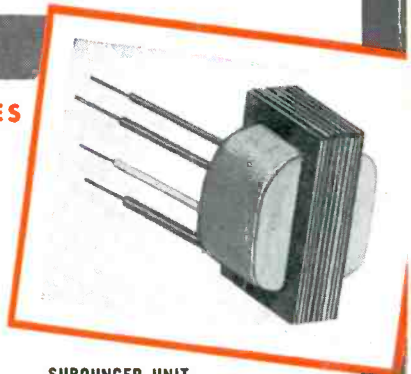
A McGRAW-HILL PUBLICATION

PLANNED PLACEMENT OF MATERIALS AND TOOLS SPEEDS WIRING

MINIATURE COMPONENTS FROM STOCK...

SUBOUNCER UNITS

FOR HEARING AIDS...VEST POCKET RADIOS...MIDGET DEVICES

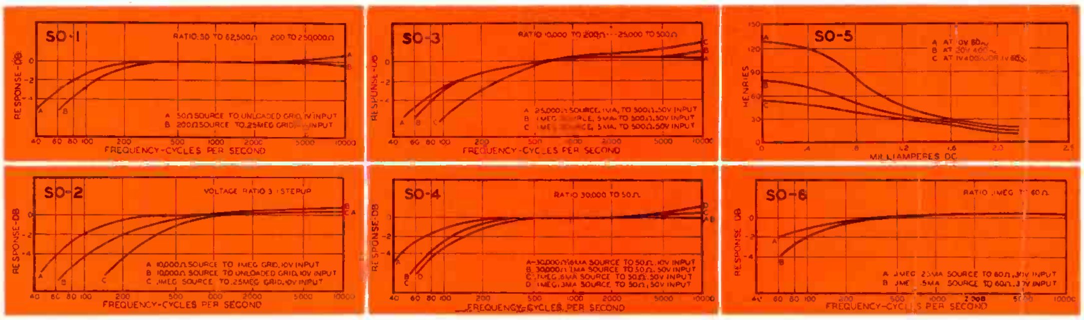


UTC Sub-Ouncer units fulfill an essential requirement for miniaturized components having relatively high efficiency and wide frequency response. Through the use of special nickel iron core materials and winding methods, these miniature units have performance and dependability characteristics far superior to any other comparable items. They are ideal for hearing aids, miniature radios, and other types of miniature electronic equipment. The coils employ automatic layer windings of double Formex wire . . . in a molded Nylon bobbin. All insulation is of cellulose acetate. Four inch color coded flexible leads are employed, securely anchored mechanically. No mounting facilities are provided, since this would preclude maximum flexibility in location. Units are vacuum impregnated and double (water proof) sealed. The curves below indicate the excellent frequency response available. Alternate curves are shown to indicate operating characteristics in various typical applications.

SUBOUNCER UNIT
Dimensions....9/16" x 5/8" x 7/8"
Weight .... .03 lb.

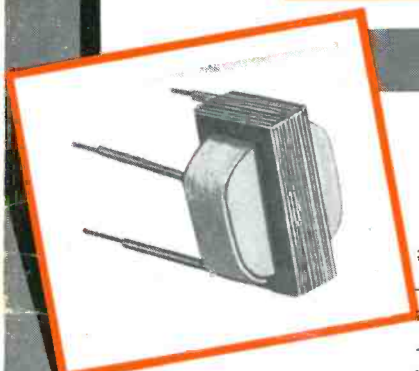
Type	Application	Level	Pri. Imp.	D.C in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SO-1	Input	+ 4 V U	200 50	0	250,000 62,500	16	2650	$6.50
SO-2	Interstage/3:1	+ 4 V.U	10,000	0	90,000	225	1850	6.50
*SO-3	Plate to Line	+ 20 V U	10,000 25,000	3 mil 1.5 mil.	200 500	1300	30	6.50
SO-4	Output	+ 20 V.U	30,000	1.0 mil	50	1800	4.3	6.50
SO-5	Reactor 50 HY at 1 mil D.C 3000 ohms D.C. Res							5.50
SO-6	Output	+ 20 V U	100,000	.5 mil.	60	3250	3.8	6.50

*Impedance ratio is fixed, 1250:1 for SO-1, 1:50 for SO-3 Any impedance between the values shown may be employed.



SUB-SUBOUNCER UNITS

FOR HEARING AIDS AND ULTRA-MINIATURE EQUIPMENT

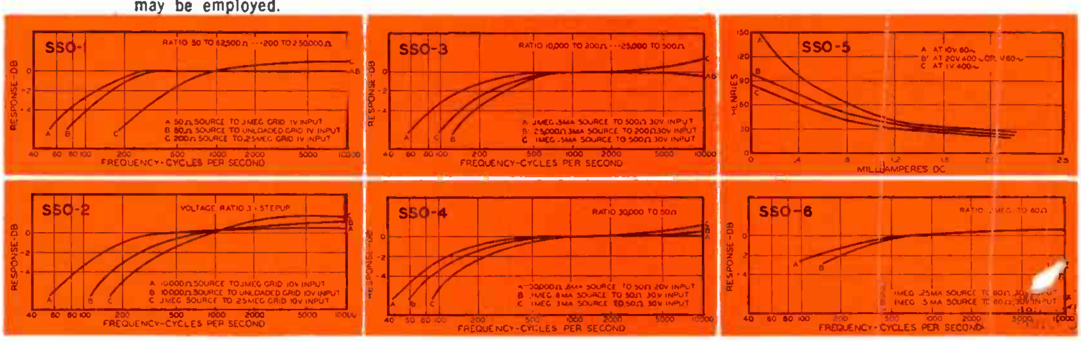


UTC Sub-SubOuncer units have exceptionally high efficiency and frequency range in their ultra-miniature size. This has been effected through the use of specially selected Hiperm-Alloy core material and special winding methods. The constructional details are identical to those of the Sub-Ouncer units described above The curves below show actual characteristics under typical conditions of application.

SUB-SUBOUNCER UNIT
Dimensions....7/16" x 3/4" x 5/8"
Weight .... .02 lb.

Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700	$6.50
SSO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	750	3250	6.50
*SSO-3	Plate to Line	+ 20 V U	10,000 25,000	3 mil. 1.5 mil.	200 500	2600	35	6.50
SSO-4	Output	+ 20 V U	30,000	1.0 mil.	50	2875	4.6	5.50
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.							5.50
SSO-6	Ouptut	+ 20 V.U.	100,000	.5 mil.	60	4700	3.3	6.50

*Impedance ratio is fixed, 1250:1 for SSO-1, 1:50 for SSO-3. Any impedance between the values shown may be employed.



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electronics

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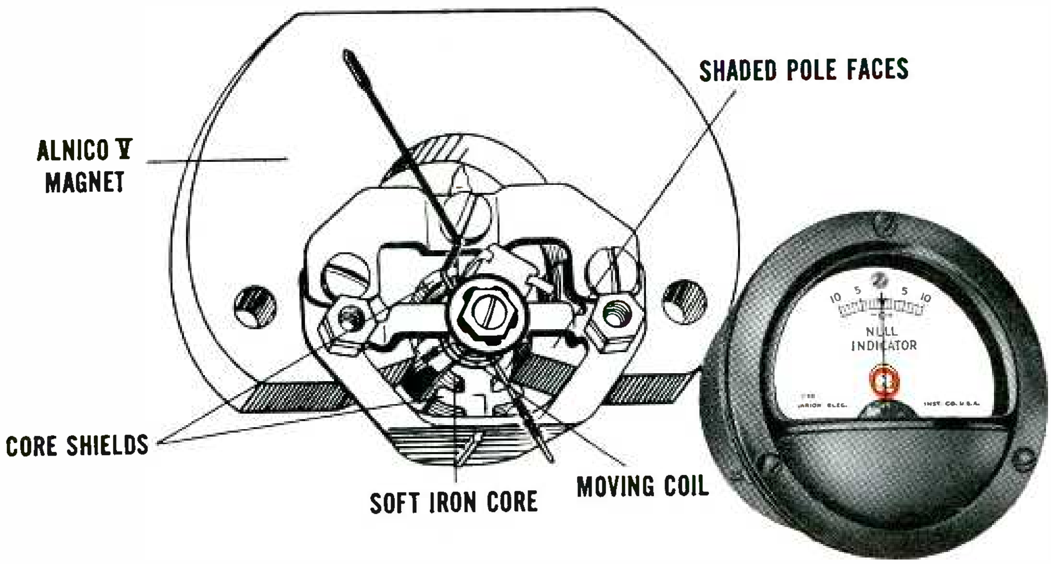
NEW

the marion Sensitive, Ruggedized Null Indicator



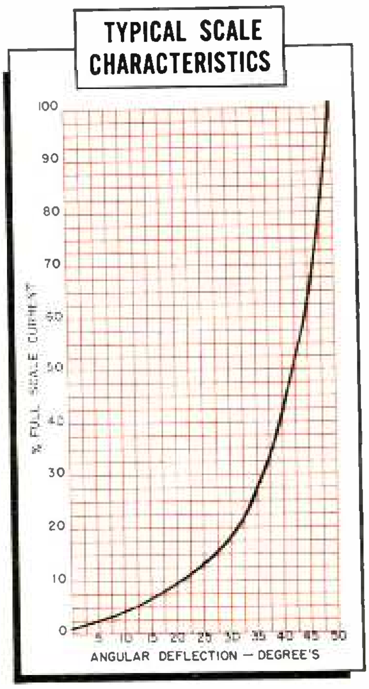
The Marion RUGGEDIZED Null Indicator offers advantages never before found in meters of this kind.

Its special construction permits the use of the null system for precise measurements under very severe field conditions, allows design engineers to use a Null Indicator in new applications.

This meter is hermetically-sealed and its mounting requirements and physical dimensions are in conformance with JAN-I-6. It has very high center-point sensitivity (1 microampere per mm. or higher), yet due to its shaded pole face and shielded core construction it gives sharply logarithmic attenuation as it departs from the null point, thus providing ample overload protection for the indicator. Maximum safe current is ten times actual rated full scale value.

The Marion Null Indicator is made in two models, the HS2 (2½" size) and the HS3 (3½" size). Each of the two models is available with numerous current sensitivity and internal resistance characteristics.

Demands of our national mobilization program come first, of course, but we will gladly supply further information and serve you to the best of our ability.



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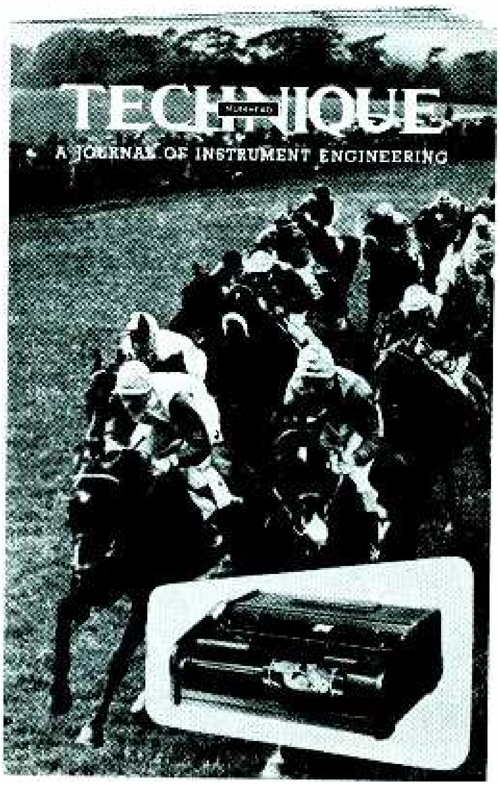

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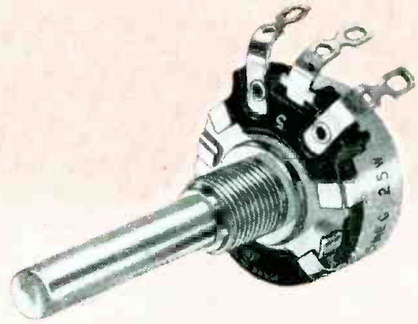
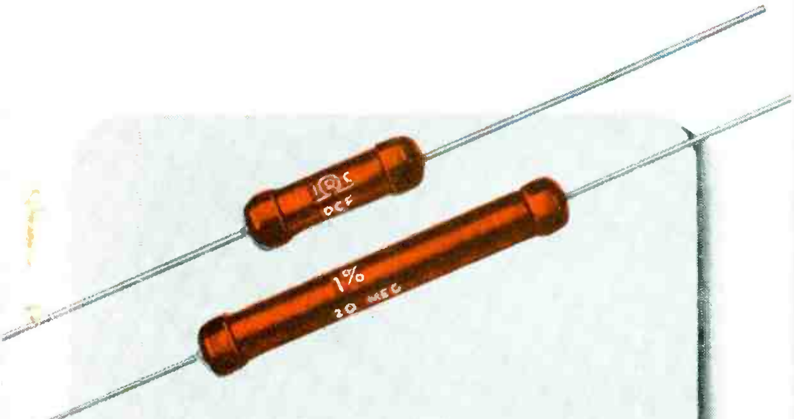
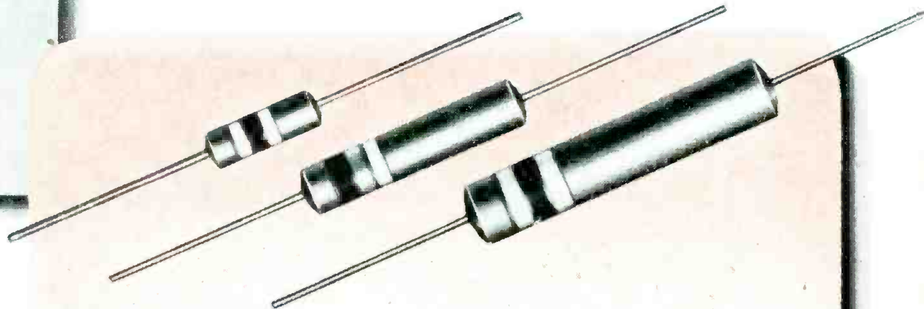
essential



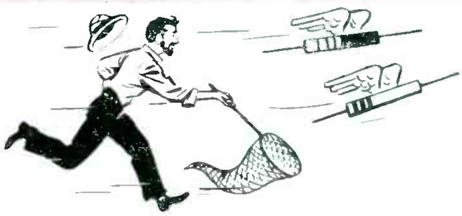
When you need dependable small-size controls, specify IRC 13/16'' Type Q Controls. New Type Q's are rugged and compact, yet increased arc of rotation permits the same resistance ratios used in larger IRC controls. Type Q's are characterized by low noise level, unusual durability and efficiency, negligible changes in resistance even after long exposure to humidity, adaptability to a great variety of small-space applications. Complete mechanization of production and testing assures uniformity of construction and performance—and affords greater availability. Bulletin A-1 gives full details.



Where a combination of characteristics is essential in precision applications, you'll cut costs with IRC PRECISTORS. These *deposited carbon* units solve availability problems in high frequency applications, metering and voltage divider circuits—combine accuracy and economy where carbon compositions are unsuitable and wire wounds too expensive. We make the two sizes of PRECISTORS to customers' specifications, rather than to standard RTMA values—subject, of course, to minimum and maximum values for each type. Write for complete data in Catalog Bulletin B-4.



For exceptional stability and economy in low range applications, choose IRC Type BW Insulated Wire Wound Resistors. Uniformly wound and completely insulated, these compact units have excellent performance records in meters, analysers, low-range bridge circuits, high stability attenuators and similar applications. Type BW's are supplied in standard RTMA ranges, tolerance ±10% standard—values of 10 ohms and above in ±5%. Available also in matched or balanced pairs. Full data in Catalog Bulletin B-5.



When experiments, pilot runs or maintenance demand standard resistors *double-quick*, you'll appreciate the advantages of IRC's Industrial Service Plan. This enables you to get prompt, 'round-the-corner service from the local stocks of your IRC Distributor. Call him for your minimum-quantity requirements. If you don't know him, we'll gladly send you his name and address.

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Send me additional data on items checked below:

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- [ ] Type Q Controls
- [ ] Deposited Carbon PRECISTORS
- [ ] Type BW Wire Wound Resistors
- [ ] Name and address of local IRC Distributor

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TITLE ____________________

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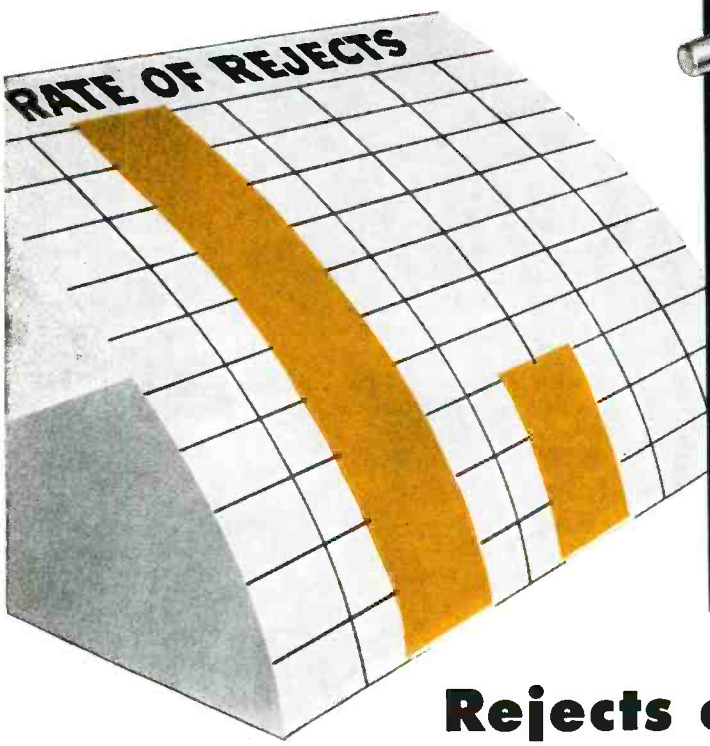

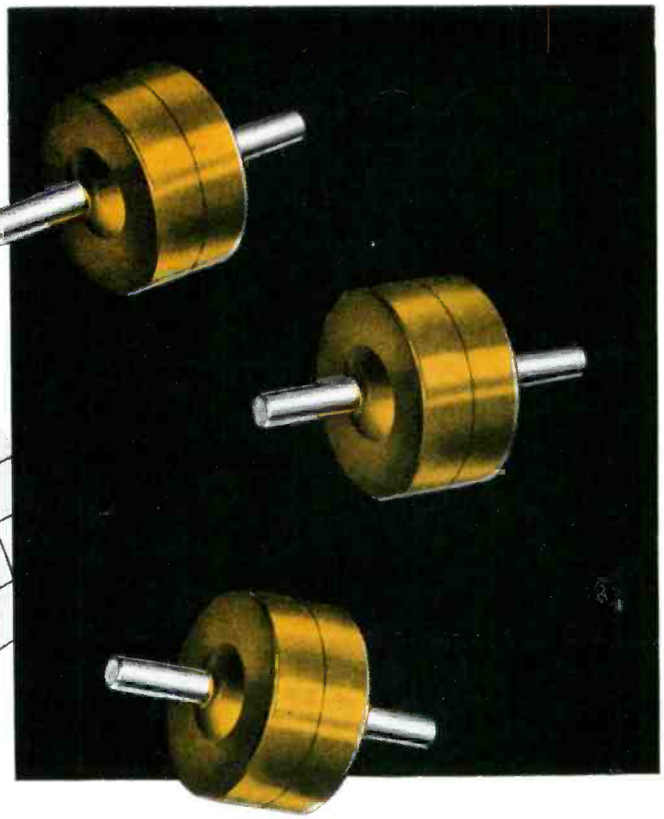

Rejects cut 70%

Like so many manufacturers, Globe-Union, Inc., received substantial rewards in a hurry from a simple switch to Plaskon Alkyd Molding Compound. In their television high-voltage capacitors, the outstanding electrical properties of this quick-curing plastic reduced rejections 70% when the parts were submitted to a high-voltage breakdown test. This manufacturer also reports: "Very appreciable labor savings have resulted from the use of Plaskon Alkyd" ..."Plaskon Alkyd has at least doubled the productive capacity of molding equipment"..."The life of molding dies has been increased."

Again... *faster, more economical production* of an *improved* product — thanks to Plaskon Alkyd. Again... important evidence that it might pay you well to investigate Plaskon Alkyd in relation to *your* product.

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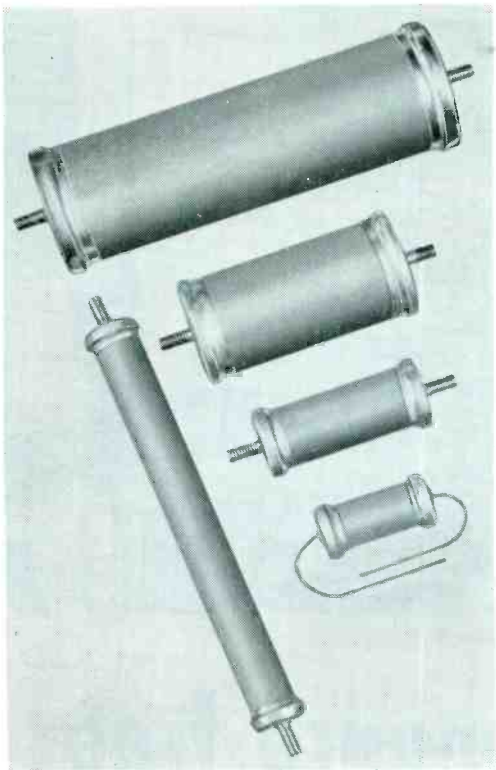
consist of capacitor elements enclosed in hermetically sealed glass tubes. The capacitor elements are wound with the plastic film which accentuates the electrical characteristics you require. The metal-glass housing assures retention of these characteristics under unusual climatic and operating conditions.



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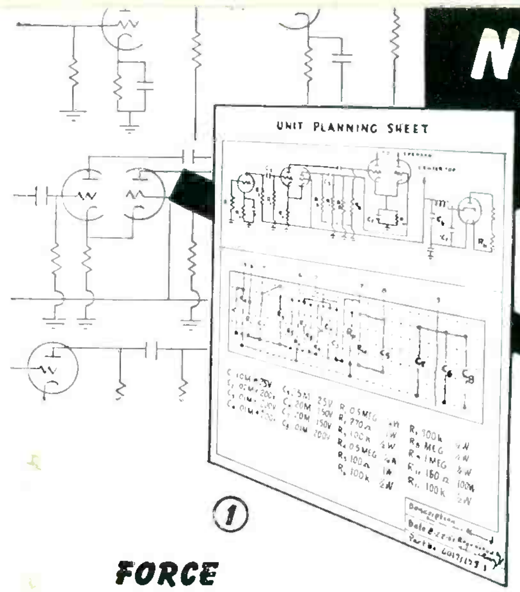
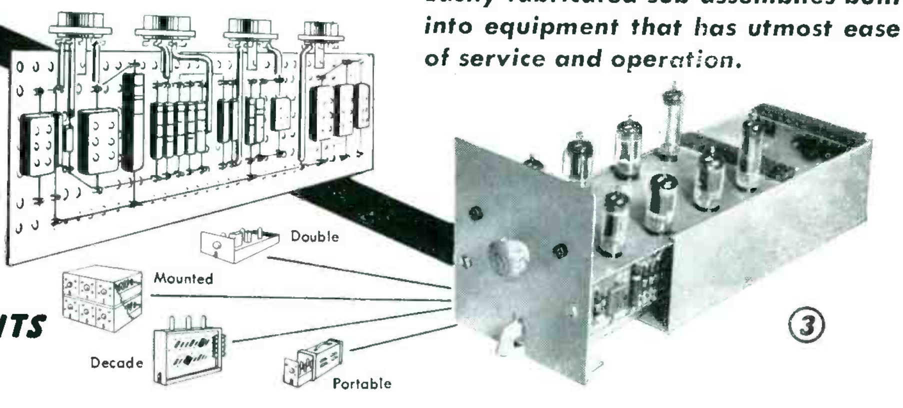


TERMINAL MOUNTING CARDS ORGANIZE CIRCUITS QUICKLY

ALDEN BASIC CHASSIS

Easily fabricated sub-assemblies built into equipment that has utmost ease of service and operation.



FORCE STRAIGHT-LINE THINKING WITH NEW ALDEN COMPONENTS FOR PLUG-IN CONSTRUCTION

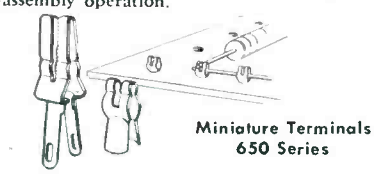
To design Electronic Equipment that must be produced quickly and in quantity, make your model with Alden Basic Chassis and "20" Packages. Save vital engineering and planning time — machine and tool hours — critical material and manhours.

① ORGANIZE CIRCUITS QUICKLY FOR SYSTEMATIC LAYOUT AND CONSTRUCTION

Schematics of most all electronic equipment can be broken down into circuit blocks of logically associated functions. These functional circuit blocks can be mounted readily either in the Alden "20" plug-in packages or Basic Chassis unit. The tube sockets and associated components lay out quickly on full scale Unit Planning Sheets for mounting on terminal cards. These special pre-punched, multi-hole terminal cards have wide flexibility to take an infinite variety of circuit variations. Both sides of card can be used to obtain maximum component density area. Using the Unit Planning Sheets, functional circuit units — components and housings — are all planned in one step.

② GET THE MOST NATURAL, EASY SUB-DIVISION OF LABOR IN MANUFACTURE

Solder terminals and sockets quickly rivet to Alden terminal card according to layout on Unit Planning Sheet. Components snap into the special **Alden Miniature Terminals** which hold them for soldering. — (No twisting or wrapping of leads necessary). — With all tube sockets and their associated components mounted on one card — the wiring and soldering of circuits is an open, easy-to-work sub-assembly operation.



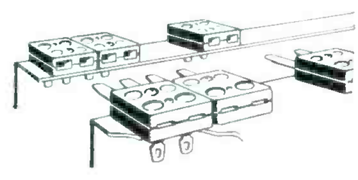
Miniature Terminals
650 Series

Terminal cards have been designed to accommodate tremendous number of circuit variations — to make neat tube and component sub-assemblies with a minimum of wiring.

③ INSURE THE LOWEST OPERATING AND SERVICE COSTS IN FINAL EQUIPMENT

The ALDEN BASIC CHASSIS UNIT is rapidly completed by mounting terminal cards into the chassis — soldering unit cables and making connections to **Alden Color Coded Back Connectors** and detachable front panel. Completed unit is easily piloted in and out of rack with the Serve-A-Unit Lock. Open sided construction, aided by the neat direct front and back connections, gives instant accessibility for rapid circuit checks and service.

Alden Terminal Card System means minimum of intercabling — but even this cabling can be laid out easily and proceed as simple sub-assembly. Open sided chassis construction makes cable easy to wire to front panel, terminal cards and back connectors.



Back Connectors — 462 Min Series

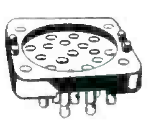
The **Alden Back Connectors** are units that can be discretely positioned on the back of the chassis — isolating lines with incompatible voltages, currents, or frequencies. This design insures accessible solder terminals for soldering — avoids rat nests of congested conventional back connector wiring. — Color coded, the Alden back connectors provide beautiful operational or service check points for all leads to and from chassis.

Hinged front panel design of chassis — allows rheostats, indicator lights, jacks, etc. to be mounted on panel as another easy-to-work sub-assembly. This panel attaches easily to chassis — is wired — swung up and fastened with Alden Target Screws.

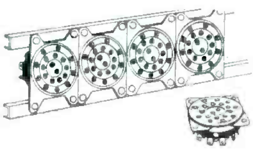
Assembled — Basic Chassis simplifies the operation of your equipment — Slashes service and maintenance time. Smooth, positive insertion and removal of the chassis is provided by the Alden "Serve-A-Unit Lock"

For Smaller Units Alden "20" Plug-in Packages

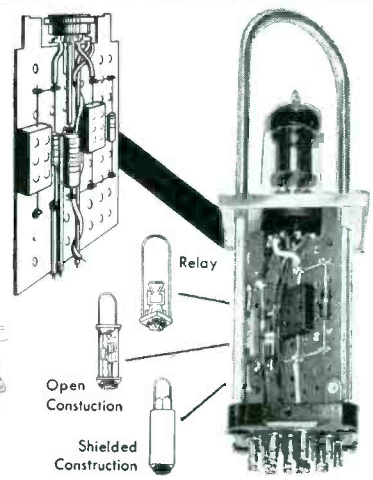
Here is a plug-in package unit using the above method of converting schematic into finished assembly quickly. Simply mount the completed terminal card sub-assembly on the Alden "20" Non-Interchangeable base, dip soldering the leads and adding cover or housing and handle . . . In operation, visual or instrument checks are easily made — if trouble occurs doubtful units are quickly isolated — these units easily unplug and a comprehensive inspection made. Spare units can be plugged in so equipment doesn't have to be inoperable while repairs are in process.



"20" Non-Interchangeable Base



"20" Rack and Chassis Mounting Sockets



TO GET STARTED QUICKLY! 'phone our New Products Director for an appointment to visit our plant — Wire for a sample Basic Chassis at $40.00 or an Open and Closed Alden "20" Plug-in Package at $10.00 — or write Dept. E for Booklet: "Basic Chassis and Components for Plug-in Unit Construction".

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Type 904 VHF-UHF Noise Generator

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Type 584 UHF Frequency Meter

470-890 MC/S

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- PRECISE CALIBRATION
- RESOLUTION BETTER THAN 0.1 MC/S

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- IMPEDANCE LEVEL: 50 OR 75 TO 300 OHMS
- LENGTH: APPROXIMATELY 6 INCHES

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40 to 950 MC/S

Fundamental Sweep Frequency Oscillator

- OUTPUT: 1 VOLT ACROSS 75 OHMS
- MINIMUM SWEEP WIDTH AT 40 MC/S: 15 MC/S

—ASK FOR
PRD TYPE 907

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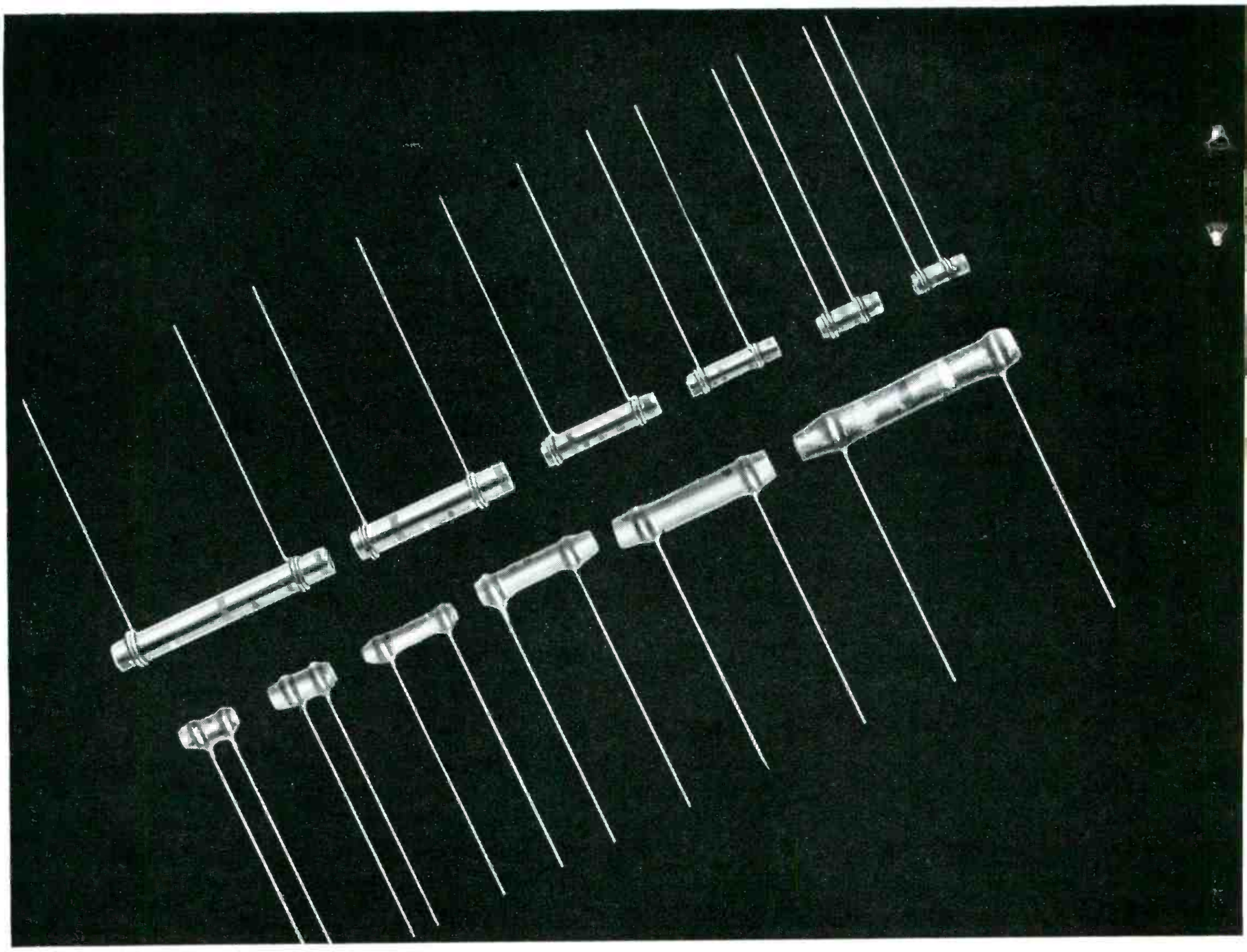
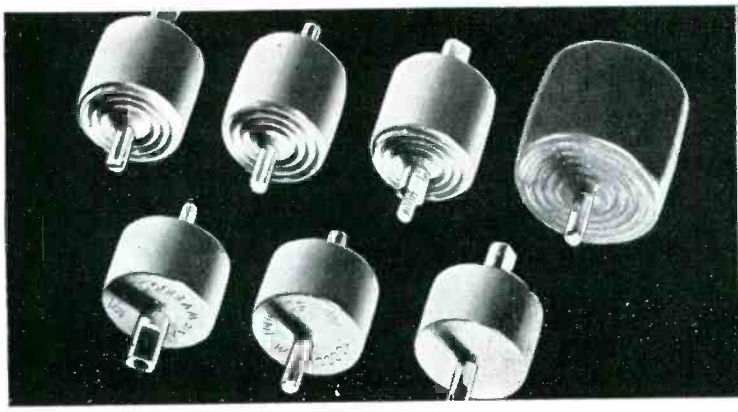
here's how to IRON OUT your power factor curve

for more information on ceramic capacitors
with lowest power factors available anywhere
see the next two pages - - - - - ▶▶

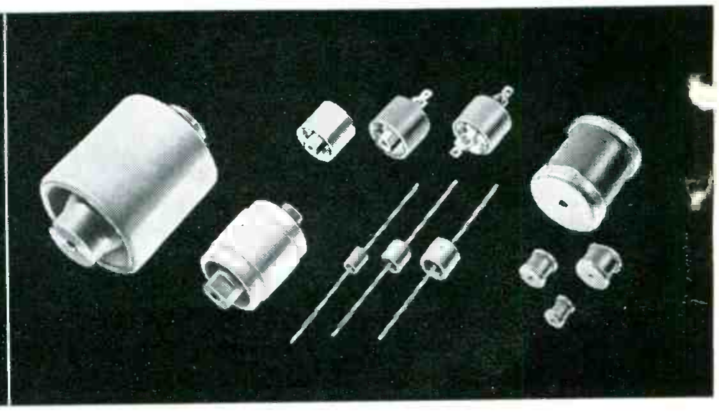
Centralab Ceramic



TEMPERATURE COMPENSATING TUBULAR CAPACITORS have extremely low power factor — very low inductance — more capacity per area — available non-insulated (top row above) or insulated (bottom row). Conform to JAN-C-20 electrical specifications. Offer full range of standard and extended temperature coefficients (NPO through N5250). Capacity, tolerance and nominal TC clearly identified by JAN-20 or RTMA color code. Recommended for VHF and UHF. 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. For more information, check Bulletin 42-10R in coupon at right.



HIGH VOLTAGE HEAVY CURRENT CAPACITORS. Capacitance: 5 to 500 mmf., 5 KV to 20 KV D.C. working. Ideal for portable or mobile equipment of high voltage and high frequency requirements. Check Bulletin No. 42-102 in coupon at the right.

Capacitors . . .

give you lowest power factors . . . highest electrical efficiency

That "thief of electrical efficiency" — high power factor — won't rob you when you specify Centralab Ceramic Capacitors. For example, *Centralab TC Capacitors have an initial power factor of less than .1% minimum . . . to only .3% maximum after 100 hours at 95% humidity! Then return to normal!*

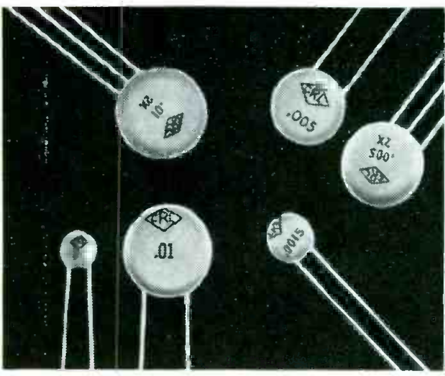
What's more, all Centralab capacitors are made to applicable portions of JAN specifications.

Low power factor is built into every Centralab Ceramic Capacitor. Centralab's Ceramic X—used for the ceramic body—is non-hygroscopic. Moisture absorption is .007% or less — ultimate in reliability under severe humidity. Ideal for tropical climates.

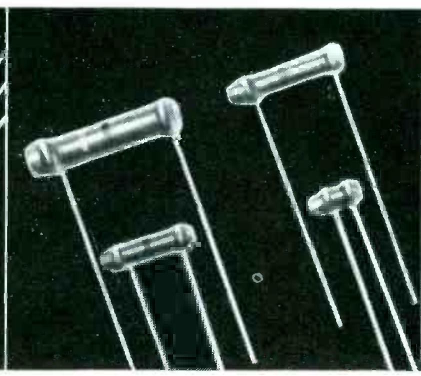
The ceramic capacitor itself will easily withstand temperatures of 85°C — higher than generally encountered in most electrical apparatus. The silver electrodes are bonded to the ceramic with a minimum tensile strength of 3000 lbs. p.s.i., preventing any possible change in position of the electrodes.

These exclusive features of Centralab Ceramic Capacitors are your assurance of lowest power factor — highest efficiency.

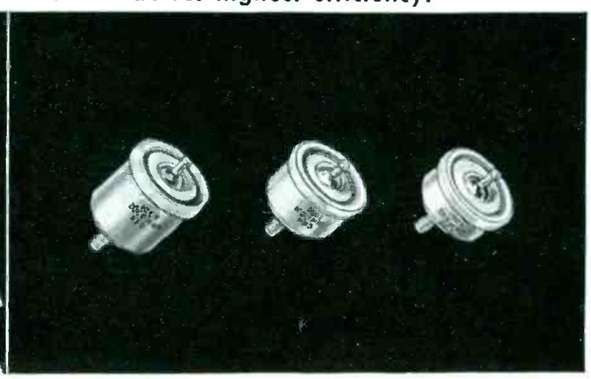
Compare with all others — and you'll standardize on Centralab for highest efficiency.



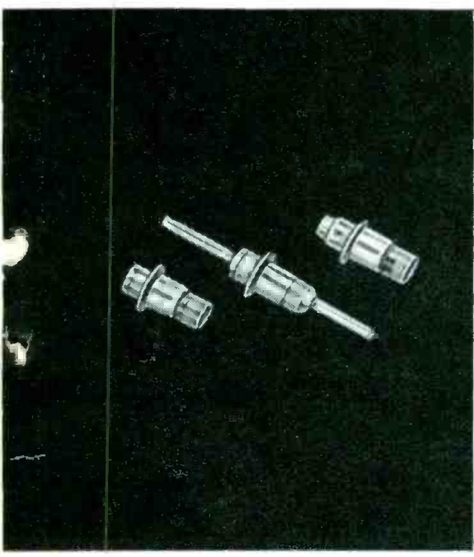
CERAMIC DISC HI-KAP CAPACITORS hold thickness to a minimum. Very high capacity in extremely small size. Used in r.f. by-pass and coupling. Send for Bulletin No. 42-4R.



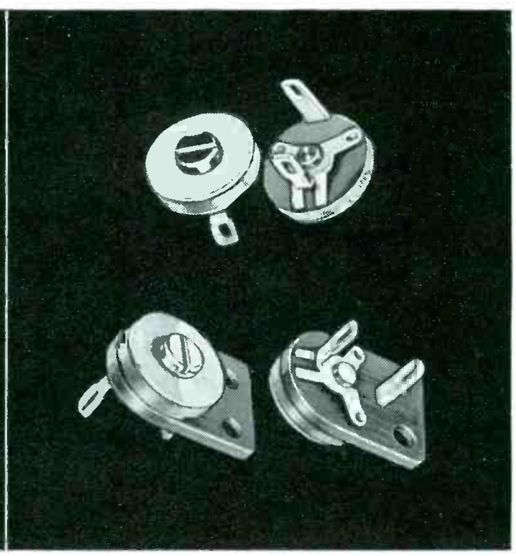
BC HI-KAP TUBULAR CERAMIC CAPACITORS available in 48 preferred values. Ideal for use in r.f. by-pass and audio-coupling. Check Bulletin No. 42-3 on coupon below.



HIGH ACCURACY CERAMIC CAPACITORS for precision r.f. circuits. Especially suited to resonant application in oscillator circuits of primary and secondary frequency standards and meters. Check Bulletin 42-123 below.



EYELET-MOUNTED FEED-THROUGH CERAMIC CAPACITORS are exceptionally small and sturdy. Capacities range from 10 to 3000 mmf. Voltage rating, 500 V.D.C.W. Check Bulletin No. EP-15 in coupon.



MINIATURE CERAMIC TRIMMERS can be mounted to chassis or terminal mounted to coil or terminal board. No. 821 (shown) has voltage rating of 500 V.D.C.W. Available in various trimming ranges. Check Bulletin No. EP-16 at the right.

For more information on the capacitors listed in this ad, fill out coupon below and check bulletins you want. For complete information on Centralab electronic components . . . switches, controls, ceramic capacitors and printed electronic circuits . . . see your Centralab representative or your local Centralab distributor. Ask for Catalog 27.

Centralab ®

Division of GLOBE-UNION INC. Milwaukee 1, Wis.

Centralab, Div. of Globe-Union Inc.
914 East Keefe Avenue, Milwaukee 1, Wisconsin

Please send me the Technical Bulletins on Ceramic Capacitors as checked below:

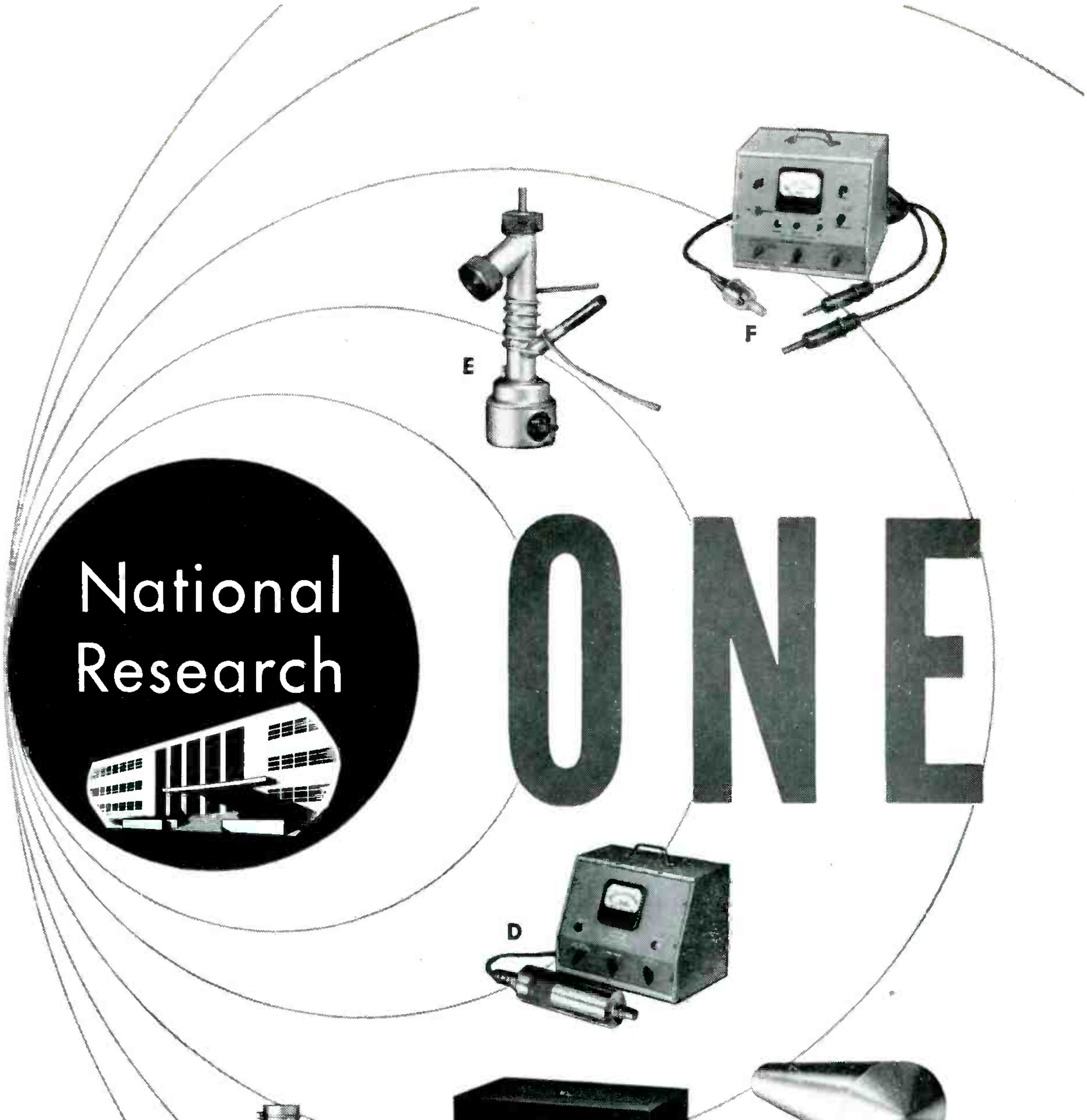
☐ 42-18	☐ 42-10R	☐ 42-102	☐ 42-4R
☐ 42-3	☐ 42-123	☐ EP-15	☐ EP-16

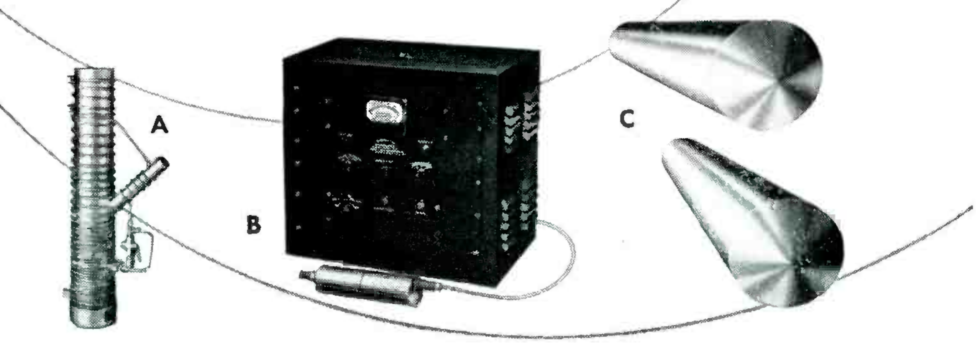
Name..

Address..

Company..

Title..





(A) B-4 Booster Pump. Takes over at forepressures up to 1 mm. Handles large amounts of gas in range from 1 — 30 microns. Ideal for roughing or backing manifolds to speed up exhaust cycles or as prime pump on aluminizing equipment or wherever high speeds are required.

(B) Alphatron* Leak Detector and Control Unit for Gas Filling. The latest high speed rotary exhaust equipment demands split second vacuum control. The Alphatron Controller responds to pressure changes in about two tenths of a second. It is used to close off leaky tubes on a station with only a two second cycle. Instantaneous, accurate pressure response makes it a natural for gas filling where accuracy of fill pressure is important or where valuable gases are used.

(C) Gas Free High Purity Metals. Copper, nickel, cobalt, and iron. Special melts on request. Ingot weights up to 600 pounds.

(D) Alphatron* Vacuum Gauge. Instantaneous response with accurate gauging from 1 micron to 10 mm. A rugged metal ionization type gauge for industrial usage. Can be adapted for recording and controlling.

(E) B-1 Booster Pump. Specially designed for rotary exhaust units in miniature and subminiature tube production.

(F) Type 710 Thermocouple-Ionization Gauge Control. One control with two thermocouple gauges (1 — 1000 microns) and one ionization gauge (10^{-3} mm. to 10^{-8} mm. Hg range). Automatic input regulation and protective circuit.

(G) Type 701 Thermocouple Gauge Control. A light, portable instrument for vacuum testing in range 1 — 1000 microns — compact and rugged.

(H) H-4-P Purifying Diffusion Pump. Similar to H-2-P but with speeds of over 300 liters/sec from 10^{-3} to 10^{-5} mm. Hg range.

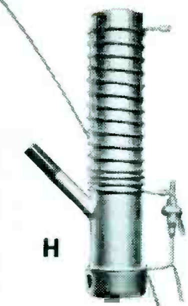
(I) H-2-P Purifying Diffusion Pump. Over 50 liters/sec in 10^{-3} mm. to 10^{-6} mm. range. Operates against forepressures as high as 0.300 mm. Blank-off 2 x 10^{-7} mm. Hg. For exhausting cathode ray tubes and magnetrons, and aluminizing operations on automatic equipment.

(J) Vacuum Seals. For introducing motion, power, gases, or connecting gauges.

(K) Standard Vacuum Furnace. A versatile packaged unit for many metallurgical operations under high vacuum or inert atmospheres. Temperatures to 2000° C. Useful for degassing tube parts, production of germanium crystals, research and production of improved metals for tube parts, as well as general high vacuum metallurgical research work.

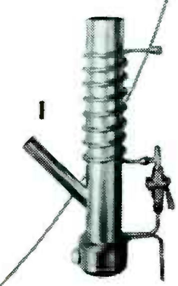
G

H



SOURCE!

I



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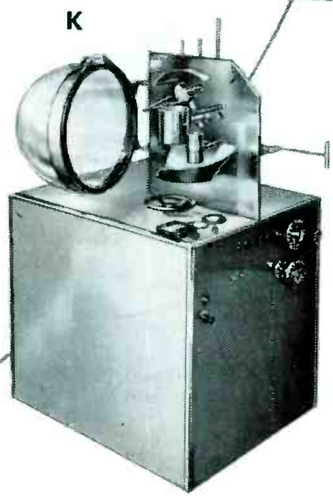

L

with a COMPLETE LINE *of* HIGH VACUUM EQUIPMENT *for the* ELECTRONIC INDUSTRY

You may be using one or two of our products without realizing that at this one source you have available such a full line of high vacuum equipment.

You will find a unique quality in most of these products. They were created to "ideal" specifications drawn up by *manufacturers* who, in many cases, never dreamed we could fulfill their exacting requirements. The products are meeting these requirements day after day on production lines.

Let us supply all your high vacuum equipment needs. You will gain the benefits of a single source of supply plus the high standards of performance designed into National Research products. Write us for further details. National Research Corporation, Memorial Drive, Cambridge, Mass.

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PROCESS DEVELOPMENT
HIGH VACUUM ENGINEERING
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DEHYDRATION
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APPLIED PHYSICS

National Research Corporation

Seventy Memorial Drive, Cambridge, Massachusetts

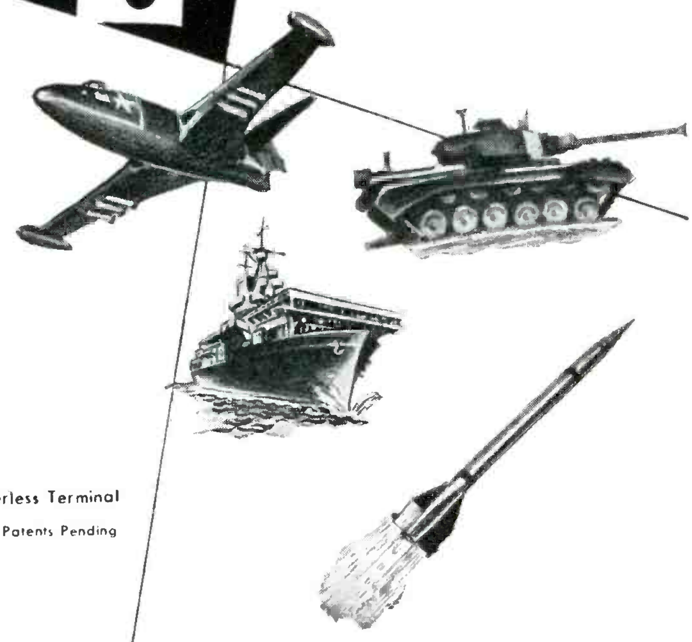
(L) Narcoil Diffusion Pump Fluids. Three different oils fulfilling industrial and scientific workers' requirements.

● **Tube Dollies.** Special NRC manifolds, dollies, and vacuum systems designed and built for electronic industry to increase production and lower costs.

*Reg. U. S. Pat. Off.

you can be sure if it's AMP

Wire termination in military equipment can be just as important as each mission, each flight or each engagement. Successful operation depends on the proper function of every part. That's why AMP solderless terminals and precision installation tools are specified and approved for all critical installations. Write for new TECHNICAL DATA CATALOG and approval lists.



AMP PRE-INSULATED DIAMOND GRIP*
Solderless Terminal
U.S. Patent Nos. 2,410,321, 2,379,567; 2,405,111, 2,468,169, other U.S. Patents Pending

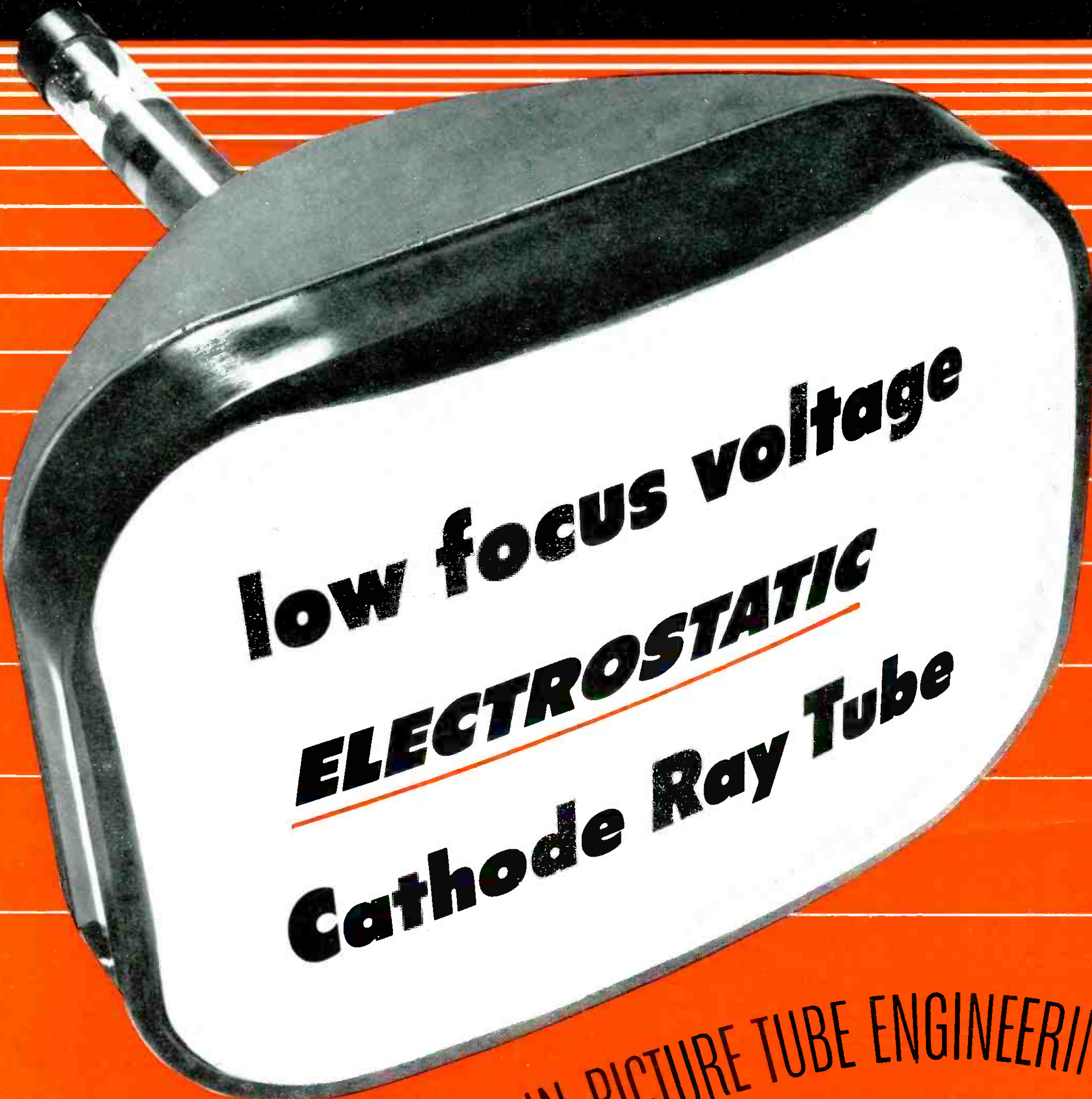
AMP SOLISTRAND* Solderless Terminal
U.S. Patent No. 2,535,013; other U.S. Patents Pending

*Trade-Mark
AMP Trade-Mark Reg. U.S. Pat. Off.

AMP

AIRCRAFT-MARINE PRODUCTS INC.
2100 Paxton Street, Harrisburg 10, Pa.

TUNG-SOL®



AN IMPORTANT ADVANCEMENT IN PICTURE TUBE ENGINEERING

see other side for additional information.

TUNG-SOL

low focus voltage
ELECTROSTATIC
Cathode Ray Tube

NEW PICTURE QUALITY MANUFACTURING ECONOMY SERVICE CONVENIENCE

New quality of TV picture reception, plus economies in both set manufacture and service are provided by the TUNG-SOL Low Focus Voltage Electrostatic Cathode Ray Tube.

Picture detail is improved by the overall accuracy and complete stability of the focus, even under a wide range of line voltage.

Critical materials are conserved by the elimination of focusing coils and magnets—a feature which contributes materially to simplification of service work.

The new TUNG-SOL Tube may be used without alteration in existing chassis design and without additional receiving tubes. Ample focusing voltage is provided by the normal power supply in the receiver.

Engineering and manufacturing procedures conform to those high standards of quality and service for which the TUNG-SOL organization is noted.

These Quality Features of All Tung-Sol Picture Tubes mean *Better TV Receiver Operation*

1—Low resistance of outside conductive coating minimizes radiation of horizontal oscillator sweep frequency.

2—Double cathode tab provides double protection against failure in the cathode circuit.

3—Rigid control of internal conductive coating materially improves service reliability.

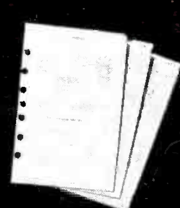
4—Fortified screen composition resists burning (X pattern).

5—Glass bead type assembly is stronger, both mechanically and electrically—gives greater protection against leakages and arcing.

6—Can be used with single or double field ion trap designs.

TUNG-SOL
ELECTRON TUBES

The TUNG-SOL engineering which has produced the Low Focus Voltage Electrostatic Cathode Ray Tube is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about these and other types is available on request to TUNG-SOL Commercial Engineering Department.



TUNG-SOL ELECTRIC INC., NEWARK 4, NEW JERSEY

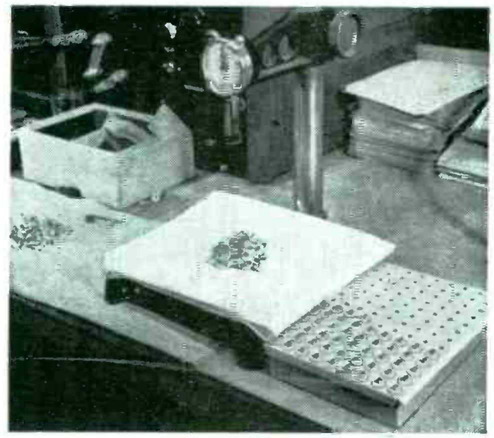
SALES OFFICES: ATLANTA • CHICAGO • DALLAS • DENVER • DETROIT • LOS ANGELES • NEWARK

TELEVISION TUBES • RADIO TUBES • DIAL LAMPS • ALSO ALL-GLASS SEALED BEAM LAMPS AND SIGNAL FLASHERS

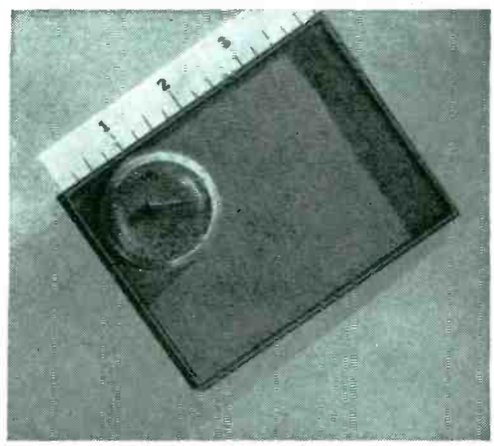
DECEMBER, 1951

Disc Cathode Speeds Assembly-Improves Performance

Expanded Facilities . . . more space, equipment and trained co-workers help to meet growing demand.



Inspection and Gaging . . . equipment for checking "E" dimensions of Disc Cathodes.



52,600 Seamless Nickel Cathodes, compared under a lens with an ordinary pin.

● Electronics manufacturers find it pays to be a customer of Superior. They receive good service, quality products and the benefits of Superior's methods and metals research that constantly improves upon already good products.

An example is the new, improved Disc Cathode. Investigation proved that a slight flaring of the open end minimized the danger of heater cathode "shorts" caused by scraping of the heater wire coating during insertion, while speeding the operation.

This feature added to an already excellent cathode, resulted in a part that does a better job at a lower cost.

The Disc Cathode is only one of the hundreds of products which Superior supplies . . . but the same program of product improvement is applied to all of them. That's why most manufacturers in the electronics field are already friends and customers. If you are one of the exceptions, it will pay you to find out more about Superior and Superior products. For information, consultation about production problems, design help or research assistance, write today to Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.

Which Is The Better For Your Application . . .

SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010" to .121" O.D. inclusive, with wall thicknesses of .0015" to .005". Cathodes with larger diameters and heavier walls will be produced to customer specification.

Or LOCKSEAM* . . . ? Produced directly from thin nickel alloy strip stock, .040" to .100" O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

Superior

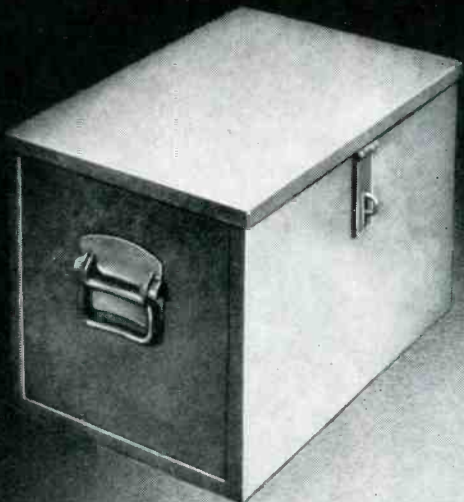
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.

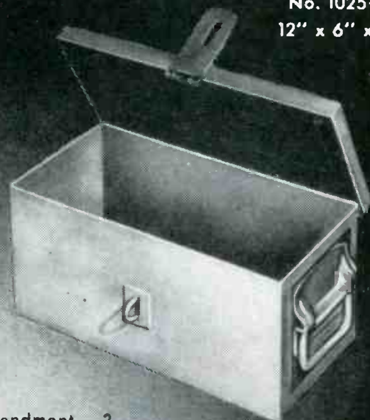
Certain analyses (.035" max wall, up to 1⅛" O.D.

**Mfd. under U.S. Pats.—Superior Tube Company • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800*

SPARE PARTS BOXES



No. 1025—6
18" x 9" x 9"



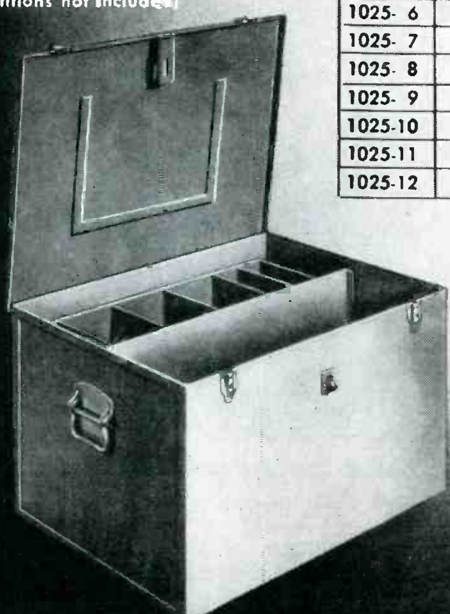
No. 1025—1
12" x 6" x 6"

24 STOCK SIZES

Made to Army-Navy specifications — Jan-B-233, amendment — 2 — Mar. 10, 1950, Army No. 65-15. Navy No. 42B9C, Army green, Navy grey. Immediate Delivery.

Number	Length	Width	Height	Number	Length	Width	Height
1025- 1	12	6	6	1025-13	18	18	12
1025- 2	12	9	6	1025-14	30	15	12
1025- 3	12	12	6	1025-15	24	15	12
1025- 4	12	9	9	1025-16	24	15	15
1025- 5	18	9	6	1025-17	24	18	12
1025- 6	18	9	9	1025-18	24	18	15
1025- 7	18	12	9	1025-19	24	18	18
1025- 8	18	6	6	1025-20	24	12	9
1025- 9	18	15	9	1025-21	42	9	9
1025-10	18	12	6	1025-22	36	12	9
1025-11	18	15	12	1025-23	30	15	9
1025-12	18	12	12	1025-24	42	12	9

No. 1025—14
30" x 15" x 12"
(Partitions not included)



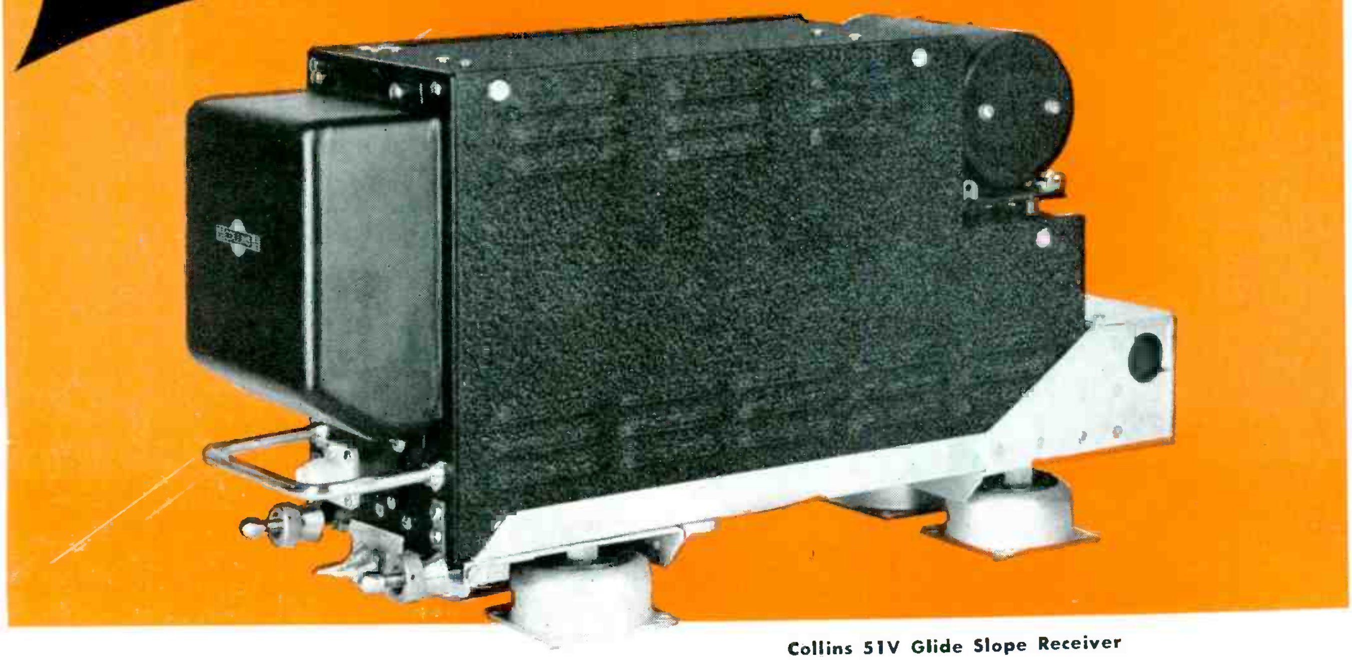
manufacturers of
the famous
**Cole steel
office equipment**

COLE STEEL EQUIPMENT CO.

285 MADISON AVE., NEW YORK 17, N. Y.

FACTORY: YORK, PA.

NOW in Production



Collins 51V Glide Slope Receiver

The design of the Collins 51V-1 receiver, now on the assembly line, is based on "Glide Slope Receiver Characteristics" issued by Aeronautical Radio, Inc.

This receiver, together with the Collins 51R navigation equipment, will fulfill ILS receiving requirements for commercial and private as well as military aircraft.

The 51V is designed for reception of 90/150 cps tone modulated glide slope signals on all ten present and ten planned channels in the UHF range of 329-335 megacycles. It utilizes crystals identical with those employed in R-89B receivers and is electrically and mechanically interchangeable with modified ten channel R-89B's, greatly simplifying installation in present aircraft.

The 51V receiver control circuits are integrated with the standardized R/theta channeling system, with channel selection provided by a Collins type 314U remote control unit.

Choice may be had of a dynamotor for 12 or 24 volt d-c operation or an a-c power unit for operation from 115 volt 400 cycle supply.

If you are not thoroughly acquainted with this new glide slope receiver from previous contact or correspondence, write us for the 51V illustrated descriptive bulletin.

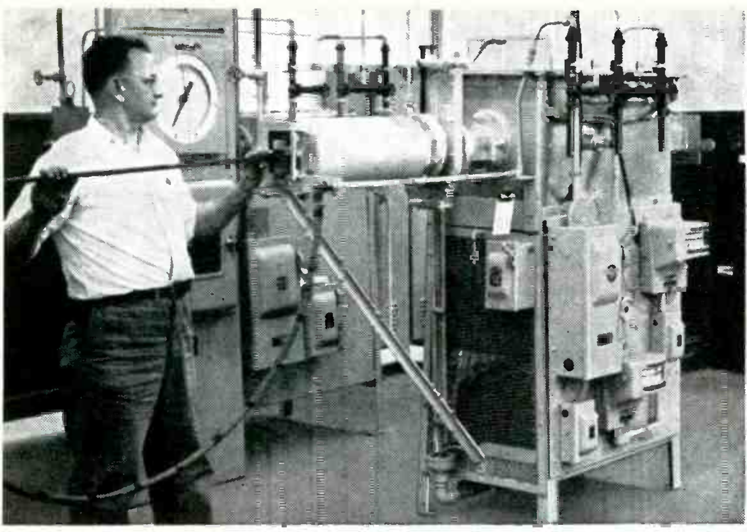
FOR PROGRESS IN INSTRUMENT LANDING SYSTEMS, IT'S . . . COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

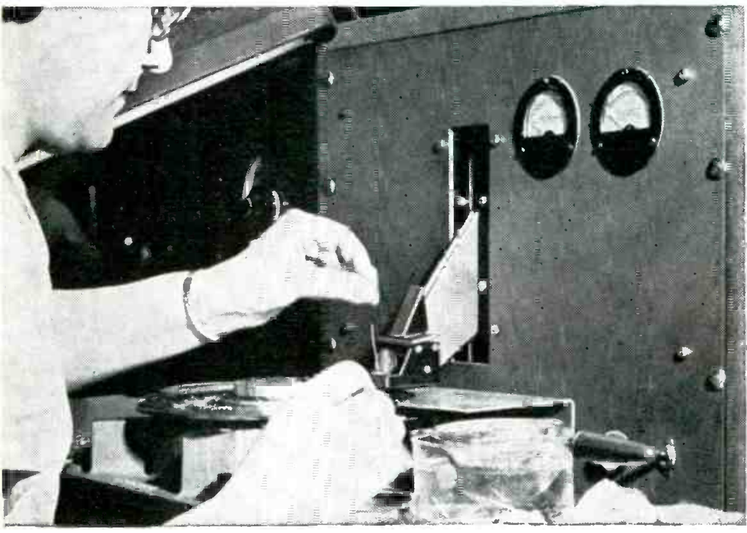
11 W. 42nd St., NEW YORK 18 | 1937 Irving Blvd., DALLAS 2 | 2700 W. Olive Ave., BURBANK

NEW GENERAL ELECTRIC PLANT PRODUCES RECORD VOLUME OF

WELDED GERMANIUM DIODES



1. MAXIMUM METAL PURITY is essential in the manufacture of diodes. In photograph above dioxide powder is being reduced to pure germanium metal.



2. GERMANIUM PELLETS are mounted to pin assemblies prior to assembly in cases. Precision centering as well as speed are essential to produce these quality units at low cost.

3. FORMING, SHEARING, AND WELDING WHISKERS on diode pin assembly calls for careful manipulation under microscope for accurately formed .003 inch diam. whisker.

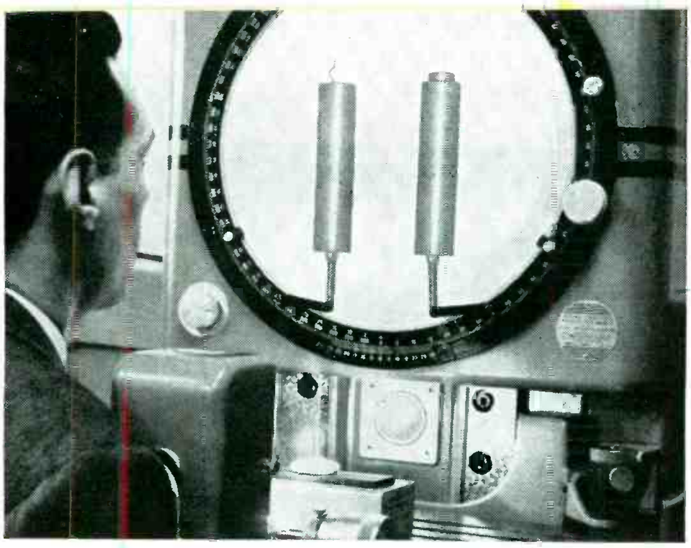
NEW METHODS OF MASS PRODUCTION in G. E.'s germanium products plant* at Clyde, New York are booming diode output to the highest peak in the industry's history. An offspring of the mother plant at Electronics Park, this factory is equipped to produce 12 million diodes a year. Television receivers, computers, communication systems and military requirements present an ever-increasing demand for these minute but vital components.

WITH EXPANDED LABORATORY FACILITIES for the development of new germanium and other semi-conductor items, G. E. is prepared to suggest electronic solutions to your design and manufacturing problems—solutions that may well save you money and improve your product.

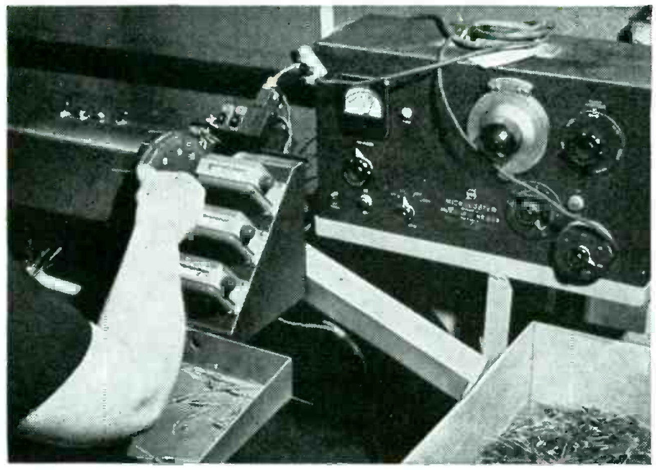
Would you like more information on this? Ask us to call. *General Electric Co., Electronics Park, Syracuse, N. Y.*

*Which you are invited to inspect when in the Syracuse area. Meanwhile, let us send you additional information and specifications on G-E diode products. Write for bulletin #X57-01A.

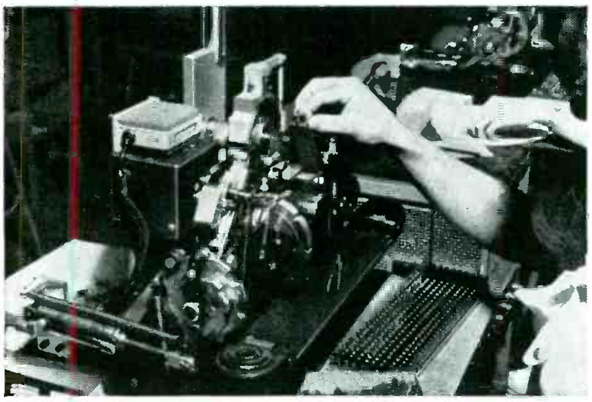
4. ORDERLY BANK OF WHISKER MACHINES is typical of modern production facilities in the new G-E plant. Quantities up to 12 million units a year can be produced here.



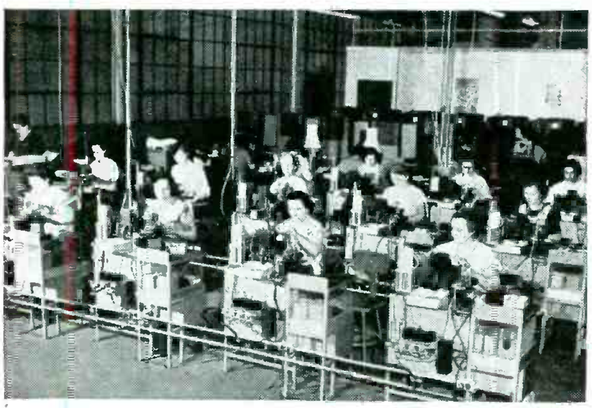
5. CONTOUR PROJECTION of diode parts for microscopic inspection. Pellet and whisker (on screen) must follow rigid specifications. This is typical of quality control processes.



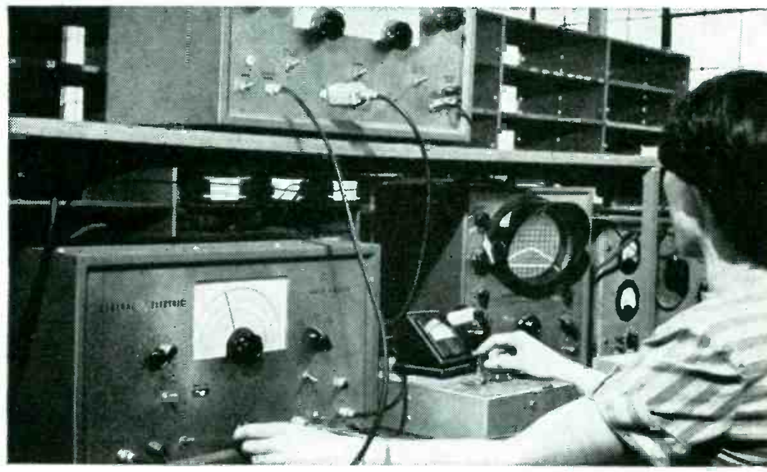
8. AUTOMATIC TEST SEPARATION of diodes by types eliminates costly hand sorting of thousands of units per hour. Every G-E diode is tested many times.



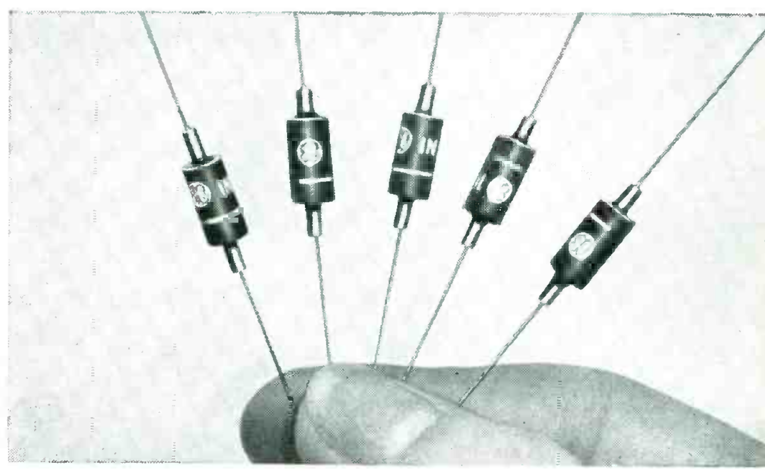
6. FINAL ASSEMBLY of whisker and pellet pins in plastic cases requires special machines designed by G-E engineers for speed and accuracy.



7. ASSEMBLY MACHINES turn out diodes of 12 different varieties. This process represents unusual advancement over former "hand-made" methods.



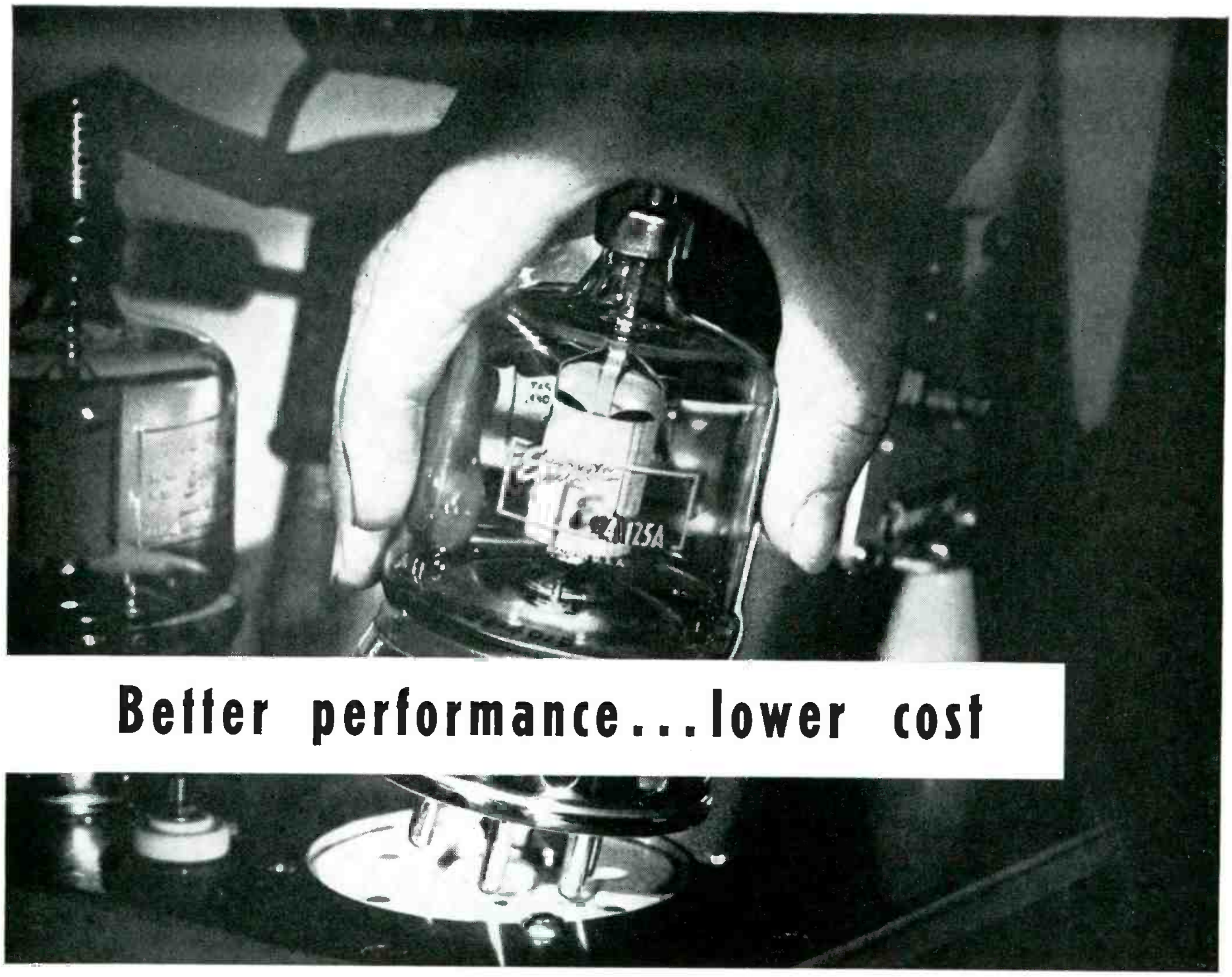
9. HIGH-FREQUENCY TESTING of diodes for television applications has proved successful in supplying over 2 million G-E units to television manufacturers for high efficiency needs.



10. FINISHED G-E DIODES of various types are small, rugged, efficient, and low in cost. These components can replace some categories of vacuum tubes.

You can put your confidence in—

GENERAL ELECTRIC



Better performance...lower cost

Transmitter performance goes up—costs go down . . . the inevitable result of specifying Eimac tetrodes to fill key sockets. Costs will stay down because the service life of these time-proved tubes is long, replacement costs are low, and the circuit simplicity they allow keeps power bills down.

Eimac tetrodes are made for a wide range of power from 65 watts plate dissipation to 20,000 watts dissipation. They are unexcelled for amplifier, oscillator, and modulator service. All are backed by the experience and know-how of America's foremost transmitting tube manufacturer.

Take the advice of countless users and equipment manufacturers who consistently not only recommend but rely on . . . Eimac tetrodes for unvarying performance, exceptional service life, and compatibility to modern circuit techniques.

Write For The Free Eimac Quick Reference Tube Catalog

Follow the Leaders to Eimac TUBES The Power for R-F

302

EITEL-McCULLOUGH, INC.
San Bruno, California

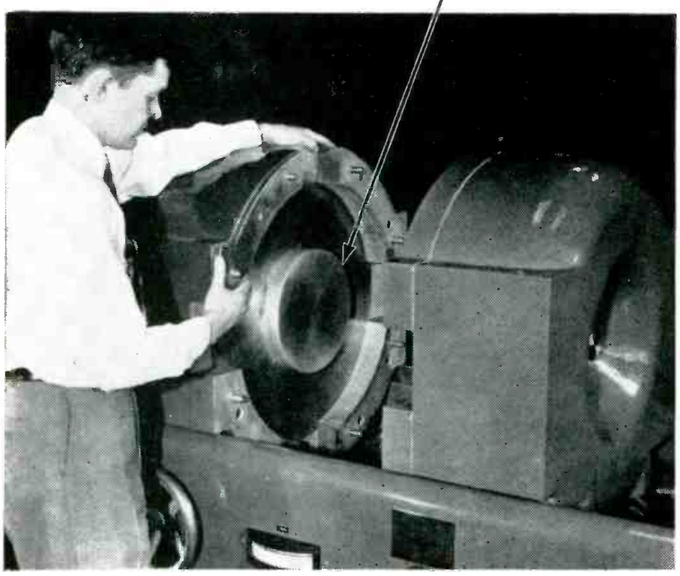
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

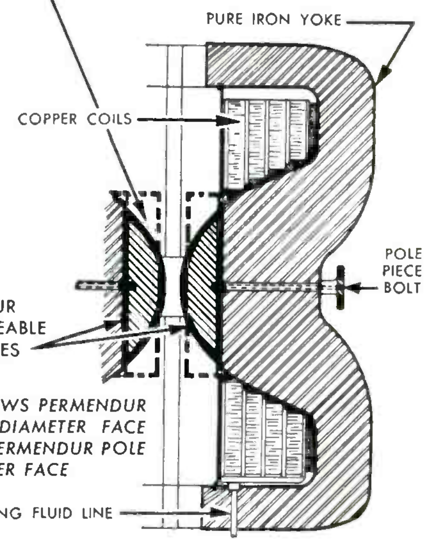
PERMENDUR*

gives you

- ☆ **High Magnetic Saturation**
- ☆ **High Permeability at very high Flux Densities**
- ☆ **High Value of Positive Magnetostriction**
- ☆ **Design Possibilities for Savings in Weight, Space and Materials**

Typical use of Permendur in the ADL ELECTROMAGNET
(ARTHUR D. LITTLE, Inc.)





Sectional Detail of Yoke Half

Permendur is available in Forgings, Castings, Hot-Rolled Bars and Plates to meet your design needs for form or shape. *Write for information*

*Manufactured under license arrangements with Western Electric Co.

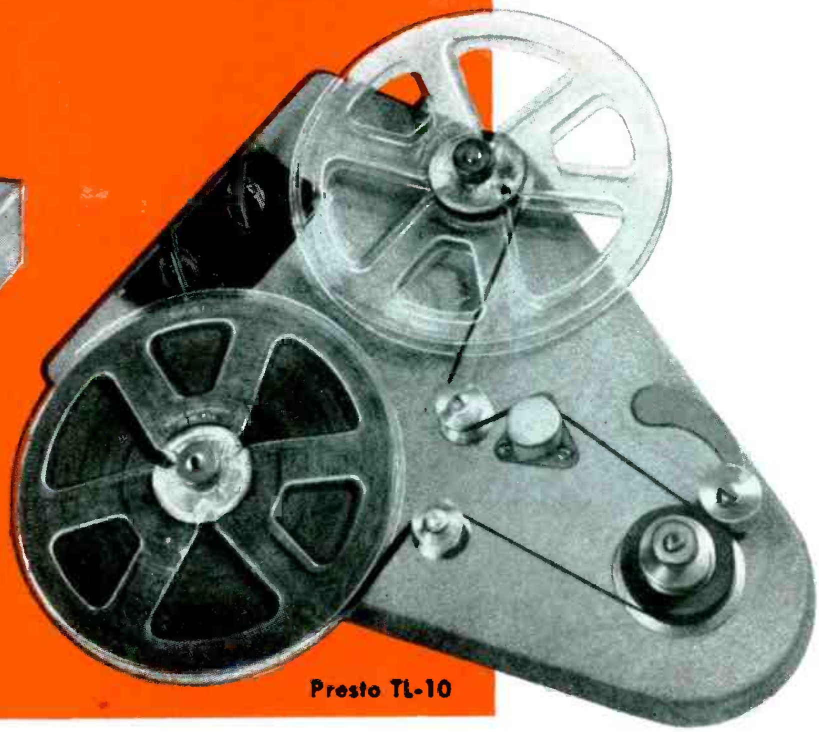
W&D 3929

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

it's red hot!



Presto TL-10

hundreds of PRESTO

Turntable Tape Reproducers sold in the past six months!

Since its introduction last spring, sales of the new PRESTO TL-10 have surpassed even our expectations. The reason . . . it's an *inexpensive instrument that fills a definite need* in the nation's stations and recording studios. Look at the advantages listed below—then join the ranks of the hundreds of satisfied TL-10 users by calling your PRESTO dealer today.

- **Reproduces tape quickly and efficiently— without tying up a regular tape recorder.**
- **Easy to attach and remove from any standard 16″ turntable.**
- **No motor—turntable acts as motor.**
- **Can be plugged into any standard speech input equipment.**
- **Speeds of 7½″ and 15″ per second, response up to 15,000 cps.**
- **Easy to operate and maintain.**
- **Costs only $140.00 complete, but has reproduction quality and fidelity of a high priced machine.**

The TL-10 is an exclusive PRESTO product—made by the world's largest manufacturer of recording equipment and discs.

PRESTO RECORDING CORPORATION
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.

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WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

Watch Master

Frequency Standards

GUARANTEED ACCURACY 1 part in 100,000 (.001%)

Type 212

TERMINATION
Front and Rear

CONSTRUCTION
Standard 8¾" x 19" Panel

HOUSING
8¾" x 19" x 8" Metal Cabinet

WEIGHT
25 pounds

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 212

Name......................................

Company......................................

Address......................................

City........................State........................

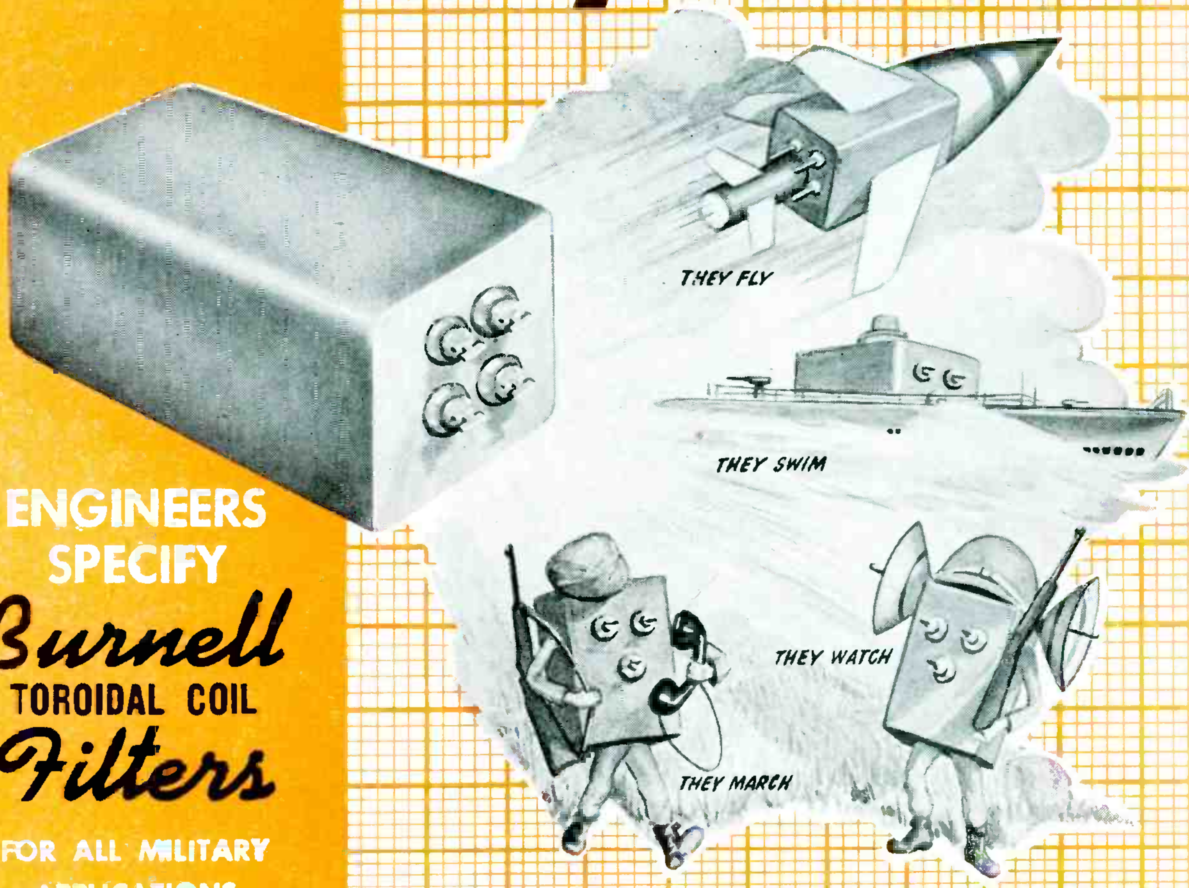
product of

AMERICAN TIME PRODUCTS INC.

580 Fifth Avenue New York 19, N. Y.

Operating under patents of the Western Electric Company

It's No Top Secret



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FOR ALL MILITARY APPLICATIONS

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THE VARIED AND OFTEN UNUSUAL APPLICATIONS THAT HAVE BEEN FOUND FOR TOROIDS AND FILTERS IN MILITARY ELECTRONICS HAVE KEPT OUR ENGINEERING STAFF CONSTANTLY ON ITS TOES. EVERY DAY WE ARE CONFRONTED WITH THE TECHNICAL PROBLEMS OF OUR CUSTOMERS WHO ARE TRYING TO MEET THE DEMAND FOR SMALLER, LIGHTER AND MORE SERVICEABLE EQUIPMENT. FORTUNATELY OUR INGENUITY AND EXPERIENCE HAS SERVED US IN GOOD STEAD IN THE DEVELOPMENT OF FILTERS TO MEET THESE DEMANDS. CONSEQUENTLY IT IS WITH MORE THAN A LITTLE PRIDE THAT WE SEE OUR PRODUCTS SPECIFIED BY MORE AND MORE ENGINEERS WHO CANNOT BUT REALIZE THAT IN THE DESIGN OF QUALITY EQUIPMENT THE "BILL OF MATERIALS" SHOULD INCLUDE BURNELL PRODUCTS.

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EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

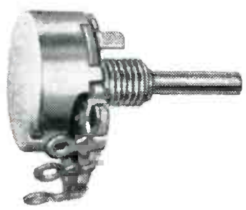
3 New Resistors

−55°C to +150°C

Complete aridity to saturation . . . An *un-precedented* temperature and humidity range

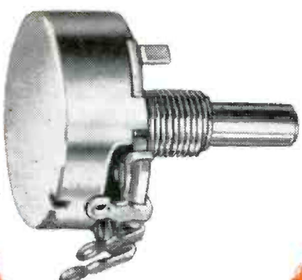
FOR MILITARY APPLICATIONS

Highly recommended for use in jet and other planes, guided missiles, tanks, ships and submarines, portable or mobile equipment and all other military communications. Manufactured from specially developed materials, these absolutely unique variable resistors are now available in a *complete range of sizes*. (See chart at bottom of page.)

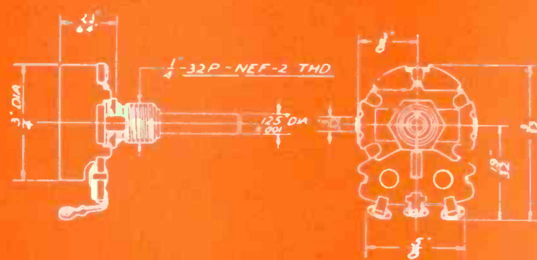


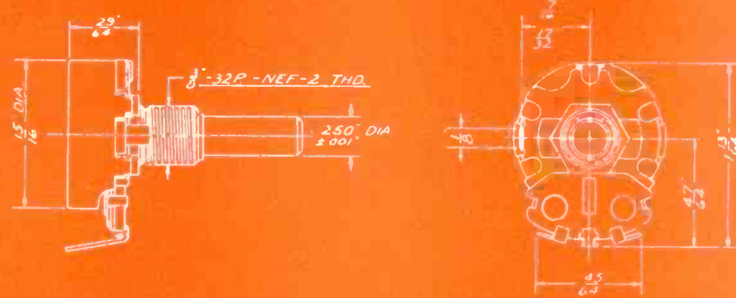
Type 65

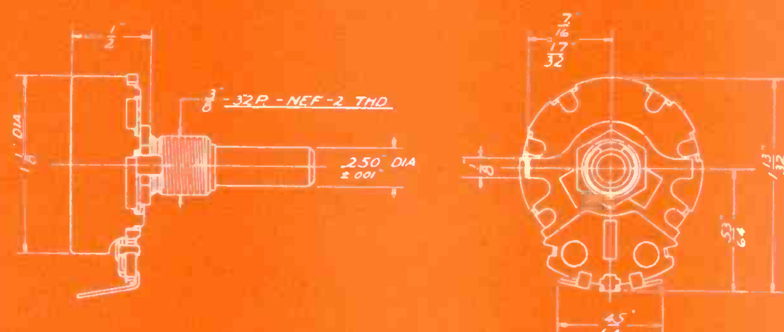
Type 90



Type 95







+150°C to −55°C

DIAMETER	TYPE 95 1⅛"	TYPE 90 15/16"	TYPE 65 (miniaturized) ¾"
Wattage and Voltage Rating	2 watts @ 70°C with 500 V max. across end terminals	1 watt @ 70°C with 500 V max. across end terminals	½ watt @ 70°C with 350 V max. across end terminals

Specialists in Precision Mass Production of Variable Resistors


Meets Military Specifications
JAN-R-94, Type RV-3A
CTS Type 35, 1 1/8" Diameter
Composition
JAN-R-94, Type RV-2B
CTS Type GC 45 with Switch
Composition
JAN-R-94, Type RV-3B
CTS Type GC 35 with Switch
Composition
JAN-R-94, Type RV-2A
CTS Type 45, 15/16" Diameter
Composition
JAN Type RV-4B
CTS Type FGC 95 with Switch
Composition
JAN Type RV-4A
CTS Type 95, 1 1/8" Diameter
Composition
MEETS ALL
JAN-R-19 SPECIFICATIONS
JAN Type FA 20A
2 Watt (CTS Type 252
JAN Type RA 20B
2 Watt (CTS Type GC-252)
JAN Type RA 25A or 30A
3 or 4 Watt (CTS Type 25)
JAN Type RA 25B or 30B
3 or 4 Watt (CTS Type GC 25)
EXCEPTIONALLY GOOD DELIVERY CYCLE on military orders due to enormous mass production facilities . . . Please give complete details on your requirements when writing or phoning for further information.
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NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strowger" type mounting.

COIL POWER: From 40 milliwatts to 7 watts D.C.

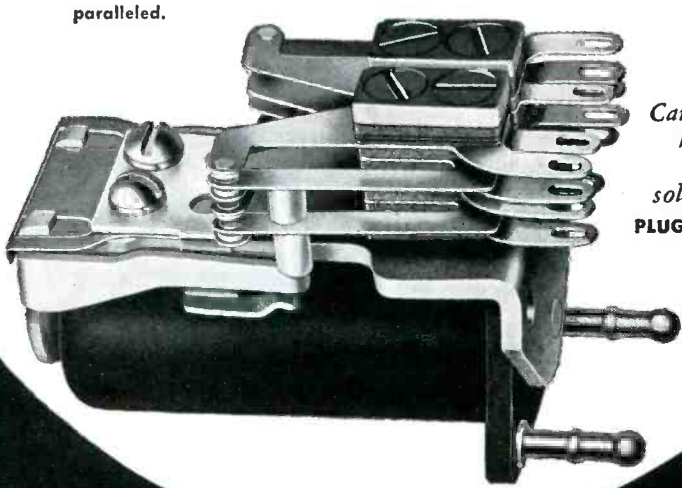
CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 ampere contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS:

$1\frac{5}{8}$" HIGH, $2\frac{7}{32}$" LONG, $1\frac{3}{32}$" WIDE

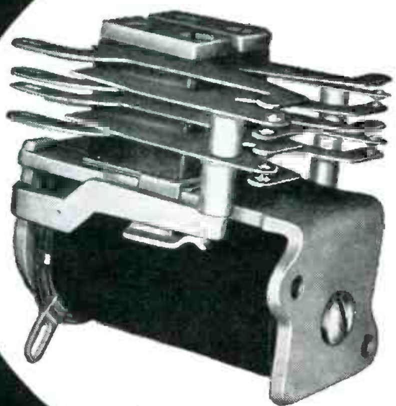
These are the dimensions for the 6 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.



Can be furnished hermetically sealed with solder terminals.

PLUG-IN MOUNTING-SPECIAL.



SK RELAY

MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliwatts to 4.5 watts D.C.

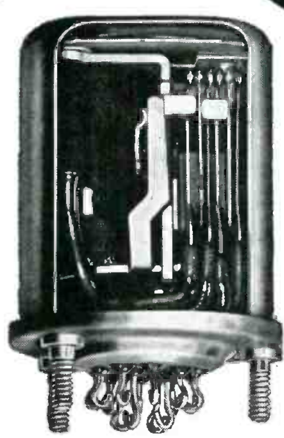
CONTACTS: Same as "LK".

DIMENSIONS: $1\frac{1}{2}$" HIGH, $1\frac{9}{16}$" LONG, $3\frac{1}{32}$" WIDE.

These are the dimensions for the 4 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS. PLUG-IN—SPECIAL.

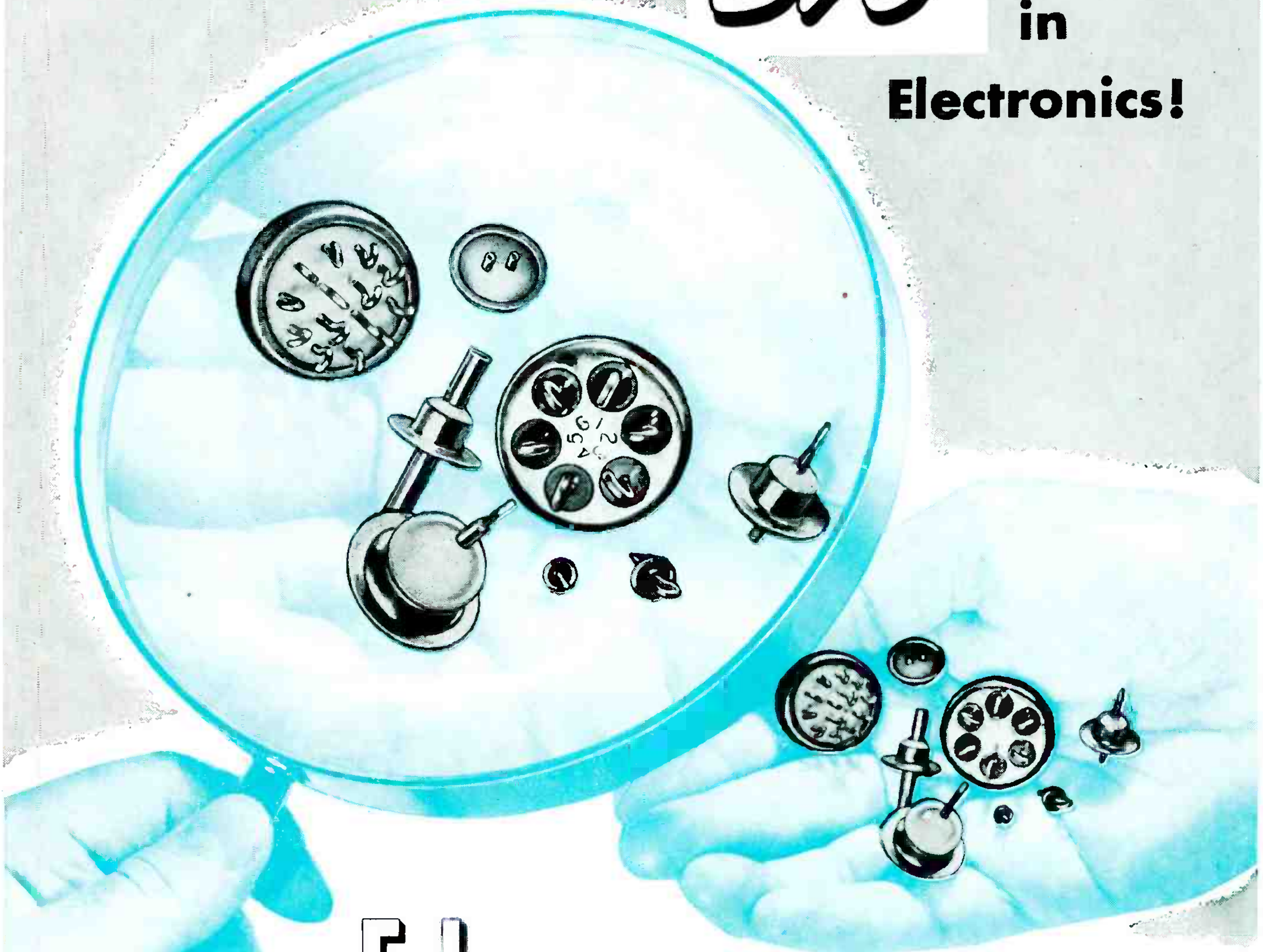


SK, HERMETICALLY SEALED

AL-132

ALLIED CONTROL CO. INC. 2 EAST END AVE., NEW YORK 21, N. Y.

SMALL PARTS
—figuring *BIG* in Electronics!



E-I *Hermetically Sealed*
MULTIPLE HEADERS and SEALED LEADS

COMPLETELY ILLUSTRATED

LITERATURE

AVAILABLE NOW!

Detailed data or standard designs is contained in new literature just off the press. Engineering assistance on special problems is also available without obligation. Please address requests on company letterhead.

Hermetically sealed multiple headers and leads are vital parts of countless electronic and electrical assemblies. E-I offers these important components in over 100 different standard types with a variety of optional features. Thus, E-I offers a quick, economical solution to most terminal problems. **For specialized applications,** E-I engineers can design and produce multiple headers and sealed leads to meet your requirements at a practical cost. If your problem involves the hermetic sealing of terminals and leads, consult us today!

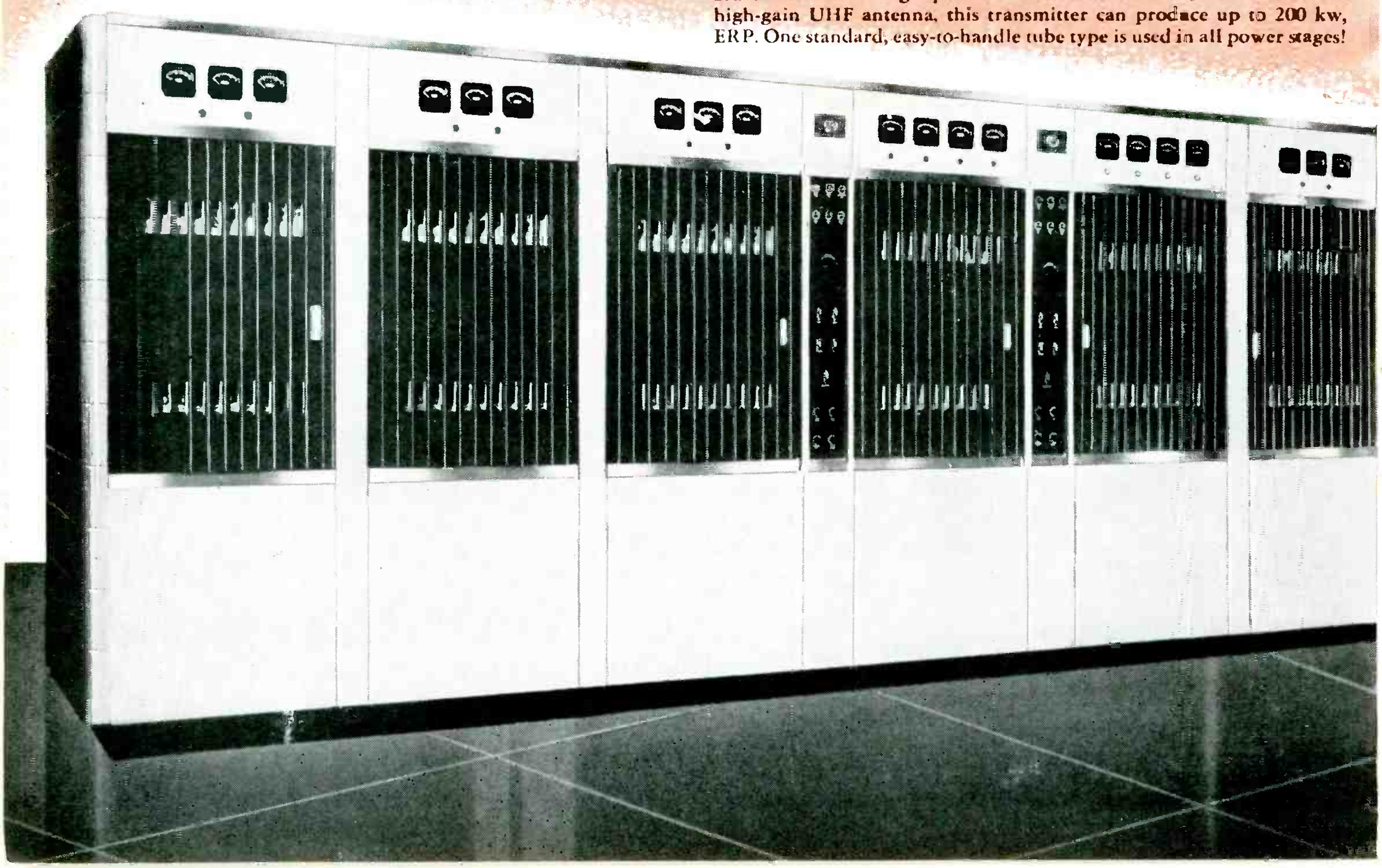
ELECTRICAL INDUSTRIES • INC.

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

MANUFACTURERS OF SPECIALIZED ELECTRONIC PRODUCTS AND EQUIPMENT

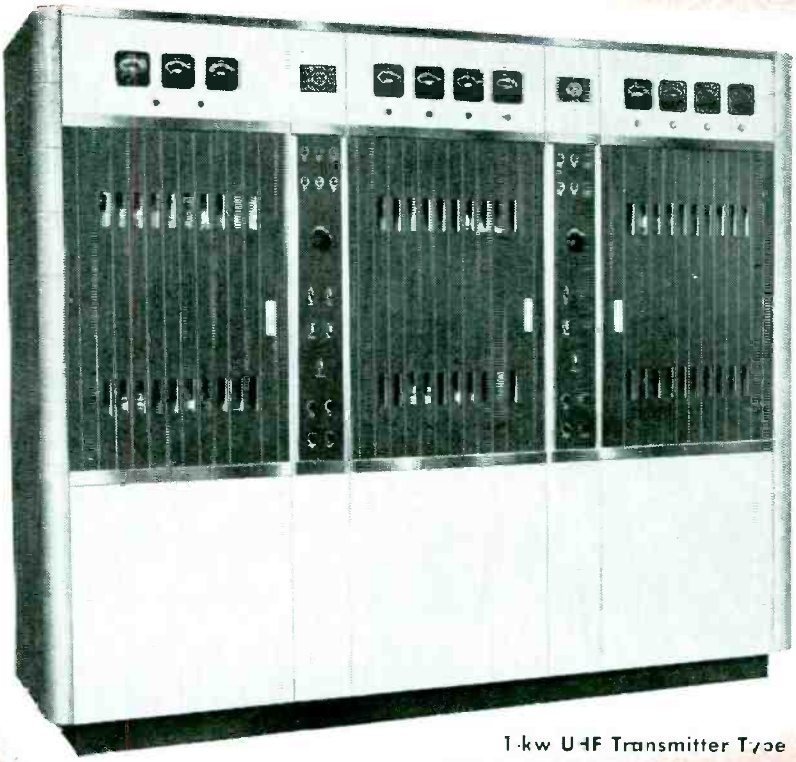
For UHF ...go RCA*

Any power to 200 kw*....



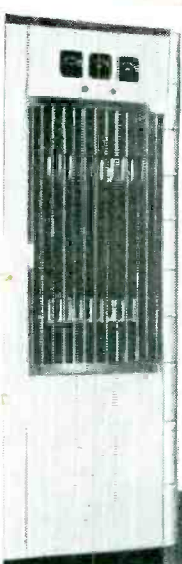
10-kw UHF Transmitter Type TTU-10A

RCA's answer to high power on channels 14 to 83. With an RCA high-gain UHF antenna, this transmitter can produce up to 200 kw, ERP. One standard, easy-to-handle tube type is used in all power stages!



1-kw UHF Transmitter Type TTU-1B

This transmitter, and a high-gain RCA UHF antenna, can produce up to 20 kw ERP on channels 14 to 83. Type TTU-1B is all air-cooled.



RCA's new 1-kw and 10-kw UHF transmitters (and RCA's high-gain UHF antennas) will give you power combinations up to 200 kw . . . on any TV channel!

If you are planning high power UHF, RCA's new 10-kw transmitter is the answer. If you are planning to start with low power UHF, then RCA's new 1-kw transmitter will meet your needs (increase power later simply by adding matching amplifier units).

Be sure your station planning is correct from the start . . . before you invest a single dollar. Your RCA Broadcast Sales Specialist will show you exactly what equipment you'll need to get on the air at lowest cost.

Available only from your RCA Broadcast Sales Specialist

A 64-page book on RCA's new line of TV broadcast equipment for all channels, 2 to 83! An indispensable reference for station planning.

Call or write the RCA field office nearest you

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Telephone: Delaware 7-0700

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Telephone: District 1260

Hollywood 28, Calif.
1560 N. Vine Street
Telephone: Hollywood 9-2154

Dallas 1, Texas
1907-11 McKinney Ave.
Telephone: R-1371, 1372, 1373

Cleveland 15, Ohio
718 Keith Building
Telephone: Cherry 1-3450

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522-533 Forsyth Bldg.
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221 W. 18th Street
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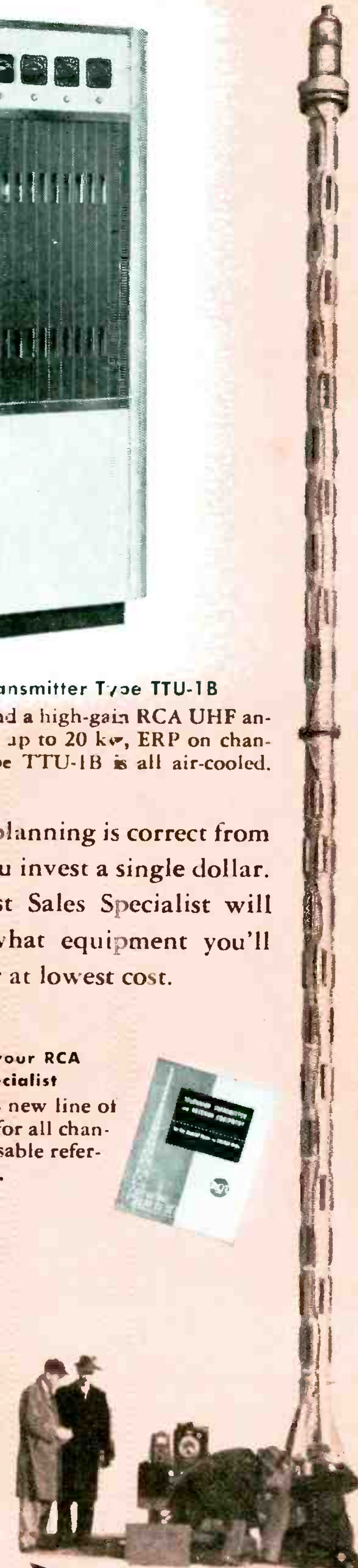
36 W. 49th Street
Telephone: Circle 6-4030

San Francisco 3, Calif.
1355 Market Street
Telephone: Hemlock 1-8300



New High-Gain Antenna for UHF

The most economical way known to produce high effective radiated power for UHF—and more kilowatts per dollar. Excellent "close-in" coverage in all directions. Power gain, 24 to 28, depending on channel.

*Effective Radiated Power

RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT CAMDEN, N.J.

Shown here are 9 good reasons why it pays to standardize on Cornell-Dubilier tubular capacitors, right down the line. Write today for engineering bulletins on the types in which you are most interested. Dept. K-121, Cornell-Dubilier Electric Corp., South Plainfield, N. J.

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CORNELL-DUBILIER CAPACITORS

1910-1951

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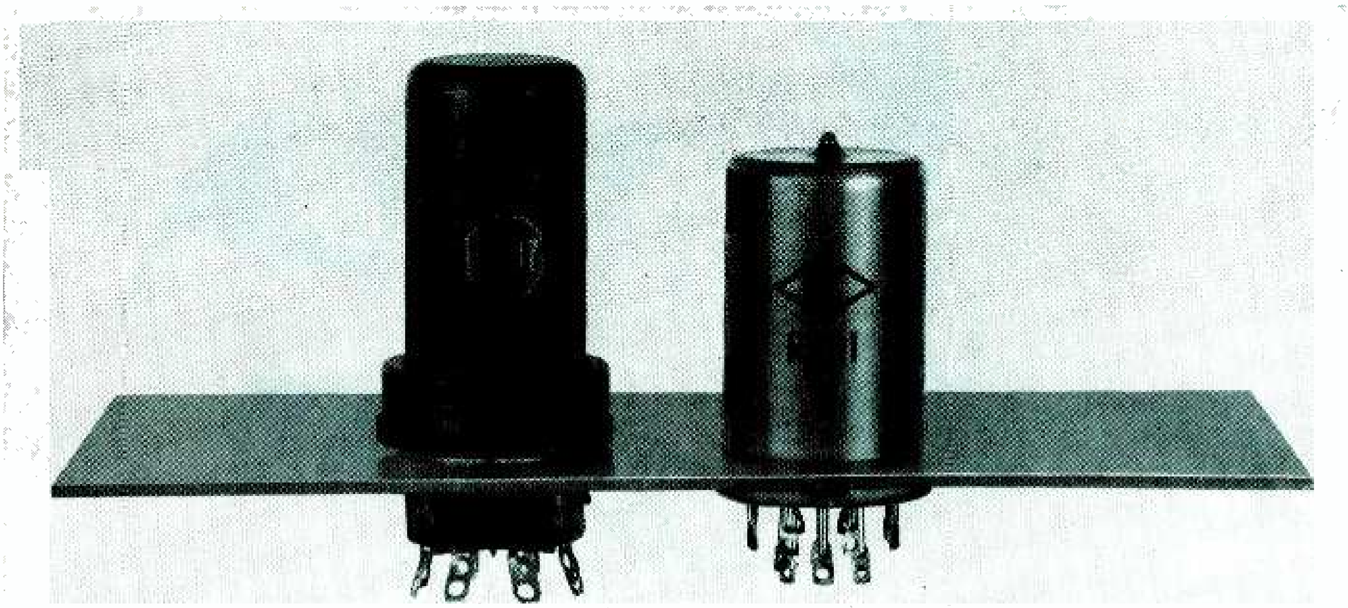
PLANTS IN SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER, AND CAMBRIDGE, MASS.; PROVIDENCE, R. I.; INDIANAPOLIS, IND.; FUQUAY SPRINGS, N. C.; AND SUBSIDIARY, THE RADIART CORP., CLEVELAND, OHIO



New "Diamond H" Relay Mounted
Beside Standard 6SJ7 Tube

Newly Designed "Diamond H" Miniature AIRCRAFT TYPE RELAY with 50 "G" Operational Shock Resistance

PERFORMANCE NEVER BEFORE ATTAINED...

- ★ In Operating Shock Resistance
- ★ In Mechanical Shock Resistance
- ★ In Temperature Range
- ★ In Transit Time
- ★ And Other Important Characteristics

An hermetically sealed, 4-pole double throw miniature relay, this newly designed unit meets the exacting requirements of such air, marine and ground devices as: GUIDED MISSILES, ROCKETS, SUPER-SONIC AND HIGH ALTITUDE AIRCRAFT, RADAR, GEOPHYSICAL, AND COMPUTER APPARATUS.

Designed to meet U.S.A.F. Specification MIL — R — 5757, it has applications wherever it is important to provide unfailing performance, miniaturization and light weight under conditions of high or low temperature, vibration and shock. Variations in basic specifications are available to meet a wide range of specific requirements.

H ®

WRITE TODAY FOR CERTIFIED TEST DATA ON THIS NEW RELAY.

The Hart Mfg. Co.
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Send me further information about your new relay.

Name ____________________

Title ____________________

Company ____________________

Street ____________________

City ____________________ *State* ____________________


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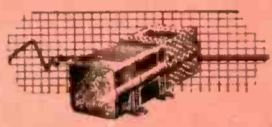
THE SOLA FAMILY OF

5 Voltage Regulator Types

MEETS MOST MILITARY and INDUSTRIAL REQUIREMENTS



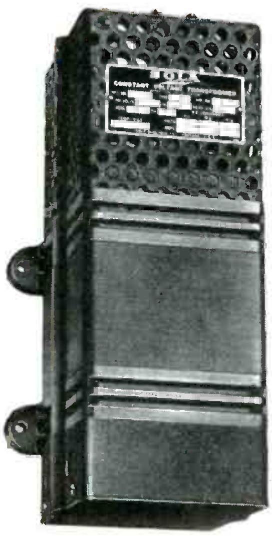
SOLA DISCIPLINES VOLTAGE

SOLA adjustable, harmonic filtered type CVL:

Regulation ±1%
Harmonic Distortion less than 3%
Output adjustable from 0-130 volts

SOLA standard type CV:

Regulation ±1%



SOLA television receiver type CVA:

Regulation ±3%
Plug-in accessory unit

SOLA plate and filament type CVE:

Regulation ±3%

SOLA harmonic filtered type CVH:

Regulation ±1%
Harmonic Distortion less than 3%

CHARACTERISTICS OF SOLA CONSTANT VOLTAGE TRANSFORMERS

- Static-magnetic regulation
- Ultra-fast response (1.5 cycles)
- No moving or renewable parts
- No manual adjustments
- Complete automatic, continuous regulation
- Self-protecting against short circuits
- Automatic current limiting action
- Choice of transformation ratios

We invite you to write regarding your voltage regulating problems, or for inclusion of your name on our technical mailing list.

SOLA *Constant Voltage* **TRANSFORMERS**

Made under one or more of the following patents: 2,143,745; 2,212,198; 2,346,621; 2,552,111; 2,489,245 and patents pending.

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

Manufactured under license by: ADVANCE COMPONENTS LTD., Walthamstow, E., England • M. C. B. & VERITABLE ALTER, Courbevoie (Seine), France ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia • UCOA RADIO S.A., Buenos Aires, Argentina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THE RECOGNIZED STANDARD OF PRODUCT EXCELLENCE WITH ELECTRICAL-ELECTRONICS INDUSTRIES
Fine quality Republic condenser foil, having uniform thickness, surface, and strength, is available in all commercial gauges and widths. Meticulous care is taken to assure close tolerances and clean straight edges free from slivers. Engineered packing insures safe delivery. Orders and inquiries for all types of foil will be given prompt and courteous attention.
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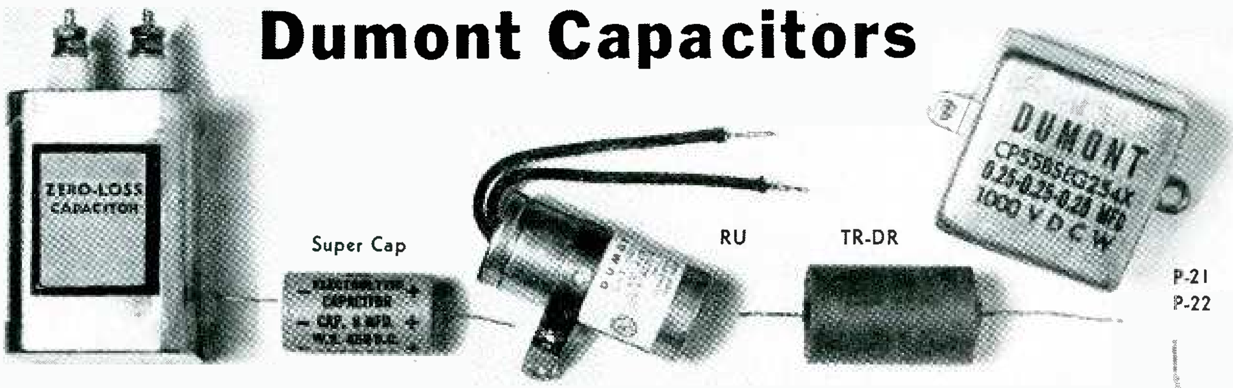
Quick-easy Selector Chart for Dumont Capacitors



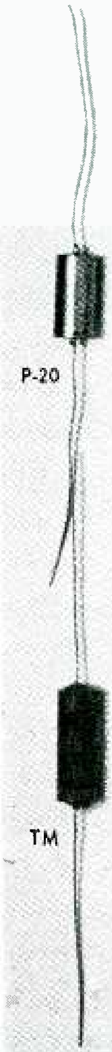
TS
DS
P70

Super Cap

RU

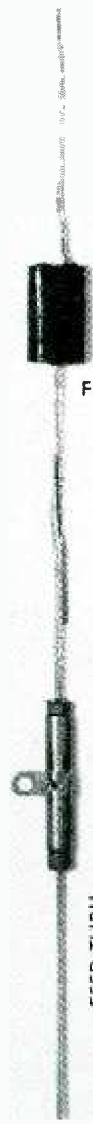
TR-DR

P-21
P-22



P-20

TM



FP-1

FEED THRU

DUMONT CAPACITOR ENGINEER SELECTOR CHART

Key	Model	VOLTAGE RANGE	CAP RANGE	DIELECTRIC	CASING	TEMP. RANGE	MAX. CAP. CHANGE	INS. RES. (Megs. x Mfds.)	P.F.	Group
	TR	200—40KV	.00005— 2MFD	Thermofilm	Bakelite or Ceramic	—65°C + 150°C	2%	10^8	.0001	a
	TS	200—40KV	.00005—10MFD	Thermofilm	Metal Can all types	—65°C + 150°C	2%	10^8	.0001	a
	TM	200— 5KV	.00005— 2MFD	Thermofilm	Molded plastic	—65°C + 150°C	2%	10^8	.0001	a
	DR	500—40K	.00005— 2MFD	Durene	Bakelite or Ceramic	—65°C + 70°C	2%	10^7	.0005	b
	DS	500—40K	.0005 —10MFD	Durene	Metal Cans all types	—65°C + 70°C	2%	10^7	.0005	b
& *	P6M	200—20KV	.001 — .5	Paper	Molded in bakelized tube	—40°C + 85°C	5%	2500meg—MFD	.005	c
& *	PB	200—20KV	.00025— 2.0	Paper	Molded in Bakelite	—40°C + 85°C	5%	2500meg—MFD	.005	c
& *	PC	200—20KV	.00025— 2.0	Paper	Molded in Ceramic	—40°C + 85°C	5%	3000meg—MFD	.005	c
& *	PBM	200—1000	.0001 — 2.0	Paper	Molded in Bakelite	—40°C + 85°C	5%	2000meg—MFD	.005	c
& *	PCM	200—1000	.0001 — 2.0	Paper	Molded in Ceramic	—40°C + 85°C	5%	2500meg—MFD	.005	c
	PCF	400— 600	.01 — .22	Paper	Ceramic	—40°C + 85°C	5%	2500meg—MFD	.005	d
	PCST	600—1000	.001 — .068	Paper	Ceramic	—40°C + 85°C	1%	3000meg—MFD	.005	d
& *	P-20	100—2000	.001 — 2MFD	Paper	Metal Tubular Can	—20°C + 100°C	5%	3000meg—MFD	.005	e
& # *	P-21	100—1500	.05 — 5MFD	Paper	Metal Bathtub with Silicone Rubber Seal	—40°C + 85°C	5%	2500meg—MFD	.005	e
& # *	P-22	100—1500	.05 — 5MFD	Paper	Metal Bathtub with Glass Seal	—40°C + 85°C	5%	3000meg—MFD	.005	e
& # *	P-70	600—6000	.05 —10MFD	Paper	Rectangular Metal Can	—40°C + 85°C	5%	3000meg—MFD	.005	e
&	FP1	200—600	.00005— 1MFD	Paper	Flat Miniature Paper wrapped	—50°C + 85°C	5%	2000meg—MFD	.005	f
& *	RP2	200—600	.00005— 2MFD	Paper	Round Miniature Cardboard Tube	—40°C + 85°C	5%	2000meg—MFD	.005	f
	SuperCap	6—450	4—1000		Metal or Paper Tubes					g
	DPF	100—400V	3 — 8MFD	Paper	Metal Cans	Fluorescent-Lighting Power Factor Correction Capacitor				
	RU	120—240	Radio Noise Suppressors		(65% & 85% noise elimination)					

Key: & = Can be supplied with plastic impregnation for 125°C operation (cap. variation 15%)—improved moisture proof qualities.
= Can be supplied with Duroil impregnate for 100°C
* = Can be supplied with Silcone oil impregnate for 125°C (capacity variation 3%).

Group a: TR—, TS—, TM— Suitable for high temperatures with high stability and low power factor. Completely molded, otherwise same as above.

Group b: DR—Highly stable low power factor capacitor.
DS—Highly stable low power factor capacitor.

Group c: P6M—, PB, PC Quality low cost commercial capacitor line with long life and low leakage.
PBM Miniature line similar to the above.
PCM Miniature line similar to the above.

Group d: PCF Fireproof capacitor.
PCST Circuit Stabilizer (television).

Group e: P-20, P-21, P-22, P-70 A hermetically sealed line of metal casing capacitors with glass seals, silicone rubber seals, plastic seals, ceramic bushings.

Group f: FPI Flat wax or plastic impregnated adapted to close spacing.
RP Round wax or plastic impregnated.

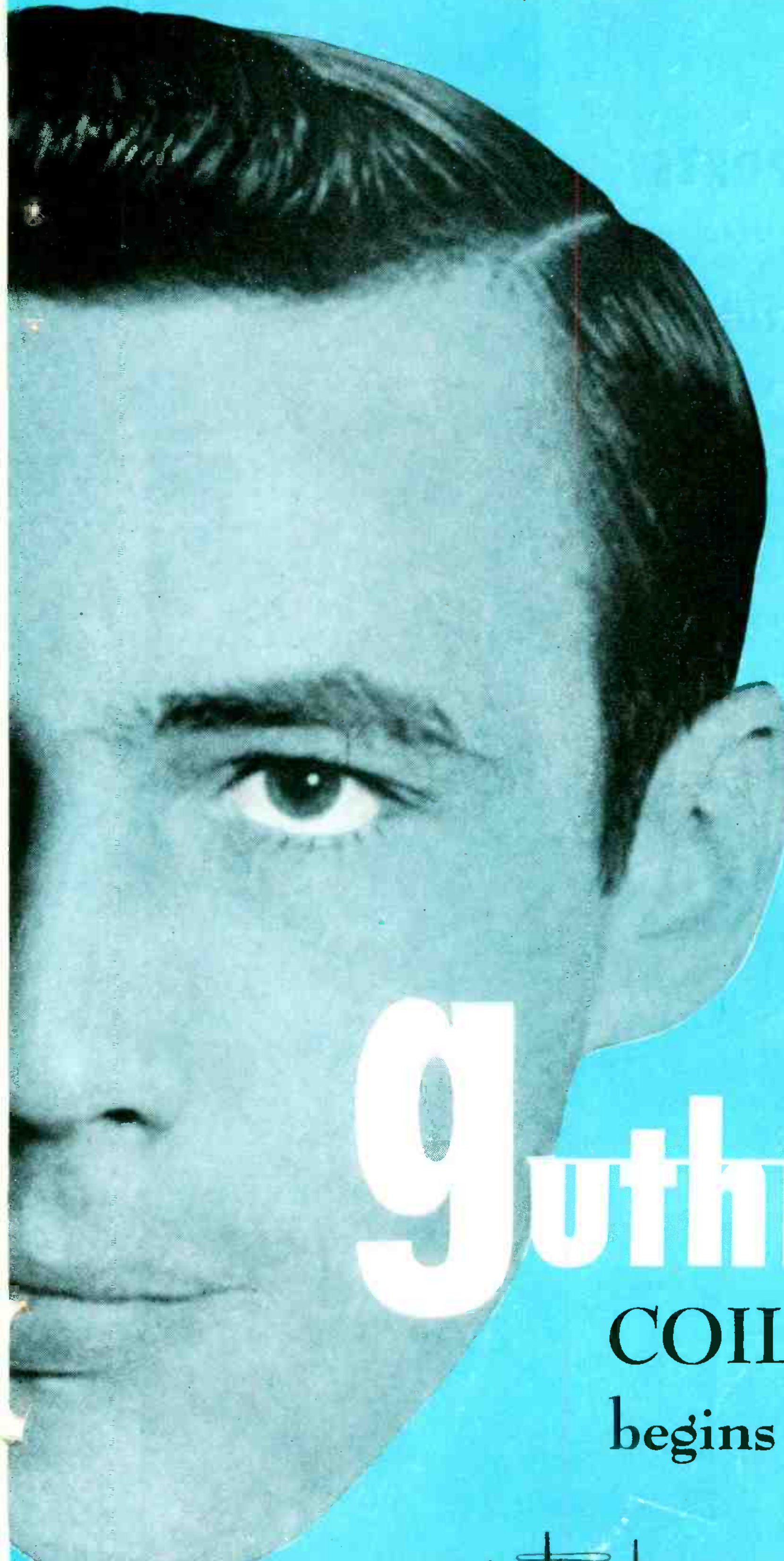
Group g: Super Cap. These electrolytics are available in hermetically sealed cans.

Serving Electronic Engineers Since 1928

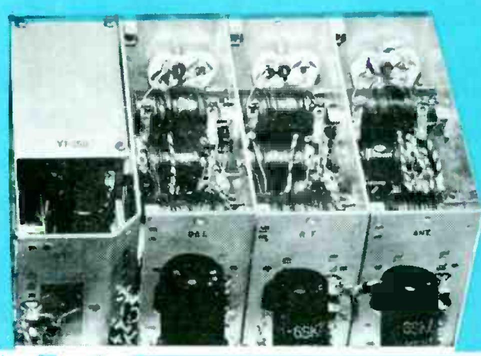
DUMONT ELECTRIC CORP.

308 Dyckman Street, New York 34, N. Y., Telephone LOrraine 9-2800

yokes • toroids • shield cans • loop antennas • oscillator coils
i. f. transformers • metal frame padder condensers • magnet and litzendraht-textile served wire • compression type mica trimmers • dual compression trimmers
output transformers • antenna coils • assemblies • r f tuners



Besides specialized quality control, custom built plant equipment and exclusive production techniques, there is yet another important reason why Guthman is the World's largest independent maker of coils and basic electronic components —*research personnel!* Eager for the challenge of new coil development are engineers like Richard Huber whose academic background and practical training under the guidance of long experienced Guthman research experts eminently qualifies him to solve today's coil problems. So we confidently urge you to incorporate Guthman components into your next design . . . products engineered and fabricated within the Guthman plant like the BC348Q oscillator, detector, R. F. and antenna stages—and Guthman engineers will gladly design components especially for you. For a comprehensive descriptive brochure of Guthman facilities, write Dept. G.



guthman

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begins with laboratory design

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introducing
richard huber

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LAPP TUBE SUPPORTS

for mounting forced-air-cooled tubes

Now available as a standardized line, these Lapp insulated supports for mounting forced-air-cooled tubes facilitate design of transmitter and other high-power circuits. They are simple, compact and efficient. For high frequency tubes they are available either in Lapp porcelain or Lapp steatite; for standard broadcast frequencies in Lapp porcelain.

WRITE for specification sheets. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N.Y.

Lapp

D-H RADIO ALLOYS

Provide Important Parts for

DUMONT's

Selfocus Teletron

Latest development in picture tubes is the Du Mont Selfocus Teletron which provides *automatic focus at all times without the aid of external circuits or devices*. This eliminates the focusing coil or PM unit now used on standard electromagnetic-focus picture tubes, affording a substantial saving of vital materials in the manufacture of television receivers.

The Selfocus Teletron employs electrostatic focus with magnetic deflection, and this type of receiver is unique among electrostatic-focus tubes because its focusing element is operated at zero volts and is tied internally to the cathode through a resistor.

The elimination of focus circuits from the receiver is made possible largely by the focusing cylinder of the Selfocus picture tube. The unusual design of the cylinder and the precision with which it can be located in the electron gun produce increased picture quality by minimizing defects which have been inherent in conventional picture tubes. With greater control of these defects, it is possible to maintain quality uniformly from tube to tube.

Driver-Harris, who has been supplying Du Mont with alloys for cathode ray tubes for more than 10 years, supplies Stainless Steel 18-12 and special D-H Nickel No. 599 for manufacture into important parts of the electron gun of Du Mont's new Selfocus Teletron. The special requirements of this facet of the television industry are well served by the properties of these metals.

At present, strategic materials and the alloys made from them are inevitably on strict allocation. However, we shall be glad to make recommendations based upon your specific needs, and serve you to the best of our ability.

Makers of the most complete line of electric heating, resistance and electronic alloys in the world

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

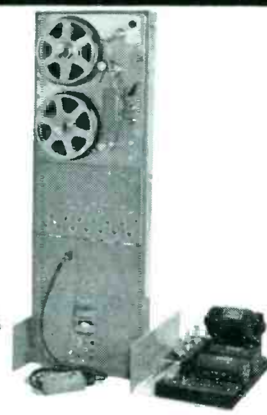
SPECIAL PURPOSE ALLOYS SINCE 1899 — D/H — TRADE MARK REG. U. S. PAT. OFF.

*T. M. Reg. U. S. Pat. Off.

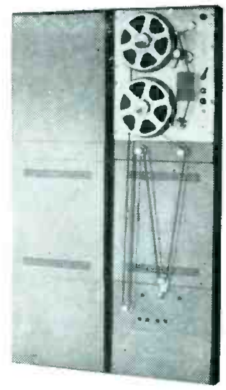
Telemetering • Data Recording with AMPEX and Magnetic Tape!

- Telemetering
- Data Recording
- Shock Analysis
- Vibration Study

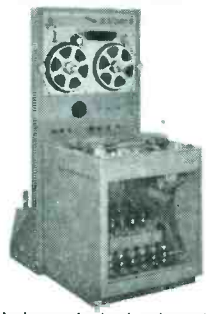
There's an AMPEX for the project.



Multi-channel recorder for seismograph data recording in the field with remote control. Custom construction by AMPEX.

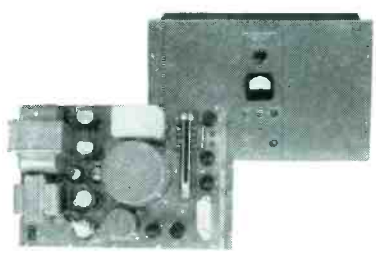


Multi-channel continuous loop reproducer. Custom construction by AMPEX.

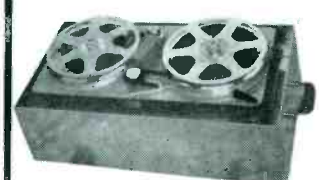


Multi-channel playback and auxiliary recorder for shock and vibration study. Custom construction by AMPEX.

Low frequency data recorder. Custom construction by AMPEX.



Model 375 Capstan Motor Power Amplifier; front and rear views.



Mobile multi-channel shock and vibration data recorder. Custom construction by AMPEX.

MODEL 303 is a pulse recorder designed to record and accurately reproduce pulse width modulated telemetering data. The input signal is converted to sharp pulses defining the leading and trailing edges of the square waves which are recorded on the tape. The sharp pulses are reproduced and reconverted to square waves, restoring the original pulse width modulation.

MODEL 306 is designed to record low frequency data within the spectrum of 0 to 2,500 cycles ±1 db.

MODEL 307 is specially designed to record all telemetering channels including 70 kc channels.

MODEL 375 Precision Capstan Motor Amplifier provides an accurate source of 60-cycle power to drive the capstan motor of Model 300 series recorders, thereby providing constant tape speed independent of power line frequency variations. This unit consists of a precision, temperature-compensated tuning fork which drives a power amplifier with ample capacity to run the drive motor.

MODEL 381 Speed-Lock automatically adjusts the playback speed to insure that any recorded frequency is played back the same as it was recorded, regardless of tape dimensional changes, power line frequency changes, or slippage.

MODEL 500 Low Flutter and Wow of less than .1% peak to peak over the spectrum of 0 to 10,000 cycles is achieved by an exclusive-with-Ampex drive system. Complete specs and data describing this and all other special AMPEX equipment are available on request.

AUDIO & VIDEO PRODUCTS CORPORATION represents AMPEX ELECTRIC CORPORATION in the sale of Magnetic Tape Recording Equipment. We also maintain an engineering consultation service in the fields of telemetering and data recording. Please do not hesitate to make use of this service. There is no obligation or fee.

Specifications and Data Are Available On Request

For Immediate Details, Wire Or Telephone Collect: PLAZA 7-3091

Audio & Video
PRODUCTS CORP.
730 Fifth Avenue • New York 19, N. Y.

Cable Address: "AUDIOVIDEO"

Please send descriptive data on the following AMPEX models:

303 . . . 306 . . . 307 . . . 375 . . . 381 . . . 500 . . .

My name is: ....

My business affiliation: ....

My position there: ....

Mail address: ....

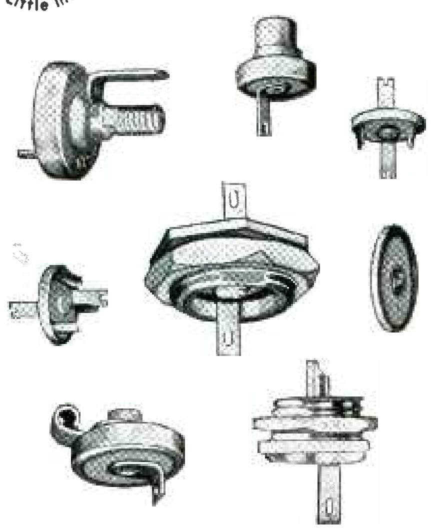
City & State: ....

Button, Button, who's got the Button (Capacitors that is...)?

THE LITTLE INDIAN SAYS-

the Little Indian

Sangamo can furnish SILVERED MICA BUTTON CAPACITORS for any requirement...



You can look to Sangamo whenever you need small sized, light weight button capacitors, with extremely low series inductance, for application in high frequency circuits. Sangamo Button Capacitors are encased in silver plated, corrosion resistant brass and are exceptionally stable over a wide temperature range. The case is utilized as the low potential terminal.

Sangamo Silvered Mica Button Capacitors meet all requirements of V.H.F. and U.H.F. applications. They can be furnished with temperature coefficients and drift characteristics up to and including "E" of Armed Services specification JAN-C-5. The normal operating temperature range is from minus 50° C. to plus 85° C. Higher operating temperature requirements will be considered and may be negotiated with The Sangamo Capacitor Engineering Department. Catalog No. 830 gives full details—write for your copy.

Your Assurance of

Dependable Performance

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

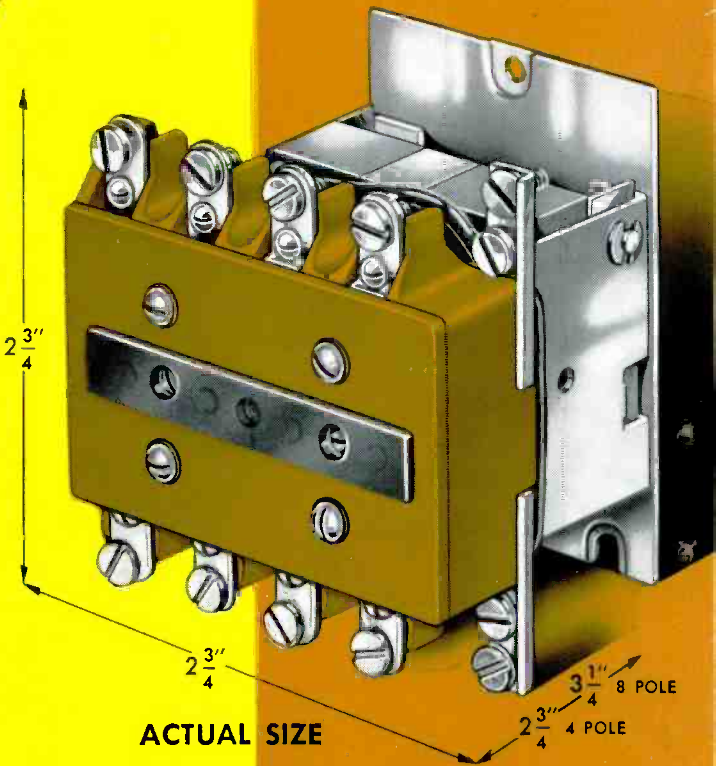
SC51-7

INCHES SMALLER...

EVERY INCH A CHAMPION!

NEW ARROW AH HART SIZE 00 Type "CRA" CONTACTOR

The revolutionary new Arrow-Hart Size 00 Type "CRA" Contactor measures just 2¾" x 2¾" — cuts inches off any other contactor on the market — yet is every inch a champion! Take the design: from Arrow-Hart's exclusive new "RA" (Right Angle) mechanism — the same which enabled A-H engineers to build the compact control package described on the preceding page — to the 00's ***automatic*** positive contact pressure control, this ingenious multi-pole convertible contactor results in big savings of space, work, time, money; assures you unparalleled performance throughout its long life.

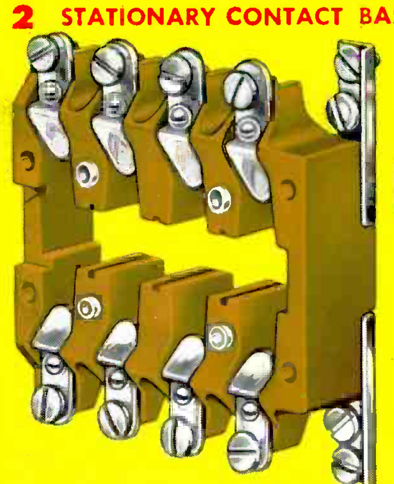


ACTUAL SIZE

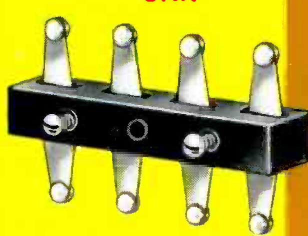
ONLY 4 BASIC SECTIONS

1 COVER PLATE

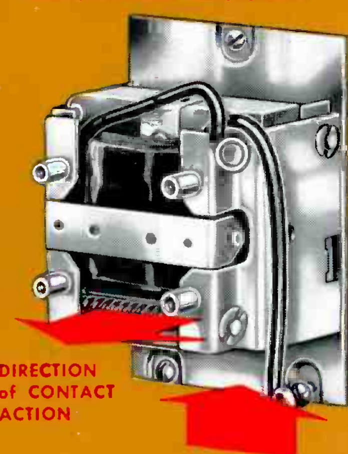
2 STATIONARY CONTACT BASE



3 MOVABLE CONTACT UNIT



4 FRAME with COIL-MAGNET MECHANISM ASSEMBLY



Here are just a few of its host of extra features: **Right Angle mechanism, reducing size by as much as ¾ • Ultra-functional design • Fewer components — reduced handling • No-twist no-rock frame • Compactness within own framework • Unit stability and rigidity • Foolproof, guided assembly throughout • Contacts operate in vertical position • Self-aligning contact action • Unusual ability to handle a multiplicity of circuits • Movable contact carrier • Enclosed contact chambers • All wiring in line and straight-thru • Mat-finished cover plate for terminal markings • and many more.**

Get all the facts about the A-H Size 00 Type "CRA" Contactor, available in 2, 3 and 4 pole types. Send for Engineering Data Folder.

ARROW·HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN STREET
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Branch Warehouses: BOSTON, CHICAGO, CLEVELAND, CINCINNATI, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, SAN FRANCISCO, SYRACUSE. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO.

PRINTED IN U.S.A.

A ONE-PIECE FERRULE RESISTOR

—without doubt the best constructed ferrule on the market!

This Hardwick, Hindle ferrule type is "one-piece" instead of the usual cemented or bolted type construction.

It is unique. It is integral—securely fastened *before* enameling and also later enameled to the tube, *sealing completely* all wire connections.

It is outstanding in its sturdiness; and it is a thoroughly dependable unit, which assures you absolutely of longer life and better performance.

The ends of the tube are left open for fullest air circulation through the entire inside of the tube.

Hardwick, Hindle ferrule resistors give you:

1. Extra strength for most rugged treatment.

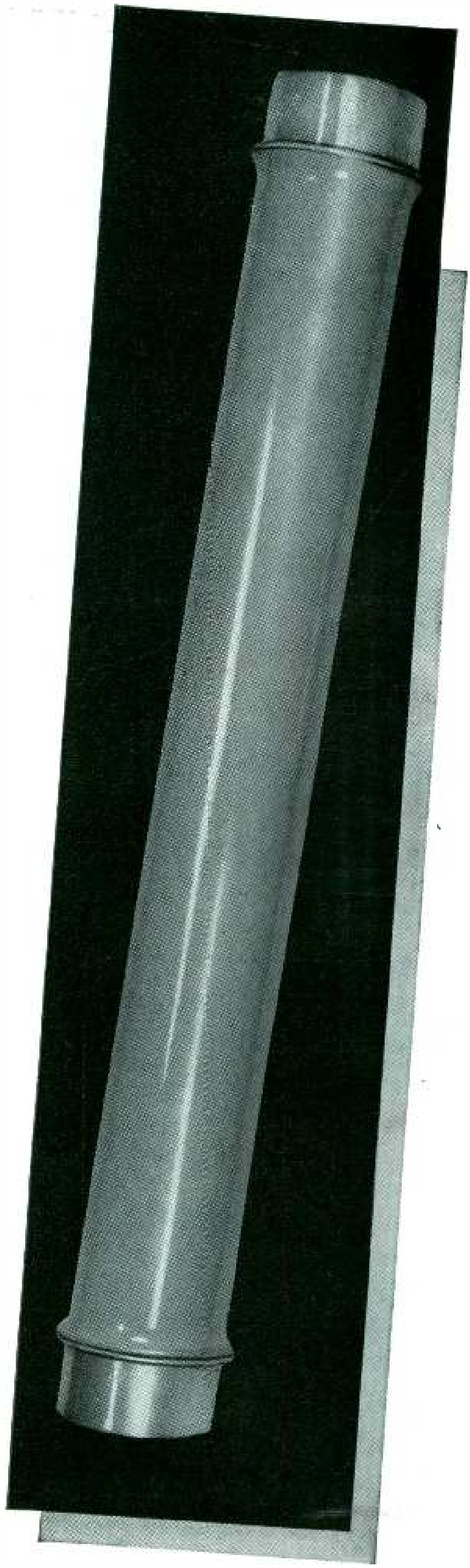
2. Simple, inexpensive installation.

plus

3. Our *new crazeless gray enamel* which completely eliminates crazing that results in failure of the resistive element due to moisture penetration from humidity, salt and severe atmospheric conditions—providing greater dielectric strength.

Plus other well known Hardwick, Hindle features.

Manufactured in accordance with JAN-R-26A specifications.



HARDWICK, HINDLE, INC.

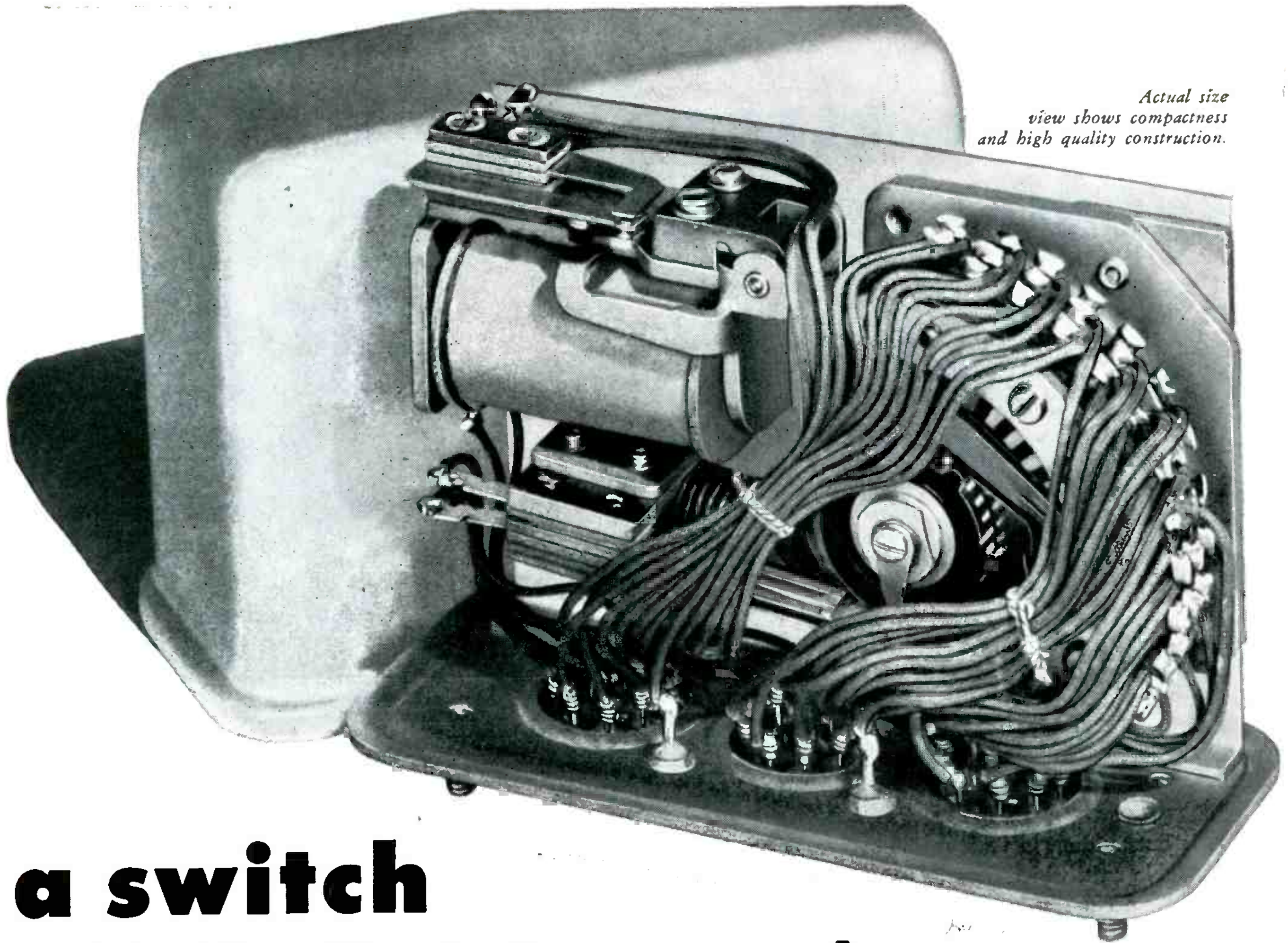
Rheostats and Resistors

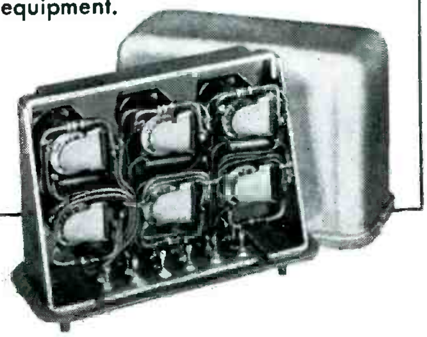
Subsidiary of

THE NATIONAL LOCK WASHER COMPANY

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

The mark of quality for more than half a century





JOHNSON electronic components

... accepted by the Industry!

Types C & D

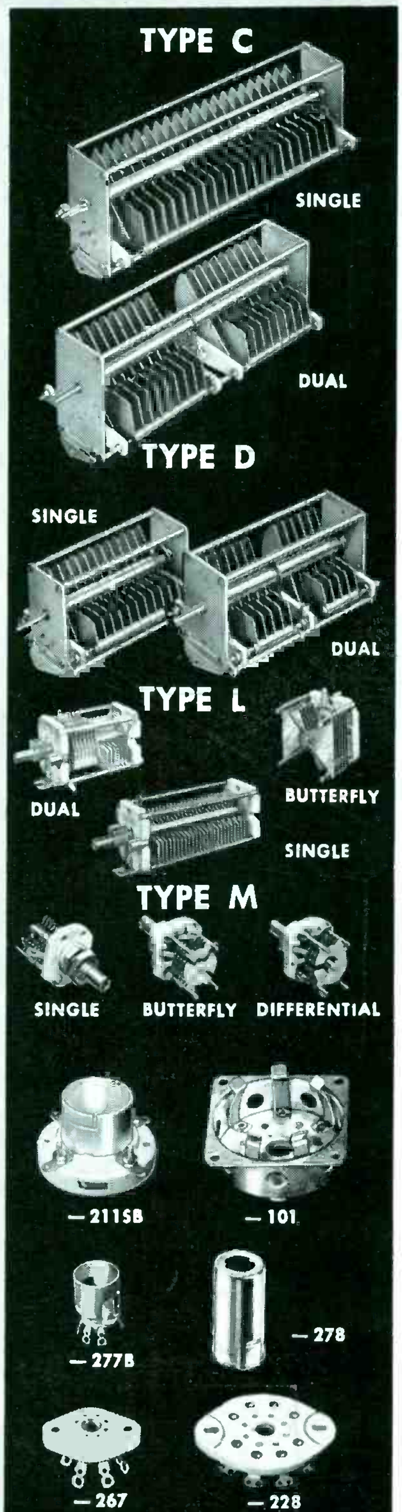
Rugged, dependable and low cost capacitors. Available in 52 standard single and dual models from 12 to 496 mmfd. and voltage ratings 3,500 to 11,000 volts. Extreme rigidity assured by heavy aluminum end frames, .051" plates, 5/16" tie rods. All are equipped with ¼" cadmium plated shafts, laminated phosphor bronze rotor contacts and Steatite high frequency insulators. Mounting brackets furnished for normal or inverted mounting. Panel space required: Type C, 5½" wide x 5⅜" high; Type D, 4¼" wide x 4" high.

Type L Variables

Built for the gruelling applications where dependable performance is a must. Tie rods soldered directly to ceramic end frames. Rotor and stator assemblies full soldered construction. No parts can work loose — capacity can't fluctuate. Metal parts are brass, plated with corrosion resistant Bright Alloy. Numerous sizes single, dual, butterfly and differential types from 11 to 200 mmfds. available with .030" spacing. Manufactured with .020", .060" and .080" spacing to special order in production quantities. Panel space required is 1⅜" square.

Type M Miniatures "Space Savers"

Smallest air variables ever built. Manufactured to extremely close tolerances these Lilliputs are quality condensers. Features of their construction are: Steatite insulation, split sleeve bearings, beryllium copper rotor contacts. Finish of metal parts is nickel plate. Capacitances of stock models range from 1.5 to 19 mmfd. in single, butterfly and differential types. Mounting area required is ¾" x ⅝". Flats on single hole mounting bushing keep condenser accurately positioned. 3/16" diameter shaft is slotted, may be tuned with either knob or screw driver.



JOHNSON manufactures a tube socket for virtually every transmitting and industrial application. Characteristics of all types are: functional design, low loss insulation and permanently positive contacts.

BAYONET SOCKETS

The 123-211SB "fifty watt" socket pictured is an example of JOHNSON bayonet type transmitting sockets. Steatite base insulation extends under contacts to prevent arcs to ground. Double beryllium copper filament contacts handle high current with minimum heating. Heavy aluminum shell provides rigid support for the tube in any position.

SEPTAR SOCKETS

The 122-101 socket accommodates all Septar based VHF tubes such as 829's and 832's. The ventilated base shield is designed for mounting of button mica bypass condensers at the tube terminals. Contacts and contact springs are silver plated and recessed in the ceramic insulation to prevent axial movement. Contacts and retaining springs hold tube securely.

MINIATURE SOCKETS

For 7 pin miniature tubes JOHNSON offers the 120-277B miniature socket equipped with shield base and 120-267 for applications not requiring shields. Both have Steatite insulation with floating phosphor bronze silver plated contacts. Lengths of shields available for the 120-277B are 1⅜", 1¾" and 2¼".

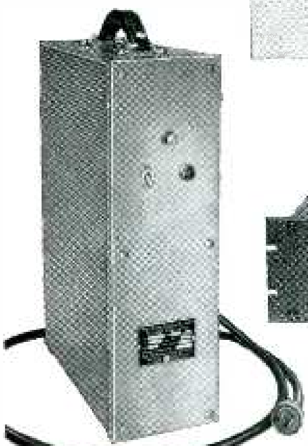
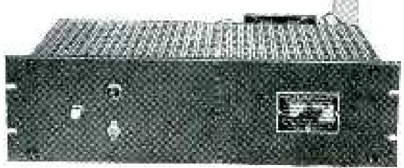
WAFER SOCKETS

JOHNSON wafer sockets are simple and sturdy. Insulation is grade L-4 or better glazed and impregnated Steatite. Contacts are brass with steel retaining springs and cadmium plated. Rivet heads are recessed and mounting holes bossed to permit sub-chassis mounting. Locating grooves facilitate tube insertion. Available for 4 pin 5, 6, 7 pin med. and octal based tubes.

JOHNSON . . . *a famous name in Radio!*

E. F. JOHNSON CO., WASECA, MINNESOTA

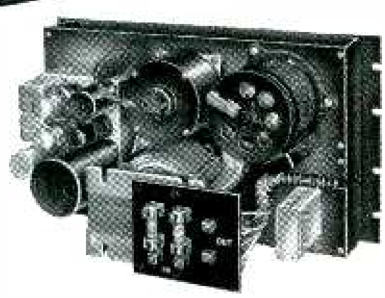
STABILINE Automatic VOLTAGE REGULATORS

IE51002R

IE51002

EM4`02



EM4102R

Two types of STABILINE Automatic Voltage Regulators are offered by The Superior Electric Company to meet the requirements of maintaining constant a-c voltage to electrical equipment.

INSTANTANEOUS ELECTRONIC

Type IE is a completely electronic unit with no moving parts. It provides almost instantaneous correction of line voltage or load changes. Waveform distortion never exceeds 3 per cent. Output voltage is held to within ± 0.1 per cent of nominal for wide line variations; to within ± 0.15 per cent of nominal for any load current change or load power factor change from 0.5 lagging to 0.9 leading. Type IE is versatile in application finding wide use in laboratory work, on test lines and as a component of other equipment where the most exacting voltage regulation is necessary. There are 28 standard models for 115 and 230 volts, 50 or 60 cycles, single phase operation ranging in capacity from ¼ to 5 KVA. Special units are available for higher frequency operation . . . to meet government agency specifications . . . or for unusual applications.

ELECTRO MECHANICAL

Type EM is an electro mechanical unit with a very sensitive detector controlling a motor-driven POWERSTAT variable transformer which feeds a buck-boost auxiliary transformer. Its outstanding advantages are zero waveform distortion and high efficiency. Type EM is most often used in the control of industrial loads. However; the demand of today's electronic equipment for constant voltage with absolutely zero waveform distortion necessitates the incorporation of a type EM as an integral part of the assembly. Type EM is offered in standard models for 115, 230 and 460 volts, 50 and 60 cycles, single and three phase duty in ratings from 2 to 100 KVA. Special units can be designed for higher frequencies, for conformance to government agency requirements and for individual needs.

FOR INFORMATION ON STANDARD STABILINE AUTOMATIC VOLTAGE REGULATORS SEND FOR BULLETIN 5351 . . . COMPLETE WITH ENGINEERING DATA, PHOTOGRAPHS, RATINGS, DIMENSIONS AND DIAGRAMS.

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

412 CHURCH STREET, BRISTOL, CONNECTICUT

MANUFACTURERS OF POWERSTAT VARIABLE TRANSFORMERS, STABILINE AUTOMATIC VOLTAGE REGULATORS, VARICELL D-C POWER SUPPLIES, VOLTBOX A-C POWER SUPPLIES, SUPERIOR 5-WAY BINDING POSTS, POWERSTAT LIGHT DIMMING EQUIPMENT.

NEO-SIL CORPORATION

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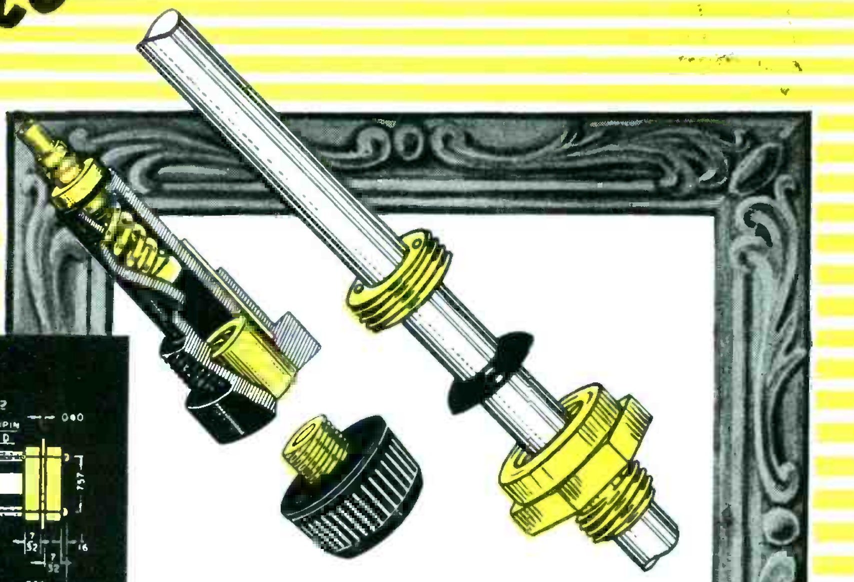
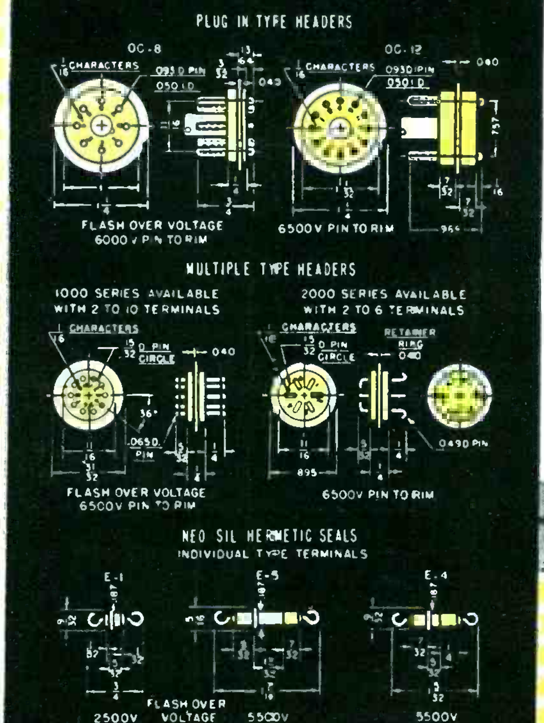




TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 1949, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm-centimeters*
1.4×10^6	3.5×10^{12}

Dielectric Constant and Dissipation Factor

Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 160° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.

HERMETIC SEAL FUSE HOLDER

"Hermetically Sealed Fuse Holders are available for 3-AG and 4-AG fuses. These units are completely sealed from moisture with or without the cap or fuse inserted and are applicable for use on vacuum or gas filled units."

¼" SHAFT WATERSEAL BUSHING

"Rotary Waterseal Panel Assemblies, with GRAF-SIL Packing Glands, have an excellent five year customer history on gas filled pressurized components. They are available for ¼" shafts and for potentiometers and switch bushings."

"NEO-SIL'S proven Hermetic sealing components are pressure checked at 25 psi—to meet military requirements and as applied to our units, NEO-SIL rubber will resist abusive temperature cycling, salt water, most acids and alkalies, and withstand high pressures and vacuums."

"In addition to the items illustrated above, NEO-SIL offers many other components, such as E Series terminals, Octal Type Plug In Headers, Multiple Pin Headers, Hermetically Sealed Cables, Hermetically Sealed Line Cords With Plugs For European use, Meter Gaskets, Panel Gaskets, Adapters (U. S. to Continental), Coil Forms, Crystal Contacts and other molded bakelite and NEO-SIL rubber units."

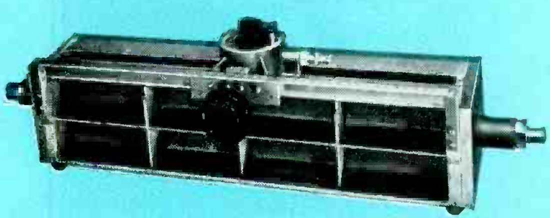
Your special problems are solicited.

NEO-SIL CORPORATION

26 CORNELISON AVE., JERSEY CITY 4, N. J.

READINGS

10 to 12,400 mc.



-hp- 805A/B COAXIAL SLOTTED SECTIONS

Continuous coverage 500 to 4,000 mc. High accuracy and mechanical stability; negligible slope, minimum leakage. Incorporates radically different structural design employing rigid parallel planes and a non-bowing central conductor. Probe setting readable in mm. to 0.1 mm. Maximum VSWR of basic section and connectors less than 1.04. -hp- 805A, 50 ohms impedance, for Type N connector and flexible cables. Model 805B, 46.3 ohms impedance, for ⅞″ rigid transmission lines.

-hp- 806B COAXIAL SLOTTED SECTION

Continuous coverage 3,000 to 12,000 mc. Employs same time-tested parallel plane principle as -hp- 805A/B. Designed for use with -hp- 809B Universal Probe Carriage. Maximum VSWR of slotted section and connecters is 1.06 to 10,000 mc. Negligible slope, 50 ohm impedance. Uses Type N connectors for flexible coaxial cable. Sets new standard for mechanical stability in coaxial slotted sections.

-hp- 440A COAXIAL DETECTOR

Tunable crystal and bolometer mount. May be used as an rf detector for coaxial systems between 2,400 and 12,400 mc. Fits Type N connectors; operates with bolometer or silicon crystal. $85.00 f.o.b. factory.

-hp- 442A BROAD-BAND PROBE

May be used in combination with -hp- 440A to provide highly sensitive, easily tuned detector for slotted sections. Micrometer depth adjustment provides quick control of rf coupling. $75.00 f.o.b. factory.

-hp- 444A UNTUNED PROBE

Frequency range 2,400 to 12,400 mc. Includes 1N26 silicon crystal. Highly sensitive, compact, easy to use. Requires no tuning. $50.00 f.o.b. factory.

-hp- 803A VHF BRIDGE

Gives direct readings in impedance magnitude and phase, 10 to 500 mc. Rapid operation for new speed, convenience in reading impedance, or resistance and reactance. Operates on new principle of sampling magnetic and electric field of transmission line. Useful for comparative measurements, 5 to 1,000 mc. Impedance range 2 to 2,000 ohms. Phase angle —90° to +90°, at 52 mc and above. Offers utmost convenience in determining characteristics of antennas, transmission lines, rf chokes, resistors and condensers; in measuring connector impedances, standing wave ratios, percentage of reflected power, VHF system flatness.

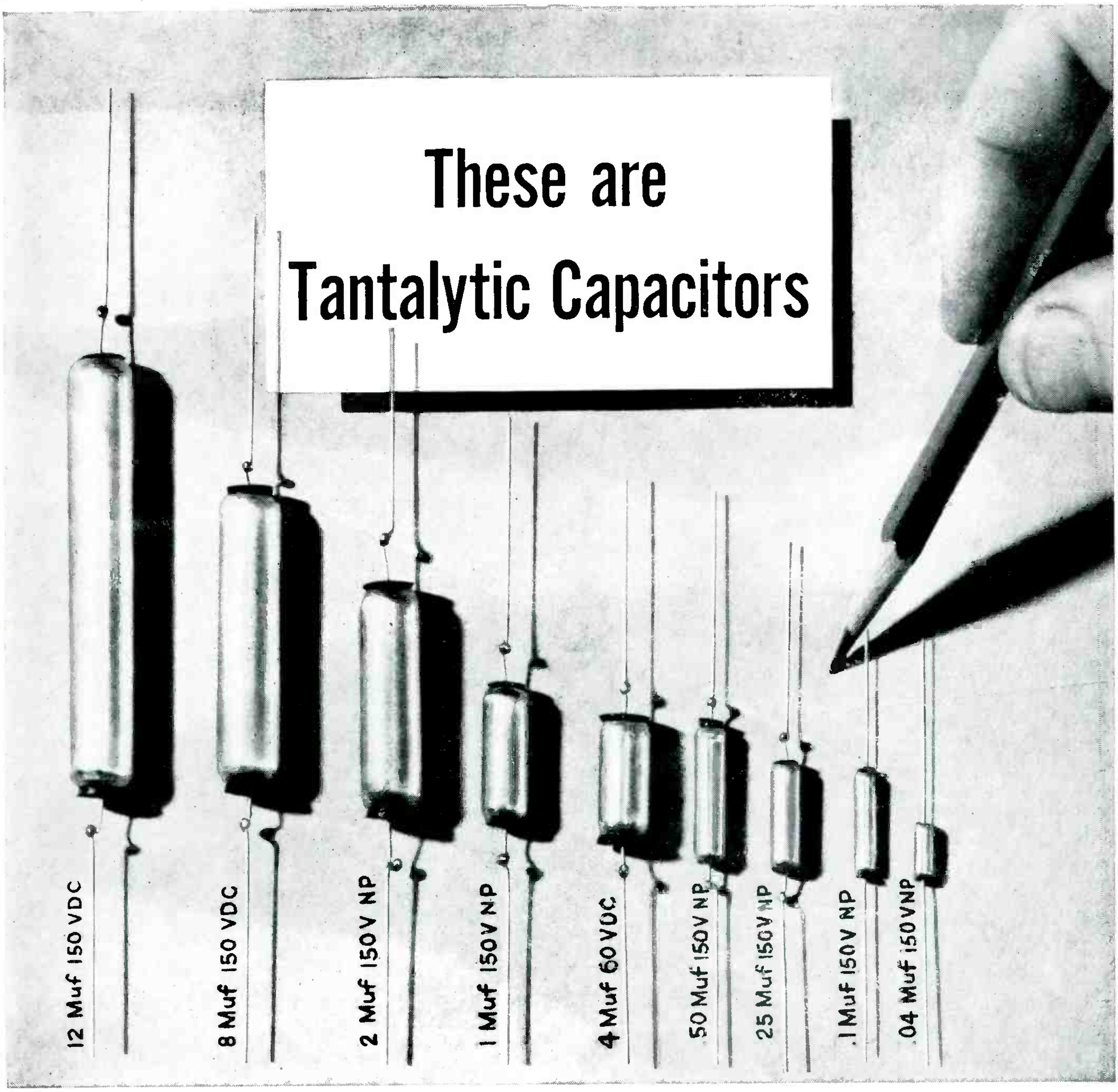
-hp- IMPEDANCE MEASURING EQUIPMENT

INSTRUMENT	FREQUENCIES—COAXIAL	FREQUENCIES—WAVEGUIDE	PRICE (F.O.B. FACTORY)
803A VHF BRIDGE	10 to 500 mc		$495.00
805A/B SLOTTED SECTION	500 to 4,000 mc		$475.00
806B SLOTTED SECTION*	3,000 to 12,000 mc		$200.00
S810A SLOTTED SECTION**		2,600 to 3,950 mc	$450.00
G810B SLOTTED SECTION*		3,950 to 5,850 mc	$ 90.00
J810B SLOTTED SECTION*		5,850 to 8,200 mc	$ 90.00
H810B SLOTTED SECTION*		7,050 to 10,000 mc	$ 90.00
X810B SLOTTED SECTION*		8,200 to 12,400 mc	$ 90.00
809B UNIVERSAL PROBE CARRIAGE	For slotted sections, 3,000 to 12,400 mc		$160.00

*Mounted on -hp- 809B Universal Probe Carriage.
**Complete assembly including slotted section and carriage.

Data Subject to Change Without Notice

HEWLETT-PACKARD hp **INSTRUMENTS**



Here is one of the fastest moving developments in recent years—General Electric's new electrolytic-type capacitors. These Tantalytic capacitors with their small size and large capacitance per unit of volume have excellent low temperature characteristics, long operating life and in many cases can replace bulky hermetically-sealed paper capacitors. Ratings presently available for consideration range from .02 muf up to 12 muf at 150 volts dc. Units pictured are representative of these ratings.

Other features of G-E Tantalytic Capacitors include:

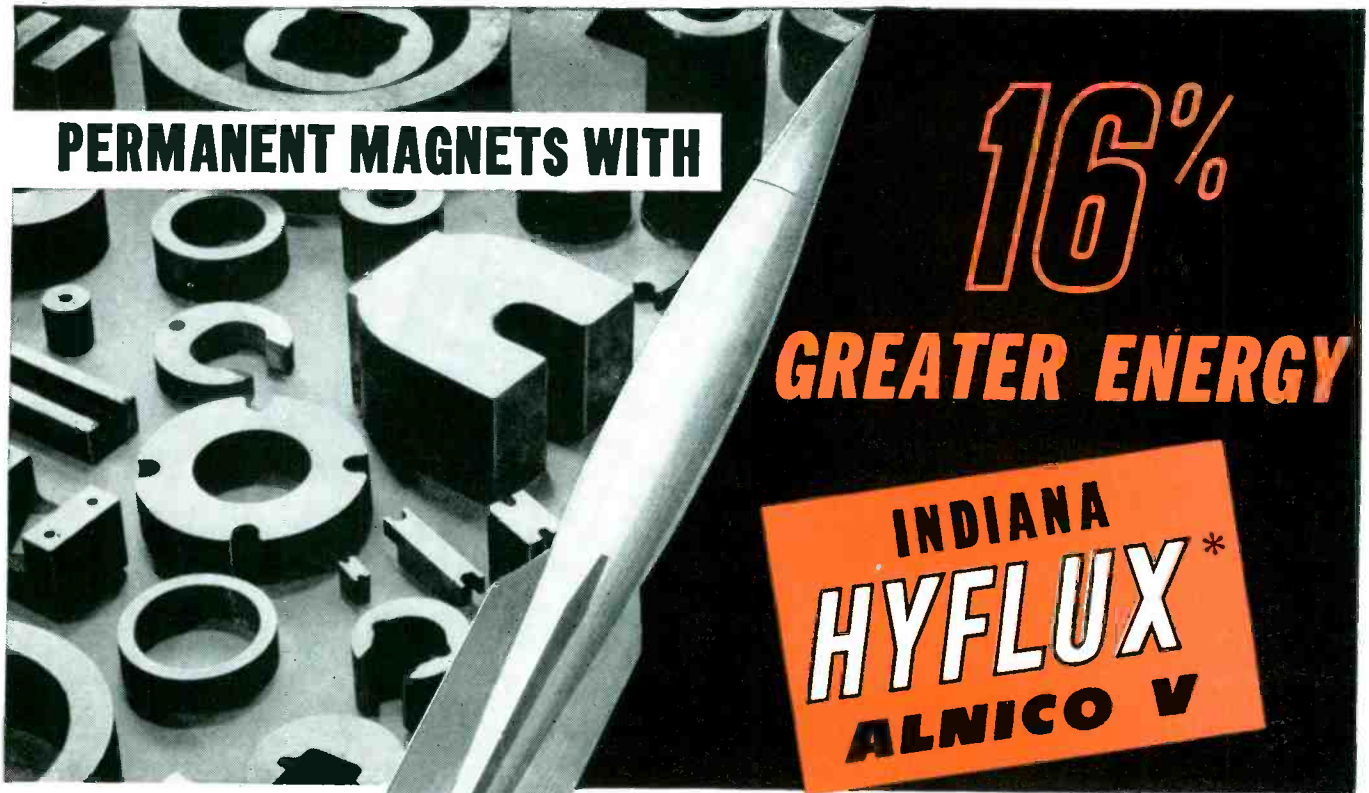
- Extremely long shelf life.
- An operating temperature range from −55°C to +85°C.
- Exceedingly low leakage currents.
- Ability to withstand severe physical shock.
- Completely sealed against contamination.

If you have large-volume applications where a price of 3 to 5 times that of hermetically-sealed paper capacitors is secondary to a combination of small size and superior performance—get in touch with us. Your letter, addressed to Capacitor Sales Division, General Electric Company, Hudson Falls, N. Y., or your nearest Apparatus Sales Office will receive prompt attention.

General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

407-306

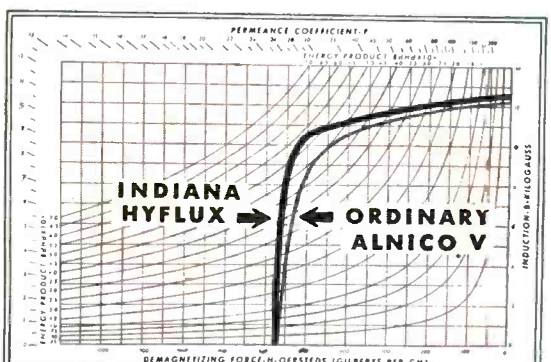


*the permanent magnet material that offers an average energy product of 5½ million BH max or more, with 5¼ million *guaranteed!*

INDIANA HYFLUX Permanent Magnets are vital components of guided missiles, proximity fuses, radar and thousands of other military and industrial applications.

There is logic in selecting INDIANA HYFLUX Alnico V for every application calling for permanent magnets.

With its 16% greater energy product, it performs old applications better and at the same time permits more compact design in new products. Yet premium quality INDIANA HYFLUX Alnico V costs no more than regular Alnico V.



DEMAGNETIZATION AND ENERGY PRODUCT CURVE

WHAT IS INDIANA HYFLUX ALNICO V?

INDIANA HYFLUX Alnico V is not a new alloy. It is the result of new precision techniques applied to dependable Alnico V, including new procedures, controls, instrumentation, equipment — and PRECISE supervision over every step of production.

It's the most important development in permanent magnets since the introduction of Alnico V itself!

ALL SIZES, SHAPES AND MATERIALS!

INDIANA is the only manufacturer furnishing all commercial grades of permanent magnet alloys. You have a choice of cast, sintered, formed or ductile materials.

Many types and sizes of INDIANA HYFLUX Alnico V permanent magnets are available from stock for your experiments.

LET OUR ENGINEERS HELP YOU!

THE INDIANA STEEL PRODUCTS COMPANY, world's largest producer of permanent magnets, offers free of charge every engineering assistance in the design and application of permanent magnets best suited to your products.

Take advantage of this wealth of experience and "know how" that has developed more than 30,000 successful applications.

Write, wire, or phone INDIANA today! Ask for Catalog No. 11A-1, that describes stock experimental magnets.

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THE INDIANA STEEL PRODUCTS COMPANY

VALPARAISO, INDIANA • • • Sales Offices Coast to Coast

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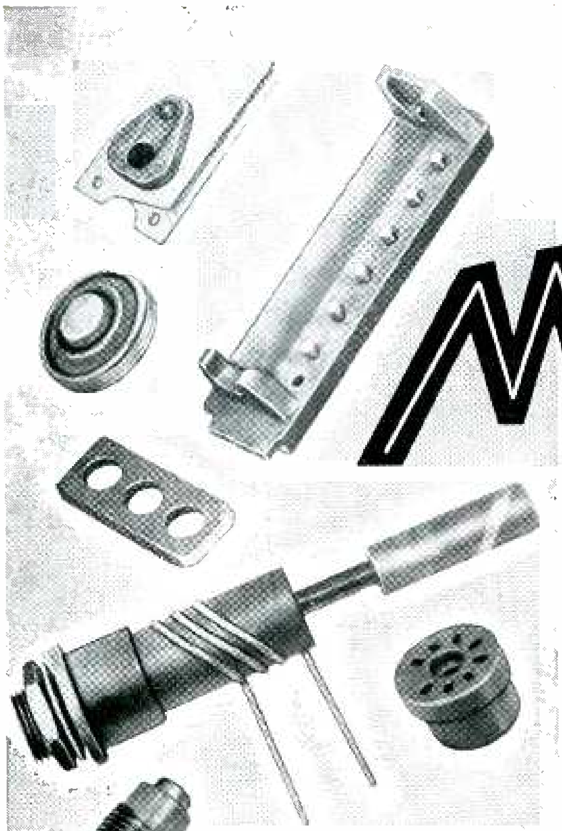
The Ideal Dielectric

FOR NEW **UHF-TV** APPLICATIONS

MYCALEX



Glass-Bonded Mica INSULATION

—for low loss at low cost!

- LOW-LOSS FROM 60 CYCLES/SECOND TO 24,000 MEGACYCLES/SECOND
- MAXIMUM EFFICIENCY, UTMOST ADAPTABILITY, LOWEST COST
- AVAILABLE MOLDED TO PRACTICALLY ANY SHAPE OR SIZE WITH OR WITHOUT METAL ELECTRODES OR INSERTS

CHARACTERISTICS OF MYCALEX GRADE 410

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

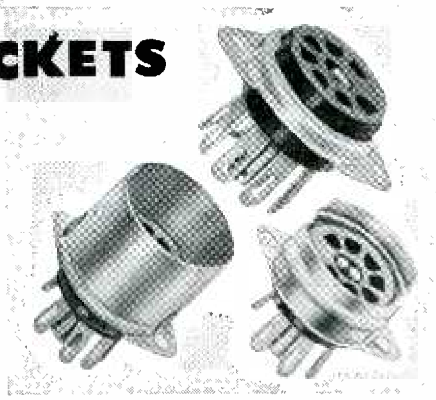
WRITE FOR 20-PAGE CATALOG
This comprehensive compilation of technical and manufacturing data includes complete dielectric information.

FCC Approval of UHF TV has introduced an era of engineering and manufacture to standards seldom before attained in mass production. Many materials, dielectrics in particular, fail to meet these more critical requirements. MYCALEX 410 is one exception. This dielectric can be molded to close tolerances with or without metal inserts—high efficiency to well over 24,000 megacycles. MYCALEX 410 can be molded in volume at low cost. It can be produced to closer tolerances than higher priced ceramics. Electrically and mechanically, MYCALEX 410 is the ideal dielectric for tube sockets, tuners, condensers, switches, coil structures and many other UHF components.

TUBE SOCKETS

MYCALEX glass-bonded mica sockets are injection molded to extremely close tolerance. This exclusive process affords superior low-loss properties, exceptional uniformity and results in a socket of comparable quality but greater dimensional accuracy than ceramics—all at no greater cost than inferior phenolic types. These sockets are available in two grades, featuring high dielectric strength, low dielectric loss, high arc resistance and fully meet RTMA standards.

Write for Tube Socket Data Sheets



MYCALEX 410 is priced comparable to mica-filled phenolics. Loss factor is only .015 1 mc., insulation resistance 10,000 megohms. Fully approved as Grade L-4B under N.M.E.S. JAN-1-10 "Insulating Materials Ceramic, Radio, Class L."

MYCALEX 410X is low in cost but insulating properties greatly exceed those of general purpose phenolics. Loss factor is only one-fourth that of phenolics (.083 at 1 mc.) but cost is comparable. Insulation resistance 10,000 megohms.

SINCE 1919 MYCALEX THE INSULATOR TRADE MARK REG U S PAT OFF

MYCALEX CORPORATION OF AMERICA

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Guessing?

... OR FACTUAL PLANNING

for that television station

The proper choice and arrangement of equipment are of the utmost importance in a successful TV station operation. A guide, reflecting the unequalled experience of Du Mont in this field, is now offered in the form of an illustrated, easy-to-follow book. Detailed renderings along with exploded views and systematic floor plan arrangements follow the text graphically. Complete breakdown of equipment complements with approximate prices are indicated throughout. Be sure to have this information in your file whether you are planning a new station or the expansion of your present operations.

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Available upon request to all managers and station engineers.

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Multi-channel -- telegraph AI or telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

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.

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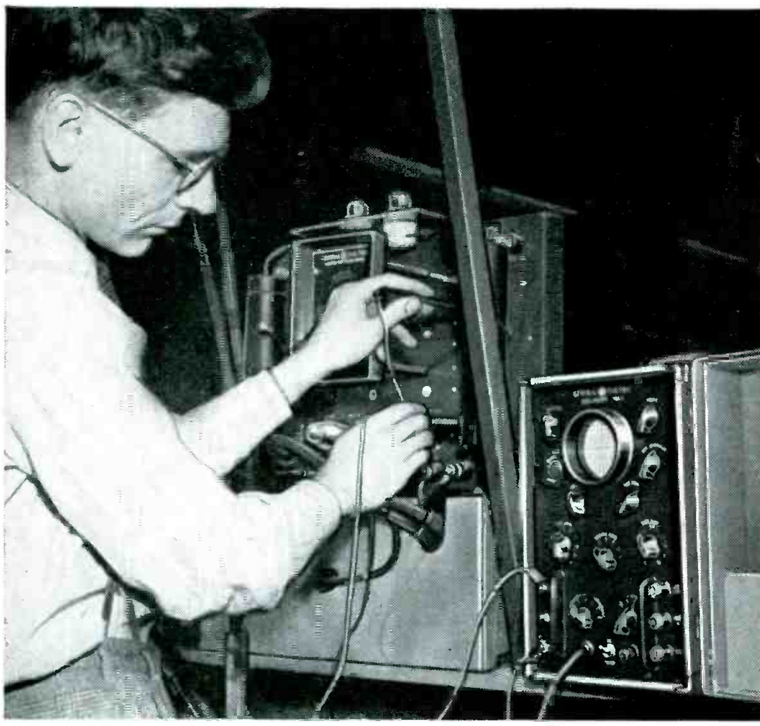
Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.



Eliminate Guesswork

For Industrial Servicing. Safety is the prime feature of Type YNA-4. Its plywood and fibre case is fully insulated and oil-resistant. Light in weight, easy to carry. High stability. Internal amplitude calibration.

★ ★ ★

For medium band width operation (20-5 mc)—the ST-2C (below) is just the ticket. This instrument is particularly good for microwave relay servicing, where desired reproduction requires broad band width and fast sweep. Easily carried—weighs only 43 pounds.

SPECIFICATIONS

Sensitivity—Oscilloscope Type ST-2A (opposite page)

Vertical
- AC Input—.015 volts RMS per inch
- DC Input—2.0 volts DC per inch
- Probe—.20 volts RMS per inch

Horizontal—.4 RMS volts per inch
Maximum Input Potential—500 V peak, Vertical or Horizontal
Deflection Plates—Vertical: 27 V DC per inch
Horizontal: 33 V DC per inch

Sensitivity—Oscilloscope YNA-4 (left)

Vertical attenuator position	Min. sensitivity volts dc/inch
Open Grid	0.5 (0.18 RMS, ac)
X1	0.5 (variable) (0.18 RMS)
X.1	5. (1.8 RMS)
X.01	50. (18. RMS)

Horizontal: 0.6 volts dc/inch (.21 rms)

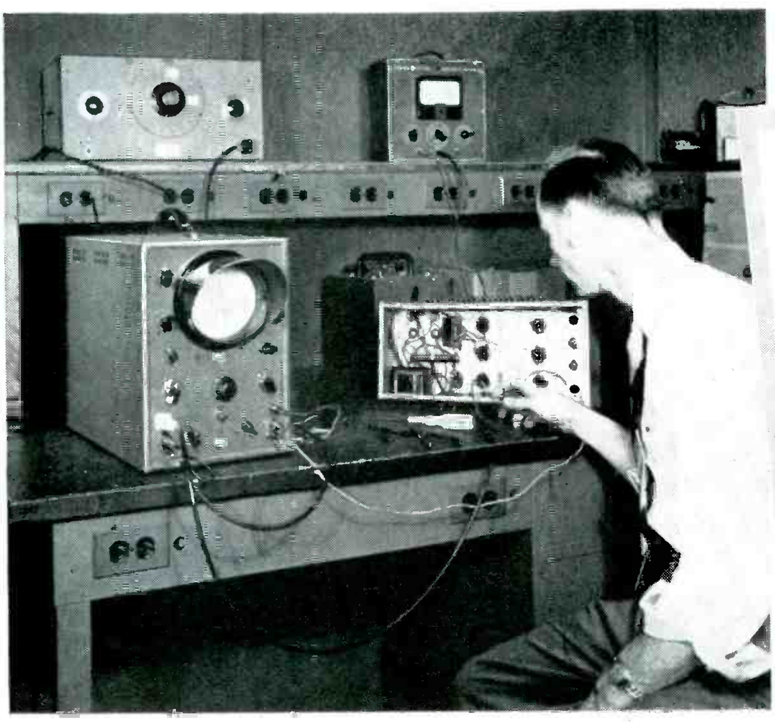
Sensitivity—Oscilloscope ST-2C (bottom left)

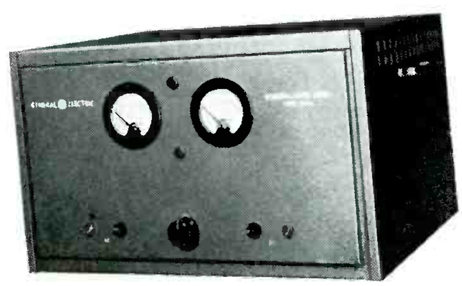
Vertical
- AC Input—0.075 volts RMS per inch
- Probe—1.0 volt RMS per inch

Horizontal—0.4 volt RMS per inch
Z Axis—negative 15 volts peak to intensify
Deflection Plates—Vertical: 27 V DC per inch
Horizontal: 33 V DC per inch
Maximum Input Potential—Vertical: 500 volts RMS
Horizontal: 10 volts RMS

Power Supply YPD-2

DC voltage output: 250-450 volts (positive or negative may be grounded to chassis)
DC current output: 0-300 milliamperes
AC output: 6.3 volts 10 amperes unregulated





Conservatively Rated. This YPD-2 power supply will work 24 hours a day for you if necessary. Highly reliable, it is the end product of rigorous laboratory tests and field checks.

in Alignments, Trouble Shooting, Signal Tracing...

OSCILLOSCOPES

Here's the precision testing equipment that delivers reliability, accuracy and speed for TV servicing, laboratory and industrial applications

IN TV receiver testing, the ST-2A scope shown at right has earned the praises of manufacturers and engineers alike. The scope responds instantly when signal is turned on or off, even under overloads. Intensity level is excellent and trace definition extremely fine. Operator sees all pips clearly.

One of our factory customers has 50 of these scopes in constant operation. *In one year,* replacement for them has consisted of only two dozen tubes and one selector switch.

The General Electric oscilloscopes you see here will give you more accurate service, over a longer period, than ordinary scopes of the same class. The G-E electronics office in your city has full information on this subject.

Sharp Picture reduces operator fatigue. This ST-2A unit is primarily a general purpose instrument for laboratories and servicing. Its wide frequency response (0-1 mc) also makes it useful for television receiver circuit work, the application shown above.

YOU'LL WANT THESE BULLETINS

General Electric Company, Section 4121
Electronics Park, Syracuse, New York

Send me your new bulletins on General Electric Scopes and Power Supplies.

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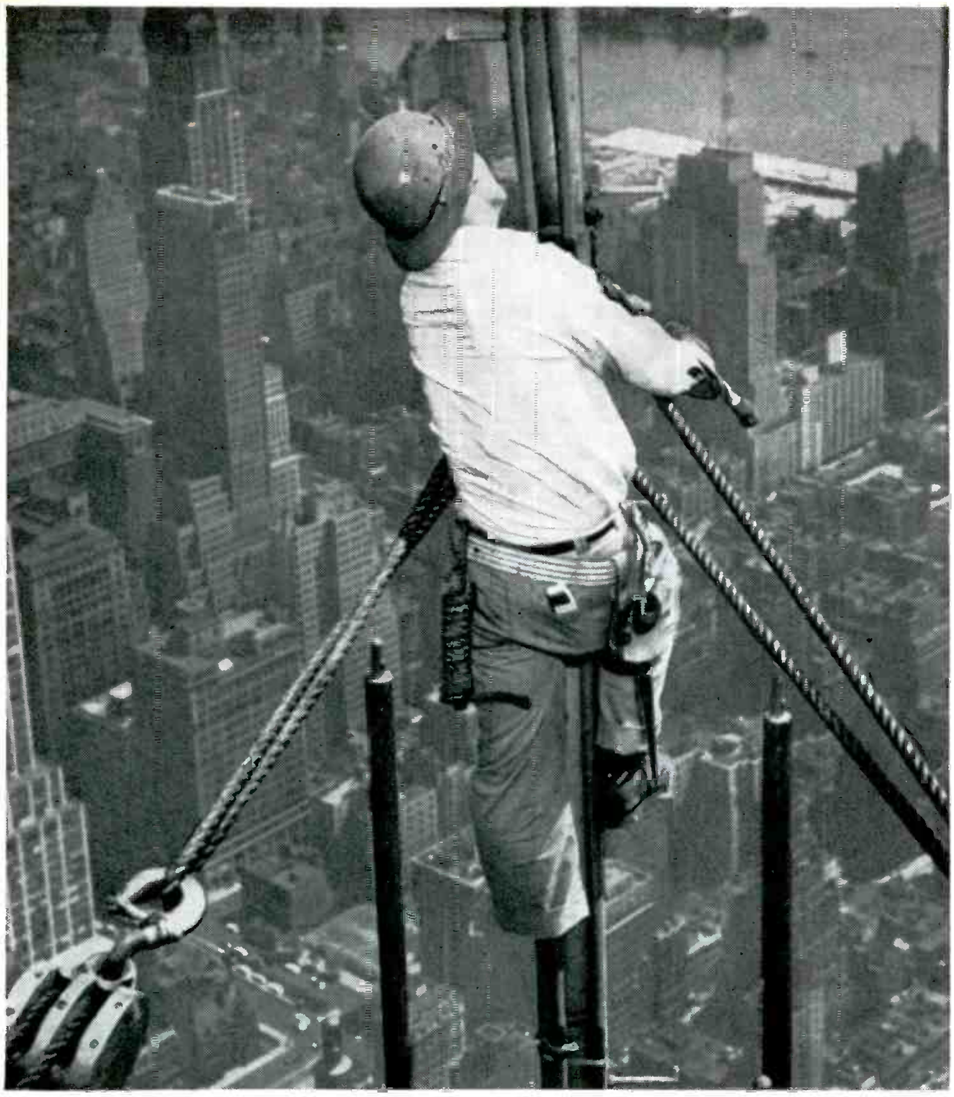
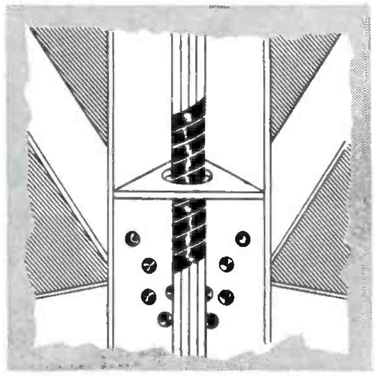


1472 FEET ABOVE THE STREET! Steeplejack protects TV cables from abrasion with "Scotch" Electrical Tape No. 22 on top Empire State Bldg., New York.

HARNESSING CABLES with "Scotch" Electrical Tape No. 22 prior to installation in Empire State TV antenna. Plastic backing of tape resists abrasion, gives dielectric strength of 10,000 volts.



CONTACT POINTS between coaxial cable and structural steel members are cushioned with two half-lapped layers of "Scotch" Electrical Tape No. 22. Tape is tough, stretchy to absorb vibration and sway.

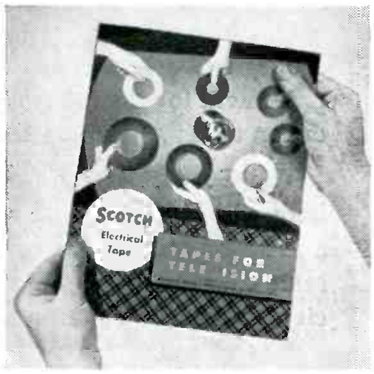
Tough tape cushions cables in world's tallest antenna!

Strong winds and structural sway cause plenty of abrasion problems on TV cables inside the world's tallest antenna on the Empire State Building. Insulation failure can put five stations off the air. Repairs can be costly, dangerous.

Solution? "Scotch" Electrical Tape No. 22 protects all contact points, dependably insulates in all kinds of weather—rain, snow, sleet, salt air and burning sunlight. That's tough punishment for *any* insulation!

And this stretchy, stick-at-a-touch plastic tape is giving top-quality performance on many other installations. It can do a better job for you, too—a faster, neater application—a more lasting job that can save you real money.

Try it today and see. Insist on "Scotch" Brand Electrical Tape—it's the one tape that does the job of two. There's nothing else like it!



FREE BOOKLET "Tapes for Television" gives many time-saving uses of pressure-sensitive "Scotch" Electrical Tapes. Write: Minnesota Mining & Mfg. Co., Dept. E-121, St. Paul 6, Minnesota.

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Electrical Tape No. 22

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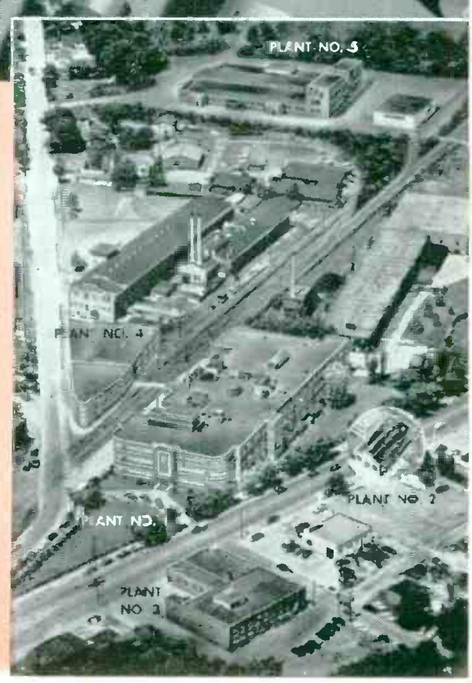
On any problem involving technical ceramics, the cooperation of our engineers is available on request. Their half a century of specialized experience has enabled them to help solve many different design problems. Hand made experimental or test designs can be made quickly and at reasonable cost. When the design has been tested and perfected, quantity production is now more quickly available from our new plants which are in production.



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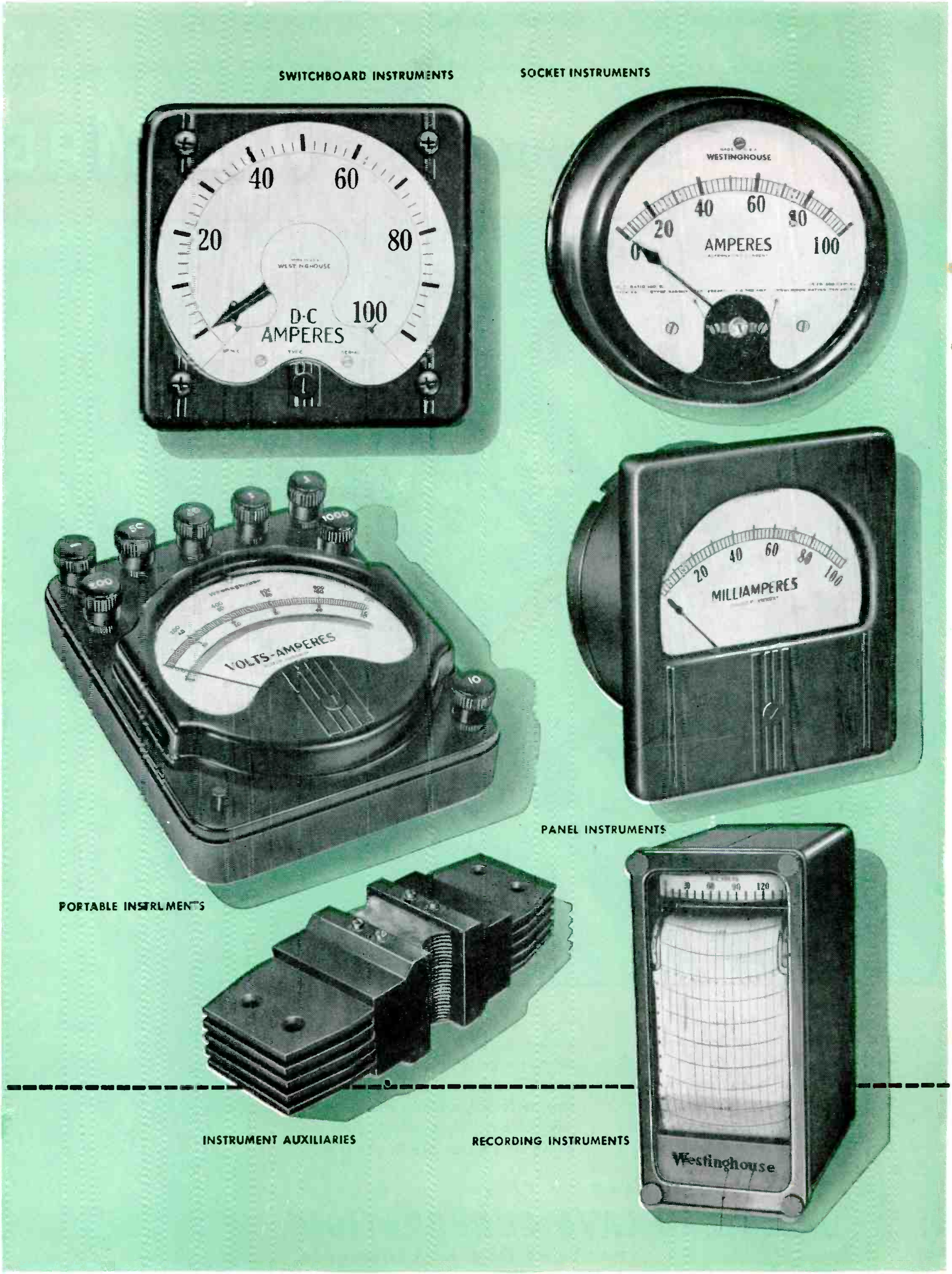
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In the complete line of Westinghouse Electrical Instruments, you're sure to find the *right answer* to your measuring requirements. Moreover, you'll get a wider selection for specific applications, whether it be a-c or d-c current and voltage, single or polyphase circuits, watts or vars, frequency, power factor, synchroscopes, temperature indicators, ground detectors or position indicators.

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YOU CAN BE SURE.. IF IT'S

Westinghouse

INSTRUMENTS

For all your potentiometer needs check this complete L&N line

When you're looking for the right potentiometer to do a specific job, it will pay you to check the *complete* L&N line first. Whether you need the extreme precision of an N.B.S.-certified Wenner, the convenience of a Micromax or Speedomax recorder, or an intermediate instrument, you'll find the characteristics you want in a soundly engineered L&N potentiometer.

More than a score of models comprise the line. Just glance at the table below. There's a potentiometer for practically any purpose—measurement of low voltages, temperature vs. temperature-difference, calorimetry, pH and other emf cell work . . . self-contained portables for temperature and pyrometer checking . . . and the popular, general-purpose Type K's. Models run from highest to moderate precision. They come in convenient single, double, even triple ranges . . . to suit the job at hand.

Naturally, we can't begin to tell you all you want to know in so short a table. So for complete details, let us send you catalog information. Simply write our nearest office, or 4979 Stenton Ave., Phila. 44, Pa.

MODEL	CAT. NO.	PURPOSE	LIMIT OF ERROR† better than .01%	.01%	.02%	.03% to .1%	.3% of range	RANGE
Wenner (N.B.S.-certified)	7559	thermocouple; other low voltages	x					0 to 0.011111 v; 0 to 0.11111 v
	7558	maintain primary standards	x					0 to 0.19111 v; 0 to 1.9111 v
White (Single)	7620	thermocouple voltages; calorimetry			x			0 to 0.01 v
	7621	thermocouple voltages; calorimetry			x			0 to 0.1 v
White (Double)	7622	temp; temp-difference;			x			0 to 0.01 v
	7623	temp-current; etc.			x			0 to 0.1 v
Type K-1	7551	general		x				0 to 0.161 v; 0 to 1.61 v
Type K-2	7552	general		x				0 to 0.0161 v; 0 to 0.161 v; 0 to 1.61 v
Students'	7651	general				x		0 to 0.016 v; 0 to 1.6 v
Indicator *	7655	pH, emf's				x		0 to 1.110 v
Millivolt Indicator *	7659	corrosion testing					x	triple; 0 to 4.1 v total
*	8667	pyrometer check (lab.); temp.				x		0 to 111 mv
*	8656 B,D,X	pyrometer check (plant); temp.					x	0 to 16 mv; 0 to 70 mv; or as spec.
*	8657	pyrometer check (plant); temp.					x	0 to 16 mv & 16 to 64 mv; or as spec.
*	8662	pyrom. check (lab. & plant); temp.				x		0 to 16.1 mv; 0 to 80.5 mv
Temperature Indicator *	8658	pyrom. check (lab. & plant); temp.					x	single; direct-reading temp.
*	8659	pyrom. check (lab. & plant); temp.					x	double; direct-reading temp.
*	8663-CD	body temps.					x	25 to 125 F; −3.9 to +51.7 C
*	8663-X	temp. check (lab. or plant)					x	single or double, as spec.
Panel Indicator *	8671-76	temp. meas.					x	single or double, as spec.
pH Indicator *	7663-A1	pH; emf cell potentials					x	0 to 13 pH; 0 to 1.100 v
Brooks (Deflection)	7630	ammeter, voltmeter, wattmeter test.				x		0 to 153 mv (used with volt boxes and shunts)
	7640	lamp efficiency test.				x		0 to 1.53 v (used with volt boxes and shunts)
Micromax *		automatic indicating, recording, controlling: voltage, temp., pH, etc.					x	as spec.
Speedomax *		automatic indicating, recording, controlling: voltage, temp., pH, etc.					x	as spec.

*Self-contained

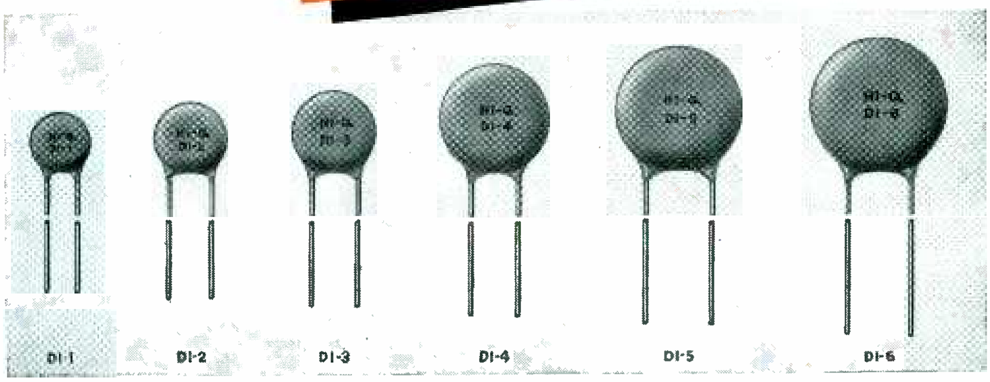
†Under normal operating conditions, except when using lowest part of ranges.

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

LEEDS & NORTHRUP CO.

Jrl. Ad EN(12)

NEW from HI-Q*



Illustrations approximately actual size.

Temperature Compensating DISK Capacitors

Capacity range from 475 mmf on the DI-6 N1400 material down to .3 mmf on the DI-1 size with tolerances of ± 5% or greater. Conservatively rated for working voltage at 500 volts DC and flash tested at 1500 volts DC. Insulation resistance at 100 volts is well over 10,000 megohms. Electrodes are fired directly to the low loss dielectric and are coated with a non-hydroscopic phenolic for protection against moisture and high humidities. Conform to RTMA Class 1 ceramic capacitors.

Extended Temperature Compensating DISK Capacitors

Produced from a recently developed group of extended coefficient ceramics, this type of **HI-Q** Disk permits a much wider temperature compensating range than was possible on the formerly available normal linear temperature coefficient ceramics. Specifically developed for applications requiring a very large gradient of capacity versus temperature. These new **HI-Q** Disks exhibit relatively higher dielectric constants permitting capacities in the range intermediate between the high K and linear or normal group of ceramics. The Q (a minimum of 250 at 1 megacycle) is somewhat lower than the Class 1 ceramics. It has, therefore, not been classified by RTMA as Class 1. However, characteristics are superior to by-pass Class 2 ceramics.

ALL HI-Q DISK CAPACITORS COME IN THESE SIX SIZES

Type	Diameter	Lead Width	Thickness
DI-1	5/16" Max.	3/16" ± 1/16"	5/32" Max.
DI-2	3/8" Max.	1/4" ± 1/16"	5/32" Max.
DI-3	7/16" Max.	1/4" + 1/8" − 0"	5/32" Max.
DI-4	19/32" Max.	1/4" + 1/8" − 0"	5/32" Max.
DI-5	11/16" Max.	3/8" ± 1/8"	5/32" Max.
DI-6	3/4" Max.	3/8" ± 1/8"	5/32" Max.

Companion Lines to the Popular HI-Q By-pass DISK Capacitors

The widely used **HI-Q** By-pass Disks are fixed ceramic dielectric capacitors which meet RTMA Class 2 specifications. They are available in the complete capacity range of from .3 mmf to 30,000 mmf. Standard tolerances of 5% thru 20% where applicable can be furnished.

Write for Engineering Bulletin Giving Details of all HI-Q DISK Capacitors

HI-Q*

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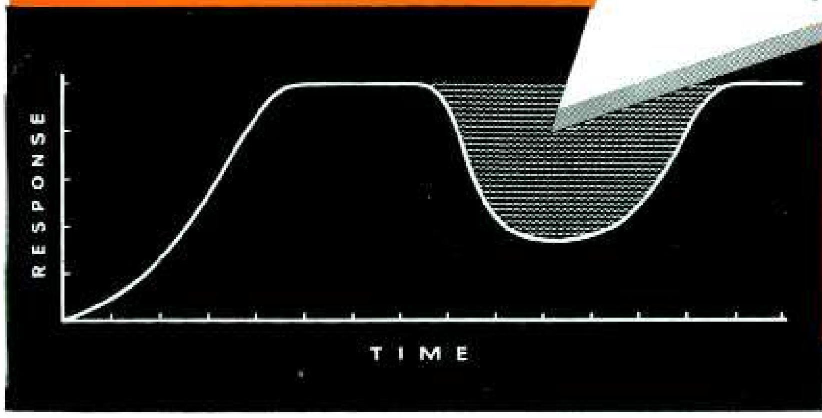

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ROUP	TYPE NO.	FREQ. RANGE	MAX PEAK POWER	LEAKAGE POWER	RECOVERY TIME, MAX
TR	GL-1B63-A	8490-9578 mc	250 kw	30 mw	4 mu sec at —3 db
				MIN FIRING POWER	LOADED Q, TYPICAL
A-TR	GL-6038	9000-9600 mc	100 kw	5 kw	4
	GL-1B35	9000-9600 mc	250 kw	5 kw	4
	GL-1B37	8500-9000 mc	250 kw	5 kw	4
	GL-1B44	2680-2820 mc	1000 kw	20 kw	4
	GL-1B56	2775-2925 mc	1000 kw	20 kw	4
					LEAKAGE ENERGY
PRE-TR	GL-1B38	2700-2910 mc	1000 kw	100 kw	.0002 joules

GENERAL ELECTRIC

186-K7

BUSINESS BRIEFS

By W. W. MacDONALD

LAST MONTH we intimated that the peak of military equipment production, originally planned to occur in mid-1952, might not be reached until much later, and that the resulting continued shortage of most critical materials could easily hold down production of civilian goods in even the last quarter of next year. Since then, additional government appropriations have been added to the already large budget, so relief that seemed unlikely now appears downright impossible.

Cessation of hostilities in Korea could cause a lull in military equipment production, but the lull would probably be quite temporary. People in government whose opinions we have had reason to value in the past say that Washington is now generally convinced that we must have a large military establishment in being, and that nothing, even an election, would more than temporarily delay its completion.

SO FAR, about 60 percent of the military dollar spent for electronic equipment has gone for a relatively small number of highly complex items not lending themselves ideally to mass production methods. Deliveries for such items will probably be stepped up about 300 percent in 1952. Eventually, about 150 different kinds of equipment are expected to account for 75 percent of total planned procurement of military electronic equipment, and many of these do lend themselves to mass production methods.

SPEAKING OF SUBCONTRACTS, Gilfillan has a multi-million-dollar order for CPN-4 ground-controlled-approach radar equipment. There are 159 subcontractors at what is known as the first level; 47 percent have 25 or less employees, 20 percent have from 26 to 50 employees, 16 have from 51 to 100, 11 have from 101 to 200 and 6 percent have over 200 employees.

Involved in the order are such people as Weber Showcase & Fixture, building the trailer body and using 37 subcontractors of its own, O'Keefe & Merritt, making the diesel generator and using 42 subcontractors, and Air Equipment, making cases and reflectors and using 15 subcontractors.

The list of suppliers to the prime contractor and to the various subcontractors reads like a manufacturing who's who in America. We have it, but it is too lengthy to publish here. The business is really spread around.

A GALVANOMETER MAKER tells us that his tiny instrument coils are wound on cores made of *walrus tusk*, this material having fine electrical and mechanical properties. He's had to buy his tusks lately from GI's, who brought them home as souvenirs, because the supply among taxidermists is nearly depleted. Federal law, it seems, protects the walrus to the extent that the beast's choppers cannot ordinarily be imported through normal commercial channels.

TRAVELOG: National Electronics Conference in Chicago pulled 3,200 men (including four from ELECTRONICS) to the Windy City, as against 2,200 in 1950 and 2,000 in 1949. Exhibits overflowed into the halls, a condition that will be rectified in 1952 by shifting the Conference to the Hotel Sherman.

Bulletin board at the Edgewater Beach was crowded with ads for engineers. Electronic Associates booth contained a sign reading: "*Applications for engineering positions gleefully accepted.*" Emerson Radio distributed free morning newspapers to all hotel rooms, affixed a sticker urging engineers to "phone John J. Hopkins if interested in job opportunities." Sid Chertok of Sprague suggested that some enterprising engineer might profitably wear a sandwich-sign

reading: *"My last offer was $XX,XXX. What's yours?"*

WHILE IN CHICAGO we went down to the Hotel Sherman to see what we could see at a joint meeting of the American Institute of Physics, Optical Society of America and the Acoustical Society of America. We saw a great many booths occupied by book publishers (including our own McGraw-Hill boys) and by manufacturers of electronic instruments, with the emphasis in both cases upon nuclear research.

We also saw an awe-inspiring employment agency in operation. As engineers seeking jobs entered a "bargain basement" on a floor below the exhibits they picked up a numbered check reminiscent of those you use to insure being waited upon in turn in a super market. Next they went to a "classifier", who told them how to fill out an elaborate form. Then they waited until their number was called over a loudspeaker. Finally, they went to desks where representatives of 73 companies looking for engineers had interviewers.

Watching the faces of interviewers and interviewees, we had no difficulty determining who was doing the selling.

TORONTO also claimed some of our travel dollars during the month, with the Radio Fall Meeting of the IRE and RTMA the target. (Syracuse gets the meeting in 1952, Toronto again in 1953.)

Trying to read in our room at the King Edward, it occurred to us that engineers primarily concerned with high frequencies were convening under 25-cycle lights.

Among other things, we learned at a session devoted to reliable tubes that the aircraft industry is starting to use the phrase "instrument-quality tubes." At the same session R. S. Bolan remarked that some commercial miniature tubes selling for 80¢ had $4 counterparts for more rigorous service and that the military might eventually need $20 tubes.

We learned, too, from DuMont's John Van Duyne, that tv receiver chassis' generally radiate more interference than the antennas connected to them, that the most serious interference is from the vhf oscillator, that this type of radiation is largely suppressed by the use of properly designed oscillator shield cans, and that the use of metal-textile gaskets between such cans and the chassis very much simplifies assembly in manufacturing.

Several papers presented at the meeting will soon appear in the columns of ELECTRONICS.

CONSERVATION MEASURES in the production of radio and television receivers will result in a saving of 70,000 tons of critical metals in 1951, according to RTMA. In addition to the savings achieved by conservation measures, additional metal will be freed by the 20 percent reduction in number of tv sets made during the year, most industry leaders believing we will wind up 1951 with a total of from 5 to 5½-million sets.

COLLABORATION of several companies in our field, including a steel maker and a plate-glass manufacturer, may result in mid-1952 production of television picture tubes having their glass faces sealed to carbon steel rather than the more expensive stainless variety. Cost of metal would be about ⅓ lower.

POST-FREEZE: GE's Doc Baker guesstimates that two years after the tv-license thaw there will be 248 vhf transmitters on the air (there are 109 now). He thinks there will also be a minimum of 36 uhf transmitters in operation.

Five years after the freeze Doc predicts a minimum of 343 vhf stations and 166 uhf stations.

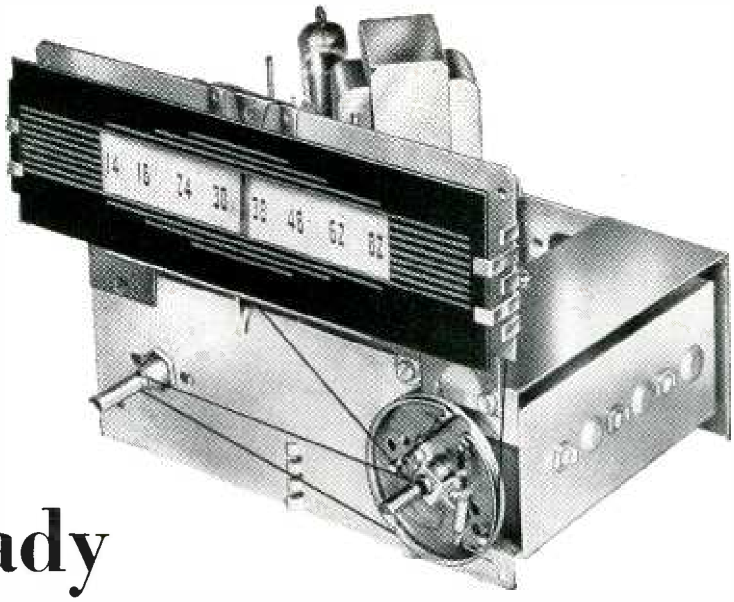
AMONG THE APPLICANTS for television station licenses pending before the bemittened FCC are Mary Pickford Rogers and Bing Crosby.

FCC PUBLIC NOTICE:

DOMESTIC PUBLIC LAND MOBILE RADIO SERVICE ACTIONS: The Commission, by its Chief of the Common Carrier Bureau, took the following actions during the past week:

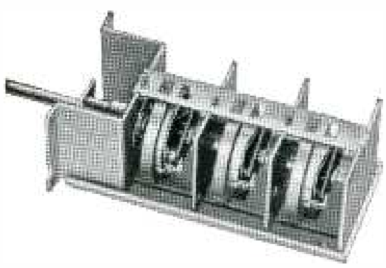
None

UHF



Mallory Is Ready

to equip any receiver for UHF channels



Mallory UHF Tuner

A new version of the continuously variable Mallory Inductuner®, consisting of three sections of variable inductance. Covers the range between 470 and 890 megacycles with approximately 2 micromicrofarads of shunt capacity and in 270° of shaft rotation. Selectivity is excellent over the entire band.

Available now for assembly in your converter or as an auxiliary UHF tuner in your receiver.

Now In Development

A combination VHF-UHF tuner.

The Mallory UHF converter has been designed to permit the tuning of *all* UHF channels by *any* TV receiver, with no sacrifice of VHF reception. Connection to the receiver involves only the power line and antenna leads—no internal adjustments are required. Check the characteristics listed below and in the panel at the left describing the basic tuner.

Physical dimensions 8⅛″ x 6¼″ x 5$\frac{3}{16}$″

Built-in IF amplifier operating at the conversion frequency (channels 5 and 6) makes up for conversion and tuning losses

Temperature compensation and stabilization prevents frequency drift after initial warm-up

Low noise figure

High image and IF rejection ratios

The converter chassis is now available to set manufacturers for assembly with cabinets, dial plates and knobs of their design. Complete technical literature will be sent promptly on request.

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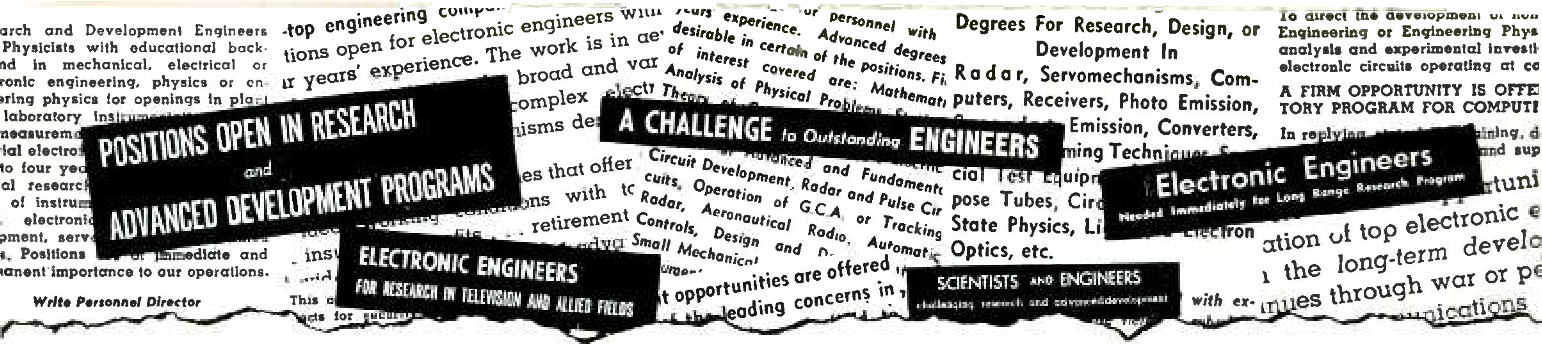
CROSS TALK

▶ **MANPOWER** . . . Bill White, one of our favorite authors, addresses himself herein to the manpower shortage in research and what to do about it (p 82, this issue). Which reminds us to mention a worthwhile booklet just issued by the Bureau of Labor Statistics on the outlook for employment in engineering (Supplement to Bulletin 968, August, 1951). Most educators attribute the alarming decrease in engineering college enrollments, which occurred two years ago, to a booklet from the same source that predicted a heavy oversupply of technical graduates. Seldom has a wrong guess done more harm to the welfare of this country. The new booklet rectifies the error and points out that opportunities for engineering graduates, including women, will be excellent for many years to come. We all should pass on this revised word to young people of our acquaintance lest they be attracted to less rewarding fields.

▶ **COLOR** . . . We wish to applaud Mr. Charles E. Wilson and his advisors in the Defense Production Administration on two counts regarding color television. First, because he asked for a moratorium on color-television receiver production to conserve needed materials and, second, because after due consideration he did *not* ask for a moratorium on further research in color television systems. The latter move, rumored for days after the news first broke, would have put a serious brake on one of the most important programs in electronics. We have an enormously expanded industry which cannot be kept busy, when we come through the peak of the mobilization effort, unless large-scale consumer-goods products are ready to take up the slack. Black-and-white tv may hold the fort for a while, but color television must be ready, in really good shape, if we are to stay healthy. Incidentally, the conference of tv manufacturers with Mr. Wilson revealed that 55 to 65 percent of the engineers of the companies represented are in defense work, only 4 to 6 percent in color television. Of the latter, half are engaged directly on military applications, the rest on civilian apparatus of indirect interest to the military authorities. It is thus amply evident that research on color systems can, and should, continue without harm to our defense effort.

▶ **SCRAP** . . . Our spies tell us that there are still a few plant managers among our readers who have not yet turned in their steel scrap, as urged last month. Come on, you laggards. Get it in!

▶ **JUNCTION** . . . At the National Electronics Conference we picked up some unofficial information about a revolutionary power germanium rectifier, superior to selenium for power supplies in radio and tv sets. By the time this item appears in print, an official announcement may have been made. Meanwhile we mention this device to emphasize the growing importance of the junction technique in semiconductor electronics, as spelled out last month ("The Junction Transistor", p 82, Nov. 1951). The new rectifier is housed in a copper shell, about the size of a quarter. Inside it is a small piece of germanium, about one-eighth inch square, and about 0.025 inch thick, with a pigtail attached. It is reported that this little sliver will provide 200 ma continuously at 200 volts peak inverse, and will carry a surge of 10 amperes! This is not the germanium we're used to, by quite a long sight. How come? Well, rumor has it that the germanium is really two kinds of germanium in intimate contact, a *p-n* junction in fact, actually a junction transistor with one end missing. And this is, or shortly will be, a commercial product at a competitive price. Like we said last month, this germanium is something to reckon with; only it appears to be marching even faster than we thought.



Solving the RESEARCH

Is the current shortage in research manpower the real difficulty? Or are we wasting engineering talent in a low-efficiency operation? At what point should stalemated projects be terminated? The author spotlights present shortcomings and suggests solutions

By W. C. WHITE
Schenectady, N. Y.

A FAMILIAR CLICHE tells us "It isn't the high cost of living that is troublesome but the cost of high living." In the research end of our business, maybe it's not the lack of manpower for research results that is our trouble but rather the lack of results from research manpower.

All this talk of manpower shortage for applied research in electronics stems from the fact that we are not getting the results we hope for fast enough; therefore, the problems and needs are piling up. The obvious course of action is to increase facilities and put more people to work. But perhaps that is not the only or even the best solution.

There is considerable circumstantial evidence that the present efficiency of research in electronics is deplorably low. This, if so, means that it should not be too difficult to solve our acute manpower problem by even a relatively slight increase in efficiency, not to mention a saving in expense.

I have always been impressed by the immunity to criticism enjoyed by researchers. Statesmen, business men, lawyers and even doctors are frequently brought to task for their failures, mistakes and omissions. Not so the research man, who enjoys a reputation for wisdom and good deeds that has seemed to shield him from most adverse comment. It is assumed that he never, or seldom, makes mistakes and only the great difficulty of his problems often prevents their solution. Some researchers themselves believe in their superior wisdom and venture into some other field; only then do they appreciate the favored position they have enjoyed in research. Maybe a step in improving research efficiency is to recognize the researcher's fallibility.

It is a complicated problem. Not only must we define what research results are, but, in addition, we know that very little has been done to measure research output. Even less progress has been made in developing ways of expressing research efficiency quantitatively.

What evidence is there that, in general, our research efficiency is low? As a matter of fact, most researchers admit it, but remind us that even though only a small percentage of projects can pay off, these come through so handsomely that they carry the failures with something to spare.

A Typical Case

Probably the best available evidence of low research efficiency is gained by merely reading the reports issued by laboratories at regular intervals on their progress. Many of these cover unclassified work done in industry, universities and government laboratories and, therefore, are often available.

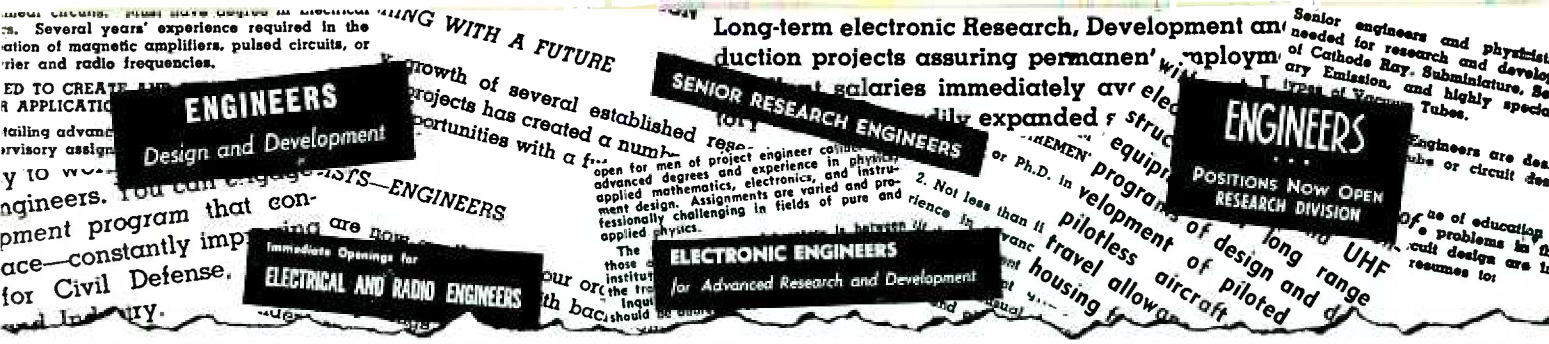
In the first quarterly report of a typical low-efficiency case, the plans for the research are outlined and the equipment being ordered is described. The following two or three reports list the references studied on previous work done elsewhere and give a resume of the problem and present knowledge regarding it. These reports also contain statements on the progress of getting the apparatus into use. A little later, the initial experimental data are given, often with some such statement as "The results were entirely satisfactory except . . . . ." Then the reports begin to tell of the tussle with the key problem or problems. The final, or near final, report makes a brave attempt at showing results, but is characterized largely by what ought to be done next if the project is extended.

Researchers have developed some rather clever techniques for creating the impression that they have accomplished much. Four of the commonly used ones are:

Writing a report that ends with the conclusion that the goal has been reached and the research is therefore completed and the next step is for the engineers and factory men to carry on. This procedure usually emphasizes the great amount of reliable information gained.

Publishing an article in a technical periodical in which "fond hopes are expressed in terms of accomplishment."

Releasing some well-written publicity that "makes" the news-



MANPOWER PROBLEM

papers and hints of much that is to follow.

Making a thorough study of the literature on the subject and then, with little or no experimental work, writing a report. This is often well written and informative but conveys the impression that original work has been done and the results listed were at least in part achieved during the current project.

Evaluating Projects

Some really serious work has been done on the very difficult problem of evaluating research projects[1] and undoubtedly this subject will receive an increasing amount of attention, particularly if the present manpower situation continues or costs become more important.

Part of the problem is that some research workers consider research as an end and not a means to an end; they feel that a given project should go on almost indefinitely. This reminds one of the saying that the primary object of charity is to eliminate the need for itself. Maybe in research we should put more emphasis on getting definite results so that the time, money and effort released can be reapplied to another promising project.

Details of executive and administrative policy can do much to increase the efficiency of conducting research but each laboratory has its own specialized problems and opportunities applicable to its particular situation. However, probably the most important single factor and the one which if wisely applied will bring improvement most quickly is the selection of research projects to initiate or continue. This, of course, involves the all-important selection of projects to drop or on which to decrease effort to release manpower for work in more promising fields.

In judging the worthwhileness of continuing research projects and the results attained, one must always take into account the almost universal human trait of depreciating the work of others in relation to one's own activities. This involves comparing relative judgment and naturally we each defend our own to the limit. Until such time as laboratories have developed for their own use an objective procedure for evaluating projects, the best that can be done is to follow some rather obvious but difficult paths.

Difficult to Terminate

It takes a lot more courage to stop a project that has been underway a few years than to start a new one. To terminate or inactivate a project rather implies that someone has made a mistake in judgment in starting and continuing it; therefore, this is a touchy subject. Furthermore, it is often discouraging to those carrying on the details of the work; they naturally feel their names will be associated with a failure. In particular, terminating a research project carried on under a government contract is not such a simple matter.

There have been instances where a decision to terminate a research project has so stimulated the thinking of those associated with it that real progress has resulted. There have been other cases where, after projects have been terminated for months or even several years, some new concept, material or technique has made it very worth while to reactivate them and valuable results were later achieved. In the meantime, however, there has been no continuing expense for the project and manhours were released for other work of more immediate importance or promise.

If a project has shown but little actual progress in two or three years (exclusive of a mass of data), the chances are not too good that it will be successful in the near future if continued along the same lines. The probability that this is a correct assumption increases as time marches on with no additional useful results.

In his interesting book "Science and Common Sense," Dr. James B. Conant says: "To those who administer funds to support research, let it be continually said: 'Don't appraise the project but the proposed investigator; don't bet on the subject but on the man. And like all successful gamblers, play your hunches heavily; don't distribute your money in small amounts over a wide field.'"

In large laboratories established for many years, there are many solid contributions. These results have come usually from a group of "doers" recognized as such by past performances. These men are also probably the best qualified ones to select and appraise projects in their own highly specialized field. Fewer but more worthwhile projects will increase efficiency. However, no procedure is a substitute for individual initiative applied to the selected projects.

REFERENCE

(1) D. E. Hertz, "The Theory and Practice of Industrial Research", McGraw-Hill Book Co., New York, 1951. An excellent bibliography.

Dielectric Amplifier Fundamentals

Power amplification is obtained through variation of the dielectric of a capacitor in an a-c power circuit by means of a control voltage applied independently to the plates of the capacitor. Materials, circuits, capabilities and faults are discussed

By A. M. VINCENT

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SHORTCOMINGS of electron tubes in certain applications have been listed and relisted in the literature. Though tubes still hold a prominent position in the world today, and probably always will, a vast amount of research is currently being directed toward the development of better substitutes.

One result of this substitute search program is the dielectric amplifier. The principles on which dielectric amplifier operation are based have been known for several decades, but not until recently have the requirements for tube substitutes become stringent enough to warrant investigation of the less-promising tube substitutes, such as the dielectric amplifier.

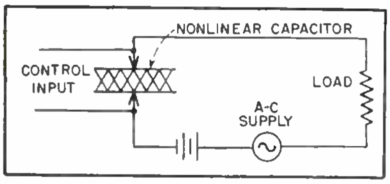


FIG. 1—Basic circuit of a dielectric amplifier

To date, remarkable progress has been made by small groups working without benefit of extensive case histories and past literature. Many of these workers are uncertain about the goal of their efforts, but they are urged on by the memory of the struggle that preceded universal acceptance of vacuum tubes.

The dielectric amplifier is probably best described by pointing out the duality that exists between it and the magnetic amplifier. The dielectric amplifier is an excellent device to supplement the magnetic amplifier in that it is a relatively high impedance device, and it requires the same type a-c supply and rectifiers used in the magnetic amplifier.

Circuitry

Dielectric amplifier operation depends on the control, by a low-power source, of the a-c reactance of a capacitor. These changes in reactance are in turn used to produce changes in the current flowing in an a-c power circuit. The diagram of a basic dielectric amplifier circuit is shown in Fig. 1. The duality between the circuit of Fig. 1 and that of a magnetic amplifier or vacuum-tube amplifier is obvious. In each case a low-power change in one circuit causes a higher power change in another.

In dielectric and magnetic amplifiers, the controlled power source must be an a-c source. In the magnetic amplifier a change in control current changes the permeability of a core material, but in the case of the dielectric amplifier the reactance of a nonlinear capacitor is changed by applying a control voltage across the dielectric, which has the effect of changing the dielectric constant of the material by changing its permittivity. The power supply normally used with the dielectric amplifier is a tube oscillator equivalent in size and power to the rectifier tube used in a regular radio receiver.

A more practical dielectric amplifier is shown in Fig. 2A, where two nonlinear and two linear capacitors are used. The linear capacitors are necessary from the standpoint of balancing the circuit, though the gain of the circuit is reduced by their presence. A push-

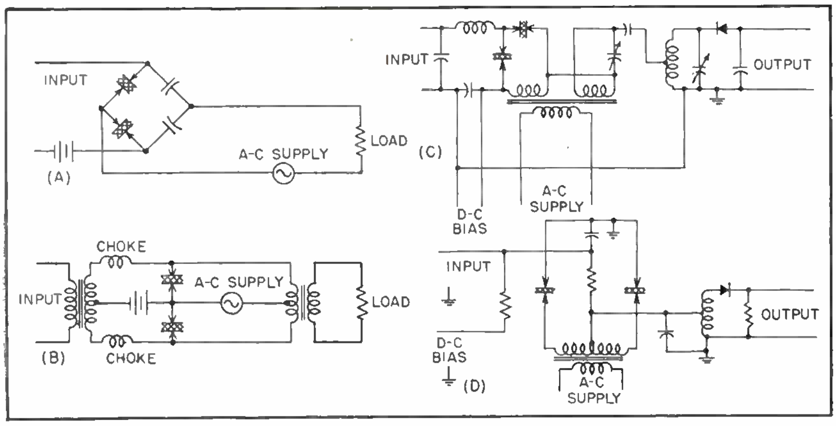


FIG. 2—Practical dielectric amplifier circuits show variations in basic circuit of Fig. 1. Push-pull circuit (developed at C. I. T.) is shown in *B*, while other practical circuits are shown at C (M I T) and *D* (Glenco Corp.)

DIELECTRIC AMPLIFIER PRO'S and CON'S

ADVANTAGES . . .

Ruggedness—practically indestructible
Efficiency—no filament to heat
Reliability—no filament to burn out
Readiness—normally requires no warm-up time
High Gain
Adaptability—small size, variety of shapes
High-Impedance Control Circuit
Size—in r-f applications, requires less space than equivalent tube amplifier
Cost—considerably cheaper than equivalent tube or magnetic amplifiers. Titanate nonlinear capacitors are actually cheaper than either paper or mica
Frequency Range—direct current to r-f

DISADVANTAGES . . .

Frequency Limitations—present state of art indicates upper limit of 10 mc, though this is not definitely determined
Curie Effect—present materials might suffer considerable gain drift. This can be compensated
Loading Effects—a consideration at high frequencies
Power Factor—losses greater than mica or air dielectrics
Impedance Ratio—somewhat limited
Power Limits—closely dependent on frequency
Aging and Lag—differ with different materials
Power Supply—requires high-frequency power supply

APPLICATIONS . . .

Dielectric amplifiers show promise for application as a-c and d-c amplifiers for regulators, relays, limiters, servos, instruments, differential systems, phase shifters, flip-flop's, modulators, multivibrators, sweep generators, filters, thermostats, phonograph pickups, sonar transducers, and many others

pull arrangement is shown in Fig. 2B. Figures 2C and 2D are practical amplifier circuits using radio-frequency power supplies. The circuit of Fig. 2D has a power gain of 15 at 4,000 cps. The voltage gain per stage would of course include any gain realized by a load transformer.

Dielectric amplifier applications parallel many of those of the magnetic and tube amplifier such as a-c and d-c amplifiers for regulators, limiters, servos, instruments, and so on.

Ferroelectric Effect

Certain dielectric materials have hysteresis loops that are very similar to those of magnetic material. The hysteresis loops in the magnetic material are formed because of the magnetic fields within the material. Therefore, those materials are said to exhibit the ferromagnetic effect. Likewise, in dielectric material an electric field produces the hysteresis loops; thus, the dielectric exhibits a ferroelectric effect. This is rather confusing as dielectric amplifiers are often referred to as ferroelectric amplifiers, although no iron is involved.

The ferroelectric effect utilized in dielectric amplifiers involves the alignment of electric dipoles of atomic ions by mutual interaction in nonmagnetic crystalline structures. Ferromagnetic effects employed in magnetic amplifiers depend on the parallel orientation of electron spins of magnetic dipoles in magnetic material.

In other words, individual molecular displacement caused by voltage strains tend to change the permittivity of the dielectric in certain ceramics.

Materials Used

Materials which show the most promise, at present, for application in dielectric amplifiers are barium titanate and certain combinations of strontium and barium titanates, and combinations of barium and lead zirconates. Figure 3 shows a typical curve of dielectric constant versus voltage. It will be noticed that small changes in field strength are capable of causing large changes in dielectric constant.

The dielectric constants of these materials are also greatly affected by temperature, as shown for several typical combinations in Fig. 4. In some cases this great temperature dependence can be used to advantage; and in others compensation can be applied. It is possible to "build" a dielectric to operate over almost any range of temperature by adding appropriate amounts of other materials such as strontium titanate, as indicated by the curves.

Greater capacitance change can be obtained at the expense of linearity, and vice versa, by changing the operating temperature or the ratio of the materials used in the dielectric. Figure 5 illustrates four different ranges of control made available by shifting the operating temperature of a 70-percent barium titanate 30-percent strontium titanate dielectric.

The ceramics used in the nonlinear dielectric capacitors are hard, similar to porcelain, thus durable and have the ability to withstand high temperature (1,000 deg C). The ceramics can be machined accurately and made into a variety of shapes and sizes. The present titanates have a breakdown voltage of the order of 300 volts per mil at room temperature. Typical dielectric constants are 1,500 to 10,000 at the Curie points.

Curie Point Dependence

The Curie point is a major consideration, when working with ceramics, as the greatest gain is obtained very near this point. If this varies with temperature, it follows that the gain is also affected. Amplifiers are designed to work on the steep slope just above the Curie point because the negative side is

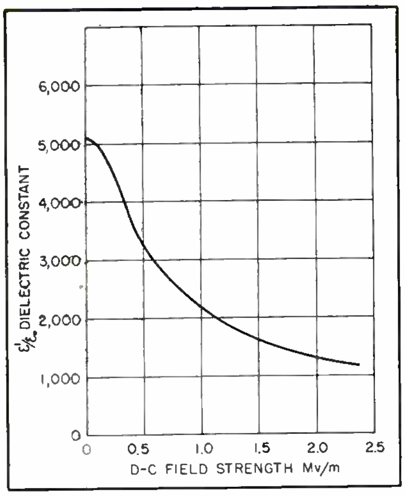


FIG. 3—Relationship between dielectric constant and control voltage

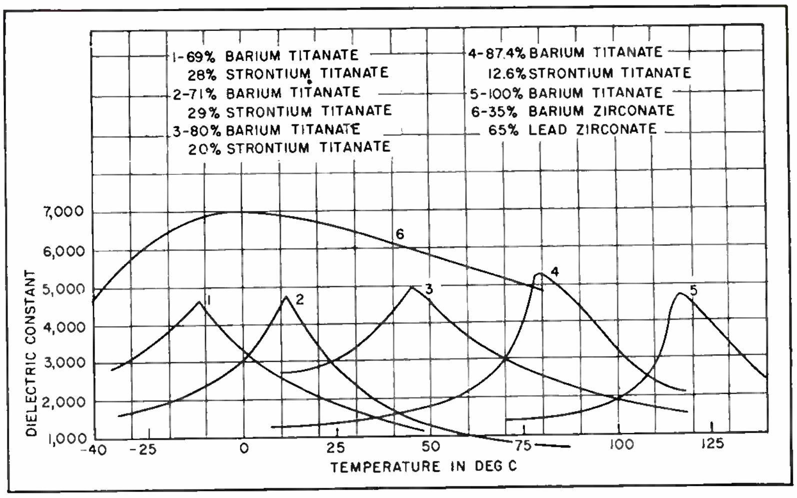


FIG. 4—Temperature has a marked effect on characteristics of nonlinear dielectric materials as shown by curves plotted at General Electric

usually less stable due to the greater piezoelectric effects, time constants, drift, and hysteresis loss. In circuit applications where low hysteresis is important, titanates should only be worked above the Curie point.

The disadvantage of the Curie point variations is less serious than it appears since the negative slope can be used in spite of its deficiencies for compensation purposes.

Two dielectrics may be used, one operating on the positive side of its Curie point and the other operating on the negative side, to compensate for each other over small temperature ranges.

An alternate approach to solving the temperature stabilization problem is to apply temperature control. The most convenient arrangement is to use a piece of the dielectric material whose temperature is to be controlled as the temperature-sensitive element in an automatic thermostat. Shifting the Curie point by changing the ratio of ingredients also provides a means for controlling temperature effects.

Some materials do not depend on the Curie point operation. Barium-lead-zirconate is an example. Figure 4 also shows the temperature versus dielectric curve of material.

It will be noticed that this material has a high dielectric constant comparable to the titanate compositions. The lead zirconate compositions have a slightly lower possible gain, but a more stable gain than the titanate combinations. Indications are that lead zirconate compositions will be used in many applications now dominated by the titanates, particularly where stability is important.

Theoretical Operation

Figure 6 shows idealized characteristic curves of both magnetic and dielectric materials as applied to amplifiers. From Fig. 6A it can be seen that the basic curves are of the same general form. The amplifying properties of dielectric or magnetic materials depend upon the changes of capacitance and inductance. These changes are shown in Fig. 6B. The changes of capacitance and inductance change the reactance. Figure 6C shows that the dielectric and magnetic characteristics differ with relation to their respective impedance versus input. As the input to the magnetic amplifier increases, the reactance decreases while in the dielectric amplifier the reactance increases as the input is increased. This fact causes the simple magnetic and dielectric amplifiers to be out of phase by 180 degrees.

Figure 7 shows transfer characteristic curves of the dielectric, magnetic, and tube amplifiers for comparison. With zero bias, the operating point of the dielectric amplifier would be the low-impedance point as indicated by point r; in the magnetic amplifier (without self saturation), the zero bias (point p) would be a high-impedance point; whereas the tube would have zero bias at r, the low-impedance point. Under the above conditions, all three amplifiers would function differently. Only the tube amplifier would reproduce a sine wave in its original form. To do this with the tube, the grid source would have to be well regulated as the grid would be drawing current in the positive region.

Biased at the zero point, both the dielectric and the magnetic amplifier would act as frequency doublers; their action however would be 180 degrees out of phase with one another with the same bias. (The bias is shifted in Fig. 7A to same phase.) This doubling action is illustrated in Fig. 8 for the dielectric body. The response of the magnetic material would be somewhat along the same lines. The fact that the dielectric and magnetic amplifiers are out of phase is often used to obtain single-stage inversion.

To compare the three types of amplifiers on an equal basis would require that a bias be added to shift the operating point to the center of the curves for class-A operation as indicated by point q (Fig. 7). To equalize the comparison further, the plate supply of the tube should also be a-c as the other two devices will not work with d-c. Further analysis would then follow that of conventional class-A amplifiers, functioning as modulators.

A further increase in efficiency and fidelity would result by operat-

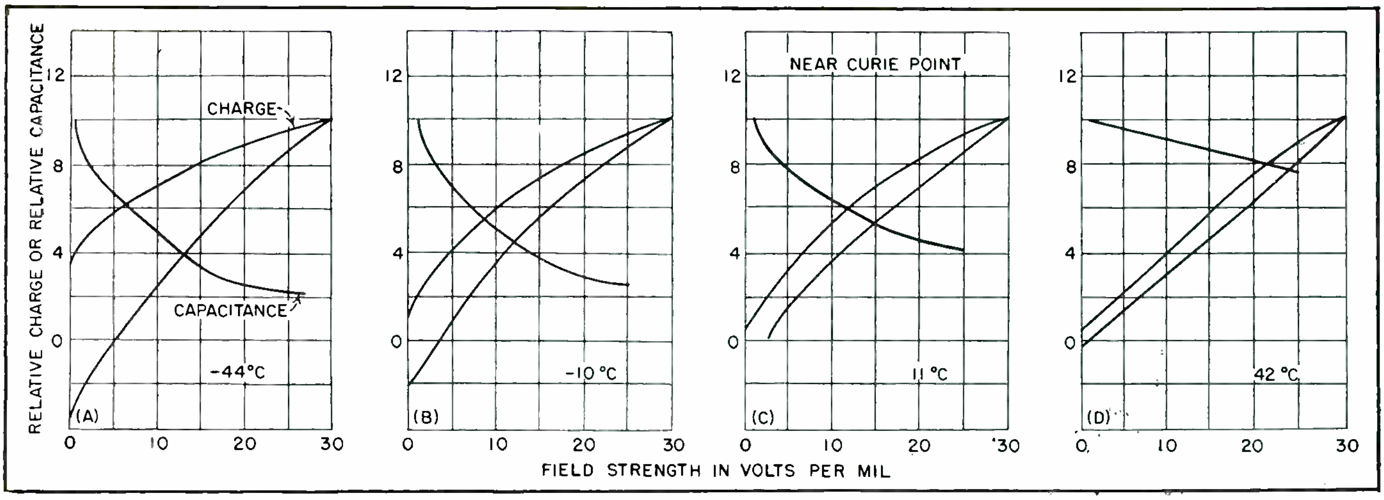


FIG. 5—Different ranges of control are made available by shifting operating temperatures. Higher gain may be obtained at the expense of linearity, and vice versa, by suitable adjustment of operating temperature

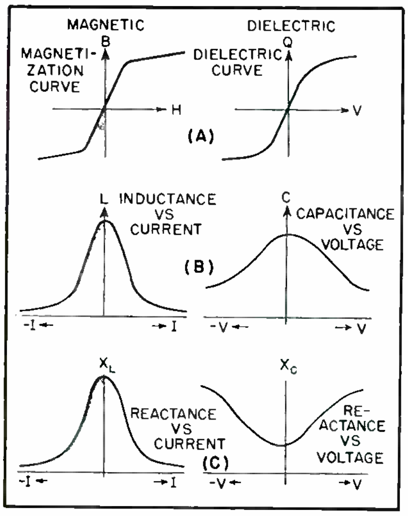


FIG. 6—Idealized curves of dielectric, magnetic and vacuum-tube amplifiers

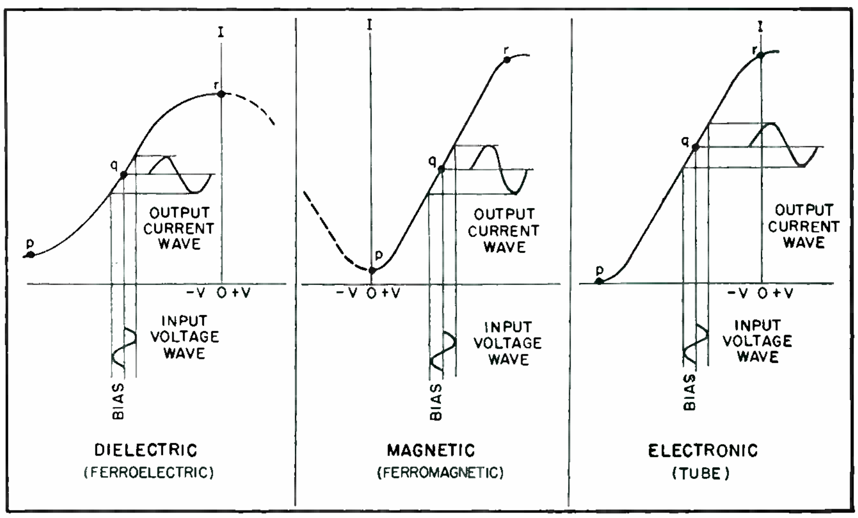


FIG. 7—Transfer characteristic curves for three basic amplifiers show impedance of dielectric and magnetic amplifiers at zero bias to be high and low respectively

ing the amplifiers at cutoff, point *p*. A half-wave replica of the exciting sine wave would result. This would be satisfactory for most radio-frequency applications as the fly-wheel effect of a tuned circuit, somewhat analogous to a class-C radio-frequency amplifier, would tend to reform the lopsided wave back into sinusodial form. However, most engineers prefer to use the dielectric in push-pull, utilizing both halves of the wave. Regeneration and inverse feedback can be used to modify the performance like any other amplifier.

In regard to Fig. 7A, the dielectric was biased negatively for purposes of comparison with the tubes and magnetic amplifier, to cause the same phase relationship. The broken line shows that both the dielectric and magnetic amplifiers could be operated with an opposite bias. Figure 8, lower right, further emphasizes this. If a zero bias inductance curve of a magnetic amplifier were plotted against the sine wave of Fig. 8, it would be similar to the dielectric curve except the lobes would be more pronounced. These curves illustrate the inherent frequency doubling characteristics of the devices.

When rectifiers are used in magnetic and dielectric circuitry to introduce self saturation, the reverse curves need not be considered because current cannot flow in the opposite direction.

The curve of Fig. 3 shows dielectric constant versus voltage of a titanate body currently in production. This titanate was operated at 25 deg C just to the right of its Curie point. It will be noted that the dielectric does have a tendency to flatten or saturate if enough bias is applied. This makes it possible to work the dielectric as a biased class-C amplifier. It should be noted that the maximum change of the dielectric in Fig. 3 is only 5 to 1, but bodies mixed to further emphasize the nonlinear qualities have a dielectric constant ratio of 10 to 1 or better.

Frequency Range

Figure 9 shows resonance peaks in the curve of capacitance plotted against frequency. The graph also shows a rather pronounced resonant dip (low capacitance) just beyond 10^7 cycles which may indicate possible radical, or unreliable performance beyond that frequency. A different size or type of dielectric changes this curve considerably. Impurities also enter into the picture. This curve was plotted several years ago, using dielectrics designed for standard capacitors. This was also plotted with capacitance measuring equipment attached which may have reflected some of the isolating radio-frequency choke characteristics. Later research does, however, bear out the fact that there may be a crystalline resonating period somewhere in the high-frequency end of this curve using currently available titanates which may determine the upper operating limits.

General Comments

The dielectric amplifier is basically a high-impedance voltage amplifier, the magnetic amplifier a relatively low-impedance device, while the tube can be designed for either.

Because the tube can be designed for both high and low impedances, it would normally be more compatible to either amplifier in most applications. It is obvious from the above that neither the dielectric nor magnetic amplifiers have the versatility of the electron tube. All three devices have their low-level amplification limitations—the tube by shot noises, the magnetic by Barkhausen and thermal noises and the dielectric by molecular disturbances caused by both electrical and thermal action. Barkhausen and thermal effects do limit the low-level signal amplification of the magnetic amplifier to around 10^{-19} watts. The low-level limit of the dielectric amplifier has not been determined to date as the basic ceramics vary considerably, depending on the compositions used to bring out different characteristics.

Preliminary tests indicate the magnetic amplifier to be more suitable for the lower frequencies although laboratory magnetic amplifiers are now on life tests functioning at 200 kc with gains of 150 per stage, excluding gains realized in the load circuit. Other tests with smaller gains are being made at 1 mc. Figure 10 shows how dielectric amplifiers might be used in a broadcast receiver. The dielectric is also an excellent d-c amplifier.

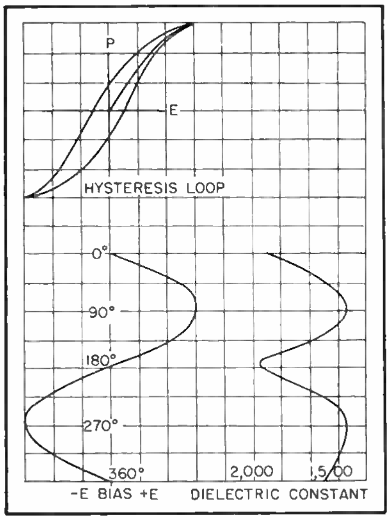


FIG. 8—Dielectric characteristics of barium titanate

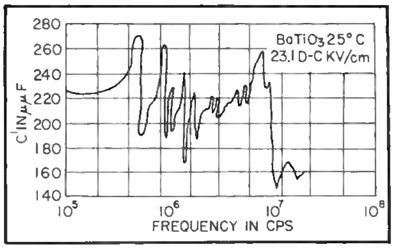


FIG. 9—Present indications show dielectric amplifiers may be limited to 10^7 cps

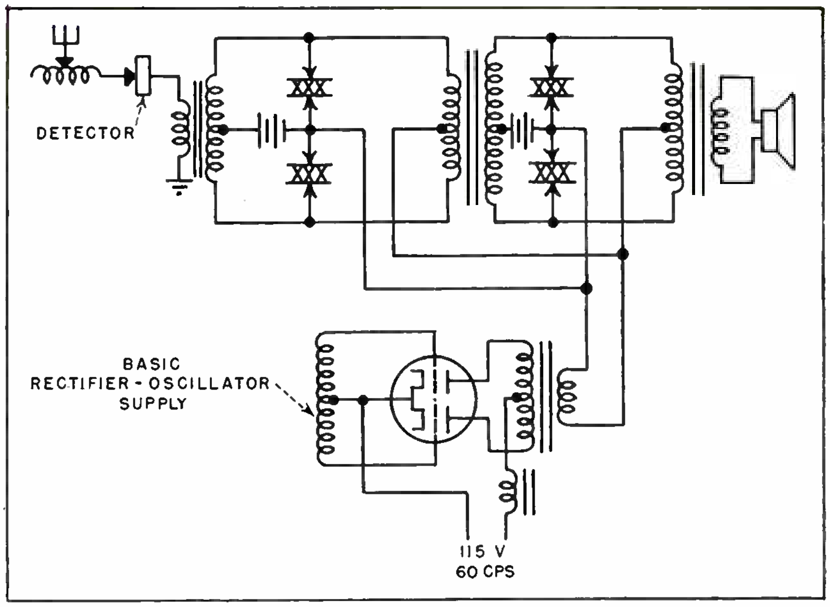


FIG. 10—Dielectric-amplifier broadcast receiver less demodulation and filtering

State of the Art

Laboratory breadboard amplifiers, using presently available dielectric materials, show power gains up to one million per stage, with indications of a possible upper frequency limit of around 10 mc. This material does, however, respond to modulations up to 3,000 mc.

It must be understood, however, that these devices are in about the same stage of development as the electron tube was just prior to World War I. Many radiomen can still remember when it was necessary to remove the bases from electron tubes to permit them to function at 40 meters as late as 1925.

Research is continuing, not only with different combinations of mixtures as previously mentioned, to produce certain tailor-made ferroelectric effects, but is also modifying some of the mixtures to the extent of transforming insulators to exhibit both ferroelectric and magnetic effects.

No claim is made that the dielectric amplifier will provide a cure for all electronic ills. But, in certain applications where the advantages outweigh the disadvantages, the dielectric amplifier with its extreme ruggedness and reliability will no doubt be put to use on a large scale.

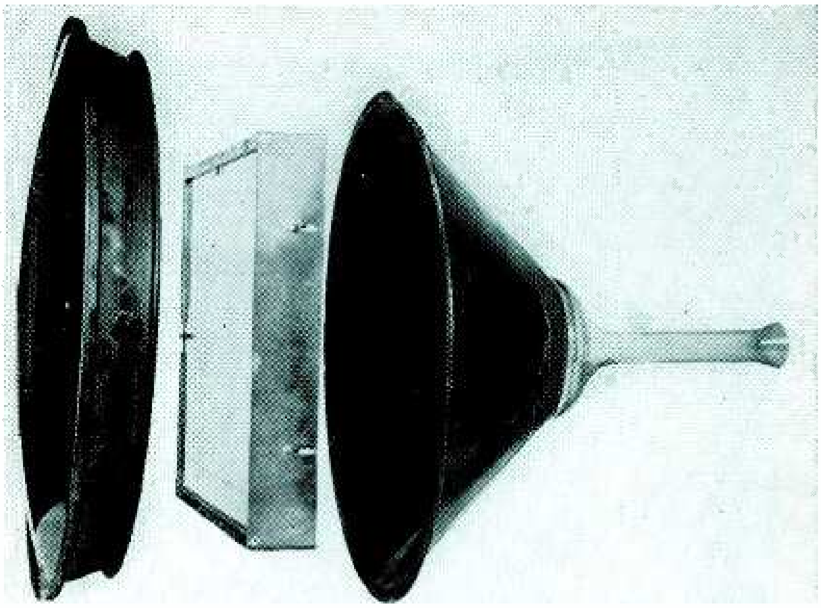
The material presented in this article is based on notes condensed from progress reports by various educational and industrial laboratories engaged in the work described under contract with the Office of Naval Research.

Phosphor-Strip TRICOLOR TUBES

New color-tv tubes designed by E. O. Lawrence employ grid of vertical wires to focus and deflect electron beam which excites color strips sequentially or simultaneously. New designs produce 12 by 16-inch image. Single-gun version requires 440 volts for color deflection

FOLLOWING the initial announcement of the new Lawrence tricolor picture tube, reported in these pages[1] last month, engineers of the Chromatic Television Laboratories have released information on the first production models of two tubes, which they plan to produce in small quantities at the CTL plant in Stamford, Conn.

The accompanying pictures show the constructional features of the tubes, which will be mounted in a 22-inch metal-cone envelope. Since details of the method of constructing the new screen assembly have not yet been made public, the photographs show the screen assembly of the initial model of the tube[2], as produced by Professor Lawrence.

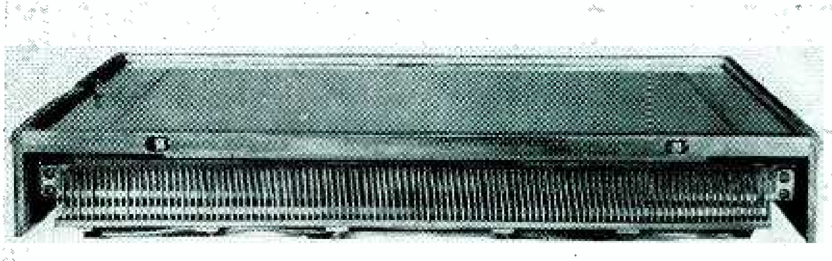


Exploded view of proposed production model of Lawrence tube. Viewing screen and wire grid are mounted as subassembly within 22-inch metal shell

Construction

The heart of the new tubes is the screen assembly, details of which are shown in Fig. 1. The viewing screen is a flat plate of glass on which are deposited 800 vertical strips of phosphor which fluoresce individually in the primary colors, green, red and blue. There are 400 green strips, each 0.0135 inch wide, and half as many red strips and blue strips twice as wide, as shown in Fig. 1. The rear surface of the phosphor is aluminized.

Parallel to the phosphor screen and 0.4 inch behind is a grid of 400 vertical wires. The grid is so mounted that the wires are accurately aligned with the phosphor strips.



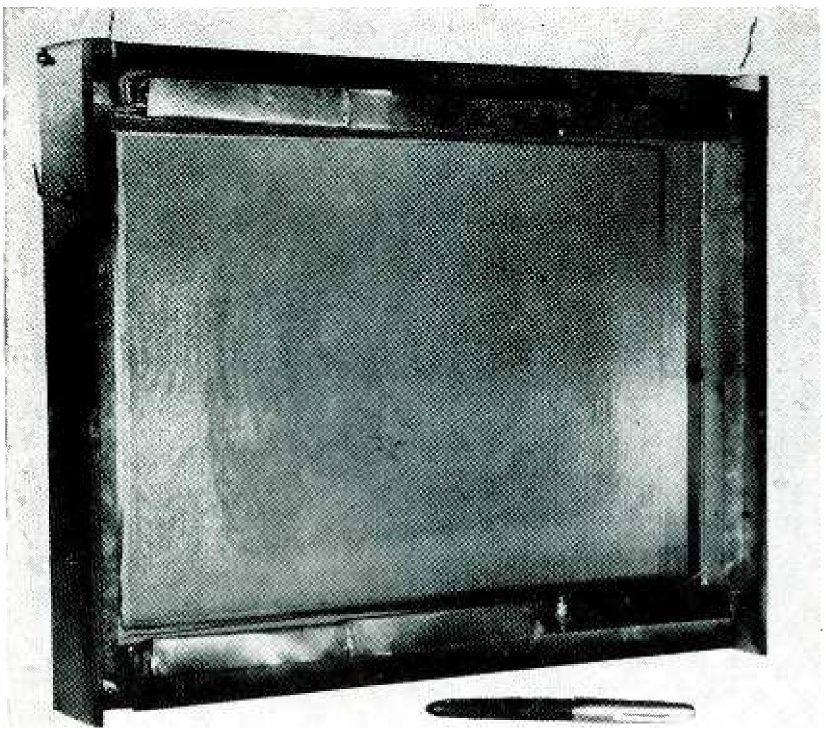
Edge view of screen assembly showing method of suspending grid wires on two sets of metal pins

The grid wires serve three purposes: (1) they deflect the electron beam to the left or right as it passes between them, thus causing the color to shift from green to red or to blue; (2) they serve as one electrode of a post-acceleration system, which adds substantially to the brightness of the image available with given power in the scanning system; and (3) they compress the beam into an elliptical cross-section less than 5 mils wide, thus assuring that the beam falls only on the strip of the desired color.

The grid wires are 8 mils (0.008 inch) in diameter and are spaced 40 mils on centers. The space between adjacent wires covers a green strip and half of the adjacent red and blue strips. Actually the space occupied by these portions of the three strips is 40.6 mils, so the phosphor screen is about a quarter-inch wider overall than the wire grid. The phosphor strips at the outer edges of the screen are thus displaced outward from the corresponding grid wires, to accommodate the angle of the scanning beam at maximum deflection.

A single electron gun, of special design to assure sharp focus at low accelerating voltage, is to be used in one production model. This gun operates at a second-anode voltage of 3,500 to 4,000 volts. This low value serves to lower the scanning power required, but a low value is required in any event to permit the grid-wire focusing action (Fig. 1) to take place. Optimum focusing takes place when the second-anode voltage of the gun is one fourth of the total accelerating voltage.

The remaining three-quarters of the acceleration is provided by a post-deflection voltage of 10,500 to 12,000 volts, the exact value being three times the gun accelerating voltage. The post-deflection potential is applied between the grid wires and the aluminized backing of the phosphor screen. The total cathode-to-screen voltage is, accordingly, 14 to 16 kilovolts.



Rear view of screen subassembly, looking through wire grid. Phosphor strips are deposited on glass plate through silk screen

Color-Deflection System

The wires in the grid are divided into two groups, as shown in Fig. 1, alternate wires being tied together and connected to two terminals to which the color-deflection voltage is applied. The two sets of wires display a total capacitance of 1,020 $\mu\mu$f which must be charged in the process of applying the color-deflection voltage. When no voltage is applied between the sets of grid wires, the beam passes undeflected between them and hits the green strips.

To create red light, a color-deflection voltage of 440 volts peak is applied between the sets of grid wires. This voltage causes the beam to move away from the negatively-charged wires and toward the positive ones. The beam is deflected to the left when it lies to left of a negative wire, and to the right when it lies to the right of the same wire. The direction of deflection thus alternates across the grid, since the polarity of adjacent wires is opposed.

The red and blue strips are twice as wide as the green strips to give an equal amount of area for each color on the plate for monochrome display.

To secure blue light, the polarity of the voltage applied to the sets of grid wires is reversed. To change from blue to red, the total color-deflection voltage required is 880 volts, peak-to-peak.

The color-deflection voltage is applied in synchronism with the color sequence used at the transmitting camera. In the field-sequential (CBS) system, successive fields are scanned wholly in one primary color at 144 fields per second. Thus the color deflection is positive for 1/144th second to produce red, neutral for the same length of time to produce green, and negative for that time for blue. The whole color-deflection cycle consumes 3/144 second, and the fundamental frequency of the deflection wave is 48 cps.

Power Required

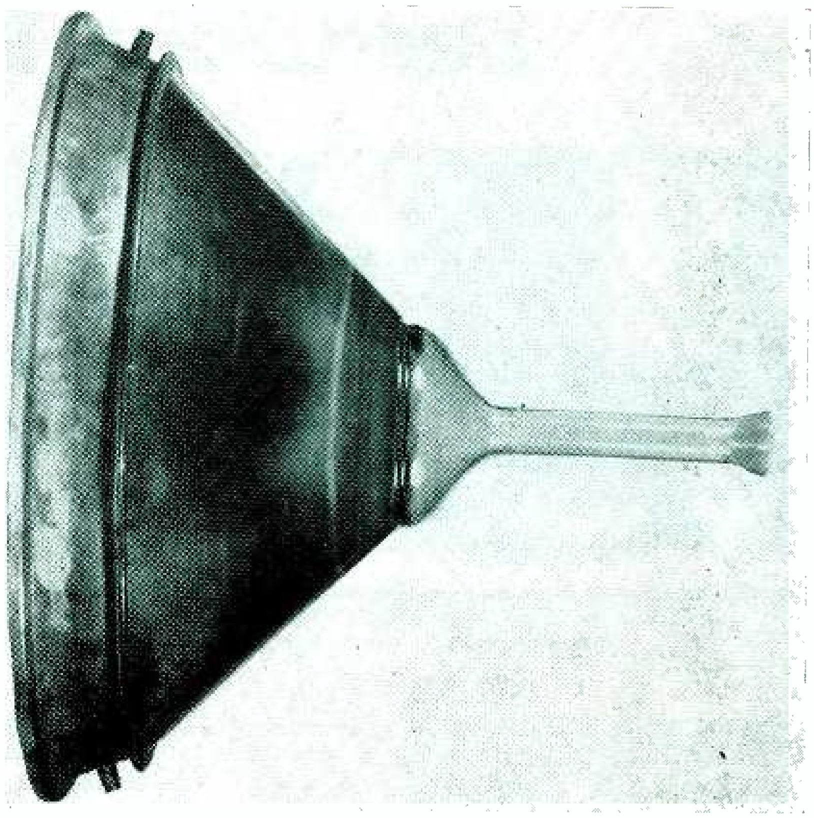
The reactive power for color deflection in this system can be computed simply on the basis that the major part (75 percent or more) of the power resides in the fundamental frequency. Then the current generated by 880 volts peak-to-peak across 1,020 $\mu\mu$f is $880/(2\sqrt{2}) \times 2\pi\ 48 \times 1{,}020 \times 10^{-12} = 96$ microamperes and the reactive power is $880/(2\sqrt{2}) \times 96 \times 10^{-6} = 3.1$ reactive milliwatts.

The single-gun tube may also be used for dot-sequential color. The deflection voltage is a sine wave at the color subscarrier frequency, which is 3.89 mc according to the tentative NTSC specifications. Since the reactive power required increases directly with the color-deflection frequency, the power in this case is $3.89 \times 10^6/48 = 810{,}000$ times as great, or about 2,500 reactive watts.

This large requirement for reactive power is avoided in a three-gun form of the tube recently announced by CTL. As illustrated in Fig. 2, three electron beams are formed in this tube by three electron guns lying in a horizontal plane and so aimed that the beams converge on the space between two grid wires. The focusing action then applies individually to all three beams, which pass through the wires to the respective phosphor strips. In this case the strips are all of the same width and are arranged in the order, red, green, blue, red, green, blue, etc. No color deflection is required and all the grid wires are connected together. This type of tube can form three primary-color images simultaneously, and can operate readily with the constantluminance, a symmetrical type of color sampling specified in the NTSC field-test specifications.

Critical comment on the performance of the Lawrence tube has pointed to the desirability of higher resolution in the grid and phosphor-strip system to insure that the image displays all the detail inherent in the color television signal applied to it. It is planned to produce, at a later date, a tube having a larger number of wires and strips, perhaps twice the present number. This prospect raises the question of the color-deflection voltage required if the wire grid has a substantially larger number of wires.

The capacitance displayed by the grid varies inversely as the logarithm of the wire spacing divided by the wire radius, whereas the required deflection voltage decreases directly with the wire spacing. As the number of grid wires is increased, these two tendencies oppose each other so far as the reactive power requirement is concerned. It can be shown, in fact, that for a given tube size, the required color-deflection reactive power actually decreases as the resolution of the image is increased by increasing the number of grid wires and phosphor strips.—D.G.F.



When completely assembled, the two-part metal shell encloses the screen assembly. The ports visible in the photographs are used for pumping down the experimental model of the tube

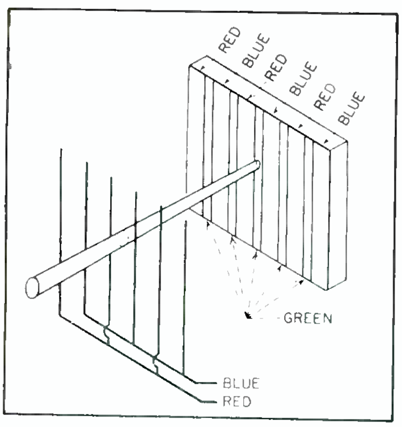


FIG. 1—In the single-gun tube, the beam is deflected to left or right to change colors. The projected electron beam is compressed as it passes between the grid wires

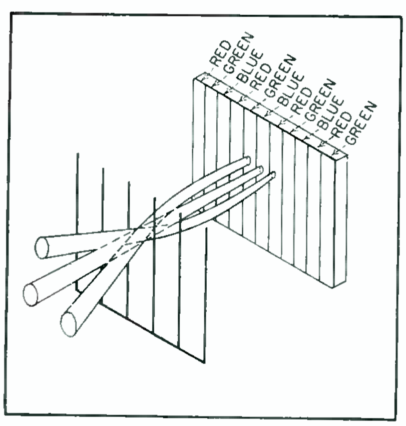


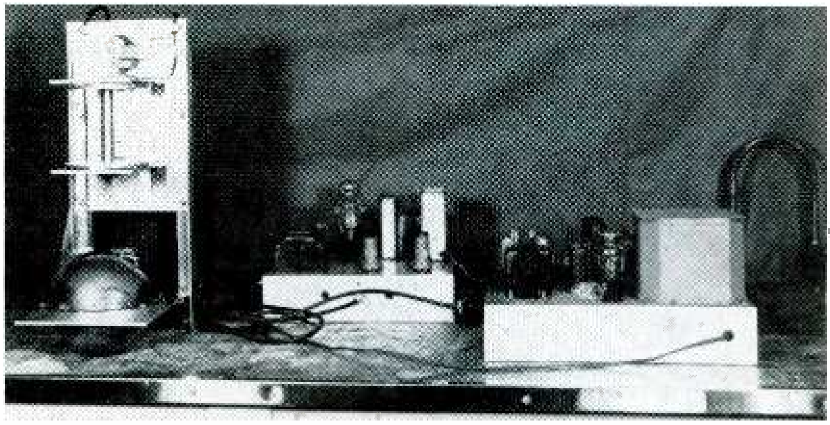
FIG. 2—In the three-gun version of the tube, three beams are aimed at the space between two grid wires and are focused simultaneously on the respective phosphor strips

REFERENCES

(1) Crosstalk, "Color Lines", ELECTRONICS p 81, Nov. 1951 and News of the Industry "Lawrence Tube Demonstrated", p 146, same issue.

(2) A photo of the initial form of the tube appears on p 146, ELECTRONICS Nov. 1951.

Feedback Photometer



Overall photograph showing optical system and associated electronic circuitry. The two source lamps are driven in out-of-phase oscillation through a push-pull 6L6 amplifier when the circuit is not balanced

By JOHN E. TYLER

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PHOTOMETRIC instruments, in general, suffer either from instability and drift or from objectionable complexity and cost. The arrangement shown in Fig. 1A offers several advantages where accurate comparisons of light values are to be made quickly and with a reasonable amount of equipment.

In this circuit the battery maintains the light output of the two lamps above zero. A current in either direction in the transformer operates to support the battery current in the circuit of one lamp, and at the same time bucks the battery current in the other circuit.

An alternating current in the transformer will therefore cause the lamps to flicker in opposite phases. At first glance this looks like an ideal way to avoid the complex and expensive optical systems sometimes used to achieve stability. Unfortunately there are a few bugs. When equal amounts of light from each lamp reach the phototube, the signal is not zero. In fact, it is quite substantial and double the frequency of the input signal.

There are several reasons for this. For example, the heating rate of a tunsten lamp does not match its cooling rate nor will the color temperature of the hotter bulb match that of the colder bulb. Of even greater importance is the fact that the relation between light output and voltage is nonlinear.

To use this circuit, these objectionable effects must be minimized. One can use lamps with fine filaments designed for rapid cooling and work at high temperatures and low frequencies but there will still be trouble at the balance point. If this is to be a null instrument, the signal at balance must be zero.

Feedback

If the input signal to the transformer is a 60-cycle signal, the output signal from the phototube in the out-of-balance condition will be a 60-cycle signal also. What will happen if the phototube output is fed back to supply the transformer as shown in Fig. 1B? The phototube signal can exist in one of two

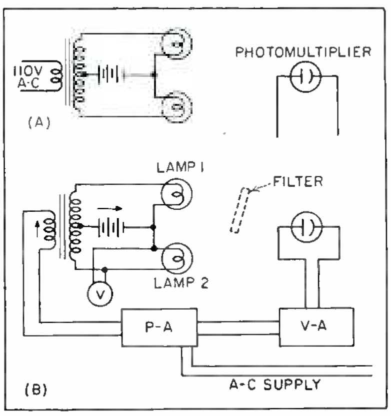

FIG. 1—Basic schematic shows how two lamps are made to oscillate out of phase when light reaching phototube from each is not equal

phases which are 180 deg apart. To understand the operation of this circuit, consider a short unidirectional pulse (indicated by the arrow) in the primary of the transformer. If the battery current is as shown, this pulse will induce a pulse in this same direction in the circuit of lamp 2 which will make lamp 2 brighter. Simultaneously, it will induce a pulse in the opposite direction in the circuit of lamp 1 which will make lamp 1 dimmer.

The net effect on the phototube is zero if the pulse is small and the original illumination from the two lamps was the same. But with the filter in the beam from lamp 1, the net effect will be an increase in light on the phototube. This gives a new current pulse in the transformer which can be in either direction depending upon the manner of connecting the phototube to the transformer. If it is in the same direction, lamp 2 will become still brighter, the net illumination will build again causing a third pulse, and if something else does not put a stop to it, the lamp will burn out. Fortunately it does not burn out. Its resistance is, of course, increasing as its temperature increases requiring higher and higher voltages to maintain the current. Since no such voltages are available, the circuit soon ceases to build.

At this point, the battery takes over. Lamp 1 has been driven well below battery voltage by the series of pulses but can now return to normal brilliance. The first move in this direction, however, starts the cycle in reverse. In short, this circuit will oscillate as long as the phototube sees unequal beams. If some means is provided for reduc-

Speeds Light Measurements

Two lamps in out-of-phase oscillation indicate bridge unbalance and also serve as two-light source for comparison measurements. Versatile optical system provides means for spectrophotometric, colorimetric, reflectance and transmission measurements

ing the beams to equality, Polaroid disks, for example, the circuit can be brought to balance, and the angular rotation of the Polaroid will be a measure of the transmission of the filter.

If one goes beyond the balance point, a new situation exists. Going back to the previous analysis, the initial pulse still causes lamp 2 to increase in brightness, but the net effect on the phototube is a reduction in illumination. The new pulse therefore operates to reduce the brightness of lamp 2 and hence the building process will not occur and the circuit will refuse to oscillate.

A schematic diagram of a densitometer employing this circuit is shown in Fig. 2. The photographs show a closeup of the optical arrangement of a practical densitometer and the densitometer with its associated electrical equipment.

Optical System

In the design of the optical system, light from the sample lamp B_1 illuminates a circular stop S which for reflectance measurements is focused by a lens L_1 on the far wall of the integrating sphere. A second lens L_2 carried in a rotatable disk can be introduced to refocus the light at the entrance port for transmission measurements. The attenuating wedge is used for balancing. Standard lamp B_2 is located in a light-tight housing on one side of the sphere and illuminates the sphere wall through a small hole.

The multiplier phototube is located at the back of the sphere where it can be illuminated by the integrated light from the sphere wall, but not by either beam directly. Provision is made for introducing color filters between the exit port of the sphere and the multiplier phototube for abridged spectrophotometric or colorimetric measurements.

This optical design was chosen because it provides a constant level of illumination at the balance point regardless of the sample. Too much light on the multiplier phototube brings about great instability of the oscillator accompanied by hunting and uncontrollable gyrations of the lamps.

The lamp transformer is driven by the power amplifier, a standard push-pull 6L6 amplifier, which in turn is driven by the voltage amplifier. The voltage amplifier contains two stages of 5693's, having a measured gain of 8,800. The multiplier phototube is operated with approximately 100 volts d-c per stage.

Operating Procedure

In the finished instrument, a housing around the sphere cuts out room light and provides a flat table for transmission samples. If reflectance measurements are required, the instrument can be placed in an upright position on the sample or it can be turned to a horizontal position with the sample held against the flat back by a spring clip (not shown).

The instrument is first balanced for zero density by mechanically adjusting the amount of light from the standard lamp. Electrical adjustment of the lamps is reserved for balancing their color temperatures when color measurements are required. The reflectance port is filled with a white diffusing material when making this adjustment and also when making transmission measurements. The sample is next inserted and if oscillation has not started spontaneously, the beams are thrown out of balance by turning the density wedge. The density wedge is then turned slowly towards balance until the oscillation stops. The lamps themselves can be used as the balance-point indicator as the difference in brightness when oscillating or when operating on d-c is quite marked, and there is no appreciable dimming as the balance point is approached. In fact the balance point is so sharp that one is in danger of passing it if the density wedge is turned too rapidly. An a-c voltmeter across one lamp can also be used as a balance indicator if one prefers this type of indicator.

The instrument shown in the photograph above is still in the formative stage and will probably undergo many improvements and refinements. Specially designed lamps would be of great assistance, and could lead to a reduction in power requirements.

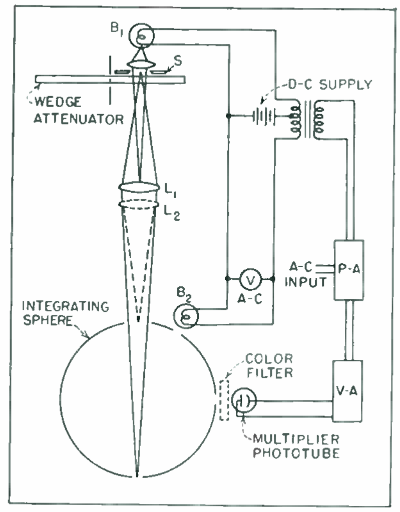

FIG. 2—Optical arrangement includes integrating sphere with attachments for a wide variety of photometric measurements

Speech Stretcher

By JOHN L. GOFORTH

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Sona-Stretcher unit, on table at right, accentuates speech mannerisms and habits. Untrained listeners using it hear more than skilled phoneticians hear in normal-tempo speech, because time available for reflection is greater than twice that with normal speech

THE SPEECH STRETCHER does for the ear what the slow-motion camera does for the eye. By means of electronic circuits the rate of occurrence of speech may be slowed to one-half without losing the intelligence. The method of doing this is to play speech, recorded either on tape or disks, at one-half speed. This of course halves all of the frequencies in the original speech. Bandpass filters followed by frequency doublers are then used to double the frequencies coming from the recording, restoring the intelligence while keeping the rate still at only half that of the original sound.

Applications

The most obvious use for the instrument is in the study of language and the methods of speaking used by the various language groups of the world. It is a great aid in transcribing dialects or unwritten languages to standard phonetic symbols, as well as for the usual stenographic uses. For example, a secretary may type recorded dictation quickly with the aid of a speech stretcher since the slower rate of presentation removes the necessity for repeating the material.

One of the main uses is in the teaching of foreign languages. A beginning student is presented with new and unusual sound combinations in a new language, especially if the written language does not always conform to the spoken word. The slow-motion effect of hearing sound is effective in exposing the actual phonetic construction of difficult, elusive words and phrases.

In the advertising field, the unusual speech from the stretcher should serve to attract attention to a radio or tv commercial.

Nature of Stretched Speech

In the ideal case, speech from the stretcher should sound exactly like the original except that every word

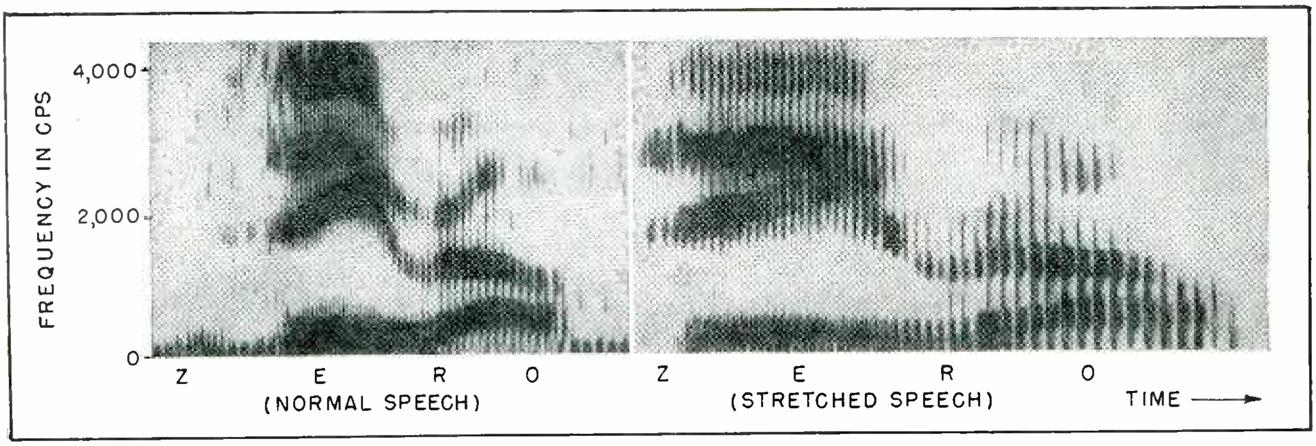

FIG. 1—Spectrograms of normal and stretched speech for the spoken word "zero"

for Language Studies

Recorded speech is played back at half speed and frequencies are doubled in ten filter-doubler channels of superheterodyne amplifier to permit analysis of sounds, just as slow-motion camera analyzes motion. Instrument also aids typing of recorded dictation

lasts twice as long. A practical sound stretcher must be a compromise between several factors, one of which results in pitch halving. This reduction in the fundamental pitch of the voice gives what might best be described as a Southern drawl, but this does not interfere with the intelligence. The overall effect is that the person is speaking slowly and deliberately with a somewhat low-pitched voice.

Spectrograms of the word "zero" are shown in Fig. 1 as heard normally and as stretched. The diagrams have a frequency scale in the vertical direction and a time scale in the horizontal direction, while the amplitude of a frequency component is shown as blackness. It is seen that the time scale occupied by the stretched-sound spectrogram is twice as long, while the frequency components fall at their proper place on the frequency scale. The vertical striations show voice pitch, which is the fundamental frequency produced by the opening and closing of the vocal cords during voiced sounds. After stretching, the pitch is one-half that of the original since the same total number of vocal cord operations takes place in twice the time.

Choice of Techniques

Somewhere in the speech-stretching process there must be a recording and playback element, for there are no electronic circuits that will change the time scale. Two possible methods of doubling the frequencies are shown in Fig. 2.

In Fig. 2A the audio signal from a microphone is amplified and applied to a number of bandpass filters in parallel. Each filter selects a part of the total frequency range and feeds this signal to a frequency doubler. Each bandpass filter must have a bandwidth less than one octave wide so that the inputs and outputs of the doubler do not overlap on the frequency scale. Each doubler is followed by a second bandpass filter having twice the frequency range in cycles of the input bandpass filter.

Filters are necessary after the doublers to remove the difference components generated when more than one frequency is applied to a doubler. For example, suppose one of the bandpass filters has a frequency range of 1,000 to 2,000 cps and the signal being applied has components at 1,000 and 1,500 cps. In the output of the doubler there will then be the desired 2,000-cps and 3,000-cps doubled frequencies, as well as the sum and difference frequencies of 500 and 2,500 cps. The output bandpass filter serves to remove the unwanted difference component. Unfortunately the sum component always falls in the doubled frequency range, although its amplitude is small compared to the doubled component.

Given a sufficient number of filter-doubler channels, the output of the system will be like the input except that every frequency component will be doubled. If this output is recorded it may be replayed at one-half speed, which will reduce the frequencies to the original

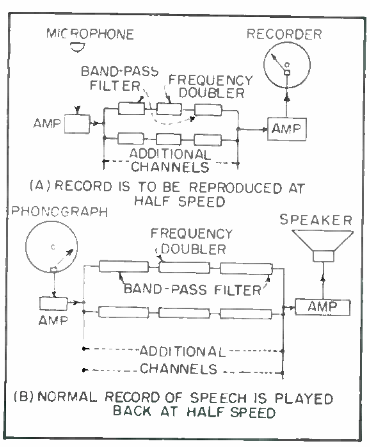

FIG. 2—Systems for stretching speech

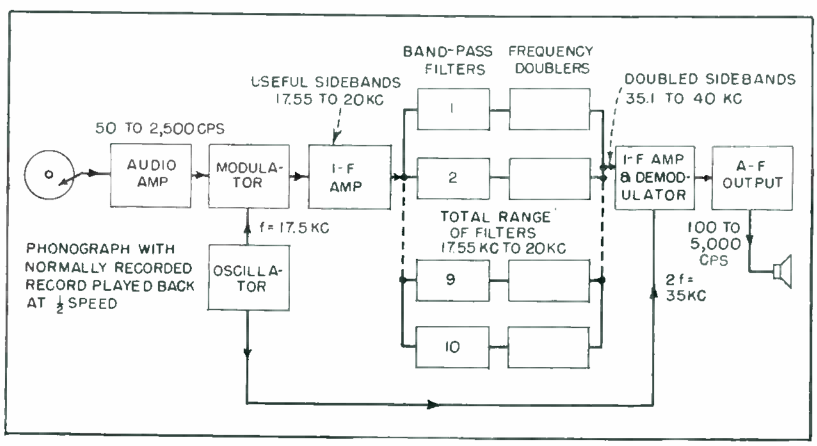

FIG. 3—Arrangement of stages in the speech stretcher described in this article

range and double the time scale.

In Fig. 2B is shown a similar system except that the material is previously recorded and reproduced at one-half speed into the input of the speech stretcher. The filter-doubler systems required for this and the previous method are bulky and expensive due to the large inductances required for a bandpass filter in the low audio range.

Superhet System Used

In Fig. 3 is shown the speech stretcher system used in the instrument to be described, called the Sona-Stretcher. The main feature is a modulator and oscillator used to translate the audio-frequency range to the low radio-frequency range where a bandpass filter is small and easy to construct. A half-speed playback feeds previously recorded material through an amplifier to a modulator, where it is mixed with a 17.5-kc carrier from an oscillator. The audio range (50 to 2,500 cps due to the one-half speed playback) is thus translated to the sidebands around 17.5 kc, of which only the upper sideband from 17.55 to 20.00 kc is used. A number of bandpass filters select portions of this sideband frequency range to be applied to the frequency doublers. The outputs of the doublers are recombined in a tuned circuit, amplified and applied to a demodulator along with the second harmonic of the oscillator to recover the audio frequencies.

One important feature of this system may not become apparent until a numerical example is considered. If the frequencies 1,000 and 1,500 cps are considered, the modulator and oscillator translate these to 18.500 and 19.000 kc. When these are applied to the doubler, we get 37.000 and 38.000 kc as the desired doubled components, and 500 cps and 37.500 kc as the sum and difference components. The 500-cps component is easily removed in one tuned circuit common to all doublers.

The other frequencies, when demodulated with the 35.000-kc second harmonic from the oscillator, give 2,000, 2,500, 3,000, 34,500 and 35,500 cps, the last two being inaudible. The process of translating the frequency range before the filter-doubler channels has thus eliminated the need for a second set of bandpass filters following the frequency doublers. In all cases, two frequencies present in the same filter channel give rise to a sum cross-modulation product which falls in the doubled frequency range.

A factor to be considered in designing a speech stretcher is the great advantage of using previously recorded material. The commercial field includes large numbers of recorded speeches and dramatic material, as well as language instruction records. To use recordings made at 78 rpm, a phonograph player may be modified to operate at 39 rpm, although only a slight loss in naturalness is noticed if they are played at 33 1/3 rpm. For tape recordings, the standard speeds of 15 inches per second and 7.5 inches per second are exactly the required ratio.

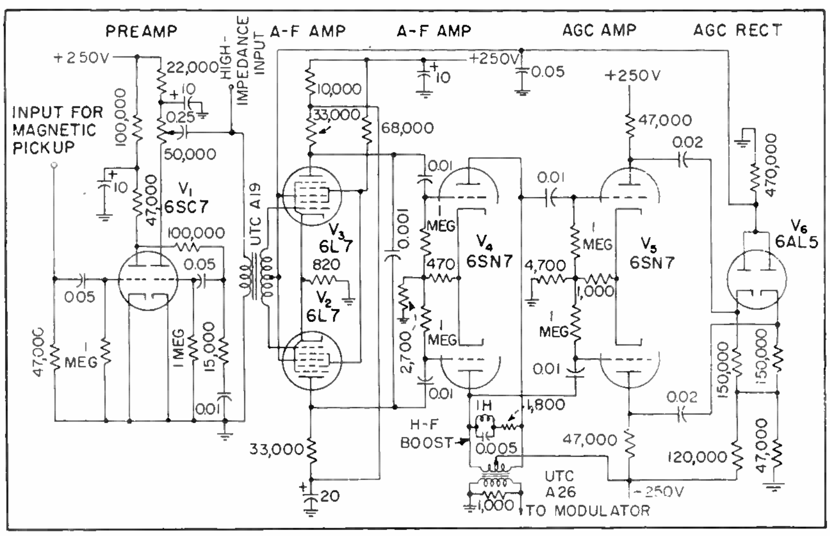

FIG. 4—Audio amplifier and fast-acting automatic gain control circuit arrangement used to insure that all ten filter-doubler channels operate at about the same high level

Filters and Doublers

A single-frequency tone fed into the input of an ideal speech stretcher should give a tone having twice that frequency at the loudspeaker. If we insert a complex sound made up of a fundamental and the harmonics of that fundamental, the circuits must double each component and recombine them in the proper phase in order to reproduce that sound exactly. To even approach that ideal, it is necessary to use filter-doubler channels which have a bandwidth less than the separation of the harmonics of the complex signal. This restriction is necessary because practical doubler circuits produce sum and difference frequencies as well as the double-frequency components.

Two adjacent harmonics of a complex signal appearing in the same filter will produce in the doubler or other nonlinear element a difference frequency equal to the fundamental. Since this is at one-half the desired frequency due to the one-half speed playback, the result is an apparent lowering of the fundamental frequency in the output to one-half that of the original sound.

If we consider speech as made up of the pitch and the harmonics of the pitch (which may be considered true for the vowels and voiced sounds), then a speech stretcher to handle a bass voice might require filter-doubler channels having 100-cps bandwidth. If the audio range is taken as up to 5,000 cps, then 50 channels would be required to reproduce the voice without pitch halving.

If such a device were practical, it is interesting to note what would happen to the consonants and impulses of the unvoiced sounds in speech. When sounds have a more or less continuous spectrum the concept of frequency doubling has little meaning. Sounds of transient nature would be seriously modified due to the long time constant associated with a narrow-bandwidth

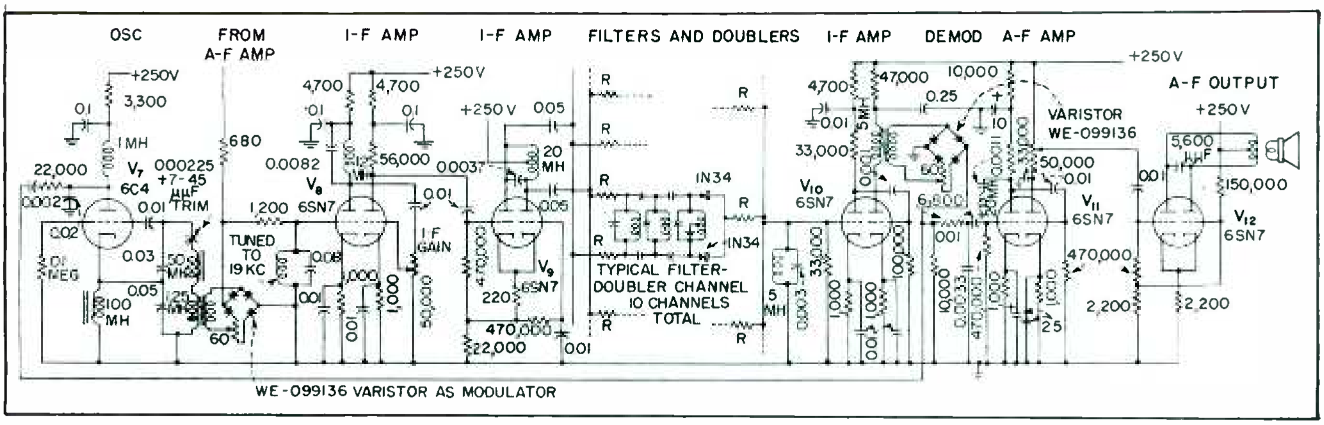

FIG. 5—Main circuit of speech stretcher. Audio amplifier feeds varistor modulator located between oscillator and first i-f amplifier

filter and the lack of uniform phase response through the filter-doubler channels. Therefore, a practical speech stretcher must have filter-doubler channels which are a compromise between the narrow bandwidth desired to avoid pitch halving and the wide bandwidth necessary to respond to the transients associated with the consonants and stops of speech.

A-F and AGC Circuits

The main audio amplifier of the Sona-Stretcher consists of a preamplifier for the magnetic pickup, two stages of amplification and an automatic gain control amplifier and rectifier, as shown in Fig. 4. The crossover frequency of the preamplifier has been lowered to compensate for the one-half frequency range at the input due to the reduction in speed of the playback turntable.

To insure good doubling action, the filter-doubler channels should be operated at a high level. Two features insure that all the channels operate at about the same level. A fast-acting automatic gain control circuit increases the average power relative to the peak power in speech. A high-frequency preemphasis or boost circuit compensates for the relative concentration of power in speech at the low frequencies.

The agc circuit consists of an amplifier and rectifier controlling the gain of pushpull 6L7's in the main audio amplifier. The high-frequency boost is supplied by a tuned circuit connected across the audio transformer.

The remaining stages of the speech stretcher are shown in Fig. 5. The high-stability oscillator provides output at 17.5 kc from the grid-cathode circuit, while 35-kc output is taken from the tuned plate circuit. The modulator is a copper-oxide varistor balanced to prevent the carrier from appearing in the filter-doubler channels. Its tuned output circuit, peaked at 19 kc, selects the upper sideband 15.550 to 20.000 kc and gives additional boost to the high audio frequencies.

The modulator is followed by three stages of i-f amplification ending in push-pull output from V_9 to drive the filter-doubler channels. Each filter consists of three loosely coupled tuned circuits having the following center frequencies and bandwidths.

Channel No.	Center Freq	Bandwidth
1	17.600 kc	100 cps
2	17.725	150
3	17.875	150
4	18.050	200
5	18.275	250
6	18.525	250
7	18.800	300
8	19.100	300
9	19.450	400
10	19.900	500

The filters are operated balanced to ground, thus providing push-pull output voltages to operate the frequency doublers. Resistors at the input to each filter provide decoupling and impedance matching for each channel. A doubler consists of two crystal rectifiers connected in the usual full-wave rectifier circuit. In this case the hum is the desired output, while the direct current is bypassed to ground through a 5-mh, 0.003-μf tuned circuit which is tuned to accept the frequency band 5 kc wide centered at 37.5 kc.

Resistors at the output of each doubler may be adjusted to compensate for variations in gain through each filter and to adjust the overall system frequency response. Some of the boost given to the high audio frequencies in the audio amplifier is removed here. The attenuation loss in the filters is made up by two additional stages of i-f amplification at the doubled frequency. The last stage is transformer-coupled to the demodulator.

The demodulator is also balanced, although in this case it is balanced against the incoming signal frequencies, since the difference frequencies produced in the doublers are in the audio range. The i-f amplifier has very low gain in the audio range, but some of the cross-modulation products may get through to be applied to the demodulator and thus to the high-gain audio amplifier. The carrier at the demodulator is the second harmonic of the carrier at the modulator, both produced by the same oscillator. Signals from the i-f amplifier in the range 35.100 to 40.000 kc beat with the 35.000-kc carrier to produce the output audio range of 100 to 5,000 cps. The response of the final three-stage audio amplifier is shaped to remove the boost applied at the high frequencies in the first audio amplifier. A 20-mh, 0.0011-μf tuned circuit in the 1st a-f plate circuit, series-resonant at 35 kc, eliminates the large 35-kc carrier applied to the input of the audio amplifier.

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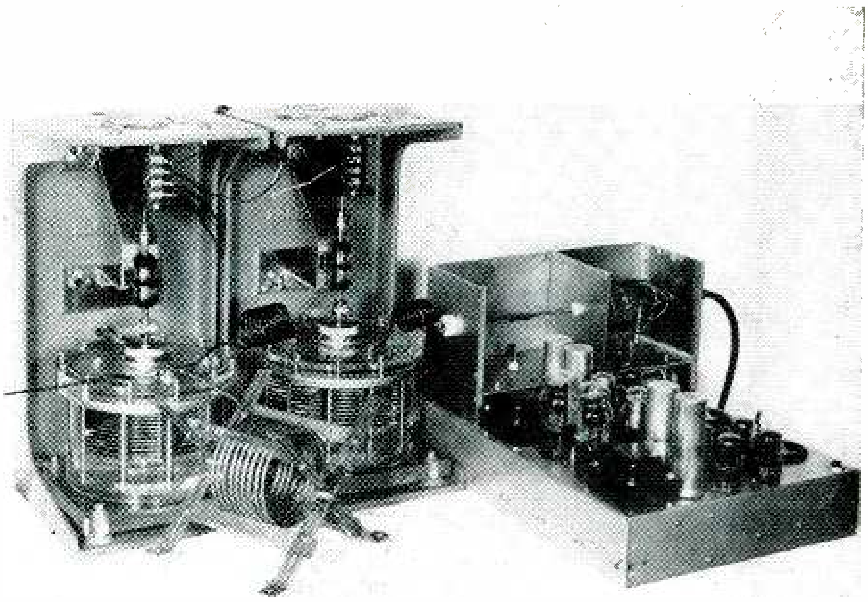

Complete matching equipment shown with one shunt coil in foreground. Sensing unit and servo amplifier at right, antenna lead at left

Automatic

By **VIRGIL TRUE**
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AUTOMATIC impedance-matching devices are desirable in matching the input impedance of a given antenna to the characteristic impedance of a given feeder line, in matching the load impedance of dielectric heating equipment to the output impedance of the heating generators or to the characteristic impedance of associated transmission lines and in power-factor correction in power distribution systems.

This article presents a solution to the specific problem of automatically matching the input impedance of a 35-foot whip antenna to a 50-ohm coaxial transmission line at all frequencies in the 2-to-18 mc band.

General Considerations

Figure 1 shows the impedance characteristic of the 35-foot whip antenna as measured with a General Radio type 916-A impedance bridge. It also shows the range of resistive and reactive components of terminal impedance to a 50-ohm line that are considered tolerable. These limits correspond to an impedance match of such accuracy that the standing-wave ratio on the line will not exceed 1.25 at any frequency in the 2-to-18 mc band.

The block diagram of the automatic impedance-matching unit is shown in Fig. 2. A breadboard model of the unit with only the shunt coil used in the 2-to-3 mc range connected is illustrated.

With the exception of the motors and gear trains, all components of this unit were designed and developed specifically for the problem at hand. The cantilever matching network was chosen because of its broad-band possibilities and because it lends itself well to the requirements of a servo-driven unit. The sensing unit was developed as two detectors because of the necessity for correcting both magnitude and phase angle of the load impedance. The servo amplifiers were designed to give maximum stability and dependability for a minimum size and weight while maintaining adequate sensitivity and power output capability.

The results obtained with this unit are shown in Fig. 3, a graph of standing-wave ratio on the feeder line as a function of frequency at balance condition. Data for this curve were obtained in the following manner:

The transmitter was connected to the antenna via the feeder line and the matching device as shown in Fig. 2. The transmitter was turned on and the servo systems were allowed to come to balance. The line was then disconnected from the sensing unit and the input impedance to the antenna including the matching device was measured.

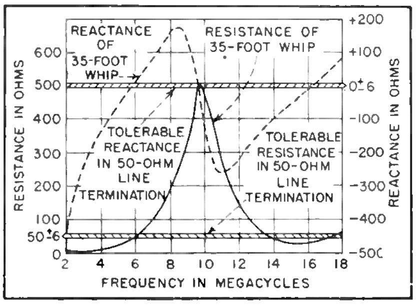


FIG. 1—Impedance characteristic of a 35-foot whip antenna and tolerable termination to a 50-ohm line

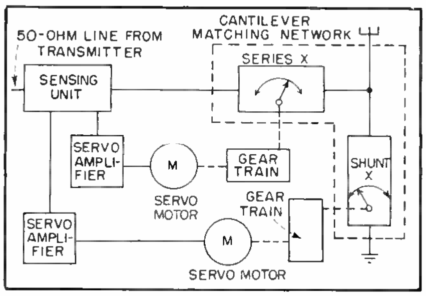
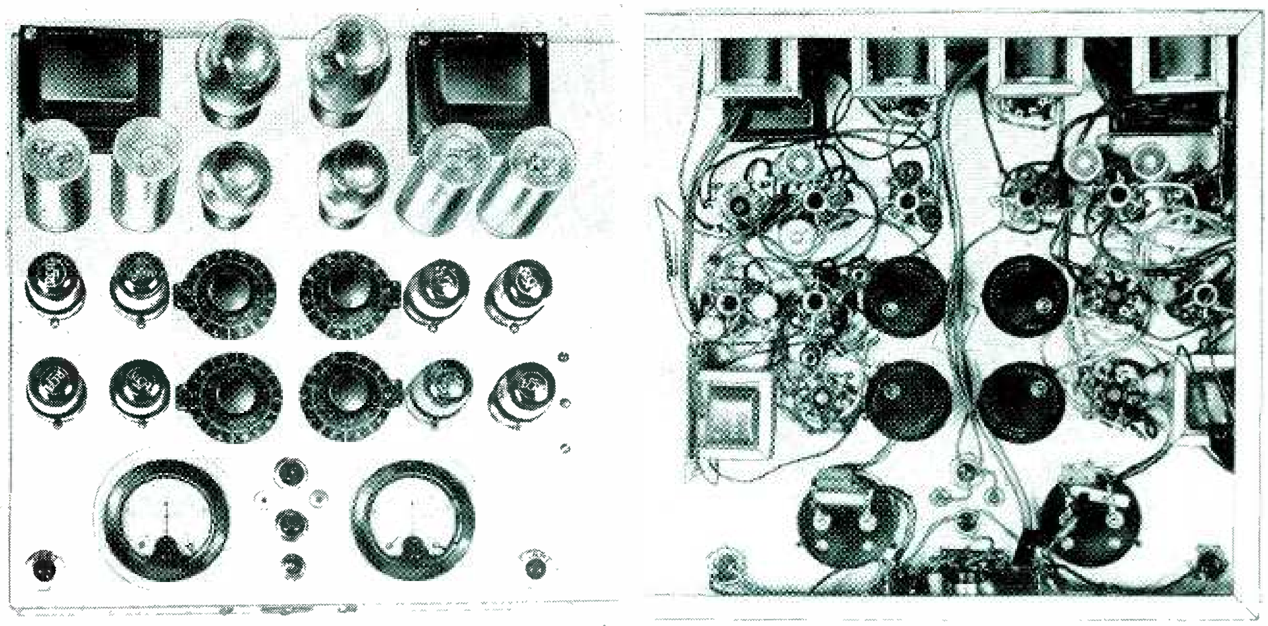


FIG. 2—Diagram showing the equipment elements making up an automatic impedance-matching device



Top and bottom chassis views of the servo amplifier showing simplicity of controls and wiring. This is the same equipment as that pictured to the right of the opposite page

Impedance Matcher

Device matches the input impedance of a 35-foot whip antenna to a 50-ohm coaxial transmission line at all frequencies between 2 and 18 mc. Unit can also be adapted to different frequency range, power level, type of load and transmission line for other communications and industrial applications

This was the terminal impedance to the 50-ohm line when the transmitter was in operation. The standing-wave ratio on the line was calculated from the known characteristic and terminal impedance and the procedure was repeated at close frequency intervals throughout the 2-to-18 mc band. Two measurements of this type were obtained at frequencies higher than 18 mc; one at 22.9 mc and the other at 25.9 mc. The standing-wave ratios were 1.1 and 1.16 respectively, indicating satisfactory operation from 2 to 26 mc.

Further checks were made to insure operation at all frequencies. The transmitter was turned on and the matching unit was allowed to come to balance. The transmitter was loaded into the properly terminated line so that its power output was at or slightly above rated value. Then the transmitter was switched to half-power operation and the frequency was varied continuously under key-down operation. The final stage of the transmitter was tuned as the frequency was varied so that the power output remained essentially constant. The automatic matching device followed the transmitter through the entire 2-to-18 mc band. Impedance measurements described as the basis for Fig. 3 were made at intervals of 500 kc to check the accuracy of the unit. At no time was an impedance measured that produced a standing-wave ratio greater than 1.2 on the feeder line.

In addition, the unit was used to match the antenna to the line under conditions of varying load impedance at fixed frequencies. The connections of Fig. 2 were made, the transmitter was turned on and the unit was permitted to come to balance. Then a large crane boom, with pulley lowered beside the antenna, was swung back and forth in the immediate vicinity of the antenna. The unit followed the change in impedance of the antenna owing to the proximity effect of the boom without allowing the terminal impedance of the transmission line to change appreciably. This check was repeated at frequency intervals of 1 mc through the 2-to-18 mc band.

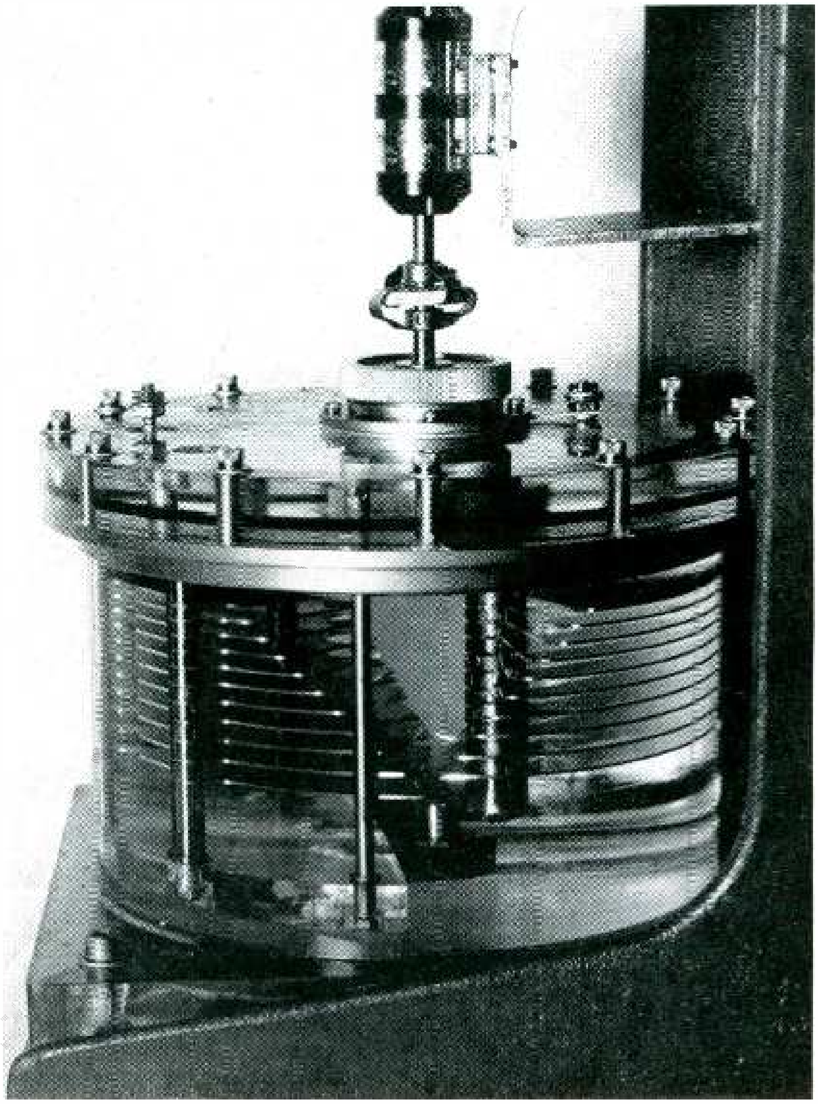
Assuming the input impedance to

the antenna plus the cantilever network can be made equal to the characteristic impedance of the feeder line by varying the reactances of the two branches of the cantilever circuit, ordinary circuit analysis yields the following equations for this assumed condition $x_P =$

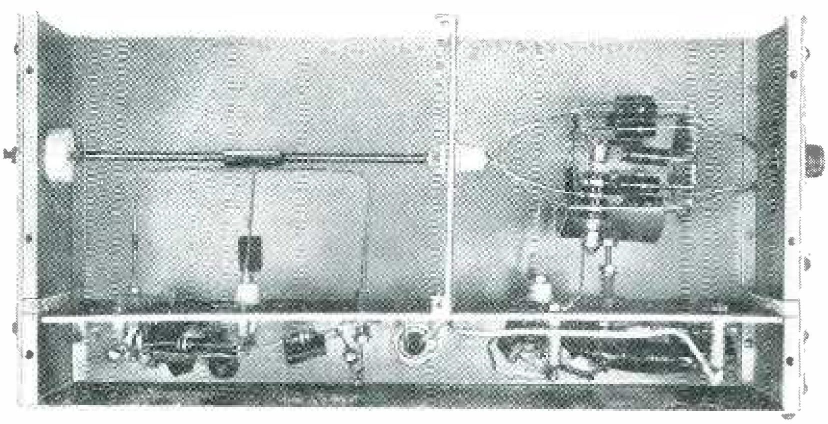
$$\frac{R_0 X_A \pm [R_0 R_A (R_A^2 - R_0 R_A + X_A^2)]^{\frac{1}{2}}}{R_A - R_0} \quad (1)$$

$$X_S = \frac{-X_P(R_A^2 + X_P X_A + X_A^2)}{R_A^2 + (X_P + X_A)^2} \quad (2)$$

where X_P = the reactance of the parallel branch of the cantilever network
X_S = the reactance of the series branch of the cantilever network
$Z_0 = R_0 + j0$ = the characteristic impedance of the feeder line
$Z_A = R_A + jX_A$ = the complex impedance of the antenna alone



Special oil-filled capacitor used in cantilever network



Detail of sensing unit, phase-angle at left and magnitude at right

The solutions to Eq. 1 and 2 were plotted as functions of frequency, with frequency varying from 2 to 18 mc. These curves of required X_P and X_s were used to determine the electrical properties of the cantilever circuit components. The component values are listed in Fig. 4, which is a schematic diagram of the variable cantilever circuit. This combination requires two relays and associated switches for changing the shunt-branch inductance to obtain complete coverage for the 2-to-18 mc band. The switching control is mounted on the transmitter in the breadboard model but could be incorporated into the transmitter band-switching mechanism. Slight variations in the sizes of the individual shunt coils are necessary to tailor a given unit to the particular bands of individual transmitters.

The fixed coils of the shunt branch are formed from ¼-in. silver-plated copper tubing. Values of Q range from 550 to 700 for these coils. The series coils are wound from No. 8 copper wire and have Q's of about 450.

The variable capacitors are identical, with a tuning range of 23 to 1,300 μμf, a minimum voltage breakdown strength of 10,000 volts, and special construction to insure a smooth curve of capacitance as a function of degrees rotation. Construction details of one of these capacitors are shown, including the offset shaft, variable plate size, and variable spacing between plates. These capacitors were designed especially for this problem because no capacitors on the market possessed all the requirements of the matching unit. A patent application has been filed on their design and construction details.

The dielectric material in these capacitors is Dow-Corning 500

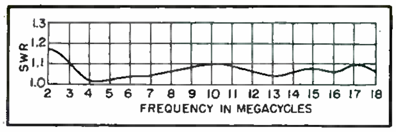


FIG. 3—Standing-wave ratio on feeder line compared with frequency at condition of balance

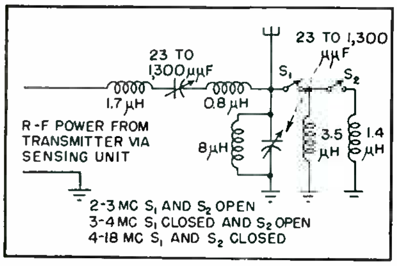


FIG. 4—Cantilever impedance matching network from line to antenna

fluid, a silicone oil with excellent electrical and thermal properties. The plates are made of aluminum 0.04 inch thick and the shafts and spacers are made of steel. The cylindrical case is made of Lucite and the ends of polystyrene. Connection to the rotor plates is made through a low-loss, high-current capacity mercury contact developed especially for these capacitors.

Impedance Sensing Circuits

Figure 5A shows a diagram of the phase-angle detector for which the mechanical construction of the circuit is also illustrated. Ultra-high-frequency techniques have been applied to good advantage here. The primary coil is merely a 4½-inch length of the center conductor of the line. The secondary is a single turn $4\frac{1}{2} \times 2\frac{1}{2}$ inches, center-tapped. The coupling capacitor between the two is formed by the primary wire and the small semi-cylindrical plate soldered to the centertap of the secondary; air serves as the dielectric.

This circuit is electrically very similar to an f-m discriminator, the difference being that in this case the difference in voltages applied to the diodes is due to a phase angle between line voltage and line current instead of a variation from a mean frequency. Use of a vector diagram in Fig. 6 simplifies explanation of the operation of Fig. 5A.

The voltage applied to D_1 is the vector sum of V_{C2}, a voltage in phase with the line voltage, and V_{L2A}, an induced voltage that leads the line current by 90 deg. Similarly, the voltage applied to D_2 is the vector sum of V_{C2} and V_{L2B}, an induced voltage that lags the line current by 90 deg. The d-c output is the difference in magnitude of these two rectified voltages.

A study of the vector diagram reveals that as the phase angle goes to zero when the load becomes purely resistive, the output of the circuit goes to zero and that the sign of the error voltage is dependent upon the sign of the phase angle. These are the two prime requisites of a device that must control a servo system to correct the phase angle to zero.

Another desirable feature of this circuit, as can be seen from the vector diagram or from a mathematical analysis, is that the sensitivity, defined by the rate of change of voltage out with respect to a change in phase angle, occurs in the neighborhood of zero phase angle. This permits extremely accurate phase-angle correction. The circuit has no critical components. Adjustment for initial balance of zero output at zero phase angle is accomplished by varying the spacing, hence the electromagnetic coupling, between L_1 and L_{2A} and between L_1 and L_{2B}.

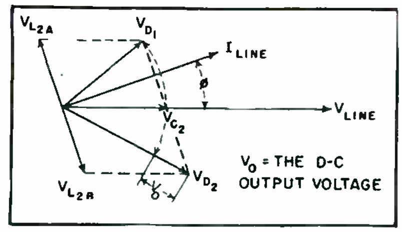


FIG. 6—Vector diagram to show operation of sensing unit as explained in text

The impedance magnitude detector circuit is similar to a Wheatstone-bridge arrangement. It is shown schematically in Fig. 5B and the photograph. The voltage applied to D_3 is a constant fraction of the line voltage, determined by the ratio of C_7 to C_8. The voltage applied to D_4 is the voltage drop across the 1-ohm resistance R_3 in series with the line. The ratio of C_7 to C_8 is approximately 1 to 50. Thus, when the total load impedance, measured at the output of the sensing circuit, is 50 ohms, the voltage applied to D_4 is 1/51 V_{Line}, the same magnitude as the voltage applied to D_3. The d-c output voltage is then zero. The accuracy of this circuit is such that at present the ratio of C_7 to C_8 is set at approximately 1 to 49. Then at balance condition the impedance seen by the sensing unit is 49 ohms. The terminal impedance to the feeder line is then 49 plus the 1-ohm series resistance, or 50 ohms.

If the total load impedance is greater than 49 ohms, the voltage applied to D_4 is less than the voltage applied to D_3 and the output voltage is positive. Conversely, if the load impedance is less than 49 ohms in magnitude, then the voltage applied to D_4 is greater than the voltage applied to D_3 and the output voltage is negative. This is the desired response for any unit that must control the magnitude of the terminal impedance of the line through a servo system.

It has now been established that

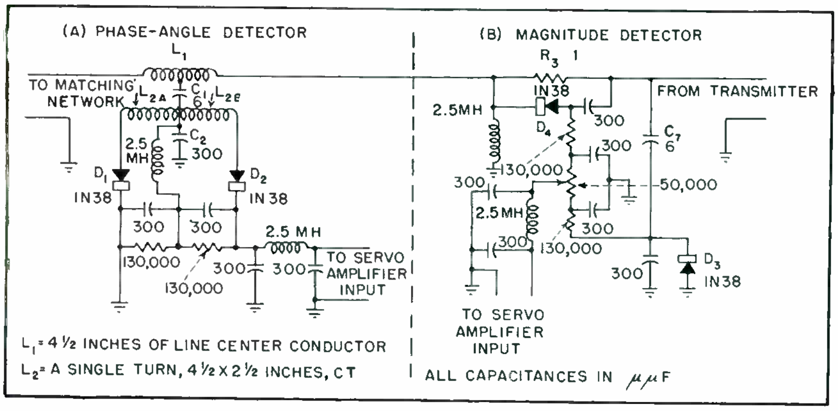


FIG. 5—Impedance sensing unit, with phase-angle detector at left (A) and magnitude detector at right (B)

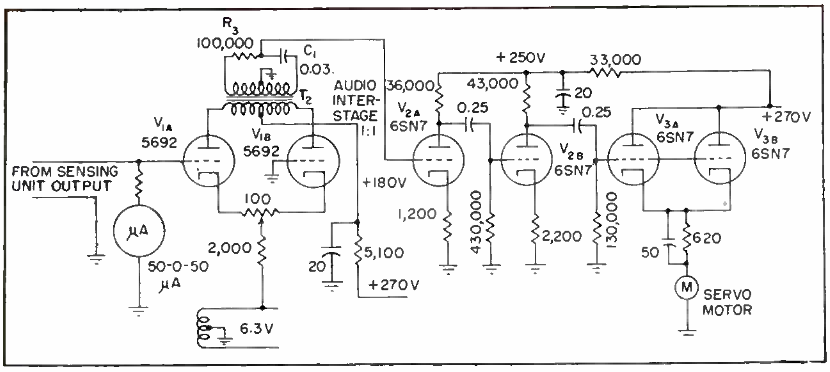


FIG. 7—Servo amplifier circuit. This is similar in function to the one actually used, but improved in simplicity and compactness

when the output of both sections of the sensing unit is equal to zero the terminal impedance of the feeder line must necessarily be 50 ohms in magnitude and have a phase angle of zero degrees. This is the condition for a perfect match between antenna and feeder line.

The purpose of the potentiometer R_5 is to set the impedance magnitude detector up for initial balance at a terminal impedance of 50 ohms to the line. Use of this potentiometer permits some variation in the fixed ratio of C_7 to C_8 or some variation of R_3 from 1 ohm, thereby making the circuit components less critical.

Physically the circuit is rugged, simple, and contains no vacuum tubes. The only critical components are the resistance R_3 and the capacitor C_7. The resistance R_3 must be a composite resistor with the detector D_4 inside it and C_7 must be an air-dielectric or some equally low-loss capacitor. The construction details of these two components were the result of considerations of the dielectric and electromagnetic field configurations and must be carefully followed if satisfactory operation is to be obtained over a wide frequency range.

Servo Amplifiers

The servo amplifiers, too, were developed specifically for the problem under consideration, but are unusually well adapted to nominal power applications throughout the servo field. The two amplifiers are identical. The circuit described is that of an improved, compact type shown in Fig. 6. Any error voltage changes the bias on V_{1A}, thereby changing the gain of this triode. This results in an a-c output across the secondary terminals of the transformer T_2. Components R_3 and C_1 form a phase-shifting network and V_{2A} and V_{2B} are voltage amplifiers with a gain of about 8 per stage. The sensitivity of the bridge arrangement permits the use of low-gain stages, which increases the stability and, by permitting the use of a rugged voltage amplifier tube, improves the ruggedness of the amplifier.

Tubes V_{3A} and V_{3B} are cathode followers in parallel, giving an output of approximately 2 watts, delivered at about 50 volts rms. It is essential to use type 5692 tubes in the bridge arrangement of either amplifier, or some other tube with equally good stability and microphonic characteristics, but it has been found experimentally that regulated plate supply voltage is unnecessary in the improved amplifier. Plate voltages may vary from 190 volts to 280 volts without disturbing either balance or smoothness of operation.

Servo Drive Mechanisms

The servo motors are 75/115 volt, 2/5 watt, 60-cycle, 2-phase, 2-pole induction motors purchased from the Diehl Mfg. Co. The gear trains are miniature speed reducers purchased from the Metron Corp. Both are zero backlash trains and the reduction ratios are 729 and 243 for the shunt and series capacitors respectively.

These drives were chosen to give minimum matching time without danger of hunting in the servo system, due consideration being given to the driving power required and to the physical size and weight of the completed unit. The time necessary to match the antenna to the line is from 2 to 15 seconds in the breadboard model, depending on the frequency of operation, the positions of the capacitors at the beginning of the matching cycle, and the power output of the transmitter during the tuning cycle. Average matching time is 5 to 7 seconds and individual tuning cycles seldom exceed a 10-second time limit.

The device described here was designed specifically to meet the requirements of a 35-foot whip antenna, a 50-ohm coaxial transmission line, and a transmitter whose power output is 200 to 700 watts and whose frequency range is 2 to 18 mc. The unit can be adapted to different frequency ranges, different power levels, various types of loads, and different transmission-line characteristic impedances with only minor circuit changes. For example, if the characteristic impedance of the line had been 72 ohms, it would have been necessary to make the ratio of C_8 to C_7 equal to approximately 71 to 1 instead of 49 to 1.

From the experiments performed to date it can be concluded that the limit of application of the automatic impedance-matching device and the efficiency and accuracy of the device depend primarily on the electrical properties that can be built into matching-circuit components. Some of these critical properties are: tuning range, dissipation factor and voltage-breakdown strength obtainable in continuously variable capacitors of acceptable physical size, the Q and high natural-resonant frequencies obtainable in inductances of equally acceptable physical dimensions.

The author wishes to acknowledge the diverse contributions of the following persons to the development of the automatic impedance-matching device: C. B. Davis, C. L. Spencer, F. J. Shanahan and Bert Fisk of Naval Research Laboratory, W. J. Rosch and G. D. Greenwood, presently with the Bureau of Ships, Navy Department, and J. A. Edinburgh, presently with Wichita Research Foundation, Wichita, Kansas.

IMPROVING A FILM-CAMERA CHAIN

Refinements in the camera control circuits of the iconoscope television film camera allow full use of its capabilities. Increased sensitivity, no clipping of black peaks, registration adjustment while on the air and compensation for white compression are results of circuit modifications

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PRACTICAL experience with the iconoscope film-camera chain, RCA type TK-20A, has resulted in the development of refinements in the camera control circuits. Each modification contributes to the flexibility and/or stability of operation.

The following modifications will be discussed: a d-c supply for bias lighting, fixed minimum setup, iconoscope centering filters and white stretching.

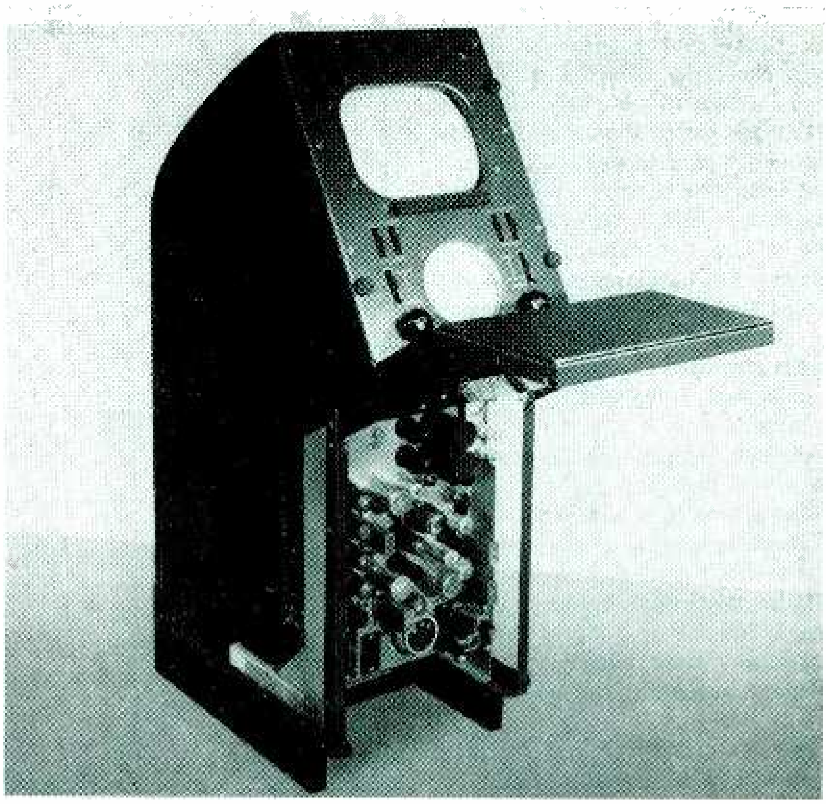
Bias Lighting

Bias lighting or back light is essential to the realization of the full capabilities of the iconoscope film-camera chain. When properly adjusted, bias lighting will increase the sensitivity of the iconoscope by as much as two to one, reduce shading requirements, increase the memory or storage capacity of the mosaic and smooth out the flicker produced by motion picture projection.

The bias light is a source of controlled intensity illuminating the rear surface of the mosaic and the glass walls whereas the photosensitive front surface of the mosaic receives light only from the image focused on it. The walls of the iconoscope are coated with a thin layer of cesium in the manufacturing process and unless these photosensitive electrons are released by some means such as the bias light, they will tend to subtract from the electric field available at the collector anode for attracting secondary-emission photoelectrons from the mosaic. The bias light, therefore, serves to increase the efficiency of the storage action in the iconoscope.

Many iconoscope film-camera units employed at the present time use an a-c source of 117 volts rms for excitation of the bias lighting lamp. Unfortunately, a 60-cps hum component is introduced which evidences itself in the form of a dark horizontal shading band in the picture. This trouble is eliminated by providing a d-c source of excitation for the lamp. The circuit shown in Fig. 1 has been installed in the film camera controls at WOR-TV and has proven to be a good expedient.

A surge-current limiting resistor is required to prevent damage to the rectifier unit. The 50-ohm 10-



Type of film-camera control unit on which modifications were made watt resistor was chosen to limit the maximum available voltage across the lamp to 100 volts.

The rectifier specified has a 600-ma rating as against a full-load requirement of 400 ma. Physical limitations necessitated vertical mounting of the rectifier unit with the plates horizontal. Because of the reserve capacity and the placement of the unit in a relatively open space, the vertical mounting has not been disadvantageous.

Setup is the guard area observed on the cro waveform monitor between the reference black level (corresponding to the specified maximum excursion of the picture signal in the black direction) and the blanking level (the level of the signal during the blanking interval). Usual operating practice calls for a setup of from five to ten percent of the signal amplitude at the reference white level (the specified maximum excursion of the picture signal in the white direction). Setup may be further defined as the operating tolerance in the manual adjustment of the pedestal in that part of the system where the d-c picture component is inserted. It insures that no black peaks in the actual picture signal are clipped off.

Fixed Minimum Setup

A convenient means for automatic insertion of fixed minimum setup is shown in Fig. 2. The circuit makes use of the sync-amplifier stage V_{11} which is available to mix sync with the picture at the camera-control unit. This method of sync mixing is seldom used since sync can be combined with the picture externally in a number of ways and usually is. Therefore V_{11} is readily modified to perform the role of an automatic fixed-minimum setup mixer.

A clean pedestal is desired for the setup and the 1N54 clipping diode insures this. In addition, by varying the amount of clipping with R_{47}, the setup level can be controlled from a maximum value down to zero. The 20 and 50-μf by-pass capacitors were added to obtain sufficient signal in the output circuit of V_{11}.

The manufacturer has recently engineered a fixed setup circuit for the current film-camera chain production. The sync-mixing feature of V_{11} has been retained and a 6AG5 setup amplifier stage using R_{49} as a common plate load has been added. The signal take-off at the kinescope blanking amplifier V_9 is similar but lacks the desirable clipping feature. The 6AG5 is installed in place of V_6, a 6AL5 clipper in the video circuit. The 6AL5 has been replaced with germanium diodes.

Centering Filters

Iconoscope centering is accomplished by introducing a direct current into the deflection coil circuits by means of the wire-wound potentiometers R_{116} and R_{117}. The direction of this current flow in the horizontal deflection coil is reversible by virtue of the center-tap connection to R_{116}. The voltage across R_{116} and R_{117} is developed by the plate-current return to ground and is of negative polarity.

Proper centering and positioning of the iconoscope scanning raster is a matter which should normally be attended to prior to airing the picture. It is not always possible to achieve perfect registration with slides and films of the variety which are available for television programming and it is desirable for the operator to be able to discreetly position the picture as required, while it is being aired. This will result in objectionable disturbances in the picture unless filters such as those illustrated in Fig. 3 are employed.

The manufacturer has issued a field-change notice recommending the installation of 1,000-μf capacitors as shown. Further, it has been suggested that four-watt Mallory units would stand up better than the original two-watt centering potentiometers. Unfortunately, the four-watt units are not easily installed side by side in place of the original smaller components. Some minor alteration with a file is required.

The 10-ohm 1-watt resistors were added to improve the filtering action by bringing up the d-c source impedance. The location of the new components is not critical. In this case, they were conveniently located under the operating shelf control panel.

White Stretching

With the development of the image orthicon camera, the direct studio pickup has been conceded to be superior in technical quality to that obtainable with the use of film in television programming. Recent operating experience has shown that most criticism of film picture reproduction concerned blank or chalky faces[1]. This has been due in part to variations in processing of film and the widespread use of kinescope recordings as well as direct film.

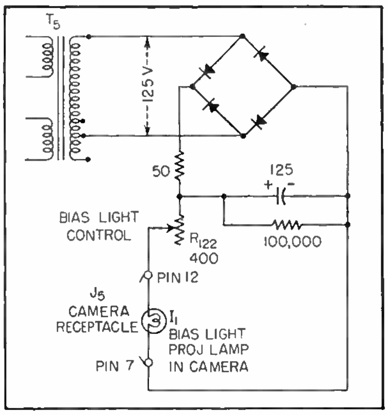


FIG. 1—Direct voltage supply for bias light. Mount rectifier Radio Receptor type Q5B1S1BM0 in place of original C_{52} (schematic diagram of film-camera control) and relocate C_{52} behind the heater transformer

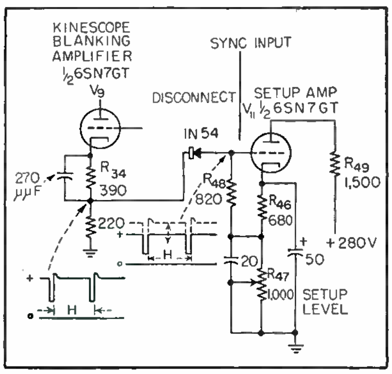


FIG. 2—Circuit for automatic insertion of fixed minimum setup in original equipment

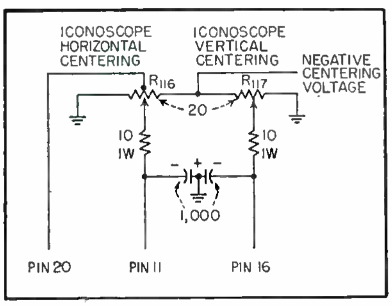
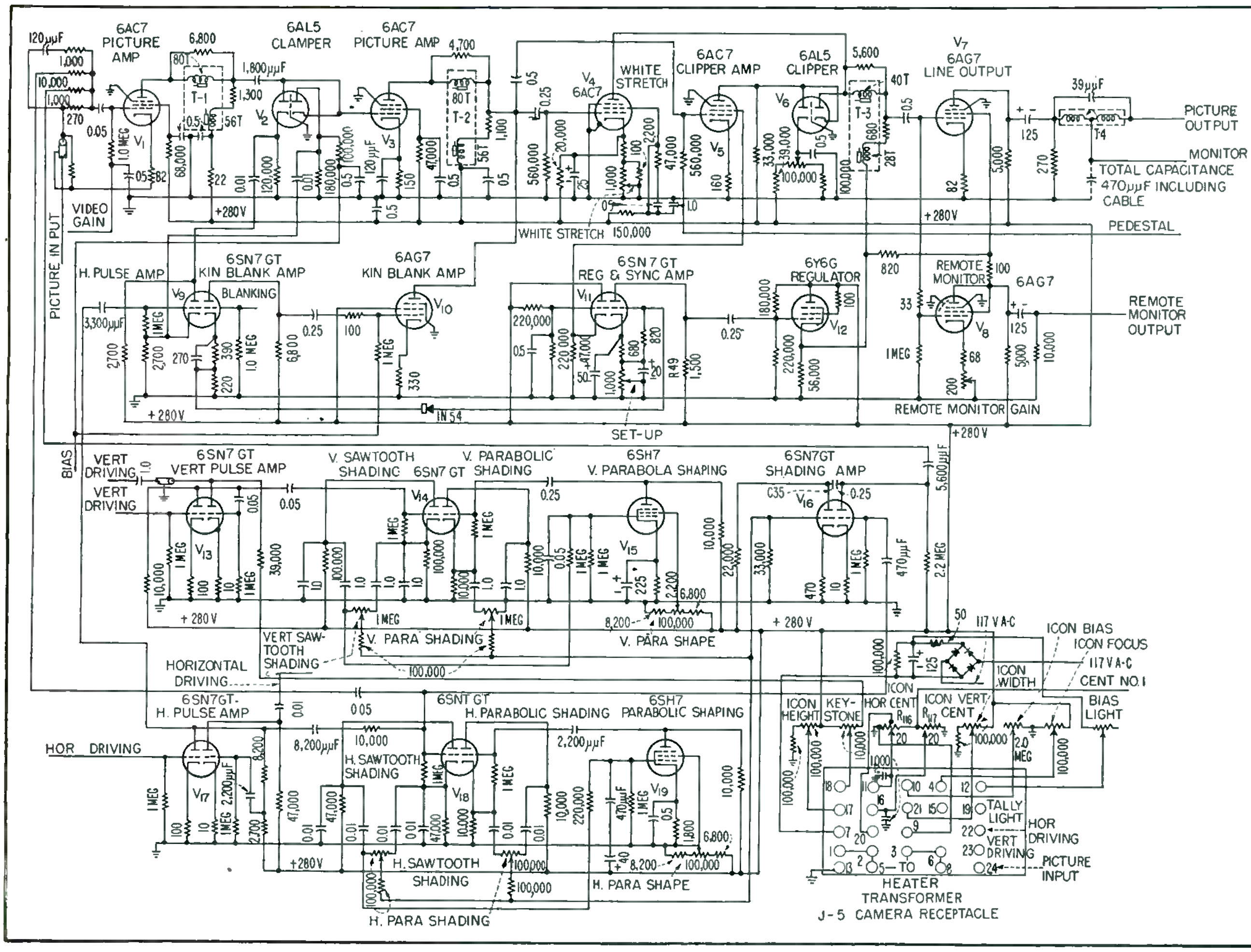


FIG. 3—Iconoscope centering filters



Schematic diagram of the film-camera control

The iconoscope output is a reasonably linear function of film density over its actual operating range. Since film density is a linear function of the logarithm of the input light energy, a linear relationship between the control-grid voltage and the logarithm of the luminous output energy of the kinescope is desired.

The typical kinescope characteristic is a linear control-grid voltage versus luminous output energy relationship. This is not consistent with the gradient of the human eye, which is logarithmically responsive to light energy. Townsend and Goodale have also shown that the transfer characteristic of the over-all kinescope recording-reproducing system is not linear and results in serious white compression. Therefore, the final quality of resolution and contrast obtainable can be materially improved by adding nonlinear compensation in the film camera control.

The white stretcher is a practical circuit, developed by the manufacturer, compensating for white-compression inherent in television film programming. The amount of white stretching provided may be varied as required to match the film quality for both direct film and kinescope recordings. The white stretching is accomplished in V_4 by means of a class-C stretcher-amplifier stage in parallel with the clipper amplifier V_5. The bias of the stretcher-amplifier is set so as to give amplification only to the whitest portions of the picture signal. The amplified whites are then mixed back into the picture signal after clipping and the white information is effectively stretched in the output signal.

To provide for expansion of the whites, the near blacks were effectively compressed by reducing the over-all video signal at the clipper amplifier. The amount of white stretching is determined by the bias-control potentiometer in the cathode of V_4. The video gain was inadequate for the conditions encountered at WOR-TV, so the value of the resistor in the cathode of V_6 was compromised. It was also found that the white-stretcher control would be more suitable if it had a value between 500 and 750 ohms. The 2,200-ohm resistor is an attempt at padding this control.

The manufacturer apparently has not yet concluded the necessary engineering prior to the decision to incorporate this modification in the current production of film-camera chains. However, there has been sufficient experience with the circuit to establish its value to the broadcaster. It is strongly recommended that modification instructions be obtained from the manufacturer before making changes.

REFERENCE

(1) C. L. Townsend and E. D. Goodale, The Orthogram Amplifier, *RCA Review*, 11, p 399, Sept. 1950.

Thyratron-Controlled

Simple and inexpensive electromagnetic drive furnishing power during part of displacement cycle only may be used to life-test aeronautical and other structures. Ordinary audio signal generator and pulse-shaping circuit furnish control pulses for thyratron

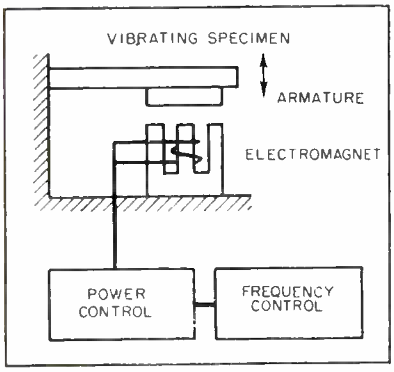


FIG 1—Block diagram of the vibrator drive

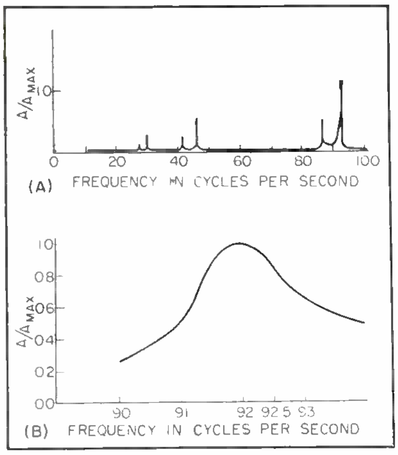


FIG. 2—Response of a metallic specimen to vibrator drive (A) and amplitude in the vicinity of resonance (B)

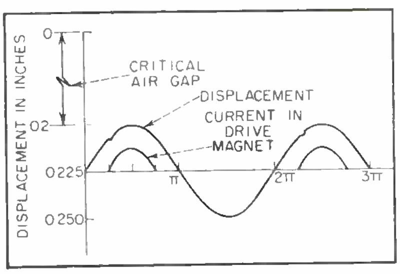


FIG. 3—Operating cycle of thyratron drive

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AN ELECTROMAGNETIC vibration drive, designed for use with resonance fatigue-test equipment, has been developed at the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics.

Chief advantages of the particular drive are relatively low cost of material and construction, adaptability to a variety of vibration problems and ease of control of frequency and amplitude of vibration. Chief limitations are the practical maximum-frequency limit of about 500 cycles and the necessity for attachment of an armature of considerable mass to the vibrating member.

The simplest form of the drive, shown in the block diagram of Fig. 1, consists of three parts; the electromagnet, the amplitude or power-control circuit and the frequency-control circuit. The electromagnet coil and core are attached to a firm base while the electromagnet armature is attached to the vibrating member. Drive force for the vibrating member is transferred electromagnetically from core to armature when current flows in the coil.

Current for the coil is furnished by the power-control circuit. The power-control circuit consists of a capacitor charged from a variable-voltage d-c source and a thyratron which discharges the capacitor through the electromagnet. The thyratron is fired by a pulse from the frequency-control circuit, consisting of a stable source of variable-frequency oscillations and a pulse-forming network.

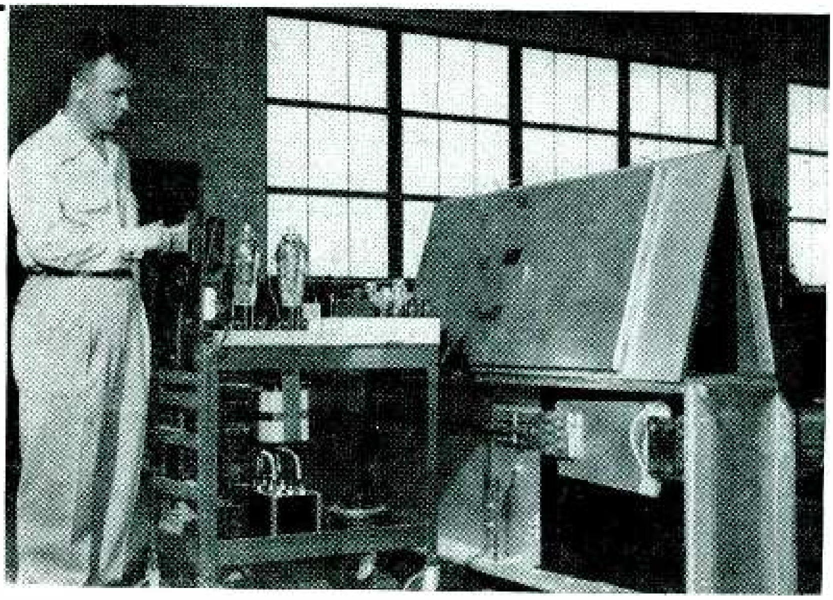
Electromagnetic Drives

Electromagnetic drives are well suited to resonance fatigue testing. In such tests, the test specimen is vibrated at its resonant frequency until failure occurs. The number of cycles required to break the specimen and the peak amplitude of displacement are the essential data of the test. The resonant frequency is the ideal operating frequency for any type of vibration drive, since at resonance, a small amount of input force from the drive will cause large amplitudes of displacement of the particular vibrating specimen under test.

Figure 2 shows a resonance curve for an aluminum-alloy specimen. The form of the curve is typical of metallic specimens. The power required from the drive at resonance is equal to the power losses of the vibrating specimen. Normally, the power losses are mostly hysteresis losses in the specimen. Losses to the atmosphere in the form of sound may be appreciable if the vibrating area is large.

The operating cycle of the thyratron-controlled vibration drive is shown in Fig. 3. Operating force is applied to the vibrating specimen during the time when current flows in the drive coil. The displacement wave shape is most nearly sinusoidal, as found by experiment, when current flows in the coil for about one-quarter of the period of the dis-

Vibration Drive



Part of a propeller blade under test with vibration drive equipment

placement cycle.

For the usual case of fatigue testing, small variations of the displacement curve of Fig. 3 from a sinusoidal wave shape are negligible. The specimen, when in practical use, usually exhibits a displacement curve that is far from sinusoidal. The peak amplitude of displacement, rather than the wave form, is normally of paramount importance since the number of cycles required to break a specimen is a function of the peak amplitude of vibration. For the usual case, the thyratron drive is suitable. For applications requiring a more nearly sinusoidal waveform of displacement, the drive described by Willson[1] is more suitable.

The maximum force obtainable from a thyratron drive is limited only by the capabilities of thyratrons. The thyratron drive is well suited to applications requiring large driving forces.

Frequency Range

Frequency range of the thyratron drive is limited by the deionization time T_D of the thyratron. The maximum obtainable frequency of vibration f_{max} when used with the current-displacement cycle of Fig. 3, will be slightly less than $f_{max} = 3/4\ T_D$.

For a mercury thyratron with a deionization time of 1,000 μsec, f_{max} is slightly less than 750 cps. For a hydrogen thyratron with a deionization time of 150 μsec, f_{max} is less than 5,000 cps. Practical circuit considerations which are discussed later may limit the obtainable maximum frequency to a small fraction of f_{max}. The minimum frequency is limited by the size of the drive capacitor (C_2, Fig. 4) and the inductance of the electromagnet. With a sacrifice in displacement wave shape, frequencies can be obtained as low as desired without diminution of peak force.

The basic thyratron drive may be changed in a number of ways to fit individual requirements. Two or more electromagnets may be operated in series with one thyratron to vibrate specimens or parts of specimens in unison. Two or more drives may be operated in parallel to shift specimen displacement curves by any desired angle. The desired phase shift may be controlled by using separate firing pulses for each thyratron, synchronizing the lagging pulse with the leading pulse. Force curves with steep leading edges may be generated for special tests.

Design considerations are illustrated by description of a drive that has given satisfactory service for several thousand operating hours.

Initial drive requirements to establish are the desired maximum force, amplitude of displacement, and frequency range. The illustrated drive required a force variable to a maximum of 20 pounds, a displacement amplitude of 0.005 inch and a frequency range variable from 2 to 110 cps.

Electromagnet design depends upon all three of the initial requirements. Roters[2] gives criteria for the design factors including the size and shape of the core and armature and coil data. For the illustrated drive, the core and armature assembly was taken from a size one, 60-cycle, 110-volt a-c contactor and the coil was rewound with glass insulation and a silicone varnish.

Experience with the rewound coil shows that good life is obtained when operating the drive at 90 cps with a peak current of 7 amp in the coil.

After choosing the type of core, a desirable procedure is to measure or calculate the static inductance for several widths of air gap and for various peak voltage values. Figure 5 shows variation of static inductance (inductance measured with stationary armature) for the size-one contactor as a function of the air-gap space.

The possibility of two modes of operation is illustrated in Fig. 5. For the first mode of operation, the air gap is less than 0.02 inch. Static inductance changes rapidly in this region and large forces are transmitted to the armature. The air gap becomes a large factor in design. No investigation of this operating mode has been made.

In the second mode of operation, armature movement is restricted to be always greater than the critical value of air gap. In the illustration, the armature never comes closer to the core than 0.02 inch. This is the region of practically constant static inductance. Experiment shows that, when operating in this region, there is no appreciable difference between the static inductuance and the dynamic inductance. Small forces are transferred across the air gap, compared with the first mode of operation, but drive operation is easier to make stable.

The static inductance of the electromagnet, taken as the value at minimum air gap, is combined with capacitor C_2 to form a circuit resonant at approximately twice the maximum operating frequency. This procedure fixes the width of the half cycle of current shown in Fig. 3.

The thyratron V_3 in Fig. 4 should be selected by consideration of the peak and average currents required by the electromagnet. Because of the relatively long time between current pulses, the average current in this application is considerably less than the average current required by many applications. For a current pulse of one-fourth the duration of the displacement cycle, the average current is $1/2\pi$ or 0.159 times the peak current. Experience with the FG95 thyratron shows that the heater can be operated 10 percent above normal voltage, as recommended for ignitor service, with a consequent improvement in tube life.

Grid-Circuit Requirements

In addition to the plate-current requirements, the grid circuit and the grid signal power requirements are important factors.

Malter and Johnson[3] indicate that a large impedance in the grid circuit will increase the deionization time of the thyratron, thus lowering the maximum frequency obtainable from the drive. From the standpoint of grid signal power, a large grid circuit impedance requires but a small amount of driving power. The circuit shown in Fig. 4 will allow a maximum operating frequency of about 130 cps when the air gap is larger than the critical value. If operation is attempted above this frequency, or with an air gap less than the critical value, the thyratron grid loses control and a direct current of considerable magnitude flows through the drive electromagnet. A circuit breaker in the incoming line, set to open on abnormal current, is used to protect the circuit against this eventuality.

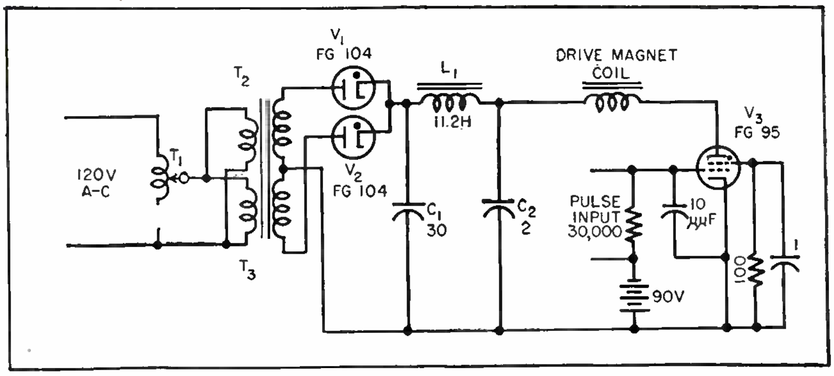


FIG. 4—Power control circuit illustrating design technique

Another factor affecting the maximum operating frequency is the impedance placed between the power source and the resonant drive circuit. The function of this impedance is to allow the thyratron to deionize before subjecting it to a positive plate voltage. The inductor L_1 in Fig. 4 performs this function. For the illustrated circuit, an inductance of 11.2 henrys is close to the minimum required inductance.

The power supply must be of the variable-voltage type. In Fig. 4, a variable-voltage auto transformer is used to meet this requirement.

The frequency-control circuits for firing the thyratron must be designed to achieve a high degree of frequency stability. Figure 2 shows that a small deviation from the resonant frequency results in a large change in displacement amplitude, which is intolerable in fatigue tests.

Satisfactory stability can be obtained by using modern commercial audio oscillators or by using a feedback circuit similar to Willson's control where the electrical equivalent of the displacement curve is amplified, shifted in phase, converted to a pulse and fed back to fire the thyratron. The feedback circuit is most useful for specimens whose resonant frequency shifts during the course of a test. For specimens whose resonant frequency does not shift, the audio oscillator, followed by a pulse-forming network, is useful.

A dual control consisting of a commercial audio oscillator and a built-in narrow range oscillator, has several advantages. The built-in oscillator is used as a vernier adjustment of frequency. Its frequency range should be centered on the resonant frequency of the speci-

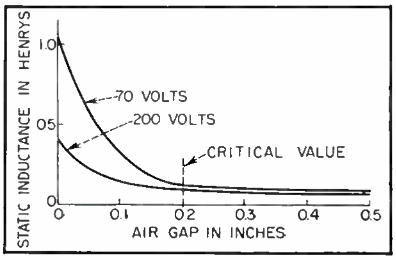


FIG. 5—Static inductance of a core and armature

men and extend only a few cycles each way. The more expensive commercial audio oscillator is used for initial calibration; the built-in oscillator is used for the duration of the test.

The pulse-forming network for firing the thyratron is considered necessary because of the stringent frequency-stability requirements. Gleason[4] gives convincing reasons for firing a thyratron by means of a pulse; he also gives response curves for several pulse shapes that enable quick and accurate calculation of R-C types of thyratron grid networks.

Acknowledgment is due A. G. Buck and S. F. Schmidt, both of Ames Aeronautical Laboratory, for their help in the development of the vibration drive. Mr. Buck supervised the project, and Mr. Schmidt suggested the final arrangement of the elements of the power control circuit.

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(3) L. Malter and E. O. Johnson, The Effect of Grid Resistance on the Recovery Time of Thyratrons, *RCA Review*, **11**, p 165, June 1950.

(4) Gleason, Pulse Response of Thyratron Grid Control Circuits, *Proc. IRE*, **34**, p 71, 1946.

SUPERREGULATED POWER SUPPLIES

Grid-controlled thyratron rectifiers in preregulator work with servo-stabilized d-c amplifier in superregulator to provide 300 volts at 20 amperes with required 0.001-percent regulation for mathematical operations in 4,000-tube analog-digital computer. Other equally stable plate and bias supplies with high current output are also described

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THE FIVE power supplies described here are believed particularly interesting because of the high degree to which some of them are regulated, the means for regulation and the unusually high current ratings for what might be considered receiving tube service. All give 0.001 percent regulation as required for plate and bias voltages in the d-c amplifiers used as integrators, differentiators, multipliers and for other purposes in the Project Typhoon analog-digital type computer recently built for the U. S. Navy. The plate supplies give + 300 and − 300 volts at 20 amperes, while the bias supplies give + 75 and − 75 volts at 6 amperes and − 500 volts at 3 amperes.

In general the genesis of each plate-bias supply is the same. As shown in Fig. 1, power is metered through the power rack to transformers, fed to the rectifiers—preregulators in the case of the − 500, − 300 and + 300 volt supplies—thence to the superregulators and on through delay-operated starting-current limiters to the distribution point. The design of each, too, is similar. For simplicity the operation of one of them, the + 300-volt supply, will be explained and subsequently the important differences between it and the other supplies will be described.

The full regulation of the + 300 volt supply is obtained in two stages. In the first, called the preregulator stage, a moderate degree of regulation is obtained by using grid control on the thyratron rectifier tubes. The output voltage from this stage is purposely made 50 volts higher so that this additional voltage may be fed to a second stage of regulation called a superregulator.

+350 Volt Preregulator

Referring to the circuit of the + 350 volt preregulator in Fig. 2, leg voltages *A-N*, *B-N* and *C-N* of a three-phase 395-volt power line are applied to the plates of the type 105 thyratrons V_4, V_5 and V_6 respectively. Disregarding the controlling bias on these thyratrons for the moment, the rectified output is fed to the filter network where the voltage to ground at the arm of the voltage divider and that obtained across the 0D3 tube may be adjusted to substantially the same value or as desired. Any variation in the set potential difference between these two points and ground may be considered to be the error voltages.

Any difference, however, in potential between these two points is fed through appropriate gain control networks to the d-c/a-c converters B_1, B_2 and B_3 where alternating voltages essentially of square wave form may be generated across the secondaries of transformers T_1, T_2 and T_3, the amplitude

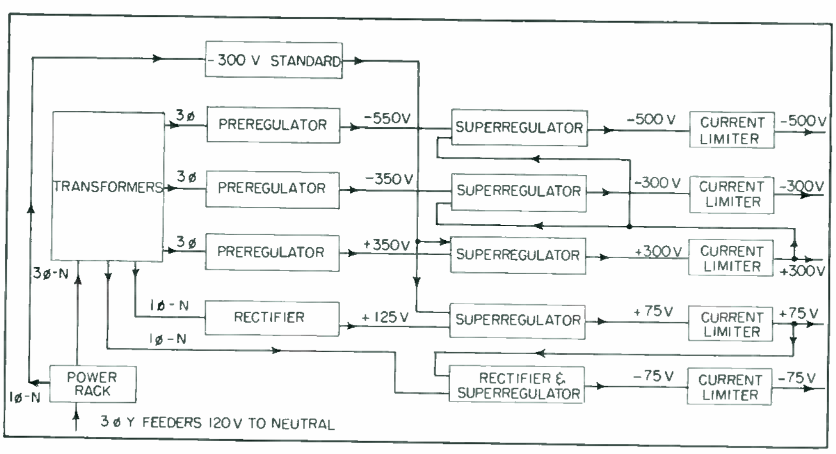


FIG. 1—Arrangement of regulator sections in power supply to provide five different highly regulated plate and bias voltages for Project Typhoon guided-missile computer

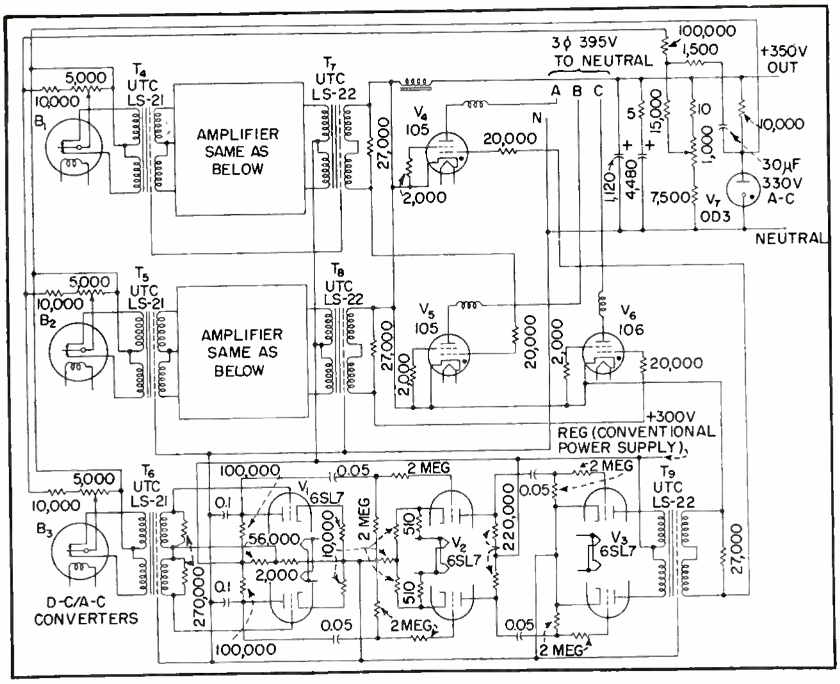


FIG. 2—Circuit of 350-volt preregulator used in the 500-volt bias supply and the two 300-volt plate supplies

being proportional to the difference voltage.

If, further, each converter is operated on a different phase of the plate 3-phase supply, at reduced voltage, the difference voltage may be made to change the firing time of all three thyratrons, the error voltage itself changing the firing time to hold the difference initially set. The method of control for one thyratron only will be described since the principle is the same for each.

There is an amplifier associated with each converter and its corresponding thyratron. The amplifier associated with the converter operated from phase C controls the grid potential of thyratron V_4, whose plate potential is supplied by phase A. The nature of this control for V_4 is shown in Fig. 3. Independent of any difference voltage fed into the input, there is introduced into the cathode circuits of V_2 an alternating voltage a from phase C which produces a square-wave voltage a' at the secondary of T_9. A voltage of approximately 0.165 volt rms between each cathode and ground produces a peak-to-peak square-wave voltage of 146 volts across the 27,000-ohm resistor when there is no thyratron conducting. This voltage will be in phase with phase C for this amplifier.

The input stage of the amplifier integrates any square-wave voltage supplied by the converter, making it essentially a symmetrical saw-tooth voltage. This voltage, now shifted in phase approximately 90 degrees with respect to phase C, is introduced in the grid circuit of V_2 between ground and the voltage-limiting two-megohm grid resistor. The magnitude and polarity of the input difference voltage determine the amount of phase shift in the square-wave output voltage produced by the cathode-introduced a-c voltage alone, as indicated in Fig. 3. As an example, if square-wave voltage b represents a positive difference voltage relative to phase-C voltage a, voltage b' indicates the resulting integration of this voltage. The algebraic sum of voltages b' and a then produces the square-wave output voltage b'', the zero crossover points being to the right on the figure, causing conduction later in thyratron V_4 at point m rather than at point l with no difference voltage. Similarly, a negative difference voltage will cause earlier firing of V_4. In general, except for the phase-A plate voltage and the square-wave output voltages a', b'' and c'', the amplitudes shown are greatly exaggerated as regulating correction will be made on a particular thyratron every single-phase cycle. However, actually the slider on the 1,000-ohm potentiometer is set to give the difference voltage necessary to regulate at the desired output voltage. Any error voltage shifts the phase to regulate at this point.

In operation under a load of about four amperes, 350-volt d-c output is obtained when V_4 or any other thyratron is triggered at about 100 degrees. The firing point shifts to the left as the load is increased. At the load of four amperes a shift to the left of about 10 degrees occurs for an increase in regulated output voltage from 350 to 365 volts. The firing point approaches full conduction, with plate at cathode potential, near full load.

Phase shifting is employed on the primaries of T_2 and T_3 in Fig. 2 to obtain exact 120-degree displacement between the a-c drive voltages supplied to the converters. Transformer differences with converter and filament load caused as much as 5-degree phase shift. The transformers were selected so that resistance and capacitance could be used on two of them.

Series resistor-capacitor combinations in the output-input circuits were somewhat arbitrarily selected to stabilize the amplifier feedback

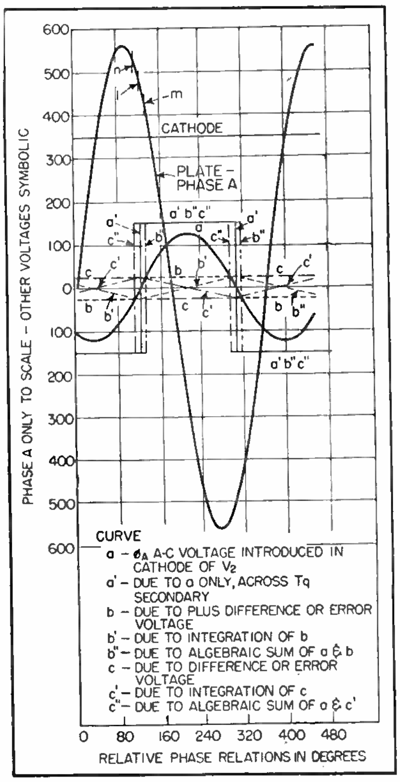
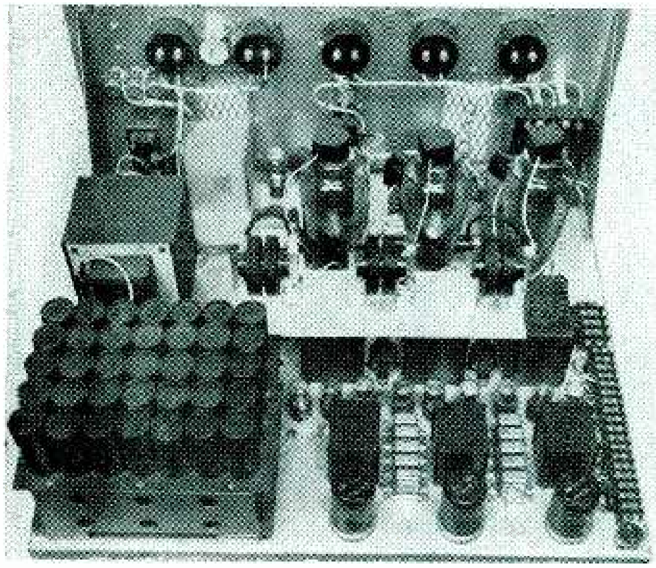
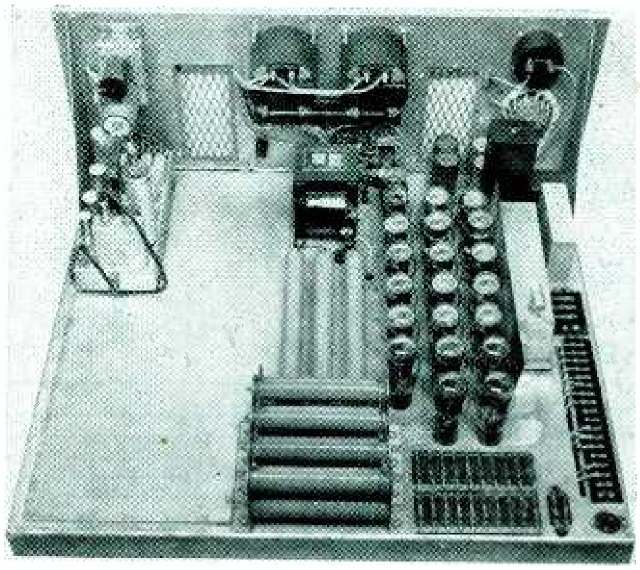


FIG. 3—Firing control curves for typical thyratron in preregulator



Typical preregulator chassis, showing the three Brown converters in right foreground, three groups of three 6SL7 amplifier tubes behind, and the three type 105 thyratrons. Bank of electrolytics at left provide 1,120 μf and 4,480 μf across 350-volt output. Hum level (rms) ranges from 220 mv for +125 v and —125 v units to 440 mv for +350 units



Typical superregulator chassis, showing 20 paralleled 6AS7 tubes. Servo system is at left. Hum level (rms) is 0.25 mv for —500, —300 and +300 units, 0.3 mv for ±75 and 0.6 mv for —75 units. Maximum offset voltage in percent ranges from 0.00027 to 0.05 for different combinations of units, between each nominal voltage and its reference

loop. One combination is of relatively high capacitance and low resistance, and the other of relatively high resistance and low capacitance. The former was used to suppress a tendency toward a low-frequency oscillation and the latter for a high-frequency oscillation.

The local + 300 volt regulated power supply shown on Fig. 2 is used to supply plate power to all of the amplifiers of all of the preregulators.

+300 Volt Superregulator

The superregulator circuit in Fig. 4 consists primarily of a stabilized d-c amplifier of the current-summing type wherein one of the voltages fed to the summing resistors is obtained from a standard reference voltage of – 300 volts and the other is obtained from the point of distribution of the + 300 volt output of the superregulator. The voltage supplied to the + 300 superregulator is + 350 volts in order to allow 50 volts for further regulation. This 50-volt drop is maintained across the 20 6AS7-G tubes used for regulating, hence their plates are operating at + 350 volts. The + 300 volt output voltage appears across the cathodes of these tubes. Thus, any deviation in output voltage from the value of + 300 volts at the distribution point, in operating to change the potential of the first grid at the d-c amplifier input, changes the grid voltages of the 6AS7-G tubes to increase or decrease the plate voltage drop across these tubes in the direction to correct for the deviation.

It will be noted that enough 6AS7-G tubes to carry the total rated output current are not provided. With a plate voltage of 50 volts, one 6AS7-G will carry approximately 0.5 ampere but for possible variations of total current in the solution of problems, it was decided to limit the current generally to 0.25 ampere per tube. Also, it was decided to try regulating with 25 percent of the total current for each superregulator. This fixed the number of tubes at 20 for the + 300 (and – 300) volt supplies.

For d-c continuity and complete stability, a local minimum load is kept on the output of the superregulator at the chassis if no other load is drawn. When the load is greater than that permissible through the 6AS7-G regulator tubes, resistance shunts are provided to bypass the excess. Each of the eight shunts consists of 25 ohms to provide a shunt of 2 amperes.

The switch that inserts one of these removes the local load so that a reduction in 6AS7-G current of 4 amperes is obtained. Thus for a tested rated current of 20 amperes, all shunts were used; no local load was connected and the 6AS7-G mean current was 4 amperes. No greater load than about 15 amperes has been demanded in the computer up to the present, however.

To observe the individual behavior of each of the 6AS7-G tubes, a small resistor is inserted in series with each tube and switching of a voltmeter is arranged so that the voltage across each resistor may be read individually.

D-C Amplifiers

All of the d-c amplifiers require three B supply voltages, + 75, + 300 and – 500 volts. With the 3-gang switch shown at the lower left of Fig. 4, these voltages may be obtained from the superregulators themselves, from an auxiliary supply or from the + 300 and – 500 volt preregulators and the + 75 rectifier. Normal operation may be obtained using the first two sources, but use of the last is limited only for test. The use of the auxiliary supply allows independent operation of either the + 300 or the + 75 volt supply since each uses the – 300 volt standard for reference. The other supplies require the first two for reference and may then be turned on together or separately.

The auxiliary supply serves no other purpose and will not be described further other than to men-

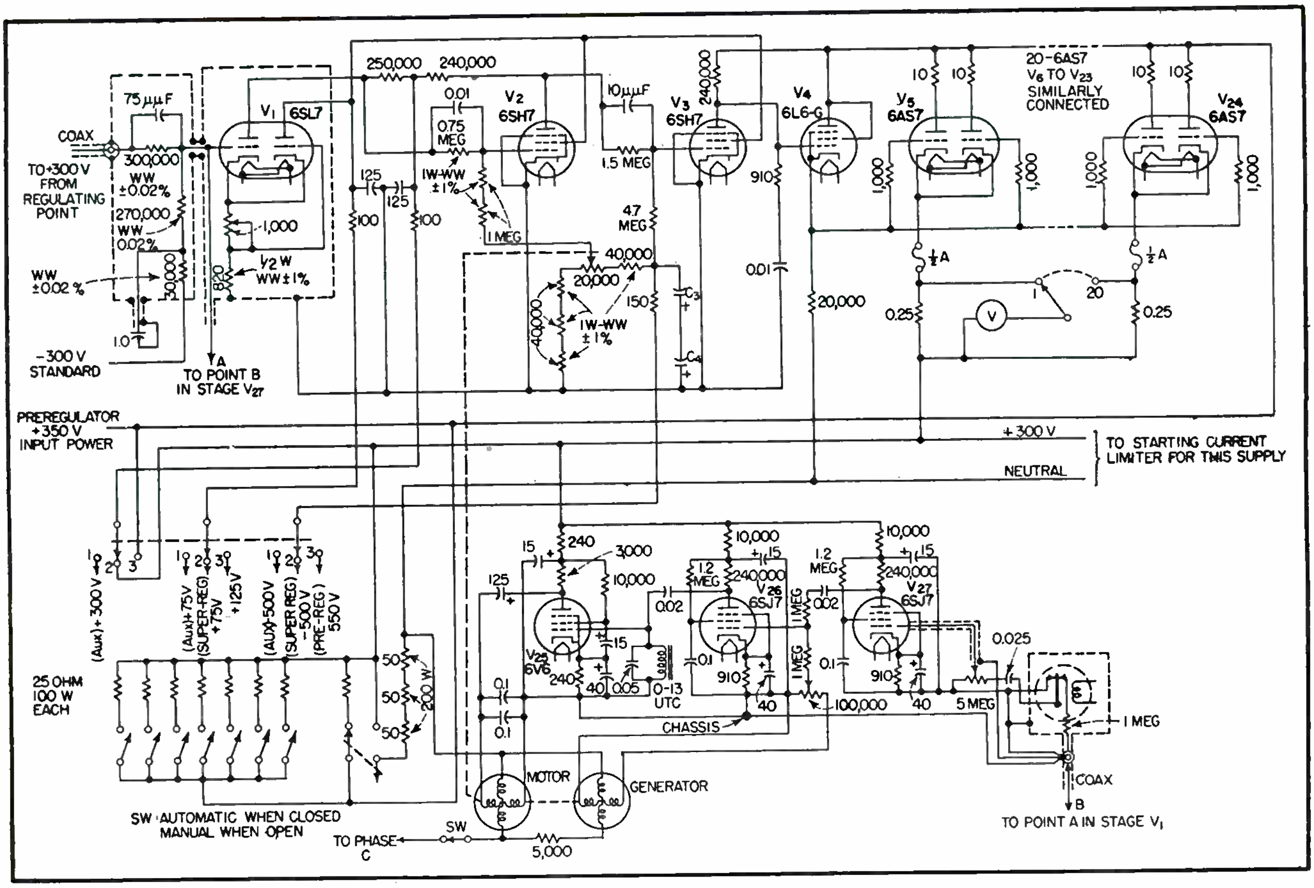


FIG. 4—Circuit of 300-volt superregulator. Voltage drop across 20 paralleled 6AS7 double-triodes is controlled by d-c amplifier and motor-generator servo system to drop exactly 50 volts of the 350-volt input power from preregulator even though load current varies from zero to 20 amperes

tion that it is a regulated supply referenced to a glow tube with a hum level of the order of 100 millivolts for the −500 volt supply and proportionately less for the other supplies.

Zero d-c amplifier difference current between that caused by the standard voltage across the resistance string associated with it and that caused by the regulating superregulator voltage across the resistance chain associated with it is obtained only if the resistances have the same resistance per volt. These resistors are therefore as accurate and free from temperature drift as could be secured. In the case of the +75 and −75 volt superregulators, small padding resistors were inserted for additional adjustment.

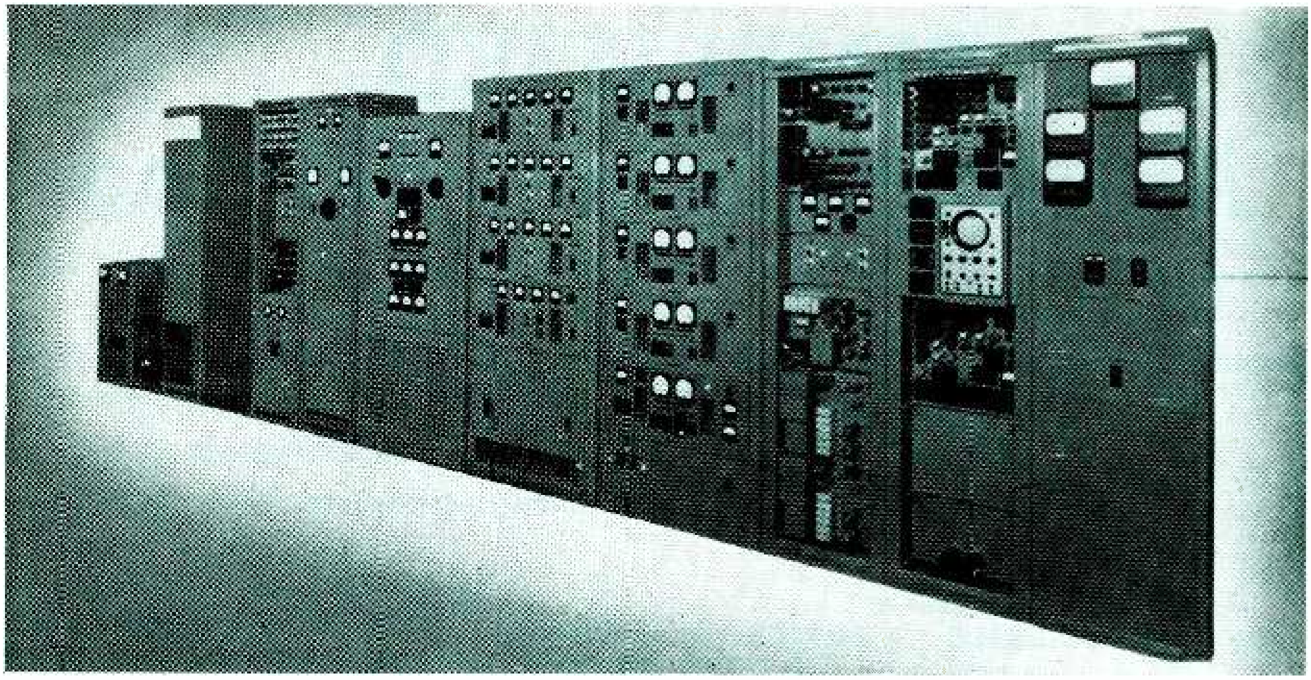
To prevent ground currents from affecting the regulating voltage fed to the amplifier, the ground connections of the later higher-current less-sensitive stages are not returned through the ground regulating lead (shield). The shield box containing the summing resistors and that containing the input tube are connected to the ground shield, as is the low side of the 1-μf filter capacitor used across the first resistor of the resistance for each standard voltage to filter any possible hum or extraneous voltage from it.

Servo System

The servo amplifier stabilizer serves the same purpose as the a-c amplifier in the Goldberg stabilizing amplifier, and permits convenient manual zero output setting if desired. The correcting voltage is introduced in the grid circuit of the second d-c amplifier tube by motor drive (automatic) of the potentiometer arm or by manual operation if the motor is not supplied with a-c on its field coils. The sensitivity is such that approximately 50 microvolts will initiate movement.

In the case of the servo units for the +75 and −75 volt superregulators, however, the sensitivity has been increased by increasing the gain of the amplifier to the point where about 7 microvolts input will initiate control. The voltage across the rotor of the motor may be either polarity depending on the d-c offset at the input of the d-c amplifier. This causes the motor to move in the right direction to correct for the offset. In addition, the motor drives a generator, the output voltage of which is in phase with the driving voltage on the motor. A portion of this voltage is introduced in the second stage of the servo amplifier to prevent too-violent motor movement and hunting.

As a part of the regulating network, large values of capacitors are connected across the outputs of the superregulators. The initial starting currents of these capacitors would open the circuit breakers if starting protection were not provided. This protection is provided by seven relays that operate in quick succession to short out current-limiting resistors, leaving no resistance in series at the final step.



Complete power supply system for the 4,000-tube computer is a research engineer's dream, filling an entire room and providing plate voltages that stay constant within 0.001 percent. The ten racks are, from left to right: servo power; filament filter; odd-frequency power; relay power; filament power; preregulators and rectifiers; superregulators; auxiliary and plotting-board power; calibrator and scope; incoming three-phase power panel

For the +300 volt and +75 volt superregulators, a −300 volt standard supply was built. In essence this is a well regulated supply developed by F. F. Shoup, the output voltage of which is referenced ultimately to an unsaturated standard cell. For continuous reference a Mallory mercury cell is used.

For the −300 and −500 volt supplies, the output of the +300 volt superregulator is used for reference. For the −75 volt supply, the reference is the +75 volt unit.

Calibrator Unit

Developed by F. F. Shoup, the calibrator unit allows the hum of all important voltage outputs to be measured directly on a commercial cathode-ray oscilloscope. Of even greater importance, it permits a comparison of any voltage output from the superregulators, auxiliary voltage supply or plotting voltage supply with an appropriate reference. The maximum sensitivity of the voltage comparison is 125 microvolts per inch and of the hum 12.5 millivolts per inch.

General Characteristics

Because of the lower voltages and lower loads required, preregulators were not used for the +75 and −75 volt supplies. A conventional single-phase full-wave rectifier using type 6B gas-filled rectifiers was used.

Since the highest negative voltage of each negative-voltage supply is connected to the cathodes of the 6AS7 regulating tubes, it was necessary to supply bias to these tubes by means of a floating bias supply. This was generated by an r-f oscillator whose rectified isolated-from-ground output was controlled by the input of the d-c amplifier. Essentially, all d-c amplifiers are otherwise the same.

The ratio of the voltage change obtained across the load terminals to the a-c load applied is called the dynamic impedance. For frequencies throughout the audio range the dynamic impedance for all plate-bias supplies may conservatively be stated to be less than 0.1 milliohm for peak currents not exceeding the mean value of current carried by the regulator tubes. At zero frequency or for changes in d-c load the dynamic impedance is less than 5 micro-ohms for changes again within the currents carried by the regulator tubes.

The important offset as regards computer operation is that between the −75 and +75 voltage supplies. For these supplies small trimming resistors were placed in series with the d-c amplifier summing resistors for further adjustment. This could have been done also for the other supplies but was not considered necessary.

Changes in offset are principally due to temperature changes. This is particularly true for the substandard mercury cell and the standard cell. Actually the offset attributed to the mercury cell is believed due to the standard cell; however, this latter cell is taken as the absolute reference. In its final placement the whole supply will be in an air-conditioned room so that the temperature factor will be minimized.

The hum output has short spikes of relatively high amplitude and very short duration which, while not apparently interfering with computer operation, are still undesirable.

Very few power supply tube failures have been experienced. These have averaged less than one per month of operation. However, it has been the practice to change thyratron and other heavy current tubes every 1,000 hours.

SIMPLIFIED Antenna Pattern Plotting

Graphical method requires only one set of curves to plot horizontal patterns for two-tower arrays having any spacing and phasing. Method may be extended to apply to systems of three or more towers. Procedure may be reversed to determine appropriate spacing and phasing to locate maximums and minimums at predetermined angles

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CONSIDERABLE progress has recently been made toward simplifying the plotting of antenna-array patterns[1]. However, it is possible to make further simplification of the process.

The field strength from an array of n towers at any point is the sum of n vectors of various magnitudes and phasings. The relative magnitudes of the vectors are known from the current ratios in the towers. If the phase angles of the vectors with respect to one reference vector are known, it is a simple matter to add the vectors graphically. The object is to describe a simple graphical method of finding the phase angles between field vectors for any spacing and phasing of towers.

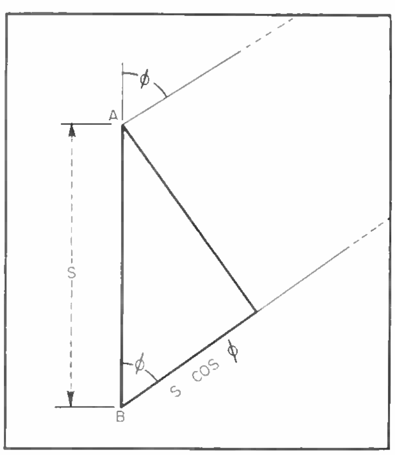

FIG. 1—Basic arrangement for a typical two-tower array

The method has several advantages over previous methods. A single set of curves is used to plot horizontal patterns for two-tower arrays of any spacing and phasing. These curves may be used in reverse to find the tower spacing and phasing to produce a maximum and minimum in the horizontal pattern at any desired angles, and also to find very quickly the general pattern shape. The method may be extended to permit plotting three-tower patterns, and arrays of more than three towers may be dealt with. A second set of curves may be used to plot vertical patterns.

Two-Tower Horizontal Patterns

Consider first the case of the horizontal pattern for two towers. Referring to Fig. 1 and taking A as the reference tower, let S be the spacing between towers in degrees, and P the phase angle of current in tower B with respect to that in tower A.

If the point at which the field strength is to be measured is far enough away so that the lines joining A and B to it may be considered as parallel, then from Fig. 1 it is seen that

$$\alpha H = P - S \cos \varphi$$

where αH = phase angle of field vector from B with respect to that from A in the horizontal plane. Dividing through by P

$$\alpha H/P = 1 - (S/P) \cos \varphi$$

Hence for each value of φ, $\alpha H/P$ may be plotted against S/P, and the result will be a straight line.

These values of $\alpha H/P$ are shown plotted for 10-deg intervals of φ from 0 to 180-deg in Fig. 2 and 3. Figure 2 includes values of S/P from 0 to 5 and Fig. 3 for S/P from 0 to 1. If higher ratios of S/P are required, it is a simple matter to extend the graphs.

To apply this method to finding a horizontal pattern where S and P are given, the following steps are employed:

(1) Find the ratio S/P. (2) For this value of S/P find values of $\alpha H/P$ for 10-deg intervals of ψ from 0 to 180-deg, using the graph of Fig. 2 or 3. (3) Multiply this angle by P, thus obtaining αH the phase angle of the field vector from tower B with respect to that from tower A. It is then just a matter of adding graphically two vectors which are known in magnitude and phase.

A simple method of adding these vectors is shown in Fig. 4. Lay off the reference vector from tower A (E_1) to the center of a sheet of polar coordinate graph paper. On the same sheet draw a circle whose radius is equal to the length of the reference vector multiplied by the field ratio. The resultants (E_0) for various values of φ will be as shown. These values of E_0 plotted against the corresponding values of φ give the pattern shape to some arbitrary scale. The rms value can be found and the conversion to millivolts per meter is made in the usual manner.

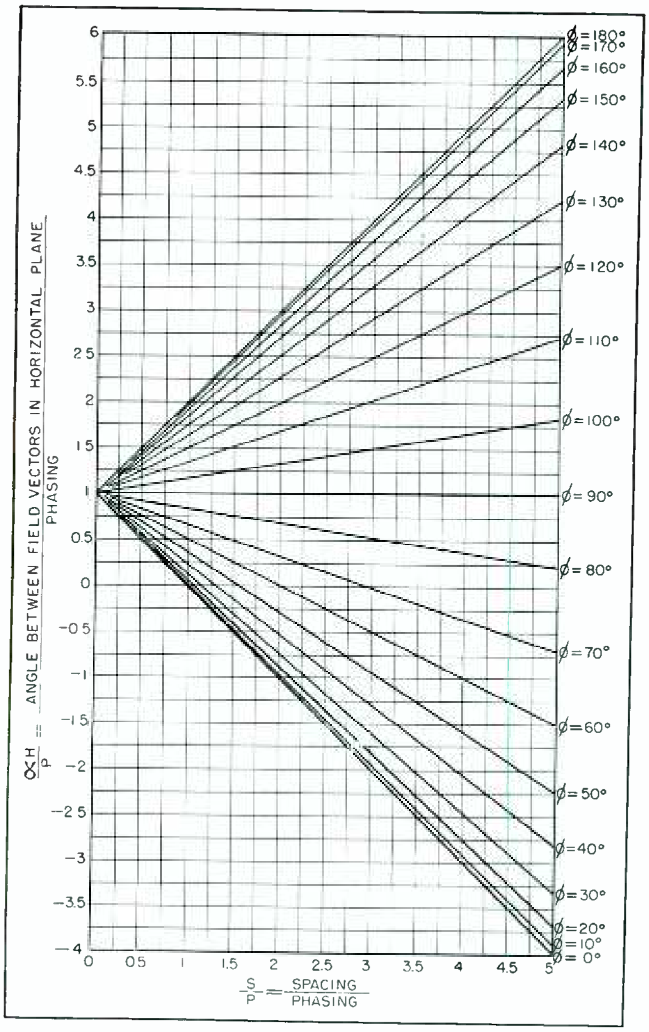

FIG. 2—Curves for determining angle between field vectors in horizontal plane for S/P ratios between 1 and 5

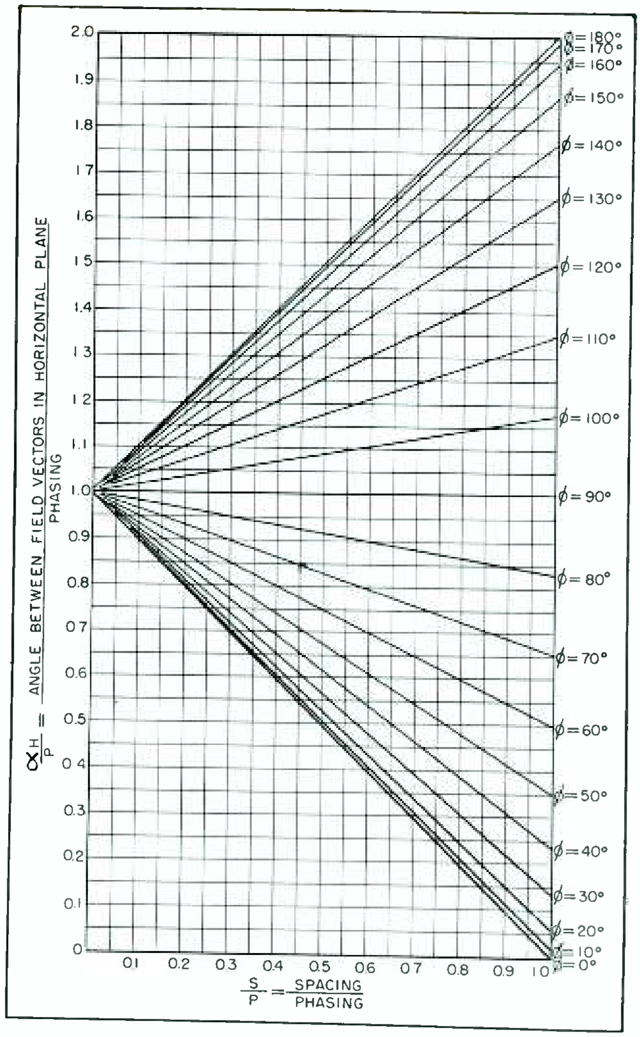

FIG. 3—Expanded portion of curves shown in Fig. 2 for values of S/P between zero and unity

For simplicity it is always well to work with P as a positive angle. In other words, the lagging tower should always be taken as reference.

If the lead tower were taken as reference, the 180-deg curve (Fig. 2 or 3) should be used for 0 deg, 170 deg for 10 deg and so on. This only means that the pattern with respect to the leading tower is shifted 180 deg from the pattern with respect to the lagging tower.

By using the above method any two-tower pattern may be plotted in a few minutes. The accuracy obtainable is as good as if the pattern were calculated with a slide rule.

Three-Tower Patterns

Horizontal patterns with three towers in line may be obtained by using the graphs of Fig. 2 and 3 twice to find αH for two towers with respect to the third, having found S/P in each case, and adding the three vectors obtained.

Again the tower which lags the other two should be used as reference. If the reference tower should be the center tower, remember that when $\varphi = 0$ deg for the first two towers, it equals 180 deg for the other two. Thus in combining vectors, add the field vectors for 0 and 180 deg to the reference vector, and the 10 and 170-deg vectors, and so on.

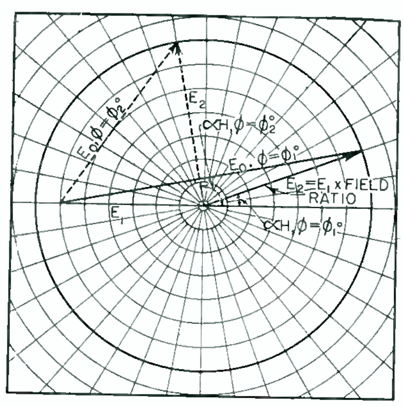

FIG. 4—Simple method for adding two vectors graphically

To plot the horizontal pattern for three towers of arbitrary position, the following steps apply: Referring to Fig. 5, let S_1 = spacing between reference tower A and tower B in degrees and let the line joining B to A represent the reference line ($\varphi = 0$ deg). Let S_2 be the spacing between A and C in degrees, and let β represent the angle between the reference line and the line joining A to C.

Then the angle between the field vector from B with respect to that from A, $\alpha H_1 = P_1 - S_1 \cos \varphi$ as indicated previously.

The angle between the field vector from C with respect to that from A,

$\alpha H_2 = P_2 - S_2 \cos(\varphi + \beta)$.

Then for any angle φ, $\alpha H_1/P_1$ is found from the graphs (Fig. 2 or 3) in the usual manner, and $\alpha H_2/P_2$

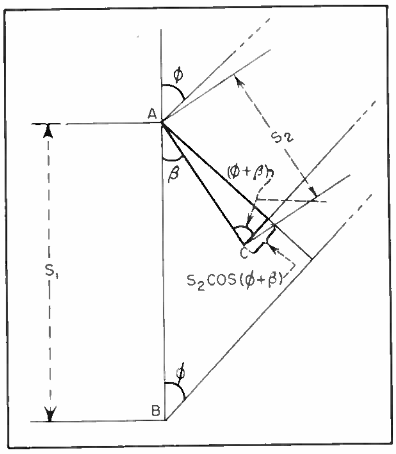

FIG. 5—Typical arrangement of three-tower system

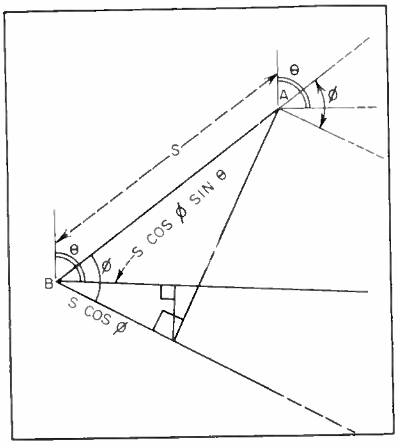

FIG. 6—Simplified drawing showing method for calculating vertical pattern for any azimuth angle

is found from the graphs by adding β to φ in each case and finding $\alpha H/P$ for the sum. The three vectors are then added.

In the configuration of towers shown in Fig. 5 it is noted that C lies to the right of AB. Hence when φ is measured in a clockwise direction the angle between AC and the line joining C to the point at which field strength is measured will be $(\varphi + \beta)$. If φ is measured counterclockwise the angle will be $\varphi - \beta$ or $\beta - \varphi$ depending on whether φ or β is larger.

Since the pattern is not symmetrical in this case αH must be found for each field vector for values of φ from 0 to 360 deg. If C lies to the right of AB as shown in Fig. 5, then, if the angles are measured clockwise, $\alpha H_2/P_2$ must be found for $\varphi + \beta$. If C lies to the left of AB, $\alpha H_2/P_2$ is found for $\varphi + \beta$ for angles measured counterclockwise.

The graphs only give $\alpha H/P$ for values of φ from 0 to 180 deg but they may be used for patterns between 180 and 360 deg since $\cos(180 + \varphi) = \cos(180 - \varphi)$, that is, the $\varphi = 170$-deg curve may be used for 190 deg, the 160-deg curve for 200 deg, and so on.

Summarizing, to find three-tower patterns with towers in arbitrary positions, the following steps must be followed:

(1) Find ratios S_1/P_1 and S_2/P_2.

(2) Find the angle β between AB and AC (as in Fig. 5).

(3) For values of ϕ from 0 to 360 deg find αH_1 from the curves of Fig. 2 or 3, in the manner described in the two-tower case.

(4) To ϕ add β and find αH_2 for the sum of these from the graphs. *Example:* Let the angle β in Fig. 5 be 10 deg.

φ	Angle used for finding $\alpha H_1/P_1$	Angle used for finding $\alpha H_2/P_2$
0 deg	0 deg	10 deg
10 deg	10 deg	20 deg
20 deg	20 deg	30 deg

Notice whether C lies to the right or to the left of AB and hence whether to proceed clockwise or counterclockwise.

(5) Add the three vectors at the angles found from 3 and 4 above, using the proper field ratios as determined from tower current ratios. The resultants when plotted against the corresponding values of φ will give the pattern shape to some arbitrary scale.

Other Applications

The above procedure can be used for more than three towers, provided the spacing of each tower from the reference tower is known, and the angle between the lines joining that tower to the reference tower and the reference line.

Consider the case where it is required to have a pattern with a

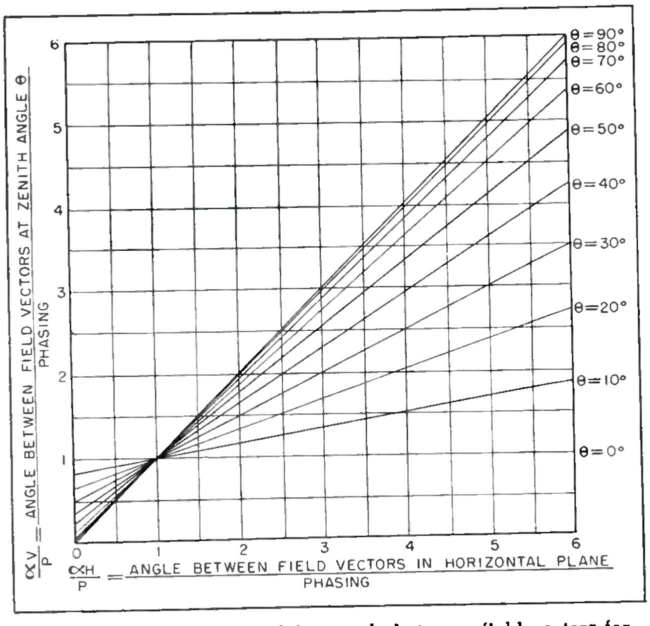

FIG. 7—Curves for determining angle between field vectors for various zenith angles

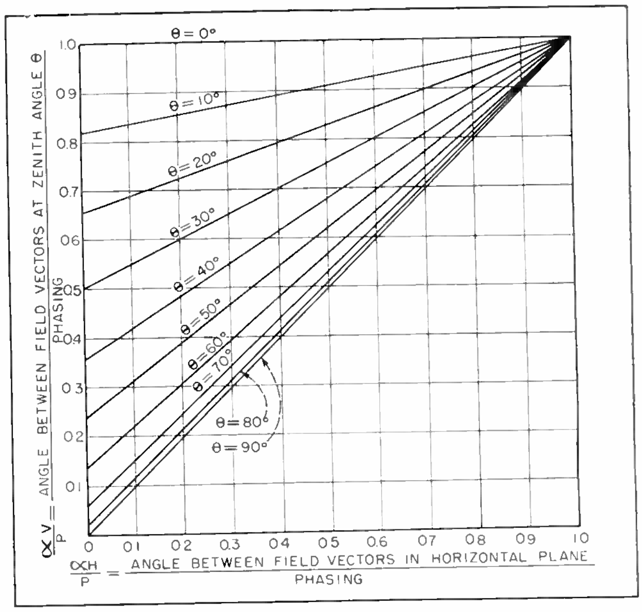

FIG. 8—Expanded portion of Fig. 7 for values of $\alpha H/P$ between zero and unity

null point in some particular direction.

The following examples will illustrate how the curves may be used to find the necessary tower parameters.

Example 1: Two towers with a null in the pattern at 140 deg and a current phasing of 90 deg. Find the spacing.

Solution: At the null point the field vectors must be equal and 180 deg out of phase, that is, $\alpha\ H = 180$ deg. Then $\alpha\ H/P = 2$. For $\phi = 140$ deg and $\alpha\ H/P = 2$, we find $S/P = 1.3$ (from graphs Fig. 2). Hence $S = 1.3 \times 90 = 117$ deg. If three towers were being used with equal currents then at a null point $\alpha\ H_1 = 120$ deg, $\alpha\ H_2 = 240$ deg.

The curves may again be used, having assumed current phasings for the two towers.

Example 2: Two towers, with a spacing of 120 deg, to give a null at $\psi = 120$ deg.

Solution: On the $\psi = 120$-deg line of Fig. 2 or 3 we can find a value of S/P and hence find P, such that when $\alpha\ H/P$ is multiplied by P, $\alpha\ H$ will equal 180 deg. This requires successive approximations but still does not consume much time. In this example the value is found to be $S/P = 1$, and $P = 120$ deg. Then $\alpha\ H/P = 1.5$, and $\alpha\ H = 180$ deg.

Plotting Vertical Patterns

Consider the field from two towers at some angle θ from the vertical. Let $\alpha\ V$ = angle between field vectors at this zenith angle. Then referring to Fig. 6, $\alpha\ V = P - S \cos\varphi \sin\theta$ where all terms have the same significance as previously. Then $\alpha\ V/P = 1 - (S/P) \cos\varphi \sin\theta$, $\alpha\ V/P - 1 = -(S/P) \cos\phi \sin\theta$, and in horizontal pline $\alpha\ H/P - 1 = -(S/P) \cos\varphi$. Hence $\alpha\ V/P - 1 = (\alpha\ H/P - 1) \sin\theta$ or $\alpha\ V/P = (\alpha\ H/P - 1) \sin\theta + 1$.

Hence a series of straight lines may be plotted ($\alpha\ V/P$ vs $\alpha\ H/P$) for values of θ from 0 to 90 deg. This has been done for 10-deg intervals of θ in Fig. 7 and 8.

These curves can be used to plot a vertical pattern having first obtained the horizontal pattern. (1) Obtain the value of $\alpha\ H/P$ for the particular value of φ which is of interest. (2) Find values of $\alpha\ V/P$ for values of θ from 0 to 90 deg from Fig. 7 or 8. (3) Add the two vectors graphically for each value of θ. (4) From available graphs[2] of percent field strength ($f\theta$) versus antenna height, find percent $f\theta$ for each value of θ and multiply the resultants found in 3 above by this value. These quantities are the pattern values to some arbitrary scale.

Since the horizontal value of field strength ($\theta = 90$ deg) is known, it is then a simple matter to evaluate and plot the vertical pattern in millivolts per meter.

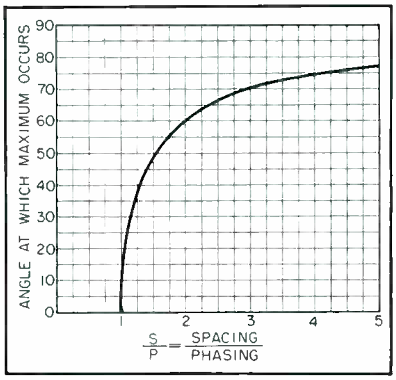

FIG. 9—Curve for determining S/P to give a maximum at any desired horizontal angle

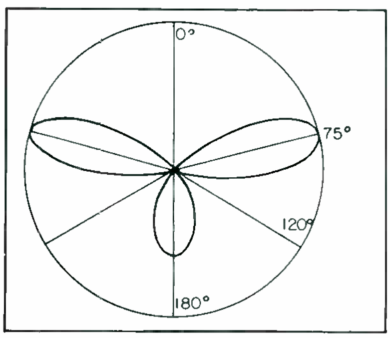

FIG. 10—Resulting shape of pattern of array designed specifically for a maximum 75 deg from line of towers and a minimum at 120 deg

Finding Spacing and Phasing

From an examination of the graphs of Fig. 2 and 3, the following is noted. The lines for $\varphi = 0$, $\phi = 10$ deg, and so on, intersect the $\alpha\ H/P = 0$ line at definite values of S/P.

Now when $\alpha\ H/P = 0$, the pattern has a maximum value at that point. Thus if the values of S/P at which the lines intersect $\alpha\ H/P = 0$ are plotted against the corresponding values of φ, we have a curve which tells us the required values of S/P to give a maximum in the pattern at any horizontal angle. This curve has been plotted in Fig. 9.

Using this curve and Fig. 2, it is a simple matter to obtain the tower spacing and phasing to give a maximum and a minimum in the pattern in any required direction.

Example 1: We require a maximum in the pattern at 50 deg from the line of the towers and a minimum at 130 deg.

Solution: From Fig. 9 we find that for a maximum at 50 deg, $S/P = 1.55$. Now referring to Fig. 2 at $S/P = 1.55$ and on the $\varphi = 130$-deg line, we find $\alpha H/P = 2$. Now for a minimum $\alpha\ H = 180$ deg. Hence $P = 180/2 = 90$ deg and $S/P = 1.55$ from above. Hence $S = 90 \times 1.55 = 139$ deg.

Example 2: To investigate the pattern and find its approximate shape, having set up certain requirements, the following procedure may be used. Assume the following requirements: Maximum required at 75 deg and a minimum at 120 deg.

From Fig. 9, $S/P = 4$ and from Fig. 2, at $S/P = 4$ and on the $\varphi = 120$-deg line, $\alpha\ H/P = 3$. Again $\alpha\ H = 180$ deg for minimum. Hence $P = 60$ deg. Then $S = 60 \times 4 = 240$ deg. Now if $\alpha\ H = -180$ deg there will be another minimum—that is, at $\alpha\ H/P = -3$, this occurs at $\phi = 0$ deg. (Fig. 2). There will be another maximum at $\alpha\ H = 360$ deg ($\alpha\ H/P = 6$). In this case there is no other maximum, because the point $S/P = 4$, $\alpha\ H/P = 6$ lies outside the graph. At $\phi = 180$ deg, $\alpha\ H/P = 5$ ($\alpha\ H = 300$ deg.). Thus pattern value = 1.5 times reference vector = $\frac{3}{4}$ of maximum. Thus a general idea of the pattern shape may be found very quickly. It will look like Fig. 10.

References

(1) George R. Mather, Pattern Calculator for A-M, Electronics, p 100, Apr. 1951.

(2) Engineering Handbook of the National Association of Broadcasters, Fourth Edition, p 2-1-14.

Wide-Band Converter

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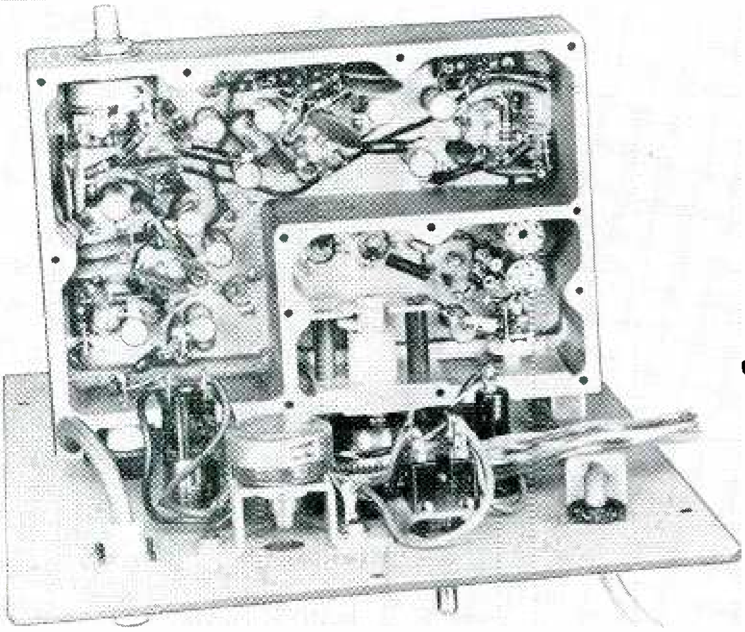
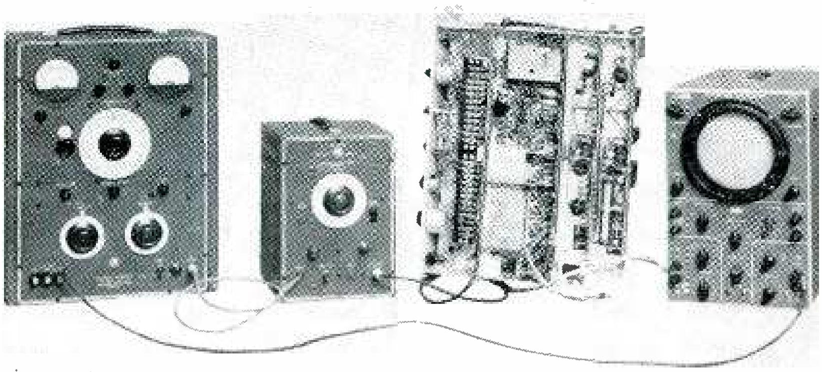


Bottom view of converter chassis shows mounting of critical components



Converter and signal generator setup for alignment of an i-f amplifier

THE FREQUENCY SPECTRUM from 100 kc to 55 mc is particularly important since it contains the intermediate frequencies of receivers of almost all types, an extremely active mobile radio band and many other communication services. Many of the associated receivers handle frequency modulation. Up to the present time, however, a signal generator providing frequency-modulated signals over the entire range has not been available.

A signal generator[1] is available which provides both frequency-modulated and amplitude-modulated signals in the range from 54 to 216 mc. If a means were available of converting the output frequency of this generator to cover the range 0.1 to 55 mc without changing the signal level or modulation characteristics, the two units would provide complete f-m and a-m generator coverage from 0.1 to 216 mc.

This paper describes the design of such a wide-band, unity-gain converter. All the usual receiver alignments and tests such as stage gain, band width, minimum quieting signal and distortion can be performed with these two units.

As shown in Fig. 1, the converter consists of a local oscillator operating at 150 mc and tunable over a small range, a mixer in which the local-oscillator output beats with the 150.1 to 205-mc input signal from the signal generator to produce a difference frequency in the range 0.1 to 55 mc, a two-stage wide-band amplifier with a pass-band flat from 100 kc to 55 mc, an output system and a regulated power supply.

Local Oscillator

It is necessary for the local oscillator to have excellent stability. It is convenient to be able to tune it to zero beat when the signal generator dial is set at 150 mc, so that the difference frequency can be easily read from the signal generator dial. It is also desirable to provide an incremental frequency control calibrated in small frequency intervals over a frequency range suitable for selectivity measurements and for better accuracy in the 100-kc to 600-kc frequency range.

The oscillator circuit shown in Fig. 2 proved to be quite satisfactory. Relatively large values of capacitance are used to reduce the effects of stray capacitance and of tube replacement. A small grid coupling capacitor is used to decouple the tube from the tuned circuit. Temperature-compensating capacitors reduce drift to a negligible amount.

As shown in the view of the chassis, the oscillator circuitry is located in the small compartment in the casting. The commercial butterfly capacitor in the compartment provides a frequency adjustment of about ±2 mc.

The incremental frequency capac-

for Signal Generator

Frequency-modulated and amplitude-modulated signals are provided over the whole range of frequencies from 100 kilocycles to 216 megacycles by a vhf signal generator operated in conjunction with a wide-band converter

itor in the oscillator compartment provides a frequency range of ±300 kc, the dial being calibrated in 5-kc frequency intervals. To provide this small tuning range of only ±0.2 percent with a capacitor of manufacturable size, the capacitor is decoupled by connecting it across only half the oscillator circuit and is additionally decoupled by connecting a capacitor in series and two capacitors in parallel with it. One of the parallel capacitors is variable and is used as an aid in calibrating the incremental frequency capacitor.

The ceramic oscillator coil form and mixer coupling coil form are at the left side of the oscillator compartment. The oscillator inductor is tuned by means of a metal screw. Initially a powdered iron screw was used for tuning but it was found that the magnetic field of the power transformer varied the permeability sufficiently to frequency-modulate the oscillator. The frequency deviation was only about 150 cycles at 150 mc but changing to a silver-plated brass screw reduced the hum modulation to about 10 cycles deviation.

Table 1 shows that the circuit is satisfactorily independent of oscillator tube characteristics. The maximum frequency variation for the ten tubes tried is ±400 kc or ±0.27 percent, while the change in overall gain is about ±2.5 percent.

Mixer

The 6AB4 high-frequency, high-transconductance triode was chosen for the mixer because of its low noise properties and high conversion gain. Low impedances are used in the grid and cathode circuits to minimize Johnson noise.

The input circuit to the mixer should present a constant 53-ohm load to prevent resonances in the cable which couples the converter to the signal generator. The mixer operates with a plate current of about 6 ma which corresponds to a transconductance of about 4,000 micromhos. The internal impedance is thus 250 ohms. If a 68-ohm cathode resistor is used, the input impedance will be 53 ohms and will properly terminate the RG-58/U input cable.

The degeneration at the difference frequency due to impedance in the cathode circuit is quite low since the 53-ohm output impedance of the signal generator shunts the 68-ohm cathode resistor. Because no blocking capacitor is used in the input circuit, several milliamperes of cathode current flow through the attenuator, but no harm is done.

If a blocking capacitor were used, it would have to be of the order of 0.25 μf to prevent change of cathode degeneration at the low difference frequencies; its omission helps in making the wiring neat. Bias for the mixer tube is developed largely in the grid circuit so that variation in the magnitude of the d-c resistance in the signal generator circuit from zero to infinity has no noticeable effect on the operation of the mixer.

The coupling between the mixer and oscillator (L_1 and L_2 in Fig. 2) can cause trouble at the two ends of the frequency range.

If the coupling is too tight, the mixer gain will vary over the lower difference frequencies between 100 kc and several mc; furthermore, the mixer gain will be different with the input signal tuned equal distances above or below the local oscillator frequency. Apparently some input signal reaches the oscillator circuit and is fed back to the mixer in such phase as to aid or oppose the incoming signal.

At the higher input frequencies, series resonance of the mixer coupling loop with the mixer grid-to-cathode capacitance causes an increase in mixer gain. If this resonance should fall in the range covered by the input frequency there would be a gain peak at the corresponding output frequency which it would be impossible to remove. This effect can be minimized by keeping the resonant frequency of

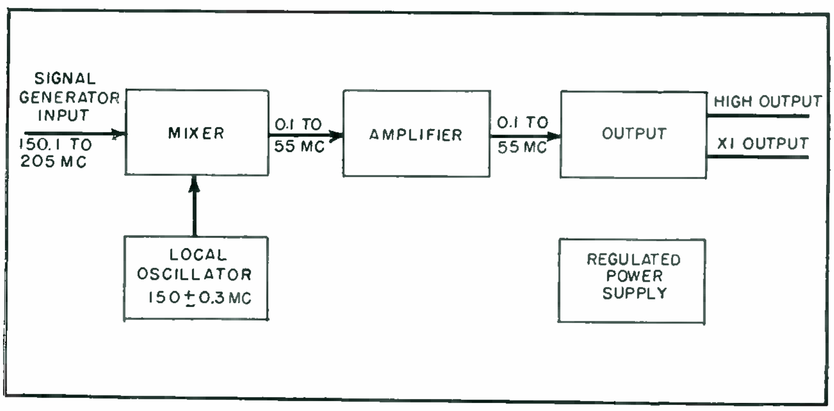


FIG. 1—Arrangement of stages in the converter

the mixer grid circuit very high and by damping the coupling circuit with a series or a shunt resistor. A small amount of resonance in this circuit aids in holding up the gain at the high-frequency end of the passband.

The measured mixer gain of about 1.6 agrees well with the maximum theoretical gain for the circuit. The grid circuit resonance aids in achieving the excellent conversion gain figure.

Wide-Band Amplifier

It was expected initially that a distributed amplifier would be required to cover the frequency range from 0.1 to 55 mc. However, computation showed that a cascaded amplifier using Wheeler's four-terminal low-pass dead-end filter coupling networks[2] is more economical. The bandwidth is too small to make distributed amplification necessary or desirable.

Experiments using a smaller frequency range showed that to achieve the desired flatness of amplification of about ±0.5 db, the design cutoff frequency would have to be at least 66 mc.

The basic coupling network with the filter divided into half sections is shown in Fig. 3A. Using the customary value, $m = 0.6$, this can be combined and rearranged as shown in Fig. 3B. The impedance R and the inductance L are determined by the cutoff frequency and the input capacitance of the following tube. The design equations are:

$$R = 2\pi f_c L/2 = 1/[2\pi f_c (C/2)]$$

The values finally used differ slightly from those indicated in Fig. 3B because of the effects of unavoidable stray reactances. Final values were determined experimentally by using a sweeping oscillator and oscilloscope, flat response being the criterion.

Adding a plate voltage feed, grid leak, grid-blocking capacitor, screen bleeder and decoupling filters produces the final network shown in Fig. 2.

Gain control is achieved by varying the cathode resistors in the two amplifier stages. Control of one stage did not give sufficient range to accommodate maximum tube variations. One gain control is made available from the front panel while the second is mounted on the amplifier chassis.

The gain of the first amplifier stage is about 1.8 and is variable over a range of about ±25 percent while the range of the second is 1.3 ±20 percent.

The unbypassed 33-ohm resistor in each amplifier cathode circuit reduces the available gain but minimizes the variation of input capacitance with gain control setting. If these resistors were not used, there would be a considerable variation of gain with frequency at extreme settings of the gain controls. With the resistors in place, this variation is reduced to about ±2 percent for ±25 percent gain control adjustments.

Output System

It is desirable to have two outputs. One should provide unity gain across a 53-ohm impedance. This is useful when working into the antenna input of a receiver. The second output should provide some gain so that single-stage measurements can be made with the aid of an r-f voltmeter. This output can have a higher impedance but should be capable of providing an easily measurable voltage across the input capacitance of a tube.

The two outputs are obtained from a single tube with load impedances in both plate and cathode circuits. A triode tube could not be used because of the interaction of grid and plate circuit impedances through the grid-plate capacitance of the tube. Presumably any high-transconductance pentode could be used; however, only the type 6AH6

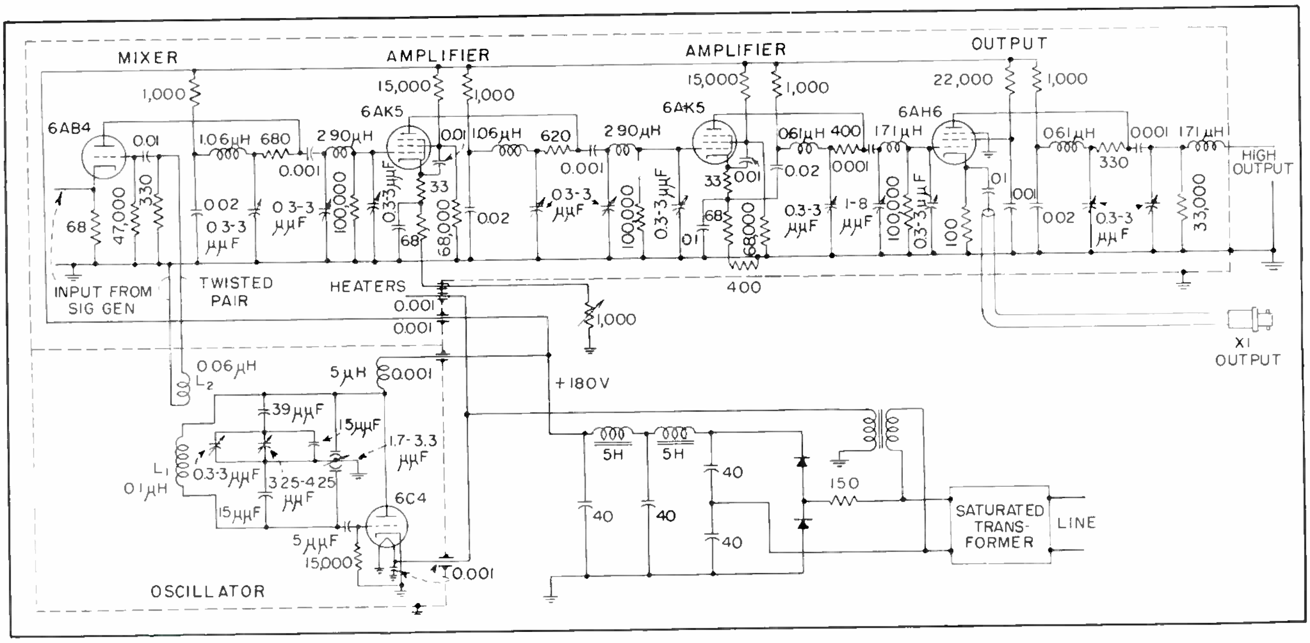


FIG. 2—Complete schematic diagram of converter. Both high and low output are obtained from a single 6AH6 tube

Table I—Effect of Changing Oscillator Tubes

Tube Transconductance *micromhos*	I_p *ma*	Oscillator Grid Bias *volts*	Mixer Grid Bias *Volts*	Frequency Shift From 150 mc *kc*	Relative Converter Output
2,640	10.3	− 9.7	1.81	+100	1.003
3,820	13.7	−11.8	1.77	+500	0.988
2,700	11.3	−10.4	2.18	−271	1.018
2,800	11.0	−10.7	2.01	−227	1.003
3,140	10.8	−11.1	2.12	+400	1.018
2,520	11.8	+ 9.8	2.17	−186	1.01
2,570	10.5	− 9.4	1.92	+ 28	1.003
2,520	10 9	−10.3	2.02	+340	1 010
2,390	10.4	− 9.2	1.90	−111	0.996
2,800	9.9	− 9.3	1.78	−217	0.974

was found to give sufficient isolation between grid and plate circuits. (Type 6AN5 and paralleled 6AK5's were tried.)

The transconductance of the type 6AH6 pentode is about 9,000 micromhos so that the impedance at the cathode is about 110 ohms. When a 100-ohm cathode resistor is used, the impedance looking into the output jack will be about 53 ohms. There is some coupling between the cathode and grid through the tube capacitance; however, the maximum standing-wave ratio in the frequency range from 0.1 to 55 mc is about 1.3.

When a cable terminated in 53 ohms is connected to the XI OUTPUT jack, the cathode load impedance is 34.6 ohms and the cathode-follower gain is about 0.27. The gain controls are set so that the overall gain under this condition is unity so that the attenuator dial on the signal generator will read the voltage across the cable termination. With the terminated cable removed, the open-circuit voltage at the XI OUTPUT jack is twice the attenuator dial reading.

The plate load impedance is 330 ohms. With a cable terminated in 53 ohms attached to the XI OUTPUT jack the grid-to-plate gain is 2.1, thus giving an overall gain of about 7.6 at the HIGH OUTPUT jack. Disconnecting the cable from the XI OUTPUT jack increases the cathode degeneration and reduces the gain in the plate circuit.

A low-pass filter network designed to operate into a 10-μμf load is used in the plate output circuit. The gain will be constant over the frequency range when the proper capacitance load, 10 μμf, is connected to the HIGH OUTPUT jack. A few inches of 300-ohm twin-lead cable and the input capacitance of a tube approximate the correct termination. Too much capacitance causes the gain to decrease at higher frequencies while too little has the opposite effect. The HIGH OUTPUT jack can be open-circuited or short-circuited with negligible effect on the XI OUTPUT.

Power Supply

To stabilize the gain against line voltage variation, it is necessary to regulate both filament and plate voltages. This is very conveniently accomplished by a built-in commercial type 115-v automatic voltage-stabilizing transformer.

No power transformer is used. Plate voltage is derived from a voltage-doubling selenium rectifier circuit. A small stepdown transformer provides the filament voltage.

The 150-ohm resistor shown following the saturated transformer in Fig. 2 protects the selenium rectifiers from peak current overloads. This resistor has an effect on the output voltage and impedance as shown in the following table.

Resistance in ohms	*Output at 50 ma volts*	*Source Impedance ohms*
75	215	1,150
150	180	1,480
300	142	1,950

The fairly high source impedance is unimportant in this application since the current drain is practically constant.

This power supply has proven very satisfactory since the local oscillator frequency varies only a few kilocycles out of 150 megacycles and the overall gain varies only a few percent when the line voltage is varied from 90 to 130 volts.

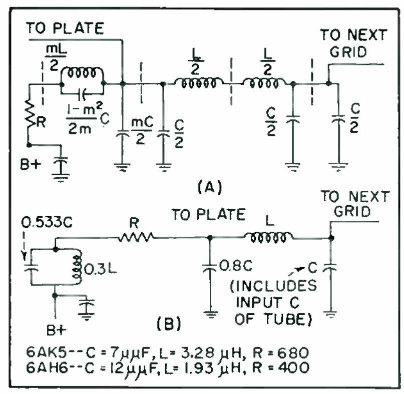


FIG. 3—Basic amplifier coupling network (A) and network with elements combined and rearranged (B). Values given are for 66-mc cutoff

The author wishes to acknowledge the assistance of Ernest Porter and Werner Hopf who participated in the development of this instrument.

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(1) Donald M. Hill and Murray G. Crosby, Design of F-M Signal Generator, ELECTRONICS, p 96, Nov. 1946.
(2) H. A. Wheeler, Wideband Amplifiers for Television, *Proc. IRE*, July 1939.

Magnet

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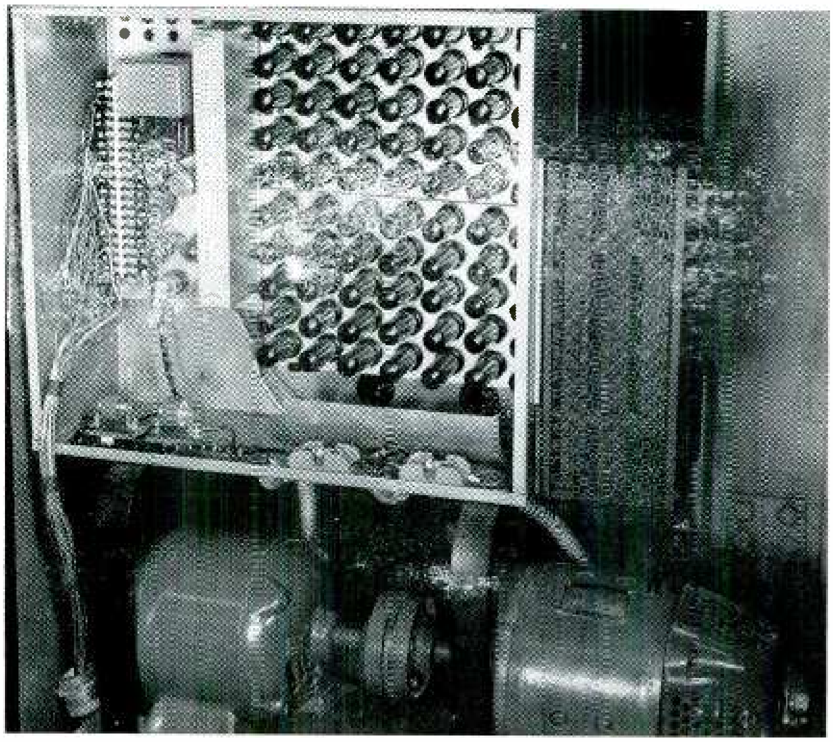


Current supply for magnet. Paralleled variable-conductance tubes and d-c amplifier controlling them are in cabinet over motor-generator set furnishing direct current

FOR NUCLEAR STUDIES in the binding energy range of the nucleus, the Van de Graaff constant-potential accelerator is peculiarly suited because of the homogeneity of its positive-ion beam and its freedom from other types of radiation, resulting in an extremely low background.

The high precision of this type of accelerator justifies and requires a particularly high stability in the magnetic-beam analyzer associated with it. The emergent beam, generally protons or deuterons (ionized hydrogen or deuterium atoms), will consist of monatomic, diatomic and triatomic singly charged ions. Since the deflection of monoenergetic particles in a magnetic field varies inversely as the square root of the mass ratios, a convenient means of separation is afforded.

Circuit Analysis

The beam-analyzing magnet is at the lower end of a 5-million-volt accelerator tube extension. One component of the analyzed beam is passed through a slit system, and is used for supplying error signals to the 5-million-volt generator stabilization circuits. In such an application the magnetic field becomes the primary voltage reference, and

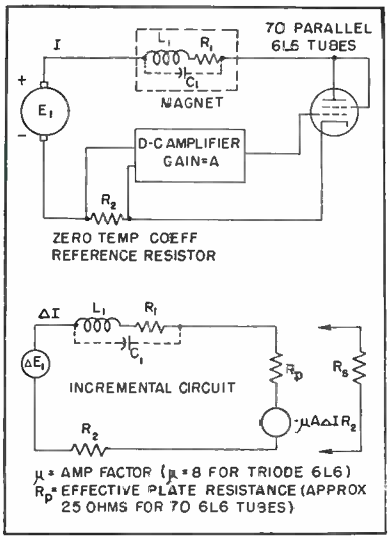


FIG. 1—Block diagram and equivalent circuit of power supply for magnet

a high order of magnetic flux stability is essential.

Basically, the magnet current supply consists of a d-c voltage source, a variable-conductance unit and a standard current reference resistance. The variable-conductance unit consists of a d-c amplifier driving seventy parallel triode-connected 6L6 tubes as in Fig. 1.

From the incremental circuit, the effective internal d-c resistance R_e of the current supply circuit is found to be

$$R_e = \Delta E_1/\Delta I = R_p + R_2(A\mu + 1) \quad (1)$$

where designations are as defined in Fig. 1, and the magnet time constant T will be approximately

$$T = \frac{L_1}{R_e + R_1} = \frac{L_1}{R_1 + R_p + R_2(A\mu + 1)} \quad (2)$$

The constants for the magnet are L_1 = 120 henrys and R_1 = 36 ohms. The d-c amplifier described has a gain of 1,000 and R_2 = 3 ohms. Using 70 6L6 tubes for the regulating element, the effective current-source impedance is approximately 24,000 ohms and the magnet time constant approximately 0.005 second.

With a maximum d-c voltage source of 360 volts, one may expect

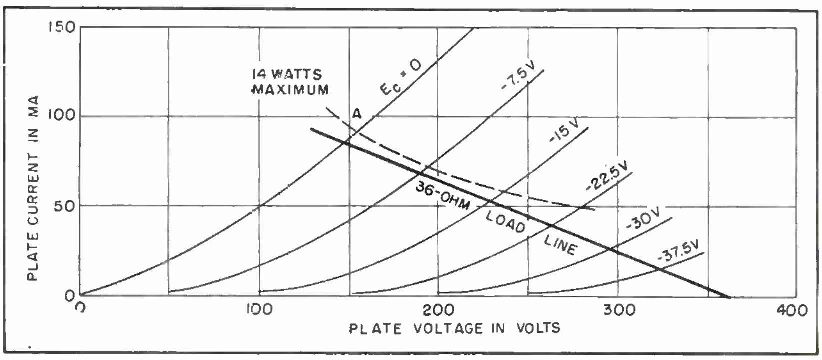


FIG. 2—Characteristic curves and typical load line for a triode-connected 6L6

Current Regulator

High-stability supply using 70 paralled 6L6 tubes delivers 6 amperes d-c with stability better than 0.05 percent to huge magnet at beam-analyzing end of 5,000,000-volt Van de Graaff accelerator. Conductance of paralleled tubes is varied by d-c amplifier

± 10 percent variations to result in current changes of only ± 0.0015 ampere or ± 0.025 percent at 6 amperes. A variation in magnet resistance R_1 of 20 percent (equivalent to considerable overheating) will result in a current change of one part in 3,330, or -0.03 percent.

Effect of Shunt Resistors

To extend the maximum current capacity of the variable-conductance unit, shunt resistances may be resorted to as shown for R_s in Fig. 1. The effective current supply impedance is then

$$R_e = \frac{\Delta E_1}{\Delta I} = \frac{\left[R_p + R_2 (A\mu + 1)\right]}{\left[1 - \frac{R_p}{R_s + R_p}\right]} \quad (3)$$

When R_s is made equal to R_p, the effective current supply impedance will be halved. The use of shunt resistance in this manner will increase the maximum obtainable current by the factor

$$\frac{(R_p + R_s)\,(R_1 + R_2 + R_p)}{R_p\,(R_1 + R_2) + R_s\,(R_1 + R_2 + R_p)} \quad (4)$$

The minimum controllable current will be that limited by the sum $R_s + R_1 + R_2$.

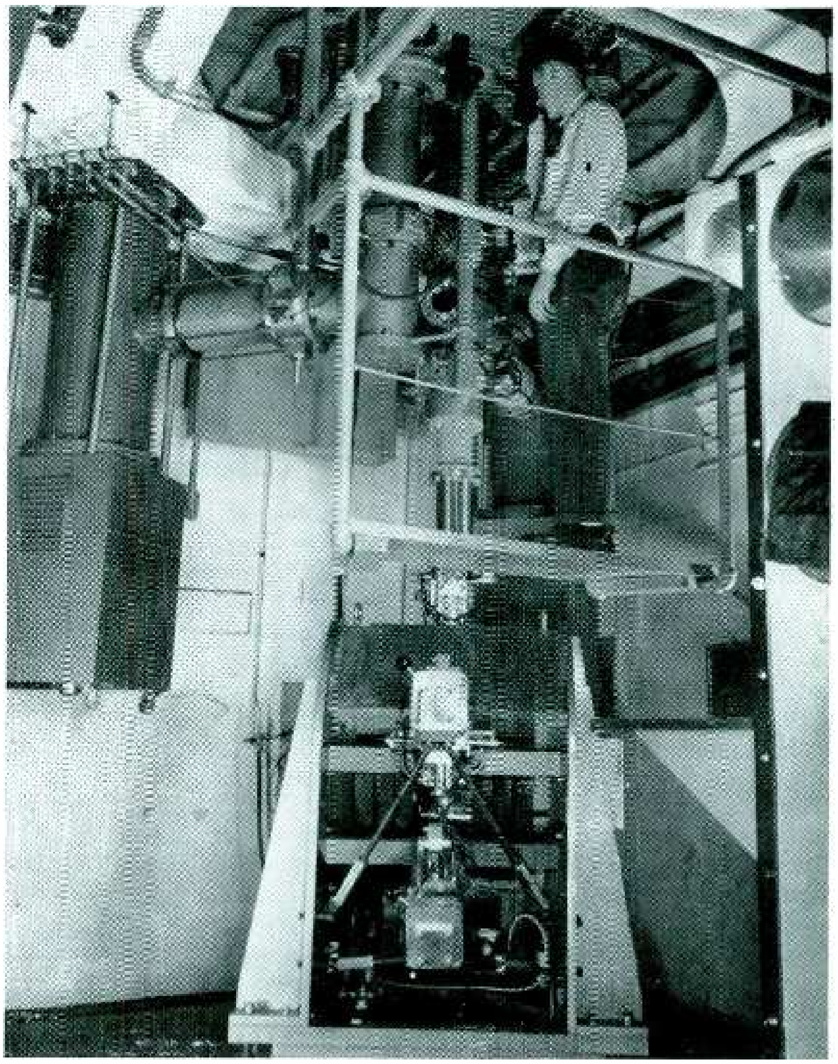
Choice of Tubes

The variable-conductance unit must have a minimum internal impedance comparable to or less than the load impedance, as well as high current capacity. Since no single available tube will meet these requirements, parallel operation of suitable tubes is utilized.

Preliminary efforts were made to make use of the type 6AS7 tube in this application. They proved to be extremely troublesome due to grid emissions which lead to variable current division in parallel operation and frequent tube destruction. Because of their low mu, one extra stage of d-c amplification was necessary and extremely wide grid voltage swing was required for complete current control.

The type 6L6 tube, operating triode-connected, is extremely stable, overcoming the difficulties above at the sacrifice of the low 6AS7 plate resistance. For a given maximum current the d-c supply voltage must be from 30 to 45 percent higher, depending upon the magnet resistance.

The maximum allowable plate



Beam-analyzing magnet is on floor just under lower end of 5,000,000-volt accelerator tube extension of Van de Graaff accelerator. Magnet current supply is remotely located

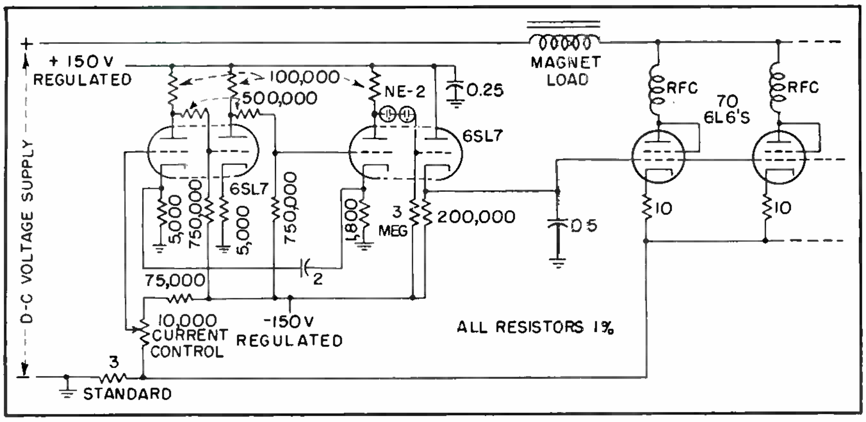


FIG. 3—Current control circuit used to control a 6-ampere direct current flowing through a huge electromagnet having a resistance of 36 ohms and an inductance of 125 henrys. The conductance of the 70 paralleled 6L6 tubes at the right is varied by the pair of twin-triodes serving as a d-c amplifier

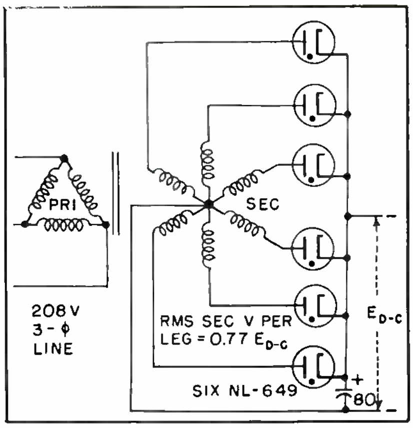


FIG. 4—Alternative six-phase transformer-rectifier arrangement that can be used in place of a motor-generator set with the current controller

voltage is 360 volts. With reference to Fig. 2 the operating region is bounded by the line $E_c = 0$ and the 14-watt dissipation line shown.

The slope of any load line, on a per-tube basis, is dependent upon the load resistance; its $i_b = 0$ intercept should be chosen so that the load line intersects the $E_c = 0$ line between the origin and point *A*. Tube overload will then be impossible. In order to obtain maximum current for any given load resistance, the d-c supply voltage should be such that the load line intersects $E_c = 0$ at point *A*.

The typical load line shown is for a 36-ohm magnet and a d-c voltage supply of 360 volts. As may be seen, the maximum current will be 86 ma per tube or 6.02 amperes total for 70 tubes.

Circuit Discussion

The circuit essentials are shown in Fig. 3. Not shown are the regulated power supplies for the d-c amplifier or the d-c voltage supply for the magnet, as these are subject to individual preference.

Three stages of d-c amplification are used, terminating in a cathode follower for coupling to the 6L6 grids. The overall d-c gain to the cathode follower is approximately 60 db.

The error signal required for correction of current drifts or changes is derived from the comparison of the IR drop across a 3-ohm zero-temperature-coefficient resistor with a stable reference voltage. The reference voltage is made variable for current adjustment and is obtained from the negative supply as indicated. In order to obtain a fine current control, the potentiometer shown must have at least 3,600 degrees rotation.

For continuous current adjustment between zero and maximum, a total 6L6 grid voltage excursion of 50 volts or more is required. The NE-2 neon glow tubes used to couple the last amplifier stage to the cathode follower permit this wide swing at the relatively low plate voltage used. The gaseous discharge noise introduced at this level is insignificant.

Stability

The magnet circuit characteristics are such that the frequency response for current is about 3 db down, with a consequent 45-degree phase shift at 30 cps. The attenuation thereafter is approximately 6 db per octave to about 3,500 cps where the magnet nears resonance; attenuation is then more rapid and the phase shift soon reaches 180 degrees. At this point the gain about the system loop must be less than one for stability. The maximum possible d-c gain under these circumstances is about 40 db. This figure is boosted to more than 60 db by the introduction of 20-db negative feedback and high-frequency attenuation in the 6L6 grid circuit. The upper half-power point of the last stage is approximately 100 times below that of the first two, and thus the amplification falls off by a large amount before the phase shift introduced by the first two becomes appreciable.

The r-f chokes in each tube plate lead avoid spurious high-frequency oscillations. Each cathode lead has a 10-ohm resistor to assist current division; this also affords a means of individual tube current measurements. The 6L6 filament circuits are series-parallel-connected for operation from the line.

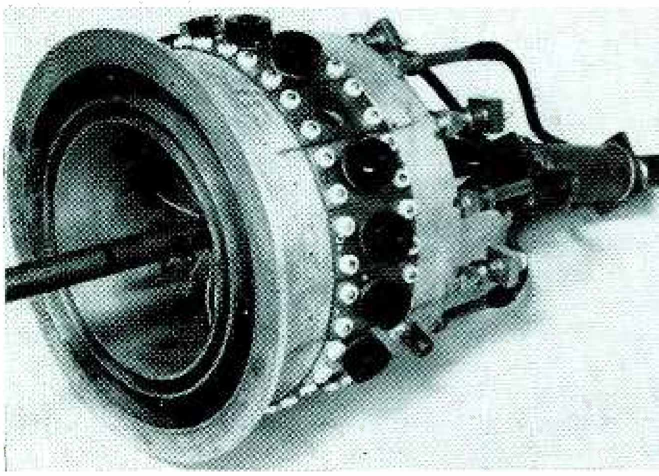
D-C Voltage Supply

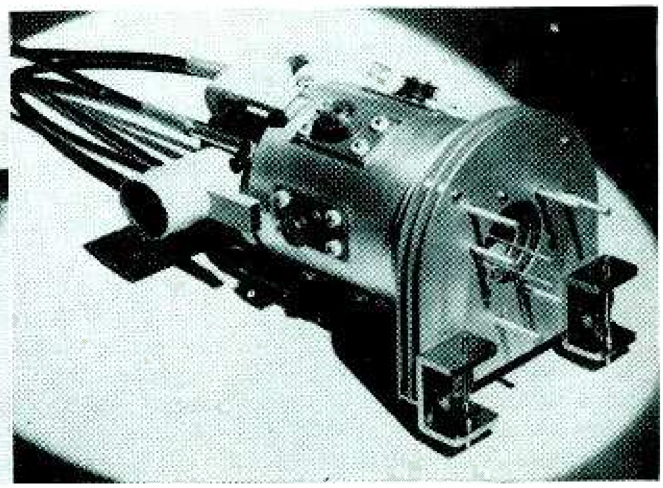
The d-c supply may be batteries, a transformer-rectifier unit or a motor-generator set. The motor-generator is preferable since it is inherently more stable with respect to line voltage variations; d-c voltage changes of only 1 to 2 percent may be expected for line voltage extremes.

A transformer-rectifier may be preferable for reasons of economy or undesirability of rotating machinery. A suitable six-phase rectifier is shown in Fig. 4. The current ripple frequency is 360 cps with a maximum amplitude of 0.01 percent.

Performance

Regulators of the type described have given very satisfactory performance. With a motor-generator supply, current stabilities of better than ±0.02 percent have been maintained for extended runs. The magnet flux stability will be several times better than the current stability by virtue of the iron hysteresis.





Eighteen-tube cavity at left is based upon the simple six-tube cavity (right) that is tuned by sliding shorts

UHF Transmitter Uses Beer-Barrel Cavity

Six type 2C39A's in parallel supply 420 watts of picture signal to the antenna of New York's first 700-mc experimental television station. Experience with a 600-mc transmitter in daily operation since March 1950 showed the way to a practical design

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Research Division
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THE EXPERIMENTAL transmitter installed at our New York transmitter site will be used to obtain propagation data at a picture-carrier frequency of 709.25 mc and a sound-carrier frequency of 713.75 mc. It will operate into an antenna at approximately the same height as the former channel 5 antenna. Its design is based upon 600-mc equipment for which construction was started more than two years ago.

This article will discuss the new transmitter that is very similar to the one in operation since March, 1950, on 609.25 mc. All test data reported here have been derived from experience with the earlier equipment.

Final Tank Circuit

A so-called beer-barrel cavity using six 2C39A tubes was made of two coaxial-line cavities with the tubes mounted in the center of half-wave foreshortened lines and connected as a grid-separation (grounded-grid) amplifier. One cavity becomes the cathode-grid cavity and the other, the plate-grid cavity.

The mechanical arrangement is shown in the photograph of a 700-mc amplifier cavity. The end shorts are used differently; one is adjustable and is used for tuning, the other is fixed and is used for coupling probes.

At the right-hand side of this figure, there are two right-angle drives. These operate a chain and sprocket arrangement that drives the cathode and plate-shorting plungers.

At the left, between the air ducts for anode cooling, are the six output probes leading upward via a piece of RG/8U cable to a quarter-wave matching transformer (not shown). Cooling is accomplished at each seal through the manifold at the left fed from a blower line facing the viewer. A coaxial fitting located in the center of the air manifold connects to a quarter-wave transformer that feeds the input slot for coupling.

Design Calculations

In calculating the cavity described above, the total tube capacitances are considered as split between the two cavity sections. Conventional methods for obtaining line lengths for a resonant cavity terminated in a capacitance are then used. The calculations shown in Fig. 1 indicate the overall length of the plate-grid line for 700 mc to be 5.52 in. and the grid line 3.1 in. Experimental results were very close to these calculations.

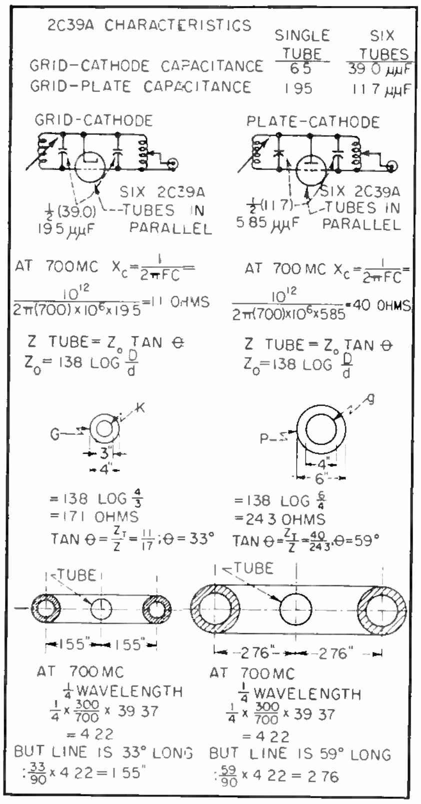


FIG. 1—Line-length calculation for overall length of plate-grid line and grid line as described in text

As noted, grounded-grid operation was used. It was found necessary to use d-c grounds on the grids to assure stable operation in the six-tube cavity. No practical bypass could be built to assure this stability. In any case, the use of a high value of grid bypass starts a vicious circle. This high value prohibits grid modulation and it therefore makes unnecessary the d-c grid isolation.

Cathode Modulator

This condition poses the problem of video modulation normally accomplished at the grid in vhf units. Cathode or series type modulation was decided upon and has proved satisfactory. Two type 6AS7G tubes are used in parallel as the modulator tubes, connected as shown in Fig. 2. This type of modulation is essentially grid modulation although some plate modulation is present. Linearity is excellent as is shown by the curves of Fig. 3.

Coupling presented a problem because of the circumferential size of the cavities. Single-probe coupling proved unsatisfactory since loading on the individual tubes varied with the circumferential phase relation of the probe to a given tube. This effect is more readily understood if one realizes that the circumference of the six-tube plate cavity at 600 mc is almost one wavelength. This condition is amplified in the experimental 18-tube cavity where the circumference of the plate cavity is almost 1½ wavelengths.

Two types of coupling were tried and proved successful, one a multiple probe system and the other a slot type coupling[1]. Both proved satisfactory, but both are critical in application.

In particular, the length of the feed lines to the quarter-wave matching section is very critical. Curves of Fig. 4 show that the length of the lines must be held to within 1/32 inch of each other to accomplish symmetrical loading. If this is not done, the plate currents or drive voltages will vary due to the difference in time delay of the different cables. It is also important to use cable from the same spool since the propagation constant of the same type of line may vary from spool to spool.

Another very important factor in obtaining balanced drive in the six-tube modulated amplifier was the balance of the cathode-bypass capacitors. Referring to Fig. 2, it is noted that the cathode bypass used was 26 μμf per tube. Since the input capacitance of each tube is 6.5 μμf, a voltage divider effect is obtained at uhf. Thus, it is important to keep the cathode-bypass capacitors within 10 percent of each other in order not to unbalance the drive voltages. Extreme care was used to accomplish this by measurement of each capacitor at the time of assembly.

The drive measurements were made with a special probe built to plug into the 2C39A hole in the cavity. This probe was constructed from the cathode-grid section of a defunct 2C39A tube as shown in Fig. 5. Measurements made on the slot cavity with the probe showed variations less than 5 percent.

Slot Coupling

To accomplish symmetrical loading without the problem of multiple probe coupling, slot-type coupling was tried. Figure 6 shows a drawing of combined plate and grid-slot coupling. The feed lines indicated are actually the beginning of quarter-wave matching transformers. This double slot is very difficult to accomplish mechanically (al-

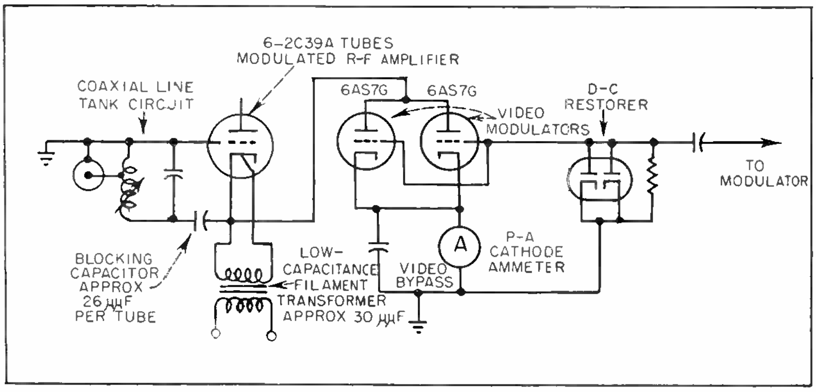


FIG. 2—Simplified schematic of cathode modulation system

though it has been done) because the grid transformer must go back through the maze of cathode and filament connections inside the cathode line.

In actual practice, therefore, the cavities are built with grid-slot coupling and multiple-probe plate coupling. The slot-type feed may be considered a pi network with the slot the input capacitor, the line the tuning inductance, and the tube capacitance the output capacitor. The adjustment of the slot spacing, therefore, becomes critical to provide proper coupling. In practice, the slot opening is less than $\frac{1}{32}$ inch.

One important detail in the use of tubes at uhf is the necessity of filament-voltage reduction to increase life because of the back-heating effect. Figure 7 shows the relation of power output to filament for two manufacturers. Our data do not show agreement with manufacturer 1 recommendations. His data say that filament voltage must be set at a point 0.5 volt above the voltage that gives 85 percent of full power. This setting results in a filament voltage lower than that allowed under any condition. The maximum-power point was used as our criterion and has proved satisfactory from life standpoint.

Tube Life

Although we did not start life checks at the time of beginning daily transmissions, we have clocked 700 hours on one set of tubes so far and predict at least another 1,000 hours of life on these tubes. This prediction is based on checking emission current regularly by JAN-tube specifications and logging any decrease. Rapid decrease indicates short life. Depending on the slope of decrease, life can be predicted approximately. This method was suggested by one of the manufacturers.

Because of the fact that the experimental 18-tube cavity illustrated was large enough so that both the grid and plate cavities were longer than a wavelength in circumference, the possibility of excitation of modes other than the coaxial TEM mode exists. Other modes are undesirable when the TEM mode is being used, because

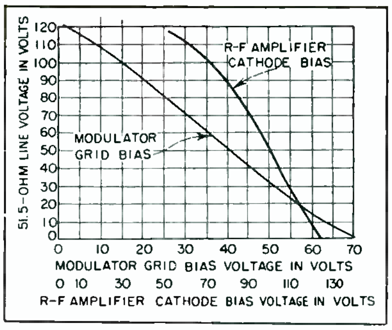


FIG. 3—Linearity curve for a six-tube 2C39A cavity at 609.25 mc

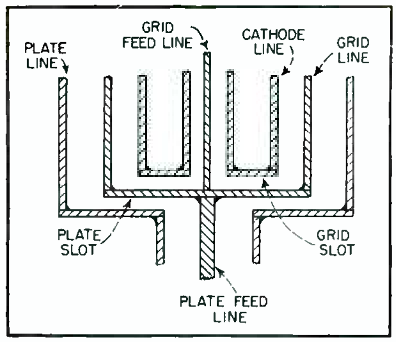


FIG. 6—Double-slot coupled cavity in essence

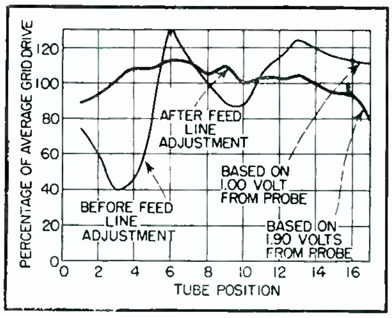


FIG. 4—Grid drive variation in a 17-tube cavity measured with crystal probe and no plate voltage

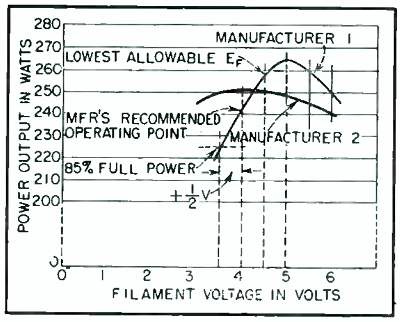


FIG. 7—Power output versus filament voltage used to determine back-heating effects

oscillations are possible and peculiar modulation effects occur near cutoff. These conditions existed in our experimental 18-tube cavity but were minimized to a point at which 750 watts of c-w power was available with good modulation characteristics at 600 mc. The oscillations were minimized by the use of slight inductance in the grid connection to act as neutralization and a ring-type mode suppressor to suppress one of the unwanted modes.

The unit described can be used to drive higher power amplifiers or used with an omnidirectional antenna with a power gain of 20 to give 8 kw erp. With a directional antenna power gain of 50, we can secure an erp of 20 kw. Such power gains are not difficult to obtain at the present state of the antenna art.

This equipment has been in operation at 600 mc since March, 1950 on a daily schedule—sometimes with a 16-hour-a-day schedule—and has proven extremely dependable. The cavities are simple to construct, have little or no maintenance problems and are not too expensive. The techniques evolved are applicable to multiple operation of tubes in the vhf range for high transmitter power in the order of 20 to 60 kw.

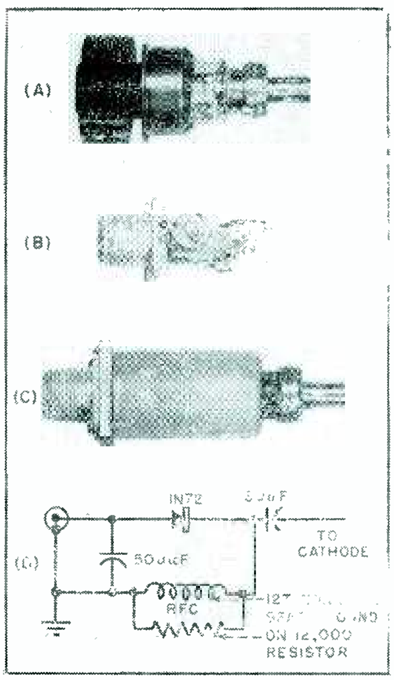
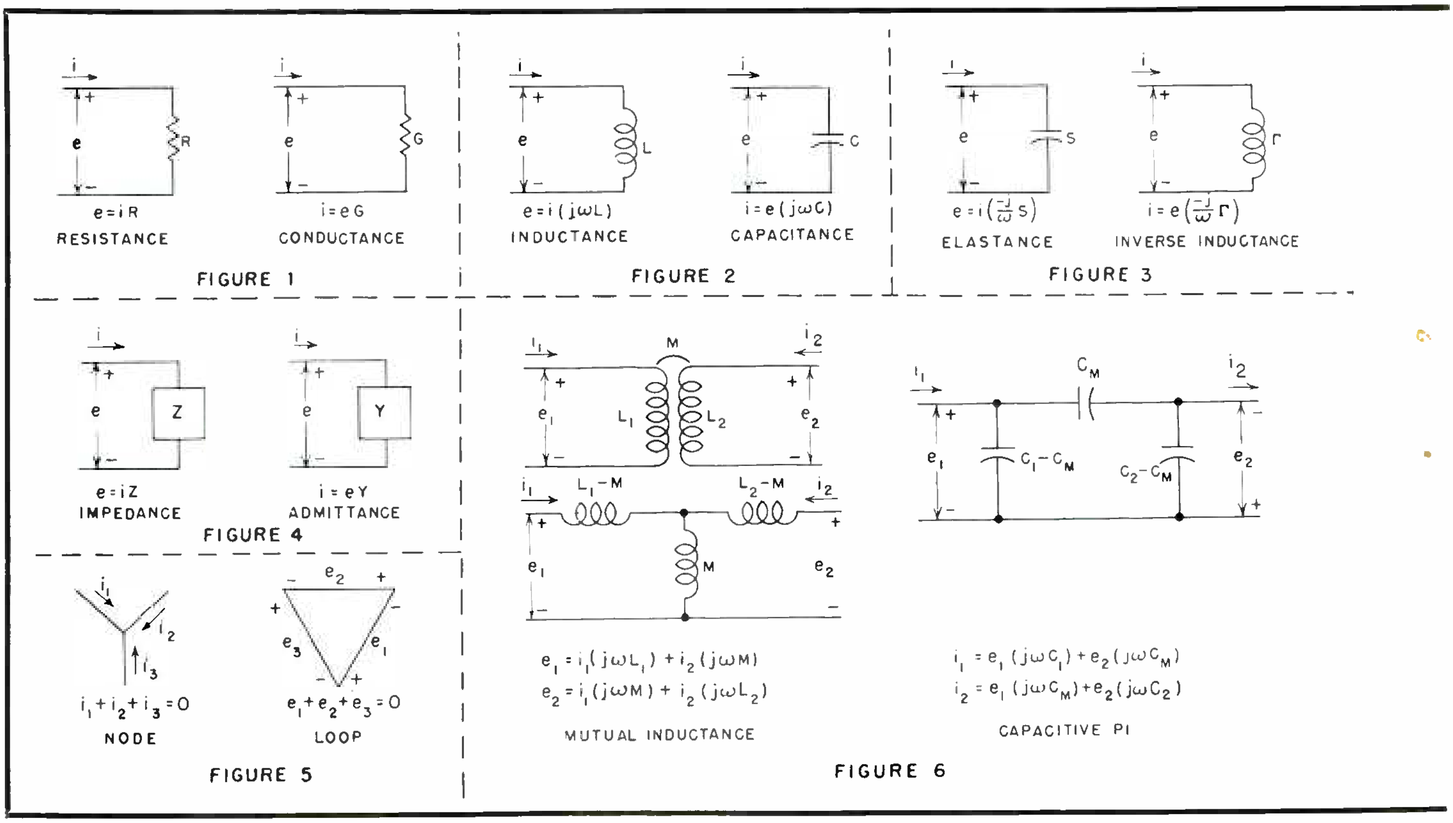


FIG. 5—Construction of the crystal probe circuit at (D) from defunct tube (A) and circuit components (B) that are fitted under shield shown at (C)

REFERENCE

(1) Donald H. Preist, Annular Circuits for High-Power Multiple Tube RF Generators at VHF and UHF, *Proc IRE*, p 517, May, 1950.



TRANSISTOR

By GORDON RAISBECK

Bell Telephone Laboratories, Inc. Murray Hill, N. J.

THE DUALITY between vacuum-tube triodes and point-contact transistors* shows a short cut to the design of a large class of transistor circuits. The pictorial description which follows describes the idea behind duality and shows how duality can be used to transform well-known vacuum-tube circuits into circuits using transistors which perform the same type of job.

The basic circuit elements are shown in Fig. 1, 2 and 3. Here are illustrated two ways of writing Ohm's law and two ways of writing the laws which connect potential drop e and current i through a coil and a capacitor. These equations have been grouped in pairs having similar mathematical form, but in which i and e are interchanged in one member of the pair. Such equations are called dual equations. The quantities which appear in corresponding positions are called dual quantities, or simply duals. As shown, resistance R is the dual of conductance G, inductance L is the dual of capacitance C and elastance S (the reciprocal of capacitance) is the dual of inverse inductance Γ. The imaginary unit j and the frequency ω remain unchanged.

The less familiar quantities G, S, and Γ will appear quite often in what follows. They will be used frequently to emphasize duality.

Two-Terminal Networks

The dual of impedance is shown in Fig. 4. Impedance Z is the dual of admittance Y. Any linear two-terminal network has a physically realizable dual; that is, given any impedance function Z corresponding to a linear two-terminal network, there is an admittance function Y having the same mathematical form as Z which corresponds to a realizable network, and vice versa. This is not true of networks in which mutual inductance plays a major and unavoidable part. In such cases the dual network may require ideal transformers, never realizable.

Kirchhoff's laws illustrated in Fig. 5 are mutually dual. Likewise, the dual of a tee of inductors is a pi of capacitors. This explains the transformation from a tee to a pi and the rather odd choice of current directions and voltage polarities in Fig. 6. Kirchhoff's laws suggest that a node is the dual of a loop and that the dual of a star formation is a delta. This is illustrated by the duality of a tee and a pi in Fig. 6. Fig. 5 also suggests that in order to avoid confusion about signs, potentials should be measured continuously in one direction around each loop. This was not done in Fig. 6, where the signs are those usually used on four-terminal networks and the confusion of signs in the dual circuit is apparent. The confusion is removed by reversing e_2 in the inductive tee and the dual i_2 in the capacitive pi, and modifying the equations accordingly.

Figure 6 shows mutual-inductance circuits. When the coupled coils can be replaced by a network

* R. L. Wallace and G. Raisbeck, Duality as a Guide to Transistor Circuit Design, *BSTJ*, 30, p 381, April 1951.

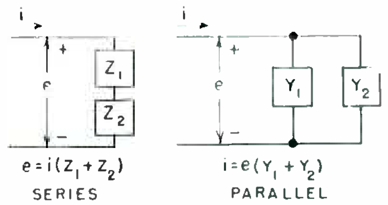


FIGURE 7

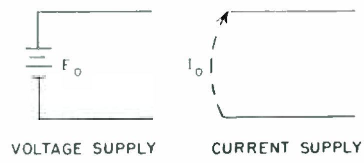


FIGURE 8

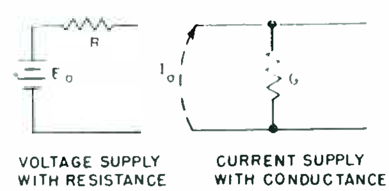


FIGURE 9

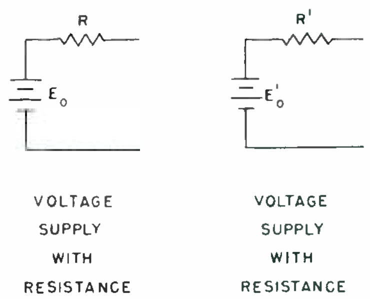


FIGURE 10

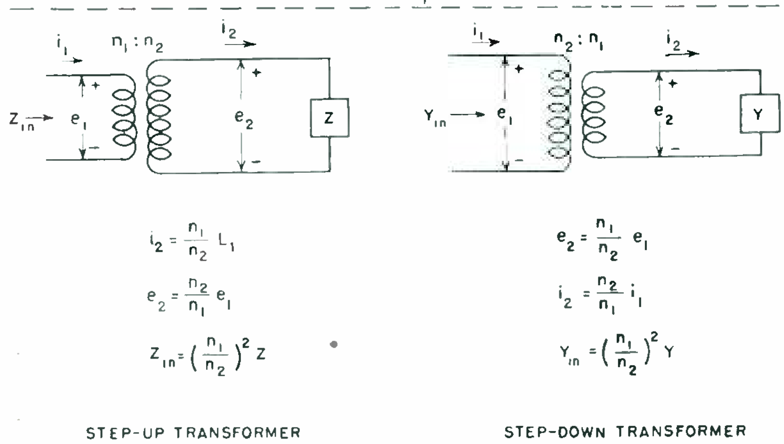


FIGURE 11

CIRCUIT DESIGN

How to derive amplifier, oscillator, modulator and multivibrator transistor circuits from known vacuum-tube circuits. Technique, known as duality, is explained in detail and may be applied to any complex vacuum-tube circuit to find the corresponding transistor circuit

of inductors, then the dual can be realized in the form of a network of capacitors. One requirement is that the mutual inductance M be positive but smaller than the inductance of either coil.

Figure 7 shows series and parallel combinations. One can take advantage of the duality discovered between impedance Z and admittance Y to show that the dual of a series combination is a parallel combination. Thus, the formula for a pair of impedances in parallel has the same form as that for two admittances in series.

Duality works two ways. Capacitance is the dual of inductance and inductance is the dual of capacitance. The relation shown to hold in one direction need not be proved for the other.

Supply circuits are shown in Fig. 8, 9 and 10. The dual of an ideal voltage source with no internal impedance is an ideal current source with no shunt admittance. A symbol has been invented for a constant current source; a dashed line with an arrow head at one end, indicating direction of current flow, with the letter I nearby.

At first sight it seems that circuits having simple batteries will lead to dual circuits calling for constant-current sources. This difficulty can be circumvented by the compromise shown in Fig. 9 and 10. Figure 9 shows a battery with internal resistance. The dual in this case is a current source with shunt resistance. This can now be transformed by Thevenin's theorem into an equivalent voltage source with a series resistance, as in Fig. 10.

Figure 11 illustrates the dual of a transformer. The dual of a step-up transformer is a step-down transformer, as long as the transformers are considered as ideal. Outside of the range where the transformer is a good approximation to the ideal, this duality is not valid.

To find the dual of a given circuit, one should write down a set of circuit equations describing the relations between the currents and voltages completely. In Fig. 12, standard mesh equations have been chosen for a mid-series terminated high-pass filter section using the meshes indicated by curved arrows. By changing i to e and e to i throughout and by replacing every symbol by the symbol of a dual quantity, the equations are transformed. Inasmuch as the dual of a mesh is a node, this results in a set of nodal equations. The elements which appear twice in one equation join two nodes and the elements ap-

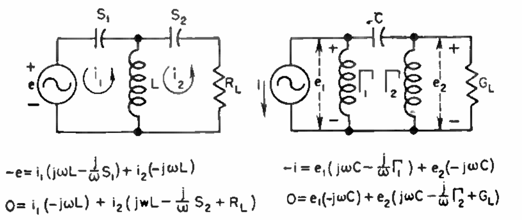


FIGURE 12

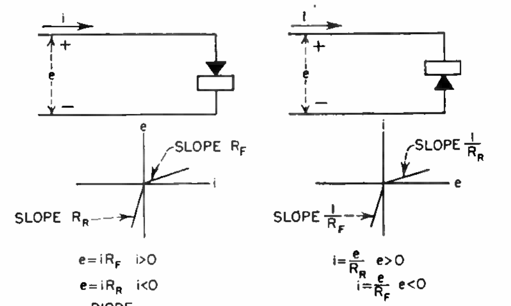


FIGURE 13

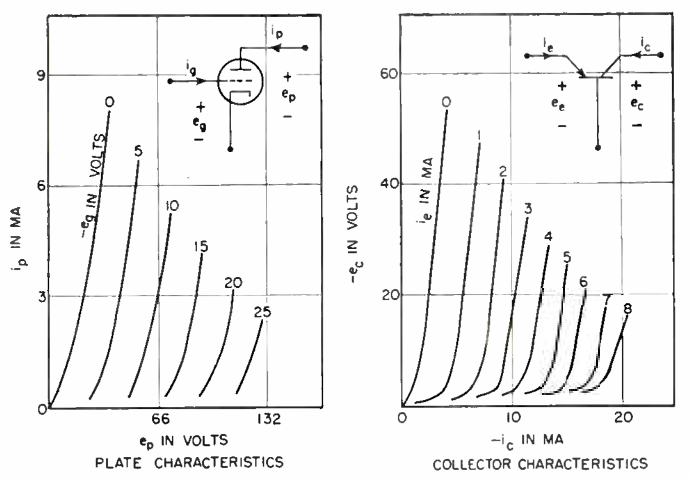


FIGURE 14

pearing only once join a node to ground. With this information it is easy to reconstruct the network.

Figure 13 shows a diode rectifier. Its dual is a device having a current-voltage plot which looks like the plot of voltage-current of a diode rectifier. The axes show that this is also the characteristic of a diode rectifier but with polarities reversed.

A vacuum tube and transistor are illustrated in Fig. 14 with plate characteristics for the vacuum-tube triode and collector-circuit characteristics for the transistor. The general shape of the two sets of curves is similar but the labelling of the axes is different. The corresponding quantities are: e_p and $-i_c$, i_p and $-e_c$, e_g and $-i_e$, and i_g and $-e_e$.

Small-Signal Circuits

Figure 15 shows small-signal equivalent circuits. At first the circuit equations do not look like duals, but the quantities which disturb the duality are only r_e and r_b. It is common for these quantities to be as small as one percent or less of r_c, so to a first approximation, they can be omitted. This gives the desired result at once, and shows that α is the dual of μ; r_c the dual of $1/r_p$.

As in Fig. 6, the directions chosen for at least two of the voltages and currents are not consistent with duality. If this oversight is rectified, it will be discovered that α has the wrong sign with respect to μ. In other words, a grounded-cathode vacuum tube has a phase reversal between grid and plate; a grounded-base transistor has none between emitter and collector.

Duals of a vacuum tube having correct phase relation are shown in Fig. 16. These two circuits correct for phase inversion with ideal transformers. For small-signal purposes it does not matter whether the transformer is in the emitter or the collector circuit. The circuits of Fig. 16 are useful in another way. If it is desired to find the dual of a simple circuit geometrically, by remembering that the dual of node is loop and the dual of series is parallel, it is best to start by using one of the circuits containing a transformer as the dual of a vacuum tube. When the transformation is complete, it is easy to see if the transformer can be removed without interfering with operation.

Figure 17 shows a grid and emitter as diodes. To a first approximation the grid circuit of a vacuum tube and the emitter circuit of a transistor are both rectifying diodes. Furthermore, if the dual quantities are to be e_g and $-i_e$ and i_g and $-e_e$ then the diodes are poled in opposite directions. Therefore, the input circuits to the vacuum tube and transistor are dual in a manner which is consistent with the duality of the plate and collector circuits. This makes it possible to find the duals of circuits whose operation depends on the rectification action of the grid.

The quantitative aspect of duality can be handled with two constants, picked at will and having dimensions of resistance. They may be called r_1 and r_2. In terms of these two constants the duality relations now come out as follows:

e	$i = e/r_1$
i	$e = ir_2$
R	$G = R/r_1r_2$
L	$C = L/r_1r_2$
S	$\Gamma = S/r_1r_2$
Z	$Y = Z/r_1r_2$
Node	Loop
Series	Parallel
E_0	$I_0 = E_0/r_1$
Ideal Transformer (turns ratio n_1:n_2)	Ideal Transformer (turns ratio n_2:n_1)
Diode	Diode, Reversed
i_p	$-e_c = i_pr_2$
e_p	$-i_c = e_p/r_1$
i_g	$-e_e = i_gr_2$
e_g	$-i_e = e_g/r_1$
μ	$\alpha = \mu$
r_p	$r_c = r_1r_2/r_p$
g_m	$r_m = g_mr_1r_2$

The equation for r_c shows that for any given vacuum tube and transistor the constants r_1 and r_2 must be chosen so that $r_1r_2 = r_pr_c$. In Fig. 14, r_1 and r_2 have both been chosen equal to 6,600 ohms. In the R-C coupled amplifier stage and its dual shown in Fig. 18, the dual of the series capacitor is a shunt inductor and the dual of a battery and resistor in series is a current source and conductance in parallel. The latter two are in series with the input instead of in shunt. The output circuit can be treated in the same way, ignoring phase reversal.

The arrangement of the power sources in the transistor circuit is inconvenient, and a better arrangement is shown in the lower circuit.

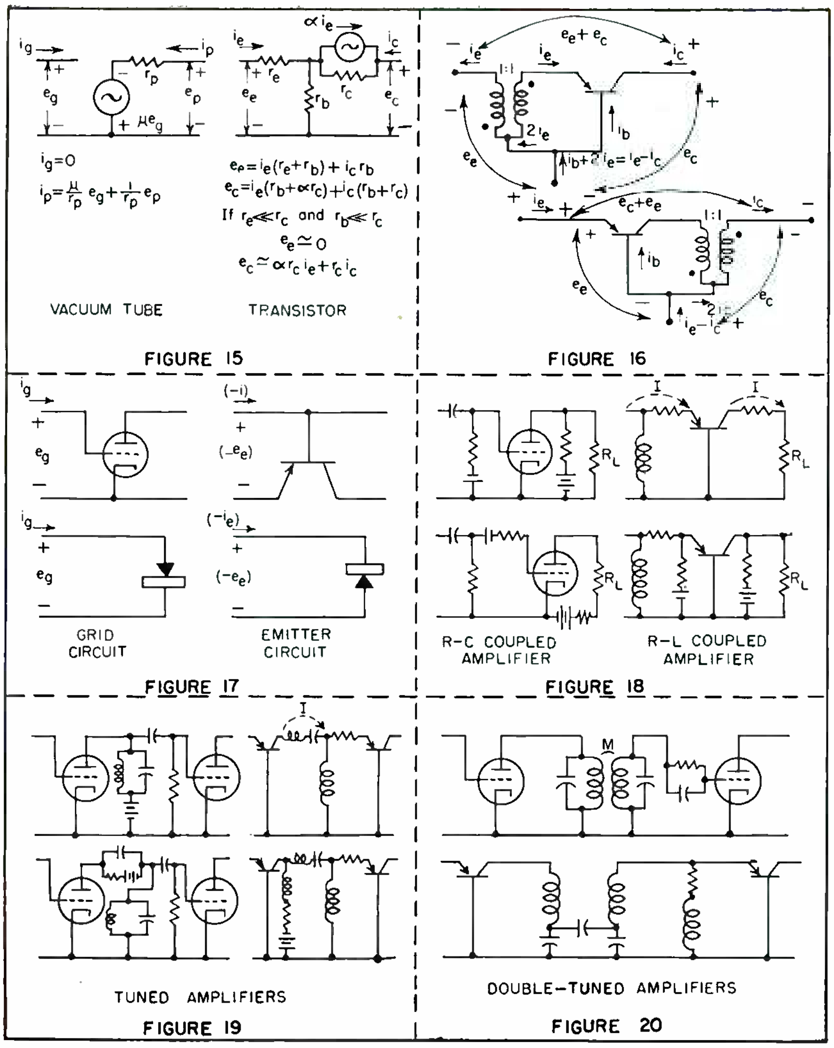


FIGURE 15 FIGURE 16 FIGURE 17 FIGURE 18 FIGURE 19 FIGURE 20

The dual vacuum-tube circuit, found by working backwards, is also shown. The connection of the power supplies is a matter of choosing one of many possible arrangements. For that reason power supplies will be omitted in most of the circuits to follow. The reader should remember that transistor circuits call for high-impedance sources whenever vacuum tubes call for low-impedance sources.

A tuned amplifier and its dual, Fig. 19, are shown in two forms to illustrate once again how to connect power supplies. The new point illustrated here is that the dual of a parallel-tuned circuit is a series-tuned circuit. Experience has shown that in transistor circuits such as the one in the figure, series-tuned circuits give better performance than parallel-tuned circuits.

The circuits in Fig. 19 can be operated class-A, class-B or class-C. Referring to transistors, however, the terms class-B and class-C mean biased so that during part of the cycle the potential drop across the transistor is nearly zero. During this part of the cycle, the transistor looks like a high conductance and current flows freely through the transistor without building up any appreciable voltage. This is the dual of the behavior of a vacuum tube beyond cutoff where the tube behaves as a high impedance and large voltages may be imposed across the tube without appreciable current flow.

Figure 20 is a double-tuned amplifier and its dual. The dual uses the transformation of Fig. 5 to avoid the difficulties of mutual inductance. Figures 19 and 20 also illustrate the two principal forms of grid-leak bias and their duals.

A push-pull class-B amplifier and its dual are shown in Fig. 21. This circuit first showed the importance of vacuum-tube transistor duality. In the vacuum-tube circuit, the tubes are driven out of phase in parallel. The two plates drive the load through a transformer. One plate is the driver at any one time. The other tube is idle and presents a high impedance, so that the load voltage may be impressed upon it without drawing any current. In the dual circuit, the transistor collectors are connected in series with the load. As before, one collector is the driver at any one time, but in this case the idle collector presents a low impedance, virtually a short circuit, in series with the load. The idle transistor hence passes the whole load current, without building up any voltage. This transistor circuit has been tested extensively and has proved to be even more efficient than a push-pull class-B vacuum-tube circuit operating at the same power level.

The remainder of this article appears in the following two pages in ELECTRONICS Reference Sheet form.

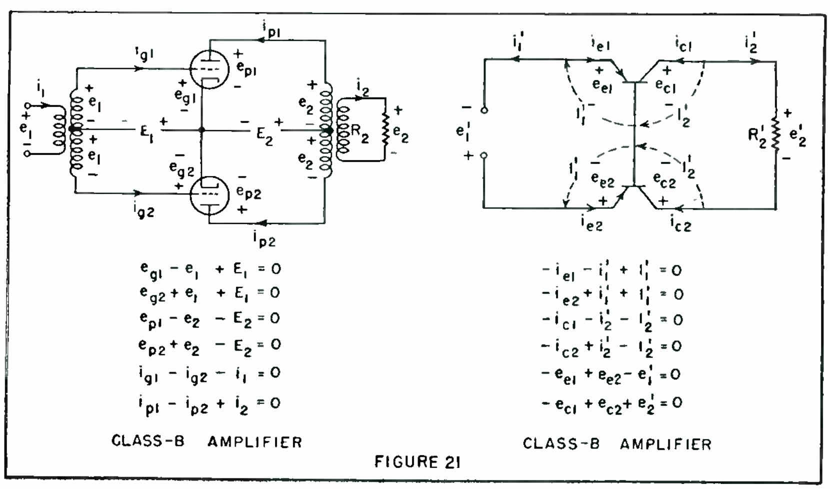
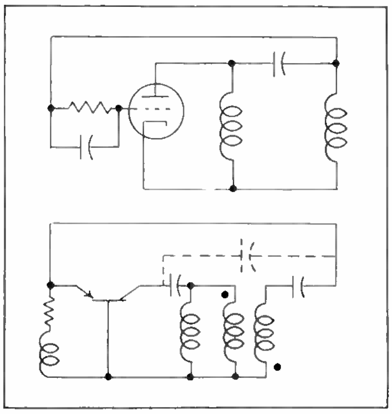


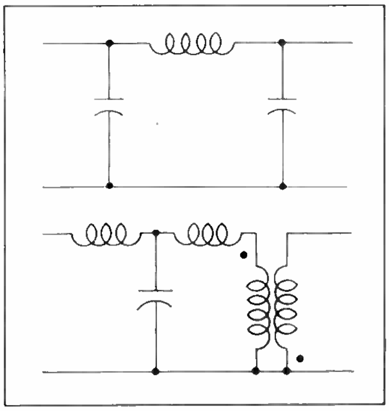
FIGURE 21

 (continued from page 131)

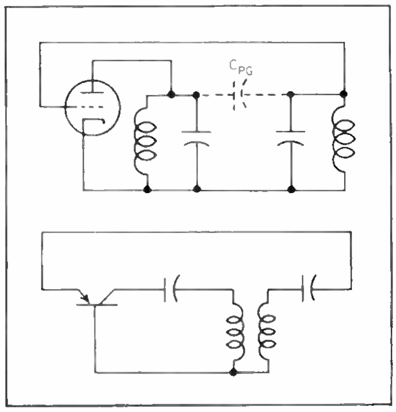
HARTLEY OSCILLATOR—It is advantageous to place the transformer in the circuit as shown because the ideal transformer with a shunt inductance can be realized physically by a transformer with properly chosen primary inductance. The capacitor shown dotted is the dual of the mutual inductance between the coils in the oscillator



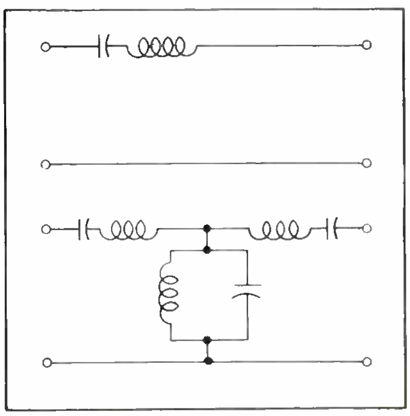
COLPITTS OSCILLATOR—If the two inductors and capacitors of the Hartley oscillator are replaced by two capacitors and an inductor, the Colpitts oscillator results. Different coupling networks lead to different oscillators. In the dual circuit, the combination of a transformer and series inductor may be replaced by a leaky transformer

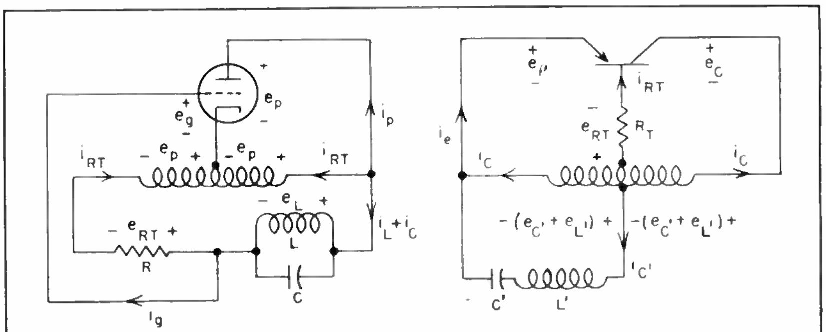


TUNED-PLATE TUNED-GRID OSCILLATOR—Has a coupling network as shown when the effect of plate-to-grid capacitance is included. This can be transformed to the coupling network shown in the transistor circuit. Here the phase reversal can be accomplished neatly in the coupled coils, so no further transformer is needed



TRANSISTOR OSCILLATOR—In all the coupling networks shown so far, the vacuum-tube network has a 180-deg phase shift at the operating frequency and the phase shift has been removed by a phase-reversing transformer. It is possible to design directly a coupling network having zero phase shift at the operating frequency. Two such networks are shown here. The second network, which has a phase shift varying very rapidly with frequency and which can be designed to give an impedance transformation, leads to a very stable transistor oscillator





$$e_g + e_p - e_{RT} = 0$$
$$2e_p - e_L - e_{RT} = 0$$
$$e_L = e_C$$
$$i_p + i_{RT} + i_L + i_C = 0$$
$$i_g + i_{RT} - i_L - i_C = 0$$

$$-i_e - i_C - i_{RT'} = 0$$
$$-2i_C - i_{C'} - i_{RT'} = 0$$
$$i_{C'} = i_{L'}$$
$$-e_C + e_{RT'} + e_{C'} + e_{L'} = 0$$
$$-e_e + e_{RT'} - e_{C'} - e_{L'} = 0$$

BRIDGE-STABILIZED OSCILLATOR—Here the circuit already contains a phase-reversing transformer. The various dual circuit elements are connected to it to satisfy the dual circuit equations. The peculiarity of this circuit is that while the vacuum-tube circuit contains a variable resistor R_t whose resistance increases with increasing load current, the dual circuit must contain a variable resistor whose conductance increases or whose resistance decreases with increasing load voltage

(Continued on p 134)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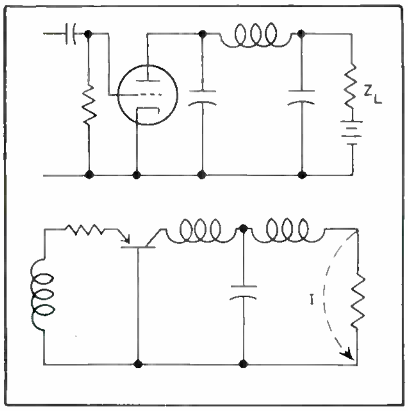
TRANSISTOR CIRCUITS (continued from page 132)

GRID-LEAK DETECTOR—These circuits use the rectifying action of the input circuit to achieve detection. The inductor and resistor in the emitter circuit act to build up a bias current in the emitter which is almost equal to the peak value of the incoming signal current. This is dual to the action of a grid-leak bias system where a resistor and capacitor act to build up a grid voltage nearly equal to the peak signal voltage



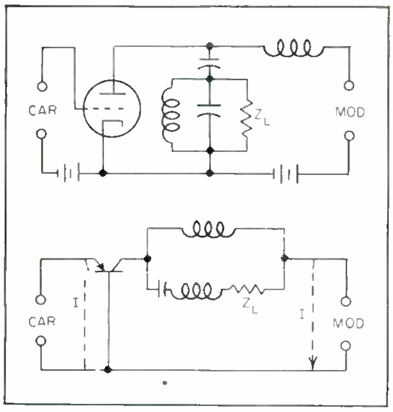


PLATE MODULATOR—A class-C amplifier in which the plate voltage is varied by the addition of the modulation voltage. The dual collector-modulator is a class-C transistor amplifier in which the collector current is varied by the addition of a modulator current

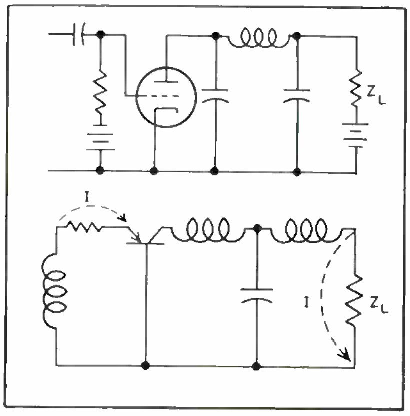
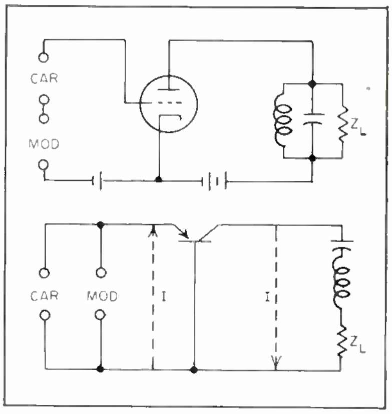
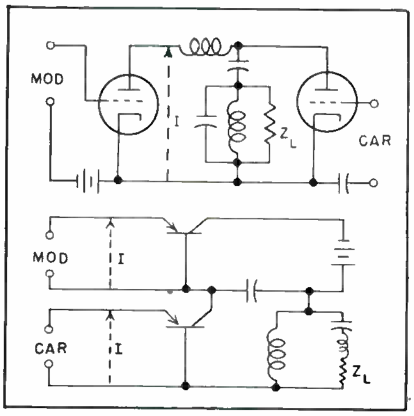


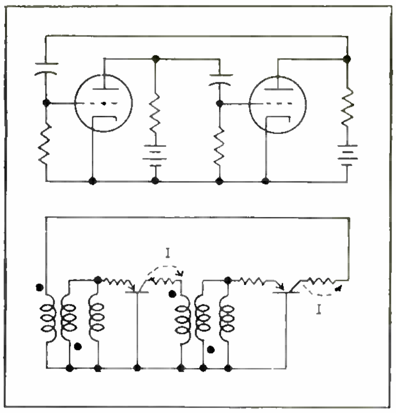
PLATE DETECTOR—Representative circuits making use of the nonlinearity of the plate and collector circuits. The plate detector is biased so that with zero signal the plate current is nearly cut off. The collector detector is biased so that with no signal coming in, the collector voltage is nearly reduced to zero

GRID MODULATOR — A carrier-frequency amplifier in which the grid bias is varied by the addition of a modulation voltage. The dual emitter modulator is a carrier-frequency amplifier in which the emitter bias current is varied by the addition of a modulation current



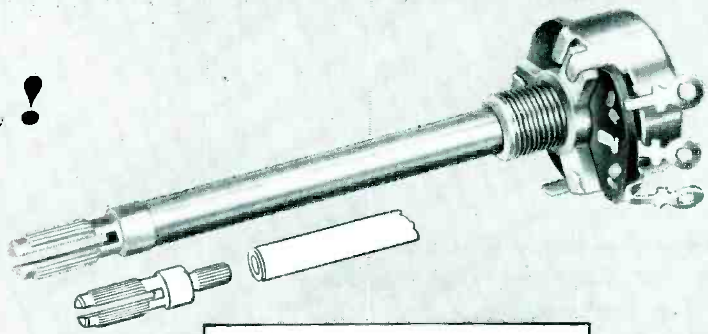
CONSTANT-CURRENT MODULATOR—A variant of the plate modulator in which the modulation voltage is derived from another tube operated from the same plate supply. For the operation to be linear, it is necessary that the supply current be constant or nearly so. In the dual circuit, two transistors are operated in series from one source of voltage, one operating as a carrier amplifier and the other as a class-A modulation frequency amplifier





MULTIVIBRATOR—These circuits are visualized as two-stage amplifiers. The transformers are required so that the two stages will be out of phase. The ideal transformer plus shunt inductor may be replaced by a real transformer with suitable primary inductance

Value Beyond Expectation!



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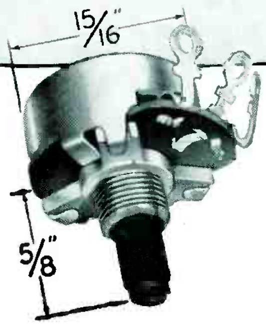

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Electronic Weighing System

A COMPACT electronic scale and recorder, developed by the Streeter-Amet Company, of Chicago, Ill., may be installed at more convenient weighing points than is possible with a bulky lever system. Also, the scale is able to record and print the weight information at some point remote from the scale.

The scale makes use of Baldwin-Lima-Hamilton load cells. In these cells, a strain gage is bonded to a calibrated load receiving column. Inside the cell is a Wheatstone bridge having the strain gage as one leg. A deflection of the load receiving column due to a load on the cell causes a corresponding deflection of the strain gage. A current is passed through the Wheatstone bridge and the deflection of the strain gage changes its resistance and causes a change in voltage across the bridge.

The instrumentation for the electronic scale provides a means of converting the electrical output of a load cell to mechanical energy by which the force exerted on the load cell may be recorded and printed.

Operation

When a force is introduced on a load cell, the output voltage from the strain gage is fed to a balancing bridge arrangement having as one leg a variable resistance, see Fig. 1. This system is initially in electrical balance. The introduction of the voltgae across one leg of the bridge causes an unbalanced condition. The difference in potential thus produced is directed into an amplifier. From the amplifier the voltage operates a servo balancing motor which causes a precision potentiometer or the variable resistance to rotate until the system is once again in balance.

Simultaneously, with the balancing of the circuit, the motor is also operating the recording apparatus. This circuit is phase sensitive and the removal of the force from the load cell causes the motor to reverse its direction of rotation, bringing the potentiometer back to its original position.

The recording apparatus consists of a series of step cams which convert rotational information from the servo motor to digital information on the printer.

Range-Change Control

Another feature of the equipment is the range-change control. On a large capacity scale, rather than using one range from zero to capacity, it is desirable to break this into several smaller ranges and obtain a more compact mechanism which can be read with closer accuracy. Changing from one range to another is accomplished by adding a resistance in series with the Helipot and equal to that of the Helipot which balances the system and brings the recorder back to zero with the preceding load on the scale.

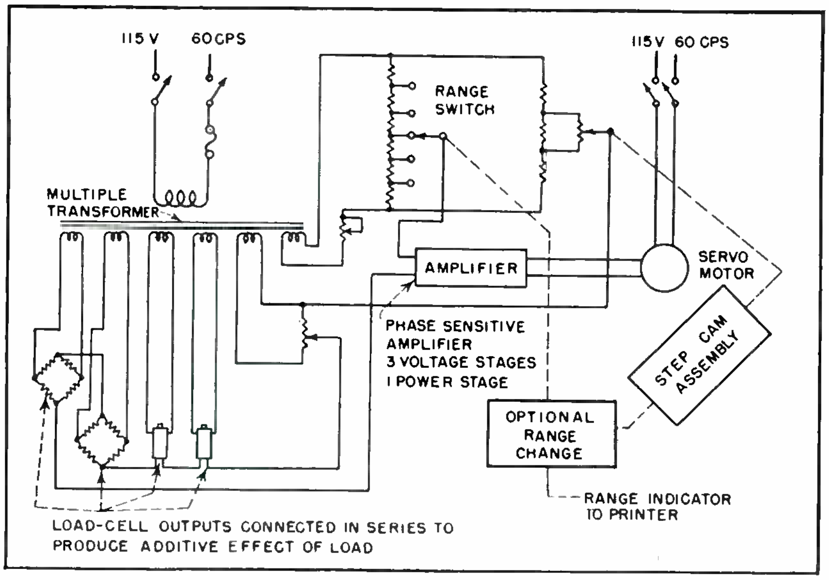


FIG. 1—Electronic scale system with five ranges

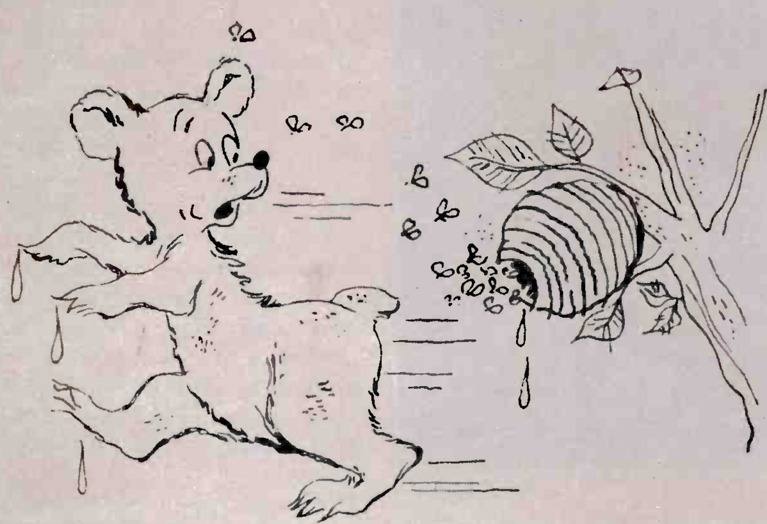
Regulated Bias Supply

By J. C. MAY and J. G. SKALNIK

Electrical Engineering Department
Yale University
New Haven, Conn.

A REGULATED d-c supply whose output voltage is adjustable to zero is of great value for laboratory and general testing purposes. This supply should also be able to maintain its regulation while carrying negative or reverse current for an application such as a bias supply for a class-C amplifier.

Since bleeder resistors are not practical in a supply with an output



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In speed of action for fast soldering, this product far surpasses anything in the Industry today. Unbelievably more active and mobile . . . absolutely non-corrosive and non-conductive.

For an actual demonstration in your plant, contact Kester's Technical Department.

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KESTER SOLDER COMPANY
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Newark, N. J. • Brantford, Canada

THE FRONT COVER

ASSEMBLY-LINE wiring techniques illustrated in the cover picture and the accompanying photograph are part of the planned production efficiency system at the Sperry Gyroscope Co., Great Neck, N. Y.

One important device illustrated is the wire rack in front of the worker. Wires are placed in the rack in advance in the order in which they are to be used. The wire to be soldered first comes from the upper left hole in the rack and then, in order, the operator takes wires from the top row from left to right before moving to the next horizontal row. In other words, the wires are placed in the rack similar to the way a page of a book is read. Each wire has been cut previously to the desired length.

Also shown in the two photographs is a universal fixture capable of holding one or several plugs. A spring is placed over the fixture to hold wires out of the way after they have been soldered.

voltage range of 0 to 250 volts, an electronic bleeder may be used that will draw approximately a constant bleeder current regardless of output voltage. Thus, the supply can draw a negative current at least equal to the bleeder current before losing its regulating ability.

The complete circuit diagram of such a supply is shown in Fig. 1. The regulator part of the circuit with its negative reference is similar to one designed by R. W. Hickman.[1] Since the output ripple is determined mainly by the ripple on the negative reference voltage, a separate full-wave well-filtered circuit is used. An alternative arrangement would be a bridge rectifier circuit fed from the main power transformer, T_1. The output ripple for the circuit of Fig. 1 is about two or three millivolts.

To insure an adjustment of the output voltage to zero, the nominal 150,000-ohm resistors appearing in the 6SJ7 control-grid circuit should be selected so that the upper one is slightly smaller in value than the lower one.

The electronic bleeder is gained by utilizing the constant-current characteristics of a beam-power tube such as the 6L6 shown in Fig. 1. The cathode resistor, which produces negative feedback and enhances the constant-current characteristics, may be made adjustable if different values of bleeder current are desired.

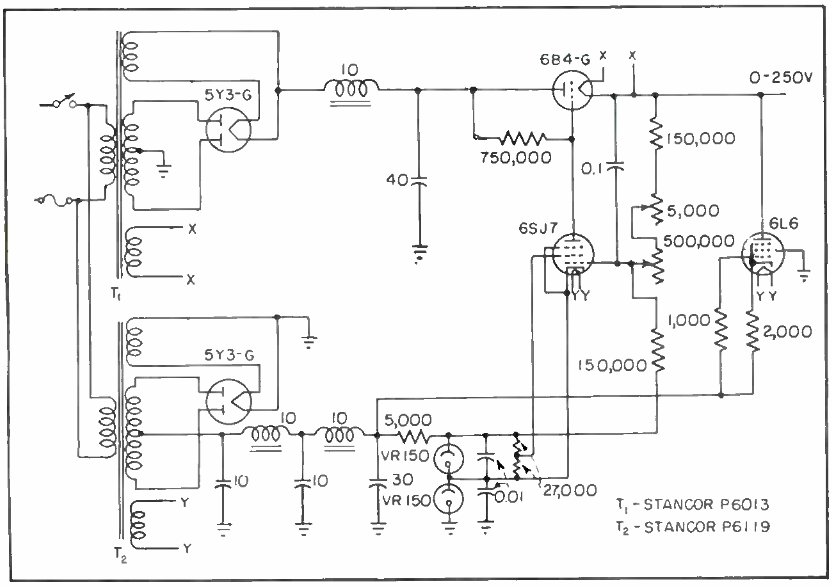


FIG. 1—Circuit diagram of a regulated power supply incorporating an electronic bleeder

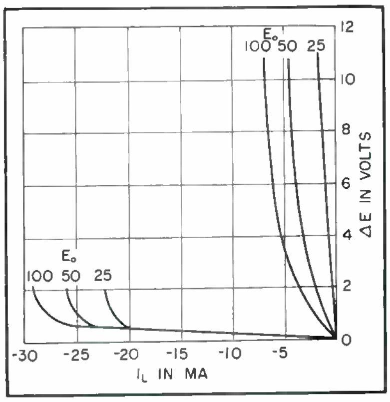


Fig. 2—Regulation curves for the circuit of Fig. 1 while drawing reverse current. The lower curves illustrate normal operation and the upper ones were taken with the bleeder tube removed

The regulating properties of this supply, while carrying reverse current, are shown in Fig. 2. The lower curves illustrate normal operation and the upper curves were taken with the electronic bleeder tube removed from its socket. The voltage increment ΔE is the change in output voltage as the reverse load is applied, and the three curves are for different values of total output voltage at no load.

Reference

(1) R. W. Hickman, Voltage Stabilizers, Radio Research Laboratory Report L-11.

Picture-Tube Language

WITH the glass-envelope manufacturing industry reaching new highs in production, an electronic language has developed in connection with specifications for picture tubes. Some of these new terms pertaining

(Continued on page 156)

BIGGER PLANES?
. . . or smaller capacitors?

In the black of night a plane steals in miles overhead. Suddenly, capacitors discharge into an electronic flashtube and a flash of light stabs through the darkness for the briefest instant as a synchronized camera shutter clicks . . . The enemy position below is recorded on film . . . The photo reconnaissance plane streaks homeward . . .

A normal military mission, of course . . . but one made possible by the development of Vitamin Q☆ energy storage capacitors to meet the severe requirements of this photo-flash application.

These space-saving Sprague capacitors literally made this type of aerial night photography practical, since they are only one-fifth the size and weight of capacitor energy-storage banks composed of "standard" general duty units made to joint Army-Navy specification JAN-C-25.

Like many other Sprague components, these special capacitors were designed to meet size, weight, and electrical requirements that were impossible with "standard" units. Naturally, the Sprague Electric Company produces standard JAN components by the thousands, but it realizes that standards are not meant to limit progress.

Wars are not won by standing still . . .

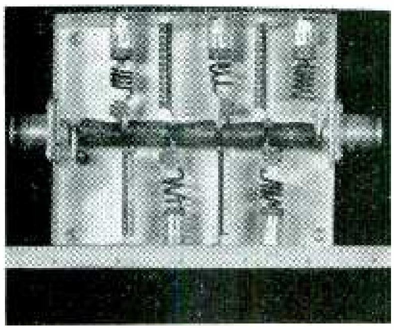
If your military production faces special problems that cannot be solved by use of standard capacitors, resistors, pulse networks, interference filters, or magnet wire, Sprague probably has the answer at its finger-tips.

Write today to the Application Engineering Section, Sprague Electric Company, North Adams, Massachusetts.

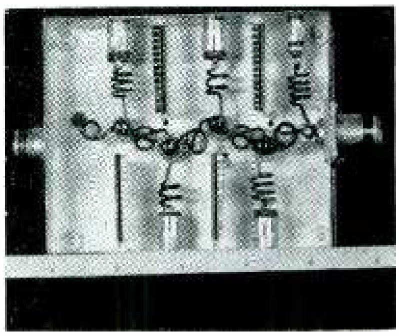
☆ Vitamin Q is a registered trade-mark of the Sprague Electric Company for an exclusive organic-polymer capacitor impregnant with unusually excellent electrical and temperature characteristics.

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK



High-pass filter section. Cutoff frequency for both sections is 218.5 mc



Inside view of low-pass section of complementary filter

Complementary Filter Permits Antenna Sharing

Two pieces of electronic equipment, operating in the respective frequency ranges of 157 to 212 mc and 225 to 400 mc, may share a common antenna simultaneously through the use of the filter shown in the accompanying photographs. The filter consists of two separate filter sections, one low-pass and one high-pass, both with a cutoff frequency of 218.5 mc. The high-pass section has a maximum insertion loss of 1.6 db at 225 mc which remains less than 1 db from 234 to 400 mc. Attenuation of 212 mc is over 70 db and more than 50 db at 157 mc.

Construction details are shown in the photographs. The series arm assembly for the high-pass side is essentially a "stick" of alternate brass cylinders and capacitors. For rigidity, cylindrical brass pieces are soldered into each end of the capacitors and the adjusting sleeve set in place and adjusted (with a Q-meter at 120 kc) to the correct value of capacitance. A flexible lead made of a strip of 0.01-inch copper, $\frac{1}{4}$ inch wide, is attached to each end of the arm to minimize series inductance. Each junction from series arm to shunt arm was made at a polystyrene stand-off post.

The values of the series arm capacitor adjustments were determined by computing the inductance at 200 mc of a rod $\frac{3}{8}$ inch in diameter and $\frac{3}{4}$ inch long. The value of nominal capacitance was then chosen so that the correct value of effective capacitance would be obtained at 300 mc in each case.

The terminating shunt arms were adjusted to resonate at 198.6 mc. The other shunt arms were adjusted initially to about 2.5 mc below the design resonant frequency, and finally, by trial and error for the best vswr and attenuation characteristics. In the early design stages, it was found that much higher attenuation in the stop band could be obtained by using copper finger contacts to make good electrical contact between partitions and the box cover. They were therefore used on all subsequent filter designs.

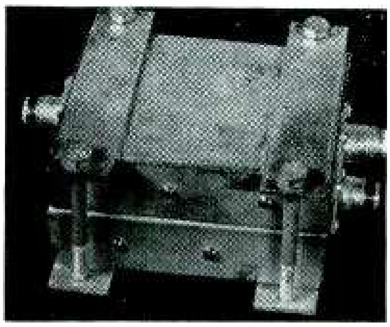
Low-Pass Adjustments

For adjusting the low-pass series arms, a capacitor with silvered disc caps on both ends was modified by drilling and tapping the end holes for 6–32 screw threads. This capacitor was then substituted for one of the standoffs. A straight piece of wire, equal in size to that used for the coils, was connected between the capacitor and the next adjacent standoff with 6–32 screws and washers arranged so that the screws were screwed into the standoff and capacitor as far as they would be when the filter was completely assembled. Care was taken to keep the wire as far above the bottom of the box as the center of the series arm coil would be in the assembled filter.

The resonant frequency of this circuit was measured. The length of the straight part of the conductor and the diameter of the conductor were measured and from these the inductance was computed. The capacitance of the capacitor was measured by the substitution method on a Q-meter at 120 kc.

From the computed value of inductance and the measured resonant frequency it was possible to estimate the residual inductance of the test setup. The straight wire was then replaced by a series coil. This was resonated at a frequency determined by the same capacitance in series with the residual and coil inductances. To reduce mutual coupling, each coil was wound with its axis at right angles to the axes of both the filter and the shunt arms.

The coils were also wound on as large a diameter as practicable (0.275 inch inside diameter) and with as large a spacing as was consistent with good adjustment properties. This tended to keep distributed capacitance low. With too



Complementary filter for operating two separate pieces of equipment simultaneously on a common antenna

small a diameter or too closely spaced windings, this procedure was unsuccessful.

After the series arm coils were carefully adjusted by this method, it was found possible to adjust the shunt arms by trial and error to produce satisfactory characteristics.

Insertion-loss characteristics change somewhat with extreme temperatures. The most important changes in these characteristics are the increases in insertion loss at the critical ends of the passbands, that is, the low end of the high passband and the high end of the low passband. The worst change of this sort is the increase in insertion loss at 225 mc from 1.6 db at 25 deg C to 2.4 db at 60 deg C, an increase of 0.8 db.

Development work on this filter was carried on by W. J. J. Klein and B. N. Navid at the Naval Research Laboratory of the Office of Naval Research.

Highly Stable V-T Voltmeter

By M. G. Scroggie

Elstree Hill Laboratory
Bromley, Kent
England

The resistance of any moving-coil voltmeter claiming even modest accuracy must be stable. Normally it is made up of low-temperature-coefficient wire. In conventional types of vacuum-tube voltmeters, however, a substantial part of the resistance is in the tube itself and has a much lower order of stability.

Current practice minimizes this part of the resistance by operating the meter in a cathode-follower circuit. But even then, if a rugged type of instrument is used, the tube resistance is far from negligible on the lowest range; and the customary balanced circuit for stabilizing the zero (Fig. 1) puts two tube resistances in series. For example, with the commonly-used 6SN7 working into a 1-ma meter on a 0 to 1-volt range, the tube resistance, approximately $2/g_m$, amounts to about 750 ohms, or 75 percent of the total. The calibration therefore drifts 75 percent as fast as the tube transconductance.

Clearly, then, a primary objective in design should be the elimination of tube output resistance, so that no recalibration of a d-c voltmeter is needed when it is coupled to the tube system, nor are any errors caused by variations in tube parameters.

Since the purpose of using a tube system at all is to enable the meter to be connected to a very high-impedance source without appreciably influencing the voltage between the points of application, the corresponding objective at the input end should be the elimination of tube input conductance. It does not seem to be generally realized how far most ordinary receiving tubes fall short of this ideal. There are few that do not show appreciable change in anode current when a resistance even as low as 10 megohms is inserted in series with the

(Continued on page 208)

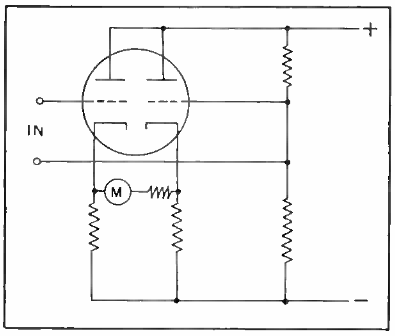


FIG. 1—Conventional v-t voltmeter output stage puts resistance of some hundreds of ohms in series with the meter

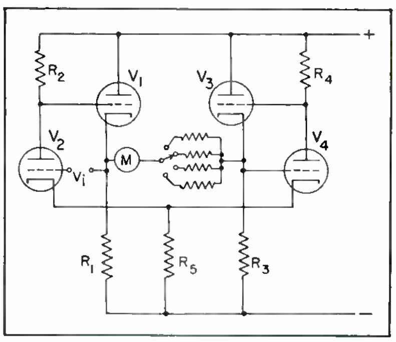


FIG. 2—Schematic of system described, in which the output resistance is of the order of 4 ohms and the output voltage is practically equal to the input voltage

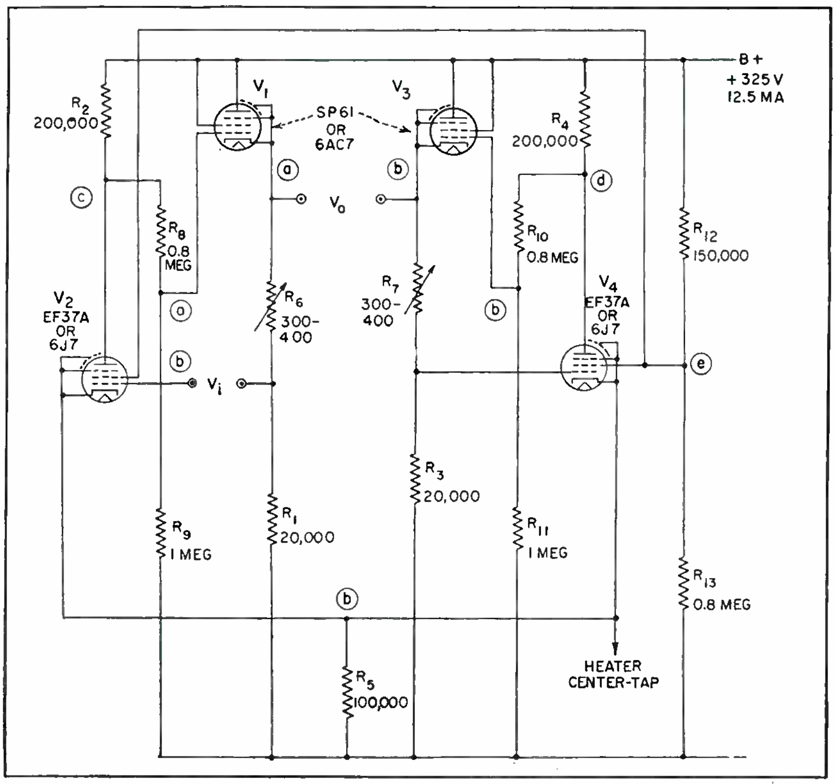
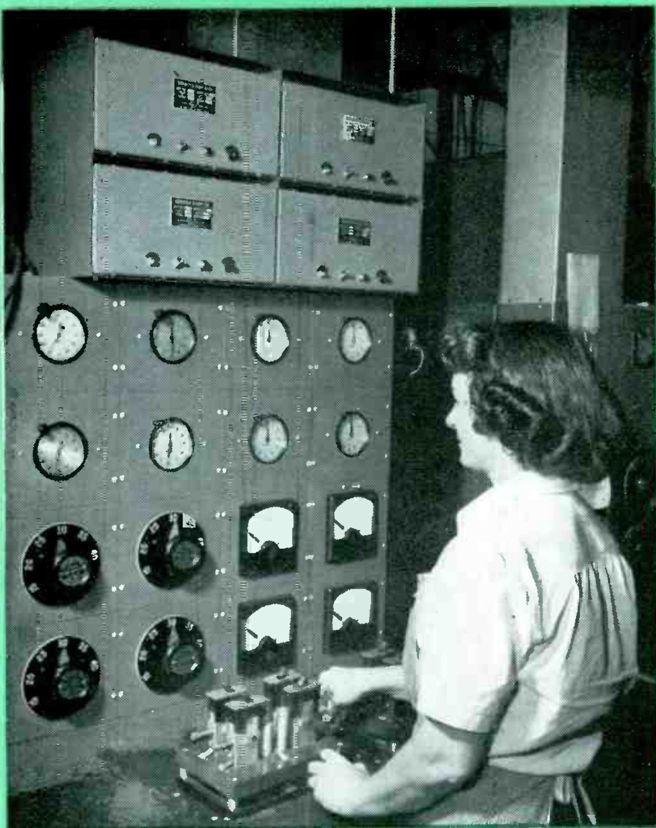


FIG. 3—Practical circuit diagram for d-c v-t voltmeter with ranges up to ±50 volts, determined by the multipliers of the moving-coil meter connected to V_o terminals. The very small insertion error is cancelled by R_6 and R_7



Calibration setup at Square D. Four Sorensen AC Line Regulators allow operator to concentrate on calibration procedures with assurance that line supply is a precise constant.

PRODUCTION UP 123%

——————— Through Isotronics*

That's the increase reported by SQUARE D's Los Angeles plant after installing Sorensen AC Line Regulators!

Square D Company, Los Angeles, manufactures circuit breakers. Calibration of these circuit breakers — adjustment so they will trip when a precise power load is imposed on them—is an important step in production.

Calibration equipment was powered from an unregulated line, and rejects at final inspection were running very high.

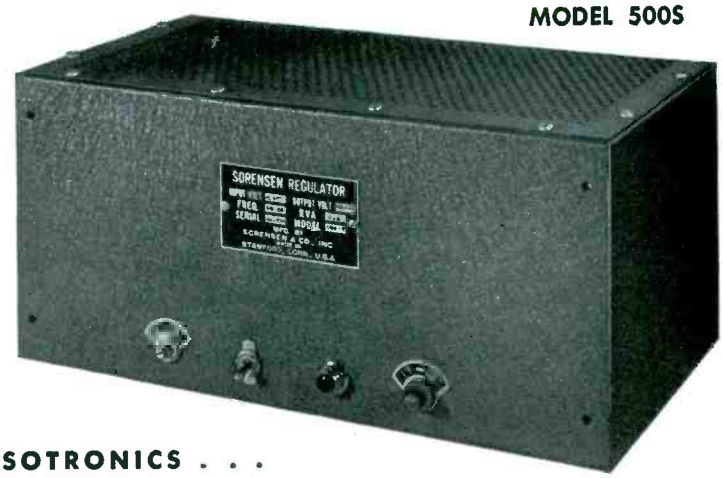
Square D engineers, realizing the source of the trouble, investigated various types of line regulators. It was essential that distortion be kept to a minimum and also that line regulation be precise; therefore Sorensen *electronic* type regulators were chosen.

Installation of Sorensen Model 500S AC Line Regulators cured the trouble, broke an important bottleneck, and, in this case, effected a production increase of *123%*.

Possibly in your plant there are situations where Sorensen line regulators or regulated DC power sources can cut costs and boost production. Write us fully — your problems will receive prompt attention.

*Isotronics is a trade-marked word pertaining to the electronic regulation and control of voltage, current, power, or frequency.

MODEL 500S



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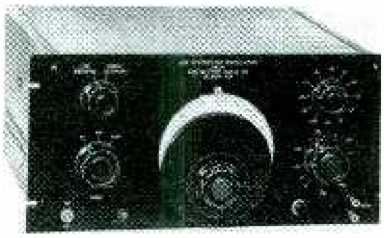
NEW PRODUCTS

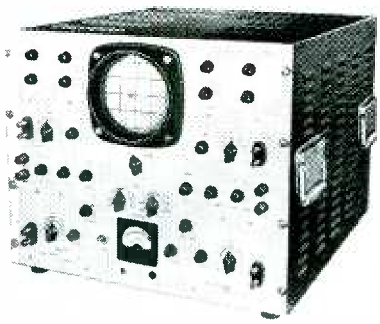
Edited by WILLIAM P. O'BRIEN

Manifold Products Appear Despite Production Cutbacks . . . Wide Variety of Testing Devices Highlighted . . . Number of Manufacturer's Catalogs Reaches New High



Low-Distortion Oscillator

BETTER AUDIO CO., 147 W. Pico Blvd., Los Angeles 15, Calif. Model 10A low-distortion oscillator has less than 1/1,000 of 1-percent distortion at any frequency from 20 cycles to 20 kc. Frequency and amplitude stability are excellent. Maximum output is ¼ watt into 600 ohms, with more than 100 db of attenuation available when needed. It is especially suited to distortion measurements and waveform analysis.



Dual-Channel Oscilloscope

ELECTRONIC TUBE CORP., 1200 E. Mermaid Ave., Philadelphia 18, Pa. Model H 23 dual-channel oscilloscope features a flat frequency response from d-c to 1 mc. The use of two independent channels working into a single two-gun c-r tube permits high or low-frequency phenomena to be viewed either singly or simultaneously on a single tube face. The vertical deflection amplifiers have capacitive and conductive input attenuators, allowing operation as either a-c or d-c coupled amplifiers. Each channel is supplied with an independently operating sweep generator designed for either single sweep or recurrent operation.

Half-Wave Rectifier Tube

RADIO CORP. OF AMERICA, Harrison, N. J. The 3B28 is a xenon-filled, half-wave rectifier tube of the coated-filament type featuring an ambient-temperature operating range of −75 to +90 C, low voltage drop, rugged construction to permit use under conditions of severe vibration and no restrictions on mounting position. It is rated at (1) a peak inverse anode voltage of 10,000 v and an average anode current of 0.25 ampere, or (2) a peak inverse anode voltage of 5,000 v and an average anode current of 0.5 ampere. In single-phase, full-wave service, a pair of the tubes will provide a d-c output current of 1 ampere at 1,600 v to the filter when the peak inverse anode voltage is limited to 5,000 v, or 0.5 ampere at 3,200 v when the peak inverse anode voltage is 10,000 v.

Varifunction Potentiometer

A. F. SMUCKLER & CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The J-15 is a tapped-shunted, functionally adjustable precision potentiometer. It consists of 15-turn interpolating-linear resistance winding, provided with desirably located fixed taps, and adjustable shunting resistances connected between respective fixed taps as a means of tapering the output. Input voltage is generally applied at the extremities of the winding and the output obtained from a movable arm wiping on the winding. Overall functional conformities as close as ± 0.02 percent have been obtained with 45 taps. The fixed taps can be uniformly or nonuniformly spaced, the closest spacing between any two fixed taps being 4 deg.

Flying Spot Scanner

FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J., has developed a new type of tv flying spot scanner that converts slide information to a video signal suitable for tv broadcasting. The FTL-

3,900,000 HOUR PERFORMANCE TEST

BY NORTHWEST AIRLINES

proves

the reliability and stamina of

RAYTHEON-developed ARINC Tubes!

NORTHWEST AIRLINES tested 1580 Raytheon-developed CK5654 ARINC Tubes over 2500 hours of active service. Some of these tubes had already given thousands of hours of service when Northwest began accumulating these exact records.

During the 2500 hour test period, only 32 of these tubes failed.

Coincidental tests of ordinary tubes over the same operating period showed 42% failure.

RAYTHEON contributions to the ARINC Reliable Tube Program include the original development and quantity production of

CK5654

The high Gm RF pentode. Reliable replacement for type 6AK5.

CK5686

An entirely new, all purpose power output tube good from audio to 150 mc.

CK5725

The gating, or mixer, pentode (dual control grids). Reliable replacement for type 6AS6.

CK5726

The high perveance twin diode. Reliable replacement for type 6AL5.

Over 300 Raytheon Special Purpose Tube distributors are at your service. Application information on tough service tubes is available at Raytheon — Newton, Chicago, Los Angeles.

RAYTHEON MANUFACTURING COMPANY

SPECIAL TUBE SECTION • Newton 58, Massachusetts

RELIABLE SUBMINIATURE and MINIATURE TUBES • GERMANIUM DIODES and TRANSISTORS • RADIATION MEASURING TUBES

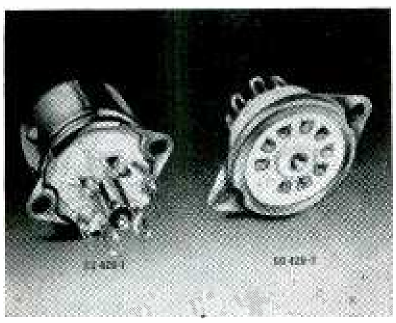
RAYTHEON®

Excellence in Electronics

35A single or basic scanning unit is designed to handle semiautomatically from 1 to 36 2 in. × 2 in. double frame, 35-mm slides which may be shown in or out of sequence. An important feature is an automatic signal cut-out which blanks out the picture while the slide is in motion.

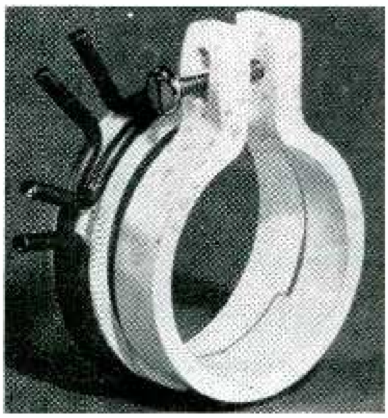
Automatic Plotter

TELECOMPUTING CORP., 133 E. Santa Anita Ave., Burbank, Calif. The Teleplotter automatically plots points on graph paper approximately ten times faster than is possible manually. It operates from digital data furnished in the form of IBM cards or introduced by means of a keyboard. The instrument uses digital electric counters and photoelectric reading head which counts the lines and the spaces on the graph paper in each of two perpendicular directions. Either linear or logarithmic graph paper can be employed. Maximum plotting area is 26 × 55 in. Plotting accuracy is ±¼ of a grid space and plotting speed is 40 points per minute.



Miniature Tube Sockets

TEFLON PRODUCTS DIVISION, United States Gasket Co., P. O. Box 93, Camden, N. J., is producing both 7 and 9-pin Chemelec miniature tube sockets for the electronics industry, designed for spots where high or low ambient temperatures of frequency stability are problems. Loss factor is less than 0.005 and dielectric constant is only 2.0 from 60 cycles to 30,000 mc. Teflon is serviceable at any temperature from −150 F to 550 F for long periods, with negligible change in dielectric strength, power factor and other critical electrical characteristics. It will not carbonize in case of arcing.

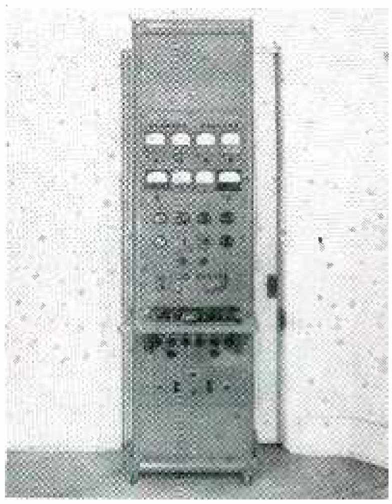


Picture Centering Device

PERFECTION ELECTRIC CO., 2635 South Wabash Ave., Chicago, Ill., is introducing a new picture-centering device for the electrostatic tv tubes which use no focus coil. The Kine-Center consists of two metal rings that can be rotated either independently or together to adjust the tv picture in the tube and center it. The rings are mounted on a special form that is easily clamped securely to the neck of the tube and close to the deflection yoke. The unit stays in place without wobble and can be operated by finger-tip control.

Germanium Power Rectifier

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced a new small, weight germanium power rectifier designed for tv and radio voltage power supplies and general-purpose rectifiers. It features 15 volts more B+ in a typical tv power supply due to rectification efficiency up to 98 percent; approximately 3.5 ohms forward resistance at 350 ma; 400 ma average d-c capacity; 400 volts peak inverse; and approximately 1 megohm back resistance at 350 v. A bulletin on the G-10 rectifier will be sent on request.



Vacuum-Tube Aging Rack

PENNSYLVANIA TESTING LABORATORY, Doylestown, Pa. Type 224 vacuum-tube aging rack, designed for use in industrial plants making special commercial and/or government equipment, ages, cycles or preheats 20 tubes of one type, or 10 each of two types with any of the standard four types of bases. In addition it will check for breakdown and heater-to-cathode leakage. It contains jacks for checking current by internal or external meters. One-percent meters monitor all voltages.

Electronic Magnetizer

LEO KLEIN-ELECTRONICS, 2404 S. La Brea Ave., Los Angeles 16, Calif. Model LG5 electronic magnetizer

(Continued on page 266)

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Electronics Task Group Organized

A SPECIAL electronics task group was recently set up in the Defense Production Administration to study the possibilities of placing additional defense work in mass production plants of the electronics industry. Members of the group are as follows:

E. T. Morris, chairman of the Electronic Production Board, DPA; Col. Leigh Hunt, USAF, Munitions Board, Department of Defense; M. F. Darling, International Brotherhood of Electrical Workers (AFL), Chicago; Daniel Arnold, chairman of the Radio-TV Conference, International Union of Electrical, Radio and Machine Workers (CIO), Camden, N. J.; Benjamin Abrams, president of Emerson Radio and Phonograph Co., New York; and William Balderston, president of Philco Corp., Philadelphia, Pa.

The task group has made the following recommendations:

(1) Military procurement services should request prime contractors to place subcontracts in areas having a surplus of skilled labor and facilities for electronic production.

(2) Labor representatives should submit a list of manufacturing companies located in the Chicago and New York-Philadelphia areas and their current and prospective employment levels.

(3) Radio and tv manufacturing companies should seek subcontracts through the Armed Forces regional councils.

(4) Defense agencies should monitor the placing of future contracts on heavily loaded prime contractors and study existing contract loads.

(5) Encourage leader-type contracts and provision of suitable incentives for prime contractors in these contracts.

(6) Production companies should be associated with design contractors from the time development contracts are placed.

(7) Manufacturers of electronic components should submit samples for testing by the Armed Services electronics standard agency.

Projection Color TV

JUST BEFORE Mr. Wilson, Defense Mobilization Chief, requested suspension of color tv manufacturing and broadcasting "for the duration of the emergency", color television pictures of theatre-screen size were shown in New York by the Radio Corporation of America. The color show was produced in the NBC Studios at Radio City and received at the Colonial Theatre in N. Y. City where representatives of the press viewed the pictures in color on a 9 by 12-foot screen.

The program was not only seen on the theatre screen, but was broadcast by the NBC experimental

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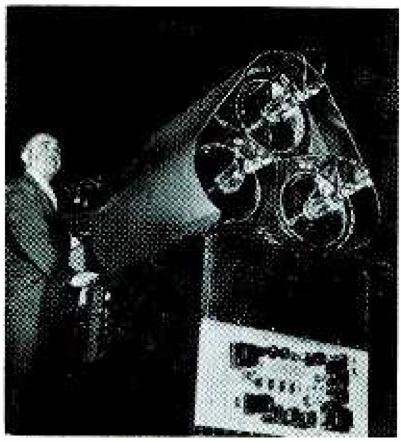
transmitter atop the Empire State Building, on channel 4. This enabled owners of existing television sets throughout the metropolitan area to view the program in black-and-white. At the same time, the program was sent to Washington, D. C., over radio relay and coaxial cable, and broadcast there on channel 4.



At the controls of the RCA experimental receiver-projector is David W. Epstein who directed development of the apparatus at the David Sarnoff Research Center

In addition, the public was invited to view the program in the Lounge of the Center Theatre in Radio City where RCA color television receivers had been set up to obtain public reaction to special field tests of color television being conducted by RCA. Later in the day, tests were transmitted over closed circuits directly from the NBC Studios in New York to the Colonial and Center Theatres, as well as by coaxial cable and radio relay to Washington for viewing on color receivers in the NBC Studios in the Trans-Lux Building.

The showings were continued throughout the week at the Colonial, with three tests daily.

Apparatus shown at the Colonial Theatre consisted primarily of an RCA tricolor receiver-projector, a refinement of one demonstrated by RCA in 1947 at The Franklin Institute in Philadelphia. Although the receiver-projector was mounted in the audience section of the Colonial Theatre for the RCA demonstrations, future models would be designed for a longer projection, permitting installation on theatre balconies.

MEETINGS

NOV. 29-DEC. 1: First Conference of the Joint Electron Tube Engineering Council and its committees, Seaview Country Club, Absecon, N. J.

DEC. 6-7: Feedback Control Conference, sponsored by the AIEE, Chalfont-Haddon Hall, Atlantic City, N. J.

DEC. 10-12: Joint AIEE-IRE Computer Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

DEC. 13-14: Symposium on Williams Electrostatic Storage, National Bureau of Standards, Washington 25, D. C.

JAN. 7-8: AIEE Conference on Electronic Instrumentation in Nucleonics and Medicine, Hotel Statler, New York, N. Y.

JAN. 21-25: AIEE Winter General Meeting, Hotel Statler, New York, N. Y.

MARCH 3-6: 1952 IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.

APR. 7-9: Radio Component Show, Grosvenor House, Park Lane, London, W1., England.

MAY 16-17: Fourth Southwestern IRE Conference and Radio Engineering Show, Rice Hotel, Houston, Texas.

JUNE 23-27: AIEE Summer General Meeting, Hotel Nicollet, Minneapolis, Minn.

Transistor Committee Appointed

THE ELECTRONICS COMMITTEE in the Research and Development Board, Department of Defense, has appointed a Transistor Group to assist the committee in establishing sound policies for the development and functional application of transistors by the Armed Services. It is believed that transistors can be used in more applications in place of the electron tube. The group will investigate further and advise the military departments through the electronics committee of RDB.

The subcommittee on transistors is made up of six representatives from laboratories and industry and six Armed Service representatives, as follows:

J. W. McRae of Bell Telephone Laboratories, chairman; E. Finley Carter of Sylvania Electric Products, Inc.; E. W. Engstrom of RCA Laboratories; I. A. Getting of Raytheon Manufacturing Co.; A. G. Hill of MIT; G. F. Metcalf of General Electric Co.; Cary J. King of the Office of Chief Signal Officer; Geo. F. Moynahan of the Office of Assistant Chief Staff-Army; James M. Bridges of the Bureau Ordnance, Navy; Charles Stec of the Bureau Ships, Navy; H. V. Noble of the Wright Air Development Center, Dayton; and E. W. Samson of the Air Force Cambridge Research Center.

The first meeting was held October 11 in New York City, at which time the group discussed its functions, responsibilities and methods of operation.

Position Vacancies

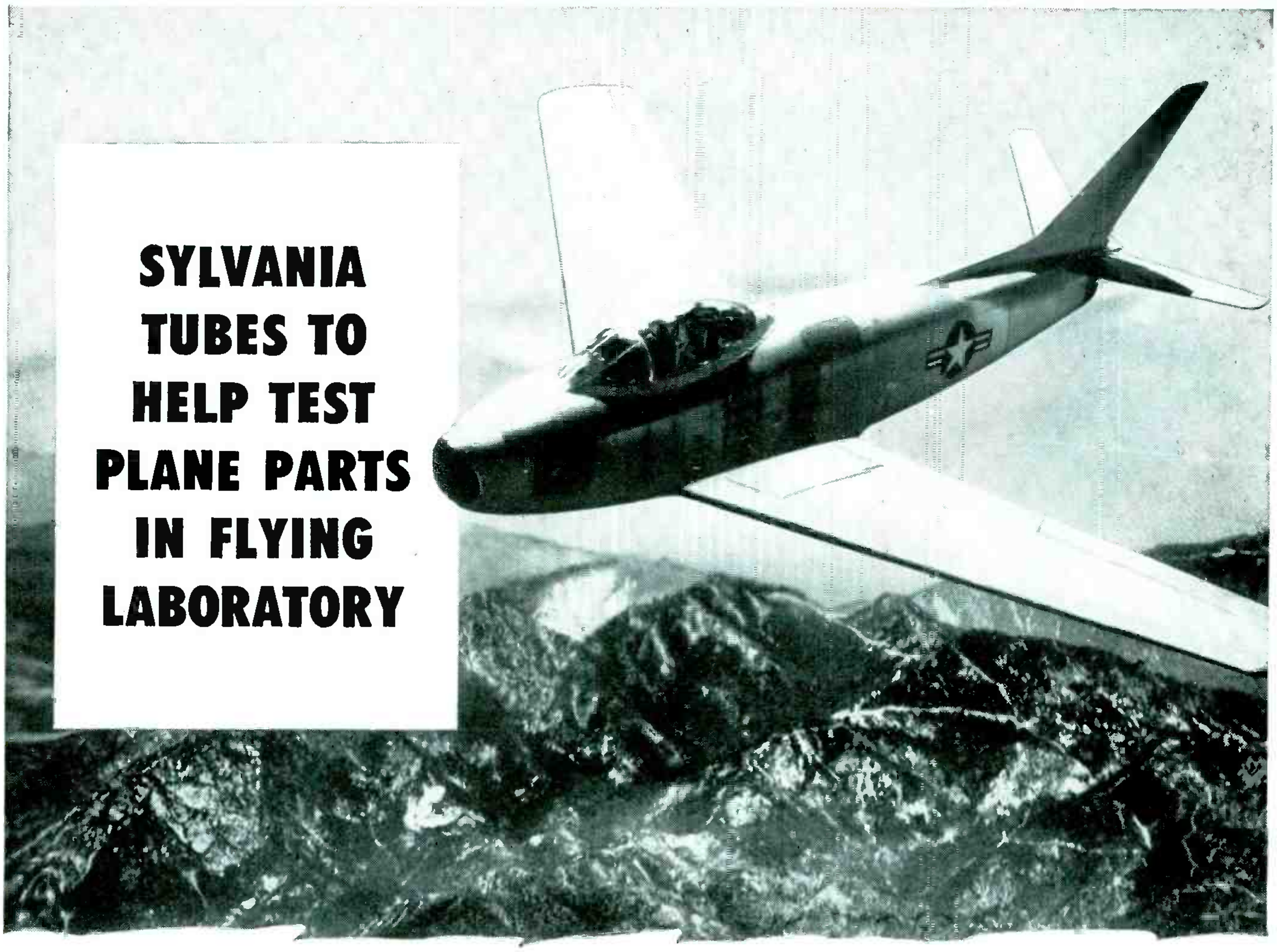
THE SIGNAL CORPS Center at Fort Monmouth, N. J., has a need for technical writers and editors in communications, electronics and associated fields. Current needs are at several professional levels, ranging from trainee positions, Grade GS-5 to senior writer, Grade GS-11. Salaries range from approximately $3,400 to $6,000 per year with promotional opportunities offered.

The Signal School also has a number of civilian openings for military training instructors in communications and electronics such as theory of electricity, mobile and fixed-station radio, microwave radio relay, repeater and carrier, radar and motion picture techniques.

Present vacancies are at every level, ranging from grade GS-5 trainee to GS-9 senior instructor, with salaries ranging from about $3,400 to $5,000 per year. Good promotional opportunities are offered.

Application form 57 may be ob-

(Continued on page 308)



SYLVANIA TUBES TO HELP TEST PLANE PARTS IN FLYING LABORATORY

"ELECTRONIC BRAIN"* *using Sylvania Tubes will check equipment under actual flying conditions for North American Aviation*

Determining the behavior of airplane components for actual conditions of stress, strain, vibration and varying temperatures is reduced to mathematical equations by North American Aviation.

The quick, accurate solution of such problems is accomplished by an improved electronic digital differential analyzer built by The Computer Research Corporation, and known as the CRC-101.

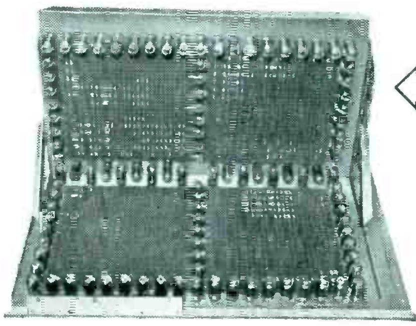
This machine can solve any problem that can be put in the form of ordinary differential equations . . . linear or non-linear.

Remarkably compact!

Matching the speed and efficiency of the CRC-101 is its unusual compactness. Employing only about one hundred Sylvania tubes, the complete computing and power units occupy a space hardly larger than an office desk.

The selection of Sylvania Tubes for this modern computer is a high tribute to their outstanding performance and dependability. That's why today, when tube ratings and characteristics are critical factors, you'll find more and more circuit engineers put Sylvania Tubes *first!* For further information about your tube problems or applications, write to: Sylvania Electric Products Inc., Dept. R-1112, Emporium, Pa.

Complete control panel of CRC-101 occupies no more space than a standard typewriter.



Computation is controlled by approximately 100 Sylvania Tubes operating through a germanium diode "nerve center."

* 50 Integrator Electronic Digital Differential Analyzer made by Computer Research Corp., Hawthorne, Calif.

SYLVANIA ELECTRIC 1901-1951 PRODUCTS INC. 50th ANNIVERSARY FIVE DECADES OF PROGRESS

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

NEW BOOKS

Super-Regenerative Receivers

BY J. R. WHITEHEAD. *Cambridge University Press, London and New York*, 1950, 169 *pages*, $4.75.

THIS book is one of the Modern Radio Technique series being edited in Great Britain by J. A. Ratcliffe, who has a reputation for insisting on lucid writing. The series is similar in scope and background to the MIT Radiation Laboratory Series in this country. Although much of the material contained in this book has appeared previously in various journals, the result of bringing together the scattered information in one volume is to enhance enormously its value to the engineer.

Engineers confronted with the design of practical super-regenerative circuits, as well as those wishing to understand the basis of super-regenerative amplification, will welcome this book. For the latter, the opening chapters provide first a physical picture, and then a detailed mathematical derivation of the theory of super-regeneration. The theoretical treatment is divided into sections on slope-control operation, where the oscillator is gradually turned on, and on step control, where the oscillator is suddenly started. These extreme cases are then compared so that interpolation to intermediate cases may be made readily. The theoretical treatment is clear and well organized and can be followed readily by those having an elementary knowledge of first-order differential equations.

After a chapter on the reception and detection of signals plus noise comes a chapter to which the design engineer can refer without having followed earlier chapters in detail. A well organized system of notation plus an excellent list of symbol definitions contribute to the feasibility of this reference use of the book. A graphical method of evaluating the performance of a receiver under specified conditions and with a specified quench voltage waveform is presented. This is followed by an approximate analysis of a super-regenerative receiver employing sinusoidal quench voltage waveform and using a tube obeying the 3/2

(continued on page 322)

Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Tech Reps Needed

DEAR SIRS:

THE letter in the Backtalk column of your September issue written by "Lieutenant A.A.C.S." and entitled "Scarcity of Engineers?" impresses us as being rather one-sided—tending to give the impression that the armed services as a whole are contracting for the employment of civilian electronic field engineers far beyond the number that they can gainfully employ. Having first hand knowledge that this condition does not prevail throughout all the armed forces, we hasten to put in our two cents worth.

As we understand the purpose of the "Tech Rep" program, it is to supplant or augment available military personnel—the sole reason for this program being the lack of sufficient numbers of qualified military personnel. The reason for the lack of qualified military personnel is not hard to see—a man having the ability and the wide scope of knowledge required for proper maintenance of today's complex electronic equipment is not going to remain in the service as an enlisted man when he can enjoy many more privileges and much greater pay as a civilian while still doing the same kind of work, either for the armed forces or for industry.

This lack of sufficient numbers of qualified electronic personnel was very much in evidence on this ship, an aircraft carrier, when it was recently recommissioned and restored to active service. At this time, when about fifty percent of the major electronic equipments on

(Continued on page 334)

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Taylor Laminated Plastics

If Your Problem

is to design your product or part with a material that offers a *combination* of electrical, mechanical and chemical properties such as high tensile, flexural and impact strength... resistance to corrosion, moisture and abrasion . . . attractive appearance . . . high insulating qualities . . . high speed machineability . . . light weight with great strength and many other desirable characteristics—

A Good Solution

to your problem is Taylor Laminated Plastics. As insulating parts and structural members, Taylor Vulcanized Fibre, Phenol Fibre and Combination Materials, available in a variety of grades, offer you a better, cheaper . . . faster means of developing a *better* product. If you do your own fabricating, Taylor can supply you with sheets, tubes, rods and rolls. If you seek a source of supply for finished parts, Taylor's completely equipped Fabricating Department is at your service.

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on Taylor Laminated Plastics and their application is available. If you have a design problem as indicated above, write today for the new 1951 Taylor Laminated Plastics Catalog. If possible, state your problem. Your copy will be sent you promptly, and experienced Taylor Sales Engineers will be happy to consult with you without obligation.

The new 1951 Taylor Catalog contains complete specifications and description of Taylor Laminated Plastics. See for yourself how you can make your product or part better *with these versatile Taylor materials. Write today for Catalog* E-12.

Taylor

TAYLOR FIBRE CO.
NORRISTOWN, PENNSYLVANIA
WEST COAST FACTORY: LA VERNE, CALIF.

This two-part radio insulator is typical of Taylor's ability to mass-produce accurate parts. Each is stamped in a single operation, one from Taylor Vulcanized Fibre and the other from Grade XXXP-10 Taylor Phenol Fibre, noted for its high dielectric strength. Whatever *combination* of qualities you may need, it's a good bet that one of the many Taylor grades can fulfill your requirements.

Taylor Post Forming Material is a special grade of Phenol Fibre produced in fully-cured sheet form, for the specific purpose of forming to various shapes by heating and forming operations. This Taylor product makes it possible to transform a flat sheet into one with relatively deep draws and compound curves, with little sacrifice in the strength of material.

More than half a century's experience in the field of laminated plastics gives Taylor the edge whenever there's a problem involving the design and fabrication of laminated plastics. There is practically no limit to the variety of shapes that may be quickly, accurately and economically produced from these versatile materials. Combining light weight and great strength with insulating, electrical or dielectric properties to fit hundreds of applications, Taylor Laminated Plastics can help you produce a *better* product.

TUBES AT WORK

(continued from page 138)

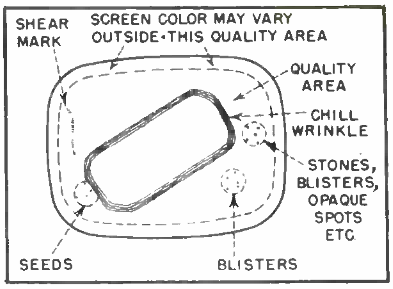

FIG. 1—Face-plate diagram illustrating terms used

to the face plate or panel of the tube will be defined in the following paragraphs.

Refering to Fig. 1, the quality area has been defined, according to RTMA specifications, as that area "concentric with the center of the bulb face, over which the optical quality of the face is important. This area is defined on each bulb specification."

Other new terms also illustrated in Fig. 1 are: shear mark, a surface scar on glassware caused by the pinching and cooling action of cutting shears; seed, an open or buried gaseous inclusion in glass; blister, a large seed or a bubble in glass; chill wrinkle, a wavy or rippled surface as a result of a forming or pressing operation because of nonuniform glass movement during uneven cooling; stone, an undissolved or recrystalized silica, batch or refractory which is embedded in the glass; and opaque spot, an opaque piece of dirt or other material in the glass.

This information was abstracted from an article entitled "Glass Blank 'Specs'" which appeared on page 5 of *Television Mis-information* for June, 1951.

High-Speed Frequency Counter

A NEW DEVICE recently placed on the market by the Hewlett-Packard Company automatically measures the frequency of an unknown with the same accuracy obtained by the use of three separate equipments; a frequency standard, an interpolating system and a detector.

The new instrument measures and displays directly the frequency of an unknown anywhere within the range from 0.01 cps to 10 mc. The

YOU TOO, MAY FIND NEW BUSINESS OPPORTUNITIES IN

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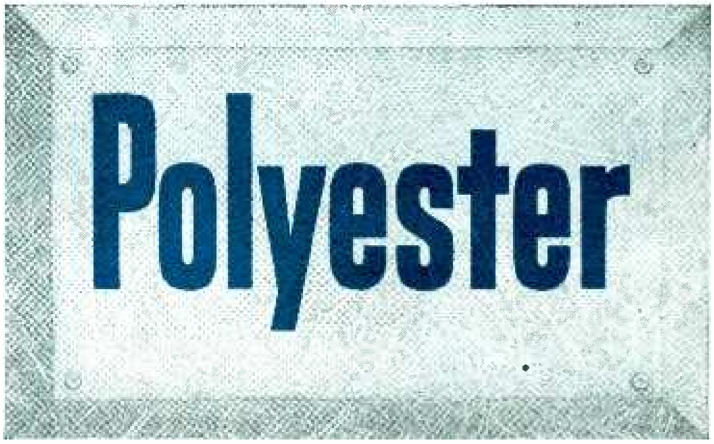
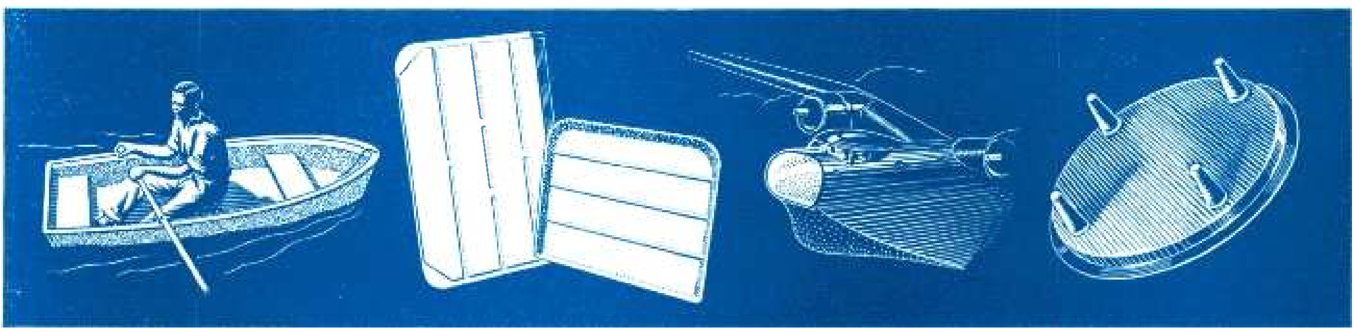


PLASTICS

BAKELITE Polyester Resins constitute a fast-growing branch of the plastics industry. These resins are used in the production of reinforced plastics, chiefly with glass fiber mat or woven cloth. When properly formulated and applied they produce truly structural plastics with high strength-weight ratios that compare favorably with aluminum and steel. Present applications include boat hulls, refrigerator panels, radar housings, tote boxes, luggage.

In general, BAKELITE Polyester Resins provide excellent resistance to moisture, many chemicals, heat and cold. Certain types have excellent electrical characteristics including electrical "transparency" for radar housings. Another type can be cast into strong transparent solids. Another type is highly flexible and is used to impart added toughness to the other Polyester Resins. Inorganic fillers can be incorporated in certain of these resins to reduce costs and to minimize cracking and crazing.

Because BAKELITE Polyester Resins are "tailor-made" to meet widely different chemical, physical, and electrical requirements, Bakelite engineers will gladly assist you in choosing the right resins or combinations of resins for the intended end use. Write Dept. CL-46 for technical assistance and for latest data on the principal BAKELITE Polyester Resins now being marketed.



BAKELITE Polyester Resins are products of a continuing program of research and development. The principal grades now offered are:

High Viscosity Polyester Resin QRS-179 An excellent casting resin. May be prepared at room or elevated temperatures.

Med. Viscosity Polyester Resin QRS-147 A general purpose liquid resin with very good molding characteristics and excellent electrical properties. Adaptable to molding at room and elevated temperatures.

Low Viscosity Polyester Resin QRS-176 A low viscosity polyester resin which can be efficiently drawn into laminating layup under vacuum.

Heat Resistant Polyester Resin QRS-142 Generally similar in properties to QRS-147, it is designed to yield higher heat distortion points according to ASTM D 648-45T test method.

Flexible Polyester Resin QRS-136 For application where flexibility is desired. Also is completely compatible permanent plasticizer with other polyester resins to impart special properties.

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POLYESTER RESINS

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BAKELITE COMPANY
A Division of
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New 1952 HEATHKITS
Heathkit TELEVISION GEN. KIT $39.50
Heathkit ELECTRONIC SWITCH KIT $19.50
Heathkit AUDIO GEN. KIT $34.50
Heathkit CONDENSER CHECKER KIT $19.50
Heathkit R. F. SIGNAL GEN. KIT $19.50
Heathkit 5" OSCILLOSCOPE KIT
• New "spot shape" control for spot adjustment — to give really sharp focusing.
• A total of ten tubes including CR tube and five miniatures.
• Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.
• Greatly reduced retrace time.
• Step attenuated — frequency compensated — cathode follower vertical input.
• Low impedance vertical gain control for minimum distortion.
• New mounting of phase splitter and deflection amplifier tubes near
• CR tube base.
• Greatly simplified wiring layout.
• Increased frequency response — useful to 5 MC.
• Tremendous sensitivity .03 RMS per inch Vertical .6V RMS per inch Hor.
• Dual control in vernier sweep frequency circuit — smoother acting.
• Positive or negative peak internal synchronization.
• Multivibrator type Wide Range Sweep Generator.
A brand new 1952 Heathkit Oscilloscope Kit with a multitude of outstanding features and really excellent performance. A scope you'll truly like and certainly want to own.
The kit is complete with all parts including all tubes, power transformer, punched and formed chassis, etc. Detailed instruction manual makes assembly simple and clear — contains step-by-step instructions, pictorials, diagrams, schematic, circuit description and uses of scope. A truly outstanding value.
MODEL 0-7
SHIPPING WT. 24 LBS.
$43.50
Heathkit VACUUM TUBE VOLTMETER KIT
• New styling — formd case for beauty.
• New truly compact size — Cabinet 4⅛" deep x 4-1/16" wide x 7⅜" high.
• Quality Simpson 200 microamp meter.
• New ohms battery holding clamp and spring clip — assurance of good electrical contact.
• Highest quality precision resistors in multiplier circuit.
• Calibrates on both AC and DC for maximum accuracy.
• Terrific coverage — Reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.
• Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.
• New styling presents attractive and professional appearance.
The 1952 Model Heathkit Vacuum Tube Voltmeter! Newly designed cabinet combines style and beauty with compactness. Greatly reduced size to occupy a minimum of space on your work-bench. Covers a tremendous range of measurements and is easy to use. Uses only quality components including 1% precision resistors in multiplier circuit for greatest accuracy. Simpson 200 microamp meter with easy to read scales for fast and sure readings.
All parts come right with kit, and complete instruction manual makes assembly a cinch.
MODEL V-5
SHIPPING WT. 5 LBS.
$24.50
Heathkit A.C. VOLTMETER KIT $29.50
Heathkit SQUARE WAVE GEN. KIT $29.50
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YOU SAVE BY ORDERING DIRECT FROM MANUFACTURER
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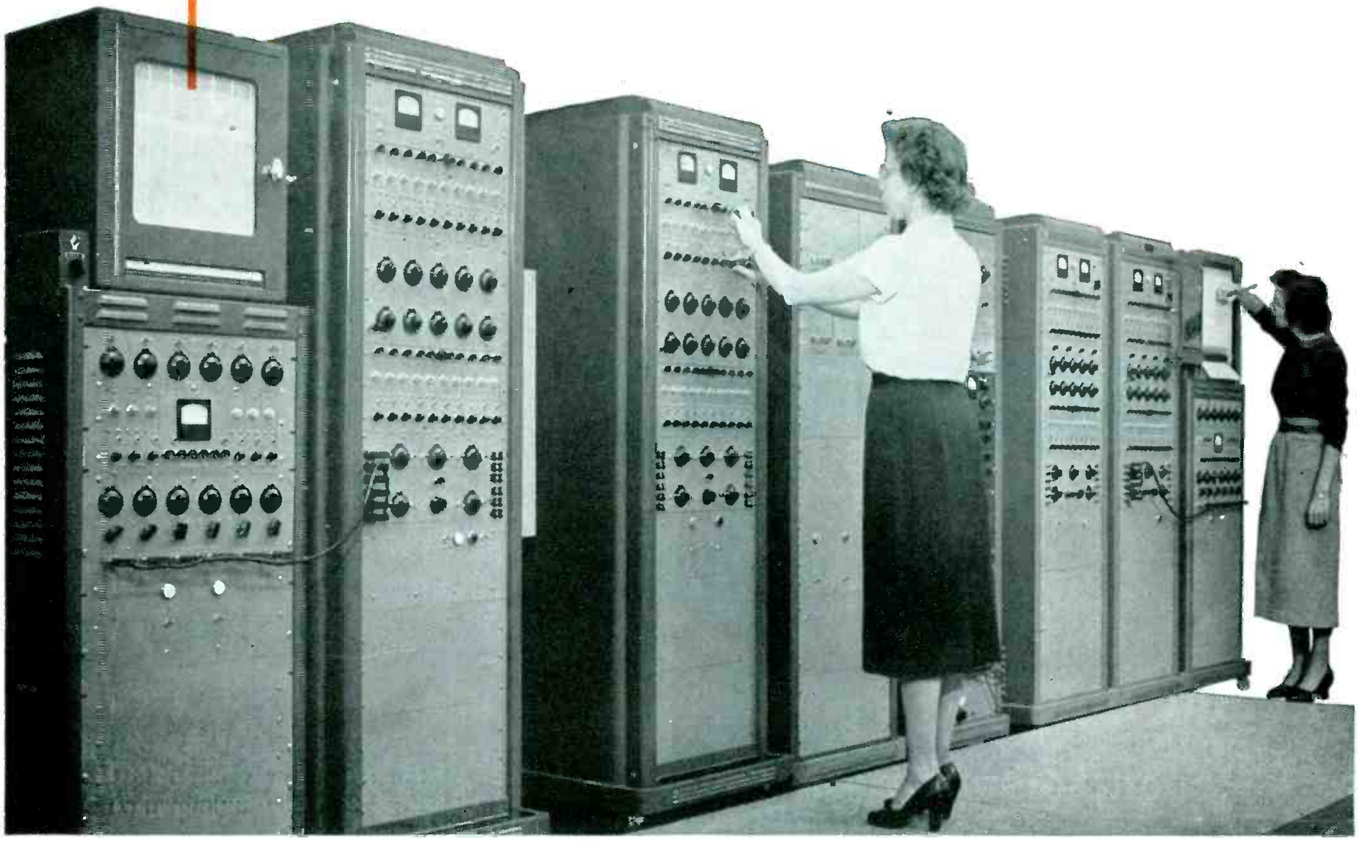
Brush recorder



...memory for an electronic brain

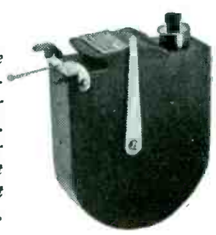
● Goodyear Aircraft's Electronic Differential Analyzer provides a method of studying performance of dynamic systems without computations by a corps of mathematicians.

Since there is a direct analogy between the dynamic behavior of electrical and mechanical systems, the performance of one system can be predicted by a study of the other. Thus, by setting up the proper electrical circuits, problems in such varied fields as aircraft design and control, vibration analysis, industrial control, structures, turbines and engines, and other dynamic systems can be solved with the Differential Analyzer.

The memory for this electronic "brain" is provided by a Brush Recording Analyzer. Here, results from as many as six different computations are recorded simultaneously. Permanent visual records are made instantaneously, eliminating laborious plotting.

Investigate Brush instruments for studies of d-c or a-c voltages or currents, strains, displacements, light intensities, temperatures, and other static or dynamic conditions. Write for information. The Brush Development Company, Dept. K-9, 3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A. *Canadian Representatives:* A. C. Wickman (Canada) Limited, P. O. Box 9, Station N, Toronto 14, Ontario.

Heart of each Brush Recorder is the Brush Magnetic Penmotor—a high-speed, direct-writing element for instantaneous, permanent recording. Flat frequency response and linear phase shift with frequency permit accurate reproduction of both transient phenomena and steady state signals.



Put it in writing with a

BRUSH RECORDING ANALYZER

THE Brush DEVELOPMENT COMPANY

PIEZOELECTRIC CRYSTALS AND CERAMICS • MAGNETIC RECORDING • ELECTROACOUSTICS • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS measured frequency is displayed by the arrangement shown in Fig. 1 whenever an unknown is connected to the input terminals.

The frequency counter operates on the principle of pulse techniques and makes two types of measurements relating to frequency. The instrument first counts unknown frequencies for an accurately-determined time interval of 10, 1, 0.1, 0.01 or 0.001 sec as desired and then displays the count, repeating the process as long as required. The device then measures the period of the unknown in units of 1 μsec up to a maximum of 100 seconds. Periods are measured and then displayed in a repeating process.

Accuracy of the Model-524A counter is set by a gating circuit accurate within 0.1 μsec and by an internal crystal oscillator accurate within about two parts per million per week.

Circuit Description

A simplified block diagram of the frequency counter is shown in Fig. 2. The unknown frequency is applied to a wideband squaring amplifier and then to a fast gate circuit controlled by a time-base generator. The unknown is applied to the counting circuits when the fast gate is open. When the fast gate closes, the counting circuits display the counted frequency until the time-base generator triggers the resetting circuit. After this cycle is completed, the counting circuits are reset to zero and the gate is again opened so that the next sample of the unknown can be counted.

The distinguishing feature of the

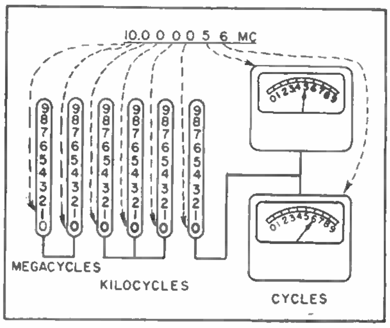


FIG. 1—Display arrangement of high-speed frequency counter. Neon tubes behind panel slots illuminate the proper numerals

"TOP PERFORMANCE plus STABILITY and always a QUALITY PRODUCT... these are essentials in the design of RCA COIL PRODUCTS"

RADIO CORPORATION OF AMERICA
RCA VICTOR DIVISION
CAMDEN 2, NEW JERSEY

TUBE DEPARTMENT

Antara Products Division
General Dyestuff Corporation
435 Hudson Street
New York 14, N. Y.

Gentlemen:

Top performance -- plus stability — and always a quality product — these are essentials in the design of RCA Coil Products.

To insure "quality throughout", we make most of the magnetic iron cores used in the various coil products manufactured by RCA. We are thus both manufacturers and users of cores.

We have now used your G A & F Carbonyl Iron Powders for many years. In our T.V. picture i.f. transformers we use the E grade where greater tuning range is required and the TH grade where the loss must be held to a minimum.

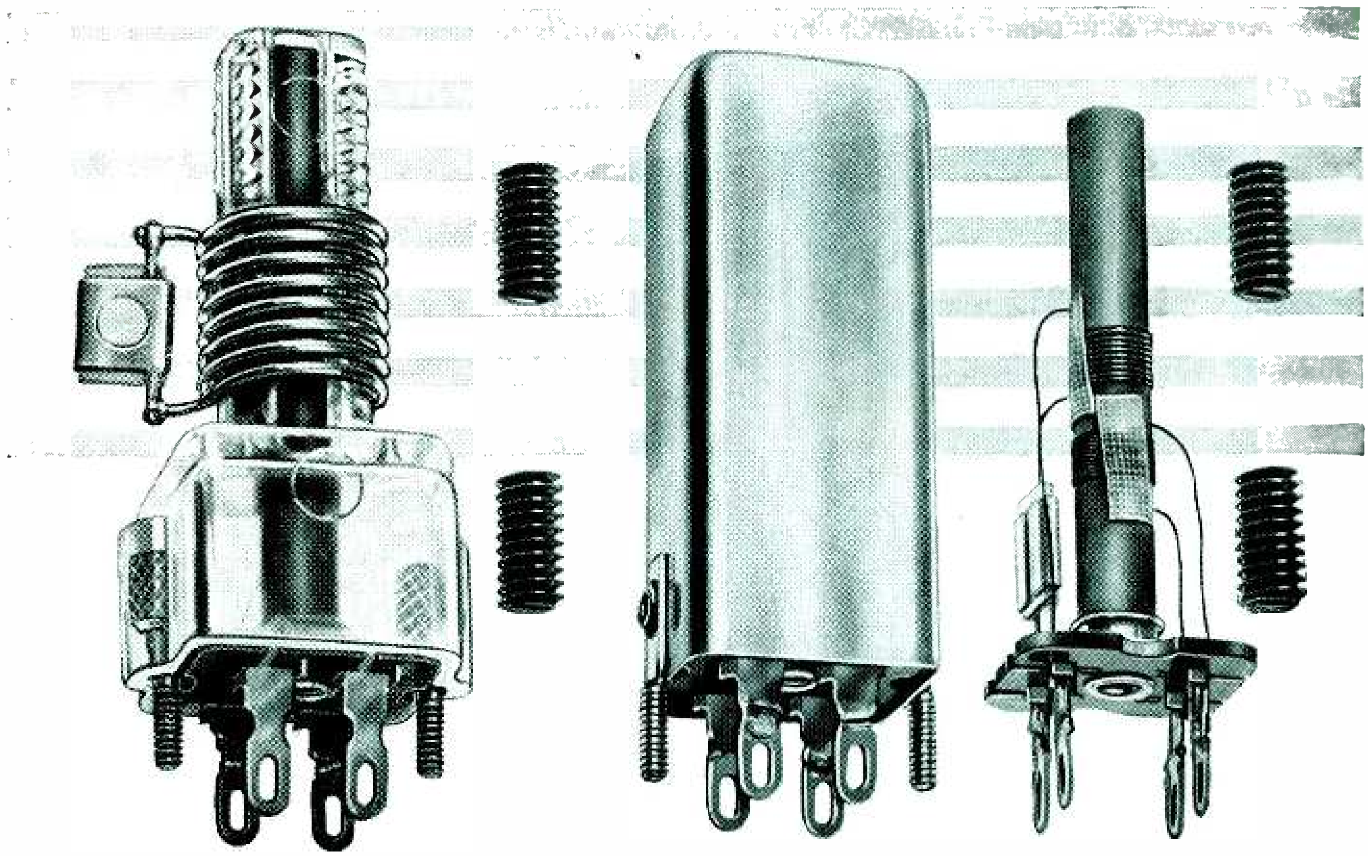
We know from experience that a Carbonyl Iron Powder — whatever its grade — can be relied on for purity and uniformity of characteristics.

Sincerely,

R. W. Mackey

Manager,
Coil Development Group

G A & F® Carbonyl



• RCA components are quality components . . . G A & F Carbonyl Iron Powders are quality materials. High standards and rigid Quality Control govern the production of both. It is logical that Radio Corporation of America should use these powders in the making of their finest magnetic iron cores.

Pictured at the left above is a TV Picture-IF Transformer—permeability-tuned and with a high-Q absorption trap circuit mounted on a moulded polystyrene form. At the right above, a TV Picture-IF Transformer—permeability-tuned and with a trap circuit mounted in a shield can. In each transformer two cores, made of Carbonyl Iron Powder, are used; the inductance of the trap winding is adjustable from the top of the unit; the inductance of the primary winding is adjustable from the bottom.

G A & F Carbonyl Iron Powders are made in six grades, each of which has its own particular combination of qualities. Collectively, the six grades have a wide range of applications in electronic cores over the whole frequency spectrum. The purity is invariably high, with non-ferrous metals in traces only; some grades contain beneficial small amounts of carbides, nitrides and oxides.

FOR FURTHER DETAILS, WE INVITE YOU TO WRITE FOR A FREE BOOK
—fully illustrated with performance charts and application data.
It will help any radio engineer or electronics manufacturer to step up quality, while saving real money.
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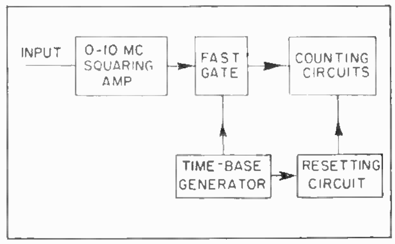

FIG. 2—Basic block diagram of the instrument

high-frequency counter is the high-speed scalar shown in basic form in Fig. 3. The complete counting circuit consists of eight cascaded scalers with indicating systems. Each scaler is a decade type that generates one output pulse for every ten pulses received. The input scalar is the high-speed 10-mc circuit which divides incoming pulses by decades and indicates remaining counts on a panel meter. Following the input scalar is a second circuit similar to the first but with slower operation. The final six scalers indicate on neon lamps the last digit of the quantity of pulses received from the preceding scaler.

Period Measurements

The frequency counter can also be used to count the frequency of its internal 100-kc precision oscillator for a time period equal to ten periods of an unknown frequency. The device counts in units of 10 μsec for a time equal to 10 cycles of the unknown, displaying a one-cycle period of the unknown in units of one μsec.

Measuring range of the instrument is extended to frequencies as low as 0.01 cps because of its ability to make period measurements.

Stages of the complete equipment are shown in the block dia-

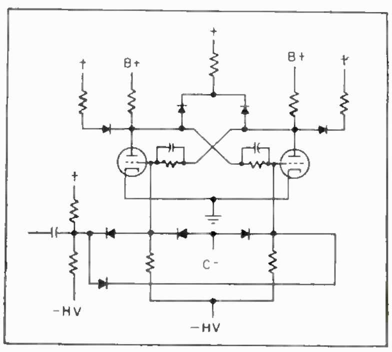

FIG. 3—Basic high-speed multivibrator circuit

RMC DISCAPS

...the standard of performance throughout the entire radio and television industry

- Small Size
- Greater Mechanical Strength
- Faster Production Line Handling
- Low Self Inductance
- High Working Voltages
- Low Power Factor
- Uniform Quality

Designed to Replace Tubular Ceramic and Mica Condensers at LOWER COST!

RMC Type C temperature compensating and general purpose DISCAPS conform to the electrical specifications of the RTMA standard for Class 1 ceramic capacitors and Army-Navy JAN-C-20A. Their capacity will not change under voltage. Ideally suited to coupling and tuned circuit applications, RMC DISCAPS are available in a wide range of capacities and temperature coefficients. If you are interested in improving quality and uniformity on your production lines, now is the time to check on the advantages of using RMC DISCAPS.

"RMC DISCAPS" *The Right Way to Say Ceramic Condensers*

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RMC

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GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

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Two RMC Plants Devoted Exclusively to Ceramic Condensers

RMC DISCAPS

...the standard of performance throughout the entire radio and television industry

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FRANK J. MOCH,
president of the
National Alliance of Television and
Electronics Service Associations.

Frank J. Moch says— "there is no other OSCILLOSCOPE like the NEW Simpson MODEL 476 MIRROSCOPE"

Simpson's new and completely advanced type of oscilloscope—Model 476 MIRROSCOPE—is designed to eliminate certain inherent disadvantages found in the conventional type of oscilloscope by use of the "Mirroscope principle." In this kind of construction the 5-inch cathode ray tube is mounted in a vertical position, thus reducing bench space requirements to an area of only 9″ x 8″ thereby permitting better concentration of associated equipment for any type of test procedure. The cathode ray image is reflected from an optical type front surfaced mirror mounted in the adjustable cover at the top of the cabinet bringing the viewing surface of instrument near eye level when instrument is used on benches of normal height. The mirror angle is quickly and easily adjusted to any position of the operator. The cover with integral side wings forms an effective shield against external light sources or may be closed down for protection of the tube and mirror when the instrument is not in use. The upright construction permits location of controls and connections for maximum convenience and allows for internal cathode ray tube connections at the front of the panel instead of the rear.

SENSITIVITY:

Vertical direct.......12 volts rms per in.
Vertical amplifier.20 millivolts rms per in.
Horizontal direct.....14 volts rms per in.
Horizontal amplifier.....38 millivolts rms per in.

INPUT IMPEDANCE:

Vertical direct.....10 megohms, 15 mmf.
Horizontal direct...10 megohms, 15 mmf.
Vertical amplifier.300,000 ohms, 30 mmf.
Horizontal amplifier......500,000 ohms, 15 mmf.

Horizontal trace expansion is over 4 times tube diameter. This makes it possible to examine minute portions of a response pattern for finer detail.

Linear Sweep frequency is continuously adjustable in five overlapping ranges from 15 cycles to 60,000 cycles. Internal, external or line frequency synchronization with variable amplitude is available.

Means for intensity or "Z axis" modulation is provided. Approximately 14 volts peak will blank a trace of normal intensity.

The vertical amplifier frequency response is within 3 DB from 20 cycles to over 300,000 cycles and is usable to well over three megacycles. Square wave slant and over-shoot is held to less than 5 per cent of amplitude. This response will be found adequate for all phases of television receiver service including observation and diagnosis of Sync. signals.

TUBE COMPLEMENT:

5UP4	Cathode Ray Tube.
4—6J6	Horizontal and Vertical Amplifiers.
1—12AU7	Vertical pre-amplifier.
1—6J6	Linear Sweep oscillator and Sync. injector.
2—6X4	High voltage rectifiers.

LINE VOLTAGE: 105-125 volts, 50-60 cycles.

SIZE: Height 16¼″; Width 9⅛″; Depth 8″ over all

WEIGHT: 25 lbs.; Shipping weight 30 lbs.

Hight Frequency Crystal Probe...$7.50

DEALERS NET PRICE including operators manual $179.50

CONSERVE CRITICAL MATERIALS

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44, Ill.
Phone: Columbus 1-1221
In Canada:
Bach-Simpson Ltd., London, Ontario

gram of Fig. 4. The unknown is applied through the input squaring amplifier and fast gate to the counting circuit on direct frequency measurement as described previously. A time base lying between 0.0001 sec and 1 sec is applied through the input switch to the amplitude discriminator. The time base is set by the position of the multiplier switch in the time-base circuits.

A decade scaler, following the amplitude discriminator, divides the time bases generated by a factor of ten. The decade scaler operates into a gate that, on automatic measurements, is always open so that the output of the scaler is

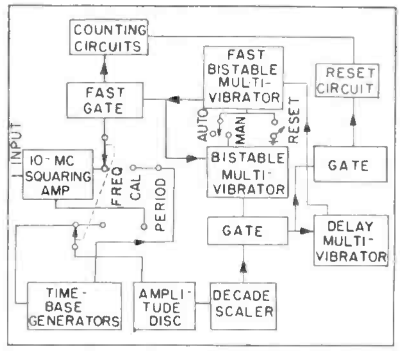


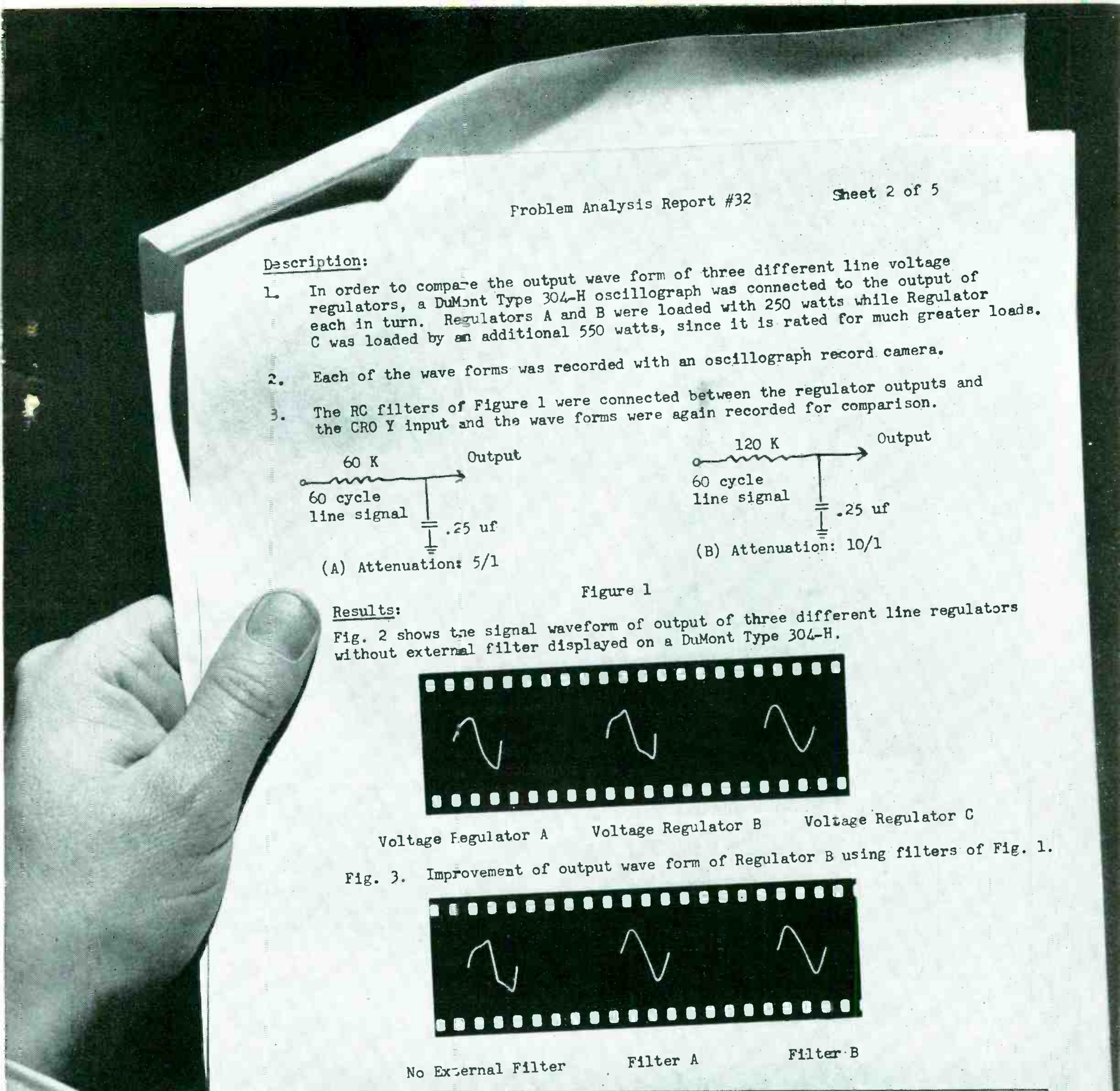
FIG. 4—Complete block diagram of the counter

fed to the gate for the resetting circuit and to the delay multivibrator that feeds the fast bistable multivibrator.

The fast gate and the gate to the resetting circuit are opened and closed by the fast bistable multivibrator. The multivibrator is so arranged that one gate is always closed when the other is open.

After a pulse comes from the decade scaler and passes through the first gate, it is fed both to the delay multivibrator and to the gate for the resetting circuit. The pulse triggers the resetting circuits, if the gate is open, clearing the counters and resetting them to zero. At the same time, the pulse has triggered the delay multivibrator which delays the triggering of the fast bistable multivibrator for a fixed interval of 100 μsec.

After the end of the 100-μsec period, the delay multivibrator



Problem Analysis Report #32 Sheet 2 of 5

Description:

1. In order to compare the output wave form of three different line voltage regulators, a DuMont Type 304-H oscillograph was connected to the output of each in turn. Regulators A and B were loaded with 250 watts while Regulator C was loaded by an additional 550 watts, since it is rated for much greater loads.

2. Each of the wave forms was recorded with an oscillograph record camera.

3. The RC filters of Figure 1 were connected between the regulator outputs and the CRO Y input and the wave forms were again recorded for comparison.

60 K Output
60 cycle line signal
.25 uf
(A) Attenuation: 5/1

120 K Output
60 cycle line signal
.25 uf
(B) Attenuation: 10/1

Figure 1

Results:

Fig. 2 shows the signal waveform of output of three different line regulators without external filter displayed on a DuMont Type 304-H.

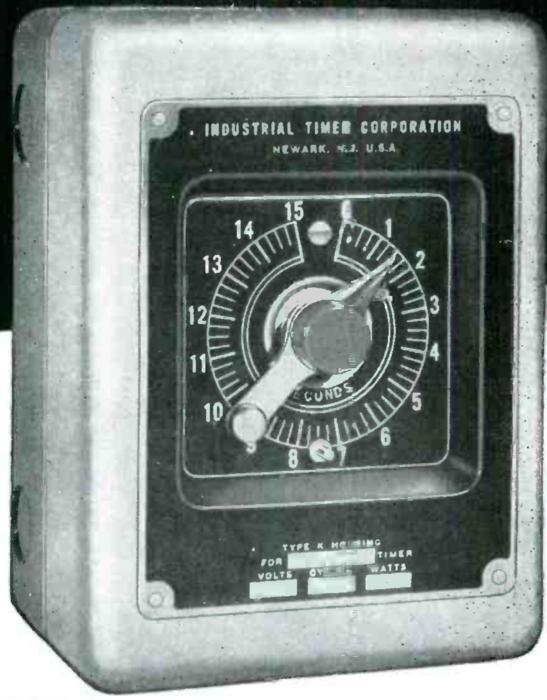
Voltage Regulator A Voltage Regulator B Voltage Regulator C

Fig. 3. Improvement of output wave form of Regulator B using filters of Fig. 1.

No External Filter Filter A Filter B

Dependable Synchronous Motor Driven INSTANTANEOUS RESET TIMERS

For Process Control in Industrial Applications



SERIES PAB INDUSTRIAL TIMERS

The simple clutch mechanism makes it possible to offer this type timer in a number of models, ranging from PAB-5S to the PAB-3H, as follows:

MODEL	TIMING RANGE	DIAL CALIBRATION
PAB-5S	5 cycles to 5 seconds	5 cycles
PAB-15S	¼ second to 15 seconds	¼ second
PAB-30S	½ second to 30 seconds	½ second
PAB-60S	1 second to 60 seconds	1 second
PAB-3M	2 seconds to 3 minutes	2 seconds
PAB-5M	5 seconds to 5 minutes	5 seconds
PAB-15M	15 seconds to 15 minutes	15 seconds
PAB-30M	30 seconds to 30 minutes	30 seconds
PAB-60M	60 seconds to 60 minutes	60 seconds
PAB-3H	2 minutes to 3 hours	2 minutes

Here, incorporated into a single, compact unit, you obtain all the features that spell *performance, dependability,* and *long life.*

Quality designing has assured exceptional accuracy—plus simplicity that means trouble-free operation.

Quality engineering has built in dependability and strength—produced a precision instrument that stands up under hard industrial usage day in and day out.

TIME SETTING—The long pointer of the timer is simply turned to the dial calibration corresponding to the time cycle required. (The red actuating arm automatically takes the same position.)

When the timer is hooked up to a power source, its motor runs continuously. Upon pushing the starter button, a magnetically engaged clutch operates—causing the red actuating arm to start traveling immediately.

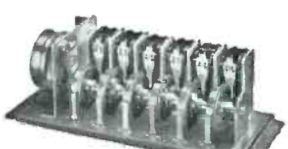
RESET—the instant the red actuating arm completes the time cycle, the clutch is disengaged, and the arm is returned to its reset position by spring action in a fraction of a second. Thus reset is *automatic and instantaneous.*

You will find this Industrial Timer—product of our long experience and close association with innumerable practical applications—*unsurpassed* for process control in industrial applications where precision timing and absolute dependability are essential.

Write us today for complete details—or, if you would like to send us specifications, we shall be glad to make recommendations based on your particular needs.

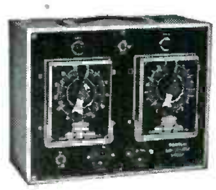
Manufacturers of These and Other Timers and Controls for Industry

Time Delay Timers



Multi-cam Recycling Timers

Manual Set Timers



Tandem Automatic Recycling Timers

Running Time Meters

Timers that Control the Pulse Beat of Industry

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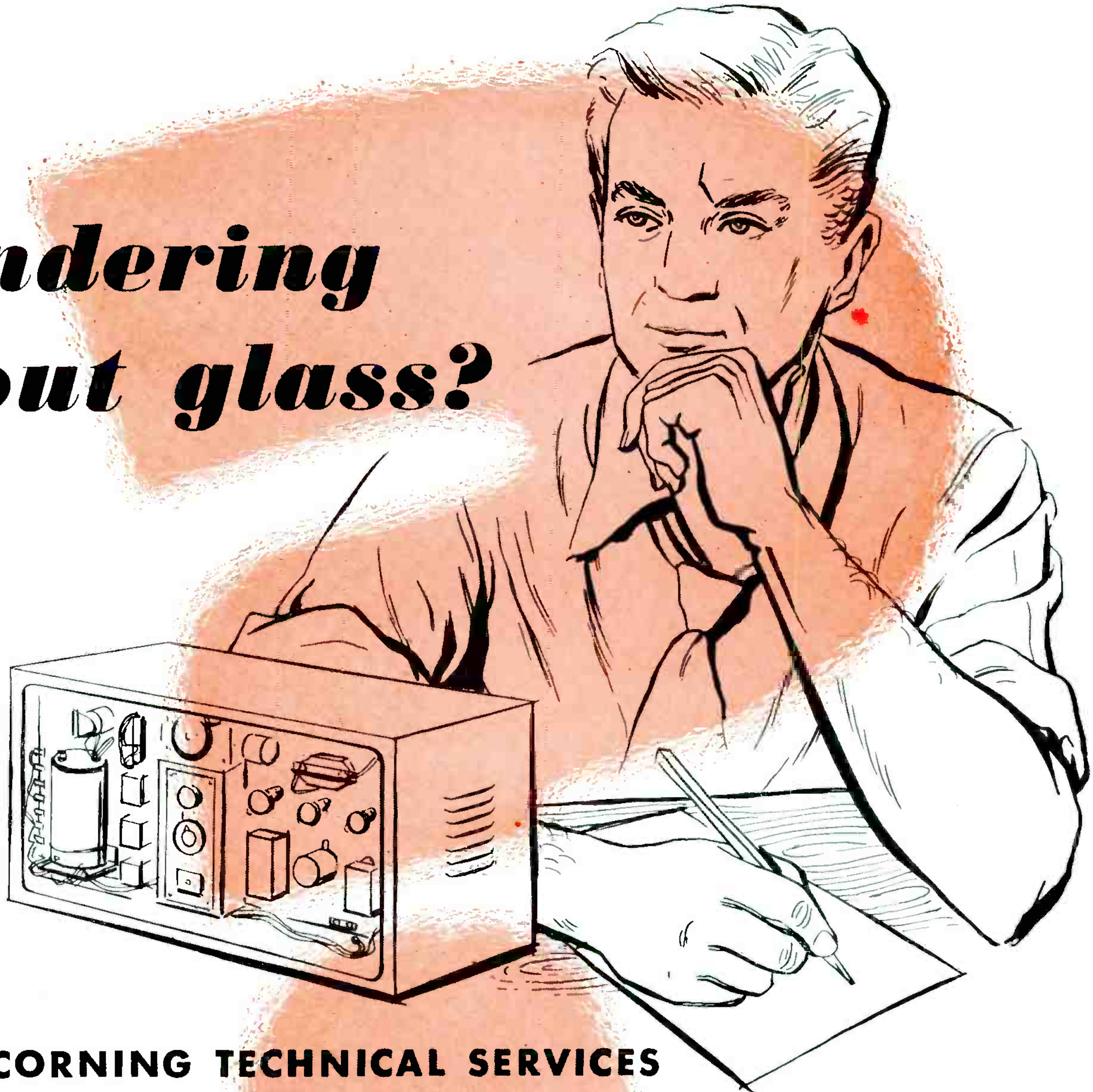

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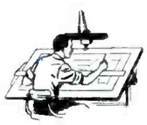
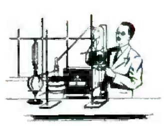


DESIGN ENGINEERING

PRODUCT ENGINEERING



GLASS TECHNOLOGY

Like most materials, glass for electronic applications must be carefully **selected and properly engineered to the** application involved. When you **come to Corning for your electronic** glass requirements you have available **complete technical services** to help solve these problems.

Specialists in **product engineering**, glass working techniques, and design are ready to go to work for you. And their experience is backed by complete and modern research, pilot plant and manufacturing facilities.

What's more, Corning has developed hundreds of glasses with widely varying electrical characteristics. Whether you need low loss, high dielectric constant and strength, or low power factor, Corning has a glass to fit your requirements. So why not take advantage of the services Corning has waiting for you. For further information, write to department E-12, Corning Glass Works, Corning, N. Y.

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Corning means research in Glass

ELECTRONIC SALES DEPARTMENT — ELECTRICAL PRODUCTS DIVISION

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causes the fast bistable multivibrator to switch, opening the fast gate and closing the resetting gate. Because the counting circuits have been cleared and reset to zero, the next unknown admitted through the fast gate will be counted.

Navy Primary Standard Frequency Meter

By JOHN M. CARROLL
Ensign, USNR
Washington, D. C.
(on Military Leave from ELECTRONICS*)*

PERMITTING measurements to the cycle from 15 kc to 27 mc with accuracy of one cycle in 10 mc, the model LAM precision frequency-calibrating equipment provides primary-standard frequency-measuring service for the U. S. Navy. Used by frequency measuring units stationed near large naval shore radio installations, the instrument makes possible round-the-clock coverage of primary naval broadcast stations and frequent spot checks on mobile transmitters to insure compliance with navy frequency tolerances, ±0.005 percent for fixed transmitters and ±0.015 percent for mobile units. The equipment is presently being replaced with Reeves-Hoffman AN-FRM3 gear. This equipment extends the frequency range upwards to 400 mc.

The LAM differs from other precision frequency measuring equipment in that it provides for rapid measuring and double or triple checking of each measurement as well as primary standard accuracy. The frequency range of the equip-

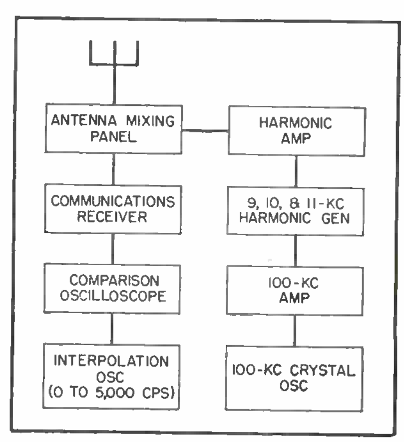
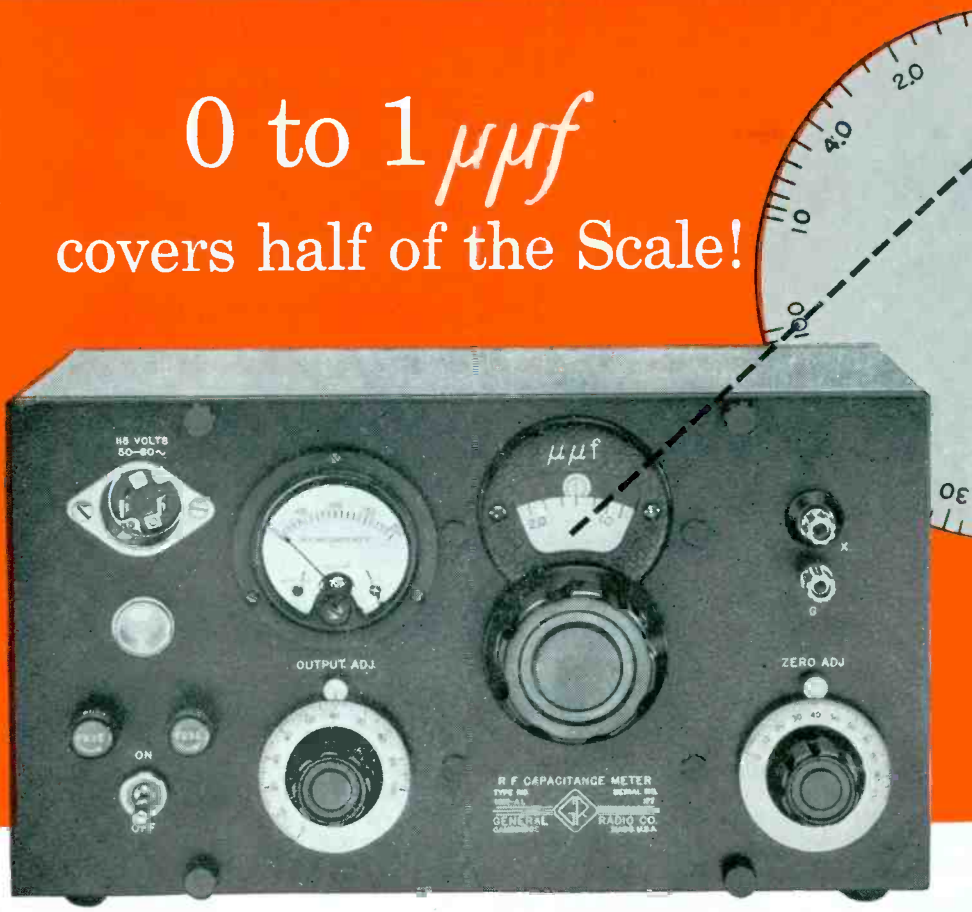


FIG. 1—Normal measuring procedure using 9, 10 and 11-kc standard harmonics

0 to 1 μμf covers half of the Scale!



The measurement of very small capacitances at radio frequencies is sometimes a difficult problem. To simplify this important measurement, G-R has developed the Type 1612-AL R-F Capacitance Meter, having two ranges from zero to 10 micromicrofarads and zero to 100 micromicrofarads.

Compact, very simple-to-use, accurate and reliable, this new meter fills a demand for many measurements of small capacitances such as:

Ceramic Capacitors — tubular ceramics (insulated and uninsulated), disc-type ceramics, tubular ceramics included in v-t sockets

Molded Mica Capacitors — foil- or silver-mica

Variable Trimmer Capacitors — variable mica, variable plate-type, variable multi-cup-type air, variable ceramic, and variable piston-type with glass dielectric

Vacuum-Tube Sockets

The operation of the instrument is very simple. Merely: (1) set the main dial to one of its two zero points, (2) turn "Zero Adjust" dial for maximum meter reading, (3) turn "Output Adjust" dial for full-scale reading on meter. Connect the unknown to the "X" terminals and retune the main dial to obtain maximum meter reading. The capacitance of the unknown is then indicated directly by the main dial setting.

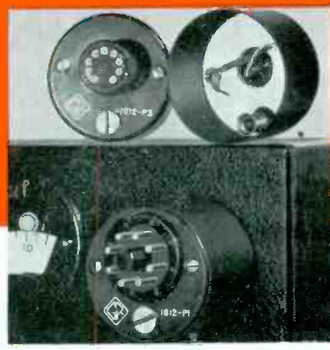
The capacitance accuracies are: LOW RANGE of 0 to 10 μμf: ±0.03 μμf below 1 μμf, and ±3% between 1 and 10 μμf; HIGH RANGE of 0 to 100 μμf: ±0.3 μμf below 10 μμf, and ±3% between 10 and 100 μμf.

On the 10 μμf range, the first μμf occupies almost one-half of the scale length, and settings can be made to 0.002 μμf!

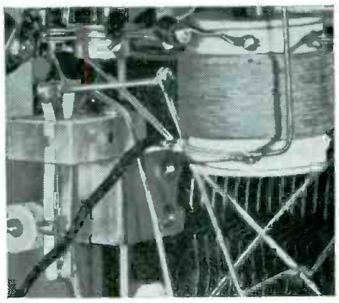
In addition, the meter can be used to approximate the dielectric loss by observing the amount by which the final tuning adjustment during measurement fails to reach full-scale on the indicating meter.

Together with its companion Type 1612-A R-F Capacitance Meter (with ranges of 0 to 1200 μμf and 0 to 80 μμf) this new meter provides an unusually simple, accurate and direct method for measuring capacitances over a very useful range, at radio frequencies.

TYPE 1612-AL R-F CAPACITANCE METER . . . $170
TYPE 1612-A R-F Capacitance Meter 170



For the measurement of r-f capacitance of tube sockets, these adaptors are required. Three are available: Type 1612-P1 for 7-pin miniature sockets, to measure "No. 4 contact to all"; Type 1612-P2 for octal sockets, to measure "No 4. contact to all"; Type 1612-P3 for 9-pin miniature noval socket, to measure "No. 5 contact to all." The adaptors fit into and shield around the "X" terminals on the meter. They are priced at $9.00 each.



In shifting from one range to another, no extra panel switching is required. The change in range is accomplished automatically as the dial is rotated from one half of the scale to the other, the switch shown above automatically performing the operation.

GENERAL RADIO Company

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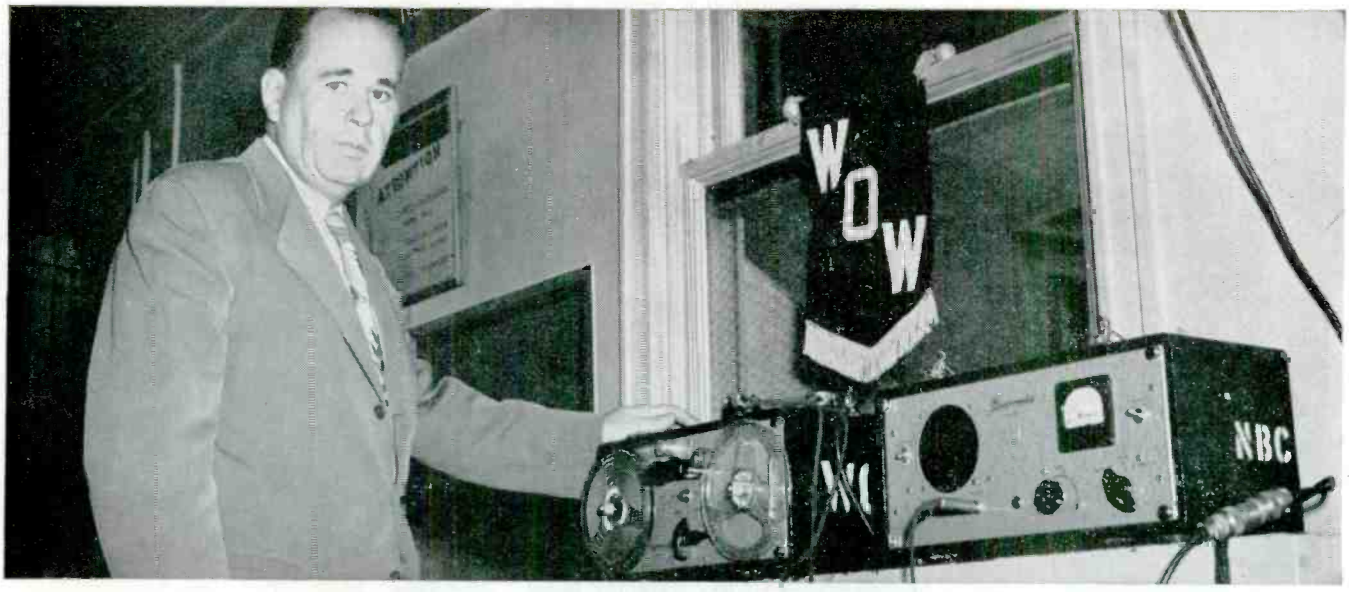
90 West Street NEW YORK 6 — 920 S. Michigan Ave. CHICAGO 5 — 1000 N. Seward St. LOS ANGELES 38



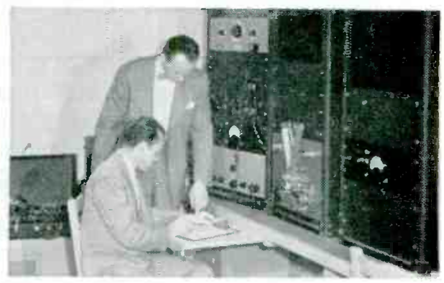
"NO WORRIES ABOUT LEVEL CHANGES WITH 'SCOTCH' SOUND RECORDING TAPE"

Says Glenn Flynn, Asst. Chief Engineer, Station WOW, Omaha, Neb.

"You're always sure of uniform output when you're using 'Scotch' Sound Recording Tape," says Mr. Flynn. "Thanks to its unvarying coating you can switch from reel to reel without worrying about level changes." Flynn is shown with the recording equipment he used on WOW's recent East Coast Farm Study Tour, a 6000-mile tour of farming areas taken by a large group of Nebraska farmers.

FIVE RECORDED INTERVIEWS daily were made by Mal Hansen during WOW's Farm Study Tour. The recordings were air-mailed to the studio for broadcast on WOW's daily Farm Service Reporter program. "Scotch" Sound Recording Tape captures every sound, reproduces it with a fidelity unmatched by any other recording medium.

SMOOTHLY-PACED PROGRAMS are guaranteed, production problems simplified with "Scotch" Sound Recording Tape. Changes can be made and dubbed in without re-assembling the entire cast; shows can be recorded a portion at a time; fluffs and miscues can be edited out; recordings can be lifted from tape to tape without noticeable loss of quality.



EIGHTY 3M SOUND ENGINEERS in the field—backed by 20 technical experts in the 3M laboratories—stand ready to give you technical assistance with any recording problem you may have. Call your local 3M Service Representative, or write us direct: Dept. E-121, Minnesota Mining & Mfg. Co., St. Paul 6, Minn. No obligation, of course.

"SCOTCH" SOUND RECORDING TAPE GIVES YOU THESE EXTRA CONSTRUCTION FEATURES

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- **LONGER TAPE LIFE**—special lubricating process reduces friction.
- **GREATER SENSITIVITY**—more output on your present machine setting.

IMPORTANT: There's more than one brand of sound recording tape. Insist on the "SCOTCH" brand, the *lubricated* tape that gives matchless fidelity, clarity of reproduction, freedom from distortion. Used by all major networks and for master recording by record companies.

ment may also be extended upwards to 160 mc with only a slight loss in accuracy.

Double-Check Measuring

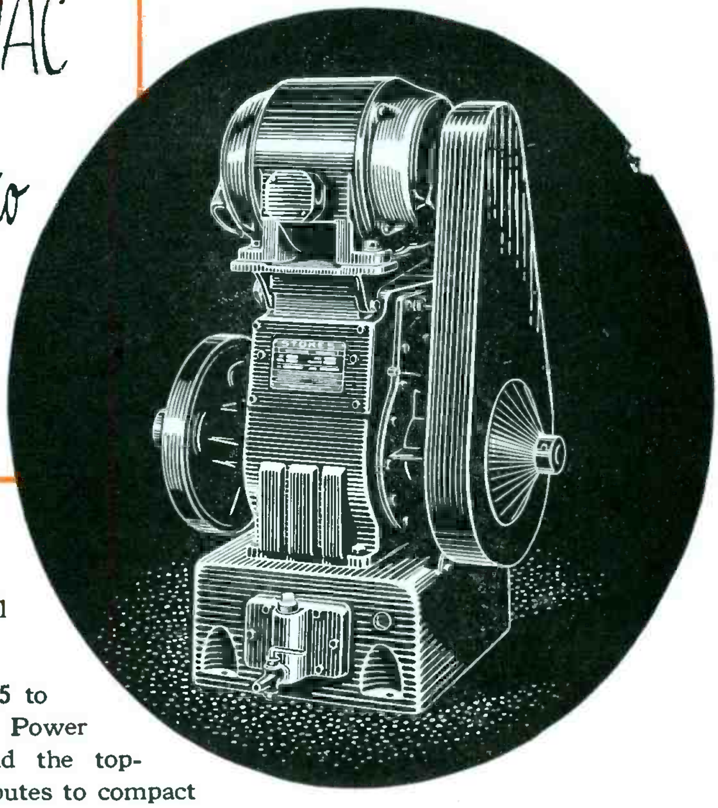
Figure 1 shows the normal measuring procedure using standard harmonics of 9, 10 and 11 kc. This is the method used when the assigned frequency of the incoming signal is known. The output of the 100-kc crystal oscillator is amplified in the 100-kc amplifier which also provides isolation of the oscillator from the rest of the equipment. The 100-kc standard output is then divided in the harmonic generator and standard outputs of 9, 10 or 11 kc, rich in harmonics, may be selected by a wafer switch in the harmonic generator unit. The harmonic output is amplified by the harmonic amplifier and fed to the antenna mixing panel.

A shielded wafer switch in the mixing panel permits selection of up to six antennas while anticapacitance switches allow either the incoming signal, the harmonics or both to be fed to the r-f section of any one of three standard navy communications receivers. These cover the spectrum from 15 kc to 27 mc and provision is made for a vhf receiver to cover from 30 to 160 mc. Since the presence of the harmonics on the antenna would cause intolerable interference in near-by receivers, a wide-band isolation amplifier is incorporated in the mixing unit. It uses a single 6AB7 with both shunt and series peaking coils in the plate circuit. The degree of isolation thus provided has not always proved adequate, however, and most stations use additional antenna multicouplers.

Both the incoming signal and the standard harmonics are fed to the r-f section of the receiver used. Due to the sharp tuning and narrow band-pass characteristics of Navy receivers, the receiver audio output is always the beat difference between the incoming signal and the nearest standard harmonic and is between 0 and 5,000 cycles in frequency. The difference frequency is placed on either the horizontal or vertical deflection plates of the comparison oscilloscope.

The output of the interpolation

STOKES MICROVAC PUMPS...*are basic to Vacuum Processing*



High volumetric and mechanical efficiency make these famous pumps economical and reliable units in any vacuum system.

Capacities of Stokes Microvac Pumps run from 15 to 500 cfm . . . pressures to 10 microns absolute. Power consumption is low and the top-mounted motor contributes to compact design requiring minimum floor space.

Send for FREE Stokes Vacuum Calculator. This slide rule determines needed pump capacity for any job . . . shows Centigrade to Fahrenheit conversion. Other useful conversion tables and scales on reverse of rule.

Lubrication of the four moving parts (including the exhaust valve of corrosion-resistant Teflon) is fully automatic. There are no stuffing-boxes or grease fittings, and no packing.

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Stokes is the only manufacturer of equipment for complete vacuum systems, including Microvac mechanical pumps, oil diffusion pumps, McLeod Gages and Vacuum Valves.

Consult with Stokes on the application of vacuum to rotary exhaust machines, house vacuum systems, vacuum impregnation, vacuum furnaces, vacuum metallizing, and to other applications in which vacuum deserves exploration.

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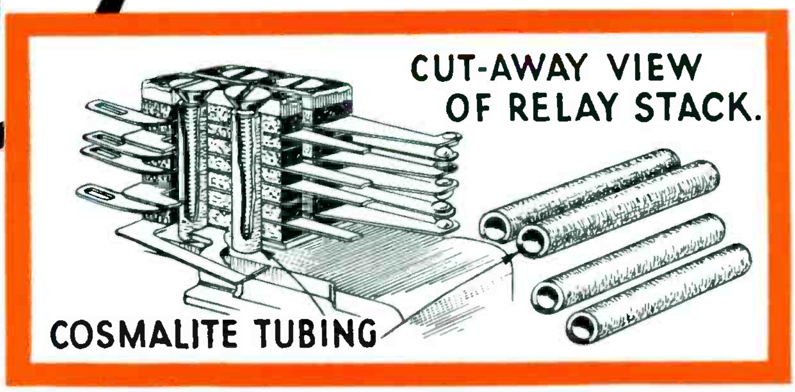

The Allied Control Co. has built a long and enviable record as a quality supplier of control relays to both private industry and governmental services.

Their S K Relay shown above, is typical of the various Allied Relays in which CLEVELAND CONTAINER tubing provides excellent service.

It is likewise the answer for hundreds of other problems of manufacturers in the electrical industry.

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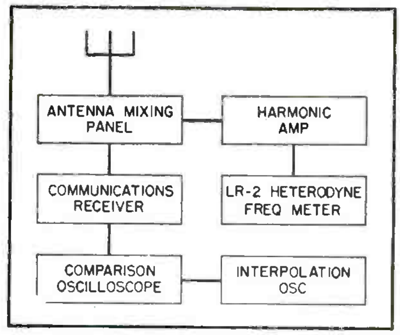

FIG. 2—Measuring procedure using heterodyne frequency meter to extend range to 160 mc

oscillator is placed on the opposite plates of the comparison oscilloscope and zero beat is determined by the oval Lissajous pattern. The beat difference frequency is read directly from the interpolation oscillator. The oscillator is calibrated before each measurement by comparison with the standard harmonic of 1 kc closest to the difference frequency to be measured. It is free from drift, the output being the audio beat difference of two Colpitts-type r-f oscillators.

Measurements are taken using all three harmonic series if possible. It is always possible to obtain at least two measurements of any frequency from 15 kc to 27 mc. The operator finds the closest harmonic of the series used in a table and either adds or subtracts the measured audio beat difference. Measurements made using two or three harmonic series must agree. Experienced navy operators have made accurate measurements in 12 seconds.

Harmonic Generator

In the 9 and 11-kc channels of the harmonic generator, the output of the 100-kc amplifier goes through a frequency-multipling stage which yields 900 and 1,100 kc respectively. In each channel, there are two multivibrators synchronized for 10-to-1 frequency division. The output of the unit is then 9 or 10 kc rich in harmonics. A single synchronized multivibrator affects 10-to-1 frequency division in the 10-kc channel.

The harmonic amplifier provides a substantially flat response for harmonics of 9, 10 and 11 kc up to 42 mc. The unit also provides ampli-


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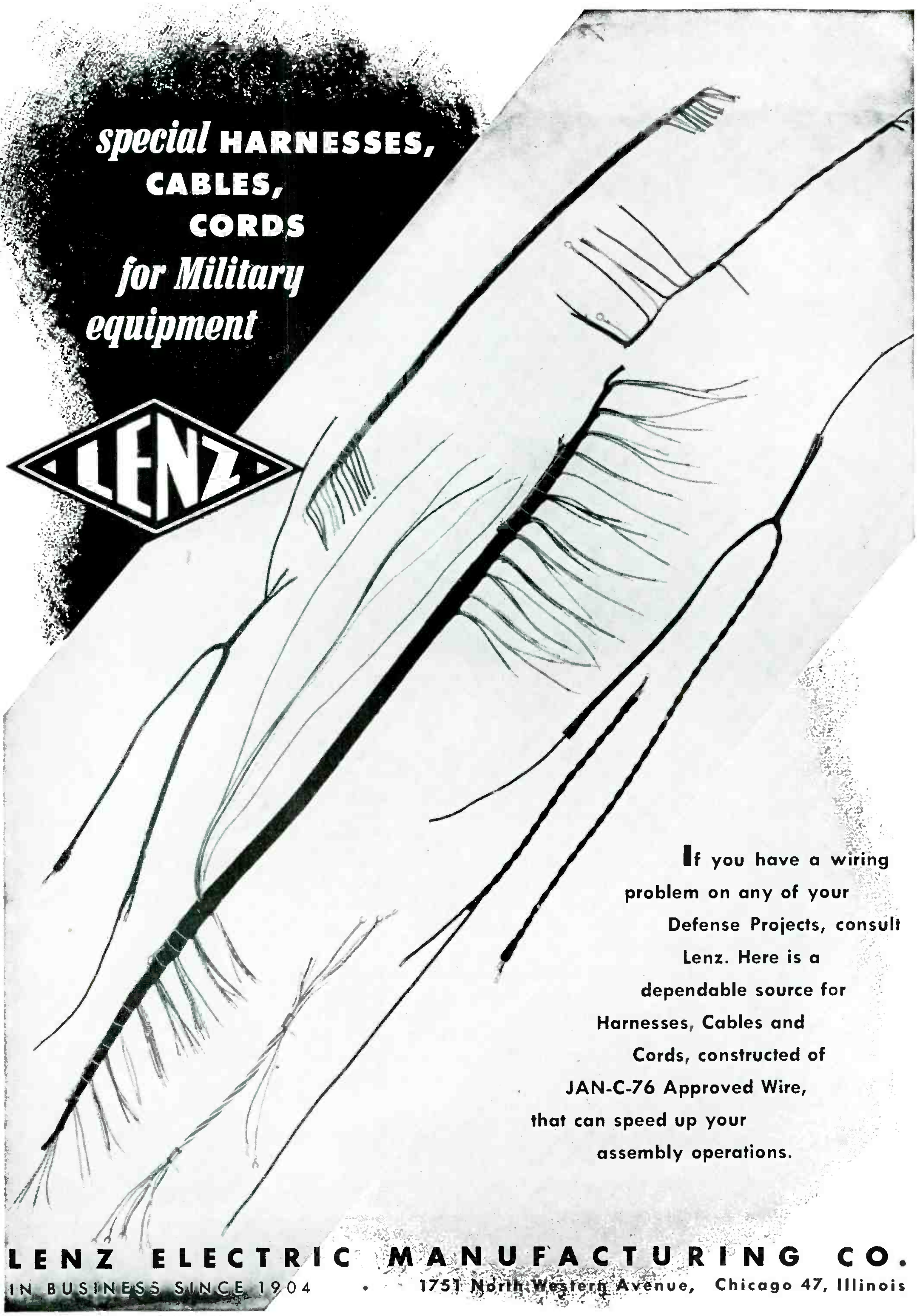
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fication for harmonics of 100 kc and 1 mc used in identification of unknown frequencies. The first stage is a 6AC7 wide-band amplifier biased beyond cutoff, the second stage provides further distortion in that the screen grid is at B+ while the plate voltage is made somewhat less. The final stage is a cathode follower; the output is taken off a potentiometer by means of which the amplitude of harmonics on the antenna may be regulated.

Extended Range

Figure 2 shows the method by which the frequency range of the LAM may be extended upwards to 160 mc. A standard Navy hetrodyne frequency meter is built into the equipment. In this secondary standard-type equipment, a 50-kc X-cut crystal provides check points for a very stable variable-frequency oscillator. When used in the LAM, the secondary standard crystal oscillator is not used and the variable-frequency oscillator is calibrated against the LAM standard harmonics. Likewise, the interpolation meter method of determining zero beat is by-passed and the comparison-oscilloscope — interpolation-oscillator method is used.

It is often necessary to measure the frequency of a transmission when the assigned frequency is unknown or when the transmitter is decidedly off its assigned frequency. In this case, the unknown signal may be bracketed between two known 10-kc harmonics by means of a panoramic radio intercept adap-

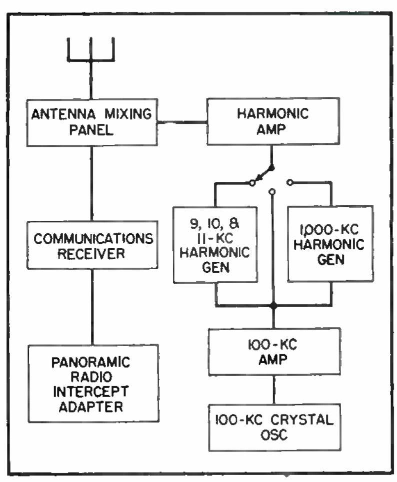

FIG. 3—Estimating frequency of unknown signal using panoramic adapter

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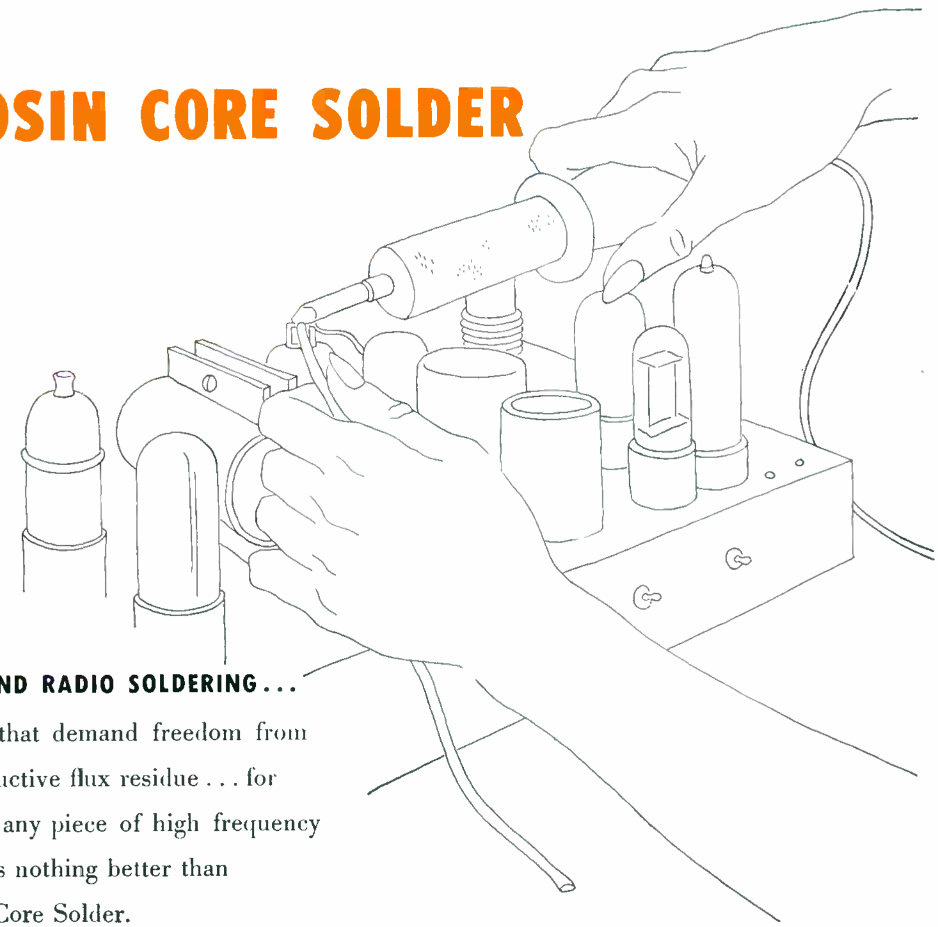

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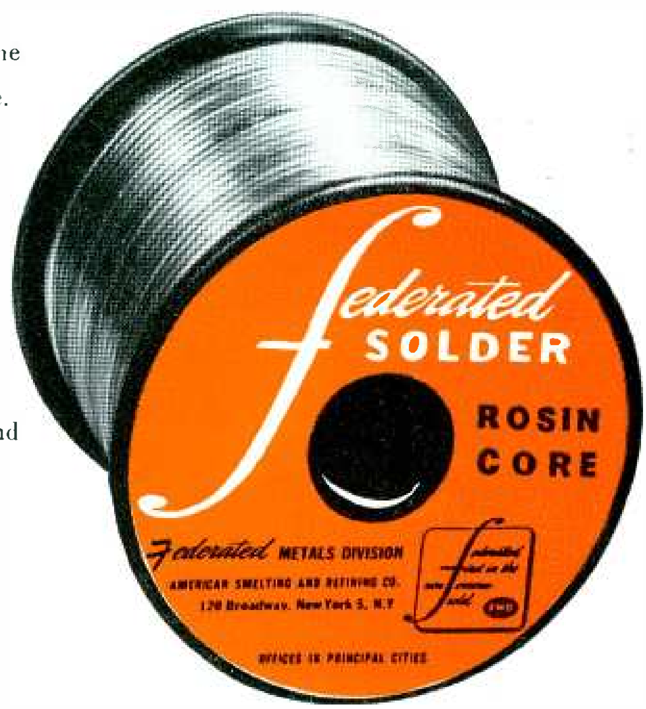

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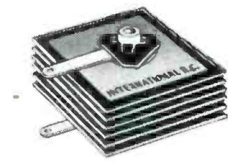

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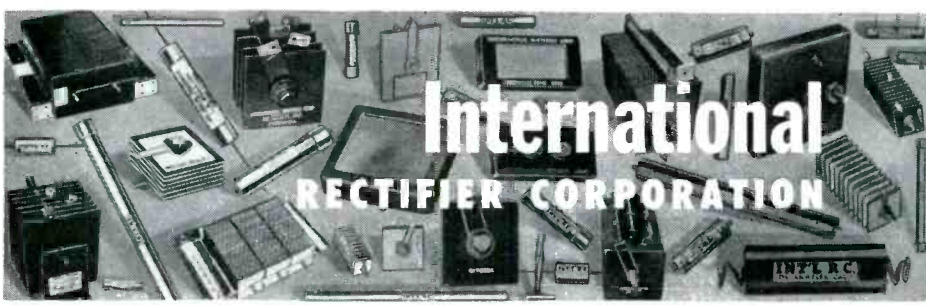

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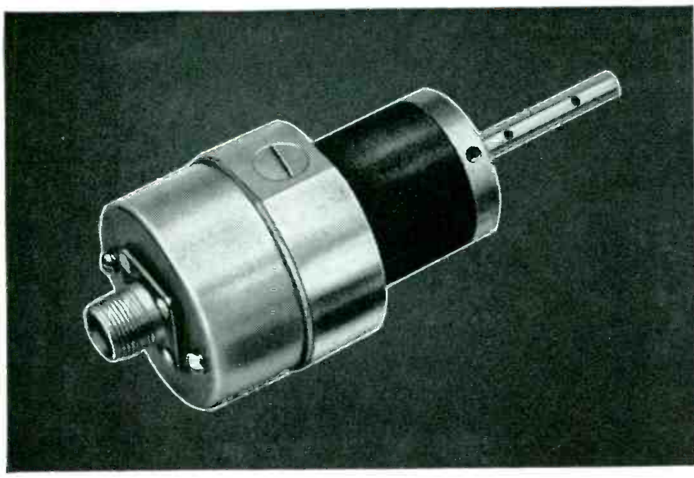

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ter. Here the receiver i-f is tapped and the panoramic adapter provides a visual display of the spectrum 500 kc about the unknown signal. As shown in Fig. 3, standard harmonic markers are used to count down to the bracketing 10-kc markers.

The 1,000-kc harmonic generator first distorts the amplified 100-kc signal to provide frequency multiplication, then a 1,000-kc crystal filter in the plate circuit of the first stage rejects the unwanted harmonics. There is one stage of amplification and the output is taken off a cathode follower and fed to the harmonic amplifier. The 100-kc markers are obtained directly from the 100-kc amplifier through the harmonic amplifier while the bracketing 10-kc markers come from the 9, 10 and 11-kc harmonic generator in 10 position. This method may also be used to determine which standard harmonic of 9 or 11 kc shall be selected when measuring should the double-check fail to agree.

Primary Standard Accuracy

By definition, a primary standard of frequency must be compared with observatory time to check its accuracy. Figure 4 shows how this is accomplished in the LAM. The 100-kc signal passes through a regenerative frequency divider from which are obtained 1 and 10-kc outputs. The 1-kc signal is employed to run the 1,000-cycle synchronous clock and to calibrate the interpolation oscillator as described previously while the 10-kc output is used in tuning and servicing the equipment. The clock is checked against the naval observatory time-ticks broadcast over navy Radio Washington.

In practice, there are three other checks used to maintain accuracy; comparison of outputs of two crystal oscillators, measurement of station WWV and WWVH and the navy simultaneous measurement program. The intrinsic value of the LAM as a standard of frequency is found in its crystal oscillator whose accuracy, freedom from drift and precision adjustment are outstanding.

The oscillator uses a Wien-bridge circuit and very fine adjustment of frequency is possible by switching

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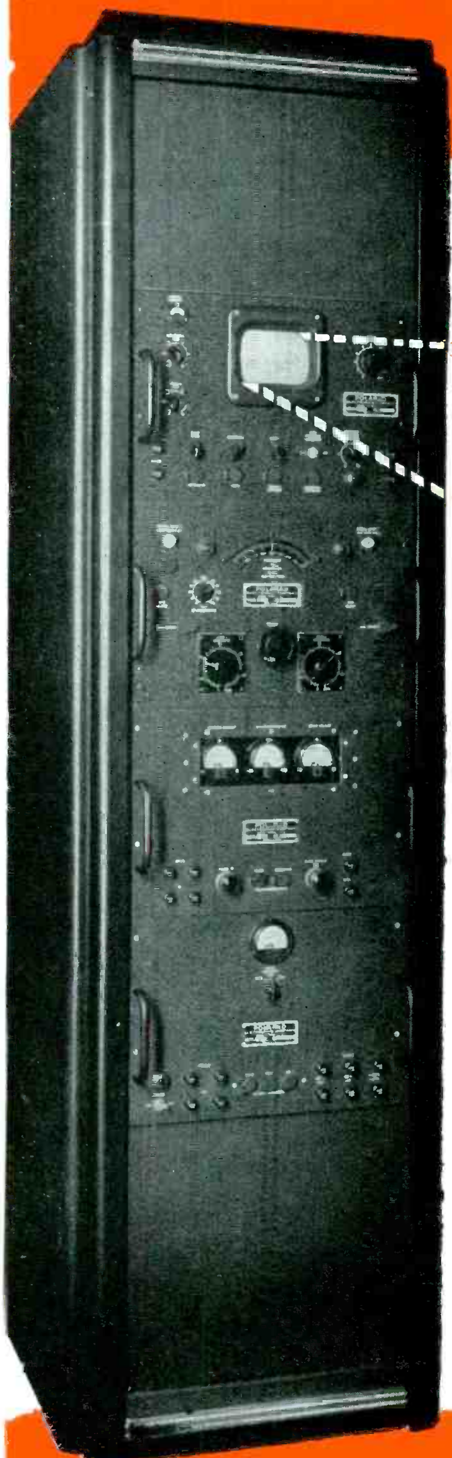
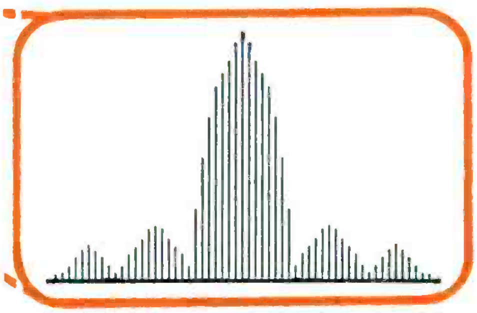


Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.



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Polarad's Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency of distribution of energy in an r.f. signal in the range 10 to 16,520 MCS.

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1. Observe and measure sidebands associated with amplitude and frequency modulated signals.
2. Determine the presence and accurately measure the frequency of radio and/or radar signals.
3. Check the spectrum of magnetron oscillators.
4. Measures noise spectra.
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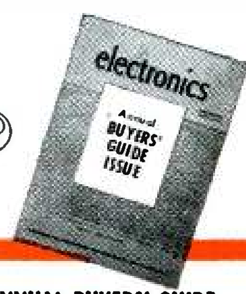

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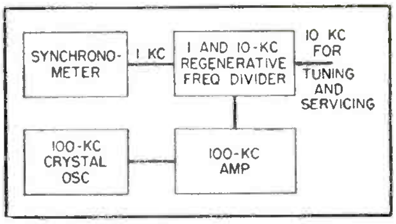

FIG. 4—Primary standards of frequency referred to time

small capacitors. The finest adjustment is on the order of 10^8. The oscillator frequency is controlled by a hermetically sealed BT-cut crystal.

The simultaneous frequency measuring program is a unique and rigorous check on the LAM's primary standard accuracy. At prearranged times throughout the day and night, frequency measuring units throughout the world measure the same station and frequency, usually a primary naval broadcast station. The list of times and stations is prepared in advance and results are air-mailed to Washington daily. Tabulation reveals whether any LAM is off frequency with respect to the others.

The LAM equipment may be used to measure any radiotelegraph or radiotelephone emission. It is particularly well adapted to measurement of frequency-shift-keyed radioteletype signals since both the mark and space frequencies may be measured easily thus affording both the measured mean carrier frequency and the shift frequency. Measurements may be taken on the rest frequency of FM and photo-facsimile transmissions and skilled operators have made approximate measurements on single side band.

The LAM equipment was designed, developed and fabricated by the Radio Measurements and Componants Section, Ship-Shore Radio Division, Naval Research Laboratory, Washington, D. C.

The opinions contained in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or of the Naval Service at large.

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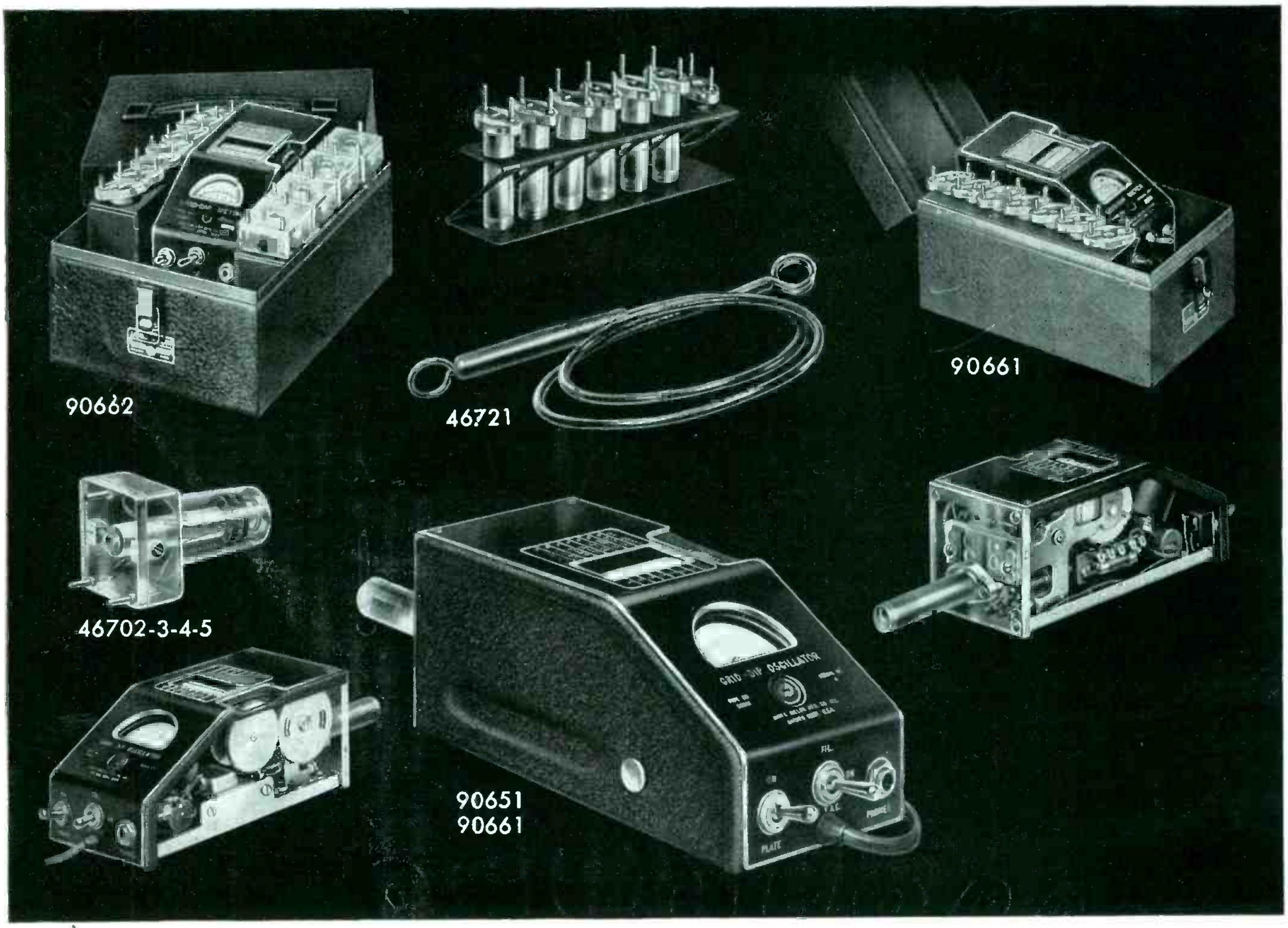
HEATER-INDUCED 60-cycle hum in a-c operated low-level amplifiers can be reduced to less than one microvolt by suitable choices of tubes and circuitry. Less fortunate tube-



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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 3⅛ in. x 3⅜ in.

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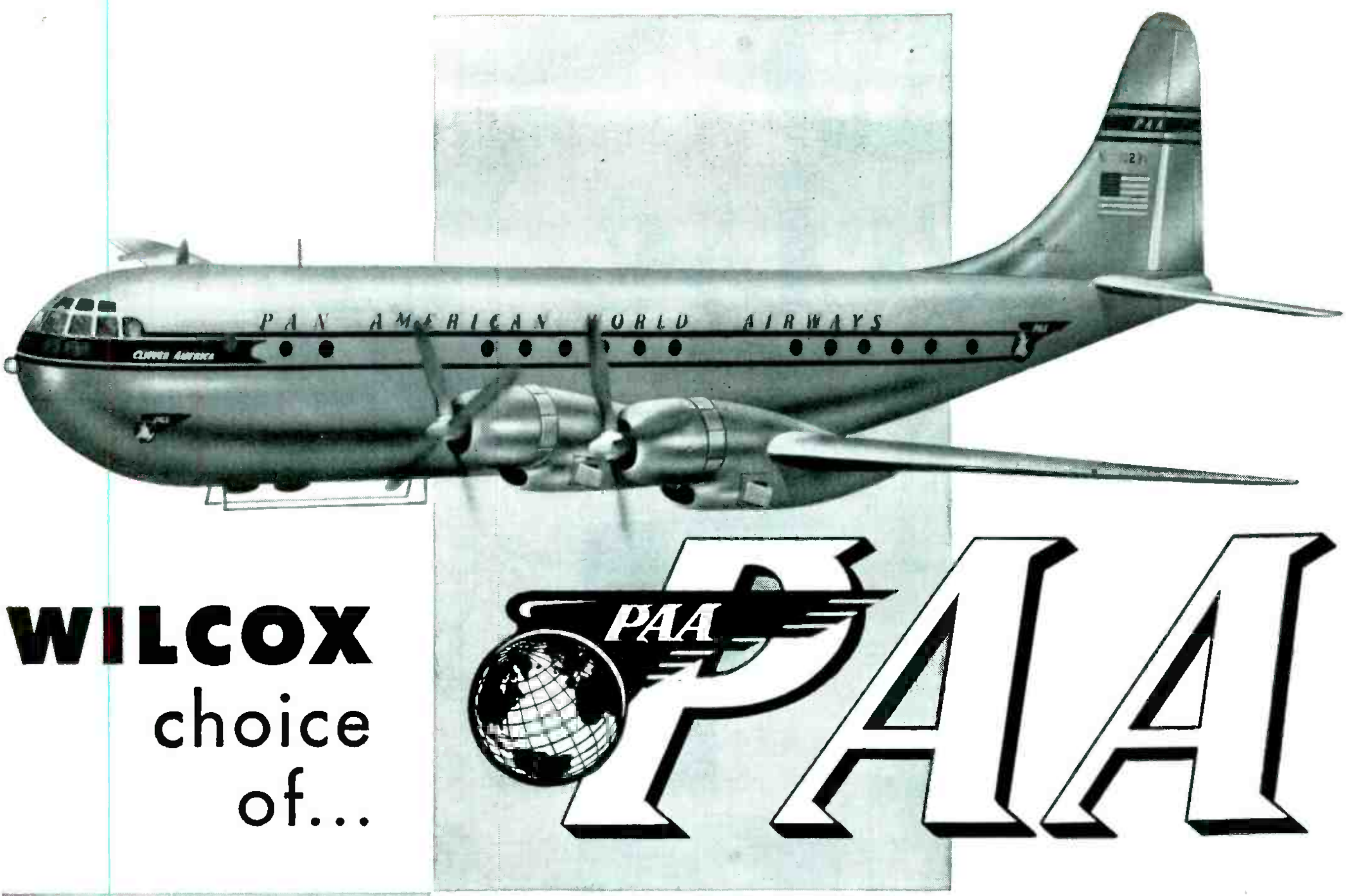

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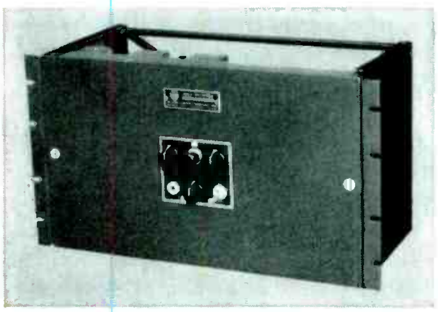

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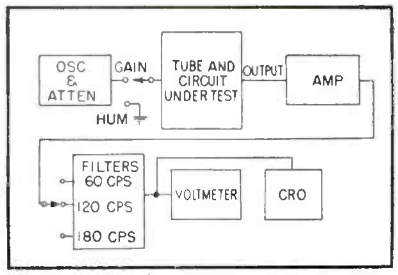


FIG. 1—Block diagram of the complete heater-hum measurement system

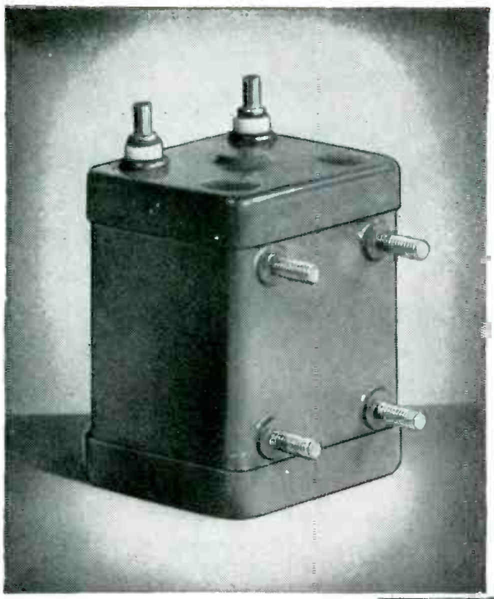
and-circuit combinations may give heater-hum levels of more than 500 microvolts, however.

Eleven tube types, in various circuit arrangements, have been studied so far in a National Bureau of Standards investigation. Included were single triodes 6F5 and 6SF5; dual triodes 6SL7, 7F7, and 5691 and pentodes 6J7, 6J7G, 6J7GT, 6SJ7, 5693 and 6SH7.

Circuits were varied with respect to cathode bypass capacitance, heater-return tie point, heater-return potential and grid-circuit resistance. The cathode resistor was either bypassed with a 50-μf capacitor or left unbypassed. Input grid resistance was either zero or 0.5 megohm. The heater return was either to one side of the heater or through the adjustable arm of a 100-ohm potentiometer placed across the heater supply and adjusted for minimum 60-cycle output. Heater return potential was either to ground, to 45 volts positive or to 45 volts negative. Hum measurements were made with various combinations of these circuit variations.

In the test setup, the 60, 120 and 180-cycle hum components of the output of the amplifier under study were measured on a vacuum-tube voltmeter, see Fig. 1, using appropriate amplification and filtering. At the same time, wave form was observed on a cathode-ray oscilloscope. Gain was measured by applying a known signal to the grid of the test amplifier, hum level could then be expressed in terms of equivalent microvolts at the grid. Provision was made for switching from a-c to d-c heater supply for calibration and comparison.

To obtain the desired measurements of heater-induced hum, external a-c hum was reduced to a negligible value, using recognized shielding precautions. Heater leads



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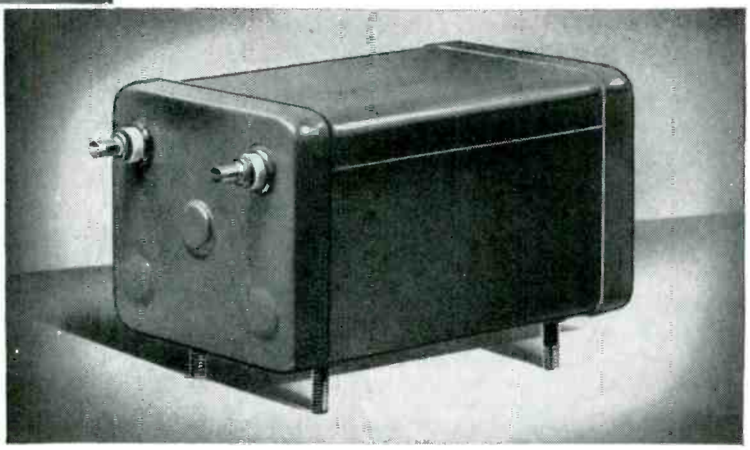

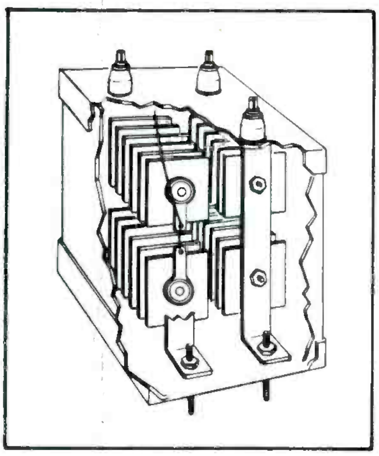

Cutaway view of typical internal mounting arrangement of a multiple stack, hermetically sealed rectifier assembly.

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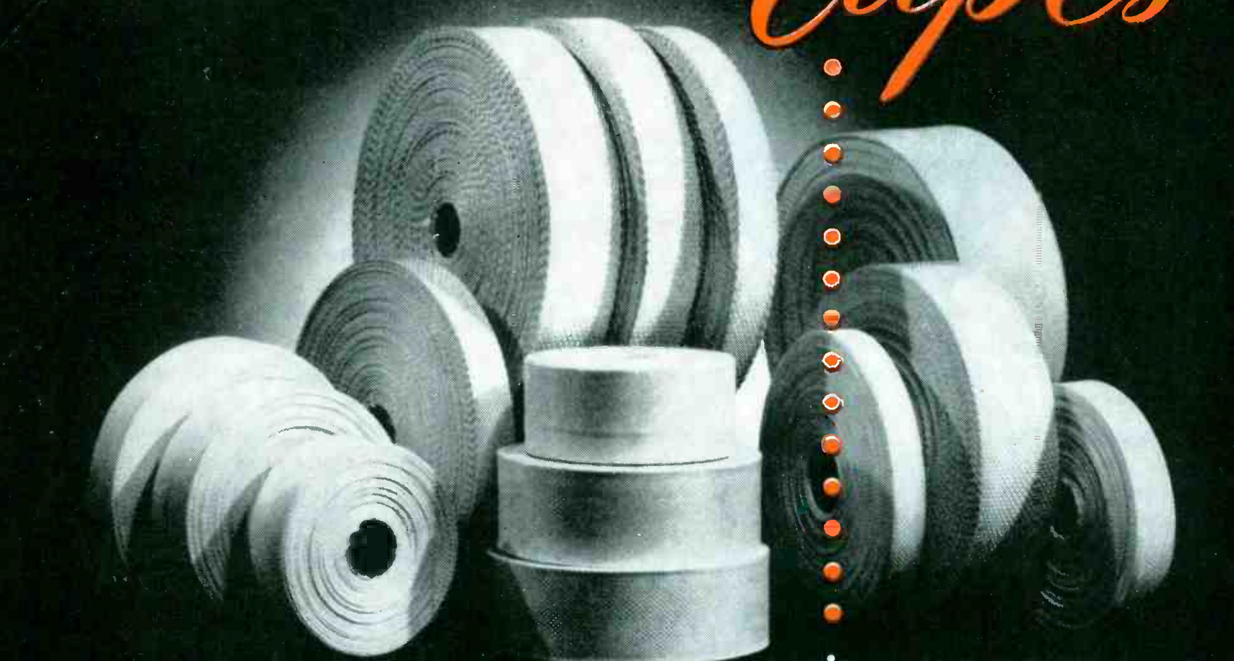

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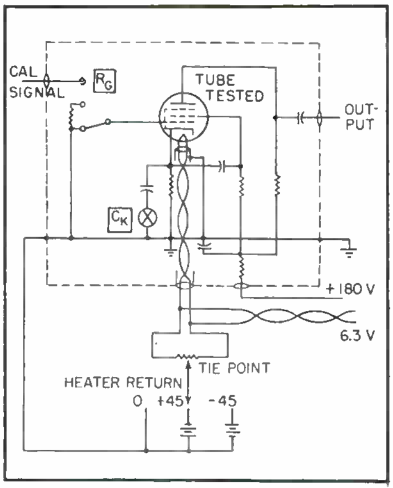


FIG. 2—Typical low-level amplifier circuit used

were twisted, Fig. 2, and shielded and kept away from the grid circuit, which was also shielded.

Preliminary checks indicated that hum is not significantly affected by the usual variations in components—plate, screen and cathode resistors and cathode and screen bypass capacitors required to match different load impedances.

The most hum-free amplifiers so far investigated used either of several triodes (6F5, 6SF5, 7F7 or 5691) or a pentode (5693) in a circuit including bypassed cathode, heater grounded through an adjustable potentiometer and low grid impedance.

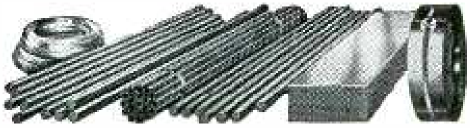
Wide hum differences were found for different tube types as well as for different circuit arrangements. Apparently, however, the 60-cycle equivalent input hum of almost any tube type tested, whether triode or pentode, can be reduced to 10 microvolts by suitable circuitry. All of the triodes tested could be brought below two microvolts.

The 60-cycle components were measured because of their importance in low-level power-frequency amplifiers often required in instrumentation applications.

High Fidelity with Small Enclosures

A NEW development in speaker-enclosure design recently demonstrated shows promise as a small and economical loudspeaker system faithfully reproduce bass fundamental notes down to 30 cycles.

The enclosure sizes used are



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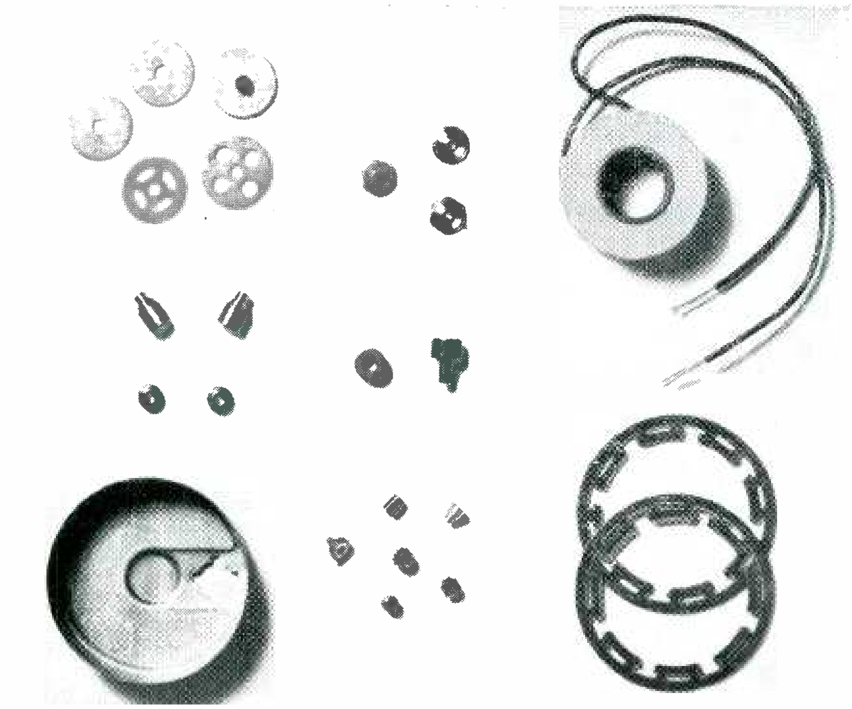
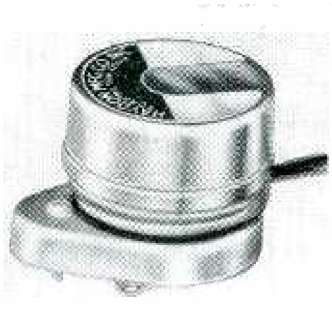


Gears, bushings, coil, motor cover, pinions and copper shading rings used in 400-cycle synchronous timing motor.—Courtesy Haydon Mfg. Co., Inc., Torrington, Conn.

Synchronous Timing Motor Designed for 400-Cycle Current

The use of 400-cycle current by the military and industry for many types of servo mechanisms and in communications systems brought about the design and manufacture of the illustrated synchronous timing motor.

The motor is used in time delay relays, elapsed time indicators, potentiometer controls, and sequence, interval and repeat cycle timers. Many other special timers have been or are being developed to utilize this motor.



Synchronous timing motor.—Courtesy Haydon Mfg. Co., Inc., Torrington, Conn.

Only frequency control is necessary to insure accurate timing since the motor is not affected by variations in temperature, altitude, supply voltage and load within the operational limits of the motor itself.

Self-Starting Insured

The motor is essentially two phase with two coils, cores and interlacing field pieces. To insure self-starting, a capacitor is put in series with one coil, thus giving this coil a leading flux effect.

Copper Alloys Widely Used

As in all electric motors, copper and copper-base alloys are widely used not only for their electrical characteristics but for corrosion resistance and ease of working or machining.

The motor cover is cartridge brass (70% copper and 30% zinc) which can be readily worked, has good corrosion resistance and a tensile strength of 76,000 psi in the hard-drawn condition. The cover is cupped, drawn and trimmed, then stamped with the company name and other information.

Since shading rings must have high electrical conductivity, electrolytic tough pitch copper 99.9% pure is used because of its 98-100% conductivity.

Self-Lubricating Bearings

Rotor bearings are of graphite bronze, which was selected for its self-lubricating properties. However, for the output bearing where long life and strength is demanded under comparatively heavy loads, commercial bronze is the choice. This alloy contains 89.5% copper, 8.5% zinc and 2% lead, which increases the machinability considerably. Many standard gear combinations are available to give varying output speeds depending on the timing involved.

Wheels of Clock Brass

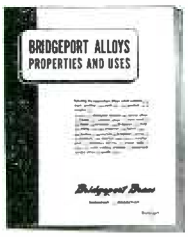
The wheels (gears) are made from clock brass (66% copper, 2% lead, and remainder zinc). The lead helps to eliminate burrs in machining the gear teeth and in blanking and piercing the wheels. Since the lead exists in the metal as small globules, some lubrication is obtained as the lead is burnished over the surface of the teeth while in operation.

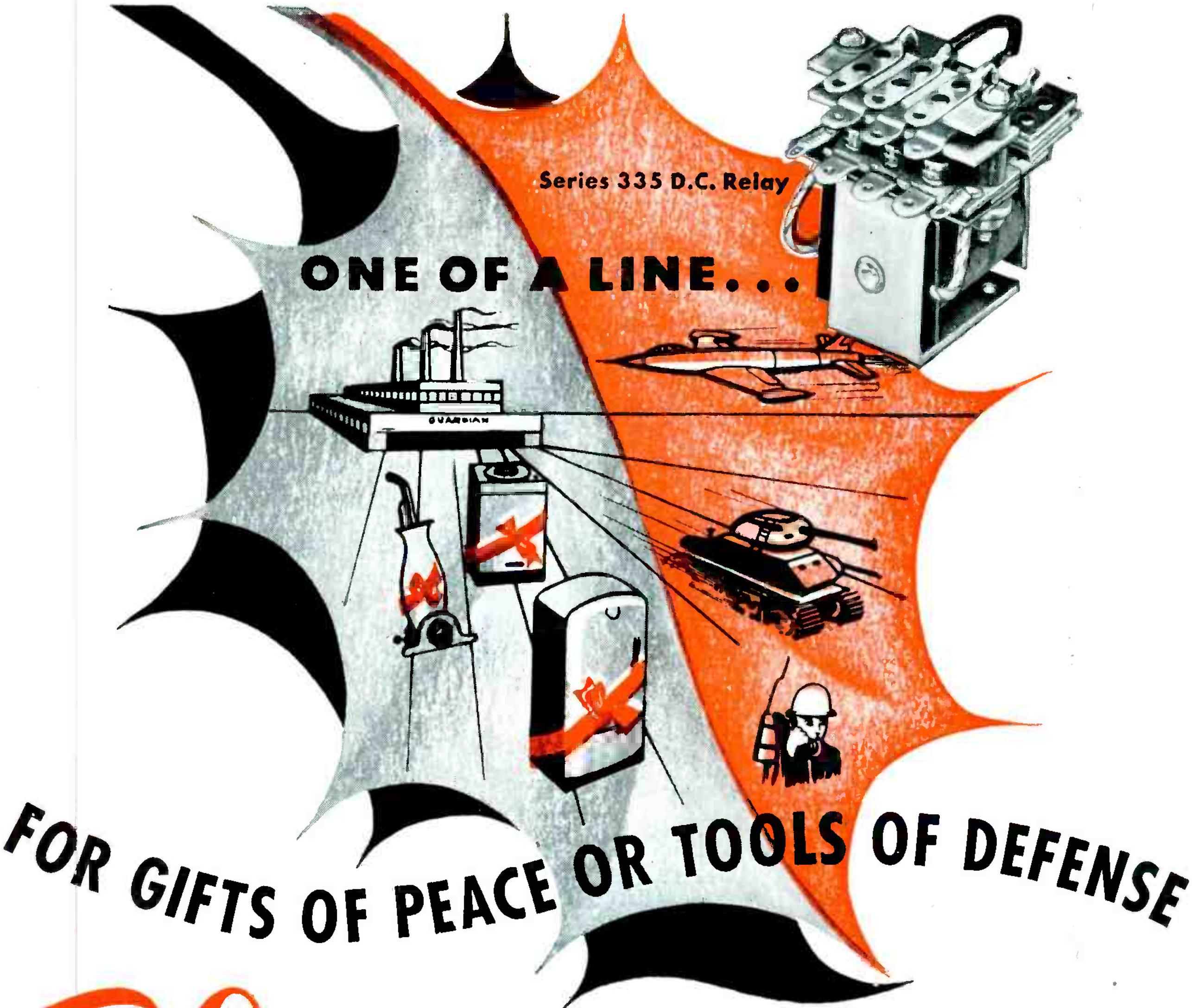
Two alloys are used for the pinion gears depending on the load put on them.

Free cutting brass rod (61% copper, 3.4% lead and remainder zinc) permits clean drilling and machining of the pinions and gives long life under relatively light loads. When the loads are greater, a leaded phosphor bronze is utilized. (7496)

New Publication Available

"Bridgeport Alloys—Properties and Uses"—new 4-page folder designed to help the metalworking industry and other fields to distinguish between copper base alloys. Lists 65 commonly used Bridgeport alloys, their composition, properties, forms and typical uses. Write to our Sales Promotion Service.





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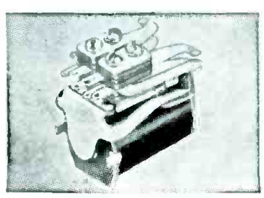
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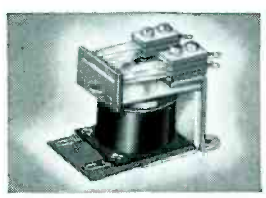
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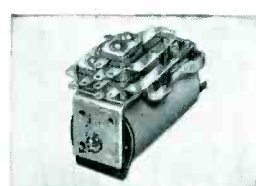
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GUARDIAN ELECTRIC

1625-P W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY barely larger than the speakers they contain. A floor enclosure, measuring 18 by 18 by 18 inches and using a two-way system with flush-mounted tweeters and a 12 or 15-inch speaker has been developed. Also, a corner enclosure measuring 24½ by 24 by 16 inches with the same speaker has been developed. Here, the 16-inch measurement is made from the corner directly out to the edge of the front of the enclosure. An eight-inch speaker in about the $13 price range was mounted in an enclosure measuring 14 by 14 by 10 inches.

The standard model enclosure demonstrated will take either 12 or 15-inch speakers without any alteration of overall size. The lower frequency response is limited solely by the speaker itself and not the enclosure. Both two-way and single speaker systems have been tested and coaxial speaker systems are under test with equally good results possible.

Back waves from the speaker are completely absorbed within the cavity so that there are no reinforcements or cancellations upon the front wave. The front wave feeds through a specially designed acoustic loading chamber and exits through a slot arrangement. The combination of front and back pressure on the speaker cone is dynamically balanced to provide ideal damping and transient response.

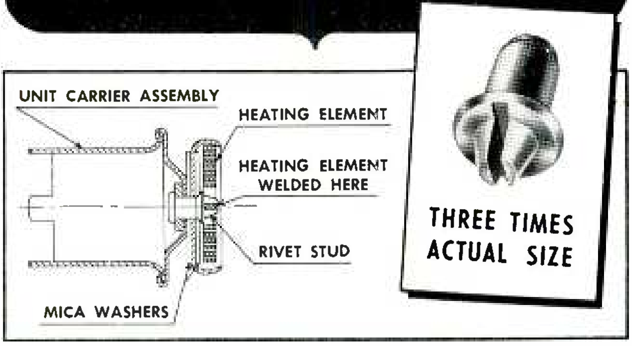
Quick-Acting Optical Shutter

By J. H. JUPE
Middlesex, England

A FAST optical shutter developed in Britain uses a photoelectric image converter. The image of an electronic flash tube is focused onto the photo-cathode of the image converter and the electron image from the cathode is focused magnetically onto a fluorescent screen, where the image of the flash tube is made visible.

The electron image may be interrupted at high speed by means of a negative bias applied to one of the electrodes of the image converter. Superimposing a short positive pulse on the electrode will restore the image but only for the duration of the pulse, which may be as short as one microsecond.

RUGGED LITTLE RIVET HAS TWO BIG JOBS



Small enough to put under your fingernail, this rivet is made by Progressive for The Cuno Engineering Corporation. Used in an automotive cigarette lighter, it serves as a post to which the center of the heating coil is spot welded and as a rivet for fastening the burner cup to the lighter shell.

This double function required precise upsetting of a metal sufficiently soft to be used as a rivet, yet rugged enough to withstand the welding operation.

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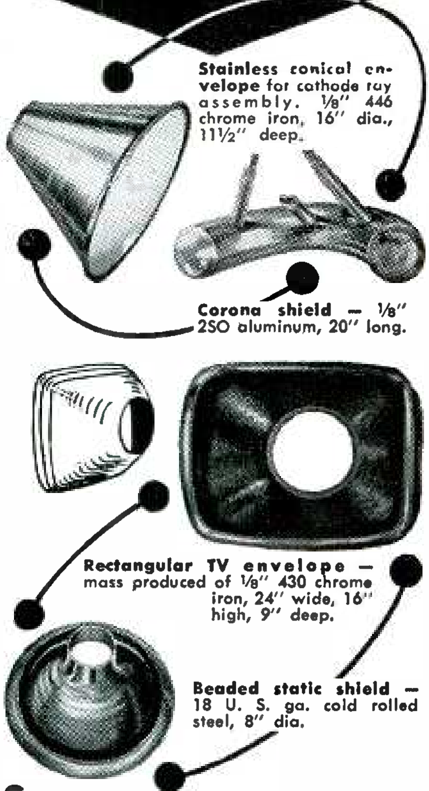

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THE ELECTRON ART

(continued from p 142)

grid. Whether directly connected, for d-c measurement, or through a rectifier for a-c, this is not good enough for general use.

The operating conditions for low output resistance are exactly opposed to those for low input conductance, so to attain a high standard of performance it is necessary to use separate input and output tubes. It can be accepted also that a balanced system is desirable for stability of zero, so altogether four tubes are needed for the d-c "resistance transformer". The design of the rectifier system needed for a-c measurements is not considered here; it can be conventional.

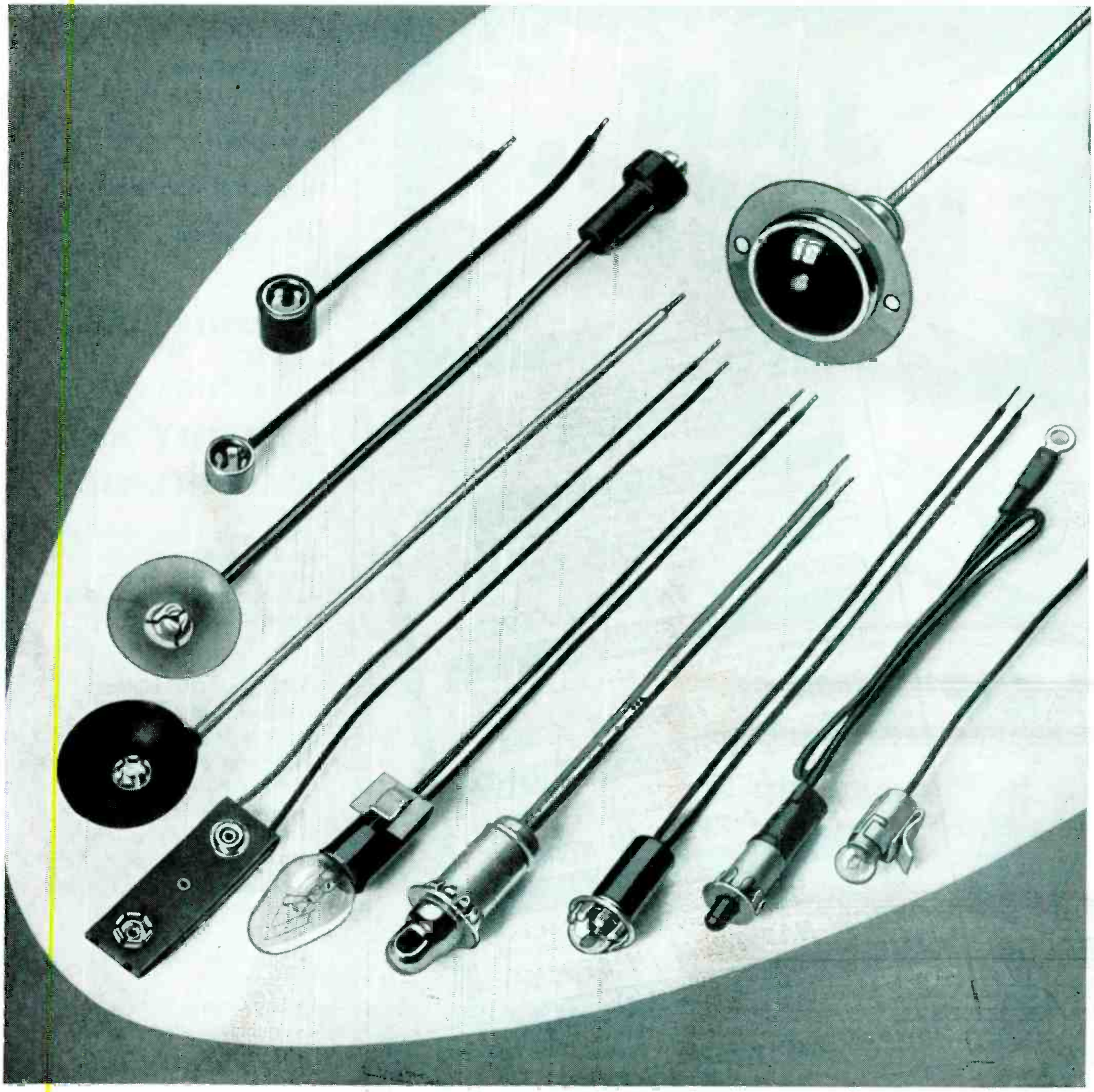
By adopting stabilized power supply technique, the output resistance can be brought far nearer the ideal zero than in conventional circuits. Figure 2 shows the schematic, in which V_i denotes the voltage to be measured. With the V_i terminals short-circuited, V_1 and V_2 can be recognized as forming a stabilizing system keeping the voltage across R_1 constant, and V_3 and V_4 similarly keep the voltage across R_3 constant. A good approximation to the total output resistance between the cathodes of V_1 and V_3 is

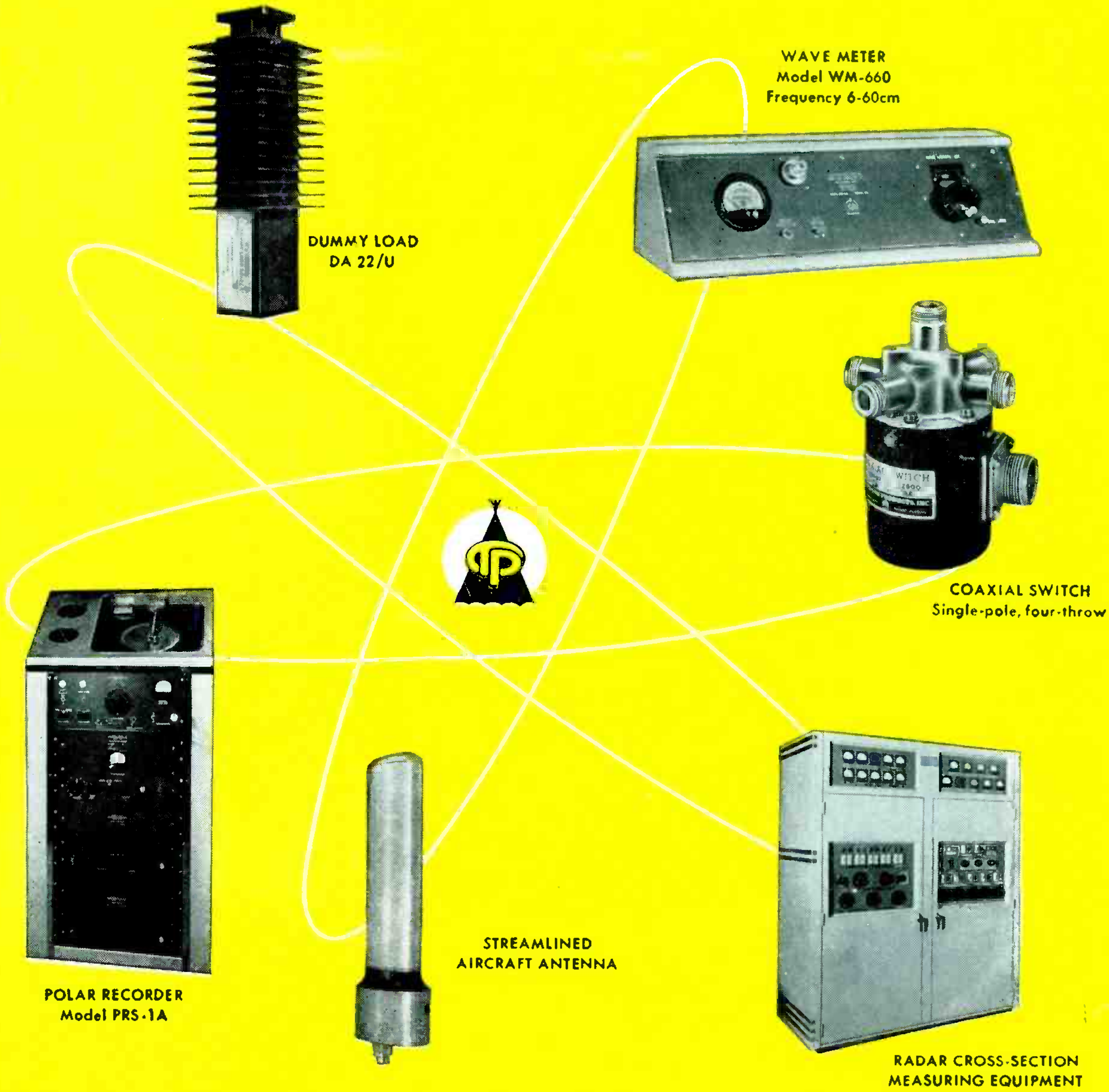
$$R_o \simeq \frac{2}{m\, g_m}$$

where m is the voltage gain from the grid of V_2 to the grid of V_1 (and V_4 to V_3) and g_m is the transconductance of V_1 (and of V_3). Tubes V_2 and V_4 are chosen for low input conductance and high gain, and these are not incompatible requirements. With suitable tubes, m may be over 100 and g_m over 0.005 mho, making R_o less than 4 ohms, which can usually be neglected.

Complete Circuit

In a practical circuit it is necessary to provide positive voltage for V_2 and V_4, and the potential-divider method shown in Fig. 3, although it throws away nearly half of m, has proved very satisfactory. With the tubes, component values, and supply voltages specified in Fig. 3, the system limits at $V_i = 65$, positive or negative, giving a margin for falling supply-line voltage and tube characteristics above the top





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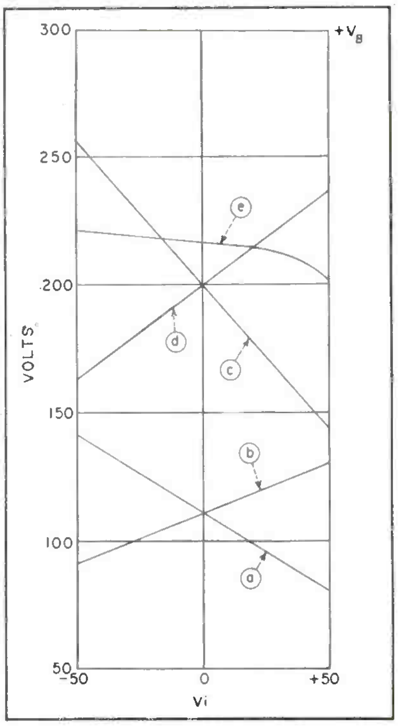

FIG. 4—Diagram showing the potentials of the correspondingly lettered points in Fig. 3 over the full range of input voltage. Differences in voltage between points with the same letters are neglected

range of 0 to ±50 volts. The limiting tube is V_2 for both positive and negative V_i; positive is limited by low plate voltage and negative by plate-current cutoff. Up to cutoff there is no perceptible departure from linearity.

The meter itself is a rugged 0 to 3-ma instrument and the characteristics of the circuit limit the possible current through it to a little above full-scale reading. The measured output resistance of the tube system is 4 ohms, so this relatively heavy-current meter lowers the terminal voltage between the cathodes of V_1 and V_3 less than 1 percent even at full-scale on the lowest (1.5-volt) range; and this small error can be entirely removed by the resistors R_6 and R_7, which slightly raise the output voltage, making it exactly equal to the input voltage V_i. Zero set R_7 adjusts the balance between V_1 and V_3.

Four ranges, 1.5, 5, 15 and 50 volts, are obtained by the usual switched series resistors; in fact, any multirange d-c voltmeter taking not more than 3 ma at full scale can be used in conjunction with the tube system up to 50 volts. There should, of course, be a meter-

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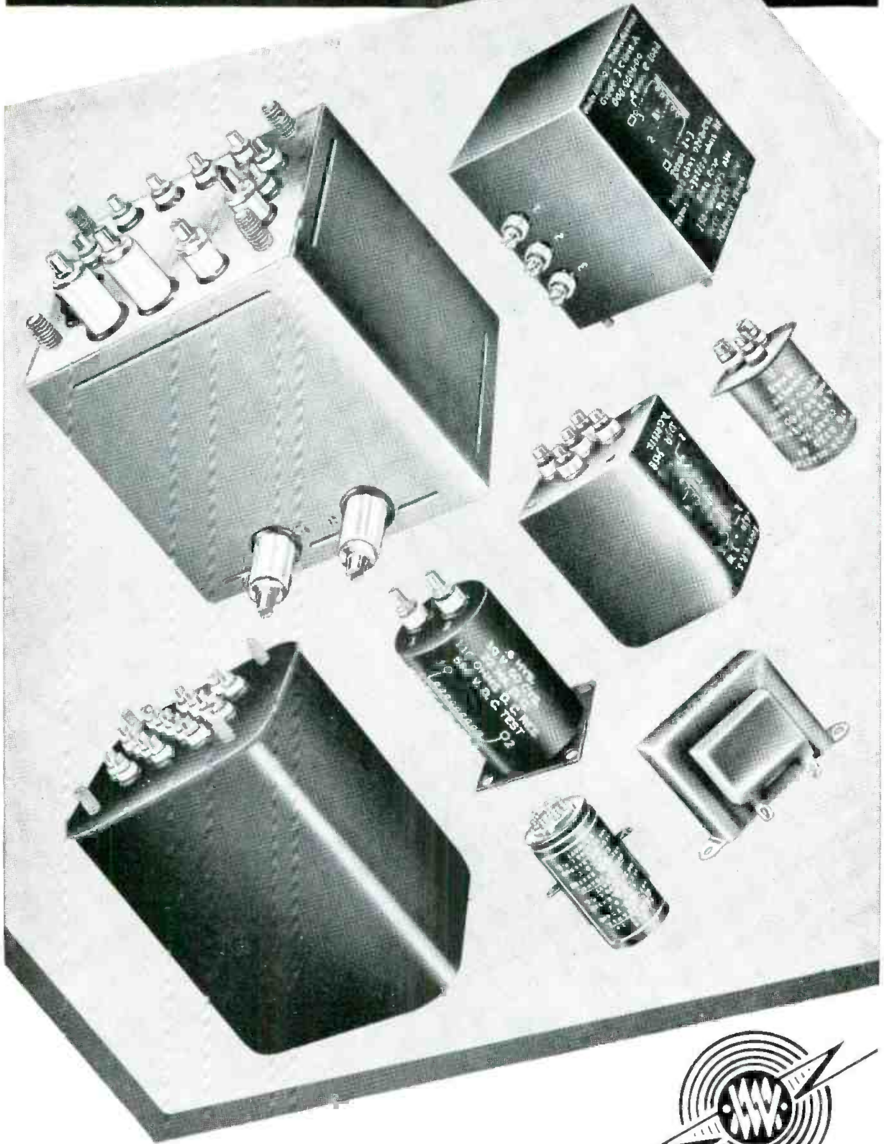

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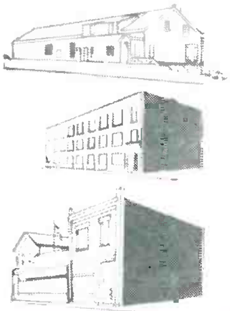

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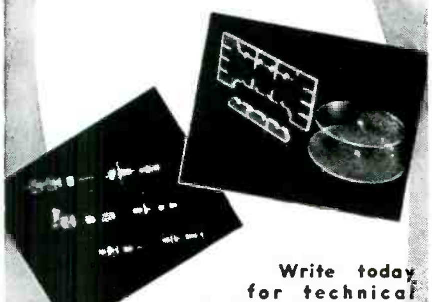

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reversing switch if both negative and positive voltages are to be measured. Higher ranges are obtained by a high-resistance input potential divider. The system should be checked to show no appreciable response to the insertion of say 20 meg in series with V_i at any voltage up to ±50.

The SP61 tubes specified could no doubt be replaced by 6AC7 or even 6J6 types, and the EF37A by 6J7's selected for low grid current. It helps to reduce grid current if the heater voltage for V_2 and V_4 is reduced to about 5.3 volts.

Proof of Performance

The insensitiveness of the system to tube characteristics has been strikingly demonstrated by paralleling a second tube with V_1 (or V_3). In spite of this unbalancing, and without any readjustment, the zero shift was no more than 0.004 volt, and as this was constant all over the scale there was no perceptible change in calibration. Results were similar with a drop of 10 percent in B+; and a drop of 10 percent in heater voltage caused 0.01-volt zero shift and no perceptible calibration error. Paralleling a second tube with V_2 or V_4 causes a relatively large zero shift (0.61-volt) but this test is far more drastic than any reasonable working conditions, and even so the calibration shift was negligible.

Under ordinary working conditions the zero is exceptionally stable. Provided that the zero is checked, the accuracy of the instrument for direct voltages can be

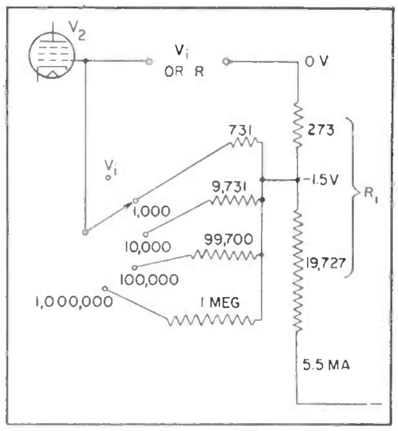

FIG. 5—Ohmmeter circuit, applicable to Fig. 4, for mid-scale readings of 1, 10, 100, and 1,000 kilohms

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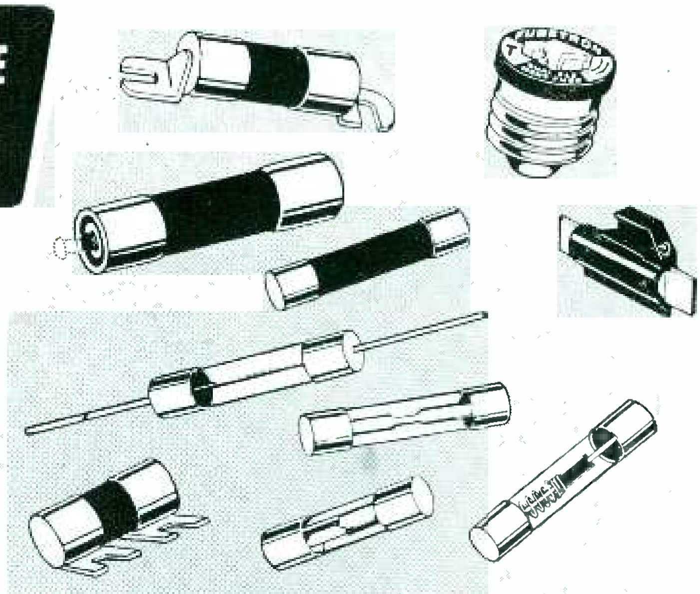

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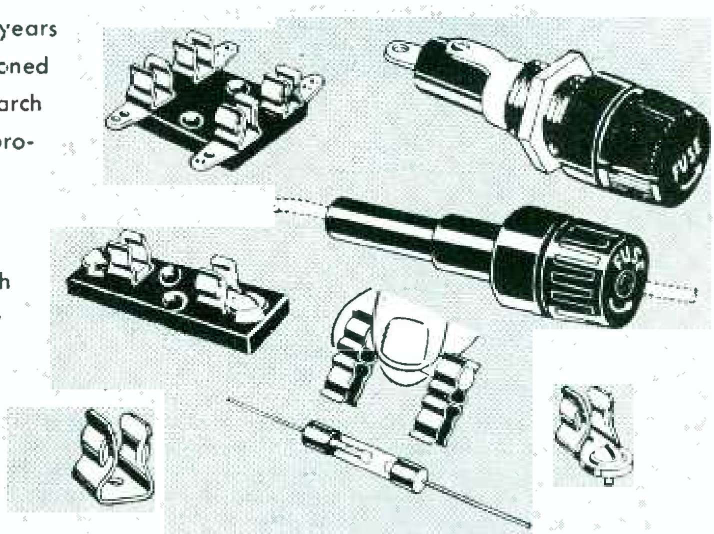

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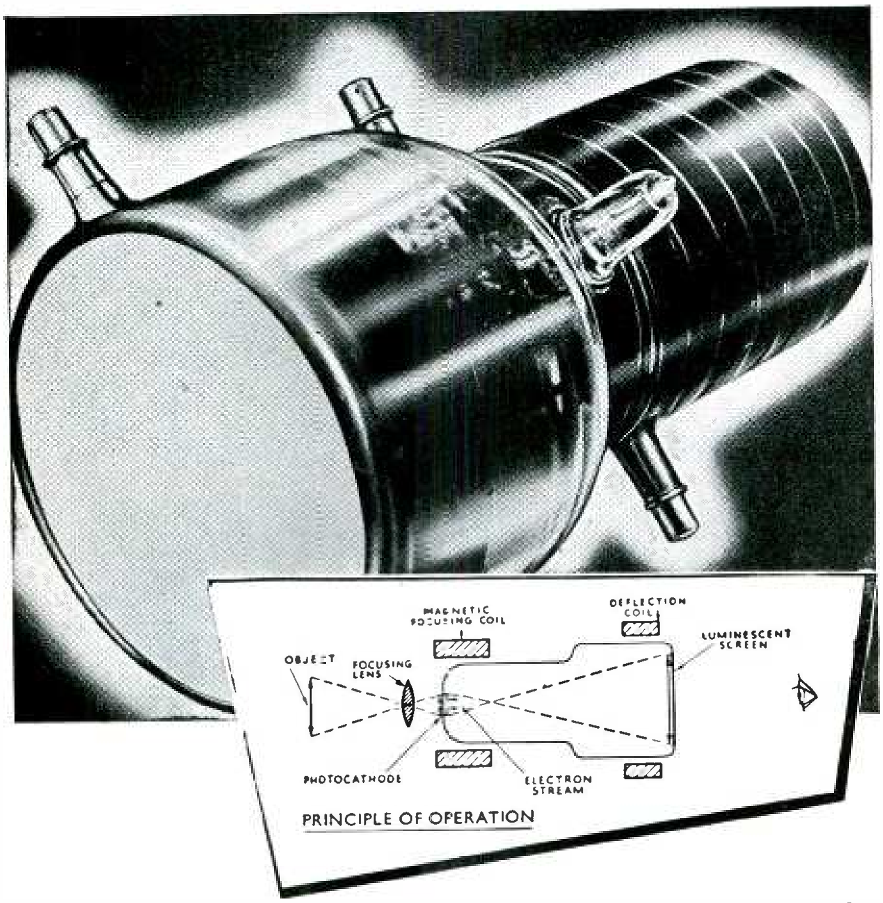
HOW FAST IS 2×10^{-8} second?



In 2×10^{-8} second light travels just about 6 metres. At something less than that speed you can take a photograph with a Mullard image converter tube. These new devices are the world's fastest electronic camera shutters. Pulsed to exposures in the order of 1/100 microsecond they out-perform Kerr cells by a factor of ten, and the best available flash tubes by more than fifty.
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PRINCIPAL CHARACTERISTICS OF MULLARD IMAGE CONVERTER TUBES

	ME1200	ME1201	ME1202
Description	Diode converter	Grid controlled converter	Diode converter
Maximum anode-cathode voltage	6 kV.	6 kV.	6 kV.
Linear magnification of image	3 times	3 times	1
Screen diameter	4"	4"	1"
Screen resolution	200 lines/cm.	200 lines/cm.	200 lines/cm.

These tubes are available with various screen materials and photocathodes.

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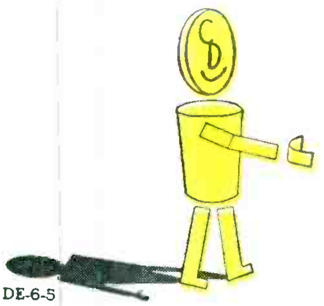

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Further Refinement

The type of tube circuit described lends itself well to the usual electronic test-meter facilities for measuring resistance, as the negative operating voltage can be tapped off R_1. The effective source resistance of this voltage is

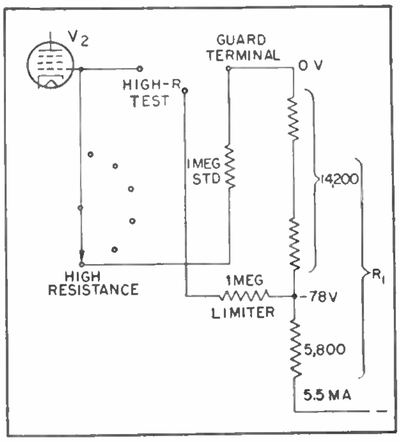

FIG. 6—Three-terminal measurement circuit for high resistance (50 to 1,000 megohms) applicable to Fig. 4

equal to the two parts of R_1 in parallel, and this must be subtracted from the standard resistance for the range.

For example, if R_1 is 20,000 ohms and carries 5.5 ma, the tapping for 1.5 volt is 273 ohms from the top. This in parallel with the remaining 19,727 is 269 ohms, which sets a lower limit to the midscale resistance of the ohmmeter. Figure 5 shows the values for mid-scale resistances of 1, 10, 100, and 1,000 kilohms. Insulation leakage from 50 meg to about 1,000 meg can be

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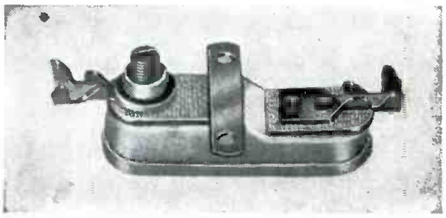

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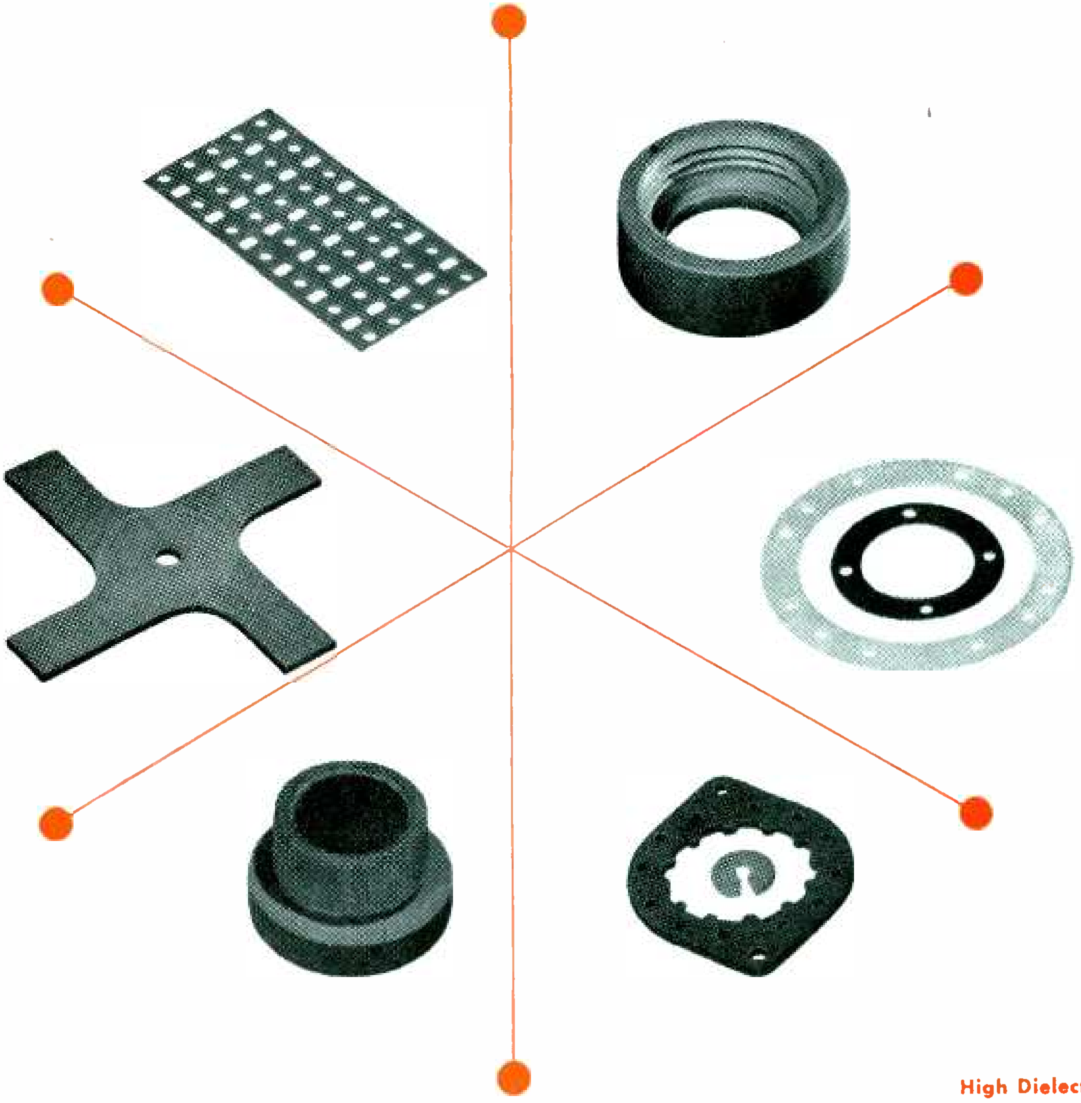


measured if there is an additional tapping on R_1 at −78 volts, as in Fig. 6. The low-potential V_1 terminal can then be used as the guard terminal to exclude undesired leakage effects.

Barium Titanate Delay Lines

By Leonard M. Orman,
Lt. Col., U. S. Army
and
Leslie G. Callahan
Capt., U. S. Army
Fort Bliss, Texas

Unusual properties of barium titanate were noticed about ten years ago, and since that time, considerable research has been directed toward its further investigation, as indicated by the bibliography at the end of this article.

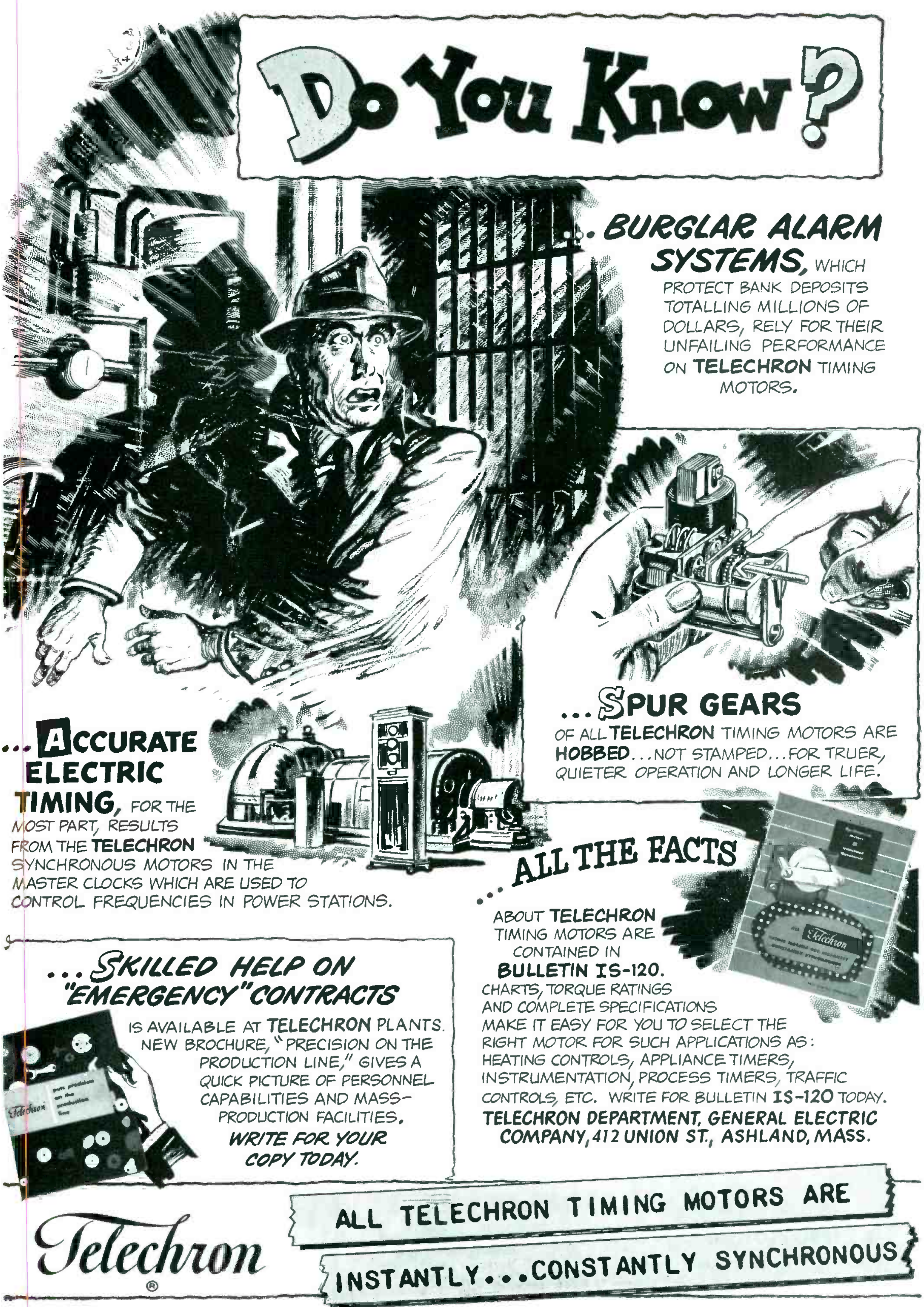
Advantages of this material are that it is easy to work, may be molded into many different shapes, may be polarized in any desired direction, has a large electromechanical coupling factor, and is quite stable in its properties at ordinary temperatures.

A mechanical wave can be induced to travel down a piece of barium titanate upon the application of an electric field across the specimen, providing the sample has been polarized under the electrodes. Here then exists the possibility of a solid delay line without electromechanical transducers. Research into this subject revealed that at least three research groups had given thought to the problem, but none has come up with anything concrete or conclusive. The authors thus felt justified in launching an additional venture on a small scale, without great risk of duplication of previous efforts. A brief description of the experimental procedures followed and the results obtained therefrom is given in the following.

Preparation of Samples

A summary of the technique developed for preparing a thin sheet of barium titanate for use as a delay line is given in the following steps:

(1) Cut Scotch tape into strips $\frac{1}{8}$ inch wide. On a thin sheet of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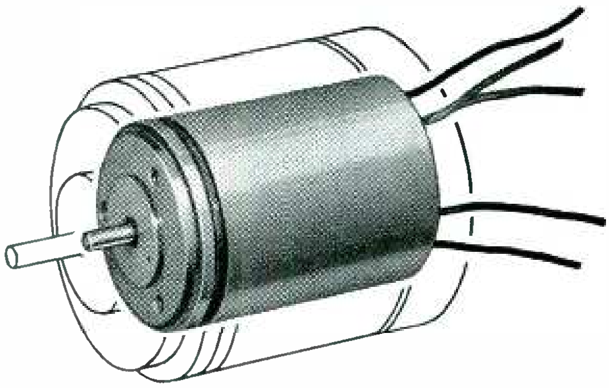

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Frequency	400 cycles	400 cycles	400 cycles
Current	88 milliamperes	110 milliamperes	55 milliamperes
Power	0.8 watts	1.2 watts	0.9 watts
Impedance	105+j280 ohms	100+j220 ohms	290+j370 ohms
OUTPUT			
Voltage Max. (rotor output)	17.9 volts	16.2 volts	14.1 volts
Voltage at null	40 millivolts	40 millivolts	40 millivolts
Sensitivity	310 millivolts/degree	280 millivolts/degree	245 millivolts/degree
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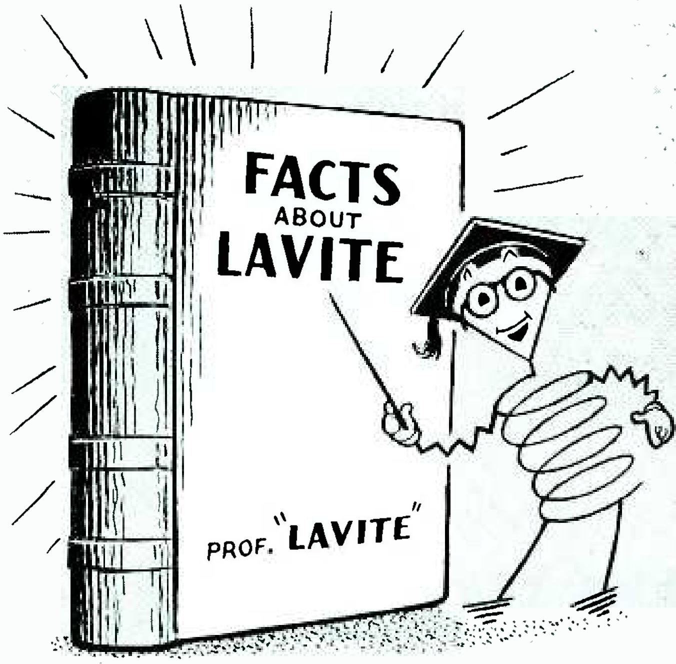

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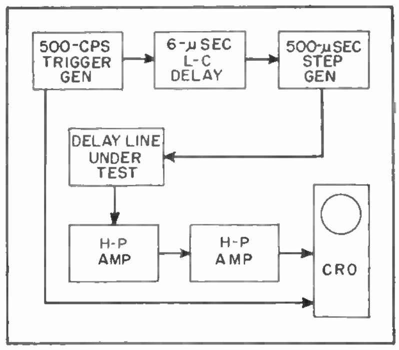


FIG. 1—Block diagram of delay line test setup

presilvered barium titanate place the strips of tape around the inside of the perimeter and across the sheet where it is desired to have the lines separating the electrodes from the central shield. This is done on one side only. Melt paraffin in a glass dish. Immerse ceramic sheet completely in the paraffin. Remove tape from ceramic while wetting with water.

Place the specimen below the surface in a dish of concentrated nitric acid. Remove after twenty minutes and wash with cold water. Scrape any unwanted residual silver from surface of ceramic with a razor blade. Soak sample in benzene until paraffin is dissolved. Extreme care must be exercised in the putting on and removing of the tape and in the scraping as these fragile sheets are easily cracked or shattered.

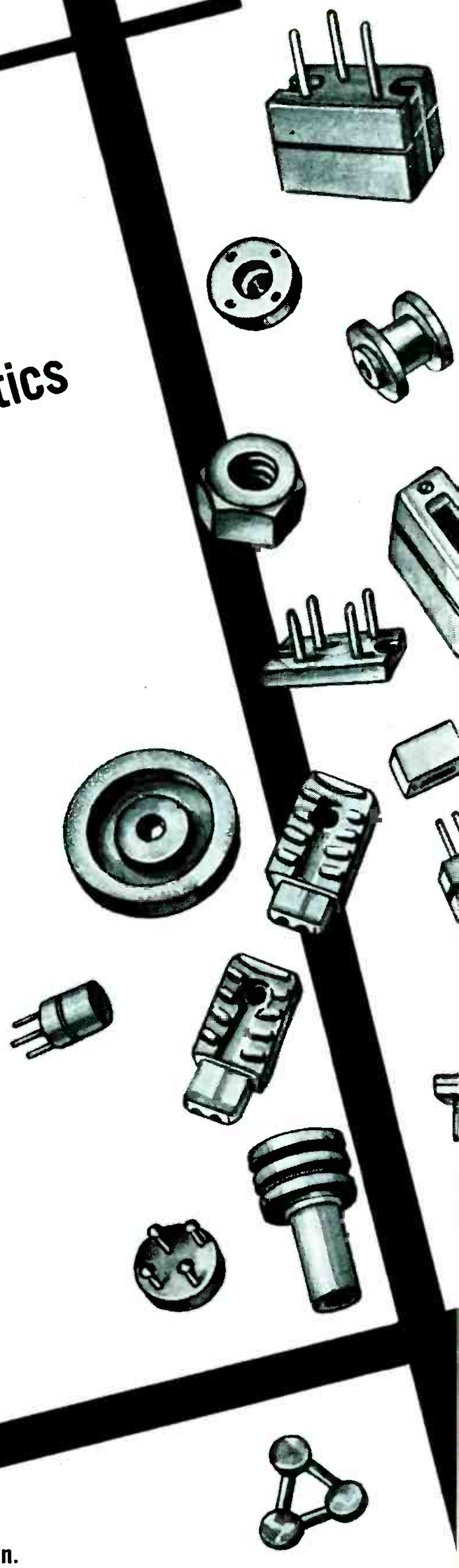
(2) Make a holder of wood for two pairs of spring relay contacts. With the contacts touching the electrodes at each end of the sample immerse the specimen in a castor oil bath previously heated to 130 deg C. Apply 300 volts d-c across the sample for one hour. Maintain the temperature of the oil at 130 deg C. Remove specimen and wash off oil.

(3) Cut sample into desired shape on a large diameter (16-inch) high-speed, glass cutter wheel with water playing directly on the sample.

Test Equipment

A block diagram of the test equipment is shown in Fig. 1.

The delay line can only detect the rise and fall of a rectangular pulse and discards the low-fre-



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Coefficient of Thermal Expansion 20°C—500°C—in./in./°C	0.063 x 10^{-6}	0.85 x 10^{-6}
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quency component. Due to this inherent characteristic the line should pass narrow pulses much better than wide ones. To drive the line with but one mechanical displacement, it is necessary to approximate a step function with practical circuits.

To measure delays of less than 1 μsec accurately an A/R Range Scope designed by Radiation Laboratory, M.I.T. is used. With this scope it is possible to read delays of 0.1 μsec without the use of external range markers.

A one-shot multivibrator was built to be triggered by a pulse delayed six microseconds from the start of the horizontal sweep on the scope. This allowed a clear picture of events occurring at the leading edge of the driving step. The pulse generator previously mentioned was used for basic synchronization.

The one-shot multivibrator circuit is shown in Fig. 2. The large capacitance of the input electrodes on the line necessitated a large sudden change of current to preserve the leading edge of the step voltage. Two 6Y6 power amplifier tubes in parallel are used as a cathode follower. This provides a high impedance to the multivibrator and a low impedance to the delay line.

The small 100-ohm resistor in series with the grid of each 6Y6 prevents oscillations with the sudden change in plate current. A frequency of 500 to 1,000 cps is used to trigger the circuit. Higher frequencies would increase the

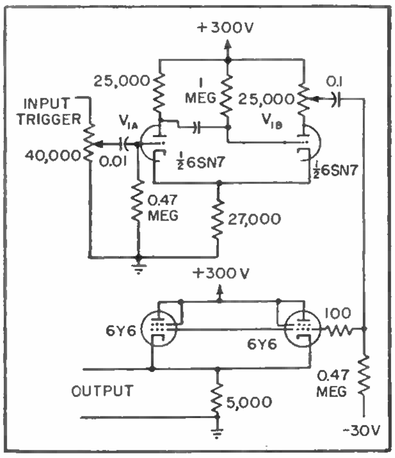

FIG. 2—Step generator used to excite barium titanate delay line

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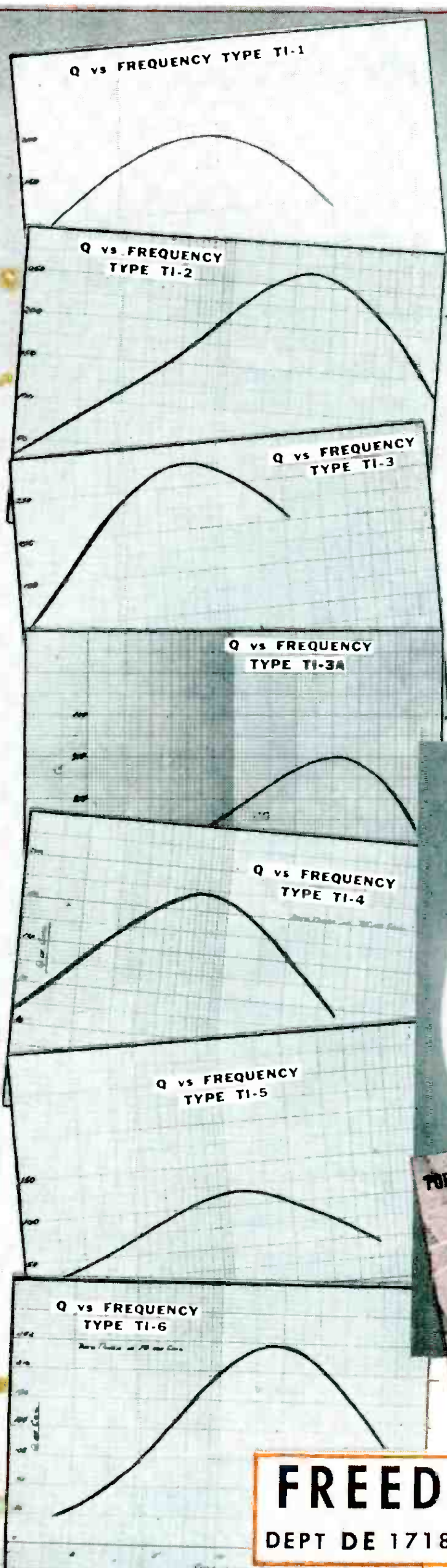

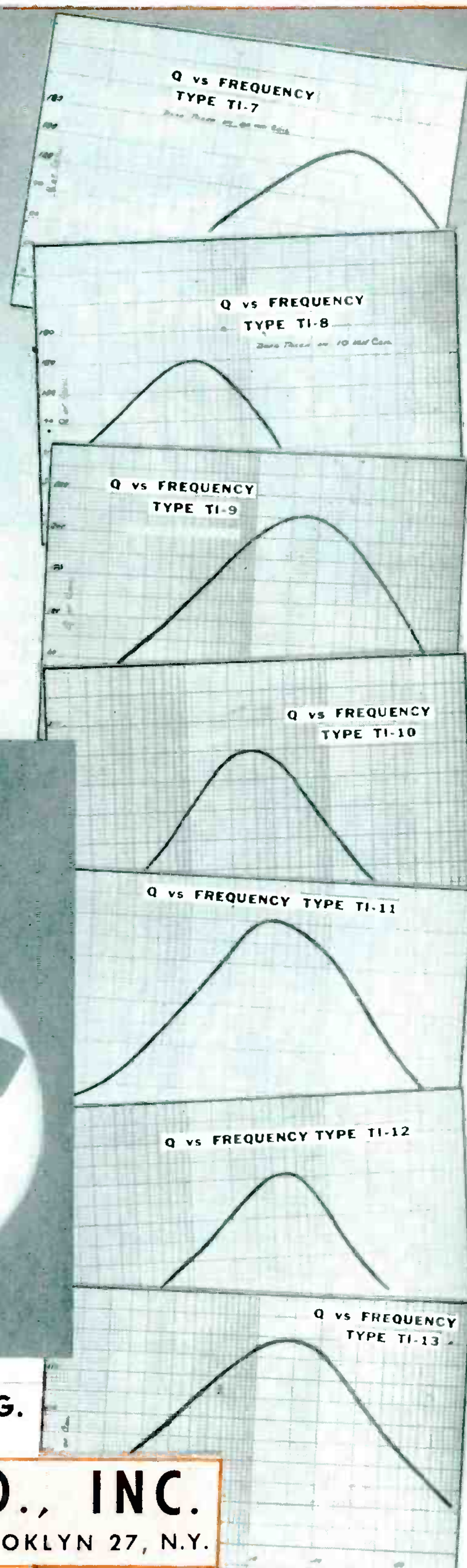

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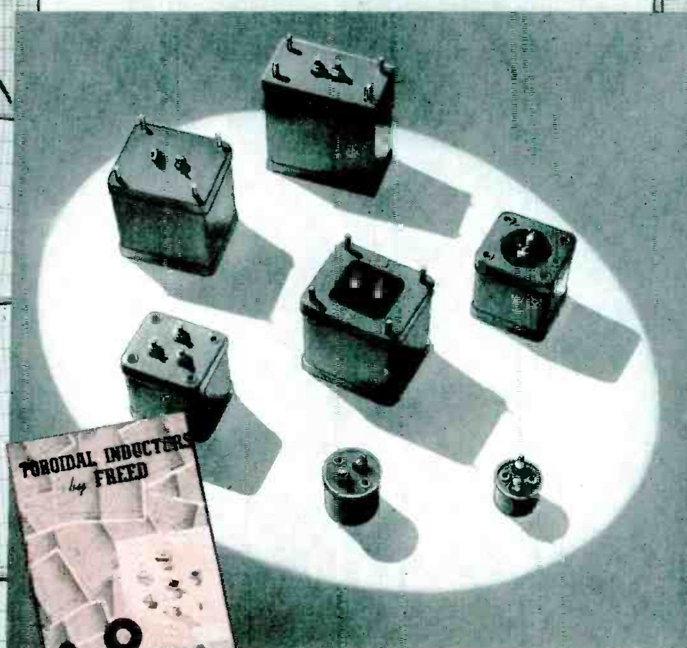

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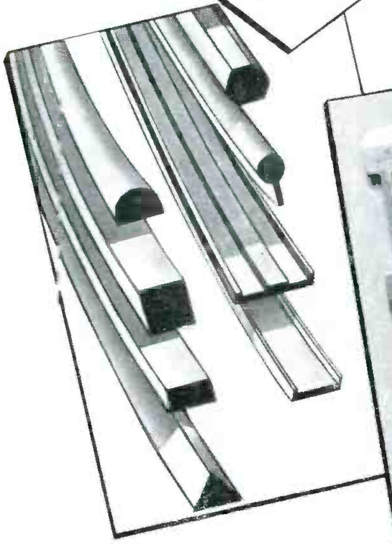

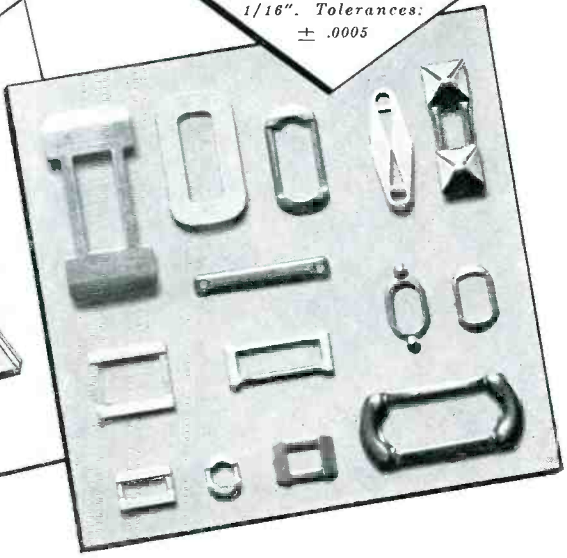

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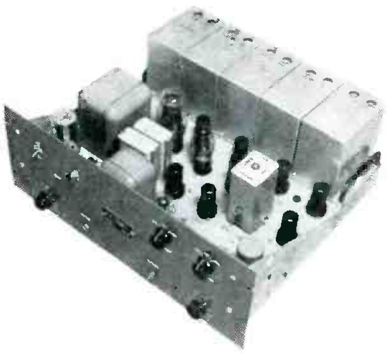

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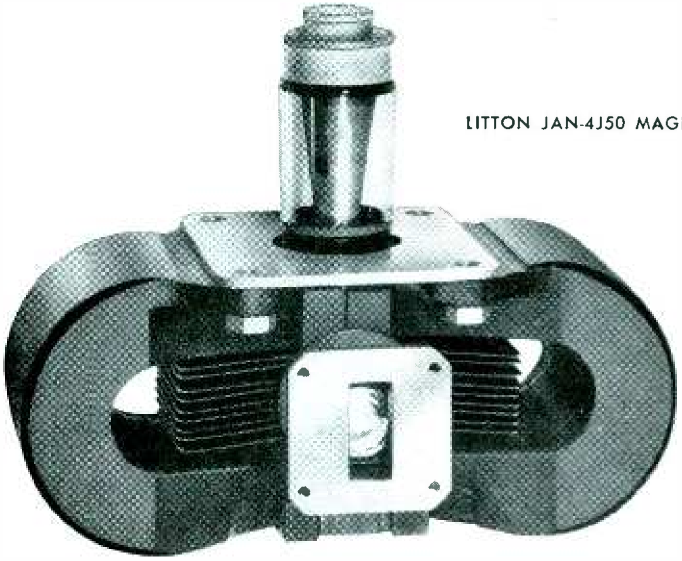

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duty cycle of the 6Y6's above normal operating condition.

The 25,000-ohm potentiometer allows an amplitude control of from 0 to 123 volts across the output. The leading edge of the output step arose from 0 to 123 volts in 0.5 μsec without the load and from 0 to 123 volts in 1.8 μsec with ¼ by ⅛-inch electrode.

Development of a Line

A step voltage (Fig. 3A) was applied to a sample bar (3½ × ¼ × ¼ inch) prepared in the above manner using relay contacts. The output voltage appeared on the oscilloscope not as a single pulse but as a long train of pulses (Fig. 3B) in much the same manner as reported by previous workers.

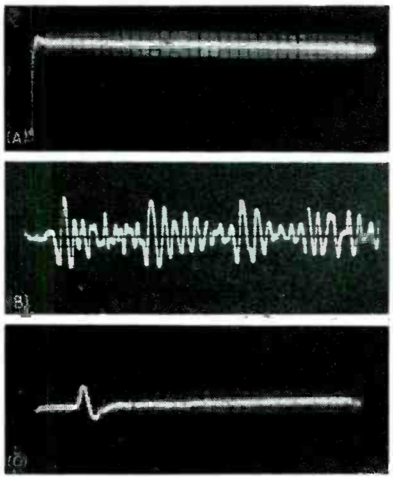

FIG. 3—Oscillograms showing result of simple damping

The same voltage was then applied to a thin sheet (3½ × 1½ × 0.01 inch) of $BaTiO_3$ prepared in the above manner. Less spurious modes and noises were noticed than in the case of the bar although the two samples were of the same length. The thin sheet was then reduced in width to one-quarter inch and similarly excited. Less spurious modes and noises were noted than in the case of the wider sample. The ends of the line were then tapered and again driven with a step function. The extraneous pulses were again reduced.

However, the problem still remained of distinguishing the direct pulse from the spurious modes and noises. It was thought that reflec-

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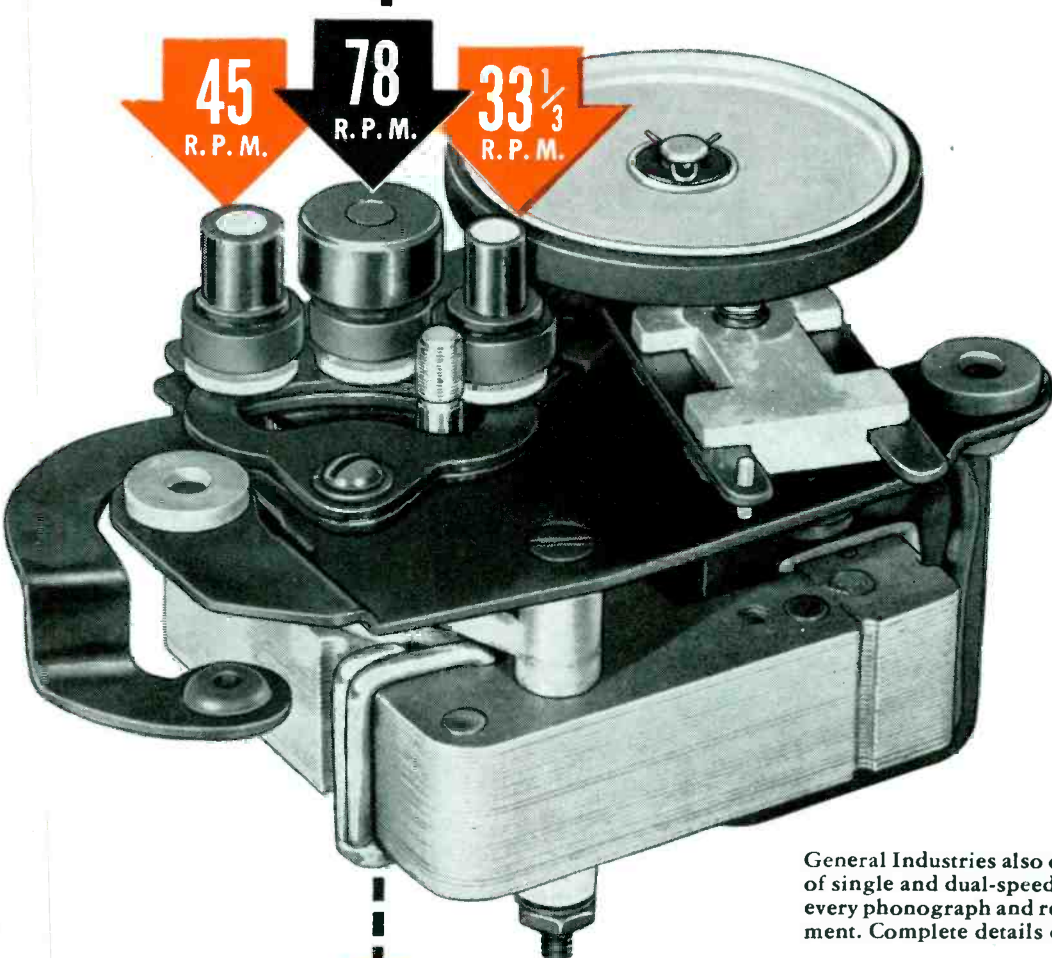

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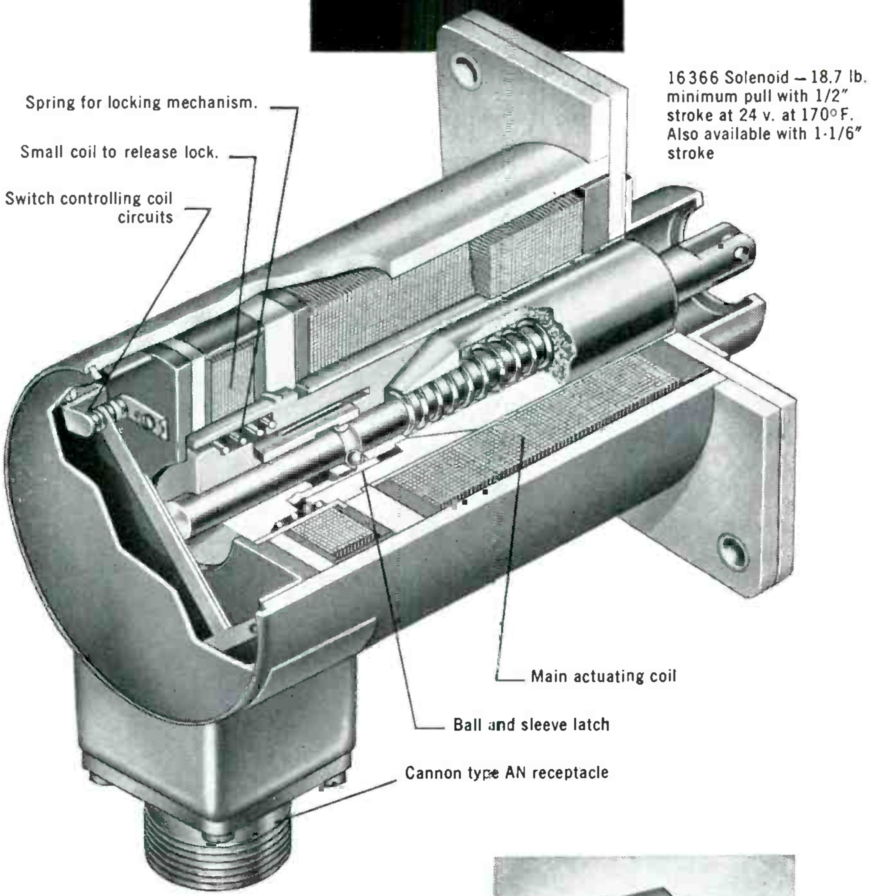

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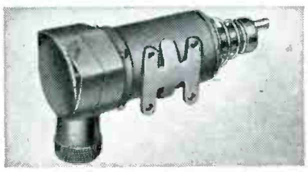

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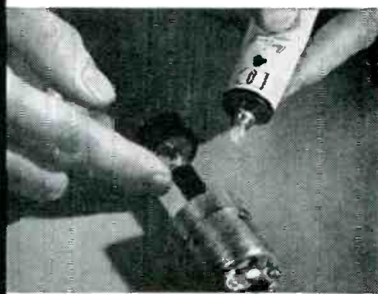

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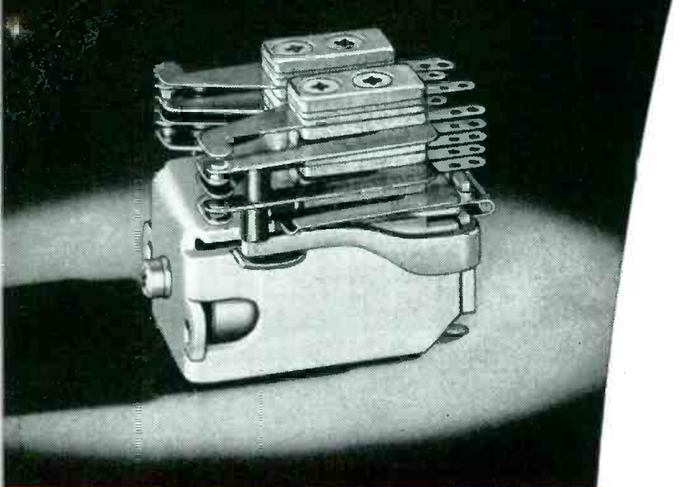

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For more detailed information on Clare Type "N" Relays you are invited to write for Bulletin No. 109. Clare sales engineers are located in principal cities. Call them or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

*With a 10,000-ohm coil, 1 Form C contact (spdt), and a standard adjustment, this relay will operate on less than 50 milliwatts. With a 450-ohm coil and four Form C contacts (4pdt), it will operate on 7/10 watt, even under conditions of vibration and high ambient temperature.

SPECIFICATIONS of CLARE Type "N" RELAY

COIL
Single- or double-wound. Double wound coils are concentric and have four terminals, two for each winding.

OPERATING VOLTAGE
Up to 180 volts dc.

ARMATURE
Single- or double-arm. Armature has high lever ratio (approx. 3:1) and no air gap.

CONTACT ASSEMBLY
Forms A to C. Maximum of 10 springs per pileup.

CONTACTS
Code No. 4 standard unless load conditions require different contact material.

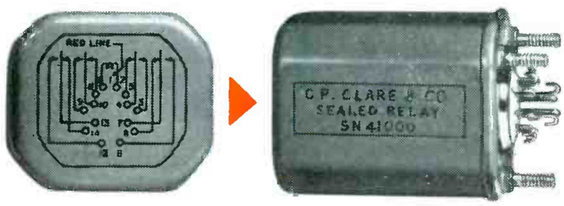
TERMINALS
All located at armature end of relay.

DIMENSIONS
Length: 1⅝", Width: 1 3/32", Height: Min. (with two contact springs): 1 1/16"; Max. (with ten contact springs): 1⅝".

NET WEIGHT
Single-arm, 2¼ oz. (approx.); double-arm, 3 oz. (approx.).

MOUNTING
Two #5-40 tapped holes on 13/16" centers. Located so mounting screws cannot foul coil.

Clare Type "SN" Hermetically Sealed Relay



Shown above is one of the hermetically sealed steel enclosures in which the Type "N" Relay can be sealed. Dimensions are: Length: 1-7/16"; Height: 2-1/16"; Width: 1⅝". Net weight of relay having 12 contact springs, six in each pileup, is 5 oz. (approx.). Note connection diagram clearly and permanently imprinted on base of enclosure by silk screen process.

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CLARE RELAYS

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tions from the receiving ends might be cancelling part of the direct pulse, since electrodes were placed at the ends of the specimen. A sample was prepared with two separate electrodes on each end. The contacts were then placed on the inner pair of electrodes. It was hoped that, since the electrodes were the same distance from each end, the multiple reflections would cancel out leaving only the direct pulse.

Results obtained from this procedure were inconclusive. The maximum length obtainable of the sheets was only three and one-half inches. The sheets were one and one-half inches wide. A wide variety of dimensions might have given more definite results.

Damping

Clay from a child's modeling set was then used as a damper on a similar sample. The specimen was covered with a coating of clay approximately $\frac{1}{16}$ inch thick and mounted on fiber board. The train of spurious pulses that follow the direct pulse were almost completely damped out (Fig. 3C). It was affirmed, as might be expected, that the first pulse of the train is the direct pulse.

This experiment was repeated with coatings of paraffin being used instead of the clay. Both thin and thick coatings were used. The results obtained were similar to that obtained with the clay. The heavier coating gave greater damping not only to the extraneous pulses but also the direct pulses.

Testing the Line

Tests were made with pulses of various widths with electrodes of various widths. These preliminary measurements seem to indicate that there is an optimum pulse width for each electrode width. Further, this test indicates that the output voltage amplitude is a function of width of electrode. The line used is shown in Fig. 4A. The width of the pulses used was 1, 2.5, 10 and 50 μsec.

A slotted line was then constructed as shown in Fig. 4B. Results obtained from tests indicate that a line of increased length with-

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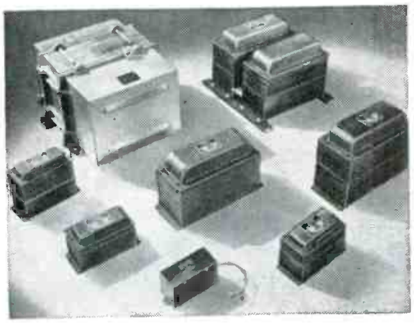

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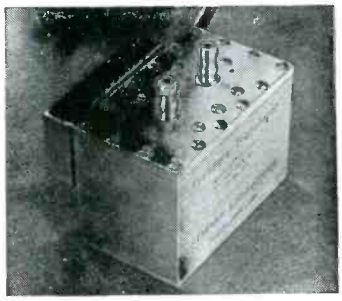

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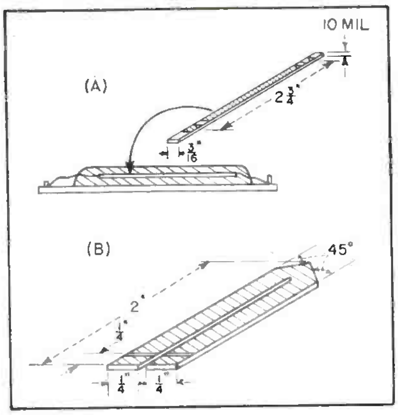

FIG. 4—Two typical $BaTiO_3$ delay line configurations

out much increase in noises can be obtained from a given specimen in this manner.

To preserve the pulse shape with a minimum of distortion, pulse-modulated carriers of several frequencies were used. Optimum carrier frequencies are in the neighborhood of 100 kc.

Conclusions

The construction of a delay line from a thin sheet of barium titanate is realizable. A method, not necessarily the best one, is suggested in the preceding pages for the preparation of such a line.

Less spurious modes are obtained from a thin sheet delay line of $BaTiO_3$ than from a similar line having a thickness twenty-five times as great. Less spurious modes are obtained from a thin sheet delay line of $BaTiO_3$ having a narrow width than from a similar line having a width four times as great. Spurious modes and noises obtained from a delay line constructed from a thin sheet of $BaTiO_3$ can be damped out by the use of clay or similar material. Polarizing a sample of $BaTiO_3$ for a period in excess of one hour has negligible effect. Carriers are effective in reducing distortion of pulses over ten microseconds in width.

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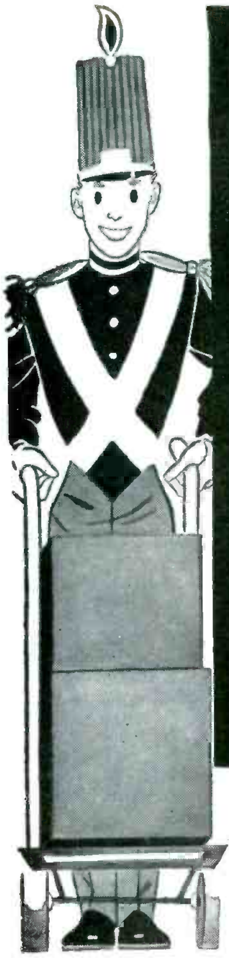

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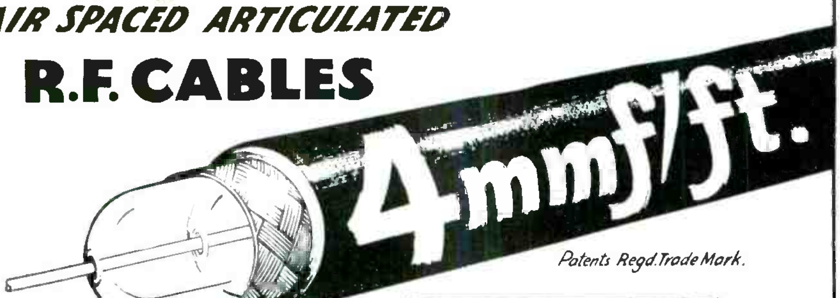

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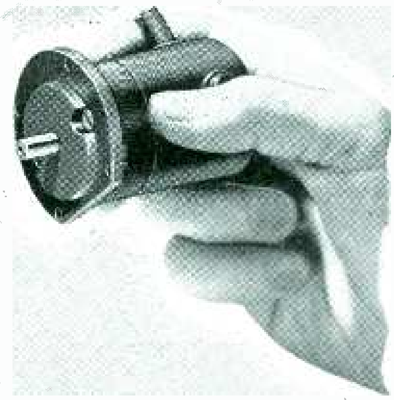

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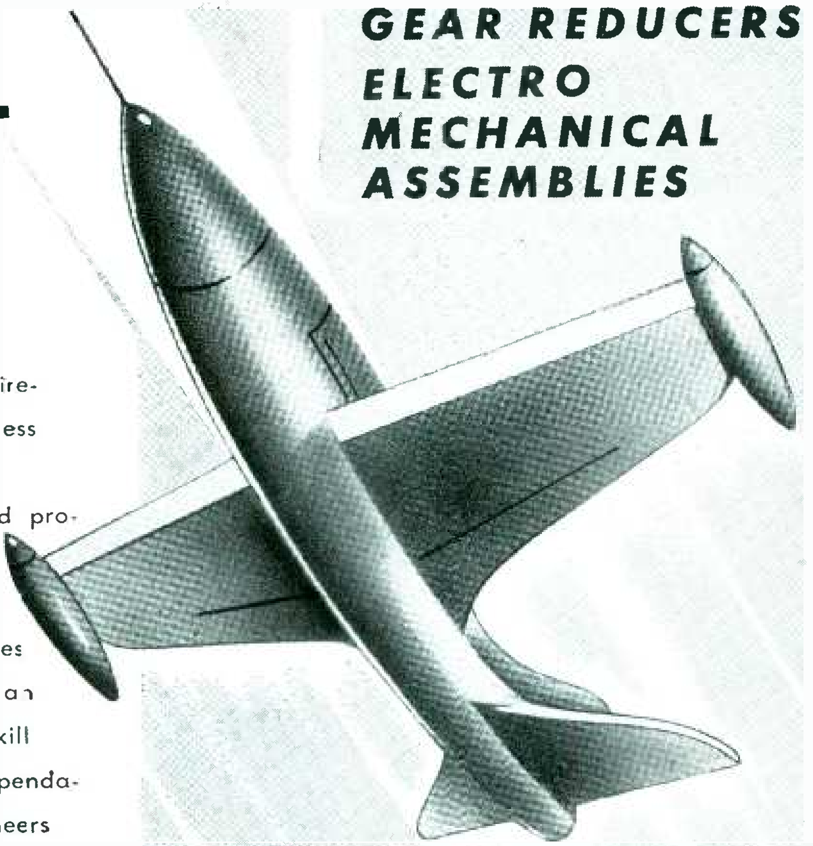

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Measuring Maximum Frequency Deviation

By Robert G. Rockwell

Hughes Aircraft Co.
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Figure 1 is a block diagram of the equipment used in determining the amplitude of a modulating voltage needed to produce a desired frequency deviation. Two assumptions, or conditions, must be met before continuing the experimental procedure after the equipment has been set up. (1) The source to be frequency-modulated—for example, a klystron (as in the block diagram)—must be heated sufficiently so that there is negligible frequency drift with time. (2) The same characteristics as those desired in practice should be used in the experiment: that is, in the case of a klystron, peak-of-the-mode op-

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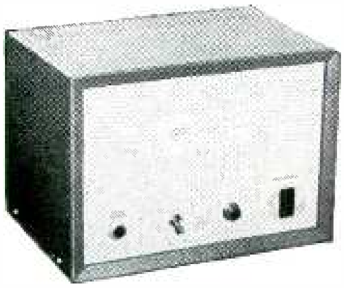

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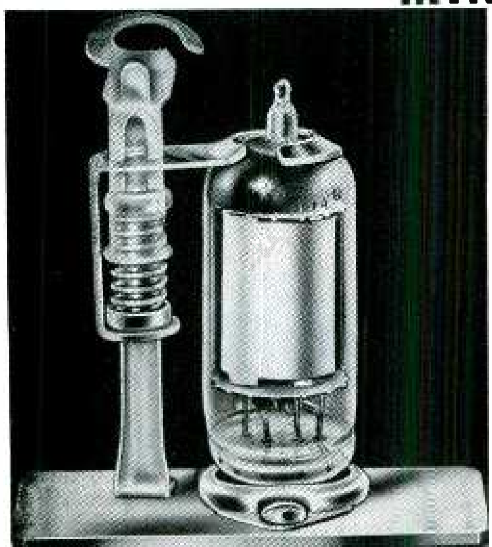

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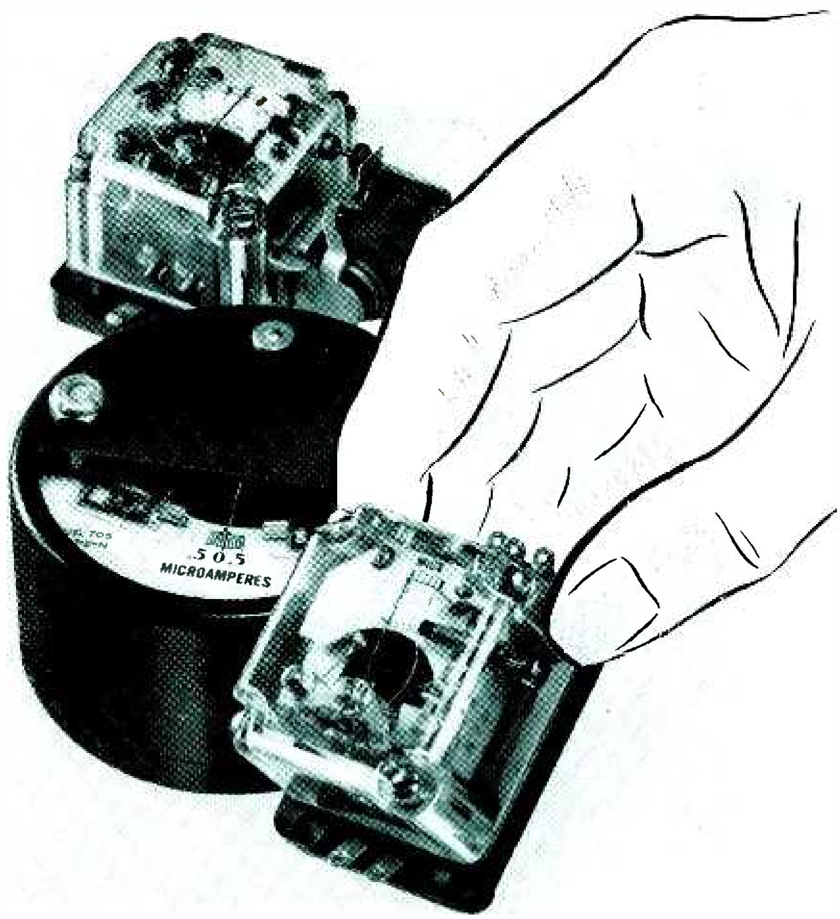

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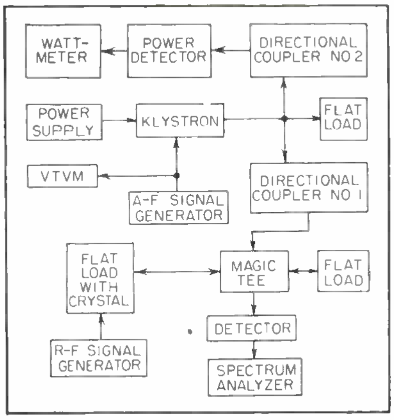


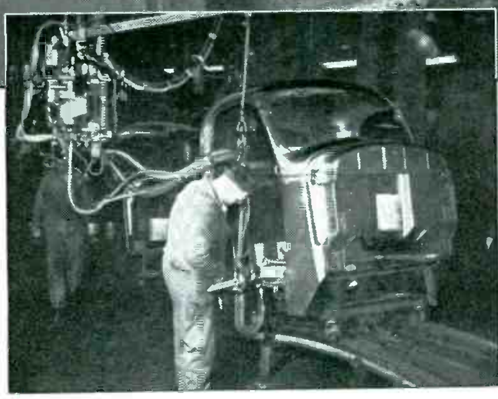
FIG. 1—Block diagram for accurate method for determining the modulating voltage amplitude needed for a maximum frequency deviation

eration. (This condition explains the inclusion in the equipment of directional coupler No. 2, the power detector, and the wattmeter. These units could presumably have been omitted if the d-c repeller voltage for peak-of-the-mode operation were accurately known).

Figure 2A illustrates the scope presentation of the pip representing the peak-of-the-mode, or carrier frequency f_c, of the klystron, as seen on the scope of the spectrum analyzer.

The next step in the procedure is to impedance-modulate at an r-f rate the crystal in one of the side-arms of the magic tee. The r-f frequency of the modulation was chosen equal to the desired maximum frequency deviation f_d. Sideband amplitudes corresponding to the amplitude of the r-f generator output were present on the oscilloscope. The spectrum analyzer was so adjusted, however, that only the first sideband on either side was visible as a pip, as illustrated in Fig. 2B.

After having established the conditions presented in Fig. 2B, the klystron itself was frequency-modulated. If the modulation index is sufficiently high, all of the significant sidebands will be within the maximum frequency deviation limits.[1] Hence it is readily apparent what the maximum frequency deviation is f_d as seen on the oscilloscope. The conditions existing, when the a-f modulating voltage is smaller than the amplitude produc-



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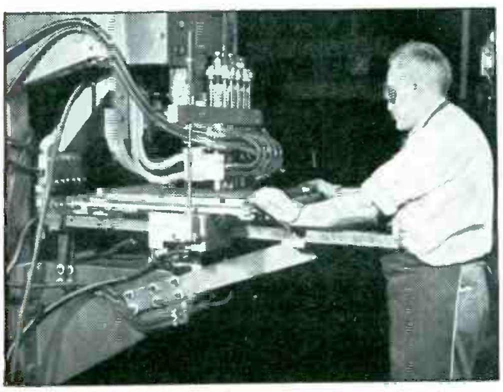
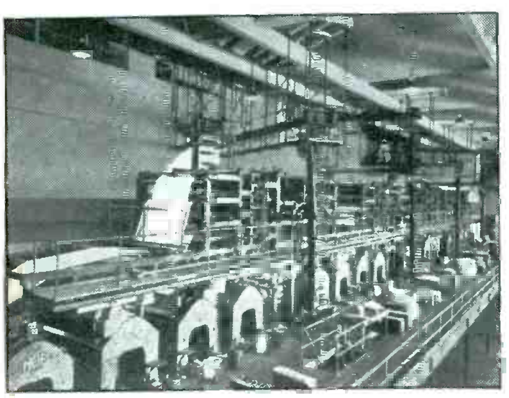


● G-E ignitrons regulate large d-c motors, such as those which drive this *Dallas News* press shown below.



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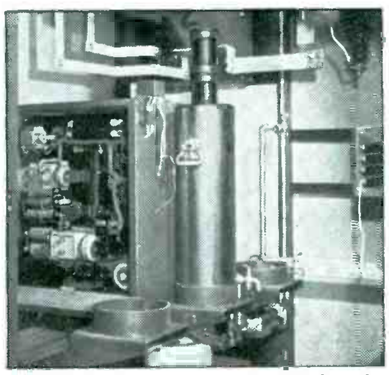
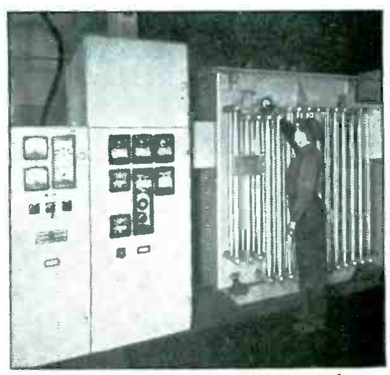


● G-E ignitrons serve in high-voltage rectification. Example: this special synchrotron power-supply unit for M.I.T.



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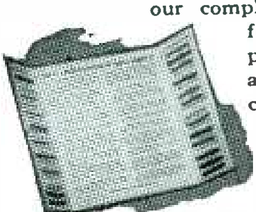

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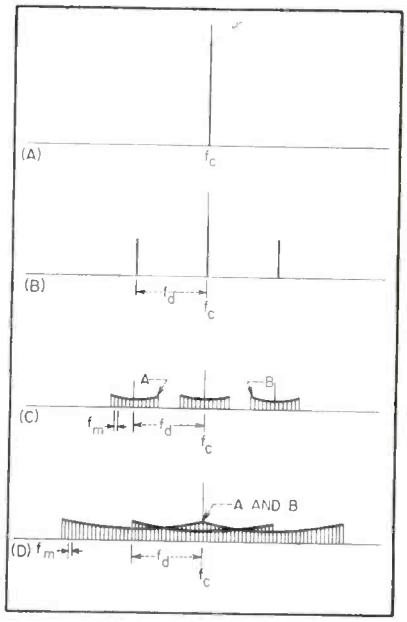

FIG. 2—Scope presentation showing position and nature of sidebands with respect to carrier

ing the desired deviation, are shown in Fig. 2C.

It can be seen that each of the pips of Fig. 2B is frequency-modulated; if the three pips are initially of equal amplitude, they will each have an identical spectrum. If they are not initially of equal amplitude, the difference between spectra is not a limiting factor for the low (7 kc) klystron-modulating audio frequencies used. The end frequencies (*A* and *B*) of the two side spectra apparently travel towards each other, and will be coincident at f_c, when each has been deviated from its side-pip an amount equal to the desired frequency deviation f_d. This condition is represented in Fig. 2D. If a-m is present, the end frequencies *A* and *B*, among others, will merely be of different amplitude, but will occur at the same frequencies as indicated for no a-m.

The a-f voltage was recorded, and this same amplitude can be used at higher (r-f) frequencies. A system was available for testing the amplitudes determined by the described method. The same system was used for testing an amplitude of a modulating voltage determined by the cruder method of counting pips (which were seldom integers). Results of the two methods were compared, and the method outlined in this paper was found to be de-

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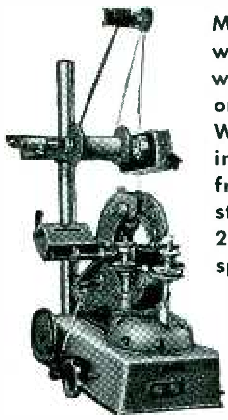
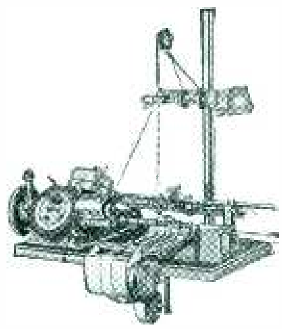
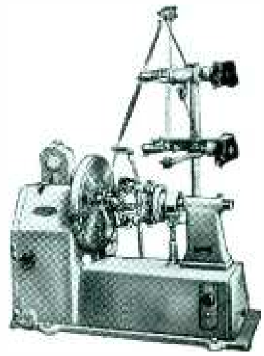


MODEL RW TOROIDAL WINDER with Coil Supports—automatically winds toroidal coils around 360° or sector coils up to 270°. Winds in either direction. Made in three sizes for single wire from 18 to 38 AWG, double or stranded wires from 2 x 18 to 2 x 26 AWG. Maximum winding speed 200 RPM.

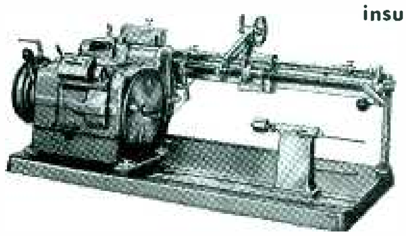


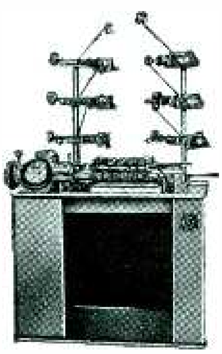
MODEL OOFA AUTOMATIC FINE-WIRE WINDER with removable semi or fully automatic paper interleaving attachment. Will wind wires from 24 to 44 AWG at certain speed ranges between 950 and 6000 RPM. Attachment available for winding two coils simultaneously. MODEL OOFA-T, similar to above, winds up to 12,000 RPM.

MODEL AWO-A SMALL ARMATURE WINDER—Fully automatic for mass production of small two-pole armatures with straight or skewed slots. Wire is guided by adjustable guide blade. Wire sizes (without insulation) from 23 to 44 SWG. Winding speed 700 RPM.



MODEL OGA AUTOMATIC WINDER with removable semi or fully automatic paper interleaving attachment. Adaptable for multiple coil winding with or without interleaving and for interweaving of cotton threads. Made for five speed ranges from 70 to 3000 RPM. Wire sizes from 8 to 44 AWG.





MODEL OOFA-PEM MULTIPLE FINE-WIRE WINDER with fully automatic paper interleaving device, for flanged or flangless coils. Winds up to 6 coils at a time with individual paper interleaving. MODEL OOFA-PEB winds up to 10 flangless coils with common paper interleaving. Wire sizes from 24 to 44 AWG. Winding speeds from 360 to 3000 RPM.

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cidedly more accurate.

An accurate method for determining the amplitude of the modulating voltage needed to produce a desired maximum frequency deviation has thus been deduced and experimentally tested. The tests show that the accuracy of the method outlined is indeed superior to that of counting pips. Although it is admittedly more complicated, the accuracy available makes the method definitely worthwhile.

REFERENCE

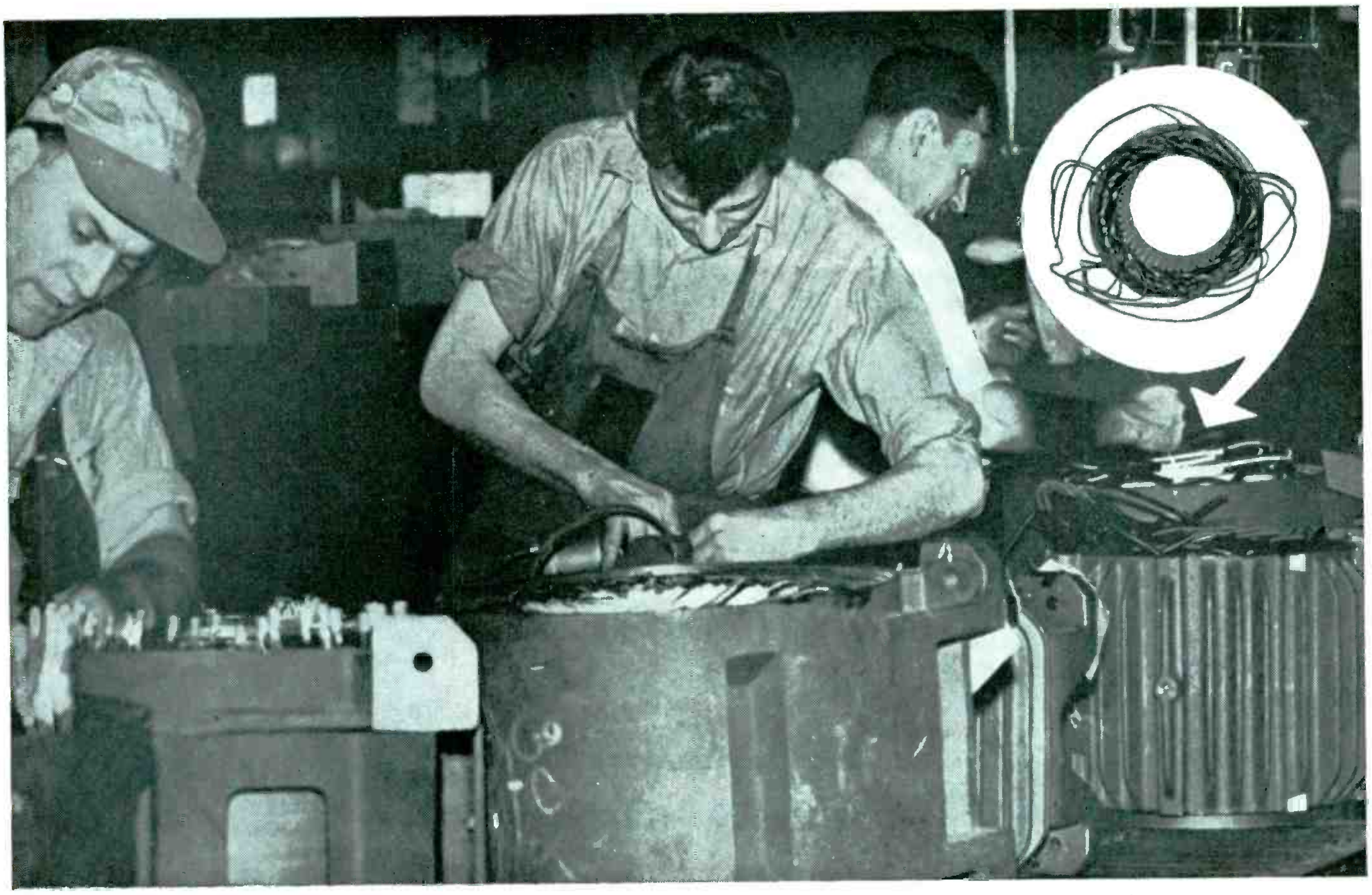
(1) F. E. Terman, "Radio Engineers Handbook," p 578, New York, 1943.

Accurate Frequency Calibration Method

FREQUENCY calibration of electronic equipment is another of the phases of the business that has felt the pressure for increased speed and accuracy. These requirements, along with the general increase in frequency range involved, have more or less antiquated the basic zero beat method. Lissajous pattern techniques have been found suitable for a large number of applications, but when used in conjunction with a primary standard, the task of identifying the proper ratio between compared signals (when not used for direct one-to-one comparisons) becomes somewhat complex, and errors are likely to result.

A method has been developed at the Naval Research Laboratory which inherently produces a signal exactly equal to the standard frequency whenever the signal to be calibrated is exactly adjusted to any detectable harmonic of the standard frequency. The equality is automatically indicated as a simple one-to-one Lissajous pattern which is obtained for each usable harmonic point. Thus, with the aid of this technique, less skilled personnel can perform, more quickly, equipment calibrations equivalent to those obtained through standard Lissajous methods.

The block diagram of the equipment used is shown. A standard frequency source is chosen that will generate a signal of a frequency equal to the frequency interval of calibration desired. If not directly



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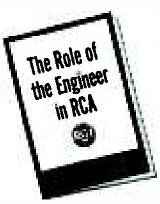

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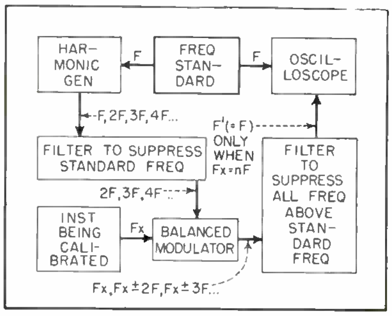
available, the standard frequency can be derived from a primary standard through frequency-dividing techniques.

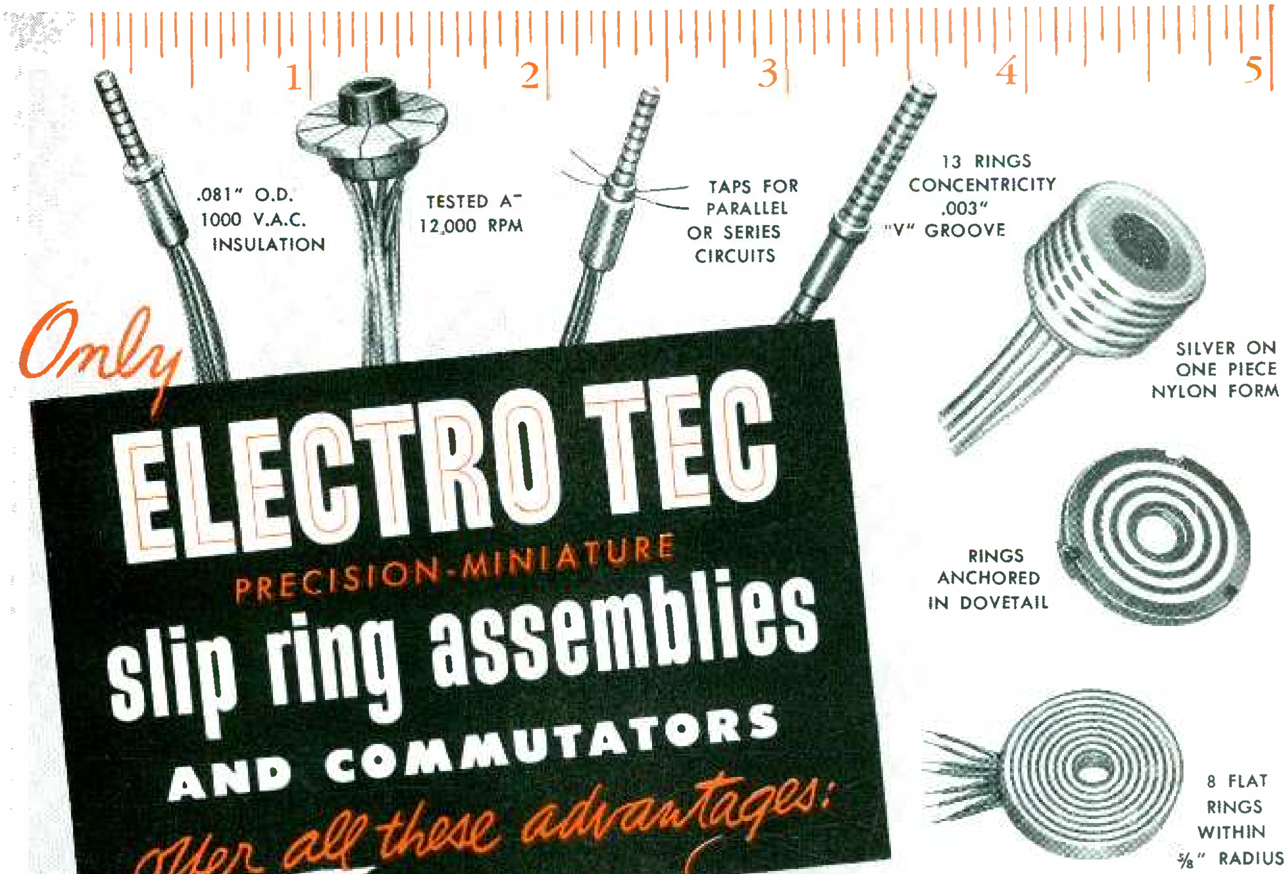
The final standard signal is fed through a harmonic generator to produce integral multiples of the fundamental. A filter suppresses the fundamental, and the resulting harmonics are fed to a balanced modulator along with the signal to be calibrated. The modulator is balanced to eliminate harmonics of the fundamental standard frequency, and its output contains the signal to be calibrated, and beats between the signal to be calibrated and the harmonics of the standard frequency. When the signal being calibrated approaches one of the harmonics of the standard, a zero frequency component will be pro-



Block diagram showing method for accurate calibration of an unknown with harmonics of a standard frequency using 1-to-1 Lissajous figures only

duced. The output of the balanced modulator thus contains the components shown in the block diagram. After filtering to remove frequencies higher than standard frequency, a one-to-one ratio then exists between the standard frequency and the unknown frequency when the unknown is equal to a harmonic of the standard frequency.

It is also possible to obtain intermediate check points by making 2-to-1 or 3-to-1 (or higher) checks between principal calibration points. This technique has been described in somewhat more detail by David I. Troxel of the Naval Research Laboratory in Washington, D. C., in NRL Report No. 3,701.



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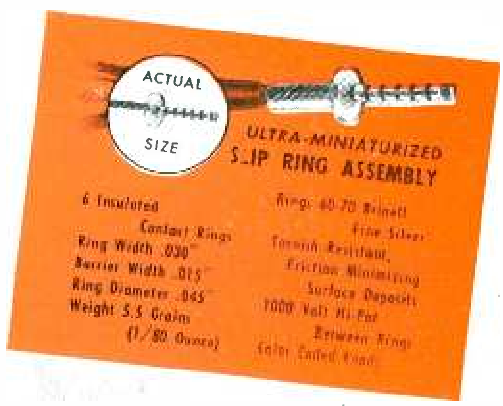

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(continued from p 146)

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HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 112-B Dynaural preamplifier features: a noise suppressor that reduces record surface noise without losing musical quality; a preamplifier for low-level magnetic pickups; a variable turnover control to compensate for different recording characteristics; an adjustable record-distortion filter; an input level adjustment for use with the noise suppressor and external automatic loudness controls. Frequency response is flat from 30 to 15,000 cycles, and usable response is from 20 to 20,000 cycles.

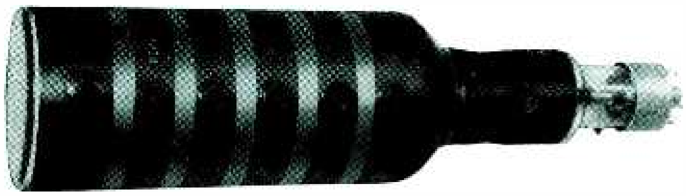
Scintillation Counter

NUCLEAR RESEARCH CORP., 2707 Federal St., Philadelphia 46, Pa., has developed a new scintillation counter with more than 25 times the gamma efficiency, of a conventional G-M tube. The portable counter includes a permanent thallium-activated sodium iodide crystal mounted in a removable cap—an RCA 5819 photomultiplier tube

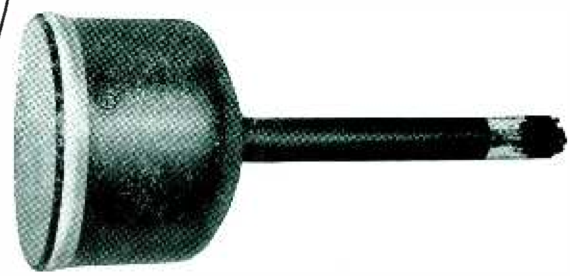
DUMONT

SPECIAL cathode-ray tubes

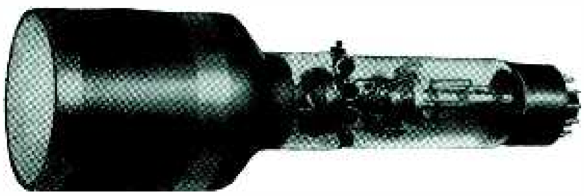
The line of Du Mont cathode-ray tubes is carefully engineered to provide the broadest possible coverage of the entire range of standard applications. In some instances, however, the requirements of highly specialized applications are beyond the capabilities of RTMA Registered cathode-ray tube types. For such cases, Du Mont SPECIAL CATHODE-RAY TUBES offer the answer. Typical examples of these special tubes are shown below.



TYPE K1101P — 5-inch flat-faced tube designed for ultra-high-speed oscillography. Will provide spot writing speeds as high as 1000 in./μsec. Overall maximum accelerating potential of 37,000 volts, with good deflection sensitivity.



TYPE K1080P — 7-inch magnetically focused and deflected tube operating at accelerating potentials up to 30,000 volts, providing high light output with excellent resolution. Face-plate manufactured to conform to uniform standard of curvature and thickness.



TYPE K1065P — 3-inch flat-faced tube with high deflection sensitivity. Deflection-electrode connections through neck enable high-frequency applications.

TYPE K1052P — 7-inch tube containing 5 wholly independent electron-gun and deflection-electrode structures in a single envelope. Auxilliary ring-socket for easy connection to all deflection electrodes.

If you have a problem beyond the range of RTMA Registered cathode-ray tube types, the facilities of Du Mont, the skill of the most experienced designers of cathode-ray tubes in the industry, are at your disposal for consultation.

The above tubes are representative of the Du Mont line of SPECIAL CATHODE-RAY TUBES. For detailed information on these, and other Du Mont SPECIAL TUBES, write to Department G at the address below.

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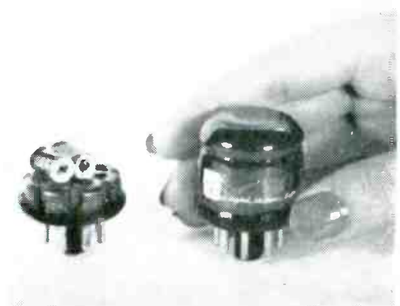
with all necessary circuitry—and a six-foot cable and connector. Size of the unit is $2\frac{1}{2}$ in. × 8 in., and total weight is $1\frac{1}{2}$ lb. Extra accessories include a lead collimator for use with standard crystal cap and a crystal cap for wide-angle gamma counting.

Voltage-Regulated Power Supply

KEPCO LABORATORIES, INC., 149-14 41st Ave., Flushing, N. Y., recently released the model 1250 voltage-regulated power supply. The high-voltage supply is continuously variable from 200 to 1,000 volts and delivers from 0 to 500 ma. In the 200 to 1,000-volt range the output voltage variation is less than 0.5 percent for line fluctuations from 105 to 125 volts and less than 0.5 percent for load variations from 0 to 500 ma. Ripple is less than 20 mv. The rack panel cabinet height is 28 in., width $21\frac{1}{4}$ in., depth 16 in. Weight is approximately 167 lb.



Flip-Flop

COMPUTER RESEARCH CORP., 3348 W. El Segundo Blvd., Hawthorne, Calif., has developed a replacement for the vacuum tube in

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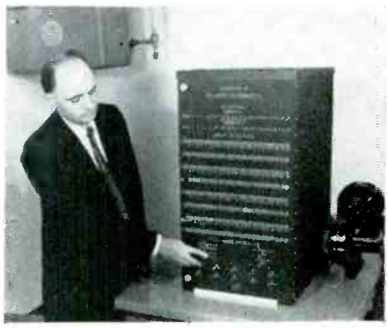
certain medium-speed counting, amplifying and control applications. The ferro-resonant flip-flop illustrated is a bistable-state device which is equivalent to a single vacuum tube Eccles-Jordan trigger circuit. It resembles, somewhat, a saturable reactor and operates at frequencies up to 20 kc. It has no filament to burn out and occupies about 0.1 the space of a comparable vacuum tube. As an amplifier it produces a high-power gain. Operating on approximately 10 percent the power needed by an equivalent vacuum tube, it delivers 90 percent of input energy as usable output. There is virtually no problem of heat dissipation.

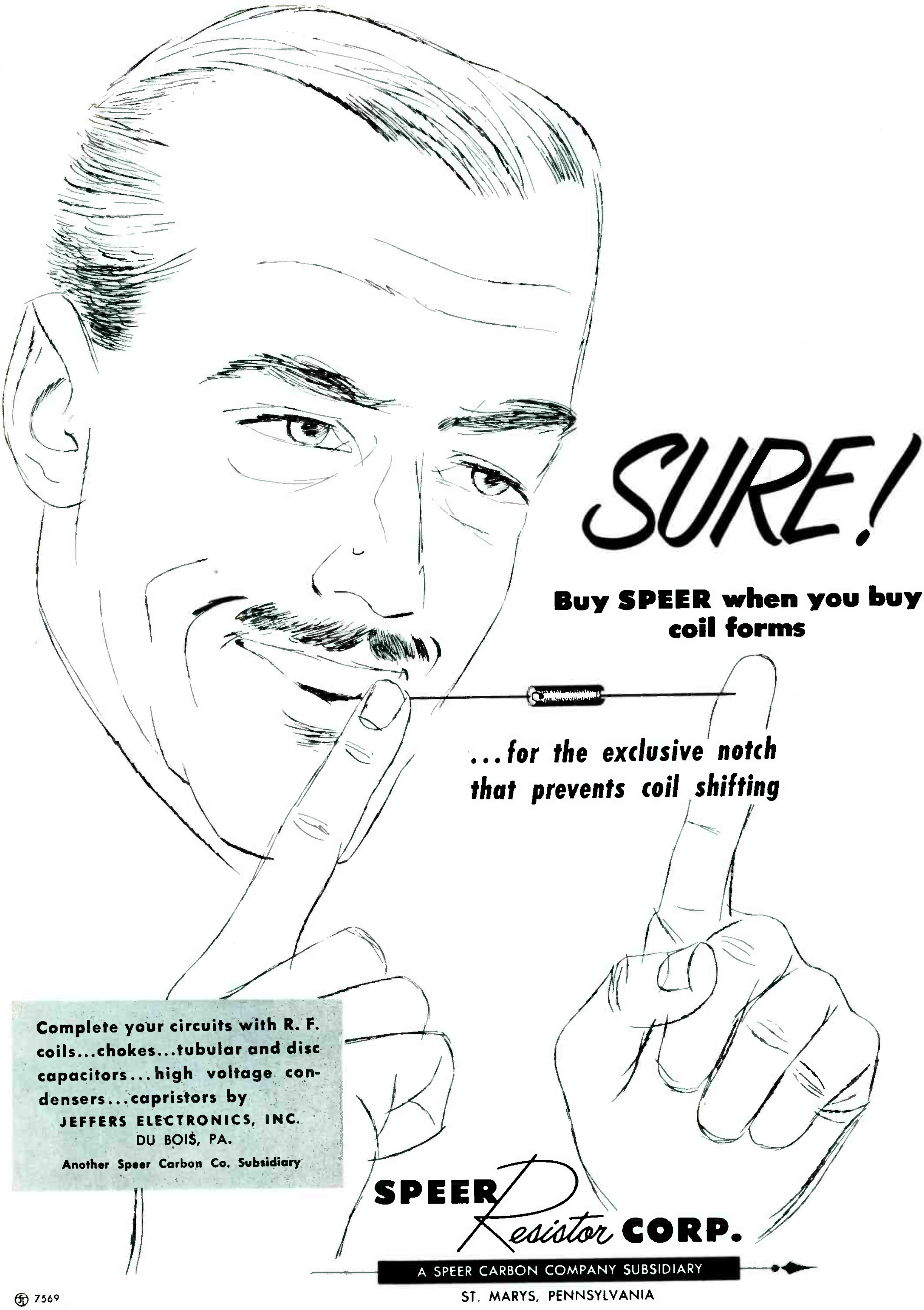


Miniature Computer

THE JACOBS INSTRUMENT CO., 4718 Bethesda Ave., Bethesda 14, Md. The JAINCOMP-B is a small electronic computer that can add two 24-digit numbers in eight millionths of a second. It is the size of a table model tv set and contains 300 tiny tubes the size of those used in hearing aids. It weighs about 100 lb. The unit described and illustrated accepts not only data in the conventional ways used in computing machines but also inputs from measuring instruments. Copies of scientific papers on the new computers are available on request.

Miniature Switches

CENTRALAB DIVISION OF GLOBE-UNION INC., 900 E. Keefe Ave., Milwaukee, Wis., has introduced a new line of unusually small rotary switches. These units are available in a variety of multipole, multiposition, multisection types, also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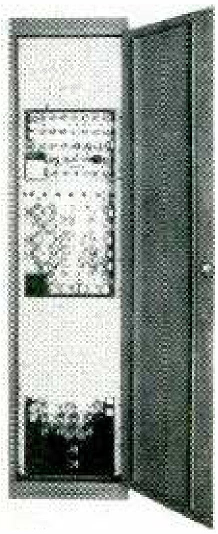
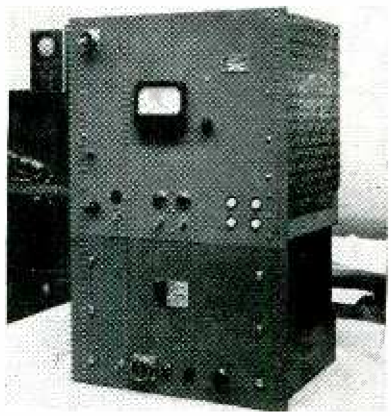
in combination with a-c line switches and variable resistors.



TV Synchronizing Generator

FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J., has developed the FTL 63A tv synchronizing generator that features a stable, high-speed binary frequency divider that eliminates the need for expensive c-r-tube monitoring. There is a choice of five lock-in sources: crystal, power-line, free, external and interlace. Provision is also made for the addition of a high-frequency interlace generator.



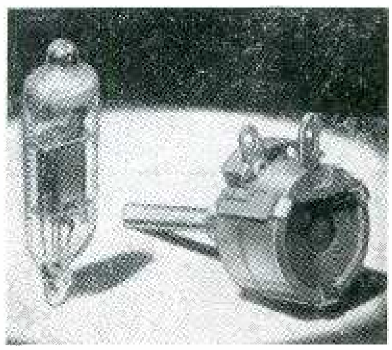
All-Magnetic Regulator

GENERAL MAGNETICS, INC., 135 Bloomfield Ave., Bloomfield, N. J., has introduced a klystron d-c power supply voltage regulator with no vacuum tubes and an all-magnetic

amplifier-type circuit. It maintains power supply output at 18,000 v d-c for load current variations from 0 to 100 ma, and line voltage variations from 105 to 135 v a-c. Regulation accuracy is ± 1 percent; and time delay, approximately 0. 1 sec. The unit may be modified for power supplies of any output rating.

Wide-Band Video Amplifier

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model V-2 improved wide-band video amplifier has a flat amplitude response ±1.5 db from below 10 cps to 20 mc. It is designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of extremely short duration and rise time. It is a tool for laboratory and industrial use to extend the amplitude range of vacuum-tube voltmeters and signal generators. Its extended low-frequency responses permit accurate analysis of tv signals. Sixty-cycle square waves are passed with less than 5-percent tilt.



Subminiature Control

CLAROSTAT MFG. CO., INC., Dover, N. H. Series 48A improved sub-

another
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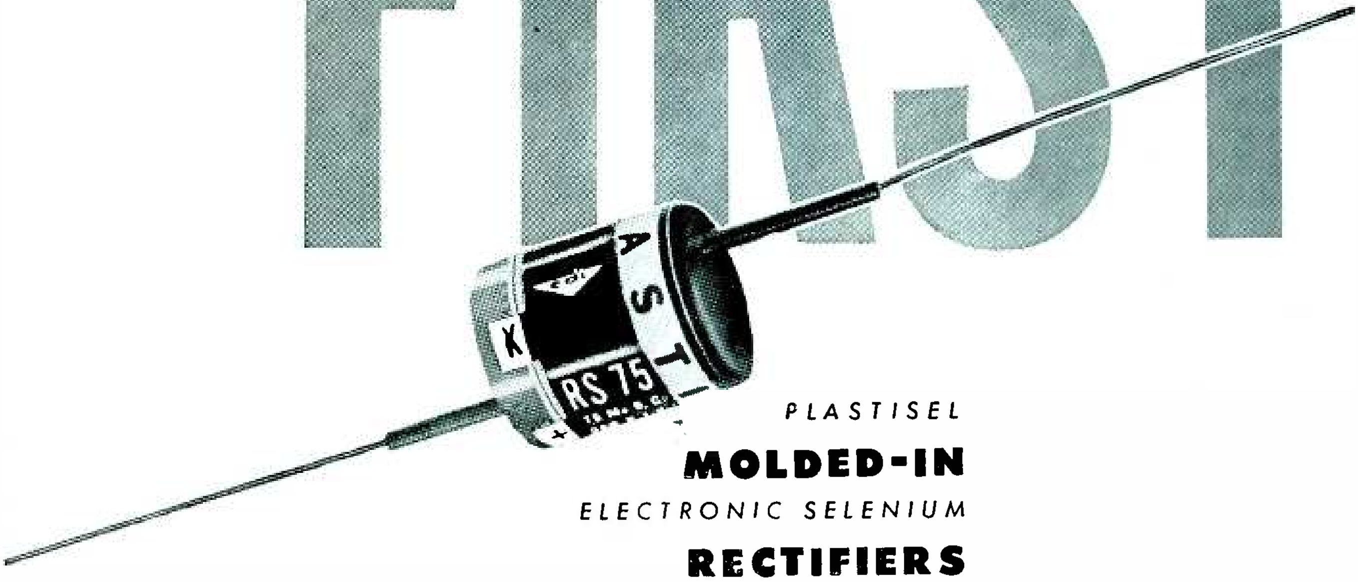
FIRST



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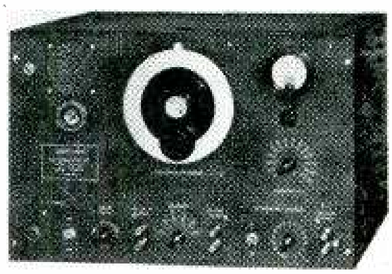
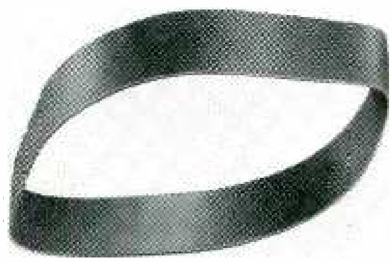
miniature control measures only $\frac{5}{8}$ in. in diameter, and is available as either a single or dual unit. Body depth of the single unit is 7/16 in., while the double unit measures 53/64 in. Bushing is $\frac{1}{4}$ in. long, beyond which the shaft extends $\frac{1}{2}$ in. Series 48A is available in either tapered or linear resistances. Linear ranges are from 1,000 ohms to 5 megohms; tapered resistances, from 5,000 ohms to 2.5 megohms.



Ultrasonic Signal Source

KAY ELECTRIC CO., Pine Brook, N. J., has announced the Sonaligner, a stable and accurate oscillator in the ultrasonic range suitable for use in determining the pass band of narrow-band ultrasonic filters and other work in this range. Frequency range is from 10 kc to 220 kc in 13 bands. Output is a maximum of 2 volts from 600 ohms. Crystal check points accurate to 0.01 percent are included with marks every 2, 10, 50 and 200 kc. Price is $695.



Magnetic Recording Rubber

THE BRUSH DEVELOPMENT CO., 3405 Perkins Ave., Cleveland 14, Ohio, has announced a new magnetic recording rubber made from a special neoprene base. Magnetic oxide has been pigmented into the neoprene

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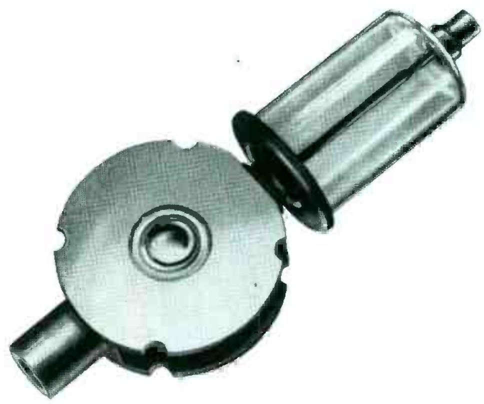


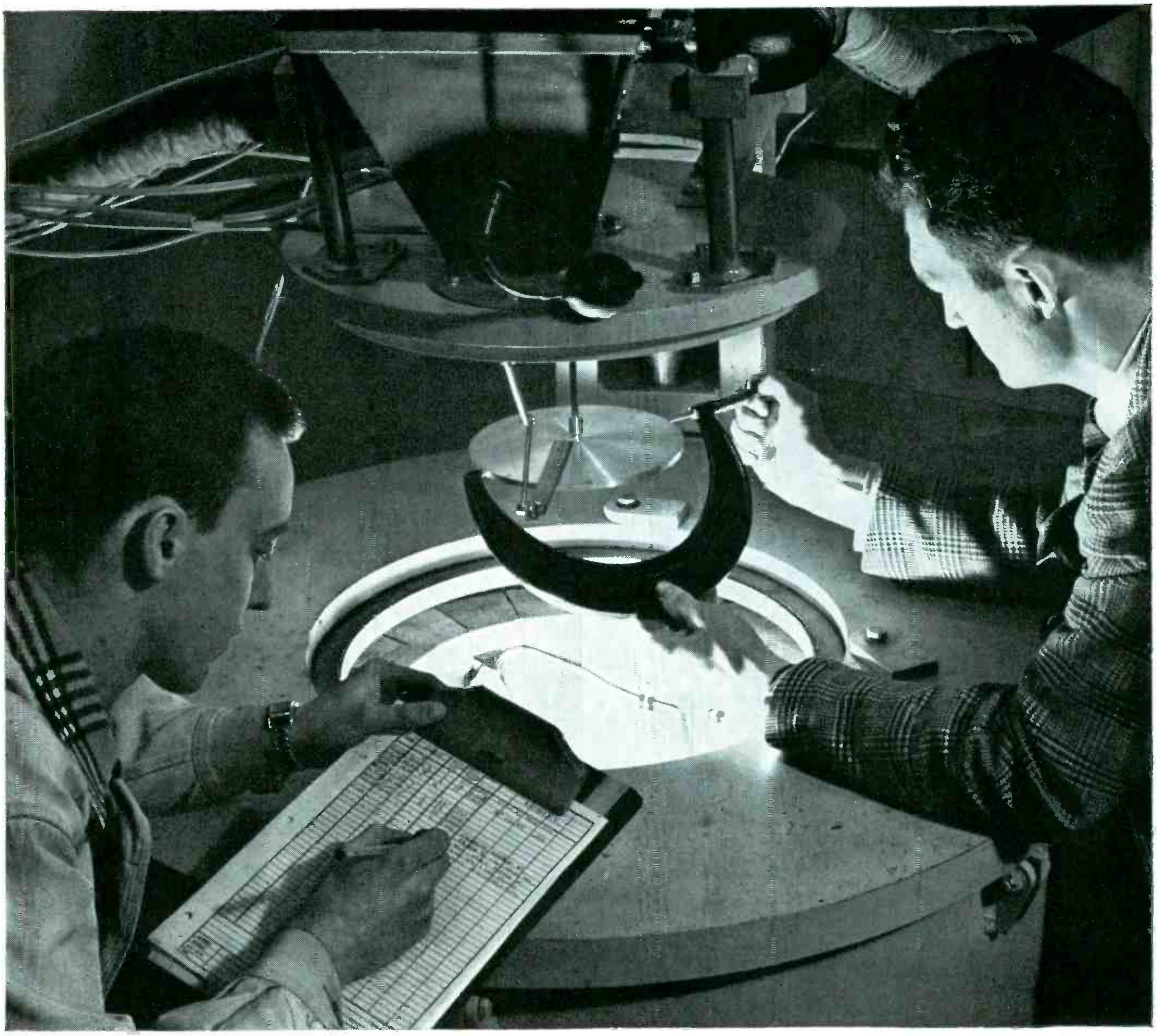
with an unusually good degree of uniformity. Included in the base material is a permanent lubricant that virtually eliminates wear of both the medium and the associated recording head. Mechanical compliance of the medium provides for intimate contact with the recording head. These recording bands have been primarily designed for use when stretched over a supporting drum.

Multifrequency Crystal Oscillator

CREST LABORATORIES, Whitehall Bldg., Far Rockaway, L. I., N. Y. Model 50 oscillator is a multifrequency high output signal generator. Compact in size, it provides a convenient and inexpensive means of obtaining multiple outputs for spot frequency alignment of television and military receivers. It is available in a crystal-controlled range of 4.5 to 50 mc.

Voltage-Regulated Power Supply

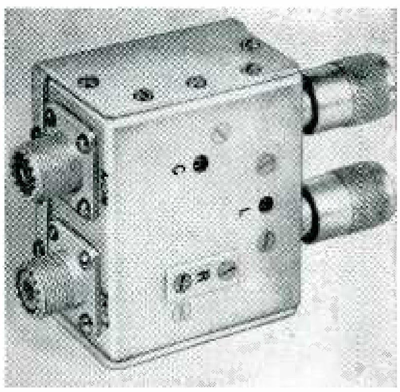
KEPCO LABORATORIES, INC., 149-14 41st Ave., Flushing, N. Y. Model 815 features one regulated B supply, one regulated C supply and one unregulated filament supply. The B



supply is continuously variable from 0 to 600 v and delivers from 0 to 200 ma. At the range 20 to 600 v the output voltage variation is less than 0.5 percent for both line fluctuations from 105 to 125 v and load variation from minimum to maximum current. Ripple is less than 5 mv. The C supply is continuously variable from 0 to 150 v and delivers 5 ma. For all output voltages the output voltage variation is less than 10 mv for line fluctuations of 105 to 125 v. The a-c output is 6.3 v, 10 amperes, center-tapped, unregulated.

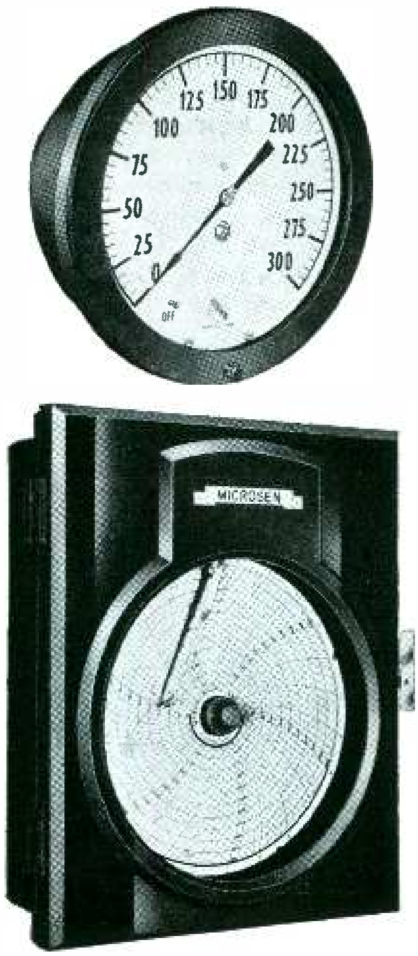
Signal Generator

ELECTRONIC INSTRUMENT CO., INC., 276 Newport St., Brooklyn 12, N. Y., has announced production of the model 322 r-f/a-f signal generator in both kit and factory-wired form. Specially designed for f-m/a-m alignment, generation of tv marker frequencies and the testing of audio circuits, the unit has a 5-step switching arrangement that permits r-f, modulated r-f or a-f output. Its Hartley oscillator produces fundamentals from 150 kc to 34 mc, with harmonics to 102 mc, and its Colpitts audio oscillator generates 400-cycle sine-wave voltage. Price in kit form is $23.95; wired, $34.95.



Video Line Pad

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., has announced the type V-102 video line pad, assembled in an aluminum case, and provided with connectors for connecting one or two line amplifier outputs, line input and monitor input. This net-



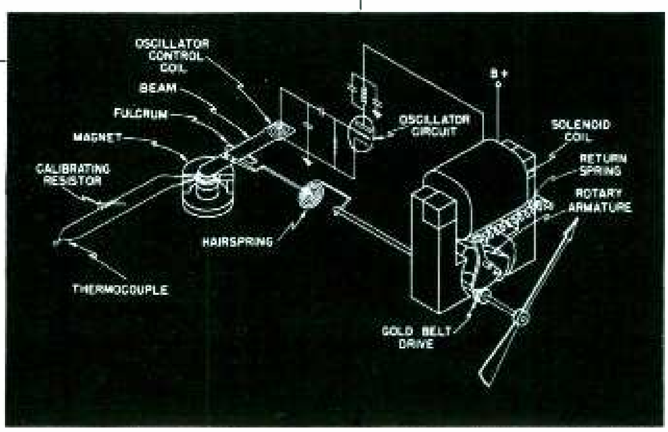
FACTS ABOUT THE NEW *American* ELECTRONIC TEMPERATURE MEASURING INSTRUMENTS

Conventional industrial temperature measuring devices, like millivolt pyrometers and potentiometers, are often too fragile, complicated or costly for many applications.

American Electronic Temperature Indicators and Recorders have none of these disadvantages, whatever the demands of service. They are rugged, simply constructed, economical—yet measure temperature precisely between –100° and + 3000°F.

Heart of the instrument is the power-actuated Microsen Balance, a unit extremely sensitive to low power input—insensitive to line voltage variations. Both dials and charts are readily calibrated to thermocouple temperature scales. Thermocouple cold junction compensation is achieved—regardless of ambient temperature effects—by a built-in, thermostatically-controlled and insulated heater. A sealed housing protects all measuring elements from dust and corrosive vapors.

The high torque rotary solenoid, which drives the pointer, makes the instrument especially suitable for round dial indication, thus reducing the opportunity for parallax error. It also assures "pin point" accuracy in positioning the pointer, and permits the use of dials as large as 12 inches.



HOW AMERICAN ELECTRONIC INDICATORS AND RECORDERS MEASURE TEMPERATURE

The Microsen Balance maintains equilibrium between two forces. One is proportional to thermocouple input, the other to the mechanical position of the instrument pointer.

Any change in thermocouple input deflects the Microsen beam and changes the proximity of the beam's flag end to the oscillator coil. The oscillator circuit then detunes and creates a current change through the vacuum tube and solenoid coil.

As the solenoid armature rotates, it positions the pointer so that the hairspring torque is opposed and equal to the input torque. The mechanical indication is thus weighed in exact proportion to thermocouple input. Consequently, the pointer accurately indicates the temperature on the dial.

MICROSEN BULLETIN 404 contains details about these revolutionary new temperature measuring instruments. Also included is information about American Electronic Indicators and Recorders for other fields of measurement. Write for a copy.

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work is designed to feed from a 73-ohm source to a 73-ohm line with zero loss, and at the same time provide a branch circuit containing 14 db of isolation, for the connection of a high impedance monitor. The unit provides a simple method for the direct monitoring of the outgoing signal between the output of the line amplifier and the line without disturbing the transmission characteristics. At the same time this network provides sufficient isolation so that the line characteristics do not influence the quality of the connected monitor.

TV Bar Generator

SUPERIOR INSTRUMENTS CO., 227 Fulton St., New York 7, N. Y. All that is necessary with the tv bar generator to display an actual bar pattern on any tv receiver screen is to connect the unit to the receiver antenna post, plug the line cord into an a-c outlet and throw a switch. The receiver under test will have a stable nevershifting vertical or horizontal pattern projected on the screen. Power supply is 105–125 volts, 60 cycles; power consumption, 20 watts; vertical sweep output, 60 cycles; horizontal sweep output 16,750 cycles.

High-Sensitivity CRO

PRECISION APPARATUS CO., INC., 92–27 Horace Harding Blvd., Elmhurst, L. I., N. Y. Series ES-500A high-sensitivity cathode-ray oscilloscope is a 5-in. laboratory type with extended range, voltage-regulated, push-pull amplifiers for multipurpose industrial, a-m, f-m and tv applications. It features a vertical amplifier with response beyond 1 Mc, a 2-megohm input resistance

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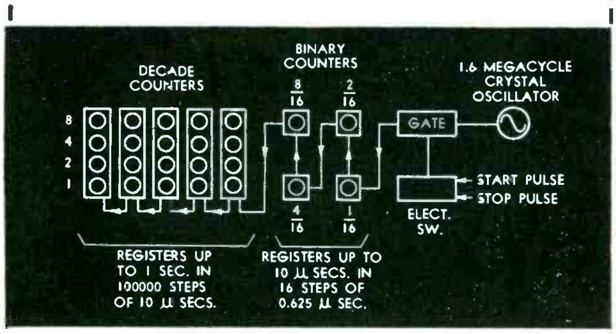

PRINCIPLE OF OPERATION:

A quartz crystal, continuously oscillating at 1.6 mc is used as a time base. During the time interval to be measured the cycles are gated into four binary counting stages having a capacity of 16 counts. The neon indicator lights of these stages are numbered 1/16, 2/16, 4/16, and 8/16 (sixteenths of 10 microseconds or 0.625 microsecond). Following the binary stages are five decade counting units having a capacity of 100,000 counts. Each count entering the decades from the binary stages represents 10 microseconds. Therefore, the time interval between 10 microseconds and 1 second is registered in the decades and the remainder is registered in the binary stages. For instance a time interval of .5374825 second would be indicated as follows: .53748 on the decade indicators plus 4/16 (of 10 microseconds) on the binary indicators.

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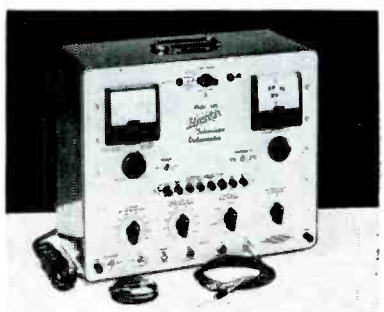
and approximately 20-$\mu\mu$f input capacity. Better than 20-mv-per-in. vertical amplifier sensitivity permits direct alignment and/or adjustment of low gain circuits and examination of minute signal levels. A multivibrator-type internal linear sweep circuit affords direct coverage from 10 cycles to 30 kc. Net price is $169.50.

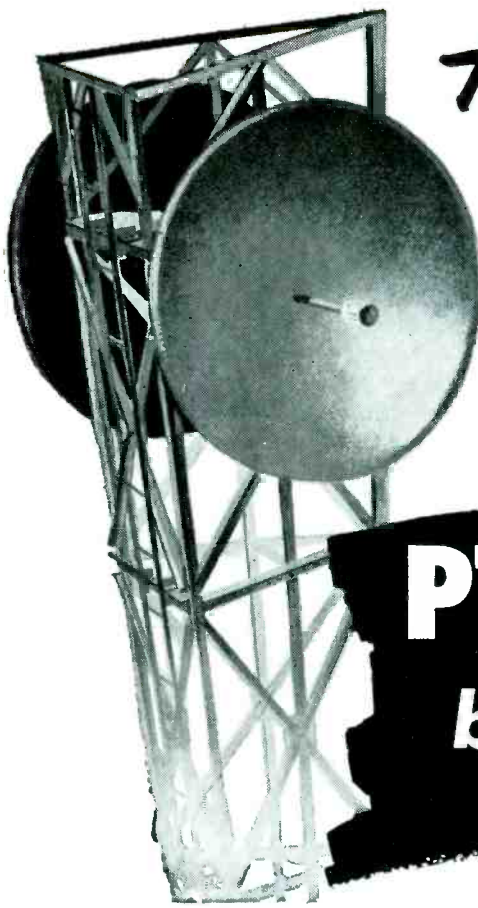
Binary Scaler

GENERAL ELECTRIC CO., Syracuse, N. Y., has developed model 4SN1A3 binary scaler with a 90-v output. It incorporates a new-type twin triode tube, the 5963, which is especially designed to avoid emission decrease in pulsed service. The scaler can count electrical impulses at speeds in excess of 200 kc per second when used in either binary or decade combinations. Output impedance is 15,000 ohms. Power supply specified is 210 v d-c ±20 percent at 7 ma; filament, 6.3 v at 0.3 ampere.



Video Generator

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave.,



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Cleveland 8, Ohio, has developed the model 650 Videometer, and all-purpose video generator designed as a test instrument for visually identifying and localizing trouble in any section of a tv receiver independent of station operation. The instrument has r-f output directly calibrated in microvolts for sensitivity checks. It contains a line voltage scale for instantaneous check on line voltage fluctuation, and includes horizontal and vertical sawtooth voltages, which can be directly substituted for vertical and horizontal oscillator in a receiver. Amplitude is sufficient to give full raster deflection, and in the case of flyback-type high-voltage power supplies, the horizontal sawtooth can be used to light up the picture tube.

Driver Unit

AUDICRAFT INC., 77 South 5th St., Brooklyn, N. Y. Model DQ loudspeaker driver unit is a heavy-duty unit handling 30 watts of program material and withstanding peaks of 80 percent over this figure. One of the exclusive features of the unit is a frequency response to the upper limit of the audio range. Another feature is the patented Self-Instal diaphragm assembly in which have been incorporated all elements of the vibrating system. Instant replacement of the assembly may be made at the point of speaker operation with only a screwdriver.

Literature

Low-Voltage D-C Capacitors. General Electric Co., Schenectady 5, N. Y. Bulletin GEC-808 describes the features, application and operation of the Tantalytic capacitors that are designed for low-voltage, d-c applications where very small

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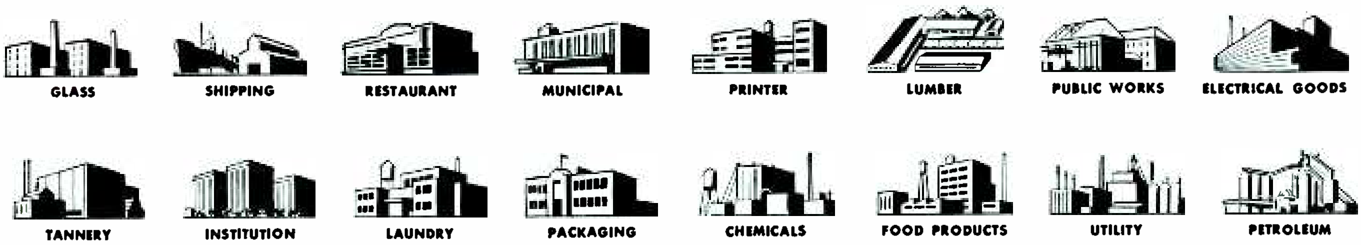

FOR EACH OF US TO GET MORE STEEL . . . AND PRODUCTS MADE OF STEEL . . . WE'VE GOT TO PROVIDE MORE SCRAP TO MAKE THE STEEL.

Half the melting stock used in the steel mill or iron foundry consists of iron and steel scrap. In normal times, enough scrap is produced by the mills, foundries, railroads, fabricators and scrap dealers to fill the need.

But now the mills have stepped up capacity to meet the greatly increased military and civilian demands for steel. And that increased capacity has outstepped the supply of scrap.

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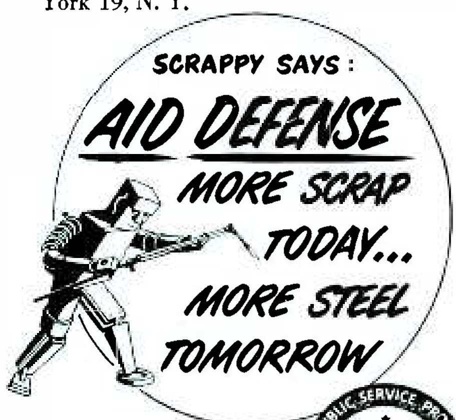
1. Appoint one top official in your plant to take full responsibility for surveying the plant and getting out the scrap.

2. Consult with your local Scrap Mobilization Committee about its program to help out in the scrap crisis. For chairman's name, check with your Chamber of Commerce, or the nearest office of the National Production Authority, Department of Commerce.

3. Call in your local scrap dealer to help you work out a practical scrapping program. Non-ferrous scrap is needed, too.

4. Write for free booklet, "Top Management: Your Program For Emergency Scrap Recovery", addressing Advertising Council, 25 W. 45 St., New York 19, N. Y.



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McGRAW-HILL PUBLISHING COMPANY, INC.

330 WEST 42nd STREET, NEW YORK 18, N. Y.

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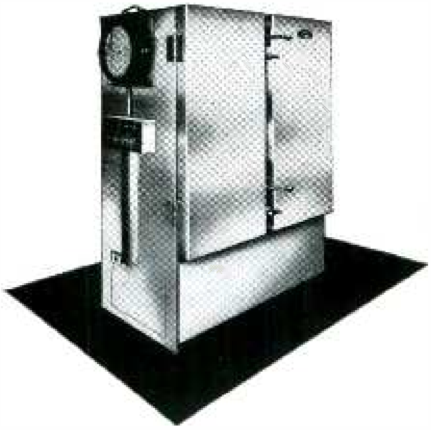
HUMIDITY TESTS



Bowser Relative Humidity Testing Units provide and automatically maintain humidity conditions from 20% to 95% at temperatures from +35°F. to +170°F. (Dry Bulb). These units are ruggedly built for extended service, yet feature the close tolerance control required for the testing of aircraft and electronic parts and equipment. The Bowser Humidity Unit is ***stainless steel throughout.*** Special accessories can be provided to meet specific requirements.

Bowser's complete line of testing, processing and storage equipment meets all MIL, JAN, USAF, AN and other Government test specs. Our Engineering staff is always available, and invites you to take advantage of Bowser's long continuous experience, the most versatile in its field.

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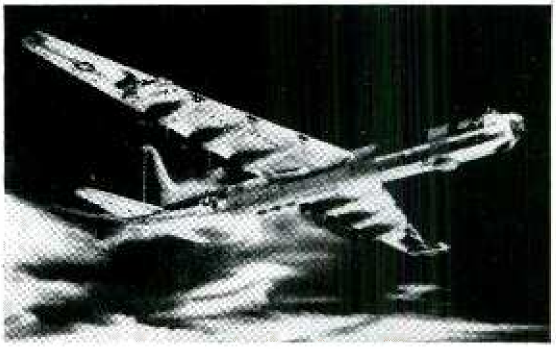
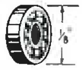


On the Frontiers of Design You'll Find Micro Ground Miniature Ball Bearings



Where instrumentation and other delicate mechanisms call for the last refinement in saving weight, space and friction, the chances are good that Micro bearings are part of the picture. America's first and only *fully ground* miniature ball bearing, Micro offers 85 sizes and types with ⅜" to ⅛" O.D. and in tolerance ranges of ABEC-5 and above. They provide all the precision advantages which are possible only in a *ground* bearing, yet they actually cost less than comparable unground miniatures.

Write for Technical Bulletin No. 50

New Hampshire MICRO Ball Bearings, Inc.

5 Main Street, Peterborough, N. H.

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size, light weight, long operating- and shelf-life are major considerations. It is illustrated with photographs, line diagrams and test-data graphs. The capacitors described are rated 0.1 to 50 μf, 150 volts d-c, and have an operating temperature range of −55 to +85 C, with a maximum loss of only 35 percent capacitance at −55 C.

Pressure Connectors. The Thomas & Betts Co., Inc., 66 Butler St., Elizabeth, N. J., has released bulletin No. 66, a new two-color 56-page catalog of pressure (solderless) connectors. It lists and illustrates the company's three complete lines of pressure fittings: the Lock-Tite line whose feature is that it has a very complete range of cable sizes; the Tite-Bind line, which is precision engineered; and the precision Hinjon line that works on the nutcracker principle. The bulletin lists connectors, lugs and taps for all kinds of copper conductors from No. 14 through 2,000,000 circular mils.

Radioactivity Equipment. Tracerlab Inc., 130 High St., Boston 10, Mass., has issued a new 108-page catalog containing full information on an extensive line of radioactivity equipment, tagged chemicals and consulting services. Many new items for laboratory, medical and industrial use are included, as well as a complete listing of chemicals tagged with radioisotopes. A section describes the firm's consulting service, especially adapted to the needs of industries not possessing a laboratory of their own, or wishing to use radioactivity for only one or two problems.

Direct-Writing Oscillograph. Offner Electronics, Inc., 5320 North Kedzie Ave., Chicago 25 Ill., has available a new bulletin giving applications, construction details and specifications of the Dynograph, high-speed direct-writing oscillograph. Contents include the story of the unit's special chopper-type amplifier for drift-free operation. The device described, operating at 100 times the speed of other industrial recorders, features a pen deflection linearity of

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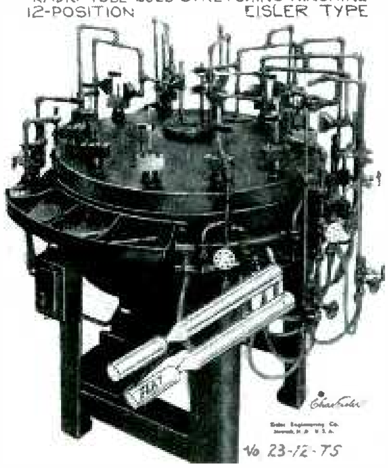

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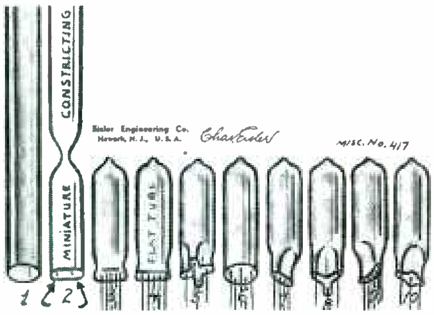

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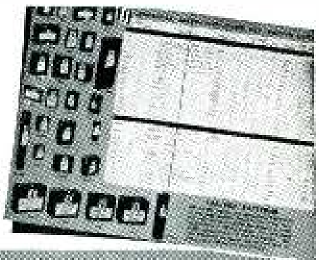

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F-M Modulation Meter. Lampkin Laboratories, Inc., Bradenton, Fla., has available a 2-page bulletin describing the type 205 f-m modulation meter that measures the maximum deviation due to modulation of fixed and mobile f-m transmitters as required by the FCC. The unit described is readily tunable to any number of transmitter frequencies as employed by public-safety, land-transportation, industrial and other two-way radio communication services from 30 to 200 mc. Price is $240 net.

TV Sound Push-Pull Amplifier. Vidaire Television Co., 576 W. Merrick Rd., Lynbrook, N. Y. A single-page bulletin introduces a push-pull sound amplifier for use with tv receivers that utilize a single tube for sound output. By plugging in the A-130 amplifier described and removing the 6K6, 6V6, or 6Y6 sound output tube, the overall frequency response of the sound system is increased. The amplifier shown in the bulletin is flat within 1.5 db between 80 and 20,000 cycles.

Lab Report. Technology Instrument Corp., 591 Main St., Acton, Mass., recently published Laboratory Report No. 4 featuring these articles: "Phase Measurements in Lattice Networks", "Production Testing of Dissipated Electrolytic Capacitors" and "Adaptation of 320-A Phase Meter in Servo System for Dynamic Balancing". Technical descriptions, photographs and drawings are included.

UHF Fundamentals. RCA Service Co., Government Service Div., Gloucester, N. J., has prepared a manual as a technical aid for uhf training and the installation, operation and maintenance of uhf electronic equipment. The booklet's content is organized for ready reference under such subjects as transmission lines, resonant sections, standing-wave measurements, cavity resonators, wave guides and wave-guide application. It will prove especially use-

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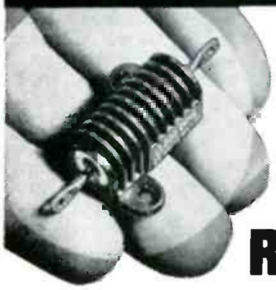

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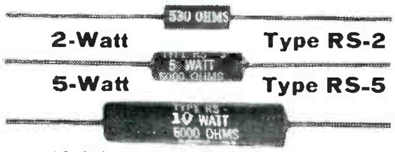

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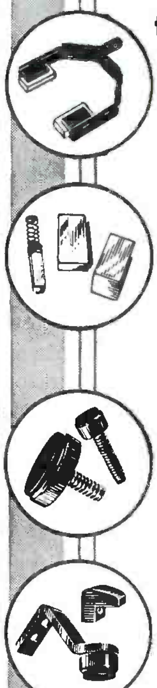

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ful to military personnel and to manufacturers holding contracts to provide uhf equipment for the military. Price is 75 cents.

Electrical Insulation. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. The new 20-page bulletin contains complete descriptive information and technical data on the properties and applications of all the different types of Macallen built-up mica electrical insulation products. Types covered include commutator segment, flat work, molding, flexible, and heater plates as well as mica combinations, tubing, tapes and commutator V-rings.

Precision Potentiometers. The Helipot Corp., 916 Meridian Ave., South Pasadena, Calif., has issued a 38-page, three-color catalog of which several pages and 8 illustrations show the facilities of the company's two factories given over to potentiometer manufacture. Twenty product pictures and more than that number of charts, diagrams and drawings amply illustrate the potentiometer catalog. Data tables, a comprehensive index, general specifications and other information are included.

Springs Bulletin. The Newcomb Spring Corp., 3902 Seventh Ave., Brooklyn 32, N. Y. In a convenient 8-page, 2-color reference guide, bulletin NS500 gives 66 hints to simplify design and reduce spring costs. Specific hints are grouped under such headings as purchasing, materials, finishes, gages, hydrogen embrittlement, compression springs, extension and torsion springs. Also given is a table of popular spring materials, their applications and specification numbers (government and civilian).

High-Vacuum Equipment. Vacuum Research Co., 2050 Orchard Ave., San Leandro, Calif., has available data sheets G-1 and S-1 dealing with high-vacuum gaskets and high-vacuum seals respectively. Various types, dimensions and prices are shown.

Recording Oscillograph. Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 8,

Calif. The 5-114 recording oscillograph, a multichannel, precision instrument for the analysis and measurement of strain, vibration, pressure, acceleration and other phenomena, is the subject of the fully illustrated technical bulletin 1500B. The instrument described records photographically up to 18 separate, static or high-frequency phenomena simultaneously at record speeds of ½ in. to 115 in. per second.

Component Manufacturing. Acme Electric Corp., Cuba, N. Y., has issued special catalog MT-188 illustrating its facilities for producing transformers and other components essential to producing electronic and electrical equipment. Illustrations of the company's research and engineering departments show several installations of the special testing equipment necessary to comply to MIL-T-27 specifications. A history of the company and examples of types of products for military, industrial and civilian use are included.

Solderless Terminals. Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa., has published a 78-page technical data catalog of interest to electrical engineers, designers and wire foremen. Actual case studies are included that show amounts of time and labor saved by use of solderless terminals on various applications. The story of the pressure crimp is augmented by test curves showing terminal performance under varying conditions of altitude, vibration, corrosion and low currents, audio and radio frequencies.

Low Resistance Test Sets. Shallcross Mfg. Co., Collingdale, Pa. Bulletin L-12 describes the company's line of low resistance test sets and milliohmmeters, including several new models. Originally developed for determining the quality of airplane and railway electrical welds or bonds by direct measurement of resistance and/or comparison with test standards, the instruments described have since been used in many other applications. Among the uses are measuring the contact resistance of switches, relays and circuit breakers, the re-

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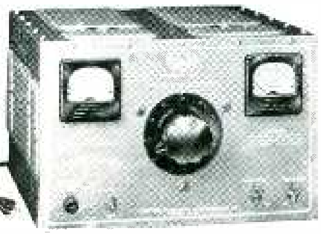

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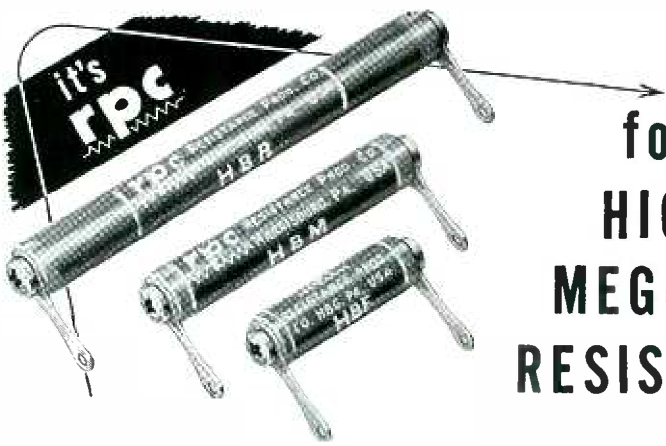

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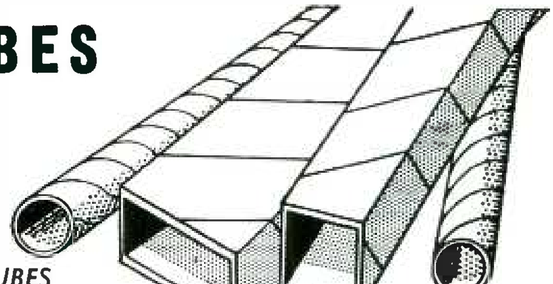

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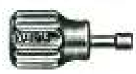

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sistivity of heavy conductors and the bar-to-bar resistance of commutators.

Continuous Balance System. Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa. Bulletin B15-12 gives a 24-page description of the circuit and component characteristics of the amplifier and motor combination of the ElectroniK continuous-balance system. This is the first in a series of bulletins to aid in the adaptation of this equipment to many specialized applications.

Radio Carrier System. Lenkurt Electric Co., San Carlos, Calif. Form 33B-P describes a stackable single-sideband suppressed-carrier communication system designed for channelizing point-to-point radio communication links. It shows the general arrangement of channelizing equipment, gives a description of system operation, and includes the frequency allocation by which three alternatives are provided: 12 100-to-2,900-cps voice channels; 11 voice channels plus 11 carrier-signalling channels for 12-pps transmission; or seven voice and seven signalling channels—the seven-channel arrangement uses only the lower 35 kc of the 48-kc spectrum utilized by the full system.

Power Rectifiers. Sarkes Tarzian, Inc., Rectifier Division, 415 North College Ave., Bloomington, Ind., has released the 16-page comprehensive catalog No. PR1, covering power selenium rectifiers. The catalog shows isothermal, frequency, reverse-versus-temperature curves and others not heretofore published. The information given is useful to engineers who design power supplies for the military service. Conventional circuits, selenium cell ratings, rectifier stack and stack connection data are included.

Tubings and Sleevings. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill., has issued an eight-page product bulletin on Dieflex flexible braided tubings and sleevings. It contains full information on their features, classes, grades and types. Easy-to-read technical data covers proper-

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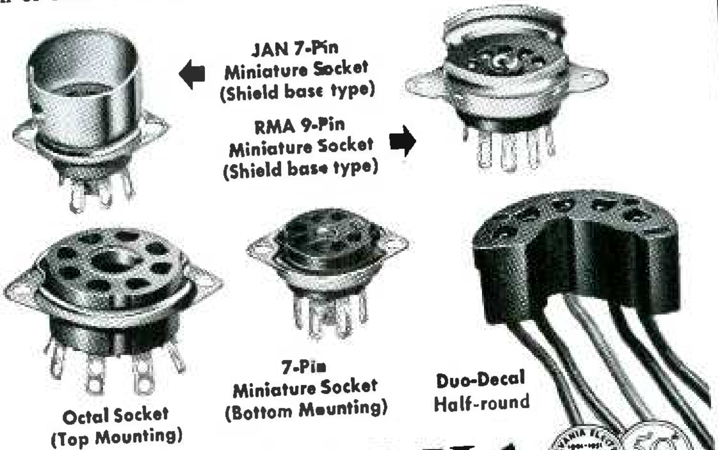

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Tube Data. Radio Corp. of America, Harrison, N. J. Arranged in an easy-to-read tabular form in Form CRPS-102-A is detailed technical data on more than 150 tube types including single-unit, twin-unit and multiplier phototubes; c-r tubes; camera tubes; monoscopes; low-microphonic tubes; uhf tubes and other types for special applications. Descriptions, ratings, operating conditions, dimensions, base and envelope connection diagrams and applications are given on all types. Many tubes are illustrated and spectral sensitivity curves are given for all phototubes. Price is 15 cents a copy.

Laboratory Report. Technology Instrument Corp., 531 Main St., Acton, Mass. Laboratory Report No. 3 now available upon request features an article on a new analog computer and also the first part of a description of a production test method for the determination of the linearity of precision potentiometers.

Speaker Catalog. Oxford Electric Corp., 3911 South Michigan Ave., Chicago 15, Ill. Completely illustrated in three colors the new catalog lists all information on the company's line which includes permanent magnet speakers, electrodynamic speakers and speakers for tv replacement, auto radio replacement, public address, intercoms and outdoor weatherproof applications.

Universal Power Supplies. Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y. A recent 4-page folder deals with a line of power supplies for general experimental use, laboratory work, production testing or service shop use. General and specific applications, typical power applications and technical data are included.

Connectors. Monowatt, A Dept. of General Electric Co., Prov-

idence 7, R. I. A 16-page booklet gives basic design, features, dimensions, alternate insert positions and numbering system for a line of AN connectors for aircraft and electronic use. Type 3100 wall mounting receptacle, 3101 cable connecting receptacle, 3102 box mounting receptacle 3106 straight plug, 3108 angle 90-deg plug and 3057 cable clamp are covered.

Magnetic Contactor. The Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford 6, Conn. An 8-page folder deals with the size 00 multipole convertible magnetic contactor. The type CRA unit described features smaller size, more adaptability, versatility and advanced design. The booklet is thoroughly illustrated and gives complete technical information.

Ultrasonic Testing.. Sperry Products, Inc., Danbury, Conn. Commercial ultrasonic testing services of metals and other materials in the field and at the company's testing laboratory are described in bulletin 50-115. The Reflectoscope described locates discontinuities in metals and plastics by directing a pulsed ultrasonic beam through the material and measuring elapsed time of reflections from discontinuities in the path of the beam. The Reflectogage discussed measures thickness of metals and other materials up to 4 inches, from one side only.

Quick Connector. Jiffy Clip Mfg. Co., 128 Clinton Place, Huntington, L. I., N. Y. A single-sheet bulletin describes and illustrates a fumble-proof connector for quick positive circuit construction. The connector discussed measures 0.051 × 0.187 × 0.520 in., has a resistance of less than 0.001 ohm, and will effectively carry up to 30 amperes with no arcing. Featured in the device described is a phosphor bronze spring tip that reaches, grips and holds in hard-to-get-to places. Prices are included.

Nucleonic Instruments. Tracerlab Inc., 130 High St., Boston 10, Mass. Catalog C gives a 108-page illustrated description of a line of nucleonic instrumentation and radiochemicals for research institutions, industrial laboratories and the medical professions. Topics covered include: scalers, scaler accessories, amplifiers and sample changers, survey meters, personnel protection devices, Geiger tubes and their accessories, scintillation equipment, reference sources, medical sources, industrial equipment, tagged chemicals and services. An index and price list are included.

All-Band Mobile Antenna. Master Mobile Mounts, Inc., P.O. Box 1817, Los Angeles 36, Calif., has available a single-sheet bulletin on an all-band mobile antenna by means of which it is possible to change coils to any band, 80 through 10. The unit discussed comes with one coil, either 20, 40 or 75 meters. An illustrated technical description, specifications and prices are given.

Plastics. The Richardson Co., 2764 Lake St., Melrose Park, Ill. Titled Facts About Plastics, a new 24-page booklet is designed to give the layman a basic introduction to the many different plastics now in use. Subjects covered include: history of plastics; plastics advantages and limitations; thermosetting and thermoplastic materials; how laminated and molded plastics are made; design suggestions; industrial and consumer applications; comparative properties of different grades; and products, facilities and services of the company.

Miniaturization. Tetrad Co., Inc., 4921 Exposition Blvd., Los Angeles 16, Calif. Bulletin 951, entitled Masterpieces in Miniature, illustrates hermetically sealed miniature transformers, solenoids, radar deflection yokes, radar peaking coils, pulse transformers, universal windings and tv horizontal output transformers, focus coils and radar tuning and peaking coils. Also shown are special coils made to customer design.

Fixed Paper Dielectrics. General Electric Co., Schenectady 5, N. Y., has announced a new two-color booklet on a line of fixed paper-dielectric capacitors for a-c and d-c applications. Designated as publi-

cation GEC-809, the bulletin describes the operation, features and application of the equipment. It is illustrated with photographs, line drawings and charts showing the deratings for a-c and d-c applications.

Terminal Bulletin. Kulka Electric Mfg. Co., Inc., 633 S. Fulton Ave., Mt. Vernon, N. Y., has issued a bulletin on its terminal blocks that simplify wiring work, reduce assembly costs and assure positive, lasting connections. Different types are illustrated and described, with dimensions, catalog number and list price of each. Dimensional drawings and complete data on marker strips are also found herein.

Radio Transmitter-Receiver. Link Radio Corp., 125 W. 17th St., New York 11, N. Y. A two-page bulletin deals with the type 1498 Ed. 6-R radio transmitter-receiver, a deluxe fixed station with a 50-watt nominal output for the 72 to 76-mc frequency range. The unit described features an automatic modulation limiting circuit. The highly selective receiver involved provides at least 100-db attenuation of a signal 30 kc from operating frequency. Principal characteristics and specifications of the unit are given.

Linear Transducers. Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa. New engineering data folders describe and illustrate Atcotran differential transformers for use where highly accurate measurements of motion, from a few microinches up to 5 inches, are required. The transducers under discussion will generate an a-c voltage signal that is directly proportional to the position of its armature from the electrical center of the transformer wiring, and will achieve a linearity of 0.1 percent. The folders contain operation features, electrical data, types available from stock and wiring diagrams.

Coil-Winding Machines. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Petersen, Chicago, 30, Ill., has issued a new 32-page catalog illustrating and giving detailed descriptions of a line of coil-winding machines that wind practically every

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Single pole and double pole
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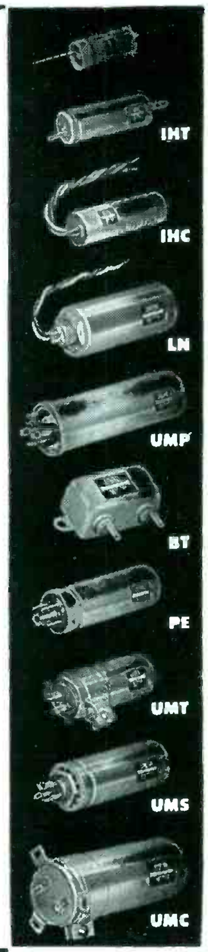

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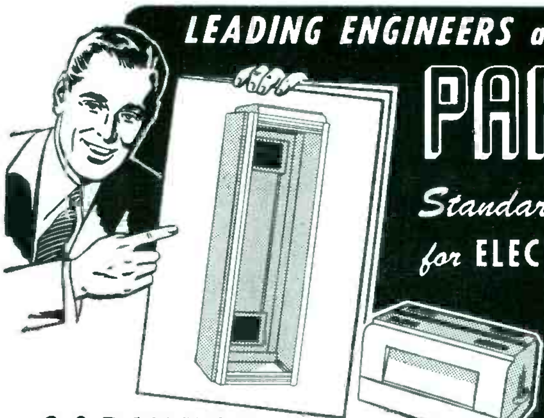

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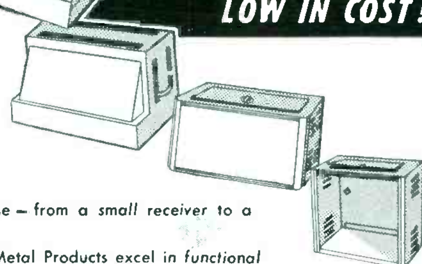

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kind of coil for laboratory or production line. Described are machines winding such coils as armature, bobbin, choke, heavy-duty field, paper section, lattice-wound progressive universal, random, repeater, resistor, solenoid, space wound, transformer and variable pitch coils in a wide variey of sizes. One section deals with special and individual applications. Another section lists accessories.

Electronic Cores. Metal Powder Association, 420 Lexington Ave., New York 17, N. Y. Up to now, purchasers and users of electronic cores were faced with the problem of trying to correlate designations of the various companies with the raw materials used and also compare one company's products with that of another. Data sheet No. 1 eliminates this problem. It cross-references designations of the basic electronic core materials with the corresponding designations of eight of the leading core manufacturers. It is now possible to determine at a glance who makes cores from any of twenty-five different basic materials; what their core designation is; and what corresponding designations are used by other core makers.

Instruments & Resistors. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J. A four-page folder describes and illustrates a line of sweep signal generators operating at video, ultrasonics, low and high radio frequencies and at intermediate frequencies. Also described are the Stablohms, a group of microcrystalline carbon film resistors for applications where precision, good delivery, low price and low temperature coefficient are important factors.

Glass for Electrical Design. Corning Glass Works, Corning, N. Y. The eight-page bulletin B-88 gives an illustrated description of the applications of glass in the electrical and electronics industry. Featured in the glass described are high dielectric strength; low power factor; low loss factor; high volume resistivity; high surface resistivity; hard, smooth surface; dielectric constant and controlled expansion coefficients.

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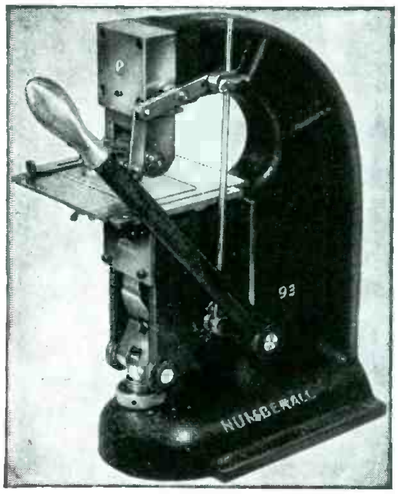

Model 93

This press is principally made for use with our Automatic Numbering Head Model No. 50 for consecutive numbering. Stamps serial numbers on name plates, etc. Non-automatic numbering head and typeholders and steel type can also be used in this press. Press exerts a high pressure up to 10 tons. Head space adjustable.

Write for Bulletin 1E93

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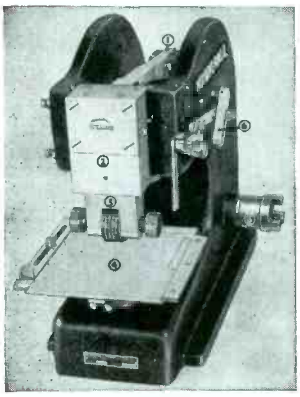

Model 133

Designed for use in stamping name plates and small parts, eliminating the use of a power press. Ram head takes Type Holders, Numbering Heads and special Dies. A tripping attachment can be supplied for use with automatic numbering heads for consecutive numbering.

Model 131 is hand operated easily by a lever. Model 132 operated by 3" air cylinder. Operation controlled by a 4-way hand or foot valve.

Stamps up to ten 1/8" characters in aluminum plates.

Model 133 is operated by motor through an eccentric having a releasing device, stamping once each time control lever is depressed. Stamps continuously if control lever is held down.

Write for Bulletin E-131.

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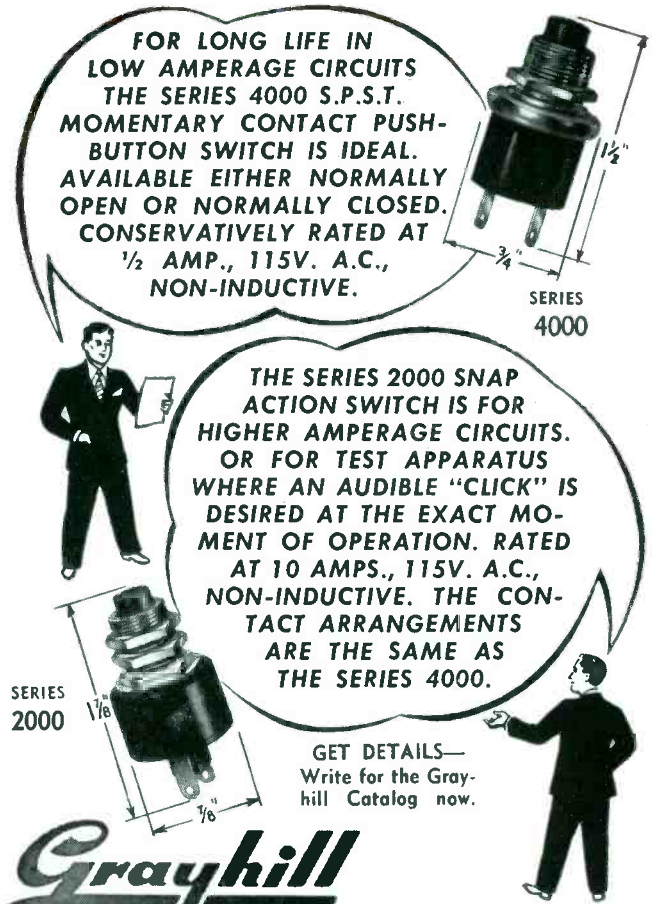

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(continued from page 150)

tained from any first or second class post office. When completed, forward to Chief, Civilian Personnel Division, Building No. 530, Headquarters, Fort Monmouth, N. J.

Freeze Lift Predictions

GOVERNMENT officials have now arrived at more realistic predictions of the approximate time that the freeze on new television stations will be lifted, the lag to be expected before these stations will go on the air, and the amount of critical materials that may be needed, assuming the military program follows present planning.

Curtis B. Plummer, chief of the FCC Broadcasting Bureau, told the transmitter group of RTMA recently that the tv freeze probably would be lifted between February 1 and March 1 of 1952. Assuming that FCC could start granting permits for new stations about April 1, 1952, he forecast as many as 80 new stations by July 1952, providing no serious legal entanglements developed during the hearings. The new outlets would go in small, relatively uncontested areas with populations of 50,000 or under—possibly a few in 100,000 population communities. This shapes up as an estimated potential market for 600,000 sets a year.

Any sizeable expansion in television is still a long way off, Plummer warned. Highly competitive markets, like Portland, Denver and El Paso, may require long-drawn-out hearings. These expected delays will be further aggravated by manpower shortages.

The commission is asking an increase of $600,000 in the budget, part of which would be used for adding seven more examiners to the staff. An examiner can move about 15 to 20 a-m applications a year.

Assuming an average of 10 months as a lead time, few, if any new stations will be on the air by January 1, 1953, according to E. T. Morris, Jr., Director of the Electronics Division of NPA. Stations should begin operating during the first quarter of 1953, he said, with

the first 80 on the air by the middle of 1953. Morris indicated that every effort will be made to give industry reasonable amounts of critical materials. He estimated that materials requirements for this equipment will hit the civilian economy between July and December, 1952.

Assuming the manufacture of equipment sufficient for 40 complete stations per quarter for the last half of 1952, Morris estimated that the equipment material requirements will be 2,000 tons of structural steel, 3,400 tons of other steel, 400,000 pounds of copper, and 85,000 pounds of aluminum per quarter, starting with the third quarter of 1952. This estimate assumes that the material will be available at that time.

Morris forecasts between 3.5 and 4 million tv sets for 1952, compared with 7.4 million sets for 1950 and about 5 million sets for 1951. He qualified his 1952 figure by saying that many factors could affect the estimate, as for example, substitutions and conservation of materials. Conversely, the shortage of one critical component could curtail production seriously, but taken all in all, there is the possibility of 4 million tv sets in 1952.

IRE Awards

AT A board of directors meeting held in September the IRE awarded its Medal of Honor for 1952 to W. R. G. Baker of General Electric Co., and its Harry Diamond Memorial Award to Newbern Smith of the National Bureau of Standards.

Recipients of the Fellow award are as follows:

J. L. Barnes of North American Aviation, Inc., Downey, Calif.; S. J. Begun of Brush Development Co., Cleveland, Ohio; R. D. Bennett of Naval Ordnance Laboratory, Silver Spring, Md.; L. L. Beranek of MIT, Cambridge, Mass.; H. W. Bode of Bell Telephone Laboratories, Murray Hill, N. J.; L. N. Brillouin of IBM, New York, N. Y.; M. Camras of Armour Research Foundation, Chicago, Ill.; C. W. Carnahan of Sandia Corp., Albuquerque, N. M.; P. S. Christaldi of Allen B. Du Mont Laboratories, Clifton, N. J.; L. J. Chu of MIT; H. P. Corwith of Western Union Telegraph Co., New York, N. Y.; A. B. Crawford of Bell Telephone Laboratories, Fair Haven, N. J.; L. A. De Rosa of Federal Telecommunications Laboratories, Inc., Nutley, N. J.; L. T. DeVore of General Electric Co., Syracuse, N. Y.; D. W. Epstein of RCA Laboratories, Princeton, N. J.; L. M. Field of Stanford

U., Stanford, Calif.; L. B. Hallman, Jr., of U.S.A.F., Wright-Patterson AFB, Dayton, Ohio; R. N. Harmon of Westinghouse Radio Stations, Inc., Washington, D. C.; H. E. Hartig of U. of Minnesota, Minneapolis, Minn.; J. K. Hilliard of Altec Lansing Corp., Beverly Hills, Calif.; R. S. Holmes of RCA Laboratories, Princeton, N. J.; C. N. Kimball of Midwest Research Institute, Kansas City, Mo.; W. E. Kock of Bell Telephone Laboratories, Murray Hill, N. J.; H. B. Law of RCA Laboratories, Princeton, N. J.; L. Malter, also of RCA Laboratories; W. S. Marks, Jr., of Coles Signal Laboratory, Fort Monmouth, N. J.; W. W. Mumford of Bell Telephone Laboratories, Red Bank, N. J.; L. S. Nergaard of RCA Laboratories, Princeton, N. J.; H. Nyquist of Bell Telephone Laboratories, New York, N. Y.; J. A. Ouimet of Canadian Broadcasting Corp., Montreal, Canada; H. W. Parker of Sylvania Electric Products, Inc., Flushing, N. Y.; D. W. Pugsley of General Electric Co., Syracuse, N. Y.; L. R. Quarles of Oak Ridge National Laboratory, Oak Ridge, Tenn.; J. D. Ryder of U. of Illinois, Urbana, Ill.; B. Salzberg of Naval Research Laboratory, Washington, D. C.; H. H. Scott of Herman Hosmer Scott, Inc., Cambridge, Mass.; W. G. Shepherd of U. of Minnesota, Minneapolis, Minn.; N. Smith of National Bureau of Standards, Washington, D. C.; P. H. Smith of Bell Telephone Laboratories, Whippany, N. J.; C. S. Szegho of The Rauland Corp., Chicago, Ill., L. C. Van Atta of Hughes Aircraft Co., Culver City, Calif.; R. H. Varian of Varian Associates, San Carlos, Calif.; J. R. Whinnery of Hughes Aircraft Co., Culver City, Calif.; J. B. Wiesner of MIT; and C. E. Williams of Puget Sound Naval Shipyard, Bremerton, Wash.

Presentation of the awards with citations will be made by the president of the Institute at the annual banquet on March 5, 1952 at the Waldorf-Astoria Hotel in New York during the 1952 IRE National Convention.

New Test Facilities for Antennas

PART of the new $25,000 test facilities being used to determine the vertical directivity pattern of broadcast antennas by the Broadcast Design Group of the RCA Engineering Products Department is a 100-foot circular concrete apron, resembling a huge sundial.

Located at Medford, N. J., the test apron eliminates the need for erecting antennas in the normal vertical position. A steel frame mounted on five wooden dollies permits movement of antenna elements in a horizontal position, the only reliable means of establishing the gain characteristics of broadcast antennas.

Antennas are connected by cables to electrical test equipment in a nearby building. A signal generator is located at a distant point, and the antenna is rotated on its horizontal axis while data is recorded by means of a selsyn drive.

The center dolly revolves through

RCA test frame to determine directivity pattern of broadcast antenna is shown in operation at Medford, N. J. Steel frame rotates on dollies, permits movement of antenna elements in horizontal position, the only reliable means of checking gain characteristics of broadcast antenna

a 360-degree arc around a vertical shaft in the center of the apron. The steel frame, which holds antennas under test, is built in sections and can be extended up to 140 feet in length.

Simplified FCC Application

FCC PROPOSES to amend Parts 1, 10, 11 and 16 of its rules so as to implement a new application Form 400 applying to stations in the Public Safety, Industrial and Land Transportation Services. Upon approval by the Commission, a portion of the application is authenticated, torn off and returned to the applicant as his station authorization.

A proposed amendment form (Form 400-A) will similarly eliminate the necessity for submitting a complicated application when simple changes, such as relocation of a control point, are desired.

As further assistance to prospective licensees, the Commission will compile and maintain a list of transmitting equipment that is acceptable for licensing in these services.

Amateur Radio Parts Quotas

NPA ORDER M-85 gives priority aid to licensed amateur radio operators who are active members of the nine

designated communications systems that include the American Red Cross National Emergency Net and Amateur Radio Emergency Corps of the American Radio Relay League.

Whereas unaffiliated amateurs will be limited to $100 on self-rated orders, network members will each have an annual quota of $200 worth of hard-to-get parts. Quotas may be pooled to meet unusual needs. Purchases made without use of a rating do not affect the allotment quota.

By its order, NPA recognizes the special role of amateur radio operators and the Civil Air Patrol in the defense program. According to estimates, the number of active amateurs should be increased from the present 40,000 to about 200,000.

BUSINESS NEWS

BRANSON INSTRUMENTS, INC., have moved their facilities to a new plant in Stamford, Conn. The new building has twice the floor space of the previous location, and will enable the company to expand its production of ultrasonic thickness gages, ultrasonic flaw detectors and other electromechanical devices.

SYLVANIA ELECTRIC PRODUCTS INC. has organized a subsidiary, Sylvania Electric of Puerto Rico, Inc., to fabricate mica for use in radio tubes.

GEORATOR CORP., Arlington, Va., manufacturer of permanent magnet generators, has acquired the complete business and manufacturing facilities of the Geophysical Instrument Co.

SPRAGUE ELECTRIC CO. has purchased a 45,000-sq ft plant in Bennington, Vt., for the manufacture of Ceroc 200 and Ceroc T magnet wire for military electronic and electrical components.

WESTINGHOUSE AIR BRAKE CO. has acquired the entire capital stock of Melpar, Inc., of Alexandria, Va. and Cambridge, Mass. Present management at Melpar, Inc., will continue. Anticipated plans call for a large expansion program to meet the increasing demands upon this company for Armed Services research and development programs.

ALLEN B. DU MONT LABORATORIES, INC., is converting its tv receiver manufacturing plant in East Paterson, N. J., for the production of the nation's military electronic needs.

MATHEMATICAL COMPUTING SERVICE, Brooklyn, N. Y., was recently organized to perform engineering calculations in the field of electronics.

TECHNOLOGY INSTRUMENT CORP., potentiometer and precision laboratory instrument manufacturers, have moved from Waltham, Mass., to a new and larger plant in Acton, Mass.

PERSONNEL

JONATHAN R. ROEHRIG, formerly with Submarine Signal Co. and its successor, Raytheon Mfg. Co., in the sonar section, is now associated with National Research Corp., Cambridge, Mass., as a project manager in the physics research department.

MILLARD LEFF, previously engaged in an engineering capacity with the Squire Signal Laboratory at Ft. Monmouth, N. J., recently joined the sales staff of David Sonkin, sales engineer for manufacturers, New York, N. Y.

WARREN D. PALEY has been appointed president of Maypal Electronic Laboratories, Inc., 200 W. 72nd St., New York, N. Y., a firm of electronic engineers specializing in the design and development of electronic and electromechanical devices.

RALPH B. LADD, until last year chief of the Electronics Section in the Chicago region of CAA, has been named chief of the Electronics Division of the Office of Aviation Defense Requirements of the Civil Aeronautics Administration. He

will be responsible for all Federal airways requirements programs as well as airborne electronics and electrical requirements for civil aviation.

IVAN A. GETTING, former professor of electrical engineering at MIT, has been elected vice-president, Engineering and Research, of Raytheon Mfg. Co., Waltham, Mass.


I. A. Getting


W. C. Peacock

WENDELL C. PEACOCK, one of the five original founders of Tracerlab, Inc., Boston, Mass., in 1946, has been elected vice-president and technical director and a member of the board of directors of the company.

W. P. MAGINNIS, in the communications engineering field for 22 years, all but one of which was spent with RCA, was recently appointed assistant to the vice-president in charge of manufacturing operations for Federal Telephone and Radio Corp., Clifton, N. J., an associate of IT&T Corp.

E. A. GAUGLER, formerly chief of the Magnetics Division, Naval Ordnance Laboratory, has left there to become vice-president and director of research of Magnetics, Inc., Butler, Pa.

ROBERT HERTZBERG, long active in the technical magazine field as writer, editor and publisher, has established a consulting publications and public relations service for radio manufacturing and merchandising firms and their associated advertising agencies in Jackson Heights, N. Y.

GEORGE I. COHN, assistant professor of electrical engineering at Illinois Institute of Technology, has been promoted to associate professor.

NEW BOOKS

(Continued from page 152)

power law. Graphical design charts are included for all except the simpler formulas, and the design of a simple super-regenerative receiver can proceed with only the additional aid of a slide-rule. This section is followed by one for a rectangular quench waveform.

Later chapters consider the logarithmic mode, automatic gain-stabilizing measures, and typical super-regenerative circuits. The analysis of the logarithmic mode of operation is necessarily approximate, but useful formulas are derived for the radio-frequency response, the distortion in reception of amplitude-modulated signals, and the limiting quench frequency. Self-quenching receivers are also briefly treated. The chapter on or superheterodyne receiver." The automatic gain stabilization again includes graphical design data for slope-controlled sinusoidally quenched receivers.

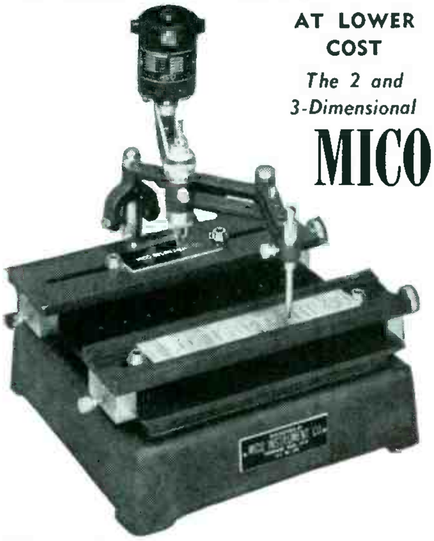
In the chapter on super-regenerative circuits Dr. Whitehead states, "There is now no doubt that the super-regenerative receiver has earned the right to be considered for a given application on the same basis as the tuned radio frequency or superheterodyne receiver." The availability in his book of an adequate theoretical treatment, as well as readily applicable design information, should do much to increase the number of applications of the economical and simple super-regenerative principle of amplification.—RUSSELL YOST, *Assistant Supervising Engineer, Airborne Instruments Laboratory, Mineola, New York.*

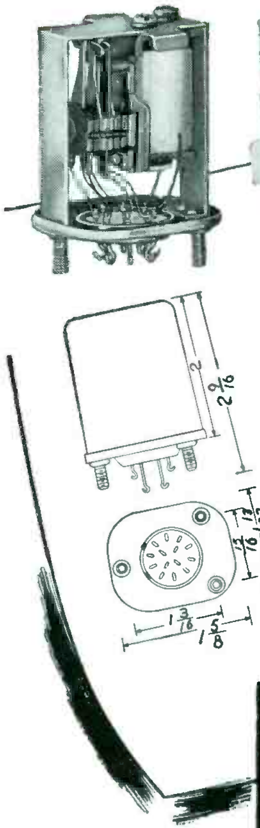
Radio Handbooks

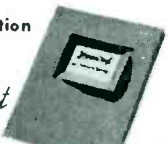
RADIO AMATEUR'S HANDBOOK, *twentieth edition. American Radio Relay League, West Hartford, Conn.*, 618 *pages*, $3.00.
RADIO HANDBOOK, *thirteenth edition. Editors and Engineers Ltd., Santa Barbara, California*, 736 *pages*, $6.00.

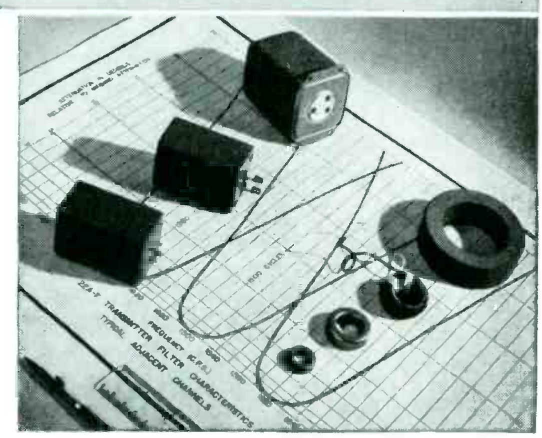
IT seems appropriate that these two books should arrive for review within the same month. They have often been compared over the air, their readership generally being among radio amateurs, technicians and engineers involved in communications development projects and research.

Both books contain general sec-







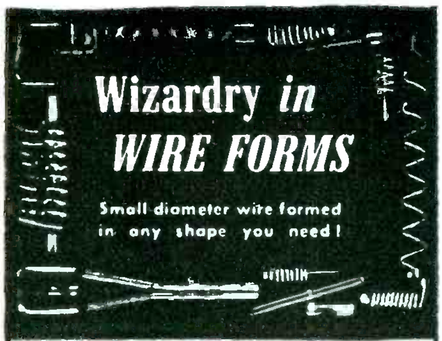


tions that should appeal to the most advanced engineer as well as the beginning experimenter, and each contains a wealth of tried and proven construction projects. In both books, many of these projects are carry-overs from previous editions. They are in general carefully and thoroughly described and generously illustrated. The "Radio Handbook" encourages the use of surplus equipment wherever practicable on the basis of availability, economy and ease of conversion.

The ARRL handbook contains what is still probably the most complete listing of communication type tubes to be found anywhere. The listing is complete in the sense that a great many tubes are mentioned, not because the information presented on each is complete. The other handbook takes a different attitude toward coverage of tube information. It includes only the more popular types, but the information is presented in a much more helpful and convenient form. All information is contained in one spot, to avoid continual cross-referencing and jumping back and forth between characteristics, socket connection charts and other data. Each tube reference contains a paragraph or two pointing out the particular merits of that tube for particular applications. This sort of information cannot, of course, be included in the lengthy but sketchy ARRL listings.

One particularly annoying feature of the ARRL handbook is the apparent reticence of its editors toward developments that were not originally reported in *QST*. To be specific, the new edition contains practically no reference to the presently popular clamp-tube modulation technique (revived in Sept. 1950 *Radio News*). Also, many developments that were brought out in *CQ* magazine (such as the popular cubical quad antenna) have been ignored. There are numerous other examples that indicate a lack of completeness in a book that has long enjoyed a high reputation among the amateurs of the world.

In general a choice between the two would seem to be a matter of personal preference. "Radio Handbook" is somewhat more progressive and thorough in its coverage



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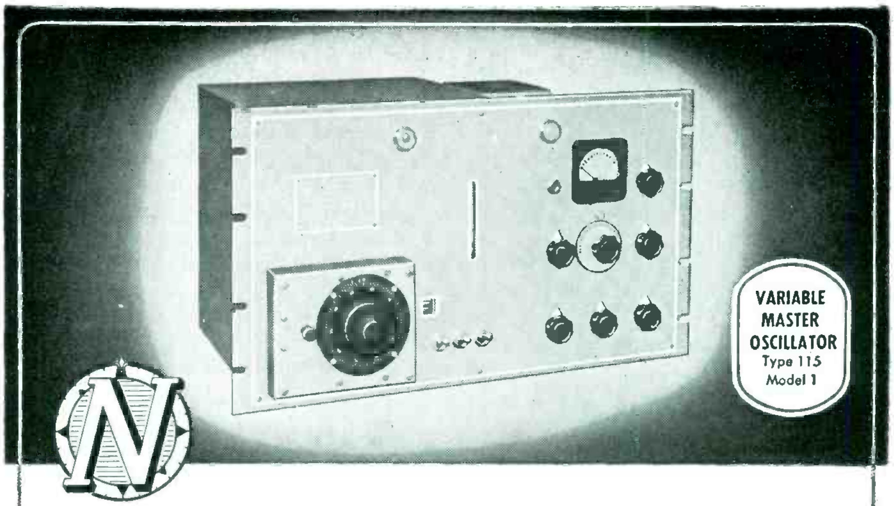

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High versatility, plus wide range, plus crystal stability and accuracy—that's the unbeatable combination for the best in diversity reception. You get all three with the Northern Radio VARIABLE MASTER OSCILLATOR. The HFO's stability is ± 20 cps/mc for ambient change of ± 25°C.—matching that of any non-temperature controlled crystal. Its range is 2-32 mc continuous. Crystal check points, with 40 curves supplied, permit absolute frequency setting to ± 25 cps/mc. Three crystal-controlled frequencies provide fixed frequency reception. There's a LF crystal oscillator for BFO.

And, this unit also serves as an excellent transmitter exciter and laboratory measuring standard.

See the specifications on this outstanding model in the 1951 Electronics Buyers Guide. For complete data on the precision-built Northern Radio line, write today for your free latest Catalog E-12.

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• STABLE • DEPENDABLE • MODERATELY PRICED •

STANDARD RACK MOUNTING
PANEL SIZE 10½" x 19"
DEPTH 9"
WEIGHT 38 LBS

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 VDC at 300 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 5A unregulated
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- **RIPPLE OUTPUT:** Less than 10 millivolts rms

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Because they combine exceptional *resiliency* with good *conductivity*, Metex Electronic Products made of knitted wire mesh offer an unusually effective means of sealing and shielding a wide variety of types of electronic equipment.

As closures for sheet metal cabinets, for instance, the resiliency of "Metex" assures positive conductive contact *at every point* between cover and cabinet —eliminating costly machining for close tolerances. Metex Gaskets also assure resilient metal-to-metal contact between flanges, and can be combined with rubber compounds to function both as a shield and as a seal.

Applications in which "Electronic Weather Strips" have already proved their effectiveness include pulse modulator shields, wave-guide choke-flange gaskets, replacement of beryllium-copper fingers and springs on TR and ATR tubes.

We will be glad to put our experience at your disposal. A letter to Mr. R. L. Hartwell, outlining your problem, will receive immediate study. For preliminary information, write for bulletin "Metex 'Electronic Weather Strips.'"

METEX QUALITY PRODUCT

METAL TEXTILE CORPORATION

641 EAST FIRST AVENUE, ROSELLE, N. J.

of the newest and most helpful developments. "Radio Amateur's Handbook" is still good, but the distribution of emphasis it employs seems to be in need of some revision. In many cases the circuits presented seem unnecessarily complex. It is obvious that the writers of the equipment descriptions have had much more time and money to devote to their projects than would the average reader.

"Radio Handbook" is superior in its coverage of mobile gear. The circuits it suggests seem to be much more down to earth and within the means of builders. The ARRL handbook holds the advantage in describing operating procedures and, of course, in telling of League facilities and activities.

In conclusion, it should be said that both books are technically well organized. It is doubtful that "Radio Handbook" will ever achieve the wide acceptance that has annually been accorded the ARRL handbook. In most cases the former will be bought as a supplement to the latter, but in certain instances, it might be purchased by direct preference.—J.D.F.

Automatic Feedback Control

BY WILLIAM R. AHRENDT AND JOHN F. TAPLIN. *McGraw-Hill Book Co., New York*, 1951, 412 *pages*, $7.50.

FEEDBACK control, as the authors point out, is not a new invention. What is new is our ability to recognize, analyze and apply the principles of feedback control. This book presents methods for analyzing and applying feedback control principles to mechanical, electrical, pneumatic and hydraulic systems.

The material in this book is roughly divided into two sections. The first section describes the mathematical approach to the general problem, while the last section describes many practical applications of automatic feedback control in the different fields. Various application analyses cover the approach to be used in similar systems design.

The introductory chapter describes the basic problem of automatic feedback control and the major components required to form a system, as well as standard termi-

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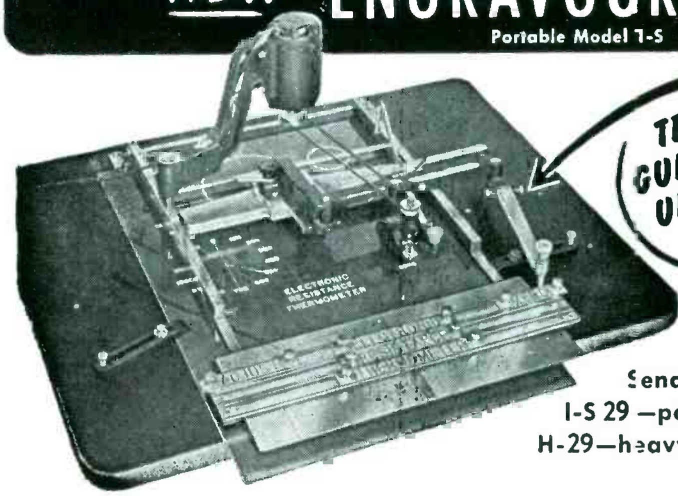

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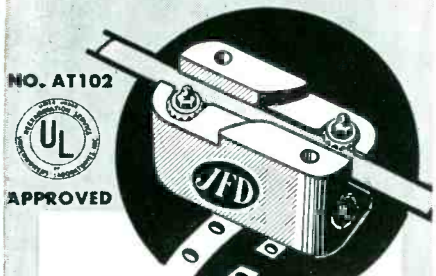

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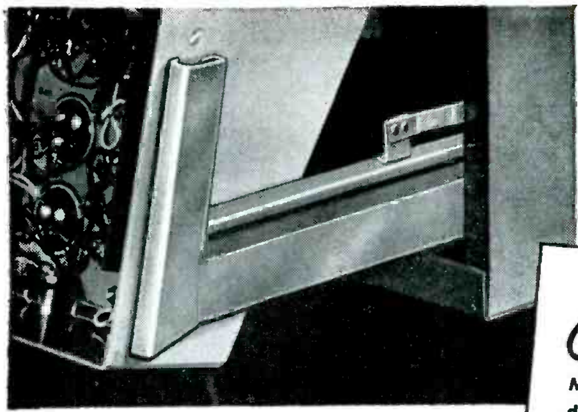

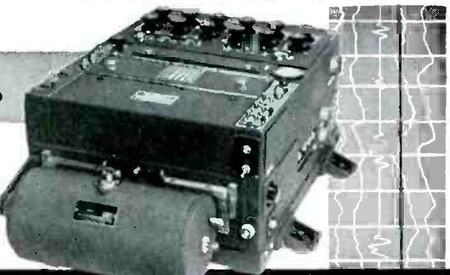

nology and symbols. It should be pointed out that the terminology and symbols used throughout this text are those proposed by both the AIEE and ASME. This is one of the first books on this subject using such symbols. The authors and the members of the Committee on Feedback Control Systems of the AIEE recommend these standard symbols so that they will eventually become common knowledge. Since the analysis of feedback control is essentially a mathematical process, the precise meaning of the symbols used is of primary importance to simplify the understanding of the problem.

A short review of differential equations, complex numbers and the Laplace Transformations is introduced in the second chapter. Example problems are worked out along with a detailed explanation of the complex or s plane.

Other chapters describe the operational method of analyzing feedback control along with the frequency spectrum analysis. Next it is shown how these methods of approach are applied to the analysis and synthesis of single and multiple feedback control loop systems.

The assumption is made when analyzing any feedback control system that the system will be linear. In actual practice, this condition does not exist; therefore, a chapter entitled Nonlinearity and Discontinuity is included which discusses these factors and how to handle them in practical applications.

The second section of this book includes chapters on Servomechanisms, Pneumatically Operated Controllers, Temperature Regulation, Speed Governing and Hydraulic Systems. These chapters describe actual systems, the components required, and the method required for analysis and synthesis peculiar to each system.

This reader feels that "Automatic Feedback Control" is one of the most complete books thus far available on that subject. The material is presented in a clear manner, and through the use of many charts and graphs the physical meaning of many formulas is brought out. Examples are worked out in the text, and problems are included at the end of the text

along with the answers. This book may be used as a text in a course on Feedback Controls for either mechanical or electrical engineering students. It is so written as to be of immense value to the practicing engineer not yet familiar with this field.—EDWARD W. GARDINER, *Servo-Tek Products Co., Inc., Paterson, N. J.*

An Introduction to Electron Optics

BY L. JACOB. *Methuen's Monographs on Physical Subjects, John Wiley & Sons, Inc., New York, 150 pages, $2.00.*

DR. JACOB is well qualified to write a book on electron optics as a result of his long association with the problems of cathode-ray tube and electron microscope design. This book, one of a series of monographs on physical subjects, is intended to supply readers of average scientific attainment with a compact statement of the modern position of the subject. To this end Dr. Jacob has done an exceptionally thorough job, as portions of the book will be of value to workers in the field of applied electron optics.

Any text of an introductory nature on this subject should contain a background of information on fundamental physical principles to enable the reader to understand the more advanced concepts of electron lens characteristics and the properties of electron beams. To fulfill this requirement, Dr. Jacob has included a chapter on the basic principles of electron motion in a potential field, treated from the standpoint of the dynamical principles of Hamilton and the optical principles of Fermat. This discussion is followed by a chapter on useful optical concepts and their analogies in electron optics. Two other chapters are used to describe the properties of the electrostatic field and the magnetic field.

The chapters of fundamental information are well written, being quite readable and yet not sacrificing essential mathematical rigor.

The remainder of the book is devoted to a discussion of electron lenses, both electrostatic and electromagnetic, with separate chapters dealing with the aberrations of

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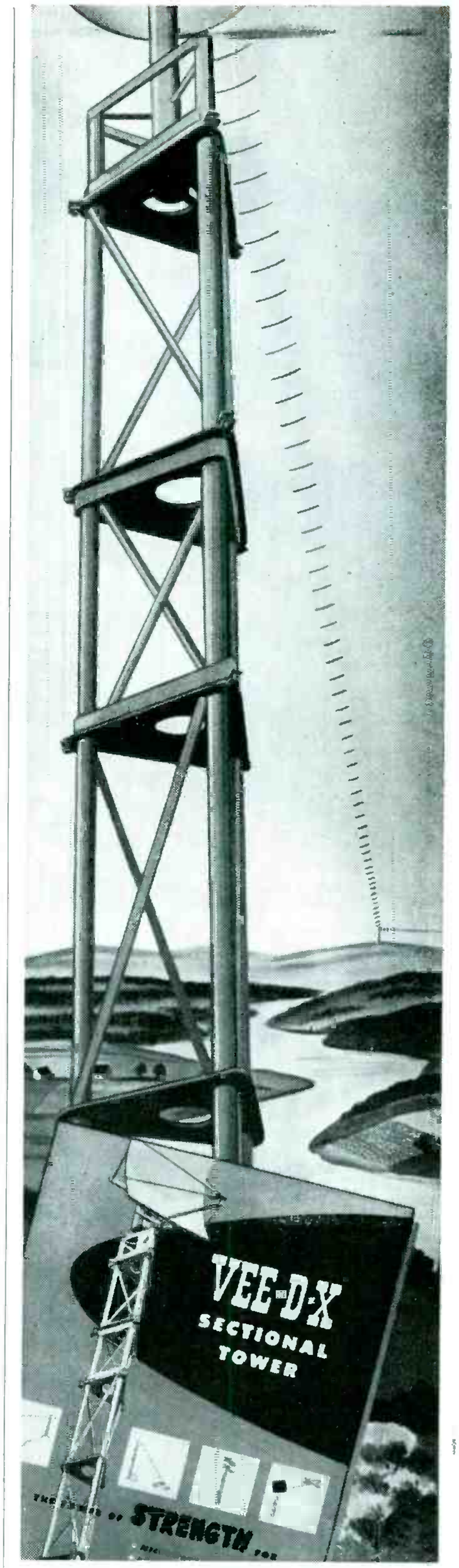

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these lenses. Additional material touches on beam deflection, trajectory determination and phase focusing. The book concludes with a discussion of the properties of electron beams, the crossover formation and the limitations of space charge in both focused and unfocused beams.

This book is recommended to those who wish a compact review and reference text on the principles of electron optics. To those concerned with the design and operation of electron optical devices, the material on lens aberrations may prove of value, as well as additional material on the author's work and the work of contemporaries which has not appeared in other textbooks of this type.—K. A. HOAGLAND, *Tube Engineering Dept., Allen B. Du Mont Labs., Clifton, N. J.*

THUMBNAIL REVIEWS

TELEVISION INTERFERENCE. By P. S. Rand and others. Remington Rand Inc., Laboratory of Advanced Research, South Norwalk, Conn., 1951, 80 pages, sent free by author to engineers writing for it. Reprints of 15 articles on reduction of interference to TV reception by r-f heaters and amateur radio transmitters, plus notes tabulating common types of TVI, TVI due to faulty television receiver design, common causes of TVI in amateur transmitters, and suggested circuit changes in transmitters. References to many other published articles are also given.

TRANSIENTS IN POWER SYSTEMS. Harold A. Peterson, chairman, E. E. Dept., Univ. of Wisc. John Wiley & Sons, New York, 1951, 361 pages, $6.50. Results of investigations of transient phenomena in electric power systems with new tools like the differential analyzer and transient analyzer, presented in convenient form for use by engineers. Book is secondarily intended as a reference for advanced study in colleges.

CHEMICAL SPECTROSCOPY. By Wallace R. Brode. American Society for Testing Materials, 1916 Race St., Philadelphia, 52 pages, $1.35. 1950 ASTM Edgar Marburg Lecture covering development and use of spectroscopic methods in analytical control. Instruments covered include spectrographs, photoelectric densitometers, recording infrared spectrophotometers and photoelectric spectrophotometers.

MOLESWORTH'S HANDBOOK OF ENGINEERING FORMULAE. Edited by A. P. Thurston. E. & F. N. Spon Ltd., London, 34th Edition, 1951, available from The McMillan Co., 60 Fifth Ave., New York. 1672 pages, $6.50. Completely revised and reset edition of book first published in 1862, presenting charts, diagrams, tables and other data needed for reference in civil and general engineering, mechanical engineering and (to a lesser extent with only 91 pages) electrical engineering, plus 664 pages of general mathematical, physical and other data of use to all branches of engineering.

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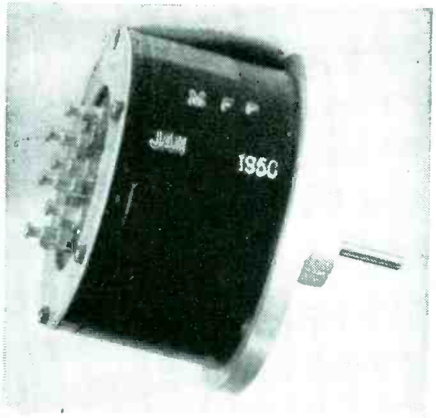

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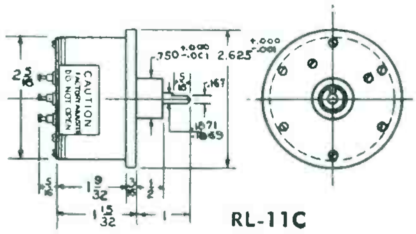

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	RL 11-C	RL 14-MS
Total resistance	16,000 ± 10%	35,400 ± 1%
Percent resistance within brush circle	Approx. 85%	99 ± 1/4%
Angle of rotation	360°	360°
Weight	4.75 oz.	1.8 lbs.
Torque (Approximate)	3/4 oz. in.	2 oz. in.
Wire	80 Ni 20 Cr	80 Ni 20 Cr
Resolution	.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.

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BACKTALK

(continued from page 154)

board were not yet giving satisfactory performance, we were fortunate in having a small number of very capable civilian electronic field engineers assigned to the ship. The equipment deficiencies, of which there were many, were overcome largely through the efforts of these very few engineers who spent long hours of hard work so that by the time the ship reached the forward area most of the electronic equipment was giving efficient and satisfactory performance.

Not until there is devised some additional inducement to attract qualified electronic personnel to the services or to retain those who become qualified while in the service, can we foresee any improvement in the service, can we foresee any improvement in the military personnel situation. Until then, the employment of civilian engineers is one way to get the job done, providing their military supervisors are not too prejudiced to fully utilize their services.

Meanwhile, since our small number of civilian engineers has been sharply reduced and no replacements are available, if any military organization having "hordes of expensive civilian 'tech reps'" (to quote Lieutenant A.A.C.S.) can spare a few to send out to us in the vicinity of Korea, we can assure the engineers that they won't have to "dabble at building little items of equipment" in order to occupy their time, and we can assure the United States Government that the salaries of these engineers will be money well spent.

We respectfully request that our names, ranks, and the name of the ship to which we are attached be withheld.

Motional Feedback

DEAR SIRS:

IN BACKTALK of your June issue, R. B. McGregor, in commenting on the idea of improving loudspeaker response with motional feedback, remarks that he and a Mr. R. Warren applied for a patent on the technique—which, by implication, was not awarded.

Now, there exists a lengthy history of prior art in this field. I became interested in the same subject

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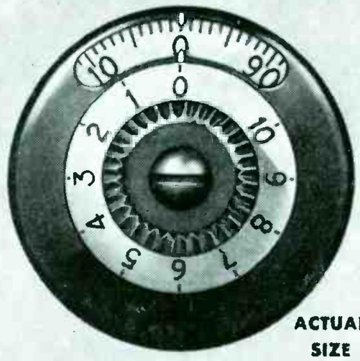

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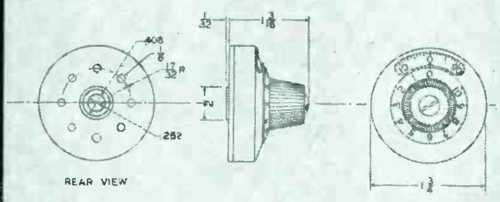

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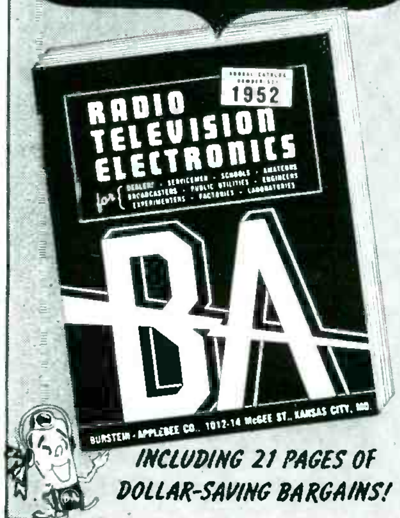

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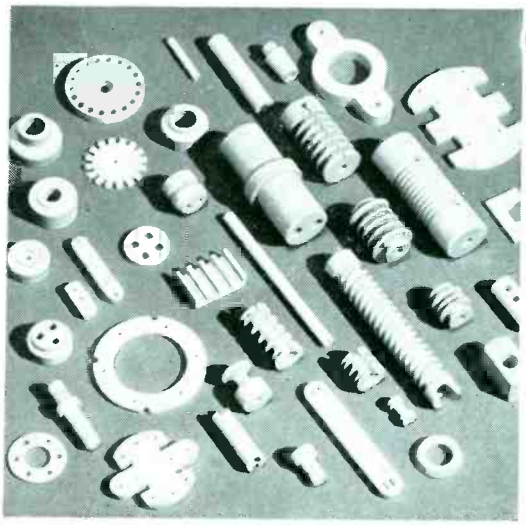

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a few months ago (having thought of the scheme for the first time while reading about a feedback-controlled magnetic cutter) and have compiled a modest bibliography since that date. To the best of my present knowledge, the earliest reference consists of the English patent No. 231,972 with application date Jan. 29, 1934. The inventor was P. G. A. H. Voigt, and the invention relates to the identical bridge scheme suggested by McGregor and Warren. According to Voigt (*Wireless World*, Dec. 1947) the circuit ". . . never went into commercial production, as it was judged to be a little ahead of time."

It might be added that such men as D. T. H. Williamson, Research Department, Ferranti, Ltd. (*Wireless World*, Oct. 1947); Dr. H. F. Olson, RCA ("Elements of Acoustical Engineering", 1947 edition, p 158-159); J. de Boer and G. Schenkel, N. V. Philips, Gloelampen Fabrieken, Holland (*Journal of the Acoustical Society of America*, Sep. 1948); J. G. Woodward, R.C.A (*RCA Review*, June 1950) and others have done work in this field.

In general, it would appear that improved results can be obtained, but only at the cost of involved analysis, careful design, use of wide-band circuits and extensive experimentation.

HERMAN H. LOWELL
Physicist, Research Staff
N. A. C. A.

Printed Circuits

DEAR SIRS:

THE writer's attention has been drawn to an article appearing in the August 1951 issue of ELECTRONICS under the caption—"Circuit Printers for Flat and Cylindrical Surfaces" (page 178.). The article states two semiautomatic machines have been developed at the NBS for printing on electronic circuits.

The description given in the article of the flat printer conforms to claims covered in the writer's patent No. 2,229,346—dated Jan. 21, 1941, entitled "Multicolored Printing Machine for Glass-Metal and the Like". This machine was originally developed for printing on dials etc., while there may be some change in the construction the operation and principle employed

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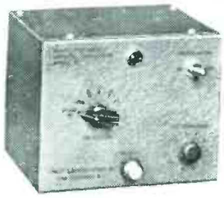

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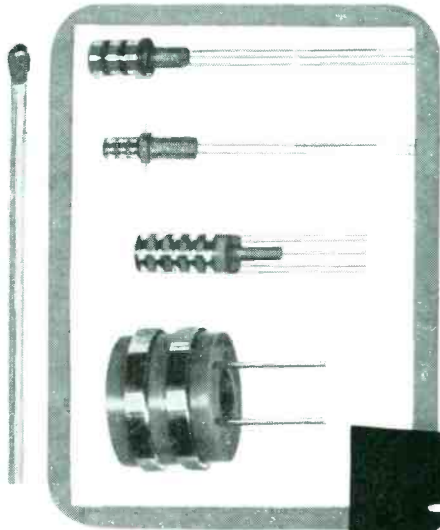

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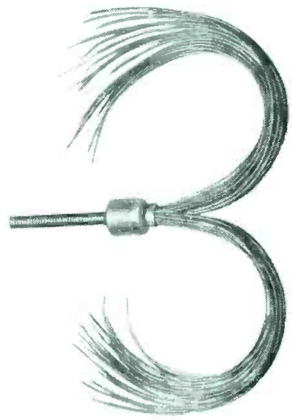

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does not deviate from the claims in the aforementioned patent.

Again, in the same article referring to the cylindrical surface printer it states, "The printer described differs from a conventional printer, in that the squeegee remains stationary, and that the screen moves forward on one stroke and backwards on the next."

In the writer's patents No. 2,060,385 and 2,085,126 of 1936 and 1940 the squeegee is stationary and the following excerpt from patents referred to the forward movement and the backward movement, as follows: Claims 5-6-7-8-10 and 11 in Pat. No. 2,060,385 and reading "the said printing frame being adapted and arranged to print an article on either the forward or backward movement of the frame"—i.e. the frame in this case is the screen. In Patent No. 2,085,126 (an improved machine) claims 9 and 10 reads," a squeegee pressing against the bottom of the printing frame (the screen) means whereby the said squeegee is raised at both the forward and backward stroke of the printing frame, (the screen).

It is quite clear from the above patents the claim that the above developments were made by the NBS is both erroneous and misleading.

DR. FREDERICK SHURLEY
Bureau of Industrial Chemical Research
Windsor, Ontario, Canada

Vidicon

DEAR SIRS:

THE ARTICLE in your May 1950 issue, "The Vidicon Photoconductive Camera Tube", by P. K. Weimer, S. V. Forgue and R. R. Goodrich, was of the greatest interest to me. In connection with this article, may I call your attention to the following facts.

In the August 1935 issue of *Radio News* I published the description of an invention of mine which relates to a television camera tube and contains some useful suggestions now being employed, after I had been unsuccessful in trying to sell it to RCA. There is a striking similarity between my invention and the Vidicon, because:

In both inventions there is a cathode-ray pick-up tube with a

transparent conductive coating on a glass surface upon which a thin semiconducting layer is deposited. The arrangement is in both cases such that light from a scene is focused through the transparent coating on the semiconductive layer, while the cathode-ray beam sweeps over the opposite side of the semiconductive layer. The principle of operation of both inventions is the same, and both are, amongst others, based on the photovoltaic effect.

The above are the important characteristics of the camera tube known today as Vidicon. No other previous publication, except mine mentioned above, described such a feasible arrangement; not even Campbell Swinton in his letter in 1926 (see Campbell Swinton's letter to *Nature*, 1926, 118, p. 590), in which he describes an arrangement where the light beam and the cathode-ray beam strike the semiconductive target which is deposited on a metal plate (which words imply nontransparence) from the same side. As Campbell Swinton put it:

". . . transmitter apparatus consisted of a home-made Braun oscillograph in which a metal plate coated with selenium was substituted for the usual fluorescent screen, the image to be transmitted being thrown by a lens upon the selenium surface and the end of the cathode-ray beam being caused electromagnetically to traverse the projected image."

However, in reply to an inquiry of mine, RCA states that there is a technical difference between the Vidicon and my invention, because the target described in my *Radio News* article "appears to be a low-resistance photovoltaic target" and the target in the Vidicon a "high-resistance photoconductive target".

This is just another way of interpretation of the Vidicon's operation, which I can, to my deepest regret, not accept.

Although my above-mentioned paper was published in this country in 1935 and I had discussed this invention of mine with RCA prior to its publication, it has been included neither in the references of RCA's Vidicon paper nor in the paper of A. Rose and H. Iams (Television Pick-Up Tubes using Low Velocity Electron Beam Scanning,

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Radio, Audio, Industrial Electronic Appliances

Proc. IRE, Sept. 1939), which is listed as reference in the Vidicon paper.

According to an RCA letter to me, the authors of the Vidicon paper did not have any knowledge of my 1935 article.

VICTOR A. BABITS
Rensselaer Polytechnic Institute
Troy, New York

Cracks

DEAR SIRS:

THE method described to get a picture of cracks in gun barrels (Sept. 1951) has been originated by myself and not by the authors.

Four years ago, 1947, the Watertown Arsenal published in several magazines a "new" method of detecting flaws in ferromagnetic materials. A paper was presented at the ASTM meeting 1947 by C. H. Hastings. The method consisted of using a rotary magnetic eye and recording the output on a strip chart as a continuous line with pips where there was a crack. In the discussion of Mr. Hastings' paper (published in *ASTM Proceedings*, 1947, page 651) I suggested the use of a facsimile recorder to get a perfect picture of the cracks. In further correspondence with the Watertown Arsenal I recommended use of an Alden facsimile recorder with a rotary helix, the very same as used now. I offered my services to develop such a recorder, but I was only told that I might bring such a recorder myself to Watertown and the Arsenal would test it. The Arsenal was also informed that I had filed a patent two years earlier, meanwhile issued as No. 2,447,018.

I would appreciate if the readers of ELECTRONICS would be informed who had actually originated the recording method for cracks and flaws, picturing them with a facsimile recorder.

GEORGE KEINATH
Larchmont, New York

Electronics Quiz

LAST month's quiz problem involved the circuit of a test set-up for determining the plate characteristic of a tube. The circuit is shown in

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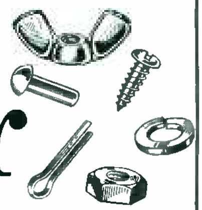

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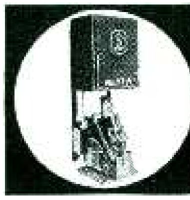
supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.



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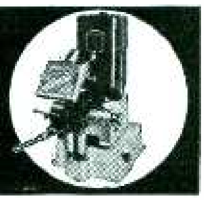

Fig. 1. (In the original circuit shown last month, the control grid was erroneously shown connected with the suppressor to +125 volts. The correct circuit is shown in Fig.

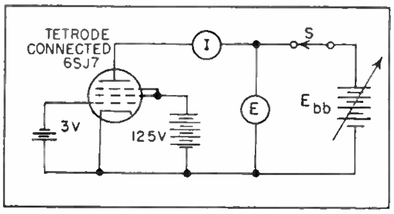

FIG. 1—Basic tube test circuit

1.) It was found that when switch S was opened when E_{bb} was 60 volts the reading of voltmeter E (an ordinary 250-volt, 1,000-ohm-per-volt meter) increased to 75 volts instead of dropping to near zero.

The explanation for the observed phenomenon, as furnished by John C. Schuder, Instructor in Electrical Engineering at Purdue University, West Lafayette, Indiana, is as follows:

The tube under test (in this case a 6SJ7) has, like most tetrodes, a marked negative resistance region due to secondary emission. This region varies from tube to tube, but in a considerable percentage of 6SJ7's the plate current actually reverses. Figure 2 shows one such experimental plate characteristic.

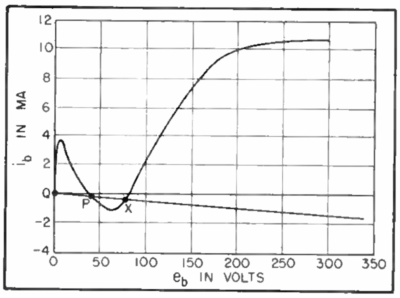

FIG. 2—Typical 6SJ7 characteristic

With switch S open the meter represents a 250,000-ohm plate load on the tube. Since the plate supply voltage is now zero, the load line passes through ($i_b = O$, $e_b = O$) Q, P and X. Both Q and X are points of stable equilibrium and are observed experimentally depending on whether voltage E_{bb}, when the switch is open, is less than or greater than that corresponding to point P.

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THE WALL STREET JOURNAL
Friday, September 28, 1951

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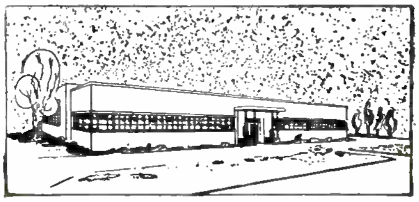

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....The security of permanent expansion

If you have
....Experience with microwave and servomechanisms
....A degree in physics, mathematics, or electronics
....Development experience in electronics, particularly antennas

WRITE TODAY TO: *Personnel Manager*

THE WORKSHOP ASSOCIATES
Division of The Gabriel Company *Specialists in High Frequency Antennas*
135 Crescent Road Needham Heights, Massachusetts

Position now available for a

PROJECT ENGINEER

- Unusual opportunity in the fields of analogue and digital computers, special devices, and fundamental research. Experience in magnetic memory systems preferred.

Applicants are invited to submit their qualifications to:

Personnel Manager

The RAND Corporation
1500 Fourth Street
Santa Monica, California

POSITIONS OPEN

Location
KANSAS CITY, MO.

Electronic & Mechanical Engineers

ELECTRONIC ENGINEERS: Must have considerable development experience in radio transmitting and receiving equipment. Ability to fill position of Senior Project Engineer a requisite.

MECHANICAL ENGINEER: Must have development experience in mechanical design of electronic or similar precise equipment. Practical and theoretical knowledge of materials, finishes, sheet metal, and machine shop design are basic requirements. Position is one of considerable responsibility.

SALARY: Open.

These positions are permanent.

Write stating educational and professional history direct to:

Jay V. Wilcox, *President*

WILCOX ELECTRIC COMPANY, INC.
1400 Chestnut St., Kansas City 1, Mo.
Dependable communications since 1931

ELECTRONIC ENGINEERS
SENIOR ELECTRONIC ENGINEERS

Opportunities with Tracerlab, Inc. are available for Electronic Engineers qualified by design experience on DC and wide band amplifiers, low power pulse circuitry, computers, telemetering or allied fields.

Tracerlab, Inc. manufactures instruments of all types for the fast growing field of radioactivity. Tracerlab, as one of the foremost leaders in this field, has much to offer its employees concerning security and opportunity for advancement.

Men who have had complete responsibility for design of complex electronic instruments in a manufacturing organization with supervision of Junior Engineers and Technicians are invited to write, giving a detailed outline of training and experience. Correspondence will be confidential. Selected applicants will be asked to come to Boston at our expense for an interview.

Industrial Relations Department

TRACERLAB, INC.
130 High Street Boston 10, Mass.

PHYSICISTS ELECTRONIC ENGINEERS ELECTRONIC SCIENTISTS MECHANICAL ENGINEERS

The Signal Corps Engineering Laboratories located at Fort Monmouth, New Jersey, have a number of attractive openings for physicists, electronic scientists, electronic engineers, and mechanical engineers in the research and development, design, modification and testing of electronic equipment in the fields of radio and wire communications, radiological detection, meteorlogical instruments, facsimile, television, photography, and communications systems.

Current vacancies are at nearly all professional levels ranging from trainee positions for engineers and physicists just out of college to project and staff positions requiring considerable background of accomplishment in the technical field. The Signal Corps Engineering Laboratories offer attractive salaries ranging from $3410 to $8360 an unusual latitude in choice of research or developmental work, and a good opportunity to develop individual ideas.

Signal Corps Engineers and scientists have at their command the most complete and finest laboratory equipment and facilities available anywhere and opportunities to progress professionally are virtually unlimited.

Applications may be obtained from 1st and 2nd Class Post Offices. Mail to:

Civilian Personnel Division

SIGNAL CORPS CENTER AND FORT MONMOUTH
Fort Monmouth, N. J.

ELECTRONICS ENGINEER—SENIOR

Sound theoretical background and 5 to 10 years experience desirable. Will be required to design and construct Special Instruments and Apparatus needed for research in resistors, capacitors, & fundamental properties of conductors. Permanent position electric components manufacturer located in Eastern U. S.

ADDRESS D-19, P. O. BOX 3414
PHILA. 22, PA.

METERS

3MA DC 2½" R—Simpson black scale..........$3.35
500 Microamps, DC—2½" round—Sun.......... 4.30
1ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R.—General Electric......... 2.95
2 amp. RF 2½" Sq.—Simpson................. 3.15
5 amp. AC 4½" R.—JBT...................... 4.11
10 amp. RF 3½" R.—Simpson................. 4.95
50 amp. AC 3½" R.—General Electric......... 4.11
3 amp. RF 3½" R.—Weston................... 6.00

MAGNETRONS

2J21A	2J37	3J31	706BY
2J22	2J38	4J31	706CY
2J26	2J39	4J33	706GY
2J27	2J40	5J23	714AY
2J31	2J41	5J29	718AY
2J32	2J48	700B	718BY
2J33	2J49	700C	720B/C/DY
2J34	2J56	700D	725A
2J36	2J61	706AY	730A

KLYSTRONS

2K23	2K33	417A	723A/B
2K25	2K45	707A	726A
2K26	2K54	707B	726B
2K28	2K55	723A	5611
2K29			

OIL-FILLED HIGH VOLTAGE ISOLATION TRANSFORMERS

Pri. 460V 66 cy. Sec. 115V 200VA Insulated for 50KV DC—G. E. Form EIR—36"H x 13"D.......$125.00
Pri. 115V 60 cy. Sec. 115V 250 VA Insulated for 35 KV DC—G. E. Form EIR—29"H x 12½"D $125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-1 and 9001934G-1 17,246,400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D.......................$77.50

2φ LOW INERTIA SERVO MOTORS

KOLLSMAN Type 937-0240—85/68V 100 cy 5 watts 2650 RPM—new $12.95
DIEHL, Type FPE-25-11 75V 60cy 4 watts — new $34.50

OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC	Price
2	600		$.69	1	2000	1.95
4	600		1.65	1-1	2500	3.85
4	600	R'd	1.65	32	2500	15.80
6	600		1.85	3X.2	4000	2.95
8	600	R'd	1.85	1	5000	4.88
10	600	R'd	1.95	.01-.03	6000	1.65
8-8	600		1.95	.1	7000	1.79
1	1000		.62	.045	16KV	4.70
2	1000		.89	.05	16KV	4.95
4	1000		1.85	.075	16KV	8.95
8	1000		3.25	.25	20KV	18.95
4	1500		2.95	7	660VAC	4.25
.1-.5	2000		87	8	660VAC	4.50

HIGH VOLTAGE TRANSFORMERS

G.E.—Pri. 115V 60 cy Sec. 6250V 80 MA—12.5 KV Ins. $18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Ins..................................$18.50
Raytheon—Pri. 115V 60 cy. Sec. 8500/6450V CT 43 MA Hermetically sealed...................$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N38	1.66
1N21B	4.00	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

ANTENNAS

AT-38A/APT (70 to 400MC)...................$13.70
AT-49/APR-4 (300 to 3300MC)................ 13.70
DZ-2 Loop antenna with pedestal............ 22.50
AN-74B (125 to 150MC)...................... 3.25
AN-65A (P/O SCR-521)....................... 1.50
AN-66A (P/O SCR-521)....................... 1.75
AIA-3CM conical scan.......................125.00
ASB Yagi—5 element 450 to 560MC........... 7.00
ASB Yagi—Double stacked 6 element......... 12.70
ASA Yagi—Double stacked 370 to 430MC...... 29.40

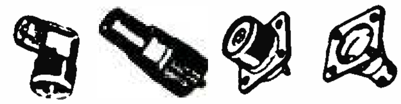
WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1R	$ .40	83-22AP	$1.40
83-1AP	.30	83-1RTY	.65	83-22R	.68
83-1F	1.30	83-1SP	.50	83-22SP	1.15
83-1H	.10	83-1SPN	.60	83-168	.15
83-1J	.80	83-1T	1.30	83-185	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF	N		BN	BNC	
UG-7	UG-23	UG-37	UG-102	UG-175	UG-254
UG-12	UG-24	UG-57	UG-103	UG-176	UG-255
UG-18	UG-27	UG-58	UG-104	UG-185	UG-260
UG-19	UG-27A	UG-85	UG-106	MX-195	UG-264
UG-21	UG-29	UG-86	UG-108	UG-197	UG-274
UG-21B	UG-30	UG-87	UG-109	UG-201	UG-275
UG-22	UG-34	UG-88	UG-146	UG-206	UG-276
UG-22B		UG-98	UG-166	UG-236	UG-290
			UG-167	UG-245	UG-291
			UG-171		UG-306

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201

93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg SS	
2500	SS	40K	SS	2.5 Meg SS	
4K	SS	50K	SS	5 Meg SS	
5K	SS	50K	1/4"		

DUAL "JJ" POTENTIOMETERS

50	SS	500	SS	1 Meg SS
100	SS	1K	SS	2.5 Meg SS
250	SS	2500	SS	5 Meg SS
330	SS	10K	SS	1K/25K 3/8"

TRIPLE JJJ POTENTIOMETERS

100K/100K/100K—⅜" 20K/150K/15K—⅜"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets.........................$8.92 ea.

F. W. BRIDGE SELENIUM RECTIFIERS

AC Volts Input — 18		AC Volts Input — 40	
DC Volts Out — 14.5		DC Volts Out — 34	
1.3 Amps......	$3.85	0.6 Amps......	$4.60
2.4 Amps......	4.95	1.2............	5.95
6.0 Amps......	7.75	3.2............	8.95
13.0..........	12.75	6.0............	15.50
17.5..........	15.75	9.0............	17.50
26............	22.75	12.............	26.95
39............	35.50	18.............	32.50
52............	38.50	25.............	42.50
70............	49.50	36.............	55.50

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

• Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400cy. 1 φ; DC 30 Volts 60 Amps. Brand New.......................$38.50
• Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing...$15.50

3 PHASE INVERTERS

Voltage and Frequency Regulated
Eclipse Pioneer Type 12121A

DC Input—24 Volts 18 Amps
AC Output—115 Volts 1.25 Amps 3 Phase
250 VA 0.7 P.F. 400 Cycles
12,000 RPM 65°C Temp. Rise
Brand New $225.00

TEST EQUIPMENT

• I-222A Signal Generator...............* $79.50
• I-72K Signal Generator................ $48.50
• Vibrotest Mod. 218 Megger............* $45.00
• C-D Quietone Filter Type IF-16 110/220V AC/DC 20 Amps. ....* $9.00
• TS-127/U Freq. Meter w/spares......... $69.50
• TS-143/CPN Oscilloscope ....* $95.00
• Dumont 175A Oscilloscope.............*$225.00
• LM-20 Frequency Meter.................* $49.50
• Gen. Radio 757-P1 Power Supply........* $27.00
• TS-6/AP Frequency Meter...............* $42.00
• I-130A Signal Generator...............* $85.00
• A.W. Barber Labs. VM-25 VTVM.........* $86.00
• TS-10A/APN Delay Line Test Set........ $45.00
• TS-19/APQ-5 Calibrator $75.00
• REL W-1158 Frequency Meter 160-220 MC $32.95
• CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars..................... $39.95
• CRV-14AAS Phantom Antenna for Transmitters up to 400 MC.......................... $11.75
• 3 CM. Pickup Horn Antenna.............. $9.95
• I-138A Signal Generator—10 cm.........*$185.00

All items New Except Where noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter...............$ 9.87
Powerstat 1226—115/230V Input—0-270V out @ 9 amp............................... 37.00
EIMAC 35 TG Ionization Gauge............. 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W... 22.95
ID-6/APN-4 Indicator 29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
FL-8 1020 cycle filter.................... 1.75
RM-29 remote control unit................. 8.95
RM-14 remote control unit................. 8.95
RTA-1B 12/24 V dynamotor.................. 40.00
BC-1206-CM2 Receiver 12.95
CY-230/MPG-1 Radar Console...............575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete............... 69.75
T-9/APQ-2 less tubes...................... 16.50
RCA AVR-15 Beacon Recvr................... 15.50
TBY Trans-Recvr 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used).................. 22.65
G.E. Inverter—28VDC to 120 VAC 800 cy 750VA 1 φ................................ 39.50
Navy SD-3 Radar complete..................1200 00
Navy DP-14 Direction Finder complete....... 385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7350
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse PH-1	W.E. D-163325
Westinghouse 132-AW	W.E. D-164661
Westinghouse 139DW2F	W.E. KS-9563

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN-APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 Microsec. 200 PPS, 67 ohms Imped. 3 sections...........$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS. 67 ohms Imped. 3 sections.........$6.75
7.5 E4-16-60-67P. 7.5 KV. "E" Circuit 4 sections, 16 microsec. 60 PPS, 67 ohms Imped........$8.25
15 E4-91-400-50P. 15KV. "E" circuit .91 microsec. 400 PPS, 50 ohms imped. 4 sections.........$12.00
15-A-1-400-50P. 15KV, "A" Circuit, 1 microsec. 400 PPS. 50 ohms imped.....................$37.50
15 E7-2-200-50P. 15KV "E" Circuit, 2 microsec. 200 PPS. 50 ohms imped., 7 sections.........$42.00

THYRATRONS & IGNITRONS

OA4G	FG-41	FG-271	722A
C1A	FG-57	393A	873
1C21	FG-67	394A	884
2A4G	FG-81A	GL-415	885
2B4	91	KU-610	1665
2D21	FG-95	KU-623	1904
3C23	FG-105	KU-628	2050
3C31	FG-166	KU-634	2051
4C35	FG-172	WL-652	5550
C5B	FG-178	WL-672	5551
5C22	RX233A	WL-677	5552
C6J	FG-235A	WL-681	5557
FG-17			5560
FG-33			

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

DISCOUNTS AND SAVINGS OF 25 - 40 - 60 %

CONNECTOR INSERTS AVAILABLE AT THIS TIME

ITEMS IN ITALICS HAVE BEEN RECENTLY ADDED TO OUR INVENTORY

8S-1P	16S-4S	18-15S	20-10S	22-9S	*24-7P*	28-7P	32-3S	*36-10P*
8S-1S	16S-5P	18-16P	*20-11P*	*22-10P*	*24-7S*	28-7S	32-5P	*36-10S*
10S-2P	16S-5S	18-16S	*20-11S*	*22-10S*	*24-9P*	*28-8P*	32-5S	*36-11P*
10S-2S	16S-6P	18-17P	20-12P	22-11P	*24-9S*	*28-8S*	*32-6P*	*36-11S*
10SL-3P	16S-6S	18-17S	20-13P	22-11S	24-10P	*28-9P*	*32-6S*	*36-12P*
10SL-3S	*16S-8P*	18-18P	20-13S	*22-12P*	24-10S	*28-9S*	*32-7P*	*36-12S*
10SL-4P	*16S-8S*	18-18S	20-14P	*22-12S*	*24-11P*	*28-10P*	*32-7S*	36-14P
10SL-4S	16-15P	*18-20P*	20-14S	22-13P	*24-11S*	*28-10S*	*32-8P*	36-14S
10SL-656P	16-15S	*18-20S*	*20-15P*	22-13S	*24-12P*	*28-11P*	*32-8S*	*36-15P*
10SL-656S	16-16P	*18-22P*	*20-15S*	*22-14P*	*24-12S*	*28-11S*	32-9P	*36-15S*
12S-1P	16-16S	*18-22S*	*20-16P*	*22-14S*	*24-15P*	*28-12P*	32-9S	*36-16P*
12S-1S	16-2P	18-23P	*20-16S*	22-15P	*24-15S*	*28-12S*	32-10P	*36-16S*
12S-2P	16-7P	18-23S	20-17P	22-15S	24-16P	28-13P	32-10S	*36-17P*
12S-2S	16-7S	18-24P	20-17S	22-16P	24-16S	28-13S	*32-13P*	*36-17S*
12S-3P	*16-9P*	18-24S	20-19S	22-16S	*24-18P*	28-14S	*32-13S*	36-18P
12S-3S	*16-9S*	18-25P	20-20P	22-17P	*24-18S*	*28-15P*	32-14P	36-18S
12S-4P	*16-10P*	18-25S	20-20S	22-17S	24-19P	*28-15S*	32-14S	36-19S
12S-4S	*16-10S*	18-26P	20-22S	*22-18P*	24-19S	*28-16P*	*32-16P*	*36-20P*
12-5P	*16-11P*	18-26S	20-23P	*22-18S*	*24-20P*	*28-16S*	*32-16S*	36-21P
12-5S	*16-11S*	18-27P	20-23S	*22-19P*	*24-20S*	28-17P	32-18P	36-21S
12S-6P	16-12P	18-27S	20-24P	*22-19S*	24-21P	28-17S	32-18S	36-646P
12S-6S	16-12S	18-28P	20-24S	*22-20P*	24-21S	*28-18P*	32-19P	36-697P
14S-1P	16-13P	18-28S	*20-25P*	*22-20S*	*24-24P*	*28-18S*	32-19S	36-697S
14S-1S	16-13S	18-29P	*20-25S*	22-21S	*24-24S*	28-19P	*32-20P*	36-799P
14S-2P	*18-1P*	18-29S	20-26P	22-22P	*24-25P*	28-19S	*32-20S*	36-799S
14S-2S	*18-1S*	18-30P	20-26S	22-22S	*24-25S*	28-20P	*32-101P*	*40-1P*
14S-4P	18-2P	18-30S	*20-27P*	22-23S	24-26P	28-20S	*32-101S*	*40-1S*
14S-4S	18-2S	18-31P	*20-27S*	*22-24P*	24-26S	*28-21P*	*32-102P*	*40-2P*
14S-5P	*18-3P*	18-31S	*20-28P*	*22-24S*	24-28P	*28-21S*	*32-102S*	*40-6P*
14S-5S	*18-3S*	*20-1P*	*20-28S*	22-27P	24-28S	*28-22S*	*32-722P*	*40-8P*
14S-6P	18-4P	*20-1S*	*20-29P*	22-27S	24-684P	28-684P	*32-722S*	*40-9P*
14S-6S	18-4S	*20-2P*	*20-29S*	*22-30P*	24-684S	28-684S	*32-810P*	*40-9S*
14S-7P	18-5P	*20-2S*	20-30P	*22-30S*	24-691P	*28-693P*	*32-810S*	*40-11P*
14S-7S	18-5S	20-3P	20-30S	22-32P	24-691S	*28-693S*	*32-811P*	*40-11S*
14S-9P	18-6P	20-3S	22-1P	22-32S	*24-710P*	28-695P	*32-811S*	*40-13P*
14S-9S	18-6S	20-4P	22-1S	22-36P	*24-710S*	28-695S	*36-1P*	*44-1P*
14S-10P	*18-8P*	20-4S	*22-2P*	22-36S	24-835P	28-702P	*36-1S*	*44-1S*
14S-10S	*18-8S*	*20-5P*	*22-2S*	24-1P	*28-1P*	28-702S	*36-2P*	44-2P
14S-11P	*18-9P*	*20-5S*	22-3P	24-1S	*28-1S*	28-745P	*36-2S*	44.2S
14S-11S	*18-9S*	20-6P	22-3S	24-2P	*28.2P*	28-745S	*36-3P*	*44.4P*
14S-12P	*18-10P*	20-6S	*22-4P*	*24-2S*	*28-2S*	28-840P	*36-3S*	*44-4S*
14S-12S	*18-10S*	*20-7P*	*22-4S*	*24-3P*	28-3P	28-840S	36-6P	*44-5P*
14-3P	*18-11P*	*20-7S*	*22-5P*	*24-3S*	28-3S	28-852P	36-6S	*44-5S*
14-3S	*18-11S*	20-8P	*22-5S*	*24-4P*	28-4P	28-852S	*36-7P*	*44-6P*
16S-1P	*18-12P*	20-8S	*22-6P*	*24-4S*	28-4S	*32-1P*	*36-7S*	*44-6S*
16S-1S	*18-12S*	20-9P	*22-6S*	*24-5P*	*28-5P*	*32-1S*	*36-8P*	44-9S
16S-3P	18-13P	20-9S	22-8P	*24-5S*	*28-5S*	32-2P	*36-8S*	*48-1P*
16S-3S	18-13S	20-10P	22-8S	*24-6P*	*28-6P*	32-2S	*36-9P*	*48-1S*
16S-4P	18-15P		22-9P	*24-6S*	*28-6S*	32-3P	*36-9S*	48-3S

3108-B

AN 3108-A

AN 3106

AN 3102

AN 3101

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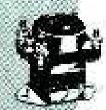

50 Amp Contacts
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Cutler Hammer, Bulletin 6041H2B, 100 ohm, #R24 **$2.25**

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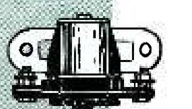

200 Amp Contacts,
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Spec. #94-32324A

Hart, Spec. No. 569A, Cat. No. 694R19, 75 ohm, #R127A **$2.95**

AutoLite, B4, 90 ohm, #R174 ....**$3.50**

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100 Amp Contacts
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Spec #94-32424A

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BJX-42 12 or 24 VDC, SP Dble break, 240 ohm CT #R226.$1.25

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10 AMP CONTACTS

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BO1535 24VDC, Dble make and break, 240 ohm #R238.....$1.30

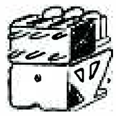
BO9D23 6VDC, 3PDT, 14 ohm #R225.....$2.25

BO1332 12VDC, 80 ohm, coil and frame only (no contacts) #RC-358 .... 40¢

BOYX40 12 ma., DPDT, 3940, #R587......$2.95

BN12D34 24VDC, 4PDT, 227 ohm, #R434..$3.49

GM 1200 SERIES



DUAL COIL
10 AMP CONTACTS

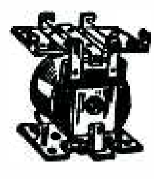
12566 6-12VDC, 3PDT, 45 ohm, #R593 ....$1.95

12889-2 24VDC, 3PDT, 800 ohm #R594 ....$2.95

12792-1 18-24VDC, 3PDT, 100 ohm, #R240 ....$1.75

12885-1 24VDC, 1A, 1B, 2C, 300 ohm, #R595 $3.25

G.E. CR2791 SERIES



CR2791B100P36SP 10,000 ohm 10 ma., 3PDT #R603 $2.50

CR2791B106J3 24VDC, 3PDT, 180 ohm, 3A contacts #R237 ....$1.25

CR2791B100J42 8-12VDC, 3PDT, 60 ohm, 3A contacts #R163 ....$1.25

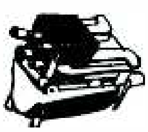
CR2791B100J4 4-6VDC, 3DPT, 12 ohm, 3A contacts #R361 ......$1.25

CR2791B100F3 24VDC, 2PDT, 150 ohm, 5A contacts #R164 .... 98¢

CR2791B101V46 12VDC, Dble, make, 100 ohm, 10A contacts, #R165................... 70¢

CR2791D107F3 24VDC, DPDT, 100 ohms, 5A contacts, ceramic insul. #R229.........$5.95

ARC 1 & 3 MINIATURES



23025 RBM 48VDC, SPDT, 8000 ohm, 6 ma #R428 $1.50

55251 Telechron, 24VDC, SPST n.o. (1A) 300 ohm, #R174 .... 90¢

55340 Price, 24VDC SPST n.o. (1A) 300 ohm #R170 .... 90¢

55342 Telechron, 24VDC, Makes 3 Breaks One (2As, 1C) 300 ohm, Anti-Capacity Arms, Low Loss Bakelite Insulation #R171.........$1.25

55526 Cook, 24VDC, Makes 2, Breaks One, (1A, 1C) 300 ohm Ceramic Insulation, #R107 95¢

55528 G.E. 12VDC, 6PST n.o. (6As), 150 ohm, #R426 ....$1.50

55531 Cook, 12-24VDC, Makes 4, Breaks (2As, 2Cs) 150 ohm #R405...................$1.25

55589 RBM, 24VDC, DPST n.o. (2As), 300 ohm, #R245 ....$1.25

55836 G.E. 24VDC, SPDT, (2As), 250 ohm, #R402 ....ea. $1.25

55837 G.E. 24VDC, Double Make, 300 ohm, #R108G $1.00

55837 RBM. Same as #R108G, #R108R....$1.25

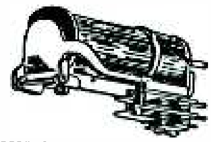
55837 Allied. Same as #R108G, #R108...$1.50

23012-O 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 ....$1.2

A.C. TELEPHONE TYPES



Clare B19553* 24VAC, 2C, 1A #R582.....$3.49

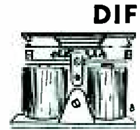
Clare Type C* 110VAC, 2A, 1B #R161..... 3.25

Automatic F Type RA 110VAC, 4PDT, #R159 4.49

Automatic F type RA 110VAC, DPDT, #R160 3.49

* Octal type plug base

DIFFERENTIAL

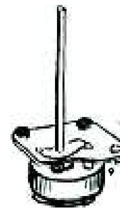


Dual 8000 coils, Armature pivoted between poles, all contacts normally open. Hi-speed. Suitable for P.P. bridge or balanced circuits where differential action is required.

COOK 11710/613 DPDT, 6 ma., #R605....$5.95

Allied 803476 SPDT, 2.5 ma., #R418...... 4.95

ROTARY RATCHET



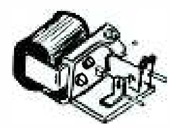
Ledex D.C. Impulse operated mechanisms rotate in 30 steps. Ratchet mechanism has ¼" shaft with flats for standard switch wafers.

#33 Mechanism only, 24V, 200 ohm, #R597.....$1.50

#76-2945 Mechanism & Ratchet & 3" long shaft. 6V, ½ ohm, #R598..$3.50

#75-3576 Mechanism & Ratchet & 4" long shaft, 6V, ½ ohm, #R599 ....$3.75

D.C. SENSITIVE



Sigma 4F 1 ma., SPDT, 8000 ohm, #R425..$3.95

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

Allied BOYX40 12 ma., DPDT, 3940 ohm, #R587 .... 2.95

Clare Type J (K102) 6 ma., SPDT, 3500 ohm, #R30 .... 3.50

Dumont 5 ma., 1A, 5000 ohm #R230..... .98

Automatic 5035A7 8 ma., 1A, 1300 ohm, #103 .... 1.25

Cooke Type C 4 ma., 1A, 6500 ohm, #R596 3.50

Clare B11613 (K101) 2 ma., SPDT, 6500 ohm, #R588 .... 4.95

Clare A8053 8 ma., 3A, 6500 ohm, #R408.. 3.95

POWER

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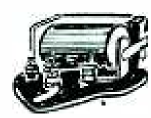

SPST n.o. (1A), 24VDC, makes at 12 volts 50 ma.; breaks at 6 volts 25ma., 240 ohm coil, contacts rated at 20 ampere, Power relay R604 ....$2.95

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1626	.45
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1630	.98
1631	1.29
1632	.79
1633	.75
1634	.75
1636	3.25
1638	.65
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RK60/1641	2.25
RK65	24.50
RK72	.59
RK73	.59
RX21A	2.95
RX120	8.95
V70D	6.95
VR78	.69
VR91	1.49
VR92	.98
VT127A	3.95
VT158	14.95
VU29	2.95
VU111	1.49
WL468	12.95
WL530	12.75
WL531	12.75
WL532	2.95
WL578	1.29
WL616	37.50
WL619	18.95
WL677	34.50
WL681	22.50
OA2	$1.55
OA4G	1.20
OB2	1.65
OZ4	.75
O1A	.73
1A3	.73
1A4P	1.30
1A5GT	.78
1A6	.85
1A7GT	.95
1AB5	.80
1B3/8016	1.25
1B4	1.15
1B5/25S	.95
1B7GT	1.25
1C5GT	.85
1C6	.73
1C7G	.73
1D5GP	.73
1D7G	.73
1D8GT	.73
1E5GT	.73
1E7G	1.19
1F4	.73
1F5G	.73
1G4	.73
1G6GT	.73
1H4G	.89
1H5GT	.75
1H6GT	1.05
1J6	.98
1L4	.73
1LA4	.89
1LA6	1.15
1LB4	1.06
1LC5	.89
1LC6	.98
1LD5	.98
1LE3	.85
1LG5	.85
1LH4	.89
1LN5	.95
1N5GT	.89
1P5GT	.79
1Q5GT	.73
1R4	.73
1R5	.95
1S4	.73
1S5	.85
1T4	.85
1T5GT	.73
1U4	.89
1V	.72
1X2	1.18
2A3	.95
2A4G	1.25
2A5	.73
2A6	.73
2A7	.75
2B7	.75
2V3G	.79
2X2	.65
2X2A	1.60
3A4	.65
3A5	.90
3B7/1291	.59
3D6/1299	.59
3LF4	.95
3Q4	.79
3Q5GT	.85
3S4	.85
3V4	.90
5R4GY	3.75
5T4	1.95
5U4G	.73
5V4G	1.12
5W4	.81
5X4G	.89
5Y3GT	.63
5Y4G	.73
5Z3	.89
5Z4	$0.89
6A3	1.25
6A4LA	1.35
6A6	.92
6A7	.99
6A8	1.05
6AB7	1.05
6AC5GT	1.20
6AC7	1.15
6AD7GT	1.35
6AE6G	.89
6AF6G	.95
6AG5	.89
6AG7	1.55
6AH6	1.40
6AJ5	1.15
6AK5	1.50
6AK6	1.10
6AL5	.82
6AQ5	.92
6AQ6	.87
6AR5	.79
6AT6	.73
6AU5	1.25
6AU6	.93
6AV6	.72
6B6G	.99
6B7	.98
6B8G	.85
6BA6	.85
6BC5	.98
6BE6	.85
6BF6	.79
6BG6G	1.18
6BH6	.97
6BJ6	.97
6BQ6	1.35
6C4	.79
6C5	.79
6C6	.79
6C8G	.98
6CB6	.98
6D6	.85
6D8	.89
6F5	.79
6F6	.95
6F7	.89
6F8G	.95
6G6G	1.15
6H6	.95
6H6GT	.79
6J5	.75
6J5GT	.69
6J6	1.20
6J7	.82
6K5GT	.89
6K6GT	.79
6K7	.73
6K8	.73
6L5G	.87
6L6	3.00
6L6G	1.75
6L6GA	1.75
6L7	.98
6L7G	.95
6N7	.89
6Q7	.95
6R7	.85
6S7G	.98
6S8GT	1.05
6SA7	.85
6SC7	1.30
6SD7GT	.98
6SF5	.89
6SF5GT	.89
6SF7	.98
6SG7	.98
6SH7	.73
6SJ7	.89
6SK7	.89
6SL7GT	.98
6SN7GT	$0.98
6SQ7	.75
6SR7GT	.85
6SS7	.95
6ST7	1.10
6SU7GTY	2.15
6SV7	1.25
6T7G	1.20
6T8	1.18
6U5G	.95
6U6GT	.98
6U7G	.59
6V6	1.55
6V6GT	.89
6W4	.85
6W7G	1.05
6X4	.73
6X5GT	.75
6Y6G	.98
6Y7G	1.25
6ZY5G	.89
7A4/XXI	.79
7A5	.89
7A6	.85
7A7	.85
7A8	.89
7AG7	1.05
7B4	.85
7B5	.85
7B6	.85
7B7	.85
7C4	.79
7C5	.85
7C6	.85
7C7	.85
7E5	.75
7E6	.59
7E7	.89
7F7	.85
7H7	.85
7K7	1.20
7L7	.98
7N7	.98
7Q7	.83
7R7	.95
7S7	.98
7V7	.95
7W7	1.05
7X7	1.10
7Y4	.75
7Z4	.85
12A	.65
12A6	.73
12A7	1.05
12A8GT	.79
12AH7GT	1.27
12AL5	[illegible]
12AT6	.73
12AT7	1.25
12AU6	.95
12AU7	1.15
12AV6	.73
12BA6	.85
12BE6	.87
12C8	.79
12F5GT	.79
12H6	.82
12J5GT	.55
12J7GT	.82
12K7GT	.79
12K8	.89
12Q7	.69
12SA7GT	.93
12SC7	.99
12SF5	.89
12SF7	.89
12SG7	.79
12SH7	.73
12SJ7	.79
12SK7	.98
12SL7	$1.05
12SN7	.98
12SQ7	.85
12SR7	.85
12Z3	.85
14A4	.98
14A7	.95
14B6	.95
14F7	.95
14F8	.95
14H7	.95
14J7	.95
14N7	.95
14Q7	.95
14R7	.95
19	.69
24A	.75
25L6GT	.85
25Z5	.79
25Z6GT	1.05
26	.50
27	.49
28D7	1.35
30	.45
31	.85
32	.95
32L7GT	.89
33	.93
34	.89
35/51	.83
35A5	.89
35B5	.89
35C5	.98
35L6GT	.85
35W4	.69
35Y4	.75
35Z3	.85
35Z4	.73
35Z5	.69
36	.79
37	.79
38	.60
39/44	.40
41	.75
42	.75
43	.75
45	.89
45Z3	.89
45Z5	.80
46	.82
47	.89
48	.98
49	.95
50A5	.95
50B5	.95
50C5	.95
50L6GT	.85
50Y6	.85
53	.98
56	.65
57	.80
58	.85
59	.95
70L7	.95
71A	.75
75	1.25
76	.55
77	.60
78	.79
80	.73
82	.89
83	1.15
83V	1.15
84/6Z4	.85
85	.89
89Y	.45
117L7/M7	1.35
117N7	1.35
117P7	1.35
117Z3	.89
117Z6	.90

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- WAVEMETERS
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RADAR—COMMUNICATIONS—TEST EQUIPMENT

AN/APA10 Panoramic Adapter	$175.00
AN/APA11 Pulse Analyzer.	
AN/APR4 Radar Search Receiver.	
AN/APR5 Radar Search Rec. 1000-31000 mcs	375.00
AN/APS3 Airborne X-Band Search Radar	875.00
AN/APS15 X-Band R.F. Head	99.50
AN/APT5 300-1500 mcs Xmitter	149.50
AN/CRT3 Dual Freq Victory Girl	129.50
AN/CRW Remote Control Receiver	5.95
AVR-15 Aircraft Receiver	19.95
AN/PPN-1 Portable Radar Beacon.	
BC-433G Compass Receiver	39.95
BC-639 Receiver	285.00
BC-733D Receiver	29.95
BC-923 Receiver	39.95
BC-1016 Tape Code Recorder	459.50
EC-1206 Beacon Receiver	4.95
CW-3 Less Coil & Xtal. New	39.95
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SCR269G Automatic Radio Compass	129.95
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SCR510 Freq Modulated Portable Transceiver.	
SCR522 Airborne VHF Transceiver.	
SCR536 Handi-Talkie.	
SCR610 Freq Modulated Portable Transceiver.	
SCR694 Lightweight Field Radio.	
SK-1M Radar Receiver Indicator	89.50
SQ Portable Radar 10 CM.	
T-50 Portable Radiotelegraph Xmitter	275.00
TCS Marine 2 Way Radio	
TRC-1 Complete Antenna System.	

AN/TPS-1 Search Radar

This is a Pack Portable Ground Search Radar for the detection of aircraft up to 100 miles. Range & Azimuth Data is displayed on a 7" P.P. 1 & a 5" scope. This set was called the G. I's Radar because of its ruggedness, dependability & ease of servicing, complete tech data is as follows: Power Output 150KW, P.R.R. 200 PPS, pulse width 2 microsec. beamwidth 3° horiz. 13° vert. power input 1100w. 115v 400 cyc & 27v DC. weight 1500 lbs. excellent condition.

ARA 500-1500KC Receiver. good	$24.95
R28/ARC-5 Receiver	29.95
BC455B 6-9 mcs. Receiver	19.95
BC433 200-1750KC Compass Rec.	29.95
ARR-2 234-258 mcs. Receiver	19.95
BC-454 3-6 mcs. Rec. w/tubes. New	16.95
T23/ARC-5 Xmitter	49.95
BC696-A 3-4 mcs Xmitter	29.95
TYPE O 5.3-7 mcs Xmitter	9.95
AVT-23 300-13,000KC Complete. New	79.50
BC-950A 100-156 mcs. Xmitter, New	59.95
BC-456 Modulator, good	2.25
BC-450 Control Box (3 Rec.) used	1.25
BC-451 Control Box (Xmitter) used	.98
BC-442 Relay Unit (Ant) Used	1.95

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RCA Sound Powered Chest & Headsets. Pair	$29.95
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HS-33 Headsets	4.95
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APA-17 D.F. Antenna. 300-1000 MC	59.00
BC-996 Interphone Amplifier	9.95
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CU-25 Loading Box for Art-13	49.95
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1D-80 APA-17 Indicator	129.95
RM-29 Remote Control	18.95
RA-300 FM Exciter	32.50
A-55 Dummy Antenna	2.25
BC-1365 Control Box	3.95
FL-8 Filter	3.95
FL-5 Filter less Cables	2.65
3C-16D GSAP Gun Camera Computer, complete	19.95
AT-2/APN-2 Antenna	4.95
CG-(172/173)CPN-8 10CM Patch Cable	4.95

TS3/AP S-Band Freq & Power Meter.	
TS10/APN Altimeter Test Set, Ex	$35.00
TS11/AP.	
TS12/AP V.S.W.R. Test Set for X-Band.	
TS13/AP XA Band Sig Gen Pwr & Freq Mtr.	
TS14/AP SA Band Sig Gen.	
TS15/AP Flux Meter.	
TS16AP/ Altimeter Test Set	$29.95
TS19/APQ5 Range Calibrator.	
TS23/APN Test Set for SCR718 Altimeter.	
TS32/TRC-1 70-100 mcs Sig Gen used to check ANTRAC Equipment.	
TS33/AP X-Band Freq. Meter.	
TS34/AP Synchroscope.	
TS35/AP X-Band Sig Gen Pwr Mtr Freq Mtr.	
TS36/AP X-Band Power Meter.	
TS45/AP X-Band Sig Gen.	
TS47/APR Sig Gen 40-500 Mcs.	
TS59/APN Altimeter Test Set.	
TS61/AP S-Band Echo Box	$140.00
TS62/AP X-Band Echo Box.	
TS67/AP I.L.S. Test Set.	
TS69/AP Freq. Mtr. 300-1000 mcs	$72.50
TS89/AP Voltage Divider.	
TS102/AP Range Calibrator.	
TS110/AP Echo Box.	
TS111/AP S-Band Freq. Meter.	
TS125/AP S-Band Power Meter	
TS126/AP Synchroscope.	
TS155/UP S-Band Sig Gen Pwr Mtr Freq. Mtr.	
TS164/AR A.C. Version of BC221.	
TS170/ARN I.L.S. Test Set.	
TS174/AP Freq. Mtr. 40-400 Mcs	$385.00
TS175/AP Freq. Mtr. 300-1000 mcs.	
TS184/AP	
TS189/AP	
TS226/AP 300-1000 mcs Pwr Mtr.	
TS268/AP Xtal Diode Test Set.	
TS278/AP AN/APS13 Test Set.	
BC-221 Frequency Meter.	
1E-19 Test Set for SCR522.	
1E-36 Test Set for SCR522.	

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Prices subject to change without notice. F.O.B. NYC. minimum order $10.00. 20% deposit required. All merchandise guaranteed.

RADIO HAM SHACK Inc.
189 GREENWICH STREET . NEW YORK, N. Y.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

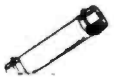
HIGH POWER TR. MICA

G-1 TYPE		G-2 TYPE		G-3 TYPE			
.0001	5KV	.0001	10KV	.0001	20KV	.000 ""	20KV
.00015	5KV	.00015	10KV	.0003	20KV	.015 ""	3KV
.0002	6KV	.0002	10KV	.0004	20KV	.0012	20KV
.0008	6KV	.000247	12KV	.00045	15KV	**G-4 TYPE**	
.0047	6KV	.0003	10KV	.0005	20KV	.0002	30KV
.005	5KV	.000375	10KV	.001	20KV	.0025	25KV
.01	4KV	.0004	5KV	.0011	20KV	.005	8KV
.032	2KV	.0005	10KV	.0024	15KV	.01	15KV
.04	1KV	.00065	10KV	.004	12KV	**TYPE #56**	
.08	1.5KV	.001	6KV	.25	1.6KV	.000155	30KV
.09	1.5KV	.003	8KV	.25	6KV	.000533	30KV
						.0004	30KV
						.001	30KV

OTHER H.V. MICAS

.0001	12.5KV	.01	7KV
.007	15KV Type 75A	.02	8.5KV
.01	5KV		

Type "F" and "NIF" GLASS FERRULE RESISTORS



Ohms	Watts	Ohms	Watts	Ohms	Watts
1	15	1000	50	6300	40
2.	20	1000	90	6500	120
2.2	15	1250	20	7500	15
4	90	1500	20	8000	90
5	15	1500	50	8200	40
6.2	15	1500	120	10,000	15
10	15	1600	40	10,000	40
15.	50	1800	15	10,000	90
20	15	2000	15	12,000	15
20	90	2000	20	12,500	15
26.	20	2000	50	12,500	90
32	90	2000	90	12,500	120
40.	90	2000	120	13,000	20
40.	12	2500	15	15,000	120
50.	15	2500	20	16,000	M-O-M
60.	20	2500	50	16,000	50
100	15	2675	38	16,000	90
100.	50	3000	20	20,000	50
125	90	3000	50	20,000	120
150.	50	3100	40	25,000	90
160	20	3100	90	25,000	120
200.	50	3150	15	35,000	120
270	20	3150	90	40,000	90
400	20	3300	20	50,000	MFC
600	40	4000	20	100,000	120
630	90	4000	50	300,000	MFC
800.	50	4500	20	500,000	M-O-M
1000	13	5000	40	600K	MFC
1000	15	5000	50	4.0 Meg.	MFB
1000	20	6000	50	40.0 Meg.	M-O-M
1000	40	6000	120	100. Meg.	MVP

NOISE FILTERS

MALLORY NF-1-1	SOLAR EA-125L
MALLORY NF12-6 EG	SOLAR EB-102
MALLORY NF12-7	SOLAR ED-101
SPRAGUE JX-51A	SOLAR EF-100
SPRAGUE JX-51B	SOLAR EF-103
SPRAGUE JX-55D	SOLAR EF-104
SOLAR EA-107	SOLAR EL-109
SOLAR EA-109	SOLAR EL-111
SOLAR EA-121	SOLAR EL-113
SOLAR EA-142	SOLAR FL-14, EV106

LEVER SWITCHES

Over 100 Varieties in Stock of MOSSMAN #4101 Series

1% PRECISION RESISTORS

Standard Brand

Ohms	Ohms	Ohms	Ohms
6.	500	5910	72K
24.	636	6000	75K
28.	680	6550	76100
34.6	733	6800	83700
35.7	743	7000	90K
38.6	750	7500	100K
40.	946	15K	110K
47.7	1000	17K	115K
75.	1250	18380	120K
78.8	1260	19500	125K
80.	1280	20K	130K
88.	1477	20500	135K
100	1485	21K	140K
107.85	2000	22K	145K
110	2142	29500	220K
125	2170	30K	235K
200	2500	32K	260K
215	2800	33800	347K
225	3460	37500	390K
248	3500	38140	500K
280	3760	39K	750K
286	4280	40500	800K
300	4500	47710	1.0 Meg.
370	5000	60K	4.0 Meg.
400	5294	61K	10.0 Meg.
450	5470	61430	
	5500	70K	

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	100	4.27
2	50	2.81	350	25	1.98
2	100	4.68	350	100	4.26
2	300	8.42	370	25	1.98
3	100	4.67	378	150	6.59
3	225	6.58	400	25	1.98
3x3	300	29.95	400	75	3.90
4	225	6.60	500	25	1.98
5	25	1.97	500	75	3.95
5	100	4.68	500	50	2.53
6	25	2.23	500	100	4.39
6	75	3.90	500	150	4.68
7	25	1.98	500	300	8.49
8	50	2.53	585	150	6.60
10	25	2.23	750	25	2.23
10	100	4.27	750	150	5.95
12	25	2.23	1000	25	1.98
12	50	2.53	1200	225	7.20
15	25	1.98	1250	50	2.66
15	75	3.90	1250	150	6.59
15	100	4.38	1500	25	2.53
20	50	2.53	1500	50	2.65
25	25	2.23	1800	150	6.24
50	25	1.98	2000	25	2.23
50	50	2.53	2000	50	2.53
60	25	1.98	2250	150	6.24
75	25	1.98	2500	150	6.24
75	75	3.90	2500	50	2.53
75	100	4.39	2500	100	4.68
80	500	12.46	3000	25	2.39
100	25	1.98	3000	100	4.68
100	50	2.53	5000	25	2.53
100	100	4.39	5000	50	2.85
125	25	2.53	7500	50	2.85
150	50	2.53	7500	100	5.31
175	25	2.53	10000	50	3.12
185	25	1.98	10000	100	5.51
200	25	1.98	15000	25	3.29
200	100	4.27	20000	150	8.43
225	50	2.53			

Specify whether shaft required is for knob or screwdriver adjust.

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	11	1	Bak-n/shtg	.60
1	21	3	Bak-n/shtg	.89
2	2	1	Cer-shtg	.50
2	6	2	Bak-n/shtg	.60
2	11	2	Cer-shtg	1.25
3	4	2	Bak-/shtg	.58
5	3	2	Cer-n/shtg	.98
6	11	6	Bak-n/shtg	1.95
10	5	5	Cer-shtg	2.25
16	2	4	Bak-n/shtg	1.35

Many other types in stock

"AN" CONNECTORS

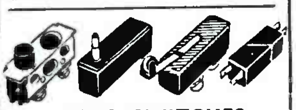
Large Variety Available At Great Savings

Send your specs and let us quote

BIRTCHER TUBE TUBES

#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

MICRO SWITCHES



CR-1070-C103-B3	"R-R12T"
CR-1070-C103-E	"YZ-7RST-1"
CR-1070-D103-A3	"WZ-7RST-1"
CR-1070-C123-C3	"YZ-2YST"
CR-1070-D123-D	"B-RS36"
TYPE "Q"	"B-RS10"
"4MC3-1B"	"WZ-2RQTC1"
"YP-5 "A""	"BZ-3RQTC"
"AZBPS"	"T-AZRPH"
"HRD7-1ATB"	"YZ-RS13"
"BZ-R37"	"BZ-2RQ91"
TYPE "D"	"BZV-2RQ9"
B-17	"TN3"
"WZ-2RT"	"AHB-201"
"YZ-2RT"	"TAAZGPO"
"2-AZG"	"TAAZG"
"WZ-RL8"	"PWDA"
"WZ-R8LT"	YZ-2RSTC
"R-RL2T"	YZ-2RS

OIL CONDENSERS

Mfd.	Voltages Avail.
.1	3-6-20K
.25	2-3-3¼-4-5K
.5	600-1½-3K
1	600-1-1½-2-5-6K
2	400-600-1-1½-2 3-4K
4	600-700-1-1½ K
6	400-600-1½-2 K
8	600
10	600-2½K
15	600-1K
30	90-vac. 3-ph
100	230-vac. 3-ph
3x4	500
3x8	600
4x3	600
4x8	600
3x10	90-vac

Special Prices on Request

BATHTUBS

Mfd.	Voltages Avail.
.033	400
.05	2-4-600
.1	4-6-1K
.15	600
.25	2-4-600
.35	400
.5	4-6-1K
.75	600
1	1-2-4-6-1 K
2	4-600
4	50-100
8	500
25	25-50-75
40	25
50	25
100	15
200	12
300	6
2x.01	2-400
2x.02	6-1500
2x.045	600
.046x.055	600
.2x.05	6-1500
.1x.05	200
.1x.5	400x50
2x.1	4-600
2x.16	600
2x.2	600
2x.25	4-600
.3x.5	500
2x.5	4-600
1.x.05	500
1.x.1	300
1.x5	200
2x1	600
2x10	25
2x200	9
3x.001	600
3x.05	600
3x.1	4-600
3x.25	4-600
3x.5	100-600
.015x.03x.045x.06x.12/	600

Also available CHANNEL Types. Special Prices on request.

SHOCKMOUNTS

100P-1	1 lb.	.15
100P-2	2 lb.	.15
100PR-2	2 lb.	.15
100P-3	3 lb.	.15
100P-6	6 lb.	.20
150P-4	4 lb.	.20
150PH-8	8 lb.	.45
100PL-1	1 lb.	.15
150P-7	7 lb.	.25
156P-6	6 lb.	.35
200PD-15	15 lb.	.59
200PHN-35	35 lb.	.75
204P-112	112 lb.	.98

TERMINAL BOARDS

5 terminal	98¢
8 terminal	1.67
12 terminal	2.49

TYPE "J" POTENTIOMETERS

TYPE "J" $1.50 / TYPE "JL" $1.75			TYPE "JJ" $2.95	
ohms	ohms	ohms	ohms	ohms
65 *†	4000†	75 K†	500-500 *†	130K-130K *
300†	5000†	80 K†	600-600†	150K-150K†
400 *†	6500†	100 K *	1500-1500†	250K-250K†
500†	10 K *†	100 K†	2000-50K *	350K-5K†
600 *†	12 K†	125 K *	2200-24K†	350K-25K†
750†	15 K *†	250 K *	6K-45K†	300K-300K†
1000 *†	20 K *†	2meg *	20K-2000†	350K-350K *
1400†	25 K *†	2meg†	25K-10K†	800K-75K *
1500 *†	30 K *†		35K-5000†	2meg-2meg†
2000 *†	50 K *†		50K-25K†	4meg-4meg†

TYPE "JJJ" $4.95

ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* 1/8" screwdriver slotted shaft.
† Knob type shaft.

TRANSMITTING MICAS

mfd.	wv	type	ea.	mfd.	wv	type	ea.
.0001	600	4	.36	.0015	600	4	.36
.0003	600	4	.36	.00162	600	4	.42
.00005	600	4	.29	.002	600	4	.39
.00005	2500	9	.57	.002	1200	4	.72
.0001	600	4	.29	.0025	600	4	.39
.0001	2500	9	.57	.003	600	4	.43
.00015	600	4	.36	.004	600	4	.45
.0002	600	4	.29	.005	1200	9	.99
.00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.86
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	600	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.08
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

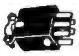
(Many other sizes in stock)

"UG" and "UHF" CONNECTORS

UG-9/U	UG-22/U	83-1H
UG/10U	UG-24/U	83-1J
UG-12/U	UG-25/U	83-1AP
UG-14/U	UG-27/U	831RTY
UG-15/U	UG-58/U	83-1SP
UG-16/U	UG-87/U	83-1R
UG-18/U	CW-123/U	83-1D
UG-19/U	UG-206/U	83-1SPN
UG-20/U	83-1AG	83-22R
UG-21/U	83-1F	CN 49151

PRICES ON REQUEST

JONES Connectors



P-101-¼	.25
P-101-⅜	.30
S-101-D-MDD	.33
S-302-AB	.13
S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.33
S-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.30
P-315-CCE	.40
S-315-AB	.36
S-318-AB	.43
P-324-FHT	.74
P-324-EB	.58
S-330-AB	.84
S-404-AB	.33
P-406-AB	.33
S-406-CCT	.58
S-408-CCT	.69
S-2408-SB	.53
P-2412-SB	.61
S-2412-CCE	.87
S-502-DB	.97
P-508-CE	2.55
P-510-CE	3.04
P-512-CE	3.52

Jones BARRIER STRIPS

3-140	.16
2-140-Y	.13
10-140-¾W	.53
10-240	.38
18-240	.66
4-141-W	.30
3-141	.21
6-141	.38
10-141 -Y (Mel)	1.04
20-141-¾ W (Mel)	2.03
4-141-¾W	.30
7-141-Y	.49
2-142-Y	.20
4-142-Y	.36
5-151	1.60
4-152	1.89
2002	.04
2008	.07
8-54	.22
8-6	.18
4-140-Y	.23
17-240 on 21	.63
20-160-R	.51
20-161-AR	.52

Many other types in stock

MALLORY PUSH SWITCH

#2001	S.P., make cont., non-L	.56
#2031	S.P.D.T., non-lock	.56
#2003L	S.P.D.T., lock	.56
#2004	D.P., make 2 non-L	.64
#2004L	D.P., make 2 lock	.64
#2006	D.P.D.T., non-lock	.78

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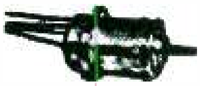
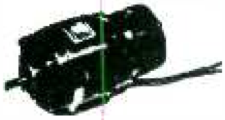
SYNCHRONOUS MOTOR



W. E. S-1283228. For 2 phase 240 cycle operation. 55 volts.
Stock #SA-317. Price $9.75 each.

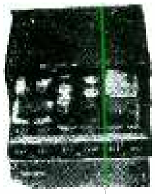
BODINE NSHG-12 MOTOR

Constant speed



27 v. D-C Governor controlled 3600 rpm. 1/30th hp. Stock #SA-39. Price $17.50 each.

C-1 Autopilot Amplifier

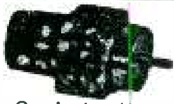


Three channel servo amplifier for use in C-1 Autopilot. 7 tubes. Stock #SA-172.
PRICES ON REQUEST.

DC MOTOR

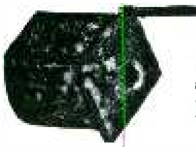
High speed 27 v motor with high inertia flywheel. Ideal for gyro demonstrations.
Stock #SA*S-313
Price $9.75 each.

PM MOTOR



Sampsel 27 V DC PM motor. Type S—151273. One in./oz. torque at 7000 rpm. 1½" x 1½" x 2¾" Lg. Stock #SA-283. Price $12.75 each. Quantity available.

REVERE CAMERA MOTOR



27 v. D-C Split field series. Approx. 2½" sq. x 2½" lg. Stock #SA-315.
Price $6.75 each.

JA1 MOTOR (D-C)

Electric Specialty. ¼ hp. 24 v. D-C. (Wing flap motor.) Stock #SA-325. Price $19.50 ea.

AC Motor Special

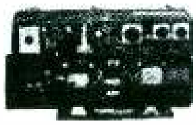
Eastern Air Devices J-33 115 V. 400 cy. 3 phase synchronous. 8000 RPM. Stock #SA-59.
Price $19.50 each

DC SERVO MOTORS

Elinco B-64 DC Servo Unit — armature voltage, 80 v d-c max. 27.5 v. field 1/165 hp 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque.
Stock #SA-211. Price $16.50 each.

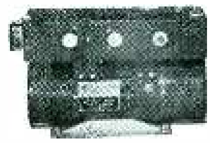
John Oster A-21E-12R — Split field series reversible motor. W.E. KS-5996-LO-4. 28 v. d-c at 0.4 amps. 2 watts output. 1½" diam. x 2½" lg. Ideal for relay or thyratron servos. Stock #SA-282. Price $8.75 each.

INVERTERS

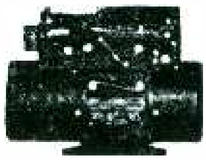


Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. Price $99.50 each.

G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. Price $29.50 ea.



PE-218E Inverters Russel Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. Price $19.50 each.



Pioneer 12130-4 B (1 ϕ) Input 28 VDC at 14 amps. Output 115 v. 400 cy. at 100 VA. Voltage and frequency regulated. Made 1949. Stock #SA-304. Price $89.50 each.

800 CYCLE INVERTER

Navy Type CRV-21AAR. GE. 5AS121LJ2. 27 v. DC input @ 45 amps. 120 v. 400 cy. Output @ 750 V. A. P.F. 0.30. Wt. 22.5 lbs. Stock #SA-192. Price $59.50 each.

MINIATURE DC SELSYN INDICATOR

G.E. miniature indicator. 24 v. d-c operation with G.E. Position Transmitter or with Ohmite 360° type potentiometer. Has iron plug for zero dial adjustment. Stock #SA-248. Price $14.50 each.

BLOWER ASSEMBLY

WESTINGHOUSE FL BLOWER

115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. Price $14.50 ea.

—SPECIAL—

Pioneer Type 12077 AMPLIFIER

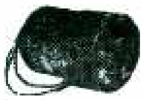
115 V. 400 cy. One Tube Servo Amplifier using saturable reactor type output transformer.

Limited Quantity

AC-SERVO MOTORS

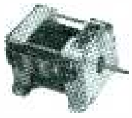
Pioneer Type CK-2
26 v. 400 cycles fixed phase, var. phase 49 v. max. 1.05 in/oz. Stall torque. Rotor moment of inertia 7 gm/cm: With 40: 1 gear reduction. Large Qty.
Prices on Request

PIONEER CK-17



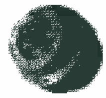
400 cycles 2 phase, 26 v. fixed phase. 45 v. max. variable phase. Built in gear reduction. Output shaft speed approx. 4 rpm.
Stock #SA-287. Price $16.50 each.

FORD SERVO MOTOR



115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. Price $49.50 each.

Pioneer Servo Motor



Type 10047-2A. 2 ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. Price $12.50 each.

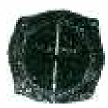
MICROWAVE ANTENNA

AS-217/APG 15B. 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs. Original boxes.
Price $14.50 ea.

A-5 Autopilot Indicator

Autosyn Type Pilot Indicator for A-5 Autopilot. 26 v. 400 cycles. Stock #SA-299. Price $12.50 each.

Compass Indicator



I-82F. Compass Indicator. 0-360°-5 in. dial. 26 v. 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.
Price $6.50 each

MICROPOSITIONER

Barber Colman AYLZ-2183. Polarized dc relay. Double coil differential current sensitive. Alnico PM polarized field. 24 v. Contacts 0.5 amps 28 v. Use for remote positioning, synchronizing, control, etc. Sens. 1.25 ma. diff. Use to 100 cy. Stock #SA-290.
Price $12.50 each.

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OA2	$2.00	2J27	29.95	5BP1	6.95	310A	7.95	722A	3.95	861	39.50
OA3	1.50	2J31	29.95	5BP4	6.95	311A	7.95	723A/B	17.95	866A	1.79
OB2	2.00	2J32	69.95	5CP1	6.95	312A	3.95	724A	4.95	869B	37.50
OC3	1.75	2J36	105.00	5D21	27.50	323A	25.00	724B	6.95	872A	3.95
OD3	1.50	2J38	17.95	5JP1	27.50	327A	3.95	725A	9.95	878	1.95
C1A	4.95	2J42	150.00	5JP2	19.50	328A	9.95	726A	6.95	884	1.95
C1B	6.95	2J49	109.00	5JP4	27.50	350A	7.95	726B	56.00	885	1.75
1B21A	2.75	2J50	69.50	6C21	29.50	350B	5.95	726C	69.00	889R	199.50
1B22	3.95	2J61	75.00	C6A	3.95	357A	20.00	728AY	27.00	914	75.00
1B23	9.95	2J62	75.00	C6J	10.95	368AS	6.95	730A	28.95	931A	6.95
1B24	17.95	2K25	47.50	7BP7	7.95	371B	2.95	801A	1.00	954	.35
1B26	2.95	2K28	37.50	7DP4	10.00	385A	4.95	802	4.25	955	.55
1B27	19.50	2K29	27.50	12AP4	55.00	388A	2.95	803	7.95	956	.69
1B32	4.10	2K45	149.50	15E	2.95	394A	7.95	804	13.50	957	.29
1B38	33.00	2V3G	2.10	15R	.95	MX408U	.75	805	5.95	958A	.69
1B42	19.95	3B24	5.50	NE16	.45	417A	27.95	806	25.00	959	1.69
1B56	49.95	3B24W	7.50	FG17	6.95	434A	19.95	807	1.69	991	.65
1B60	69.95	EL3C	5.95	RX21	3.95	446A	1.95	808	3.50	E1148	.35
1N21	1.35	3C24	1.95	35T	4.95	450TH	45.00	809	2.45	1280	1.95
1N21A	1.75	3C31	5.95	45 Special	.35	450TL	45.00	810	11.00	1611	1.95
1N21B	4.25	3DP1A	10.95	RK39	2.95	464A	9.95	811	3.15	1613	1.38
1N22	1.75	3E29	15.50	VT52	.35	471A	2.75	813	8.95	1616	2.95
1N23	2.00	SN4	5.50	RK72	1.95	527	15.00	814	3.95	1619	.89
1N23A	3.75	4A1	1.75	RK73	1.95	WL530	7.50	815	3.50	1622	2.75
1N23B	6.00	4B26	10.95	100TH	9.00	WL531	22.50	816	1.45	1624	2.00
1N26	8.00	4C27	25.00	FG105	19.00	700A/D	25.00	829	12.95	1625	.45
1N27	5.00	4C28	35.00	F123A	8.95	701A	7.50	829A	13.95	1851	1.85
1N48	1.00	4E27	17.50	203A	8.95	703A	6.95	829B	15.95	2050	1.85
1S21	6.95	4J25	199.00	211	.95	705A	3.95	830B	11.50	2051	1.80
2B22	4.95	4J26	199.00	217C	18.00	707A	17.95	832	7.95	8012	4.25
2B26	3.75	4J27	199.00	242C	10.00	707B	27.00	832A	9.95	8013	2.95
2C34	.35	4J31	199.00	249C	4.95	714AY	7.95	833A	49.95	8013A	5.95
2C40	20.00	4J32	199.00	250TL	19.95	715A	7.95	834	7.95	8020	3.50
2C43	27.00	4J33	199.00	274B	3.00	715B	18.00	836	4.95	8025	6.95
2C44	.90	4J37	199.00	304TH	15.00	715C	25.00	837	2.95	9001	1.75
2D21	1.75	4J38	89.00	304TL	14.50	717A	1.95	838	6.95	9002	1.50
2E22	3.75	4J39	199.00	307A	4.95	718AY/EY	48.50	845	5.59	9003	1.75
2E30	2.75	4J41	199.00			719A	29.50	849	52.50	9004	1.75
2J26	27.75	C5B	3.95			721A	3.95	851	80.50	9005	1.90
								860	4.95	9006	.35

This Month's Special 4C28 . . . . $35.00 OTHERS

Minimum Order $25.00

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TEST EQUIPMENT

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WE BUY—WE SELL—WE EXCHANGE—WILL PAY CASH FOR YOUR INVENTORY NO MATTER HOW SMALL OR LARGE. —TURN YOUR OVERSTOCKED ITEMS INTO CIRCULATION

Test Equipment
Microwave K Band 24,000 MC

TSKI-SE Spectrum Analyzer

X Band 10,000 MC

- TS 12 Unit 1 USWR Measuring Amplifier, 2 channel
- TS 12 Unit 2 Plumbing for above
- TS 33 X Band Power and Frequency Meter
- TS 35 X Band Pulsed Signal Generator
- TS 36 X Band Power Meter
- TS 146 X Band Signal Generator
- TS 62, TS 102, TS 168
- X Band Tunable Crystal Mounts
- TVN #3EV Bridge Cy 94

S Band 3000 MC

- TS 102, TS 270
- TS 125, TS 155, TS 127
- RF 4 Electrically Tuned S Band Echo Box
- BC 1277/60ABQ S Band Pulsed Signal Generator
- PE 102 High Power S Band Signal Generator

L Band

Hazeltine 1030 Signal Generator 145 to 235 Megacycles

Audio Frequencies

RCA Audio Chanalyst

Broadcast Wave Bands

- 162C Rider Chanalyst
- Short Wave Adapter for 162C
- TS 174 Signal Generator

Oscilloscopes

- BC 1287A used in LZ sets
- Supreme 564
- APA10, APA28
- TS 34 Oscilloscopes WE
- TS 126

Other Test Equipment and Meters

- TS 15/A Magnet Flux Meter
- General Radio V T Voltmeter 728A
- Calibrator WE 1-147
  - General Radio 1000 cycles type 213
  - Limit Bridges
  - Boonton Standard instructions
- Model 40 Pyrometer
  - Rawson, meters 0-10 Microampere 0-2 Millivolt

RADAR Sets & Parts

APS 3—APS 4—R-111/APR5A

Prices Subject to Change

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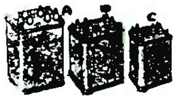

TRANSFORMERS

These XFRMFS are Army 6 Spec. All Underrated.

PRIMARIES, 115V, 60 CYCLE

Item		Amp.	Filament Ratings	Price
CT-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, 3lbs.	2.95
CT-071	110V	.200	33/.200, 5V/10, 2.5/10	4.95
CT-378	2300V	4MA	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	.026MA	5V/3A	2.75
CT-610	1250	.002MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026MA	5V/3A	2.75
CT-866	330V	.065	6.3V/1.2, 6.3V/600 MA	1.75
CT-456	390VCT	30MA	6.3V/1.3A, 5V/3A	3.45
CT-160	800VCT	100MA	6.3V/1.2A, 5V/3A	4.95
CT-319	660VCT	.085A	5V/2A, 6.3/7.5A, /6.3/3A	3.25
CT-931	585VCT	86MA	5V/3A, 6.3V/6A	4.95
CT-441	50–46V	200MA	110VCT/2A	2.75
CT-442	525VCT	75MA	5V/2A, 10VCT/2A, 50V/200MA	3.85

FILAMENT TRANSFORMERS

Stock	Rating	Price
FT 104	6V/5A	$4.78
FT 924	5.25V/21A, 2x7.75V/6.5A, 2x26V/2.5A	17.95
FT 824	16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A, 2x26V/2.5A	12.95
FT 357	9VCT/45A	14.75
FT-781	866 Trans. 2 x 2.5/5A	2.25
FTG-31	2.5V/2.5, 7V/7A (Tape @ 2.5V/2.5A), 16 lbs	9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79

PLATE TRANSFORMERS

Item	Rating	Each
PT-976	Auto: 120VCT/10MA	$0.69
PT-31A	2 x 300V/5 MA	.79
PT-033	4150V/400 MA 11¼ x 9¼ W x 9" D 70 lbs	49.95
PT-403	Auto: 70V/1A	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	2 x 300V/5 MA	.79
PT-976	120VCT/10MA	.79
PT-12A	280VCT/1.2A	2.95
PT 919	1200–0–1200 200 MA	8.95

SPECIAL FIL. TRANSFORMERS

Item	Pri.	Output	Price
STF-946	210/220/230	2.5V/4A 3½" H x 2¼" x 2¼" D	$1.29
STF-638	230	5V/9A 5½" H x 4½" x 3¾"	1.25
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-968	230	2.5V/6.5A	1.10
STF-405	230/115	5V 12/9A	2.95
STF-370	22 /440	3 x 2.5V/57, 2.5V/15A, 5¼ x 5 x 4½	5.25
STF-619	11 /220	2.5V/500A, 7 x 5¼ x 5.	19.95
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, 103/4H x 5 x 7 30 lbs.	24.95
STF-96B	230	2.5V/6.5A	1.95
STF-608	220	24V/600, 5V/2A, 2 x 6.3V/1A	2.25

SPECIAL PLATE TRANSFORMERS

Item	Pri.	Output	Price
STP-945	210/20/30	1100VCT/300 5¼ x 4 x 3½	$5.95
STP-444	230/460	230/105/115/125/115 lbs. 5¼ x 6 x 4½	14.95
STP-613	230V	2 x 230/.05	1.29
STP-823	137V	222VCT/300 MA	2.95

FILTER CHOKES

Stock #	Description	Price
CH 776	1.28 H/130 MA/75 ohms	$2.25
CH 344	1.5 H/145 MA/1200V Test	2.35
CH 905	.257 H/2 ADC/DCR — 2.24 ohms	4.79
CH 854	1 HY/80 MA	1.29
CH 43A	10 HY/15 MA—850 ohms DCR	1.75
CH 999	15 HY/15 MA—400 ohms DCR	1.95
CH 511	6 H/80 MA—310 ohms DCR	2.45
CH3-501	2x.5H/400 MA	2.79
CH188M	5 HY 200 MA	1.79
CH488	10 HY .030A	1.19
CH791	Dual 1.75–.125 HY 100 MA	1.27
CH86C	Dual .01–3.5 HY 950–75 MA	1.10
CH981	15 HY .110A	1.59
CH22-1	1 HY .100A	1.17
CH779	.6 HY .490A	1.25
CH25A	SW .09/.018 HY 3/.3A	8.95
CH922	10000 HY O MA	2.75
CH043	2.2 HY 80 MA	.98

COMMUNICATIONS EQUIPMENT COMPANY *For your needs*

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
DM 42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
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 $49.50

PE-218-H: Same as above except size; 16½"x6"x10". New $49.50

PE-206: Input: 28 vdc. 38 amps. Output: 80 v 800 cy. 500 volt-amps. Dim: 13"x5½"x10½". New...$22.50

SPECIAL CONVERTER

IN: 115VDC. OUT 12/26VDC, 500W. BRAND NEW $99.50

400 CYCLE TRANSFORMERS

Stock #	Ratings	Price
901699-501	2.77V @ 4.25A	$3.45
901698-501	900V/75 MA, 100V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/80 MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300VCT, 135 MA	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
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
D-167254	6.4V/8A, 6.4V/1A	2.79
302433-A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	59.2VCT/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	600 VCT/36 MA	2.65

RADAR	RADIO	SONAR
APS-2	APN-4	QBF
APS-4	SCR-518	QBG
APS-10	SCR-545	QCJ
APS-15	FDMK-4	QCL
SA-SC-SN	MK-10	QCO

MANY OTHER SETS—WRITE

B-19 MKII TRANS. RECEIVER

Less Power Pack .. $32.50
B-19 Power Pack .. 8.95

ID-24 ARN-9

Dual 0-200 Micro-vamp Movement in 3" Case. ILS Equipment $6.95

ARC5 MODULATOR

MD7/ARC5 Plate Modulator w/dynamotor complete w/Tubes 1—12J5, 2—1625, 1—VR50. Good cond.

Price $6.95

TUBES

LARGE QUANTITY AVAILABLE

01-A	12SF7	705-A	F-127
1B26	12SR7	724-B	FC258A
2C21	15P	800	GL532
2C22	28D7	801-A	FC271
2X2/879	70 (Spec.)	815	GL562
3BP1	45 (Spec.)	836	GL623
2C24	39/44	837	GL697
3C30	35/51	843	ML100
3D6	227A	860	QK59
3D21-A	225	861	QK60
3DP1	268-A	874	QK61
3EP1	355-A	876	QK62
3FP7	417	1005	VR91
3Q5	530	1619	VR130
5FP7	531	1624	VR135
5J30	532	1629	VR137
6C	559	1961	VU120
6SC7	562	9004	VU134
10Y	615	CEQ72	WL532
12K8Y	704-A	EF50	WN159
			WT260

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: .5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-71B, 4-829-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-10 MODULATOR DECK. Complete, less tubes........$75.00

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT. 1 microsec 400 PPS, 50 ohms imp........$42.50

G.E. #6E3-5-2000-501P2T, 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

7.5E33-200-6FT, 7.5 KV, "E" Circuit, 3 microsec 200 PPS, 67 ohms imp, 3 sections........$12.50

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. #166173 Hi-Volt input transformer, W.E. impedance ratio 50 ohms to 900 ohms, Freq. range: 10 kc to 2 mc, 2 sections parallel connected, potted in oil........$36.00

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. UX7896—Pulse Output Pri. 5v, sec. 41v...$7.50

Ray UX 8442—Pulse Inversion:—40v + 40v........$7.50

Ray. UX 7361 ....$5.00

UTAH NUMBERS

9332 9340 9278

DELAY LINES

D-168184: .5 microsec. up to 2000 PPS, 1800 ohm term........$4.00

D-170499: .25/.50/.75 microsec. 8 KV. 50 ohms imp........$16.50

D-165997: 1¼ microsec........$7.50

VARISTORS

D-167176	$ .95
D-172155	$2.25
D-172307	$1.70
D-168687	$ .95
D-171812	$ .95
D-171528	$ .95
D-162356(308A)	$1.50

THERMISTORS

D-166288	$1.50
D-167332 (tube)	$1.50
D-170396 (bead)	$1.50
D-167613 (button)	$1.50
D-164699 for MTG "X" band Guide	$2.50

MICROWAVE TUBES

MAGNETRONS

Tube	Freq. Range	Pk. Pwr. Output
2J27	2965–2992 mc.	275 KW
2J31	2820–2860 mc.	265 KW
2J21-A	9345–9405 mc.	50 KW
2J22	3267–3333 mc.	265 KW
2J26	2992–3019 mc.	275 KW
2J32	2780–2820 mc.	285 KW
2J38 Pkg.	3249–3263 mc.	5 KW
2J39 Pkg.	3267–3333 mc.	87 KW
2J49	9000–9160 mc.	58 KW
2J61	3000–3100 mc.	35 KW
2J62	2914–3010 mc.	35 KW
3J31	24,000 mc.	50 KW
5J30		
718DY	2720–2890 mc.	250 KW
720BY	2800 mc.	1000 KW
725-A	9345–9405 mc.	50 KW
730-A	9345–9405 mc.	50 KW
700 A, B, C, D		
706 AY, BY, DY, EY, FY, GY		

KLYSTRONS

723A 723A/B—2K25—726A 707

"CW" MAGNETRONS

QK 62 3150–3375 mc.
QK 59 2675–2900 mc.
QK 61 2975–3200 mc.
QK 60 2800–3025 mc.

CR—TR—PULSE TUBES

705A	721	3EP1
3DP1	3EP7	5J30
3GP1	5CP1	15R

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Full Wave Bridge Selenium Rectifiers

UP TO 18 VAC IN—UP TO 14 VDC OUT

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10A	7.50
12A	9.00
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2A	4.00
4A	8.00
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UP TO 54 VAC IN—UP TO 42 VDC OUT

2A	$6.50
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UP TO 120 VAC IN—UP TO 100 VDC OUT

2A	$11.00
10A	48.00
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COMMUNICATIONS EQUIPMENT CO.

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....$47.50 ea.
MAGNETRON TO WAVEGUIDE Coupler with 721 Duplexer Cacity, 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/APRA 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized 45 degrees....$75.00 per set
MAGNETRON COUPLING FOR TYPE 720 MAG. to 1½" x 3" Waveguide....$35.00
AS14A/AP-10 CM Pick up Dipole with "N" Cables....$4.50
OAJ ECHO BOX, 10 cm, Tunable....$22.50
S BAND SIGNAL GEN. Comp. with calibrated attenuator, W.E. Coax Wavemeter, McNally Klystron Oscillator, Regulated Power Supply, operating from 115v. 50-1200 cycles. Manufactured by W.E....$650.00

⅞" RIGID COAX—⅜" I.C.

RIGHT ANGLE BEND, with flexible coax output pick-up look....$8.00
SHORT RIGHT ANGLE bend, with pressurizing nipple....$3.00
RIGID COAX to flex coax connector....$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length..$5.00
RT. ANGLES for above....$2.50
RT. ANGLE BEND 15" L. OA....$3.50
FLEXIBLE SECTION. 15" L. Male to female....$4.25
FLEX COAX SECT. Approx. 30 ft....$16.50

3CM RESEARCH EQUIPMENT 1" X ½" WAVEGUIDE

1" x ½" waveguide in 5' lengths, UG39 flange to UG40 cover, silver plated....$7.50 per length
Rotating Joint supplied either with or without deck mounting....$17.50 each
2J42 Magnetron Pulse Modulator, 14Kw max. rating 7Kw min. Plate voltage pulsed 5.5kv. 6.5 Amp. .001 duty cycle, 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
3 cm. mitred elbow "E" plane unplated....$12.00
UG 39 flanges....85c
UG 40 chokes....$1.00
90 degree elbows #E or H plane 2½" radius....$12.50
90 degree twist 6" long—UG39 to UG40....$8.00
45 degree twist....$8.00
40 KW X Band radar, complete as described and illustrated in July, 1951, Electronics—APS-4 under belly assembly, less tubes....$375.00

1¼" x ⅝" WAVEGUIDE

Waveguide Lengths, cut to size and supplied with 1 choke, 1 cover, per length....per ft. $2.00
BI Dir-Coupler WG output calibrated—25 db nominal....$17.50
Mitred 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

1.25 CM RESEARCH EQUIPMENT

Complete 24,000 MC RF Head, including 2K33 Klystron, 3J31 Magnetron and Magnet, all plumbing, and associated circuitry, in standard A-N Pressurized housing. New, $1100.00.

Low Power Load....$20.00
Shunt Tee....$35.00
Waveguide Lengths. 2" to 6" long, gold plated with circular flanges and coupling nuts....$2.25 per inch
APS-34 Rotating Joint....$49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, choke to cover....$12.00
Mitered Elbow, cover to cover....$4.00
TR-ATR-Section. Choke to cover....$4.00
Flexible Section 1" choke to choke....$5.00
"S" Curve Choke to cover....$4.50
Adapter, round to square cover....$5.00
Feedback to Parabola Horn with pressurized window....$27.50
90° Twist....$10.00
"K" Band Directional Coupler....$49.50 ea.

SUPERSONICS

QCU Magneto striction head RCA type CR 278225—New....$95.00
Stainless Steel streamlining housings for above....$18.50
Driver Amplifier, New....$200.00
Magneto striction head, coil plate assembly, new....$14.50
Magneto striction head coil plate assembly....$14.50
Magneto striction head assy. consists of coil, plate, nickel diaphragm plate, milled steel body unassembled....$65.00
Supersonic Oscillator RCA 17-27 Kc. Rec. Driver, Osc. 115 V 60 cy. AC. Designed for use w/200 watt drive. New less tubes....$39.50
QBF Sonar mfg. WE complete console consists of 10-40 kc. rec. driver osc. ind. & control unit, and driver amplifier 22-28 kc. Write.
QJA Sonar QBF w/OJA adapter kits w/cathode ray tube indication. Write.
Supersonic Oscillator: 50 watts, A-1 Emission 18-25 kc. Operates from 115 V. 60 cy. New....$150.00

MICROWAVE ANTENNA EQUIPMENT

3 CM ANTENNA WITH DISH 14". Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanism. 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
AS14A.AP, 10 CM pick up dipole assy, complete w/length of coax and "N" connectors....$3.50
AS46A/APG-4 Yagi Antenna, 5 element array....$22.50
30" Parabolic Reflector Spun Aluminum dish....$4.85

140-600mc 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
SO-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-1, 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
Mark 4, Gunlaying, 800 MC, Less Ant., Used
Mark 10, Gunlaying, 10 CM, Compl., New
CPN-3, Beacon, CM, Major Units, Used
CPN-8, Beacon, 10 CM, Compl., Less Ant., New
SCR-533, IFF/AIR, 500 MC, New

TEST SETS

TS 102/AP	TS 56A/AP
TS 45/APR	TS 89
TS 36/AP	1-203-A
TS 12 UNIT 2	TS 11/AP
Q. METER	BC 438
TS 69/AP	CS60-ABW
CW60-ABM	I-158
LU-1	I-222
LU-3	I-185
TS 159	TS 268/U

Send for Further Info. & Price Others

AN/APS-6

RT 17/APS-6 . . . A 3 C.M. package designed for aircraft interception . . . night fighter radar work for use with a conical scan antenna. Package consists of 725A magnetron and magnet, 1B24 duplexer, 724 ATR, 723 A/B local oscillator and beacon oscillator, complete transmitter-receiver, RF plumbing, IF strip using 6AK5's and 6AL5's. Miniature tubes used throughout, enclosed blower, pressurized housing. A complete 3 CM RF package of the latest design, using miniaturized components.

Less receiving type tubes.......... **$425.**

AN/APS-6-(A1A) Test Synchroscopes—WRITE

All merchandise guaranteed. All prices F.O.B. N.Y.C. Send M.O. or Check. Only shipping charges sent C.O.D. Rated concerns send P. O.

COMMUNICATIONS EQUIPMENT CO.

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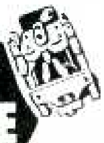
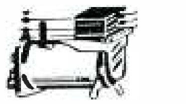
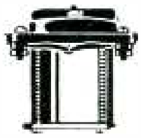
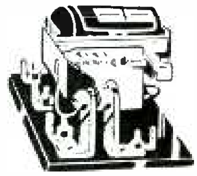
RELAYS FOR EVERY PURPOSE









Over a Million in Stock!

Each relay is brand new, standard make, inspected, individually boxed and fully guaranteed.

The following list represents only a portion of our relay stock. Write or wire us for information on types not shown.

STANDARD DC TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-806	115*	900	1A	$2.05
R-161	6	10	2B & 1A	1.10
R-518	85/125	6500	1C	3.60
R-633	180/350	10,000	1C & 5 Amps.	2.90
			Oct. Skt.	2.45
R-667	6	.75	1B/10 Amps.	
			1A/3 Amps.	1.45
R-632	6	12	5A & 1C	1.25
R-154	6/12	200	1A	1.50
R-517	12	250	2A	1.50
R-116	85	3000	1B	3.05
R-631	100/125	3300	2A	1.90
R-545	110/250	7000	1C	2.45
R-124	300	1200	1A	1.55
R-160	6	12	3C & 3A	1.30
R-155	12	100	4A & 4B	1.45
R-520	200/300	14,000	2C	3.45
R-159	6	50	2A	1.35
R-153	12	200	1C & 1A	1.55

SHORT TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-635	12	100	1C & 1A	$1.35
R-826	12	150	2C, 1B	1.55
R-770	24	150	1A/10 Amps.	1.45
R-771	24	200	1A/10 Amps.	1.45
R-603	18/24	400	2A	1.55
R-575	24	500	2C	2.40
R-764	48	1000	2C & 2A	2.00
R-563	60/120	7500	1A	1.70
R-801	115*	——	None	1.45
R-213	5/8*	——	2A	3.10
R-589	12	125	2A	1.30
R-113	12	150	4A	1.55
R-689	12/24	255	1C	1.55
R-799	24	500	None	1.00
R-115	24	500	1C	1.70
R-110	24/32	3500	1C	1.70
R-121	150	5000	2A & 1C	2.05
R-634	150/250	6000	1A & 1B	2.45
R-800	12	150	2C & 1A	1.55
R-537	12/24	150	2C & 1B	2.00
R-750	24	400	1A	1.60

CONTACTORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-650	24	100	1A/50 Amps.	$3.70
R-312	24	7	1A/200 Amps.	5.50
R-333	98/120	975	4A/Size 2	5.50
R-334	115	1200	3A/Size 2	5.50
R-338	6	7.5	1A/50 Amps.	3.45
R-353	65*	——	2A	3.95
R-358	18/29	200	1A/Dble. Brk.	2.00
R-445	14	12.5	1A/200 Amps.	4.05
R-446	12	18	1A/50 Amps.	3.90
R-447	12	18	1A/50 Amps.	3.90
R-448	24	67	1A/50 Amps.	3.90
R-449	28	160	1A/50 Amps.	3.90
R-450	24	75	1A/50 Amps.	3.90
R-188	24	200	1A/75 Amps.	3.70
R-183	24	60	1A/50 Amps.	3.45
R-187	24	100	1A/50 Amps.	3.70
R-554	24	85	2A/100 Amps.	5.90
R-788	100*	——	3B & 2A	5.45
R-682	115*	35	5A/10 Amps.	6.10
R-767	24*	20	2A/10 Amps.	4.95
R-180	12	25	1A/50 Amps.	4.05
R-265	24	60	1A/100 Amps.	3.45
R-535	24	70	1A/100 Amps.	4.80
R-556	24	70	1A/100 Amps.	4.80
R-557	24	100	1A/50 Amps.	3.85
R-178	24	100	1A/100 Amps.	4.80
R-608	24	125	1A/200 Amps.	2.80
R-184	28	50	1A/100 Amps.	4.90
R-719	24	10	1A/200 Amps.	4.95
R-182	28	80	1A/25 Amps.	2.40
R-244	75*	265	1A/20 Amps.	2.20
R-659	12	7.2	2A/20 Amps.	1.70
R-552	24	70	4A/50 Amps.	5.35
R-185	24	100	1A/50 Amps.	3.45
R-186	24	132	1A/50 Amps.	4.35
R-817	24	150	1A/50 Amps.	3.45

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-534	14	45	1A/30 Amps.	2.05
R-223	28	150	1A/40 Amps./48 VDC.	1.70
R-680	6	3	1A/50 Amps.	3.90
R-677	6	3.5	1A/50 Amps.	3.90
R-532	6	15	1A/50 Amps.	3.90
R-676	12	16	1A/50 Amps.	
			1AUX/25A	3.90

ROTARY RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-712	24	200	2B	$2.05
R-711	24	200	2C & 1B	2.05
R-573	28	200	1C & 1B	2.05
R-766	24	230	12 Pos. 8 Deck	4.90
R-809	28	7	1B & 12 Pos. W/	2.45
			7" Shaft for Wafers.	

DIFFERENTIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-208	120	2000	2C/3 Amps.	$2.45
R-209	220/250	8000	1C/3 Amps.	3.10

SEALED RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-261	12/24	1900	1C/5 Pin Plug	3.75
R-673	48/150	7500	1C/5 Amps.	2.80

VOLTAGE REGULATORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-745	6	2	1A/10 Amps.	$1.05
R-780	24	350	1C/6 Amps.	1.05
R-509	6/12	35	1B/2 Amps.	1.05

SPECIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-503	12/32	100	3A, 2C	$13.50
R-749	600	——	Max. 28 Amps.	7.45
R-804	550*	——	1B/38 Amps.	4.35
R-579	220*	——	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	——	2C	6.10
R-246	115*	——	1B	11.20
R-246A	115*	——	1A	11.20
R-611	24*	——	1A/30 Amps.	5.35
R-283	12	125	1C/10 Amps.	4.35
R-614	18/24	60	1A/15 Amps.	4.35
R-245	12	25	4" Micalex Lever	3.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	——	——	1A	3.50
R-669	75*	400 Cy.	1B, 1A	1.20
R-660	6	——	⅝" Stroke	1.20
R-651	24	100	Solenoid Valve	3.10
R-295	12	275	Annunciator Drop	2.70
R-230	5/8	2	2A, 1C	2.70
R-813	12	12	Wafer	5.35
R-275	12	750	1A, 1B, 1C	3.45
R-716	24	70	2A/5 Amps.	1.80
R-620	6/12	35	2C, 1A	1.30
R-629	9/14	40	1C/10 Amps.	1.55
R-720	24	50	2C Ceramic	1.70
R-500	12	10/10	2C/6 Amps.	3.55
R-816	12	10/15	2C/6 Amps.	3.55
R-524	24**	——	——	1.20
R-566	115*	Coil Only		1.00
R-710	——	150 Coil Only		.75

*AC. **AC/DC.

KEYING RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-714	9/14	65	2C/5 Amps.	$1.55
R-850	12	450	1A/1.5 Amps.	1.50
R-721	18/21	290	2C/5 Amps.	1.55
R-694	24	300	1A/5 Amps.	1.50
R-935	28	1000	1C/1.5 Amps.	1.65
R-949	2.4*	60 Cy.	1A/5 Amps.	1.95
R-704	2/6	.25	2B/5 Amps.	1.35
R-173	2/6	2	1A	3.00
R-280	6/8	77	1A Dble. Brk.	2.45
R-647	6/12	15	1B/20 Amps.	1.45
R-273	20	160	2A/15A Dble. Brk.	3.55
R-169	24	200	1A	2.45
R-570	24	230	1B Dble. Brk.	2.70
R-960	24	230	3C/15 Amps.	2.95

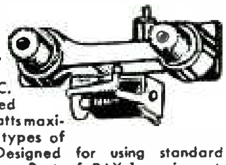
Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-529	24/48	1020	2C	3.10
R-715	24	——	2C Ceramic	3.70
R-584	6	20	1A Dble. Brk.	1.30
R-192	12	44	3C/10 Amps.	1.70
R-204	12	66	2A	1.45
R-224	12	85	1A	1.45
R-221	18/24	5000	1A	2.00
R-205	24	260	2C	1.55
R-891	24	475	1C/5 Amps.	1.45
R-536	27	230	2C	1.55
R-858	27.5	250	1A Dble. Brk.	1.45
R-833	6.5	1300	2C	3.05
R-220	75	5000	1C	1.50
R-828	6/8	42	1A	1.50
R-627	115*	——	1B Dble. Brk.	3.10
R-734	24	150	3C/10 Amps.	1.30
R-598	28	185	2C	1.30
R-622	20/30	200	3A & 2C/10 Amps.	1.45
R-274	24*	——	2A	1.55
R-855	110*	60Cy160	1A Dble. Brk/15A	3.25
R-277	12	30	2C-D Break Cera	2.20

MIDGET RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-572	24	256	1C	$1.25
R-857	24	260	1 Make Before Make	1.75
R-912	4/5	20	3A-1C Ceramic	2.50
R-291	6	5	1A	1.25
R-921	6.7	18	1A Dbl.Brk. @10 Amp.	1.45
R-738	12	60	3A	1.20
R-922	12	75	1A Dbl.Brk. @10 Amp.	1.45
R-144	12	228	1A	1.45
R-145	18/24	250	2A Ceramic	1.45
R-298	21	300	1A	1.25
R-296	21	300	1A	1.25
R-586	21	300	1A & 1C	1.25
R-137	24	300	1C	1.45
R-142	24	400	2C	1.50
R-785	24	200	2C/10 Amps.	2.00
R-607	24*	——	1A	1.20
R-606	24*	——	1A & 1B	1.20
R-605	24*	——	3A	1.20
R-728	6	30	1A	1.25
R-149	6/8	45	1B	1.50
R-732	12	120	1A	1.45
R-281	12	126	2A	1.25
R-818	18/24	300	1B	1.30
R-135	24	250	1B	1.45
R-133	24	300	None	.75
R-138	24	300	4A	1.45
R-132	24	300	2C	1.50
R-731	24	300	2C	1.55
R-292	24	350	1C	1.25
R-626	24	400	1A/5 Amps.	1 55
R-786	60	1300	2C	2.00
R-588	90/125	6500	4C	2.70
R-755	24	300	1A	1.45
R-150	6	30	1A	1.50
R-893	14	150	1A, 1C	2.50
R-895	14	150	2A, 1B, 1C	2.50

SPECIAL!

CO-AXIAL RELAY

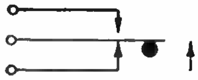


D153766 SPDT, 6 VDC. 19 Ohm coil. Designed to accommodate 75 watts maximum. Perfect for all types of antenna switching. Designed for using standard 83-1SP coaxial fittings. Part of RAX-1 equipment. No. R-846—**$6.95** Ea.

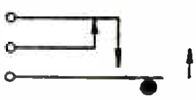
BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION

Form A—"Make" (Single Throw, Normally Open)

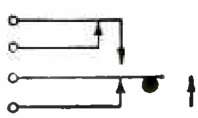
Form B—"Break" (Single-Throw, Normally Closed)



Form C—"Break-Make" (Double-Throw)



Form D—"Make-Before-Break"



Form E—"Break-Make-Before-Break"

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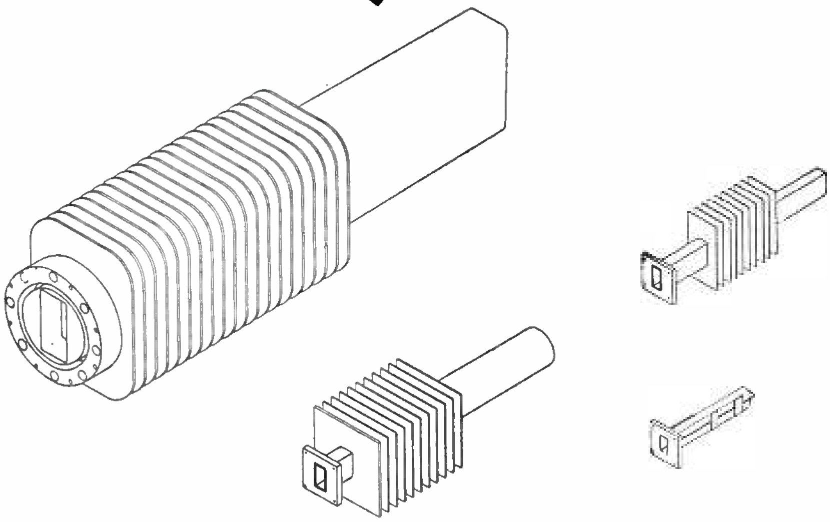
TEST EQUIPMENT



HI-POWER DUMMY LOADS

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 1,200 watts average power in still air, VSWR less than 1.15 between 2.5 to 3.7 KMC, choke flange, weight 13 pounds.

TS-30, 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 Frequency Meter, 8,500 to 9,600 megacycles, direct reading within 25 megacycles; within 4 megacycles with correction chart. Transmission type for ⅝" x 1¼" wave guide.

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-33/AP X Band Frequency Meter, 8,700 to 9,500 megacycles,—$150.00.

TS-62/AP X Band Echo Box,—$150.00.

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

T-85/APT-5, 300-1,600 megacycles Noise Modulated Transmitter, 40 watts C. W.

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 bandwidth 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 18 300-1,000 megacycles
TN 17 80-300 megacycles — TN 19 1,000-2,200 megacycles
TN 54 2,200-4,000 megacycles

ELECTRO IMPULSE LABORATORY

62 White Street — Red Bank 6-0404 — Red Bank, N. J.

COLUMBIA ELECTRONICS LTD.

SCR 291

Semi-portable Radio Direction Finder. Uses a U-Adcock type antenna array designed for ground station operation. The overall frequency range of this equipment when used for direction finding is continuously variable from 2 to 10 mcs. Receiver has continuous frequency range from 1.5 to 30 mcs., divided into 4 bands. Sensitivity is approx. 5—15 microvolts/meter for ±2° bearing readability. Power requirement 115 V. 60 cycles, single phase. Complete. New.

TEST EQUIPMENT Complete Line!

Signal Generator 804-C
DuMont 224-A Oscilloscope
1-77 Hickok Tube Checker
1-208 FM Signal Generator
RPC Model 644 Multimeter
Ferris Microvolter Mod. 18-C

IE-36 (New)	TS-100/AP
1-122	TS-102A/AP
I-139 METER	TS-111/CP
I-212	TS-126
1-222	TS-127/U
TS-3/AP	TS-170/ARN-5
TS-5/AP	TS-175/UP
TS-10B/APN	TS-182/UP
TS-19/APQ-5	TS-184A/AP
TS-24A/ARR-2	TS-204/AP
TS-34/AP	TS-250/APN
TS-36/AP	UPM-1
TS-61/AP	(Complete)
TS-62/AP	WE I 193
SL-1 Slotted Line Test Set	Range Calibrator I-146

MODULATOR UNIT BC-1203A
With Coupling Heads BC-1201 & BC-1202

RC-184 IFF EQUIPMENT
Complete. Brand new.

APS-4 Complete Radar
Mark 16 Complete Radar
APS-6 Complete

RECEIVERS
APR-4 — APR-5

SCR-720 Equipment | MG-19A New

HEADSETS
HS-38 & HS-33 Brand new

MK-20A/UP
Brand new. Individually boxed.

TELEVISION CAMERA

350 line resolution. Easily converted to present RMA standards. Circuits available with camera. Complete, like new.

VARIAC TRANSTAT AMERTRAN
Input 0-115 V., 50-60 cycles; output 115 V 100 amps. 11.5 Kva. Excellent condition.

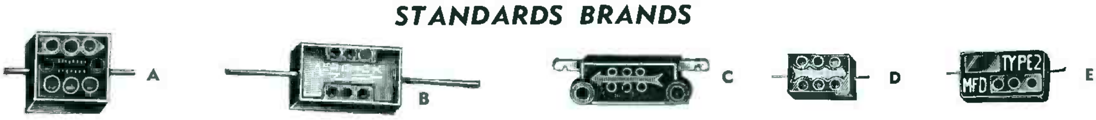
SEE COLUMBIA ELECTRONICS AD ON PAGE 384

COLUMBIA ELECTRONICS LTD.
524 S. San Pedro St., Los Angeles 13
CALIF.
Cable Address: COELECT
ALL ITEMS SUBJECT TO PRIOR SALE

Buy TOP Radio-Electronic Values!

MICA CAPACITORS

STANDARDS BRANDS



Stock No.	Cap.	Tol. %	Work Volts	Type No.	Fig.	Price Per 100
4100*	.000025	5%	300V	1468	D	6.00
4102*	.000025	5%	300V	"O"	D	6.00
4103*	.000027	10%	300V	"O"	D	6.00
2378*	.000033	5%	300V	MOS	D	6.00
3781*	.00043	5%	300V	"O"	D	6.00
3902*	.00055	5%	300V	CM35	A	6.00
2544	.00068	20%	300V	1468	D	4.50
2771	.0015	20%	300V	MO	D	4.50
2557	.006	20%	300V	1441	B	5.00
2404	.0062	20%	300V	1467	A	5.00
4104	.00001	10%	500V	CM20	D	4.50
3981	.00001	10%	500V	CM20	D	4.50
4105	.00001	10%	500V	5W	D	4.50
4107*	.00001	20%	500V	2R	E	6.00
4108*	.00001	20%	500V	1468	D	6.00
4109	.00001	20%	500V	1468	D	4.50
3982	.00001	20%	500V	CM20	D	4.50
4111*	.00002	2%	500V	Silver Cap	B	6.00
2248*	.00002	20%	500V	CM20	D	4.50
3983	.000022	10%	500V	CM20	D	4.50
3777	.000022	20%	500V	CM20	D	4.50
3678	.000022	20%	500V	CM20	D	4.50
4113*	.00003	20%	500V	CM20	D	6.00
4114	.000033	20%	500V	MO	D	4.50
4115	.000033	20%	500V	5W	D	4.50
2379*	.000035	20%	500V	"O"	B	6.00
3558	.000051	5%	500V	1468	D	5.00
4117	.000056	5%	500V	CM20	D	5.00
5080	.00006	10%	500V	CM20	D	5.00
2381	.00006	20%	500V	1468	D	5.00
4118	.000068	10%	500V	CM20	D	5.00
3988*	.00007	2%	500V	CM20	D	6.50
3679*	.00007	5%	500V	1468	D	6.50
2292*	.0007	20%	500V	2R	E	6.50
4156	.007	20%	500V	CM30	A	6.00

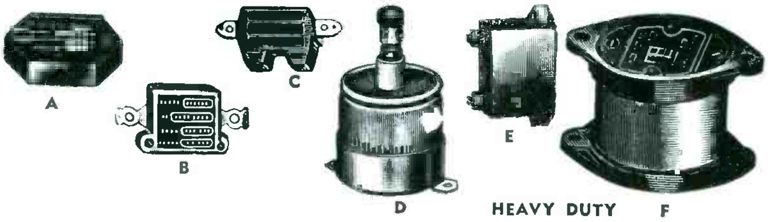
*Silver Mica

Stock No.	Cap.	Tol. %	Work Volts	Type No.	Fig.	Price Per 100
2384	.00008	20%	500V	1468	D	5.00
4119	.000082	10%	500V	CM20	D	5.00
4123	.00018	10%	500V	CM20	D	5.00
4124*	.00019	20%	500V	CM20	D	6.50
4125	.0002	20%	500V	MO	D	5.00
2578	.00035	20%	500V	5W	D	5.00
4126	.0004	20%	500V	"O"	D	5.00
4128	.0004	20%	500V	5W	D	5.00
4134	.00056	5%	500V	1⅛x⅜	E	5.00
2312*	.0008	10%	500V	MWS	A	6.00
4136	.0008	10%	500V	MW	A	5.00
2802	.0008	10%	500V	W	A	5.00
4137	.00082	10%	500V	CM30	A	5.00
4138	.0009	10%	500V	1⅜x⅜	E	5.00
4140*	.001	10%	500V	Silver Cap	E	6.50
4141	.001	10%	500V	CM30	A	5.00
4142	.001	10%	500V	CM35	A	5.00
2412*	.001	20%	500V	Lugs	C	3.50
3787	.0012	10%	500V	CM25	E	5.00
4143*	.0015	5%	500V	MWS	A	6.50
4144	.0015	5%	500V	MW	A	5.00
4145*	.0015	10%	500V	MWS	A	6.50
3789	.0015	10%	500V	CM35	A	5.00
2417	.0015	20%	500V	CM40	B	5.00
2418	.0015	20%	500V	W	A	5.00
4148	.0034	20%	500V	MW	A	6.00
4149	.004	20%	500V	CM30	A	6.00
2399	.004	20%	500V	CM40	B	6.00
4150	.005	20%	500V	MW	A	6.00
4152	.006	20%	500V	CM35	A	6.00
3528	.006	20%	500V	CM40	B	6.00
4154	.0062	5%	500V	CM40	B	6.00
4155	.0062	20%	500V	CM35	A	6.00
2610	.0068	20%	500V	CM30	A	6.00
2609	.0068	20%	500V	CM35	A	6.00

* Silver Mica Mfr. Name on Request.

MORE STOCK THAN LISTED. OTHER TYPES AND SIZES ON REQUEST

TRANSMITTING MICA CAPACITORS



Stock No.	Cap.	Test Volts	Fig.	Type No.	Price Each
5493A*	.01	1000	B	1445	35¢
5494A	.02	1000	B	1445	30¢
5495A	.006	1200	A	A 2	35¢
5496A	.0001	1500	C	BE 15	20¢
5497A	.0005	1500	C	BE 15	20¢
5498A	.004	2500	B	4	40¢
5499A	.001	5000	A	F	40¢
5600A	.0036	5000	A	A2	60¢

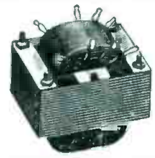
*Supplied with meter Bracket

Stock No.	Cap.	Test Volts	Fig.	Type No.	Price Each
5601A	.15	1000V	E	XS	90¢
5602A	.00007	2500V	E	3	90¢
5603A	.00005	3000V	E	15L	1.00
5604A	.0001	5000V	E	F2L	1.00
5605A	.0008	5000V	E	F2L	1.00
5606A	.000025	10,000	D	PL-341	1.95
5607A**	.00015	10,000	F	PL-315	7.95

** D.C. Working Voltage

STANDARD BRAND. MFR. NAME ON REQUEST. OTHER TYPES AND SIZES AVAILABLE

6.3 VOLT FILAMENT TRANSFORMERS



Stock No. 5254 A
Three 6.3 Volt Secondaries
115 Volt—
60 Cycle Primary
1600 Volt Insulation

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Price Each **$2.65**

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. 2½" above Chassis. Solder Lug Terminals—All Terminals Marked.

BIRTCHER TUBE CLAMPS

Type 926-A16
Type 926-B-20

Stock No. 56 28A **25¢ ea.**

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OUR FULLY ILLUSTRATED BULLETIN OF ELECTRONIC PARTS IS MAILED AT REGULAR INTERVALS TO MANUFACTURERS AND WHOLESALERS. IN THE CATALOG ARE LISTED AND PICTURED HUNDREDS OF ITEMS OF INTEREST TO PURCHASING AGENTS OF ELECTRONIC PARTS. WE SHALL BE PLEASED TO PLACE YOUR COMPANY'S NAME ON OUR MAILING LIST. PLEASE REQUEST ON YOUR COMPANY LETTERHEAD.

LARGE STOCKS OF FERRULE RESISTORS AVAILABLE. Write for list or specify your requirements. We also have mounting clips.

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OIL FILLED CONDENSERS

3 MFD — 4000 VOLT For BC-610. 2 Ceramic Insulated Screw Terminals 3¾" x 4½" x 6½" High Can....

Stock No. 5134A **$4.95**

045 MFD.—16,000 Volt Vitamin "Q". One Ceramic Insulated Screw Terminal 1¾" x 3½" x 4¾" High Can.
Stock No. 5399A **$4.95**

Standard Brand. MFR. Name on Request

83-1R COAX CONNECTOR

Stock No. 5657A

$.60 ea.

Oil Filled Condenser 10 Mfd. 220 V.A.C. Round Can, 2-½" Diameter x 3-⅞" High. Stock No. 5658A. **$1.95 each**

AMPHENOL & CANNON CONNECTORS & FITTINGS

Terms: Open Account to rated or acceptable referenced accounts. Others Pre-payment or 25% deposit with order, balance C.O.D. Prices F.O.B. Chicago and subject to change without notice. Merchandise subject prior sale.

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- Wire—Hook-up
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Immediate Action! → **MU 6-4164**

19 WEST 26th STREET • NEW YORK 10, N. Y.

CONDENSERS

10 mfd.—600 V . . . . $ .75
Three term. bot. mntg. channel type. Dims. 3¾"x3½"x2". Two 5 mfd. sections rated 400 V at 72 deg. "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs. "C". Ideal for filter or power factor application where ruggedness and quality are paramount. Carton or 24 weight 42 lbs. $.65 ea.

16 mfd.—600 V $1.75
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket. *Quantity discount.*

7 mfd.—600 V . . . . . . $1.45-$1.95
Small, high quality oil cond. by a leading mfg. measuring *only* 2⅛"x3¾"x1¾" complete with brackets.

6 mfd.—150 V . . . . $ .25
Three term. dual 3 mfd. oil cond. complete with brackets, measuring 4¼"x1¾"Wx1".

8 mfd.—1000 V $2.39
Dual 4 mfds. hermetically sealed and packed, measuring 5⅜"x3¾"x2 7/16". Case of 10 $2.10.

8 mfd.—600 V	$1.98
8 mfd.—500 V	1.35
4 mfd.—600 V	1.75
4 mfd.—400 V	.85
2 mfd.—600 V TLAD	.80
1 mfd.—600 V Channel	.65
1 mfd.—500 V Channel	.58
1 mfd.—400 V Channel	.47
.5 mfd.—400 V Channel	.29
.2 mfd.—1000 V ST Bathtub	.19

POTENTIOMETERS

$1.35-$1.50

Ohms	Shaft	Ohms	Shaft
50	1/8 S	20000	1/8 LS & 1 1/4
60	1/8 LS	25000	1/8 S & 3/8
150	1/4 S	30000	1/8 S
300	1/8 S	40000	1/8 LS
500	3/8 & 1/8 S	50000	1/8 S & 1/4 S
1000	1/8 S	50000	1/8 LS
1500	1/4 S	100000	1/2
2000	3/8 S &1/8 LS	150000	2 1/8
2500	1/8 S	200000	1/8 LS
3000	1/8 LS	250000	1/8 LS & 9/16
5000	1/8 LS & 3/8	250000	1/8 S
6000	1/4	500000	1/8 LS
10000	3/8 & 1 1/4	600000	2.0
10000	5/16	1 Meg	1/8 & 1/8 LS
15000	1/8 S		

Dual Pots—$2.75

Ohms	Shaft	Ohms	Shaft
1500	5/16	20 K	7/16
1–5 Meg	1/2	1 Meg	1/2
		2 Meg	1/8 S

SEE NOV. ISSUE

For many other listings of condensers, switches, relays, connectors and instruments. Inquiries solicited.

WANTED
Condensers of all types in any quantity. Also other standard components. Top prices.
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CONDENSERS OUR SPECIALTY
OIL FILLED & TRANSMITTING MICA TYPES
All Values and Voltage Ratings
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TELEPHONE EQUIPMENT & PARTS

Brand New RM29A Remote Control units Export packed with carrying bag..............$16.00 ea.
Rebuilt & Reconditioned EE8 Field telephones $19.95 ea.
New TS9 handsets for EE8 telephone......$5.95 ea.
Brand New W.E. F1W3 handsets.........$6.95 ea.
Rebuilt like new W.E., A.E., Kellogg, with new 3. Cond. Cords......................$4.95 ea.
New transmitter & receiver elements, interchangeable with the W.E. HA1 & F1..........$1.00 ea.
New export packed high impedance Conn. receiver elements ....$1.00 ea.
New W.E. Operators head & chest sets...$6.00 ea. Rebuilt $4.95 ea.
New Federal 101-A two wire Applique—Provides necessary balancing facilities for 4 wire repeater when used on two wire lines—Export packed $42.00 ea.
New MC131 ringers......................$.90 ea.
New Crank GC9 for EE8..................$.30 ea.
New CA-355 capacitors..................$.50 ea.
New TS9 switches.......................$.30 ea.
C-161 repeat coils.....................$2.00 ea.
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Lever switches for EE8.................$.30 ea.
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Rebuilt like new W.E. 202 desk telephones, dial blanked with separate ringer Box......$13.50 ea.
Federal 803 Desk telephone with self enclosed ringer, like new, dial blanked.........$17.50 ea.
A.E. New sound powered transmitters....$3.00 ea.
Rebuilt sound powered handsets with new Cords $5.00 ea.
Sound powered field telephones..........$18.00 ea.
New Bd 62C switchboards................$25.00 ea.
New Standard Brand Condensers—D161882A-D 161880-E—D163 176B ....$.90 ea.
New Capacitors 100MFD-50WV..........8 for $.50
Switch SW-150 ....$.50 ea.
JK-47 ....$.40 ea.

Terms; Check with order F.O.B. Brooklyn 15, N. Y.

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ELECTRICAL STEEL

We can offer about 26,000# of Hi-Grade Strip—.005 x 12⅜" "Hipersil" 3¼% Transformer grade — In Coils weighing about 900# each—Material new and prime but outside wrap weather discolored.

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(NEW) HEAT CONTROL AND RECORDERS

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New in original crates

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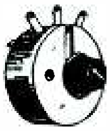
SURPLUS EQUIPMENT

POWER RHEOSTATS



Standard Brands: 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.

Boxed, Brand New with Knob $2.50 each—or— $25.00 per Doz.

ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
Delco-Type 5069230: 27.5 volts; DC; 145 RPM **$12.50 ea.**
Delco-Type 5069600: 27.5 Volts; DC; 250 RPM ....**$12.50 ea.**

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.**

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle......**$25.00 ea.**

Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor. **$25.00 ea.**

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.**

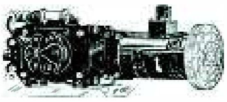
TYPE 12606-1-A: Same as 12604-3-A except it has a 30:1 ratio between output shaft and follow-up Autosyn....**$70.00 ea.**

TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train...........**$70.00 ea.**

PIONEER AUTOSYNS

AY-1......26 Volt—400 Cycle.......**$4.95**
AY-5......26 Volt—400 Cycle.......**$5.95**
AY27D **$25.50**
AY6—26 Volt—400 cyc..........**$4.95 ea.**
AY30D—26 Volt—400 cyc.......**$25.00 ea.**
AY38D—26 volt—400 cyc., shaft extends both ends ....**$19.95 ea.**
AY20—26 volt—400 cyc.........**$12.50 ea.**

AIR COMPRESSOR, AIRCRAFT



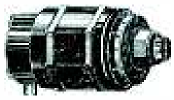
Rated pressure 1000 PSI. measures 13½" x 9¼"; driven by 27VDC-1/3rd HP series wound motor 11,000 RPM; 17 amp; cont. duty Mfg. General Electric Mod. # 5BA40EJ28B. **$39.95 ea.**

TACHOMETER INDICATOR

SINGLE

Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer. **$9.95 ea.**

TACHOMETER GENERATOR



Pioneer Instrument, Mark V, screw mount. Used with Kollsman Mark V Indicator **$25.50 ea.**

Tachometer Indicator and Generator (above) ....Both **$33.50**

SENSITIVE ALTIMETERS

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.

SMALL DC MOTORS

(Approx. size . . . 4" long x 1¼" dia.
General Electric-Type 5BA10AJ37: 27 volts, DC; .5 amps, 8 oz. inches torque; 250 RPM; shunt wound; 4 leads; reversible **$6.50 ea.**

G. E. Type 5BA10FJ215, 24 volts DC, .77 amp. 30 lbs. in. torque, 4 RPM...**$15.00 ea.**

General Electric-Type 5BA10AJ52C: 27 Volts, DC; .65 amp; 14 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$6.50 ea.**

MICROPOSITIONER

Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive; Alnico P.M. Polarized field. 24 V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc. **$12.50 ea.**

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12077-1-A. A single tube amplifier designed for autosyn take off signal. Contains magnetic amplifier assembly. With tube ....**$24.50 ea.**

SERVO MOTOR 10047-2-A: 2 Phase; 400 Cycle; with 40-1 Reduction Gear $10.00 ea.

400 CYCLE MOTORS

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.**

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.**

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.**

SYNCHROS

1F Special Repeater (115V-400 Cycle **$15.00 ea.**
2J1F3 Generator (115V-400 cyc)..**$7.50 ea.**
5CT Control Transformer: 90-50 Volt; 60 Cyc. ....**$50.00 ea.**
5F Motor (115/90 volt—60 cyc.)..**$60.00 ea.**
5G Generator (115/90 volt—60 cyc.) **$50.00 ea.**
5SDG Differential Generator (90/90 volts —400 cyc.) ....**$30.00 ea.**
5DG Differential Generator 90/90 volts 60 cycle ....**$50.00 ea.**

METERS

AC Volt, Westinghouse, Type NA-35—3-inch round. F.S.-10 MA...........**$6.95 ea.**
FREQUENCY, 57-63 cycles per second, 125 volts, mfg. Aero. mod. 7007. 3-inch round **$8.95 ea.**
KILOVOLTS, 0-4, mfg. Dejur; 3-inch round; mod. 310, less resistor....**$3.95 ea.**

PLEASE ENCLOSE FULL AMOUNT WITH ORDER — EQUIPMENT FULLY GUARANTEED

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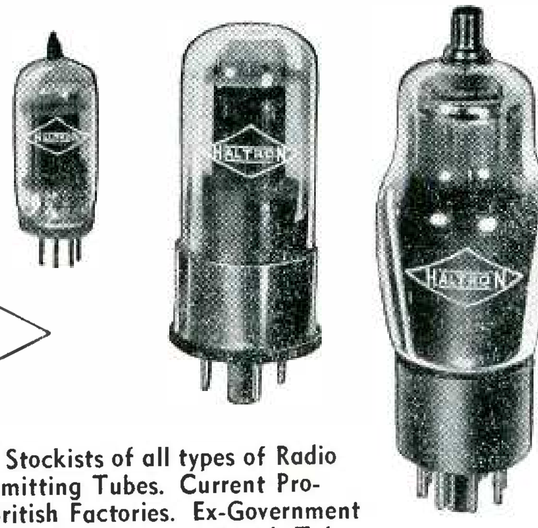

Leading Exporters and Stockists of all types of Radio Receiving and Transmitting Tubes. Current Production of main British Factories. Ex-Government Surplus, American, Canadian and British Tubes in Original Brands. Suppliers to Foreign Governments, Airlines, etc.

HALL ELECTRIC LTD

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Phones: MUSEUM 9661 (5 lines)
Cables: HALLECTRIC. LONDON

119 BRAND NEW SPECIALS!!!

SELENIUM RECTIFIER CELLS

Brand New Cells—Aluminum Base Plates

Rectangular		Round	
Size	Price	Diameter	Price
1" sq.	$.02	1"	$.02
1-3/8" sq.	.03	1-3/8"	.03
1-3/4" sq.	.06	1-3/4"	.06
4-1/8 x 6"	.17	2-5/8"	.11
5 x 6"	.19	3-1/4"	.12
4-1/8 x 12"	.40	4-3/8"	.14

NOTE: Due to the great expense entailed in testing each cell for current and voltage ratings, we are offering these unrated at at only a fraction of their original cost. Over 25,000 sold recently. Money back if not completely satisfied.

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Magnovox Co. Type G-19. 24 VDC. Adjustable stroke. Wt. 2-3/4 lbs. New.........$1.60
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Leece-Neville Co. #S-20686. 12 VDC. Silver and platinum contacts. Worm screw adjustment. New. $1.25

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General Electric. Sym. M305. Indicates 1-99, 999 hours. 115 VAC. 60 cycles. 3" round bakelite case. Square, flush face New..$11.95

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100 high quality springs made of genuine music wire. Rust-proofed and cadmium-plated. Tension, compression, and torsion types. Sizes up to 7" lengths and 1-1/2" diameters. A real buy and MUST for the experimental work bench. All New...$2.95

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WRITE FOR OUR LATEST 24 PAGE

SURPLUS SALES CATALOG

WE WILL BUY YOUR NEW OR CLEAN USED ELECTRONIC SURPLUS: ARC-1, ARC-3, BC-224, BC-348, BC-312, BC-342, ATC, ART-13, APS-13, BC-221, LM's, TS-12, TS-13, TS-23, TS-34, TS-35, IE-19A, I-222, SCR-522, TS-100, I-100, or any BC, I, IE, TS, APR.

WRITE FOR PRICES:
APR4, APR5A, APR7, TS-34, 804CS2, APA-38, BC-348, ART-13, TS-12, ARC-1, APN-9, BC-610, TCS, 304TL, 889R.

Weston 769 Electronic Analyzer LIKE NEW $200.00
Weston 779 Analyzer.........LIKE NEW 100.00
Bristol Dynamaster Recorder-Controller KRQ1531 for Resistance Thermometers 130-145 ohm ....LIKE NEW 350.00
APN-1 Altimeter Indicator 0-1 ma. shunt. 250° dial ....NEW 2.95
Counting Rate Meter General Radio 1500A 0-20,000 counts per min..........EXC. 395.00
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RC-376H Oscillator ....EXC. 35.00
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DuMont 208 Oscillograph...........EXC. 225.00
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Drafting Machines 16" & 18" less scale $35.00 and $40.00 respt.
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NOTE: One of the largest and most complete electronic surplus stocks in the country. We have thousands of tubes, capacitors, plugs, accessories, transmitters-receivers, test equipment, etc. Send us your requirements.

TERMS: Prices F.O.B. Pasadena, California. 25% on all C.O.D. orders. Californians add 3% Sales Tax. Prices subject to change without notice.

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IN STOCK
IMMEDIATE SHIPMENT

6B8	.60
6B8G	.55
6J8G	.65
6L7G	.65
6S7G	.60
6U7G	.50
12A6	.50
12F5GT	.48
12K8GT	.50
50	.65
70L7GT	.85
85	.57
807	1.40
1619	.40

PLEASE WRITE FOR UP-TO-DATE SPECIAL PURPOSE TUBE LIST WITH NEW LOW PRICES

ALL LISTINGS ARE QUALITY GUARANTEED. INQUIRIES REGARDING THESE AND OTHER REQUIREMENTS GIVEN PROMPT ATTENTION. USUAL DISCOUNTS TO MANUFACTURERS AND JOBBERS

PARTS

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5000 volt AC, center tapped, 350 MA. Primary 115 volt, 60 cycle. Unmounted and not potted, overall dimension 6½ inches x 6 inches x 7 inches, weight 37 lbs.
New. $25.00

PULSE TRANSFORMER

68G828-G1 ....New. $5.50

PLUGS

TELEPHONE PLUG, Equivalent to PL-55, with Screw Terminals Inserted. Samples furnished to quantity users....New. $.30

BUTTERFLY CONDENSER
(A-PR-4TN-17)

Antenna Tuning Unit Condenser (C-302) for TN-17, 74-320 MC, in original package $12.50

All items subject to prior sale. Shipments BEST WAY C.O.D. if desired. Rated accounts net ROG.

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Technical Radio Since 1919

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7½ KVA 115/220 volts, 400 cycle AC output motor generator set, 3 phase, 4 wire, with separate exciter. Has vari-drive permitting adjusting frequency from 300 cycles to 420 cycles. Powered with 3 phase 220/440 volt, AC motor. Price $890.00.

One generator only 400 cycle, 40 KW, 3 phase, $950.00.

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10 KW 110/220 volt single phase lighting plants with Minneapolis Moline 1200 RPM engine, $1200.00. Also available in 3 phase.

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Photos and detailed information available.

Manufacturers of many types of electrical generating machines ranging up to 300 KW

KATO ENGINEERING CO.

105 Maxfield Ave. Mankato, Minn.

Radio Tube Closeout

FIRST QUALITY, UNBRANDED, GUARANTEED MADE BY STANDARD MANUFACTURERS

25c each in lots of 1,000

1A4P	12,200	1H6GT	5,996	1230	350
1B5	1,696	1J6G	3,700	33	37,000
1C6	7,650	1J6GT	18,199	34	7,300
1C7G	7,800	2A6	9,150	35	100
1D5GP	15,840	2A7	51,100	35/51	40,300
1D7G	4,784	2B7	2,250	36	12,450
1E7GT	40,000	2E5	700	37	15,350
1F4	7,000	6L7G	22,200	38	2,800
1F5G	1,500	6S7G	22,898	39/44	5,500
1F6	1,100	12F5GT	7,100	46	1,548
1G4GT	36,300	12Z3	31,350	49	27,700
1H4G	9,300	19	51,500	50	2,486
1H6G	872	22	5,600	55	5,700
				89	1,489

35c each for following lock-ins

14A5 2,200—14J7 9,250

BULK PACKING — 100 TUBES TO A CARTON.

Subject to prior sale.

RENE M. JACOBS CO., Inc.

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BRAND NEW STANDARD BRAND TUBES

OA2	1.45
OA3/VR75	1.47
OB2	1.49
OB3/VR90	1.19
OC3/VR105	1.25
OD3/VR150	.89
C1A	9.75
1A3	1.10
1A4P	.69
1A6	1.25
1B4P	.79
1B5/25S	.89
1B7GT	.89
1B22	6.95
1B26	2.75
1B29	4.75
1B36	14.75
1B56	34.95
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1C6	69
1C7G	.79
1D5GP	.89
1D7G	.79
1D8GA	.79
1E5GP	.79
1E5	.89
1E7GT	.89
1F4	.59
1F5G	.69
1F6	.79
1G4GT	.79
1G5G	.79
1G6GT	.69
1H4G	.79
1H6G	.69
1J6G	.69

1J6GT	.69
1L4GT	.65
1LA4	.89
1P5GA	.69
1R4/1294	.89
1T4	.69
1T5GT	.89
2A4G	.89
2A6	.59
2A7	.59
2C21/1642	.65
2C22/7193	.30
2C26	.19
2C26A	.39
2C34/RK34	.59
2C40	5.95
2C44	1.00
2E5	.89
2E22	2.95
2E24	4.85
2E26	3.49
2J22	7.50
2J26	24.50
2J27	24.50
2J30	69.50
2J31	24.50
2J32	37.50
2J33	37.50
2J36	89.50
2J40	37.50
2J61	39.95
2J62	42.50
2K25/723AB	29.25
2V3G	.98
2X2	.59

3A4	.79
3B7/1291	.59
3B22	2.69
3B24	5.25
3B26	3.50
3C24	1.75
3C28	4.95
3D6/1299	.59
3D23	4.75
3E29	13.95
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5C30/C5B	3.75
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6A3	1.25
6AC5GT	.89
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6C8G	.79
6D8G	.79
6K7G	.59
6L7G	.89
6R7G	.99
6S7G	.79
6SA7GT	.89
6SR7GT	.69
6T7G	.79
6U7G	.59
6ZY5G	.79
7C4	.69
7E5	.89
7E6	.79
10Y	.75

12A6	.79
12A7	.89
12F5GT	.69
12H6	.79
12J7GT	.89
12K8	.89
12Z3	.79
19	.59
20	.89
22	.89
24G	1.75
25AC5	1.19
34	.59
RK34	.59
35/51	.79
36	.50
38	.49
39/44	.49
45 Spec/VT52	.29
46	.79
49	.69
EF50	.89
CRP72	1.25
RK72	1.25
CRP73	1.25
RK73	1.25
FG81A	3.50
VT90	.98
VT98	175.00
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HY114B	.75
VT127	2.50
205B	3.95
211	1.75
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250R	8.95
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286A	18.95
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304TL	10.95
307A	3.95
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316A	1.39
329A	8.95
331A	8.95
353A	4.95
371B	.89
388A	1.49
417A	8.49
450TH	44.50
530	16.95
531	6.75
533	175.00
559	3.95
HY615	.22
700A	24.95
701A	4.95
702A	3.19
703A	5.75
704A	.95
705A	2.75
707A	9.95
707B	17.25
710A/8011	.75
713A	.98
714AY	5.75
715A	5.95
715B	9.50

715C	24.10
721A	4.95
722A	2.39
723AB	14.25
724B	3.25
725A	6.25
730A	20.95
800	1.95
801A	.49
802/RK25	2.95
803	3.50
805	3.75
807	1.60
808	2.95
809	2.39
810	12.75
811	3.25
812	3.25
813	8.50
814	3.75
815	2.89
828	11.95
829	10.95
829B	14.95
830B	3.25
832A	9.50
833A	48.75
836	4.75
837	1.49
838	3.95
843	.25
846	49.95
851	48.75
860	6.50
861	23.25
864	.75

865	1.25
866A	1.35
869B	39.50
872A	2.35
874	1.25
876	.59
879	1.43
931A	5.95
954	.35
955	.55
956	.69
957	.45
958A	.59
CK1005	.75
CK1006	3.49
E1148	.33
1608	4.95
1613	.89
1616	.89
1619	.45
1624	1.49
1625	.40
1626	.40
1629	.35
1636	2.95
1642	.98
2051	1.09
7193	.35
8001	14.95
8011	.75
8012	2.75
8013A	4.75
8020	1.25
8025A	7.95

9001	1.50
9002	1.25
9003	1.75
9004	.55
9005	1.75
9006	.29
C5B	3.75
C6A	5.75

CATHODE RAY TUBES

3CP1/S1	1.95
3DP1	4.75
3FP7	1.85
4AP10	4.50
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5FP7	3.95
7BP5	18.95
10BP4	17.95
12LP4	20.95
12LP4A	22.25
14BP4	26.50
16DP4A	34.00
16RP4	35.00
17BP4A	35.00
19AP4A	61.25
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6 Amp. Rectigon Westinghouse 4.75

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- Amphenol Connectors
- Allen-Bradley Potentiometers
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- Burndy Hylugs
- T & B "Sta-Kon" Terminals
- Dialco Panel Light Assemblies
- Superior Powerstats
- Ferrule Type Resistors
- Relays, Transformers and Chokes
- Synchros
- Tube Sockets
- Hardware
- Contactors
- Magnet Wire & Hook-up Wire
- Vacuum Condensers
- Gas-filled Condensers
- Oil-filled Condensers
- High-voltage Mica Condensers
- High-voltage Oil-filled Condensers
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- Tubes
- Switchboard Meters
- Crystal Diodes
- Interlock Switches
- Key Switches
- Hook-up Wire

We invite inquiries regarding items not listed above.

Replies will be made to your inquiries within twenty-four hours after they are received by us.

Key Electronics Division

1801 North Longwood Street Baltimore 16, Maryland

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STANDARD BRANDS

1B3	$1.35	6AQ5	.80	6SN7	1.09
1LN5	.95	6AT6	.70	6SU7GTY	2.50
1N21B	3.50	6AU6	.79	6V6GT	.89
1N23B	4.00	6AV6	.60	12A6	.70
2A3	1.45	6BA6	.79	12AT7	1.19
5U4	.79	6BG6E	1.89	12AU7	1.19
5V4	1.20	6BQ6	1.59	12AX7	.95
5Z4	1.20	6C4	.85	12AY7	4.50
5Z3	.85	6CD6	2.25	12BA6	.69
6AB5/6N5	1.25	6H6M	.85	12BE6	.69
6AC7	1.29	6J7GT	.80	12H6	.59
6AG5	.90	6K6	.75	12JGT	.65
6AG7	1.65	6N7M	1.20	12SK7GT	.79
6AK5	1.20	6R6	1.50	25W4	.90
6AK6	1.10	6SH7	.95	59	1.50
6AL5	.79	6SC7	1.25	89Y	.75
		6SL7	1.10		

Many more types in stock. Write for quotations.

2C40	9.50	304TH	12.49	884	1.70
2C51	5.95	350B	5.50	931A	6.75
2E25	5.95	394A	5.50	CK1005	.79
2D21	1.65	446A	1.95	1655	2.95
2K29	21.95	450TH	36.95	2051	1.65
3B24	5.35	715B	9.50	5663	2.45
6J4	6.75	721A	3.45	5670	5.95
T20	2.25	723A/B	13.95	5749	4.95
TUF20	3.95	807	1.45	5814	4.95
TZ20	2.25	837	1.75	8025	5.75
TZ40	3.25	809	2.25	9001	1.75
CK70	4.95	829B	13.95	9002	1.50
RK73	1.50	832A	11.95	9003	1.75
T200	16.95	866A	1.30	9005	1.75
304TL	12.49				

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CO 7-6091

TUBES STANDARD BRANDS FIRST QUALITY TUBES

OA4	1.25
1B22	2.25
1B32	3.50
1B51	20.00
1C21	1.50
1E1	.45
1P23	3.50
2C22	.45
2C26	.25
2C26A	.45
2E22	1.10
2J21A	8.75
2J26	25.00
2J27	25.00
2J31	27.50
2J34	27.50
2J40	35.00
2J51	45.00
2J61	50.00
2J61A	50.00
2J531	8.00
2X2	.50
3A4	.75

3B24	4.75
3B24W	7.50
3B27	3.50
3C24	1.75
3C31	3.00
3D6	.40
3E29	12.75
4A1	1.50
4B24	5.50
4B25	8.00
4B26	8.00
5J29	11.50
6-4	.35
6 AMP TUNGAR	4.25
10Y	.45
12A6	.65
15E	1.00
24G	1.75
35T	4.00
101L	1.25
211	.50
203Z	5.00

244A	3.75
250R	8.75
274B	1.75
286A	7.50
304TH	10.00
313C	2.75
316A	1.35
329A	8.50
350B	4.75
371A	1.25
371B	.75
417A	8.50
446A	4.50
700A	25.00
700B	25.00
700C	25.00
700D	25.00
702A	3.00
704A	.85
705A	2.25
706AY	35.00
706BY	35.00
706CY	35.00

706DY	35.00
706EY	35.00
706FY	35.00
706GY	35.00
708A	4.50
715B	9.00
717A	1.25
721A	2.25
724A	3.50
724B	3.00
725A	4.75
728AY	25.00
728BY	25.00
728CY	25.00
728DY	25.00
728EY	25.00
728FY	25.00
728GY	25.00
801	.35
803	3.50
805	3.75
826	.75

829B	12.50
830B	3.25
832A	9.50
835	10.00
837	1.35
866A	1.25
874	1.10
876	.35
920	2.50
954	.25
955	.35
956	.35
957	.35
958A	.35
1613	.90
1616	.75
1619	.25
1625	.35
1626	.35
1630	.85
1631	.90
1632	.70
1633	.60

1644	.80
1851	1.65
2051	1.25
8020	1.10
9003	1.00
9004	.55
9006	.25
CE1-C	2.50
CE2	5.00
CE2-A	5.00
CE2-B	5.00
CE2-C	2.75
CE2-T	3.00
CE25	3.00
CE25-C	3.00
CE309	5.00
C5B	8.75
C6A	6.75
C6J	6.50
CK1005	.45
CRP72	1.25
EL6C	8.75
HY31Z	2.50

HY114B	.65
HY615	.25
RK34	.75
RK47	3.75
RKR72	1.35
RK73	1.35
RX212	15.00
RX233A	3.50
SD828	.85
VR105	1.25
WL481	3.00
WL532A	2.25
WL670A	8.00

C.R.T.

3BP1	6.50
3CP1	1.75
3CP1S1	2.25
3DP1	4.50
3EP1	5.25
5AP1	3.25
5BP1	4.50
5BP4	3.50

5CP1	4.50
5HP1	4.50
7BP7	6.50
7GP1	10.00
7HP4	10.00
9GF7	10.00
9LP7	10.00
10BP4A	17.50
10CP4A	19.50
12BP7	15.00
12GP7	15.00
EX1515	10.00

J.A.N.

2C51	6SL7
6AG5	6SN7
6AK5	12AT7
6AQ5	12AU7
6AS7	12SL7
6C4	28D7
6J6	5687
6V6	5763

All Radio & TV receiving tubes 50% off list. 25% deposit required on orders, rated firms send P.O. All merchandise guaranteed. Prices subject to change without notice. *Merchandise subject to prior sale.*

ROLE ELECTRONICS INC.

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OIL CONDENSERS

2 MFD. 5000 VDC $12.95

6 MFD. 600 VDC CP 70 BIFF 605K with Brackets. $1.69

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110 V.A.C.
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3.6 Watts
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2.2 watt 1-120 RPM..........$1.68 each

Minimum order 5 pieces on synchronous motors

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LINE CORD AC manufactured by G.E. molded rubber plug, 12' lengths. $25 per 100 pcs.

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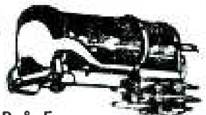

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	Coil	Contacts	Will Close At	Price
1)	6500 ohms	1C	2.8 MA	$2.75 ea
2)	6500 ohms	1A-1C	3.2 MA	2.75 ea.
3)	6500 ohms	3A	4.0 MA	3.00 ea.
4)	6500 ohms	3A-1B	4.0 MA	3.00 ea.

CLARE TYPE G SENSITIVE HALF-TELEPHONE RELAYS

1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	2B-1C	5 MA	2.50 ea.
3)	4800 ohms	1A-2C	6 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

Legend (A) Normally open set of contacts.
(B) Normally closed set of contacts.
(C) Single pole double throw set of contacts.

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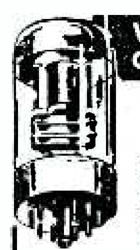

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1LN5.....	0.80	6C4:......	0.86	6SS7.........	0.95
1R5......	0.90	6C5GT....	0.51	12A6.......	0.49
1S4......	0.86	6C6.......	0.75	12SH7.......	0.96
1T4......	0.86	6H6.......	0.94	12SK7.......	0.98
5U4G....	0.80	6J5.......	0.60	12SQ7GT...	0.90
6AB7....	0.90	6J5GT....	0.51	12SR7.......	0.90
6AC7....	1.20	6K6GT....	0.91	35Z4GT.....	0.85
6AL5....	1.00	6K7GT....	0.70	35Z5GT.....	0.75
6AQ5....	1.40	6SG7.....	0.90	50L6GT.....	0.90
6B8......	0.93	6SK7.....	0.96	42..........	0.76

TYPE	PRICE
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1N23A....	2.50	102-F(WE)	1.25	955......	.40
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1N34.....	.65	104-D(WE)	1.25	958-A....	.65
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2E22.....	1.25	242-C....	4.00	1625.....	.40
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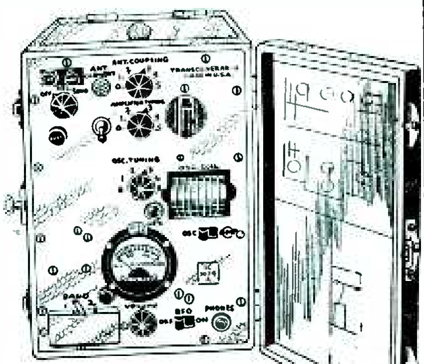

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Sigma #5	same as above		cased	2.95
Sigma #5	5000(2)	SPDT	1½ plate	4.75
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Leach P-3	1280	SPDT	15 ma submini.	.85
G.E.	10000	SPDT	9 ma plate	1.35
G.E.	2000	SPDT	4 ma plugin	2.95
Clare SK-5032	32	DPDT	6 VDC plugin	3.45
W.E. KS-9665	2000	1A,1B,1C	9 ma	4.45
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F-12 NUMETAL 1000 lbs.............quote
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100,000 RELAYS
50 TYPES

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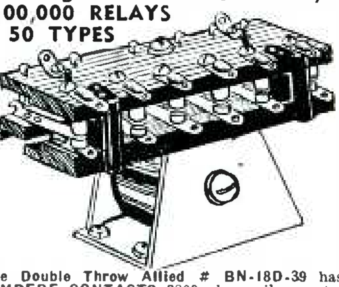

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Advance Series 2000 115v. DC Coil 4200 ohms. All Other Specs as Above.............$3.95
Leach Relay #1024-A 3 Pole N.O. 100 ohm coil operates on 6v. DC.............$1.95
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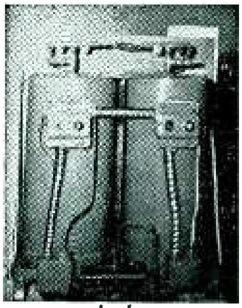

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An all purpose self-reactivating dehydrating uint. To be used for removing moisture from gases. Numerous applications in the fields of Physics, Electronics and Chemistry. Dual insulated tanks with thermostatically controlled heating elements. Complete with 20 lbs. of Silica gel., heating elements, shut-off and safety valves.

$62.50 F.O.B. N. Y.

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TS-11	TS-15	F-3	HS-30

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Mfrs: Cords, Harnesses & Specialties
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Cap. 20 K.W.

Hi-Frequency Induction Model 4F20 for 3/60/220 Like New (1948) with work Table 2 positions.

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LARGE QUANTITIES OF WESTON STOCK

Microammeters, Milliameters, Voltmeters R.F. AC & DC in most brands 2", 3", 4"

Prompt Replies ALL Requests
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For cooling tubes, instruments, mechanisms, etc.
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100 Cu. Ft. Per Min. Centrifugal Blower (Approx. 85 C.F.M. @ ¼" S.P.; 65 C.F.M. @ ½" S.P.)
Rotor: Squirrel Cage, Approx. 3" Dia. x 2" Width.
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Rotor: Squirrel Cage, Approx. 3" Dia. x 2" Width.
Motor: A. C., 60 Cyc., Single Phase, 110 Volts, 1500 R.P.M., Open Frame, Continuous Duty.
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Gast Mfg. Co. Pump, 15" Vac., Belt Driven, with Visible Oiler, Muffler, and Capacitor/AC/60/1/110/1725 RPM Motor:
With 1/3 HP Motor (8 Cu. Ft.) **$65.50**
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0-200 Ua 3" sq. G.E. DO-50..........$ 9.00
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Molded Bakelite Case 7"x4½"x3"

D.C. MICROAMMETERS
5...10...50...microamperes

THERMOCOUPLE MILLIAMMETERS
1.5...5...10...milliamperes
Available in multiple range combinations

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The Astro Compass is a precision instrument measuring 8¼" high x 5¼". Furnished in Carrying Case. Designed to provide accurately (a) True heading of Aircraft or boat. (b) True bearing of a distant object. (c) The relative bearing of distant objects.

Of special interest to Astronomers & Experimenters.

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KURMAN SENSITIVE RELAY
10,600 ohm, will close at .6 mils SPDT—Ideal for Plate Circuit application. Bakelite base mounting Dim. 2½" x 2½"....................$2.95 each

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RADIO TRANSMITTER
BC-375-E, Complete Equipment, has Dynamotor, Tuning Units, etc.
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150 watts, made by General Electric
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HEADPHONES P-19, w/headband, cord, PL-55 plug. Extra sensitive (24,000 ohms imp.). Used. P/o SCR-193, -209, -210. Sig. C. #2B919 $1.89 ea.

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Beryllium Copper Strip
.0062 (+ — .0005) x 5" x 60"
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115 V 60 Cyc Input TV & CR Pwr Xfmr for 7" to 20" Tubes. Hi VOLTS to 20KV (w/quadrupler ckt). ALL Tubes, PL & FIL wndgs dlvrng; 300 VDC/275Ma Full-Wave, 6.4V/10.3A, 5.4/8A, 2.5V/3A Hypersil Core, Oil impreg. $7.98
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1000VCT/150MA, 300V BIAS, 6.3V/5A, 5V/3A 2X6.3V/.65A, 6.3V/1.25A...$4.98
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600VCT 150MA, 6.3V/4A, 5V/3A ..$3.98
570V/150MA, 5V/3A 12V/4A HSLD.$4.49
550VCT/275MA, 5V/4A, 6.3V/6A...$4.49
500VCT/60MA, 6.3V/4A HSLD...$2.98
480VCT/80MA, 6.3VCT/4A, 5V/3A..$2.69
420VCT/90MA, 6.3V/1.9A W/INPUTS 6, 12, 24, 115VDC & 115 230VAC @ $1.98
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550VCT/150MA, 5V/3A, 6.3V5A....$3.49
220V/50MA, 6.3V/2A, 6.3V/1A, 5V/6.5A **JEFFERSON H'SLD** $1.89

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2.5V/2A @ 79c, ...2 for $1.49
2.5VCT/10A 10KVINS 4.98
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6.3VCT/1A THORDASON HVINS CSD. 1.98
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6.3VCT/4A USN USABLE 6.5A CSD 2.69
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24V/2A CSD @ $1.98, 2 FOR.... 3.49
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42.5V/2A SEL RECT TRANS...... 4.85
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6.3V/.6A, 2X2.5V/1.75A HSLD... 3.49
2X2.5VCT/6A, 2.5VCT/12A/12KVINS BRDG. RECT 8.49
6.4V/12A, 6.4V/10.6A, 3X5V/3A, 2.5V/1.75A, 2X6.3V/.3A, 2X5V/3A.6A, 7V/14A .147KVA GE.... 4.98

STEP UP OR STEP DOWN

220V to 110V/100W Ametran.....$ 3.98
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Isolation 115to115V/185Watts ... 3.98
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2X330VCT/25MA or 660VCT CSD..$ 1.29
355VCT/325MA 490V TAP HVINS. 4.98
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3000V/10MA CSD WE D161913... 8.95
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1800V/4MA NAVY HSLD HVINS.. 4.49
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DUAL 30HY/60MA CSD.$0.98
3HY/40MA HIQ CSD 2 For .98
15HY/40MA AC/DC SETS 3 FOR .98
10HY/60MA/UTC 2 FOR 1.25
12HY/80MA CSD 2.25
10HY 85MA @ 98c........**2 FOR** 1.79
5HY/100MA HMSLD G.E. 1.39
8HY/100MA/60MA/CSD/H'SLD/2KVINS/USN 1.49
10HY/100MA/80∼UTC HSLD 1.89
59HY/100MA/CSD 3KVINS/ HSLD.. 1.98
DUAL 5HY/120MA/2000VTEST 2.89
50HY/125MA/CSD/HSLD 2.25
DUAL 12HY/150MA/CSD/2KVINS... 2.98
8HY/200MA UTC 2.25
12HY/300MA/CSD/3KVINS/HSLD.... 3.95
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DUAL 2HY/300MA HMSLD USN @ **$1.25** ....**2 FOR** 1.98
20HY/300MA, or 15HY/400MA/12KVINS 8.95
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.35HY/2.5A/GE/1.8KVINS 3.98
10HY 135MA 1.35

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MODUL/240 Watts Peak PP Par 807's to PP807's RF/2000 ohm Load STANCOR/USN H'Sld $6.95
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Mike or Line to Grid "ouncer" UTC 0-14 50:1/200 ohms to ½ meg $13 List.$2.98
OUTPUT/300 Watts Hi-Fi PP805 to 9 ohm VC. Weco H'Sld HiVins.........$12.98

CONNECTORS

UG9/U	$1.90	UG58/U	$0.75
UG19/U	2.20	UG106/U	.10
UG21/U	1.30	UG254/AU	3.40
UG22/U	1.60	CW123U	.55
UG24/U	1.50	M359A	.75
UG27/U	.70	UG30/U	2.45

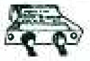
831R/SO239 Receptacle $0.50
831SPN/PL259A Plug .... .65
831SP/PL259 Plug .... .50
83-1J/PL258 Junction .... .95

VARIABLE CONDENSERS

A. 150mmf/300VGap HF .$1.39
B. BUD Dual 75mf ea. Sect 1000V Gap. HF.....$1.29
C. JOHNSON 70H30 70 mmf/3000V Gap $1.29
D. Cardwell Neut ZT/12 mmf 500 Volt Gap 98c
E. CARDWELL TK-300-US 53 to 312 mmf. Can be made Split Stator. BRAND NEW $10.95
Vernier Drive 10 to 369mmf, each....69c
Midget 3 to 15 mmf, Midline, each...39c
Phasing Condenser 90 Degree Quadrants, 4 Taps, 360deg Sinewave Gen.....$4.98
2½ Meter Butterfly Cndsr 30mmf w/RF Tank & Choke........59c; 2 for 98c

"TAB" THAT'S A BUY

OIL CAPACITORS



Mfd	Each
25wvdc	
50	$6.98
50wvdc	
4	.49
150wvdc	
1-1-3-5	.69
250wvdc	
1	.39
2x.25	.35
300wvdc	
1.2	.39
400wvdc	
.1	.49
.25	.55
.5	.59
1	.69
4	1.69
6	2.29
8	2.49
10	2.89
2x.1	.75
2x.5	.94
3x.1	.91
3x.25	.99
600wvdc	
.034	.49
.1	.64
.2	.69
.25	.71
.5	.75
1	.85
2	.99
3	1.08
4	1.89
5	2.29
6	2.69
7	2.89
10	3.29
2x.1	.79
2x.25	.85
2x.5	.98
2x1	1.19
2x2	1.39
2x8	3.49
3x.05	.89
3x.22	.98
3x.25	1.09
700wvdc	
4	1.98
800wvdc	
.1	.69
1000wvdc	
.1	.73
.45	.79
1	.99

Mfd	Each
2	1.69
3	2.29
5	2.98
10	3.98
15	4.98
1400wvdc	
.25	1.29
.5	1.39
1500wvdc	
.5	1.59
.75	1.69
1	1.79
2	2.29
4	2.98
5	3.49
6	3.98
.05	.79
2000wvdc	
.1	1.49
2x.1	1.75
1	1.98
2	2.49
3	3.98
4	4.49
5	5.39
8	9.49
2500wvdc	
25	2.29
3000wvdc	
.1	2.49
.5	2.98
2	4.49
3	5.39
4	6.49
4000wvdc	
2	8.98
5000wvdc	
.2	4.49
2	10.98
4	19.98
5500wvdc	
2	12.98
7000wvdc	
.002	1.69
.0075	1.98
.1	4.98
7500wvdc	
.03	2.98
.05	3.49
10000 wvdc	
.03	3.49
12000 wvdc	
.02	4.98

Mfd	Each
12500 wvdc	
.65	16.98
2	95.00
15000 wvdc	
.0016	9.98
25000 wvdc	
.00025	7.49
1	95.00
AC RATED	
220vac/600dc	
2	.69
4	.89
5	1.29
225vac/630dc	
3.3	.79
230vac/630dc	
5	1.29
330vac/1000dc	
1.25	.79
1.5	.89
1.75	.98
2	1.03
2.5	1.09
2.8	1.15
3	1.19
4	1.29
5	1.49
12	3.49
15	3.98
25	6.49
40	9.98
405vac/1200dc	
.15	1.29
600vac/1800dc	
16	6.98
660vac/2000dc	
5	4.49
6	4.98
10	6.98
16	7.98

Brond NEW Made to Rigid Gov't Specs.

MICA CAPACITORS

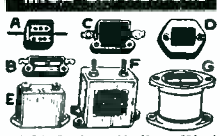


Fig. A. Postage & ½ Postage (*Silver Mica)

Mfd.	Each	Mfd.	Each
.00002	$0.09	.0011*	$0.17
.000022	.09	.0012*	.23
.000024*	.17	.002	.15
.000025*	.17	.00224*	.27
.00004	.09	.0025	.15
.00005*	.17	.003/1KV	.29
.000082	.09	.0033*	.35
.0001	.09	.004	.22
.0001*	.17	.004*	.43
.0003	.09	.005	.22
.001*	.17	.006	.23
.0011	.09	.01	.29
.0002	.08	.00015	.09

Fig. B. .001 mf, 10c; .006 mf, 23c; .01 mfd, 35c.

Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	Each	Mfd.	Each
600 WV		**600 WV**	
.0001	$0.29	.02	$0.76
.001	.42	.03	1.19
.002	.45	**1200 WV**	
.004	.53	.002	.66
.005	.55	.004	.68
.006	.59	.005	.71
.008	.63	.01	.78
.01	.66	**2500 WV**	
		.00047	.59

Fig. D. Screw Term & Mtg

Mfd.	Each	Mfd.	Each
600 WV		**1200 WV**	
.0001	$0.29	.01	$0.78
.00055	.37	.013	.89
.00085	.42	.03	1.89
.0012	.44	.033	2.39
.003	.49	**2500 WV**	
.005	.54	.0004	.59
.015	.71	.002	1.09
.02	.78	.0022	1.09
.03	1.19	.0024	1.13
.033	1.29	.0035	1.19
.039	1.98	.0036	1.19
.04	2.09	.0043	1.29
.05	2.39	.005	1.45
1200 WV		.006	1.55
.001	.61	.01	1.89
.002	.66	.015	2.19
.0051	.71	**3000 WV**	
.0068	.75	.0055	1.35

Fig. E. Upright Xmtg Micas

Mfd.	Each	Mfd.	Each
250 VDC		**3000 VDC**	
.05	$0.47	.005	$1.65
.2	2.59	.008	1.79
1500 VDC		**3500 VDC**	
.04	.89	.000033	.78
.05	1.08	**5000 VDC**	
2000 VDC		.000082	1.65
.003	1.08	.0001	1.79
.005	1.19	.00015	2.29
.006	1.25	.00018	2.39
.01	1.39	.0002	2.49
.015	1.68	.0003	2.75
.02	1.98	.00043	2.85
.03	2.35	.0006	3.59
2500 VDC		.001	3.89
.0025	1.08	.005	4.29
.006	1.65	.01	4.79
3000 VDC		**6000 VDC**	
.00005	.78	.001	4.29
.0001	1.08	.002	4.79
.0003	1.15		
.0007	1.19		
.0055	1.39		

Fig. F. Heavy Duty, Upright, Bklte Csd

Mfd.	Kv.	Each	Mfd.	Ky.	Each
.004	6	$5.59	.01	8	$10.95
.0003	8	3.98	.0025	8	5.59

METER SPECIALS

Best Buy—5 Ma DC Tuning Meter. G-E. 2½" dia. $1.29
SPECIAL—0-15 VAC. 2 1/16" Rd., GE, 800 cyc. USN. .$1.69

DC MICROAMMETERS

0-50 ua Weston 3" sq. 16.98
0-150 ua. 2" McClintock.... 8.49
0-500 ua, 2½" DeJur.... 6.98

DC MILLIAMETERS

0-1 Ma (Reads 5KV. Less Mult) 3" sq. Weston 7.50
0-10 Ma & 0-5KV (Basic 1 Ma). 3½" 4.98
0-10 Ma & 0-1KW (Basic 1 Ma), 3½" 4.98
0-25 Ma, Weston 3" sq.... 6.98
0-30 Ma, Weston 3" sq.... 6.98
0-200 Ma, 2½" GE.... 5.98
0-300 Ma, Weston 3" sq.... 5.98

DC AMMETERS

0-1A, 3½ Wstghs 4.98
0-5A, 2½" Triplett.... 3.49
0-10A, 3½" sq. Triplett.... 3.98
0-15A, 2½" Triplett.... 3.49
0-30A, 2½" Shunt WECo, Wstghs.. 2.98
0-35A, 2½" Gen. Elec.... 3.49
0-60A, 2½" Int. Shunt, WECo..... 3.49
0-120A, 2½" Ext Shunt WE/Wstg.. 3.98
0-240A, 2½", Less Shunt....... 3.98
0-300A, 3", Less Shunt, WECo..... 4.49
30-0-30A, 2⅜", Weston 203P&Wstg 4.98
60-0-60A, 2½", W/Shunt. WE/Wstg 4.98
620-0-120A, 2½" Shunt, WE/Wstg. 3.98
240-0-240A, 2½" Less Shunt, GE.. 3.69
480-0-480A, 2½" Less Shunt, Wstg. 3.69

DC VOLTMETERS

0-5 Volts, 2" sq. Wstghs.... 2.98
0-800 Volts, Weston 3" sq. Blit-in Mult. 12.98

RF METERS

0-1A, 2½" G-E. USN—B'Csd...... 3.95
0-8A, 3" Triplett Hi-Freq.; Int.C ouple 4.98
0-9A, 2½" Wstghs USN.... 2.49
0-5A, 2½" Rnd Wstghs 3.79

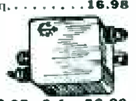
AC VOLTMETERS

0-7.5V, 3½" Wstghs 2.49
0-8V, 3¼", Weston 3.49
0-130V, Weston 476, 3½" Rd.... 7.49
0-150V, Weston, 3" sq., Rect. Type.. 8.98

VOLUME LEVEL INDICATOR

—20 + 3VU, Weston, 3 sq.........16.98

LINE FILTERS

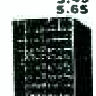


10Amp/130vacdc Csd USN 0.1 to 1000 Mc's....$1.29
30Amp/250vacdc Csd USN 0.1 to 1000 Mc's........$3.98; 2 for $6.00
50Amp/600vdc/250vac. Fltrs both sides of line. SOLAR "Elim-O-Stat". New $9.98;
100Amp/usable 110 vacdc GE **2 for $1.98**

SELENIUM RECTIFIERS

Volts In	Volts Out	Amps	Each
HALF WAVE			
18	12	.15	$0.69
130	120	.075	.59
130	120	.065	.55
130	120	.09	.69
130	120	.2	.98
FULL WAVE BRIDGE			
18	14	2	$2.40
18	14	4	3.85
18	14	6	5.49
18	14	8	5.65

PARTS CABINETS



50 Draw Hvy Steel 34½"H/18"W/9"L/65Lbs. draws3"W/2½"H/8"L ......@$38.00
100Draw as above @$63.00
27Draw Hvy Steel 37"H/30¾" W/14¼" L/120 Lbs Draws 3"H/9"W/12"L ....@$39.95
Write for Quantity Price "Extend Do"

END EQUIPMENT BUYS!

US Navy Version BC645 Ideal Citizens Band Conversion, NEW, less tubes, connector & Dyn. $12.95
RADIO COMP RCVR Less Tubes,AsIs 5.98
TG5 Keyer, As Is.... 5.98
EE8 RingingGenAssy, Like New, Less Handset(TS-9) 7.98
RM-53 TEL CONTROL 4 Xmitter.... 5.49
R9/APN4 Receiver, Less Tubes, As Is 14.98
TG10 Code Unit, Less Tubes & Cabinet, as is 19.95
RM29 Control Unit, BRAND NEW.. 11.98
RT34/APS13 30 Mc IF Less Tubes, As Is, Good Condition.... 7.98
R59/TPS3 Good, As Is, Less Tubes. 29.98
EE65 Telephone Test Set, Fine Cond. 24.98
BE65 Time Interval Signal, Used... 3.98
R74/CRW Rcvr, Less Tubes, As Is.. 2.49
I-81 Compass Indicator, Like New.. 7.95
I-82 Compass Indicator, Like New.. 4.95
PE97 Plate Supply Unit, Less Tubes 9.98
I-108 Range Calibrator, Metal Case. 29.98
PE120 Pwr Supply, Less Tubes, Used 9.98
Mackay 168BRadioXmitter, w/Metal Case, Less Vibrapack & Tubes, As Is 2.98
I-198 Sig. Gen,Good Cond.LessTubes 14.95
ART SPCH AMP, New Less Tubes.... 6.98
BC456 Mod, Less Tubes, Dyn, As Is 1.98
BC457 Xmtr (4-5.3Mc), LT*, As Is.. 3.49
BC458 Xmtr (5.3-7Mc), LT*, As Is. 3.98
SCRIFF Unit, Less Tubes, As Is.... 3.98
BC602 Cont Box for 522, As Is.... 1.29
BC605 Amp, Less Tubes, As Is.... 3.98
BC733 Rcvr, CAA appvd, LT*, As Is 19.98
BC906 Freq.Mtr.ExcCond.LessTubes 29.95
FOXBORO GRAPHIC RECORDER.....39.50
BC 322, WALKIE TALKIE w/Bag, Tubes Crystal, A pair.......... 98.00
DYNAMOTORS in stock—What are your requirements?

TUBE SOCKETS, ALL TYPES

A. RCA 5-pin GIANT, 803, etc.....$1.49
B. Johnson 4-pin Bayon, 866, etc.. .85
C. 304TL Socket 1.15
D. Johnson 7-pin Steatite, 829B; 69c; 10 for 5.00
D. Johnson 122-237, HK257, 813 .63
E. Small Shell DUODECAL, 2BP1... .75
F. Med Shell DIHEPTAL Cinch MICA .89
G. 5-pin ACORN 1-9/16" dia.... .39
H. Johnson 122-234, w/tube Lock, 5D21 .... .98
I. 4-prong STEATITE Johnson, 866 .30
J. 5-prong STEATITE Johnson, 807 .30
K. 7-pr. STEAT Johnson, 1625.... .36
L. 7-pin NATIONAL CIR7L Steatite .30
M. MINI 7-pin Mica 'B-HF & Shield .30
M. MINI 7-pin Mica 'B Top Mtg&½ Shld B .... .23
M. MINI 7-pin Bot Mtg Bklt Sim Amph 147-500 .... .13
M. NOVAL 9-pin Mini. ½ Shld Base, Top Mtg. .... .45
M. NOVAL 9-pin Min. ½ Shld. Top .45
M. NOVAL Shld. 1½", 12c; 1-15/16" .14
N. AMPH fem 78F Pin 4,5,6,8.... .17
O. 4-pin AMPH49RSS4&mtg Ceramic .27
P. OCTAL 8-pin & plate Bklte..... .10
Q. OCTAL 8-pin & plate Steatite.... .25
Q. OCTAL 8-pin & plate Mica 'B.... .11
R. LOKTAL 8-pin & lock Mica 'B HF .10

PRECISION RESISTORS—

Over 2½ Million in Stock

"TAB"—Specialists in Precision Resistors
No Mfrs Choice—We Ship Types in Stock

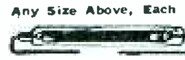
0.116	271	1200	3100	14550	90000
0.42	275	1223	3163	14600	91000
0.425	280	1250	3259	15000	93300
0.607	286	1260	3290	16000	95000
0.7	289	1300	3333	16500	100000
1.03	299	1350	3384	16800	110000
1.3	300	1355	3500	17000	115000
1.75	310	1400	3509	17500	116667
2.5	311.5	1488	3700	17977	120000
3	320	1495	3730	18000	130000
3.83	325	1500	3760	18300	135000
4	330	1510	4000	18380	140000
4.35	340	1518	4030	18500	141000
5	350	1600	4200	18800	145000
5.025	360	1640	4220	19000	147000
6.25	366.6	1646	4280	19500	150000
6.5	370	1650	4300	20000	155000
7	375	1670	4314	20441	160000
7.8	380	1680	4440	20500	165000
7.9	389	1710	4444	21000	166750
8	390	1712	4500	21500	167000
10.38	400	1740	4720	22000	169200
11.25	410	1770	4750	22500	175000
12	414.3	1800	4850	22990	180000
13.52	418.8	1818	4885	23000	180600
14.2	425	1830	4900	23150	185000
14.25	426.9	1865	5000	23325	186600
14.5	427	1892	5100	23400	190000
15	440	1894	5210	23500	198000
16	450	1895	5235	24000	200000
17	452	1896	5270	24600	201000
19	460	1897	5300	25000	205000
19.2	470	1898	5500	25200	210000
20	475	1899	5600	25400	215000
22	478	1900	5730	25833	220000
23	480	1901	5770	26000	225000
24	487	1902	5910	26500	229000
25	500	1903	6000	26600	230000
26	520	1904	6100	27000	235500
28	525	1905	6125	27500	238000
30	540	1906	6140	28000	240000
31.5	550	1907	6200	28430	245000
37	575	1908	6300	28500	250000
48	580	1909	6495	29000	265000
49	588	1910	6500	29500	268000
50	600	1911	6840	29990	270000
51.78	612	1912	6990	30000	275000
55	625	1913	7000	31000	294000
56.7	633	1914	7320	31500	300000
60	640	1915	7500	32000	307500
63	641	1916	7700	33000	311000
68	645	1917	7717	35000	314000
74	649	1918	7900	37000	316000
75	650	1919	7930	38140	325000
80	657	1922	7950	38500	330000
81.4	665	1924	8000	39000	333500
88	668	1926	8094	39500	350000
89.8	670	1960	8250	40000	353500
95	673	1980	8500	42000	375000
100	675	2000	8700	43000	380000
101	680	2045	8770	45000	400000
105	681	2080	9000	.....	402000
105.7	684	2095	9100	47500	420000
107	689	2141	9445	48000	422000
120	697	2142	9500	48660	425000
121.2	699	2145	9710	49000	450000
125	700	2150	9800	50000	458000
130	711	2160	9900	52000	478000
135	733	2180	9902	55000	500000
147.5	740	2187	10000	56000	520000
150	750	2195	10430	57065	521000
160	800	2200	10500	58333	525000
165	806	2250	10600	60000	543000
170	850	2300	10900	61430	550000
175	854	2400	10936	62000	570000
179	899	2450	11000	64000	575000
182	900	2463	11400	65000	600000
182.4	910	2485	11500	66800	620000
200	917	2490	11690	66650	650000
209.4	946	2500	12000	67500	654000
216	978	2525	12500	68000	680000
220	1000	2600	12800	70000	690000
220.4	1030	2625	13000	72000	700000
225	1056	2635	13100	73500	750000
230	1059	2700	13500	75000	781300
235	1067	2750	13550	80000	800000
240	1100	2850	13600	82000	813000
245	1110	2860	14000	84000	850000
245.4	1150	2870	14250	85000	900000
250	1155	2900	14400	85750	930000
260	1162	3000	14500	88000	950000

Any Size Above, Each 35c; Ten for $3.29

MEGOHMS

1.	1.57	2.25	3.673	6.	8.02
1.1	1.579	2.5	3.75	6.5	8.5
1.2	1.65	2.7	3.9	6.6	9.05
1.25	1.75	2.75	4	6.7	9.5
1.3	1.8	2.8	4.23	7	10
1.35	1.9	2.855	4.25	7.5	11.55
1.39	2	3	4.5	7.62	12
1.4	2.11	3.3	5	7.74	12.83
1.5	2.2	3.5	5.5	8	13
					13.85

Any Size Above, Each 70c; Ten for $6.49



Vacuum Precision HiVolt Resistors

Megohms—.12/.25/.6/.75/.83/.99/1/1.5/2/3/3.75 ½% Accy...Ea. $1; 10/$7.50

SWITCHES AND MICROSWITCHES

SPNC/10A/WZ-RQ11/Plunger $0.69
SPNO/10A/YZ-7RTC/Pin Plunger... .54
SPNO/10A/G-7RS1/Plunger ...... .59
SPNC/30A/B-1/HI-ALT/Cased 1.25
6 AMP/125V Removed from Equip. Bklt. CSD **CLEAN** SPST..4/$1; DPST..3/$1

6-VOLT CARTER GENEMOTORS

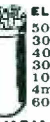
Brand New! Way Below List Price

Inpt.	Outpt.	Model	Each
6V/29A	400V/375maint	4037AS	$29.95
6V/27.5A	590V/150maint	5915AS	29.95
6V/42A	590V/250maint	5925AS	34.95

All Carter Genemotors Supplied with General Electric Input Filter Free

SELSYNS

2J1G1 GE As Is No Returns...2 for .49c
2J1H1 GE Selsyns ....2 for $6.98
2J1F3 GE Brand New115V/400cy.ea.$9.75
C78248 Sync.Trans115V/60cy.2for $18.00
C78249 Sync.Diff..115V/60cy.@$9.95; 2 for $18.00



ELECTROLYTIC CNDSR SPECIALS!

50 mf/350vdc FP........3 for 98c
30-15-10mf/250vdc .....3 for 98c
40-20mf/250-25vdc .....4 for 98c
30-2x20mf/450-25vdc FP..2 for 98c
10-2X 20mf/450-25vdc FP 3 for 98c
4mf/450vac "Tynee-Dry"..2 for 98c
6000mf/15vac. SPECIAL.....$3.29

HIGH CURRENT MICA CNDSRS.

CYLINDRICAL SIMILAR TYPE "G"

Mfd	Kv	Amps	Mc	Each
.09	1.5	35	1	$12.49
2X.003	1.5	7	1	2.98
0002	6	5	3	5.98
01	10	37	1	35.00
00005	20	4.5	3	6.98
0005	35	13	3	37.50

Write In Your Requirements

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DEPT. 12E SIX CHURCH ST. NEW YORK 6, N.Y., U.S.A. - CORNER CHURCH & LIBERTY STS. ROOM 200

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Money Back Guarantee (Cost of Mdse Only) $5 Min. Order FOB NYC. Add Shpg. Charges & 25% Dep. Prices Subject to Change Without Notice.
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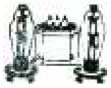


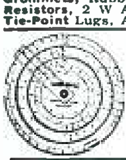
866A KIT and XFORMER

2 Tubes, Sckts, xmfr 115v 60cyc Inpt, outpt 2.5vct 10A/10Kvins $6.98

DIODE PROBE TUBE
Unexcelled for No-Loss VHF testing. Ultra-sensitive subminiature-envelope. App. 1¼x⅜". Element and probt at tip. Low pwr. htr. Brand New, w/data VR92 25c; 5 for $1.

KITS.....

Silver & Mica Cndsrs	30 for	$2.50
Controls, 50 ohm to Megs	10 for	2.98
Resistors, ½&1W, to 2 Megs	100 for	3.98
Vitreous WW Resistors	5 for	.69
Sockets, Asstd, 8, 7, 5, 4P	25 for	2.49
Rotary Switches, Asstd	6 for	1.75
G&P Tube Caps, Asstd	50 to for	1.49
Coil Forms, Th'd Sm HF	50 for	1.00
Iron Core Slub & Screw	50 for	1.00
Elastic Stop Nuts, Asstd	50 for	1.00
Knobs, Asstd. w/Insert	10 for	.98
Spaghetti Sleeving, Asstd	75 ft. for	1.00
Ceramicon Cndsrs, Asstd	12 for	1.00
Fuses, Asst, LF & Buss	75 for	1.95
Grommets, Rubber Asstd	50 for	1.00
Resistors, 2 W Asstd	25 for	3.69
Tie-Point Lugs, Asstd	35 for	.98



CIRCULAR SLIDE RULE

12" Equiv—2⅛" Radius PRINT STAYS ON, Laminated Plastic, Multiply, Divide, Logs, Dec Equivs, Case 98c
PARALLEL RULES, Handy Drafting Tool, 6" Lg Mfr BRUNING 39c

Infrared Snooperscope

Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lines/in. Complete data & tube, each ....$4.98; 2 for $9.49

NEW THRIFT-LITE LIFETIME PHOTO-FLASH

Not a kit. Incl Pwr pck, Life gtd Lamp, Rflctr & 15' cord 1/10:0 Sec flash every 7sec.True daylite color. Usable all cameras oper 115VAC w/lite Type AC40...$41.98
Complete Outfit for AC & Battery opr. Incl AC40&BP25 portopak & all accssrs for KODAK&COMPUR shutters. Complete $69.95
Write for Complete "THRIFTLITE" Data Boosterpacks, Ext lites, Units for Focal plane shutters & accessories. WE BUY SELL & SWAP.

TAB "SUN-FLASH" LAMPS

"Tab" No.	Replaces	W-Sec. Max.	Each
U10	GE FT112	100	$ 9.98
No. 1	AMGLO 5804X	100	10.98
23ST	GE FT114	200	10.98
53GT	GE FT403	500	16.98
VA	SYLV. 4330	200	11.98

R4340 FLASH TUBE—Nationally Advtsd @ $57. NEW........$36.00
X-400 Air Corps Lamp...... 14.98

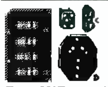
CIRCUIT BREAKERS

Heinmann Magn Bkrs, Amps; 0.22, 2, 3, 5, 7, 9, 12, 15, 20, 25, 30, 35, 40, 50, 80, 100, 180. Each..............$1.69
Sq.D & CH Toggle Sw Brkrs, Amps; 5, 10, 15, 20, 25, 30. Each..............98c
Klixon Thermal Push Button Brkrs Amps; 5, 10, 15, 20, 25, 30. Each........89c

MERCURY THERMO REGULATOR

DUAL CKT. 105°F & 32°F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max-Min Temp Control. Brand New. Indivd. Boxed w/data & ckt. SPECIAL........Ea. 98c; 12 for $10.00
Ball Pens Gtd Red or Blue....5 for $1.00
Ball Pens Draftsman Black.....2 for 1.00

"TAB" THAT'S A BUY



SOCKETS for CRYSTAL HOLDERS

A. 4-crystal holder ⅛" pins, ¾ & ½" spacing 10c; 12/$1
B. HiFreq Dual Xtal holder 10c; 12/$1
C. HF Xtal Holders ½" spacing ⅛" pins ....10c; 12/$1
D. Johnson Mycalex 3 pin BENDIX..35c

CRYSTALS

Mtd FT243 exacting S... specs
3525Kc 4190Kc 5233Kc
3980Kc 5030Kc ea. 98c; 3 for $2
Write for other Frequencies.
Htr Oven Xtals—HiAccy Stability 5010, 5025, 5055Kc, ea. $14.98
Rochelle Salt Xtals, 69c; 10 for $5.00

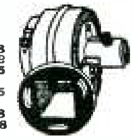
35mm and 16mm FILM Guaranteed Govt. Surplus

35mm Microfilm 20 Exp cart. 5 for $1.00
16mm PAN film GSAP camera. Perfect 54 rolls (1320 ft.) $5.98
Fresh 35mm Fine Grain PAN film. Original Factory Pkg. In 20 exp Cart & Safety Can. Day 50. Tung 32, 49 Date Special 5 Cartridges for $1.00

ALIGNMENT TOOLS

Ideal NO-LOSS Alignment Screwdriver TL150, long Insulated Shaft. Sure-Grip Knurled Knob. Only................49c
RELAY Spring Adjuster & Switch-Bd Tool Slot takes up to .022". WEC No. 293.98c
Feeler Gauge for Relay, Telephone & Teletype contact. 8 Detachable sizes......98c

BLOWERS



Cool That Tube!

40 CFM 28vacdc...$5.98
70 CFM 115v/400cy 4.49
250 CFM 28vacdc.. 9.95
250 CFM & 28 to 115 vac Transformer..11.95
40 CFM 24vdc BL1000 .... 6.98
175 CFM 220vac...11.98

"WILLIAMSON" 10W HI-FI KIT

10 to 20000cycles with Ease! Internationally Famous; For HiFi enthusiasts. Incl Pwr supply, selected parts; Balanced resists.....$29.95
W'mson PreAmp Kit & Tone boost Amplifier, chassis, parts, pwr supply....$34.95
SUPER-Wide-Range HiFi TRIODE LOW KIT. 1to20000 cycles, 6B4G's, Max Harmonic Distortion 1¾% at full outpt & only 1 % at 5W outpt. Includes Bass & Treble tube boost & Tone ckts 4PreAmp G.E. pickup 5dual & 2outpt (7) tubes, Parts, RCA chassis & info., less outpt xformer....$29.95
UTC Hi-Fi Output Xfrm for P.P. 2A3, 6B4, 6A5 & 6L6. Csd cap 30W; Sec 5 taps 2½ to 250 ohms $6.98
GE Reluc Cartridge perm needle...$1.98
GE Dual Reluc Cartridge RPX 050..$7.29
GE Reluc Cartridge RPX040 or 041.$7.29
GE 51201D Hi-Fi Hvy dty 12" PM Spkr $18.98
Sensational 10" HiFiSpkr Ideal 10 Watt Home Size, Concentric, Separate Driver Woofer & Horn Driver Tweeter—30 to 16000 cps Range $18.98
Electro Voice EV16H dual twilt Cart.$3.98
"LP" Anti-Static fluid GUD 1000 plays.69c
Extra dual needle for Twilt Cart....$1.20

Hi Gain Dynamic Mike & Xfrm. Buy Comb. Spcl. Dyn Mike & Xfmr. $1.98
XFMR Hmt-sld UTC/SuperElect 3 wdg. 600∿ct & 400tapped 250 & 150∿can be used Mike to Grid, Line to Grid & Line to Line. Csd & Hmt Sld SPECIAL 49c; Ten for $4.49

OA2	$1.58	2J22	7.90	6AU5GT	1.49
OA3/VR75	1.47	2J31	29.75	6AU6	.69
OA4G	1.45	2J31A	79.95	6AV5GT	1.29
OB2	1.58	2J32	59.95	6AV6	.59
OB3/VR90	1.23	2J33	39.39	6AW6	1.89
OC3/VR105	1.43	2J34	38.50	6AX5GT	.79
OD3/VR150	.98	2J36	120.00	6B4G	1.39
OY4	2.53	2J37	12.70	6B5	1.19
OZ4	.79	2J38	17.75	6B6G	.89
VS-1	12.49	2J39	49.50	6BF5	1.09
C1A	9.75	2J42	250.00	6B8G	1.09
O1A	.69	2J48	28.50	6BA6	.79
1A3	1.10	2J49	39.45	6BA7	1.19
1A4P	.79	2J50	27.50	6BC5	.69
1A5GT	.79	2J52	249.50	6BC7	1.23
1A6	1.49	2J56	199.50	6BD5GT	1.65
1A7GT	.98	2J62	49.45	6BD6	.89
1AE4	1.80	2K25	31.95	6BE6	.79
1B3/8016	.89	2K25/723AB	29.45	6BF6	1.49
1B4P	.89	2K29	23.95	6BD6G	1.65
1B5/25S	.99	2V3G	1.29	6BH6	.89
1B7GT	.99	2W3GT	.98	6BJ6	.99
1B21/471A	2.85	2X2	.69	6BL7GT	2.75
1B22	3.23	2X2A	1.89	6BN6	1.49
1B23	9.90	3A4	.99	6BN7	1.69
1B24 Wstnghs.	8.75	3A5	1.69	6BQ6GT	1.29
1B24 Sylv.	17.49	3A8GT	1.59	6BQ7	2.45
1B26	2.65	3B4	2.69	6C5GT	.79
1B27	24.00	3B5	.98	6C6	.79
1B32/532A	3.98	3B7/1291	.69	6C7	1.26
1B35	11.98	3B23/RK22	4.95	6C8G	.89
1B37	18.00	3B24	5.40	6C21	29.45
1B38	29.95	3B25	4.50	6CB6	.89
1B40	4.95	3B26	3.70	6CD6G	2.49
1B41	49.95	3B28	8.80	6D4	2.85
1B42	18.00	3C6 XXB	1.49	6D6	.89
1B46	1.98	3C22	64.25	6D7G	.89
1B53	49.95	3C23	10.98	6D8G	.89
1B56	38.50	3C34/HK24	5.49	6E5	.89
1B58	350.00	3C31/C1B	3.45	6E6	1.39
1B60	69.75	3C45	19.90	6E7	1.39
ELIC	2.70	3D6/1299	.69	6F4	6.35
1C5GT	.89	3D21A	1.95	6F5	.79
1C6	.79	3D23	4.90	6F6	.99
1C7G	.89	3E29	14.95	6F6GT	.79
1D5GP	.99	3LF4	1.29	6F7	1.39
1D7G	.89	3Q4	.79	6F8G	1.29
1D8GT	.89	3Q5GT	1.29	6G6G	1.39
1E5	.99	3S4	.79	6H4GT	.98
1E7G	.99	3V4	.79	6H6	.89
1F4	.69	4-125A	29.95	C6J	6.95
1F5G	.79	4-250A	40.95	6J4	7.65
1F6	.89	4-1000A	108.50	6J5GT	.59
1F7G	.89	4B27	4.98	6J6	1.29
1G4GT	.89	4C25/HK54	5.98	6J7	1.09
1G5G	.89	4C33	59.00	6J8G	1.19
1G6GT	.79	4C36	15.98	6K4	3.39
1H4G	.89	4E27/257	14.98	6K5GT	1.09
1H5GT	.89	4J22	148.50	6K6GT	.79
1H6GT	.79	4J31	95.00	6K7	.85
1J5G	1.20	4J34	194.00	6K8	.99
1J6GT	.79	4J42/700	27.00	6L5G	.79
1L4	.69	4J47	260.00	6L6	2.43
1L6	.98	4J47CY	198.00	6L6G	1.69
1LA4	1.19	4J52	350.00	6L6GA	1.69
1LA6	.99	4T4/2	5.95	6L6GAY	2.29
1LB4	1.29	4X150A	45.00	6L7	1.19
1LC5	.79	4X-500F	85.00	6N4	2.39
1LC6	.89	5AX4GT	.54	6N6G	1.69
1LD5	.99	5AZ4	1.35	6N7GT	1.29
1LE3	.99	5C30/C5B	3.95	6P5GT	.89
1LH4	.89	5D21	24.30	6Q7	.89
1LN5	.79	5D23/RK65	24.95	6R7	.99
1N5GT	.99	5J29	12.40	6R8	1.39
1P5GT	.79	5R4G Spec.	1.49	6S4	.98
1P42	4.32	5R4WGY	2.98	6S7G	.89
1Q5GT	.89	5T4	2.49	6S8GT	.99
1Q26	89.00	5U4G	.59	6SA7GT	.89
1R4/1294	1.29	5V4G	1.39	6SA7GTY	3.37
1R5	.79	5W4	.89	6SB7Y	1.19
1S4	1.19	5X4G	.79	6SC7	1.39
1S5	.79	5Y3GT	.49	6SD7GT	.99
1S21	6.90	5Y4G	.79	6SF5	.89
1T4	.79	5Z3	.99	6SF7	.89
1T5GT	.99	5Z4	1.29	6SG7	1.39
1U4/5910	.69	C6A	6.75	6SH7	.99
1U5	.79	6A3	1.59	6SJ7	.89
1V	.79	6A4	1.89	6SK7GT	.89
1V2	.70	6A5G	2.39	6SL7GT	.89
1X2	.99	6A6	.89	6SN7GT	.79
1Y2	6.98	6A7	1.39	6SN7WGT	2.25
1Z2	3.98	6A8GT	1.09	6SQ7GT	.79
2A3	1.19	6AB4	.79	6SR7	.69
2A4G	1.19	6AB5/6N5	1.33	6SS7	1.09
2A5	.89	6AB7/1853	1.39	6ST7	1.33
2A6	.69	6AC5GT	1.09	6SU7GTY	3.37
2A7	.69	6AC6G	1.49	6SZ7	1.05
2AC15	4.98	6AC7	.99	6T7G	.89
2AS15	4.98	6AD69	.98	6T8	1.09
2B7	.89	6AD7G	1.49	6U4GT	.89
2B22	3.90	6AE5	.89	6U5/6G5	.99
2C21/1642	.67	6AF6G	1.33	6U6GT	1.09
2C22/7193	.33	6AG5	.89	6U7G	.89
2C26	.19	6AG7	1.99	6V6	2.25
2C26A	.47	6AH5G	1.49	6V6GT	.69
2C33/RX233H	2.98	6AH6	1.99	6V8	1.99
2C34/RK34	.69	6AJ5	2.16	6W4GT	.69
2C39	33.98	6AK5	1.39	6W6GT	.89
2C40	9.98	6AK5W	2.98	6W7G	1.33
2C40 JAN	19.90	6AK6	1.49	6X4	.49
2C43	26.75	6AL5	.89	6X5GT	.49
2C43/464A	9.49	6AL7GT	1.29	6Y6G	1.27
2C44	1.20	6AN5	5.95	6Y7G	.89
2C51	6.95	6AQ5	.69	6Z7G	.89
2C52	5.98	6AQ5W	5.98	6ZY5G	.89
2D21	1.49	6AQ6	1.25	7A4/XXL	.89
2E5	1.19	6AQ7GT	1.19	7A5	.99
2E22	1.25	6AR5	.79	7A6	.79
2E24	4.85	6AR6	2.98	7A7	.99
2E25/HY65	5.15	6AS5	.79	7A8	.89
2E30	2.19	6AS6	2.79	7AD7	1.49
2J21	10.69	6AS7G	4.98	7AF7	.89
2J21A	9.25	6AT6	.59	7AH7	1.19

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE

7B4	.79	14W7	1.09	58	.79	355A	14.15	866A	1.35
7B5	.79	14X7	1.23	RK59	1.45	368AS	7.75	868/CEIC	3.49
7B6	.79	15E	1.47	59	1.78	3718	.90	869	36.95
7B7	.89	15R	.89	T60	10.49	380A	.79	872A	2.35
7B8	.89	FG17/5557	4.98	HY69	4.98	388A	1.49	GE872A	4.98
7C4/1203A	.79	18	.98	70A7	1.59	393A	8.90	874	1.39
7C5	.79	19	.89	70L7GT	1.59	394A	4.90	878	1.95
7C6	.99	19BG6G	1.79	71A	.79	FP400	15.98	884/6Q5G	1.80
7C7	1.49	19T8	1.09	72	.95	X400	14.98	885	1.45
7C23	72.00	19V8	1.62	CRP72	1.37	417A	8.95	893A	250.00
7C29	69.95	T20/1623	3.79	CRP73	1.49	GL434	14.98	922	.95
7E5/1201	1.29	TUF20	5.19	73	1.67	446/2C40	1.19	923	1.00
7E6	.89	TZ20	3.79	NR74	.29	446B	3.89	927/CE25	1.4
7E7	.89	20	1.17	HY75	4.59	450TH	39.00	929	1.33
7F7	1.09	RK20A	8.95	75	.79	450TL	44.00	930	.98
7F8	2.19	RX21	3.75	75TL	6.89	460/HE200		931A	6.90
7G7/1232	1.29	22	.99	76	.79		15.95	954	.29
7H7	.89	24	.85	77	.69	WL468	13.95	955	.40
7J7	1.09	24A	1.10	78	1.05	GL471A	2.69	956	.39
7K7	1.29	24G/3C24	1.90	79	.89	GL502A	1.79	957	.45
7L7	1.19	25A6	1.09	80	.69	RH507	9.98	958A	.67
7N7	1.19	25A7	3.17	81	1.69	GL530	22.00	991	.39

Top Dollar Paid for Your Surplus Tubes—Send List and Prices

7Q7	.79	25AC5GT	1.59	FG81A	3.90	531	6.98	FM1000	1.50
7R7	.99	25AV5GT	1.29	82	1.19	WL532	3.89	CK1005	.85
7S7	1.09	25BQ6GT	1.19	82V	1.39	550P1	19.95	CK1006	3.49
7T7	1.03	25C6	1.18	83	1.89	575A/975	13.75	CK1007	.89
7V7	1.39	25L6GT	.89	83V	1.89	WL579	10.49	CK1090	2.69
7W7	1.19	25W4GT	.89	84/6Z4	.99	WL579B	12.98	R1100	5.00
7X7/XXFM	1.19	25Y5	.79	85	.79	601B	.19	R1130	12.00
7Y4	.69	25Z5	.79	89	.75	HY615	.25	E1148	1.35
7Z4	.69	25Z6GT	.99	VR92	.25	616	37.00	HY1231Z	5.39
8DC-15	4.98	26	.79	FG95/5560		KU627	18.00	1612	1.98
10Y	.49	27	.69		24.85	WL670A	11.98	1613/6F6X	.98
12A	.89	FG27A	8.70	FG98	19.95	701A	5.89	1616	.90
12A5	1.39	RK28A	4.89	100TH	8.89	702A	3.29	1619	.29
12A6	.89	28D7	1.39	102D	2.98	702B	5.98	1620	5.75
12A7	1.29	30	.79	102G	2.98	703A	5.98	1622	2.69
12A8GT	.79	31	.59	FG104	37.98	704A	.98	1624	1.90
12AC7	1.45	HY31Z	2.75	FG105	18.98	705A/8021	2.79	1625	.42
12AH7GT	1.99	32	.49	VU111	1.45	707A	10.49	1626	.42
12AK5	1.98	FG32/5558		HY114B	.75	707B	17.49	1629	.35
12AK5W	2.98		13.85	HY115/145	.79	710A/8011	.95	1630	.97
12AL5	1.11	32L7GT	1.49	117L/M7GT	1.59	713A	1.00	1631	1.25
12AT6	.59	33	.59	117N7GT	1.79	NL714	5.95	1632	.77
12AT7	1.39	34	.69	117P7GT	1.39	714AY	5.90	1633	.73
12AU6	.89	35/51	.89	117Z3	.59	715A	6.45	1634	.73
12AU7	.95	35A5	.79	117Z4GT	1.39	715B	9.65	1635	1.49
12AV6	.69	35B5	.79	117Z6GT	1.19	715C	24.25	1636	3.19
12AW6	1.79	35C5	.69	117Z7GT	1.49	717A	1.49	1644	.95
12AX7	.99	35L6GT	.79	CK118		718BY	48.45	2000T	149.50
12AY7	2.95	35T	4.89	F123A	8.49	718CY	48.45	2050	1.79
12BA6	.79	35TG	3.45	T125	12.49	719A	49.95	2051	1.19
12BA7	.79	35W4	.49	F127A	19.98	721A	2.49	R4340	36.00
12BD6	1.75	35Y4	.69	VT127A	3.90	722A/287	2.45	5516'	7.75
12BE6	.89	35Z3	.79	CV148	4.98	723A	9.75	5517	3.39

Use Your Priority for SPEEDY DELIVERY—Extend Your DO & Contract Nos.

12BF6	.85	35Z4GT	.69	150T	14.50	723A/B	14.49	5594	6.65
12BH7	1.29	35Z5GT	.59	VT158	14.49	724A	3.95	5608A	5.95
12C8	1.39	REL36/6J4	.49	FG166	49.00	724B	3.45	5651	3.30
12F5GT	.79	36	.65	FG172	42.50	725A	6.49	5653	....
12H6	.89	37	.69	182B	1.20	726A	6.90	5654	4.79
12J5GT	.69	38	.59	FG190	12.80	726B	59.95	5656	9.98
12J7GT	.99	RK39	2.89	T200	22.98	726C	69.95	5658	....
12K7GT	.89	39/44	.59	201A/CX301A		801A	.45	5663	1.85
12K8	.99	CRC40	.59		.98	802	3.98	5670	5.98
12Q7GT	.79	T40	4.29	203A	5.98	803	3.89	5684	14.98
12S8GT	.98	TZ40	3.98	205B/VT2	1.69	804	8.95	5686	4.23
12SA7GT	.89	40	1.09	CE206	3.15	805	3.90	5687	5.75
12SC7	1.39	HY40Z	3.75	211/VT4C	1.89	807	1.67	5692	7.69
12SF5GT	.79	41	.79	CE215	8.98	808	2.98	5693	7.69
12SF7GT	.59	42	.69	RX125	9.95	809	2.43	5694	3.65
12SG7	.89	43	.85	WE215A	.18	810	10.98	5726	4.39
12SH7	1.10	45	.69	217C	8.75	811	2.90	5749	4.39
12SJ7GT	.79	45S/VT52	.34	227A	4.98	812	2.90	5751	5.98
12SK7	.89	45Z3	.69	231	1.20	813	8.65	5763	1.70
12SL7GT	.79	45Z5GT	.89	242C	8.49	814	3.85	5812	2.99
12SN7GT	.89	46	.89	244A	4.15	815	2.90	5814	5.49
12SQ7GT	.79	47	.99	247A	9.95	816/866Jr.	1.09	5881	3.39
12SR7	.98	48	1.99	250R	9.90	826	.95	X6030	4.49
12X3	.90	RK48A	14.85	250TH	22.25	828	11.29	UX6653	.69
12Z3	.89	RK49	7.50	250TL	19.40	829	11.49	8002R	99.50
14A4	1.09	49	.83	HK254	14.49	829B	13.45	8005	5.85
14A7/12B7	.99	50	1.19	262B	3.98	830B	3.49	8008	6.49
14AF7/XXD	1.19	EF50	.98	274B/5R4	1.90	832	5.65	8012	2.89
14B6	.99	50A5	1.19	276A	9.89	832A	9.75	8013	2.75
14B8	.89	50B5	.79	T300	26.98	833A	48.90	8013A	4.79
14C5	1.09	50C5	.69	304TH	11.25	834	5.95	8014A	28.95
14C7	1.09	50C6	1.49	304TL	11.25	836	4.75	8020	1.25
14E6	.99	50L6GT	.69	307A/RK75	4.85	837	1.55	8025	5.79
14E7	1.09	50X6	.89	310A	6.75	838	3.98	9001	1.65
14F7	1.09	50Y6GT	.79	311A	7.90	843	.39	9002	1.29
14F8	1.29	50Z7G	.98	313C	2.98	845	4.90	9003	1.19
14H7	.99	52	.99	316A	1.49	849	29.45	9004	.59
14J7	1.19	53	.69	323A	24.25	852	19.98	9006	.29
14N7	1.49	T55	8.79	327A	4.95	860	4.90	Sub-Miniatures	
14Q7	1.09	58	1.06	350B	5.90	861	23.95	1AD4	2.95
14R7	1.19	56	.85	383A	4.78	864	.39	2E31	1.49
14S7	1.09	57	.79	HK354	24.98	865	1.29	2E36	1.49

2E43	1.39
CX501X	1.26
CK501AX	1.26
CK502AX	1.79
CK503AX	1.79
CK505AX	1.79
CK506AX	1.79
CK509AX	1.26
CK512AX	1.79
CK522AX	1.79
CK525AX	1.79
CK526AX	1.98
CK528AX	1.79
CK529AX	1.98
CK531DX	.98
CK532DX	.98
CK533AX	1.39
CK534AX	.89
CK536AX	.89
CK537AX	4.98
CK538DX	.89
CK539DX	.98
CK541DK	1.98
CK542DX	.98
CK543DX	.98
CK544DX	.98
CK546DX	1.98
CK547DX	1.98
CK571AX/5886	6.98
SD828	.98
SD969	.98
CK1028	9.98
CK1089	4.69
CK1090	4.69
5638	4.79
CK5672	3.15
CK5676	2.98
CK5678	2.45
CK5697	5.98
CK5702	5.98
CK5704	5.79
CK5783	6.69
CK5784	4.49
5829	5.98
CK5875	1.98

C'Ray Tubes

2AP1	11.90
3AB1	12.95
3AP1	14.25
3BP1	7.95
3BP1A	14.98
3CP1	2.20
3DP1	4.85
3EP1	5.85
3FP7	1.89
3FP7A	14.98
3GP1	4.70
3HP7	3.85
3HP14	14.98
3JP7	12.50
3JP12	19.95
3JP14	16.95
4AP10	4.69
5AP1	3.65
5BP1	4.89
5BP1A	14.98
5BP4	4.75
5CP1	4.89
5CP7	4.95
5FP7	2.95
5FP14	18.98
5HP1	9.75
5HP4	9.75
5JP2	24.40
5LP1	29.95
5MP1	9.75
5NP1	5.85
7BP1	4.95
7BP7	6.75
7JP4	18.39
9GP7	14.89
9LP7	10.95
10BP4	18.29
10FP4	24.50
12DP7	16.89
12DP7A	49.50
12GP1	49.98
12GP7	16.89
12HP7	16.89
12JP4	27.00
12KP4	47.00
12LP4	21.25
16KP4	47.29
16LP4A	36.98
16MP4A	43.98
16RP4	36.49
16TP4	39.98
16YP4	43.98
17BP4	43.45
17BP4A	36.49
19DP4A	67.65
20CP4	68.25
902	10.65
905	3.49
912	89.98
913	11.98
914A	45.00

Vacuum Capacitors

MMF	5KV	Each
25	5	3.49
100	7.5	6.95
50	15	7.98
12	20	9.98
50	20	9.98
55	20	9.98
100	20	12.98
150	20	14.98
12	32	12.98
25	32	14.98

Tungar Bulbs

16x897	3.49
20x672	2.95
195528	2.49
217283	6.75
289881	2.50
859483	2.95

Mazda Pilots

49, box 10	.60
51, box 10	.55
55, box 10	.50
64, each	.07
S6/T4/3W	.18
100W/20V	.25
291, box 10	.36
311/28V	.15
313/28V	.15
323/3V	.25

Sylvania

S6/6W120V	.15
WStghs C7/7W/120V	.15

MedScrewBase

15W/125V	.08
25W/125V	.08

Neon Bulbs

NE16/991	.40
NE20	.10
NE21	.45
NE32	.35
NE45/2W	.27
NE51/NE20	.10

Xtal Diodes

Many Late Dates Latest JAN Specs

1N21	.89
1N21A	1.65
1N21B	3.98
1N21C	26.70
1N22	1.25
1N23	1.49
1N23A	2.98
1N23B	4.98
1N25	7.45
1N26	6.45
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1N38	1.62
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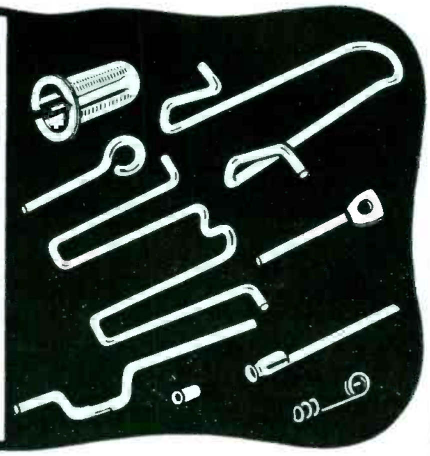

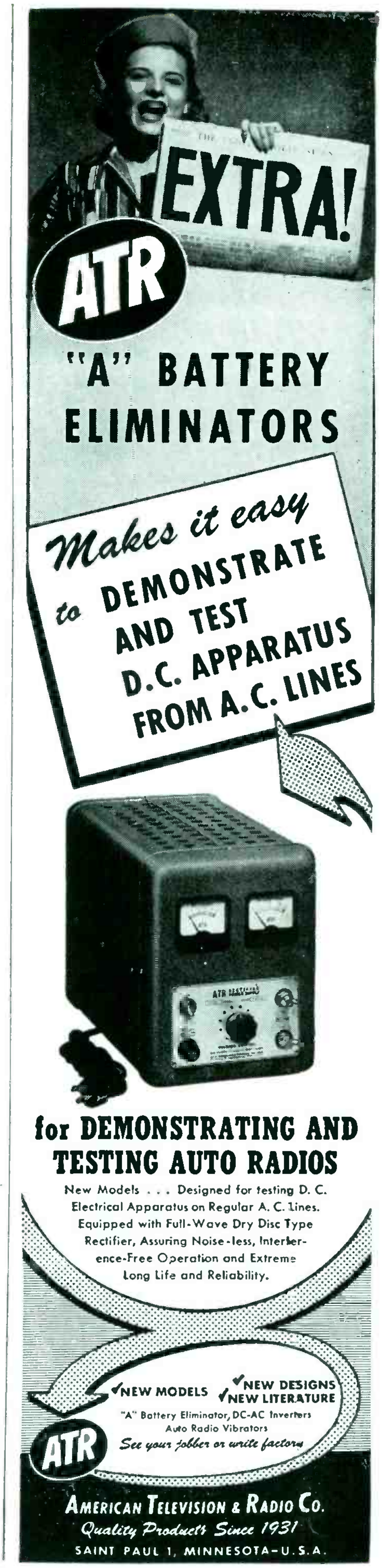

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The Fountainhead of Modern Tube Development is RCA

Pulse-rated Four RCA tubes specifically designed for pulsed applications

RCA-5893 "Pencil-Type" UHF Triode

RCA-5893 is a new, medium-mu, "pencil-type" triode employing a double-ended, coaxial-electrode structure. As a plate-pulsed oscillator in grounded-grid service, the 5893 will deliver a useful power output at peak of pulse of 1200 watts at frequencies up to 3300 Mc.

Maximum Ratings as Plate-Pulsed Oscillator

For max. total "on" time, in any 5000-μsec interval, of 5 μsec

Peak Positive-Pulse Plate Supply Voltage	1750 max. volts
Peak Negative-Pulse Grid-Bias Voltage	150 max. volts
Peak Plate Current from Pulse Supply	3 max. amp
Peak Rectified Grid Current	1.3 max. amp
Plate Dissipation	6 max. watts
Pulse Duration	1.5 max. μsec

RCA-5946 UHF Power Triode

RCA-5946 is a new forced-air-cooled power triode for use in circuits of the coaxial-cylinder type. In plate-pulsed service, the 5946 will deliver a useful power output at peak of pulse of 14 kw at a frequency of 1250 Mc.

Maximum Ratings as Plate-Pulsed Oscillator & Amplifier

For max. total "on" time, in any 1000-μsec interval, of	10 μsec	100 μsec
Peak Positive-Pulse Plate Supply Voltage	7500 max.	7500 max. volts
Peak Negative-Pulse Grid-Bias Voltage	600 max.	600 max. volts
Peak Plate Current from Pulse Supply	4.5 max.	3.5 max. amp
Peak Rectified Grid Current	1.0 max.	0.75 max. amp
Plate Dissipation	250 max.	250 max. watts

RCA-4C33 UHF Power Triode

RCA-4C33 is a forced-air-cooled power triode for coaxial-type circuits. For plate-pulsed service, it will provide a power output at peak of pulse of 130 kw at a frequency of 600 Mc.

Maximum Ratings as Plate-Pulsed Oscillator

Peak Positive-Pulse Plate Supply Voltage	13000 max. volts
Peak Negative-Pulse Grid-Bias Voltage	2000 max. volts
Peak Plate Current from Pulse Supply	30 max. amp
Peak Rectified Grid Current	4 max. amp
Plate Dissipation	250 max. watts
Pulse Duration	5 max. μsec

RCA-3E29 Twin-Beam Power Amplifier

RCA-3E29 is a twin-unit, beam power amplifier designed to handle a peak plate current of 10 amp. in pulse modulation service.

Maximum Ratings as Pulse Modulator (both units in parallel)

For pulse length of	1 max.	1.2 max. μsec
DC Plate Supply Voltage	5000 max.	5000 max. volts
DC Grid-No. 2 Supply Voltage	850 max.	850 max. volts
DC Grid-No. 1 Supply Voltage	−200 max.	−200 max. volts
Plate Input	85 max.	60 max. watts
Peak Grid-No. 2 Current	0.5 max.	0.5 max. amp
Plate Dissipation	15 max.	15 max. watts

For further technical data or design assistance on any RCA pulse tube, write RCA, Commercial Engineering, Section 42LR, Harrison, N. J., or contact the RCA Field Office nearest you.

FIELD OFFICES: (EAST) Humboldt 5-3900, 415 S. 5th St., Harrison, N.J. (MIDWEST) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill. (WEST) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Calif.

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