DECEMBER · 1947

electronics

A McGRAW-HILL PUBLICATION

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DECEMBER • 1947

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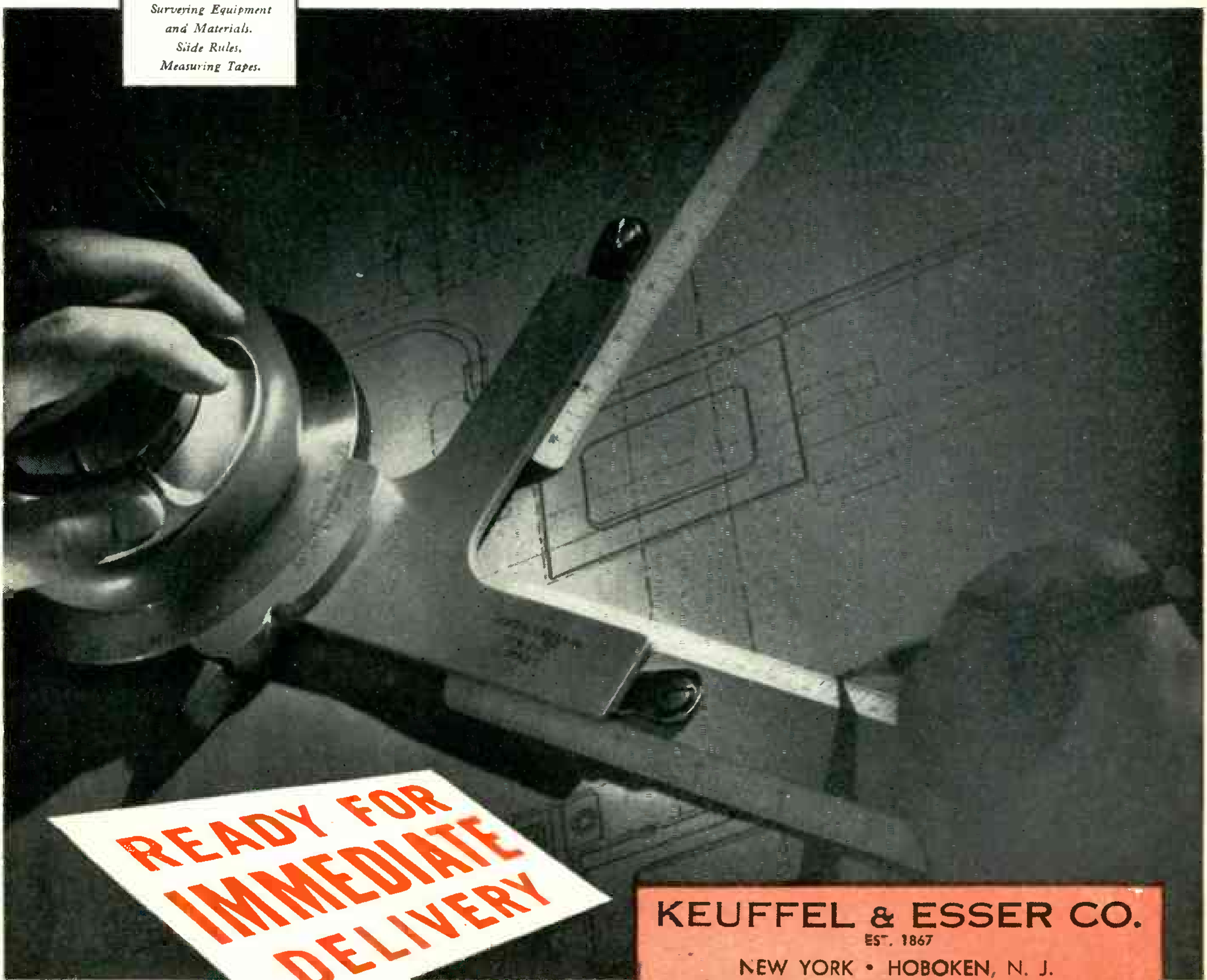

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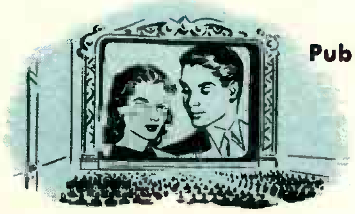

SOUND PICTURES

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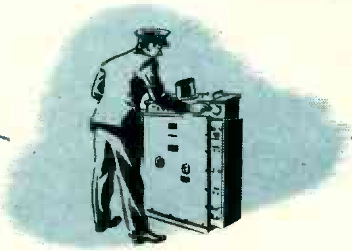

RADAR

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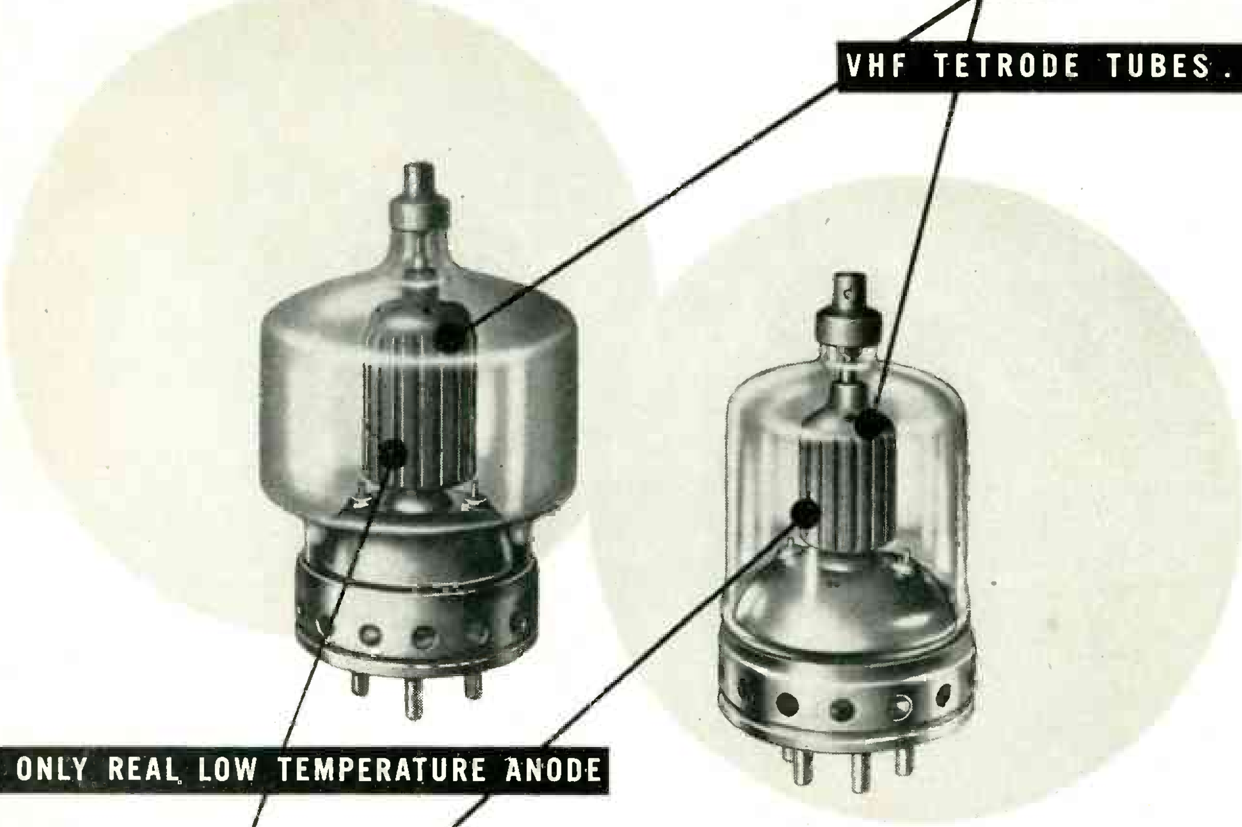
World's largest organization devoted exclusively to research and development in all phases of electrical communications.

Western Electric
Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

NOW GRAPHITE IN 4D-21 and 5D-22



Using Speer *GRAPHITE* Anodes, United Electronics Company has introduced the virtues of this material in the intermediate power, VHF transmitter field. Extensive research, production and testing by UNITED has revealed that graphite—the only low temperature anode—provides these advantages in transmitting tubes:

1. ***Greater Safety***—*Graphite* anodes can take overloads with a higher safety factor than anodes of any commonly used metal.

2. ***Longer Life***—*Graphite* anode tubes operate at lower temperatures . . . outlast metallic anode tubes even under continued severe service.

3. ***Non-Warping***—Even when tubes are operated in the neighborhood of 100 Mc's or over, *graphite* anodes will not warp. They maintain their original characteristics, assure stability of associated tube parts.

Speer has worked steadily with United and other tube manufacturers in their progressive program of making *graphite* anode tubes for a wide range of electronic applications. Speer Graphite Anodes are now widely used in oscillator, amplifier, doubler, modulator and rectifier tubes—making possible cooler, more efficient operation.

Look for graphite anodes when you're looking for better tubes.

Speer

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3240

brushes · contacts · welding electrodes · graphite anodes · rheostat discs · packing rings · carbon parts

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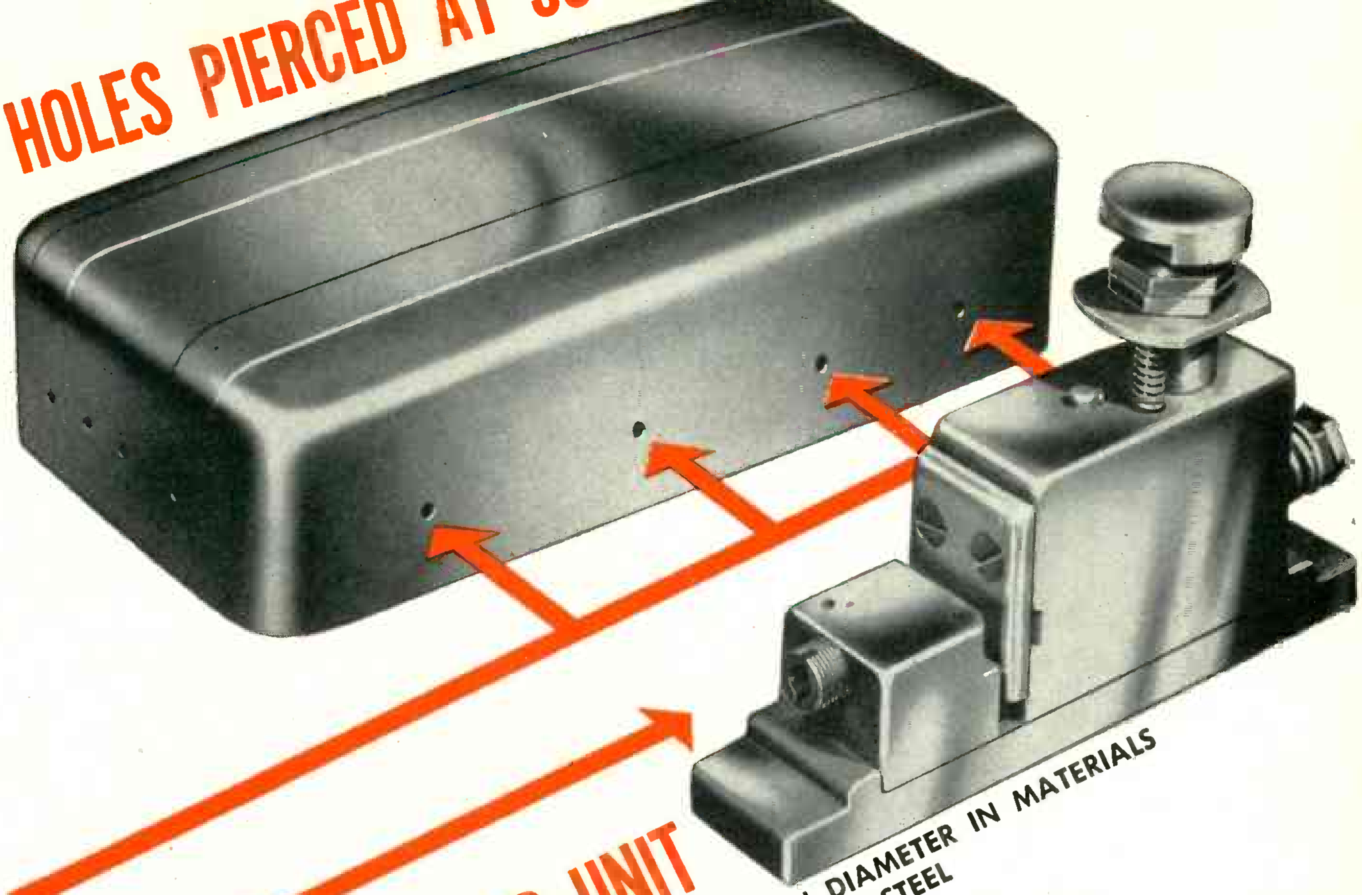
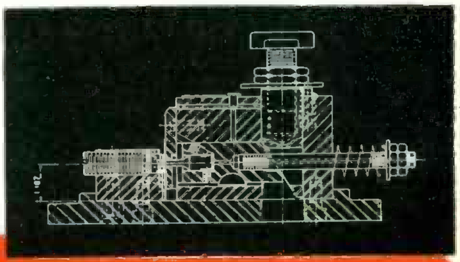
HOLES PIERCED AT 90° ANGLE...



with NEW WHISTLER UNIT

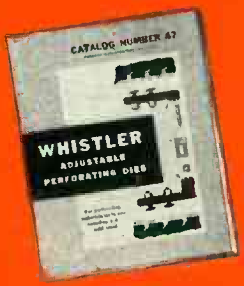
PERFORATES HOLES UP TO ½" IN DIAMETER IN MATERIALS TO 1/16" THICK MILD STEEL



Detailed drawing showing operation of HU-50 90° Perforating Unit.

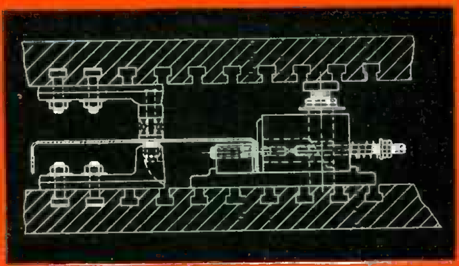
Extruded shapes, ells, angles and other molded, shaped or fabricated pieces are easily pierced from the side at 90° with HU-50 Perforating Units. Quickly set up and adjustable, these units may be used separately or with standard perforating equipment. The advantages provided by other Whistler Adjustable Dies are retained. Absolute accuracy is assured. Quick change-over of hole arrangements can be made ...in many cases, on the press. Production economies and speeded up operating schedules are effected. Continued re-use of units in different groupings spreads initial cost.

It makes sense to look into the use of Whistler Adjustable Dies for all perforating, notching, slitting or rounding operations.



DETAILS EXPLAINED IN CATALOG NO. 47

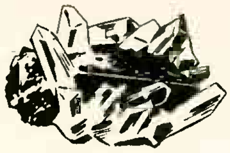
Get the facts about this 90° perforating unit in a hurry. Your copy of this catalog will be sent at once upon request.



Typical set-up shows 90° perforating unit operated in conjunction with standard perforating equipment.

S. B. WHISTLER & SONS, INC.

746 MILITARY ROAD BUFFALO 17, NEW YORK



This unique Callite Book is more than a mere catalog. Printed with full color and black-and-white illustrations, it provides comprehensive metallurgical data and valuable charts that you need for easy, day-to-day reference. Also presents excellent briefing material for new personnel in your organization. Write on your company letterhead for your free copy of Catalog Number 156.

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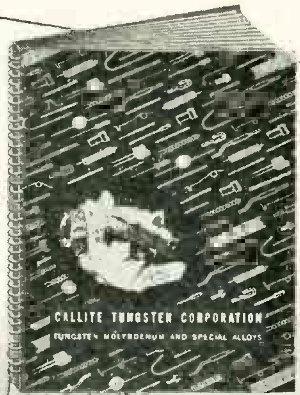

callite's book on tungsten and molybdenum metallurgy

for tube and lamp components

CALLITE TUNGSTEN

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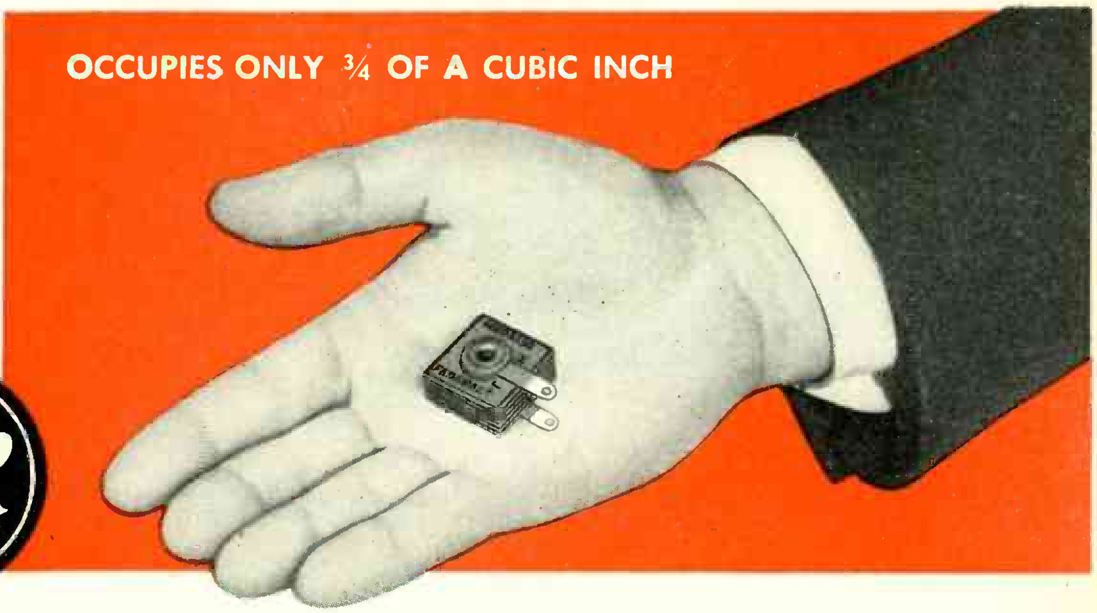
TUBE AND LAMP COMPONENTS

Hard glass leads, welds, tungsten and molybdenum wire, rod and sheet, formed parts and other components for electronic tubes and incandescent lamps.

NOW

Federal Offers You a New 75-Ma Selenium Rectifier that is

SMALLER THAN EVER!



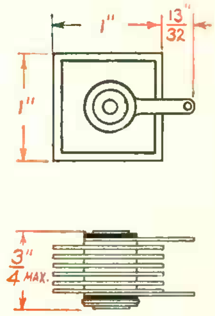
A new solution to the *space problem* in your smallest electronic equipment

WHEN FEDERAL first introduced the Miniature Selenium Rectifier to replace the rectifier tube in AC-DC radio receivers, it was the smallest, most compact unit of its type ever developed. Now the new 75-Ma rectifier is even *smaller* than before—providing additional space savings so valuable in modern miniature receivers and equipment. It's easier to install in restricted spaces—leaves more "hand room" to work in. And this reduction in size has been made without any sacrifice in performance or dependability. In fact, it incorporates *added* safety factors for longer trouble-free operation.

Compared to a rectifier tube, this space-saving Selenium Rectifier offers the advantages of longer life, rugged all-metal construction, only two soldered connections, and instantaneous current output without warm-up. For complete data on the new 75-Ma rectifier, write to Federal today-Dept. F 513.

APPROXIMATE DIMENSIONS

75-Ma Rectifier — No. 402D3150



NOTE: **This rectifier is electrically interchangeable with Rectifier No. 402D2738.**

KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

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Type 71 Capacitors

Longer Life • Smaller Size • Lighter Weight

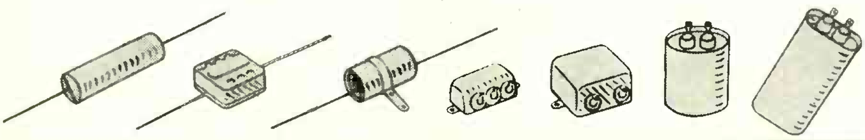
Sangamo Type 71 Capacitors are compact units, designed for use in broadcast and aircraft transmitters, industrial applications, and in many varied high-voltage circuits. They give highly satisfactory performance even under the most severe conditions.

These Diaclor impregnated capacitors have the advantage of longer life, smaller size, and lighter weight. Diaclor, a specially compounded chlorinated dielectric, permits greater uniformity of production because of its controllable characteristics. The use of this synthetic impregnant assures high volume resistivity, low power factor, and high dielectric strength. Fire hazard due to accidental leakage is eliminated because Diaclor is non-inflammable and non-explosive.

Type 71 capacitors are available within a range of 600 to 6000 Volts Working, or higher. They can be supplied with either composition rivet, screw type, pyrex glass or stand-off porcelain terminals, and with any one of three types of mounting brackets.

Sangamo manufactures a complete line of paper, mica and silver capacitors for every radio and electronic application. A quarter of a century of capacitor manufacturing experience is your assurance of Sangamo Quality.

Write for the new Sangamo Capacitor Catalog



SANGAMO
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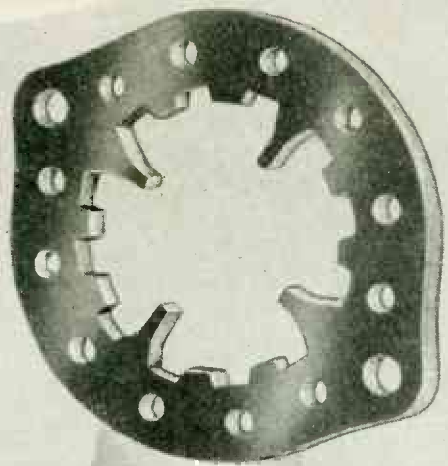
SC 479

Lower Power Factor!



Higher Insulating Resistance!

Punches Easily!

Lower Moisture Absorption!

Lower Dielectric Constant!

Saves Wear on Dies!

RICHARDSON OFFERS THE NEW T-800 INSUROK!

a combination of properties unparalleled in phenolic laminates

Once again Richardson is *first* with the best! Now you can get a phenolic laminate which has practically everything manufacturers of electrical equipment, appliances and apparatus want in a plastic—in the NEW T-800 INSUROK!

T-800 INSUROK has a better combination of properties . . . higher in insulating resistance, lower moisture absorption, lower power factor, lower dielectric constant, and minimum loss factor . . . than any other phenolic laminate which can be punched with moderate heating.

T-800 INSUROK is easy to process. Intricate parts can be punched cleanly with the use of moderate heat.

If you are manufacturing anything in the electrical field—particularly in electronics, radio, television, hearing aids, or anything else—you will want the full facts about the NEW Richardson T-800 INSUROK. Send today for Bulletin L-103. Requests on company letterheads only will be promptly answered.

Specification Data on INSUROK Grade T-800

Thickness	1/16"
Volatile	0.30%
Moisture Abs.	0.22%
Expansion	
Center	.0001"
Edge	.0000"
Tests at Room Conditions	
Specific Gravity	1.300
Dielectric Strength	
Short Time	658
Step by Step	554
Power Factor	.0197
Dielectric Constant	3.90
Loss Factor	.0767
Tests after 96 hrs. at 90% Relative Humidity 104° F.	
Power Factor	.0210
Dielectric Constant	3.99
Loss Factor	.0838
Insulation Resistance	167,000

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in making HF, FM, and TV measurements

THE TYPE WV-75A VOLTOHMYST — a new member of the famous RCA line

RCA HIGH-FREQUENCY VOLTOHMYST

. . . flat up to 250 megacycles!

● With diode probe, measures peak-to-peak voltages up to 250 megacycles. The High-Frequency (Advanced) VoltOhmyst is ideal for television, FM, and routine, high-frequency measurements. The diode response is also flat down to 30 cycles.

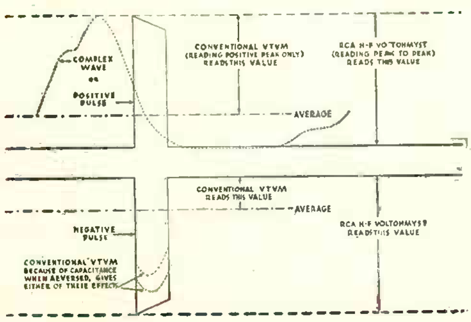
The WV-75A is calibrated in rms voltages up to 100 volts in 4 ranges. An adaptor is supplied for low-frequency measurements up to 1000 volts.

The WV-75A also measures d-c voltages up to 1000 volts in six ranges and resistances to 1000 megohms in six ranges.

• • •

Available from your RCA Laboratory Measuring Equipment Distributor.

RCA H-F VoltOhmyst reads peak to peak for either simple or complex wave forms.



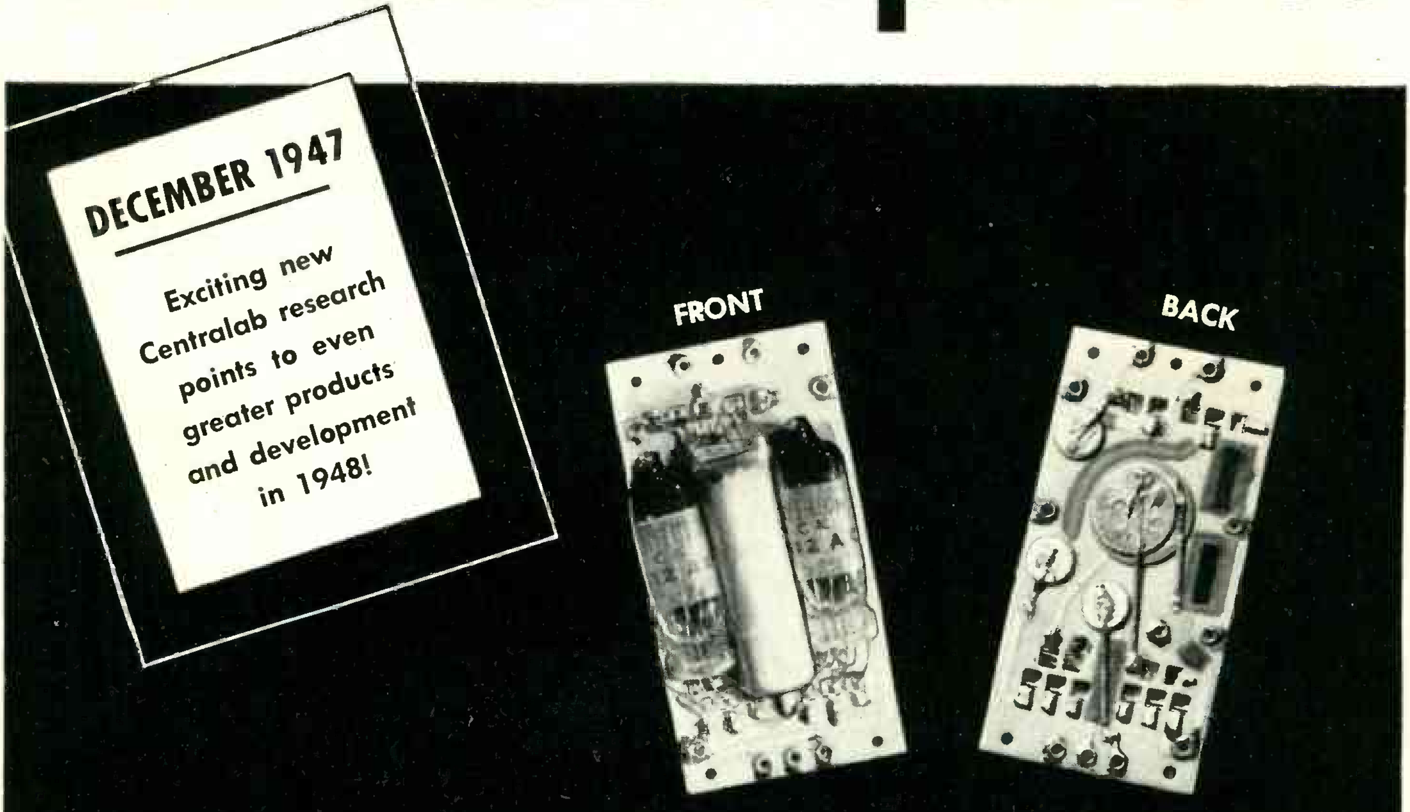
TEST AND MEASURING EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

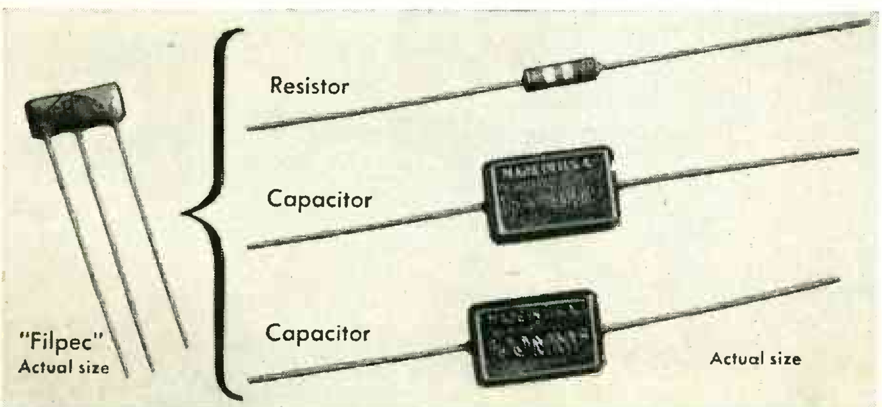
In Canada: RCA VICTOR Company Limited, Montreal

Centralab reports to

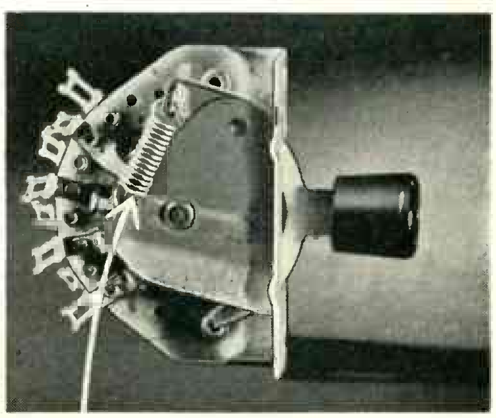


ANNOUNCING "AMPEC" — a miniature three-stage amplifier, Centralab's newest application of its revolutionary "printed electronic circuit" (PEC)!

1 **December 1947:** Lightweight, durable, with reliability and efficiency heretofore unobtainable in small units, *Ampec* is a complete, 3-stage audio amplifier — a typical application of CRL's "printed electronic circuit" (PEC). Provides all the components of an audio amplifier — tube sockets, capacitors, resistors, wiring — "printed" on one compact ceramic chassis according to your special requirements. 2.250" long, 1.156" wide. Wt. 0.63 oz. Write for Bulletin 973.

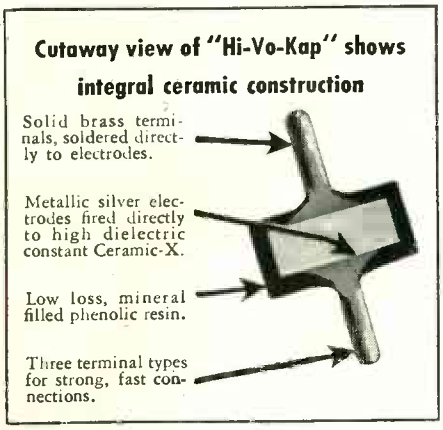


2 **November 1947:** Centralab announces new and revolutionary *Filpec* — the "printed electronic circuit" filter! As shown, *Filpec* is a brand new balanced diode load filter, lighter in weight, smaller in size than one ordinary capacitor. Resistance values: 5 ohms to 10 megohms. Write for Bulletin 976.

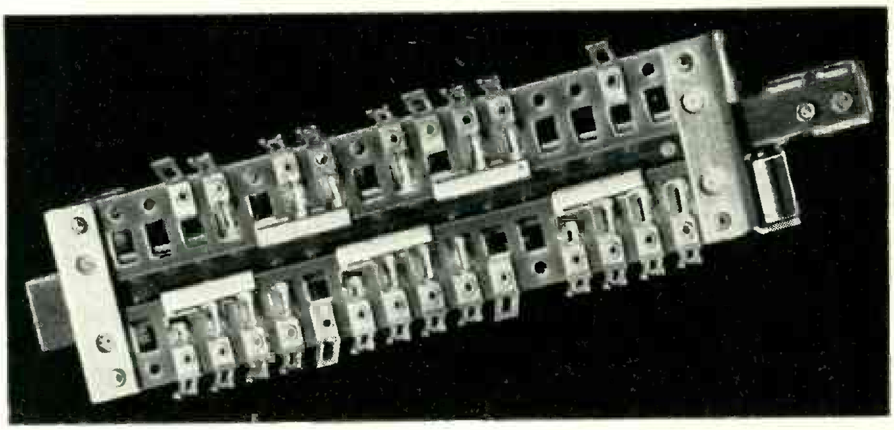


3 **July 1947:** New CRL *Lever Switch* features exclusive coil spring design. Guaranteed minimum life of 50,000 cycles. Write for Bulletin 970.

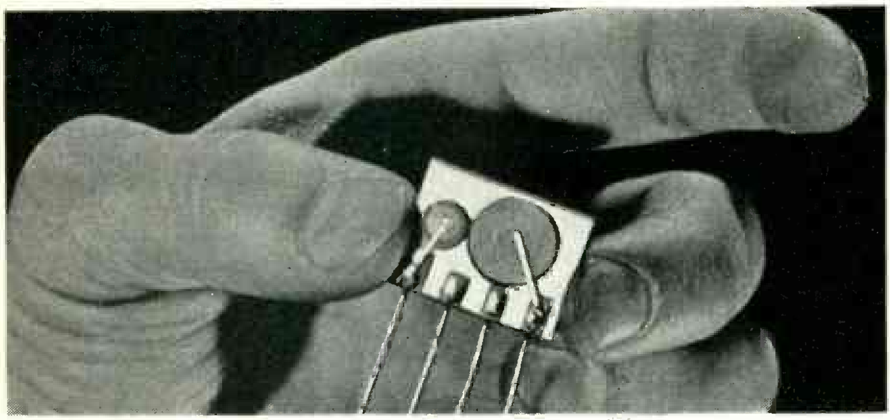
Electronic Industry



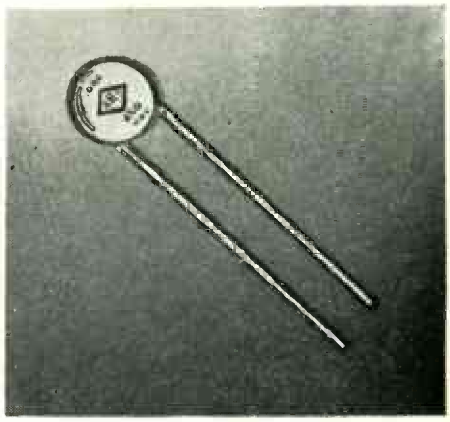
4 **June 1947:** CRL *Hi-Vo-Kaps* combine high voltage, small size for television applications. For use as filter and by-pass capacitors in video amplifiers.



5 **May 1947:** CRL development of brand new *Slide Switch* promises improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.



6 **March 1947:** First commercial application of its "printed electronic circuit", Centralab's new *Couplate* gives you a complete interstage coupling circuit which combines into one unit the plate load resistor, the grid resistor, the plate by-pass capacitor and the coupling capacitor. Write for Bulletin 943.



7 **February 1947:** CRL *Hi-Kaps*, miniature ceramic disc capacitors, offer utmost reliability in small physical size, low mass weight. Write for Bulletin 933.

LOOK TO CENTRALAB IN 1948! ***First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!***

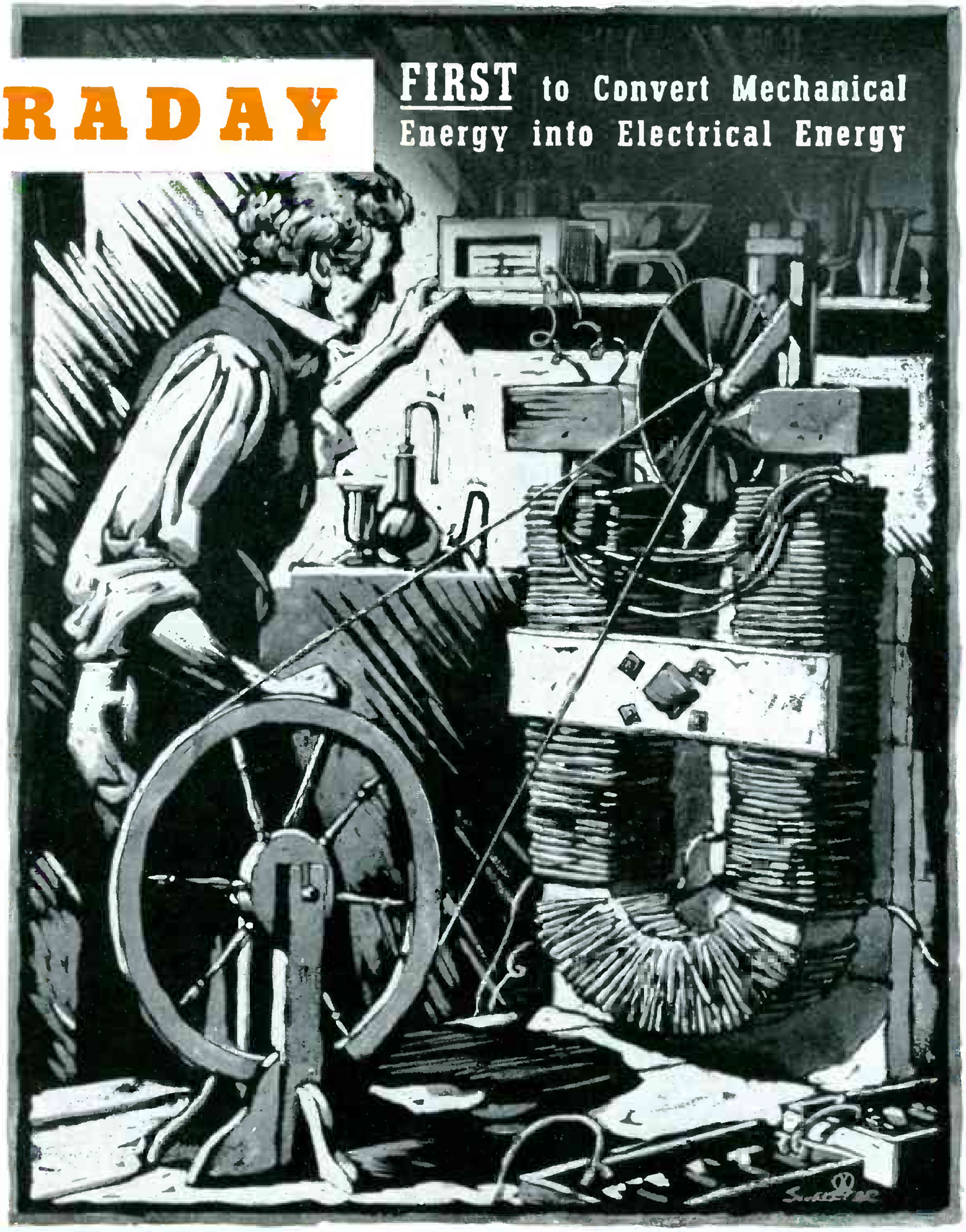
Centralab

CRL

DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.

FARADAY

FIRST to Convert Mechanical Energy into Electrical Energy



Michael Faraday (1791 — 1867)

This celebrated English experimenter discovered the principles of electromagnetic induction in 1831, and with a copper disc and horseshoe magnet, built the first dynamo. The farad, unit of electrical capacitance, is named in his honor.

Drawing by courtesy, "Machine Design"

OHMITE

FIRST in Wire-Wound Resistance Units *Today*

Be Right with
OHMITE
RHEOSTATS • RESISTORS
TAP SWITCHES

Ohmite rheostats and resistors have become "Industry's First Choice"... the No. 1 selection of design engineers who want extra dependability and unfailing performance under the toughest operating conditions. It will pay you to standardize on these superior resistance units for your products.

The HIGH-FIDELITY RECORDER...

...for The Studio Professionalist

RCA 73-B RECORDER, with its optional cabinet type MI-11827

RCA Type 73-B

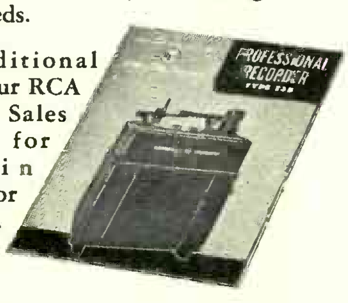
DESIGNED with almost every known device for cutting your high-fidelity reproductions, this professional recorder has everything you need for versatile control of cutting to meet any recording situation.

- For instance, a new improved cam-operated lowering device prevents stylus damage and overcutting . . . because it enables you to lower the flutter-proof cutting head gently with decreasing speed as the head approaches the spinning record.

- For instance, start and finish spiralling is controlled by a *separate* motor . . . push-button operated. Spiralling pitch: approximately 6 lines per inch at 78 rpm and 2.5 lines per inch at 33⅓ rpm.

- For instance, *you can change cutting from inside out to outside in* by the simple turn of a dial . . . without adjusting the lead screw or driving gears. The pitch is continuously variable, while recording, from 96 to 152 lines per inch to handle program overruns. During actual running, too, you can adjust the stylus cutting angle and cutting depth. Groove grouping is eliminated because the head rides smoothly along a tubular enclosure that protects the feed screw. An automatic equalizer . . . available on special order . . . compensates for recording-level variations due to changes in surface speeds.

For additional facts ask your RCA Broadcast Sales Engineer for Bulletin 1J3137 . . . or write Dept. 30-L.



CHECK THESE SPECIFICATIONS

Frequency response	30 to 10,000 cycles, ± 2 db
Head sensitivity (groove velocity 6.3 cm/sec., 0.00079" peak to peak at 1000 cps)	+30 dbm (1.0) watt
Turntable accuracy	± ½% 33⅓ or 78 rpm
Speed regulation (wows)	0.14% rms at 33⅓ rpm 0.07% rms at 78 rpm
Turntable drive	2 hysteresis type synchronous motors, using rim drive through rubber idler rollers
Type of stylus	Sapphire or Steel
Microscope	36 power Spencer
Playback	removable plate provided for mounting RCA Universal Pick-up arm, MI-11871

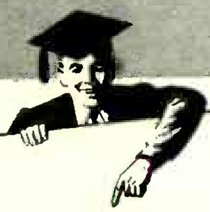
BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Temperature, Moisture—Important



No. 4

...in a series of advertisements on electrical insulation. Discussed in theory are the effects of temperature and moisture on dielectric strength. Several practical applications, in which these conditions play a prominent role, are also illustrated.

To gain a more complete understanding of dielectric behavior, it is necessary to study also the effects of temperature and moisture. Although it is not possible to predict the total effect of these factors, due to many changes occurring in the dielectric, tests have revealed certain consistencies.

DIELECTRIC STRENGTH versus TEMPERATURE

Generally speaking, lower temperatures increase the dielectric strength of an insulating material. Conversely, higher temperatures produce the following undesirable results: lower dielectric strength, higher dielectric loss, decreased electrical resistance. This holds true regardless of whether the temperature increase stems from internal or external causes. By internal heating is meant higher temperatures caused by the flow of current when a test voltage is applied. External heating results from ambient conditions.

Figure 1 consists of typical curves indicating a lowering of dielectric strength with temperature increases. It is noteworthy that the curves all show gradual changes in the beginning, a sharp decline during the critical temperature range, and a gradual tapering off beyond this range. As a rule, thick specimens are more seriously affected by temperature increases than thin ones. This is particularly true of materials having high dielectric losses.

Another important consideration in the effect of temperature changes is the length of time of voltage application. In short-time tests and impulse tests, for instance, most insulations show very little effect of temperature. However, voltage applications of extended duration usually result in the weakening of the dielectric, due mostly to internal heating.

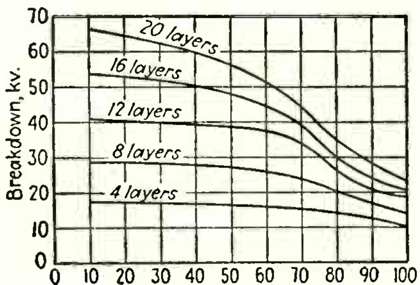


Fig. 1

Effect of temperature on breakdown of 0.005-in. cotton-base paper in oil. (*S. Whitehead*)

DIELECTRIC STRENGTH versus MOISTURE

In general, the more moisture there is contained in a material, the lower will be its dielectric strength. Nonabsorbent materials such as mica, glass and varnished cloth, when exposed to an atmosphere of increased humidity show little change in dielectric strength. On the other hand, most moisture-absorbing materials (usually fibrous in nature) have lower breakdown values when tested under similar conditions. Figure 2 illustrates the effect of humidity on breakdown of an absorbent type insulating material. It is evident that

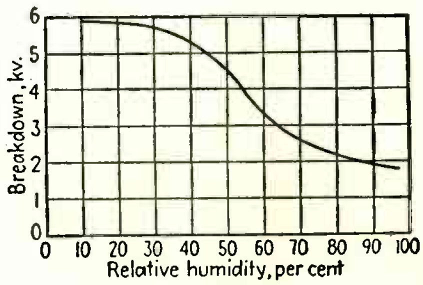


Fig. 2

Effect of humidity on breakdown of paper (1 cm. dia. spheres). (*S. Whitehead*)

this curve has the same form as the breakdown-temperature curves shown in Figure 1.

When tests are performed under conditions of increased temperature, most moisture-absorbing materials show higher breakdown values during the period in which the moisture is being driven off. However, when the material is completely dried, its dielectric strength will be lowered with temperature increases.

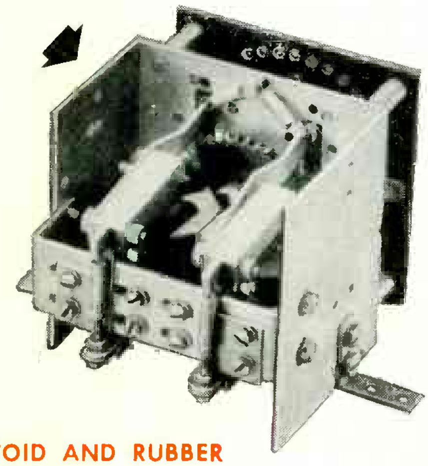
MICA

Factors in Insulation Selection

MICA INSULATOR PRODUCTS MEET EXACTING DEMANDS

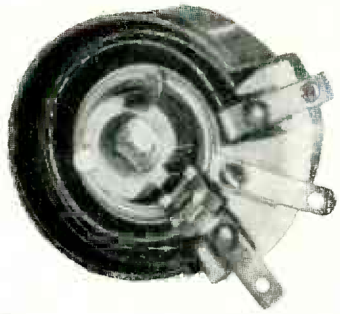
LAMICOID

—a thermosetting laminated plastic, provides low dielectric losses, assures high operating efficiency when used for contact spacers, coil ends and ratchet gears on such products as this adding and subtracting relay. Lamicoid has unusually low moisture absorption—changes little even when exposed to high humidity over long periods.



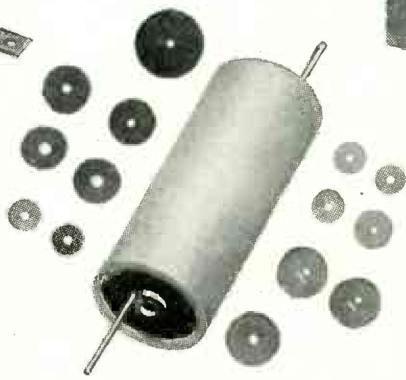
MICANITE TUBING

—mica films bonded with quality resins—was slit and inserted between the resistance element and metal case of this metallic rheostat. Specifications called for a thin, flexible material that would provide complete electrical insulation and be capable of withstanding temperatures up to 300°F.



LAMICOID AND RUBBER

team up to provide rare combination of properties. Millions of "can-type" electrolytic condensers are sealed by washers of Lamicoid bonded to natural or synthetic rubber. This use is only one of many interesting applications where Lamicoid's good dielectric properties, mechanical strength and resistance to chemical corrosion combine with the properties of rubber for better product performance and dependability.



MICA

insulation between commutator segments and Micanite wrappers on pre-insulated coils protect this mine locomotive motor from dampness, condensation and high temperatures encountered in service.

More than 50 years' experience in all types of insulation materials enables Mica Insulator Company to recommend the insulation best suited to your particular application. For a quick, accurate solution to your insulation problems—send your specifications and requirements to our Technical Service Department.

MICO
ELECTRICAL
INSULATION

trade-mark

Insulator COMPANY

SCHENECTADY 1, NEW YORK

Atlanta • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Detroit • Houston
Los Angeles • Milwaukee • New York • Philadelphia • Rochester • St. Louis • San Francisco

ELECTRONICS Designers

More energy storage per cubic inch

with these NEW G-E DISCHARGE CAPACITORS

If you are trying to squeeze a lot of energy-storage capacity into a small space to reduce the size or weight of your equipment, General Electric's new Pyranol† discharge capacitors may be your answer. These new, smaller, lighter units give economical energy storage, fast discharge and service reliability.

Ambient temperature operating limits, at rated voltage, range from 0 to 50 C and the capacitance tolerances, measured at 25 C, are ± 10 per cent. The performance of these compact units has been thoroughly proved by several years of laboratory tests and actual operating experience in the field.

G-E light-duty energy-storage capacitors are particularly applicable to light-metal welding equipment and flash photography apparatus. Check the table below for ratings and dimensions of G-E discharge capacitors to fit your application . . . or mark Bulletin GEA-4646 on the coupon for more details.

†Pyranol is G.E.'s noninflammable liquid dielectric.

PREFERRED RATINGS

D-C Voltage Rating	Muf	Watt-Seconds	Number of Bushings	Catalog Number	Height over Terminals $\pm\frac{1}{16}$ In.	Case Height $\pm\frac{1}{32}$ In.	Base Dimensions $+\frac{1}{8}, -\frac{1}{32}$ In.	Base Dimensions $\pm\frac{1}{32}$ In.	Approximate Net Weight in Pounds
2000	25	50	*2	25F903	$5\frac{7}{64}$	$4\frac{19}{32}$	$3\frac{3}{4}$	$4\frac{9}{16}$	5.2
2000	28	56	*2	25F939	$5\frac{17}{64}$	$4\frac{3}{4}$	$3\frac{3}{4}$	$4\frac{9}{16}$	5.3
2000	40	80	1	25F910	$8\frac{1}{4}$	7	$3\frac{3}{4}$	$4\frac{9}{16}$	7.8
2500	25.5	80	1	25F911	$8\frac{1}{4}$	7	$3\frac{3}{4}$	$4\frac{9}{16}$	7.8
3000	60	270	2	14F312	$15\frac{1}{8}$	$13\frac{1}{8}$	4	8	26
3350	17.8	100	1	25F912	$8\frac{1}{4}$	7	$3\frac{3}{4}$	$4\frac{9}{16}$	7.8
4000	25/50	200/400	3	14F309	$15\frac{1}{8}$	$13\frac{1}{8}$	4	8	26
4000	100	800	2	14F311	$15\frac{1}{8}$	$12\frac{7}{8}$	$5\frac{1}{8}$	$13\frac{1}{2}$	56
4000	12.5	100	1	26F906	$6\frac{3}{4}$	$5\frac{1}{2}$	$3\frac{3}{4}$	$4\frac{9}{16}$	6
5000	25/50	313/625	3	14F305	$15\frac{1}{8}$	$13\frac{1}{8}$	$4\frac{1}{8}$	$13\frac{1}{2}$	46
6000	55	990	2	14F313	$16\frac{5}{16}$	$12\frac{7}{8}$	$5\frac{1}{8}$	$12\frac{1}{2}$	56
6000	25	450	2	14F314	$16\frac{5}{16}$	$13\frac{1}{8}$	4	8	26

* Cup-type bushings with solder lug terminals.

TWO NEW MOUNTINGS FOR GENERAL-PURPOSE RELAY

Two new mounting arrangements, this "plug-in" design and a "back-connected" design, have been added to General Electric's line of CR2790-E magnetic relays. These two new forms, plus the open and enclosed forms, make this general-purpose 10-amp relay useful in a wide variety of electronic applications.

Three contact arrangements—single-pole, single-throw; double-pole, single-throw; double-pole, double-throw—provide further design flexibility. Heavy silver contacts are rated 10 amps continuous at 115/230 volts, 60 cycles, and will safely close on 45 amps and open on 20 amps maximum. Check Bulletin GEA-4668 below for further details.

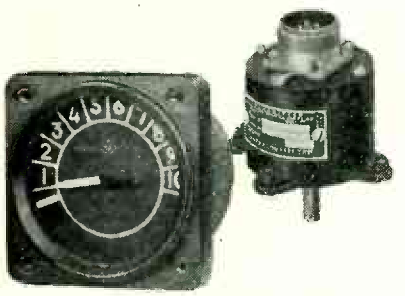
REMOTE POSITIONS THAT ARE ACCURATE

Here's a war baby that you can use. It's General Electric's d-c selsyn position-indicating equipment perfected for use in military aircraft. Transmitters will operate in ambient temperatures from −85 F to 158 F and are weather resistant. Indicators are available in two standard sizes: $1\frac{7}{8}$-inch dial with 1 or 2 pointers, and $2\frac{3}{4}$-inch dial with 1, 2, 3 or 4 pointers. Dial markings to meet your needs

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



A single d-c selsyn indicating system consumes about 2 watts at either 12 or 24 volts. Any reasonable lead length may be used. Two indicating instruments can be operated from the same transmitter. Bulletin GET-1304 is a comprehensive application manual you'll find extremely helpful. Check it on the coupon.

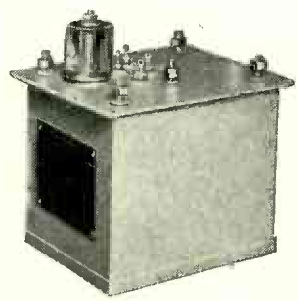
COILS TESTED FAST ... INDUCTIVELY

High-speed production testing of small coils is possible with this General Electric low-voltage tester which shows the presence of short-circuited turns in unmounted coils and gives an approximate indication of the number of short-circuited turns. The coil to be tested is simply slipped over the core which projects from the top of the case; the coil's leads need not be connected.

This tester was designed for manufacturers who want accurate tests of coils before assembly in small motors, relays, radios, transformers, instruments and other equipment. It is simple to operate, and connects to any 115-volt, 60-cycle supply. More information on this and another equipment for high-potential coil testing is included in Bulletin GEA-4539 . . . check it on the coupon below.

PRECISION RECTIFIER IN A SMALL PACKAGE

These new, small a-c to d-c power supplies are specially built for precision work with cathode-ray tubes, television camera tubes, radar indicator scopes, electron microscopes . . . or any job where good regulation, light weight and small size are primary considerations. These hermetically sealed, oil-filled power supplies will furnish up to 7 kv at 0.1 ma. They have a regulation of 3.5% per 0.1 ma d-c output, or better.



They easily meet Army and Navy specifications both in design and ability to withstand mechanical shock and operate continuously for long periods of time. Designed to operate in ambient temperatures from −40 C to +60 C. For quotation and further data, write General Electric Co., Section 642-15, Schenectady 5, N. Y., giving complete information on application proposed and specifications required.

25 G's WON'T BOTHER THIS SWITCHETTE

Shock, vibration, humidity and heat are all taken in stride by General Electric's tiny, light-weight Switchette. It is built to operate in ambient temperatures from 200 F to −70 F, and is tested at 95% relative humidity. Low-inertia moving parts, high contact force, and

double-break contact structure make it unusually resistant to vibration. Phenolic-resin operating button assures safety from live parts during operation.

The snap-action contact construction gives the Switchette a high current rating. Because of negligible contact bounce and lightness of moving parts, it is particularly well suited to application on electronic equipment. Bulletins GEA-3818 and GEA-4259 give electrical and mechanical details; check coupon below.

GENERAL ELECTRIC COMPANY, Sec. G 642-15
Apparatus Department, Schenectady 5, N. Y.

Please send me:

..........GEA-4646	(Discharge capacitors)	..........GET-1304	(Position indicators)
..........GEA-4668	(Magnetic relays)	..........GEA-3818	(Switchettes)
..........GEA-4539	(Coil testers)	..........GEA-4259	(Switchettes)

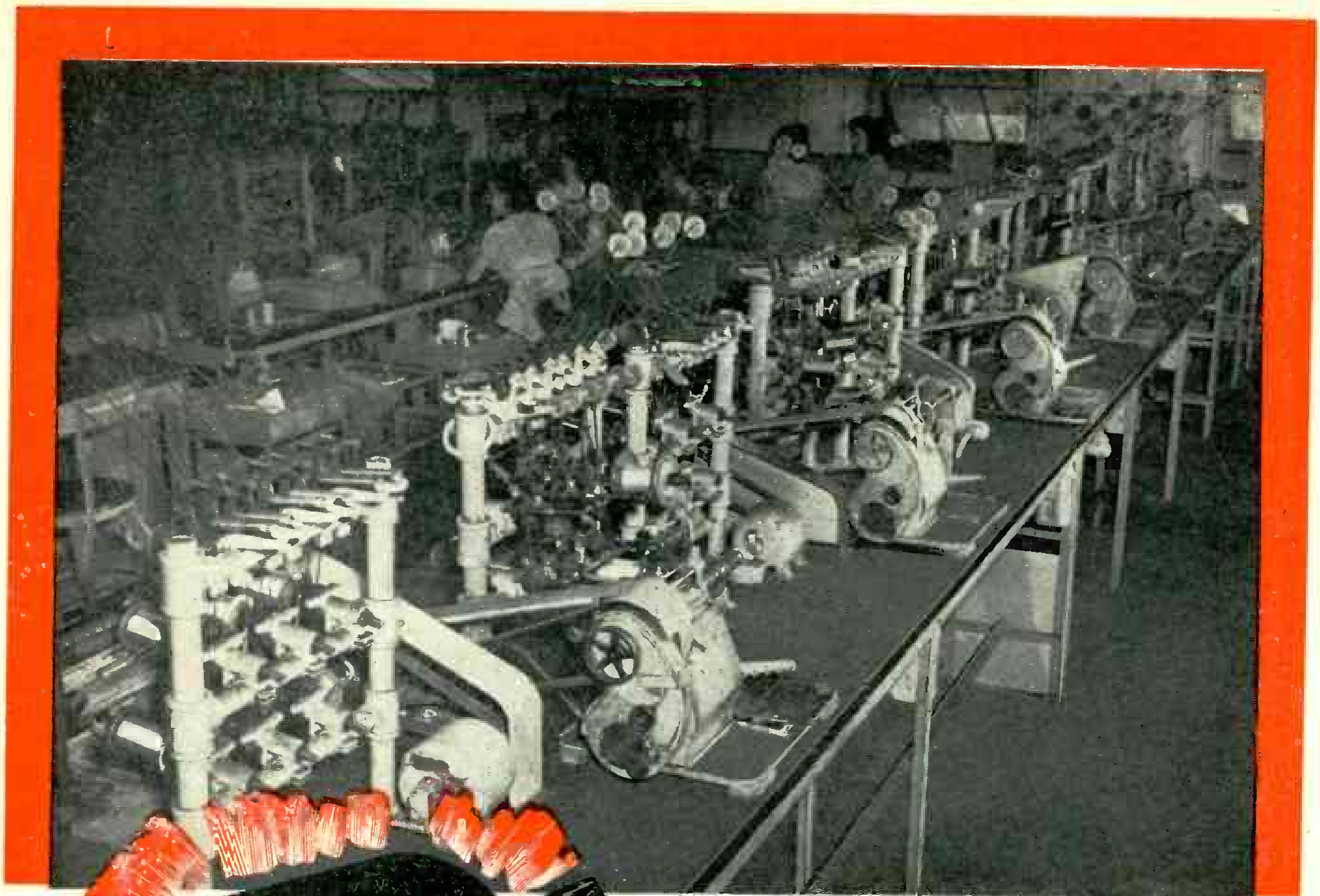
NOTE: More data available in Sweets' File for Product Designers

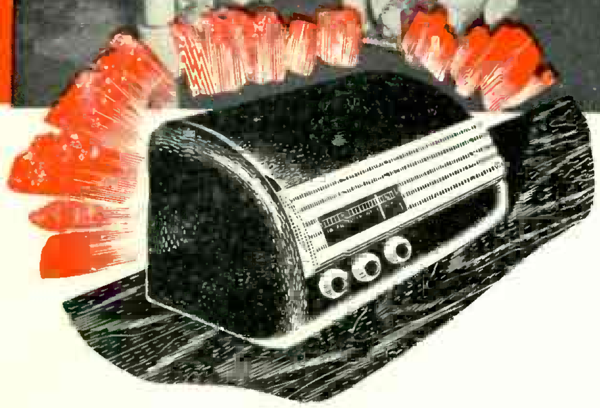
Name..........

Company..........

Address..........

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





Accurate Turns

FOR ACCURATE TUNING
at 1400 per day per operator

The perfect coil accuracy required for perfect radio reception is obtained by RCA Victor Division, Radio Corporation of America using No. 84 Universal Coil Winding Machines. The coils have two sections, each containing 855 turns of No. 38 single silk and enameled wire; one operator running two machines produces 700 pairs of coils in an 8-hour day.

Highest possible accuracy in controlling wire turns at high speed results from such Universal features as:

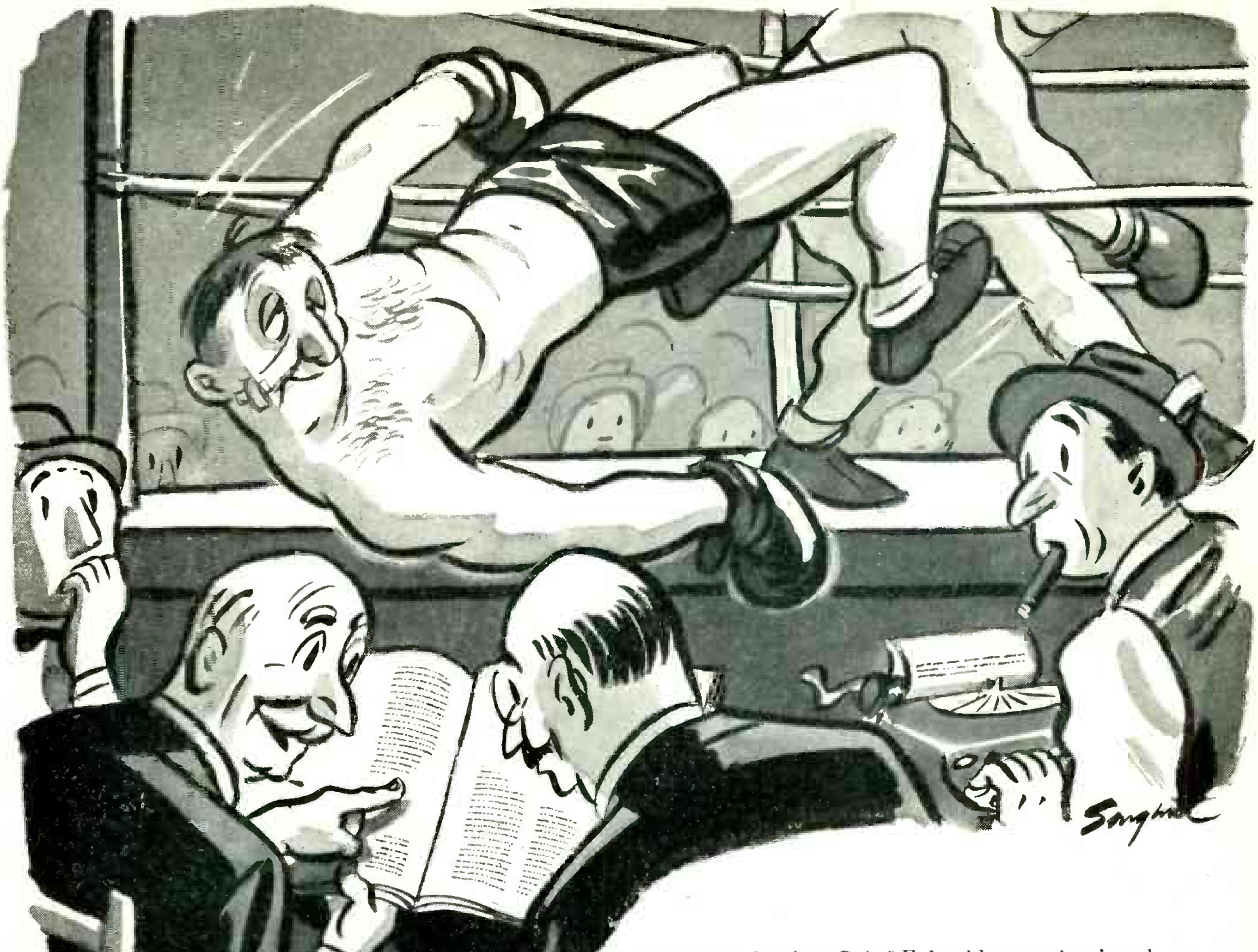
- *Quickly-adjustable "gainer" mechanism accurately places wire turns (spaced or close-wound).*
- *Calibrated "strap-type" tensions facilitate handling of even the finest wires.*
- *Counter-control provides instant automatic stop upon completion of coil.*
- *No. 84 Machines are offered in models to wind 1, 2, 3 or 4 cross-wound coils at once. Send for Bulletin 84.*

Universal Winding Company, P. O. Box 1605, Providence 1, Rhode Island.

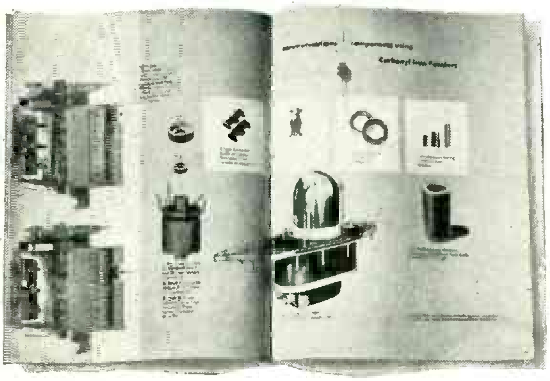
23B-7-3

LEESONA REG. U.S. PAT. OFF.

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



"Gee, Bill, this free G.A.&F. booklet sure is a knockout. Look—it shows that SF Carbonyl Iron Powder is a natural for permeability tuning of the FM band. How it gives you remarkably low losses and uniformity. And excellent electrical and temperature stability, too! Something to take advantage of, eh?"



FREE! This easy-to-read booklet that can save money—*real* money—for every radio engineer and electronics manufacturer!

Clip this coupon—Mail it today!
(Ask your core manufacturer—he's an authority on the use of G.A.&F. Carbonyl Iron Powders.)

G.A.&F.

carbonyl iron powders

An Antara Product of
General Aniline & Film Corporation

General Aniline & Film Corporation
Special Products Sales Division, Dept. 122
444 Madison Ave., New York 22, N. Y.
Please send me a free copy of:

☐ G.A.&F. Carbonyl Iron Powders ☐ Polectron dielectrics

Name______________________________

Address____________________________

Now...

This RCA Switching System consists of a master "on-the-air" monitor and oscilloscope, a waist-high control panel (enlarged view, above) and mixing amplifier, below. This equipment becomes one of the standard-size sections of RCA's unit-built video console (top of page). Any combination of camera-controls and monitors is possible to fit your particular station.

split-second selection

of all television program material

New RCA Camera Switching Unit provides convenient, push-button control at your video console

FADING CONTROL

MONITOR SWITCH
3-position: program line, either of two remotes

GAIN FOR REMOTE INPUT (#6)

REMOTE INPUTS

RELEASE BUTTONS

TALLY LIGHTS
and switches for remote sync

CAMERA SWITCHES
(2 rows) handle 4 inputs from studio and film cameras and 2 remotes to permit fading, instantaneous switching, special effects.

TALLY LIGHTS
for six inputs

GAIN FOR REMOTE INPUT (#5)

HERE, in one compact unit, is a control center for your television programs. Into it can be brought as many as six video inputs—from studio cameras, film cameras, relays, and network. *One* operator can handle the lot!

Twelve different types of switching are your assurance of a smooth, dramatic presentation, whatever the program. Look at the possibilities:

Your operator can *instantly* switch: (1) between two local camera signals; (2) between two remote signals; (3) from local to remote; (4) from remote to local; (5) from local to black screen (no signal); (6) from remote to black (screen); (7) from black to remote. With the special manual fader control he can, *at any desired speed:* (9) fade out local to black; (10) fade in local from black; (11) lap-dissolve between any two locals; (12) superimpose two locals and adjust the level of each. All sorts of trick effects are possible by moving the two levers that make up the fader control.

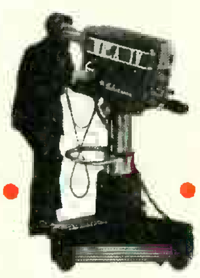
Tally lights provide an instant check on which input is being used and whether a remote signal is being received. If remote sync fails for any reason, local sync automatically takes over.

The monitor in the top of the console section allows the operator to either view the on-the-air signal or preview one of the two remote signals.

An unusually flexible intercom switching system (not shown) is included to permit private, special-group, or conference communication between practically all personnel. All have access to program sound through one earpiece of their headsets.

Here, we believe, is a switching system that represents the most advanced engineering in television station techniques. It will help you simplify television station routine—bring new possibilities to television programming. Be sure to get the complete story. Write Dept. 30-L, Radio Corporation of America, Engineering Products Department, Camden, N. J.

PROGRAM SOURCES



RCA Studio Camera (Switching Unit handles up to four)

RCA's Mobile Studio (Switching Unit can handle two remotes)

RCA Film Camera (Switching Unit handles two with 2 studio cameras)

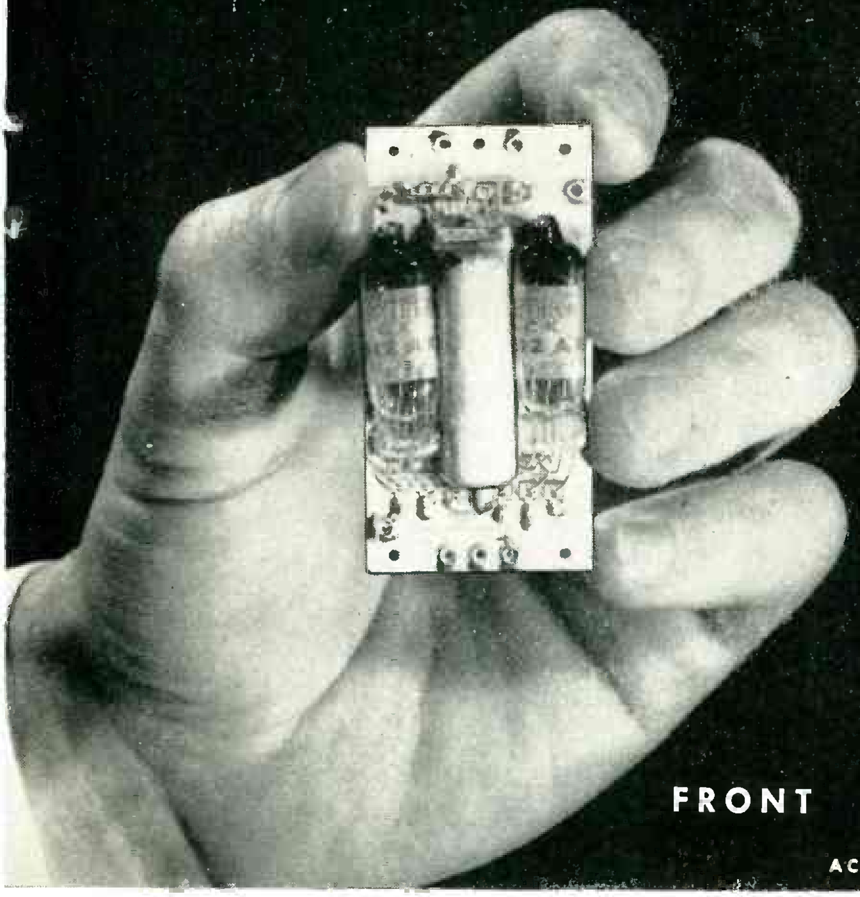
RCA

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

In Canada: RCA VICTOR Company Limited, Montreal

Announcing the "Ampec"

A typical new application of Centralab's revolutionary "printed electronic circuit"!

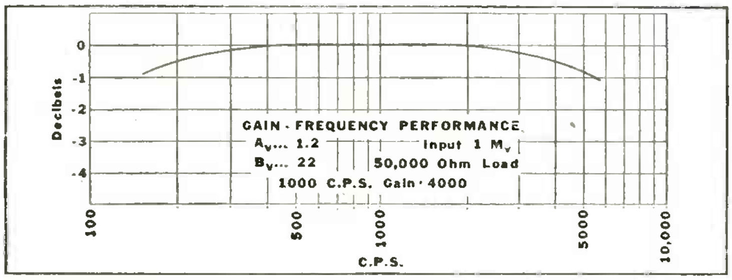


Important News!

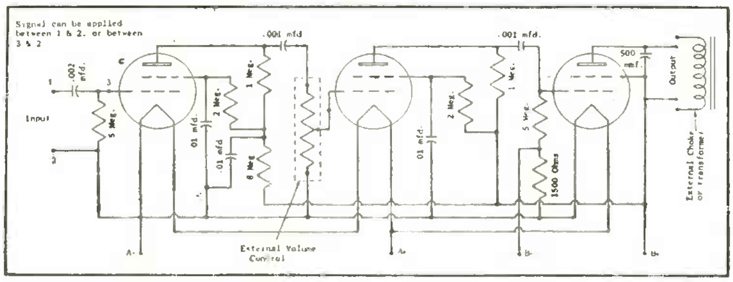
"Ampec" — a typical application of Centralab's printed electronic circuit — is a compact, highly efficient, dependable 3-stage audio amplifier. Can be designed for hearing aids, mike preamps or any electronic voltage or frequency applications where small compact size, high efficiency and reliability are required.

FRONT BACK

ACTUAL SIZE ILLUSTRATED



GAIN-FREQUENCY CHART above shows flat response of typical "Ampec" within 1 decibel between 200 and 5000 cycles. Why not investigate the application of this technique to your problems?



SCHEMATIC DIAGRAM of typical "Ampec" illustrated shows what components can be used. "Ampecs" can be designed to meet a wide range of gain or frequency response requirements.

Miniature, one-piece amplifier unit can offer complete electrical circuit from input to output! There's never been an electronic device like Centralab's new "Ampec"! Lightweight, durable, with reliability and efficiency heretofore unobtainable in small units, "Ampec" illustrates how you can get all components of an audio-amplifier — tube sockets, capacitors, resistors, wiring — "printed" on one, compact ceramic chassis according to your special requirements.

Look at these advantages: no jumble of wires to shift or come loose. Since "Ampecs" can be made from one "master plate", characteristics of all units are uniform . . . a complete unit can be replaced by an exact duplicate. Only 2.250" long, 1.156" wide, .187" thick over tube clips. Weight with tubes, 0.63 oz.

Write for Bulletin E973.

Centralab
CRL
Division of GLOBE-UNION INC., Milwaukee

MITCHELL RAND

WAX...COMPOUND PRESCRIPTION HEADQUARTERS

TO SOLVE YOUR INSULATING AND IMPREGNATING PROBLEMS . . . MORE THAN 3500 WAX AND COMPOUND FORMULAE AVAILABLE TO BETTER SERVE YOUR REQUIREMENTS

. . . Yes, you can rely upon Mitchell-Rand to supply the particular **COMPOUND OR WAX** to meet your specific requirement . . . and if in the extensive line totaling more than 3500 formulae, there isn't one which meets your conditions—then, Mitchell-Rand will create a **WAX OR COMPOUND** embodying every quality required . . . an outstanding example of such special service is the development of EX 1257 Dipping and Impregnating Wax — following are the specifications of the latest in Mitchell-Rand's large list of Waxes and Compounds:

SPECIFICATIONS AND TEST DATA
M-R EX1257 DIPPING AND IMPREGNATING WAX

Ring and Ball Softening Point	171 to 177° F.
Melting Point, UTD (Ubbelohde Method)	192 to 198° F.
Penetrations	32/200/60-8 to 10
	77/100/5-6 to 8
	115/50/5-10 to 12
Flash Point	500° F.
Specific Gravity at 60° F.	1.005 color tan
Viscosity, Sayboldt Furol	at 250° F.—175 to 180 seconds
	at 275° F.—125 to 130 seconds
	at 300° F.— 90 to '95 seconds

M-R COMPOUNDS—RESIST high voltage breakdown, salt spray atmosphere, humidity, cracking or flaking, acids and alkalis. HAVE excellent flexibility, adhesive qualities, high cold flow, good thermal conductivity.

M-R WAXES—PENETRATE fibre, floss, bakelite, paper and cloth. HAVE low viscosity, high surface tension, good electrical characteristics. **MORE THAN 3500 FORMULAE.**

No matter how difficult or involved your insulating and impregnating Wax or Compound problems are—bring them to Mitchell-Rand . . . the "Electrical Insulation Headquarters."

Write today for your free copy of the M-R WALL CHART with its engineering tables, electrical symbols, carrying capacities of conductors, dielectric averages, thicknesses of insulating materials, tubing sizes, tap drills, etc.

MITCHELL-RAND INSULATION CO. Inc.

51 MURRAY STREET • COrtlandt 7-9264 • NEW YORK 7, N. Y.

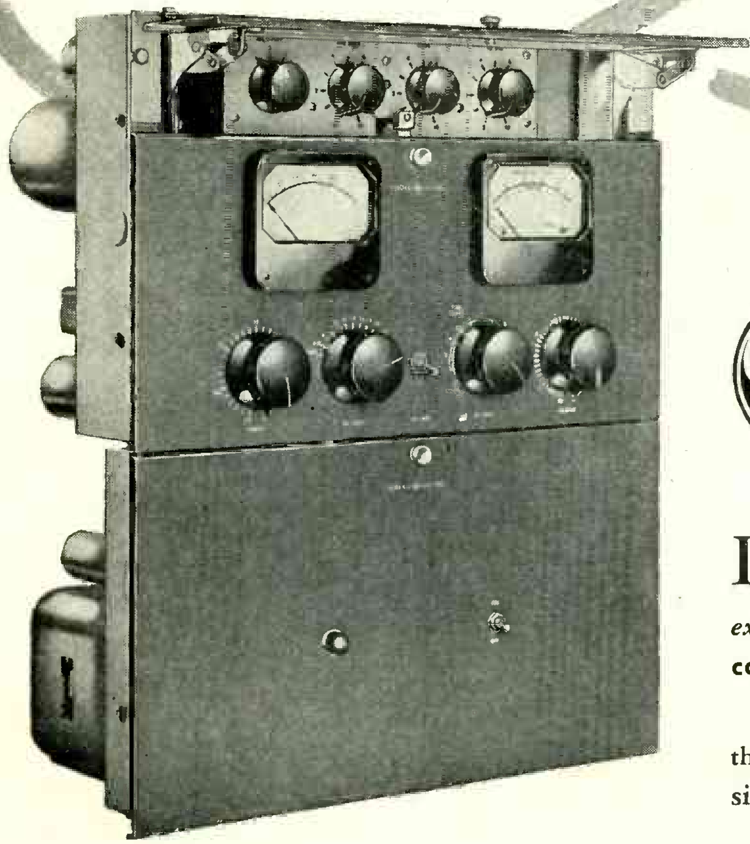
A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICTION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

SAME TRANSMITTER

SAME ANTENNA

but MORE POTENTIAL LISTENERS

How?



with the new

LIMITING AMPLIFIER

IN AM, you will maintain higher modulation levels, protected against sharp peaks—an *extra margin of power* that means **increased coverage for your station.**

Based on developments by CBS engineers, the Limiting Amplifier BA-5-A has been designed by General Electric for *efficiency plus.*

THESE ARE UNIQUE FEATURES:

- Fast attack reduces program distortion.
- Exclusive "anticipator" circuit.
- Higher compression ratio for higher average modulation.
- Automatic control of recovery time for smoother limiting—greater listening pleasure.
- Less critical gain-riding necessary.
- Protects against overmodulation flashover at transmitter.
- Instant accessibility, of course.

AND IN FM, TOO,

your listeners are protected against receiver distortion caused by transmitter overswing. Amplifier controls may be set so that program dynamic range, so important in FM, is maintained.

MANAGERS, ENGINEERS:

Write today for EBR-99, descriptive specification of this new Limiting Amplifier. Address your local General Electric broadcast equipment sales engineer, or write to Transmitter Division, General Electric Company, Electronics Park, Syracuse, N. Y.

LEADER IN RADIO, TELEVISION AND ELECTRONICS

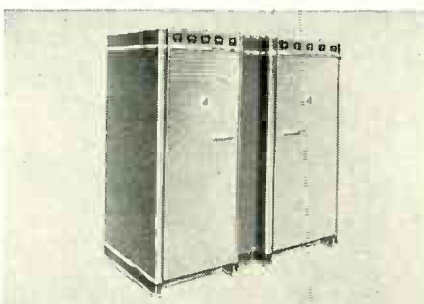
GENERAL ELECTRIC

160-F3-6914

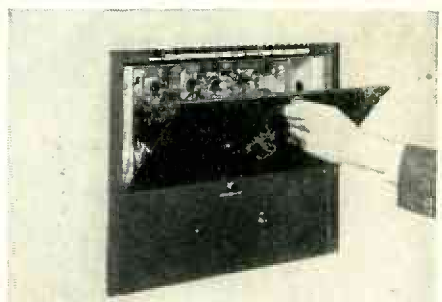
Whenever you have a broadcast equipment problem

Ask GENERAL ELECTRIC

● Look ahead with General Electric! Dimensions, styling and appearance of all G-E units are harmonious; circuits are coordinated and allow you to quickly block-build to higher power at minimum expense. General Electric equipment is *engineered for economy.*



Station Equipment—unmatched performance from 250 watts to 50-kw, AM or FM.



Audio Facilities—instant accessibility, complete flexibility to meet the most exacting demands.

GENERAL ELECTRIC IS AS NEAR AS YOUR TELEPHONE

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Walnut 9767

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140 Federal Street
Hubbard 1800

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1122 Merchandise Mart
Whitehall 3915

CINCINNATI 2, OHIO
215 West Third St.
Parkway 3431

CLEVELAND 4, OHIO
4966 Woodland Avenue
Endicott 4464

DALLAS 2, TEX.
1801 North Lamar Street
Riverside 9121

DENVER 2, COLO.
650 17th Street
Keystone 7171

KANSAS CITY 6, MO.
106 West 14th Street
Victor 9745

LOS ANGELES 14, CAL.
530 West Sixth St.
Trinity 3417

MINNEAPOLIS 2, MINN
12 Sixth Street
Main 2341

NEW YORK 22, N. Y.
570 Lexington Avenue
Wickersham 2-1311

PHILADELPHIA 2, PA.
1405 Locust Street
Pennypacker 5-9000

SAN FRANCISCO 4, CAL.
235 Montgomery Street
Douglas 3740

SCHENECTADY, N. Y.
Building 267—Room 105
Schenectady 4-2211

SEATTLE 4, WASH.
710 Second Avenue
Main 7100

WASHINGTON 5, D. C.
806 15th Street, N. W.
Executive 3600

SYRACUSE 1, N. Y.—Syracuse 6-4411

TOPS in performance, trim in appearance and featuring instant accessibility, General Electric broadcast equipment is being specified by progressive broadcasters everywhere. *More FM transmitters have been shipped by General Electric than by any other manufacturer.*

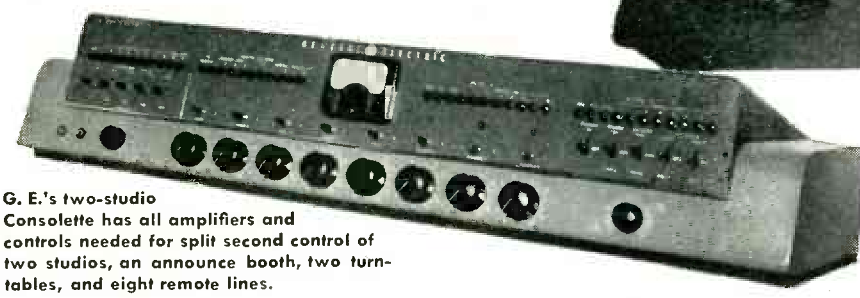
You will have easier maintenance and fewer outages with a General Electric FM transmitter. Highest quality construction, simplified design, fewer tubes, and fewer components result in lower cost-per-hour on the air.

In the studio, the new General Electric two-studio Consolette provides a compact, flexible, and economical speech-input control unit to meet the needs of every station.

Here is the 250-watt General Electric FM transmitter in operation—doing a job. It will do the same for you. When you plan to build or modernize, *specify G.E.*

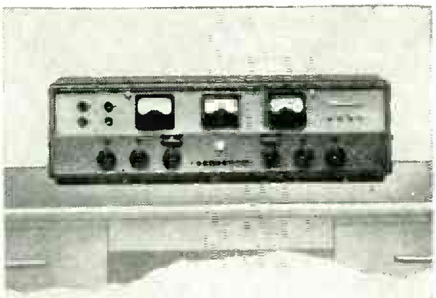
On the job **at WEAW-FM**

Mr. E. A. Wheeler, president of WEAW, Evanston, Ill., says: "General Electric quality equipment and prompt service are important when a small station undertakes independent commercial operation, and both have proved to be of value to us."

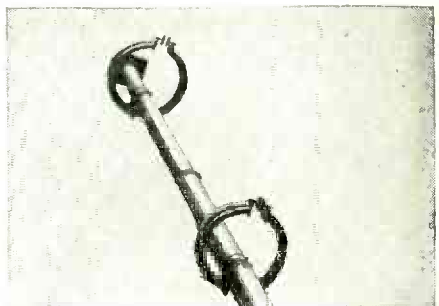


G. E.'s two-studio Consolette has all amplifiers and controls needed for split second control of two studios, an announce booth, two turntables, and eight remote lines.

FM Station Monitor—one unit, for complete and continuous FM monitoring, plus proof-of-performance tests.



Transmitter Console—all major station functions centralized for instantaneous control.



Circular Antenna—provides high power gain, ease of installation and low wind loading.

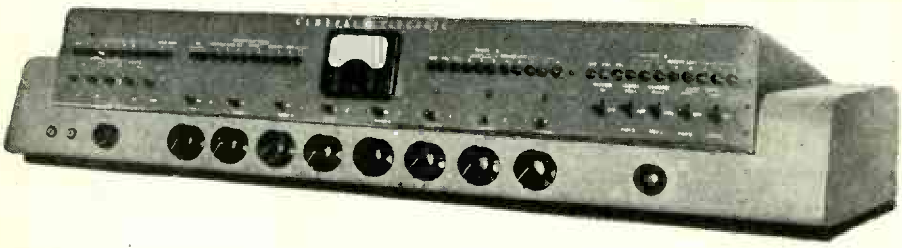
LEADER IN RADIO, TELEVISION AND ELECTRONICS

GENERAL ELECTRIC

140-F4-8914

On the job

THE CONSOLETTE . . .



At **WFBL-FM**—another General Electric Consolette is on the job.

Outstanding performance and unmatched styling help WFBL-FM and scores of other broadcasters decide on General Electric broadcast equipment.

Operators like this simplified switching—visitors are impressed by its smart modern appearance.

COMPLETE studio facilities are provided by General Electric's two-studio Consolette—monitoring, cueing, simultaneous broadcasting and rehearsing, and over-ride talk-back that operates without need for order wires—all at a price every station can afford.

Here is an outstanding control unit that contains all the amplifiers and controls needed for split-second control of two studios, an announce booth, two turntables, and eight remote lines. Two program amplifiers give maximum operating flexibility and program protection.

A reliable push-button system and simplified switching, careful arrangement of controls, and a correctly sloped panel combine new operating ease and operator comfort unmatched by other consolettes. A hinged top and a hinged-type chassis mounting provide complete accessibility.

Ask your nearest General Electric broadcast sales office for complete information, or write: *Transmitter Division, General Electric Company, Electronics Park, Syracuse, New York.*

LEADER IN RADIO, TELEVISION AND ELECTRONICS

GENERAL ELECTRIC

160-F5-6914

Send for This Free Booklet

If you can better the performance of your products by using lighter cores with higher operating inductions, here is a fact-filled booklet you should have!

It tells all about Armco's three new oriented electrical steel grades—TRAN-COR X, XX and XXX. You'll find these cold-reduced steels have many unusual advantages, especially for operation at 60 to 400 cycles per second. For example: Lower core loss *concurrent* with higher permeability in the rolling direction, plus a higher space factor.

Send for your copy of this useful booklet on ARMCO Oriented Electrical Steels. Just fill in and mail the convenient coupon. The American Rolling Mill Company, 424 Curtis Street, Middletown, Ohio.

YOUR PRODUCTS GET ALL THESE ADVANTAGES

CARLITE INSULATION—All ARMCO Oriented Electrical Steels are CARLITE Insulated. CARLITE assures low inter-lamination loss. Its extreme thinness has practically no effect on space factor.

GREATER RUST-RESISTANCE—The special CARLITE surface treatment also increases rust resistance and improves shear and die life.

FULLY ANNEALED STRIP—The hazard and cost of a high temperature anneal in your plant are eliminated. Superior magnetic qualities are fully mill-developed by a special heat treatment.

LIGHTER WEIGHT—Because of the low core loss, high permeability and superior space factor, you can design transformers more economically and with better electrical performance.

GOOD DUCTILITY—ARMCO TRAN-COR X, XX and XXX punch and shear readily. They are much less brittle than conventional high silicon hot-rolled transformer steels.

LOW CORE LOSS—Test Limits are: TRAN-COR X, 1.00 watt per pound; TRAN-COR XX, 0.90 watt per pound; TRAN-COR XXX, 0.80 watt per pound. Tests at induction of 15 kilogausses.

ARMCO

ORIENTED STEELS

THE AMERICAN ROLLING MILL COMPANY
424 Curtis Street, Middletown, Ohio

Send me a copy of your free booklet: "ARMCO Oriented Electrical Steels."

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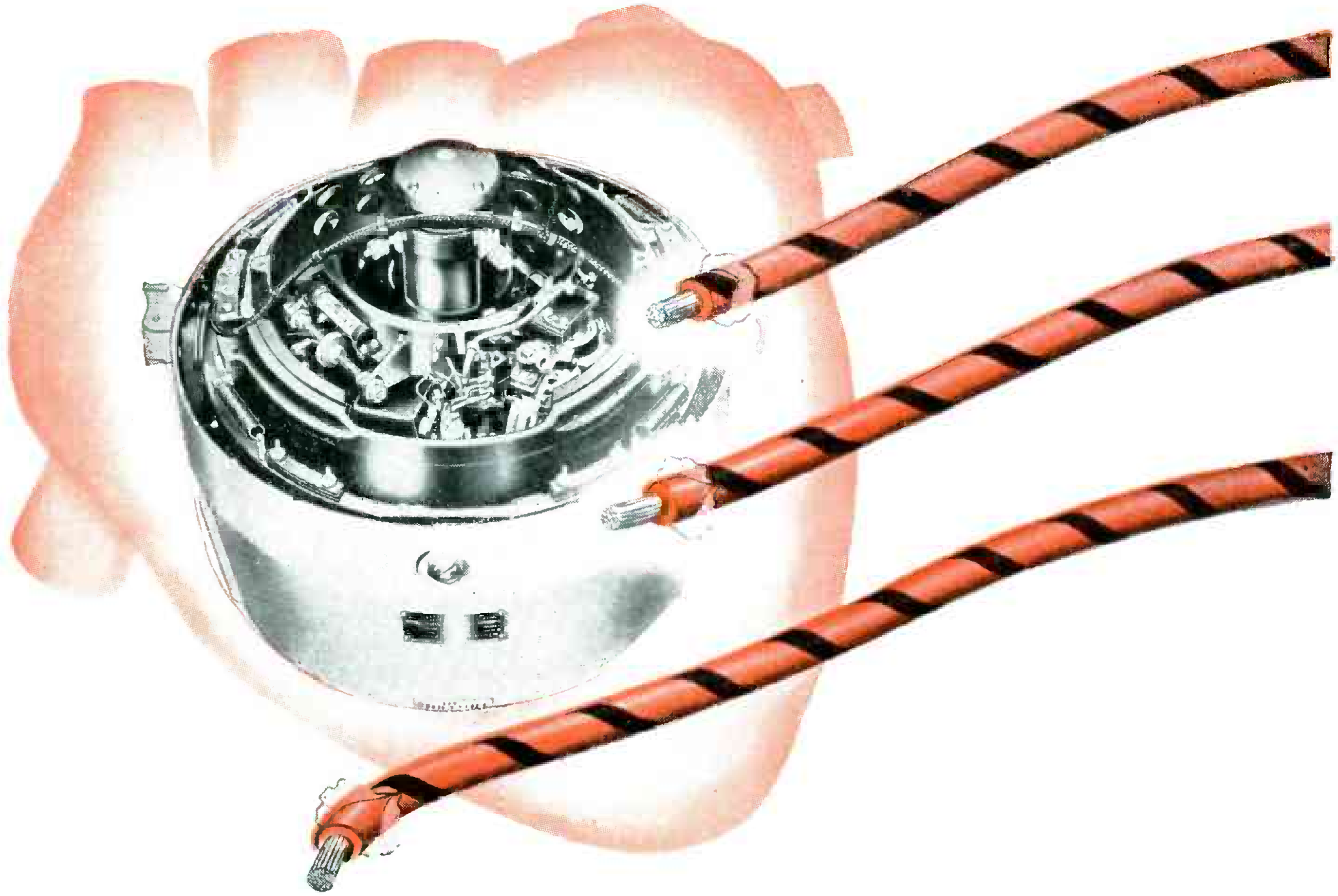


ARTERIES FOR A SHIP'S HEART GET PROTECTION WITH DU PONT NYLON

In wiring for the Arma gyro compass, tough, long-lasting nylon jacketing resists heat, oils, abrasion, and flexing

The heart of a modern ship is the gyro compass—which tells the navigators what course they're on.

Arma Corporation of Brooklyn, N. Y., makes gyro compasses for the Navy. Naturally, they make them with the best materials obtainable. And that's why they're using connective wiring jacketed with Du Pont nylon.

Arma says that before adopting this wire jacketed with nylon they tested wire with many and various jacketing materials. None before nylon met the rigid specifications. None sufficiently withstood lubricating oils, heat and hard mechanical abuse.

Nylon-jacketed wire not only meets every one of the specifications, but a much thinner jacket is required than with previous jacketing materials, and thus space is saved.

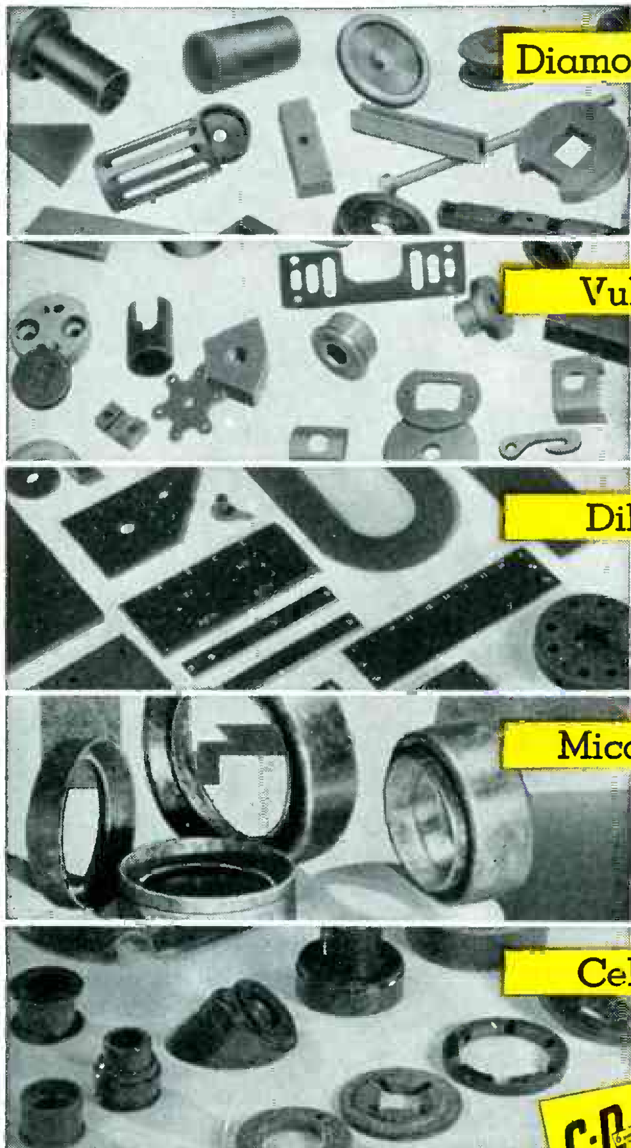
Surprenant Manufacturing Company of Boston, manufacturer of the wire, has this to say: "As an extrusion jacket of protective covering on wire, nylon is unsurpassed in present-day thin-wall extrusion. The abrasion resistance of nylon is greater than that of any existing material used in a like manner. Nylon has a 'slick' surface that allows easy movement through narrow apertures. In addition it has the desirable properties of very high tensile strength and great extensibility. Compression strength, necessary especially in a protective covering, is more than adequate. To these properties can be added the more apparent features of ease of extrusion with proper controls and ability to color in delicate shades when required."

When you think of jacketing for wire and cable, think of Du Pont nylon. It is tough and abrasion-resistant, able to stand flexing and rubbing over extended periods. It can resist heat, oils, many chemicals, salt water and fresh water, and aging. Write us *today* for more information. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 1412, Arlington, New Jersey.

DU PONT
Plastics
BETTER THINGS FOR BETTER LIVING ...THROUGH CHEMISTRY

Put These Plus Factors of C-D "High-Strength" Plastics to Work

C-D offers design-engineers a variety of High-Strength Plastics in many types and grades for an almost unlimited number of applications. Each supplies the exact combination of properties for its specific job. They lend themselves readily to machining and forming on standard wood or metal working machinery.



Diamond Fibre

. . . Light, tough, and strong. A versatile, low cost plastic with good mechanical and electrical insulating properties. It is light in weight, dense in structure and highly abrasion resistant.

Vulcoid

. . . Resin Impregnated Vulcanized Fibre. An exclusive C-D development, specially treated to retain most of the arc resistance of fibre coupled with added moisture resistance and excellent dielectric properties. Approved by Underwriters as a support material for current carrying parts.

Dilecto

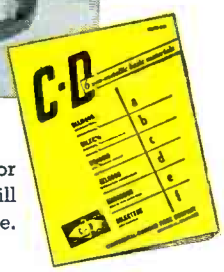
. . . Thermosetting Laminated Plastic. High in electrical insulating properties, structural strength and moisture resistance. Available in numerous standard grades to meet specific performance requirements.

Micabond

. . . Built-Up Mica Electrical Insulation. Here is mica in its most usable forms—sheets, rods, tubes, and tapes. Maintains stability under severe heat and moisture conditions.

Celoron

. . . Fabric-Base Molded Phenolic Plastic. A material with good electrical insulating properties along with high mechanical strength, moisture and heat resistance and dimensional stability.



For complete information on these C-D High-Strength Plastics write for BULLETIN GF-46 which gives you such basic data as: • Electrical Properties • Physical Properties • Composition of Material • Grades, Types and Sizes • Fabrication Methods • Recommended Uses.

For Help on any insulation problem, write, wire, or phone our nearest office and a C-D technician will be glad to give you the benefit of C-D experience.

D-6-47

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
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Continental-Diamond FIBRE COMPANY

Established 1895..Manufacturers of Laminated Plastics since 1911—NEWARK 16 • DELAWARE

Listen! ...for FM and TELEVISION

(finest in radio)

...it's a Jensen SPEAKER

(finest in sound)

FM and Television — latest refinements in the electronic art — are bringing to the radio listener new and undreamed-of realism and fidelity in program quality. Listening enjoyment has been increased a hundredfold for him whose receiver is capable of these lifelike programs.

For *finest* FM and Television reception, both receiver *and* loud speaker must offer smooth extended-range frequency response, low distortion, and startling "presence." Such a speaker, of course is a JENSEN!

World famous as fine acoustic equipment, JENSEN speakers are especially suitable for FM and Television. Before you purchase your FM or Television receiver, be sure it's JENSEN equipped. If the receiver you have does not include a JENSEN speaker, have your dealer replace it with one. The best FM or Television receiver made is made *better* with a JENSEN speaker.

JENSEN MANUFACTURING COMPANY
6607 South Laramie Ave., Chicago 38

In Canada: Copper Wire Products, Ltd., 11 King St., W. Toronto 1

Designers and Manufacturers of Fine Acoustic Equipment

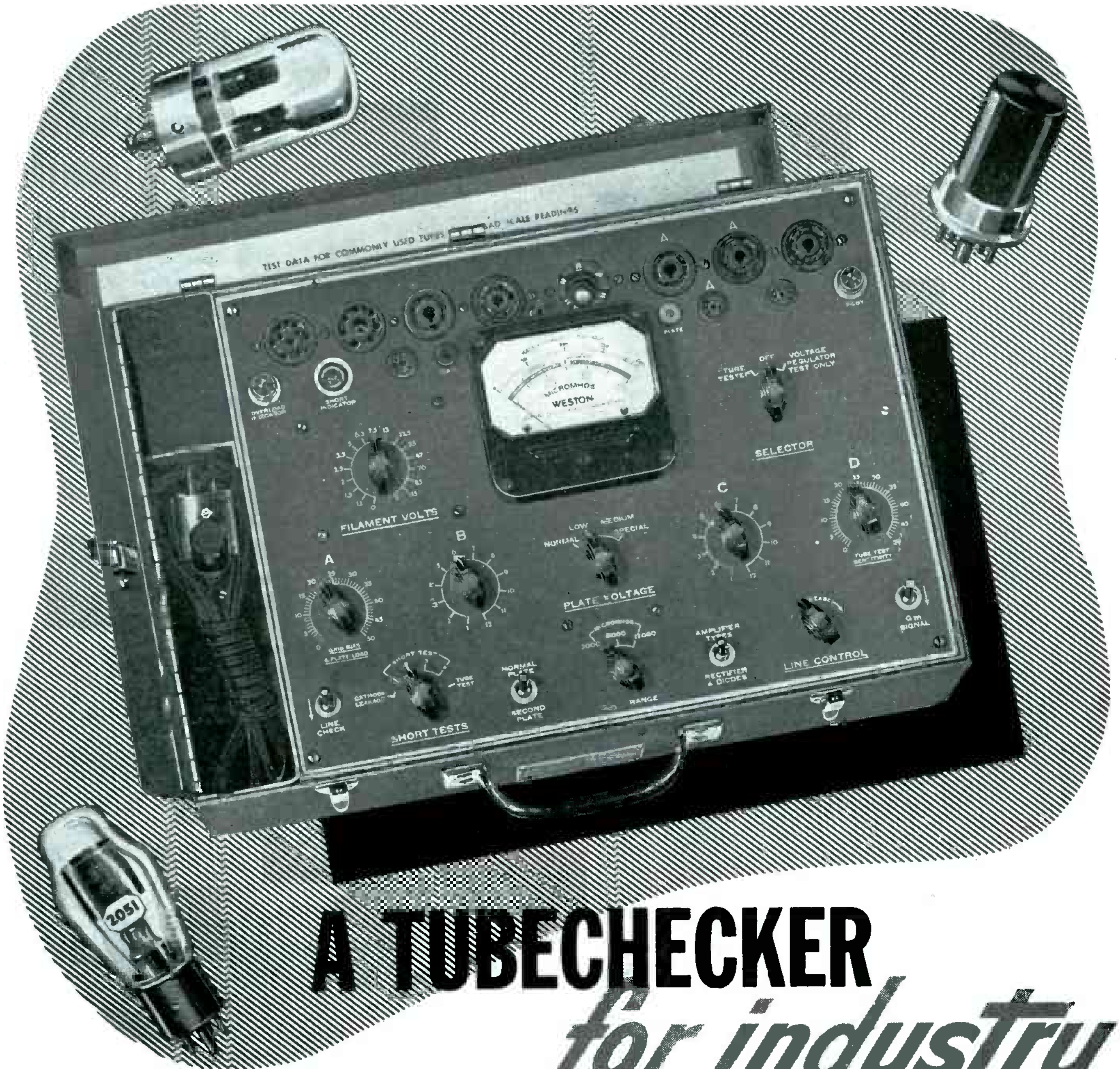
Jensen SPEAKERS with ALNICO 5

Jensen
Fine Acoustic Equipment

STOCK MODELS* for FM and Television Receivers

6-Inch	8-Inch	12-Inch	15-Inch
P6-TH	P8-SH	P12-SH, P12-QH, P12-NH, F12-NH, F12-SH	P15-NH, F15-NH

*See Catalog 1010 for complete listing of single-radiator and Coaxial extended range speakers, reproducers and systems, ranging in price from $5.00 to $1,500.



A TUBECHECKER *for industry*

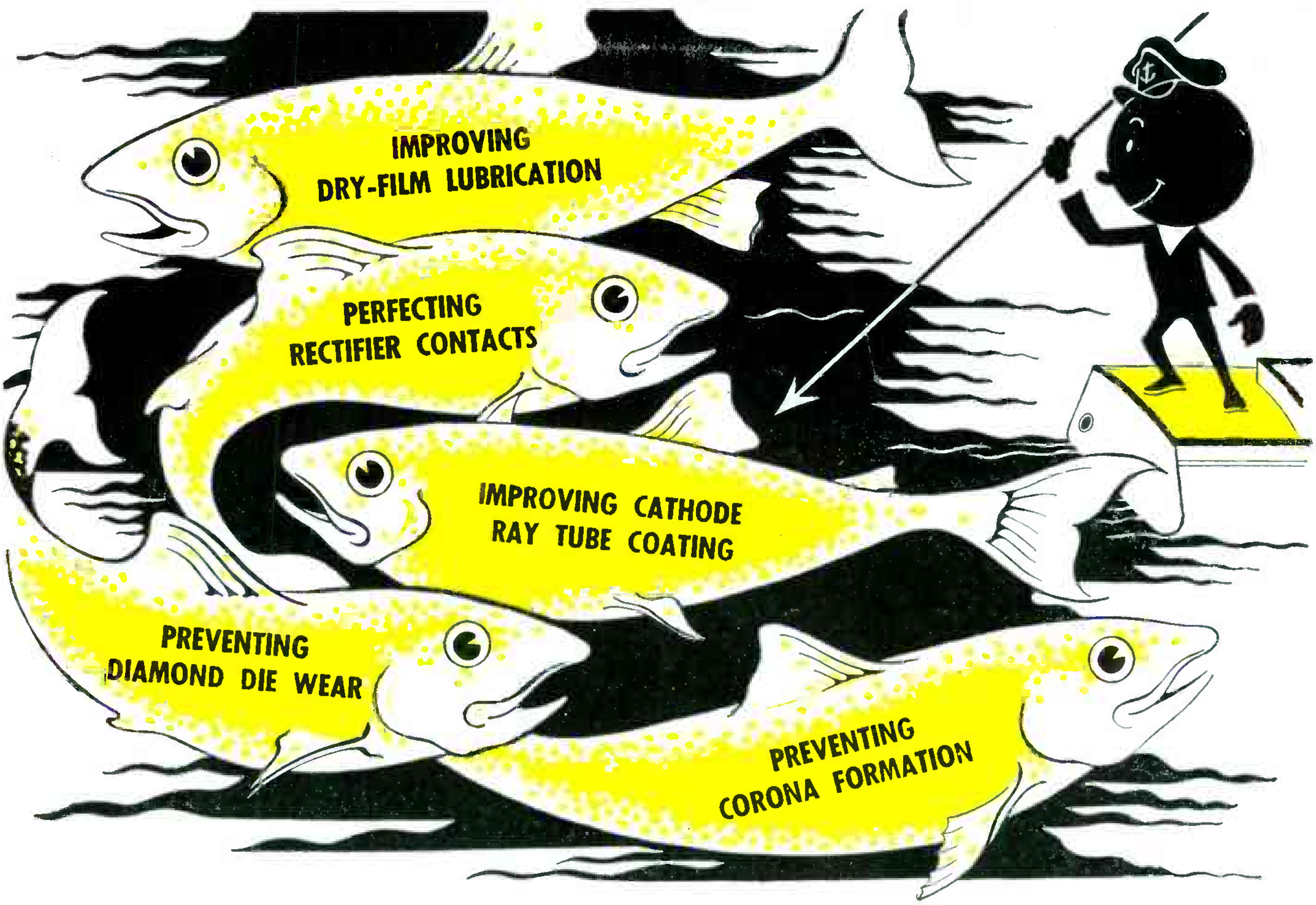
TESTS: Receiving Tubes, Voltage Regulator Tubes, *low power* Thyratrons

The WESTON Model 798 Mutual Conductance Tubechecker provides, for the first time, adequate tests on voltage regulator tubes, light-duty Thyratrons such as the 884, 885, OA4, 6D4, 2A4, 2050, 2051 in addition to tests on regular receiving tubes. Ranges of 12,000, 6,000, 3,000 micromhos as well as "Good-Bad" indications cover the tube checking requirements of electronic control and radio circuits. Housed in rugged aluminum case to withstand rough usage in shop or field.

For full details consult your local WESTON representative, or write . . . WESTON Electrical Instrument Corp., 618 Frelinghuysen Ave., Newark 5, N. J.

WESTON *Instruments*

ALBANY · ATLANTA · BOSTON · BUFFALO · CHARLOTTE · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · JACKSONVILLE · KNOXVILLE · LITTLE ROCK · LOS ANGELES · MERIDEN · MINNEAPOLIS · NEWARK · NEW ORLEANS · NEW YORK · PHILADELPHIA · PHOENIX · PITTSBURGH · ROCHESTER · SAN FRANCISCO · SEATTLE · ST. LOUIS · SYRACUSE · IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.



Go After problems like these...

dag
REG. U.S. PAT. OFF.

colloidal products

ACHESON COLLOIDS CORP.
Port Huron, Michigan

. . . with **"dag"** colloidal graphite. Simple lubrication, because of the adsorptiveness of **"dag"** colloidal graphite to metal bearing surfaces, is a primary use. Every engineer knows of it. But the unique success of **"dag"** colloidal graphite in this field should not obscure its success in electronics, photography, the process industries, and other fields in which it has solved stubborn problems which would not yield to other mechanical or chemical expedients. Moreover, Acheson engineers are constantly going after new problems which have been submitted to our laboratory, developing new products in addition to the 18 dispersions currently available.

You will find Acheson literature interesting for its information on what **"dag"** colloidal graphite has done in many industries. You will find it still more valuable for its worth in *suggesting* ways of going after your own problems.

This new literature on **"dag"** colloidal graphite is yours for the asking:

460 — A data and reference booklet regarding **"dag"** colloidal graphite dispersions and their applications. 16 pages profusely illustrated.

421 — Facts about **"dag"** colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY.

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432 — Facts about **"dag"** colloidal graphite in the FIELD OF ELECTRONICS.

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN, DEPT. M-5

Please send me, without obligation, a copy of each of the bulletins checked:

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NEED SOMETHING *Special* IN *Capacitors?*

Here are examples of recent G.E. special designs

A maker of photographic flash tube equipment wanted a lighter portable capacitor;—he got one ***that could also be used in studio equipment.*** A maker of precipitation equipment had a mounting problem;—he solved it with a capacitor ***costing one-third what he had been paying.***
Another manufacturer was using 600-volt capacitors in a 400-volt application;—he ***saved mounting space*** with a new 400-volt capacitor and ***saved money, too.***
Let us try our hand at your special requirements. You may get even more than you ask for.
New developments like silicones, a new paper—to mention two—are continually giving us new materials, new ideas, that we can put to work for you. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

FOR FLASH TUBES
More light per pound for both studio and portable

New 14-muf flash-tube capacitor, weighs 2½ lbs. and delivers 43.8 watt-seconds for studio use (2500 volts, 1000-hr service life) or, as a portable, 58 watt-seconds (2880 volts, 400-hr service life).
This is a new high in capacity per pound for portable use. Same unit, in pairs, is interchangeable with popular 28-muf studio rating, saves 5 per cent in weight, 8 per cent in cost.

$1.28 (NET)
buys this ceramic-tube, low-muf, high-voltage capacitor

New .0075 muf, 10,000-v d-c capacitor for television, precipitation, and similar equipment requiring filtering in high-voltage power supply. Other capacitances (.0005 to .01) and voltages (3000 to 30,000) can be made.
Ceramic container acts as insulator, simplifies mounting; cuts size (volume) to 1/5th without lowering quality in any way. Ingenious internal hermetic silicone seal eliminates solder. Pyranol* filled. Net price, $1.28 in quantities of 1000.

New 400-v d-c line
PRICES LOWER,
sizes smaller

New 400-v d-c capacitors now available in 2, 4, 6, 8 and 10 muf. Pyranol* filled. Solder-lug bushings of the recently announced silicone type, or screw-thread bushings.
Newly developed paper has permitted a 24 to 51 per cent cut in size (volume), yet with three sheets of solid dielectric—and, as a result, allows an appreciable cut in price over older designs. The same high quality level of the 600-v units is maintained in every way.

*Reg. U.S. Pat. Off.

GENERAL ELECTRIC

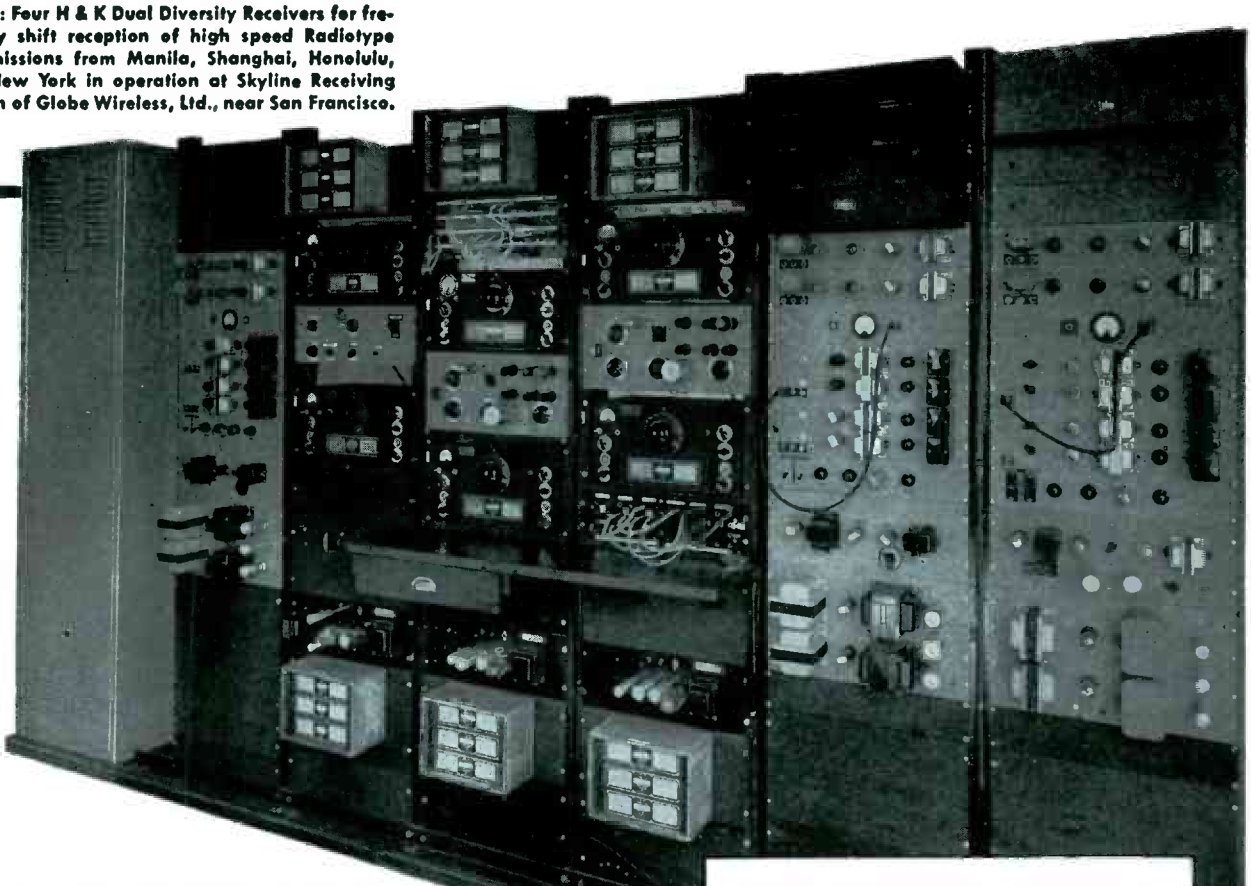
407-147

Specialty Capacitors FOR

- Motors
- Luminous-tube transformers
- Fluorescent lamp ballasts
- Industrial control
- Radio filters
- Radar
- Electronic equipment
- Communication systems
- Capacitor discharge welding
- Flash photography
- Stroboscopic equipment
- Television
- Dust precipitators
- Radio interference suppression
- Impulse generators

AND MANY OTHER APPLICATIONS

Below: Four H & K Dual Diversity Receivers for frequency shift reception of high speed Radiotype transmissions from Manila, Shanghai, Honolulu, and New York in operation at Skyline Receiving Station of Globe Wireless, Ltd., near San Francisco.



H&K FREQUENCY SHIFT EQUIPMENT

Improves Signal-to-Noise Ratio by as much as 22 Db.

As compared to "make-break" keying systems, Heintz and Kaufman frequency shift terminal equipment permits an improvement in signal-to-noise ratio of 11 db. by virtue of using frequency shift alone. Further gains are obtained under circuit conditions where noise and atmospherics are high. The total gain of a dual diversity carrier shift system over a single channel make-break system approximates 22 db.

Offers High Speed Keying Without Loss of Selectivity

Selectivity is obtained with FS which cannot be approached in constant frequency systems except at very slow keying speeds. Key clicks, transients, and keying sidebands are either eliminated or kept within the pass band of the FS system. High speed telegraph tape recorders, Radiotype, or teletype can be operated with greater speed and efficiency with this equipment.

WRITE FOR ADDITIONAL INFORMATION

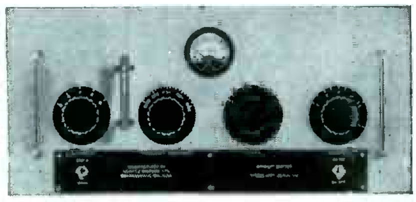
HEINTZ AND KAUFMAN LTD.

Communications Equipment Division

50 DRUMM STREET • SAN FRANCISCO • CALIF.

Gammatron Tube Division • South San Francisco • Calif.

H&K FREQUENCY SHIFT EXCITER



Shifts the carrier around the center frequency. Shifts normally used vary from 600 to 850 cycles between mark and space frequencies. Type A-4722 exciter (above) replaces the usual crystal oscillator stage in the transmitter.

H&K TONE TO D.C. KEYER

Communication services often find it desirable to transmit telegraphic impulses forming Radiotype, teletype or International Morse characters over wire lines or v.h.f. radio through the use of tone (audio frequencies) rather than direct current. The Type A-4613 Tone to D.C. Keyer is designed for such applications. Audio frequency input range is 500 to 4000 cycles. D.C. output of 50 to 55 ma. is ample for control of high speed relays.

Also Available

D.C. TO TONE KEYERS • LINE AMPLIFIERS BRIDGING AMPLIFIERS • V.H.F. CHANNELING EQUIPMENT • RADIO TRANSMITTERS V.H.F. ANTENNAS AND FREQUENCY MEASURING EQUIPMENT

WHAT IT IS . . .

- Two separate, completely independent, electron guns.
- Individual circuits for intensity, focus, and X-, Y- and Z-axis modulations.
- Independent, identical linear time bases for each beam. Choice of driven or continuous sweeps, or combinations thereof.
- Provision for applying common linear time base signal to the horizontal plates of both guns.
- Automatic beam control.
- Balanced-output deflection amplifiers for each deflection system.
- Built-in voltage calibrator applicable to either Y-axis amplifier at any time.
- Position and sensitivity equalizing circuits for X-axis.
- Provision for use of an oscillograph-record camera such as Du Mont Types 271-A or 314.
- Operation at total acceleration potential of 4500 volts.
- Brilliant traces.

WHAT IT DOES . . .

Only the dual-beam oscillograph can simultaneously . . .

- ✔ Compare the complete signal and an expanded portion thereof.
- ✔ Enable observation of transient voltage and current (see accompanying oscillogram).
- ✔ Measure explosion time and rate of change of pressure.
- ✔ Show velocity and acceleration.
- ✔ Show velocity and pressure changes on engine valves.
- ✔ Compare speed and vibration.
- ✔ Compare voltages and currents in multiphase circuits.
- ✔ Compare adjustment of push-pull and other symmetrical circuits.
- ✔ Compare electrocardiograms picked up from two different points.
- ✔ Compare input and output signals of amplifiers.
- ✔ Offer two channel recordings, with Type 314 Oscillograph-record Camera.
- ✔ Compare related periodic phenomena on different sweep frequencies.

SPECIFICATIONS . . .

Type 5SP- Cathode-ray Tube.

Sweep-frequency range: 2 to 30,000 sawtooth cps.

Sweep recurrence: single or continuous.

Y-axis amplifier response: flat to dc., down 3db at 200 kc.

X-axis amplifier response: flat to dc., down 3db at 150 kc.

Deflection: for all amplifiers 1 v. dc./in. approx.

Power: 115/230 v., 50-60 cps., 300 watts, 3 amp. fuse.

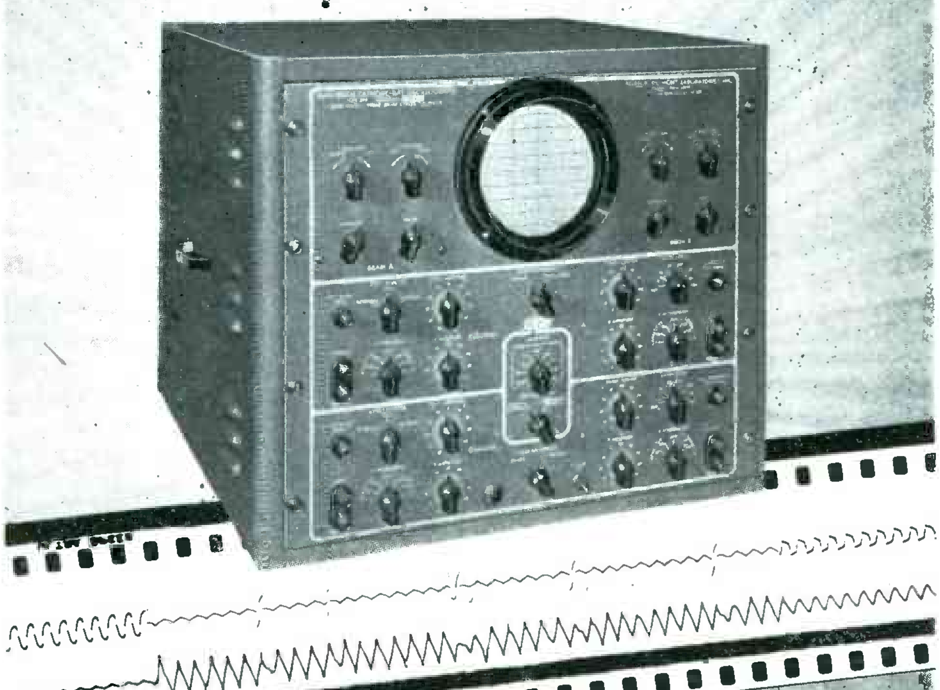
Size: 17½" x 22⅝" x 22⅛"; wt. 125 lbs.

Housing: Cabinet or relay rack.

Two Completely Independent Oscillographs are combined in the *new* DUMONT Type 279

DUAL-BEAM

CATHODE-RAY OSCILLOGRAPH



Starting voltage and current characteristics of a fluorescent-lamp fixture.

The introduction of the Type 279 Dual-beam Cathode-ray Oscillograph makes available for the first time a really dual instrument with *separate and wholly independent* electron guns. The circuits associated with each gun are also distinct and separate. For the first time, separate time bases are provided for each beam with provision for applying one time base to both guns, if so desired. For the first time, an oscillograph is offered which alone can perform the applications listed.

Now it is possible to superimpose two complete traces without a cumbersome and costly optical system or by the use of time-sharing devices. And with the P2 screen, the light output is more than sufficient for visual observation or for photographic recording of high-speed transients.

Other advanced features are the built-in calibrator and the ability to respond to direct-current signals.

Descriptive literature on request.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: ALBEEDU, PASSAIC, N. J., U. S. A.

Here are two types of General Ceramics STEATITE

SPECIAL SHAPES

1. STANDARD AND CUSTOM MOLDED PIECES IN ANY QUANTITY

Trimmer bases, coil mountings, tube bases and similar items—are produced in any volume to exact specification. Many standard pieces are available for selection to meet ordinary requirements with economy. Before specifying your insulating material, check up on the advantages and the cost reduction possibilities of General Ceramics Steatite components.

SEALEX BUSHINGS

2. HERMETICALLY SEALED LEADS AND MULTIPLE HEADERS

SEALEX Bushings provide an absolute hermetic seal that is unaffected by mechanical shock, thermal shock or continuous vibration. Every Bushing is pressure tested at 50 psi for proven dependability. SEALEX Bushings are manufactured in standard sizes from 0.5 to 20 amps, and flashover voltages range to 40 kv. Multiple lead types are included, and special types can be furnished to almost any specification.

. . . that provide economical solutions to difficult insulating problems!

The advantages of steatite as an insulator are universally recognized. Chief factors responsible for this superiority are a very low loss factor, non-hygroscopic characteristics and ready adaptability to practically any shape or form.

Important to manufacturers interested in these excellent dielectric properties, is the fact that General Ceramics facilities are geared to supply steatite components in large or small quantities with unusual economy. Modern production techniques—coupled with rigid quality control—result in all the usual advantages of volume production—fast delivery, low unit cost, and exact uniformity of every piece regardless of the size of run. Inquiries are invited

WRITE FOR CATALOG

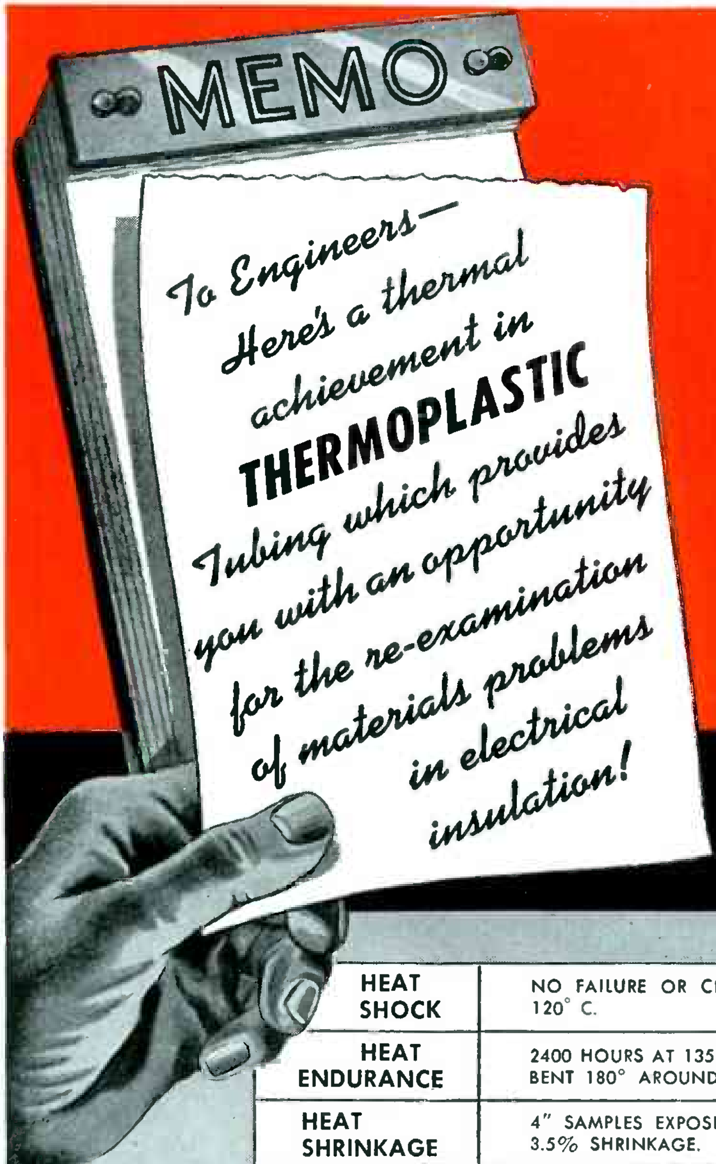
This informative catalog fully describes the facilities and products of the Steatite Division of General Ceramics. Complete technical data and design criteria concerning steatite and its application in the electrical and electronic fields. Write for your copy today on company letterhead; no obligation.

GENERAL CERAMICS AND STEATITE CORPORATION
STEATITE INSULATORS

General CERAMICS and STEATITE CORP.

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, ALUMINA, LIGHT-DUTY REFRACTORIES, CHEMICAL STONEWARE



TURBO
EXTRUDED PLASTIC TUBING
TYPE REL-16

...the New Heat-Resistant Thermoplastic Tubing!

HEAT SHOCK	NO FAILURE OR CRACKING OF REL-16 INDICATED AFTER 1 HOUR AT 120° C.
HEAT ENDURANCE	2400 HOURS AT 135° C. NO SAG, FLOW OR CRACK WHEN COOLED AND BENT 180° AROUND 5/16" MANDREL.
HEAT SHRINKAGE	4" SAMPLES EXPOSED TO 135° C FOR 30 MINUTES SHOW LESS THAN 3.5% SHRINKAGE.
FLAME RESISTANCE	TURBO REL-16 WILL NOT BURN OR SUPPORT COMBUSTION.
WATER ABSORPTION	NEGLIGIBLE — APPROX. 0.65%. NO DIMENSIONAL CHANGE BEFORE OR AFTER IMMERSION.
ELECTRICAL PROPERTIES	DIELECTRIC STRENGTH AT 28° C — 1600 VPM (SAMPLES TESTED—.020 NOMINAL WALL)

IF IT'S TURBO — IT SAFE-GUARDS

Many applications for electrical insulating sleeving and tubing once considered beyond the practical limits of thermo-plastic material are now economically possible with TURBO Extruded Type REL-16 Tubing.

This improved thermoplastic tubing corrects the previous thermal limitations of polyvinyl compounds, as becomes evident from the data presented in the accompanying table of properties. This data also discloses other significant factors important in meeting rigid specifications of essential electrical and physical characteristics.

Complete, detailed information including Electrical Testing Laboratory reports on TURBO REL-16 will be supplied on request.

OTHER *TURBO* PRODUCTS

INCLUDE FLEXIBLE VARNISHED TUBING, FIBROUS GLASS TUBING, SATURATED SLEEVING, PLASTIC INSULATED WIRE, MICA and MICA PRODUCTS, VARNISHED CAMBRICS, INSULATING PAPER and TAPES, etc. Write for samples today, on company letterhead, please.

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WILLIAM BRAND & COMPANY

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MARION METER *SPECIALS*... SIGN POSTS OF *Progress*

. . . Selected by BOONTON Radio Corp. Engineers for Their New Type 202-B FM SIGNAL GENERATOR.

The Boonton Radio Corporation, manufacturers of fine electronic test equipment, selected Marion to design and create two "special" meters for their new FM Signal Generator. One of these Marion "specials" is used for indicating modulation, another as an RF monitor.

The Marion Modulation Meter provides three scales, 0-80 kc. deviation in 5 kc. increments, 0-240 kc. deviation in 10 kc. increments and a 0-50% amplitude modulation, with calibration marks at 30 and 50%. The Marion RF Monitor Meter is used to standardize the power level of the last RF amplifier stage. Both of these "specials" are hermetically sealed and electro-statically shielded to insure precision performance despite humidity, dust and other disturbing external factors. Both meters fulfill the need for high torque-to-weight ratio and extremely low pivot roll . . . accomplished by the use of Alnico V Magnets and Osmium Iridium Alloy Pivots.

As in this case, close co-operation between manufacturer and Marion brings optimum results. An instrument such as the 202-B FM Generator, which meets the rigid requirements set forth by leading FM and television engineers throughout the country, is the result of this type of co-operation.

Let MARION Solve Your "Special Instrument" Problem

Quickly...Economically...Accurately!

There's A MARION METER For Your Requirements

For standard requirements you'll find a meter to fit your needs in our complete line of electrical indicating instruments. Marion Glass-to-Metal Truly Hermetically Sealed Instruments are a feature of our standard line . . . cost no more than most unsealed meters . . . are 100% guaranteed.

Write TODAY for complete information.

The Name "MARION" Means the "MOST" in Meters

MARION ELECTRICAL INSTRUMENT COMPANY

Manchester, New Hampshire

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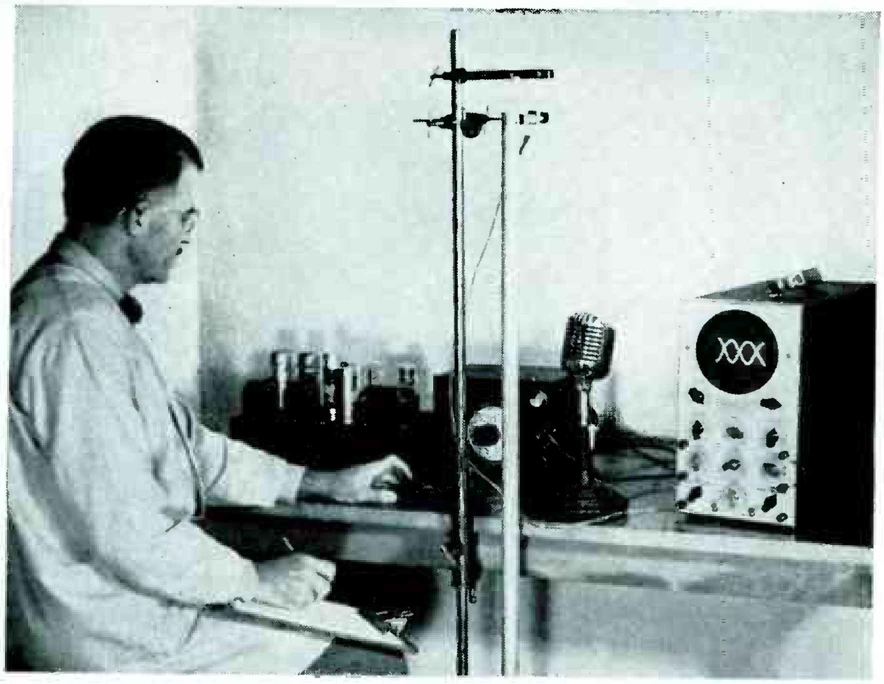
(*Advertisement*)



Laboratory set-up for measuring tone of chime tubes. Lissajous figure on screen of cathode ray oscilloscope is being used to determine the frequency (cycles per second) of the chime's fundamental note.

Revere Tubes make Good Music

BECAUSE of the importance of the market for brass tube used in door chimes, Revere some time ago embarked upon a complete scientific study of the musical qualities of such tube, to determine the factors responsible for pleasing tone. Here is a brief report of the work, which offers an example of the thoroughness with which Revere attacks problems concerning the application of its mill products.

The first step was purely experimental. We proceeded by ear. Over 100 samples of tubes in various alloys, tempers and gauges were hung up, struck, listened to, and preferences obtained from many people. These tests indicated not only what was the best alloy, but also what were the proper temper and wall thickness requirements to produce the most acceptable and desirable tone. But Revere did not stop there. It was desirable to know what made that tone preferable, what were the factors that influenced it, and how they could be controlled. It was felt that only with such complete information in hand could Revere be in position to control chime tube quality accurately, and fill customers' orders reliably with a standard product.

The project then was turned over to a laboratory physicist who is also a talented musician. Here began the most ambitious and lengthy and scientific part of the work, employing the most modern electronic apparatus, including a beat-frequency oscillator and a cathode ray oscilloscope. These made it possible to dissect the tone produced, measuring the frequency and intensity of the fundamental note and its partials with an accuracy of one cycle per second. Much new information was uncovered. For example, the strike tone so clearly heard when the chime is struck does not actually exist in the tube, but is a difference tone between the 1st and 3rd partials. Hence, for good tone, those partials must be equal in intensity and duration.

It requires seven closely-typed pages just to sum up the work in general terms; the laboratory records fill a large volume. The net of it is that Revere really knows about all there is to know about chime tube, scientifically, musically, physically, and, of course, how to produce it. If you need such tube, come to Revere.

Perhaps you use brass tube not for its sound, but for its corrosion resistance, strength, machinability, the polish it takes, the ease with which it can be bent, soldered, brazed, plated. Revere also knows how to control the factors influencing such applications, so come to Revere for brass tube for any purpose.

Revere also makes other types of tube, including copper water tube, condenser tube in such alloys as Admiralty, Muntz, cupro-nickel, tube in aluminum and magnesium alloys, lockseam tube in copper alloys and steel, and electric welded steel tube. Many of these can be had not only round, but also square, rectangular, oval, and in various flutings and special shapes. The Revere tube line therefore is complete, and awaits your orders.

The Technical Advisory Service will gladly collaborate with you in such matters as selection of alloys, tempers and gauges, and in fabrication processes.

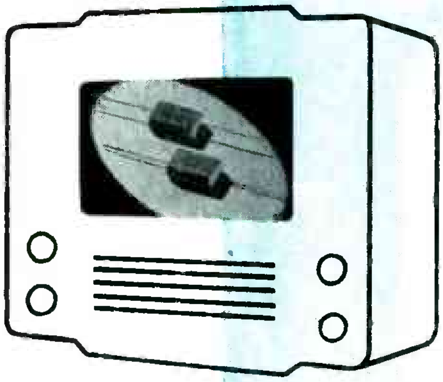
REVERE

COPPER AND BRASS INCORPORATED

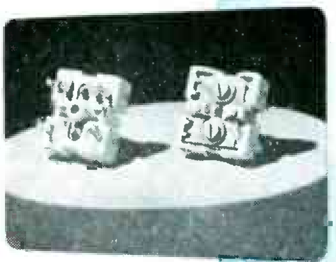
Founded by Paul Revere in 1801

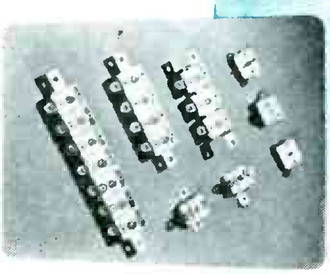
230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities, Distributors Everywhere.



A GOOD TRADEMARK *is* BUT A REFLECTION OF *Many* OTHERS





WHEN a manufacturer puts his trademark on a product, he not only expresses pride in his own workmanship, but also his confidence in the trademarks of those who have contributed vital parts to its manufacture. For instance — on capacitors he recognizes the El-Menco branding as his assurance of trustworthy performance under all operating conditions.

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THE ELECTRO MOTIVE MFG. CO., Inc., Willimantic, Conn.

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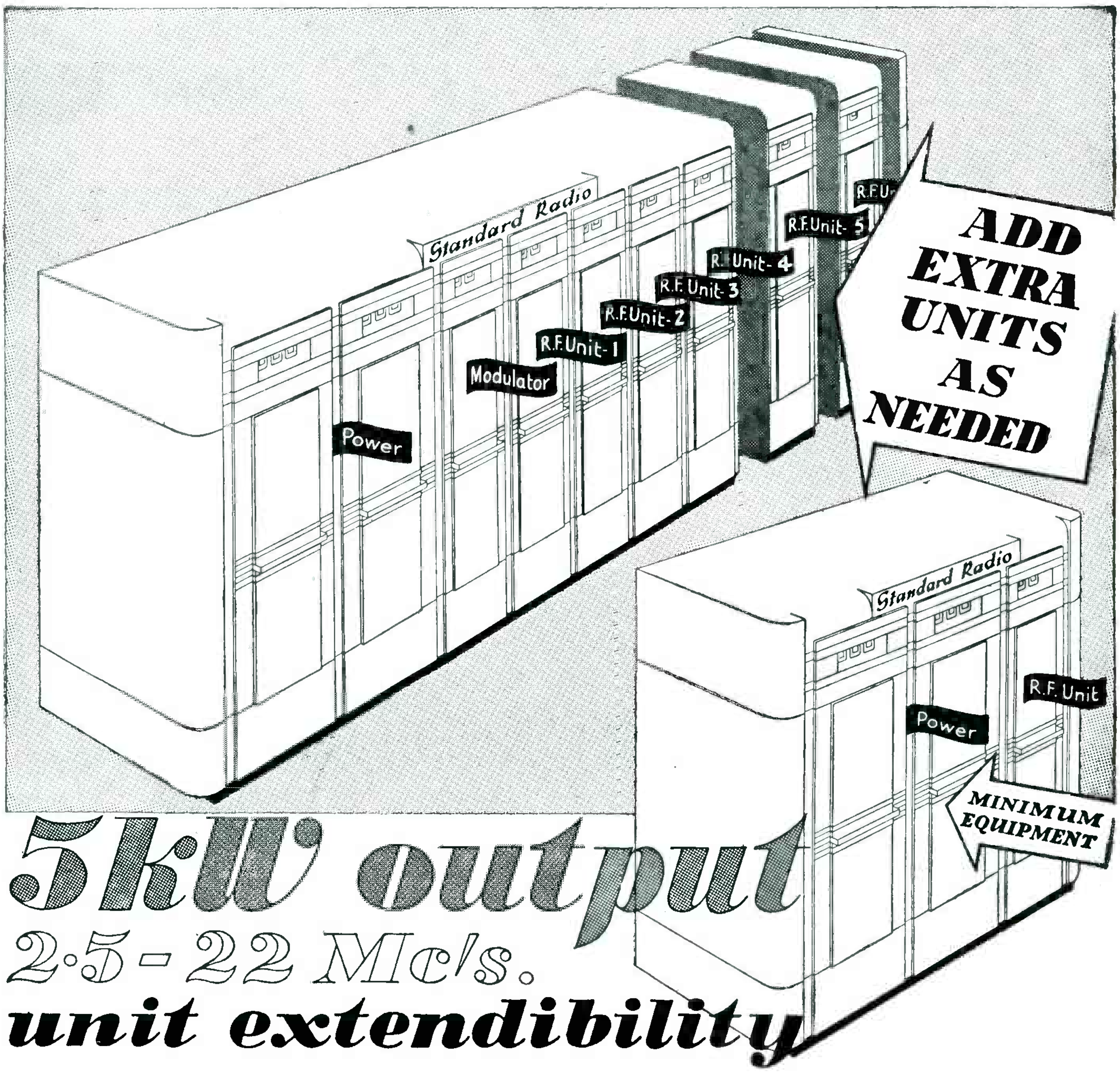
CAPACITORS



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2·5 - 22 Mc/s.
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The D.S.10 is a general purpose transmitter with many unusual features, suitable for airports, ship/shore, point-to-point, mobile communications, etc. In particular, its scope can be extended to include up to six R.F. units which can be used as follows: (A) Instantaneous selection of any single channel at full, reduced or low power—C.W., M.C.W. or 'phone; (B) Simultaneous operation of two C.W. channels at 5 kW each or 3 C.W. channels at 3 kW—both arrangements with independent keying—or two C.W. channels at 3 kW with common keying; (C) one C.W. channel at 3 kW plus one 'phone channel at 3 kW. These facilities and many others can be provided with either local or remote operation. Keying speeds up to 600 w.p.m.

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... **Cathode Sleeve Material**: special melted Nickel Alloys to meet any emission requirements.

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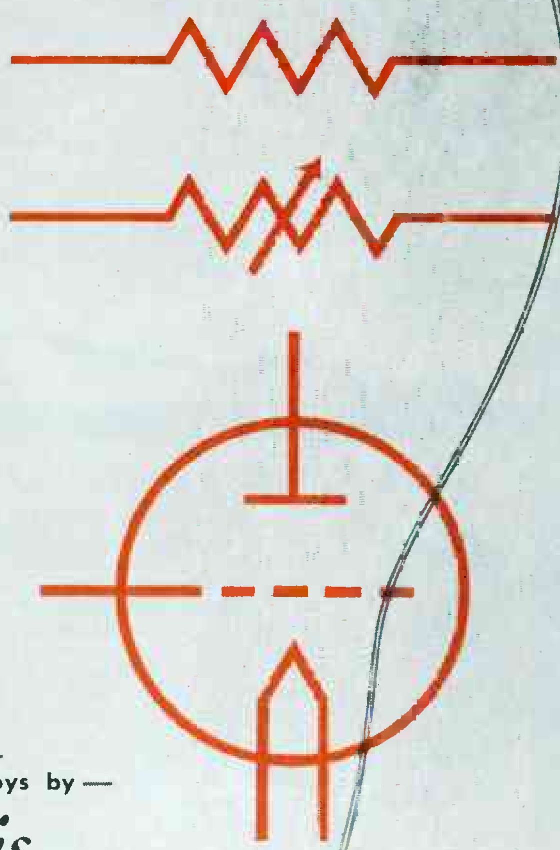

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11 NEW INSTRUMENTS IN 2 POST-WAR YEARS

PROGRESS REPORT

Here are the 11 new *-hp-* instruments — developed, announced, and put into production since the war's end. Each fills a definite need. Each is the product of painstaking research and advanced manufacturing methods. Each helps make simpler, easier, the measurement problems of the electronics industry.

Brief specifications appear here. For complete details on these and other *-hp-* laboratory instruments, write or wire today!

HEWLETT-PACKARD COMPANY
1513A Page Mill Road • Palo Alto, California

1 201B AUDIO OSCILLATOR

Meets every requirement for speed, accuracy, wave-form purity, ease of operation in FM and other fields where high fidelity is most important. Provides 3 watts output into 600 ohm resistive load. Distortion held to 1% or less at 3 watts, ½% at 1 watt output. Excels in testing high fidelity amplifiers, speakers, and in comparing frequencies. Output controlled by volume control ahead of amplifier, or attenuator controlling amplifier output. Attenuation approximately linear from 0 db to 40 db.

2 410A VACUUM TUBE VOLTMETER

This *-hp-* voltmeter employs a special *-hp-* diode probe which places a low capacity of approximately 1.3 uuf across circuit under test. Combination of this low capacity and high input resistance results in great measuring accuracy without detuning or danger of loading circuit. Frequency response is ± 1 db throughout the instrument's range. Six voltage ranges provide full-scale sensitivities from 1 to 300 volts. Besides covering frequencies from 20 cps to 700 mc as an a-c voltmeter, this *-hp-* 410A is a d-c voltmeter with 100 megohms input impedance. It is also a precision ohmmeter for resistances, 0.2 ohms to 500 megohms.

3 330B DISTORTION ANALYZER

-hp-'s newest and finest distortion measuring instrument. Unusually valuable for the measurement throughout the audio spectrum in broadcast, laboratory or production problems. Measures average value of "total" distortion at any frequency from 20 cps to 20,000 cps. Accurately makes noise measurements as small as 100 microvolts. Linear r-f detector makes possible measurement direct from modulated r-f carrier. As voltmeter, measures voltage level, power output, amplifier gain; or serves as high-gain wideband stabilized amplifier with maximum gain of 75 db.

THESE *-hp-* REPRESENTATIVES ARE AT YOUR SERVICE

CHICAGO 6, ILL.: Alfred Crossley, 549 W. Randolph St., State 7444 • HOLLYWOOD 46, CALIF.: Norman B. Neely Enterprises, 7422 Melrose Ave., Whitney 1147
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DENVER 10, COLO.: Ronald G. Bowen, 1886 S. Humboldt St., Spruce 9368 • TORONTO 1, CANADA: Atlas Radio Corp. Ltd., 560 King St. West, Waverley 4761
DALLAS 5, TEXAS: Earl W. Lipscomb, 4433 Stanford Street, Logan 6-5097

4 450A WIDE BAND AMPLIFIER

Here is a new, wide-band instrument for laboratory or production use. Provides exceptional stability at 40 or 20 db gain. Gives freedom from spurious responses. Low phase shift assured by straightforward, resistance-coupled amplifier design, together with inverse feedback. Frequency response flat within ½ db between 10 and 1,000,000 cps. Varying tube voltages or aging tubes have no appreciable effect on gain or other characteristics. When used with *-hp-* 400A Vacuum Tube Voltmeter, increases voltmeter's sensitivity to 100 times. Increases bridge and recorder sensitivity.

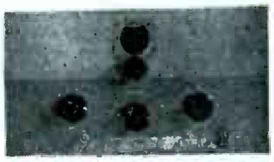
5 710A POWER SUPPLY

Light, compact, inexpensive, this *-hp-* power supply is an excellent all-around source of d-c power. It replaces batteries for temporary setups, or serves as permanent installation. Output varies approximately 1% with changes in load current to 75 ma or normal line variations. Noise and hum level exceptionally low. Output unusually stable over long periods of time. Instrument also contains auxiliary center-tapped 6.3 volt source providing 5 amperes a-c. Output is continuously variable, 180 to 360 volts, and is practically independent of either line voltage or applied load.

6 610A UHF SIGNAL GENERATOR

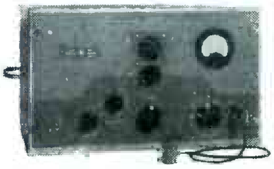
This new *-hp-* generator is an extremely stable general-use laboratory standard for measurements between 500 and 1350 mc. Throughout those frequencies it gives accurately known voltages ranging from 0.1 microvolt to 0.1 volt. R-f output may be continuous, amplitude modulated, pulsed or square-wave modulated. Pulse length can be controlled between 2 and 50 microseconds. Pulse rate is variable 60 to 3000 times per second. Instrument is particularly valuable for determining gain or alignment, antenna data, standing wave ratios, signal-to-noise ratios or circuit "Q."

7 202B LOW FREQUENCY OSCILLATOR



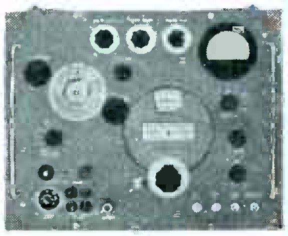
This newest *-hp-* oscillator gives maximum speed and accuracy for tests between ½ and 1000 cps. Particularly designed to test performance of electro-cardiograph and electro-encephalograph equipment, check vibration or stability of mechanical systems, simulate mechanical phenomena, check geophysical equipment. Throughout frequency range provides excellent wave form. Frequency stability within 5%, including initial warm-up drift. Output is 10 volts maximum into 1000 ohm resistive load. Four frequency ranges. Cps read direct on large illuminated dial. Tuning is controlled by direct or 6 to 1 micro-drive vernier.

8 650A WIDE BAND OSCILLATOR



Continuous frequency coverage 10 cps to 10 mc, is provided in this stable, new *-hp-* oscillator. Output is flat within 1 db. Voltages available range from .00003 to 3 volts. 94" scale-length, 6 to 1 micro-controlled tuning drive, 50 db output attenuator variable in 10 db steps. Output voltage divider provides 6 ohm internal impedance. *-hp-* 650A is specially designed for testing television amplifiers, wide-band systems, tuned circuits, receiver alignments, and checking filter transmission characteristics. And, this precision-built *-hp-* oscillator serves admirably as a power source for bridge measurements or as a signal generator modulator.

9 616A UHF SIGNAL GENERATOR



Here for the first time is a precision instrument making possible fast, direct output and frequency readings between 1800 to 4000 mc, *plus* simplified controls and a choice of c-w, pulsed, delayed or limited f-m output. No calibration charts are necessary. R-f output ranging from 0.2 volt to 0.1 microvolt is available. Output continuous, pulsed or frequency modulated at power-supply frequency. Wide selection of pulse rates, internal and external synchronization. Stability approximately 0.005% per degree centigrade change of ambient temperature.

10 *-hp-* 335B FM MONITOR

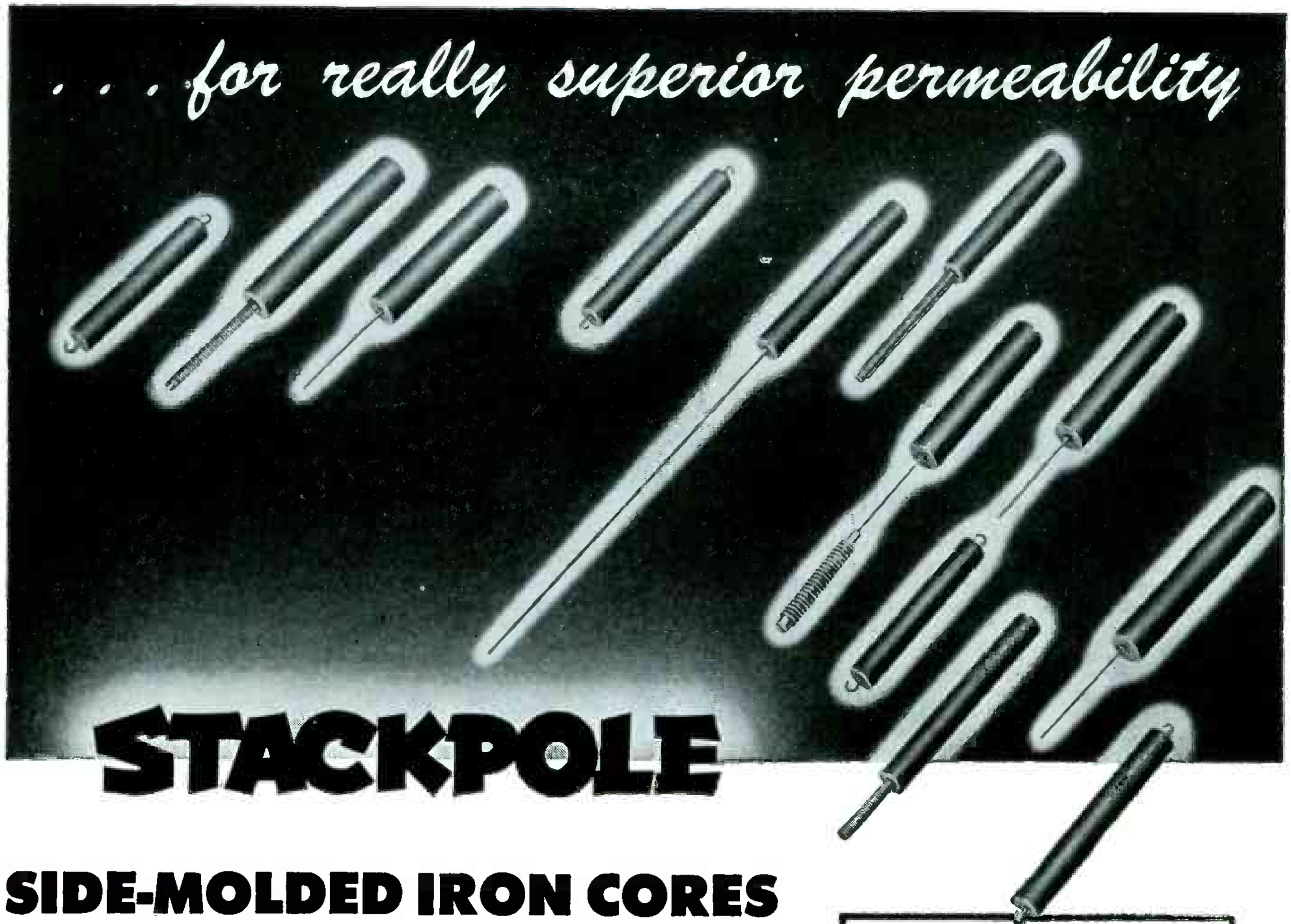
This new *-hp-* 335B is the finest FM monitor ever developed. Requires no attention during operation. Provides continuous measurement of carrier frequency and modulation swing. Approved by F.C.C. for FM broadcast service. Frequency range 88 to 108 mc. Audio output has less than 0.25% residual distortion. Audio output supplied with 75 microsecond de-emphasis circuit, flat within ½ db of standard curve, 20 cps to 20 kc. Residual noise and hum in audio output at least 75 db below 100% modulation. Modulation may be monitored at control console or other remote point.

11 AUDIO SIGNAL GENERATOR *-hp-* 206A

Here is a source of continuously variable audio frequency having total distortion of less than 0.1%. High stability, frequency response flat within 0.2 db beyond output meter. Output impedances are 50, 150 and 600 ohms. Instrument provides continuously variable frequency range 20 cps to 20 kc, tunable throughout 3 bands with a 47" micro-controlled dial. Precision attenuators vary output signal level in 0.1 db steps over 111 db range. Both *-hp-* 206A generator and *-hp-* 335B Frequency Modulation Monitor can be supplied in special colors to match transmitter installations.

hp laboratory instruments

FOR SPEED AND ACCURACY



SIDE-MOLDED IRON CORES

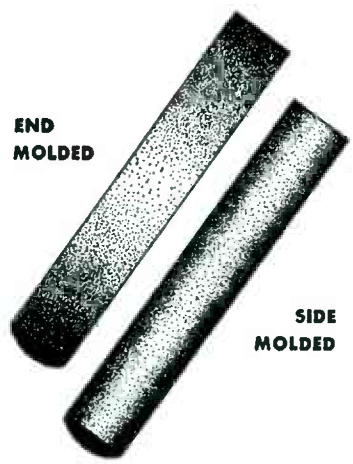
The ratio of induction to magnetizing force is greatly improved in these popular iron cores by the Stackpole side-molding process. Conventional processing whereby molding pressure is exerted from the ends obviously results in a dense grouping of iron particles at these points with a corresponding decrease in permeability with respect to length. Stackpole side-molding, however, aligns particles in even density along the entire length. Greater iron core efficiency is thus assured. The method is particularly advantageous in the manufacture of long, thin cores.

In addition to units in broadcast band frequencies, Stackpole now offers side-molded cores in short wave frequencies for FM and television.

Samples gladly submitted to your specifications.

Write for Stackpole Electronic Components Catalog.

Electronic Components Division
STACKPOLE CARBON COMPANY, ST. MARYS, PA.



This diagrammatic illustration shows how conventional cores, molded by applying pressure to the ends, results in a dense grouping of iron particles at these points. In side-molded cores, however, any density resulting from molding pressure extends evenly along the entire length of the core, assuring uniform permeability with respect to length.

STACKPOLE IRON CORE HEADQUARTERS

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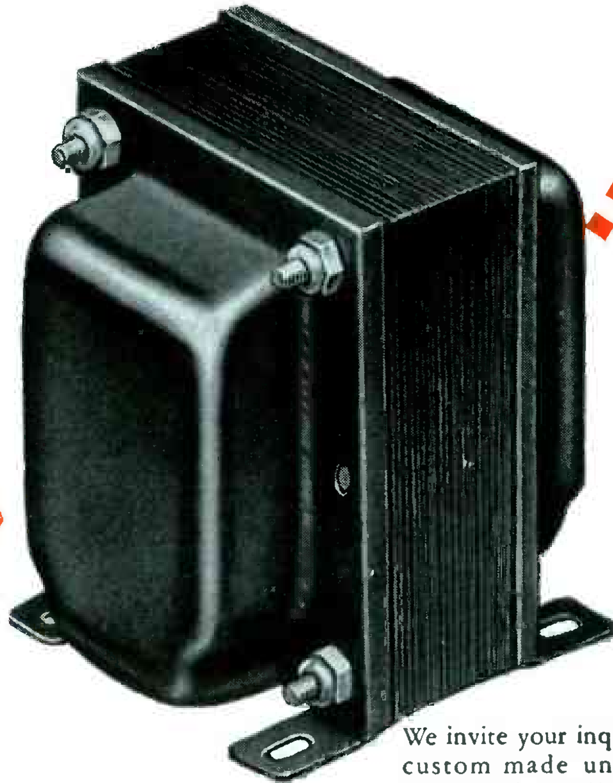

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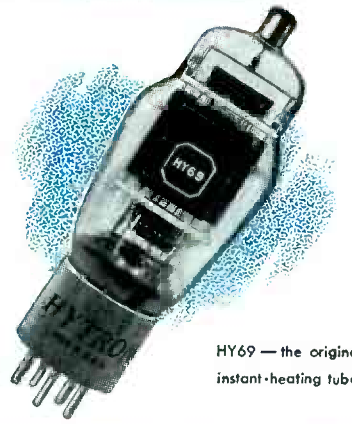
THE ORIGINAL INSTANT-HEATING TUBE



HY69 — the original instant-heating tube.

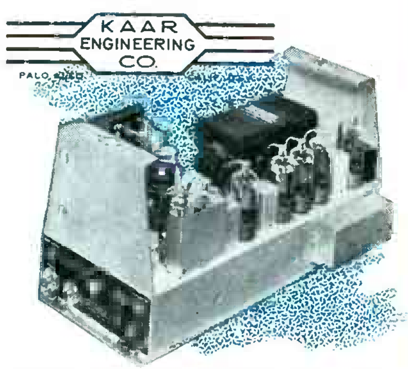
Because they fill a real need for conserving filament power, Hytron instant-heating tubes are in. Yes, the 2E25, 2E30, HY69, HY1269, and 5516 are in the new mobile transmitter designs of many famous friends—too many to thank in this small space. The 2E25 and 2E30 also appear on the Army-Navy Preferred List. Why so popular? With no standby current, battery drain can be cut to 4% of that with cathode types—attainable power output and range increase. Potentials of rugged filaments are centered for battery operation. Beam pentode versatility simplifies the spares problem—one type can power all stages. Join the leaders. If you build mobile equipment—for land, sea, air—put Hytron original instant-heating, easy-on-the-battery tubes on *your* preferred list.

Bendix MRT-3A, 152-162 mc f-m taxicab transmitter uses 2E30's generously.

Federal's 25-watt, vhf Model FMTR-25-VC. Note emphasis on 2E30 and 5516.

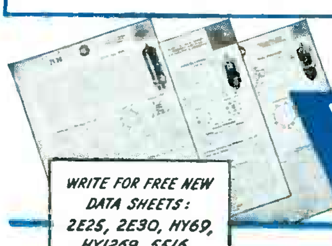
Harvey Laboratories chose 2E30's, 5516's for its Model 542 f-m transmitter.

Jefferson-Travis Model 35T, 35-watt marine radio-telephone employs HY69's.



Kaar FM-50X features 2E25, HY69 throughout. Hytron instant-heating tubes since 1939.

5516's power both driver-doubler and final of Motorola's Model FMTRU-30D.



WRITE FOR FREE NEW DATA SHEETS: 2E25, 2E30, HY69, HY1269, 5516.

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PROGAR* is a new instrument... Not just a Limiting or Governing amplifier, but a new device incorporating a *Guardian Memory circuit* (Level Restoring Action) with improved PEAK LIMITING.

Dynamic expression is preserved in the PROGAR by the Memory (time delay) circuit in the Guardian. When the program level decreases this Memory Portion holds the gain constant for a predetermined adjustable period of time and then lets the Guardian slowly act to restore the program level to its original value.

The Guardian in the PROGAR precedes the Peak Limiting . . . therefore a regulated signal is fed into the limiter... maintaining consistent, pre-set peak limiter action and assuring a higher percentage of modulation than can be obtained with a limiter alone.

*Reg. U. S. Pat. Off.

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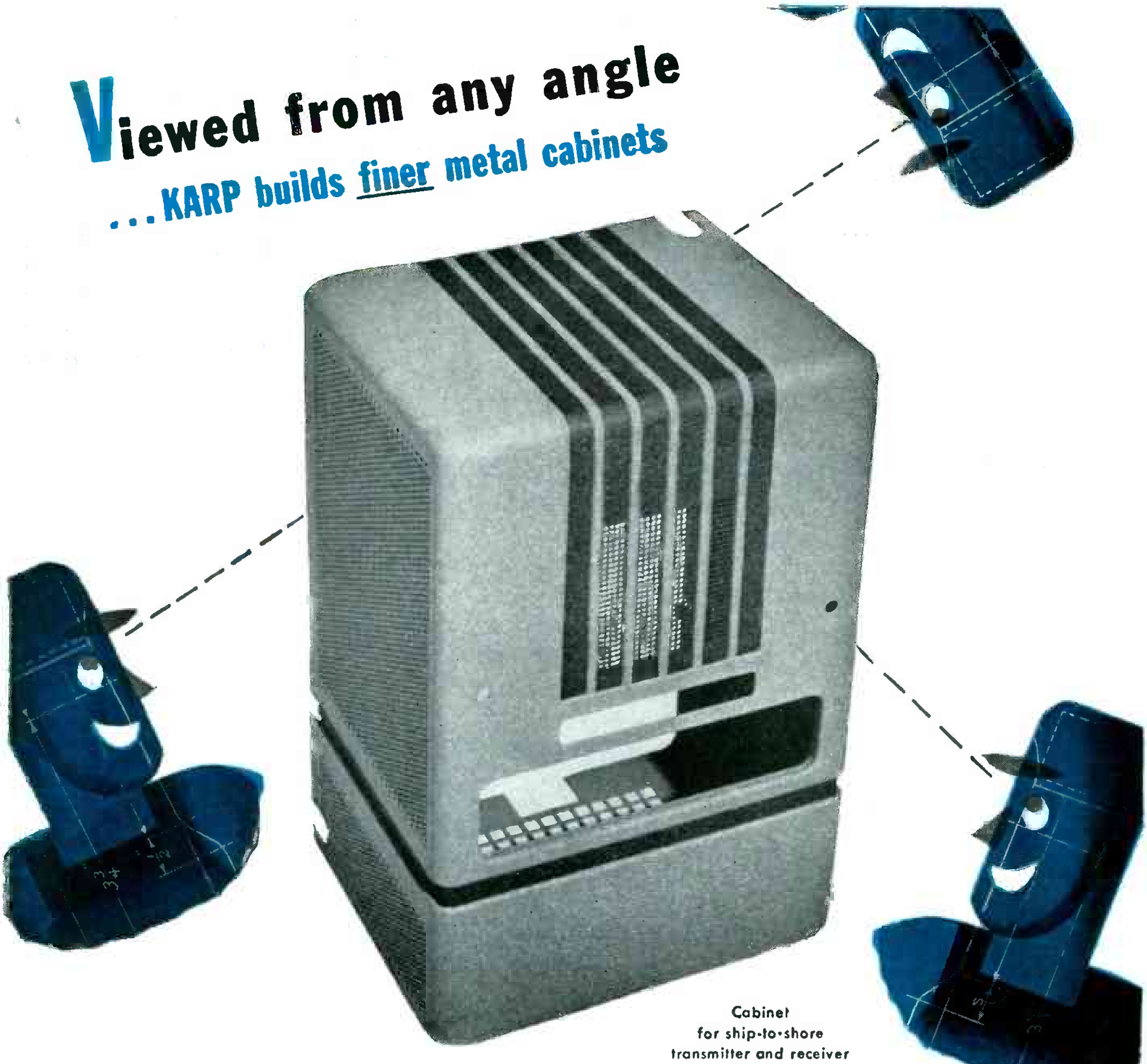

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We will follow your designs with fidelity, or our design specialists can suggest design ideas which will enhance appearance, achieve ruggedness, save space or weight. Our work insures uniformity and accuracy—which mean production economy both in the fabrication and in your own assembling operations.

At your service is our staff's combined "know-how" gained in 22 years of specialization. Our tool and die department is so complete that we often save customers special die costs. We make our own dies and do all our own finishing. We do all kinds of welding—including spot-welding of aluminum with electronic timing controls.

It's the hard-to-do type of craftsmanship that brings out the best in our trained minds and skilled hands. We invite your inquiries on any sheet metal fabrication.

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CAPACITANCE "ON-THE-NOSE" FOR HIGH CURRENT, HIGH POWER ELECTRONIC CIRCUITS

The variable capacitance feature of Lapp Gas-Filled Condensers permits you to "tune-to-a-whisker," with power on, to get the most out of any high current, high power circuit. And once set, this gas-dielectric unit delivers uniformly—no "warm up," no change of capacitance with change in temperature. Non-deteriorating, too, the Lapp unit is truly puncture-proof and will outlast almost any other components of any circuit of which it is a part. In addition to the variable unit, there are adjustable units, continuously adjustable within their range but not designed for frequent "tuning dial" adjustment, and fixed capacitance units. Current ratings range up to 500 amperes R.M.S.; power ratings to 60 Kv peak load. Capacitance to 60,000 mmf. (for fixed units); to 16,000 mmf. (variable and adjustable units). Higher ratings on special design order.

Lapp

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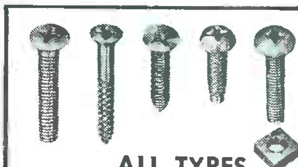
. . . when AMERICAN PHILLIPS SCREWS
Fasten Better Faster!

Here's the PRODUCTION "LIFT" Production goes up, cost goes down for elevator-escalator builders, appliance, furniture, auto and other manufacturers who assemble with fast fumble-proof, automatically straight-driving American Phillips Screws! This *maintained* speed means TIME SAVINGS UP TO 50%—with a bonus in no scars or work spoilage and added safety for workers.

Here's the SALES APPEAL "LIFT" No burrs to catch hose or clothes with this smart, decorative, straight-set screw head that speaks quietly of solid construction from here on in—that's the American Phillips Screw. Why not get these competitive advantages in speed, sales and COSTS today? Write:

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. *Detroit 2:* 502 Stephenson Building

AMERICAN PHILLIPS *Screws*



ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

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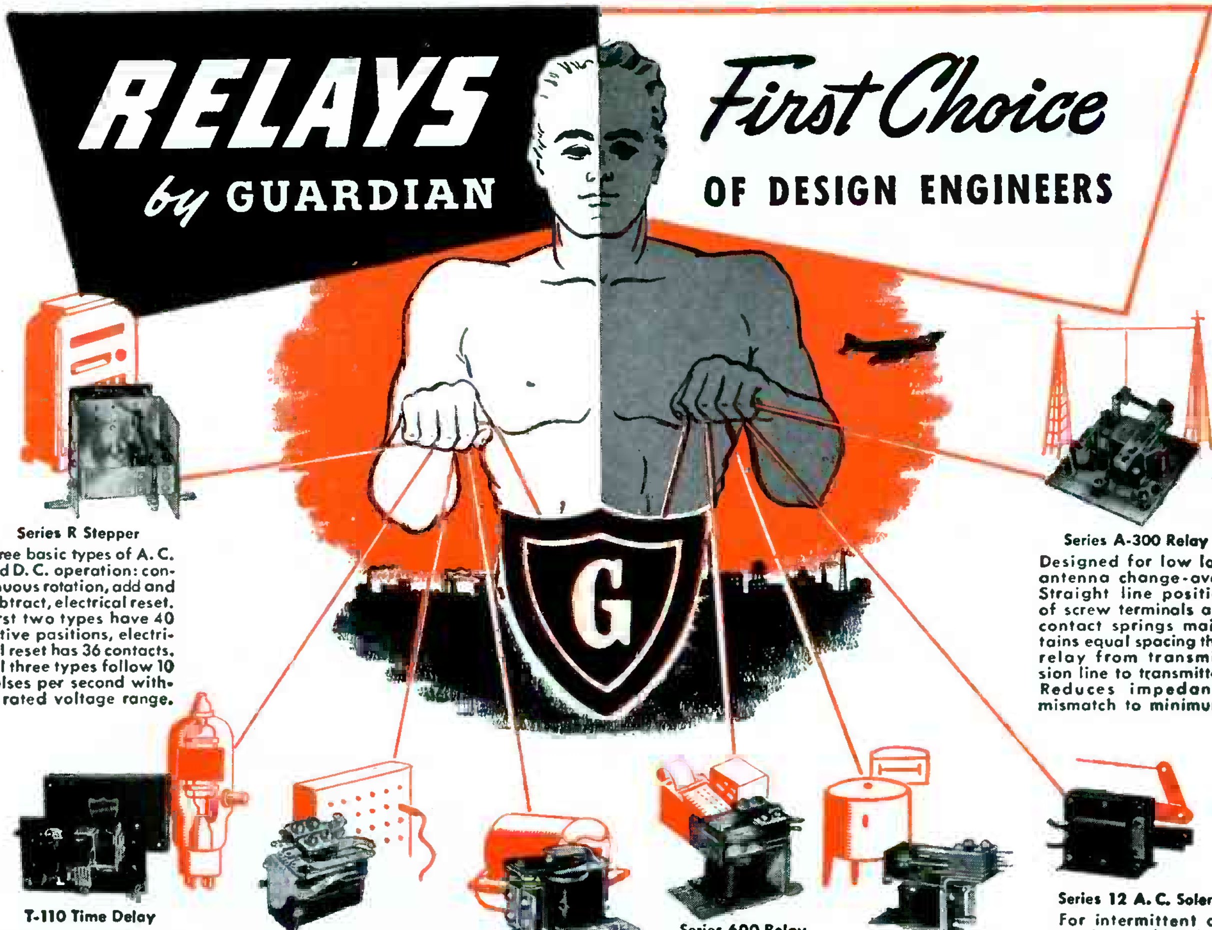

Series R Stepper
Three basic types of A. C. and D. C. operation: continuous rotation, add and subtract, electrical reset. First two types have 40 active positions, electrical reset has 36 contacts. All three types follow 10 pulses per second within rated voltage range.

Series A-300 Relay
Designed for low loss antenna change-over. Straight line position of screw terminals and contact springs maintains equal spacing thru relay from transmission line to transmitter. Reduces impedance mismatch to minimum.

T-110 Time Delay
Provides delayed operation from 10 to 60 seconds using a resistance wound bi-metal strip. In radio it prevents damage to rectifiers and tube filaments by retarding plate current until tubes are sufficiently heated. Used widely in industry to change circuits after a predetermined interval.

Series 595 D. C. Relay
Midget telephone type unusual for amount of power provided. Size only 1 7/16" x 1 3/8" x 1". Three outstanding features — frictionless pivot — proper copper-iron balance—capacity to carry up to 8 single pole, single throw contact combinations.

Series 220 A. C. Relay
Capable of breaking currents up to 20 amps at 230 v., 60 c., A. C., non-inductive load. Bakelite contact block tests 1500 v. break-down to ground. 5/16" dual contacts minimize arcing.

Series 600 Relay
Small, compact, low-cost. Size: 2 1/8" x 1 1/2" x 1 1/8". Contact combinations up to 4 P. D. T. Power consumption, 6 V. A. Max. cap., 8 amps, 3 v. to 230 v. A. C., or 3 v. to 110 v. D. C. Coil and contact assemblies interchangeable.

Series 100 A. C. Relay
Used successfully in automatic home washing machines. It is incorporated in many new household appliances now on drafting boards.

Series 12 A. C. Solenoid
For intermittent and continuous duty. Rated at 6 v. to 230 v., 60 c., A. C. Stroke ranges from 1/8" up to 7/8". Series 6 D. C. rated 6 v. to 230 v. Stroke 1/8" up to 2".

Faced with responsibilities for the design and successful performance of their companies' products, American design engineers are eagerly turning to Guardian Electric *first* for relays and complete control assemblies. They find at Guardian a vast wealth of application and performance data, an expert engineering staff with more than a decade of specialized experience solving the most complex and widely diversified control problems. Such experience offers design engineers an *extra bonus value* thru practical suggestions and valuable specific recommendations given without cost or any obligation. Should your design call for a "special" control, Guardian has probably built the self-same principle you seek into one of its large line of *basic* type units. When such a *basic* type unit becomes the "special" you need thru slight variations, the savings in time and money are substantial, you circumvent die costs and beat delivery schedules in the bargain! Should special engineering be required, our staff is at your disposal. Write — call on Guardian for these excellent controls designed by Guardian engineers *for* engineers. Expert advice is yours for the asking to help you design better products thru improved techniques which are now so vital to meet competition.

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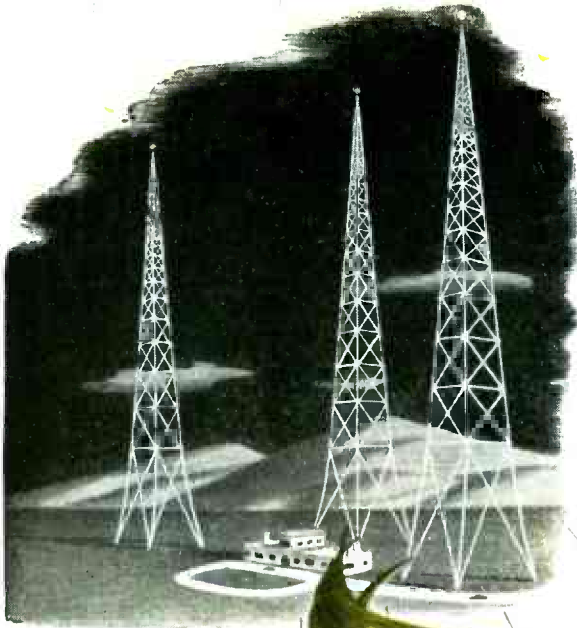
1625-P W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

Where there is Horsepower–

There is Wire



Man has always wanted news—and felt a frantic urge to "get the message through." There were shouters on the hilltops—a runner to announce the Persian loss of Marathon. Then horses sped the mails; but they were yet too slow—too slow for instance to prevent a battle after the peace was signed.

The telephone was a novelty in 1902—when Belden Manufacturing Company was founded. The story of instantaneous communications reads on from there.

Words have conquered space and time—because the products of the wiremakers have harnessed horsepower.

Belden

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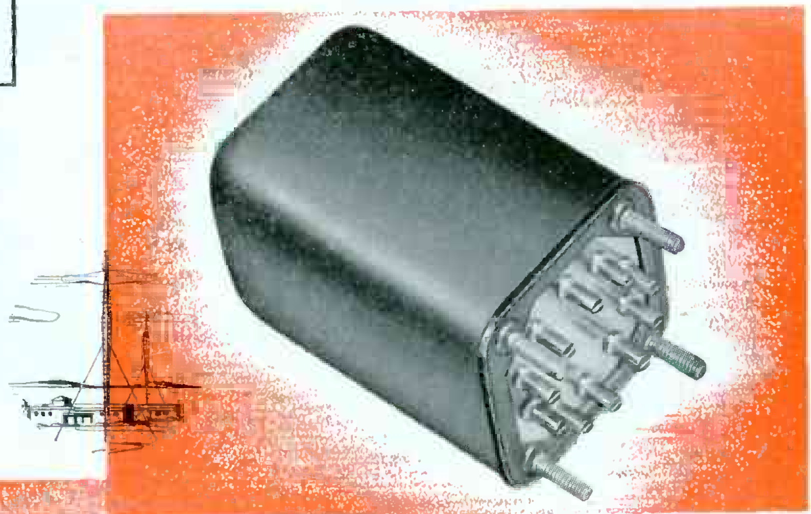
FOR INDUSTRY

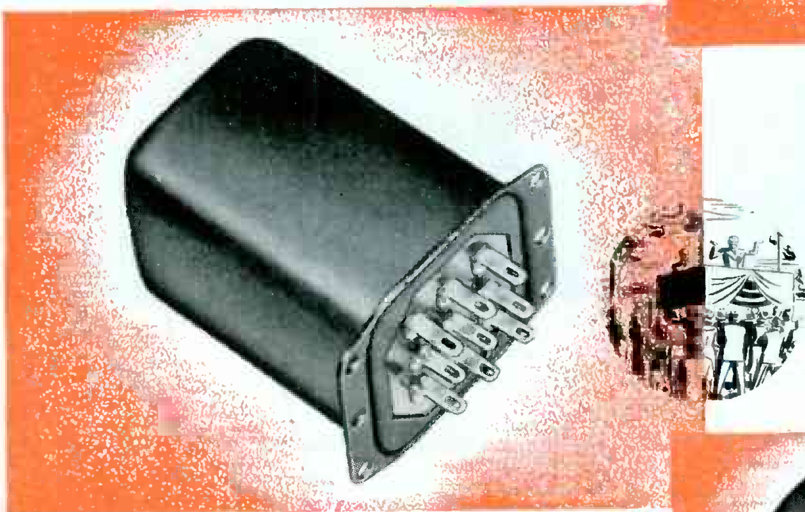
AUDIO TRANSFORMERS *for* UNIFORM RESPONSE LOW DISTORTION IN 3 FREQUENCY RANGES

Write for Catalog showing complete new stock line



Full Frequency Range

30 to 15,000 Cycles, provides uniform response over this entire band with ± ½ db up to 10 watts of audio power, within ± 1 db over 10 watts. Standard RMA impedances. Hum balancing coil structures and nickel alloy shielding. Included are Input, Output, Driver, and Modulation Transformers; Modulation Reactors. *Sealed in Steel* construction, stud mounting, with pin-type terminals.



Public Address Range

50 to 10,000 Cycles, frequency response within ± ½ db up to 10 watts of power, within ±1db over 10 watts, throughout this range. Secondary impedances match 600 and 150-ohm lines, 16, 8 and 4-ohm reproducing systems. Listed are Driver and Output Transformers. *Sealed in Steel* construction, flange mounting, with solder lugs or wire leads.

Communications Range

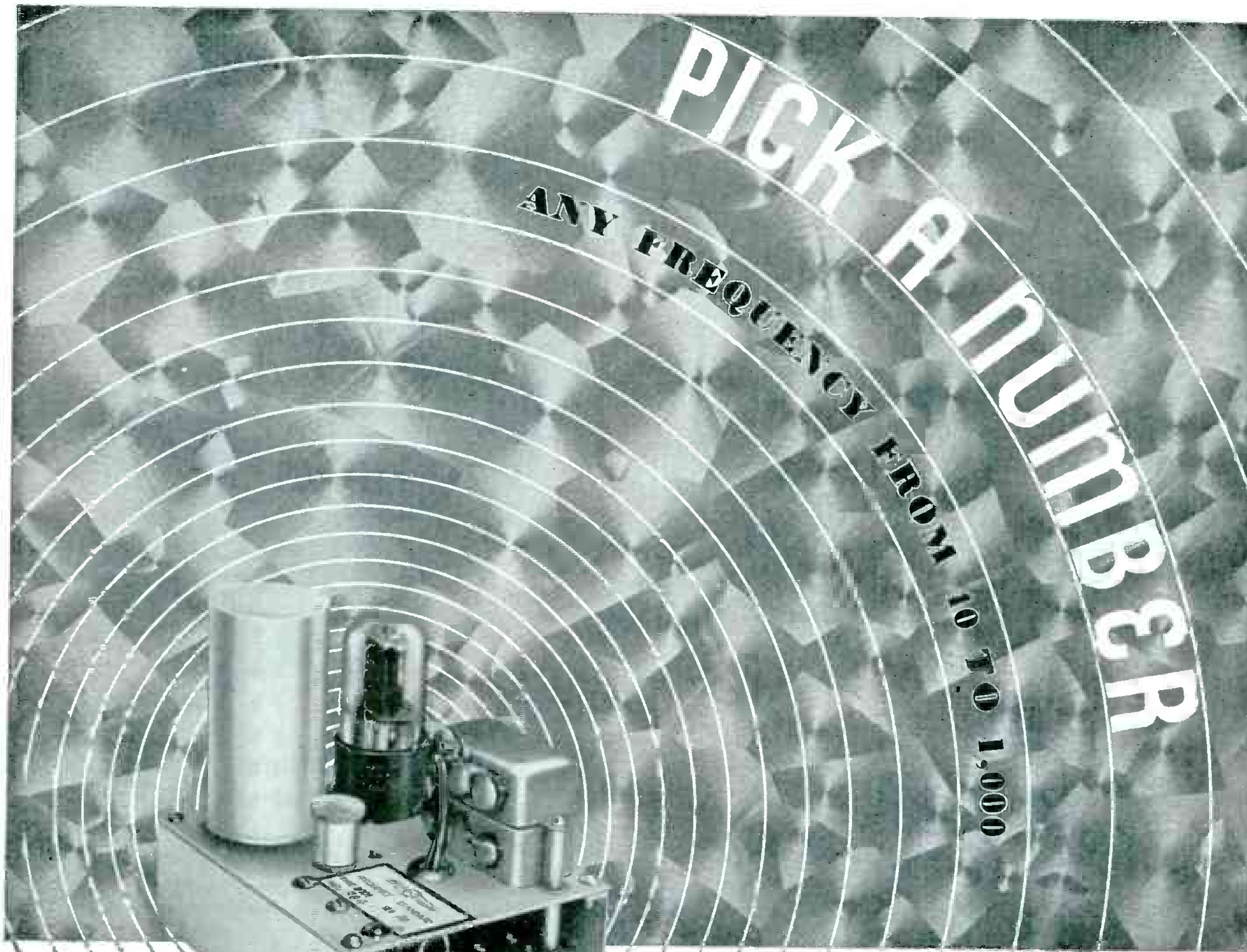
200 to 3,500 Cycles, affords response with variations not exceeding ± 1 db over the range of voice frequencies. For use with 600 or 150-ohm lines. Input, Output, Driver and Modulation Transformers offered. *Sealed in Steel* construction, flange mounting, with wire leads or solder lugs.

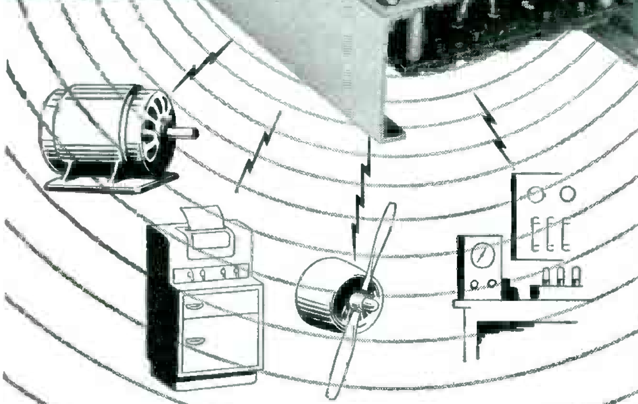
CHICAGO TRANSFORMER TRADE MARK REG.

CHICAGO TRANSFORMER

DIVISION OF ESSEX WIRE CORPORATION

3501 ADDISON STREET • CHICAGO 18, ILLINOIS





Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

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American Time Products, Inc.

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Quadrupled Capacity for Better Service with a Better Product!

FORMICA
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CAPACITY for sheets, tubes and rods at the Formica factory has been multiplied by four since the war began.

New types of equipment, more efficiently arranged, have prepared the plant for production on a scale never attempted in the laminated industry.

At the same time new types of resinoids and new types of bases have made possible the production of better and more efficient materials better adapted to specific jobs they are expected to perform.

Machining and finishing equipment for electrical parts has been expanded in proportion. So you can send your blueprints here with confidence that when your order is placed you will get promptly, uniform materials of high quality, produced in the most efficient way by the finest manufacturing equipment, manned by the most competent staff in the industry.

THE FORMICA INSULATION CO., 4661 SPRING GROVE AVE., CINCINNATI 32, OHIO

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but no Fire

A radio manufacturer was faced with a potential fire hazard in a new portable radio. A resistor designed to act as a fuse in the event of failure of the electrolytic condenser drew a bad arc when the fusible link opened up. The danger of fire resulted.

This manufacturer brought his problem to Bentley, Harris over a year ago. Here is what he recently reported:

"Laboratory tests proved that BH Extra Flexible Fiberglas Sleeving successfully smothers the arc . . . eliminates the danger of fire resulting from the arcing across the open resistor. Its great flexibility has saved considerable time in installing this added protection."

Whether your problem is heat, cold, high voltages, vibration or any other of the many causes of insulation break-down, try BH Fiberglas Sleeving in your product. See for yourself its many production advantages.

BENTLEY, HARRIS MFG. CO., CONSHOHOCKEN, PA.

BH *Fiberglas** SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

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Bentley, Harris Mfg. Co., Dept. E-17, Conshohocken, Pa.

I am interested in BH Non-Fraying Fiberglas Sleeving for __________ (product)

operating at temperatures of ____°F. at ____ volts. Send samples so I can see for myself how BH Non-Fraying Fiberglas Sleeving stays flexible as string, will not crack or split when bent.

NAME __________ COMPANY __________

ADDRESS __________

Send samples, pamphlet and prices on other BH Products as follows:

- ☐ Cotton-base Sleeving and Tubing
- ☐ Ben-Har Special Treated Fiberglas Tubing

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Unforeseen Events via Electronics Research

No guess-monger and no axe-grinder is the Sherron laboratory scientist. He is concerned solely with the logical tasks of research. There are those who postulate the imminence or remoteness of threats to our national security. But the Sherron scientist digs in, striving to develop electronic techniques and applications in anticipation of tomorrow's surprises. He is strictly a scientist, doing a strictly scientific job. At his command in the Sherron laboratory is the finest and most advanced electronics equipment. At his side are Sherron mathematicians, physicists and engineers of the first rank.

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This 2.0 mfd. Sprague Vitamin Q Capacitor, conservatively rated at 16,000v. D.C., has standard base dimensions of $4\frac{1}{4}$" x $13\frac{1}{2}$" and is only $12\frac{1}{4}$" high, exclusive of insulators.

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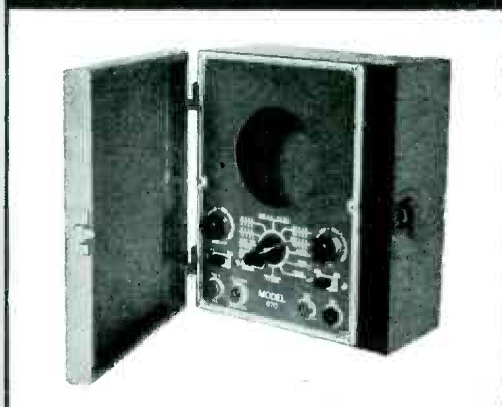
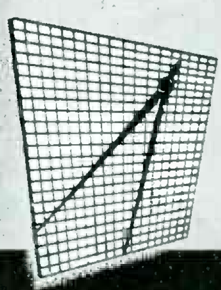
INSTRUMENT PANELS, RADIO COMMUNICATION CASES and ENCLOSURES, OSCILLATOR BOXES, CHASSIS and CABINET ASSEMBLIES, RACKS and SPARE PARTS BOXES, WATERPROOF CABINETS and BOXES, METAL STAMPINGS, FORMING and WELDING of FERROUS and NON-FERROUS METALS.

We specialize in ELECTRONIC, RADIO, TELEVISION and COMMUNICATION METAL PRODUCTS. "Whistler and Wiedermann Setups" used for economic and speedy production.



We can assure you of excellent workmanship and prompt deliveries. Send us your blueprints and specifications. We shall quote you immediately.



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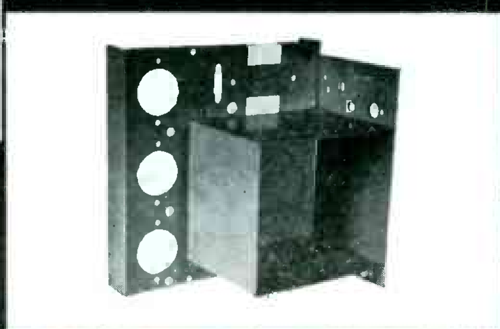

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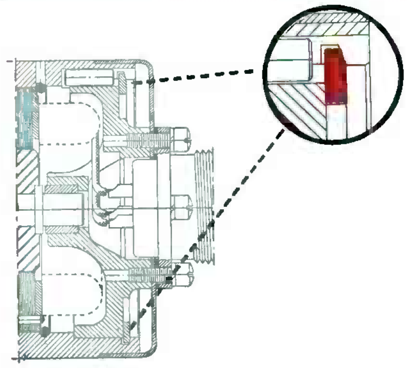
Telephone MAin 4-7395

Truarc Beveled Ring takes up end-play, eliminates shims, saves 20 minutes' assembly time



TACHOMETER GENERATOR—Kollsman Instrument Division, the Square D Company—showing Waldes Truarc Beveled Retaining Ring.

When installed in a groove with a corresponding bevel, the tapered edge of the Beveled ring acts like a wedge and rigidly bridges end-play. End-play can also be taken up resiliently by another type Truarc ring—the Bowed.

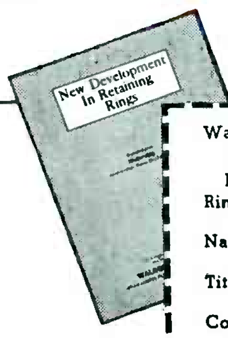
Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Truarc rings are precision engineered, easy to assemble and dis-assemble, always circular to give a never-failing grip. They can be used over and over again.

See what can be done for your product: send a drawing to Waldes Truarc Technical Service Engineers for individual attention without obligation.

One Waldes Truarc Beveled Retaining Ring gives Five big advantages:

- Secures the cover with its connecting parts in the housing against strong pressure, heavy vibration
- Absorbs accumulated tolerances up to .010 (ring diameter is 1.9375)
- Eliminates shims, saves material and weight
- Saves 20 minutes' assembly time
- Simplifies field maintenance by facilitating quick dis-assembly, re-assembly

Mail this coupon today for your copy of "New Development in Retaining Rings"



WALDES

TRUARC

Reg. U. S. Pat. Off.

RETAINING RINGS

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

Canadian Distrib.: Controlite Engineering & Sales Ltd., 20 Bloor Street W., Toronto 5

Waldes Kohinoor, Inc., 47-10 Austel Place 18-V
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Please send booklet, "New Development In Retaining Rings" to:

Name__________

Title__________

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WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND.

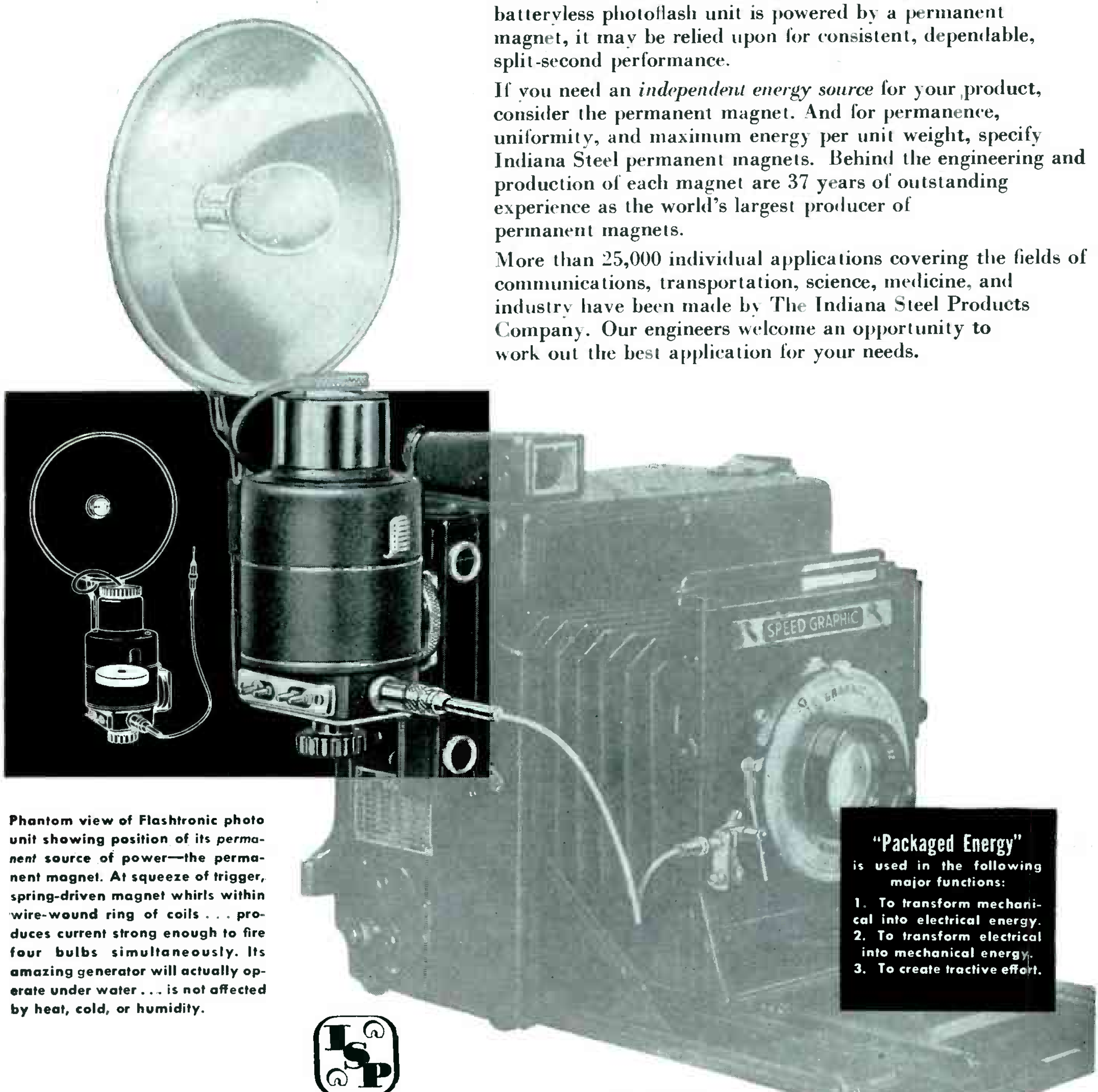
PERMANENT MAGNETS MAY DO IT BETTER

here permanent magnets DO IT BETTER!

Flash—goes the Flashtronic, and a fleeting fraction of a second is forever frozen on film. Because this revolutionary new batteryless photoflash unit is powered by a permanent magnet, it may be relied upon for consistent, dependable, split-second performance.

If you need an *independent energy source* for your product, consider the permanent magnet. And for permanence, uniformity, and maximum energy per unit weight, specify Indiana Steel permanent magnets. Behind the engineering and production of each magnet are 37 years of outstanding experience as the world's largest producer of permanent magnets.

More than 25,000 individual applications covering the fields of communications, transportation, science, medicine, and industry have been made by The Indiana Steel Products Company. Our engineers welcome an opportunity to work out the best application for your needs.



Phantom view of Flashtronic photo unit showing position of its *permanent* source of power—the permanent magnet. At squeeze of trigger, spring-driven magnet whirls within wire-wound ring of coils . . . produces current strong enough to fire four bulbs simultaneously. Its amazing generator will actually operate under water . . . is not affected by heat, cold, or humidity.

"Packaged Energy" is used in the following major functions:

1. To transform mechanical into electrical energy.
2. To transform electrical into mechanical energy.
3. To create tractive effort.

THE INDIANA STEEL PRODUCTS COMPANY

PRODUCERS OF "PACKAGED ENERGY"
SPECIALISTS IN PERMANENT MAGNETS SINCE 1910
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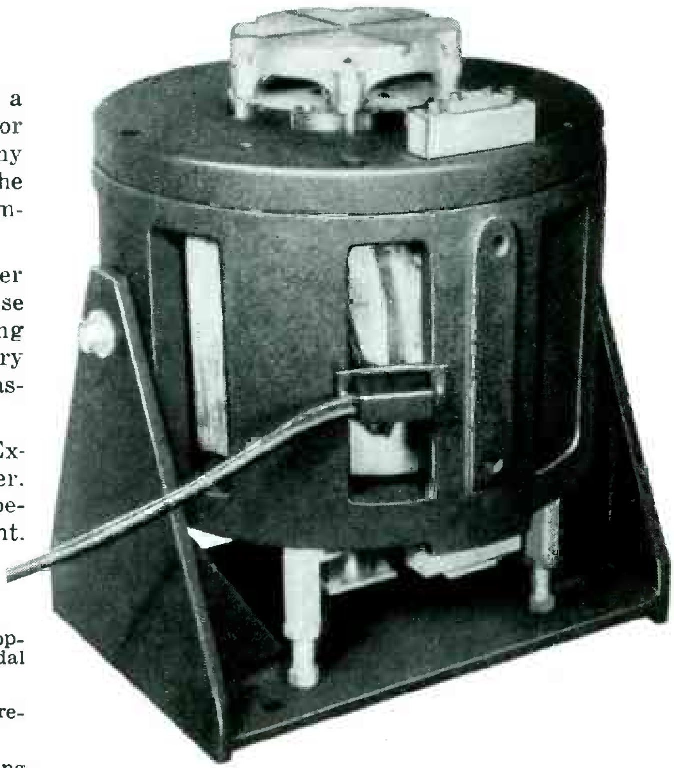
PLANTS { VALPARAISO, INDIANA; CHAUNCEY, WESTCHESTER COUNTY, N. Y.

HOW TO USE VIBRATION

to shake the "bugs" out of your product

This MB Vibration-Exciter will do it for you . . . quickly . . . efficiently!



THERE ARE many ways you can put vibration to work for a better product. Use it for quality-control, or inspection, for example. With this MB Exciter, you can shake-test many electrical and mechanical products for defects — right on the production line. Or you can connect it to power-driven assemblies to locate rattles and hums — *and their sources.*

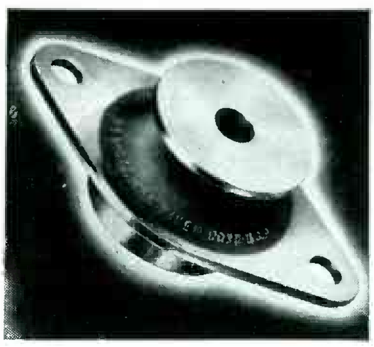
As an aid to research, this shaker is hard to beat for sheer usefulness. It reproduces vibrational effects of *years* of use within *hours!* Shake testing also shows whether operating conditions produce destructive resonance in any part. In every case, the "cure" is then easier, more accurate — and you assure a quieter, safer, longer-lasting product.

Many plants and laboratories are now using the MB Exciter for just such purposes. It pays for itself many times over. Why not write us about your "tough nut"? As vibration specialists, MB can show you how to crack it with this equipment.

PARTIAL TECHNICAL DATA

- Wide frequency range — 3 to 500 cps.
- Output — up to 200 pounds peak value.
- Power — 1500 v.a. maximum, continuous.
- Amplitude — 1-inch total excursion.
- Waveform—electrodynamic operation produces pure sinusoidal motion.
- Electrical adjustments—for frequency, force and amplitude.
- Smaller sizes available having wider frequency ranges.

IT'S EASIER DESIGNING WITH MB ISOMODE* MOUNTINGS



1. THEY ABSORB VIBRATION EQUALLY WELL IN ALL DIRECTIONS, so they control not only vertical, but troublesome horizontal and rocking motions as well.

2. THEY'RE NON-DIRECTIONAL. With an equal spring rate in all directions, they mount at any angle, giving you extra design freedom.

3. THEY HAVE HIGH LOAD-CAPACITY IN COMPACT SIZES, saving you space and weight.

4. THEY HAVE PLENTY OF RUBBER FOR SOFTNESS, yet are perfectly stable and safely self-snubbing.

Together with the tremendously simplified MB Design Method for positioning them, they offer you performance that makes satisfied customers. Send your vibration problems to MB if you want results. Our engineers are always ready to assist you.

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

SEND FOR FREE BULLETINS

Bulletin on "Vibration Testing Technique." No. 4-5 provides helpful design information on mountings. Reprint of technical Paper describes Isomode Simplified Design Method. Write Dept. C-5.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.

VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

TAFT-HARTLEY ACT

Frees "Slave" Labor

THE TAFT-HARTLEY ACT is two months old. Its full meaning is yet to be determined by decisions of the National Labor Relations Board and the courts. However, on its face, the Act refutes the attacks made upon it by union leaders as hysterical and fanciful.

Management has had every provocation to reply to these attacks in kind. To the credit of the employers of this country, they have not succumbed to that temptation. They have maintained a temperate attitude toward the new law and the problems it is designed to correct. This approach is right. But it is only an approach.

Union leaders will want to settle for nothing short of *repeal*. Their attack on the Act has made some headway. It may be more effective as time goes on. *Certainly the Taft-Hartley law will be repealed if management just sits tight and lets union leaders continue to confuse their followers.*

Management, therefore, must implement its present temperate attitude with a program of positive action. The Taft-Hartley Act must be made to work not because management wants it, but because it is fair to labor—and management can do things right now to see that the Act works. Management can:

I. Utilize every means at its disposal to acquaint the rank and file of union workers with the truth about the Taft-Hartley Act.

II. Suggest amendments to the Act if experience indicates that amendments are necessary.

III. Use the law as little as possible in settling labor disputes.

IV. Stand firm in its refusal to bargain away the rights accorded by the Act to workers, management, and the public.

An examination of those four *must's* will show why they provide management with its best program of action.

I.

Union members do not know what the Taft-Hartley Act provides.

There is abundant proof of that statement.

While Congress was still trying to write a law that the President would not veto, FACTORY magazine asked workers how they felt about major proposals in the pending House and Senate bills. Overwhelmingly they felt good. They were in favor of almost every individual provision that was finally incorporated into the bill and passed over the President's veto.

The same story emerged from the national opinion poll made by the Opinion Research Corporation of Princeton, N. J. and published by Look magazine after the law was enacted. It showed that union members uniformly favored major provisions of the Act, but were strongly opposed to the Act itself.

This inconsistency is easily explained. Instead of telling their members what the Act does for them, most union leaders have been condemning it as "a slave labor law" because it curtails the leaders' power and recognizes the rights of the union member and the public.

It is not a slave labor law. All of the basic rights accorded to labor by the Wagner Act of 1935 are preserved by the Taft-Hartley law. All of the unfair labor practices that were forbidden by the Wagner Act are still forbidden by the Taft-Hartley Act.

Nothing in the law impairs labor's right to bargain through representatives of its own choosing.

The Wagner Act condemned as an unfair labor practice any effort by employers to coerce employees in the selection of their bargaining representatives. So does the new law.

The Taft-Hartley Act merely recognizes rights of individual employees, of management, and of the public that were ignored by the Wagner Act.

For example, while the Taft-Hartley Act continues the workers' protection from coercion by employers, it also gives them new protection against coercion by unions. The individual worker is freed from the necessity of joining a union to *get* a job. He may still be required to join a union to *keep* his job, but not unless a majority of the workers vote for such a requirement in a government-supervised election.

Some people think the Taft-Hartley Act is weak in protecting the rights of the individual worker. They think that membership in a union should never be made a condition for holding a job. This is true. However, the Act does restore to the individual worker some rights which were blotted out under the Wagner Act, just as it does to management and the public.

A fair examination of the new law's provisions will show that they spring from one dominating purpose: i.e., to re-establish equality before the law.

For example, under the Wagner Act union leaders were free to say whatever they pleased about the employer to his employees. The employer, on the other hand, was denied freedom of speech in talking to his own employees. Now freedom of speech is largely restored.

Under the Wagner Act the employer was compelled to bargain with a certified union. Now the union must bargain, too.

Under the Wagner Act, unions alone had the right to petition for an election to determine whether the petitioning union represented a majority of the workers. Now the employer also has the right to secure an election.

These are features of the new Labor law that management must help workers understand. They must understand why the Act is not the "diabolical monstrosity" Philip Murray tells them it is.

Some companies have already started to explain these things to their workers. Techniques are well established, and they are techniques that any company can use. They include labor law digests in language workers can understand, supervisory conferences to cover points in the Act that affects the supervisor's handling of his job, distribution of reprinted articles that point out how employees benefit from the new law, editorials in plant newspapers and magazines, and advertisements in local newspapers.

II.

Management should take the lead whenever amendments to the Taft-Hartley law become necessary.

For twelve years labor leaders wilfully opposed every attempt to correct obvious abuses in the Wagner Act. We have now proved that a labor law *can* be amended. Let us be sure that management does not resort to the same obstructionist tactics labor has always used

In carrying out its basic purpose to re-establish equality before the law, the Taft-Hartley Act makes it "unlawful... for any corporation whatever or any labor organization to make a contribution or expenditure in connection with" national elections. Corporations have long been so restrained. The novelty is the balancing restraint upon unions, which now have huge financial resources amounting to very many millions of dollars. However, the language of the Act *may* restrain the labor press from saying what it thinks about candidates, thus impinging upon the freedom of the press. Senator Taft has recognized this possibility.

If it should develop that the Act inadvertently throttles freedom of the press—or misfires otherwise—management should take the lead in securing suitable amendments to the Act. By assuming a completely stiff-necked attitude toward any and all changes in the Wagner Act, no matter how badly needed, the dominant labor leaders and their political outriders finally brought on the sweeping revisions provided by the Taft-Hartley Act. Management must not follow that example of stupid leadership.

III.

Management will be wise if it uses the new law gently in settling labor disputes.

So far employers show no disposition to use the law excessively That is good. An analysis of the NLRB's docket from August 22 to September 30 shows that approximately 90 percent of the cases now before the Board were filed by unions and employees — not by employers.

We have been surveying employers, asking if they will have occasion to use their right to sue their unions. The answer so far is consistently, *"no."* That answer frequently is accompanied by this remark, "We certainly hope not. We have no desire to conduct our labor relations in the courthouse."

The desired result should be for the Act to produce only those law suits that are matters of vital principle. As many employers have remarked, the courthouse remains the worst possible place to conduct labor relations. The best place is in the plant—by free collective bargaining between parties enjoying an equality before the law. The Taft-Hartley law will serve its most constructive role if it encourages this kind of collective bargaining.

IV.

Employers should not bargain away legal rights accorded to them by the Taft-Hartley Act.

By bargaining away rights given them in that Act, employers serve only to upset a carefully created balance of equality before the law which is an essential element of fair collective bargaining.

Also, by bargaining away rights properly accorded to them, they let down those members of Congress who, in voting for the Act, braved continuous threats of political assassination by powerful union leaders. For their statesmanship in the complicated field covered by the Taft-Hartley Act these Congressmen deserve the support and gratitude of the whole nation—of management, of labor, and of the public alike.

Fairly handled on all sides, the corrective force of the Act can be made a major bulwark of industrial freedom.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

THIS IS THE 62ND OF A SERIES

Making Broadcast History!

NEW RING-SEAL POWER TUBES FOR FM AND TELEVISION

—110 to 220 mc frequency at max ratings

—1.5 to 6.4 kw typical Class C output

GENERAL ELECTRIC'S great 1947 series of ring-seal power tubes spells more efficient performance to those who build—or use—FM and television transmitters. Modern as tomorrow's telecast, these v-h-f tubes need minimum neutralization . . . are directly designed for grounded-grid circuits . . . meet in every way the *new* requirements of *new* station equipment going into service.

Ring-seal design — a G-E development—makes it possible to plug in a tube quickly, so that time off the air is cut to seconds. Firm terminal contacts with *wide surface areas* are another ring-seal advantage—moreover, all contacts are silver-plated to reduce r-f losses. An important aid to dependability and long life is the use, throughout the tube, of strong, enduring fernico metal-to-glass seals.

Your nearest G-E electronics office will be glad to give you prices and full information, as well as arrange for you to secure circuit application advice when desired. Or write direct to *Electronics Department, General Electric Company, Schenectady 5, N. Y.*

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Tetrode, forced-air cooled. 110 mc frequency at max ratings. Typical power output (Class C telegraphy) 1,575 w.

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Triode, forced-air cooled 220 mc frequency at max ratings Typical power output (Class C telegraphy, grounded-grid service) 2.45 kw.

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FIRST AND GREATEST NAME IN ELECTRONICS

BUSINESS BRIEFS

By W. W. MacDONALD

Printed Circuits Symposium sparked by Bureau of Standards' Brunetti featured 20 speakers, attracted 700 electronic engineers and executives to Washington. Discussed were six methods[1-6] of achieving unitized wiring . . . *printing, spraying, dusting, stamping, chemical and vacuum* . . . and many manufacturing techniques in each of these categories.

Highlight impressions gained during the meeting include these: Many more manufacturers than most people realize are working on the problem. Widespread use of new wiring methods is largely dependent upon the speed with which suitable components can be developed, and this part of the program is just getting started. Actual military use of the idea is as yet limited to a few specialties such as the proximity fuse, but the Air boys are very much interested and even in the Army and Navy light, compact gear has many applications. Similarly, a hearing aid is the only commercially available device we know about at the moment that uses printed circuitry throughout, but several leading radio receiver makers are setting up pilot production lines so that they can check comparative costs.

Unitized wiring is destined to play an important part in our business. *But technical problems still to be solved will prevent it from revolutionizing the field overnight.*

(1) ELECTRONICS, p 104, April 1946.
(2) ELECTRONICS, p 194, May 1947.
(3) ELECTRONICS, p 82, June 1947.
(4) ELECTRONICS, p 158, July 1947
(5) ELECTRONICS, p 132, Sept. 1947.
(6) ELECTRONICS, p 106 (this issue).

Quotes: At the Printed Circuits Symposium an airforce representative said that what his branch of the service wanted in the way of electronic equipment was something that *"took no space, weighed nothing and did everything."* A manufacturer responded that what his company was trying to develop was a product that *"cost nothing and sold for something."* A third speaker injected the intriguing thought that when wiring equipment, we once *"started with the conductors and then put in insulation, and now start with the insulation and put in the conductors."*

Railroad Radio and inductive communications systems in use represent a substantial investment. Following is a partial list, compiled by the Association of American Railroads in October:

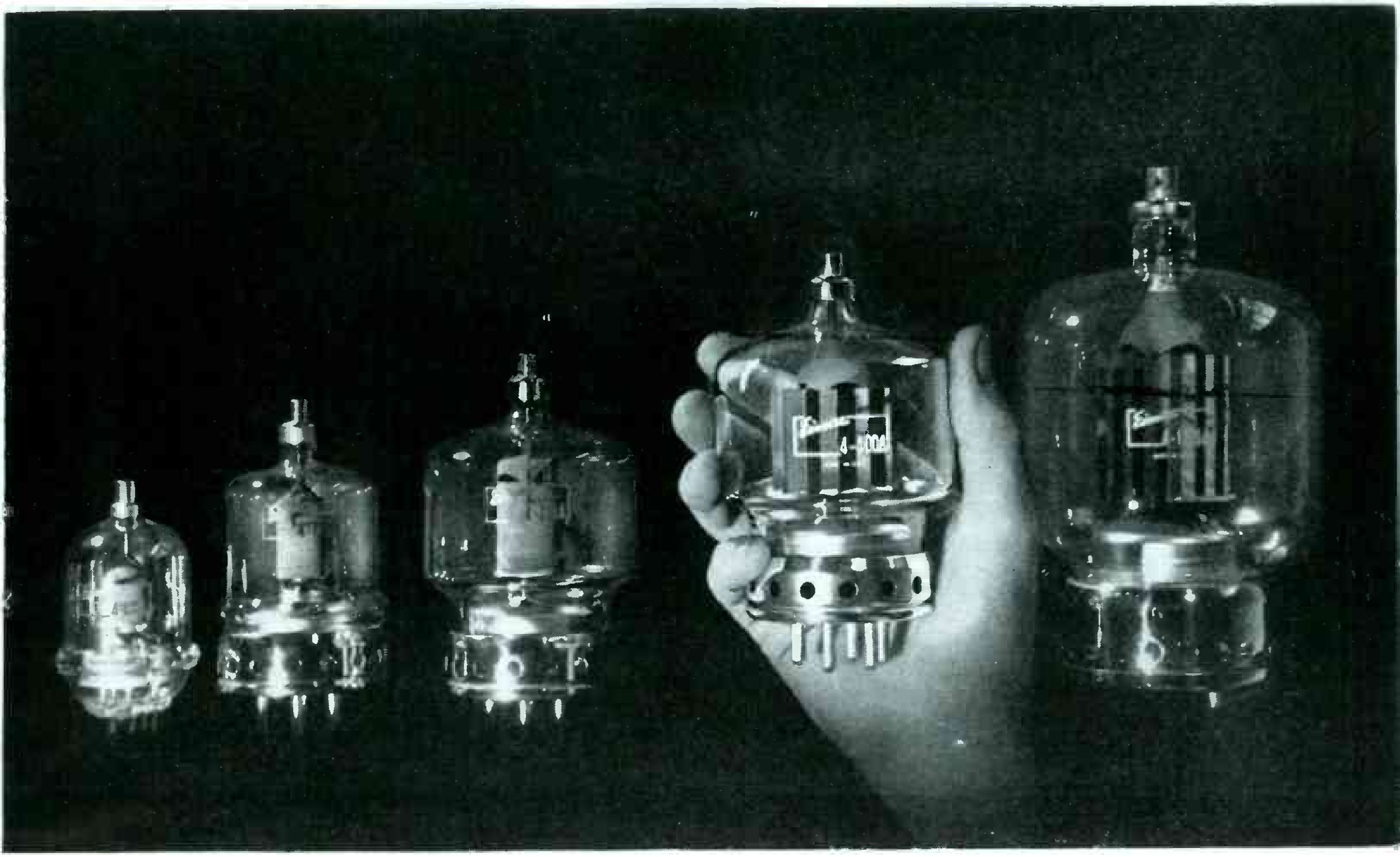
	*	
Atchison, Topeka & Santa Fe	R	$91,850
Baltimore and Ohio	R	7,635
Canadian Pacific	R	11,370
Chesapeake & Ohio	R	13,841
Chicago, Burlington & Quincy	R	46,720
Chi. Milwaukee, St. Paul & Pac.	R	34,778
Delaware, Lackawanna & Western	R	14,000
Denver & Rio Grande Western	R-I	109,524
Elgin, Joliet and Western	R	4,550
Florida East Coast	R	12,500
Great Northern	I	4,091
Jacksonville Terminal Co.	R	16,000
Kansas City Southern	I	63,900
Louisiana & Arkansas	I	8,600
Louisville & Nashville	I	3,756
Missouri-Kansas-Texas	R	13,500
Missouri Pacific	R-I	96,000
Pennsylvania	I	27,389
St. Louis-San Francisco	R	8,000
Terminal RR Ass'n of St. Louis	I	3,289
Union Pacific	R	20,645
Western Maryland	R	11,071

* R = radio, I = inductive.

Airborne Engine Analyzer developed by Sperry Gyroscope automatically narrows trouble down to a particular cylinder, and sometimes to a particular valve or spark-plug. Occasional misses are frequently shown up long before the pilot would otherwise be aware of impending failure.

We understand that faulty plugs account for about 50 percent of all engine troubles in the air and most delays on the ground, so the new electronic gimmick should save airlines much money and also improve schedules. One operator reports that it takes his mechanics an average of three hours to find faulty plugs without an analyzer, 30 minutes when one is available. The financial importance of time is emphasized by another, who says his big four-motored ships bring in $800 an hour in revenue.

Hotel Sound Survey by RCA just before the end of the war covered 108 buildings in the New York-Philadelphia area and several mid-western cities, indicated that all-year-round commercial types having 150 rooms or more (there are



FOR 1 KW FM . . . A NEW RADIATION COOLED TETRODE

ANOTHER in the Eimac line of power tetrodes . . . Type 4-400A embodying stability, high performance, and economy characteristics familiar to all Eimac tetrodes.

PROVEN DESIGN

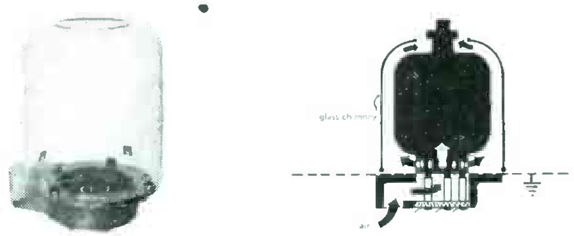
The 4-400A was created to fill the established need for a tetrode of the internal anode type capable of providing 1 kw FM-broadcast output per pair at low driving power, while operating well below maximum ratings. Type 4-400A inherits the Eimac know-how of tetrode design, it incorporates maximum shielding of the tube input—output circuits, processed non-emitting grids, low-inductance leads, thoriated tungsten filament and a rugged plate contributing to exceptionally long tube life.

AMPLE POWER

In typical operation, at frequencies in the 88-108 Mc FM broadcast band, two 4-400A tetrodes provide over 1000 watts of useful power output, operating at 4000 plate volts, while the plate dissipation is considerably under the maximum rating of 400 watts per tube. Complete operational data and characteristics are available by writing direct.

UNIQUE FEATURE

To assure adequate cooling and extended tube life, the 4-400A must be used in the special Eimac socket and air control chimney. This unique socket makes maximum use of a small amount of air by directing it first on the terminals, around the base seals, through the socket, around the envelope, and then on the plate seal and lead. The socket housing is of cast aluminum and conveniently mounts below the chassis deck while spring clips on the deck support the pyrex chimney.



LOW COST

Type 4-400A tetrodes are priced at $50.00 each, an exceptionally low price considering their power performance capabilities.

DESIGN ASSISTANCE

Let Eimac engineers assist you in your vacuum tube application problems. A letter to the Application Engineering Department will bring you up-to-the-minute data and application suggestions on the 4-400A and other Eimac tube types.

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Eimac TUBES
The Power for R-F

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some 2,100 of these) represent the bulk of the potential market. Among the hotel managers contacted 64 percent appeared to be good prospects for centralized systems, 53 percent indicated interest in intercommunication equipment, and 16 percent were receptive to the idea of installing sound reenforcing gear.

Among the hotels interested in centralized systems 86.1 percent wanted four radio channels, 63 percent wanted an additional transcription channel, and 51 percent wanted a special events channel too, indicating a desire for a six-channel system. Flush-mounting speakers were preferred by 46.4 percent, 30.5 percent leaned toward surface-mounted types, 10.2 percent thought they might use both types, and the remainder liked the idea of installing speakers in furniture. Neutral colored units were specified by 82 percent, while 10 percent asked for walnut. Some 58 percent wanted selector switches to be part of or adjacent to speakers, 42 percent wanted the switches remote from the speakers. About 87 percent preferred switch radio positions designated by station call letters. Emergency means of reaching all rooms, regardless of whether speakers were turned on or not, appealed to only 30 percent. On the other hand, 64 percent said it might be useful if they could make announcements over speakers that happened to be in use.

Among managers interested in intercommunication equipment 76 percent visualized administrative service, 50 percent planned to buy such equipment to speed service, as in kitchens. Lobby and public-room paging equipment appealed to 49 percent of the hotels interested in sound reenforcement, and 35 percent said they might eventually be interested in recorders. (Some 38 percent planned to originate their own transcribed music, while 29.6 percent expected to buy it from an outside source.)

Managers said they would prefer to buy sound equipment on an "installed" basis, which in most cases dictates the use of local labor if not a distributor, dealer or contractor, but felt that factory supervision was desirable.

National Business Show in New York featured several electronic recording devices for general office use, one for immortalizing telephone conversations. Also featured was a photoelectric card-punching device having many uses, and a 400-tube multiplying machine. The latter, we suspect, is just one of many imminent applications of electronics to commercial calculators.

Receiver Production by RMA members in the first three quarters of 1947 is reported as follows:

	F-M/A-M	Television	All Sets
January	51,318	5,437	1,564,171
February	53,594	6,243	1,379,966
March	67,264	6,639	1,377,269
April	112,256	7,886	1,759,723
May	84,507	8,690	1,316,373
June	76,624	11,484	1,213,142
July	70,649	10,007	1,155,456
August	72,014	12,283	1,265,835
September	90,546	32,719	1,839,980
	678,772	101,388	12,371,915

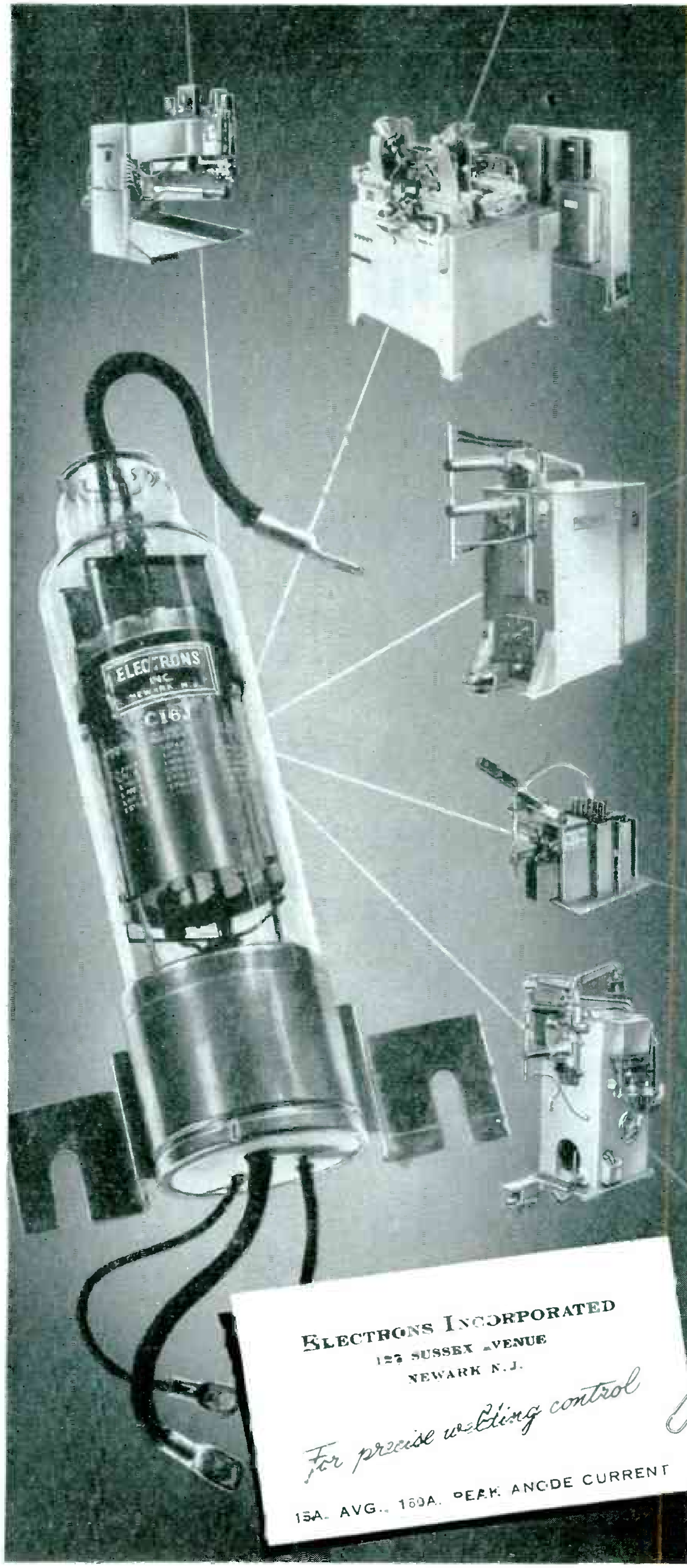
Predicted in July (p 74) were methods of economically duplicating wire recordings in quantity. Now Minnesota Mining advises that its engineers are developing a machine which will be able to mass-produce tape recordings from a master record at least as fast as disk recordings are turned out.

One Of Our Readers has developed an extremely compact portable tape recorder containing a spring-wound motor and a couple of small batteries. It seems to us that such a device, completely independent of power lines, has many potential applications. The trouble is that our correspondent has neither manufacturing nor sales facilities. Anyone out there interested in a tieup?

FM Association says that 86 percent of all f-m broadcast stations contacted in a nationwide survey during October were operating at a loss, 6 percent were breaking even and 8 percent were making a profit.

A Television Engineer who shall be nameless exhibited great interest in having his programming associates retain the services of a young lady at a time when studio personnel was being reduced. Investigation disclosed nothing peculiar about the lady other than the fact that she had a rather prominent chip on one of her front teeth.

The chip, it seemed, represented a most useful test pattern.



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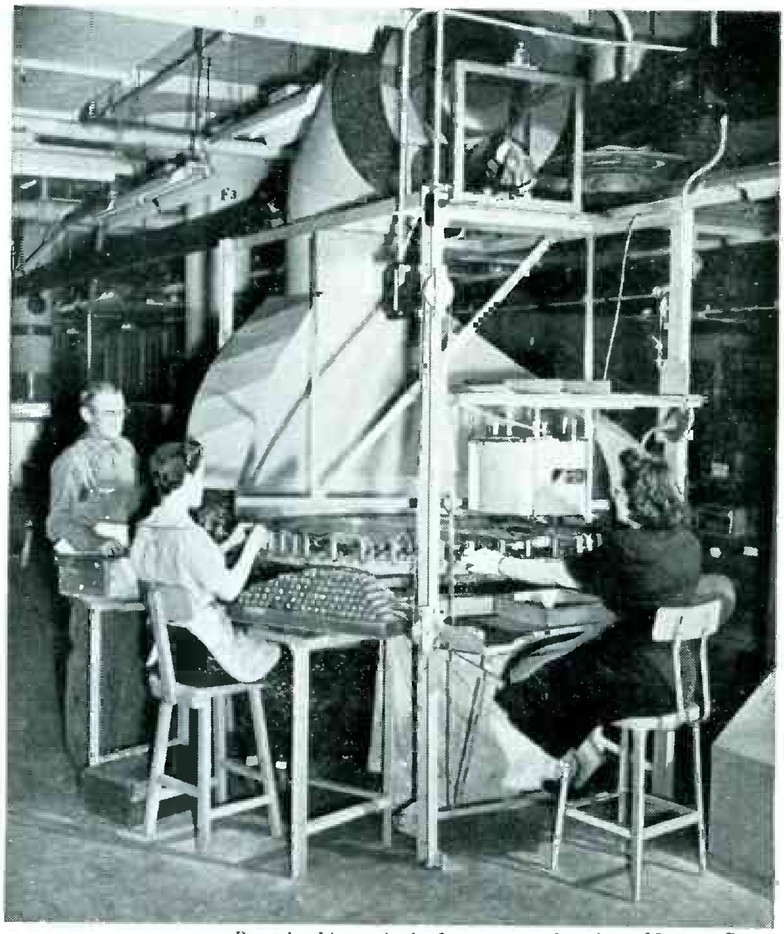
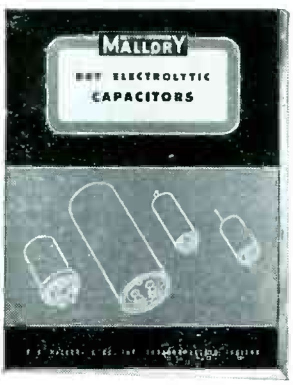


Round table method of pouring end seals at Mallory Plant

We put more into them . . . You get more out of them

DEPENDABLE PERFORMANCE at low cost has won widespread popularity for cardboard tubular electrolytic Capacitors in low priced equipment where operating conditions are not severe. Mallory tubulars are made under the same rigid processing and inspection methods that haved earned for Mallory Capacitors a world wide reputation for highest quality.

The extra inner seal, generous end seals and controlled freedom from contamination in handling provide the extreme reliability for which they are noted. Their long life, their ability to survive high temperatures and heavy ripple currents are due to unique processing operations developed in nearly twenty years of research experience.



Send for Mallory Capacitor Catalog which contains useful data on tubulars and on other Mallory electrolytic Capacitors.

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CROSS TALK

▶ **OBIT** . . . The death of Max Planck, which occurred last October third, reminds us that electronics, a young man's science, is based on the findings of men who have reached a ripe old age. Planck died at the age of 89, honored throughout the world for his contributions to physics, particularly for the quantum theory. He was 42 years old, in 1900, when he suggested that radiant energy occurs in discrete segments, the amount of energy in each quantum being proportional to the frequency. Acting on this suggestion, Einstein in 1905 solved the riddle of the photoelectric effect, a cornerstone of the electronic industry. Since then, whenever electrons are studied as individuals in atoms, the study must start with the quantum concept. The whole theory of the electric discharge in gases and vapors, with all its applications in industrial electronics, makes sense only in the light of quantum mechanics. Only when electrons swarm in huge numbers, as in an antenna, can the quantum idea be replaced by the simpler concept of the Maxwell equations. We rejoice that Planck, to whom we owe so much, lived a long and honored life.

▶ **PCM** . . . We have been amazed at the interest generated by an item in these columns in the August issue to the effect that the Hartley law (not to be confused with the Taft-Hartley law) was up for modification. A large manufacturer of radio receivers sent an emissary to MIT to consult the Tuller thesis on the subject. Major E. H. Armstrong, who was first to draw the connection between increased bandwidth and lowered noise, called us to find out more about it. Discovering that we had printed everything we knew, he planned to make a stopover at Cambridge. At the Bell Telephone Labs we hear that staff members are impatiently waiting for C. R. Shannon to complete his paper on the subject. For the present, there it lies. We have only one additional item to report: Studies at BTL indicate that the pulse code modulation scheme (pcm, see p 126, this issue) may be the most efficient way of using bandwidth for securing high quality in multichannel radiotelephone systems, in the light of the new theory. In addition, by regenerating pulses, the pcm signal may be sent through as many repeaters as you please (a really indefinite number) without harming the signal-to-noise ratio.

Note added in proof: A N. Y. IRE Section meeting, instigated by reports in the "recent technical press", presented a four-paper symposium on this subject, Nov. 12th last. Full report next month.

▶ **TUBELESS** . . . Electronic equipment, according to the simplest definition we know, has electron tubes in it. And an electron tube operates by virtue of a flow of free electrons in a vacuous or gas-filled space. If we were to confine the pages of ELECTRONICS to such simon-pure electronic matters, we would miss a lot of important developments which are, definitions or no, part and parcel of the electronics industry. So for some time we have been interpreting the word electronics rather broadly, to include such devices as crystal rectifiers and saturable core reactors which fill functions essentially the same as those performed by electron tubes. While we are reasonably sure of this ground, it is nevertheless encouraging to know our readers agree with us. Recently we queried 2,000 readers concerning their relative interest in articles on industrial electronics appearing in the September issue. Out in front by quite a margin were two papers, on magnetic amplifiers and a crystal-operated remote relay, neither of which uses vacuum tubes.

▶ **SUPPRESSED** . . . Since we printed H. H. Scott's article on his dynamic noise suppressor just a year ago, we have been swamped with requests for circuit details. Having promised to publish them, we were accused, not of suppressing information, but of being tardy. This issue, p 96, we redeem the promise, with interest. As so often happens, when the long-sought manuscript came through, the log jam broke with a vengeance. So we are happy to present *two* articles on dynamic noise suppressors. The second (by Harry F. Olson, p 118) uses a radically different technique to accomplish much the same result. This time next year, if any reader is still bothered with noise on phonograph records, we don't want to hear about it. All the answers are in this issue.

ATOM SMASHER

Forty-foot tube in Westinghouse electrostatic ion-accelerator

Electronic Techniques in Nuclear Science

The basic tools for studying the nucleus are particle accelerators and instruments that permit the effects of fast-moving ions and electrons to be observed. Basic electronic devices developed for these purposes are described

By SERGE A. KORFF

Professor of Physics
New York University
New York, N. Y.

IF ELECTRONICS is defined as the science of controlling ions and electrons then it is the most important single tool man possesses for the study of atomic nuclei. To study the nucleus experimentally we must do two things. We must hit it with a projectile of known and controllable momentum, and we must observe the results, both on the target and on the projectile. Whether the result of the impact is entry into and disruption of the nucleus, or merely the deflection of the projectile, we can deduce something about the nucleus.

Means of accelerating projectiles, and means of detecting, measuring and analyzing subsequent events, are both problems in electronics. Let us consider these two problems in turn, and take a look at some of the many sub-divisions in each category.

Accelerating Devices

There are two types of devices which supply fast streams of atomic projectiles. These are the electrostatic machines which accelerate the projectile in one long, continuous act, and the resonance accelerators which supply energy to the projectile in the form of many small impulses, correctly timed. These two systems are analogous to the ordinary rifle, in which expanding gases continuously accelerate the bullet, and proposed guns in which the bullet is given an impulse each time it passes one of a series of electromagnets suitably arranged within the barrel.

All matter is composed of atoms; molecules being a term applied to groups of two or more atoms held together by an electrostatic force called a chemical bond. Thus ordinary table salt is sodium chloride, a molecule which consists of an atom of chlorine and one of sodium. Each atom consists of a central positively charged nucleus, surrounded by a cloud of negatively charged electrons. Each atom contains as many positive charges in the nucleus as it has electrons, and so is electrically neutral. The electrons may be removed from the atom by a variety of processes, the most usual of which is bombardment with other atoms or electrons. The resulting atoms, lacking one or more electrons, are called ions. The process of removing one or more electrons from a previously neutral atom is called ionization.

The positive nucleus itself consists of aggregates of positively charged particles called protons, and neutral particles of nearly the same mass, called neutrons. The chemical nature of a substance, i.e., the element of which it consists, is determined by the number of protons. The atomic weight is determined by the number of protons plus neutrons. Thus hydrogen consists of one proton, no neutrons, and one electron. Heavy hydrogen, or deuterium, consists of one proton, one neutron and one electron. Helium consists of two protons, two neutrons and two electrons; and so on up to uranium, the common form of which consists of 92 protons, 146 neutrons and 92 electrons. The elementary particles are the most common projectiles, although compound nuclei have sometimes been used. Thus we shall usually speak of accelerators emitting streams of electrons or protons, and occasionally deuterons, alpha particles, or heavier nuclei. (Neutrons are not accelerated by electric fields and are obtained from nuclear reactions. Hence they fall outside the domain of electronics as we have originally defined it, although they produce effects which are detected by electronic techniques.)

An electrostatic particle-accelerating machine, called a Van de Graaff generator in honor of R. J. Van de Graaff who built the first successful model, consists of a long insulating tube containing a fairly good vacuum, along the length of which a potential difference may be applied. The high potential is generated and maintained by a motor-driven belt which, in the manner of a bucket-brigade, carries a charge up to the high-voltage electrode. The charge is sprayed onto the belt by an electrode consisting of a set of sharp points looking like a steel comb, and maintained at a potential of 50,000 volts or so by a transformer-rectifier combination. The continuous accumulation of charge by the high potential electrode causes a high voltage to be produced. The attainable voltage is limited ultimately by the insulation characteristics of the surrounding air and by the supports of the electrode. Potentials up to 3 million volts or more have been produced by such machines. Fig. 1 shows a typical Van de Graaff machine schematically.

Contained in the high voltage electrode is an ion gun which initiates the stream of charged particles to be accelerated by the high potential difference. If an electron beam is desired the electrode is operated at a negative high voltage, with the target grounded and positive. If positive particles, such as protons or deuterons, are to be accelerated then the potentials are reversed. An ordinary filament is used as a source of electrons. For positive ions the gun consists of an arc in which ions are produced and a series of electrodes to pick out and start some of the ions on their way. In each case the beam, once formed, can be focussed in a manner similar to a light beam by using specially shaped electrodes.

The Van de Graaff generator has two important advantages over the resonance accelerators to be described below. The high voltage is steady and can be measured with accuracy. The beam of particles therefore has a constant and a uniform momentum, an important consideration in many nuclear physics applications and almost indispensable in accurate measurements of excitation functions, cross sections and other nuclear properties of similar nature.

The first of what we term resonance accelerators is the cyclotron. This device depends for its operation on the fact that the travel-time of a charged particle moving in a circular orbit is independent of its energy. A charged particle will be deflected by a magnetic field at right angles to the lines of magnetic force. Hence if we have a narrow gap between two magnetic poles and introduce particles with small initial velocities in the plane of the gap they will perform circular orbits in the field. If we accelerate the particles, we will not alter the length of time it takes to complete a circle, or half circle, for although the particle is now going faster it describes a larger circle. Since the distance a particle travels to complete a half-circle (or semi-circumference) of a radius r is πr, if its velocity is v its travel time t will be $t = \pi r/v$. But a particle of velocity v in a magnetic field of strength H gauss will describe a circle of radius r given by

$$mv^2/r = \mu Hev, \qquad (1)$$

where e is the charge of the particle, μ is the magnetic permeability of the medium, m is the particle's mass. If we solve for r and substitute this relation into the value for t, we get

$$t = \pi m/\mu He \qquad (2)$$

and both r and v have disappeared from the result.

The first successful cyclotron was built by E. O. Lawrence at Berkeley, California. He reasoned that since the result computed above was true, he could give a particle a series of accelerations by allowing it to perform its orbits between two hemi-cylindrical electrodes. These electrodes were hemi-cylinders, shaped like the letter D, and called dees. Fig. 2 shows the arrangement. If the potential between the dees is reversed during the time it takes for a particle to traverse its half-circle within the dee, the particle comes to the space between the dees at the opposite half-cycle, and receives another acceleration equal to the first. This reversal of the potential of the dees is accomplished by driving them with a radio-frequency oscillator.

In principle, cyclotrons can be used to accelerate any charged particles of either sign, although in general they are used to accelerate positives, i.e., protons, deuterons and sometimes alpha particles. The theory of relativity is the ultimate limiting factor in the energies attainable. If a particle's speed approaches that of light then, the theory tells us, the mass will change. We see from Eq. 2 that the travel-time in the orbits, while it does not depend on the velocity, does depend on the mass. Hence if the mass changes the particles will drop out of resonance and will not reach the gap between the dees at the right time for the next pulse. The relativistic variation of mass with velocity starts, for electrons, well below a million volts. Therefore, electron cyclotrons are not practical. (One possible way to get around the relativity limit would be to alter the frequency of the r-f oscillator at the right rate so that resonance for the particle of varying mass would be maintained. Calculations of the variation have been carried out, and frequency-modulated cyclotrons are now on the drawing boards.) For protons which have 1,850 times the mass of the electron, and for deuterons and alpha particles the relativistic mass variation does not become important until the energy is up around 50 million volts. Thus cyclotrons may be used to accelerate heavy positives up to 100 million volts in some cases. Before the war, such cyclotrons were already producing 30 million-volt particles, and this figure has recently been exceeded.

Another accelerating device is the betatron. The first model was built by D. W. Kerst in Illinois in the

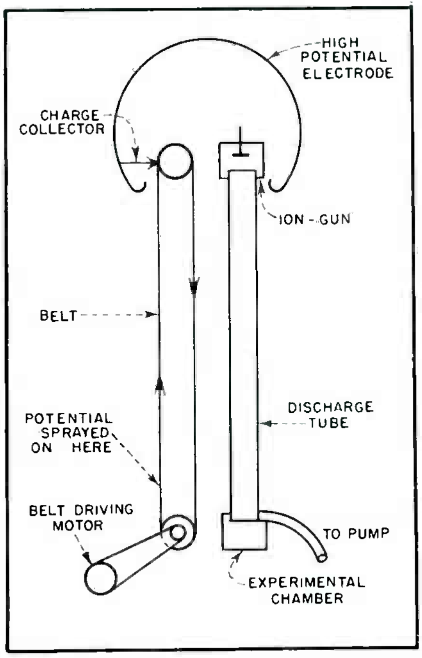


FIG. 1—Van de Graaff electrostatic particle-accelerating machine, with potential-distributing rings omitted

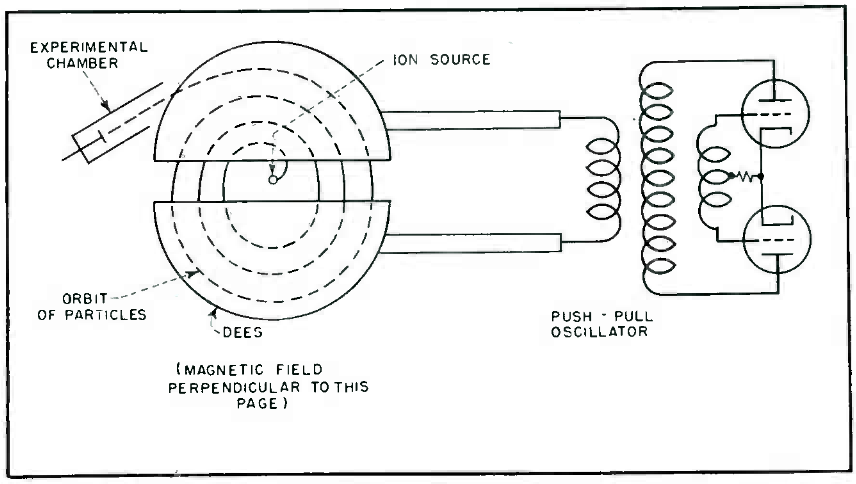


FIG. 2—Basic operating principle of cyclotron resonance-type particle accelerator. Magnetic poles are above and below the dees

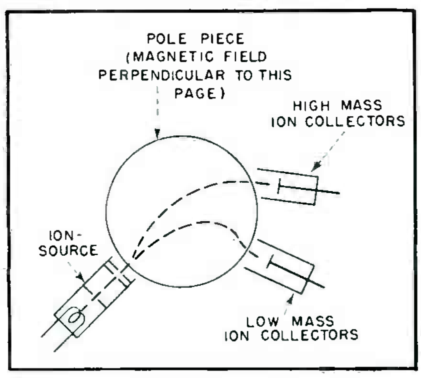


FIG. 3—Simplified diagram of typical mass spectrograph

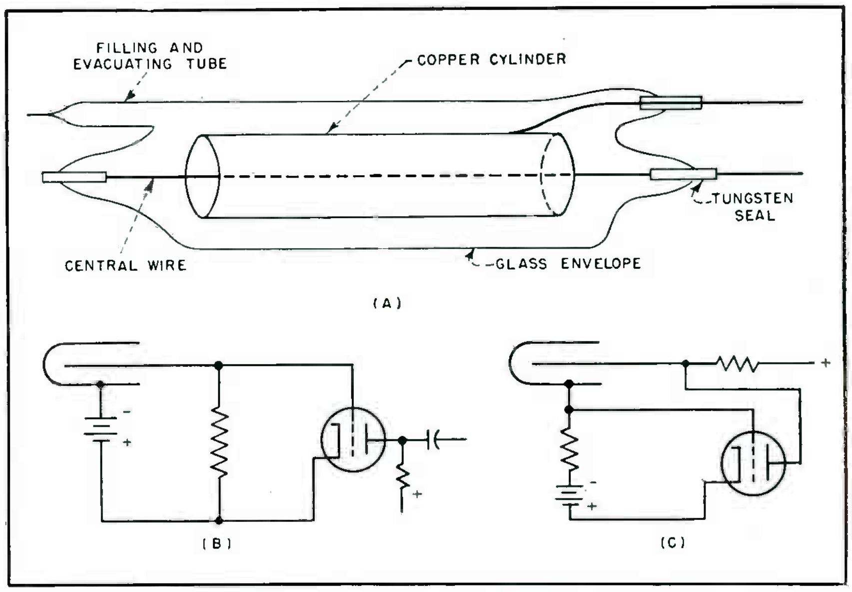


FIG. 4—(A) Geiger counter tube. (B) Neher-Pickering quenching circuit. (C) Neher-Harper quenching circuit

year before the war. This device is used for accelerating electrons and is not limited by the relativity mass-variation. It depends for its operation on the fact that a varying magnetic field will accelerate a charged particle. Suppose an electron is moving in a magnetic field. It will be moving in a circle. Suppose now that the field is increased. Then, while the field is changing, the electron will receive an impulse. Because of the acceleration, the electron will move faster, hence in an orbit of bigger diameter; but the field was increased, and this will tend to decrease the orbit diameter. By proper choice of constants these two rates of change can be made to compensate so that the orbit diameter remains constant and the electron spins around in a fixed orbit at progressively higher speeds. The electron orbit is contained in a glass envelope called a doughnut, in which a vacuum is maintained. The General Electric betatron at Schenectady is now operating at 100 million volts. The betatron itself is an electronic device, and the various auxiliary circuits, including the electron injector and the orbit-expander, which flips the orbit out onto the target at the moment it has reached maximum energy, are all electronic in nature.

All three devices have one purpose in common, namely, to produce high-speed projectiles for nuclear research. Each accelerating device has quite different properties and economics of operation from the others, and is suitable for the solution of a special group of problems. Thus, for example, at low energies a Van de Graaff machine costs less than a cyclotron, whereas at high energies the reverse is true. Also, since most of simple problems in the medium-voltage range have been solved, many medium-sized cyclotrons are today operating as production machines, producing artificially radioactive elements and compounds for biological, medical and chemical research and tracer problems.

Measuring Devices

An important tool of nucleonic research is the mass spectrograph. There are three principal modifications. The first is typified by the precision model built by F. W. Aston and one built by K. T. Bainbridge for the precision determination of atomic weights. In both models great accuracy is sought and difficulty of operation is unimportant. These investigators have been able to determine weights to three, four and sometimes five decimal places. The second modification is that used for rapid identification of isotopes and relative intensities. In this model, it is merely necessary to get separate indications for each mass-number and some idea of the intensity of each. Units are used in medical, chemical and biological isotopic tracer studies. The third modification is made for the purpose of actually separating isotopes and securing useable amounts of each. The arrangement differs from the other types in that collectors for each isotope are provided. Usually this model is set up to work on only one element.

The mass spectrograph operates on the principle that charged particles are deflected in magnetic fields, the amount of deflection depending on the mass as described by Eq. 1. A schematic diagram is shown in Fig. 3. The substance to be studied is vaporized and introduced into an arc, where it becomes ionized. Some of the ions are drawn by an attracting field and then accelerated by a somewhat larger accelerating potential into the space where the magnetic field exists and where deflection takes place. The beam then falls onto one or more detecting or collecting chambers. We shall describe detecting devices later; collecting chambers are exactly what the words imply, spaces in which a foil may be placed to receive the isotope.

Many detecting devices are used in nuclear physics. The majority of these are electronic in nature, and the majority operate by detecting and measuring ionization. We must

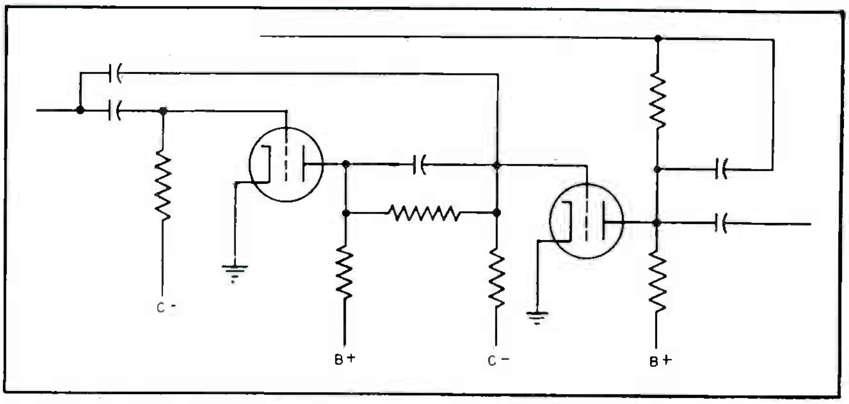


FIG. 5—Eccles-Jordan trigger circuit, the basis of scale-of-two counters

therefore define the word ionization. It will be used here, in its broad sense, to mean any process by which an atom or molecule, originally electrically neutral, acquires a charge. This may occur by the separation of a neutral atom into positive and negative charges, or by the adherence of a charge to a neutral atom or molecule. Most of the important and much-used detectors of nuclear processes operate by measuring or counting or otherwise observing the passage of electrical charges by using electronic techniques, procedures or auxiliary circuits. Since the charge on a single electron is an exceedingly small quantity, some form of electronic amplification is usually employed. It is clear, then, that we may either count the number of electronic charges or observe their passage through a suitably sensitive device. In nuclear research we usually measure both the number of particles or projectiles in the beam and the number and types of particles resulting from the disintegration of the target.

Devices used to determine the number of charged particles are called counters. There are many forms of such counters, those named after H. Geiger being perhaps the best known. The majority of those in use at the present time operate in the same manner as the first counters did, many years ago. Indeed, counters have been known and used for forty years. The first paper describing such detecting devices was published in Cambridge, England, by Sir Ernest Rutherford and Geiger. They arranged a cylinder with a central wire running along its axis, applied a potential between the cylinder and the wire, and measured the voltage changes (pulses) on the wire. When the charged particle to be detected passed through the space within the cylinder, a pulse was observed on the wire. Thus a counter is a gas-filled diode, as shown in Fig. 4A.

Suppose that the particle to be counted passes through the cylinder. The particle will produce ionization by collision with atoms of gas as it travels, and electrons thus produced will be attracted to the positive central wire. By cumulative ionization, which becomes more and more violent the nearer the electron gets to the wire, an avalanche of electrons is built up near the wire and the change in potential of the central wire is proportional to the number of electrons which arrive. The number of additional electrons produced by each original electron is called gas amplification.

At high amplifications (with sufficient voltage applied to the counter) space-charge limits the growth of the avalanche, so that all avalanches are of the same size, no matter whether they were initiated by one electron, by ten or by ten thousand. It is this feature which may be used to identify particles. Suppose, for example, that the amplification is moderate (say 1,000). Then if an electron passes through the counter and leaves 10 electrons behind it as a result of collisions which it made in the gas

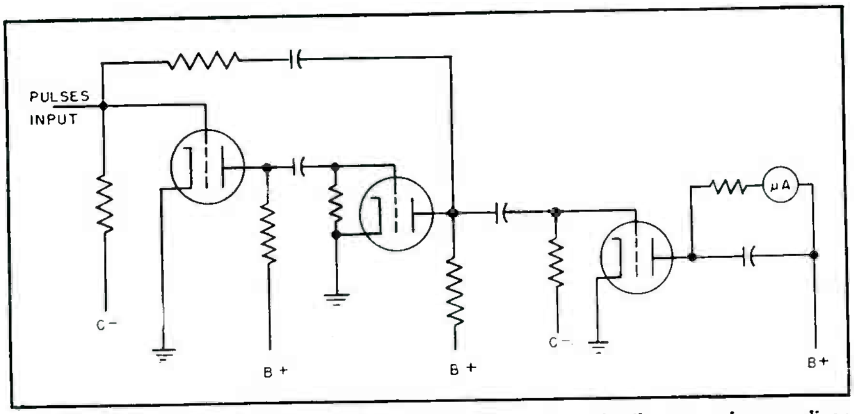


FIG. 6—Counting-rate meter. The first two tubes are a multivibrator pulse-equalizer

these ten electrons drift toward the wire and generate a thousand more each. A total of ten thousand electrons arrive on the central wire, producing a pulse which can be measured quite readily with ordinary vacuum tube amplifying circuits. Now suppose that an alpha particle passes through the counter. Such a particle may leave ten thousand electrons behind it along its path because it is much heavier than the electron and a more powerful ionizing entity. These ten thousand electrons each initiate an avalanche and the total number of electrons arriving at the wire will be ten million. Hence the alpha particle will produce a much larger pulse on the central wire than does the electron. Since the pulse size observed on the central wire is proportional to the amount of ionization produced by the primary particle as it passes through the counter, such counters are called proportional counters.

Suppose we increase the voltage on the counter so that space-charge limits the growth of the avalanche. Then the growth of the larger pulses is prevented and all pulses will have the same size, regardless of the number of electrons produced by the primary particle as it passed through. Now the counter simply counts the total number of particles passing through it but no longer distinguishes between the types of particles; the heavily-ionizing alpha particles produce no larger pulses than do the lightly-ionizing electrons. Counters with such characteristics are called Geiger counters or Geiger-Muller counters, because Geiger and Muller first described large and easily constructed counters of this type.

We have pointed out that the particle to be counted must leave at least one electron behind in the gas to initiate the avalanche. But a neutron passing through a gas does not leave electrons behind and hence this type of counter will not count neutrons. To devise a counter for neutrons the author filled a proportional counter with boron-trifluoride. Neutrons interact with boron, giving out an alpha-particle which may readily be counted by ordinary proportional counting procedures.

Auxiliary Circuits

A Geiger counter has its avalanche size limited by space charge. But it is of the nature of this type of gas-discharge to be self-perpetuating. Thus if left to itself a Geiger counter would break down into a continuous glow-discharge as soon as the first count occurred. To prevent this contingency it is necessary to quench the discharge.

Some typical quenching circuits are shown in Fig. 4B and 4C. In Fig. 4B, the circuit developed by Neher and Pickering, the triode has its grid connected to cathode and hence is normally conducting. When electrons are collected on the counter wire the grid triode is driven to a negative value and the tube ceases to conduct. During the time that it takes for charge to flow through the grid resistor the counter is isolated from the high voltage supply and the discharge terminates. In the Neher-Harper circuit of Fig. 4C the triode is normally cut off because of the negative grid potential. A positive pulse appearing on the cylinder of the counter causes the triode to conduct, thus partly short-circuiting the counter and dropping the potential across it long enough to permit recovery.

Quenching can also be achieved by an internal mechanism. It has been found that by introducing some organic vapor such as a centimeter or two of alcohol or ethyl acetate into the counter the discharge goes out by itself. Such counters have the disadvantage that the quenching vapor changes with time, so that the counter characteristics are not constant over a long period.

There are many other circuits which assist the counting operation. If the pulses occur at slow and regular intervals the most elementary circuits will serve. If, as is more usual, the pulsing rate is both fast and irregular, more complex circuits are necessary. Thus, for example, we may require a scaling circuit to scale down the number of counts. Customarily, scaling circuits are based on scales-of-two employing a biased multivibrator circuit with two stable modes of operation. The basis is the trigger circuit devised by W. H. Eccles and F. W. Jordan thirty years ago. Fig. 5 shows the typical circuit, the operation of which is familiar to students of electronics. The first pulse causes the circuit to go through half a periodic cycle, and the second pulse restores the circuit to its initial condition. If the bias on one tube is such that only positive pulses will operate it we may feed the positive output pulse to another similar stage and so forth. Each stage will deliver a positive output pulse for every second incoming pulse, and by adding the desired number of stages we may construct a scale of 2 or 4 or 8, and so on. There are many scales-of-4048 in operation at the present time.

A modification of the scaling cir-

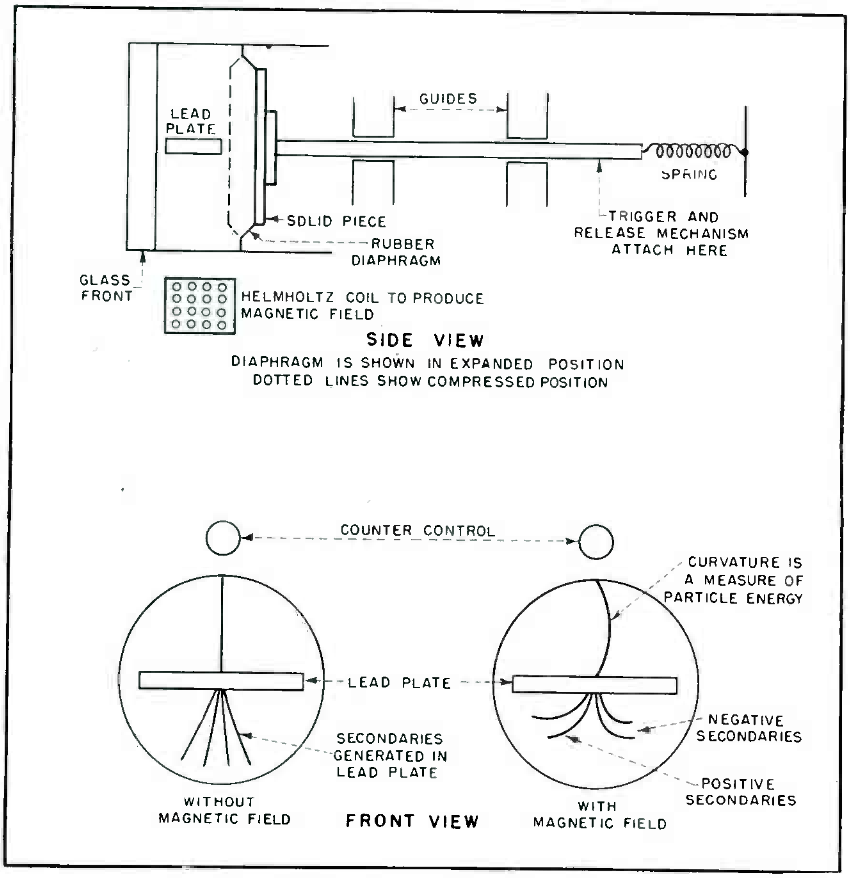


FIG. 7—Cloud chamber used in studies of the atom

cuit is the scale-of-ten, or decade scaler. This is usually accomplished by arranging ten tubes, the plate current of each supplying the grid bias of the next one, in a ring, so that when pulsed the pulse will flip one tube each time. It will require ten pulses before the tube controlling the output is actuated. A set of such rings-of-ten will provide any integral decimal multiple; and indeed this is the basis for an electronic computing machine familiar to many engineers.

Other Instruments

At times it is convenient to know not the total number of pulses but the rate of counting in counts per minute. This has led to the development of a counting-rate meter. Such a device operates by piling charge on a capacitor and measuring the rate of increase of potential between the plates as shown in Fig. 6. It is necessary that all pulses be of the same size; hence the stage which has a tube with a capacitor, high-resistance resistor and microammeter in its plate circuit is usually preceded by a multivibrator pulse-equalizer. The last tube is cut off by its negative bias and passes current only when the pulses are incident on its grid. These pulses then appear on the capacitor, and leak off through the high resistance and the microammeter. The microammeter may be calibrated directly in counts per minute.

In addition to these direct measurements of numbers of counts, it is sometimes desired to know the pulse size, or the number of pulses in each size group. Pulse size measurements are usually made by varying grid bias, the bias being so selected that only the pulses larger than a certain size are counted. These bias arrangements are sometimes also used to exclude noise or background. Thus, for example, a neutron counter operated near a cyclotron will have an enormous background due to small pulses produced by beta and gamma rays scattered in the neighborhood of the machine. The neutron counts will be much larger, but many fewer. Hence elimination of the background is essential. With several biased amplifiers operating simultaneously a pulse-size distribution curve can be rapidly obtained. Such distribution curves are the end-products usually required for interpretation of nuclear reaction.

All the circuits mentioned will operate best if the voltages supplied to various parts thereof are kept at a fixed value. Hence modern nucleonics relies heavily on various types of electronic voltage regulators. These are used not only for controlling the high potential supplied to various types of counters but also for regulation and stabilization of all the other potentials in the circuits. In addition, a whole set of auxiliary circuits finds its uses in aiding the study of nucleonics and in the interpretation of results. Pulse generators are of use in checking circuits. Double-pulse generators, with controllable spacing between the components of the double pulse and adjustable repetition-rate, are of value in determining experimentally the resolving-time of the circuits and of the counters themselves.

An important type of nuclear detecting device is the cloud chamber. This device has been known for many years, and in birth date antedates the first world war. Suppose we arrange a volume of gas so that by suddenly moving a piston the volume can be expanded to a somewhat larger volume. Then suppose that some moisture is introduced so that the volume of gas contains vapor at a saturated or almost-saturated value. A sudden expansion will produce cooling, and will drop the temperature of the vapor down below the dew or condensation-point. A cloud will form in the chamber. Examination with a microscope will show that any cloud or fog in nature usually has droplets forming about the dust or smoke particles, called nuclei of condensation. If dust is carefully excluded, condensation will take place about ions. Hence if a cosmic-ray particle has passed through the chamber, leaving behind it a trail of ions, and then an expansion occurs the cloud will form along the path which the particles followed, and will look like a fuzzy string passing through the chamber, shown in Fig. 7. Thus the paths of the electrons and other particles can be rendered visible.

The cloud chamber is an extremely useful and versatile instrument. By placing slabs of lead transversely in the chamber, the particle may be studied as it traverses the lead, for it can be seen before it hits the slab and after it emerges. The various processes of secondary production in the lead may be studied, for one may observe one particle entering and several emerging. Further, by applying a transverse magnetic field, which will bend the particles into curved orbits, the energy of the particles may be deduced. The amount of bending will vary with the momentum of the particle, that is, will depend on its mass m and velocity v, as described by the equation.

$$r = mv/He \qquad (3)$$

where r is the radius of the bend, H is the field strength and e is the charge of the particle. This equation follows directly from Eq. 1. By combining the magnetic field with the lead plates, the loss of energy as a particle passes through the lead (or any other substance) can be determined.

In operating cloud chambers, much electronic technique is required. Usually, cloud chambers today are counter-controlled, and are expanded only after the discharge of a master counter or set of counters placed above or otherwise adjacent to the cloud chamber. This procedure insures that almost every expansion will show the desired track, whereas a random uncontrolled expansion would only occasionally and by chance show something passing through. When the counter gives the signal for expansion, a complex series of operations follows. First, a thyratron trips the expansion trigger. Then, a second thyratron flashes the gas-discharge (Edgerton) lamp which illuminates the chamber and allows a photograph to be taken. This flash, usually timed electronically, must occur after the expansion by the proper fraction of a second; if too soon, the track will be almost indistinguishable, for the cloud will not have formed; if too late, the track will be fuzzy as it starts to diffuse. Then the chamber must be restored automatically to its sensitive position. The chamber is recompressed and the trigger reset. A sweeping-field is applied long enough to clear out the ions, or debris of the previous expansion. The capacitors for the Edgerton lamp are recharged; and the camera is rewound to prepare it for the next photograph. Usually, this cycle of events is carried through largely with the aid of electronic circuits.

Of the multitude of other electronic devices which have assisted nuclear research one in particular deserves mention. This is the cathode-ray oscilloscope. It is used both for examining pulses and ionizing events produced in the various nuclear reactions and for trouble-shooting, not only in counter circuits, but in many of the accelerating devices and associated control-circuits.

Needs of the Future

Looking ahead, it is clear that there is much still to be done. There are innumerable ways in which the electronic engineer can be of use to the science of nucleonics. Let us consider a few contributions yet to be made.

First of all is improved instrumentation. Faster scaling circuits, simpler, more stable and easier to adjust than the present ones, are needed. Counting-rate meters which are more stable and operate over a wider range will be of value. Better voltage regulators and stabilizers, capable of delivering a controllable voltage over a wider range, and keeping this voltage constant despite fluctuations in both the primary voltage and frequency, and variations in load, are needed. For example, a high voltage supply to provide 6,000 to 10,000 volts, continuously variable from 200 volts to the maximum which would not vary by as much as one volt while the primary fluctuates five cycles or ten volts either side of normal would be of great value. The output should be fully floating, so that either side can be grounded. This particular circuit would supply the voltage for Geiger and proportional counters, and would not need to supply more than a few microamperes of current.

The second field in which new ideas will be of value is in designing new and higher energy accelerators. The frequency-modulated cyclotron, to overcome the relativity-limitation on particle speeds, is an example. Some start has been made in this direction, but there is a long way to go. The application of radar techniques to the design of accelerators, both linear and resonant, will open an enormous field in which the advice of the electronic engineer will be of value to the physicist.

In medicine and in the use of radioactive tracers, there is yet much to do. We are here considering only the instrumentation, and not suggesting that engineers become medical men, but merely that engineers design and adapt instruments to the new problems.

The field of nuclear power is wide open. The fission reactions which have been so widely publicized, yield a few fast-moving particles. What is the most efficient way to turn this energy into useful power? Is it by conversion into heat, inefficient as boilers are known to be? Or can some means be found directly to convert the energy, tied up as ionization or as particle-velocity, into useful force? These questions are now calling loudly for answers by competent engineers.

Looking forward, one can see that we are on the opening edge of a new era, in which there will be vast new fields into which any competent engineer may go and in which he can make significant contributions. As soon as he is familiar with any two or more fields he can map out a campaign in the borderline region with attendant useful results if he is successful. The sciences all interlock, and an improvement in one field will suggest new techniques adaptable in another. It appears that as long as we can continue to apply our knowledge gained in one field to the extension of another field we shall have an increasing flow of interesting new developments and benefits for the human race.

This Douglas transport flew across the Atlantic and back without a pilot at the controls. Flights between its Ohio base and Newfoundland were also automatic and nonstop, making a total round-trip flight of 8,000 miles

Automatic Controls for Pilotless Ocean Flight

With no hands on the controls from takeoff to touchdown, a U. S. Air Forces C-54 transport recently crossed the Atlantic, carrying only a standby crew. The robot-like equipment used, detailed here for the first time, offers aid to overburdened airline pilots

PILOTLESS FLIGHT across the Atlantic ocean became history this year when a C-54 four-engine transport took off from the landing strip at Stephensville, Newfoundland under control of a new robot pilot, and touched down at Brize Norton Aerodrome near London just 10 hours and 15 minutes later. The emergency flight crew took over only to apply brakes and taxi the plane off the runway. A few days later the same performance was repeated on the westward crossing, but the plane was brought down manually at Stephensville since no radio-beam landing facilities were available there.

Commercially, the complete control of an airplane by a robot pilot on a flight across the Atlantic brings closer to realization the airline operator's goal of all-weather flying, with greater comfort and

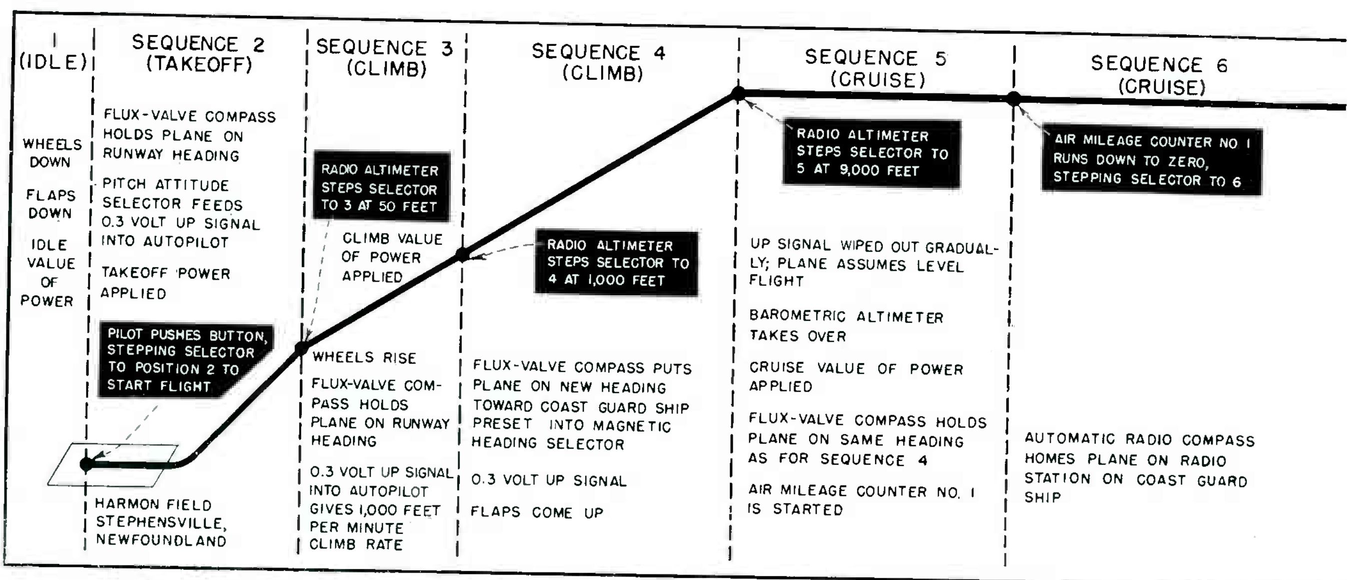
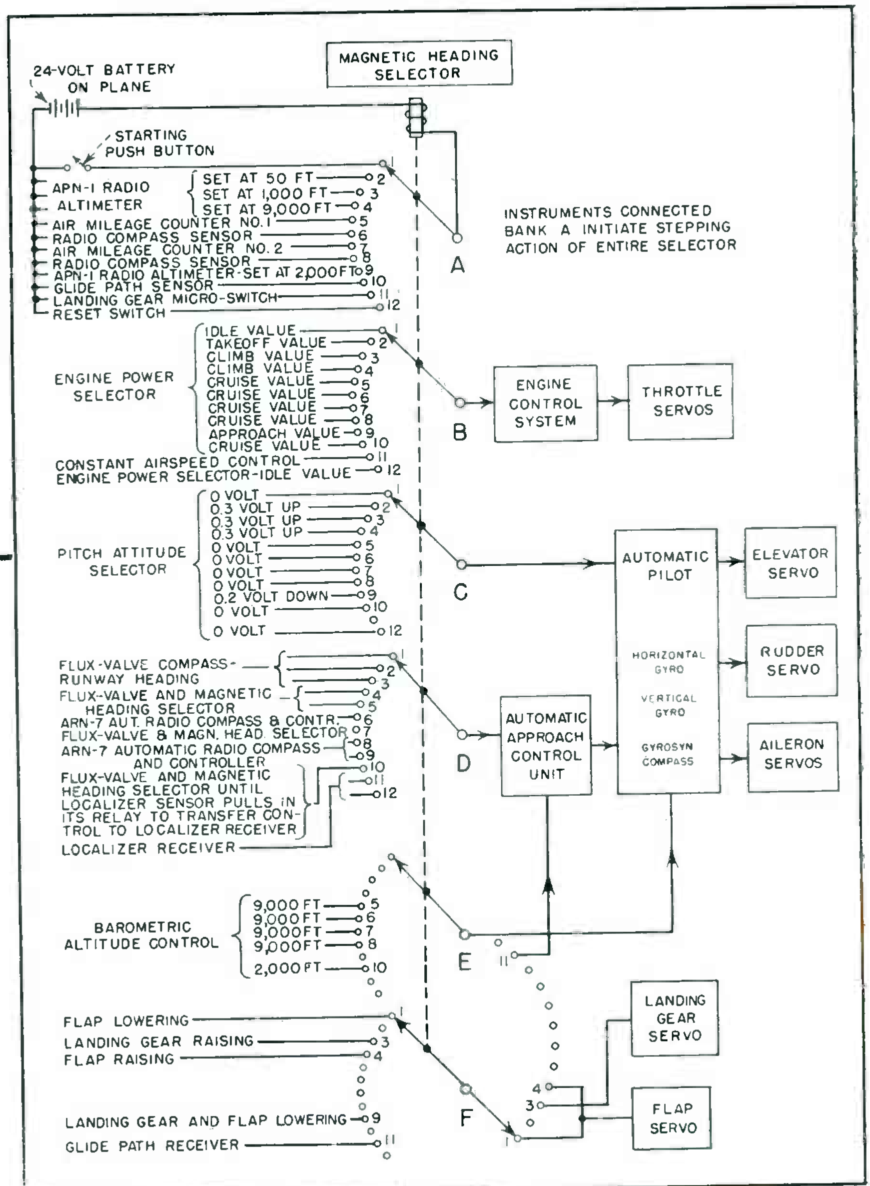


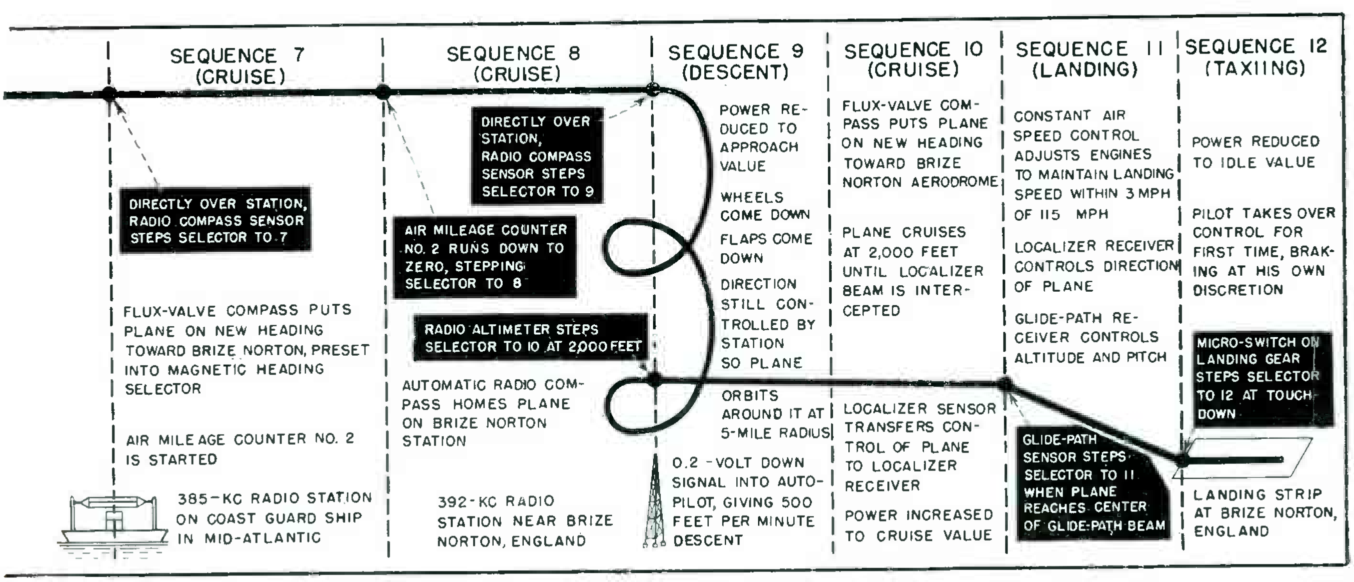
FIG. 1—Program for pilotless flight from Harmon Field, Newfoundland to Brize Norton Aerodrome, England

FIG. 2—Simplified block diagram of automatic flight controller used to duplicate functions of a human pilot from takeoff to touchdown



safety for passengers as well as adherence to time schedules. The electronic, electrical, and mechanical sensing controls are smoother and more responsive than human senses, so that correcting forces are applied at almost the same instant that a flight deviation occurs. This makes for much smoother flight through turbulent air, along with conservation of fuel through elimination of overshooting and hunting.

Greater safety is achieved in flight because mechanizing of normal flight and navigation functions gives the pilot more time for executive decisions. In bad weather today, when such decisions are all-important, the pilot's eyes can never leave the flickering pointers that become his only reference with



Only three radio aids were used for navigation by the robot pilot on the 2,400-mile flight, during sequences 6, 8, 9, and 11

Table I—Components of Control System for Automatic Flight

CONTROL UNIT	HOW IT WORKS	FUNCTION ON OCEAN FLIGHT
Flux-valve compass	Flux valve gives three currents whose magnitudes vary with angle at which earth's magnetic field cuts the three inner legs. Resultant of currents is always related to direction of earth's magnetic field and can be used to control the autopilot. Flux valve keeps horizontal gyro in N-S position	Kept plane in line with landing strip during takeoff and climb (sequences 2 and 3)
Magnetic heading selector	Uses zero-locked selsyn operating from the flux valve of the E-4 automatic pilot, rotatable through 360 degrees to permit flying accurately in some other direction than north. Feeds turn-control amplifier of automatic pilot	Kept plane at predetermined desired headings for sequences 4, 5, 7, and 10
APN-1 radio altimeter	Depends on velocity of radio waves (186,000 miles per second). Measures frequency change between transmitted and received f-m signals and converts to vertical height	Closed switch to initiate sequence 3 at 50 feet, sequence 4 at 1,000 feet, sequence 5 at 9,000 feet, and sequence 10 at 2,000 feet
Air mileage counter	Depends on known relation between air speed of plane and pressure of air in pitot tube set into leading edge of wing. Combines speed with time to tick off miles (mph times hours equals total miles flown). Veeder-Root dial	Counter No. 1 closed switch to initiate sequence 6 approx. 600 miles out of Newfoundland. Counter No. 2 closed switch to initiate sequence 8
Altitude control	Hermetically sealed bellows expands as air gets thinner during climb. Expansion is proportional to altitude and is converted into proportional voltage by mechanical coupling to armature of coil system. Voltage controls autopilot	Controlled elevator to keep plane at 9,000 feet during sequences 5, 6, 7, and 8, and at 2,000 feet for first part of sequence 9
Automatic radio compass	Loop antenna rotates automatically during flight so it is always positioned in direction of station to which it is tuned. Voltage from zero-locked selsyn coupled to loop transmitter selsyn is fed to an integrator-amplifier whose output is fed to the turn-control amplifier to keep plane flying toward (homing on) radio station	Kept plane heading for Coast Guard ship in sequence 6. Kept plane heading for radio station in sequence 8 and orbited plane around station for descent in sequence 9
Radio compass sensor	Depends on reversal of pointer of radio compass as plane flies over radio station to which it is homing. As pointer rotates through 180 degrees it touches a contact set into the face of the radio compass indicator	Closed switch to initiate sequence 7 over Coast Guard station on ship, and initiate sequence 9 over Brize Norton station
Constant airspeed control	A complex arrangement of a pitot tube, bellows, five selsyns, three electronic amplifiers, three electric motors, and dozens of gears and levers. Air pressure in the pitot tube, proportional to air speed, pushes the bellows in or out to actuate system, which moves unilever engine control	Held speed of plane constant within 3 mph of 115 mph during landing at Brize Norton, England. This speed kept plane in correct altitude for a three-point touchdown
Localizer sensor	Uses three-tube circuit to amplify 400-cycle localizer signal derived from automatic approach controller of autopilot, to operate balanced relay when aircraft passes through center of 110-mc localizer beam of ILS	Found localizer beam at Brize Norton, England and initiated second part of sequence 10
Localizer receiver	An airborne part of the SCS-51 Air Forces Instrument Low Approach System used by Army during war for blind landings in darkness or fog. Feeds autopilot through automatic approach control unit	Controlled rudder through autopilot to keep plane in line with center of landing strip during downward glide
Glide path sensor	Uses three-tube electronic control circuit that pulls in a relay when glide path indicator reads zero, meaning plane is in center of 335-mc glide-path	Found glide path in England and initiated sequence 11 for automatic landing
Glide path receiver	Another airborne part of SCS-51 automatic landing system. Feeds up or down signals to autopilot	Controlled elevator through autopilot during descent at Brize Norton, England
Micro-Switch	Small snap-acting switch that is mounted on right landing gear of plane in such a way as to close when wheel first touches ground	Initiated sequence 12 at touchdown in England, for manual braking and taxiing by emergency pilot

respect to the earth. Automatic flying now offers real promise of lightening the pilot's burden.

From a military standpoint, push-button planes taking off from U. S. territory without crews could be preset before takeoff to fly to any location in the world with acceptable tactical accuracy. If need be, these flights could even be independent of radio navigation aids vulnerable to jamming. By applying refinements of instrumentation and control already under development ocean flights could be made with reliance solely on gyros, magnetic compasses, mileage counters, and ground speed indicators for navigation, up to the point of orbiting downward for a landing.

Master Control System

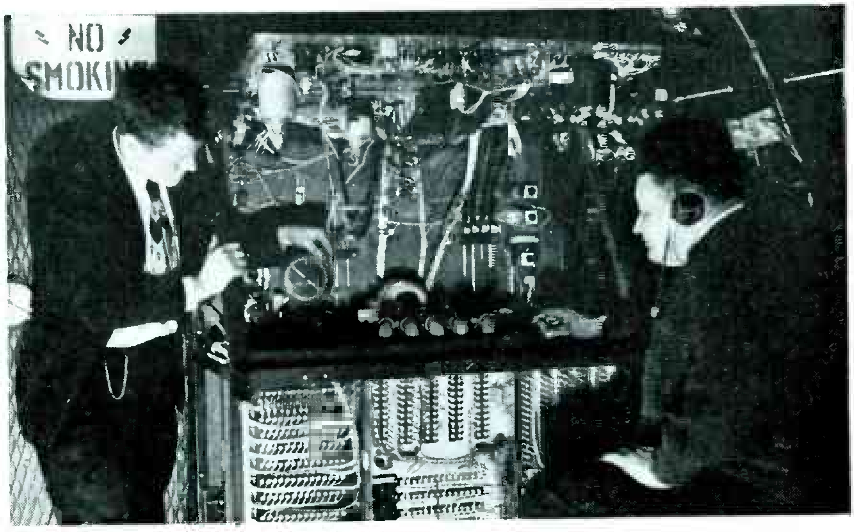
Basically the automatic flight controller, developed by the All-Weather Flying Division of the U. S. Air Forces at Clinton County Army Air Field, Wilmington, Ohio, is an electronic brain that manipulates three knobs to which all flight controls on the plane have been coupled. Two of these knobs are part of a standard Sperry E-4 automatic pilot and provide for right-left and up-down maneuvers; the third is a new single control to change power settings and speed of all four engines simultaneously. The controller stores information given to it before a flight begins, reads the flight instruments through dozens of selsyns, listens to radio signals, measures distances and air speed, and coordinates all this to carry out for pilot and crew all functions required for point-to-point flight from one airfield to another.

The automatic pilot consists essentially of two gyros; one is chained to the earth's gravitational force and serves as roll and pitch reference, while the other is used in conjunction with a flux-valve compass as a north-seeking directional reference. Amplifiers and servo control units boost the low-power signals derived from the gyros to sufficiently high levels for driving servos that operate the airplane's control surfaces.

The various instruments that take over control of the autopilot during the different stages of a flight are energized and deenergized in turn by a 6-bank, 12-position stepping switch known as the automatic sequence selector, used in conjunction with 12 relays. The twelve operational sequences for the trans-Atlantic flight are diagrammed in Fig. 1, and the corresponding circuits are given in Fig. 2.

Pressing the starting pushbutton steps the selector to position 2 to initiate a flight. Automatically the robot pilot advances the engine control lever to rated takeoff power, sets elevators for climb, places the rudder under control of the flux-valve compass, and connects the radio altimeter so it will advance the selector to position 3 when the plane reaches an altitude of 50 feet.

Flight conditions during any other sequence can be determined in a similar manner by examination of Fig. 1 and 2. Technical features and functions of the control units are summarized in Table I.



The robot pilot with cover lifted, showing (bottom center of upper compartment) the stepping switch that sequences the circuits according to a predetermined flight program

Air Speed Control

A single-lever power control system developed by Eclipse-Pioneer Division of Bendix was modified in order to provide for preselection of manifold pressure and engine speed. Potentiometers are set prior to flight to provide different engine power values for takeoff, climb, cruise, descent, and landing. Speeds of the four engines are synchronized by comparing the tachometer generator output of engine 1 against corresponding outputs of the other three engines. A difference in voltage is applied through a synchronizing unit to the governor of the engine that is running fast or slow.

In sequence 11, involving final approach for a landing under guidance of the localizer and glide path receivers, a constant airspeed control is used in place of a fixed power setting, to insure the correct attitude of the plane at touchdown. This pitot pressure actuated device is mechanically linked to the rotor of a variable transformer in such a way that transformer output is zero when air pressure and hence air speed are correct. If speed is in error, a voltage output is developed, either in phase or out of phase with stator excitation, according to whether the plane is too fast or too slow. Three amplifiers, three electric motors of various types, and four more selsyns convert this error voltage into a change in the position of the single lever that controls manifold pressure and speed of all four engines. Additional electronic circuits are incorporated to maintain airspeed without overshoot when transient errors in speed occur.

Directional Control

Use of a magnetic heading selector in conjunction with the flux-valve compass is one method of obtaining directional guidance during automatic flight. When the plane deviates from the chosen heading, the appropriate turn voltage is fed into the right-left control system of the autopilot. This method, in conjunction with an air mileage counter, was used for portions of the trans-Atlantic crossing. The counter is preset before flight to a given number of miles; when this distance has been flown, the counter registers zero and steps the selector to the next flight sequence.

When a flight can be routed over radio stations, as was possible on the ocean flight, automatic radio compasses can be pretuned for homing on each station in turn. The compass here feeds the autopilot through an appropriate electronic coupling unit that also forms a part of the automatic approach control unit (bank D in Fig. 2). When the plane passes over the station being homed on, the resultant 180-degree rotation of the radio compass pointer closes contacts in a radio compass sensor circuit to initiate stepping of the selector to the next sequence.


Master control panel of robot pilot. Pushbutton that initiates a flight is on this panel, along with twelve indicating lights showing which sequence the plane is in

Course Computer

If no radio station is available for homing on the route to be flown, two automatic radiocompasses are used in conjunction with the flux-gate magnetic compass and an electrical course computer to obtain directional information from pairs of off-course radio stations. The compass receivers energize computer selsyn rotors to produce output voltages proportional to course errors. These voltages act through the autopilot to fly the plane along the desired course. When the aircraft reaches a preselected position with reference to the two radio stations in use, a simple cam system on the rotors of the compass receiver selsyns energizes the selector to step to the next sequence. If this involves use of another pair of radio stations, preset automatic tuners tune each radio compass to its intended new station.

One radio station was available in mid-Atlantic (on a U. S. Coast Guard cutter) for homing purposes during the ocean flight. When this was reached, an RAF medium-frequency beacon radio station at Brize Norton provided homing guidance after the second magnetic heading sequence and thereafter, making a course computer unnecessary.

Automatic Landing

Arrival at the RAF radio station initiated sequence 9 for the beginning of an automatic landing. A 0.2-volt down signal was now fed into the autopilot by a preset potentiometer serving as pitch-attitude selector, with the radio compass still controlling the rudder. The plane therefore descended in a spiral having the station's tower as its center, with a radius of 5 miles.

At 2,000 feet the radio altimeter turned rudder control over to the magnetic heading control, preset in the direction of the Brize Norton localizer. Cruising on this new heading, with constant altitude being maintained by conventional barometric altimeter feed to the autopilot, the plane intersected the localizer beam. The localizer sensor circuit, responding to signal conditions at the center of the localizer beam (coinciding with the centerline of the runway) transferred rudder control from the magnetic system to the localizer receiver.

Still cruising at 2,000 feet, the plane flew the localizer beam until the center of the glide-path beam was reached. The glide-path sensor then transferred control of the elevator from the barometric altitude control to the glide-path receiver.

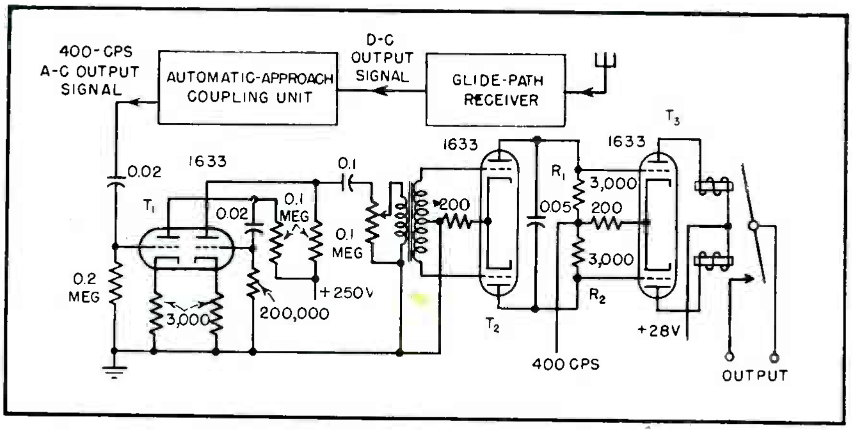


FIG. 3—Circuit of glide-path sensor used to initiate instrument landing sequence when plane intercepts exact center of glide path

Electronic circuits in the automatic approach coupling unit made the change from level flight to descent smooth.

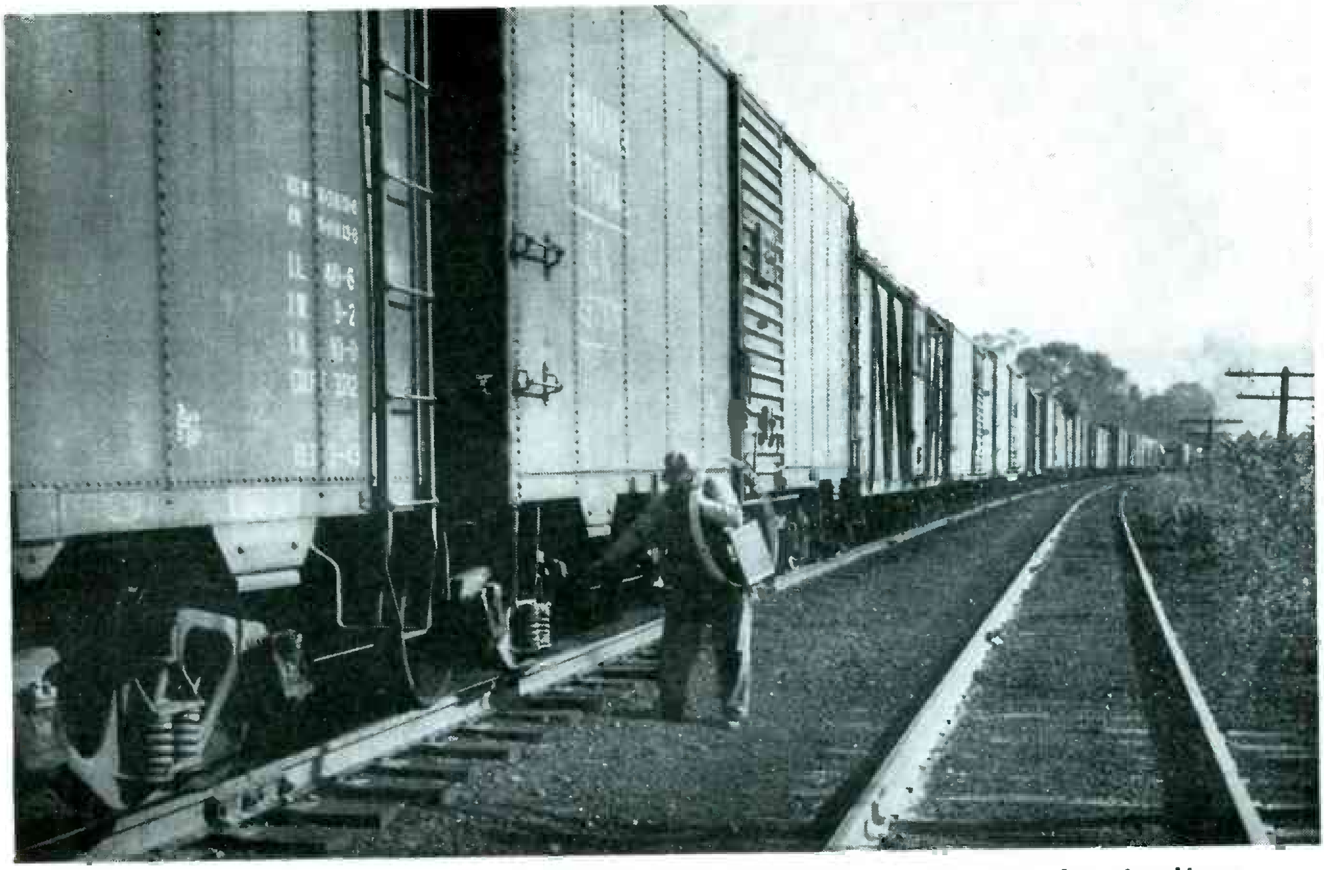
The circuit of the glide-path sensor is given in Fig. 3. The d-c signal output of the glide-path receiver is applied to the automatic-approach coupling unit. When the plane is below the glide-path, this unit delivers a 400-cycle output signal that is in phase with the 400-cycle inverter supply of the plane. As the plane flies through and above the glide-path, the glide-path receiver d-c signal changes in polarity and causes a 180-degree change in the phase of the 400-cycle coupling unit signal. It is this 180-degree change in phase that actuates the glide-path sensor circuit, causing its balanced relay to flip over and initiate the descent sequence.

Tube T_1 in the circuit merely provides two stages of amplification for the 400-cycle output signal of the approach coupling unit. to insure adequate signal for circuit actuation immediately after phase reversal at the center of the glide path. The transformer applies this signal to the grids of T_2 with such polarity that the lower grid of T_2 is positive when both plates of T_2 are made positive by the 400-cycle inverter supply. The lower section of T_2 conducts, producing a voltage drop across R_2 that drives the lower grid of T_3 to cutoff. Since the upper grid of T_2 is negative when the lower grid is positive, this section is nonconducting and the upper grid of T_3 is at cathode potential. The upper section of T_3 therefore conducts, holding in the balanced relay as shown. Flying through the glide path reverses the potentials on the grids of T_2, so that now the top half of T_2 and the bottom half of T_3 are conducting, and the relay flips over. This advances the selector one step, to initiate sequence 11 for a complete instrument landing to touchdown using SCS-51 beams.

A similar double-beam landing system developed by Sperry Gyroscope Co. has been installed at Clinton County Army Airfield and successfully used in bringing down the automatic C-54. This microwave instrument landing system, employing a localizer frequency of approximately 2,640 mc and a glide-path frequency of approximately 2,617 mc, provides a tighter and more constant beam that is less affected by heavy precipitation static conditions than the SCS-51 beams. Beam modulation frequencies are 90 and 150 cps for SCS-51 and 600 and 900 cps for the Sperry system.

Acknowledgments

This article was made possible through the cooperation of Colonel A. E. Key, W. S. Foster, G. T. Minshall, and other members of the All-Weather Flying Division at Wilmington, Ohio. Appreciation is also expressed to James L. Anast, chief of the Automatic Flying Branch, and other engineers who could not contribute personally because they were in England with the pushbutton plane at the time, but had previously prepared technical reports from which much of the data in this article was obtained.—J. M.



Typical operation of Carryphone equipment. Trainman reports trouble to engineman and to conductor in cabin car

Portable Inductive Radiophone

F-M equipment operating on 80 kilocycles furnishes communication from one train to another up to two miles, or with way stations as far as 20 miles. Portable units extend scope of inductive telephone system in use for several years

By W. R. TRIEM
General Supt. of Telegraph
The Pennsylvania Railroad
Philadelphia, Pa.

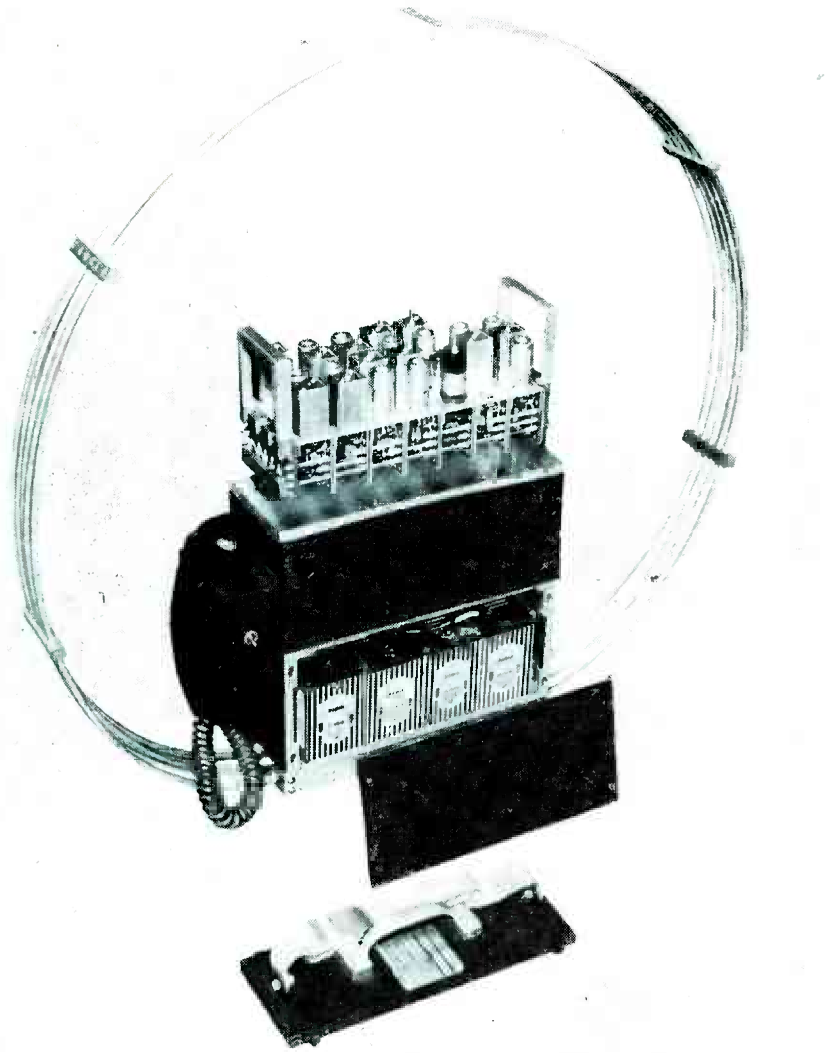
THE PENNSYLVANIA RAILROAD recently placed in service six portable inductive communication units. Two of these have been assigned to the Belvidere Branch and four to the main line between Pittsburgh and Harrisburg.

The portable inductive communication unit is particularly suitable for use by train crews because of its light weight and small size; each weighs approximately 25 pounds, and the longest dimension of the case is about 16 inches. It is equipped with a durable woven band which can be slipped over the shoulder of the user, thus leaving his hands free for the performance of regular duties. Transmission and reception are effected by the use of a five-turn loop of duralumin tubing that is securely fastened to the bottom of the case. This loop is of such size and proportion that it surrounds the upper portion of the user's body in a manner that does not cause interference with normal movement.

Initial development was based upon the need for portable apparatus that could operate in conjunction with existing inductive train communication apparatus installed in wayside stations, on locomotives, and in cabin cars (sometimes known as cabooses).

Inductive Communication Systems

The Union Switch and Signal Co. inductive train communication system used by the Pennsylvania is closely related in fundamental principle to the familiar telephone and telegraph carrier systems that are



Complete portable radiophone with covers and chassis removed from carrying case

used to secure additional channels over existing line wires. It utilizes a modulated carrier wave that is transmitted over, and closely confined to, a path which is made up principally of the paralleling line wires and to some extent the track rails. The electronic equipment installed on vehicles and at wayside stations makes it possible to communicate, inductively, between the ends of a train, between two or more trains and between trains and wayside stations.

In addition to a loudspeaker, each vehicle is equipped with a telephone-type push-to-talk handset. At wayside stations, the operator is furnished a desk type transmitter with head-band receiver, as well as the loudspeaker. Therefore, as far as the operators and trainmen are concerned, the system is as simple to use as the regular push-to-talk telephone system.

Over 3,300 miles of main track on the Pennsylvania are equipped for cab signal operation, and the apparatus is installed on approximately 2,800 locomotives. On the basis of experience with such electronic equipment, the specifications for the train communication equipment called for a sufficient degree of ruggedness and protection to stand up against the shock, vibration and other severe treatment encountered in everyday freight service. As an aid to maintenance, the design included arrangement of the various apparatus in unit assemblies, mounted on separate trays that could be handled easily by only one man.

Although inductive train communication had been used successfully in yard installations previously, the Belvidere Branch was the original proving ground for the system in road service. Experimentation included a two-channel frequency modulation system using 80 kc and 144 kc. As a result of these experiments, a train communication system was produced that satisfactorily meets railroad requirements, and a large scale installation was made on the main line between Pittsburgh and Harrisburg, Pa.

At present, equipment has been installed on 295 locomotives, 105 cabin cars, and in 36 wayside stations. The system is in regular service on 1,056 miles of main tracks, providing communication between head end and rear end crews of the same train, between two or more trains, and between trains and wayside stations.

The two-channel system was decided upon to assure adequate communication facilities in view of the tremendous amount of traffic involved. Normally the 144-kc channel is used for communication between the engines and cabin cars, and between trains, with the 80-kc channel reserved for communication between trains and wayside stations. In an emergency, of course, either channel can be used for either purpose. The stations are so spaced that trains are always within range of one or more stations.

Portable Equipment

Portable equipment supplies a missing link, as it is not dependent upon the fixed apparatus installed on vehicles. Since it is strictly an independent unit of the system, a trainman may leave the immediate vicinity of his train and, using the portable unit, keep in constant touch with either end of his own train or with other trains moving within a distance of approximately 2 miles. He also may establish contact with wayside stations at distances up to 15 to 20 miles.

Train crews find the portable inductive train communication unit an exceptionally effective means of minimizing delays under unusual circumstances. When it is necessary to stop a train a crew member takes the unit with him to the affected car. He can then report to either end of the train the nature of the trouble and issue instructions for corrective procedures from the actual point of trouble. If repair equipment is required, such information can be phoned promptly to either the locomotive or cabin car, and if necessary, relayed to a wayside station. With this swift reporting of the emergency condition, the dispatcher is in a better position to make prompt arrangements for other trains to bypass the disabled train.

As an example of the time saving and convenience effected through the use of portable equipment, on one occasion trouble developed 40 cars from the rear of a train. The conductor took the portable unit with him to investigate. Using this portable means of communication, he transmitted the car number to the wayside office, made arrangements for setting out the car and instructed the engineer to proceed. In getting the train started a draw bar was pulled out 19 cars from the trouble spot. The conductor immediately advised the operator at the wayside station, obtained instructions for setting the car out, set it out, recoupled and got the train under way, all in less time than it would have taken to return to the cabin car from the location of the original trouble and make out his report.

Although designed primarily for the use of trainmen, it is expected that the portable inductive train communication unit will prove useful in many other practical applications. For example, it can be used on work trains, where the foreman can direct and coordinate the operation of derricks and various work machines from a single location on the ground. Furthermore, he can keep informed of train movements and take better advantage of lulls in traffic, thereby obtaining better efficiency without delaying trains. Because of its portability, it can also be used as an emergency wayside station and in numerous other services, depending upon the particular conditions that develop from time to time.

Where standard inductive train communication apparatus is already installed, no changes are required in the apparatus to operate with portable equipment. This is an advantage realized by designing the portable equipment for inductive carrier operation at the same frequency as the parent installation. All that is required is to have the vehicle or wayside equipment in regular operating condition. Communication from the portable unit is received in the usual manner and outgoing transmissions are handled in exactly the same way as is used for normal system operation.

Design Details

The suitability of the portable equipment for its job is enhanced by its small size and light weight. The compact assembly consists of a frequency-modulation transmitter, a receiver for f-m reception, a power unit with battery, a combination transmitting and receiving loop and a standard telephone handset, all housed in, or mounted on, a single lightweight aluminum case finished in black crinkle lacquer. The overall dimensions of the case are 16 in. wide by 13 in. high by 5 in. deep.

An 8-tube receiver of the superheterodyne type is assembled on the same chassis as the transmitter. It is made up of two carrier-frequency amplifier stages, converter stage, two stages of intermediate frequency, one limiter stage, a discriminator stage and one stage of audio amplification. The tube complement consists of four type 1T4, one type 1L4, one type 1R5 and two type 1S5 tubes of the miniature design with one of the latter serving as the receiver output tube. It can supply ample power through an impedance matching transformer to energize the receiver unit of the handset. The filaments of the tubes are connected in series, with two groups in parallel across the battery.

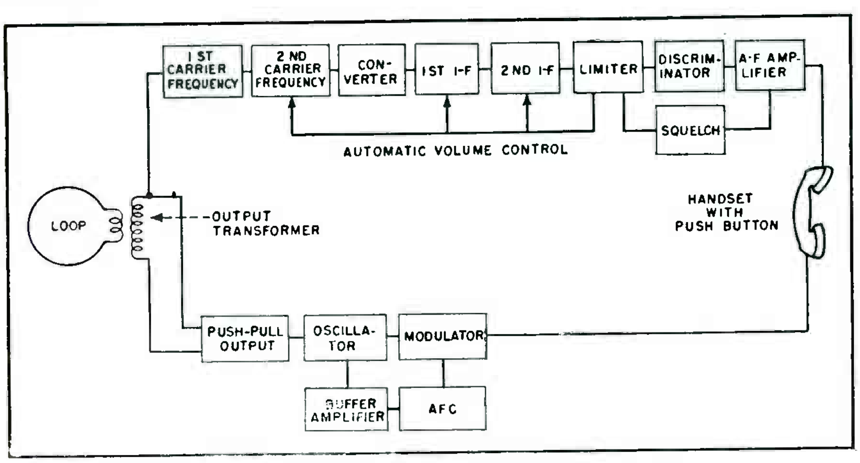
To obtain quiet operation under standby conditions the receiver is provided with a nonadjustable squelch with its accompanying single-stage noise amplifier.

The transmitter is arranged for frequency modulation using the reactance tube method of obtaining the required frequency swing. The reactance tube is a type 3Q4 and its associated oscillator tube is type 3A4. No separate driver stage is required since the oscillator has sufficient output to feed the two type 3A4 push-pull output tubes that deliver the modulated carrier to the output transformer. The secondary of this output transformer is connected directly to the terminals of the five-turn transmitting loop. This loop is tuned to the desired output frequency to obtain maximum loop current, by the use of small fixed capacitors located in the base section of the case.

The tube filaments are arranged for the use of a six volt supply, with two series circuits connected in parallel across the battery. An amplifier for the automatic frequency control circuit is also an integral part of the transmitter.

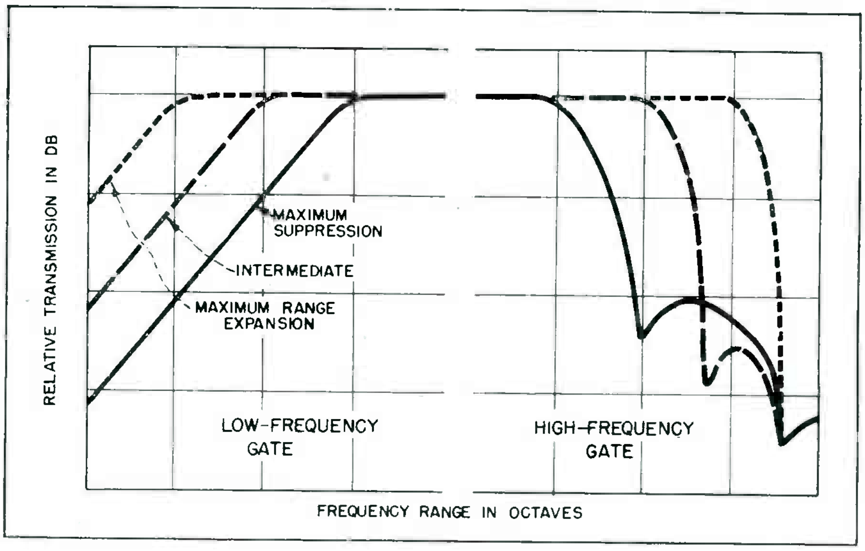
The power delivered to the transmitting loop circuit is of the order of 2½ watts. This power is ample for the required service range of the equipment; hence, any increase would be at the expense of a corresponding reduction in total operating time.

Dry cells are used for both A and B circuits. These cells have sufficient capacity to furnish energy for normal operation of a portable unit over an extended period of time.



Block diagram of the f-m transmitter-receiver

FIG. 1—Transmission characteristics of dynamic noise suppressor for conditions of maximum range expansion, intermediate suppression, and maximum suppression



By H. H. SCOTT

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Dynamic Noise

Complete technical details of a system that provides essentially noise-free reproduction from phonograph records and transcriptions. Circuits are given for a 2-tube phonograph version and a 10-tube broadcast model

A DYNAMIC band-pass system for separating signals from noise, as exemplified in the dynamic noise suppressor described here, provides what many consider the most satisfactory method of utilizing the maximum frequency range of a modern phonograph record or transcription while minimizing rumble, needle scratch, and other extraneous noises usually associated with recorded music.

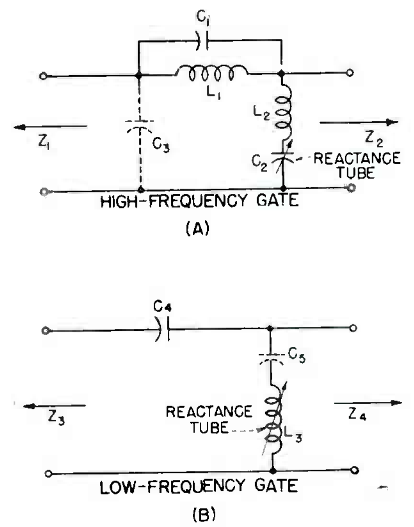
The dynamic noise suppressor is now in regular use in a number of broadcast stations, both a-m and f-m. The suppressor has also been adopted by several manufacturers of high-fidelity radio-phonographs, and the circuits are now being engineered into less expensive sets.

It should not be inferred that the system to be described is the only one which has ever been proposed. Although little has appeared in technical literature, a number of investigators have worked on the problem. Included among these investigators are Carlisle, Devine, Hammond, Heising, Llewelyn, Olson, and Purington.

The systems proposed have included volume expanders, circuits nonlinear with respect to amplitude, and automatic tone controls. Some of these have been used in commercial equipment. For instance, the volume expander or dynamic amplifier was used in certain models of RCA phonographs and is still used in some public address amplifiers. The automatic-tone-con-

Broadcast model Dynamic Noise Suppressor

This paper was presented at the 1947 National Electronics Conference in Chicago.



How It Works

Signal-controlled reactance tubes in these basic filter circuits act as gates that move the ends of the audio response curve inward and outward continuously and independently to let only the desired audio modulation through.

All noise signals in portions of the spectrum not having audible music components at a particular instant are suppressed.

Fundamentals of desired high-frequency notes are filtered out and rectified by a control circuit to change bias and hence capacitance of C_2 in high-frequency gate, and harmonics of desired low-frequency notes similarly vary inductance of L_3

FIG. 2—Basic gate circuits used to provide the continuously shifting response curves of Fig. 1

Suppressor

trol type of noise-reduction system was used for several years in prewar receivers manufactured by the Scott Radio Laboratories.

Basically, noise-reduction systems fall between two extreme types—the dynamic band-pass system, in which the frequency range or pass band is varied in accordance with some characteristics of the signal, and volume-expander types in which the overall amplification or gain of the system, either effective or actual, is increased and decreased in accordance with some characteristics of the signal. In terms of the overall transmission-versus-frequency characteristics of a system as plotted in a conventional manner with a horizontal frequency scale and a vertical transmission scale, the dynamic band-pass system represents a horizontal change, while the volume-expander system represents a vertical change.

Noise reduction systems may also be designated as class A or class C, the terminology being borrowed from the similar applications in amplifiers. A class-A system is one in which, except for any filtering action, the output wave-form is a replica of the input wave-form. Such a system is linear with respect to amplitude so far as any cycle of the signal wave-form is concerned. A class-C system is one in which the output current flows only during a portion of the cycle of the input voltage. For very small input voltages, practically no output current will flow, and hence noise or signals below a certain level will be attenuated. This type of system depends upon amplitude nonlinearity for its noise-reducing action, which naturally results in distortion.

When only a single sine wave is being transmitted, the output waveform of a class-C system can be restored by means of filters, and octave band-pass filters are conventionally used. However, even the best octave filter will not eliminate many higher-order intermodulation products such as $2f_1 - f_2$ or $2f_2 - f_1$ which may be of considerable magnitude in such a system when reproducing low-level signals.

Vertical noise-reduction systems include both class-A and class-C systems, the former being the volume expander in various modifications and the latter utilizing biased rectifiers or other barriers to obtain a class-C transmission characteristic.

The first requisite of a noise-reduction system is ability to reduce noise. To this end it is often desirable to control the transmission characteristics in accordance with some features of the signals not present in the noise. In the dynamic noise suppressor and other class-A systems this is possible because the control function may be divorced entirely from the controlled circuits.

Fuzz and Swish

Any noise-reduction system has certain limitations. The maximum bandwidth should be restricted somewhat when the noise level is excessive, so that in the loudest portions of the signal the noise is not heard superimposed on the music as a fuzz. A system with definite time constants is desirable, but if the time constants are made too long, loud notes may also be followed by an annoying swish.

Both fuzz and swish may be kept at a minimum only when the bandwidth transmitted at any instant is limited to that required by the signal. This is possible in the dynamic band-pass or horizontal type of system. In a vertical system, transmission in an entire frequency band increases and decreases as a unit whether or not the entire band is required. This causes considerably more fuzz than in a horizontal type of noise suppressor.

The amount of objectionable fuzz is also a function of the smoothness with which the transmission characteristic is altered. In this re-

CIRCUITS, AS PROMISED

Broad principles of the dynamic noise suppressor were presented by the author in the December 1946 issue of ELECTRONICS.

Audience reaction to demonstrations and queries for more details have since indicated a high degree of interest in the system, applicable to f-m and a-m broadcasting, wired music, public address, and home phonographs.

spect, class-A systems are preferable to class-C systems, since with the latter the noise tends to pop in and out instantaneously at a given volume level.

The class-A horizontal system can be designed with an opening time-constant sufficiently long to provide suppression of loud clicks and similar transient disturbances, but not long enough noticeably to alter the reproduction of musical transients such as the crashing of cymbals. In similar cases where a high degree of suppression is used, the closing time-constant can be made long enough to prevent any effect of deadness resulting from removal of reverberation.

In actual practice, the closing time-constant is adjusted for the best compromise between reverberation and freedom from swish. Such factors are not controllable in the usual class-C noise-reducing system which operates instantaneously, tending to transmit all loud transient noises such as clicks and, when set for a high degree of suppression, to remove considerable reverberation.

In the vertical type of class-A system (the volume expander), such time constants sometimes provide serious problems in regard to the correct reproduction of musical transients, but with the class-A horizontal system (the dynamic noise suppressor), reproduction of musical transients is easily accomplished since the transmission is not altered in the frequency range which contributes most to the loudness of the signal.

Performance of Dynamic Noise Suppressor

In general, the dynamic noise suppressor causes less difficulty with fuzz than other types. It allows complete freedom of choice in any compromise which may have to be made between loss of reverberation and swish, while simultaneously allowing significant reduction in the amplitude of clicks and transient noises as well as the hissing type of surface noise. If volume expansion is desired for its own sake, the expander performance will be noticeably better when used with a dynamic noise suppressor, since the resulting reduction in noise level will tend to eliminate swishes resulting from the volume expander.

There are other noise-reducing systems intermediate between the true vertical and horizontal types and operating in much the same manner as automatic tone controls; in other words, the high-frequency end of the transmission characteristic is rolled off at a slight angle which decreases as the signal amplitude increases. Such systems are of the class-A type, but more closely resemble the vertical than the horizontal in general performance characteristics. If the noise reduction here is sufficient to be worthwhile, the change in tonal balance generally becomes noticeable because of the varying attenuation of signal components in the middle portion of the frequency spectrum.

While the dynamic noise suppressor makes previously useless records usable again, music lovers will generally find it an even greater advantage on modern high-quality records, where the noise level is not excessive but is still noticeable and annoying. Such records have a sufficiently wide frequency range to render undesirable any noticeable range restriction as a means of reducing noise. Playing such records with a wide-range dynamic noise suppressor eliminates the background noise without impairing tonal quality.

Response Curves

The number of circuits which can be used to obtain a dynamic band-pass system is almost limitless, but in any practical application it is desirable to secure the maximum of performance with a minimum of cost. It is therefore necessary to determine the minimum operating characteristics that will provide satisfactory performance, and use the minimum number of components to obtain these characteristics.

The first operating requirement is a sharp cutoff, particularly for the high-frequency gate circuit, since the most annoying scratch noise is concentrated in the high-frequency portion of the spectrum. Typical gate circuit curves which can be obtained with simple circuits and which have proved satisfactory in actual commercial applications are shown in Fig. 1. In normal suppressor operation, these are not static transmission characteristics, but vary rapidly from one extreme to the other in accordance with the requirements of the music or other signal. The vertical scale may typically represent 10-db intervals, while the horizontal scale may typically represent octaves.

The shape of these curves can be controlled considerably by proper choice of circuit constants and terminating impedances. If the shape of the curve in the neighborhood of the high-frequency cutoff is changed too abruptly, a disagreeable ringing may result, although with a dynamic system much more of this can be tolerated than with a static system.

Beyond cutoff, a maximum suppression of approximately 20 db below the normal flat response curve provides adequate noise reduction. Any further attenuation is definitely beyond the point of diminishing returns unless the system is capable of being adjusted to provide considerable high-frequency or low-frequency boost.

The function of the low-frequency gate circuit is to suppress hum, rumble, and other low-frequency noises and to maintain tonal balance, even under conditions of extreme noise suppression. A cutoff sharper than a simple RC or LR circuit affords is desirable. While exactly the same types of curves may be obtained at the low end as at the high end if economically justified, in practical applications the general shapes shown for the low-frequency gate are adequate. This is partly a result of the general nature of low-frequency noises —hum, rumble, etc—which tend to be harmonic in character rather than random.

High-Frequency Gate

A simple gate circuit that can be varied to provide the high-frequency cutoff and attenuation curves of Fig. 1 is given in Fig. 2A. Such a circuit may be considered roughly as a combination of a series m-derived and a shunt m-derived filter. The points of high attenuation caused by resonance in the series and shunt arms do not coincide except momentarily and in a random fashion while the cutoff frequency is varied by the signal. Normally, when the greatest suppression is taking place the points of high attenuation are separated by an octave or more.

Varying C_2 in Fig. 2A changes not only the cutoff frequency, but also the point of high attenuation determined by series resonance between L_2 and C_2 in the shunt arm. This provides a sharp cutoff with a high degree of attenuation just above the cutoff frequency.

In a practical gate circuit, C_2 is a reactance tube. The series-arm parallel resonance between L_1 and C_1 provides a fixed point of high attenuation which maintains attenuation at higher frequencies and provides high attenuation above the normal operating range or, when used on a-m, serves as a whistle filter.

Addition of C_3 maintains attenuation at still higher frequencies above the upper (fixed) null point when necessary. In more elaborate gate circuits, C_3 may be replaced by another reactance tube to provide still greater control range.

Impedance-Matching Problems

According to classical filter theory, filters should be terminated in certain definite impedances in order to provide satisfactory operating characteristics and freedom from undesired resonances. Where one of the important filter elements such as C_2 is variable, this poses a serious problem.

Impedance Z_1 across the input is most critical when C_2 is at a maximum and the cutoff point is, accordingly, at a minimum. Under these conditions Z_1 may be selected to control the shape of the cutoff curve so that a wide range of possible contours can be obtained, ranging from a gradual roll-off to a resonant type of cutoff having a definite peak. The effect of varying Z_2 will then be relatively unimportant so long as Z_2 is maintained reasonably high.

On the other hand, when C_2 is reduced in capacitance and the cutoff frequency consequently increased, the circuit impedance increases, and the shunting effect of Z_2 becomes important. Under these conditions, the shape of the cutoff curve is controlled mainly by Z_2 and only secondarily by Z_1. By proper selection of operating impedances, therefore, the curves for minimum and maximum high-frequency response can be adjusted more or less independently, with a gradual transition at intermediate bandwidths.

For wider-range suppressor action, a second reactance tube may be added in place of C_3. For greater suppression, as in systems with unusual amounts of high-frequency noise or high-frequency boost, other sections may be added to the gate circuits.

A typical low-frequency gate circuit is shown in Fig. 2B. The variable inductance is obtained at low cost by means of a reactance tube. Such a circuit will provide low-frequency cutoffs approximating those shown in Fig. 1. Again, through proper selection of terminating impedances Z_3 and Z_4, it is possible to control the cutoff shapes to a high degree over a wide range of cutoff frequencies. If desired, the circuit can be expanded to m-derived and more complex forms.

Home Phonograph Model

The circuit of Fig. 3 shows a complete dynamic noise suppressor unit such as might be used on a phonograph, including an amplifier stage for coupling the crystal pickup to the gate circuit and for providing the necessary driving signal voltage for the control circuit.

Amplifier stage V_1 is not required when the suppressor is designed as an integral part of a complete amplifier system. The gate circuit then becomes merely an interstage coupling circuit. Suitable voltage for feeding the control filter can be obtained from some other amplifier stage, either preceding or following the gate circuit. The relative amplitudes of the voltages applied to the control circuit and to the gate circuit depend upon the types of tubes

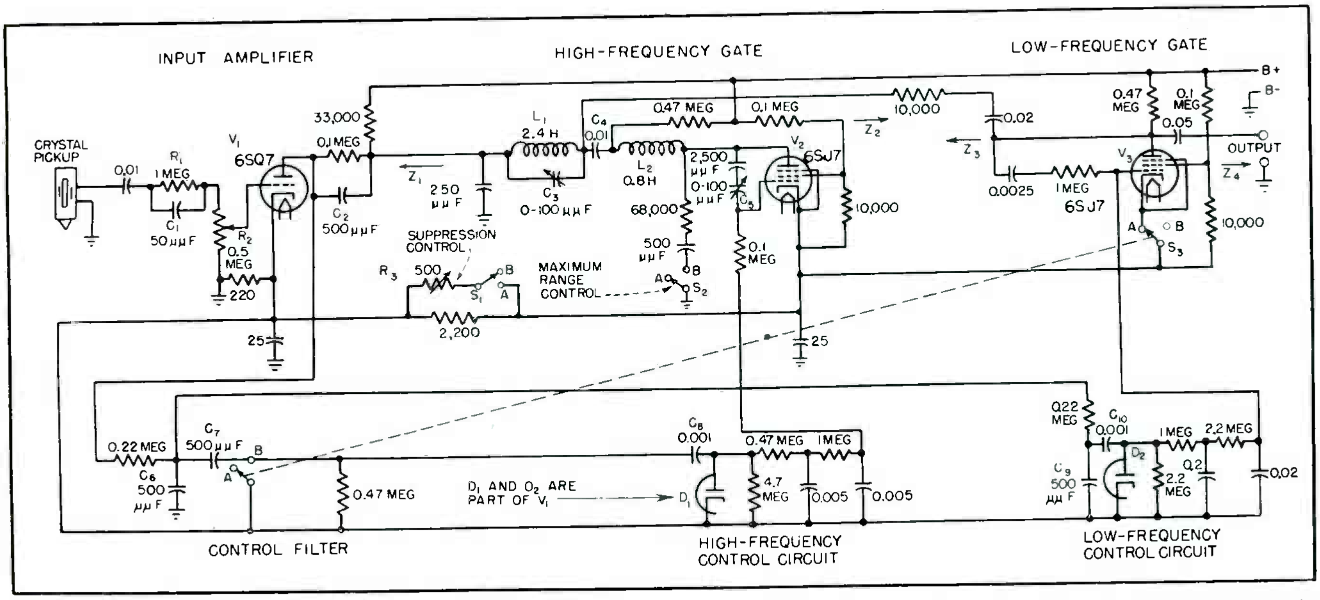


FIG. 3—Circuit of two-tube dynamic noise suppressor as incorporated in a home phonograph, with additional amplifier stage for coupling crystal pickup to suppressor circuit

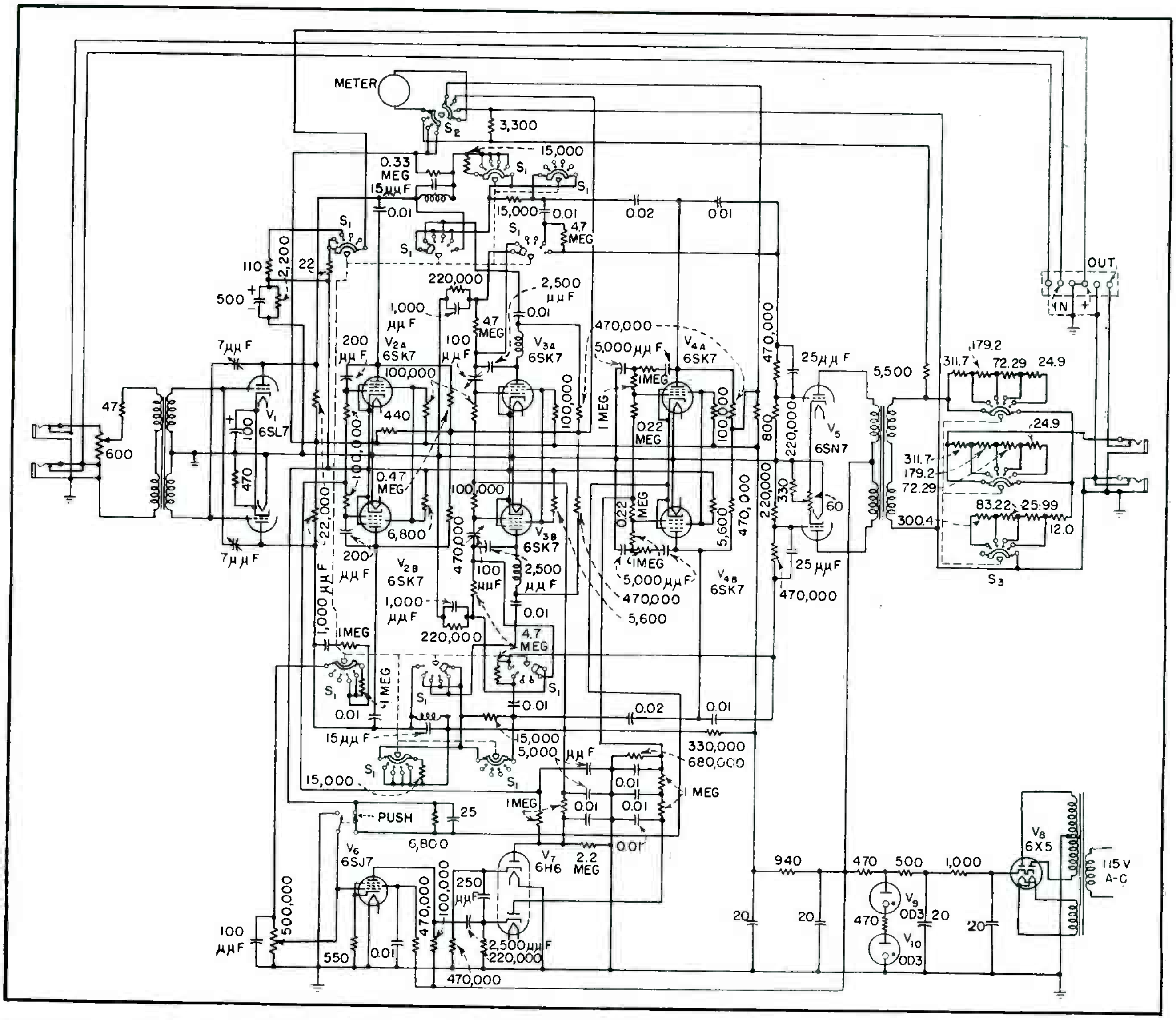


FIG. 4—Circuit of Scott model 910-A dynamic noise suppressor as designed for broadcast station use. Balanced 600-ohm input and output circuits are optional in place of the unbalanced terminations shown

used in the gate circuits and their control characteristics.

Diodes D_1 and D_2 are sections of V_1. In a radio receiver or amplifier design, these diodes can be in any other amplifying tube or in tubes V_2 and V_3. Under this latter condition, the degree of suppression can be controlled by varying the screen voltages rather than the cathode resistors of V_2 and V_3.

Switch S_1 allows the suppressor to be opened, providing maximum range when no suppression is desired. When S_1 is closed, R_3 controls the amount of suppression by adjusting the degree to which the gate circuits close. For bad records, switch S_2 allows restriction of the maximum frequency range.

Switch S_3, included mainly for demonstration purposes, closes the high-frequency gate and leaves the low-frequency gate open, thus giving the effect of a low-pass filter providing the same scratch reduction as the dynamic noise suppressor but no rumble suppression. Comparison of tone quality for the normal (A) and filter (B) positions shows the superiority of the dynamic noise suppressor over a fixed filter of equivalent scratch reduction. For best results, both maximum and minimum bandwidths should be adjustable.

Control of Gate Circuits

Speed of control is particularly important on the high-frequency gate, which must open rapidly enough to provide satisfactory reproduction of high-frequency transients such as cymbals and triangles.

Ordinarily it would be considered impossible to provide such fast operation through grid-bias control in an unbalanced circuit, but certain features of the circuit shown in Fig. 3 make this possible. Any control voltage applied to the grid of reactance tube V_2 will produce a change in the plate current of that tube, causing a low-frequency transient voltage to appear in the plate circuit. Capacitor C_4, however, may be sufficiently small to prevent transfer of that voltage to the output terminals, and the low value of shunting impedance Z_1 further improves this action.

In other words, C_4, in conjunction

with the low impedance Z_1 to which it is connected through the low inductance L_1, provides in effect a high-pass filter. Components of the control voltage, which because of previous filtering will be entirely low frequencies, will not actually appear in any appreciable amplitude across the output terminals of the gate circuit. This allows extreme rapidty of control of the high-pass filter used in the high-frequency gate, without introducing thumps or other objectionable transients into the reproduction and without the necessity of resorting to a push-pull stage.

The control circuits shown in Fig. 3 are simple but allow considerable discrimination between the desired signal and noise. Capacitor C_6 in the control filter restricts the high-frequency response of the two grid bias control circuits to prevent opening on loud high-frequency noise, while C_7 and C_8 restrict the low-frequency response of this control circuit.

The high-frequency sensitivity of the low-frequency control circuit is further restricted by C_9, and C_{10} prevents this control circuit from opening the low-frequency gate on loud low-frequency rumbles.

The over-all curve for the high-frequency control circuit approximates the response of the human ear. The control therefore resides in the desired signal rather than in the noise. This is possible because musical tones contain a fundamental and a series of harmonics. Opening the extreme high-frequency range of the gate to transmit high harmonics is controlled mainly by the corresponding fundamental tones. Opening the extreme low-frequency range to transmit low fundamentals is controlled mainly by the corresponding harmonics. This provides a high degree of discrimination against usual record noise, which tends to be greatest at extreme high and low frequencies. Of course, more elaborate filters may be used to restrict the operating ranges of the control circuits under extreme operating conditions.

For a typical home-type phonograph pickup having a replaceable needle or a bent stylus, a suppressor like that in Fig. 3 is designed to have a maximum range of 6,000 cycles. Components R_1 and C_1 in the pickup coupling circuit, as well as C_2, may be adjusted to provide the best over-all response characteristics.

Adjustments

Experience has shown that equalization which plays the low-frequency end of Columbia test record 10,004 reasonably flat provides a good average bass response for American recordings.

The overall response of the system at the high-frequency end of this record should theoretically roll down to approximate the NAB characteristic, since pre-emphasis of this general magnitude is used on most present U. S. recordings. Such a roll-off would droop above 1,000 cycles, being down approximately 10 db at 5,000 cycles. Unless a high-grade loudspeaker is used with the system, however, it may be found that this roll-off is too much and that a flatter high-frequency response is desirable to obtain sufficient brilliance. For best suppressor operation, however, the overall response of the system should be as smooth as possible and free from sharp peaks.

Resistor R_2 is normally adjusted so that the gate circuits are open during the louder passages of the music and closed during the quiet passages in order to suppress noise. Some experimentation with the setting of this control will be necessary on any new system.

Trimmer C_3 should be adjusted for a minimum of response at 9 kc or, if the unit is to be used also for a-m reception, at 10 kc. With switch S_3 thrown to position B and R_3 set at 0, trimmer C_5 should be adjusted for a minimum response at 4 kc. An a-f oscillator and an oscilloscope or vacuum-tube voltmeter are desirable for these adjustments. For maximum effectiveness the noise suppressor should be engineered as part of a complete reproducing system.

Broadcast Station Model

Since the dynamic noise suppressor does not introduce any volume expansion, it is ideally suited for broadcast station use. The complete circuit of the type 910-A unit made particularly for this purpose is given in Fig. 4. Additional high-frequency reactance tubes extend the range up to 8 kc, which accommodates most present-day shellac records, and improve high-frequency noise suppression. The high-frequency cutoff in the expanded position is not as sharp as in the simpler model of Fig. 3, allowing appreciable transmission at 10 to 12 kc. However, in this wider-range unit provision is made for restricting the frequency range when playing badly distorted records. A somewhat more elaborate control circuit is also used.

The suppressor shown in Fig. 4 is built push-pull in order to minimize such factors as hum and residual vacuum tube distortion, and to provide the very highest degree of performance for broadcast station use. The reasons for using the push-pull circuit in this instrument are exactly the same as for using push-pull circuits in other broadcast station equipment.

Extended-range transcription models, based upon the broadcast unit, have been developed providing substantially flat response to 14 kc and utilizing somewhat different suppression characteristics and time constants in order to provide the best performance on high-quality recordings and transcriptions. Such units are usable not only on music but on speech and practically any other type of program material.

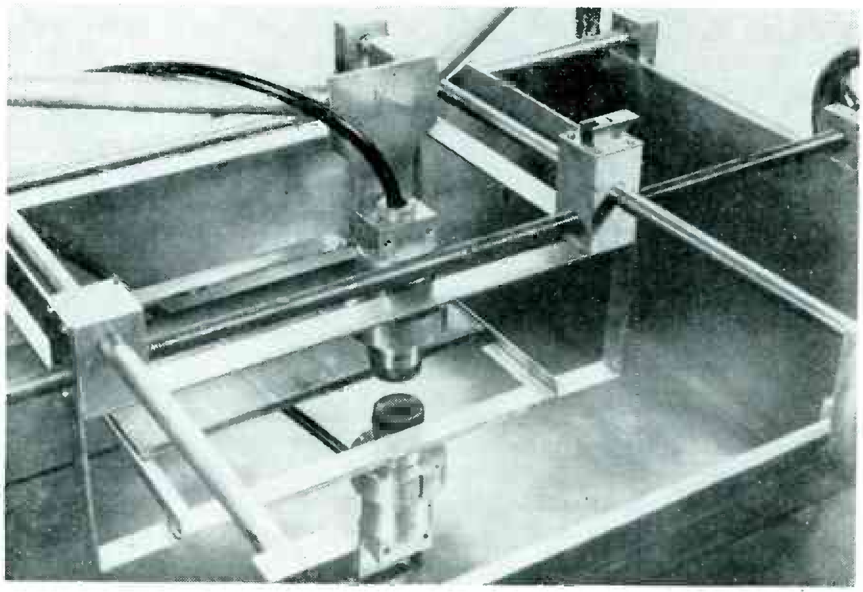
Other Applications

It is probable that in practically any instance where the desired signal varies in its bandwidth characteristics, the dynamic band-pass principle can be used to maintain an optimum signal-to-noise ratio. The flexibility of the control arrangements possible with a system of this type permits a high degree of discrimination between the desired signal and the noise, particularly in those cases where the signal and the noise have different distinguishing characteristics.

In the field of recorded music, the combination of new recording techniques, improved pressing materials, and the dynamic noise suppressor provides a realism of reproduction which is almost indistinguishable from a live program.

Design of an Ultrasonic Analyzer

Equipment for nondestructive inspection of metal strip and production testing of uniform parts comprises a noise generator, transmitter, piezoelectric transducers, and a recording receiver. Frequencies of 50, 440, 880, and 2,000 kilocycles are used; flaw location can be automatically marked



Tank in which materials are tested, with transmitting and receiving transducers fixed and the metal plate under test mounted in a frame positioned by worm screws at right angle to each other. The tank is filled with water during actual measurement

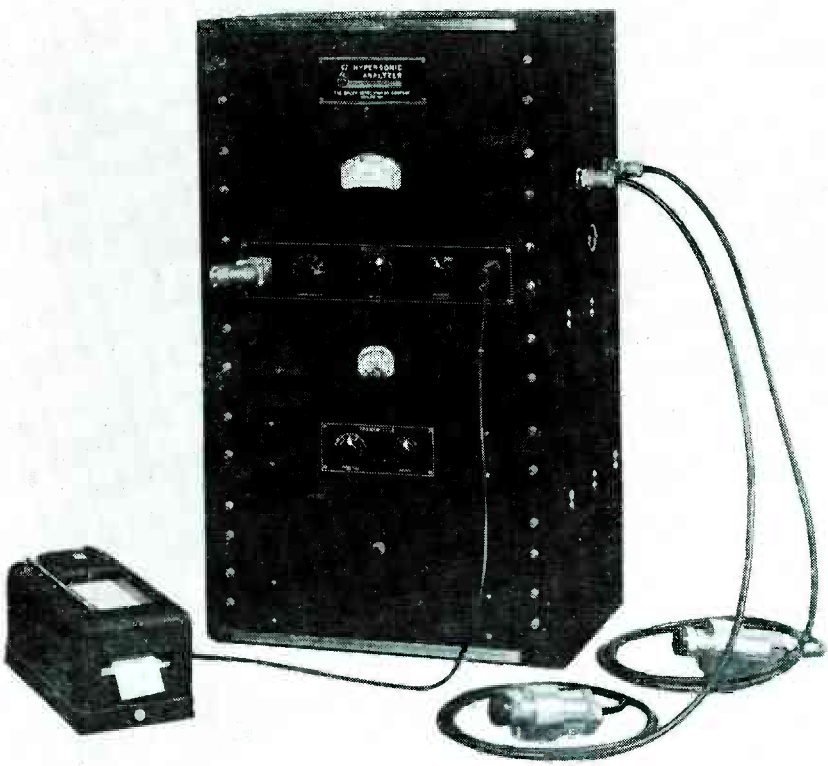
DEVICES employing ultrasonic frequencies for the nondestructive testing and inspection of materials were postulated and experimental models described as early as 1935. A simple technique that lends itself to continuous inspection of metal strip or production testing of moderately uniform parts comprises an ultrasonic power source and a receiver equipped with some sort of indicator to show a predetermined level of received energy when the article to be inspected is interposed between transmitter and receiver. If a diminution of energy occurs, the article probably contains a flaw that has attenuated the ultrasonic energy.

There are several[1] relatively simple electronic devices in which essentially radio-frequency energy is generated, transformed to ultrasonic energy by means of a piezoelectric crystal transducer and passed through the material to be tested. An oil or water bath is usually necessary to provide close coupling between transmitting transducer, the material, and the receiving transducer. The ultrasonic energy is converted at the receiver to r-f energy, and the receiver operates a meter or gives a cathode-ray display; it can also be made to give an audible or visual signal, a graphical trace, or to mark the material itself at the point of flaw indication.

Basic Principles

The production use of the Brush Hypersonic Analyzer has already been described in these pages[2] so that the principles of flaw detection need only be briefly reviewed before considering the electronic circuits involved.

If a transmitter of sonic energy is directed towards a receiver of such energy in a water medium of large physical dimensions, the receiving transducer will generate a given voltage. If a sheet of steel of large extent is inserted perpendicularly in the sound field, it can be expected that the sound pressure will be attenuated and that the receiving transducer voltage will be lowered. This ratio of pressure attenuation from the transmitter to the receiver side of the steel sheet can be shown to approximate a 10-to-1 reduction for a 0.25-centimeter-thick sheet if an



Single-channel analyzer, transmitting and receiving transducers, and graphic recorder. Upper meter indicates flaws or discontinuities

ultrasonic energy beam of 500 kilocycles is used. If the same system is used with a sheet of steel that has an air slit of 0.001 centimeter, an attenuation of approximately 1,000 to 1 is experienced. It is therefore reasonable to expect that thin laminations of air in steel sheets will give much larger attenuations than the 10-to-1 ratio predicted for the solid sheets of steel in water.

Various models of the Brush Hypersonic Analyzer are available. The following description applies to the type BE-306, which was designed primarily for laboratory or experimental stations. This instrument has a meter for indicating flaws and also contains a relay that can be set to operate for different degrees of flaw.

Noise Generator and Transmitter

The noise generator shown in Fig. 1 consists of a type 6SJ7 tube with its control grid grounded, five type 6SJ7 voltage amplifiers, and a 6J5 output stage. The shot noise in the first tube is used as the noise source. The resultant band of frequencies extending from 50 to 2,000 kilocycles is supplied to the transmitter on another chassis. Test terminals are provided to the input of the noise generator so that an external signal can be introduced for checking the gain and frequency characteristic of the equipment.

The input of the transmitter diagrammed in Fig. 2 consists of two 6SJ7 amplifiers. The 2,200-ohm

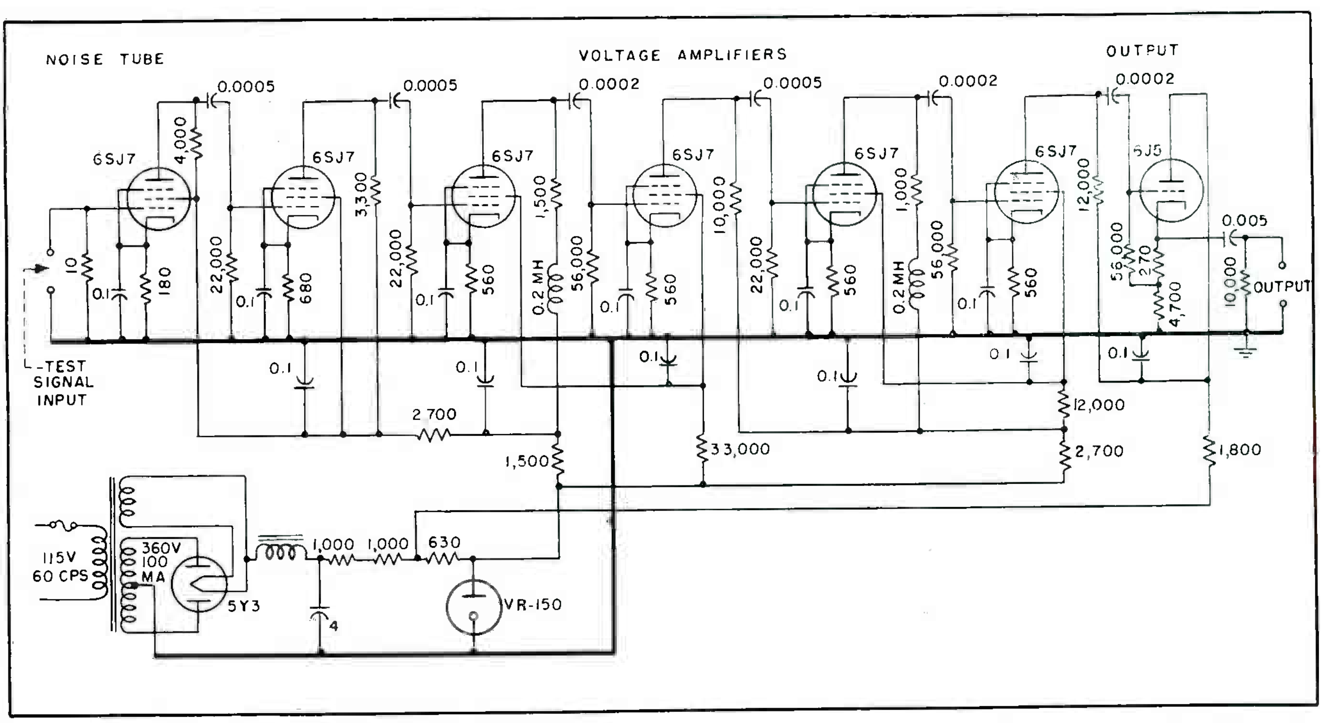


FIG. 1—Circuit diagram of the noise generator used to produce r-f energy at frequencies between 50 and 2,000 kilocycles. Shot noise in the first tube is amplified in succeeding stages and fed to the transmitter

plate load of the first amplifier passes the full noise band from 50 to 2,000 kilocycles, but a 5-point switch allows the substitution of tuned circuits, making the plate tank resonant to 50, 440, 880, or 2,000 kilocycles. An adjustable input control is provided on the chassis, but a front-panel operating control determines the output from the tuned-amplifier section.

The power amplifier is a type 6L6, driven by a 6AC7. A feedback loop from the resistive load across the 6L6 output to the cathode of the 6AC7 driver stabilizes the power amplifier output.

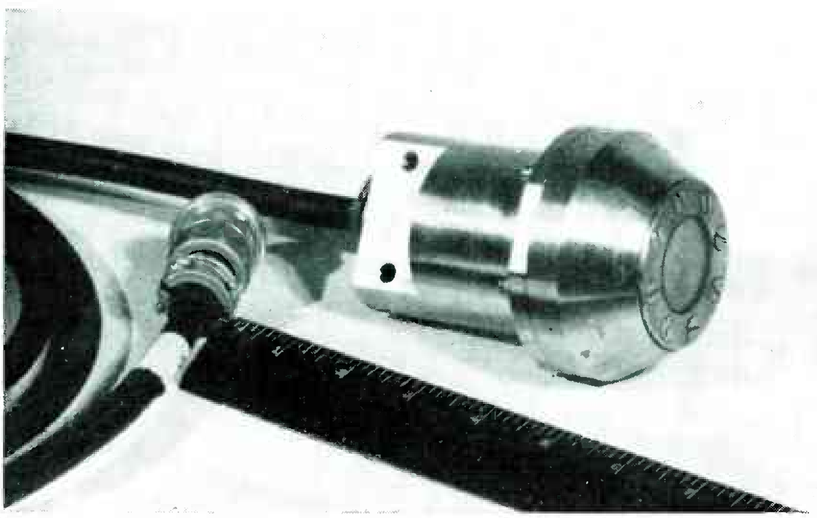
Voltage output at 50 kilocycles is approximately 100 volts, falling off to 20 volts at 2,000 kilocycles. Because the high frequency transducers that are used are more efficient than those employed at low frequencies, this decrease of voltage is not serious. Each transmitter is capable of handling three or more sets of transmitting transducers, depending upon the length of cable used to energize the transducers. The diode and associated circuits operate a meter to indicate transmitter output.

Receivers

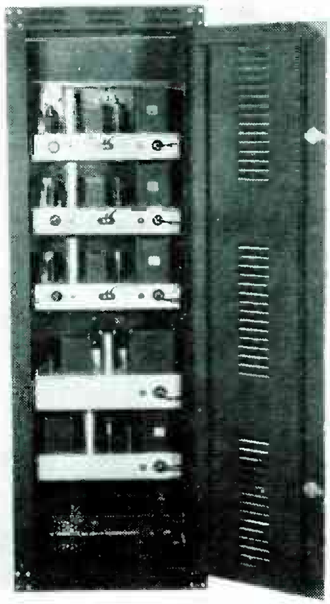
The receiver in Fig. 3 comprises a 5-tube resistance-capacitance coupled wide-band amplifier to which the receiving transducer is connected. Type 6SH7 tubes are used throughout. The amplifier is stabilized by a feedback loop from the output of the last tube to the cathode of the one just preceding it. A db-decade gain control follows the first tube and there is a fine gain control in the grid circuit to the third tube.

A type 6J5 tube is used as a diode-type detector. A FLAW SENSITIVITY control on the chassis changes the diode cathode bias voltage to set the point at which flaw indication commences. The milliammeter in the output of the 6SJ7 tube following the diode gives an upward deflection to indicate flaws.

Following the meter tube is another 6SJ7 used to energize a relay for operating a lamp, bell or flaw-marking device. Chassis controls are provided for determining the character of signal on which the relay will operate. With the ADJUST-OPERATE switch in the ADJUST position, output from the meter amplifier is directly coupled to the grid of the relay amplifier. All changes in the transmission of the material being tested or irregularity in the movement of the material between the transducer heads will affect the signal mechanisms. When the switch is in the OPERATE position, only comparatively fast changes in received signal level will operate the relay. Meter operation remains unaffected. This condition of operation reduces the chance of obtaining false flaw indications when small density gradients are existent in the material, but requires that the material being tested pass through the transducers at a fairly constant rate.



Single Brush type AX-191 transducer used for transmitting or receiving ultrasonic energy passed through material being inspected



Rear view of type BE-306 three-channel analyzer. Upper three chassis are receivers, with transmitter and noise generator for driving three transducers below. Such equipment is used for inspection of wider strip than can be accommodated with a single pair of transducers

The SLOW-FAST switch provides for a wide range of scanning speeds. In the SLOW position, the minimum speed of material is ½ inch a second and in the FAST position the minimum speed is 2 inches a second. Maximum speed depends upon the size of the flaw to be detected and the type of flaw indicating device that is used.

Receiver amplifiers are constructed with individual regulated plate and bias power supplies to obtain uniformity of performance and ease of replacement.

Transducers

The transducers used depend upon the frequency of operation, being broadly resonant at the applied frequency. Models designed for operation at 2,000 kilocycles can be used at 880 kilocycles with some loss of efficiency. A single transducer operates satisfactorily at 50 or 100 kilocycles. Special types having smaller dimensions or greater sensitivity at a particular frequency can usually be fabricated. The choice will depend upon definition, attenuation and natural resonance of the material, and frequency.

The transducer faces must be

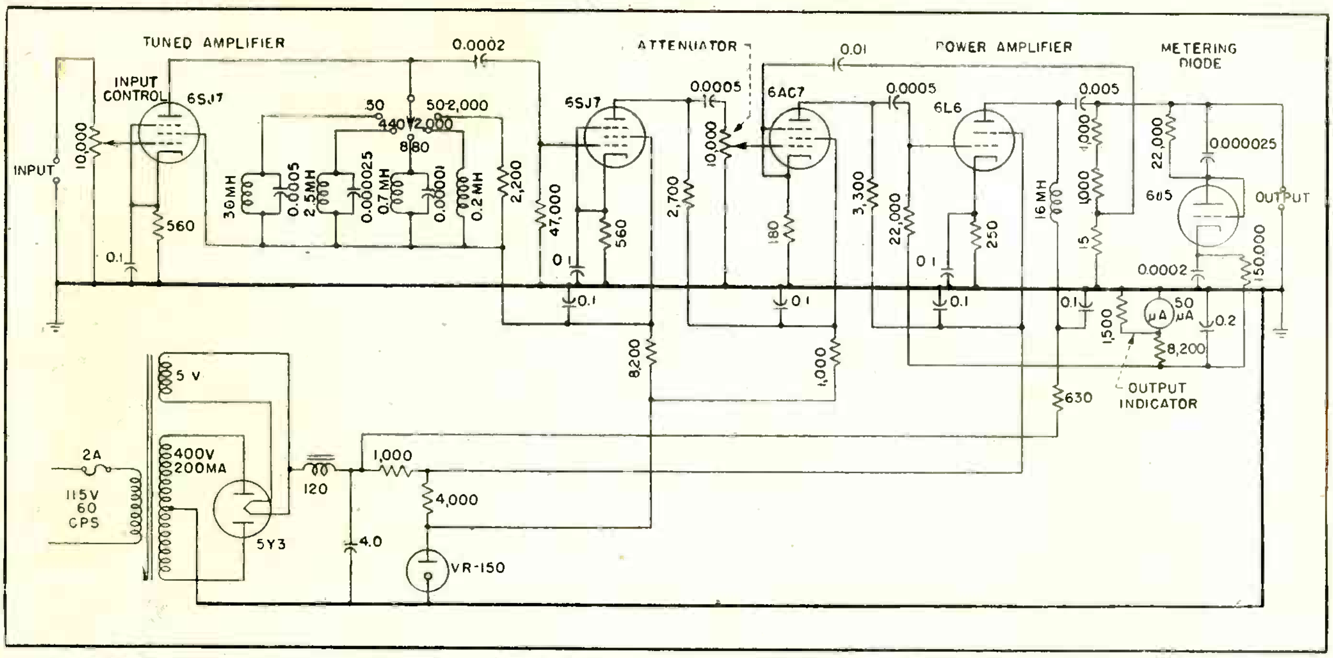


FIG. 2—Transmitter: Desired frequency is selected by resonant circuits at left, amplified and sent to transducer connected to output

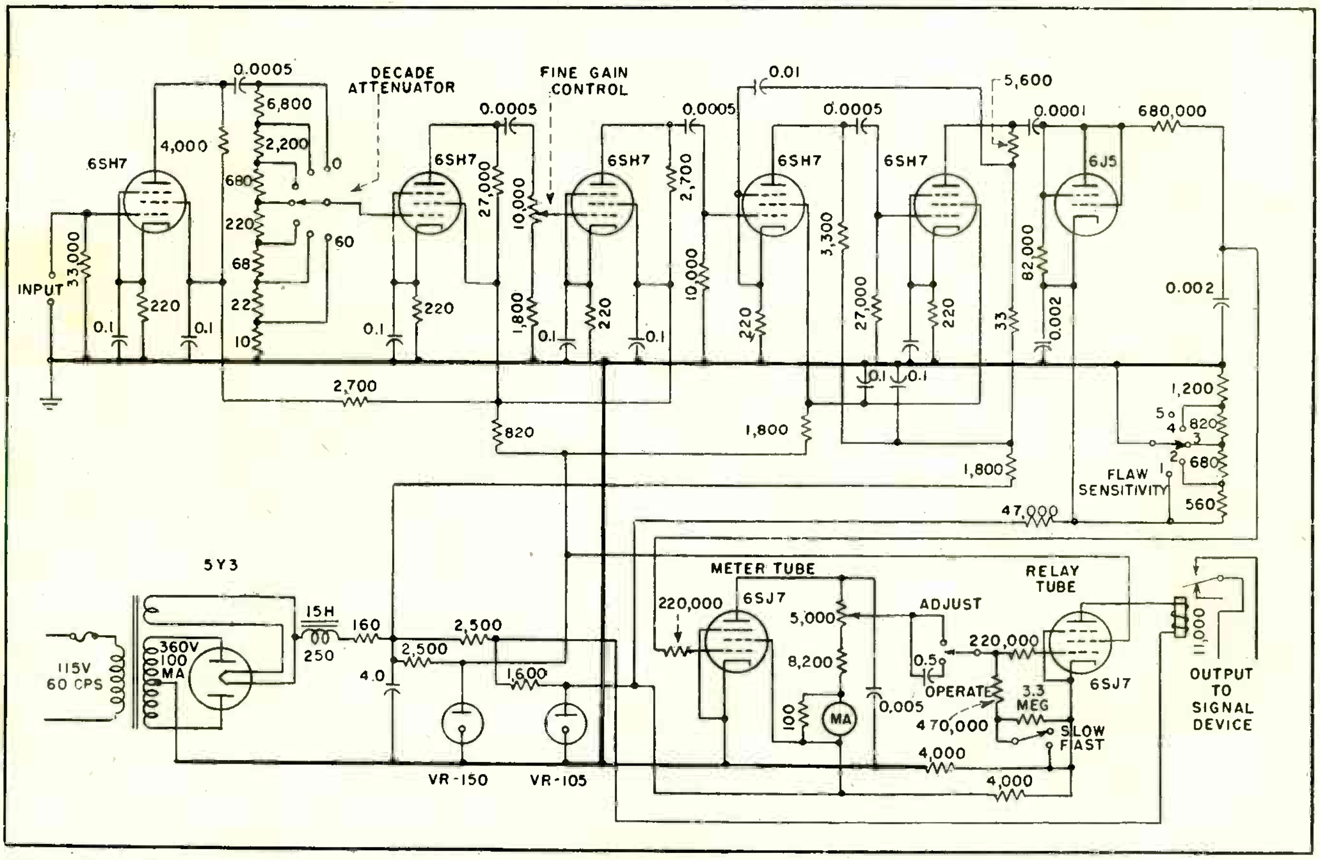


FIG. 3—Diagram of receiver used to convert ultrasonic energy at receiving transducer to radio-frequency signal, for ease of amplification then to meter or mechanical indication of flaw. Controls and adjustments are explained in text

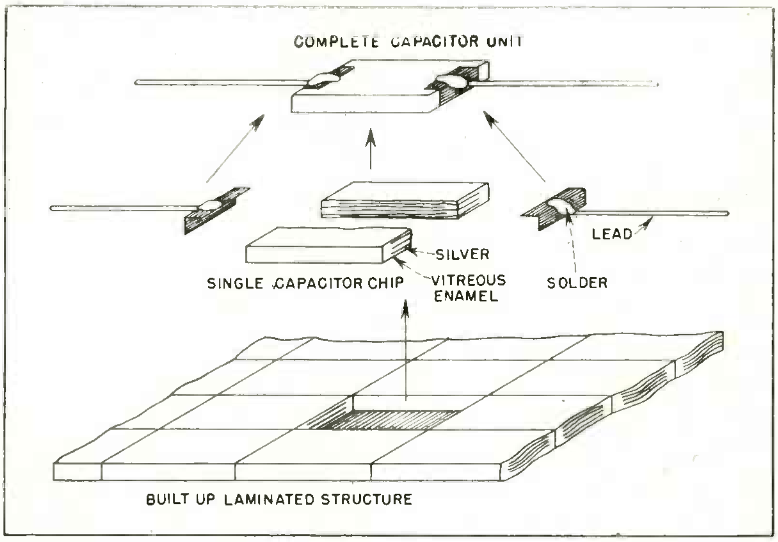
kept clean and properly aligned. The scanning medium, whether water or oil, must be clean and free of gas bubbles. When water is used, it must stand for a short time so that the dissolved air can rise. The material to be analyzed must have a clean surface, because any oil or grease may drag air bubbles under the surface of the scanning medium and therefore give a false indication of flaws. In most cases, the use of a wetting agent would be recommended.

Acknowledgement is made for basic information furnished by engineers, particularly H. A. Stearns, of the Brush Development Company—A. A. McK and F. R.

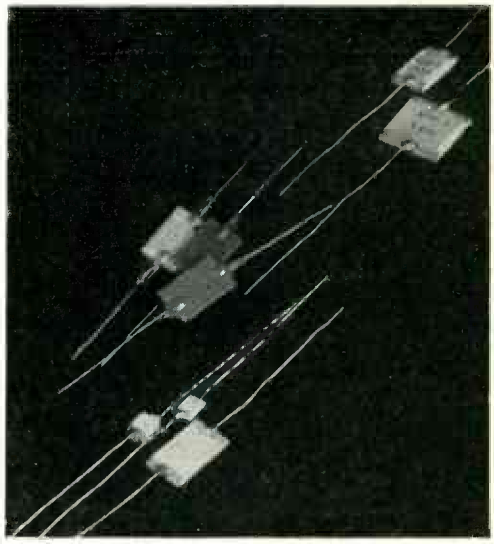
REFERENCES

(1) The Thruray, the Reflectogage, Sperry Products Co., Hoboken, N. J.; Materials Tester, General Electric Co., Schenectady, N. Y.

(2) Supersonic Inspection of Strip Materials, ELECTRONICS, p 166, March 1946.



Laminated structure produced by build-up process is cut to obtain single ceramic capacitor chips of desired size. After chips are fired, leads are attached to form completed capacitor units



Samples of vitreous enamel capacitors. Finished units can be dipped in organic lacquer or wax if sealing is required

Printed Vitreous Enamel

Capacitors having electrical characteristics comparable to those of high-quality mica units are produced by sprayed-enamel printed-silver process. This technique also yields multiple capacitors, printed circuits, and high-voltage connectors

THE CRITICAL SHORTAGE of mica during the war resulted in a need for materials and a process for making vitreous enamel capacitors with electrical characteristics comparable to those of mica capacitors. To meet this need, means were develeped for producing capacitors with unusually attractive physical and electrical characteristics.

The extremely low loss and high stability of these units permit their use in many cases where silvered mica capacitors are normally used. Their vitrified ceramic composition results in mechanically strong units with high insulation resistance and high permissible operating temperatures.

The process is based on the laying down by spraying, of layers of vitreous enamel alternating with layers of conductive silver paste deposited by silk screen or squeegee printing. The silver paste consists of about 60 percent conventional Du Pont V-9 silver flake in an organic vehicle. The dielectric enamel is of suitable consistency for spraying and in general consists of 15 to 25 mole percent of silica, 3 to 11 mole percent of alkali oxides, 5 to 11 mole percent of alkali fluorides, 15 to 25 mole percent of lead oxide, and 11 to 30 mole percent of other bivalent metal oxides.

The basic unit of the process is the build-up machine in which the desired structure is built up on 9-inch by 12-inch steel conveyor plates that have been precoated by dipping in a dilute solution of ethyl cellulose in methanol. The coated steel plates are loaded onto a conveyor which travels a rectangular path. The conveyor carries the plates into a paint-spray booth where the enamel is applied from a spray gun directed downward to the horizontal surface of the plates. The thickness of the layer of enamel sprayed on the plate is regulated by controlling the rate at which enamel is fed to the spray gun. Periodically, sprayed plates are removed and enamel layer thickness is checked.

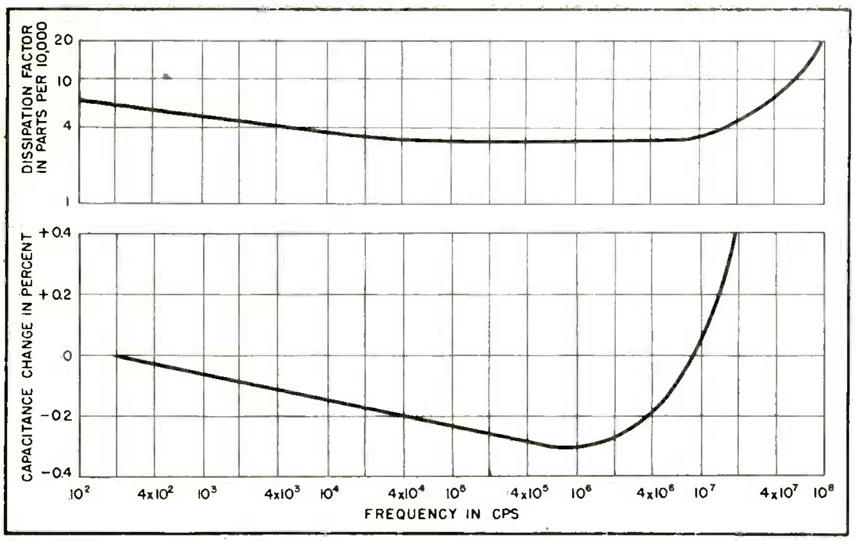


FIG. 1—These variations with frequency of capacitance change and dissipation factor are typical for vitreous enamel capacitors. The units compare favorably with silvered mica capacitors

Components

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After receiving the sprayed enamel, the plates are carried by the conveyor through an infrared drying tunnel in which the enamel dries to a consistency best described as "cheesy". After drying, the plates are momentarily halted at a station where the desired pattern is squeegeed on them. This pattern may contain as many units as can be drawn within the area of the steel plate depending upon the size of the particular capacitors that are to be produced. After receiving the silver pattern, the plates continue along the fourth side of the conveyor which returns them to the spray booth.

This spray-dry-silver cycle is repeated until the desired number of laminations have been formed. On leaving the machine, the plates pass through a mechanism which cuts the built up structure into units of appropriate size and shape. Next, the plates are baked to remove some of the organic matter, to free the enamel-silver structure from the steel plate and to impart to each cut unit sufficient rigidity to allow the unit to be handled.

Depending upon the relation between the silver patterns and the size of each cut unit, silver will be exposed at specified points on the edges of the unit. Any desired connections between different layers of exposed silver may be made by applying silver paste to the edges of the unit. The unit is then fired for about 12 hours to produce a monolithic structure typical of vitrified ceramic articles. The fired unit at this stage of the process is already a usable capacitor, but in general, leads are attached and a finish is applied to form a completed capacitor.

Mechanical Characteristics

This process can be used to produce a wide variety of capacitors with dimensions limited only by economic considerations. The present equipment is capable of making pieces with maximum dimensions of 6 inches by 8 inches. It is possible to cut the single units as small as 0.3 inch; the most economical thickness is of the order of $\frac{1}{8}$ inch. Samples of these units can be supplied in capacitances from 15 to 5,000 $\mu\mu$f. However, the relative economics favors units having capacitances of less than 1,000 $\mu\mu$f. The simplest form which these units can take incorporates a single capacitor. The particular capacitances and dimensions are governed by product design considerations.

The integral construction of silver and ceramic results in high mechanical strength approximately equal to that of steatite. Although the material is brittle, it is adequately shock resistant to withstand normal handling.

Since the most economical capacitor designs require a minimum of unused ceramic, silver is distributed throughout the entire volume and the resulting thermal conductivity is excellent. This feature makes the unit relatively immune to heat shock so that leads can be soldered directly to the end silver without cracking the unit. These leads can meet standard pull and bend tests.

Electrical Characteristics

The ceramic dielectric has a loss factor of the same order as mica and the properties of the silver are such that high electrical conductivity is obtained. Incorporation of this silver and the ceramic into a monolithic block adds the further characteristic of high stability.

Capacitors produced thus far are rated at 500 volts and have capacitance of approximately 0.01 μf per cu. in. Typical sizes are 0.3 inch by 0.3 inch by 0.05 inch for 50 $\mu\mu$f and 0.5 inch by 0.5 inch by 0.1 inch for 350 $\mu\mu$f. The smallest sizes are restricted only by lead capacitance and handling limitations.

Since it is possible to adjust both electrode areas and dielectric thickness during production, capacitance of the units in every yield can be closely controlled. With appropriate sorting, it is economically feasible to produce capacitors to tolerances as close as 2 or 3 percent.

Figure 1 shows data obtained by the General Radio Company on the variation of capacitance with frequency. There is relatively little change at frequencies up through 20 mc. Figure 1 also shows the variation of dissipation factor with frequency. The fact that the dissipation factor is of the order of 2×10^{-3} at frequencies as high as 100 mc is of particular interest in the fields of f-m and television.

The capacitance drift as defined in specification JAN-C-5 is 0.02 percent. The drift of the vitreous enamel capacitors is within this limitation and therefore meets the rigorous requirements of the F characteristic, thus demonstrating the high stability of these units.

The temperature coefficient of these capacitors has a uniform positive value of about 105 parts per million per degree C. The capacitors are usable at temperatures up to 125 C with no change in temperature coefficient. Figure 2 shows the approximate usable temperature range of these capacitors.

These units have leakage resistance of the order of 10^4 to 10^6 megohms for capacitances up to a few thousand $\mu\mu$f. Proper finishing insures that this high resistance is maintained even in the presence of high humidity.

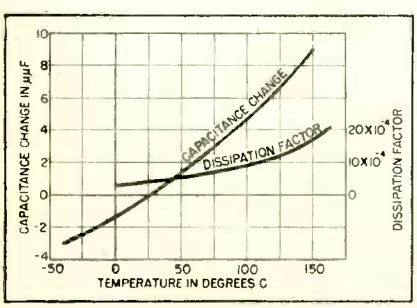


FIG. 2—Capacitance change and dissipation factor as functions of frequency for a 500-$\mu\mu$f vitreous enamel capacitor

Printed Circuits

The production technique can be easily extended to include a number of capacitors or a combination of capacitors, resistors and inductors incorporated in one unit. Typical examples are shown in Fig. 3. Sample A contains two capacitors which have a common terminal at one edge and separate terminals at the other. This particular arrangement contains an electrostatic shield between the separate plates which is connected to the common terminal. Sample B shows a similar application of two capacitors in one unit to be used as the tuning capacitors for i-f transformers. In this case a hole through the chip is provided to mount the i-f coils or to make the core accessible for tuning.

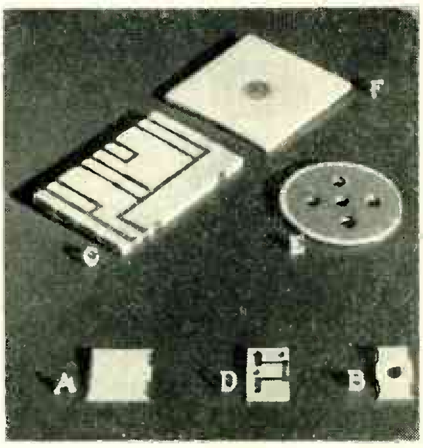


FIG. 3—Multiple capacitor units and printed R-C circuits

Since conductors may be printed either internally or externally, the arrangement of elements need not be limited to one plane. The assembly shown at C illustrates an application of this principle. This block contains all circuit elements and interconnections for a two-stage amplifier.

Two capacitors and four resistors are incorporated in the diode filter unit at D. This experimental assembly is being used to investigate the practicability of supplying eyelet terminals in the ceramic.

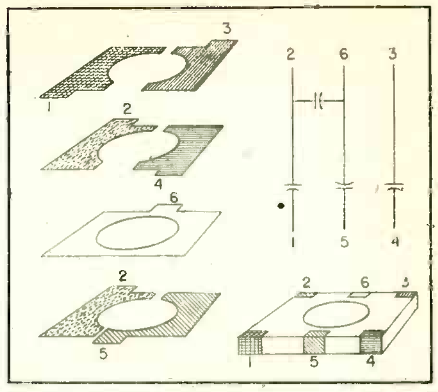


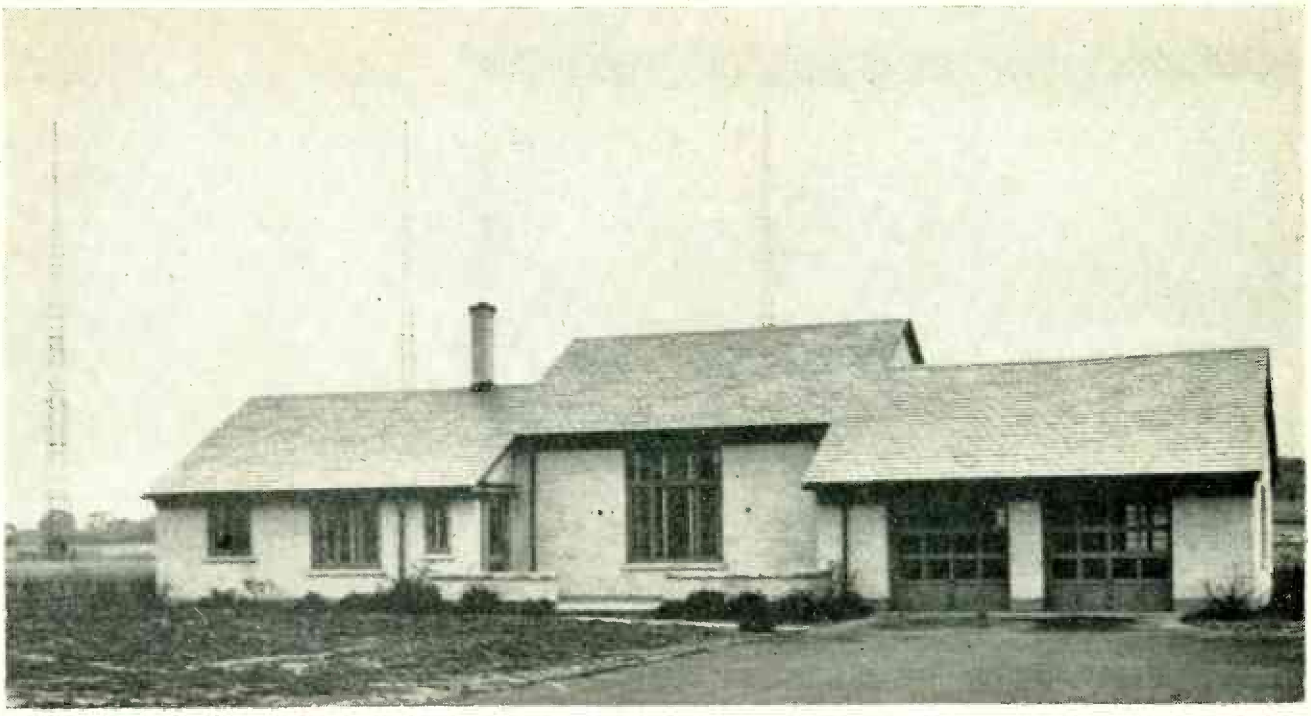
FIG. 4—Silver-paste laminations are arranged in this pattern to form four-capacitor unit with internal circuit as shown

Samples E and F are, respectively, a cable connector unit, containing four capacitors—one from each of the outer four terminals to the common center terminal—and a high-voltage unit, about 1/10 inch thick containing floating electrodes spaced 1/100 inch apart, capable of operation at 20 kilovolts.

Although there is no limit to the number of capacitors which can be built into a single unit, practical considerations usually make it undesirable to incorporate more than four capacitors. The construction of such a unit is shown in Fig. 4. Capacitors between electrodes 5 and 6, 2 and 6, 1 and 2, and 3 and 4 are formed with multiple dielectric thicknesses although only single layers are illustrated here. Connections to these units are made with the tabs shown. Proper design reduces unwanted capacitances below the limits allowed from circuit considerations.

The authors of this paper wish to acknowledge the contributions made to this development by C. Robertson, K. H. Ballard, and A. J. Deyrup of the Technical Division of the Du Pont Electrochemicals Department and E. H. Schmidt of the Du Pont Engineering Department. The advice and assistance of Harold A. Wheeler, consultant, and the contribution of T. G. Owen of the Remington Arms Company in the production of samples is also appreciated.

The research reported here was done under Signal Corps Contract W 28-003-SC-304. Contributions and cooperation of members of the Signal Corps Engineering Laboratories is also acknowledged.



WHEC transmitter building with directional array towers at the rear

PHASE MONITOR for Broadcast Arrays

The phase angle between any two directional antenna towers can be checked in thirty seconds to within a degree of the design value for the array, by a device that is mechanically simple to construct, easy to check or use. It requires no power supply and contains no components whose drift or age affects the calibration

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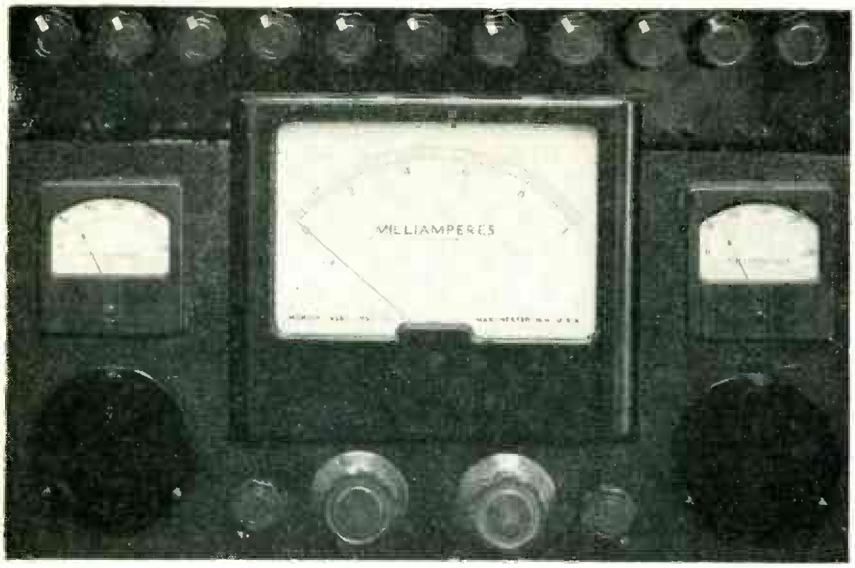
Directional broadcast antennas are becoming more and more complicated and require an accurate means of measuring the phase and magnitude of the individual tower currents, if the radiated pattern is to be maintained. The phase monitor described here is fundamentally simple and stable and will indicate phase relations between r-f currents in any desired number of towers, within one half of one degree. Readings may be made of either the large or small angle between two currents, and no ambiguity can exist as to the quadrant involved.

The phase monitor is the result of a few experiments with an r-f bridge and some flexible plastic dielectric coaxial line. At approximately 90 degrees from the top of each of our towers, we had installed a large rectangular one-turn shielded loop. Energy picked up by the loop was fed to the transmitter house by three ⅜-inch coaxial lines. Considerable care was taken to make these lines of equal length, in order that each sample of current



Original model of the phase monitor. Large meter is the null indicator; line selector switches and potentiometers are just below. Eleven switches at the top introduce a total delay of 360.5 degrees

should experience the same delay in traveling from the towers to the phase monitor.

The principle of operation of the monitor is illustrated in Fig. 1. Two tower sampling currents, between which the phase angle is to be determined, are selected by switches S_A and S_B. A phase delay is introduced in the current chosen by switch S_B, by cutting in and out predetermined lengths of coaxial line, using switches S_1 through S_{11}. Thus, the current from S_B is delayed sufficiently to bring it into phase with that from S_A. The currents leaving the phase delay lines flow through r-f milliammeters and terminating resistors R_A and R_B, to ground. A portion of the voltage drops across R_A and R_B is fed through potentiometers R_2 and capacitors C_1 to a germanium rectifier, X.

When the two r-f voltages leaving potentiometers R_2 are equal in magnitude and exactly in phase, no voltage appears across X, and no current flows through it. When these conditions do not exist, the rectifier current is indicated by the d-c flowing through the two r-f chokes and the galvanometer G, a 0-1 d-c milliammeter. The two r-f milliammeters are in the circuit simply to indicate relative tower currents and have no function in measuring phase relations.

In operation, the switches S_A and S_B are set to the desired position, and potentiometers R_2 are advanced simultaneously, until meter G gives a substantial indication. Delay is then added to channel B, by switches S_1 through S_{11} and both potentiometers R_2 are progressively advanced, until a zero reading is obtained on meter G. The switches S_1 to S_{11} that have been brought into the circuit are then totaled to indicate the amount of phase delay that has been introduced. Maximum accuracy is obtained when one or the other of potentiometers R_2 are advanced to the maximum position. In this manner readings may be duplicated to within 0.5 degree or better.

Complementary Readings

Sufficient delay line is available to carry a current through a complete 360-degree circle. Thus, each phase measurement can be checked by first measuring the smaller angle between two currents by delaying the leading current and next by delaying the lagging current to determine the larger angle which should complete the 360 degrees. As shown in Fig. 2, it is possible to delay the No. 1 current 120 degrees to meet the No. 2 current, or to delay the No. 2 current by 240 degrees to coincide with the No. 1 current. Each pair of measurements made in this way adds to 360 degrees to make the procedure self-checking. Three or more currents can also be checked to total to 360 degrees, a procedure that inspires a good deal of confidence in the readings taken, provided the total comes out right.

Checking Monitor Calibration

It is possible to check the phase delay network itself for any slight variations, simply by putting both switches S_A and S_B on the same source and obtaining a balance with

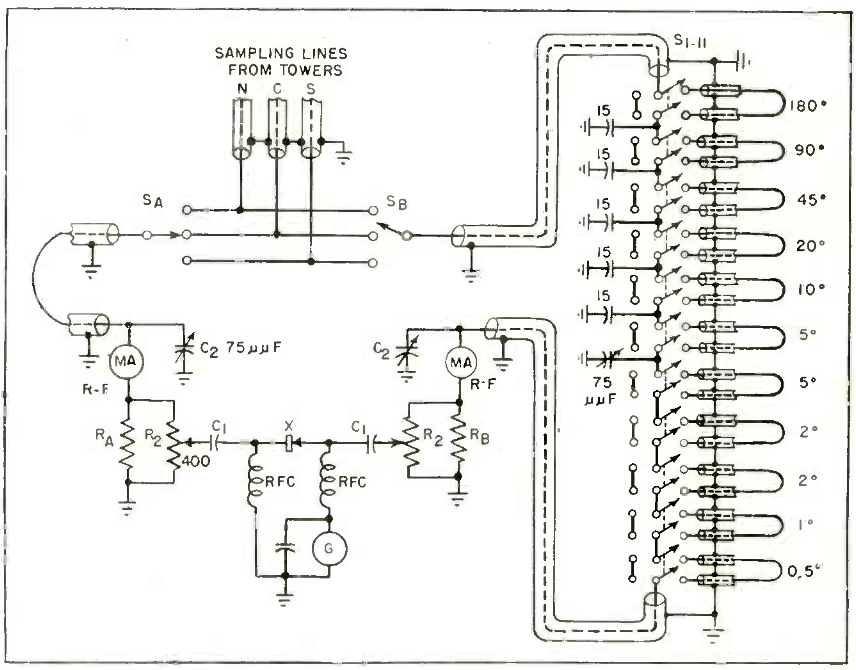


FIG. 1—Schematic diagram of the phase monitor with coaxial-cable phasing sections and switching arrangement at right

zero degrees and 360 degrees of delay line. This method has been used repeatedly in an effort to detect any tendency of the coaxial sections to change characteristics. So far, no drifting has been observed, within the 0.5-degree accuracy of the monitor.

With a little practice a single phase reading may be made in about thirty seconds. The instrument is always ready for use, as it requires no warming up period or calibrating adjustments. Modulation does not affect the measurements, since the signal is completely canceled for exact balance.

The indicating meter used is a large scale 0-1 milliammeter. A 0.5-degree error at balance is indicated by a needle deflection of about $\frac{1}{16}$ inch on the large scale. More sensitivity can be obtained by substituting a microammeter, or by using an audio amplifier and speaker in place of the meter. A 0.25-degree coaxial section and switch may also be added, for finer readings.

The phase monitor used at WHEC has the following characteristics

ADVANTAGES

1. Monitor maintains calibration without repeated adjustments
2. There is no warming-up period or drifting
3. Readings do not depend upon accuracy of a meter scale or calibrated dial
4. No resonant circuits that might change characteristics with time
5. Requires no power supply, with resultant voltage variations
6. Phase readings can be duplicated within 0.5 degree
7. Absolute accuracy is of the order of one degree; relative phase changes of 0.5 degree can be detected
8. Any angle can be measured in both directions around the circle; three or more angles can be checked in every possible combination
9. Accuracy of reading is constant regardless of magnitude of angles measured
10. No confusion exists as to correct quadrant
11. Construction is simple and inexpensive

DISADVANTAGES

1. Phase delay network must be built for a single frequency
2. R-f bridge must be available during construction
3. No direct reading dial
4. Minimum input (terminated) of 2 volts for accurate results
5. Space must be provided for several hundred feet of coaxial line

Building a Delay Line

For the coaxial delay line a flexible low-loss plastic dielectric line was used, of about $\frac{1}{4}$ inch outside diameter having an outer coating of rubber. A 175-foot unterminated piece was connected to an r-f bridge and was trimmed to exactly 90 degrees by observing when the bridge indicated a short circuit on our frequency of 1460 kc. The 90-degree section was found to be exactly 106 feet indicating a velocity of 63 percent of that in free space. The characteristic impedance of the line was next determined by locating a nonreactive resistor that gave the same bridge indication when measured either alone or through the 90-degree section of line. The value of this resistor turned out to be 62.5 ohms.

The input impedance at the monitor terminals was next measured and adjusted. It is important that each termination be equal and nonreactive, and constant for all delay combinations; otherwise slight phase shifts will be introduced at this point, with resulting error in measurements. With the bridge connected directly to the r-f milliammeter input post, R_A and R_B were adjusted to give a termination of exactly 62.5 ohms. The remaining inductive reactance due to wiring was cancelled by adjusting C_2, 75-micromicrofarad variable capacitors. The wiring from input terminals to S_A and S_B was made as short and symmetrical as possible, in order to minimize reactances at the line terminations.

Inductive reactances due to wiring between switches S_1 to S_{11} were canceled by adding shunt capacitances at various points along the switch row. After some trial and error, the combination of capacitors shown held the input impedance to channel B at 62.5 + j 0 ohms for all settings of the phase delay network.

Adjusting for Zero

The length of the coaxial line between S_A and its associated r-f milliammeter was adjusted to give a delay exactly equal to that between S_B and its r-f meter, when all phase delay switches S_1 through S_{11} were turned off. This was done by feeding both S_A and S_B from the same source and trimming the channel A coaxial line to obtain a zero galvanometer indication, with no delay introduced in channel B.

A specimen phase reading on WHEC's tower currents gives the data presented in Fig. 3 and corresponds exactly to values assigned in the original design for the required directional characteristics of the array.

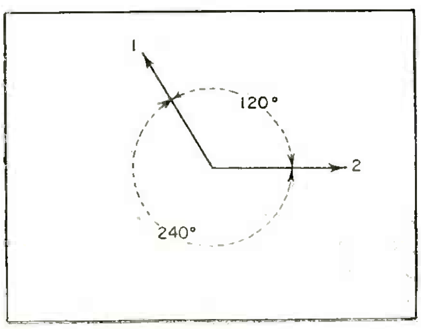


FIG. 2—Vector diagram showing how to measure angle from either tower

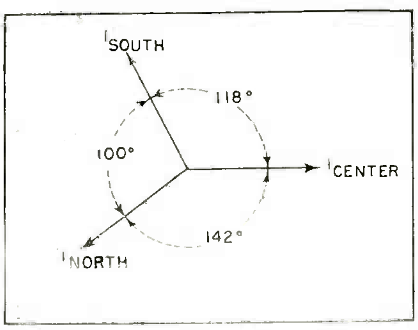


FIG 3—Vector diagram showing actual phase relations of WHEC three-tower array

Experimental carrier system undergoing laboratory tests

F-M Short Range

A simple communication system for open-wire lines twenty to thirty miles in length operates in the 100 to 400-kilocycle range. Wide-band frequency modulation and limiting are used to minimize audio gain variations due to climatic changes

THE USE of carrier systems has become widespread in the telephone industry in the last few decades, and a number of systems are available on the market. In general, these systems are designed to permit the bridging of long distances.

In view of the cost of long-distance lines, it has been desirable to accommodate the largest practicable number of speech channels, which results in a close spacing of the frequency bands used for the different carrier channels. This puts very stringent requirements on the design and manufacture of the filters employed to separate the different speech channels. In addition, it is generally required that a number of such carrier sections can be used in tandem to form parts of transcontinental and other long-distance telephone channels. This requires extremely low distortion.

There are many cases where additional circuits are needed for relatively short toll lines of 25 or 30 miles; where only two or three additional circuits are required, and where the need for using many such systems in tandem does not exist. Such problems are encountered in large numbers by the independent telephone industry, the telephone companies not forming part of the Bell System. These companies operate an appreciable number of toll lines, most of which are restricted to the ranges mentioned.

For use in such applications, the carrier equipment developed for long-haul applications is prohibitive in cost in the majority of cases. It seemed that a much simpler carrier system could be developed if short-range requirements were given full consideration from the start and that the cost of such a system might be low enough to make carrier systems attractive for short-haul applications.

The system to be described will operate over 20 to 30 miles of open-wire line. It permits application of three carrier channels, and the channels are selfcontained so that they can be added or removed without affecting the remaining channels.

Basic Operation

One of the major items in the cost of conventional carrier systems is represented by the filters necessary to separate the different speech channels. As the needs for short-haul carrier systems are as a rule restricted to only a few circuits, it was decided to use large frequency separation (50 kc) between channels; this greatly simplifies the filter design and manufacture. This

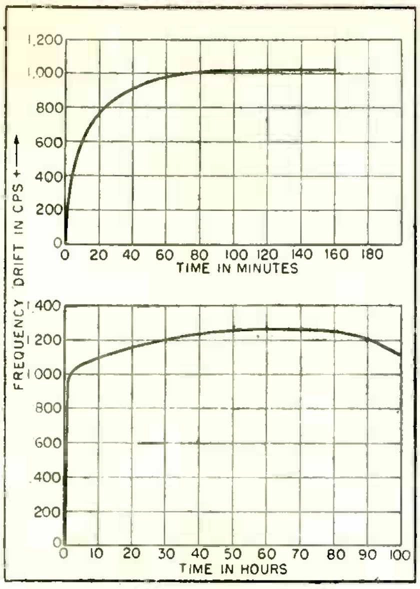


FIG. 1—System frequency change

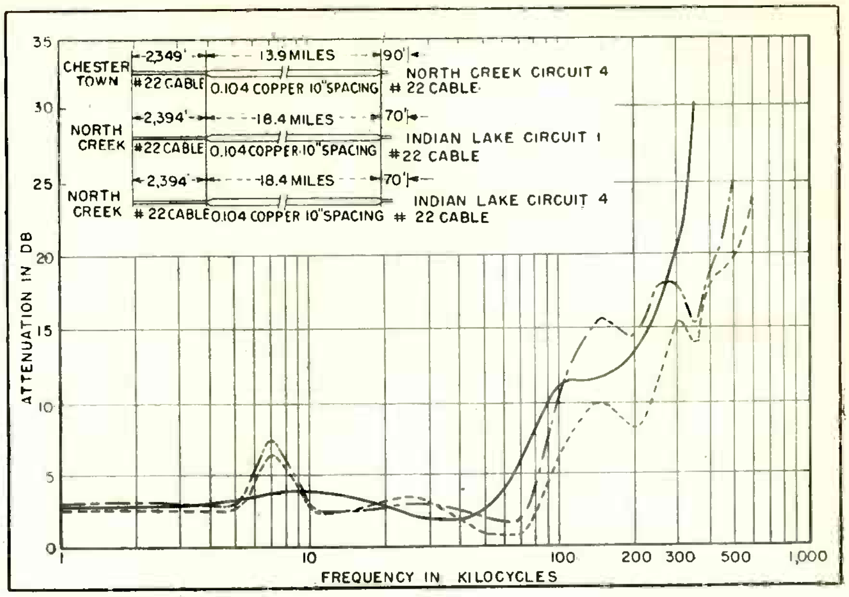


FIG. 2—Attenuation of signal on three open-wire lines and their entrance cables

Carrier System

By E. H. B. BARTELINK and EDWARD DASKAM
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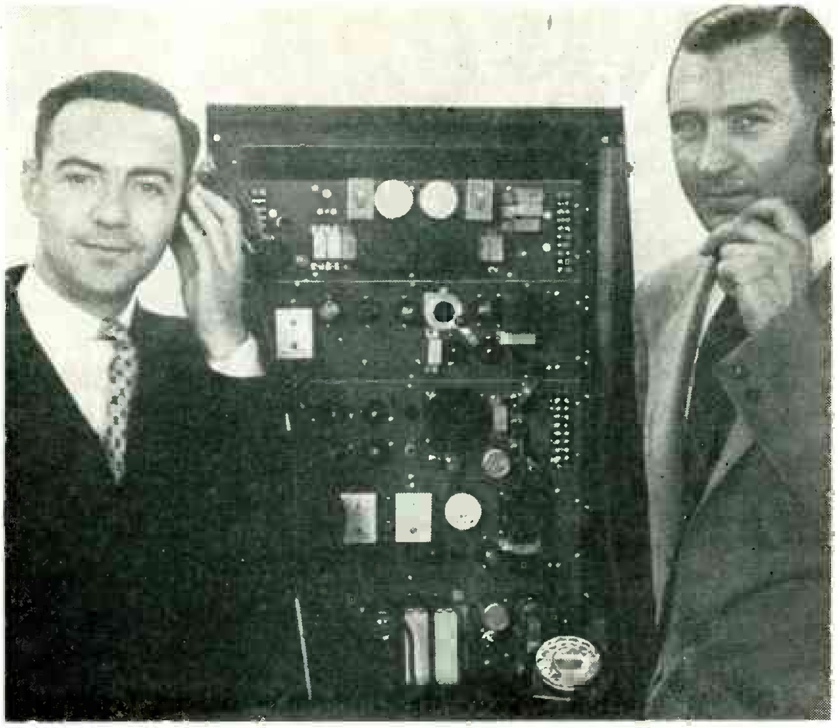
process is further helped by putting all carrier channels in the 100 to 400-kc range where the required pass bands have been reduced to reasonable fractions of the carrier. As a result, the filters closely resemble standard double-tuned i-f transformers used in broadcast receivers. In addition, the use of these higher frequencies reduces the equipment for separating the normal (300-3,000 cps) speech channel from the carrier to the most elementary and uncritical components.

Another problem encountered is that of paralleling the filter output circuits for the different channels at the transmitting end and the filter inputs at the receiving end. In conventional carriers, it is necessary to design the filter systems so that the overall impedances of these paralleled structures will meet close tolerances. In this system, a brute-force method was used. Relatively high resistances were inserted between some of the filters and the line. Thus the bridging impedances of these filter branches have been made sufficiently high so that interaction of different carrier channels may be neglected. This involves some transmission loss in the system, but power on the transmitting end and gain on the receiving end can be obtained easily and at low cost. In addition, it is possible to put in additional carrier channels without having to modify any other channels.

Another problem in the design of carrier systems is that of keeping the transmission in the circuit reasonably constant, independent of any climatic and other changes to which the line might be subjected by conditions.

This problem is solved by the use of wide-band frequency modulation which, with proper limiting, will provide an audio-output signal which is independent of the incoming r-f voltages within wide limits. Frequency modulation also helps suppress crosstalk from undersired signals, whether it originates in a neighboring carrier system operating on the same channels or from adjacent carrier channels.

Wide-band frequency modulation is obtained by the use of a positive-bias multivibrator. Such a device was described in an earlier paper,[1] and it was shown that the relation between frequency and positive-bias voltage is a linear one in first approximation. As was described in patent literature,[2] it is possible to apply a modulation voltage in series with the positive-bias supply of such a multivibrator, and



Authors Daskam and Bartelink use short range carrier equipment

such an arrangement will permit frequency modulation corresponding to a large fraction of the carrier frequency.

This is the method used in the new carrier system. Its usability for practical communications purposes depends to a large extent on the ability of obtaining stable average frequencies in the multivibrators because excessive deviations would cause them to drift beyond the filter acceptance bands. Refinements in technique and proper choice of components have made it possible to obtain a high degree of frequency stability in multivibrators. Figure 1 shows that if constructed with proper care, such a circuit can be stable enough to meet the requirements.

Attenuation

The attenuations which occur in a uniform open-wire line can be calculated with reasonable accuracy. However, in most cases the actual lines will have entrance cables at both ends and sometimes at intermediate points. If these are of any appreciable length, mismatch and reflection losses can occur. In the process of determining the attenuations for which the system should be designed, consideration has been given not only to the losses of uniform lines, but also to attenuations existing in some actual operating circuits.

Figure 2 gives a plot of attenuations as a function of frequency for three circuits, each having an appreciable amount of entrance cable. These measurements were made in mid-winter when a considerable amount of snow and ice were deposited on both insulators and cross arms along the line and thus represent rather adverse climatic conditions.

Several irregularities occur in these curves, corresponding to reflections and standing waves. However, for all frequencies under 300 kc, the attenuations do not exceed 20 db, and do not exceed 30 db for any frequencies up to 350 kc. It is possible to eliminate the irregularities and reduce the losses by proper modification of the line, but the carrier system as a whole is most valuable if it does not require any changes in existing lines.

Crosstalk and Noise

In most cases 2-wire operation, using adjacent channels for the east-west and west-east transmission, is desirable. The interfering signals will then reach the receiver without any attenuation, while the desired signal may be down by a maximum of 30 db with respect to it. An interference level of at least 35 db below the desired signal at this extreme condition has been assumed to be satisfactory for service and the filter systems have been designed towards this value.

A high transmission level will simplify the receiver sensitivity problem and reduce the influence of outside interference. Excessive levels may give rise to interference in neighboring radio circuits. On this basis, a maximum transmission level of 50 milliwatts in 600 ohms was assumed. To develop the same output voltage in entrance cable which may have an impedance as low as 100 ohms at these frequencies up to six times the power or 300 milliwatts may be required. This level can be obtained for normal circuits without undue requirements on the power output stage.

Bandwidth and Selectivity

The frequency excursion chosen for this system is approximately 6 kc each side of center. As the speech band normally transmitted is 300 to 3,000 cycles, this gives a frequency modulation index of 2.0 on the highest frequencies. On this basis, an interference suppression of approximately 10 db can be expected.

To have a safety factor in the crosstalk, the interference suppression obtainable by the use of frequency modulation has been completely discounted in the determination of the selectivity needed in the receiver. The adjacent channel at-

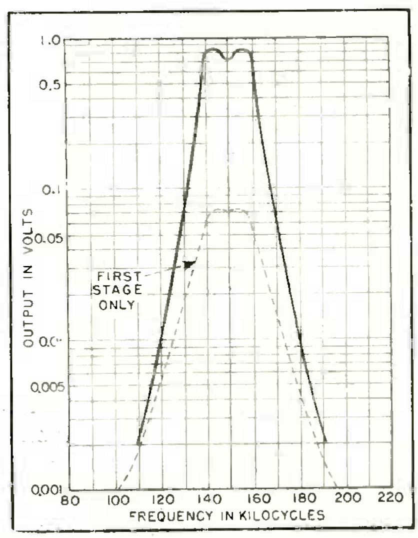


FIG. 3—Selectivity of two stages in the receiver is indicated by solid curve. Output voltage taken from a 500-ohm resistor in each plate circuit

tenuation requirement was accordingly set at 65 db at frequencies 40 kc removed from the center of the carrier channel.

A selectivity curve for the first two stages of the receiver is given in Fig. 3. It shows that a rejection of 50 db at 40 kc off, is already obtained in the first two of the three filter stages. The third stage, which is connected as a discriminator stage, will raise this selectivity to the desired value, as can be seen in Fig. 4. Because of the discriminator connection, this curve does not have a flat top; the significant item is the steepness of the sides of the curves, which shows an attenuation of 65 db at frequencies 40 kc from the center carrier frequency.

Parallel Filters

The method chosen to connect the receiver filters in parallel is a brute-force one. Between the line and filter systems, some fairly high resistances ($2 \times 3,300$ ohms or more) have been connected. As a result, the bridging impedance of these filters is high enough so that they can be connected in parallel without causing undue interaction.

Since entrance cable as well as open-wire line must be fed by the transmitter, it must be capable of developing normal output voltage across a 100-ohm entrance cable as well as a 600-ohm open-wire line. This means more than 50 milliwatts will be put into an entrance cable, but the cable will attenuate it to such an extent that by the time the transmitter output reaches the open-wire line no trouble from excess radiation is expected. To develop this voltage in such a low impedance, the tuning elements in the secondary of the output transformer are series rather than parallel connected to the line. Since the series connection is used, the off-resonance impedance is higher than at resonance, thereby solving the problem of paralleling transmitters 50-kc apart. The transmitter output is adjusted to the desired level for the type of line encountered by a screen voltage control on the power output stage.

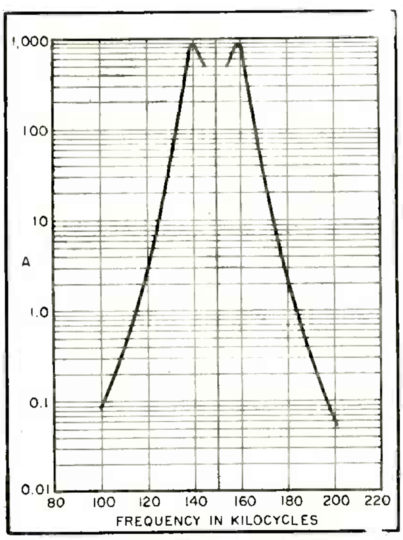


FIG. 4—Selectivity of three stages of the receiver plotted for values of *A*, the d-c voltage from the discriminator divided by receiver a-c input

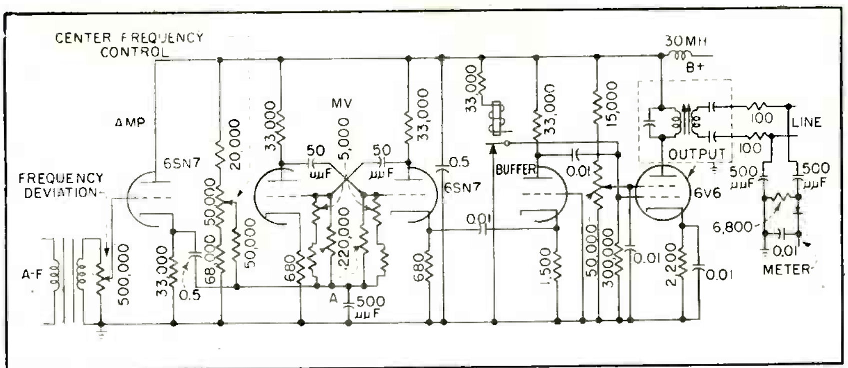


FIG. 5—A frequency-modulated multivibrator is used as the transmitter oscillator

Transmitter Circuit

The circuit of the transmitter panel is shown in Fig. 5. The audio signal from the termination panel is fed into one triode section of a 6SN7 connected as a cathode follower. This tube modulates the carrier oscillator which is the positive-bias multivibrator comprised of both triode sections of another 6SN7.

The multivibrator frequency, linear with the positive-bias voltage impressed at point *A*, can be changed over wide ranges by changing this potential from zero to B+. Hence wide-band frequency modulation is obtained directly from the output of this multivibrator. The bias potential and thus the center frequency is controlled by a 50,000-ohm potentiometer in a voltage-divider circuit between the plate-supply voltage and ground.

The output from one of the cathodes of the multivibrator is connected to the cathode of the other triode section of the first 6SN7 tube which acts as a cathode fed, grounded-grid buffer stage that feeds the 6V6 output tube. This latter tube is tuned to the center frequency of the carrier channel in its plate circuit. The pass band of the tuned circuit is wide enough to pass the + and − 6-kc carrier swing without too much discrimination, yet is selective enough so that it reduces the harmonic output to a low level and hence provides a fairly sinusoidal output waveform.

If it is desired to reduce any single harmonic in order to suppress interference in other channels, this may be done by adjusting the pulse width of the multivibrator, so that the amplitude of that particular harmonic is zero, and operating the output 6V6 class A. The selectivity of this circuit also aids in tuning the multivibrator approximately to the desired channel. This tuning is done by adjusting the multivibrator frequency control for maximum r-f output voltage.

A tuned secondary on the transmitter-output transformer provides an inductively coupled r-f output. The secondary tuning capacitors also act as blocking capacitors. This type of connection is used to obtain sufficient output voltage since the line presents such low impedance (100-500 ohms) to the tank circuit. Two 100-ohm resistors are also connected in series with this circuit to help raise the off-resonance impedance for paralleling purposes.

A transmitter-control relay grounds the grid of the output tetrode when it is energized, thus taking the transmitter off the line. Since this relay follows dial pulses and ringing frequencies, it is fast acting.

Receiver Circuit

The circuit of the receiver panel is shown in Fig. 6. The r-f input to

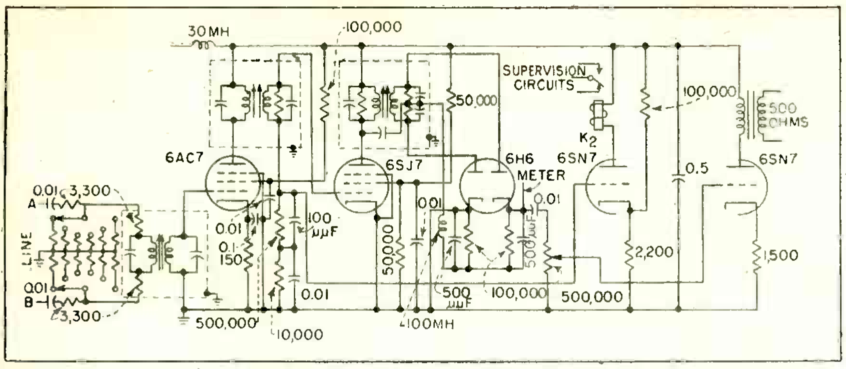


FIG. 6—In the receiver circuit, output of the discriminator feeds both an audio channel and an electronic relay circuit for supervision

the receiver, which comes from the line via the distribution panel, is fed to a simple H-pad resistance attenuator. This attenuator has at least 6,600 ohms input impedance and provides 25-db attenuation in 5-db steps. It is used to set the input to the grid of the first amplifier tube in the receiver just above the point at which the limiting begins. The first stage feeds a 6SJ7 limiting r-f amplifier pentode.

A standard discriminator transformer provides the typical S-curve characteristic of the discriminator; the straight portion of the curve being used for the detection of the frequency-modulation signals. The audio output from the discriminator is fed to one triode section of a 6SN7, which provides the final audio output through an output transformer to the wiring-distribution panel.

When a signal is received, a negative voltage is developed across the grid-leak combination in the grid circuit of the 6SJ7 limiter tube. This voltage is directly applied to the grid of the other triode section of the 6SN7 tube which operates as a d-c amplifier. The sensitive relay K_2 in the plate circuit of this tube is normally held in by plate current flow when no signal is being received. When a signal is received and a negative voltage applied to the grid of the d-c amplifier, the current in its plate circuit decreases below that required to hold the relay and it releases. In this manner the relay provides supervision of the incoming carrier.

In the receiver circuit, the high-impedance attenuator between the line and the input is of the H type. The four series elements consist of 3,300-ohm resistors; the parallel branch is made variable in order to provide a symmetrical control of the incoming carrier level. In all cases, the impedance bridged across the line will exceed 6,600 ohms. This method of coupling and attenuator construction does involve appreciable minimum losses between the line and the first receiver filter circuit, but makes it possible to use extremely simple components. At the same time, it provides some of the necessary damping for the first filter circuit.

Audio-Frequency Characteristics

The requirements for the audio-frequency characteristics are: (1) to have as near a zero loss voice circuit as possible, (2) to have a flat frequency response within 3 db from 300 to 3,000 cps, and (3) to have the distortion at normal operating level low enough so that two or three channels can be cascaded without the overall distortion rising to an objectionable level.

The overall audio-frequency characteristics of the system are shown in Fig. 7 as plotted for an output level of 0.5 miliwatt in 600 ohms. The solid curve was plotted for normal gain on the channel in one direction and zero gain on the channel in the opposite direction. This gives the true audio response of a complete channel unaffected by any positive or negative feedback, which results if the impedances of the line and the line balance are not matched perfectly through the frequency range.

The dotted curve was plotted for normal gain on the channels in both directions, with as good a hybrid balance as could be obtained at short notice, and hence is representative of actual operating conditions. The irregular variations of gain with frequency for this curve are partially caused by the fact that the phase of the feedback due to imperfect balance varies with frequency.

With the return channel at either zero gain or normal gain, the mid-band gain is zero db. This may be slightly higher or slightly lower in practice, depending upon how perfect a balance of the hybrid may be obtained, because the obtainable gain is determined by the point at which the feedback due to unbalance becomes of the proper phase and amplitude to produce oscillations or serious amplitude distortion, rather than because of lack of gain in the transmitter or receiver audio circuits.

The frequency response between 300 and 3,000 cps is flat within -2 and $+0.5$ db with zero gain on the return channel and within -2 and $+1$ db with normal gain on the re-

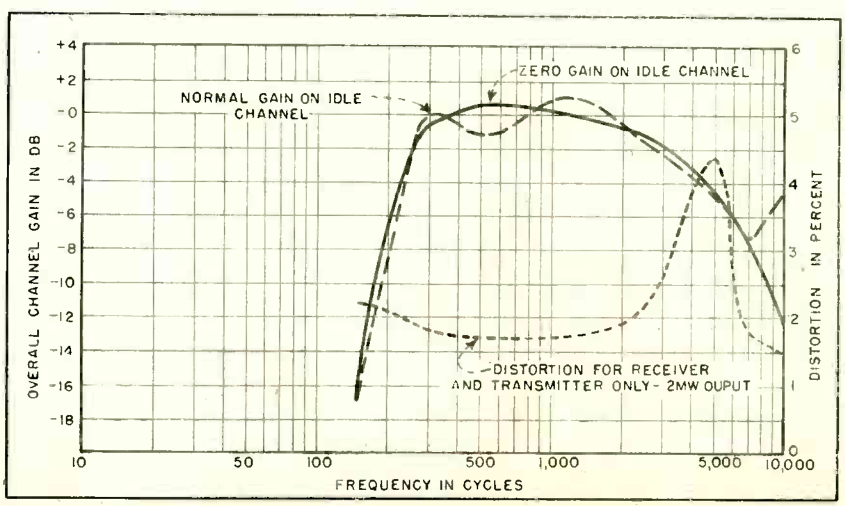


FIG. 7—Audio response of complete channel at 0.5-mw output

turn channel when a 600-ohm resistive line termination is used.

In the normal transmission band of 300 to 3,000 cps, the total harmonic distortion for the receiver and transmitted alone at a 2-milliwatt output level is 2 percent or less. This is about as high a level as would ever be normally encountered. At 3,000 cps and higher, the distortion rises above this; but since any harmonics of even 3,000 cps would be above the response range of normal telephone equipment, this additional distortion is of little importance.

Signaling

The carrier is switched on and off to transmit supervision signals. Short interruptions in the carrier are used to transmit ringing signals in a manual system and dial pulses if it is desired to dial through the system.

To obtain proper hook-switch supervision, a high voice-frequency tone (3,500 cps or higher) can be superimposed on the transmission channel whenever the reverse battery supervision indicates that the distant subscriber has not yet lifted his receiver or terminated the call—his tone is removed as soon as the distant subscriber lifts his receiver. Thus this supervision does not take up any part of the total available modulation percentage of the system during the transmission of speech.

The carrier-relay is adjusted to operate approximately at the carrier level where effective limiter action starts. The normal adjustment of the receiver level is about 3 or 4 db above this point. The limiter action occurs at approximately 23 db below the reference level of 1 milliwatt in 600 ohms (0.775 volt) or 40 db below the maximum transmitter level of + 17 db, which corresponds to 50 milliwatts in 600 ohms (5.50 volts). These data refer to maximum gain setting of the receiver r-f control.

This method of using the carrier to control the supervision relay makes it possible to obtain extremely fast operation. The system in its present version permits operation of the supervision relays up to speeds of over 100 cps.

Apart from the requirement of proper transmission of speech in either direction, a carrier system must provide suitable termination and supervision facilities. The proper termination can easily be obtained by means of a differential transformer or hybrid which, by proper balancing between the line and an artificial line, prevents the incoming received speech signals from energizing the outgoing transmitter and thus prevents feedback and oscillations.

The supervision signals permit the operator at one end of the line to signal the distant operator when she wants to initiate or terminate a call or when she wants her to come in on an existing connection for further instruction (so called "recall"). They are also needed if 1-way or 2-way dial operation is desired. The problem of providing proper supervision is sometimes more tricky than that of obtaining the proper speech transmission. In the system described here, the presence or absence of the carrier and its interruptions are used for this supervision.

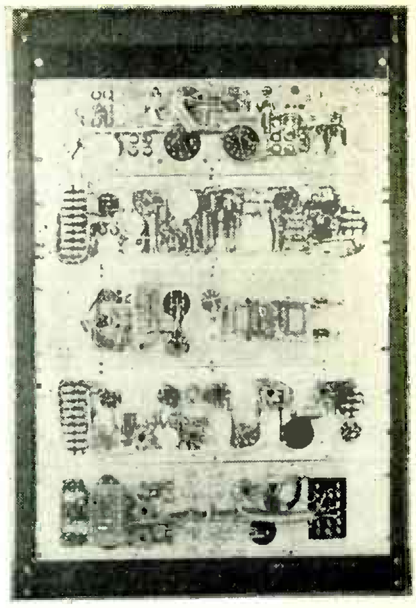
Ringdown Toll Supervision

About the most common method of supervision on the toll lines operated by the independent telephone companies is the ringdown supervision in which an a-c ringing current (generally 20 cps) is used for initiation of a call, for termination, and for recall.

The exact method of obtaining the desired performance differs but in general the method of operation is as follows:

A line relay is attached to both ends of the line when it is idle. Reception of ringing current will energize this relay and light a line lamp or other visual signal. A locking arrangement keeps the lamp lit until it is restored, which happens when the operator plugs a cord into the corresponding line jack. This extinguishes the lamp or releases the visual signal; it also disconnects the line relay from the line by means of additional contacts on the line jack.

The supervision is now taken over by a similar relay attached to the cord circuit. If this supervision relay receives ringing current, it will light a cord lamp or operate a visual signal; another locking arrangement keeps the lamp lit or the signal operated until the operator has connected her receiver and microphone to this cord circuit and thus answered the call. This latter connection is made when the operator throws the talking key associated with each cord circuit; she can then receive and acknowledge instructions to terminate the call or take further action. Extra contacts on the talking key release the locking arrangements for the cord lamp or signal.



Rear view of the rack mounted panels of the short range carrier equipment

By changing some connections on a terminal board in the termination panel, this same carrier system can also be used to give service to individual subscribers from either a manual or a dial control office. Another arrangement of connections makes it possible to give service to a remote community. In this case the remote subscribers are interconnected by means of a wire line and the carrier system is used to give them a direct connection to the nearest control office. By substituting a different termination panel—leaving the rest of the carrier system unchanged—it is possible to give full 2-way dial service between dial exchanges.

REFERENCES

(1) E. H. B. Bartelink, A Wide-Band Square-Wave Generator, 1941 AIEE Paper No. 40-119.
(2) E. H. B. Bartelink, U. S. Patent 2-32895.

Audio Noise

Simple circuit employing germanium diodes as nonlinear elements reduces phonograph record-noise without substantially affecting desired signal. Single-channel unit up to 6,000 cycles and a three-channel 0-to-12 kilocycle version for broadcast stations are described

NOISE is one of the most disagreeable forms of distortion that occurs in sound reproducing systems. Therefore, any means which reduces or mitigates noise is extremely useful and important.

There are many ways of increasing the signal-to-noise ratio thereby reducing the deleterious effects of noise. A few of the systems that have been used may be listed; (1) a system in which the high-frequency response is attenuated; (2) a system with suitable pre-compensation and post-compensation so that the high-frequency response is accentuated in recording or transmitting and attenuated in reproducing or receiving; (3) a system using two channels—one channel is used to carry the signal and the other channel to control the amplitude of the signal in reproduction; (4) a system in which the high-frequency cutoff of the reproducing system is automatically made a function of the general level of the signal.

The use of two channels, in which one is used as a volume control, has been applied in some special cases but, in general, is impractical because two channels are not available in conventional reproducing systems.

Systems in which the high-frequency response is accentuated in recording or transmitting and attenuated in reproducing or receiving are used in phonograph and sound motion-picture reproduction as well as frequency-modulation radio broadcasting. This procedure is quite effective, but in some systems it is also necessary to reduce the frequency transmission band in order to obtain a substantial reduction in noise.

A system in which the high-frequency range is limited introduces frequency discrimination against high-frequency sounds, regardless of whether the high-frequency cutoff is fixed or is automatically controlled by the signal. Of course, in the case of the automatic system frequency discrimination occurs only when the amplitude of the signal is small. Nevertheless, this discrimination may be serious for certain sounds.

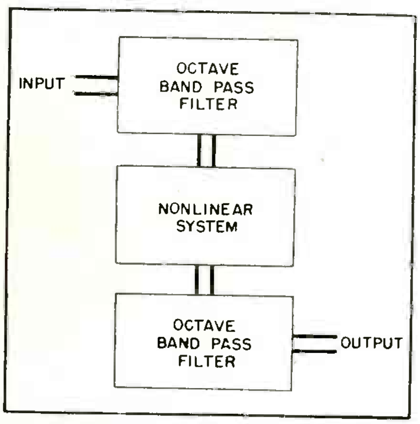


FIG. 1—Noise reduction system elements

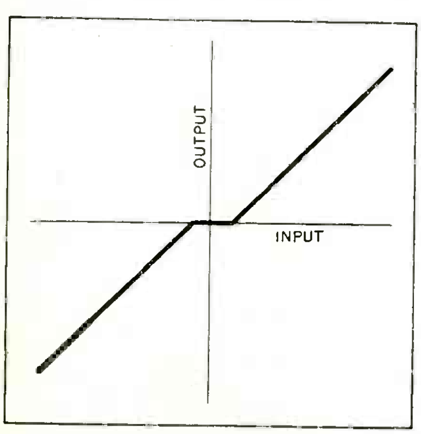


FIG. 2—Amplitude characteristics of a simple nonlinear element

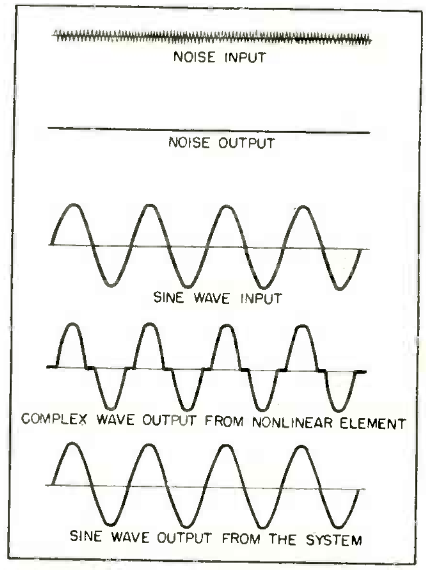


FIG. 3—Response of noise reduction system to noise and sine wave input

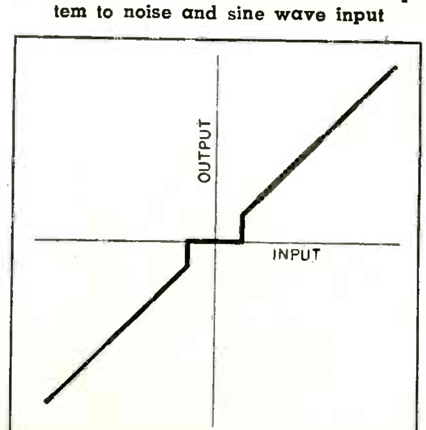


FIG. 4—Amplitude characteristics of a complex nonlinear element

Reduction Circuits

By HARRY F. OLSON

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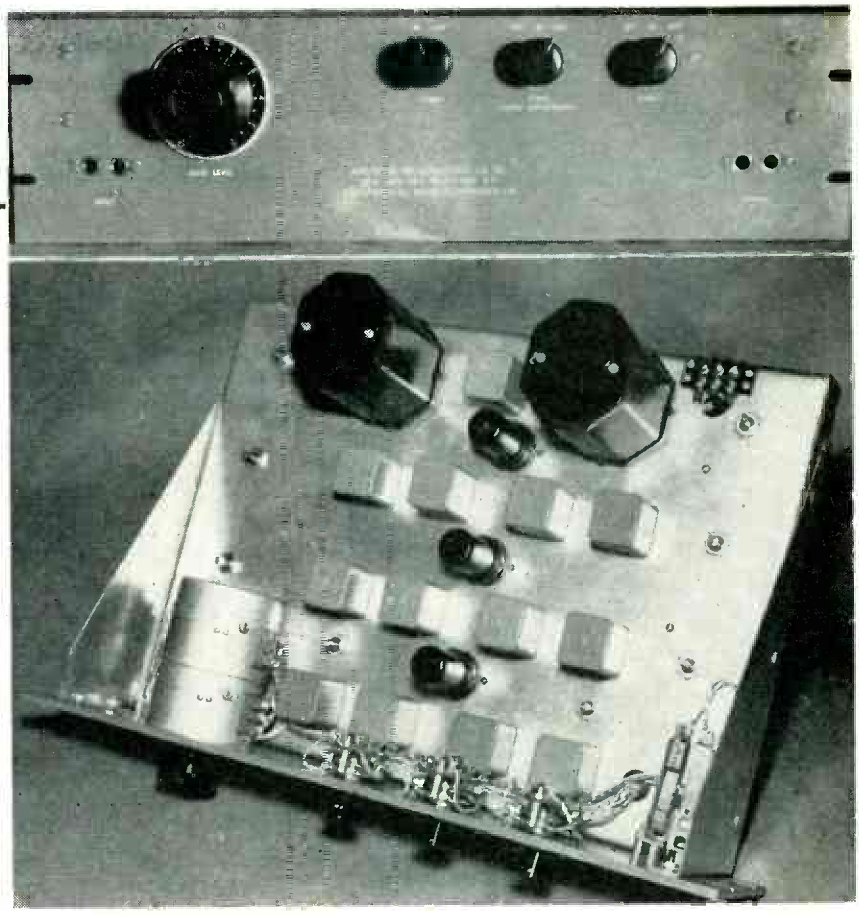
The noise reduction system to be discussed here employs a nonlinear element. The nonlinear element allows the useful signal to pass and discriminates against noise. This system lowers the ground noise level and thereby increases the signal-to-noise ratio without discrimination against the useful part of the signal.

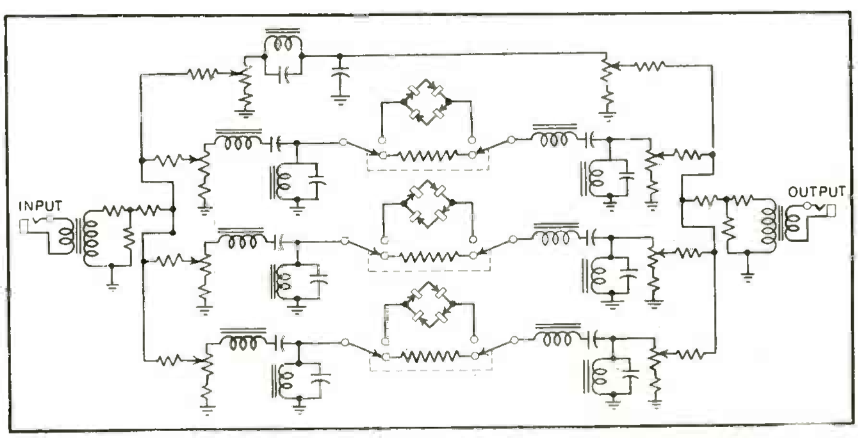


Panel and chassis views of experimental three-channel noise suppressor in use by American Broadcasting Co., described by John Colvin at NAB convention in Atlantic City, September 1947

Principle of System

A block diagram of the system is shown in Fig. 1. Band-pass filters which pass frequencies over a range of an octave are used at the input and output of the nonlinear element. The amplitude characteristic of the nonlinear element is illustrated in Fig. 2. As will be described later, this amplitude characteristic can be obtained with a properly biased diode vacuum tube or crystal rectifier. By using this method the system will exhibit high attenuation to signals of small amplitudes.

The response of the noise reduction system to noise and a sine wave is depicted in Fig. 3. If the amplitude of the noise is kept below the response range of the noise reduction system, the noise will not be reproduced. The response of the noise reducing system to a sine wave signal is also shown. The output of the nonlinear element contains the fundamental, harmonics, and subharmonics of the fundamental. However, since the pass band of the input and output band-pass filters is an octave, the harmonics and subharmonics will not be transmitted by the system. The



Schematic wiring diagram of ABC three-channel noise suppressor. Any of the channels can be switched to suppression or straight-through operation and the two top bands can be switched off entirely

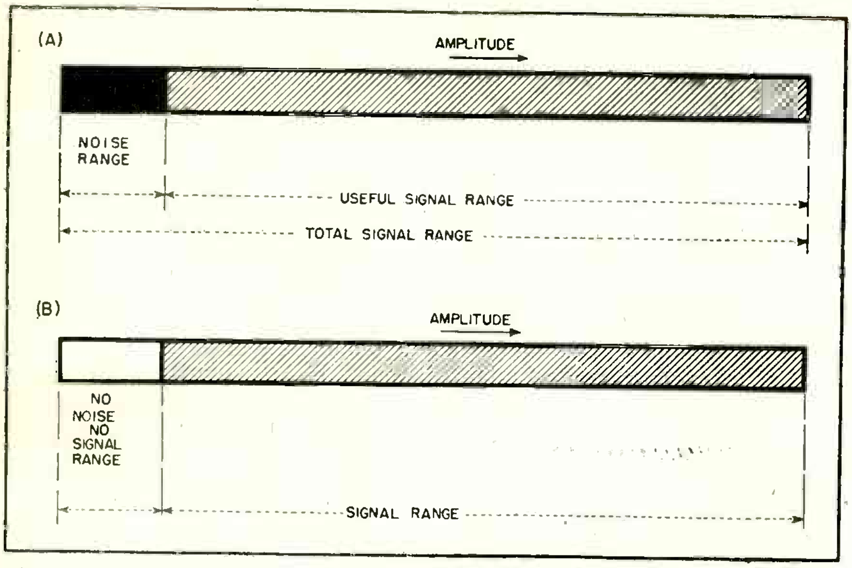


FIG. 5—(A) Amplitude ranges of total signal, noise, and useful signal in a conventional reproducing system; (B) amplitude ranges in a system with noise reduction

output wave, then, is a sine wave of the same frequency as the input sine wave. If two sine waves of different frequencies are impressed upon the system, the two frequencies must lie within the pass band octave in order to be admitted by the input band-pass filter. The output of the nonlinear element contains harmonics and subharmonics of the two fundamental frequencies, but these are rejected by the output band-pass filter. The output of the nonlinear element also contains the sum of the two frequencies and the difference of the two frequencies. Since the input is confined to an octave, the band-pass output filter will reject the sum and difference frequencies.

To summarize; if the input and output band-pass filters are confined to one octave or less, there will be no distortion produced by the system in the form of spurious harmonics, overtones, subtones and sum or difference tones. There will be some amplitude discrimination against signals of small amplitude. This discrimination may be reduced to a negligible quantity by employing the amplitude characteristic of Fig. 4. In this case, the transition from no response to a constant input-output relationship occurs very suddenly.

The gain in signal-to-noise by the use of a noise discriminating system employing a nonlinear element is depicted in Fig. 5. The amplitude ranges of the signal, the noise and the useful part of the signal are shown in Fig. 5A. The portion of the signal amplitude which is equal or less than the amplitude of the noise may be considered to be lost and of no value. By means of the nonlinear element, it is possible to eliminate the reproduction of all amplitudes below a certain level. If this amplitude corresponds to the maximum amplitude of the noise, the noise will not be reproduced. This condition is depicted in Fig. 5B. It will be seen that the noise reducing system reduces or eliminates the noise but does not increase the dynamic range of the signal. In effect, the nonlinear system separates the signal and noise in amplitude.

Nonlinear Elements

One way of obtaining the amplitude characteristics of Figs. 2 and 4 is by the use of unilateral conducting devices. These may be vacuum tube, crystal, copper-oxide or selenium rectifiers. Use of the vacuum tube diode and the germanium crystal rectifier as the nonlinear element is described below.

The input versus output voltage characteristics of two opposed germanium crystal rectifiers with a resistance load is shown in Fig. 6. It will be seen that the ratio of the output to the input voltage decreases rapidly below an input of 0.1 volt. This is due to the contact potential in these rectifiers. Supplying a bias voltage of about 0.1 volt.

The input-to-output voltage characteristic of two opposed biased vacuum-tube diode rectifiers is shown in Fig. 7. Below the bias voltage, the impedance of the rectifier is practically infinite because the reverse current in a vacuum-tube rectifier at audio frequencies is negligible.

The nonlinear elements of Figs. 6 and 7 approximate the amplitude characteristics of Fig. 3. The characteristics of Fig. 4 can be approximated using two sets of opposed biased diodes, one in series with the line and the other in shunt with the line. By a suitable choice of diodes, resistances and bias voltages, the characteristics shown

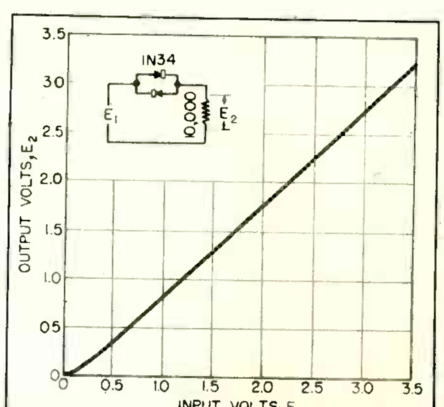


FIG. 6—Input-output voltage characteristics of two opposed germanium diodes

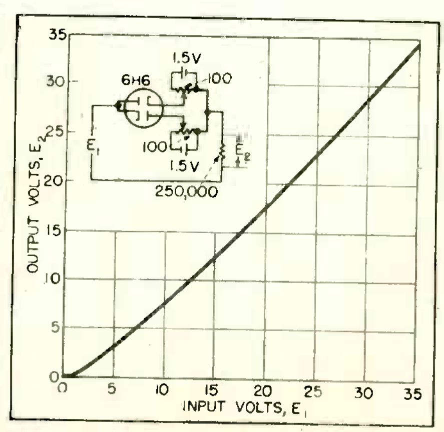


FIG. 7—Input-output voltage characteristics of two opposed biased tubes

below in Fig. 8 can be obtained.

Thermal noise energy per cycle is independent of the frequency. However, in a phonograph record, the noise per cycle increases with increase of frequency, as indicated in Fig. 9. A consideration of the noise spectrum of a conventional shellac phonograph record, together with typical living-room noise spectrum and the response-frequency characteristics of the ear, indicates that a relatively sharp cutoff is required at about 4,500 cycles in order to obtain tolerable reduction of the noise level in a conventional phonograph reproducing system. In view of the characteristics of phonograph reproduction, it was felt that the threshold type of noise reduction system would be particularly effective in reducing noise produced by records.

A block diagram of a phonograph reproducing system employing a simple audio antinoise system is shown in Fig. 10. The noise reduction takes place in the octave between 3,000 cycles and 6,000 cycles. This allows reproduction to 6,000 cycles with the low noise characteristics of a 3,000-cycle cutoff. The circuit diagram including the preamplifier, the filters and the nonlinear elements is shown in Fig. 11. The system consists of two crystal rectifiers, one vacuum tube, four inductors, eight capacitors, two potentiometers and five resistors. The response-frequency characteristics of the low-pass channel, the band-pass channel and the combination are shown in Fig. 12. Referring to the block diagram of Fig. 10, it will be noted that the input and output potentiometers are complementary and ganged together so that the overall gain is not changed by varying the potentiometer setting. In this way, the low response range of the nonlinear system can be adjusted to correspond to quiet, medium and noisy records by varying the ganged potentiometers. Noise reduction in the unit described is about 15 db for shellac home-type records.

The threshold noise reduction

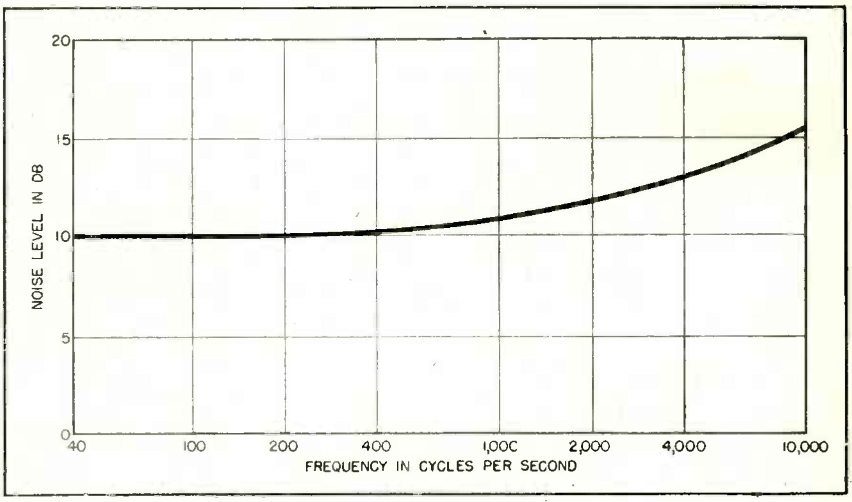


FIG. 9—Noise per cycle response-frequency characteristics of a phonograph record

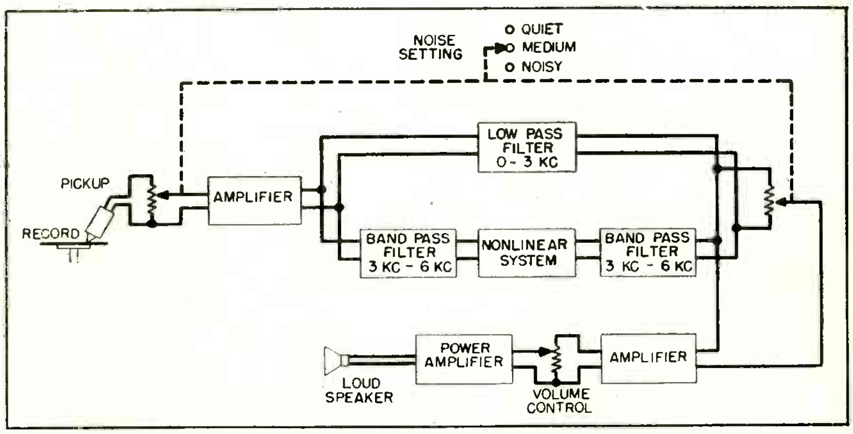


FIG. 10—Phonograph reproducer with simple audio noise reduction

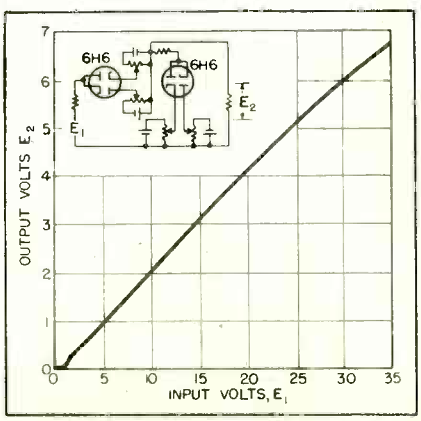


FIG. 8—Characteristics of two sets of opposed biased diodes specially connected

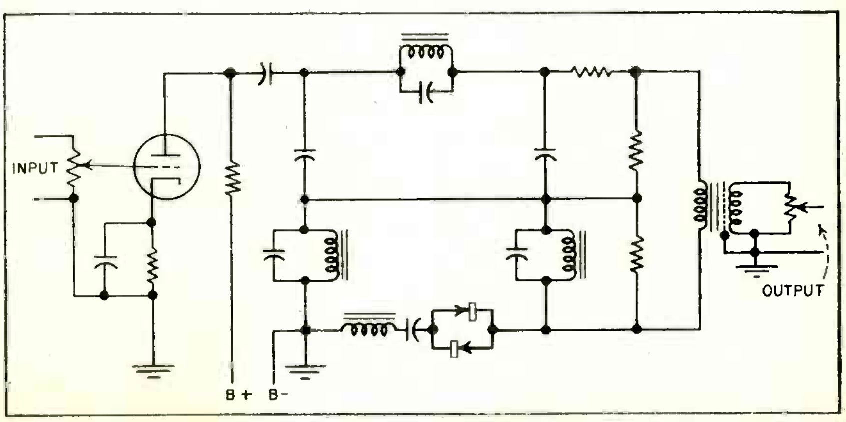


FIG. 11—Circuit diagram of block system in Fig. 10, showing amplifier, 0-3 kc low pass filter, band-pass filters, and nonlinear system

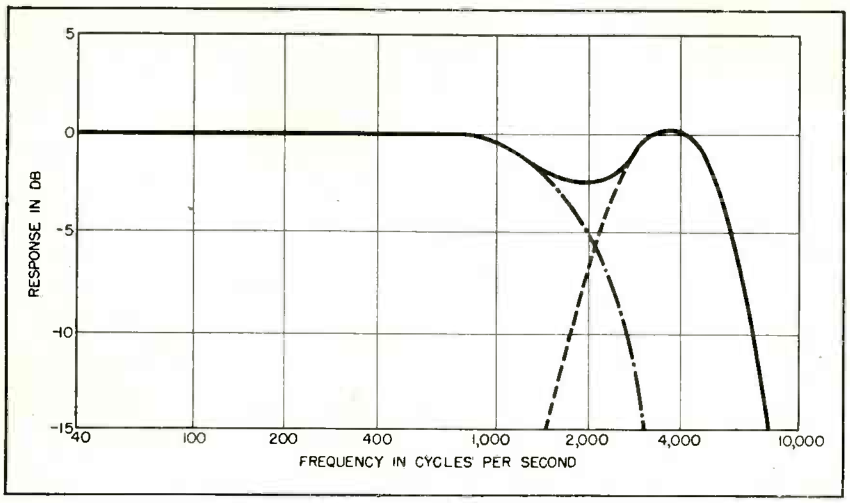


FIG. 12—Voltage response frequency characteristic of low-pass, band-pass (broken lines) and combined channels for the circuit of Fig. 11

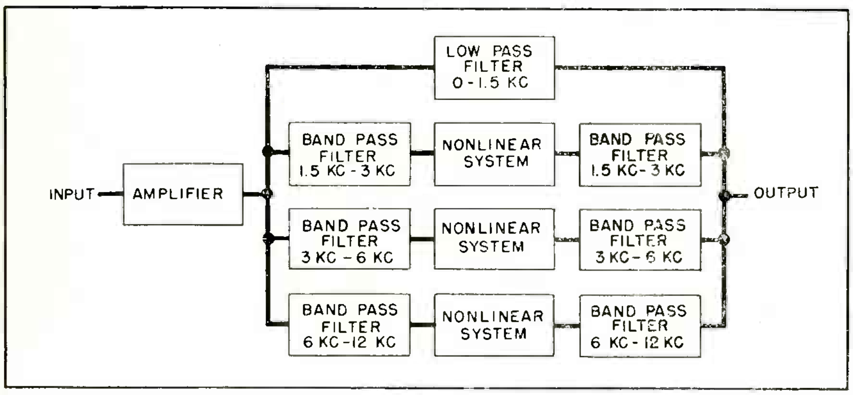


FIG. 13—Wide-range noise reduction system for 0-to-12 kc use

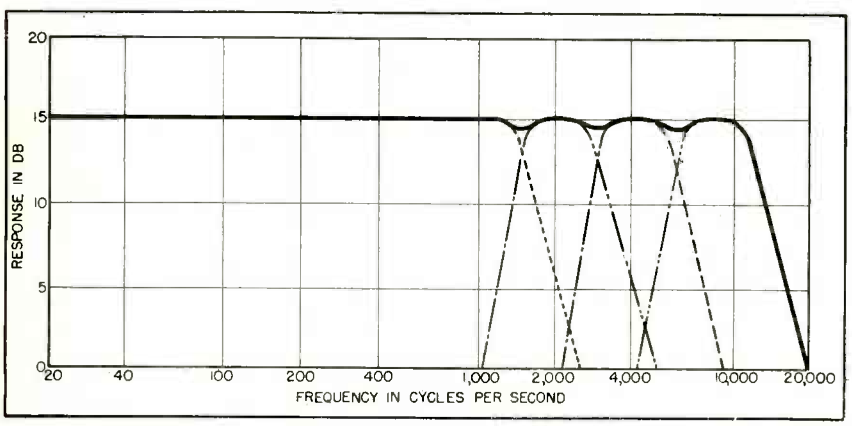


FIG. 14—Overall characteristics of three-channel system in Fig. 13. Band-pass channels are indicated by broken lines

system described possesses advantages as contrasted to any system in which the high-frequency cutoff is a function of the general level of the sound. In such systems rectifiers are employed to supply the control bias of the tubes in the filter system. The retreat time of these rectifiers is relatively large, which means that with high-level sounds of short duration the high frequency cutoff may not follow the sound. If the cutoff remains at a high frequency after the level of the sound has returned to a low level, the result is an audible swishing of the noise. With sounds having a low general level, the high-frequency cutoff will be relatively low regardless of the overtone structure, with a resulting loss of overtones. In the system here described the output of the nonlinear element in the transmitting region corresponds to the input because the operation of the nonlinear element is instantaneous as far as audio frequencies are concerned. Therefore, there will be no swishing on high amplitude sounds of short duration. Furthermore, it transmits any sound which lies above the noise level. Therefore, there is no discrimination against any frequency band in this domain regardless of the general level of the sound.

Multiple Channel System

The system described, with an upper cutoff frequency of 6,000 cycles, has a much wider frequency range than the conventional home phonograph reproducing system, and the noise level is also lower. Extending the range beyond this frequency requires increased power output and improved loudspeaker systems. However, for wider range transcription phonographs an even wider frequency range is desirable.

A system with an upper cutoff of 12,000 cycles and three channels of noise reduction is outlined in the block diagram of Fig. 13. This system uses the nonlinear elements of Fig. 8. Each nonlinear system is equipped with a separate bias control so that the noise can be reduced in each band without discrimination against the useful signal. The response-frequency characteristic of the separate channels and the overall response is shown in Fig. 14. Conventional band-pass filters are used to confine the response to octave bands. A two-stage input amplifier overcomes the loss in the filters and nonlinear elements. Noise reduction of up to 20 db can be obtained in each of the channels.

The audio noise reduction system described is particularly effective in phonograph reproduction because the noise per cycle increases with the frequency. However, it may be applied with good results in other sound reproducing systems, as for example, sound on film, magnetic wire or tape, and radio broadcasting.

Television Resolution Chart

Designed for the purpose of standardizing television resolution measurements, the chart illustrated overpage has been made available to the industry by the RMA Engineering Department. To provide maximum utility, various branches of the television engineering field were canvassed and suggestions obtained for its preparation

Prepared by
Committee on Television Transmitters

Transmitter Section, RMA Engineering Department

CALIBRATION of the chart illustrated is based on a height of 18 inches and a width of 24 inches, which is the size supplied by the RMA Data Bureau. For transmitter checking, the chart should be televised by the studio equipment and reproduced on a suitable picture monitor.

Resolution is to be read only after equipment has been adjusted to have a minimum of distortion; by checking scanning, shading if system employs shading, low-frequency phase shift, and focus.

Procedure

After these adjustments, note the maximum gray scale reading (for perfect adjustments, reading should be same on all four scales), and then take maximum resolution (horizontal and vertical) readings on the large wedges in the central portion of picture; and on the small wedges in circles at corners. For example, read the horizontal resolution from the wedges located vertically on the chart, and read the vertical resolution from the wedges located horizontally on the chart. A measure of maximum resolution should be accompanied by a statement of the number of the distinguishable gray steps (for example, 400 lines—steps 2, 3, 4, 5 and 6).

The maximum resolution reading will indicate system performance. The least of the maximum resolution readings (usually found in picture corner) will indicate the system degradation due to failure in achieving optimum results for one or more of above adjustments or due to inherent c-r tube distortion.

To Check Scanning

The scanning adjustment involves size, linearity, and aspect ratio.

Focus the chart on the camera tube so that its area (boundaries determined by arrow heads) exactly covers the usable area scanned by the camera.

Check vertical sweep linearity by comparing the spacing of the short horizontal bars at both top and bottom of picture with that of the bars midway between.

Check horizontal sweep linearity in a similar manner by comparing the spacing of the vertical bars in the square at each side of picture with that of the bars in the center square.

Check aspect ratio by measuring the large pattern formed by the gray scales to see if it is a square. If the horizontal and vertical scanning is linear and the above pattern is square, the aspect ratio is correct.

To Check Shading

If camera employs shading, check by visual inspection of the picture monitor to determine if the background is an even gray, or use the waveform monitor and note if the average picture signal axis is parallel to the black level line both at line and field frequencies. As an additional aid in correcting the shading, adjust same until the gray scale reading is the same (and a maximum) for all four scales.

Streaking following either one of the two horizontal black bars at the top or bottom of the large circle is an indication of low-frequency phase shift.

To Check Focus

Two checks are required: camera lens focus and cathode-ray beam focus (camera tube and receiving tube). Cathode-ray beam focus adjustments are made for a maximum resolution reading, first of the horizontal scanning and then of the vertical. Due to beam characteristics a maximum adjustment for one may not be the maximum adjustment for the other; in this event a compromise adjustment is used.

Miscellaneous Chart Information

All bars for checking sweep linearity are spaced for 200 lines resolution.

One of the wedges for checking horizontal resolution is calibrated in both lines and megacycles to facilitate equipment checking.

The gray scale is composed of ten steps varying in an approximate logarithmic manner from maximum white brightness to approximately 1/30 of this value. This scale may be used in connection with a waveform monitor to check the transfer characteristic of the system.

The four diagonal lines in the square may be used to check quality of interlacing. A jagged line indicates pairing of the interlaced lines. (Not effective when interlace failure is 100 percent).

The circumference of each of the four small circles is tangent to an imaginary circumference at the point nearest the corner of the chart. The radius of this imaginary circle is 4½ inches (on the full-size chart), and is located along a line bisecting the corner angle of the chart. (This is to indicate the part of corner masked off by some television receivers.) The corner circles should be visible on a receiver whose picture corners are masked.

The resolution circles in the center of the pattern and in the center of the corner resolution wedges are for testing spot ellipticity on cathode-ray picture tubes (useful to tube manufacturers). The resolution of the circles in the corners (150) was made less than the resolution in the center (300) because of added deflection defocusing in these areas.

The four crosses (+), positioned one at the center of each side of the chart, are used for alignment of projection kinescopes and the optical system of projection receivers.

The gray background of the chart provides a satisfactory balance with the whites so that a studio system correctly set up by the use of this chart will operate satisfactorily on an average scene without additional adjustments.

The two sections of single-line widths, 50–300 (50–100–150–200–250–300) and 350–600 (350–400–450–500–550–600), provide an accurate means of checking "ringing" in equipment. (The multiple lines in the wedge are confusing in checks of this type.)

Printed copies of the chart, in its original size of 18 by 24 inches, may be obtained from the RMA Headquarters, 1317 F. St., N.W., Wash. D. C. Photographic copies on film may be obtained from Loucks and Norling, 245 West 55th Street, New York, N. Y. on 16-mm or 35-mm motion picture film, and on 2-by-2 inch or 3¼-by-4 inch lantern slides.

Table I—Line Calibration of Resolution Wedge, Based on 18-inch Chart Height

No. of Lines	Width per Line	Width of 9 lines	Width of 19 lines
200	0.090″	0.810″	1.71″
250	0.072″		1.37″
300	0.060″	0.540″	1.14″
350	0.051″		0.97″
400	0.045″	0.405″	0.85″
450	0.040″		0.76″
500	0.036″	0.324″	0.68″
550	0.033″		0.62″
600	0.030″	0.270″	0.57″

Example: The 300-line point is located on the large wedge where its total width is 1.14 inch and on the small wedge where its width is 0.54 inch.

Table II—Frequency Calibration of Resolution Wedge, Based on 18-inch Chart Height

$$f_n = A_r n \frac{10^6}{H_a \times 2}$$

Where f_n = fundamental frequency for n number of lines
A_r = aspect ratio = 4/3
n = number of lines
H_a = active time of horizontal trace. (Horizontal time less blanking time. Blanking time is 0.16 H — the average between maximum and minimum allowable time.) Horizontal time = 63.5 μsec and H_a = 63.5 × 0.85 = 53.3 μsec

Substituting given values in the above formula:

$$f_n = \frac{4}{3}\frac{10^6}{53.3 \times 2} n = 0.0125 \ n \text{ mc, or } n = f_n/0.0125 \text{ lines}$$

When f_n =	3 mc	4.0	5.0	6.0	7.0
n =	240 lines	320	400	480	560

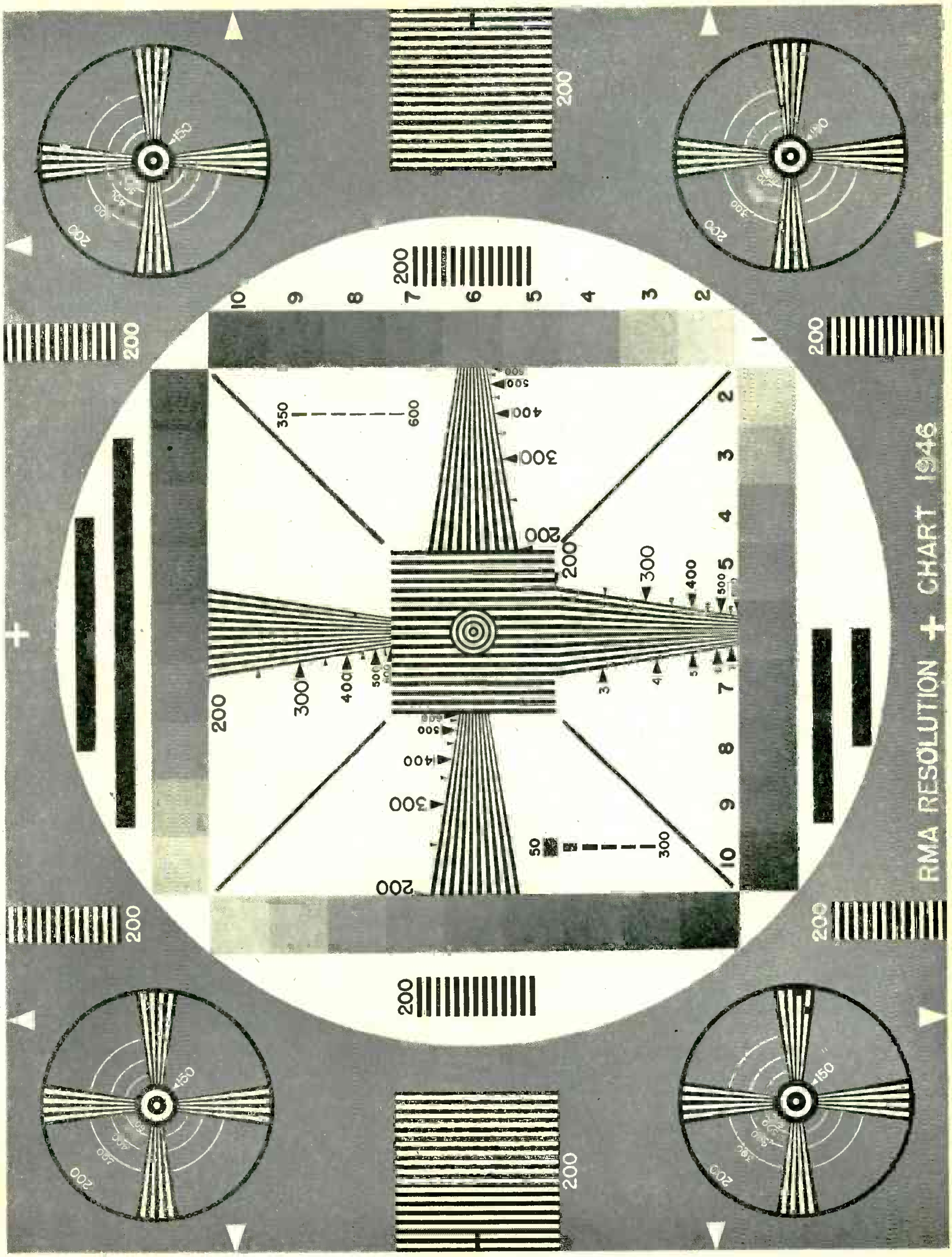
f_n	No. of lines	Width per line	Width of 19 lines
3	240	0.0750″	1.42″
4	320	0.0562″	1.07″
5	400	0.0450″	0.85″
6	480	0.0375″	0.71″
7	560	0.0325″	0.62″

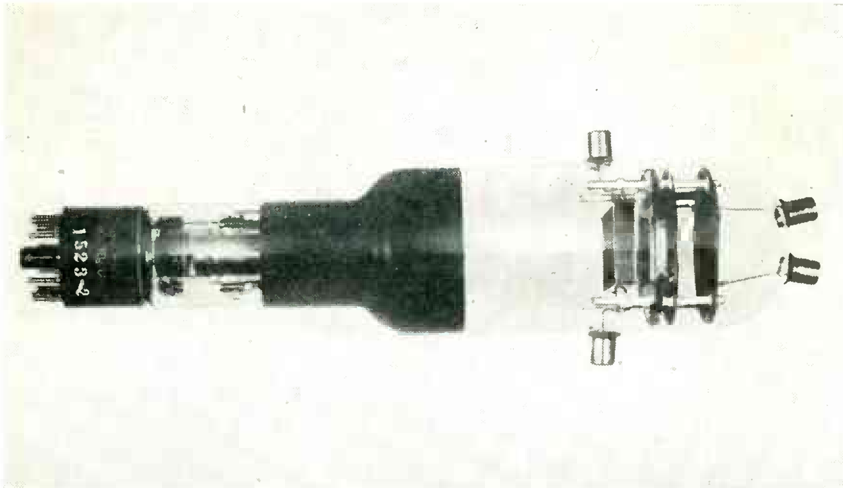
Locate frequency calibration along wedge by same method employed to locate line calibration (see example in Table I).

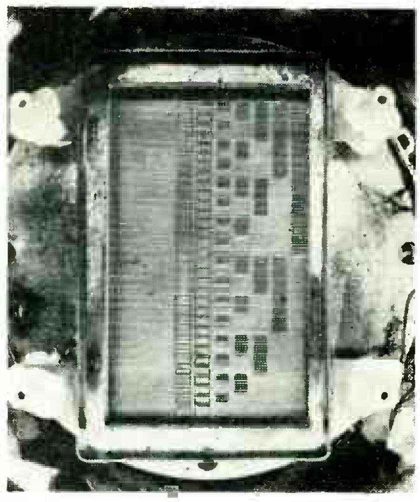
An alternate method suggested for locating the line calibrations along the wedge uses the following formula:

$$L_n = L\left(\frac{300}{n} - 1/2\right)$$

Where L_n = distance from end of wedge indicating maximum lines resolution (in this case 600)
L = length of entire wedge (shortest distance between ends)
n = number of lines per picture height


RMA RESOLUTION + CHART 1946





In effect, this cathode-ray coder tube looks up the binary number and transmits the corresponding pulse code stamped on its aperture plate (shown at the right) according to the amplitude of the voice sample

Coded Pulse Modulation Minimizes Noise

GROWING utilization of telephone toll facilities is necessitating studies into ways of improving and extending long-line equipment. Present practice, using amplitude-modulated, single-sideband, multichannel carrier over either open wire, multiconductor cable, coaxial cable, or radio links, is subject to noise interference and signal attenuation. Also, present techniques, although making efficient use of the frequency spectrum available with wire circuits, do not make the best use of microwaves which offer economical possibilities for future long-line service.

Therefore, the Bell Telephone Laboratories have undertaken the development of pulse code modulation (pcm). In this article the significance of the revolutionary techniques of the system are interpreted. Various modifications of the system have been developed, the most recent experimental link having been demonstrated by L. A. Meacham and E. Peterson of the Murray Hill, N. J. Laboratory before the New York IRE Section, the paper to be published in the BSTJ. One of the outstanding features of this development is the electronic coding tube. It and other novel methods of handling pulses are described.

Freedom from Noise

The greatest advantage to be gained from pcm is low noise level. But before describing the operational details whereby noise is suppressed, it is desirable to summarize the obstacles that pcm is intended to overcome.

In long distance communication facilities, attenuation in the transmission medium is counteracted by repeaters. Spacing of the repeaters must be sufficiently close so that the signal amplitude will not fall below tolerable limits of noise level. To keep the signal sufficiently above the noise, the initial level must be quite high and the repeaters closely spaced. In any event, the noise acquired between repeaters is accumulated, so that a line which is suitable for transmission by itself may not have an adequately low noise level when used as part of a longer circuit. Coaxial cable is used for high-quality long lines because, being self-shielding, it has an inherently low noise level. Likewise, highly directive microwave beams are relatively free from atmospheric noise. Nevertheless, there is a finite noise threshold that limits the length to which either coaxial or microwave circuits can be extended with reasonable repeater spacing.

The purpose of pcm is to make possible regeneration of the signal at each repeater, thereby freeing the signal from noise picked up on each segment of line. Once an amplitude varying signal is contaminated with noise, it cannot be regenerated (although a variable-bandwidth filter can be gated by the frequency components of the signal to minimize the noise accepted by the circuit). Most of the noise that interferes with a frequency (or phase) modulated carrier or a pulse train modulated in time (or position or rate) can be reduced by limiting (or slicing), but the signal can never be completely divested of noise picked up during transmission.

On the other hand, in pcm the signal is transmitted (as from a teletypewriter) as a series of regu-

By transmitting coded standard pulses that can be regenerated and thus completely cleared of interference, microwave relaying can be made practically noiseless. The sampling and quantizing methods whereby voice signals are translated into pulse codes are described

larly spaced, identical pulses whose presence or absence is the only intentional modification produced by the signal. The signal, in the form of these pulses, can later be completely freed from noise provided the pulses can just barely be identified from the noise with certainty. To regenerate the signal, the repeater transmits a locally generated standard pulse whenever it receives a noisy pulse, but remains inactive otherwise.

Because of this complete regeneration, a long circuit can be as free from noise as a short one, a particularly desirable condition in telephone practice where alternate routes may be necessary during periods of peak loads and where economic considerations require that all equipment be constantly used near its peak performance. Furthermore, the pulse can be identified at a signal-noise ratio 50 db below that required in amplitude-modulated circuits, thus permitting wider repeater spacing and lower transmitter powers, so that, although repeater and terminal equipments are more complex than with amplitude-modulated carrier systems, fewer repeaters are needed. An interfering signal 9 db down from the wanted signal is below the interference threshold. For flawless reception, the rms signal at the peak of the pulse has to be 18 db above the rms noise.

Sampling the Signal

In the experimental system, two groups of 12 voice channels are used; the system has a total possible capacity of eight 12-channel groups, each group providing facilities comparable to conventional carrier systems. To be able to use a regularly repeating series of standard pulses as the transmitted signal, it is first necessary to sample the original speech waves. After passing individual lowpass filters and peak limiters, the 12 channels of each group terminate in an electronic commutator, symbolized in Fig. 1 as a rotating collector. Rectangular pulses applied to grids of the tubes in the commutator gate the ring so that each channel is sampled in sequence for about 10.5 microseconds each 125 microseconds, (8,000 revolutions of the ring per second). Thus, not only is each signal sampled, but all 12 channels are assembled in time sequence producing a time division multiplex of the group.

Sampling is a technique common to all forms of pulse modulation. The essential information of the speech wave is its constantly varying amplitude. This amplitude is instantaneously sampled at regular intervals by the commutation. If the sampling rate for a channel is somewhat higher than twice the highest frequency component to be transmitted, the modulated pulse train contains all the information that is in the original wave (just as the harmonic content of a complex wave can be found by a systematic analysis of the amplitudes at a finite number of points). A Fourier analysis of the series of samples of various amplitudes into which the wave is broken indicates that all the original frequencies are still present (at reduced amplitudes), and in addition there are frequencies symmetrically disposed about the harmonics of the sampling frequency. (The intermittent pulse samples occupy less time than the original continuous wave, but consume a greater bandwidth.) With the sampling frequency twice the highest frequency in the voice wave (or slightly more to allow a margin for imperfect filter cutoff), the frequencies disposed about the sampling frequency do not overlap the fundamental signal frequencies, so that a lowpass filter will remove the additional frequencies and the sampling component, leaving only the original undistorted speech wave. Thus, the sampling, although enabling the signal to be transmitted for recurring but very short intervals, does not introduce any inherent distortion. In the interval between transmission of pulses for one channel, pulses for the other channels are transmitted forming the time-division multiplex.

Coding the Signal

The sampled amplitude of the original wave (Fig. 2A) is shown in Fig. 2B. The amplitude of this sample is the information to be transmitted. This amplitude is translated into a binary number represented by the presence or absence (mark or space) of uniformly spaced identical pulses (Fig. 2C). (Binary numbers use only two digits—0 or 1—whereas decimal numbers use ten digits—0 through 9. Binary numbers, like decimal numbers, are written with as many places as necessary to indicate the required magnitude.)

Converting the amplitudes of the voice wave to a numerical representation necessarily substitutes a number of discontinuous levels for the continuously changing speech wave. Although this quantizing of the signal introduces an inherent distortion, the quality of transmission can be made as high as required by making the steps small compared to the maximum signal amplitude.

The number of steps in amplitude that can be counted in this way is 2^N where N is the number of places in the binary number. (The corresponding number of steps with a decimal number would be 10^N.) Binary numbers are used because the two digits can be represented by no pulse (0) or pulse (1), whereas if decimal numbers were used, pulses of different amplitudes

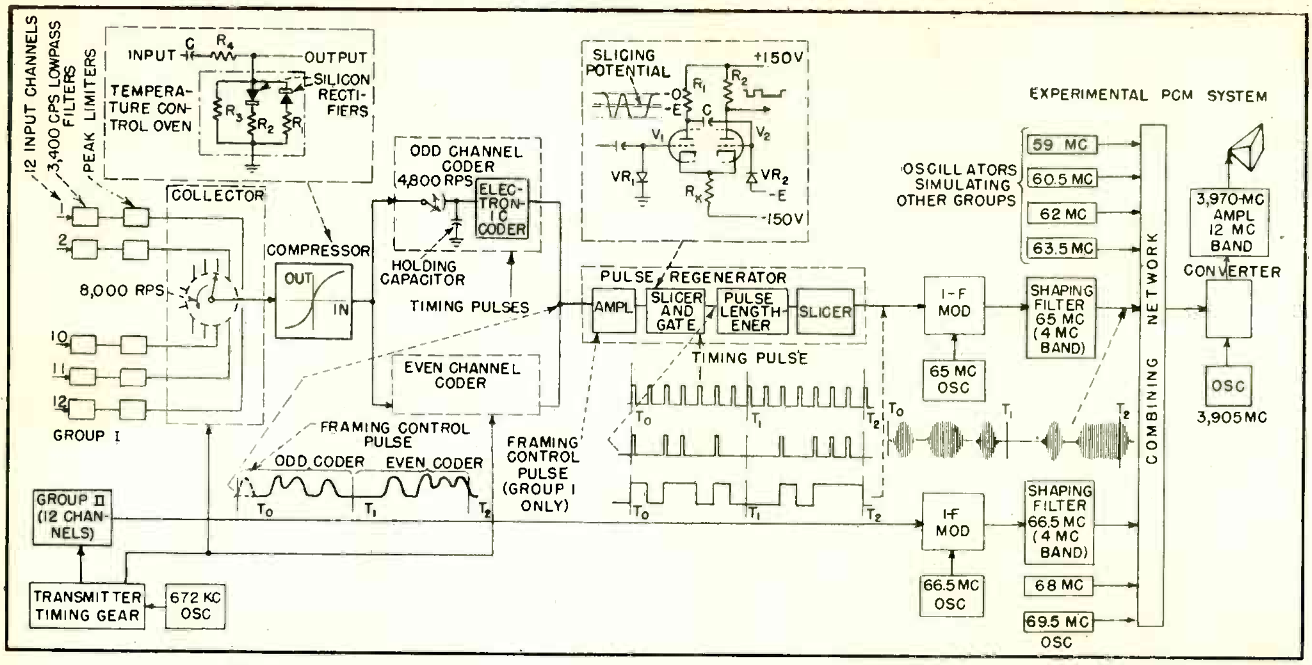


FIG. 1—Block diagram shows functions of multiplex equipment; inserts indicate details of novel circuits

would have to be used, thus leaving the system open to interference. The greatest amplitude error in reproducing the signal after quantization is half a step, the size of which is determined by the number of steps and the amplitude (dynamic range) to be covered. The error results in a multiplicity of harmonics and high order modulation products between signal components and sampling frequency. For speech where the wave is complete, these distortion components merge into an essentially flat band having much the characteristic of thermal noise, the level of which is fixed by the size of quanta.

The dynamic range has to embrace the 30 db difference between low consonant levels and high vowel levels, and an additional 30 db between loud and soft talkers (peak limiters keep the signal within this limit). So that the accuracy with which the wave is reconstructed from the quanta will be of a uniform percentage at all levels, and because noise is less objectionable at high levels than at low ones, the steps are made unequal by nonlinear compression prior to quantizing and coding.

The instantaneous compressor shown in Fig. 1 uses two selected silicon rectifiers connected in parallel but poled oppositely with padding resistors to balance the network. The d-c resistance varies from 6,000 ohms at zero signal to about 200 ohms at peak signal. Input is applied through the relatively high resistance R_4, and the variable voltage across the varistor unit is the output. Because of their large shunt capacitance, copper-oxide elements respond too slowly for this service. Germanium varistors have a thermal hysteresis. Therefore, silicon was chosen, and the units were temperature controlled; effects of aging over many months have been negligible. An identical unit is used in the feedback of an amplifier at the receiver to produce a complementary expansion so that the overall response is linear.

Preliminary listening tests and noise measurements have led to a seven place code giving 128 steps, and with the steps tapered by the compressor so that the smallest one (at the zero axis) is 26 db shorter than the average step, and the largest ones (extreme positive and negative) are 6 db above. With this apportionment of the quanta levels the idle circuit noise is down 68 db

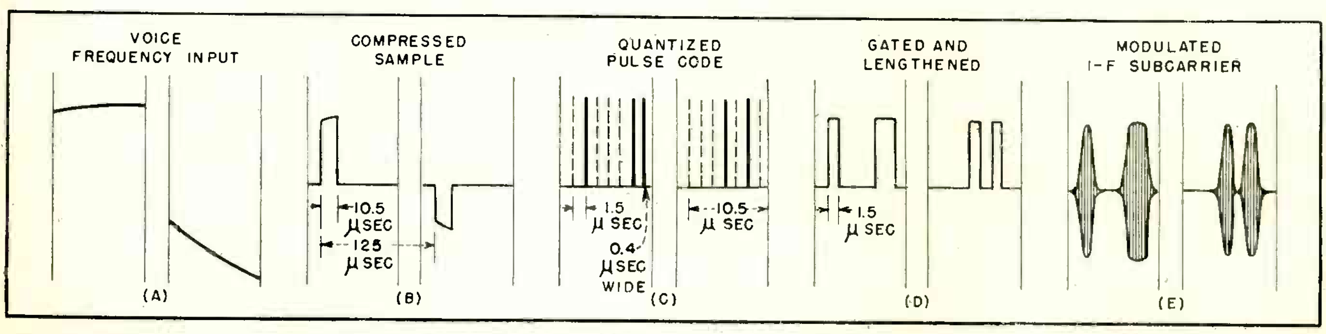


FIG. 2—Waveshapes at critical points in the transmitter are shown in synchroscope fashion. Views of two successive frames of one channel are shown in each case

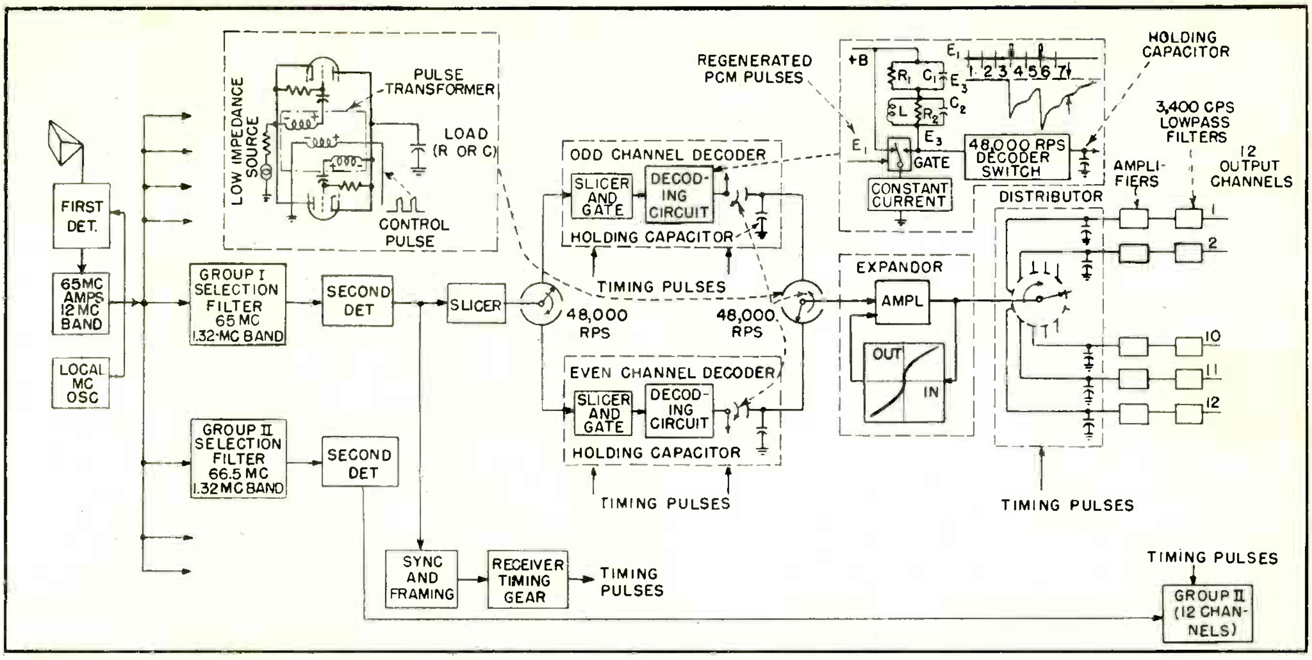


FIG. 3—Receiver operation is indicated diagramatically; rotating commutators symbolize electronic gates or sampling circuits

from the full load sinewave level.

If the coding circuit has insufficient time to completely clear itself of voltages from one coding operation before the next, crosstalk would be introduced from each of the time division channels to the following one. Therefore two identical coders are used alternately. The compressed signal is delivered from a low impedance to electronic switches that route alternate pulses to their coders. The switch closes for about 5 microseconds, 48,000 times each second. During the closure, a holding capacitor quickly charges to and follows the sampled amplitude. When the circuit opens, the charge is held for 16 microseconds until the next closure (thus, the instant of signal sampling is the same as that of the opening of this switch).

Quantizing and coding is performed by a novel cathode-ray tube, the essential feature of which is an aperture plate on which are punched the 128 combinations of the 7-place binary number with holes for units and solid metal for zeros, as shown in the illustrations. Low numbers corresponding to negative amplitudes are at the bottom of the aperture plate; high numbers corresponding to positive amplitudes are at the top. In front of the aperture plate is the quantizing grid of 129 uniformly spaced parallel wires with their intervening spaces aligned with the rows of binary numbers on the aperture plate as viewed from the point of origin of the electron beam.

Stored audio samples deflect the beam to a level in the vertical plane corresponding to their individual amplitudes. A linear sweep and an unblanking signal keyed by the master timing system restore the electron flow and move the beam across the appropriate number on the aperture plate. As the beam passes perforations, current flows to the pulse plate producing the pulse code. The beam is blanked and then retraced in readiness for the next coding while the holding capacitor is being charged by the next sample. By this means, the necessarily high speed of operation for coding is obtained.

The wires of the quantizing grid are used to guide the beam so that it is centered on and follows only one binary row with each sweep. Without the quantizing grid, the beam could scan between binary rows producing false codes, and might migrate from row to row

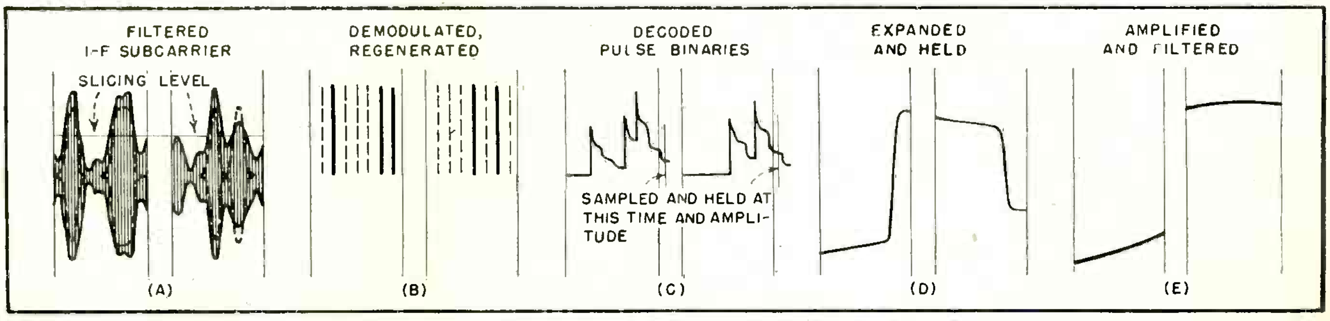
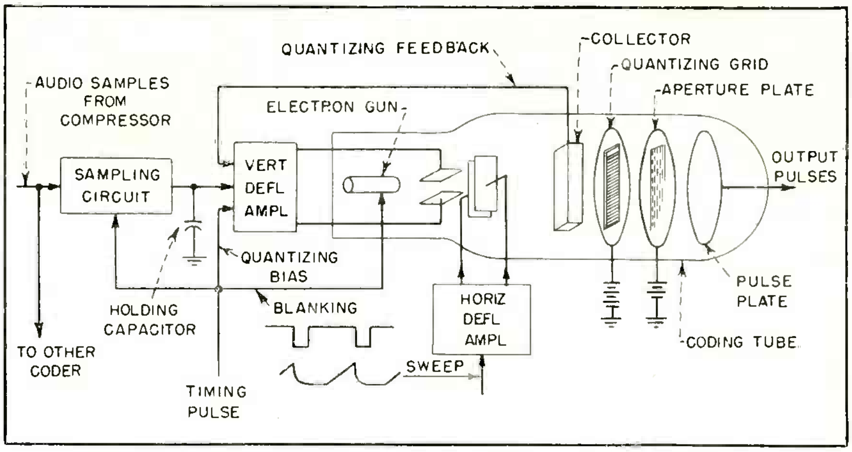


FIG. 4—At receiver, pulses are regenerated and reconverted to voice waves through the shaping stages shown here corresponding to various circuit operations of Fig. 3

during a scan. A quantizing bias during scan is applied to the vertical deflection amplifier, thus tending to move the beam up. Electrons from the beam then strike one of the wires of the quantizing grid producing secondary emission, which is attracted to the collector. The signal so produced is superimposed on the quantizing bias as feedback to maintain the beam just under the wire near which the signal sample positioned it. The spot centers itself in this stable region before the sweep is initiated and stays there, resisting twice the vertical interference that would deflect it from one grid opening to the next in the absence of this stabilization. The beam locates itself at its quantized position in about a microsec. The imperfect output of the coder is sliced and gated as shown in Fig. 1 giving a pulse code such as that shown in Fig. 2C in which dashes represent no pulse.



Operation of the coder is shown by its association with other equipment

Slicing and Gating

The slicer circuit used throughout the pcm system to regenerate pulses, shown in Fig. 1, resembles a conventional single-shot multivibrator, but, because of the size of the parameters, functions differently. Feedback capacitor C is so large that the potential drop across it does not vary appreciably during normal operation, and load resistor R_1 is small enough to limit the gain around the feedback loop to unity when both triodes are active. Germanium varistors VR_1 and VR_2 maintain the desired biases regardless of the number of pulses or spaces in the input. Thus, the circuit trips whenever the input falls through a narrow potential range near E on the wave plot, and trips back when the input rises through the same potential range. A square wave of constant amplitude is thus produced across output resistor R_2. The circuit can slice pulses as narrow as 0.1 microsecond.

Time gating to standardize the occurrence position of the pulses is added to this circuit by connecting a triode so that its plate and cathode are connected respectively to the plate and cathode of V_1. The grid of this triode is normally at ground potential. The timing pulse from the master timer pulses the grid of this tube negatively by about $2E$. The total current passing through the common cathode resistor R_K is essentially constant, being entirely carried by the one conducting tube, or shared if both are conducting. Hence, the tripping action transferring the current to V_2 occurs when the grid potentials of both V_1 and the added tube fall below the slicing range. Thus, tripping occurs only during the gating pulse and in the presence of a signal pulse. This circuit handles pulse codes from both coders at the rate of 672,000 a second.

The timing pulses for all switching and gating operations are derived from a master oscillator by frequency stepdown multivibrators (instead of harmonic selection, both because the circuits are simpler—waveshapes nearly as required are produced directly by the multivibrators—and because phase shifts in the base frequency are less apparent in the subharmonics than in the higher harmonics). These control pulses are generated at a common point and applied to the message equipment by common power amplifiers through shielded cable.

Microwave Radio Transmission

The 12-channel time-division pulse codes of each group modulate i-f subcarriers to obtain frequency division multiplexing of the groups. In the experimental system only two groups were filled, the others being represented in transmission only by their i-f subcarriers, this practice being sufficient to determine the feasibility of the system for commercial service. The amplitude-modulated i-f subcarriers are then filtered, combined, and used to amplitude modulate the microwave radio carrier, as shown in Fig. 1.

The passband of the overall transmission portion of the system is such that the shape of the pulse envelope is cosinusoidal, the duration at the half-amplitude point being equal to that of the original rectangular pulse, as illustrated in Fig. 2E, and the peak amplitude is the same. The lengths of the elongated pulses are equal to their spacing, thus, in effect, the cosinusoidal envelopes overlap at their half-amplitude points so that if several pulses occur in succession, the peak of the envelope is constant for an interval at its maximum value for one pulse alone. Also, the greatest rate of rise or decay of the envelope is the same whether one or several pulses occur in succession with the result that the bandwidth is independent of the sequence of pulses and spaces.

With this choice of pulse shape and the accompanying transmitted bandwidth, the signal-noise ratio is optimum. To narrow the bandwidth (in an effort to reduce the accepted noise) would be to increase the buildup and decay (transit) times resulting in reduced pulse amplitude and greater overlap, thus lowering the margin over the noise. On the other hand, increasing the bandwidth, although shortening the transit time, would not increase the pulse amplitude, but would increase the noise amplitude. In the experimental system, the microwave is beamed to the N. Y. Laboratory, at 463 West St., through a nonregenerative repeater, and back to the Murray Hill Laboratory giving a 40-mile transmission path.

Repeaters and Decoders

At the repeaters and receiver, the envelope is demodulated by usual methods giving the pulse codes as shown in Fig. 3. To further minimize the effect of noise, a scanner with a threshold at half the combined noise and pulse amplitude as shown in Fig. 4A is gated near the center of the interval during which a pulse would be present if called for in the code group. The threshold is provided by an amplitude discriminator that passes a thin slice of the pulse. The scanning is timed to be done at the midpoint of the expected pulse occurrence interval by gating the sliced pulses with a narrow timing pulse generated by the receiver timing equipment. If noise has not obliterated the pulse (or if there is no pulse), the regeneration completely removes the noise, giving pulse codes as shown in Fig. 4B. In repeaters these pulses are then transmitted as in the terminal transmitter.

The electronic commutators represented throughout the diagrams by rotating brush and segments are a form of sampling circuit as shown in Fig. 3. Two forms of circuit are used, one employing diodes that are gated by the timing pulses, and the other using triodes controled by their grids. In the triode type as shown, control pulses, with sloping tops so that after passing through the pulse transformer they are flat topped, drive the grids strongly positive allowing plate-cathode conduction. Although the diode circuit is advantageous for the collector (Fig. 1) because of its low capacitance to ground, the triode circuit, having a d-c path from source to load, is best for feeding circuits where any residual charge from the preceeding time division channel would cause crosstalk. Also, the triode circuit can sample signals of greater amplitude than the control pulse.

Two decoders are used to avoid crosstalk, just as two coders were used in the transmitter. The essential details of the circuit are shown in Fig. 3. As each pulse of the code reaches the decoder, an identical increment of charge is placed on C_1. Between normal pulse occurrence times, half of the remaining stored charge leaks off, so that the remaining charge at the end of the code is weighted in a binary manner to give a potential proportional to the indicated count. Any value from 1/128 to 127/128 in steps of 1/128 can be produced. For example, the samples near the zero axis of the orignal audio wave are coded near the center of the coder aperture plate, so the corresponding decoded values lie near $\frac{1}{2}$. The additional circuit LR_2C_2 has its resonant frequency and time constant matched to the R_1C_1 circuit to arrest the decay at each pulse interval thereby holding the decoded voltage constant for an interval long enough for sampling at the end of the decoding operation, making the timing of application of charges and final sampling less critical than with simple R-C storage.

Storage and Synchronization

Although the outputs from the decoders are available for only 2 microseconds, they are held by the circuit for 19 microseconds. The decoded signals are then reassembled into 12-channel group time division, passed through the instantaneous expander, and the samples, now identical with the original voice wave samples except for quantizing effects, are distributed to their individual channels. Because the 8,000-cps distributor closes on any one channel for only 5 microseconds (instead of the full 1/12th of the 125 microsecond frame period, which would require extremely accurate synchronization at the receiver of the repeater), each channel input has a holding capacitor that stores the pulse for the full 125 microseconds as shown in Fig. 4D. This lengthening, by enabling the following amplifier to deliver full useful power constantly, makes possible a simple single-stage triode amplifier for the output of each channel. (The pulse lengthening introduces a gain-frequency slope of about 3 db from low to high ends of the passband, comparable to the aperture effect of other scanning systems, which is compensated by an opposite slope in the input channel filter of the transmitter.) A 3,400-cps lowpass output filter removes sampling components leaving original voice signal at commercial quality (Fig. 4E).

The timing synchronization whereby each transmitted pulse code is delivered to its associated channel at the receiver is governed directly by the received message pulse train. The basic 672 kc recovered from the pcm train by way of highly selective filters controls the rate of timing at the receiver. To distribute signals to their respective channels at the receiver, the first pulse of the code group of the first channel is used for synchronization (leaving this channel with 6-place quality). The synchronizing pulse is 1.5 microseconds long, like the message pulses, and occurs alternately in each successive 8,000-cps frame, giving a readily distinguishable 4,000-cps repetition rate. When this signal is being distributed to the synchronization channel, the receiver is locked both in time (by the 672 kc) and in phase (by the presence of the 4 kc) to the master timer at the transmitter. If the distributor at the receiver is not in phase with the transmitter, the receiver waits while the transmitter distributor continues cycling until the 4,000-cps is again distributed to the receiver timing channel. Thus within 0.1 second, the commutator will be framed with the transmitter. If the repeater falls out of frame or synchronization with its transmitter, all output channels are cut off until proper framing is re-established so that noise and crosstalk cannot occur. Because of the high accuracy with which synchronization is maintained, no guard times are necessary between time division channels, and thus fullest use is made of the transmitted bandwidth for message pulses.

Being a point to point communication system using amplitude-pulsed carrier, this experimental system is readily adapted to microwave relaying, and affords high quality long-line service.—F.R.

Simplified Microwave AFC
Part II

Construction of complete afc unit having six channels 30 mc apart at 3,000 mc, with emphasis on physical characteristics of circuit components. Resonators using Invar, Nilvar, or copper and molybdenum are described. Silicon-rectifier or loudspeaker-diaphragm sensing modulation and methods of cavity tuning are considered

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Possible combinations of motor and electronic automatic frequency control for microwave oscillators were discussed in the first part of this article. Design problems involved in the construction of special components and the more specific description of a working equipment are now considered.

The Reference Resonator

One of the most critical components in the entire afc equipment is the reference resonator. The important characteristics of this component are: frequency-temperature coefficient; stability of sensing modulation method; means of coupling to the microwave tube; tuning range or channelling and the mechanism required. Each of these factors has to be carefully considered so that the completed resonator unit will have sufficient frequency stability within itself to act as the reference for the afc system. All of the above-mentioned resonator characteristics are treated in some detail in another paper[3].

Since the type of afc system being discussed is not a precision system, the required stability of the reference resonator is not as great as if it were used in a system attempting to compete with crystal control performance. Nevertheless, it is desirable to make the frequency-temperature coefficient of the cavity as low as conveniently possible. The use of Invar or Nilvar steels will produce a resonator whose frequency-temperature coefficient will be only several parts per million per degree Centigrade.

This accuracy can be achieved, however, only after the certified material is double checked for proper coefficient of thermal expansion, and then making certain that the resonator is machined from the measured stock. A chemical or spectrographic analysis is not enough. A piece of the actual material to be used must be measured for coefficient of thermal expansion. All soldering operations must be done in an oven and with soft solder. After machining and soldering, the piece should be artificially aged to remove the greater part of the material creep which would otherwise occur.

Materials such as plated fused quartz, Multiform, or Vycor can be used if satisfactory fabrication methods are available. Another approach is to make a temperature-compensated resonator from two different pure metals, such as copper and molybdenum. Each of these metals has a relatively stable coefficient of thermal expansion over a wide temperature range. By proper choice of the geometry of the compensated resonator, it can be made more stable than an Invar resonator. If operation over a wide ambient temperature is required, some means of temperature control for any of the resonators may be needed to keep it within frequency tolerance.

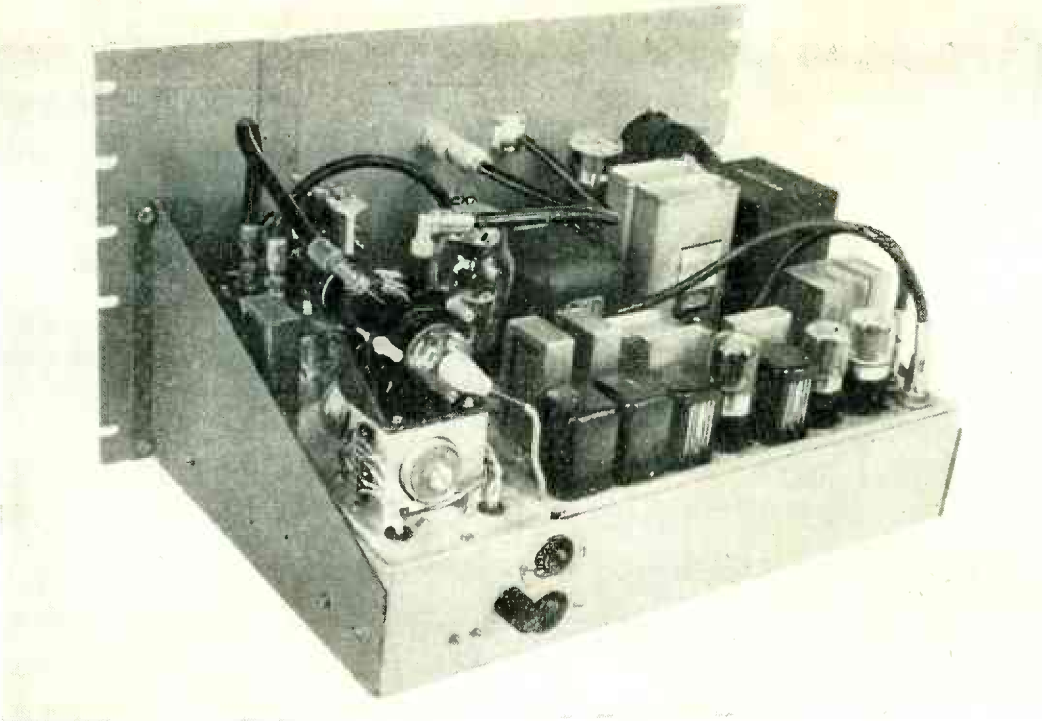
The stability of the sensing modulation method means the ability of the modulating device to be dimensionally stable. If a diaphragm or plunger is moved in the resonator it will produce tuning, and when moved sinusoidally at the modulation rate it provides the sensing signal.

Figure 10 illustrates two modulating methods. It is important that the vibrating member always oscillate at the same place within the cavity, else the center-frequency tuning will shift as a result of such movement. Usually, if the drifting of the mean position of the modulating member is limited to approximately one-hundredth of the amplitude of vibration, it will be accurate enough for the type of afc systems being discussed.

If the sensing modulation is produced by an electrical means, such as a silicon rectifier in a transmission line, it is again necessary to use a unit whose stability is good over long periods of time. Any change in the crystal characteristic will reflect a reactive component into the cavity, thereby causing a shift in its resonant frequency. The advantage of the crystal rectifier type of modulation is that the sensing frequency can be anywhere between the low audio range and the low radio frequency range; the upper limit being dependent upon the sideband attenuation due to the resonator Q.

Coupling the resonator to the microwave source is sometimes a

* The equipment was developed while the author was with Sperry Gyroscope Co.



Complete 3,000-mc oscillator with afc shown schematically in Fig. 12

problem, since it is necessary that the modulated resonator shall not pull or react on the oscillator to produce a similar modulation on the outgoing carrier. Loose coupling consistent with suitable energy into the resonator is about the average condition. It might be desirable to add a series impedance between the two, to locate the resonator characteristic at a more suitable spot on the oscillator's load-power output diagram.

The tuning range or channelling required, is entirely dependent upon the intended application of the equipment. Fixed-station point-to-point operation may demand a single frequency, or possibly two or three, while portable-mobile equipment may need ten to a hundred channels. Laboratory apparatus usually requires continuous tuning over the available frequency band. Whichever type of tuning is required, it is important that the tuning mechanism (the mechanical device which positions the tuning member inside the resonator) be given considerable engineering thought.

Schemes are now available whereby a resonator can be tuned smoothly over a large frequency range, or it can be channelled at equal frequency intervals. With relatively close spacing between channels, it is necessary that the tuning member have a rather low mechanical tuning rate in megacycles per inch to achieve good frequency repeatability.

Figure 11 shows two methods of tuning reentrant type resonators. If remote channel selection is desired, the indexing device which operates the tuning member should not require high angular tolerances on the shaft rotation. The design should be such that ordinary detent tolerances can be used.

Microwave Oscillator Tuning

The method of obtaining mechanical and electrical tuning will depend largely upon the type of microwave oscillator used, such as magnetron, klystron, or special triode. This discussion is based on klystron oscillators, since all the experimental work was done with such tubes.

Klystrons like the 2K28, using cavities which are external to the vacuum section, can employ a simple paddle or plunger system to provide mechanical tuning. Designs where the tuning member is inside the vacuum or is part of the vacuum enclosure, as for example the 2K57 for the former and the 2K41 for the latter, require a somewhat more complicated tuning mechanism. Some means of maintaining a vacuum is needed, and bellows or diaphragms are ordinarily used. These devices add a considerable amount of extra work for the motor tuning mechanism, since producing a tuning motion requires that the devices be deformed. However, such tuning systems have been used successfully without experiencing detrimental effects due to work hardening, provided the tuning correction motion of the motor afc is a small fraction of the total available tuning travel.

An important requirement of the tuning characteristic of the microwave tube is that the tuning curve does not reverse in slope over the range of travel to be covered by the afc system. A change in slope of this curve is not too serious, since this merely changes the system gain, but a reversal of slope would mean that the afc would drive away from that frequency region.

Some mechanical tuners use a screw thread which actuates the tuning member. Upon reaching the end of travel, the direction of rotation has to be reversed to repeat the tuning cycle. When using motor afc with this tuning method, provision must be made to reverse the motor at the end of travel during scanning, otherwise the system will drive to the end and jam. A more suitable method is to use a cam to actuate the tuning member. The tuning cycle can be repeated by just rotating the cam in the same direction, and no intricate limit-stop reversing switches are necessary.

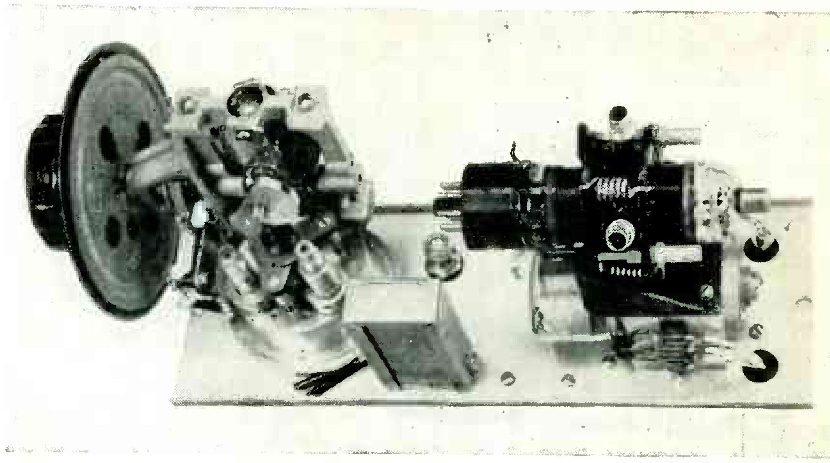
The angular tuning rate (megacycles per degree of shaft angle, using a cam drive) is quite often determined by the total tuning range required and the allowable physical size of the mechanism. Of course, the greater the angular tuning rate the more accurately positioned the shaft must be for setting to a given frequency. Too low a rate may make the correction response time too long. A compromise between several factors is usually required in each individual application.

Motor-Generator Unit

The choice of the motor-generator unit depends upon several factors: sensing frequency; output torque required for tuning operations; physical size; constructional details. The sensing frequency is determined by the choice of motor for other reasons than frequency, as motors are available at 60 cps or 400 cps. There is little difference in system performance between 60 cps and 400 cps, and other factors are usually more demanding, such as weight, size, and availability.

The output torque is determined by the type of tuner mechanism employed on the klystron. However, most small motors have a reasonable amount of torque after going through a gear reduction of 1,000 to 1 or better. The speed of the output shaft is directly related to the correction response time. There should be minimum backlash between the klystron tuning member and the motor shaft. Any backlash in the gear train should occur as near to the motor shaft as possible, and not near the klystron tuning member.

The physical size of the motor-generator unit is dictated primarily by the required output torque, duty cycle, and the sensing frequency. For special applications where light weight and compact size are paramount, small 400-cps units are available. If the generator has to be coupled to the motor shaft as a separate unit, the overall size may be greater than desired.



Detail of microwave section of signal generator, showing resonator tuning cam and mechanism for setting the reference frequency

The constructional details of the motor-generator unit are important, since good bearings, good alignment and balance, and small rotor diameter, all tend to reduce the frictional forces which the signal voltage has to overcome. From Eq. 2 (Part I), Δf_m will be smaller if the value of E_m is smaller. Good dynamic balance is necessary to prevent damage both to the bearings and the alignment by vibration during high-speed scanning. To avoid warp and twist between the motor and the klystron tuner, both should bolt solidly to each other. If it is necessary to fasten them to a third member, the design of this third member should be such as to provide maximum stiffness and rigidity.

A Practical Design

During the experimental work on afc systems of the type under consideration, several laboratory models were constructed. One of these illustrated is a 3,000-mc signal source of 200 to 300 milliwatts output, using pushbutton scanning.

The reentrant type reference resonator is made of Invar steel, and is tuned by an annular ring that moves coaxially inside the resonator adjacent to the center post section, similar to that shown in Fig. 11. Three polystyrene rods support this tuning ring, and they in turn are fastened to a spider on top of the resonator. A smooth cam moves this spring-loaded spider through the tuning range.

In the sample model the tuning range was 100 mc, with a total travel of about 0.375 inch. A vernier dial with gear reduction was used to operate the cam. Connected to the dial shaft, between the dial and the gearing unit, is a clutch plate that operates either of two pairs of switch contacts for small angular motions of the dial. One pair closes with motion in one direction, the other closes with motion in the other direction. These contacts are connected to the scanning circuit, and put the correct phase of 400-cps voltage into the scanning switch so that the motor will scan in the direction of frequency shift caused when the dial is turned. The correct adjustment of the clutch spring is such that only one pair of contacts is kept closed at all times.

The resonator is modulated by a simple miniature dynamic speaker unit, mounted so that its metal diaphragm is concentric with and just under the bottom section of the resonator. A small plunger about $\frac{3}{16}$ inch in diameter and $\frac{3}{8}$ inch in length is connected to the center of the diaphragm and protrudes through a hole in the bottom of the cavity, as shown in Fig. 10. When this plunger is vibrated by the diaphragm, it cyclically changes the distribution of the electric field in the resonator gap space, thus producing frequency modulation.

The tuning dial and gear reduction are mounted above the Invar resonator, and beneath the panel is the dynamic modulator unit. The 2K41 reflex klystron is mounted horizontally with its tuning cam just below the base end. The motor-generator unit and its gear train are under the klystron mount.

In designing this sample unit, a small 400-cps motor-generator from the Sperry A-12 pilot turn-control was chosen because it was compact, had a suitable gear train, and delivered sufficient torque. A 400-cps motor was used because it is easier to make an amplifier free from hum pickup at that frequency than at 60 cps. Any 60-cps pickup in the 400-cps amplifier is greatly reduced by the tuned circuit used to attenuate the second harmonic before it is applied to the motor. It is still necessary to keep the amplifier relatively free from hum to prevent overloading of the input stages.

The gear train supplied with the motor was modified slightly to allow the tuning cam to come out at right angles to the motor shaft, as shown. The klystron tuner was redesigned to permit the tuning lever to be operated by a cam. A small roller is located at the end of this lever to provide free motion over the cam surface, especially on the steep backside. This tiny roller is just visible in the illustration. The torque required to move the tuning lever over the cam surface is about 2 ounce-inches.

The complete block diagram of Fig. 8 (Part I) shows the afc system of which the schematic diagram for the entire equipment is given in Fig. 12. Triode tubes are used throughout. From the input of the amplifier (the crystal detector) to the motor winding there is a gain for small signals of 90 db, and from the same input to the phase detector there is a gain of 93 db. A tuned circuit is used at the input of the push-pull motor-amplifier to introduce a 20-db attenuation at 800 cps, the second harmonic of the sensing frequency. Since the second harmonic is a maximum when the system is exactly in tune with the reference resonator, it is necessary to avoid putting second harmonic power into the motor. No rotational torque is produced by this frequency, but but it would heat the motor and reduce the allowable fundamental frequency dissipation. A small amount of second harmonic energy is desirable at the motor, however, since it keeps the rotor jittering slightly and helps to reduce the static friction in the bearings. In this way the value of E_m is made smaller, consequently improving the motor error.

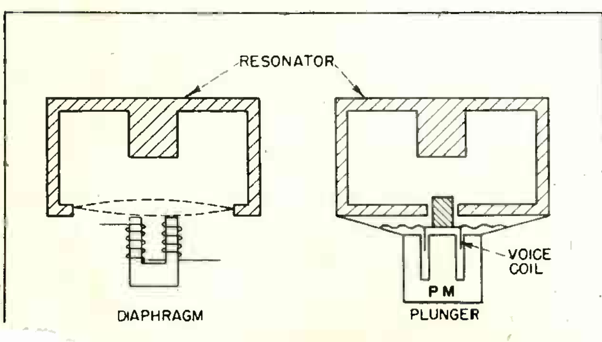
A transformer-coupled stage with 40-db gain is provided for the antihunt voltage from the eddy-current generator. This tube envelope also contains a diode which is used to rectify some of the signal to operate a tuning meter. In automatic scanning systems this diode provides the scanning bias, as will be explained later. Meter indication is obtained when the tuning of the klystron is within the skirts of the resonator. It takes a slight dip when the system is correctly in tune.

The pushbutton scanning switch disconnects the antihunt generator, and puts scanning voltage into its amplifier instead. The phase of this scanning voltage is determined by the two pairs of contacts operated through the clutch on the reference resonator-tuning shaft. Scanning is produced by injecting the voltage into the last stage of the motor-amplifier by way of the feedback amplifier circuit. This allows the remainder of the circuits to respond to the resonator-detector signal as soon as the system drives within frequency range. When the tuning meter shows a reading, the scanning button can be released and the system will pull in of its own accord.

The motor-amplifier output stage is push-pull connected to avoid d-c saturation of the transformer core. Signal voltage for the second grid is obtained from the output winding of the transformer. The 6SN7 tube supplies a maximum of one watt to the motor control winding.

Transformers in the phase detector circuit are insulated at the secondary to withstand 1,500 volts d-c working voltage. This is necessary since the reflector potential of klystrons is negative with respect to ground by a rather high value. An electrostatic shield between the core and the pushpull output winding is desirable to distribute the capacitances equally to ground. The center-leg transformer supplies the reference voltage directly from the 400-cps line.

Small crystal diodes (a 1N35 balanced pair) are used as rectifiers in the phase detector. Vacuum tubes could be used equally well, except that isolating heaters at high negative voltages is not always convenient. A brute-force capacitance filter is used to reduce any 400-cps voltage which might get onto the reflector. In this unit an impedance was provided in the reflector circuit across which external modulation could be applied to the reflector. A switch is connected across the output of the phase detector for turn-



’hods of frequency-modulating a resonator cavity with loudspeaker units

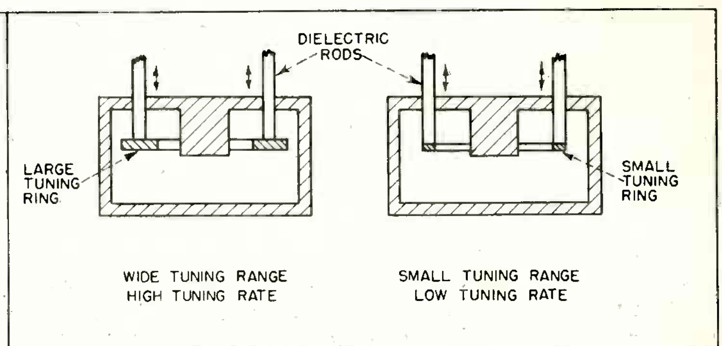


FIG. 11—Methods of resonator tuning that give different rate and range characteristics

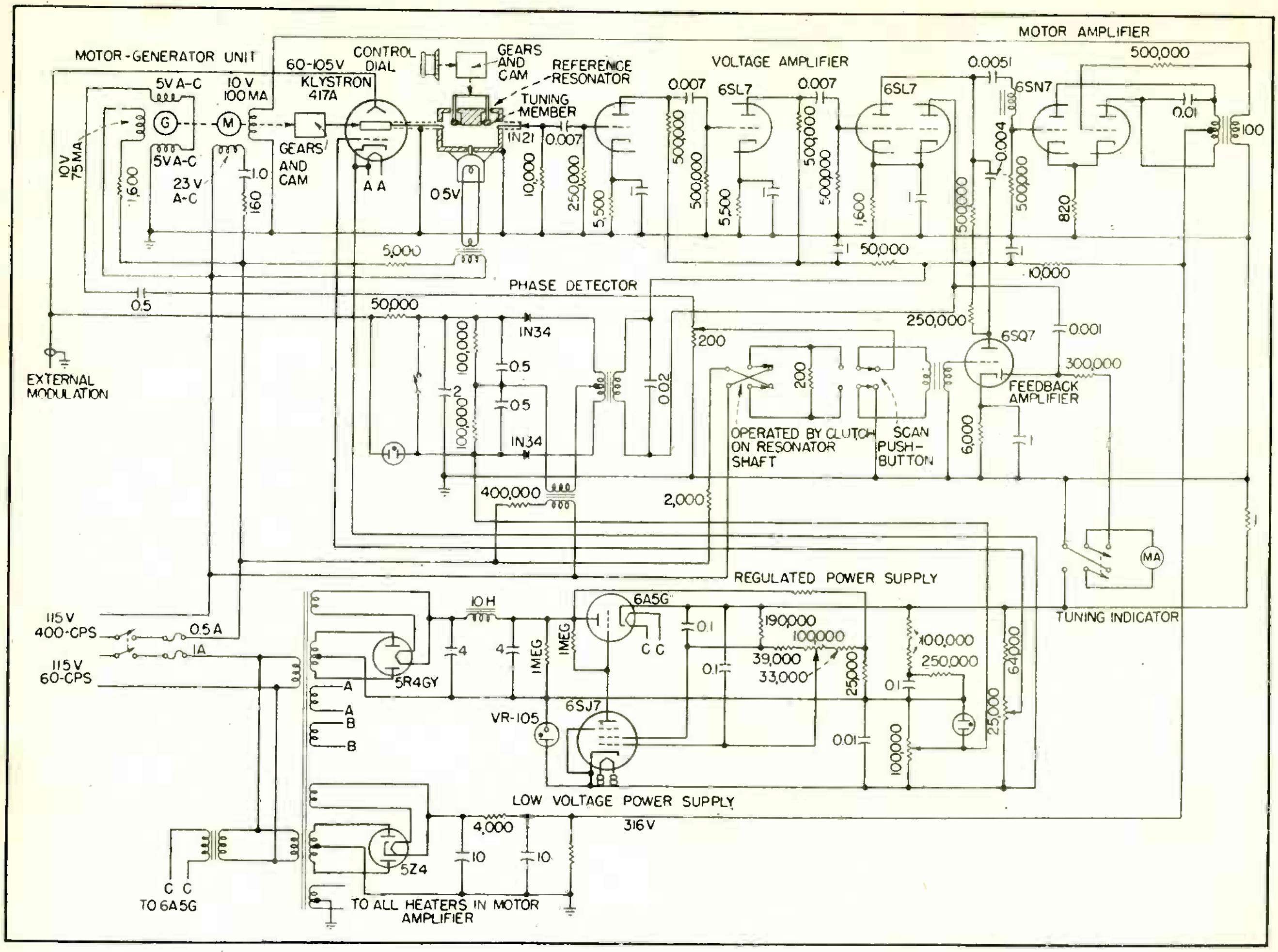


FIG. 12—Complete circuit diagram of a working afc system for which the block diagram appears in Fig. 8 (Part I of this article)

ing off the electronic afc system, but it does not affect the external modulation circuit.

Since rather high value resistors are used in the reflector circuit, it is advisable to have some means of preventing the reflector from drawing excessive current should the reflector voltage momentarily go positive. The simplest method is to connect a 0.25-watt neon bulb across the output of the phase detector. A more desirable way is to use a diode between the reflector and the cathode of the klystron. Any tendency of the reflector to go positive with respect to the cathode is prevented immediately by conduction of the diode.

Six Channels with Automatic Scan

Another experimental model had six channels spaced 30 mc apart at 3,000 mc and incorporated the automatic scanning feature. It used a cutoff tube to control the scanning, but a more satisfactory method is to use a relay tube to perform the scanning function similar to the pushbutton system just described.

The reference cavity, method of modulation, klystron tuning mechanism, and control amplifier were essentially the same as the previous unit. The only major changes are in the resonator tuning cam and the scanning control means. The special cam is made in six steps, each step at a constant radius for the particular channel. This type of construction does not require close angular tolerances when changing channels, and ordinary switch-type detent mechanisms can be used. It may be necessary to couple a wafer switch to the cam shaft, so that a correction in the d-c reflector voltage can be made at each channel to peak the power output.

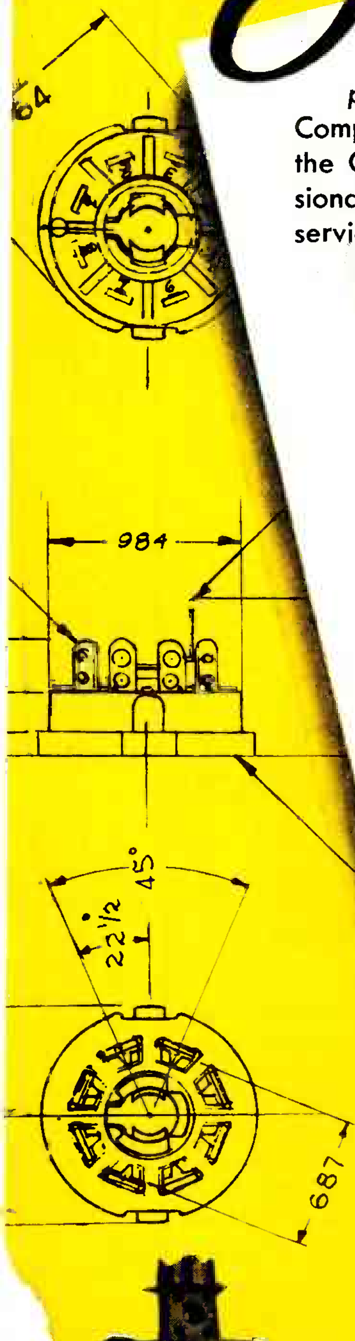
The diode previously used to provide signal for the tuning meter is now also used to bias the relay tube to cutoff. During scanning no signal is in the control amplifier, and hence no bias is developed by the diode. As the klystron frequency gets within the resonant skirts of the cavity, bias is developed and the relay shifts to the afc position and the system takes hold. With this type of control it is most important that the second harmonic signal alone provide enough bias voltage to keep the relay in the afc position.

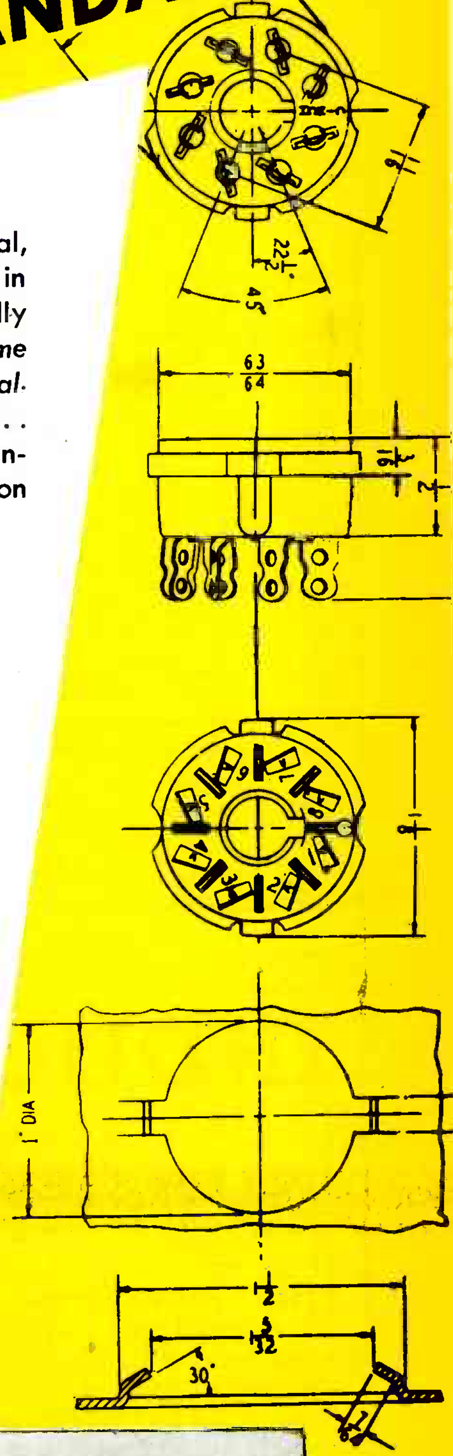
For unattended operation, it is desirable to select a relay which is hermetically sealed. An unsealed relay can accumulate dirt and dust on the contacts, and fail to operate in low-voltage, low-current circuits. It is also desirable to have the relay relaxed, not energized, during normal afc operation. This latter condition automatically occurs in this circuit since the bias voltage cuts off the relay tube except when scanning.

REFERENCE

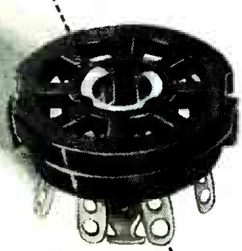
(2) F. A. Jenks, Sperry Repor
Design Considerations of
Precision Resonators fo
lished).

Cinch CHASSIS-CLINCH *Sockets* ARE STANDARD





Cinch Molded, Octal and Loktal, Chassis Clinch Sockets are mounted in specially punched chassis holes, and are rigidly fastened by lugs sheared from the chassis. *The same punched chassis hole is used for either socket, Octal or Loktal.* Compact with simplicity of design . . . and ease of assembly . . . the Cinch Chassis Clinch Socket saves valuable space; dimensional details are here illustrated. Samples and the application services of our field engineers are available on request.



CINCH MOLDED CHASSIS CLINCH LOKTAL SOCKET NO. 6983

CINCH MOLDED CHASSIS CLINCH OCTAL SOCKET NO. 9914

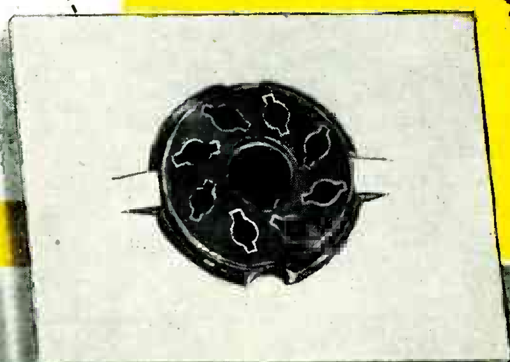


FIG. 10—Me...

CINCH MANUFACTURING CORPORATION

ELECTRONICS — D...

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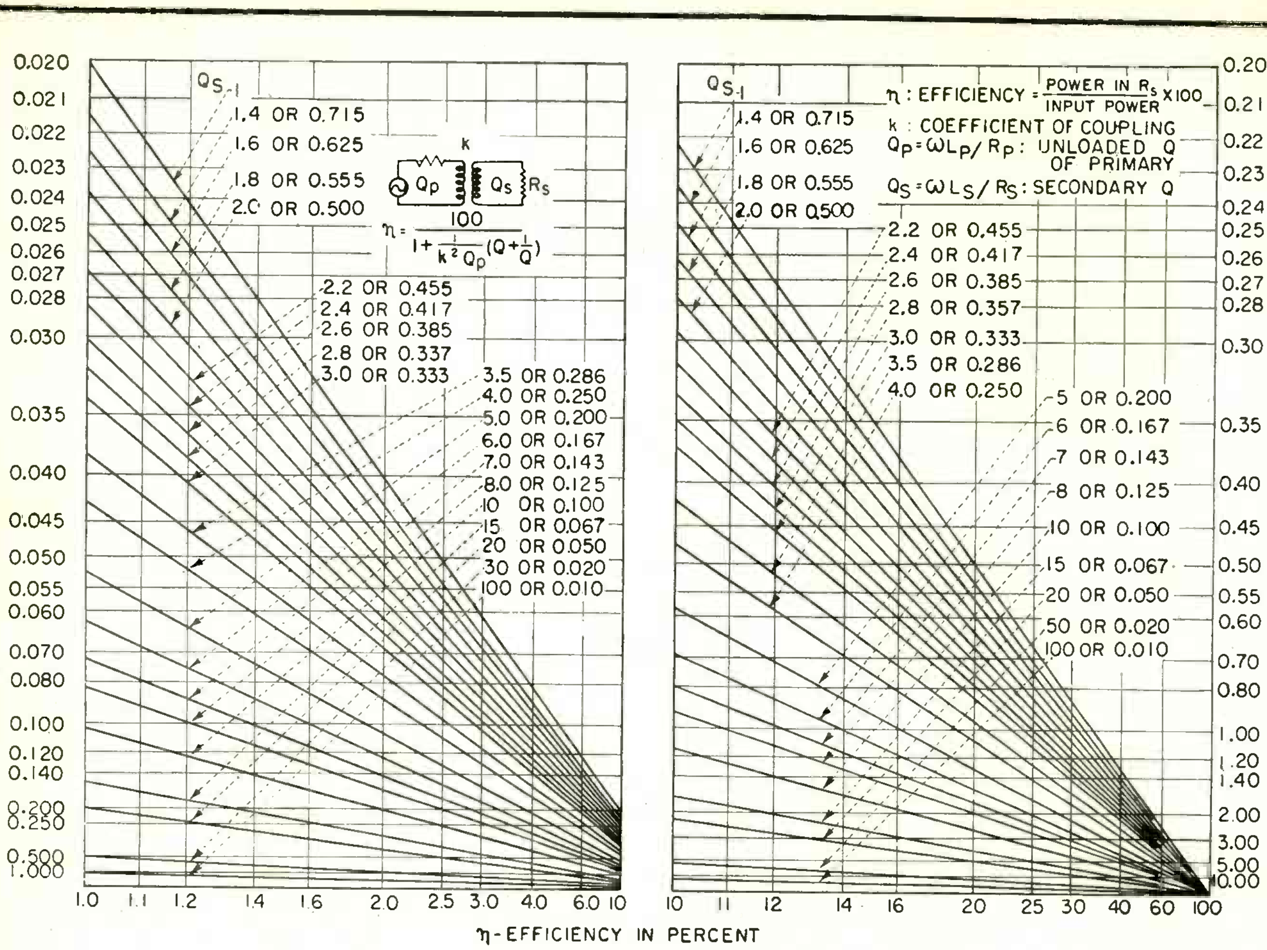

Efficiency of INDUCTIVE COUPLING

Power transfer through inductively coupled resistive circuits is given directly from chart, or coil parameters can be found if required efficiency is known

By A. C. HUDSON

National Research Laboratories Ottawa, Ontario

THE CHART expresses in graphical form the exact relation between circuit k^2Q_P and efficiency η given in the equation. If the load includes reactance, it can be lumped with the secondary reactance; k may then exceed unity. This chart shows that efficiency rises as Q_P or k is increased, or when $Q_S \rightarrow 1$.

One application of the chart is in induction heating, the load comprising the secondary and the work coil the primary. For example, a 2.56 in. diameter work coil 1.5 in. long with a Q of 28.3 at 200 kc is used to heat a section of steel tubing 0.5 in. in diameter, 1.5 in. long to 850 C. By assuming symmetrical current flow and allowing for skin effect, Q_S is found to be 0.44 and k is 0.128. (For calculation of skin depth, permeability is assumed to be unity, as it will be at the final temperature. Below the Curie point the error in this assumption will be safe because the magnetic effect will increase efficiency.) The chart shows that the efficiency is 14.8 percent.

Reducing the work coil diameter by 36 percent will increase k by 54 percent, thus doubling the efficiency.

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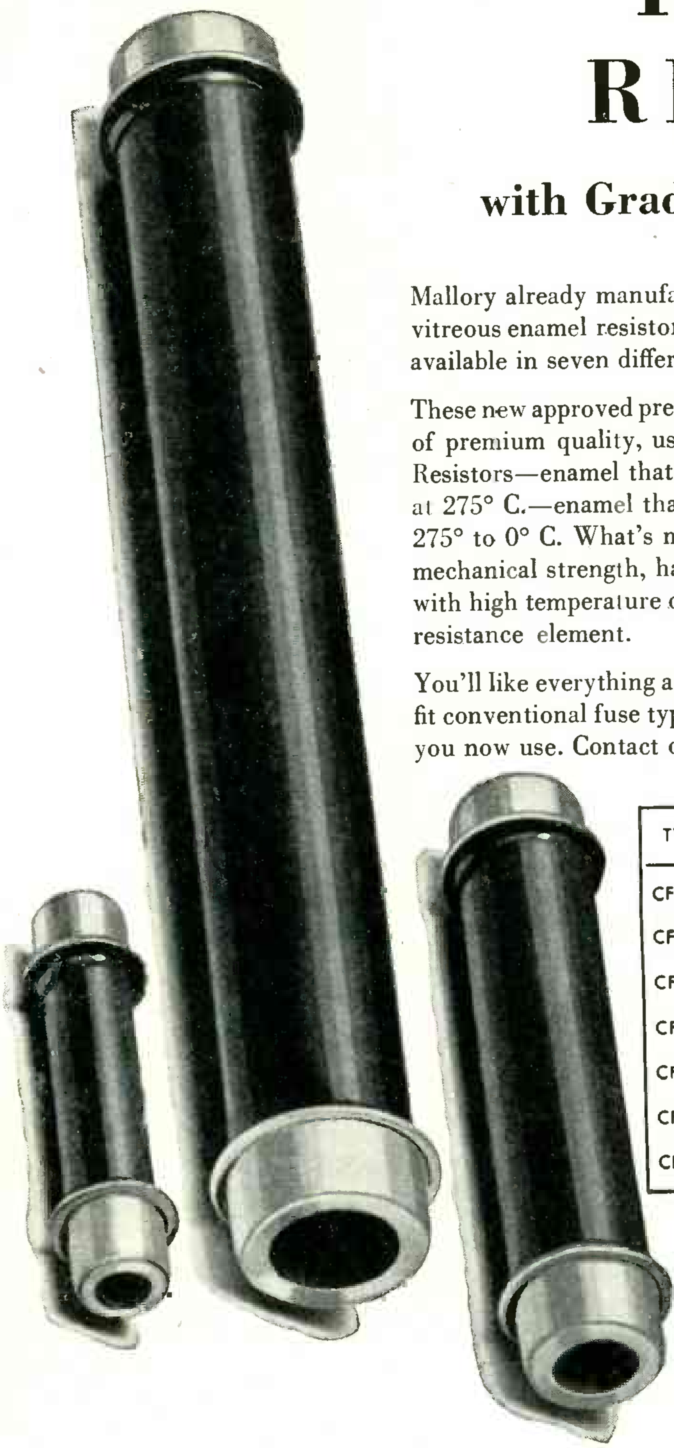
with Grade 1, Class 1, Vitreous Enamel

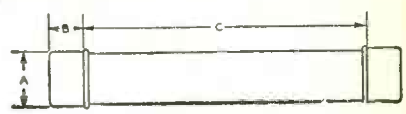


Mallory already manufactures a large and varied line of fixed lug and adjustable vitreous enamel resistors. Now it adds to that line with a series of ferrule resistors, available in seven different wattages and sizes.

These new approved precision products, measuring up to Mallory's famous standards of premium quality, use the same type enamel as Mallory Grade 1, Class 1, RN Resistors—enamel that won't chip, crack or craze even under continuous service at 275° C.—enamel that remains undamaged even after thermal shock tests from 275° to 0° C. What's more, the metal ferrules meet Navy-approved standards for mechanical strength, have high conductivity and are secured to the winding form with high temperature ceramic cement, electrically and mechanically bonded to the resistance element.

You'll like everything about these new ferrule resistors, including the fact that they fit conventional fuse type mounting clips and can be interchanged with the resistors you now use. Contact our district sales office or write us direct.

TYPE	RATING	Resistance Range		A	B	C
		Min.	Max.			
CF 10	10 Watts	0.2 ohms	5 M ohms	9/16	1/2	1 3/8
CF 15	15 Watts	0.3 ohms	10 M ohms	9/16	1/2	1 15/16
CF 35	35 Watts	0.5 ohms	25 M ohms	13/16	1/2	3 7/16
CF 45	45 Watts	0.7 ohms	40 M ohms	13/16	1/2	4 1/8
CF 100	100 Watts	1.5 ohms	80 M ohms	1 1/8	1/2	6 7/16
CF 150	150 Watts	2.6 ohms	120 M ohms	1 1/8	1/2	8 5/8
CF 200	200 Watts	3.2 ohms	160 M ohms	1 1/8	1/2	10 7/16



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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by VIN ZELUFF

Remote Amplifier and Program Meter

BY DON V. R. DRENNER,
Engineer, KGGF
Coffeyville, Kansas

ONE of the most interesting pieces of apparatus which I have seen, and with which I have worked, is the BBC amplifier to be described.

The uniqueness of this amplifier was amply illustrated during wartime, because it served as both control room equipment, in small continuity studios, monitor amplifier, recording feed amplifier, and many others in addition to its main job as a remote amplifier. It was the main factor in keeping the BBC on the air during the Blitz, and indeed during the entire war.

The amplifier circuit consists of two high-gain stages utilizing high-slope pentodes, with an over-all gain of about 90 db, a dual potentiometer between the two stages, which acts not only to control the signal voltage to the second stage, but also controls the amount of feedback; and a program metering circuit, which measures the approximate power delivered to the line, instead of voltage, as is customary.

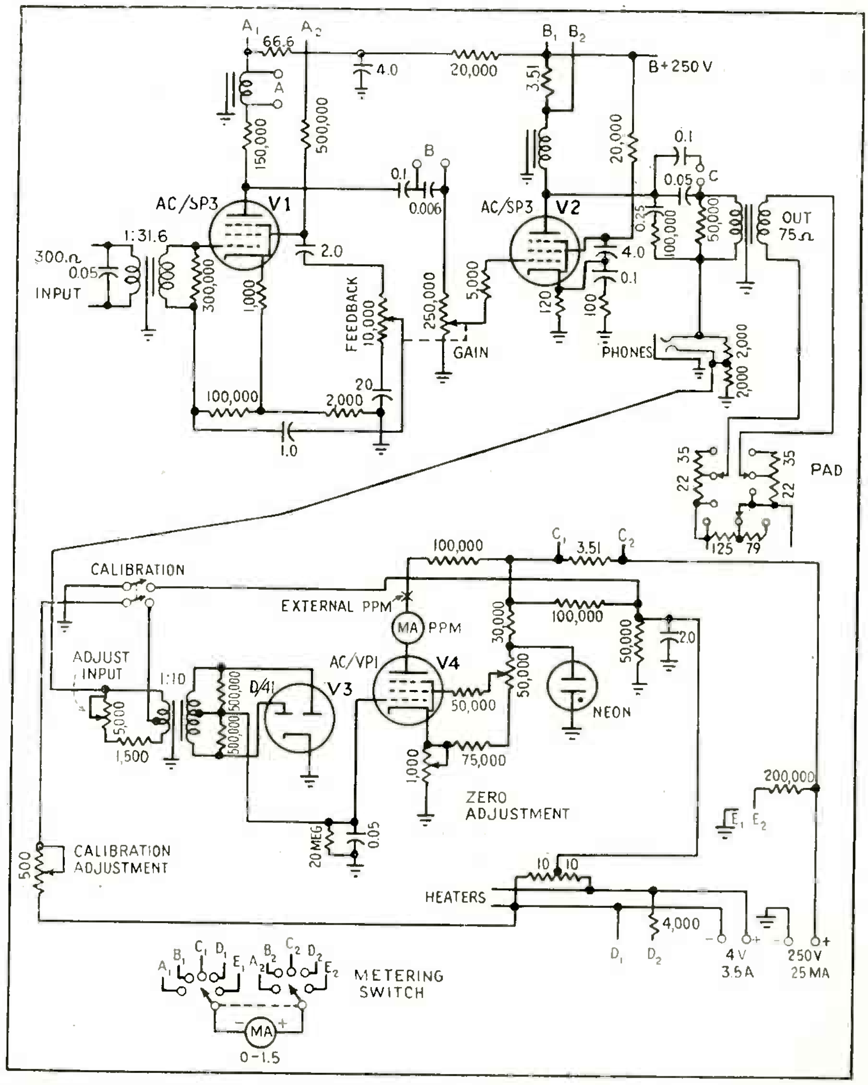
The tubes used, type AC/SP3, have a rather steep grid-plate curve: 7.5 ma/v (7,500 μmhos). The overall gain of 90 db is aided by the special input transformer. The leakage inductance of this transformer, plus the grid-cathode capacitance and the 0.05 μf across the primary, constitute a low-pass filter cutting off at approximately 10,000 cycles.

The output circuit of the second stage also constitutes a low-pass filter, with the plate choke shunting the load for the low frequencies. A resistor in the plate circuit, effectively shunting the choke, restricts its effect to frequencies below 30 cycles. Thus the amplifier from input to output acts as a band-pass filter from 30 to 10,000 cycles.

Since a rising characteristic is desired (at about 2,000 cycles) with the ribbon microphones commonly used by the BBC, the first stage has a choke in the plate circuit to increase the gain at higher frequencies, and suitable capacitors are chosen for the coupling circuits. These capacitors are inserted or taken out, depending on the low-frequency correction desired.

Step Attenuation

As previously mentioned, gain control is accomplished by two potentiometers, one of which is in the grid circuit of the second stage, and the other in the feedback circuit of the first stage. Both potentiometers are on the same shaft, and their operation is as follows: the feed-back potentiometer operates by



Terminals at *A* are left open for high-frequency correction and terminals at *B* and *C* for low-frequency correction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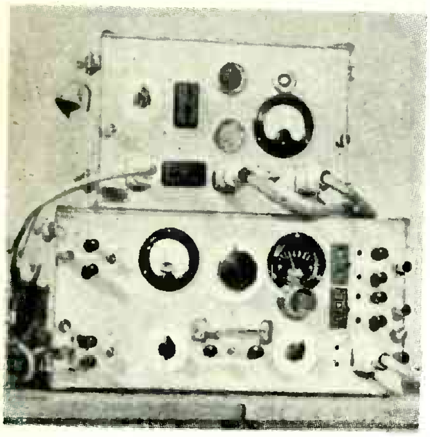


View of the remote amplifier and program meter with power supply above

the progressive application of negative feedback in 8 steps of 2 db each over the first 9 studs of the potentiometer. The grid circuit potentiometer operates over the remaining studs, providing attenuation of 2 db also over the greater part of the range, and then in larger steps to give a complete fade-out.

There are 35 studs on both potentiometers, and studs 35 to 27 on the grid-circuit potentiometer are connected together, so that from stud 26 onward the gain is increased by decreasing the negative feedback, the gain of the second stage being at maximum so far as its input circuit is concerned. So far as attenuation is concerned, from 0 to stud 11 it is 3 db per step; from stud 11 to 35 it is 2 db. When the control potentiometers are at stud 35, the grid circuit of stage two is maximum, and the feedback on stage one is at minimum.

The maximum voltage gain at 1,000 cycles, working into a 600-ohm load, is 91 db. The gain at 9,000 cycles is plus 4 db, and at 50 cycles minus 5 db, with respect to that at 1,000 cycles, when the correction networks and chokes are in use for ribbon microphones.

Peak Program Meter

The most interesting part of this amplifier is the output meter. In BBC parlance this is the ppm, or peak program meter and it is used to control virtually all programing at the BBC. It consists of a diode and a pentode, the latter having a right-hand zero meter in its plate circuit. The initial plate current of the pentode is arranged so that the meter reads full-scale, or zero at the left-hand side. Movements of the meter to the right-hand side are aided by its spring, but those to the left are retarded by it. In addition to a very lightly damped movement, this action allows the meter to rise on a rapid program peak in less than 4 milliseconds.

The return of the meter to the left is further retarded by the R-C combination across the grid of the pentode which feeds the meter. The return time from full deflection (the meter rises within 2 db of the value of the applied peak signal in 4 milliseconds), is in the order of 3 seconds. In some models a further damping of the return time is arranged by a large capacitor thrown into the circuit by a relay, so that the meter will rise and hold its position for several minutes. The meter face is calibrated in divisions reading 1 to 7; each division represents 4 db.

The screen and bias voltages of the pentode are controlled by small variable resistors, and the meter circuit can be calibrated so that it operates over the particular curved portion of its characteristic to give the desired logarithmic law, and a standing current to deflect the meter to zero.

Meter Circuit

Since the impedance of the lines into which the amplifier operates may vary considerably, the peak program meter is connected across a 2,000-ohm load resistor included in the amplifier output circuit. The voltage across this resistance, and therefore, the total current in the output loading network is maintained constant whatever the impedance of the line may be. With this arrangement, for a particular reading of the program meter, the maximum variation of the level sent to the line varies within practical limits of plus or minus 1.5 db.

Program voltages are rectified by the diode, which charges the capacitor connected across the grid circuit of the pentode, and thus reduces the total plate current. Zero deflection corresponds to 1 ma. The resistor across the capacitor gradually allows the charge to leak off, and the meter returns to zero; that is, the bias is removed from the grid, and the plate current goes to the predetermined maximum.

Automatic Opinion Meter

By Robert R. Person
Special Products Division

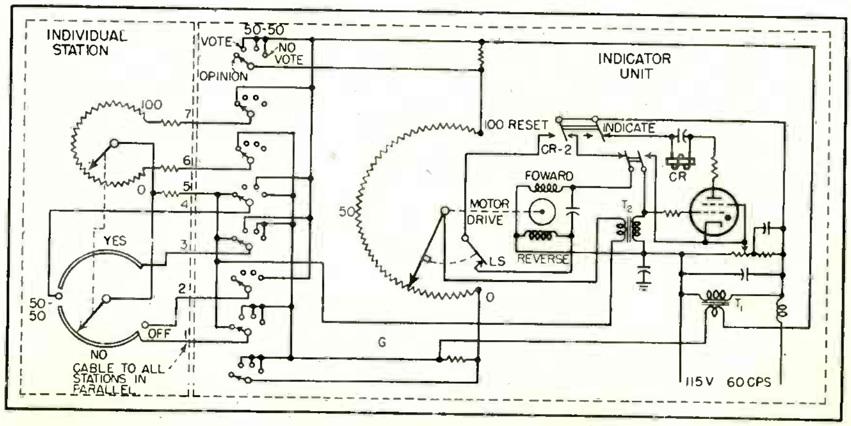
and

T. A. Rich
General Engineering and Consulting Laboratory

General Electric Company
Schenectady, N. Y.

Group opinion can be quickly indicated by means of an oral ballot or show of hands, but the results of these methods are sometimes misleading because of human error, prejudiced interpretation, or because of the influence on people

(continued on p 156)



Complete schematic diagram of opinion meter

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THE ELECTRON ART

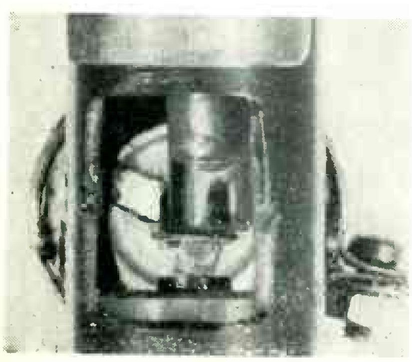
Edited by FRANK ROCKETT

Crystals as Detectors of Nuclear Radiation

DIAMONDS, and possibly other crystalline substances such as sodium chloride, can be used to detect nuclear and x-ray radiation. A diamond crystal mounted as shown below between brass electrodes that are maintained at a potential difference of about 1,000 volts acts much like a Geiger-Mueller counter tube, but is capable of faster counting.

Radioactivity studies conducted by Dr. L. F. Curtiss of the National Bureau of Standards have shown that diamonds are highly sensitive to gamma rays, and probably to other nuclear radiations. Similar experiments at the Bell Telephone Laboratories with alpha particles gave the same results. In this case the electrodes were both placed on the same side of the diamond crystal because of the poor penetration of this radiation.

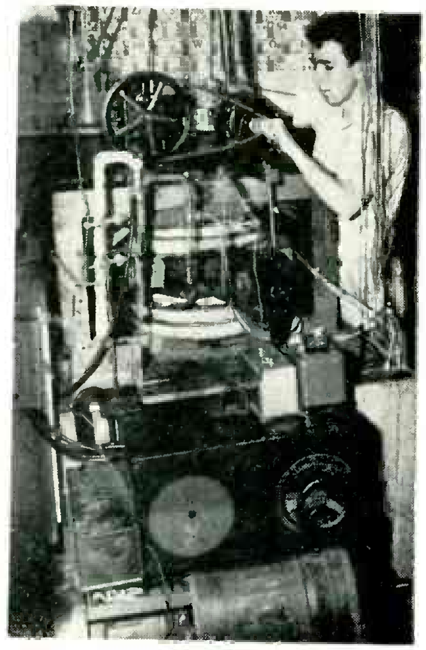
When a high energy particle strikes a carbon atom in a diamond crystal it is absorbed, liberating an electron. Because of the wide spaces in the crystal lattice of diamond, the electron travels a relatively great distance under acceleration from the externally applied potential gradient and attains high velocity. Upon finally striking another carbon atom in the crystal, the electron dislodges additional electrons. The avalanche proceeds in much the same manner as the gas ionization in G-M tubes, producing a sharp output pulse. Because the crystal has faster recovery following the avalanche, it is capable of higher counting rates and shorter resolutions than G-M counters.



Experimental mounting for diamond counter

The larger the diamond, the greater the sensitivity; a diamond measuring $\frac{1}{8}$ inch on each face has approximately the sensitivity for gamma rays as laboratory constructed G-M tubes. The diamond counter must be clear and free from faults. Discoloration is apparently indicative of abnormal orientation of outer electrons in the atom; faults interrupt the ionization avalanche. About one in forty industrial diamonds are suitable for counters, cost about the same as G-M tubes, and have much longer life. Diamond is the only material so far investigated that has sufficiently low background noise at normal temperatures for this application. Because they are much smaller than G-M counters, diamond counters are especially useful in exploring small spaces. The circuits and indicators are the same as those used with G-M counters.

Cyclotron Is Kids' Stuff



Dick Sinnott, one of four high school students who built this cyclotron, adjusts belt to roughing pump to initiate vacuum in chamber

GENERAL impression is that nuclear accelerators such as cyclotrons are complicated scientific apparatus that interest only advanced physicists. Because of this impression, it has been stated that nuclear research can only be carried on by laboratories backed with hugh financial resources.

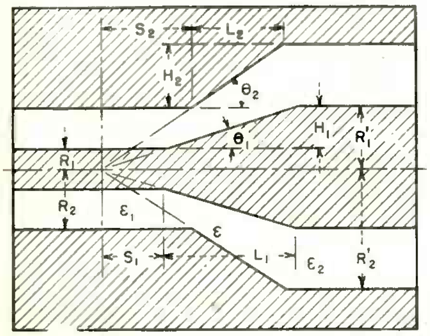
Actually many details of nuclear reactions and electron optics can be studied using relatively simple and inexpensive equipment. Pioneering research has passed on to frontiers requiring very high energy machines, but much is left to de done filling in the studies at low energies.

The students at El Cerrito, California high school have built the 1,000,000 electron volt cyclotron shown here under the direction of their physics teacher B. V. Siegal. The machine, patterned after a 100 mev cyclotron at the Berkeley campus of University of California, cost $600, some parts being obtained from war surplus, but is valued at $7,000, counting donated labor. Research Foundation of New York, holder of Dr. E. O. Lawrence's cyclotron patents, has given the school a royalty free license for the machine. Cans of water forming a 3-ft thick wall provide suffi-

cient absorption to protect students from radiation. Since this picture was taken, the machine has been dismantled to incorporate changes that will increase the developed energy.

Tapered Coaxial Junctions

By Sanford Hershfield
Glenn L. Martin Co.
Baltimore, Md.



Essential parameters of tapered junction

To change dimensions of a coaxial line without changing its characteristic impedance or introducing noticeable discontinuities, a tapered coaxial junction is used. Characteristic impedances of two coaxial lines having the same dielectric are equal if the ratios of their radii are equal. However, an abrupt dimensional change at a junction introduces a shunt capacitance. A long transitional section would eliminate this discontinuity, but would be cumbersome. Using the following relations, a reasonably short taper can be made that provides a sufficiently good match for use with slotted coaxial lines in measuring impedances and in other applications requiring negligible reflections.

The impedance of a conical coaxial transmission line is, using the dimensional notation of the accompanying drawing, and with ε designating the dielectric constant

$$Z_K = (138/\varepsilon^{1/2}) \log \cot(\theta_1/2) \times \tan(\theta_2/2)$$

The impedance of a uniform coaxial transmission line is

$$Z_K = (138/\varepsilon_1^{1/2}) \log R_2/R_1$$

Hence for minimum discontinuity

$$(138/\varepsilon_1^{1/2}) \log (R_2/R_1) = (138/\varepsilon^{1/2}) \log (R_2'/R_1') = (138/\varepsilon^{1/2}) \log \cot(\theta_1/2)\tan(\theta_2/2)$$

When the dielectric is air, this design equation simplifies to

$$R_2/R_1 = R_2'/R_1' = \tan(\theta_2/2)/\tan(\theta_1/2)$$

By way of illustrating the application of these equations, suppose a standard 50-ohm type-N connector line is to be connected to a 50-ohm slotted section made from commercially available brass tubing. The type-N connector line has an inner conductor of 0.120-in. diameter, and outer conductor of 0.276-in. diameter giving a ratio of radii of 2.30. If the inner conductor of the slotted line is chosen to be 0.500-in. diameter, an outer conductor of 2.30 × 0.500 = 1.150-in. diameter is required. Brass pipe of 1.250-in. outside diameter and 0.049-in. wall thickness gives this inner diameter. For space requirements the axial length of the taper is to be about 1.25 in. Assume θ_2 is 20 deg. Then $\tan(\theta_1/2) = 0.0765$, or θ_1 is 8.76 deg. The other dimensions are

$$L_2 = H_2/\tan\theta_2 = 1.202 \text{ in.}$$
$$L_1 = H_1/\tan\theta_1 = 1.233 \text{ in.}$$
$$S_2 = (R_2/\tan\theta_2) = 0.379 \text{ in.}$$
$$S_1 = (R_1/\tan\theta_1) = 0.389 \text{ in.}$$

The coaxial taper is machined to these dimensions.

3-Cm Continuous Range Oscillator

By Irving M. Gottlieb
Electrical Engineer
Los Angeles, Calif.

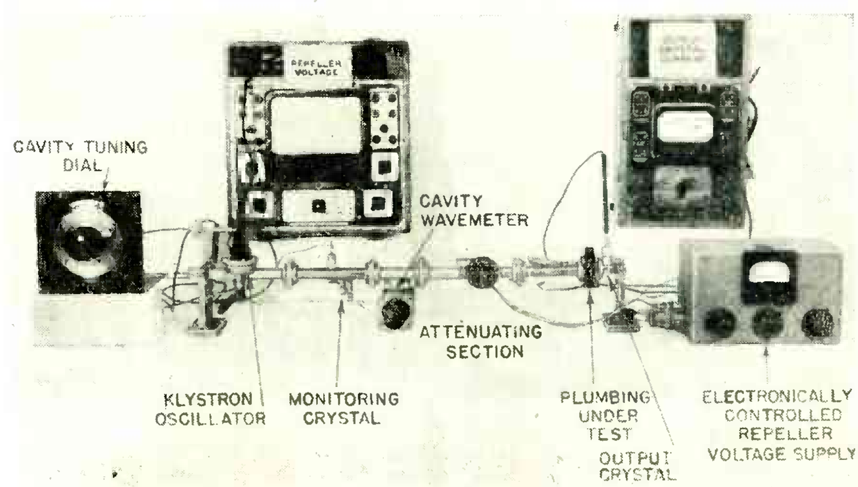
Design and testing of r-f plumbing components in the 3-cm band can be greatly facilitated by means of a signal generator capable of providing continuous calibrated tuning over the desired frequency range. With the laboratory oscillators available, it is a very tedious and laborious process to plot frequency characteristics of a mixer unit or to obtain the Q of a resonant cavity. The desirable requirement that power output remain constant over the frequency band involved in the measurement procedure is difficult to satisfy, inasmuch as the reflector potential adjustment for the reflex klystron affects both power and frequency.

The system described delivers constant power at any frequency within the range of 8,800 to 9,500 mc by tuning a calibrated dial to the desired frequency. A precision-calibrated tunable cavity is employed as a wavemeter to check the tuning dial calibration from time to time. Once the tuning dial has been calibrated, one merely selects the desired frequency increments and records the corresponding microwave power output from the component under test. The plumbing setup used is shown in the photograph.

Klystron Operation

Both the power output and frequency of oscillation of a klystron

(continued on p 180)



Microwave measuring circuit consists of a klystron oscillator and dial and linkage for cavity tuning; monitoring crystal to feed an electronic voltage control; wavemeter and attenuating section; and crystal to measure output from plumbing under test

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ANACONDA WIRE AND CABLE COMPANY

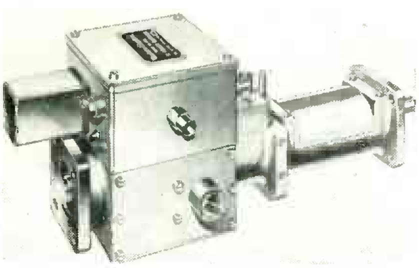
NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, packaged units, allied products; new tubes. Catalogs and manufacturers' publications reviewed.

Wattmeter-Monitor

GRAYBAR ELECTRIC CO., 420 Lexington Ave., New York, N. Y. Western Electric type 3A power and impedance monitor serves as a radio frequency wattmeter and standing wave ratio indicator. It protects the



transmitter and transmission line system from damage by automatically shutting off power when changes in transmission line load impedance occur. The monitor is standard equipment in the company's line of f-m transmitters.

Metals Comparator

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Quick nondestructive comparison of magnetic or nonmagnetic metal parts can be made using a new metals comparator. A speci-

men is placed within a test coil and when a bridge circuit is balanced for zero meter reading, other parts can be compared with the original at a rate exceeding 1,500 per hour. Tolerances are established on the basis of a meter reading. Additional information is given in bulletin GEA-4894.

Standing Wave Detector

DEMORNAY-BUDD, INC., 475 Grand Concourse, New York 51, N. Y. A new standing wave detector operating in the frequency band from 23 to 27 kilomegacycles utilizes a solid steel block from which the main block and waveguide extremities are machined and then gold plated.

Scale calibration is in millimeters with a vernier scale and lens that permits readings down to a tenth of a millimeter per division. Square choke and cover flanges are used for waveguide couplings and a type 1N26 crystal is used.

Platter Quieters

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge, Mass. Type 910A dynamic noise suppressor is designed for use with shellac and other phonograph records particularly when they are used for programming broadcast stations. The simpler unit type 210A is also available and includes an amplifier. The latter unit is suitable for laboratory or home use.

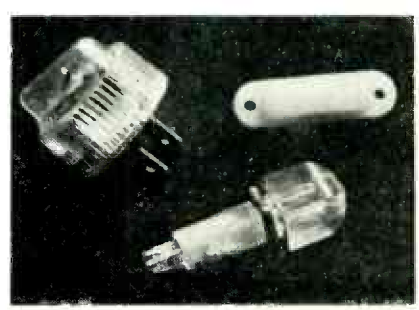
Photoelectric Package

JOHN T. O'CONNOR & CO., 208 South Valley Road, West Orange, N. J. The Electronic Handyman is a photoelectric device designed as a semi-universal equipment for switches, counters, gages, and controls that

can be actuated by a light beam. Suitable added mechanisms, also available, convert the basic unit to a wide variety of industrial uses. A descriptive brochure suggests many specific applications.

Indicators

LITTELFUSE INC., 4759 N. Ravenswood Ave., Chicago 40, Ill. A line of neon indicators suitable for use on electronic equipment is illustrated. In the center is a pilot light similar to conventional types. That at the right requires either a slot or two panel holes. For use with equipment on which it is not con-



RAYTHEON chosen for

Simultaneous AM-FM Programing

Mr. Dan Leibensperger, Chief Engineer of WHP examining their new dual Raytheon installation.

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venient to insert a selfcontained indicator, the combined plug and indicator at the left can be attached to the power cord.

Printed Hearing Aid

ALLEN-HOWE ELECTRONICS CORP., 5 No. Wabash Ave., Chicago 2, Ill. A new hearing aid utilizing printed circuits is now in production. Circuit and components are imbedded in the ceramic wafer illustrated, considerably reducing physical size of the unit.

Thermostat Relay

SIGMA INSTRUMENTS, INC., Boston 21, Mass. A totally enclosed relay with characteristics that make it suitable for handling loads that are switched by the closure of a mercury-column thermostat operates on 2 ma at 115 volts a-c. The unit is a plug-in type, and stands only 2 inches above the base.

F-M Signal Generator

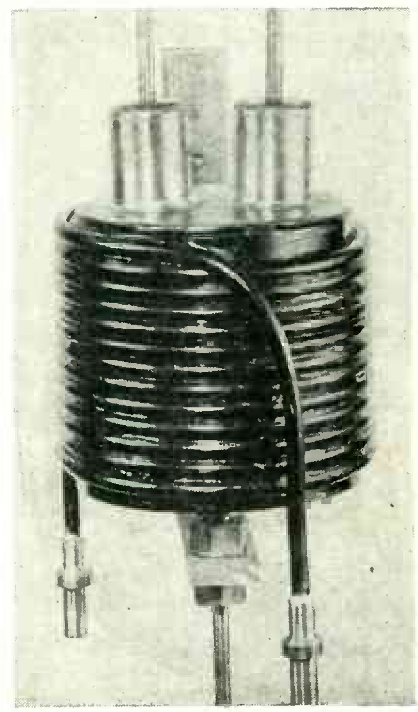
MEASUREMENT ENGINEERING LTD., 61 Duke St., Toronto, Ont., Canada. Model 167 is a fixed frequency signal generator with four f-m broadcast station signal channels available in the band from 88 to 108 megacycles. Internal modulation is provided as well as connections for external modulation. Percentage modulation is adjustable from 0 to 100 kc and on high frequencies from 0 to 200 kc. Model 185 is similar except that the frequency is continuously variable over the band.

Versatile Oscilloscope

BROWNING LABORATORIES, INC., Winchester, Mass., announces an all-purpose 5-inch oscilloscope, model OL-15A. A special feature is the response curve of the vertical amplifier which is linear and without positive slope from 10 cycles to 4 mc. Triggered sweeps of 0.2, 0.5, 1, 5, 20, and 200 microseconds per inch may be inaugurated by the internal trigger generator or by external pulses. Further information for individual adaptations is available.

Power Rectifier

CLARK ELECTRONIC LABS., Box 165, Palm Springs, Calif. Type CE-6001 heavy duty rectifier has two anodes, but no mercury pool. A special porous alloy cathode is impregnated with mercury so that the vapor is available for conduction without requiring any special mounting position. Available for straight rectification service between 250 and 600 volts, it has an average rating of 25 amperes. Other sizes include ratings up to 600 amperes. The rectifier is selfstarting and requires no ignitor rods or auxiliary apparatus.



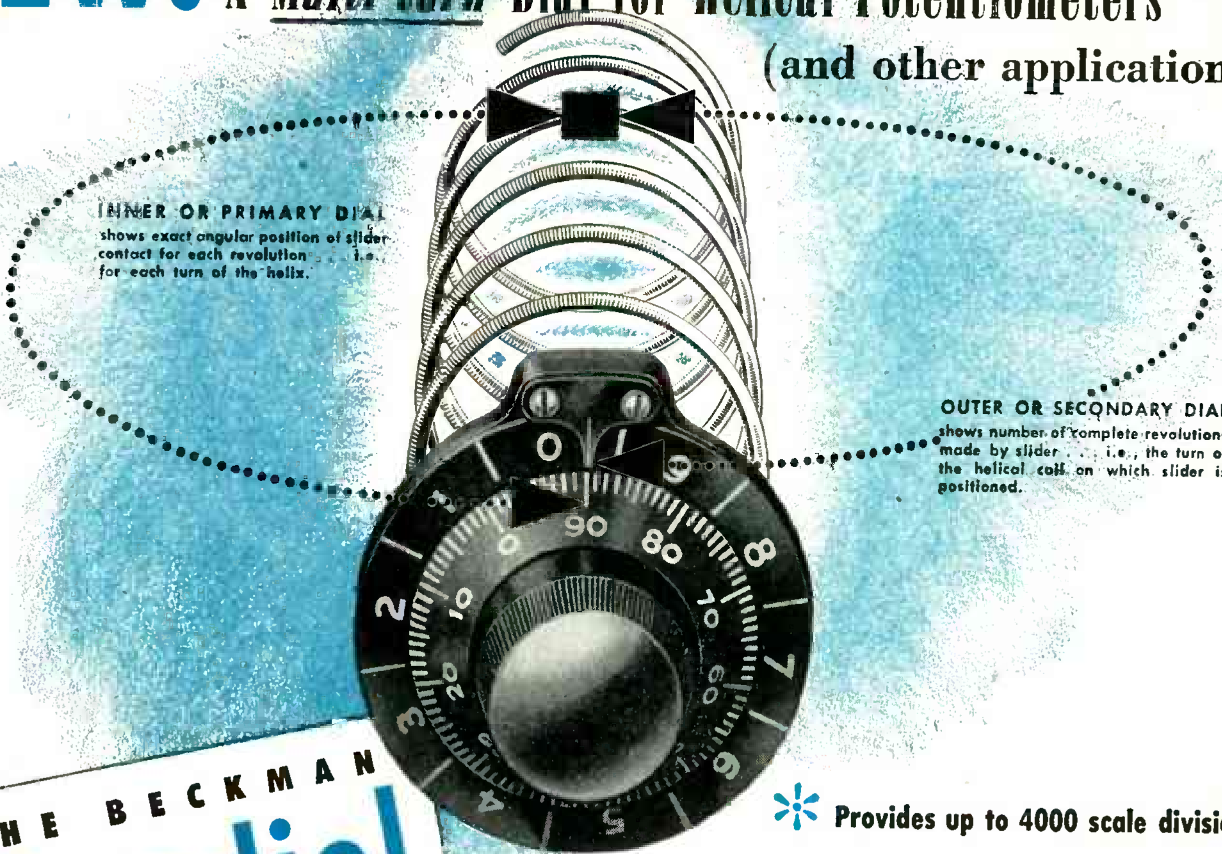
Tape Recorder

SOUND RECORDER AND REPRODUCER CORP., 5501 Wayne Ave., Philadelphia, Pa. The Magnesonic is a new home recorder using a magnetic tape. Tape reels furnished record

(continued on p 206)

NEW! A *Multi-turn* Dial for Helical Potentiometers

(and other applications)



THE BECKMAN

Duodial

- Provides up to 4000 scale divisions
- Requires only 2" diameter space

HERE'S A DIAL development entirely new in operating simplicity, convenience and versatility. It's the Beckman DUODIAL — a multi-turn rotational-indicating unit consisting of a primary knob-dial geared to a concentric turns-indicating secondary dial, *and the entire unit so compact it requires a panel space only 2" in diameter.*

The DUODIAL permits extremely accurate vernier adjustment of driven controls and, when used with helically-wound devices such as the Beckman Helipot, it registers *both* the angular position of the slider contact on any given helix and the position of the slider along the helical winding. The DUODIAL is so designed that — as the primary dial is rotated through each complete revolution — the secondary dial moves one division on its scale.

Thus the secondary dial counts the number of complete revolutions . . . or, when used with helical potentiometers, it indicates the helical turn on which the slider contact rests.

Although developed originally for use with the well-known Helipot Potentiometer, the DUODIAL is readily adaptable to other helically-wound devices of similar nature, as well as to many conventional gear-driven controls where extra dial length is desired without wasting panel space. Its compactness and simplicity — and unique advantage of providing an accurate rotational indication from a minute fraction of a turn through as many as 40 full turns — make the DUODIAL invaluable for many applications where maximum dial accuracy is essential.

Complete information on the DUODIAL can be secured from your nearest Helipot representative . . . or write direct.

THE HELIPOT CORPORATION
1011 MISSION STREET, SOUTH PASADENA 2, CALIFORNIA

IMPORTANT DUODIAL FEATURES

- The DUODIAL contains only two moving parts. Mechanical wear and operating torque are reduced to an absolute minimum, assuring long, trouble-free life. All parts, including knob itself, are made entirely of metal for maximum strength and durability.
- The primary scale, which indicates angular position, is an integral part of the knob, and, by means of a set-screw, is rigidly affixed to the shaft of the driven device. Thus, in contrast to most turns-indicating mechanisms, the scale readings are not subject to error from backlash of internal gears. For maximum convenience in making decimal notations, this dial is graduated 0 to 100.
- The DUODIAL cannot be damaged through jamming of the driven unit, or by forcing beyond any mechanical stops. The dial can readily be used with power-driven devices, because, due to the absence of worm gears, it can be operated from either the shaft or knob end.
- The DUODIAL is currently available in turns-ratios of 10:1, 15:1, 25:1 and 40:1 (ratio between primary and secondary dials). Other ratios can be provided on special order. The 10:1 ratio DUODIAL can be readily employed with devices operating fewer than ten revolutions and is recommended for the Model C three-turn Beckman Helipot. All ratio-types are identical in size and appearance except for the numbering of the secondary (turns-indicating) dial.
- The DUODIAL is designed for mounting directly on 1/4" diameter round shaft, and in all sizes the primary dial and shaft operate with a 1:1 ratio.

* Range for 40:1 ratio DUODIAL.

NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Dates for forthcoming conventions; Navy puts superpower transmitter on air; business news; movements of engineering personnel

Atomic Physics Division at Bureau of Standards

A NEW Division of Atomic Physics has been set up at the National Bureau of Standards, with six major sections: Spectroscopy, Electronics, Mass Spectrometry, Radioactivity, X-Rays, and Atomic Physics.

Broad functions of the division are promotion of fundamental fact-finding research and precise determination of important basic standards in the field of atomic physics. Protective and safety codes will be developed to reduce industrial hazards arising from new applications of physics. Dr. E. U. Condon, the Bureau's director, has assumed charge of the division, and Dr. Robert D. Huntoon has been named assistant chief.

The Electronics Section is divided into two units, one of which is concerned with the basic physics of emission of electrons and atomic ions from various materials under the influence of light, heat, or the impact of other electrons or ions. The other unit is concerned with the physics of electron and ion ballistics, as applied to electron microscopes and the study of biological or metallurgical materials with the aid of electrons emitted by radioactive tracer elements.

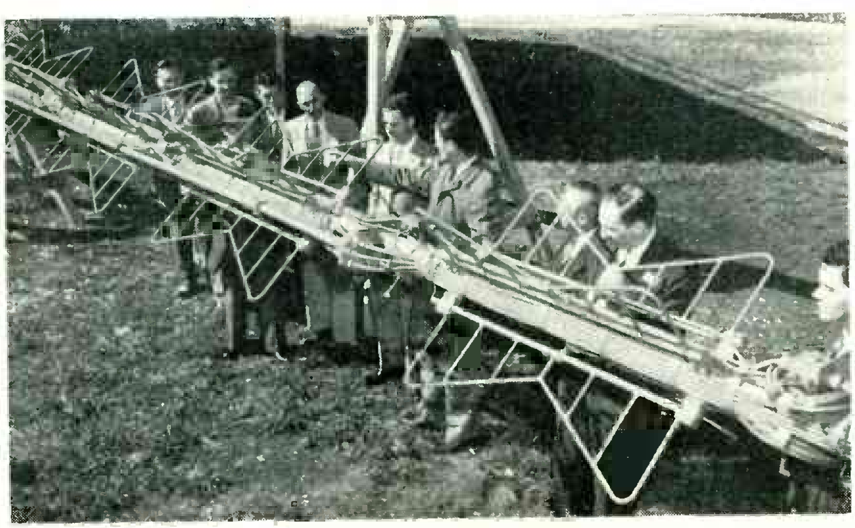
The Radioactivity Section is the national standardizing laboratory for the measurement of radioactive materials and radioactive radiations. It has measured all commercially sold radium preparations from the time radium first became available in the United States in 1913 to the present time. Extremely sensitive methods have been developed for measuring radioactive contaminations in the air for the protection of industrial workers. Precise standards for the measurement of neutron radiation are now being developed.

Officers for Parts Show

CHARLES GOLENPAUL of New Bedford, Mass., representing the Sales Managers Club, Eastern Group, was elected president of Radio Parts and Electronic Equipment Shows, Inc., sponsor of the national Radio Parts Show in Chicago. Jerome J. Kahn of Chicago, representing the Parts division of RMA, was chosen vice-president, R. J. Sherwood of Chicago, representing EP & EM, is secretary, and W. O. Schoning of Chicago, representing National Electronic Dealers Association, is treasurer.

The 1948 Board of Directors includes J. J. Kahn and R. C. Sprague representing RMA, Charles Golenpaul and W. W. Jablon representing SMCEG, R. J. Sherwood and John L. Robinson representing EP & EM, and W. O. Schoning and Aaron Lippman representing NEDA.

Broadcasters Inspect Reclining Superturnstile



Some of the 26 broadcast engineers attending RCA's second television engineering clinic inspect a six-bay RCA superturnstile television transmitting antenna at the Camden, New Jersey plant of the RCA Engineering Products Department

FCC Monitoring Stations

THE FCC MONITORING network today comprises 22 field stations which are equipped with radio receivers covering the entire radio spectrum, frequency-measuring equipment, fixed long-range direction finders, and mobile units able to take radio bearings at close range.

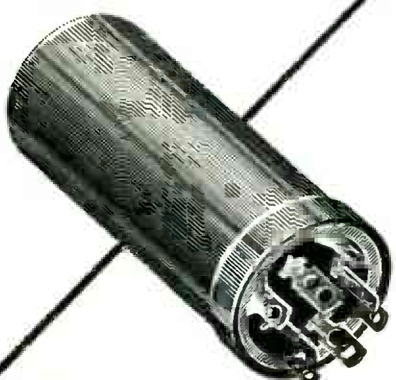
The monitoring stations are linked by leased teletypewriter service as well as radio. Thus, they form a nation-wide network which can obtain long-range bearings in order to locate an illegal station or a station which is causing interference to other stations.

The main job of these monitoring stations today, in addition to assuring that stations are on their assigned frequencies, is to trace sources of interference which can disrupt or jeopardize some two score types of radio services. Interference may result from a transmitter operating improperly, or from the operation of a device like a diathermy machine which frequently radiates radio energy just like a radio transmitter.

The problem of running down interference is becoming increasingly important. Thousands and thousands of stations are being added to the already crowded radio spectrum not only in this country but throughout the world. Two recent interference cases are typical:

On January 15, 1947, the FCC

Skilled operators rolling fabricated plate electrolytic capacitors.



Electrolytic Capacitors—standardized into 8 container sizes to simplify design and assembly problems.

Magnavox Components Have Led the Field Since 1915

TODAY Magnavox loudspeakers, capacitors and other component parts are established as *the standard of quality in radio manufacturing.* Over a period of 32 years, Magnavox has developed over-all skills and experience that are unsurpassed in the radio industry.

Leaders in the field know that their finished products can be only as good as the parts they use. This is why they insist upon component parts by Magnavox, oldest and largest quantity producer of quality components exclusively for the manufacturing trade. Economy, dependability and long-life are assured in every type of equipment.

In the modern, six-acre Magnavox plant, skilled engineers and designers can meet your specifications *exactly.* When you need component parts, specify the name Magnavox. The Magnavox Company, Components Division, Fort Wayne 4, Indiana.

There is no substitute for experience!

Magnavox

has served the radio industry for over 32 years

SPEAKERS · CAPACITORS · SOLENOIDS · ELECTRONIC EQUIPMENT

monitoring station at South Miami was alerted to an industrial heater type signal interfering with the circuit operated by Tropical Radio Telegraph from Miami to Central America. Long-range direction-finding bearings fixed the source of this interference in the vicinity of Detroit. In less than an hour, a mobile unit was on the way to track it down. By the evening of the following day the offending machine was located at a manufacturing plant.

On January 13, 1947, American Airlines reported interference on a frequency being used for aircraft operation. Though the intermittent signal remained on the air an extremely short time, bearings taken by monitoring stations indicated that it originated around New York City. This enabled the airline to trace the trouble to the control line of one of its own transmitters grounded out through a tree.

In 1946 the Commission handled 1,012 major interference cases requiring personal investigations, and during the first three months of 1947, a total of 379 such cases. In addition, the Commission clears daily a large number of minor cases at its field offices and stations. For the first three months of 1947 the number of these cases totaled 1,065.

Interference cases handled by the Commission originate in various ways. Some are developed by its monitors cruising the spectrum, detecting an improper operation, and setting up an alert. Other cases are referred to it by commercial services, police, and Federal agencies.

The same direction-finding network which is used to trace sources of interference is also employed to detect illegal operations—that is, stations operating without licenses. The Commission ran down 123 unlicensed transmitters in 1946, and 40 during the first quarter of 1947.

In addition to this work, the monitoring stations provide assistance to lost aircraft. For example, on October 11, 1946, the CAA requested the monitoring network to get bearings on a C-47 plane which lost its way in flight from Hawaii to the mainland. On the basis of fixes obtained by FCC, the CAA was able to advise the pilot of his position and to guide his course to a safe landing at San Francisco.

These important activities are, of course, a 24-hour job, and require the services of 184 employees.

MEETINGS

MARCH 22-25: IRE Convention and Radio Engineering Show, Hotel Commodore and Grand Central Palace, New York City.

APRIL 7-9: Midwest Power Conference, Sheraton Hotel, Chicago.

MAY 9-14: 1948 Radio Parts Show, Hotel Stevens, Chicago.

Navy 565-kw Transmitter

The world's most powerful radio transmitter has just been completed by the Navy on Oahu Island, Hawaii. Some 20 miles from Honolulu, at the Lualualei Naval Radio Station, the new 565-kw long-wave transmitter is one of 82 different transmitters at the station.

The antenna is carried by seven 600-ft towers. The powerful low-frequency signals go through even when sun spots or other atmospheric conditions blanket all high-frequency sets.

West-Coast Convention

OVER 3,200 persons registered at the three-day Electronics Trade Show in San Francisco Sept. 24-28. More than 60 firms displayed equipment, and educational exhibits were provided by the U. S. Navy, the University of California, and Stanford University. Technical sessions, sponsored by the Pacific IRE section, had a paid registration of over 750.

Next September the Fourth Annual Electronics Trade Show will be held in Los Angeles, and the following year it will return to San Francisco.

Books for Finland

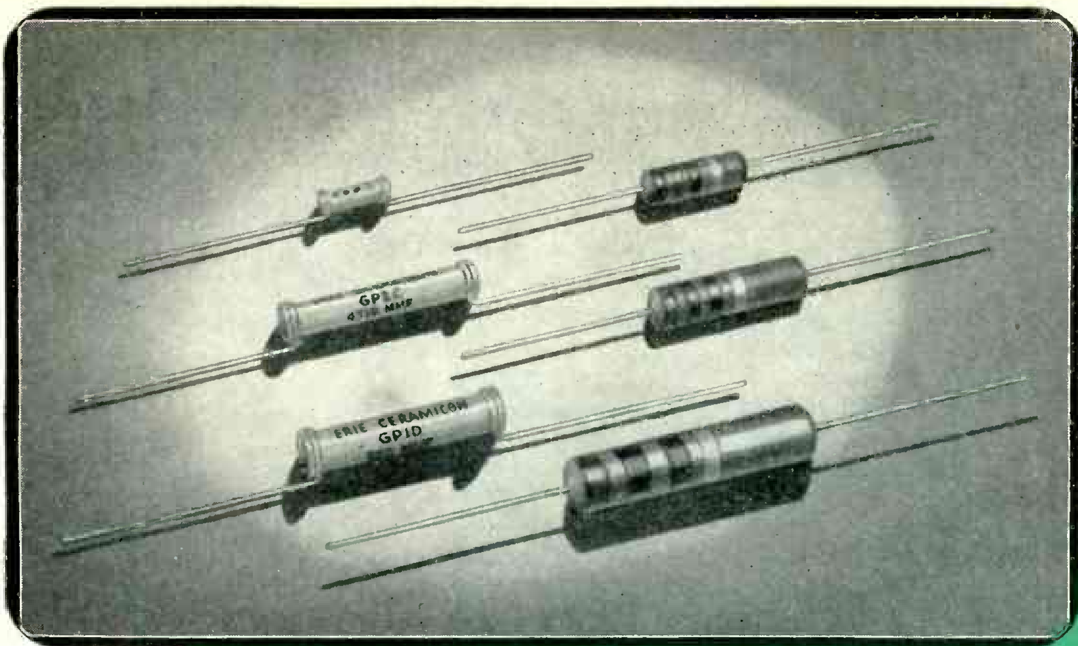
GIFTS of good scientific and technical books and periodicals from America will be welcomed by the Institute of Technology, Helsinki, whose library was bombed and totally destroyed during the war. Any such gifts should be sent to the Legation of Finland, 2144 Wyoming Ave. NW, Washington, D. C.

Bibliography on Electrical Contacts

THE 26-PAGE 1946 supplement to the ASTM Bibliography on Electrical Contacts, giving replacements and new references 1940–1944 in the original bibliography and covering publications in 1945 and 1946, can be procured from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa., at 75 cents per copy. The original Bibliography with 148 pages is available at $5.00, cloth binding, and the first and second supplements at $2.00 and 50 cents respectively. The original Bibliography with all three supplements is $6.50. All have been prepared by the same group, headed by E. I. Shobert, II, of Stackpole Carbon Co., and comprising George Durst

(continued on p 246)

Speakers' table at IRE banquet of recent West-Coast Convention sponsored jointly by Pacific IRE section and West Coast Electronic Manufacturers' Association. Left to right: L. G. Cumming, technical secretary, IRE; Earl Scott, Portland section IRE; Wallace Wahlgren, president of WCEMA; Captain Rawson Bennett, chairman San Diego section IRE; Dr. F. E. Terman, principal speaker, past president of IRE, and dean of engineering, Stanford; Professor Karl Spangenberg, convention chairman, electrical engineering department, Stanford; Rear Admiral J. R. Redman, USN, deputy commander Western Sea Frontier; Colonel L. C. Parsons, signal officer Sixth Army; George W. Bailey, executive secretary IRE; William Barclay, chairman San Francisco section IRE; B. Walley, secretary Los Angeles section IRE



Use ERIE "GP" CERAMICONS*

General Purpose

ERIE "GP" Ceramicons have a wide range of adaptability covering practically all by-pass and coupling applications in which the condenser is not directly frequency determining. They are made in insulated styles in popular capacity values up to 5,000 MMF, and in non-insulated styles up to 10,000 MMF.

Good Performance

The low cost of ERIE "GP" Ceramicons is achieved by mass production, with no sacrifice in quality. Because of their basic, simple construction they have higher resonant frequencies. This factor is increasingly important in the higher frequencies used in FM and Television.

Greater Production

High capacities are available in ERIE "GP" Ceramicons in extremely compact sizes. Because they are tubular in shape they require less space than many types of rectangular shaped condensers of equal capacities. Their physical properties and their sturdy construction make them easy to handle in the assembly line, and speed up production.

Growing Popularity

More and more radio manufacturers are standardizing on ERIE "GP" Ceramicons, because they find that these silver ceramic condensers make possible lower product cost with improved efficiency. If you haven't switched to "GP" Ceramicons for by-pass and coupling applications, write Erie Resistor for full details.

**Ceramicon is the registered trade name of silvered ceramic condensers made by Erie Resistor Corporation.*

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND · TORONTO, CANADA

TUBES AT WORK

(continued from p 142)

of the voting of their more confident neighbors. Another serious difficulty is that the degree of conviction of the group is not shown. The use of questionnaires and analyzing procedures would enable this factor to be measured, but this method is generally time consuming, complicated, and costly. In contrast to these two commonly used methods is the application of the opinion meter.

An ideal opinion meter must permit everyone in the group to express an opinion, and it must give equal weight to the opinion of each individual. In addition, such a device must provide secrecy, rapidity and simplicity of operation, and a means for expressing opinion in degree.

Physical Description of Meter

Designed to comply with these criteria, each opinion meter consists of an indicating unit and a string of hand-held stations. There are twelve stations to a string. Any number of strings up to ten may be added, so that a total of one hundred twenty people may be accommodated with one indicating unit. There are approximately 30 inches of wire between each station.

Each station is a cylinder about 2 inches in diameter and 3 inches long. Figure 1 shows the station dial and adjustable pointer. The dial is calibrated from 0 to 100, and marked with a banding arrow to indicate that from 0 to 50 is

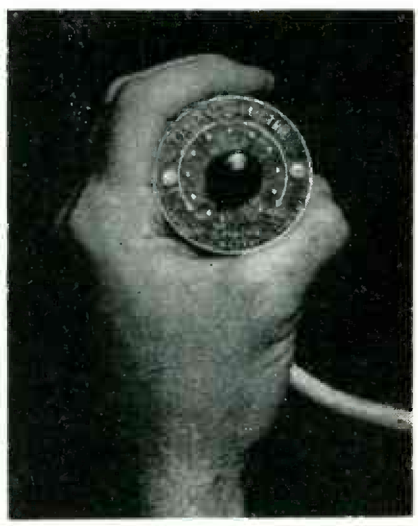
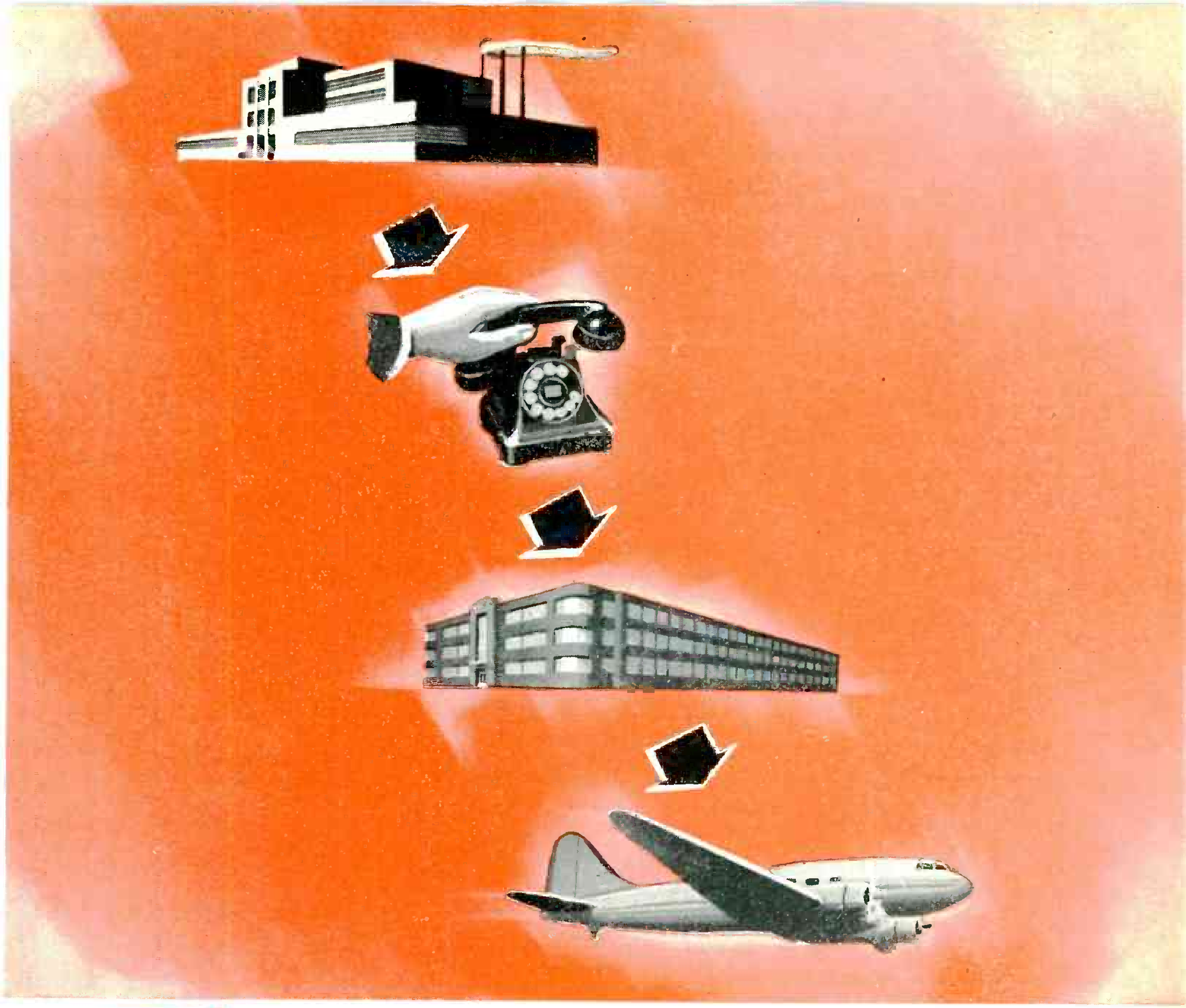


FIG. 1—Each individual expresses his opinion by means of this hand-held station



Speedy service on ALSIMAG

TRADE MARK REGISTERED U.S. PATENT OFFICE

The phone and the plane put us next door to your plant. When you need custom made technical ceramics in a hurry, reach for your phone and see how quickly we can serve you.

We can now handle a limited number of rush orders for die pressed, extruded and machined AlSiMag.

For 46 years we have had an enviable trade reputation for delivering "What you want, when you want it." The war improved our ability to give you what you want. But it damaged our reputation for "When you want it."

We are fighting hard to regain that reputation. Expansion has been continuous. We now have, we believe, the world's largest, best equipped and best manned plant devoted exclusively to the manufacture of custom made steatite ceramics. Phone, wire or write and see how well and how quickly we can serve you.

46TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

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NEWARK, N. J., 671 Broad St., Tel: Mitchell 2-8159 • CHICAGO, 9 S. Clinton St., Tel: Central 1721 • SAN FRANCISCO, 163 2nd. St., Tel: Douglas 2464 • LOS ANGELES, 324 N. San Pedro St., Tel: Mutual 9076

the "No" side and from 50 to 100 is the "Yes" side. There is also an "Off" position on the dial.

The indicating unit resembles a suitcase in size and shape. When the indicator is set up for operation as shown in Fig. 2, a dial, 3 feet high, appears on one side of the

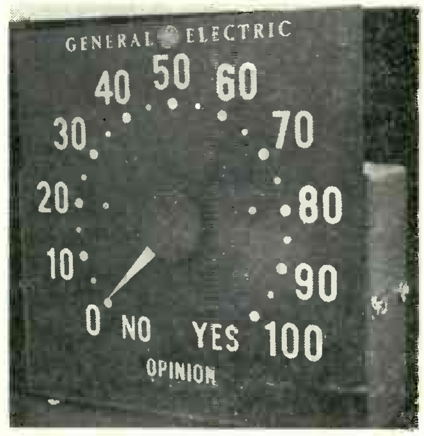


FIG. 2—Front view of indicator unit

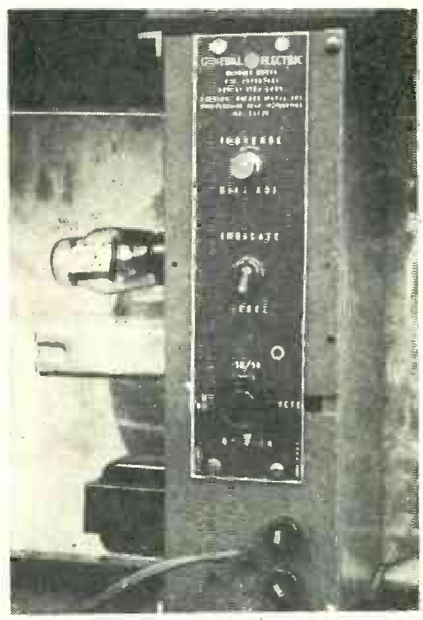


FIG. 3—Simplified control panel is mounted in rear of indicator unit

unit. This dial is similar to the dials on the hand-held stations.

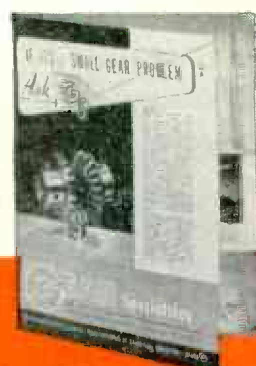
In the rear of the indicator as shown in Fig. 3, is a control panel on which are mounted fuse holders, a bias control adjustment, an indicate-reset switch, and a four-position selector switch. When the selector switch is rotated, words appear in a window at the bottom of the indicator dial, and show

WANT *SMOOTHER RUNNING* GEARS?

EXTREME *accuracy* is the key to the smoother performance of the gears we make. Although quantity runs are produced in record time, each gear is cut to closest tolerances and to the most exacting specifications. Among the many different types of Fractional Horsepower Gears in which we specialize are straight and spiral pinion rod and special shapes in pinion rod form. These are cut with the same precision and uniformity as are other G.S. Small Gear products. You can get pinion rod in brass, steel or any other material in continuous lengths up to ten or twelve feet. ★ Let our skilled engineers and the highly developed facilities at their command help you make a *smoother running*, more dependable, longer lived product. Send us samples, drawings or descriptive material today. Our suggestions, ideas, and moderate cost estimate incur no obligation.

The G.S. Gear Bulletin illustrates and describes many different types and applications of G.S. Small Gears. It offers valuable aid to anyone concerned with specifying Gears 12 D.P. and finer. Ask for it on company stationery, please.

SEND FOR OUR CATALOG BULLETIN



GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS which one of four aspects of opinion is being measured: "Opinion," "No Vote," "Vote," or "50-50."

Aspects of Opinion Measured

The main purpose of the opinion meter is to indicate the average opinion of all those in a group who are expressing an opinion. This aspect is called "Opinion."

To aid in the interpretation of this composite opinion, it is necessary to measure the percent of the group who are not expressing any opinion. This aspect is called "No Vote."

The aspect of group opinion measured by percentage of people voting who are in favor of a question is called "Vote."

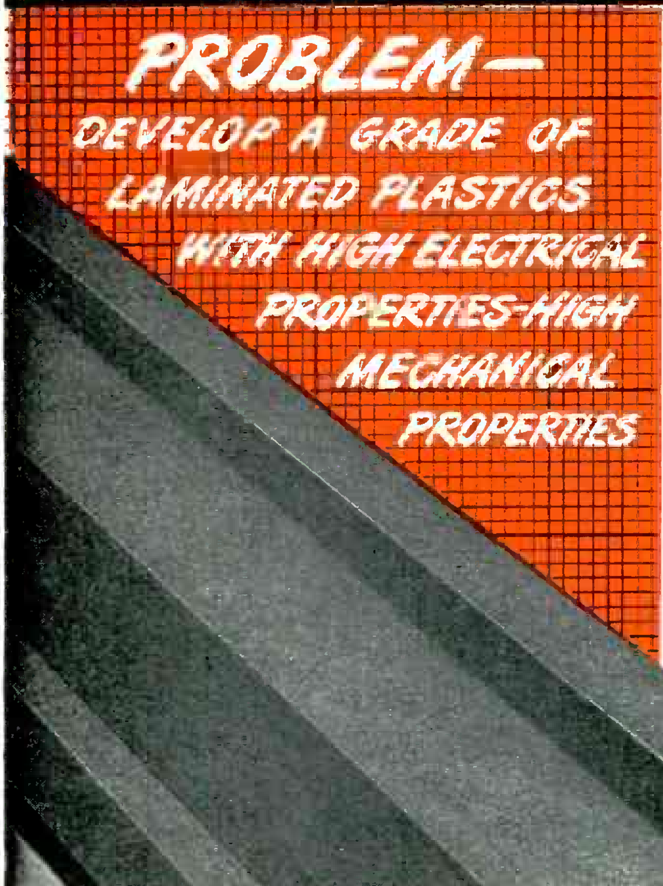
An expression of 50 on the dial is the result of an individual's deciding that the pro and con arguments cancel one another, and is therefore not taken into account in the "Vote" interpretation. This indication differs from a lack of opinion which would be measured as "No Vote." The percent of the group who are expressing neither pro nor con opinion is the fourth, "50-50" aspect of group opinion which can be measured by the meter.

Circuit Operation

The opinion-measuring instrument is a form of self-balancing bridge. The complete schematic diagram and Fig. 4 show the means of obtaining the four aspects of opinion. Only one individual station is shown on the complete schematic diagram since the similarly numbered points of all stations are interconnected. Each station consists of a potentiometer with fixed resistors on either side, as shown connected between points 6 and 7, and a four-position switch. The station's adjustable pointer turns the slider of the potentiometer and also turns the arm of the switch. The slider and arm positions are indicated on the station's 0-100 scale. In series between junction of the potentiometer slider and the switch arm and the output bus 5 is a fixed resistor.

Complete counter-clockwise rotation of the adjustable pointer makes the switch arm engage the "Off" contact 2. At this position, the slider

MORE THAN 50 GRADES OF G-E TEXTOLITE LAMINATED PLASTICS ARE AVAILABLE



G-E Textolite grade No. 2008 is an excellent general-purpose laminate because it has both high electrical and high mechanical properties. This factor enables it to fill a number of jobs well. Grade 2008 can be punched hot and is readily machined. In the electrical industry it is frequently used for relays, vibrators, switches and in applications where low dielectric losses are important.

THERE ARE OTHER GRADES

In fact there are more than fifty grades of G-E Textolite laminated plastics for you to select from. And like grade 2008 described above, each of these many grades has an *individual combination* of properties. None are exactly alike. With such a selection, you can be certain of getting the grade with the right properties for your job.

And this wide range of grades is supplied in numerous forms—sheets, tubes, rods; fabricated parts; molded-laminated parts; low-pressure laminated parts; post-formed laminates. Investigate fully the many grades and forms of G-E Textolite for greater economy . . . for product improvement. Plastics Division, Chemical Department, General Electric Co., One Plastics Ave., Pittsfield, Mass.

TEXTOLITE LAMINATED IS SUPPLIED IN FIVE FORMS

SHEETS, TUBES, AND RODS—These standard shapes are available in thousands of sizes. Up-to-date manufacturing methods facilitate quick deliveries.

FABRICATED PARTS—G.E. has modern fabricating equipment to machine Textolite laminated plastics parts to your own specifications.

MOLDED-LAMINATED PARTS—Textolite is custom molded directly to shape. Molded laminated products are among the strongest plastics parts produced.

LOW-PRESSURE MOLDED PARTS—Extremely large and irregular Textolite shapes are custom molded by the low-pressure laminating process.

POST-FORMED LAMINATES—Sheets of Textolite laminated plastics are custom formed into simple shapes by this very inexpensive method.

GET THE COMPLETE STORY! Send for the new bulletin G-E TEXTOLITE LAMINATED PLASTICS. Mail the coupon below for your free copy.

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Please send me the new G-E Textolite laminated plastics bulletin.

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GENERAL ELECTRIC

CD17-E4

of the potentiometer is disconnected. The "No" segment of the switch is closed between 0 and 48. The "50-50" contact 4 is a single contact which is closed over a range of approximately 48 to 52. The "Yes" segment 3 makes contact from 52 to 100.

As shown in the schematic circuit of the indicating unit, trans-

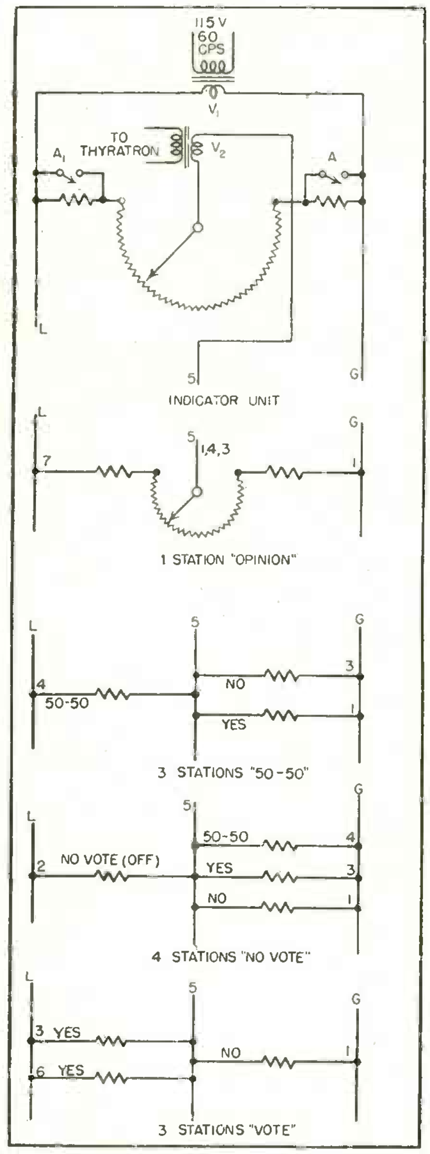

FIG. 4—This schematic diagram illustrates typical circuit connections for measurement of four aspects of opinion

former T_1 supplies approximately 6 volts a-c to the bridge. The potentiometer marked 0-50-100 has a motor-driven slider to which the indicator pointer is mechanically connected. An output transformer T_2 is connected in series with the

INCREASED PRODUCTION to meet increased demand permits NEW LOW PRICES for FRANKLIN AIRLOOPS*

* AIRLOOPS . . . *back panel and loop antenna in one unit*

More and more manufacturers of receiving sets are adopting **AIRLOOPS** as standard for their loop antenna and cabinet back requirements . . . this increase in demand permits manufacturing economies which are going right back to **AIRLOOP** users, in the form of NEW LOW PRICES . . . competitively **AIRLOOPS** are the lowest cost loop antenna and cabinet back and more important **AIRLOOPS** incorporate many superior features which in themselves improve set performance . . . no set builder can afford to overlook the significance of the **AIRLOOP**.

. . . FRANKLIN AIRLOOPS are flat sheets of copper die-stamped into perfect super sensitive loops . . . are air dielectric throughout . . . are lower in cost . . . are back panel and loop in one unit . . . have high uniform "Q" over entire band . . . have low distributed capacity . . . have 27% greater effective loop area . . . have electrical and mechanical stability . . . increase set sensitivity . . . eliminate individual loop adjustment . . . eliminate haywire.

FRANKLIN *Airloop* **CORPORATION**

43-20 — 34th ST., LONG ISLAND CITY 1, N. Y.

slider, and is actually across the diagonals of the bridge. The voltage output of this transformer controls a thyratron circuit, which in turn controls the power to the slider motor.

Resistance Changes

The diagram in Fig. 4 illustrates the circuit connections for each of the four measurements. On either side of the indicator potentiometer are fixed, series resistors. The ratio of each series resistance to that of the indicator potentiometer is equal to the corresponding ratio, in the stations, between the side resistor and potentiometer values. Points A and A_1 are contacts on the indicator selector switch and short out these fixed resistors for measurements not involving the potentiometers of the stations.

The potentiometer in the indicating unit forms two arms of a bridge whose other two arms are made up of different combinations of the individual station resistances, according to the measurement being obtained.

For "Vote," "No Vote," and "50-50" measurements, only the four-position switch in the individual stations is utilized. The simplest measurement is that of "Vote." This utilizes only terminals 1, 5, and 3 of the individual stations. If an individual turns his dial to the "No" side (0-48), he then connects a fixed resistor between terminals 5 and G through 1. If his dial is on the "Yes" side (52-100), the fixed resistor is connected across terminals 5 and L, through 3. The "50-50" position does not enter into a "Vote" interpretation.

The bottom circuit in Fig. 4 illustrates "Vote" conditions. Three people are voting, two voting "Yes" and one "No." In this measurement, contacts A and A_1 will short circuit the fixed resistors. The potential at 5 will be two-thirds of V_1. The motor-operated slider on the indicator potentiometer is at 0. Therefore, if $V_1 = 6$ volts, the potential across the transformer primary would be four volts.

Under these conditions, the motor will operate to move the slider and pointer from 0 toward 100. When two-thirds of the resistance between 0 and 100 has been tra-

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versed, the voltage of the transformer will drop to zero, activating the thyratron circuit, and stopping the motor. If the indicator potentiometer is uniformly divided between 0 and 100, the indication will be 66.6. This is, of course, the percentage of "Yes" volts, where two out of three people are voting "Yes."

Another circuit in Fig. 4 illustrates measurement of the percentage of the people who are not expressing an opinion ("No Vote"). Those people will have their stations turned to "Off," individual station switch position 3. A bridge circuit is constructed in which all of the "Off" stations are connected across 5 and L, through 2. All the other stations will be on the "No" side, contact 1; on the "Yes" side, contact 3; or at "50-50", contact 4. The fixed resistors in series with the switch arms of all the stations on "No", "Yes", or "50-50" will be connected in parallel across terminals 5 and G. In this no-vote example (Fig. 4), four stations are shown. Three of these individuals are expressing an opinion; the fourth has the station turned to "Off".

The resistance from 5 to L is three times the resistance between 5 and G. Hence, the potential of 5 would be one-fourth of V_1, or 1.5 volts. The indicator potentiometer is across V_1, which is 6 volts. Therefore, the motor-operated slider will move up to a position corresponding to one-quarter of the total potentiometer resistance before balance is achieved. The indicator pointer will be at 25, which represents the percentage of the stations which are on "Off".

The measurement of the percentage of the stations on "50-50" is also illustrated in Fig. 4 and is obtained in the same manner as the "No Vote".

In the measurement of "Opinion," shown in Fig. 4, the potentiometer circuit between 6 and 7 of the individual stations is utilized. Contacts A and A_1 in the indicating unit are open. Points 1, 4, and 3 are connected to point 5. If a single station were connected in this manner, the motor-operated slider of the indicator unit would rotate to the same position as the slider of the

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station potentiometer.

The resistors can be chosen so that when many stations are used in parallel, the balance point of the bridge will be at a position essentially equal to the average of the individual station dial settings. By choosing the proper circuit constants, it is possible to have a device which is independent of voltage and the number of voters.

Thyratron Switch

The thyratron circuit for controlling the indicator motor does not directly control the motor power. If the manually operated indicate-reset switch is at the indicate position, and if there is a potential unbalance across the primary of T_2, the line voltage will be applied to the indicator motor. When the potential across the primary of T_2 is zero, the thyratron conducts. This energizes the relay *CR* opening the normally closed contact *CR*-2, and stopping the motor. The closing of the normally open contacts *CR*-2 holds relay CR. Manipulation of the hand-held stations after the relay has picked up will not change the indicator reading.

The indicator pointer can be returned to zero if the reverse windings of the motor are connected across the line supply by manually closing the "Reset" switch. When the pointer reaches zero, the motor stops because an arm on the pointer shaft operates the limit switch *LS* opening the power connection to the motor windings.

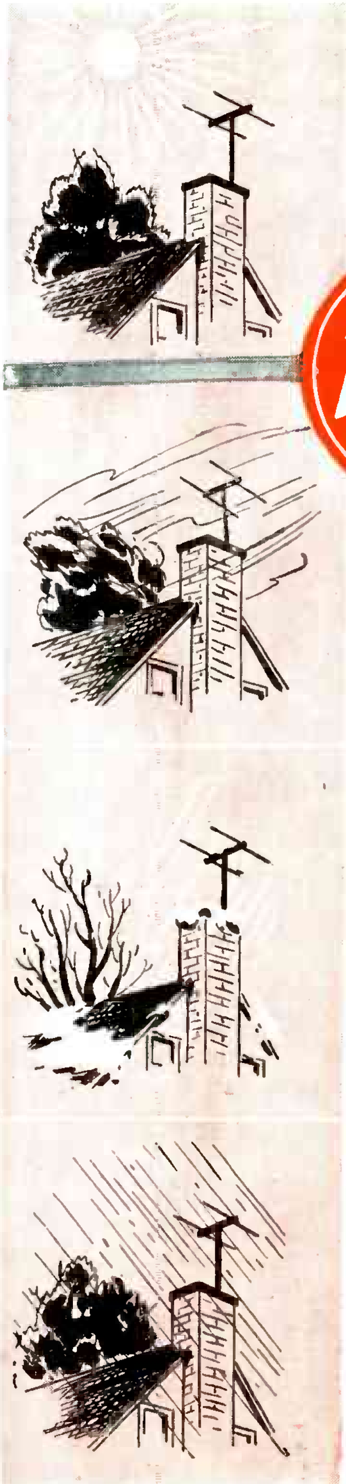
High Accuracy Signal Generator

By J. J. Bann

Design Engineer
Premier Crystal Laboratories
New York, N. Y.

Unusual accuracy in a signal generator can be accomplished using quartz crystal frequency control. In the instrument illustrated, output at any fundamental frequency from 100 kilocycles up to about 12 megacycles is determined only by the crystals available.

In addition, the small degree of correction necessary for a crystal which is either slightly low or



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Stock up now to meet the increasing demand for new FM and TV installations. This 300-ohm line, as well as other Federal h-f cables—can be obtained through local distributors all over the country.

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Type Number	Characteristic Impedance	Velocity of Propagation	Capacitance Per Ft.	Attenuation, Db per 100 Ft. Frequency in Megacycles				Physical Dimensions	
				1.0	1.7	3.0	100	Conductor Size	OD over Jacket
K-1046	300 ohms	81%	4.0 mmf	.38	.57	.85	2.0	7/# 30	.36"x .08"

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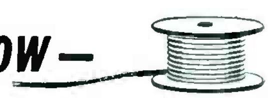

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slightly high in frequency can be done by the switching circuit shown. A variable capacitor permits final adjustment of the crystal

Frequencies from 100 kc up into the vhf region are provided by the Premier crystal-controlled signal generator

circuit to zero beat against WWV or a secondary frequency standard.

This adjustment enables the operator to use the crystal harmonics as standard frequency markers throughout the radio spectrum up to 30 megacycles. If the same results are desired at higher frequencies, up into television channels, they can be achieved with crystals of higher fundamental frequencies ground to the same accuracy as the 100-kc standard supplied with the instrument.

With a crystal at 10.7 mc, f-m discriminators and ratio detectors can be aligned to their respective center frequencies. A 10.8 and a 10.6-mc crystal can then be used successively to check the balance in the negative and positive directions, and also the band limit amplitudes. The 10th harmonic of either of these i-f crystals provides the frequency for alignment of the 108-mc end of the r-f section in the receiver. The 10.7-mc signal is unsuitable since it will ride through the i-f stages.

For television receiver alignment, five crystals can be employed

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But when you can amortize the cost of one set of moulds over 9 to 15 years of steady scheduled production—Mister, that's a different story! That's the Kurz-Kasch story! We preach—and practice—the principle of designing for the future and building moulds for the future too. Take this American Thermometer electric thermostat. Some of the original moulds have been altered to double capacity, but the original cavities and forces are still in use after 9 years of busy production.

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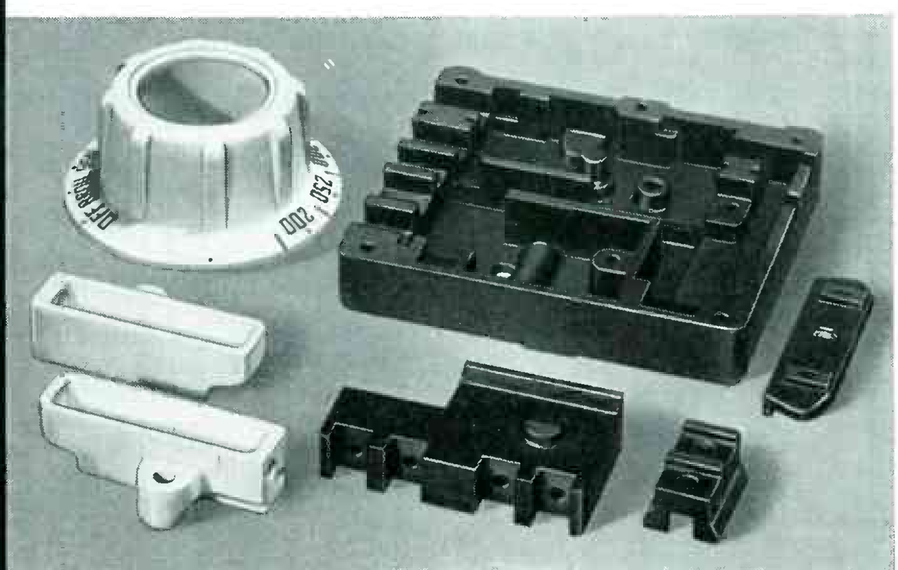

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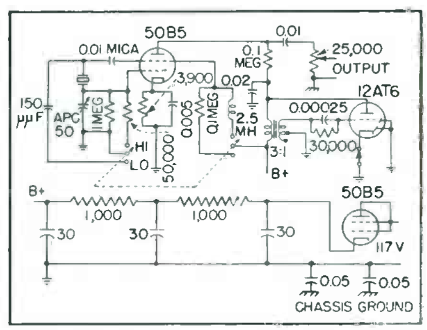
at the five frequencies equal to one-half the frequencies required for stagger tuned i-f peaking. For example, RCA receivers are aligned at 21.8, 22.3, 23.4, 25.2 and 25.3 mc. Ordinary peaking methods are employed with an amplitude-modulated signal at the above points. Five crystals, at 10.9, 11.15, 11.7, 12.6, and 12.65 mc, will double to the desired frequencies. In addition, a crystal for tuning each of the trap frequencies to minimum is useful. These frequencies are 19.75 and 21.25 mc, for which the crystal frequencies for doubling would be 9.875 and 10.626 mc.

Where peaking adjustments are being made the set is trimmed for maximum detector output (or avc voltage) at each of the peak frequencies, and when trap adjustments are made the traps are tuned for minimum output at the trapped frequencies.

Multiple Standards

Aligned by zero beating against WWV at 2.5 or at 5.0 mc, the 100-kc frequency can be used as a direct source of harmonics at 100 kc or as a sine wave generator for a multivibrator. A similar application for higher frequency use would employ a 1,000-kc crystal or one at 5.0 or 10 mc. In each instance after alignment by the zero-beat method against WWV standard frequency transmissions, harmonics of the fundamental crystal frequencies can be used up into the vhf region.



In the circuit of the generator, the ganged switch permits correction of the crystal frequency by a variable capacitor when it is either above or below a standard frequency

Television receiver local oscillators can be adjusted to their proper fixed frequencies for each channel by use of crystals at a lower frequency with a harmonic at the

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1625 R. P. M.
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RESILIENT MOUNT
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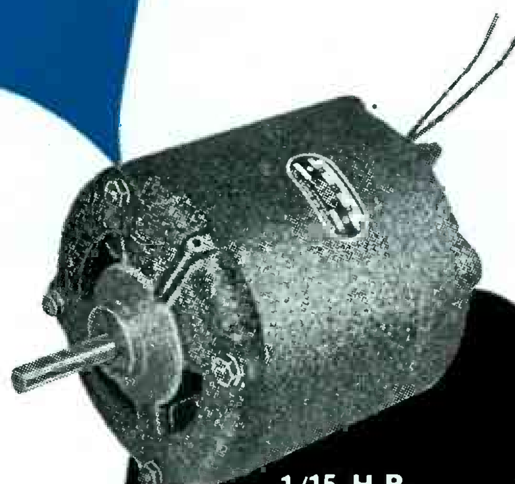

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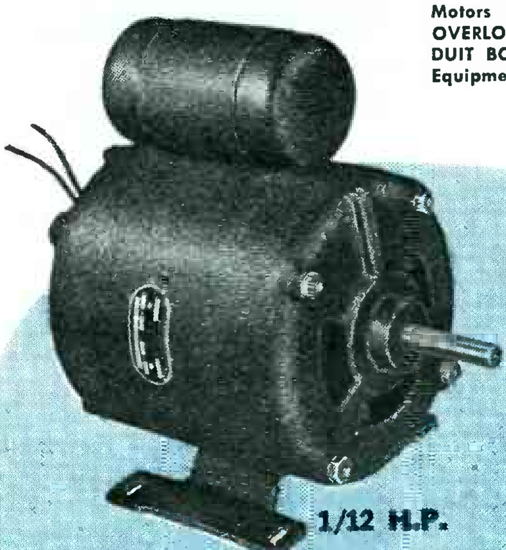

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desired frequency. For example, a channel 4 local oscillator in recent receivers is set at 93 mc by zero beating it against the 10th harmonic of a 9.3 mc crystal. A prewar television receiver would have a channel 4 local oscillator setting of 80 mc. This can be adjusted against the 10th harmonic of 8.0 mc or 8th harmonic of 10 mc.

Tests for Biggest Inch

FAULTS or breaks in the protective coating of "Biggest Inch" gas pipeline now being laid to bring natural gas from Texas to southern California are located with the Stearns electronic "holiday" detector. The device impresses a 5,000-volt potential across the coating. When a weak spot is encountered, a spark jumps through and energizes a bell alarm, a light indicator and a counter. The assembly shown, weighing 120 lb, gets power from a wet cell storage battery.

Operators use the high-voltage tester for finding weak spots in the coating of Biggest Inch, a gas pipeline of Southern California Gas Company

Two men operate the detector, which rides directly on the pipe by being slid along with the encircling flexible tube. When a "holiday" is reported, one of the operators marks spot with chalk for future repair. The instrument can cover as much as 2,000 feet per hour.

Gamma ray test pictures are taken of about 10 percent of field welds on the Biggest Inch gas

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- ***Jigs Last Indefinitely***
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Possessing excellent wetting properties, Lo-Flo SH7 needs no flux and can be used in any atmosphere suitable for bright annealing of ferrous or non-ferrous metals. Its low melting point means that many parts can now be brazed which ordinarily would be ruined at the high temperatures required for copper brazing. In addition, lower furnace temperatures also reduce furnace maintenance.

Another big advantage of Lo-Flo SH7 is that jig and fixtures last indefinitely because no flux is used and solder does not stick to them . . . and since jig and fixtures are usually expensive, prolonged life results in substantial dollar savings.

General Plate Lo-Flo SH7 silver solder is available in any form for prepositioning such as strips, washers, wires, rings, etc.

Investigate General Plate Lo-Flo SH7, today. Find out how this amazingly new silver solder, which requires no flux, can increase your production, give better bonds, and save you money. Write:

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pipeline to bring some of the oversupply of natural gas from Texas wells to fuel-short southern California. In gamma ray equipment shown in the illustration, a radium

Photographic film secured by the belt wrapped around the pipeline is exposed to gamma rays from a radium capsule to provide a test picture of a field weld

capsule is inserted in the pipeline. Films are each 16-inches long and 6-inches wide and overlap. A belt acts as a film holder and is centered over the weld and wrapped around the pipe. A set of lead numbers denoting inches is also wrapped around the pipe to facilitate locating defects that appear on the film. A 400-mg radium capsule is used for making the negative; the exposure time varies from 35 to 45 minutes depending on wall thickness.

X-Rays for Railroad

PENNSYLVANIA RAILROAD has installed an x-ray plant at Altoona, Pa., as an addition to its test department. X-ray photographs are taken through metals as much as three inches thick to provide assurance against such internal defects such as concealed cracks, imperfectly welded joints, and cavities due to shrinkage of metal during cooling.

A 250,000-volt mobile x-ray ma-

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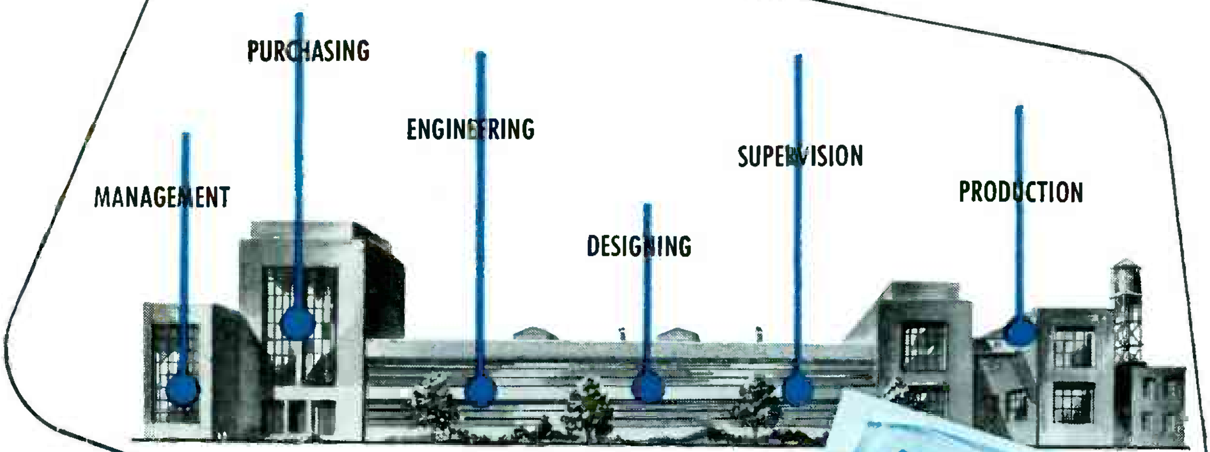

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chine is mounted on automobile wheels so that it may be used either in the specially constructed laboratory building, or, when some very large object such as a locomotive boiler is to be examined, in the adjacent construction and repair shops of the railroad's Altoona Works. The lab building is equipped with 18-inch thick solid concrete walls and permits the safe use of x-ray voltages as high as 2,000,000 volts. It includes a dark room for immediate development of x-ray photographs, and equipment for projecting them for close examination by engineers skilled in detecting the slightest flaw.

X-ray testing of metals is particularly helpful in examining welded metal parts, because it permits the technicians to examine the weld in detail.

The increasing use of welding as a more efficient means of constructing high pressure locomotive boilers, frames for Diesel-electric locomotives, fabricated cylinders for steam engines, passenger and freight car truck frames, and other parts indicates an expanding field for x-ray equipment since it permits minute examination of the weld without damaging the metal.

The Pennsylvania plans to install a permanently mounted x-ray machine of 1,000,000-volt rating in the laboratory building to augment the mobile machine now in operation. Training of sufficient numbers of operating technicians and full development of a wide range of testing techniques will precede the higher voltage installation.

French Coax Cable Laid

McGraw-Hill World News

A COAXIAL telephone cable 430 miles long, between Paris and Toulouse, was put into service recently. It allows 600 simultaneous telephone conversions.

Forty-two 100-watt amplifiers are stationed along the cable, and powered by current fed through the cable itself, 380 volts at 50 cycles. Most of the amplifiers are placed in stations without personnel, their functioning being watched by telemetering from several central points. Average voice power on each line is no more than 0.001 watt.

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Say it any way you like—but it all adds up to the same thing. Whatever kind of fastener you use, you want it to fasten (or anchor or secure) tightly and permanently. And you want to do the job as fast as possible. This is where Cherry Rivets come in. Cherry Blind Rivets are not just blind rivets—they will do any fastening job, blind or otherwise, in less time with less cost.

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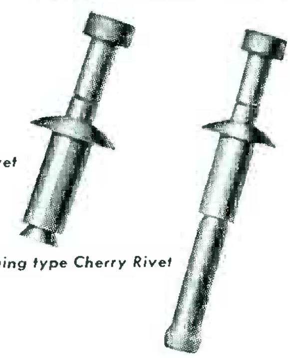

Tight-clinching, pull-through type Cherry Rivet

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Neat and solid. Cherry Pull-through Hollow Rivets fasten hinges on soda fountains securely. Rivets will be plugged with neat, attractive nickel-plated umbrella-head plugs.

More secure than screws, and faster and easier to install than ordinary rivets, Cherry Rivets fasten molding to ice cream cart faster with less cost.

For more information, write to Dept. L-120, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California

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LOS ANGELES 13, CALIFORNIA

ELECTRON ART

(continued from p 146)

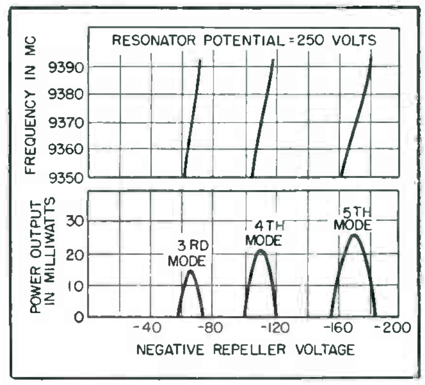

FIG. 1—Power output and oscillation frequency of a 723A/B klystron vary with repeller voltage in the three voltage modes shown

can be adjusted by varying the negative voltage on the repeller electrode. The tube will oscillate only within certain ranges of repeller voltage, known as voltage modes. Figure 1 shows power output and frequency as functions of repeller voltage for a type 723A/B klystron oscillator. Of the three voltage modes shown, the one for the range of repeller voltages between –160 and –180 volts gives the greatest power output. Consequently, this circuit is designed to deliver voltages within that range to the repeller of a 723A/B.

The klystron can be tuned over a relatively narrow frequency range by changing its repeller voltage alone; wide changes in frequency are obtained by mechanically tuning the resonant cavity of the klystron and simultaneously adjusting the repeller voltage. This simultaneous adjustment is not easy to accomplish by the most obvious expedient of gearing a potentiometer to the cavity tuning screw. The exact value of repeller potential required at any given frequency does not coincide exactly to that indicated by the curve, but is rather erratic, and at the same time, critical. The electronic system described, automatically provides the correct repeller potential for constant output over the entire tuning range.

Circuit Design

The circuit of the automatically controlled repeller voltage supply is shown in Fig. 2. Tube V_1 is one section of a 6J6 connected as a grid-controlled rectifier. When no signal voltage is applied to the grid of this tube its quiescent output causes

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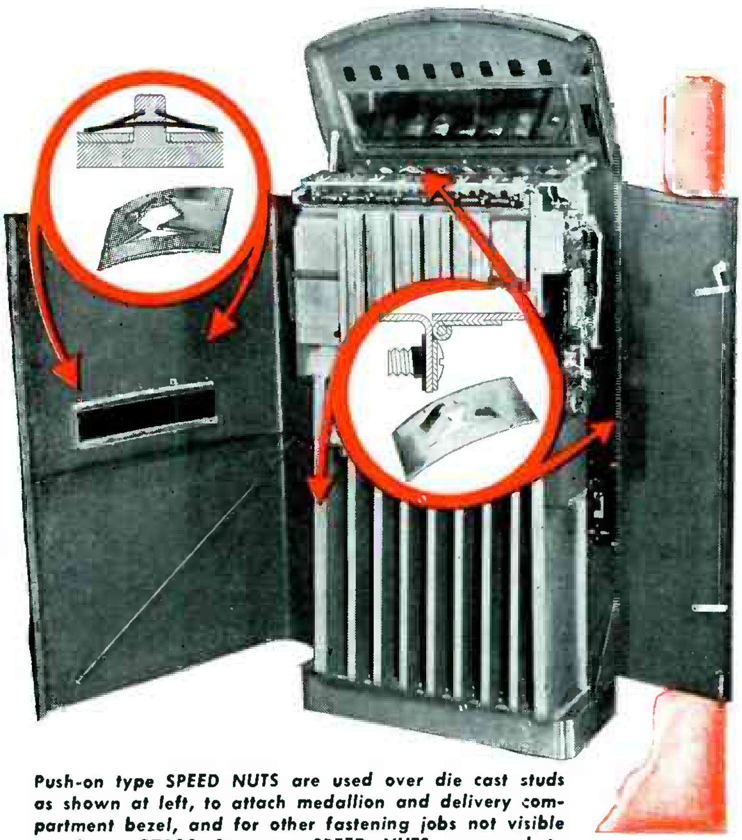

Push-on type SPEED NUTS are used over die cast studs as shown at left, to attach medallion and delivery compartment bezel, and for other fastening jobs not visible in photo. C7000 flat type SPEED NUTS are used to attach hinges to top cover, bottom frame and doors.

Mr. M. Caruso, President of C-Eight Laboratories, Newark, New Jersey, has this to say about SPEED NUTS:

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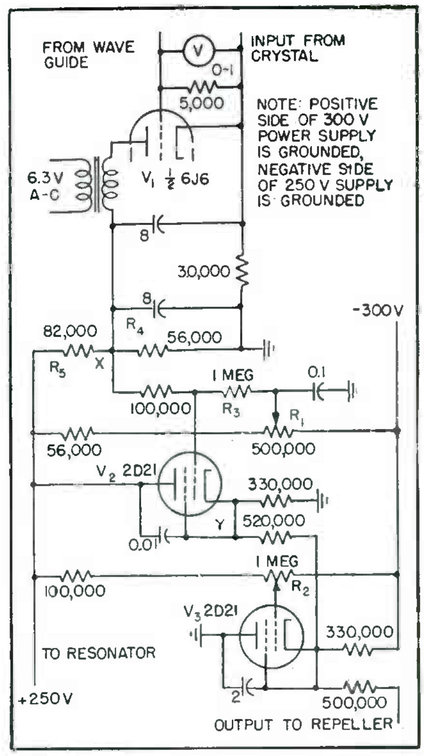

FIG. 2—Circuit of the automatically controlled repeller voltage system includes grid-controlled rectifier, control thyratron, and relaxation oscillator thyratron

point X to be at ground potential. When the oscillator is functioning, the emf appearing across the silicon monitoring crystal is applied to the grid of V_1 and causes a shift in the potential of point X so that it is no longer zero, but rather several volts positive with respect to ground.

The next tube V_2 is a 2D21 thyratron. Its grid bias is adjusted by means of R_1 so that the tube is just on the threshold of ionization. Thus, a slight positive voltage appearing across the crystal can cause this thyratron to fire with the result that point Y becomes about 200 volts positive with respect to ground.

The last tube V_3 is also a 2D21 thyratron. It serves as a relaxation oscillator to generate negative-going sawtooth waves of about 1 cps frequency and with a peak negative amplitude adjustable by means of R_2 to the vicinity of 200 volts. For most 723A/B tubes, the repeller voltage range for the fifth mode will be approximately from 150 to 190 volts. The exact value of repeller voltage is obtained by halting the generation of sawtooth waves. Suppose that the relaxation oscillator attempts to develop a negative sawtooth having a negative amplitude

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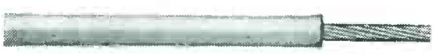
This heat, flame and moisture resistant wire, insulated with high dielectric tapes and impregnated asbestos and covered with lacquered glass braid, has an operating temperature range of 125°C. to minus 50°C. Widely used in airborne, ground, marine and mobile communications systems, electronic devices, transmitters, amplifiers and calculators. Ideal for small motor, coil, transformer and dynamotor leads. Sizes No. 22 to 4 AWG in 1000 volt rating and 12, 14 and 16 AWG in 3000 volt. Also in twisted pair, tripled or cabled multi-conductor constructions.



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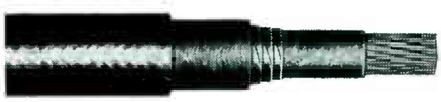

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A 600 volt cable for coil connections, motor and transformer leads exposed to overloads and high ambient temperatures. Insulated with felted asbestos and varnished cambric and covered with asbestos braid like Power Cable. Sizes 18 AWG to 1,000 MCM.

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ROCKBESTOS RESEARCH

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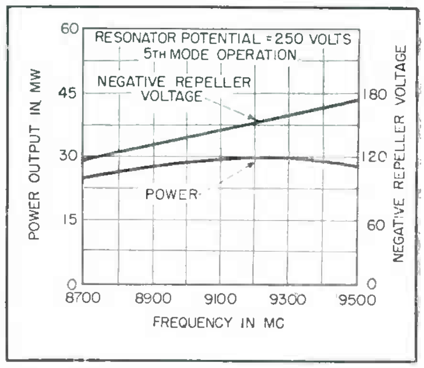

FIG. 3—As the klystron cavity is mechanically tuned, the automatic control varies potential on repeller as shown by upper curve to provide fairly constant power indicated by curve below

of about 200 volts. Also, assume that the klystron will operate only in the fifth mode and that for a particular adjustment of the cavity screw, maximum r-f output will occur at –165 volts.

Now, as the negative sawtooth approaches 165 volts, the klystron begins to deliver microwave power and a positive emf appears across the monitoring crystal. This occurrence upsets the balance of point X with respect to ground so that a positive voltage is impressed upon the control grid of V_2. If R_1 is so adjusted that this tube is near its threshold of firing, the emf delivered by the crystal will continue to increase, as will the positive voltage impressed on the thyratron grid. At some value of microwave power close to the optimum for fifth mode operation, V_2 will fire and cause point Y to suddently become positive with respect to ground. The sawtooth is thus caused to reverse and to go in the positive direction, resulting in a decrease in the output of the klystron. Consequently, the control thyratron deionizes and allows the relaxation oscillator to again begin generating a negative sawtooth. As before, the klystron output increases, causing V_2 to fire, and the cycle of operation is repeated.

Once the system has searched for and found the region of optimum repeller potential, the subsequent small oscillations about this potential are of very minute amplitude, less than 0.1 volt. Variation in the klystron oscillator frequency with respect to repeller voltage is about 2 mc per volt. Therefore, the hunting action of V_3 produces deviations in

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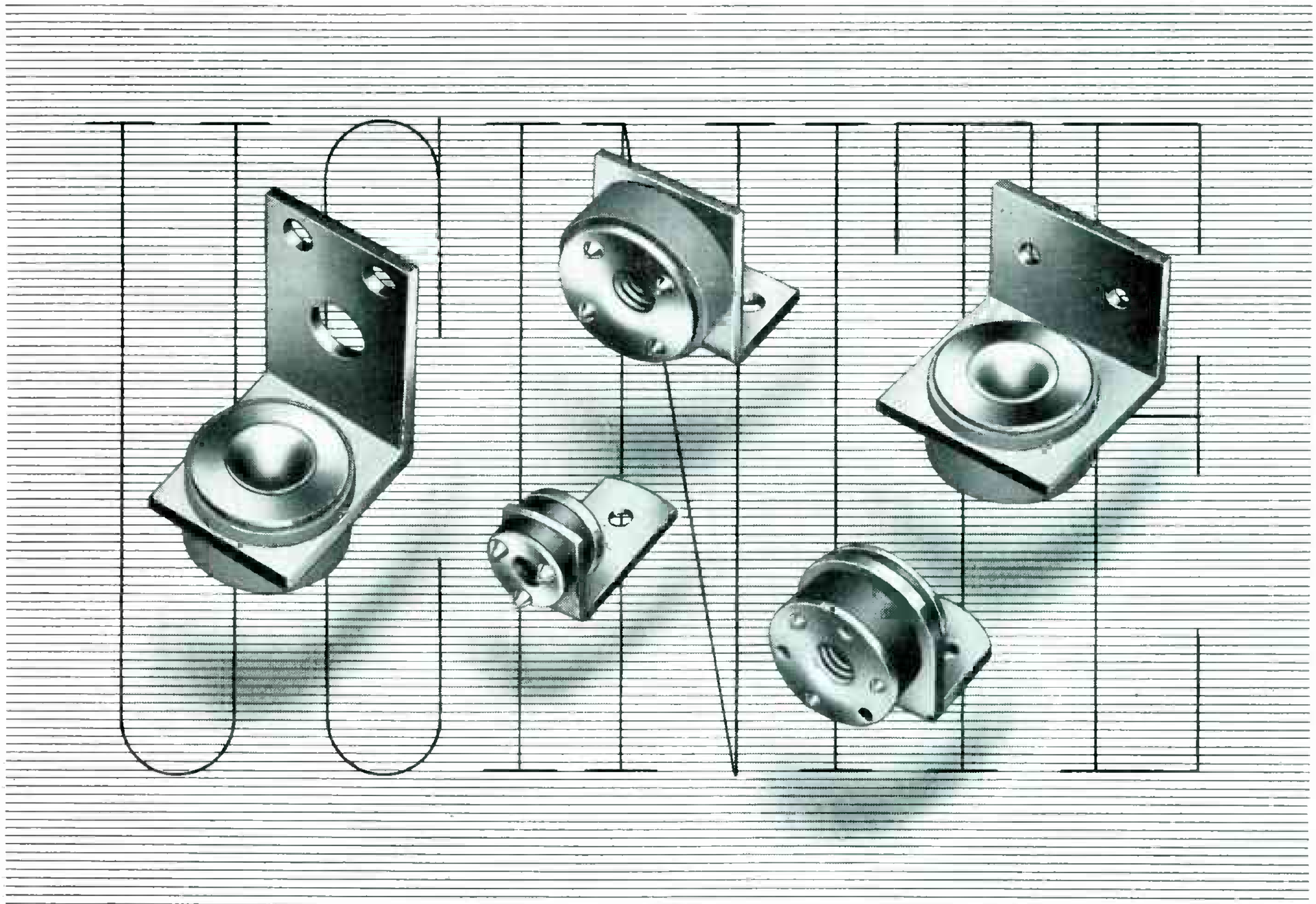
klystron frequency of only 0.2 mc, of negligible importance in the vicinity of 9,300 mc.

Preliminary Adjustment

The 0–1 d-c voltmeter connected across the monitoring crystal indicates oscillation and is handy for the initial tuning up of the system. A 300–0–300 volt midget type power transformer is used with the 6.3-volt filament winding connected to the filament supply. The conventional 120-volt primary winding is unused.

As previously mentioned, point X should be at zero potential with respect to ground with no signal input to the 6J6 grid. This voltage should be measured with R_3 disconnected. If this condition is not obtainable, either R_3 or R_5 should be changed from the values designated in the schematic diagram. A vacuum-tube voltmeter should be connected from the repeller voltage output to ground and with V_2 removed from its socket, R_2 should be adjusted to yield a sawtooth voltage having a negative peak of approximately 200 volts. This voltage can be easily observed on the vtvm, inasmuch as the sawtooth frequency is about 1 cps. Next, with all tubes in place, adjust R_3 until the needle of the vtvm ceases to fluctuate, then back off just sufficiently to permit oscillation of the relaxation oscillator. It will now be found that a slight positive potential impressed upon the 6J6 grid will prevent oscillation of the 2D21 relaxation oscillator. The sawtooth will "freeze" somewhere in the vicinity of 100 volts. If the repeller voltage output is now connected to the klystron repeller and the monitoring crystal is connected to the input, the system should be immediately operative. Figure 3 shows how the repeller voltage is automatically controlled to produce nearly constant microwave power output while the klystron is mechanically tuned.

The dial should be calibrated by means of the cavity wavemeter which is always available for checking the frequency. The attenuating section should be adjusted so that a 0–100 microammeter can be used in conjunction with the output crystal. It will then be found that negligible reaction exists between the component under test and the amount of



Their uses are mounting, too

These Ucinite shock mountings, with a self-contained TEENUT, are set in a synthetic rubber ring of great toughness and resiliency. In Service use during the war, they proved their worth under extremities of shock, temperature, climate.

Today they are making a name for safeguarding radio and television sets, phonograph turntables, electrical condensers, and other delicate equipments.

The mountings shown above represent only one general type of a basic design which can be adapted to a wide variety of applications.

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energy flowing through the waveguide. An added refinement would involve a combination of resistors and tuning stubs such that the standing wave ratio throughout the guide would be at a minimum. However, it was observed that this condition is approached sufficiently for the purpose by employment of the single attenuating section.

Mode Selection

The searching range covered by the relaxation oscillator is such that with 250 volts applied to the klystron resonator, there will be little opportunity for operation in a mode other than the fifth. If the 723A/B shows a tendency to jump to the fourth or sixth mode, as evidenced by an abrupt change in the tuning calibration, this effect can be corrected. Operation in the fourth mode can be rendered impossible by backing R_1 away from the threshold of firing of V_2, thus making necessary the stronger input from fifth mode operation to actuate this tube. Operation in the sixth mode can be halted by adjusting R_2 so that the peak amplitude of the negative sawtooth will not be high enough to support sixth mode operation. However, with most 723A/B tubes, this trouble will not be encountered, and it is a simple matter to record the frequency characteristics of a plumbing unit.

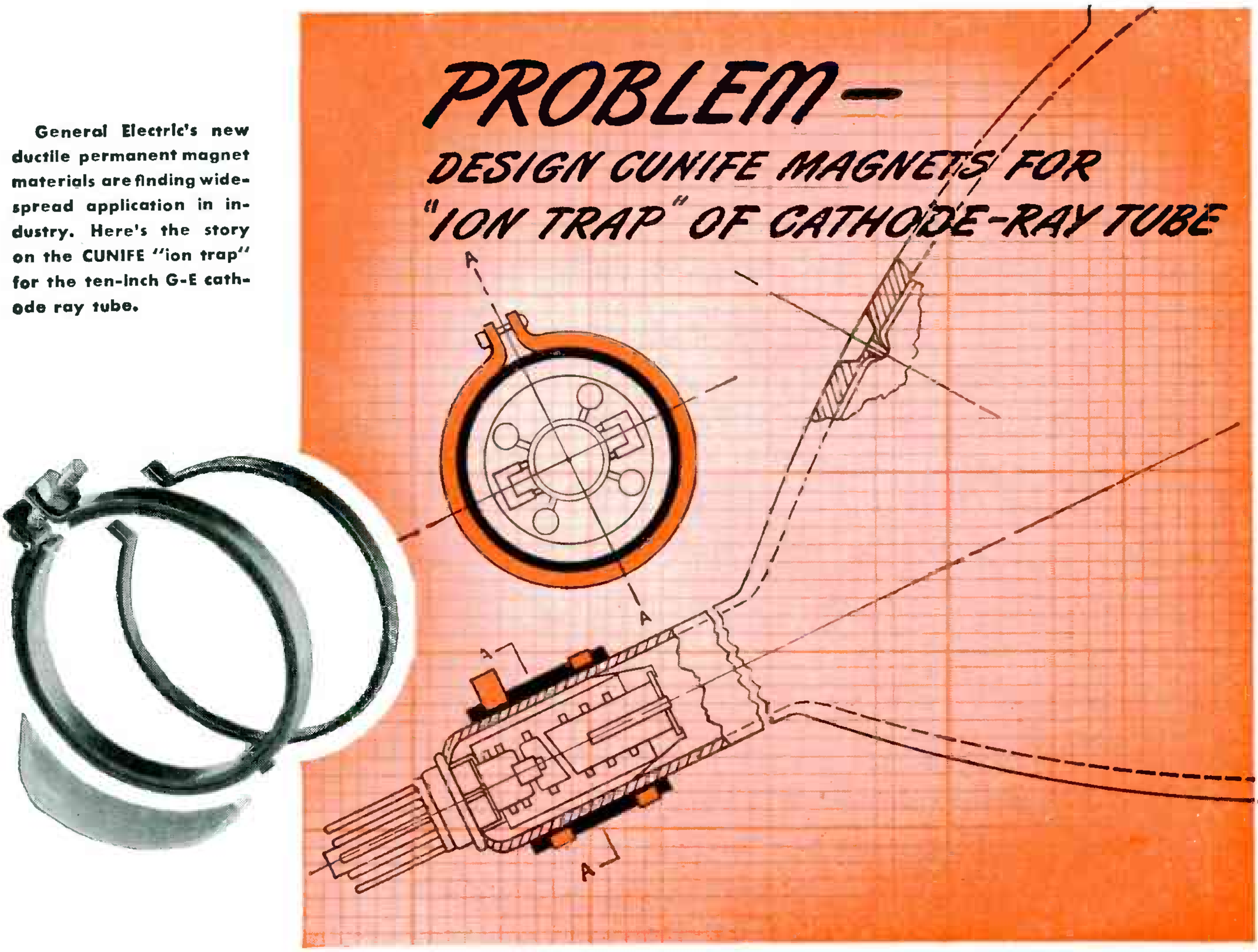
Two power supplies are required: one to deliver 300 volts at 10 ma, and the other, stablized with respect to line voltage fluctuations, to furnish 250 volts at 30 ma. The 300-volt supply is employed as a source of negative potential for the klystron repeller and the relaxation oscillator and for bias voltages for the two thyratrons. The 250-volt supply furnishes positive voltage for the various electrodes in a conventional manner and also powers the klystron resonator electrode.

Simulating a Jet Engine

TO DEVELOP a simplified system of controlling tubine engines at Wright Aeronautical Corp., an electrical analog of the engine is used. The analog (ELECTRONICS, p 136, Sept 1947) simulates such operating characteristics of the engine as power, speed, temperature, and

YOU GET QUALITY PLUS ENGINEERING SERVICE WITH G-E PERMANENT MAGNETS

General Electric's new ductile permanent magnet materials are finding widespread application in industry. Here's the story on the CUNIFE "ion trap" for the ten-inch G-E cathode ray tube.



The Magnets that Keep Electrons on the Beam

Two ring-shaped G-E permanent magnets made of ductile CUNIFE are now used on cathode-ray tubes to help eliminate the troublesome ion spot on the direct view television screen. When mounted in the correct position on the tube neck surrounding the electron gun, these CUNIFE rings supply the magnetic field which deflects the electrons out of the ion-electron stream. The deflected electrons are thus rapidly returned to their original course while the massive ions are "trapped" and do not strike the tube screen.

In addition to ductile CUNIFE permanent magnets, General Electric also offers ductile CUNICO and SILMANAL which greatly extend magnet design possibilities. Other G-E permanent magnet materials include many grades of CAST and SINTERED ALNICO and lightweight VECTOLITE.

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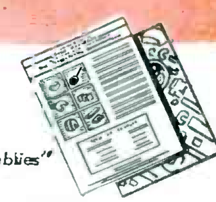

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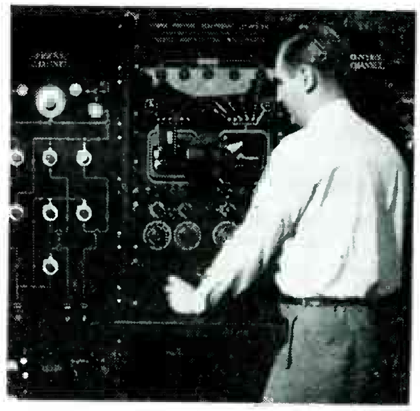

Electronic equipment duplicates engine operation for testing of controller designs

fuel flow so that actual engine tests of the controller are unnecessary until final stages of design. The analog computer, described by its designers W. T. Stark and W. C. Schaffer of the Wright Engineering Department, and G. A. Philbrick of Philbrick Researchers at the October meeting of the Nat. Aero. Meeting of the Soc. of Auto. Engrs. in Los Angeles, is operated by only one engineer and solves problems in seconds that would otherwise take him days. It can be modified to solve other engineering problems. Although such computers represent a large capital investment, they offer great savings in time and personnel at offices engaging in extensive computations, with the result that automatic computer techniques are becoming fairly common.

Tube Characteristics with 28-Volt Plate Supplies

MOBILE EQUIPMENT is usually required to operate from 28-volt sources. A study of the characteristics of conventional tubes indicates that the plate circuits can be operated satisfactorily directly from this voltage.

Choice of Circuits

Vehicular generators can be expected to deliver 28 volts $\pm$ 10 percent. Where a receiver uses a variety of coupling methods between stages, the screens can all be connected directly to the positive high voltage. If the leads are short, decoupling is unnecessary, thus saving components and cost. Of the several methods of obtaining bias for the control grids, the most satis-

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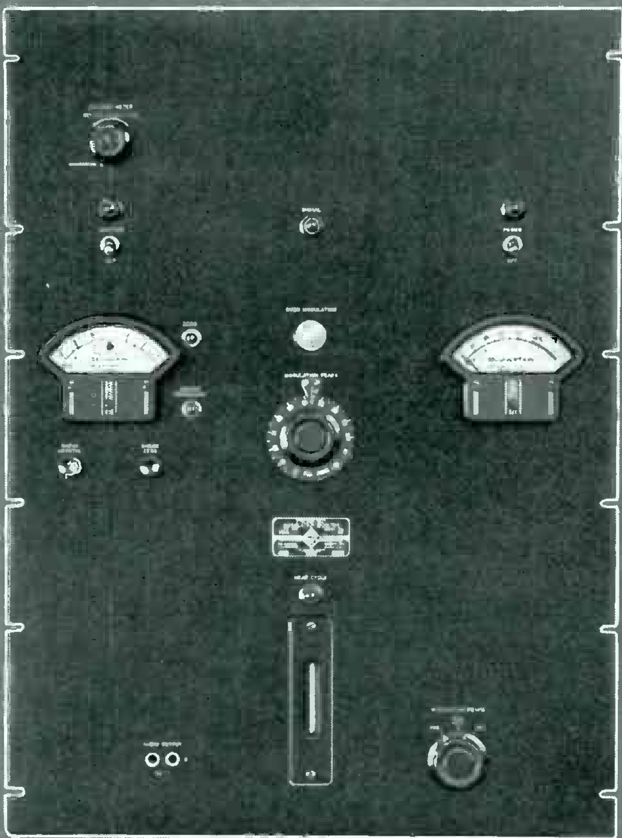
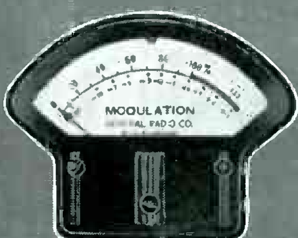
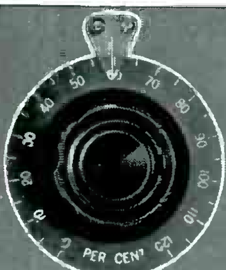


In announcing the new Type 1170-A FM Monitor, General Radio brings to a conclusion a development project to make available to FM and Television stations a monitor with the same simplicity of operation, high stability and accuracy, and many-year reliability found in standard AM monitoring equipment in use in hundreds of G-R equipped stations. The G-R FM Monitor is here. It has been designed with the same engineering care . . . manufactured under the same rigid standards . . . and tested with the same thoroughness as all other G-R broadcast equipment. FM and Television stations can use it with the same confidence that AM engineers have shown in G-R equipment ever since monitors became a necessary adjunct to broadcasting.



Percentage Modulation meter, calibrated from 0 to 133 per cent. Additional db scale. Switch selects positive or negative peaks or full-wave indication. For FM, 100% modulation corresponds to 75 kc deviation; for television, internal adjustment changes calibration to 100% at 25 kc deviation.

Frequency Deviation meter calibrated in 100-cycle divisions from —3000 to +3000 cycles. To compensate for long-time drifts and to bring monitor into check with frequency measuring services, zero reading is adjustable over ±3000 cycle range.



Modulation Indicator Level is set by this dial; lamp flashes when modulation level exceeds that to which dial has been set. Dial range 0 to 120% modulation.

R-F Input Level is indicated on this behind-panel meter. Signal and center-frequency meter pilot lamps illuminated when input level is sufficient, and extinguished when level drops too low.

FEATURES

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- **REMOTE MONITORING** — Equipped for several remote monitoring circuits and for use with a recorder.
- **HIGH STABILITY** — 200 cycles (2 parts per million), or better, with a daily check of electrical zero of meter.
- **LOW INPUT POWER** — 1-volt input at high impedance — amplified to several hundred volts for high level operation to avoid harmful effects of excessive coupling to transmitter.
- **LOW RESIDUAL DISTORTION** — Less than 0.2% at 100 k.c. swing — accurate for measurements to as low as ½ per cent.
- **75-25 KC DEVIATION** — Provided with a single internal adjustment for either 75 kc deviation for FM monitoring, or for 25 kc deviation for television audio monitoring.
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  - Center-frequency Indication
  - Percentage-modulation Meters
  - Over-modulation Lamp
  - 600 ohm Unbalanced Aural Monitor
- **F.C.C. SPECIFICATIONS** — Designed and manufactured to meet all F.C.C. monitoring requirements.

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factory for use with low plate voltages is by grid current flowing in a resistor between grid and cathode. Such a method, where signal levels are low, provides limiter action thus eliminating the need for avc; it produces uniform results despite widely varying characteristics from tube to tube; and is economical of components and plate voltage, because the cathode is at ground potential. In R-C coupled stages, a grid resistance of 10 meg. and in other circuits of 2 meg gives proper bias.

Choice of Tubes

Tubes with high transconductance (6AC7, 6SH7, 6SG7) develop relatively large contact potentials so that they over-bias. With the tubes of lower transconductance (6K7, 6SK7, 6SJ7), there is less degradation when used at lower plate voltages. Table I shows what can be expected from several such tubes, and the observed variations of transconductance at 28 volts of randomly selected batches of 20 tubes each.

Table I—Comparison Between 250 and 28-Volt Operation

	Transconductance in μmhos at 28 V	Transconductance in μmhos at 250 V	Percent Variation in Transconductance at 28 V	
6SK7 (12SK7)	1,350	2,000	−17	+13
6SJ7 (12SJ7)	1,350	1,650	−30	+20
6SG7 (12SG7)	1,325	4,000	−40	+40
9003	1,250	1,800	−24	+16
6SH7 (12SH7)	1,200	4,900	−67	+44
9001	1,150	1,400	−26	+39
6SF7 (12SF7)	1,075	2,050	−16	+14

Variable-mu tubes maintain their characteristics at low plate and screen potentials, but tubes with high grid contact potential have to be prevented from overbiasing other tubes connected to the avc by isolating resistances. The only satisfactory mixer for 28-volt operation is the 6SA7 or 12SA7. Useful gains in the audio section can be obtained from the 6SJ7, 6J5, 6SR7 or their 12-volt counterparts.

A single-frequency superheterodyne receiver was designed using internationally available tubes operating at 28 volts. The set had a sensitivity of 5 microvolts at 100 milli-

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The newly developed Thermocouple-Ionization Gauge Control, complete with Thermocouple and Ionization Gauges, covers the pressure range from 2 x 10^{-7} mm to 1 mm Hg. Operation is dependable and simple. Full-scale meter deflection occurs at 1 mm and 5, 1, 0.1 and 0.01 microns. The unit is removable from its cabinet for incorporation in a central panel.

The Alphatron is an ionization-type vacuum gauge using the ionizing power of alpha particles from a radium source to measure total pressure of any gas, vapor or mixed atmosphere from 1 micron to 10 mm Hg. with instantaneous linear response. A complete feature article on this gauge appears in the April issue of ELECTRONICS. National Research Corporation, Cambridge 42, Massachusetts.

Alphatron Vacuum Gauge Type 510

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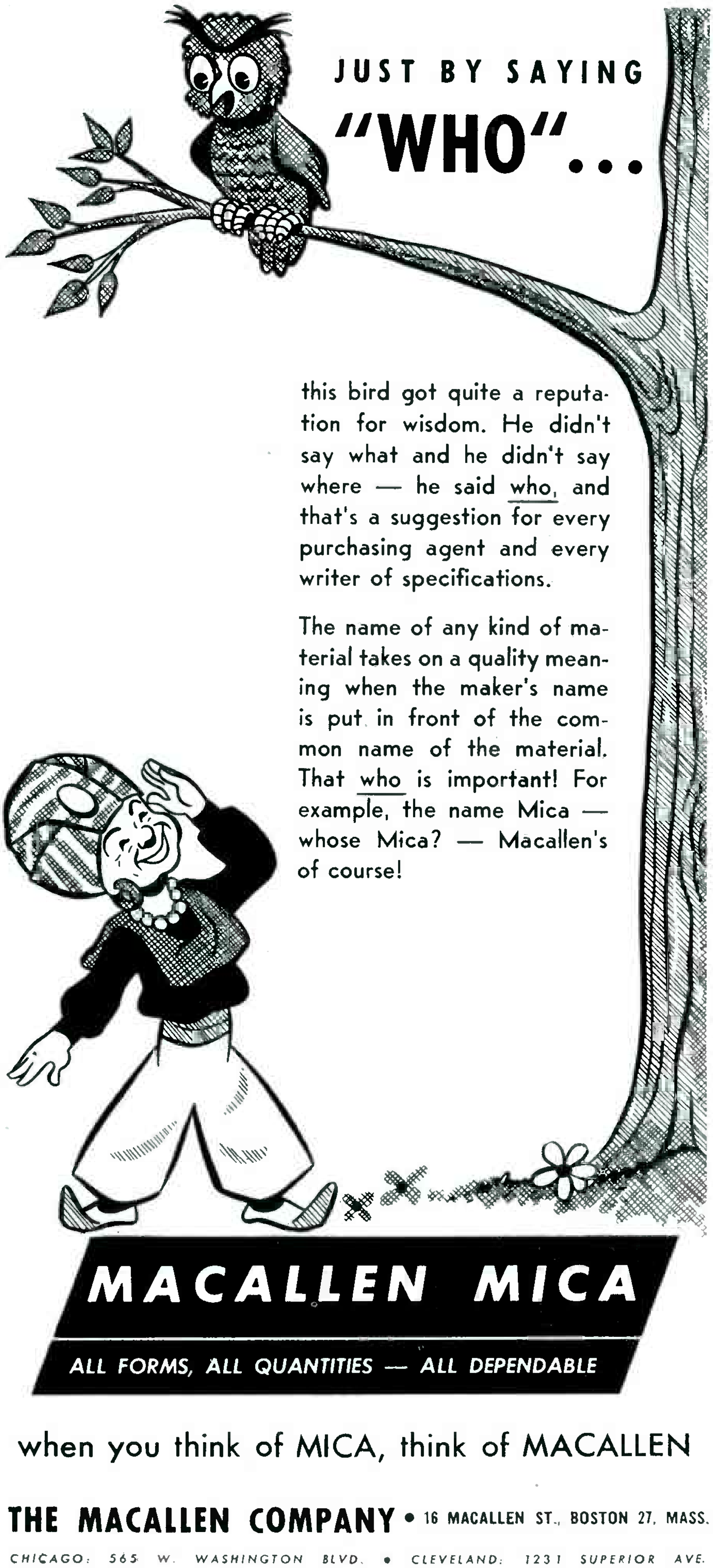


watts output, a signal-noise ratio better than 6 decibels, and occupied a space only 3 by 3 by 4 inches, thus indicating the feasibility of low-voltage operation of tubes where compact, lightweight equipment is essential (R. Terlecki and J. W. Whitehead, 28 Volts H. T. and L. T., *Electronic Engineering*, p 157, May 1947).

Industrial Magnetron

MICROWAVE dielectric heating promises to become an important application of magnetrons and klystrons. Toward this end the British Thomson-Houston Co. has developed a high powered 10-cm magnetron that produces pulses of 2 megawatts peak power with a mean power out-

High power microwaves for industrial heating are generated by this magnetron

put from 3 to 4 kilowatts. Power for such tubes, and for broadcasting stations can be provided by the company's recently developed pentode-type hot-cathode thyratron rated at 33 amps mean, 200 amps peak, and 1,000 volts.

Graphical Fourier Analysis

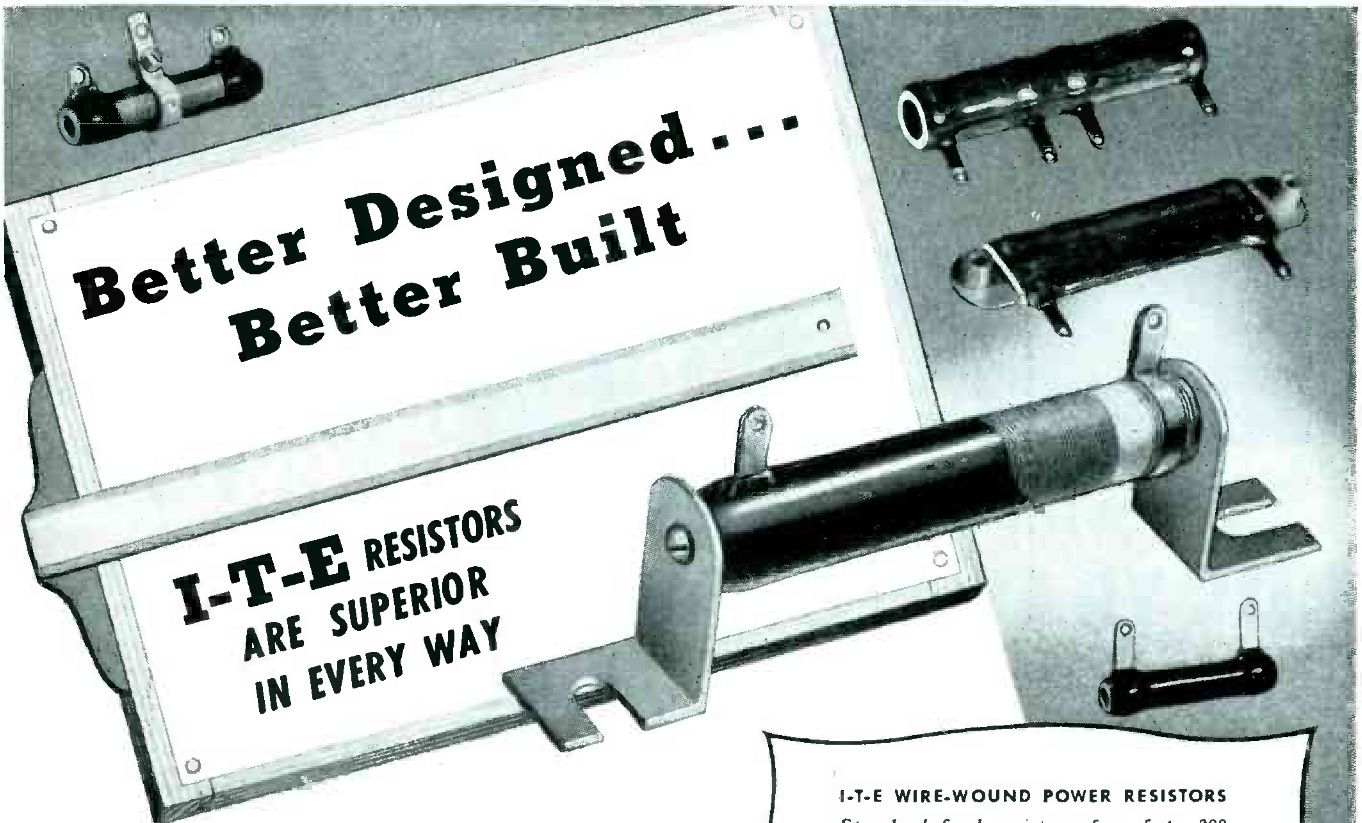
By THOMAS C. BLOW

Massachusetts Institute of Technology Cambridge, Mass.

PERIODIC FUNCTIONS can be analyzed into their harmonic contents by several methods. Simplified schedules[1] are available that shorten numerical step-by-step integrations[2] but a graphical method that is short and accurate enough for engineering purposes is simpler. In addition, as will be seen from the following description, only a few ordinates need be used when determining the lower order harmonics.

Vector Addition

The accompanying diagram shows how the analysis is performed with



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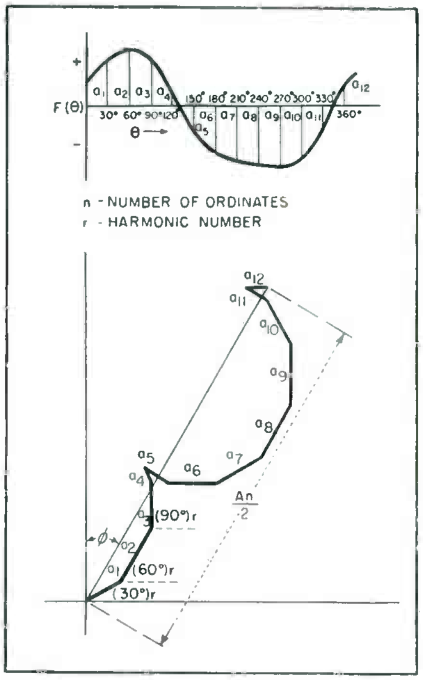

At the top is shown a wave to be analysed; twelve ordinates are constructed at 30 deg intervals to illustrate the technique. Below is shown the construction by which the amplitude and phase angle of the fundamental are graphically determined

a protractor and scale. The first ordinate a_1 is laid off from the origin in the direction specified by its abscissa, 30 deg in this illustration. Successive ordinates are laid off end to end in their respective directions. Ordinates of negative values such as a_5 through a_{11} are, of course, laid off in the negative direction. The line closing the polygon is then the desired coefficient A_1, but multiplied by $n/2$ where n is the number of ordinates used in the analysis, 12 in this case. The angle ϕ_1 is the angle between the resultant and the vertical axis.

The coefficient and angle so determined are substituted in the equation

$$F(\theta) = A_0 + A_1\sin(\theta + \phi_1) + A_2\sin(2\theta + \phi_2) + A_R\sin(R\theta + \phi_R)$$

To determine A_2 and ϕ_2 for the second harmonic, the process is repeated but with the modification that each ordinate is laid off at twice the angle of its respective abscissa. For example, a_1 is laid off at 60 deg. The length of the line closing the polygon so formed, divided by $n/2$, is A_2; its angle to the vertical is ϕ_2. The third harmonic coefficient will be found by laying off the ordinates at three times their respective angles.

For the steady state component

A_0 the algebraic average of the ordinates is taken and divided by n. For the case of $R = n/2$ the line closing the polygon should also be divided by n instead of $n/2$ and the angle will always appear in this case to be 90 deg. However, in actual practice such a condition will not be encountered because the number of ordinates must be at least three to four times the highest order harmonic to be analysed reliably. Fewer ordinates can be used in determining the lower harmonics but, in any case, a sufficient number should be employed to adequately describe any abrupt variations during the cycle. Also, the analysis is greatly facilitated by the use of a universal protractor for making the graphical construction.

(1) R. P. G. Denman, 36 and 72 Ordinate Schedules for General Harmonic Analysis, ELECTRONICS, p 44 Sept. 1942.
(2) A. V. Eastman, "Fundamentals of Vacuum Tubes", McGraw-Hill Book Co., New York, 1941. A good example of the step-by-step integration method is presented in Appendix B.
(3) J. R. Ashworth, A Simple Graphical Method for the Harmonic Analysis of a Cyclic Function, *Electrician*, p 888, 67, 1911.

SURVEY OF NEW TECHNIQUES

CANCER and other life processes can be more fully studied by using stable isotopes than by using radioactive ones. A mass spectrometer developed by Professor A. O. Nier of the University of Minnesota and manufactured by the Consolidated Engineering Corp. has sufficient resolution to reproduce measurements of the ratio of carbon 13 to carbon 12 within 0.25 percent. This mass spectrometer thus makes possible accurate determination of concentrations of rare isotopes. With such determinations, tracer techniques (currently relying on radioactive isotopes that are detrimental to human anatomy if used over protracted periods) can be employed using stable (nonradioactive) isotopes to study growth and functions of the human body from birth to maturity. The rare stable (harmless) isotope carbon 13 is being made available for such studies.

SYNCHROTRON type accelerator evolved by Alva Archer, electrical engineer at the University of Witwatersrand (Johannesburg, South

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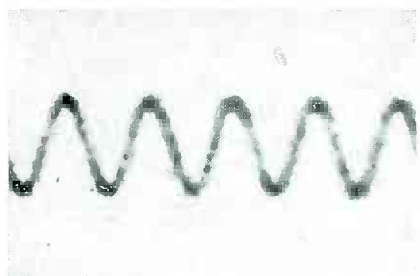
G-E LAMPS

GENERAL ELECTRIC

Africa) produces 40 mev and costs approximately the same as deep therapy or heavy industry x-rays. The field of the ring magnet in the vicinity of the electron orbit is shaped to provide axial and radial stability, the local modifications expanding with the orbit. The machine makes it possible for small research groups to experiment with radioactivity and to generate x-rays for medical and industrial purposes.

OSCILLOGRAPHS of three simultaneous phenomena having frequency components as high as 10,000 megacycles can be made. The single sweep that is used is fast enough to resolve time intervals of 10^{-10} second. In this Central Research Laboratories equipment, magnetic focusing is used with electrostatic deflection in each of the three independent electron guns. Deflection plates are made small to reduce their capacitance and the transit time of the beam, thereby providing the response to high frequencies. To compensate for the reduced deflection sensitivity, the beam is focused directly on photographic film to a spot only 0.01 millimeter in diameter; the resulting trace is enlarged about 100 times to give the oscillograph.



Portion of single-sweep oscillogram of 3,000-mc 20-rms-volt signal enlarged 100 diameters

GAS CAN BE ANALYZED by measuring its thermal conductivity. In a bridge analyzer, there are two identical tungsten filaments and two Manganin resistances (Driver-Harris Co.) forming a bridge. Sufficient current passes through the bridge to heat the tungsten arms. The gas to be analyzed is passed over one of the tungsten elements, cooling it in proportion to the thermal conductivity of the gas; the arm thus assumes a resistance indicative of the type gas being passed. Manganin elements are

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large stocks...

wide selection...

quick delivery, too!

Authorized WAA Electronics Distributors

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122 Brookline Ave.
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Carr Industries, Inc.
1269 Atlantic Ave.
Brooklyn, New York, N. Y.

Tobe Deutschmann Corp.
863 Washington Street
Canton, Mass.

Electronic Corp. of America
353 West 48th Street
New York, N. Y.

Emerson Radio & Phonograph Corp.
76 Ninth Ave.
New York, N. Y.

General Electric Co.
Bldg. 267; 1 River Road
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General Electronics, Inc.
101 Hazel Street
Paterson, N. J.

Hammarlund Mfg. Co., Inc.
460 West 34th Street
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76 LaFayette Street
Salem, Mass.

Johanns & Keegan Co., Inc.
62 Pearl St.
New York, N. Y.

Newark Electric Co., Inc.
242 West 55th St.
New York, N. Y.

Radio Parts Distributing Co.
128 West Olney Road
Norfolk, Va.

Smith-Meeker Engineering Co.
125 Barclay Street
New York, N. Y.

Standard Arcturus Corp.
99 Sussex Ave.
Newark, New Jersey

Sylvania Electric Products, Inc.
Emporium, Pa.

Technical Apparatus Co.
165 Washington St.
Boston, Mass.

Tung-Sol Lamp Works, Inc.
95 Eighth Ave.
Newark, New Jersey

W. & H. Aviation Corp.
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Rochester, New York

MIDWESTERN

American Condenser Co.
4410 N. Ravenswood Ave.
Chicago, Ill.

Belmont Radio Corp.
3633 S. Racine Ave.
Chicago, Ill.

Electro-Voice, Inc.
Carroll & Cecil Streets
Buchanan, Michigan

E. F. Johnson Co.
206 Second Ave., S. W.
Waseca, Minnesota

SOUTHERN

Navigation Instrument Co., Inc.
P. O. Box 7001, Heights Station
Houston, Texas

Southern Electronic Co.
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New Orleans, La.

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Cole Instrument Co.
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1377

Customer Service Centers in these and many other cities.

used in the General Electric analyzer because they have substantially constant resistance at all temperatures, give constant resistance with age, and produce no thermal emf against the copper with which the bridge is wired.

HEARING AIDS can be fitted to a deafened person's particular requirements by the Selectrometer developed by engineers of Beltone Hearing Aid Co. The instrument

Hearing aids are fitted by determining from standard word lists what combination of factors gives patient best hearabiity

provides 140 different combinations (magnetic or crystal earphone, power output, peak level, amplification, and frequency response can be varied) from which the patient selects the most suitable one. Three years of field and laboratory testing have indicated the utility of this technique.

LUMINESCENT MATERIALS, produced in quantity for use in television cathode-ray tubes are analysed for quality in an instrument that duplicates conditions under which the coatings operate. The instrument measures color, visual efficiency, peak energy, buildup and decay of phosphorescence and flourescence under continuous and discontinuous excitation, flicker, stability, photoconductivity, and infrared quench and stimulation effects. The luminescent material, coated on a glass disc, is inserted in a demountable vacuum chamber that houses a standard electron gun. A spectroscope analyses the color of the light from the material by a rotating prism which causes the spectrum to scan a phototube. The same motor that drives the prism produces the horizontal sweep for another cathode-ray tube, and the phototube output produces the vertical deflection. This trace thus indicates the color content of the

Model 666HH

VOLT-OHM-MILLIAMMETER

Here it is! The NEW "hand-size" Triplett tester that packs a laboratory of versatile service into a size that fits your hand and weighs only 1½ pounds. It's the tester you've been looking for.

In a handsome, streamlined, molded case, Model 666HH features greater scale readability; low contact resistance at jacks achieved by new banana-type plug-in leads; greater stability evolved through special new type resistors—these are just a few of the many refinements.

Model 666HH is an engineered marvel of compactness, a miniature "laboratory" that delivers more accurate, precise results per square inch than many kinds of larger, more costly equipment.

See, try, compare the brilliant performance of this thorough-going example of dependable Triplett engineering. It's the ideal tester for radio servicemen, radio amateurs, industrial engineers and laboratory technicians.

RANGES

D.C. VOLTS: 0-10-50-250-1000-5000, at 1000 ohms-Volt.

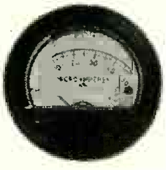
A.C. VOLTS: 0-10-50-250-1000-5000, at 1000 ohms-Volt.

D.C. MILLIAMPERES: 0-10-100-500) at 250 millivolts.

OHMS: 0-2000-400,000.

For Descriptive Material Write Dept. E-127

Precision first ... to last



STANDARDS ARE SET BY TRIPLETT

Triplett

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO

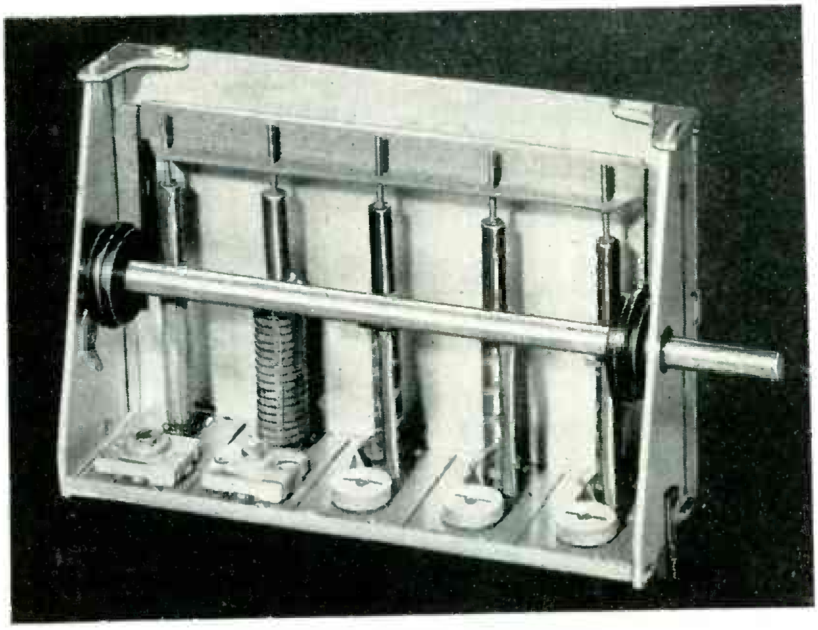
Spectroradiometer is adjusted by its designer, Austin E. Hardy, 27-year old head of the Physical Testing Lab. at RCA's Lancaster plant

phosphor. The long-persistence screen enables four curves to be swept across and compared. Different speeds of sweep permit studying buildup and decay also.

MICROKYMATOTHERAPY (medical term for microwave therapy) using 2,450 mc (uhf frequency recently assigned to physical medicine by FCC) promises to be more useful—judging from comments at Atlantic City convention of American Medical Association—than short-wave diathermy (13.66, 27.32, and 40.98 mc) both because the microwaves can be readily directed for local heating and because they are absorbed 7,000 times more effectively by water at 100 F than the 27-mc waves. The Microtherm (Raytheon Mfg. Co.) microwave diathermy with which the studies on which these conclusions are based has the added advantage that it meets FCC requirements for non-interference with other radio services.

INDUCTIVE COUPLER, used during the war by OSS agents for tapping telephone lines, has been adopted to pick up signals from radio or telephone handset and feed them to Dictograph hearing aids. Because no mechanical connection was required to the line and because the coupling was very loose, the OSS used this means of line tapping to avoid detection. Used with hearing aids, the coupler, called Mystic Ear, provides greater fidelity than placing the hearing microphone near the sound source because with it the acoustic elements are bypassed. A suction cup holds the coupler to the radio or handset; wires connect it to the hearing aid.

FM + AM = PT



Permeability Tuner—Model 770-5

The EQUATION *of* MODERN RECEIVER DESIGN

1. **Higher L/C ratios.**
2. **Freedom from microphonics.**
3. **Greater frequency stability.**
4. **Simplified wiring and switching.**
5. **Shorter H. F. leads.**
6. **All tuning elements in one integral unit.**
7. **Lower overall cost.**

● This company has long pioneered the permeability tuning field and has secured a number of patents which disclose substantial improvements in that field. These patents are all available for licensing upon reasonable terms.

JOHNSON LABORATORIES

DIVISION OF MANTLE LAMP COMPANY OF AMERICA

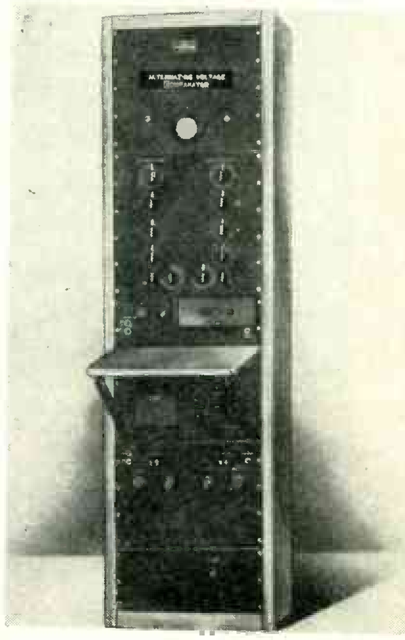
223 W. Jackson Boulevard, Chicago 6, Illinois

(continued from p 150)

and reproduce an hour's music or speech. Material no longer desired can be erased and the tape reused.

A-C Comparator

ARMA CORP., 254-36th St., Brooklyn 32, N. Y. The alternating voltage comparator, now commercially available, functions at any frequency between 50 and 1,250 cps. It measures a-c voltage and phase angle with an accuracy of 1 part in 50,000. The equipment can be used in computer development.



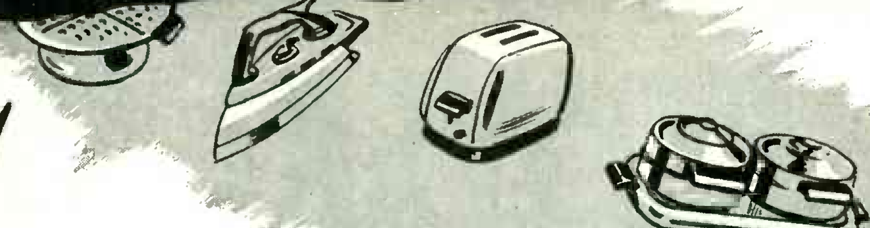
Industrial Stroboscope

C. D. BROWN TEXTILE ENGINEERING SERVICE, INC., 1 Assonet St., Worcester 8, Mass., are distributors for Machine Design Products, Inc., of the Strobolite. The equipment, furnished in two models has been designed for studies of motion too fast for the eye in manufacturing processes. Sufficient illumination is provided so that photographs of moving parts can be made.

Television Receivers

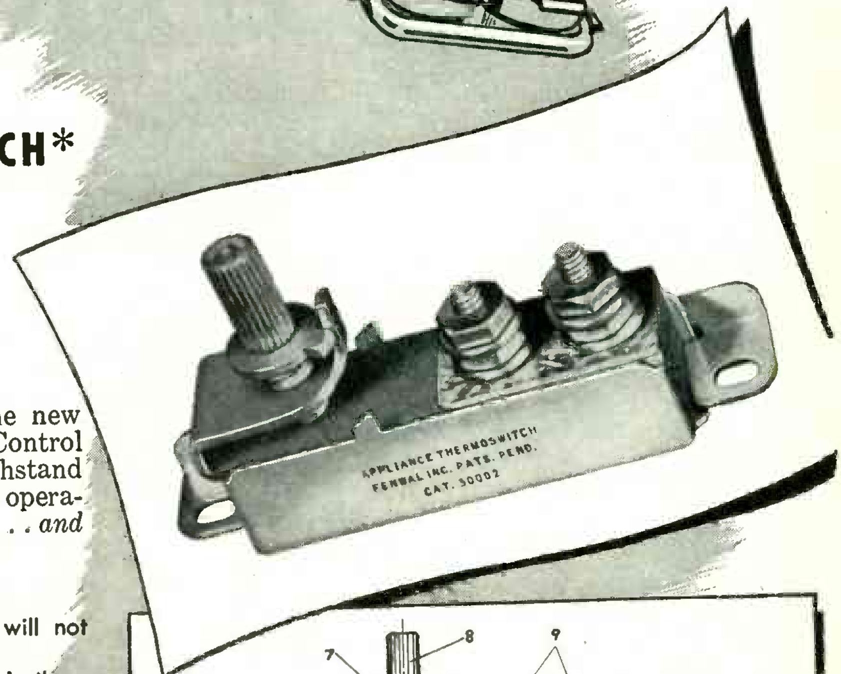
BACE TELEVISION CORP., Green & Leuning Sts., South Hackensack, N. J. Illustrated is the 15-inch model commercial or industrial television receiver with 120-square

If your product uses HEAT



Specify

THE *NEW* FENWAL APPLIANCE THERMOSWITCH* CONTROL



Safe • Accurate • Long-Lasting Temperature Control For All Types of Electrical Appliances

The unique and rugged design of the new Fenwal Appliance THERMOSWITCH Control provides a heat control unit that will withstand shock, vibration, tampering and other operational hazards that lower product life . . . *and influence buying attitudes.*

Note these outstanding features:

- Torque applied to terminal binding posts will not shift contact support members.
- Adjusting screw will not drift under normal vibration.
- The mounting bracket provides for side or bottom mounting, or a cross-mounting bracket is available for special applications.
- One-piece, welded case and cover assures rugged, tamper-proof unit . . . stable temperature settings.

TWO DISTINCTLY DIFFERENT MODELS FOR HIGH AND LOW TEMPERATURE RANGES

The Appliance THERMOSWITCH Control is available in models especially designed for both high and low temperature ranges. The high temperature model provides control over the wide range of 175°F.–600°F. The low temperature model provides extremely critical control for low temperature applications throughout its range of 50°F.–250°F. Each model assures the highest degree of efficiency and dependability; both incorporate the outstanding Fenwal characteristics.

SPECIFICATIONS

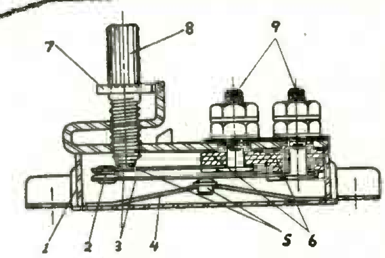
Overall case dimension: ½" high x ⅝" wide 2⅛" long.

Maximum Load Rating: 1200 watts on 110 volt 60 cycles.

TEMPERATURE RANGE:

50° F. to 250° F. (Series 30003)

175° F. to 600° F. (Series 30002)



1. Expanding stainless steel case.
2. Fine silver contacts.
3. Contact Supporting Members.
4. Low expansion metal bridge.
5. Ceramic Insulating Buttons.
6. Precision Ceramic Locator.
7. Stop Collar.
8. Adjusting Screw.
9. Terminal Binding Posts.

RUGGED • COMPACT • LIGHTWEIGHT

Precision built **FOR FOOL-PROOF PERFORMANCE**

There is a Fenwal THERMOSWITCH Control to meet the requirements of most temperature control applications. Write for complete information.

Fenwal

FENWAL INCORPORATED

43 PLEASANT STREET, ASHLAND, MASSACHUSETTS

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

inch picture. The 20-inch model's picture is 220 square inches. Both models feature remote control and provide for controlling a number of other screens and sound systems.

Automatic Scaler

INSTRUMENT DEVELOPMENT LABORATORIES, 223 West Erie St., Chicago, 10, Ill. Model 163 scaler incorporates facilities for predetermined count and predetermined time operation with Geiger counters in radioactivity research. A selfcontained regulated high-voltage supply and voltmeter with depressed zero are provided. No preamplifier is neded with selfquenching tubes. Terminals in the rear allow connection of Neher-Harper or Neher-Pickering quenching circuits.

Plug Remover

THEODORE MALCOLM, 525 Lexington Ave., New York 17, is eastern distributor for Gray Development Corp., Box 1001, Beverly Hills, Calif. of the Commercial Control that is inserted in the power line to a radio broadcast receiver. Two buttons are provided, each equipped with a variable time delay feature. The object of the device is to cut out long and short commercial announcements by an arm chair control. For use at 125 volts, 5 amperes, the switch safely handles 600 watts with a large safety margin.

Vibrator Motor

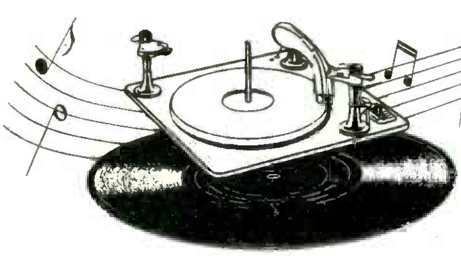
PIQUA MACHINE AND MFG. CO., Piqua, Ohio. The Vibratrol motor operates by virtue of an a-c vibrator

New Listening pleasure! with a Seeburg Changer!

What do music lovers look for in a record changer? The last word in listening pleasure—quiet, smooth performance—simple, dependable operation—long life.

Seeburg Record Changers will bring all these advantages to your radio-phonograph combinations. That is why Seeburg mechanisms have been adopted as standard equipment on so many of today's finest and most popular instruments.

Plan now to build every possible advantage into your combinations by equipping them with Seeburg Changers. Seeburg's long experience in the design and manufacture of changing mechanisms of all kinds assures satisfaction.



Seeburg

RECORD CHANGERS ★ MUSIC SYSTEMS

J. P. SEEBURG CORPORATION
1500 N. Dayton St., Chicago 22

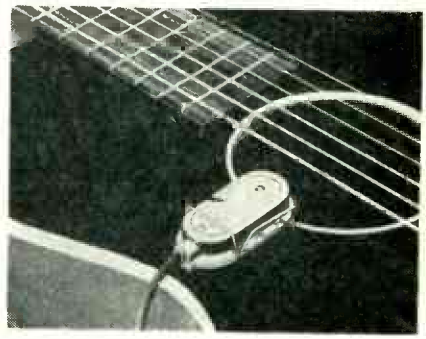
driving a one-way clutch. No brushes or slip rings are required. The new device is adapted to applications requiring a low-cost motor where normally a shaded pole motor of the geared head type would be used.

Up-Rated Capacitors

AEROVOX CORP., New Bedford, Mass. High-voltage requirements for television and other cathode-ray tube circuits are met by extended ratings for the series 84 oil impregnated wax filled paper tubular capacitors.

Banjo Pickup

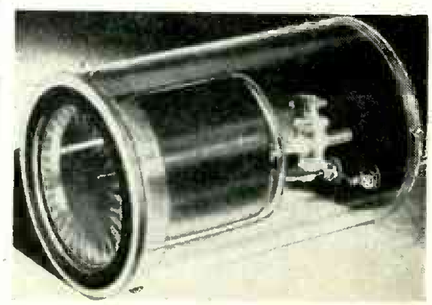
ELECTRO-VOICE, INC., Buchanan, Mich. Model 805 pickup microphone can be used on all vibrating musical instruments, such as banjo, violin,



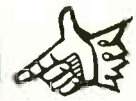
and harp. It has a frequency response between 40 and 8,000 cycles. Output level varies between 0.1 and 1 volt depending on the instrument with which it is used.

Counter Tube

CYCLOTRON SPECIALTIES CO., Moraga 11, Calif. Type 410-A Geiger tube has an unsupported mica window $2\frac{1}{2}$ inches in diameter with thicknesses available from 0.7 to 2.3 milligrams per square centimeter. Used for alpha, soft beta, as well as hard beta and gamma radia-

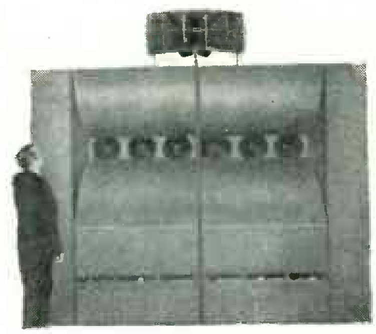


from the **smallest**



12″ Altec Lansing
Model 600 Speaker using the
exclusive diacone principle,
on up through the famous
15″ Duplex Speaker,

to the **largest**



Model A-1X Altec Lansing
"Voice of the Theatre"
sound system for optimum
quality of sound reproduction
in the world's largest
moving picture theatres,
reproducing the complete
frequency range as recorded
on the sound track

Altec Lansing **quality**

is the yardstick by which all sound reproduction
is measured: impartial comparative tests by independent
research organizations reaffirm the industry's
opinion that Altec-Lansing quality of reproduction

is the **highest**

There is an Altec Lansing
loudspeaker to meet
every need of the audio field.
Inquiries are invited:
write Department E

ALTEC
LANSING CORPORATION

1161 North Vine Street, Hollywood 38
250 West 57th Street, New York 19

tions, the tube in the Geiger region has a background of approximately one count per second when shielded. Detailed information can be supplied by the manufacturer.

High-Voltage D-C Capacitors

SPRAGUE ELECTRIC Co., North Adams, Mass., announces a line of small light-weight capacitors impregnated with Vitamin Q dielectric which require no derating up to 85 C. They operate on d-c from 8,000 to 20,000 volts. Bulletin No. 203 gives full details including a complete set of electrical characteristics in curve form.

Analysis Unit

NORTH AMERICAN PHILIPS Co., INC., 100 East 42nd St., New York 17, N. Y. A new Geiger counter fluorescence analysis unit utilizes an x-ray diffraction technique for rapid quantitative metal analysis. In actual practice, the equipment

Select DPI HIGH VACUUM OILS for their 9 ESSENTIAL QUALITIES

1. Low vapor pressures. **2.** Narrow boiling ranges. **3.** Stability. **4.** Ease of fractionation and recovery. **5.** Low operating cost. **6.** Uniformity. **7.** Low viscosity. **8.** Easy vaporization. **9.** Nontoxic vapors.

PUMPING FLUIDS play a big part in attaining the maximum operating efficiency of high vacuum equipment. The wide variety of DPI high vacuum equipment has been designed to accomplish specific tasks . . . and a complete series of oils—esters, hydrocarbons, and silicones—has been provided and classified according to the unique characteristics so that each piece of that equipment may be supplied with the oil to enable it to do its job at its best.

Similarly, DPI vacuum greases, ideal for lubrication of stopcocks, ground glass joints, and other vacuum seals, should be carefully selected for their special properties.

DP INC

For full information on DPI high vacuum oils and greases write—

Vacuum Equipment Division

DISTILLATION PRODUCTS, INC.
Rochester 13, N. Y.

is used to compare reflection angles from standardizing samples and the specimen in question. Goniometer readings are compared with a calibration chart for rapid determination of percentage content.

Small Relay

ALLIED CONTROL CO., 2 East End Ave., New York 21, N. Y. Type BO relay is available for either a-c or d-c coil operation with double-pole double-throw or double-break contact arrangements in ratings up to 15 amperes.

Probe Signal Generator

CLIPPARD INSTRUMENT LABORATORY, INC., 1125 Bank St., Cincinnati 14, Ohio. Operating from either an a-c or d-c socket, the Signalette produces signals with a fundamental of 2,500 cycles modulated by 60

cycles when used in an a-c line. Harmonics up to 20 megacycles are generated in the probe-like device. Further details on the multifrequency generator are given in a bulletin.

Hearing Aids

WESTERN ELECTRIC CO., 195 Broadway, New York 7, N. Y. Two new hearing aids now available through authorized dealers are the model 65

Aerovox Series 26 Bakelite-cased Tubular Capacitors Used Individually or Series-stacked Provide for . . .

VOLTAGES UNLIMITED!

● Name the voltage. These capacitors will handle it. The units shown are for a special high-voltage research project. They are rated at 125,000 volts for single units, 250,000 volts for two units in series. Yet they are *standard* Aerovox items—fully engineered; tried-tested-proven construction; ready to be built at any time—and in time!

Series-stacking builds up to any required voltage. Matched sections insure uniform voltage gradient throughout battery of series-connected capacitors. Plus, of course, Aerovox capacitor craftsmanship.

Originally designed for X-ray, impulse generators and other intermittent dc or continuous ac high-voltage applications such as indoor carrier current coupling, high-voltage test equipment and special high-voltage laboratory work, these *standard* units are now meeting the overnight call for atom-smashing equipment. Indeed, Aerovox is already in the forefront of this Atomic Age.

● *Let us quote on your capacitance requirements—from the modest paper tubular or mica, to giant oil or mica capacitors. Engineering data on request.*

INTERESTING FEATURES . . .

Oil-impregnated and oil-filled with Aerovox Hyvol D, permitting smaller size and minimum weight.

Adequately insulated and matched sections of uniform capacitance, connected in series.

High-purity aluminum foil with generous number of tab connections. High conductivity. Lower inductive reactance.

Capacitor sections dried and impregnated under high vacuum. Closely-controlled long cycle. Eliminates voids. Higher insulation values. Lower losses.

Special laminated bakelite tubing container. Protected by high-resistance insulating varnish. High dielectric strength. Maximum safety from external flash-overs.

Design provides for low voltage gradient along case at maximum operating voltages.

Dependable operation assured at rated voltages and at ambient temperatures up to 65° C.

Three-piece cast aluminum end-cap terminals, Bakelite-treated cork gaskets locked in to provide hermetic seal.

Caps available with mounting feet for space-saving assemblies in series, parallel, or series-parallel arrangements. Or wih plain caps.

In 50,000, 75,000, 100,000 and 150,000 v. D.C. max. ratings per unit. Range from 14" to 32" high; 4⅜" to 13½" dia.

AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.

SALES OFFICES IN ALL PRINCIPAL CITIES • Export: 13 E. 40th ST., NEW YORK 16, N. Y.

Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.

with minimum size and weight for most users, and the Super 66 with high power output and wide frequency response. The latter unit is generally required by those with most severely impaired hearing.

Dual-Beam CRO

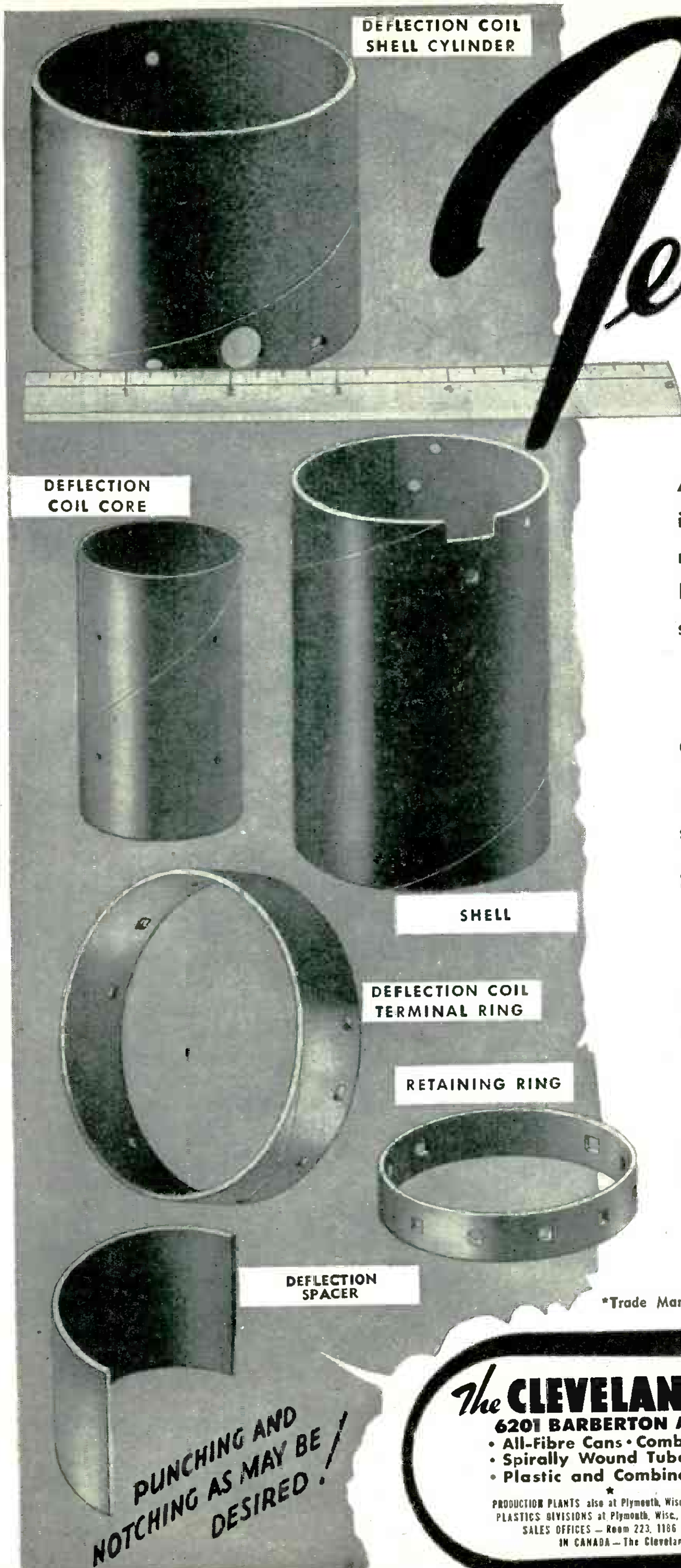
ALLEN B. DUMONT LABORATORIES, INC., 1000 Main Ave., Clifton, N. J. Type 279 dual-beam cathode-ray oscilloscope uses a two-gun type 5SP-A tube. Each gun is provided in the new instrument with separate controls for X, Y, and Z axes. Various connections can be made for studying related phenomena with the same time base, and the display is sufficiently bright to allow photographing the trace.

Speed Control

ELECTRIC MACHINERY MFG. CO., Minneapolis 13, Minn. Regutron rectifies 3-phase supply current used for excitation and speed control in industrial plants and allows adjustments for load speed to within plus or minus 1 percent of selected speed. Excitation current from the unit is balanced against voltage from a tachometer generator belted to the load.

Oscilloscope Tube

NORTH AMERICAN PHILIPS CO., INC., 100 East 42nd St., New York, N. Y. Type 3QP1 cathode-ray tube is short, has a flat face, and pro-



PUNCHED COSMALITE* COIL FORMS FOR.. Television RECEIVERS

A new and further step in the ever increasing use of these spirally laminated paper base, Phenolic Tubes. Performance based upon approximately seven years of research.

Other Cosmalite Types

#96 COSMALITE for coil forms in all standard broadcast receiving sets.

SLF COSMALITE for Permeability Tuners.

Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

Attractive prices. Fast deliveries.
Inquiries given specialized attention.

*Trade Mark Registered

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

- All-Fibre Cans • Combination Metal and Paper Cans
- Spirally Wound Tubes and Cores for all Purposes
- Plastic and Combination Paper and Plastic Items

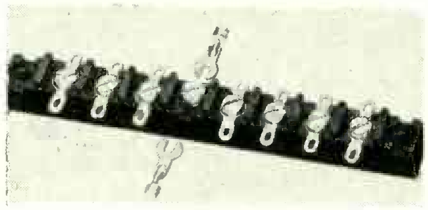
★ ★ ★

PRODUCTION PLANTS also at Plymouth, Wisc., Ogdensburg, N. Y., Chicago, Ill., Detroit, Mich., Jamesburg, N. J.
PLASTICS DIVISIONS at Plymouth, Wisc., Ogdensburg, N. Y. • ABRASIVE DIVISION at Cleveland, Ohio
SALES OFFICES — Room 223, 1186 Broadway, N. Y. C., also 647 Main St., Hartford, Conn.
IN CANADA — The Cleveland Container Canada Ltd., Prescott, Ontario.

vides improved electron-optical characteristics particularly at the screen edge. The tube has improved cross talk characteristics between pairs of deflection plates. It is suitable for servicing equipment. Deflection factors are 168 volts d-c per inch and 105 volts d-c per inch with potentials of 800 and 300 volts.

Terminal Blocks

CURTIS DEVELOPMENT & MFG. CO., 1 North Crawford Ave., Chicago 24, Ill. A new type of terminal block is provided with solder-type spade lugs that are recessed into the body of the strip, thus preventing accidental pulling out of the lug from under the screw. Type K blocks are described in Bulletin DS-114.



Thickness Gage

SCOTT ELECTROFLUX CO., 400 Main St., Waltham 54, Mass. A new precision instrument can be used for measuring corrosion and wall thickness from one side of a metallic surface to an accuracy of 3 percent. It comprises a 4-electrode probe, battery and electronic voltmeter. Steel thickness from 0.125 to 2.250 inches can be determined.

Sealed-In-Steel Batteries

RADIO CORP. OF AMERICA, Camden, N. J. The VS036, a radio A battery for use in smaller sets, has a special radio mix, doubling power hours. Shelf life is increased by a steel jacket.

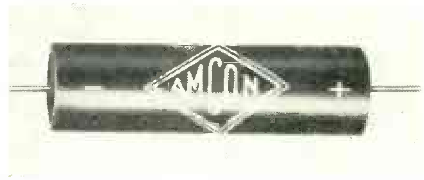
Flame Propagation Indicator

ELECTRO PRODUCTS LABORATORIES, 549 West Randolph St., Chicago 6, Ill. Exact rate of flame propagation during explosion in internal combustion machines can be determined with the new Synchro-Marker Pres-

suregraph. Photographs can be made of the cathode-ray tube trace including 5-degree markers. The device is also useful for other pressure and explosion problems.

Tubular Electrolytic

American Condenser Co., 4410 N. Ravenswood Ave., Chicago 40, Ill., recently added to its line of plastic-encased capacitors the new type PLA, a compact tubular electrolytic with working voltages from 25 to 450 d-c. It measures $2\frac{1}{8}$ in. x $\frac{5}{8}$ in.



Camera Tube

Radio Corp. of America, Camden, N. J., Dangerous operations in industry and elsewhere can be observed with the 5527 iconoscope, a television camera tube, two inches in diameter. It uses electrostatic deflection and requires no keystoning circuits.

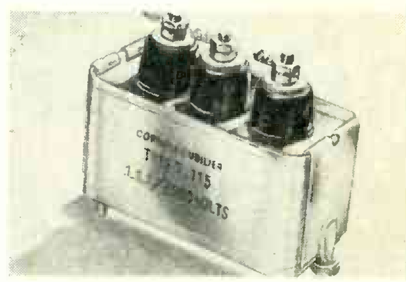
Dual Scaler

Tracerlab, Inc., 55 Oliver St., Boston 10, Mass. The Duoscale now in production is an electronic scale-of-two similar to the Higginbotham circuit. Built into a small cast aluminum housing the unit is supported by a nine-prong tube-base plug that also serves for electrical

connections. Full details of the equipment and a circuit diagram are given in the Oct. 1947 issue of Tracerlog.

Television Type Capacitor

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. Type T-115 capacitor has three sections each with a capacitance of 0.1 μf rated at 3,500 v d-c working. Dimensions are $1\frac{3}{4}$ by $3\frac{3}{4}$ by 2 inches. Capacitor is Dykanol impregnated and hermetically sealed in a metal housing.

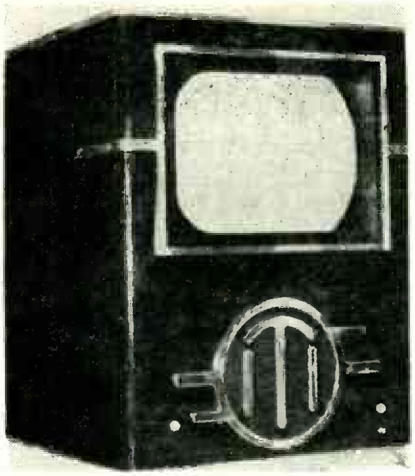


New Platters

SONIC RECORDING PRODUCTS, INC., 50 Mill Road, Freeport, L. I., N. Y. Sonic recording discs use a new lacquer deposited by a controlled coating technique and are available in three grades, both single- and double-faced.

Television Monitor

INDUSTRIAL TELEVISION INC., 34 Franklin Ave., Nutley 10, N. J. Type IT-4R series program monitor is designed for use in television stations for client and public viewing. The unit which is not a con-



ventional receiver can be furnished for either 15- or 20-inch cathode-ray tube.

Visual Alignment Generator

MEASUREMENT ENGINEERING LTD., 61 Duke St., Toronto, Ont., Canada. Model 166 visual alignment generator is intended for alignment of i-f and discriminator stages of domestic radios as well as in the development laboratory. The equipment operates in conjunction with an oscilloscope and has a sweep width continuously variable from 0 to 400 kilocycles. Input power frequency is 25 to 60 cycles.

Magnetic Recorder

RANGERTONE, INC., 73 Winthrop St., Newark 4, N. J. Model R-1 magnetic tape recorder is available on

order for broadcast or other commercial use. Frequency response characteristics exceed present standard broadcast requirements. The magnetic tape used will give at least 500 playbacks before physical deterioration sets in.

Audiometer

AUDIO DEVELOPMENT CO., 2833-13th Avenue South, Minneapolis, Minn. Model 50-E audiometer combines fixed frequency tone (512 to 4,096 cycles) and actual microphone input for a more versatile hearing tests. Either aural or bone conduction methods can be used. A new malingering control has also been added.

Power-Level Recorder

SOUND APPARATUS CO., 233 Broadway, New York 7, N. Y. Model HPL sound level recorder represents a redesign and improvement of the basic type PL and includes such additions as three pushbutton-operated paper speeds, improved accessibility, and advanced electrical circuits. The equipment is used in sound level recording work.

Little Motor

JOHN OSTER MFG. CO., Racine, Wis. Weighing only 2 pounds, the type DU-400 motor has a standard rating of 1/30 h-p at 7,500 rpm continuous duty on 115 volts. It operates on both a-c and d-c with varying speed characteristics.

5-KW Television

RADIO CORP. OF AMERICA, Camden, N. J. The heart of the new TT-5A television transmitter is its power tube, the 8D21, of dual tetrode construction. High power output and stable, wideband operation are provided. The unit measures 17 x 3 x 7 ft. Controls are centralized in one cabinet with auxiliary switches on the console for operating convenience. A super-turnstile antenna is used.

High-Speed Recording Paper

EASTMAN KODAK CO., Rochester 4, N. Y., has developed a high-speed photographic recording paper for use with galvanometer and c-r oscillographs. The Linagraph 1127 is a glossy, single-weight base coated with a fast orthochromatic emulsion. Highly sensitive to blue light, it permits use of smaller beam apertures requiring less mirror area.

Hearing Aid Components

TIBBETTS INDUSTRIES, INC., Camden, Maine. Model HS-41 square microphone illustrated and model HAR-6 crystal receiver are new components in a line of hearing aid accessories characterized by light weight. Output of the microphone is −49 db.

Small Motor

ALLIANCE MANUFACTURING CO., Lake Park Blvd., Alliance, Ohio. Model B small motor can be used as a power source for driving fan blades, magnetic tape disc and wire recorders, and similar devices. It is a semi-enclosed four-pole, shaded-pole induction motor rated for 1/70th hp at 1,600 rpm.

Industrial Limit Switch

MICRO SWITCH, Freeport, Ill. The new switch housing with rotary actuator for closing is listed as type

LMR5. The housing is sealed except where the actuator shaft enters. A conduit fitting has standard half-inch-14 internal threads.

Soldering Gun

WELLER MFG. Co., 803 Packer St., Easton, Pa. Two models of a new loop-tip type soldering gun are available. One has a rating of 100 watts and the other 100 watts normal and 135 watts for short-time use. Five seconds is required for heating. A feature of the device is a spotlight for illuminating the work.

Foot Switch

HART MFG. Co., 110 Bartholomew Ave., Hartford, Con. A new line of momentary contact foot switches for industrial use can either be mounted on the floor or to a machine by means of two screws. The switch carries up to 35 amperes.

P-M Generator

AMPEX ELECTRIC CORP., 1155E Howard Ave., San Carlos, Calif. Light a-c generators using permanent magnets are available in models with low sine-wave distortion and an output voltage linear with rpm. Generators are totally enclosed with single-piece aluminum or magnesium housing.

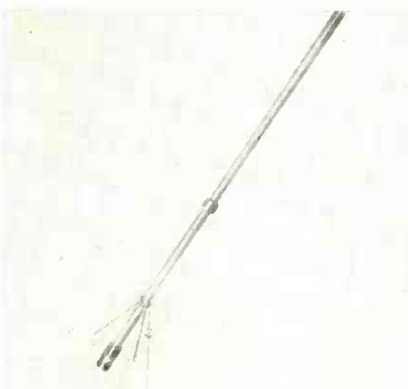
Production Counter

LANSING ENGINEERING Co., 934 Clark St., Lansing 6, Mich. The Lectro-Count makes an automatic

production record of any a-c operated motor-driven machine output with indicating and recording mechanisms located at the machine and in the production superintendent's office.

Airline and Taxi Antennas

BENDIX RADIO, Baltimore 4, Md. Type MS-171A and MS-171B antennas are used to cover the airline frequencies 122 to 136 megacycles and railroad radio and taxicab systems in the range 152 to 162 megacycles respectively. This type of antenna has a gain of 2.6 over a half-wave dipole. Connection is made through a 52-ohm coaxial cable. Standing wave ratio on the line is low owing to the broad-band characteristics of the antennas. A four-page brochure is available.



Precision Potentiometers

THE GAMEWELL CO., Newton Upper Falls, Mass. Potentiometers in a range of values from 500 to 20,000 ohms are available for electrical computers, servo systems, and other control circuits requiring 360-degree rotation, precision, and low noise level. A variety of contact and tapping arrangements can be furnished; linearity is within plus or minus 0.3 percent.

Sine Wave Source

BIRMINGHAM SOUND REPRODUCERS LTD., Claremont Works, Old Hill, Staffs, England. Type LO 800A audio oscillator is available in several models, with and without attenuators and in ranges up to 54,000 cycles. Two scales are used, one covering only the low-frequency end of the equipment, the other the whole range. Type LO 50 is a beat-frequency type for portable operation.

Rotary Indicator

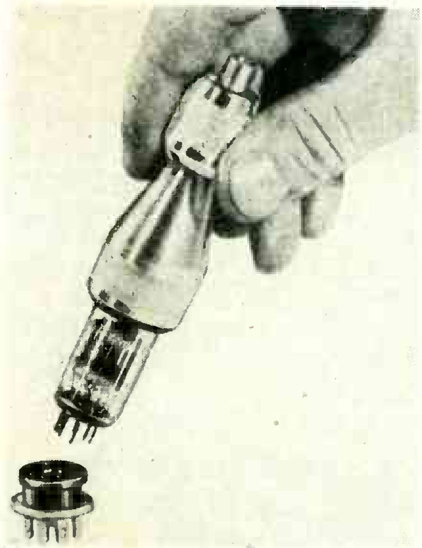
STEVENS-ARNOLD, INC., 22 Elkins St., South Boston 27, Mass. Numbers printed on a rotating cylinder are displayed through a window after magnetic actuation. Figures from 1 to 10 can be completed in step-by-step operation within 0.7 second. The indicator operates on 0.043 ampere d-c at 48 volts. Complete details in catalog 220.

Geiger Tube

NORTH AMERICAN PHILIPS CO., INC., 100 East 42nd St., New York 17, N. Y. A new multipurpose self-quenching Geiger tube for use with beta, gamma, and soft X-radiation employs an extremely thin mica window, vitreous sealed to the main tube body. Used with suitable circuits, the tube is capable of handling in excess of 3,000 discrete counts a second.

R-F Chokes

OHMITE MANUFACTURING CO., 4954 Flournoy St., Chicago, Ill. Six new radio frequency chokes designed for frequencies up to 520 megacycles are single-layer wound on low power factor steatite or molded plastic cores and covered with a moisture-proof coating. The units are mounted by means of their own tinned copper leads. Full details in Bulletin 133.



Tube Puller

SALESCRAFTERS, INC., 510 N. Dearborn St., Chicago 10, Ill., are distributors for Oliveri Tool Co. of the Amo miniature tube puller. List price of the item is $1.50. The device illustrated is pressed down on a tube. When the tube has been removed from the socket, the release button on the top is pushed to free the tube.

Capacitors

SOLAR MANUFACTURING Corp., 285 Madison Ave., New York 17, N. Y. Motor manufacturers should reduce costs with the new type ANXRHT a-c paper capacitors for small motors. A snap-cap device avoids the need for splicing connections between capacitor and motor winding, and each capacitor is filled under high-vacuum with a nonflammable impregnant.

Voltage Regulator

SUPERIOR ELECTRIC Co., 577 Laurel St., Bristol, Conn. The new type IE (instantaneous electronic) voltage regulator provides the automatic correction of line voltage fluctuations with negligible waveform distortion so necessary in all laboratory and industrial voltage regulation applications. Type IE5101, the first model in production will maintain a constant voltage to any load up to 1 kva. The units are offered in black wrinkle-finished cabinets and for relay rack mounting.

Permeability Tuned Oscillator

COLLINS RADIO Co., Cedar Rapids, Iowa. Designed to give maximum reliability as a frequency control device, the 70E-8 is also popular as an r-f control in laboratory equipment. It has a direct-reading dial covering a frequency range from 1,600 to 2,000 kc and its overall accuracy and stability are within 0.015 percent.

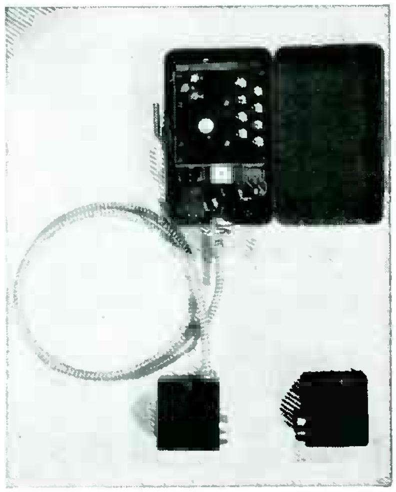
Pyrometer Controller

ILLINOIS TESTING LABORATORIES, INC., 420 N. La Salle St., Chicago 10, Ill. The Alnor controller uses a pyrometer movement that is double-pivoted on jewelled bearings. A lamp indicates whether the heat supply is on or off.

Servicing Equipment

COASTWISE ELECTRONICS CO., INC., 130 North Beaudry Ave., Los Angeles 12, Calif. A new line of Ferret test instruments includes four equipments. Model 701 signal generator is suitable for f-m, a-m, and television work with a range from 170 kc to 110 mc. An audio oscillator, model 710, has an accuracy of 2 percent from 20 to 24,000 cycles. The signal tracer and electronic voltmeter, model 730, uses a

germanium crystal probe for measurements up to 110 mc and will also measure resistance in the range of 10 ohms to 10 megohms. A test speaker eliminates the need for removing speakers from sets when servicing. The model 721 unit has an arrangement for matching to the proper impedance output.

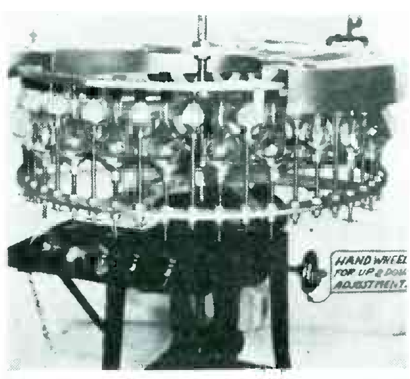


Photoelectric Control

PHOTOSWITCH INC., 77 Broadway, Cambridge 42, Mass. Recommended for high-speed industrial applications, the type 20DJ1 photoelectric control operates in 1/20th second over a range of 10 feet and is adjustable for operation at any predetermined level of illumination from 10 to 50 foot-candles. Bulletin PA477 describes the units.

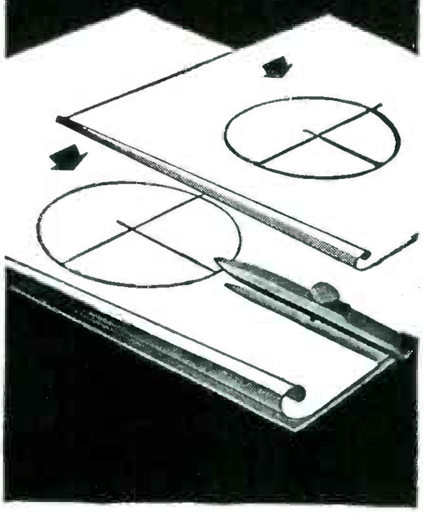
Tube Baser

EISLER ENGINEERING CO., INC., Newark 3, N. J. Operation of the continuously revolving basing machine for small lamps and electronic



tubes is automatic. After a base has been filled with Bakelite cement and joined with the lamp or tube, it is inserted in a holder in the ma-

Tracing cloth that defies time



● The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

IMPERIAL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

"Wow-Meter"

Newly developed direct-reading instrument simplifies measurements of variations in speed of phonograph turntables, wire recorders, motion picture projectors and similar recording or reproducing mechanisms.

The Furst Model 115-S "Wow-Meter" is suitable for both laboratory and production applications and eliminates complex test set-ups.

The Model 115-R incorporates an additional amplifier stage so that a direct-inking recorder may be connected for qualitative analysis of speed variations. Send for Bulletin 115.

Designers and Manufacturers of Specialized Electronic Equipment

FURST ELECTRONICS

806 W. North Ave., Chicago 22, Illinois

New . . . Improved ATTENUATORS by TECH LABS

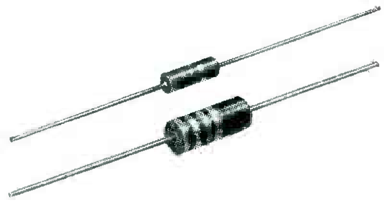
"New Times—New Modes", says old proverb. These new attenuators were born to meet new war-created demands. They represent a new medium frame size: Type 800 (2¼" dia.) and a larger size: Type 900 (3" dia.). The Type 800 is supplied as potentiometer, rheostat, ladder and T-pad up to 20 steps. The larger size Type 900 is similarly furnished with up to 45 steps. Write for new bulletin.

TECH LABORATORIES, INC.

Manufacturers of Precision Electrical Resistance Instruments

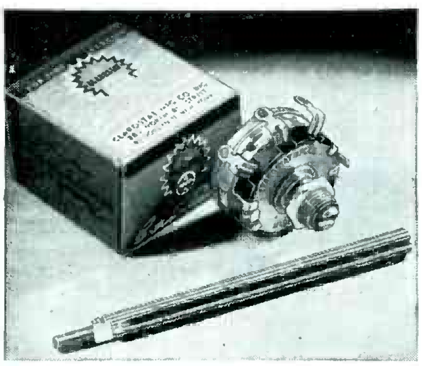
337 CENTRAL AVE. • JERSEY CITY 7, N. J.

chine and passed through the oven. Production of 600 to 1,000 an hour is possible.



Five Percent Resistors

OHMITE MFG. CO., 4980 West Flournoy St., Chicago 44, Ill. Half-watt and one-watt resistors meeting JAN specifications R-11 are now available with a tolerance of plus or minus 5 percent. Values from 10 ohms to 22 megohms are in stock.



Controls and Shafts

CLAROSTAT MFG. CO., Inc., 130 Clinton St., Brooklyn, N. Y. Any one of a selection of popular shafts can be permanently attached to any Ad-A-Shaft series of standard or tapped controls quickly and securely. The feature eliminates the need for many types involving combinations of resistance and shaft characteristics, and reduces storage requirements to about a fourth.

Capacitance Bridge

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. The new type 716-C capacitance bridge measures capacitance and dissipation at all frequencies between 30 cycles and 300 kilocycles. Direct-reading capacitance range is

precision-fabricated PLASTIC PARTS

QUALITY and SERVICE AT A PRICE THAT'S RIGHT

With more and more manufacturers switching to plastic parts to improve the appearance and performance of their products, it is significant that so many look to Sillcocks-Miller for the quality and service they want. This organization of specialists is recognized throughout the industry for its skill in fabricating plastic parts to close tolerances and its reputation for unvarying quality. With complete facilities to meet your requirements . . . no matter how large or small . . . Sillcocks-Miller offers you the dependable source you want for plastic parts and service, at a price that's right.

Write for illustrated booklet or phone South Orange 2-6171 for quick action.

THE SILLCOCKS-MILLER CO.

10 West Parker Avenue, Maplewood, N. J.
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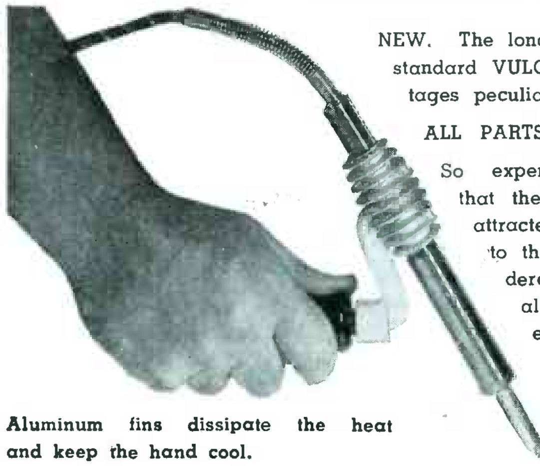
SPECIALISTS IN HIGH QUALITY, PRECISION-MADE PLASTICS FABRICATED FOR COMMERCIAL, TECHNICAL AND INDUSTRIAL REQUIREMENTS

Makes BETTER Soldering *EASIER*

VULCAN *Counterpoised* Electric Soldering Tool



NEW. The long-lasting quality of standard VULCANS, plus advantages peculiarly its own.

ALL PARTS REPLACEABLE

So expertly counterpoised that the tip seems to be attracted like a magnet to the point to be soldered. Tip is clear of all interference, so it easily reaches hard-to-get-at points, always in clear view of the operator.

PLUG TIP

Aluminum fins dissipate the heat and keep the hand cool.

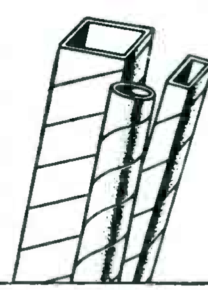
Standard Heating Head UL approved.

VULCAN ELECTRIC COMPANY
DANVERS 10, MASS.

MAKERS OF A COMPLETE LINE OF ELECTRIC SOLDERING TOOLS—SCREW TIP—PLUG TIP—PYGMY—MERCURY—ELECTRIC GLUE POTS—ELECTRIC SOLDERING POTS AND OTHER ELECTRICAL HEATING DEVICES.

Jensen RADIO MFG. CO. *uses* PARAMOUNT PAPER TUBES *in impedance matching transformers*

● This is typical of the wide use of PARAMOUNT paper tubes by leading manufacturers of electrical, radio and electronic products. With over 15 years of specialized experience, PARAMOUNT can produce exactly the shape and size tubes you need for coil forms or other uses. Square, rectangular, or round. *Hi-Dielectric, Hi-Strength*, Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for *you*.



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Inside Perimeters from .592" to 19.0"

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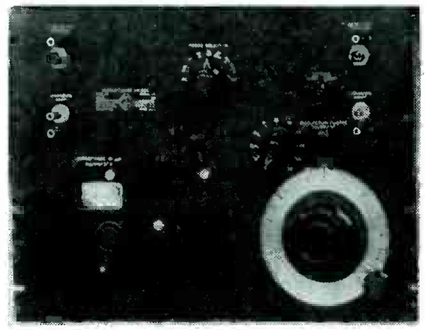
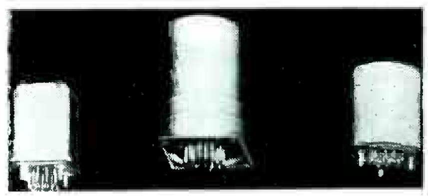
616 LAFAYETTE ST., FORT WAYNE 2, INDIANA
Manufacturers of Paper Tubing for the Electrical Industry



100 $\mu\mu$f to 1 μf at 1,000 cycles and 100 $\mu\mu$f to 1,100 $\mu\mu$f at other frequencies. Using the substitution method of measurement, the range is from 0.1 $\mu\mu$f to 1,000 $\mu\mu$f. Dissipation factor is from 0.00002 to 0.56. Accuracy is plus or minus 0.2 percent for capacitance and plus or minus 2 percent for dissipation factor. The bridge is supplied either in a walnut cabinet or for rack mounting.



Hermetic Sealing

ELECTRO-SEAL CORP., 946 Lee St., Des Plaines, Ill. A service is offered in which the design of a suitable enclosure, terminals, and other appurtenances; assembly and wiring of the unit; and final evacuating and sealing the equipment under gas or oil is done by the contractor. A few standard enclosures are illustrated.

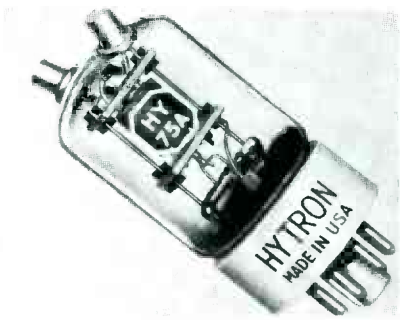
Chart Mover

GORRELL AND GORRELL, Haworth, N. J. The Mono-Drum chart mover is a 10-inch tall aluminum drum driven by a sparkless oil-immersed motor that turns at speeds that can be varied from 0.0296 to 575 inches a minute. Further details and a description of accessories is given in a bulletin.

Pulsing Drive

YARDNEY LABORATORIES, INC., 105 Chambers St., New York, N. Y. Pulsing drive type B just an-

nounced is an improvement on the system that uses a series of short electrical pulses for accurately controlling the position of electric motors. Rate of the pulses depends upon speed of knob rotation.

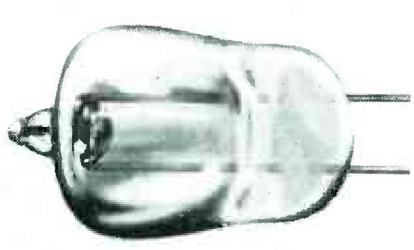


VHF Oscillator

Hytron Radio & Electronics Corp., Salem, Mass. Type HY75A represents a redesign of the HY75 vhf power oscillator and amplifier. Useful power output at 144 megacycles has been increased to 17 watts and the tube can be operated at 0.75 meters at 60 percent of maximum ratings. Price remains at $3.95.

Tilt Switch

Minneapolis - Honeywell Regulator Co. A new switch for vertical mounting is available in two

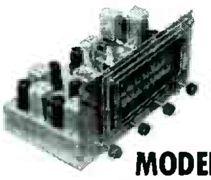


BROWNING LABORATORIES

Precision Instruments for Electronics and Radio Research and Testing

Versatile, Precision OSCILLOSCOPE MODEL OL-15

This is a highly flexible instrument particularly adaptable for production testing or research work in television, radar, facsimile work, and radio-frequency equipment.



MODEL RJ-12 FM-AM TUNER

An easy-to-install highly-sensitive tuner that provides distortion-free reception on FM and quality reception on AM. Tuning eye shows correct tuning. One antenna serves both FM and AM. Many other features. Armstrong circuit

WWV FREQUENCY CALIBRATOR

Full, accurate use of station WWV, the world's finest primary frequency and time standard, is obtained from the Browning Model RH-10 Standard Frequency Calibrator.

WRITE FOR LITERATURE

OTHER EQUIPMENT manufactured by Browning Laboratories includes an accurate frequency meter and ECO Model MJ-9, for operating in the Ham bands, and a frequency meter (Model S-4) especially designed for checking mobile transmitters.

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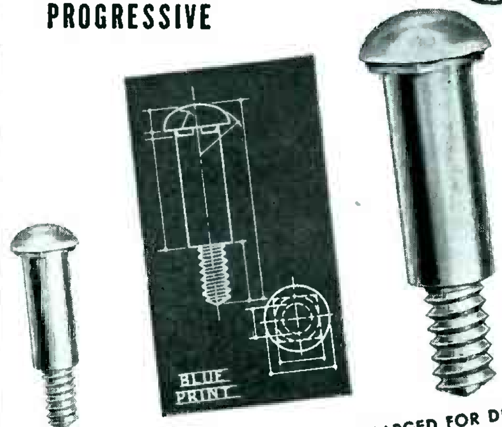
ANOTHER SPECIAL BY PROGRESSIVE

QUALITY PROMCO BRAND



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Special heads, threads and finishes on any metal or alloy adapted to cold upset. Weekly output: 25,000,000 pieces. Many specials, suggesting production savings for you, illustrated in latest catalog. Includes weights per 1M standard pieces, dec. equivs. of fractions, other purchasing and engineering helps. Write for Catalog 19.

The PROGRESSIVE MFG. CO.
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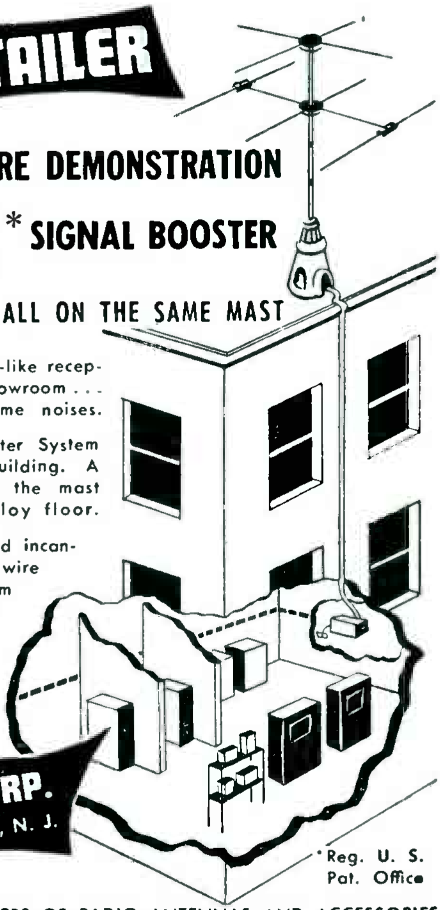
MR. RADIO RETAILER

A MUST for NOISE-FREE STORE DEMONSTRATION

BRACH PURATONE* SIGNAL BOOSTER

CARRIES AM, FM and TV ANTENNAS ALL ON THE SAME MAST



Increase your radio sales by bringing home-like reception to any AM, FM and TV set in your showroom . . . eliminating all interference and bothersome noises.

HERE'S HOW: The Puratone Signal Booster System is easily installed on the roof of your building. A shielded coaxial cable runs directly from the mast to the concealed amplifier on the display floor.

From the amplifier a radiating wire is placed inconspicuously around the display space. No direct wire connection to radio sets required. One system serves any number of floor models. Dual wave traps in the video-type AM-FM amplifier bring in all stations at an average tone-level. 30-40 DB gain on FM; 40-60 DB gain on AM. Effective for any radio department layout.

Write for illustrated circular.

L.S. BRACH MFG. CORP.
200 CENTRAL AVE., NEWARK 4, N. J.

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WORLD'S OLDEST AND LARGEST MANUFACTURERS OF RADIO ANTENNAS AND ACCESSORIES sizes for currents of 1 or 12 amperes. It was designed for safety control, coin-operated machines, or other applications in which space limitations prevent use of conventional horizontal devices.

Literature

Insulation Series. Bakelite Corp., 30 East 42nd St., New York. A series of bulletins entitled "Kabel-items" describes new developments in wire and cable insulation. Number 18, recently issued, recommends pigments for cold blending of Vinylite insulating compounds.

House Organ. James G. Biddle Co., Dept. B-14, 1316 Arch St., Philadelphia 7, Pa. Biddle Instrument News is published on an average of four times a year, serving to announce new apparatus, new company literature, and testing methods. Write to the address above.

Office Recorder. SoundScriber Corp., 146 Munson St., New Haven 4, Conn. Several single-page sheets and a mimeographed bulletin are available describing the new models of office machines that use electronic means of recording dictation on plastic discs.

Industrial Testing. General Electric Co., Schenectady 5, N. Y. More than 90 modern electronic and electrical industrial testing equipments are listed in a new catalog. Contents are carefully and clearly classified. With the description of each device there is also listed the number of a bulletin describing it in greater detail.

Radiotelephone. Motorola, Inc., 4545 Augusta Blvd., Chicago 51, Ill., has issued a 6-page brochure announcing the new f-m mobile radiotelephone transmitter and receiver designed for use in noisy city areas. The units operate in the 152-162 mc band.

Strip Chart Recorder. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill. Of interest to instrument engineers and anyone dealing

with automatic process control is Educational Bulletin no. 7. This 16-page technical data book gives diagrams, charts, and listings explaining the diversified functions of the Capacilog, an improved strip chart recorder.

Electric Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Calif. A revised fourth edition, Bulletin No. DP-547 gives complete technical coverage of a series of electric connectors used with various rack and panel equipment in electrical and electronic devices.

Microphones. The Turner Co., Cedar Rapids, Iowa. A 24-page booklet describes and illustrates a wide variety of microphones for both general and particular applications. Each is complete with specifications.

Fibrous Components. Rogers Corp., 73 Mill St., Manchester, Conn. Engineering personnel directly interested in fabricating facilities for fibrous components may obtain a compact display kit of samples ranging from the simplest type of scored pieces to parts involving deep drawing and precision stamping. Write in on company stationery giving title.

Transformer Book. Standard Transformer Corp., 3560 Elston Ave., Chicago 18, Ill. "Engineering a Transformer" is an 88-page book that describes in some detail the construction of transformers, not only in the Stancor line but for any given service. Formulas, testing audio response, production testing, and soldering are among the many topics discussed. Company officers, production managers, and design engineers may request this book on their company stationery.

Facsimile Brochures. Alden Products Co., 117 North Main St., Brockton 64, Mass. Several brochures describing facsimile equipment and systems have been published to show how the technique can be used in the home, by airlines or other businesses, and how broadcasters can develop programs.

HOW *fast* CAN A SCREW GO?

How fast can a screw go? Sounds screwy? It's not! There's a case of a large Eastern manufacturer of electrical appliances (name on request). His assembly line was hopelessly slowed down. Production was hitting new lows when he called in our Engineering Department. We designed new screw parts that could be assembled faster — thereby speeded up production. It also saved him money and resulted in a better product. Perhaps we can do as much for you. It costs nothing to find out.

NEW ENGLAND SCREW CO.

Manufacturers of Special Screws

KEENE, NEW HAMPSHIRE

You Can Depend Upon

SYNCHRON

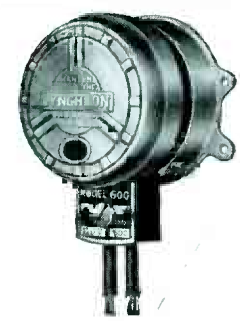
TIMING MOTORS

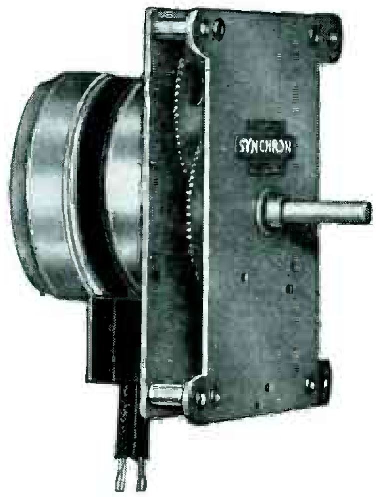
and

TIME MACHINES

for Sustained Accuracy

and Full Rated Power on Quick Starts





Ask any time machine maker—any electric clock repair man — what motor outlasts all others, and he'll say "SYNCHRON". In these tiny motors, all pinions and shafts are of steel, operating against polished brass gears—for least possible wear. All bearings are genuine Babbitt, lubricated by a sealed-in supply of oil surrounding all moving parts (patented process). SYNCHRON timing motors and time machines are designed, patented, and built for dependable, trouble-free service.

A new catalog containing engineering data on SYNCHRON Motors, Timing Machines, and Clock Movements is just off the press. Your copy will be mailed promptly upon request.

HANSEN MANUFACTURING CO., INC.

Princeton 10, Indiana

(Established 1907—a Pioneer in Synchronous Motors)

WHO'S WHO IN SOUND

D20
DYNAMIC

Plenty of personality

Dynamic in appearance as well as in performance. Full-ranged, smooth response. In demand for public address, recording, etc. Not bothered by weather. Micro-Adjust Swivel gives poise and balance in any position. *Everybody votes for*

UNIVERSAL D20 DYNAMIC MICROPHONE

UNIVERSAL MICROPHONE CO
Inglewood, California

PLASTIC FABRICATING ...O.K!

BAKELITE SHEETS, RODS, TUBES
FABRICATED PARTS

Twenty Years of Experience

ELECTRICAL INSULATION CO., INC.

12 VESTRY ST., NEW YORK 13, N. Y.

(continued from p. 154)

of General Plate Division of Metals and Controls, Inc., S. G. Eskin of Robertshaw Thermostat Co., and F. R. Hensel of P. R. Mallory and Co.

The most important single item in this year's supplement is the review of the original German text of the book "Electric Contacts" by R. Holm, published by Hugo Gebers Forlag, Stockholm. A review of the English revision of this book appeared in ELECTRONICS, p 248, Aug. 1947.

Teaching F-M Servicing

TO EDUCATE radio servicemen for the job of servicing some 4,500,000 f-m receivers now in use and the millions more expected to be produced in 1948, General Electric Co. is conducting a traveling f-m radio workshop. The 10,000-mile tour is scheduled to include 33 meetings, each in a different city and lasting for three hours. Characteristics of a-m and f-m receivers are compared, technical aspects of f-m servicing operations are discussed, and actual test steps are carried out on an f-m chassis that is mistuned or placed out of alignment.

BUSINESS NEWS

PHILCO CORP. has begun construction of a 552-foot antenna tower at the transmitter of Philco television station WPTZ, Philadelphia. This will bring clear television signals within reach of about 4,000,000 people.

THE REK-O-KUT CO., recording and transcription equipment manufacturers, moved to larger quarters at 38–01 Queens Blvd., Long Island City 1, N. Y.

INTERSTATE MFG. CORP. recently completed and occupied their new plant at 32–36 Newark St., Newark 4, N. J., to increase production of cord sets, heater cords, and wiring harnesses.

RCA VICTOR AND 20TH CENTURY-FOX FILM CORP. have signed a contract for a joint program of re-

★STAR

VITAL AIDS

FOR THE

Manufacturers of 7-pin and 9-pin miniature tube—radios and equipment

#JE-9 (9-pin)—#JE-10 (7pin)—Star Miniature socket wiring plugs for accurate alignment of miniature socket contacts during wiring. Precision cast of zinc base alloy—pins of stainless steel.

#JE-15 (9-pin)—#JE-13 (7-pin)—Star Miniature tube pin straighteners (with stainless steel insert) to obtain a perfect fit when the tube is placed in the equipment.

Scientifically designed—Precision made

READY FOR IMMEDIATE DELIVERY IN ANY QUANTITIES

STAR EXPANSION PRODUCTS CO. INC.

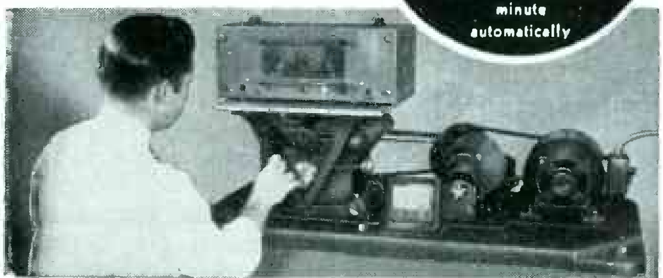
147 Cedar St. New York 6, N. Y.

All-American VIBRATION *Fatigue Testing*

SHOWING MODEL 100VA VERTICAL ACTION

600 to 3,300 vibrations per minute automatically

Basic testing . . . spotting the "bugs" of stress and strain . . . fosters bettered products and lowered costs in your new postwar lines. All-Americans have uniform acceleration - deceleration, besides control at fixed cycles of vibration. An inspection and research favorite. Write for Catalog F.



10 to 55 cycles per second, automatic with automatic acceleration and deceleration. 10 to 60 cps. manually.

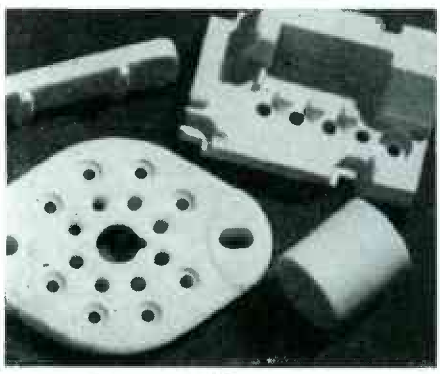
Load capacity 100 lbs.; other models 10 to 25 lbs. capacity. 8 models to choose from.

QUICK DELIVERY!

ALL AMERICAN

Tool & Manufacturing Co.

1014 Fullerton Ave., Chicago (14)



Lavite STEATITE CERAMIC

Properties and Characteristics of Our LAVITE S1-5 Steatite Ceramic Body

Compressive Strength	96,000 lbs. per square inch
Tensile Strength	7,200 lbs. per square inch
Fluxural Strength	10,500 lbs. per square inch
Modulus of Rupture	20,000 lbs. per square inch
Dielectric Strength	235 volts per mil
Dielectric Constant	6.42 (Frequency of 1 megacycle)
Loss Factor	2.90 (Frequency of 1 megacycle)
Power Factor	446 (Frequency of 1 megacycle)
Bulk Specific Gravity	2.664%
Density (from above gravity)	0.096 lbs. per cubic inch
Hardness (Mohr scale)	7.0
Softening Temperature	2.350°F.
Linear Coefficient of Expansion	8.13x10—6
Moisture Absorption (ASTM D-116-42-A)	0.009%

Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency application.

We will gladly supply samples for testing.

D. M. STEWARD MFG. COMPANY

Main Office & Works: Chattanooga, Tenn.
Needham, Mass. • Chicago • Los Angeles
New York • Philadelphia

ADAPTABILITY

REEVES-HOFFMAN CORPORATION

SALES OFFICE: 215 EAST 91 STREET, NEW YORK 28, N. Y.
PLANT: 321 CHERRY STREET, CARLISLE, PA.

search on large-screen television, the project to be centered in the film company's newsreel studios in New York City. Delivery of the first elements of the RCA large-screen equipment began in the early fall.

INSTRUMENT DEVELOPMENT LABORATORIES has moved to 223-233 West Erie St., Chicago, Ill., to expand services in nuclear research.

SPERRY GYROSCOPE CO., INC., has lent its Flying Laboratory to the University of Southern California College of Aeronautics in Santa Maria for aeronautical experimentation and research. The plane, used for development and testing of gyropilots, radar, aircraft instruments and homing devices, and communications equipment, joins a fleet of 95 aircraft at the school.

THE RADIO PARTS AND ELECTRONIC EQUIPMENT SHOWS, INC., has retained the S. I. Nerman organization, Chicago, as public relations counsel. The 1948 show will be held during the week of May 9th at the Hotel Stevens, Chicago.

THE LANGEVIN MFG. CORP. has announced that all its industrial control devices are being serviced by the Altec Service Corp.

ALLEN B. DUMONT LABS., INC., New York City, now has all departments of the television transmitting equipment division consolidated in its new quarters at 42 Harding Ave., Clifton, N. J.

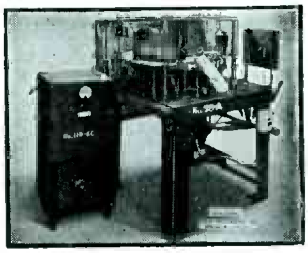
ELECTRONIC ENGINEERING CO. OF CALIFORNIA, 2008 W. Seventh St., Los Angeles, was recently organized by Burgess Dempster and R. B. Bonney, consultants.

NEDERLANDSCH RADAR PROEFSTATION, Noordwijk aan Zee, Netherlands, has been established to carry out systematic research into uses for radar in the Netherlands and its overseas territories.

MAGNETIC POWDERS, INC., Stamford, Conn., is the new corporate name of Magna-Metal Products Co.

G. M. GIANNINI & CO., Pasadena, Calif., is now associated with the Radio Engineering Products Division of Raymond Rosen & Co. Inc., Philadelphia, and will build com-

EISLER ELECTRICAL & ELECTRONIC EQUIPMENT
ELECTRONIC TUBE EQUIPMENT



24 HEAD RADIO TUBE EXHAUSTING MACHINE

•

We Make Complete Equipment For The Manufacture Of Incandescent Lamps Radio and Electronic Tubes

TRANSFORMERS OF ALL TYPES

For LIGHTING
POWER
FURNACES
PHASE CHANGING
DISTRIBUTION
ETC.

•

Air, Oil or Water Cooled

Sizes 1/4 To 250 KVA

SPOT WELDERS

OF ALL TYPES
FOR ALL PURPOSES
SIZES 1/4 to 250 KVA

Butt Welders • Gun Welders
Arc Welders
Neon Sign Units
Fluorescent Tube
Manufacturing Equipment

CHAS. EISLER
EISLER ENGINEERING CO., INC.
751 So. 13th St. (Near Avon Ave.), Newark 3, N. J.

52-75 Ohm Coaxial Relay

Series 7200 (AC)
Series 8200 (DC)

DESIGNED FOR USE WITH RG 52 OR 75 OHM CABLE

Another dependable performer right from the design laboratory....Standard model handles **880 watts of RF power** at 100 mc. (limited only by the rating of the cable connectors). • Designed for SPDT switching of RG cable—1/4" pure silver internal contacts • Inspection port next to internal contacts • 3/16" pure silver external contacts up to DPDT for associated circuits • Standard model with Amphenol 83-1R connectors, other types on special order • Coil voltages up to 440 volts AC or 240 volts DC

See this new relay at your jobber's today.
For information on complete Advance line, write for August, 1947, catalog. "SPECIFY ADVANCE RELAYS."

Advance Relays

ADVANCE ELECTRIC & RELAY CO.
1260 West 2nd St., Los Angeles, California • Phone Michigan 9331

IN-RES-CO
WIRE WOUND
RESISTORS

TYPE ALA—3 WATTS
MAX RES: *25,000 ohms
MAX RES: 5,000 ohms (Manganin)
BODY SIZE: 1 1/16" Lg. by 3/8" diam.
TOLERANCES: Std. 3%
*Max. Res. 0015 Nich. 10,000 ohms

TYPE BLA—5 WATTS
MAX RES: *50,000 ohms
MAX RES: 10,000 ohms (Manganin)
BODY SIZE: 1 5/8" Lg. by 3/8" diam.
TOLERANCES: Std. 3%
*Max. Res. 0015 Nich. 15,000 ohms

Compact - Accurate!

IN-RES-CO resistors are precision built of the finest materials obtainable. All ratings are conservative—your assurance of long dependable service. Write today on company letterhead for completely illustrated catalog.

INSTRUMENT RESISTORS CO.
1036 COMMERCE AVE.
UNION, NEW JERSEY

APPLICATION-DESIGNED RESISTORS!

Sherlock Holmes seldom made mistakes. Maybe you don't, either, but it's good to know that when you *want* to erase, you *can* on PEL-X Water Repellent Tracing Cloth — without detection!

Rugged resistance to repeated erasure is only part of the story. You also get cleaner, sharper reproductions, true to scale and free from feathered lines, fog or cloudiness. *And* you get this more quickly, with less eyestrain — because PEL-X is truly *transparent*. Ask your dealer for PEL-X today!

HERE'S ERASABILITY
WITH A CAPITAL "E" FOR EXCELLENCE

FOR BETTER PLANS . . . Better Plan on PEL-X Tracing Cloth

WHITE PENCIL PEL-X WATER REPELLENT TRACING CLOTH

Current Holliston Production includes: TRACING CLOTHS, COATED and IMPREGNATED FABRICS, INSULATING CLOTH BASE, SEPARATOR CLOTHS, MAP CLOTH, PHOTO CLOTH, REINFORCING FABRICS, SIGN LABEL and TAG CLOTHS, BOOKBINDING CLOTHS, SHADE CLOTH.

THE HOLLISTON MILLS, INC. Norwood, Mass. CHICAGO • NEW YORK plete systems for transmission of signals from guided missiles and pilotless aircraft to ground observers. Both companies are presently engaged in research for the government's guided missile program.

HAZELTINE ELECTRONICS CORP., Little Neck, N. Y., was recently honored for its war efforts and accomplishments. The following personnel received Navy Certificates of Commendation:

Basil A. Bels	Arthur V. Loughren
Robert B. J. Brunn	Knox McIlwain
Charles E. Dean	Fielding Robinson
Orville M. Dunning	Bertram H. Rogers
John D. Grayson	James Stirling
W. H. Grimditch	Benjamin F. Tyson
Daniel E. Harnett	Claude Vermilye
Charles J. Hirsch	Harold A. Wheeler
Gilbert C. Larson	James Willenbecher

UNITED STATES TELEVISION MFG. CORP., New York City, has increased its laboratory space by about 50 percent to house extensive television receiver development.

THE ELECTRONIC CONTROL CO., Philadelphia, Pa., responsible for the design and construction of ENIAC and the original plans for EDVAC, is now designing the UNIVAC, a general-purpose electronic digital machine for the Census Bureau. The work is being done under a contract with the National Bureau of Standards.

INDUSTRIAL TELEVISION, INC., Nutley, N. J., has presented to the Nutley High School a television receiver especially designed for a visual education program.

PERSONNEL

K. BLAIR BENSON, formerly in charge of the design and development of projection television receivers at General Electric, has been appointed senior engineer at United States Television Mfg. Corp.

CHESTER I. SOUCY has been appointed chief engineer of the Electronics Division of Canadian Aviation Electronics Limited, St. Hubert, Quebec, Canada.

GEORGE L. VAN DEUSEN has been elected president and a director of RCA Institutes, Inc. Prior to retirement in 1946 he served as Major General in the regular army.

JAMES L. FLY, ex-chairman of the FCC and now practicing law in New

Linde

ARGON
HELIUM
KRYPTON
NEON
XENON

and Standard or Special

MIXTURES

LINDE rare gases are spectroscopically pure—argon, helium, neon, and standard mixtures are available in one- and two-liter glass bulbs and in cylinders; xenon and krypton are available in liter and fractional-liter bulbs.

The word "Linde" is a trade-mark of

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd St. UCC New York 17, N. Y.

PRECISION POTENTIOMETERS

For use in electrical computers, servo systems and other control circuits where 360° rotation, high precision and low noise levels are essential.

Potentiometer Toroidal Type

Can be supplied in a wide variety of styles within linear resistance ranges from 500 to 20,000 ohms—Linearity ±.3%; enclosed toroidal wound, low torque, electrical angle 360° or less. Capable of rotation through angles greater than 360°.

SPECIAL FEATURES: Capability of continuous rotation—Accuracy of linearity—Wide variety of contact and tapping arrangements—Durability, the RL-210 type (6000 ohms, 2 brushes) showed no serious wear nor measurable departure from initial characteristics following over one million revolutions at speed of 20 RPM—Overall diameter 3 15/16", height 2 15/16".

Write for Bulletin F-68

THE GAMEWELL COMPANY

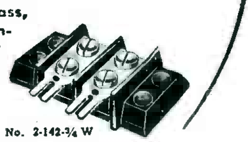
NEWTON UPPER FALLS 64, MASSACHUSETTS

INCREASED INSULATION BETTER CONNECTIONS

JONES BARRIER Terminal Strips

Leakage path is increased—direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder head screws and terminals brass, nickel plated. Insulation, molded bakelite.

No. 2-142



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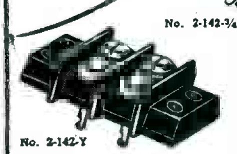


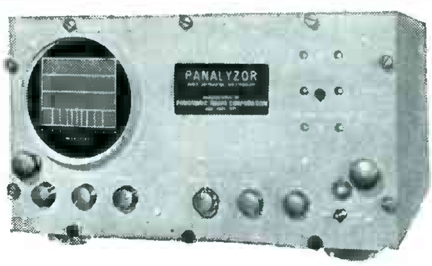
No. 2-142-Y

Shown: Screw Terminals—Screw and Solder Terminals—Screw Terminal above, Panel with Solder Terminal below. For every need.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

Catalog No. 16 lists complete line. Send for your copy.

HOWARD B. JONES DIVISION
Cinch Mfg. Corp.
2460 W. GEORGE ST. CHICAGO 18, ILL.



Designed for

YOUR APPLICATION PANADAPTOR

Whether your application of spectrum analysis requires high resolution of signals closely adjacent in frequency or extra broad spectrum scanning, there is a standard model Panadaptor to simplify and speed up your job. Standardized input frequencies enable operation with most receivers.

	MODEL SA-3 TYPES						MODEL SA-6 TYPES		
	T-50	T-100	T-200	T-1000	T-1000	T-6000	T-1000	T-10000	T-20000
Maximum Scanning Width	50KC	100KC	200KC	1MC	1MC	6MC	1MC	10MC	20MC
Input Center Frequency	455KC	455KC	455KC	5.25MC	10.2MC	30MC	5.25MC	30MC	30MC
Resolution at Maximum Scanning Width	2.5KC	3.4KC	4.4KC	11KC	11KC	25KC	11KC	75KC	91KC
Resolution at 20% of Maximum Scanning Width	1.9KC	2.7KC	4KC	9KC	7.5KC	22KC	7.5KC	65KC	75KC

Investigate these

APPLICATIONS OF PANADAPTOR

***Frequency Monitoring**
***Oscillator performance analysis**
***FM and AM studies**

WRITE NOW for recommendations, detailed specifications, prices and delivery time.

PANORAMIC RADIO CORP.
92 Gold St. New York 7, N. Y.
Cable Address PANORAMIC, NEW YORK
Exclusive Canadian Representative: Canadian Marconi, Ltd.

York City, was elected to the board of directors of Finch Telecommunications, Inc.

GEORGE F. DEVINE was recently appointed commercial engineer of the specialty division of General Electric Company's Electronics Department at Syracuse, N. Y. He has been with the company since 1935 and during the war was assigned to naval ordnance projects.

ALFRED J. KLAPPERICH, formerly with W. J. Polydoroff and Associates, continues his consulting practise in the fields of powder metallurgy, high-frequency iron powder, and magnetic measurements at 5102 N. Glenwood Ave., Chicago.

ROBERT Y. CHAPMAN, associated with the U. S. Naval Underwater Sound Laboratory at New London since 1945, has been appointed executive engineer of the David Bogen Co. in New York.

PAUL H. TARTAK, former owner of Oxford-Tartak and Cinaudagraph, is now president of Tartak Speakers, Inc., on the west coast. The company offers a complete line of loudspeakers for manufacturers and jobbers.

P. H. Tartak

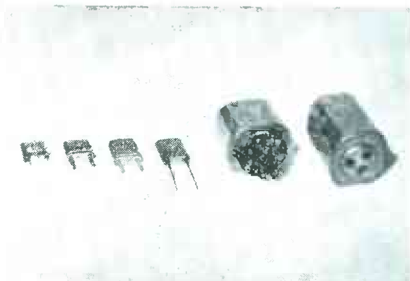
D. P. Caverly

DON P. CAVERLY, having joined Sylvania Electric Products Inc. in 1937 as a commercial engineer, was recently named manager of the company's expanded Commercial Engineering Department. He is author of "A Primer of Electronics," published in 1944 by McGraw-Hill.

EDWARD R. WAGENHALS has been appointed production manager of the hearing aid division of Sonotone Corp., Elmsford, N. Y. He was at one time assistant manager of the Harrison, N. J., receiving tube plant of RCA-Victor.

JOHN M. CAGE, formerly manager of industrial electronics at Ray-

The New "HSM" Series
QUARTZ CRYSTAL UNITS



Plated quartz crystals hermetically sealed in metal holders.

- more activity
- higher Q
- greater stability
- less costly
- moisture proof
- fungus proof
- dirt free
- no aging

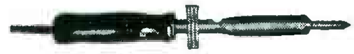
Technical Characteristics:
Frequency range—100 kc to 50 mc.
Frequency calibration—.01% to .001%
Frequency vs. temperature coef. — 1 cy/mc/°C
Temperature range—in accordance with FCC regulations or customers specifications
Holder—all metal with contacts for standard ½", octal, or loctal sockets or lugs
Electrodes—silver, gold, or nickel plating

Designed for stability, dependability and economy BY

CLARK CRYSTAL CO.
Marlboro, Massachusetts, U. S. A.

THERE'S A DRAKE SOLDERING IRON FOR EVERY TYPE OF ELECTRONIC WORK

From that mighty mite



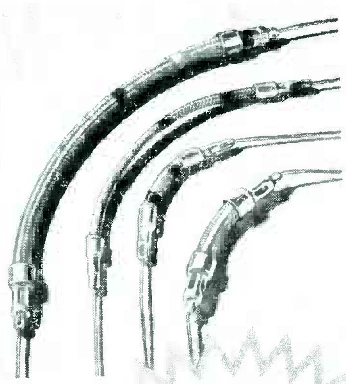
the Drake No. 400 to the high-speed production "honey"

the Drake No. 600-10 there is a high quality Drake Soldering Iron "just right" for the job.

Drake Heat Controls and the Drake "Magic Cup" Stand are important soldering aids.

SEE YOUR RADIO PARTS JOBBER

DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.



GLASOHM flexible resistors

★ Exclusively Clarostat! These flexible glass-insulated wire-wound resistors spell *tougher* components for *tighter* spots. Fibre-glass core and fibre-glass braided covering. Nothing to char or burn. Self-supporting when soldered in place. Especially handy for point-to-point wiring. Ideal for attenuators or step-by-step controls. Truly midget power resistors. Also as *miniature heating elements*, in longer lengths.

GLASOHMS

In two ratings: Series FXG, 1 watt per winding inch; Series FYG, 2 watt.

Maximum resistance per winding inch: Series FXG, 750 ohms; FYG, 1500 ohms.

Minimum resistance per winding inch: Series FXG, ¼ ohm; Series FYG, ½ ohm.

Both types supplied to any reasonable length especially for heating-element applications.

Patented "Clinch-Grip" ferrules and 2" pigtails, standard.

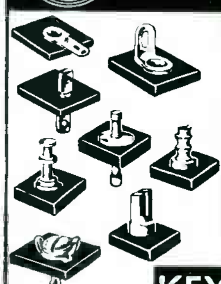
CLAROSTAT

Engineering Bulletin No. 115, on request. Let us quote on your needs.

Controls and Resistors

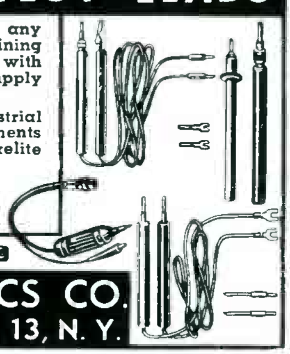
CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.

KEYSTONE DESIGNERS & MANUFACTURERS — *Specialists* IN TERMINAL BOARDS AND TEST LEADS



Keystone offers prompt delivery on any size run. Complete tooling and machining facilities. We fabricate and assemble with turret or stamped lugs (you may supply these or use our stock).

Special test leads or probes for industrial apparatus or UHF testing instruments using Cellulose or Ethyl Acetate—Bakelite or Fibre. Large stocks of standard probe tips. Send prints for prompt quotation. SEND FOR OUR CATALOG OF STANDARD ITEMS.



KEYSTONE ELECTRONICS CO.
50 FRANKLIN ST. NEW YORK 13, N. Y.

LABORATORY TEST EQUIPMENT *by* **FREED**

No. 1010 Comparison & Limit Bridge

No 1040 Wide Range Vacuum Tube Voltmeter

No. 1030 Direct Reading Low Frequency "Q" Indicator. "Q" .5 to 500 Frequencies from 50-50,000 Cycles.

No. 1020 Direct Reading Megohmmeter up to 1,000,000 megohms. Self Contained A.C. Operated.

No. 1110 Incremental Inductance Bridge

FREED TRANSFORMER CO., Inc.
72-78 Spring St., N. Y. C., N. Y.

theon Manufacturing Co., is now professor of electrical engineering in charge of electronics at the School of Electrical Engineering, Purdue University.

NORMAN E. WUNDERLICH, for the last two years executive sales director of the radio division of Federal Telephone & Radio Corp., has established his own consulting radio engineering company and radio laboratory at 1337 Fargo Ave., Chicago, for serving the broadcast and radio communication fields.

GEORGE LEWIS, assistant vice-president of Federal Telephone & Radio Corp., was elected to the RMA board of directors for a term expiring in 1950.

ROBERT S. MAUTNER, formerly with RCA and CBS, is the newly appointed chief engineer of Tele-tone Radio Corporation's television division.

R. S. Mautner S. C. Kolanowski

STANLEY C. KOLANOWSKI, a member of the radio division of Stewart-Warner Corporation for more than 12 years, has been named chief radio engineer of the firm.

EDWARD D. GRAY has been elected president and director of the Electronic Tube Corp., Philadelphia, Pa. Heretofore he was with the New York Telephone Co., and was director of communications of the 8th Bomber Command during the war.

HENRY S. BAMFORD, former chief engineer, was elected vice-president and director of the Electronic Tube Corp.

FRED F. LOOCK, formerly vice-president and general manager, has been elected president of the Allen-Bradley Co., Milwaukee, Wisc., control apparatus manufacturers.

FRED C. LINDVALL, professor at California Institute of Technology, was recently elected to the board of di-

rectors of Consolidated Engineering Corp., Pasadena, Cal.

LOUIS A. THOMPSON, chief engineer of NEA-Acme, will head the laboratory, research, and engineering work in Acme Telectronix, a new division set up for research work and the manufacture of telephoto and electronic equipment.

L. A. Thompson

G. Reber

GROTE REBER, formerly a radio engineer at Stewart Warner Corp. and Belmont Radio Corp., has joined the staff of the National Bureau of Standards and will direct several new projects aimed at investigating effects of cosmic and solar noise on radio communication.

ARTHUR KOEHLER, previously with the Arma Corp. and the Langevin Co. of New York, has been appointed production manager of Sorensen & Co., Inc., Stamford, Conn., manufacturers of voltage regulators and electronic equipment.

ALBERT R. HODGES, former patent engineer at Airborne Instruments Laboratory, will now handle patent prosecution and related matters in the radio and electronics field for Stromberg-Carlson Co., Rochester, N. Y.

ELLERY W. STONE has been elected vice-president of the International Telephone and Telegraph Corp. Previously, before returning to active duty as Rear Admiral in the Navy in 1943, he had been president of the Federal Telegraph Co., operating vice-president and director of Mackay Radio and Telegraph Co., and executive vice-president, finally president, of Postal Telegraph, Inc.

WARREN A. MARRISON, a member of the technical staff of Bell Telephone Laboratories, has been awarded the British Horological Institute's gold

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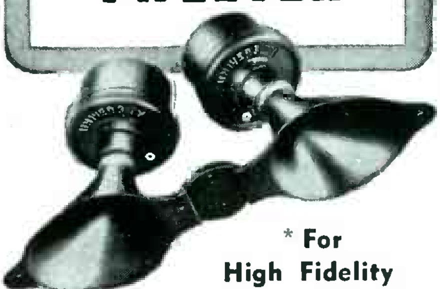

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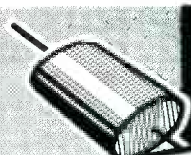

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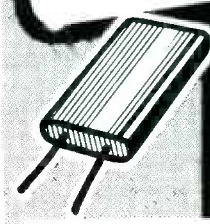

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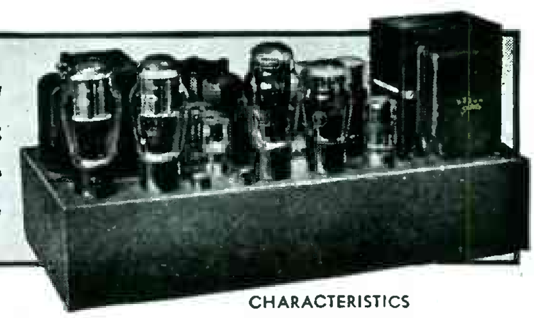

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medal for 1937 in recognition of pioneer researches in the development of the quartz crystal clock.

JAMES F. WHITE has recently been appointed assistant sales manager of Andrew Co. in Chicago. During the war he served as radar officer aboard a carrier and later was appointed engineer at MIT Radiation Laboratories.

DONALD A. QUARLES, director of apparatus development at Bell Telephone Laboratories, was elected a vice-president on July 21. He has been associated with the Bell System since 1919.

D. A. Quarles

P. R. Kendall

P. R. KENDALL is the newly appointed New York regional sales manager of the Communications Division of Motorola, Inc. He is the designer of the Kendall hearing aid for churches and was previously sales and field engineering manager of Belmont Radio in Chicago.

CARROLL G. KILLEN, former Signal Corps engineer and AAF officer, has been appointed to the field engineering staff of the Sprague Electric Co., North Adams, Mass.

FREDERICK E. HANSON, in charge of engineering at Western Electric's Electronics Shops in New York City and Allentown, Pa., was recently appointed manager of the shops.

C. B. JOLLIFFE, with RCA since 1935 in engineering and executive capacities, was elected to the board of directors of Radio Corp. of America.

HARRY C. INGLES, director of Radio Corp. of America and RCA Communications, Inc., was elected president of the latter organization.

GEORGE E. RICHTER, electronics engineer previously with Ruge-de Forest, Cambridge, Mass., has joined the technical staff of Arthur

D. Little, Inc., Cambridge, Mass., industrial research organization.

RUDOLF FELDT is now in charge of the C-R Oscillograph Manufacturing Dept. of Allen B. DuMont Labs., Inc., with headquarters in the Clifton plant.

ARTHUR B. BRONWELL, professor of electrical engineering at Northwestern U., was made secretary of the American Society for Engineering Education.

VICTOR F. RAGNI, electrical engineer, has been appointed to the research staff of Batelle Institute, Columbus, Ohio, where he will be associated with its division of industrial physics.

HOWARD W. RUSSELL, chief physicist of Battelle Institute since its origin, was recently made an assistant director. During the war years, he headed Battelle's work on the Manhattan District project.

ROBERT F. HERR, Philco vice-president in charge of the service division, was elected to the board of directors of the Company.

WARREN MASTER was recently appointed rectifier engineer at Richardson-Allen Corporation. For several years prior to his present connection he was associated with Federal Telephone and Radio Corporation as development engineer on selenium rectifier equipment.

EDWARD S. MAURY, formerly research engineer for Signal Corps Engineering Laboratories, is now manager of instrument sales at Roller-Smith, Bethlehem, Pa.

ROGER J. PIERCE was promoted to manager of radio communications at Mutual Telephone Co. of Hawaii.

SAMUEL SEELY, previously associate professor of electronics at the Naval Postgraduate School at Annapolis, is now professor of electrical engineering at Syracuse University. He joined MIT Radiation Laboratory in 1941, and spent considerable time in the southwest Pacific area in charge of a group of radar experts attached to General MacArthur's headquarters.

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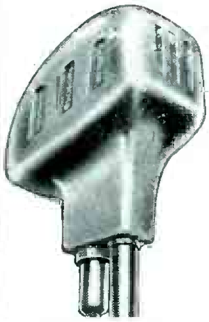

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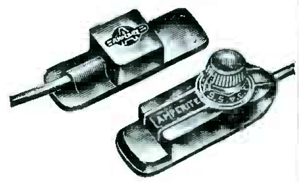

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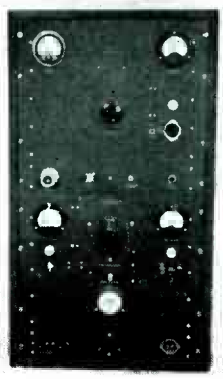

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NEW BOOKS

Industrial Electronics Maintenance

BY R. C. ROETGER. *Prentice-Hall, Inc., New York*, 1947, 190 *pages*, $3.50.

AS CLEARLY stated at the outset, this is a trade-school text intended to familiarize electrical service men with the principles of modern electronic control devices, other than communications equipment. Industrial electronics maintenance is both preventive and corrective, and keeping factory machinery in good order with the minimum of breakdowns requires a simple understanding of circuits, the actual components, their installation and hookup in the machine they control, and a practical knowledge of magnetic, electromechanical, pneumatic, hydraulic and optical control elements.

Circuit-testing equipment, the keeping of records, and trouble-shooting are well emphasized. The only presupposition is that of a fundamental training in electricity. Typical circuits of modern applications of electronic control are given, together with their explanation so the student should be well prepared to handle any specific piece of equipment with the aid of manufacturer's literature.

This book clearly identifies and explains the workings of industrial electronic equipment with a minimum of mathematical "whys and wherefores." It emphasizes that in the long run the cheapest maintenance is an ample supply of spare parts and frequent, sensible replacements before failures actually occur.—JAMES VAN VOAST

Fundamentals of Electricity and Magnetism

BY LEONARD B. LOEB. *John Wiley and Sons, Inc., New York*, 1947, 669 *pages*, $6.00.

THIS is the third edition of a textbook first published in 1931, designed to meet the needs of second-year students of engineering, physics, and chemistry at the University of California. The book is designed to cover the fields of electricity, magnetism and atomic structure, and this new edition differs from the older ones primarily in a condensation of the historical survey

and an expansion of the material on atomic structure and modern physics. A knowledge of elementary differential and integral calculus is assumed.

The book should be of considerable interest to a wide variety of readers, primarily for the more modern material on atomic structure, nuclear phenomena, gaseous conduction, photoelectric and thermionic effects, and modern techniques of electrical and magnetic measurements.

The modern material referred to above is to be commended highly. It embraces a surprisingly large number of topics, is relatively easy to read, and presents a large number of quantitative relations, most of which are of necessity stated without proof. It thus forms an excellent introductory, up-to-date survey of these broad fields of physical inquiry. On the other hand, the classical development of the fundamentals of electricity and magnetism leaves much to be desired. The order of presentation follows the standard line of many of the older books on the subject. This adherence to the older conventional order of topics, starting with magnetism, makes even more difficult the inherently difficult task of achieving unity and coherence of the subject as a whole. The treatment of the magnetic field is based almost exclusively on the concept of the magnetic pole, focussing the readers' attention on these "sources" of the magnetic field, so that the fundamental nature of the source-free field of magnetic induction fails to appear in its proper emphasis.

Although basic definitions are presented in very great detail, there are occasional lapses in precision of statement. Thus, for example, on p 219 the statement, "Since the internal resistance of a charged condenser is very low, the discharge of a large capacity at a high voltage will give instantaneous currents of high value", is, to say the least, somewhat puzzling. It is curious to note that the Maxwell equations are written for a lefthanded coordinate system, with the consequent result of an unfamiliar array of algebraic signs.

Although this reviewer has no quarrel with the Gaussian system of units employed generally throughout the text, it seems unfortunate that the discussion of the important m.k.s. system should be relegated to a mere footnote on p 31. In view of the relatively elaborate treatment of electromagnetic systems of units and dimensions, it seems unfair to refer only to the size of the m.k.s. units relative to those in the various c.g.s. systems, ignoring the fundamental question of dimensions, which form a large and essential contribution of the m.k.s. system.

A large and useful collection of problems is to be found at the end of this extensive book.

—N. H. FRANK

Fluorescent Lighting Manual

BY CHARLES L. AMICK. *McGraw-Hill Book Co., Inc., New York, N. Y., Second Edition*, 1947, 318 *pages*, $4.00.

THIS COMPREHENSIVE book covering electrical characteristics, illuminating properties, maintenance, and installation of fluorescent lamps has now been revised to include data on more recent equipment and practices. Many examples of lighting fixtures and installations are given. Valuable in the planning of factory or office lighting, this volume will also be of interest to radio engineers concerned with the suppression of radio interference arising from fluorescent lamps.—E.M.R.

Getting a Job in Television

BY JOHN SOUTHWELL. *McGraw-Hill Book Company, Inc., 1947, 120 pages, $2.00.*

THIS IS a book for those who know nothing about television except that they want to get into it. Written in an informal conversational style, it briefly outlines the types of jobs to be found in the fields of directing, writing, acting, set designing, and engineering. It will be of value mostly to those young hopefuls who want to write or act, by reminding them gently that they must be equipped with more than ambition and that experience in allied arts (radio, stage, motion pictures) is the best wedge. An engineer interested in television will find the book useful as a present to his friends or relatives in the young hopeful class.—E.H.A.

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.

Broadcaster Speaks

DEAR SIRS:

IT IS rather discouraging to observe the dubious quality of the receiving equipment presented to the public as high-quality equipment. In the average radio station, the engineer, as a matter of pride if for no other reason, works hard to gain the wide-range, low-distortion type of emission that is generally available to the public. Neither time nor money is spared in the task, and the management seldom complains at the outlay of cash to obtain the result.

Why this type of thinking is entirely absent in the receiver manufacturing industry has never been satisfactorily explained. The set builders claim they operate in a highly competitive field, and that "some other guy" turned out the original $9.95 job. If they can't get together through their own organizations, such as RMA, then FCC regulation certainly seems in order. At the manufacturing end of the line, an extra r-f stage to reduce image response, and the handful of of parts generally required to fix up the audio end would make so little difference in the retail price that it seems criminal not to include them.

Nobody screams when we pay $200 or $300 for one audio amplifier, but if the production cost of a complete receiver runs more than $20 somebody howls like a banshee. How a designer can call himself an engineer and turn out the junk is beyond comprehension. The only explanation is economic, of course, but it is hardly fair to the broadcaster to ask him to uphold his high standards, only to have them thrown away because some penny-pinching tin ear hasn't the guts to

build a good set in the face of competition.

The claim is made that the public doesn't want high-fidelity sound. I wonder of these same people have ever heard high-fidelity equipment. The so-called listening tests have been conducted for the most part under highly debatable circumstances. Certainly no one is going to like equipment of high audio range if that range is coupled with extraneous noise and distortion.

With friends and neighbors as the listeners, and using some passably good audio equipment playing broadcast type transcriptions, almost without exception an appreciative response was noted, and, more significantly, a willingness to buy, even at an estimated cost of $300. If the receiver manufacturers can't turn out a comparable set on a mass production basis for this amount of money, there is certainly something wrong with their production methods. Instead, the high-priced sets seem to have all the dough tied up in the cabinets—big walnut jobs with $9.95 chassis. Specifically, the changes needed in receivers include a stage or two of r-f, higher audio standards, certainly better loudspeakers, and enclosures designed for ear, rather than eye appeal. Tuning indicators such as the tuning eye would be very desirable, and are indispensible in f-m receivers. In one of the finest sounding sets I have seen, tuning on f-m was an impossible task, even for a trained man, and a tuning indicator is certainly needed for the set to do justice when placed in the hands of the public.

The only other thing that might be desirable is the placement of a king-size stick of dynamite inside the average juke box. This should be wired so that the dynamite explodes upon applying power to the amplifier.

JOHN L. KELLEY
Chief Engineer, KWWB
Walla Walla, Washington

CONSOLE FOR DUBBING, pictured on the front cover of ELECTRONICS November issue and further described on p 142 of that issue, is used by Reeves Sound *Studios*. The editors inadvertently used the word "Laboratories."

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New York Metropolitan Area, Connecticut and New Jersey, Calling on Radio Jobbers, Manufacturers, Department Stores, seeks additional allied electronic and radio parts lines. Organization completely staffed.

RA-2847, Electronics
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SOCIETE INDUSTRIELLE ALFA

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Oldest importer of American radio, electrical and electronic material.

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ENGINEER OR Physicist for mathematical research work on vacuum tubes. Should have a good knowledge of microwave tubes and electron optics. P-2820, Electronics.

ELECTRICAL ENGINEER (Electronics option). Young recent graduate with E. E. degree to design communication equipment, special electronic equipment, special electronic instruments, electronically controlled automatic equipment involving servo-mechanisms for pipe line company affiliated with large oil company. First class commercial radio license desirable. Some travel involved in summer months. Winter months in laboratory. Location eastern Pennsylvania. Appearance, personality and ability to work with small group of engineers important. State age, experience and salary requirements. P-2757, Electronics.

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SALARIED POSITIONS $2,500-$25,000. This thoroughly organized confidential service of 37 years recognized standing and reputation carries on preliminary negotiations for supervisory, technical and executive positions of the calibre indicated, through a procedure individualized to each client's requirements. Retaining fee protected by refund provision. Identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 278 Dun Bldg., Buffalo 2, N. Y.

EXECUTIVES $3,000-$25,000. This reliable service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer, Jennings, Dept. E, 241 Orange St., New Haven, Conn.

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MEASUREMENT AND Control Engineer. College graduate (Foreign) 6 years experience abroad in design, 7 construction of electrical laboratory equipment for the supervision of physical quantities, seeks responsible position in Los Angeles, Calif. PW-2774, Electronics.

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For Sale:
Nationally known quartz crystal manufacturing business. Large Western city. BO-2842, Electronics.

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ANYTHING within reason that is wanted in the field served by Electronics can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

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Eastern transformer plant. Well equipped —fully staffed—good business. All types of power transformers up to 5 KVA, chokes and audio. Special apparatus transformers our specialty. Plant capacity $75,000 monthly. This is not a sacrifice sale—asking no good will, net worth only. If you want to manufacture transformers or if you are a large user this is worth investigating.

BO-1257, Electronics
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VA approved. Fully equipped. 100 student capacity. Only Radio School in area. A profitable business. Reasonable.

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You may save valuable computing time. Free Brochure.
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New England manufacturer of sound recording equipment has positions available for:

CHIEF ELECTRICAL ENGINEER to direct the work of 7 electrical and electronic project engineers.

PROJECT ENGINEER with experience in the design of electro-acoustic transducers, communications degree preferred.

PROJECT ENGINEER with experience in the design of small induction and Universal motors.

PROJECT ENGINEER with electrical or mechanical degree experienced in the physical layout of amplifiers for high production.

PROJECT ENGINEER with experience in the mechanical design of disc or film sound recording equipment. If interested, submit resume to

P-2780, Electronics
330 West 42nd Street, New York 18, N. Y.

WANTED
PHYSICISTS & ELECTRONIC ENGINEERS

A major oil company located in the Southwest requires the services of a few competent physicists and electronic engineers as permanent research staff members. Positions are available for project engineers and group leaders. Preference will be given to men with the Ph.D. degree or equivalent in training and experience.

Work involves research in the field of physics, physical chemistry, and geophysical exploration, and development of analytical instruments and equipment. Applicant should have training and experience along theoretical as well as experimental lines. These positions are permanent and offer unusual opportunities for the right men.

Give complete details as to personal history, education, experience, and salary required. All applications will be treated confidentially.

P-2159, Electronics, 520 North Michigan Ave., Chicago 11, Ill.

SCIENTISTS and ENGINEERS

Wanted for research and advanced development work in the fields of microwaves, radar circuits, gyroscope systems and general Electronics. Scientific or Engineering degrees required. Salary commensurate with experience and ability. Inquiries should be directed to Mgr.-Eng. Personnel,

BELL AIRCRAFT CORPORATION
Buffalo 5, N. Y.

RADAR AND ELECTRONIC ENGINEERS MISSILE GUIDANCE PROJECT

New Navy electronic guidance and control project requires engineers for analysis, development and test of radar equipment, electro-mechanical servomechanisms, electronic timing and control circuits, and other guided missile equipment. Bachelor's degree in Electrical Engineering or Physics required; Master's degree or equivalent study of Mathematics, electronics and applied physics very desirable for responsible positions. Salary to $7500 depending upon qualifications.

Write or phone Mr. C. D. Perrine, Jr., Chief Electronics Engineer

PILOTLESS PLANE DIVISION
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A graduate engineer with drive having a sound theoretical background and a high degree of experience in the design and development of photo-electric and electronic circuits and control devices. Experience in practical design of electronic control assemblies is essential.

The requirement is for an unusually ambitious and hard-hitting man who desires executive responsibility and a substantial career on the basis of results; with a leading manufacturer of industrial electronic controls.

P-2647, Electronics
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5 POSITIONS NOW OPEN
Location - Long Island

Phd—Physicist, Math. or Electronic, Major.
MSME—Designer, small electro-mechanisms.
MSEE—Radiation Lab. or Equivalent.
BSEE—Electronic Engr; Servos.
BSEE—Electronic Eng; pulse circuits.

Have you considered the advantages of working for a growing company?

1. Greater flexibility.
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3. Greater variation in problems.
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If you are alert to these advantages, please send resume of qualifications to

P-2996, Electronics
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Nationally recognized Philadelphia research organization is interested in men with the following qualifications for its permanent staff.

E.E., pref. M.S. or Ph.D., qualified by 7-10 yrs. exp. to design circuits, mechanize math. equations. Ability to originate, instruct and direct others. Refer to M 8.

Math. Physicist, Ph.D. physics or math. Previous exp. should include math. analysis of physical or physical-chemical problems. Ability to supervise. Refer to M 104.

E.E., pref. M.S. or Ph.D. 7-10 yrs. exp. Application electrical, electronic and physics to instruments, communication equipt., recording equipt. and possible servo-mechanisms. Refer to M 76.2.

Salaries will be commensurate with exp. Apply by duplicate resumes to:

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Employment Consultants
Lewis Tower 15 & Locust
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Television Components Engineer Wanted

To develop designs and test equipment for production of sweep transformers, yokes, high voltage transformers, etc. Excellent opportunity with progressive eastern transformer company.

NEW YORK TRANSFORMER CO.
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ENGINEER or PHYSICIST for mathematical research work on vacuum tubes. Should have a good knowledge of microwave tubes and electron optics.

Apply Director of Research

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350 Scotland Road Orange, N. J.

ELECTRICAL ENGINEER

Must be graduate E. E. Must have heavy experience in audio work, particularly with sub-miniature parts. Some mechanical knowledge and production experience. Will be completely responsible for research, design and assembly small electronic device. Give complete education, experience—particularly as applied to above, age and salary required. Unusual opportunity and permanent security for right person. Box

P-2074, Electronics
330 West 42nd Street, New York 18, N. Y.

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for Metropolitan New York to call on Radio manufacturing trade, wanted by old established company. Please give details, background and past experience. Your reply will be held strictly confidential.

SW-2376, Electronics
330 West 42nd Street, New York 18, N. Y.

PORTABLE CURRENT TRANSFORMER

Weston Model 461 Type 4 (see illustration). This unit can be used with any precision 5 Amperes A.C. Meter to extend the ranges of the meter to 50, 100, 200, 250, 500 or 1000 Amperes A.C. Accuracy within ¼ of 1%; Normal Secondary Capacity = 15 Va; Binding Posts for 50 Ampere tap; Inserted primary for 100, 200, 250, 500 and 1000 Amperes; Insulated for use up to 2500 volts. List Price $98.00.........NET fob. NY $35.00

PORTABLE A. C. VOLTMETER

Weston Model 433, 0-600 volt A.C.; accuracy within ¾ of 1% from 25 to 125 cycles. Hand Calibrated Mirror Scale 4.04" long with 150 Scale divisions; Knife edge pointer. Moving Iron Vane type magnetically shielded. Dimensions 5"x6"x3½". List Price $59.50...........NET fob. NY $27.50

A. C. VOLTMETERS

15 V—G.E., AO-22—3½", black scale, red fl bake case $3.00

150 V—G.E., AO-22—3½", rd fl bake case..$5.50

150 V—with external resistor for 300 Volt to make dual range 150 and 300 Volt—G.E., AO-22—(multiply scale readings by two)..$6.50

75 V—Weston 517—ring mtd 2" rd fl metal case $2.95

300 V—Weston 517—2½", rd fl bake case..$6.00

8 V—Weston 476—3½", rd fl bake case.. $3.50

130 V—Weston 476—3½", rd fl bake case..$4.95

150 V—Weston 476—3½", rd fl bake case..$5.50

15 V (100 MA)—W.H., NA-35—3½", rd fl bake case $3.95

150 V (10 MA)—W.H., NA-35—3½", rd fl bake case $5.50

150 V—Triplett 331-J.P.—with external resist for series connection to increase range to 300 V. (multiply reading by 2) to make a dual range 150-300 Voltmeter—3½", rd fl bake case..$5.50

150 V—Burlington 32 XA—3" square fl bake case $4.00

15V—G.E., AW-41—black scale—no scale calibration (SC IS-122) bland scale reference mark at 10 Volts $2.50

300/600—Burlington 32 C—with external resistor for 600 volt; sc calibrated 300 and 600 volts $8.00

A. C. AMMETERS

30 A—Triplett 331-J.P.—3½", rd. fl bake case $4.00

75 A—Triplett 331—J.P.C.—3½", rd fl bake case $3.50

50 A—G.E., AO-22—3½", rd fl bake case..$4.50

60 A—Simpson—3" sq fl bake case........$3.50

75 A—W.H., NA-35—3½", rd fl bake case. $4.00

SPECIAL METERS

Frequency Meter—Dual Range—covers frequency ranges from 48 to 52 cycles and 58—62 cycles—J.B.T. 30-F—Dual element. Vibrating Reed type—115 V—3½", rd fl metal case........$5.95

Voltage Polarity Phase Rotation Tester—Triplett 337 AVP—Checks 115, 220 and 440 line voltage—locates open circuits, blown fuses, damaged wiring, etc. Indicates whether A.C. or D.C. and polarity of D.C.—Checks phase rotation to determine direction of rotation of motors, operation of controls, etc.—Consists of a 3" square meter and a small polarized vane movement in a small handy sized case—Complete with 36" leads with test prods. $8.50

Running Time Meter—G.E. SKTS—115 Volt, 60 cycle—totals up to 99,999 hrs—3½", rd fl bake case $4.95

Time Totalizer—Indicates up to 9,999.9 hours for 50 or 60 cycle—Operation on 105 to 130 volts—Black scale 3" rd fl bakelite case—clamp mounted—Made by Industrial Timer Corp. $4.00

DB Meter—W.H. RC-35—minus 10, plus 6 ODB—1.897 V. 6 MW—600 ohms—3" square $4.50

D. C. MICROAMMETERS

100-0-100 microampere—zero center—approximately 950 ohms resistance—W.E.—3½", rd fl bake case—concentric style $6.50

200 microampere mvt—G.E., DO-41—Knife edge pointer—sc mkd "Set Carrier"—supp with paper V.O.M.A. sc—3½", rd fl bake case........$4.95

500 microampere mvt—G.E., DO-41—sc cal 0-20 KV—supp with paper V.O.M.A. sc—3½", rd fl bake case $4.95

400 ua mvt—approximately 500 ohms resistance—Triumph—sc cal 0-3, 0-15 and 60 V MA—4" Rect fl bake case—Knife edge pointer......$5.50

McClintock 2" rd ring, mounted metal case—0-700 microamperes D.C.—Full scale 0-100 microamperes D.C. Half scale, 0-1 MA A.C. Full scale and 1½ Volts A.C. Complete with self contained half wave rectifier. Black scale, luminous markings, scale 0-10- $2.50

D. C. VOLTMETERS

5 KV—Weston 301—Complete with 1000 ohms per volt—ext prec wire wound resistor & mtg clips—3½", rd fl bake case........$9.95

15 Volt—G.E. DW-41—black sc, no Caption—sc cal 0-15—2½", rd fl bake case........ $2.50

200 V—G.E. DO-41—black scale—3½", rd fl bake case—1000 r/v $3.95

2.5 KV—G.E. DO-41—black scale—with 1000 r/v ext wire wound resist........$6.95

0-10 V—W.E.—3½", rd fl bake case—concentric style $1.00

0-75 V—W.E.—1000 ohms per volt—3½", rd fl bake case—concentric style........$3.00

500 V—W.E.—1000 ohms per volt—3½", rd fl bake case—concentric style........$5.00

50 V—W.H., NX-35—200 ohms per volt—3½", rd fl bake case........$3.95

200 V—W.H. NX-35—200 ohms per volt—3½", rd fl bake case........$3.95

1.5 KV—W.H. NX-35—with 1000 ohms per volt—ext prec wire wound resistor & mtg clips—3½", rd fl bake case........$7.25

20 KV—W.H. NX-35—with ext prec wire wound 1000 ohms per volt resistor and mtg clips $21.00

10 V—Sun 2AP45S—100 ohms per volt—2½", rd fl bake case $2.50

15 V—McClintock D-100-R-1—1000 r/v—black sc—2½", rd fl bake case........$3.00

5 V—W.H. NX-33—200 ohms per volt—2½", bake case $3.50

D. C. AMMETERS

30-0-30 A—zero center—G.E. DW-51—2½", rd fl metal case $3.50

150 A—W.H. F-1 (NX-33)—black scale—comp with ext 50 MV (Aircraft style) shunt—2½", rd fl bake case $2.50

200 A—Weston 506—Comp with ext 50 MV shunt—2½", rd fl bake case........$7.50

15 A—Triplett 0321-T—3½", rd fl bake case. $4.00

30-0-30 A—Beede—2½", rd fl metal case.....$3.00

50 A—Hoyt—2½", rd fl metal case........$2.95

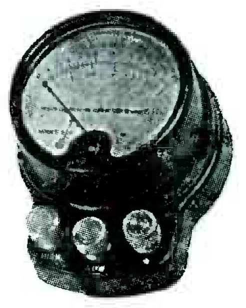
240 A—W.H. Aircraft type—Complete with ext 50MV shunt—2½", Aircraft style case.....$3.95

PORTABLE A.C. AMMETERS

Surplus New

WESTON

MODEL 528



DUAL RANGE 0-3 Amp. and 0-15 Amp full scale for use on any frequency from 25 to 500 cycles. The ideal instrument for all commercial, industrial, experimental, home, radio, motor and general repair shop testing. Comes complete with a genuine leather, plushlined carrying case and a pair of test leads. A very convenient pocket sized test meter priced at less than 50% of manufacturers list. Your cost..............ONLY $12.50

A. C. VOLTMETERS

(See illustration of Ammeters)

SURPLUS NEW WESTON

MODEL 528

DUAL RANGE 0-15 and 0-150 Volts for use on any frequency from 25 to 125 cycles. Complete with plushlined leather carrying case and a pair of test leads. This Voltmeter, with the matching model Ammeter as illustrated above, makes an ideal pair of test meters for any mechanic to carry around in his tool box.........ONLY $9.50
Combination Offer: 528 Voltmeter—528 Ammeter BOTH For $21.00

WESTON 687 OUTPUT METER

3 full scale ranges 0-2, 0-10, 0-50 Volts Audio Frequency. Complete with 3' lead with pin plugs and plug (PL 55)
NET fob. NY 7.50

D. C. MILLIAMMETERS

30 MA—G.E. DO-41—3½", rd fl bake case...$3.50

50 MA—Weston 506—2½", rd fl bake case...$3.95

200 MA—Weston 506—black scale—2½", rd fl bake case $3.50

1 MA—G.E. DW-51—100 MV mvt, sc cal 0—50 MA—2½", rd fl bake case........$3.50

20 MA—GE DO-53—3" sq fl bake case.......$3.25

80 MA—GE DO-41 3½" rd fl bake case.......$3.25

1.5 MA—Weston 506—2½", rd fl bake case..$2.95

1 MA—Sun 3AP259—3½", rd fl bake case....$3.00

1 MA—Triplett 0321—3½", rd fl bake case——with circuit diagram $3.95

1 MA—DeJur Amsco 310—sc cal 0—4 KV sc—3½", rd fl bake case—supp with V.O.M.A. sc and circuit diagram $3.95

1000 MA (1Amp)—DeJur Amsco 310—3½", rd fl bake case $3.00

150 MA—Gruen 508—2½", rd fl bake case...$3.00

200 MA—Gruen 511—2½", rd fl bake case...$3.00

RADIO FREQUENCY AMMETERS

1.5 A—Weston 507—black scale—2½", rd fl metal case $2.50

2.5 A—Weston 507—2½", rd fl bake case....$3.95

3 A—Weston 507—black scale—2½", rd fl bake case $3.50

250 MA—W.H. NT-33—black sc, sc cal 0—5 mkd "Antennae Current"—2½", rd fl bake case $3.50

3 A—W.H. NT-35—3½", rd fl bake case......$5.50

2 A—Simpson 135—2½", rd fl bake case.....$3.50

1 A R.F.—GE DW-52—2½", metal case.....$3.00

1 A R.F.—Weston 425—3½", rd fl bake case $7.50

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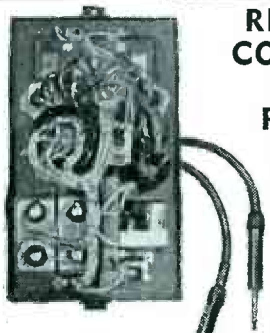
REMOTE CONTROL UNIT RM-53



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TRANSFORMERS 115V/60cy INPUT 110 to 220V/50-60cy/3.4Amp $4.95
115 to 230V/50-60cy/2KW 19.95
375VCT/110ma, 1320V/8ma, 5V/3A 2.5V/3.25A, 6.3V/3.25A, 6.3V/2.75A Cased Cathode Ray Transf................. 7.95
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21600V'Dblr or 10800VCT/95ma.......... 19.95
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3000V/10ma $4.50; 4000V/10ma......... 5.50
5000V/10ma $6.95; 2.5V/3A/20KV....... 4.95
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BRADLEY DUAL BRIDGE meter Rect... .98
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WSTGHSE RECTOX FW/COPOX 13V/2Amp. 3.95
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IT&T SELENIUM 110 VDC/2.6Amp FW.... 6.95
IT&T SELENIUM 2.2V/1.5Amp FW....... 1.79
OIL CONDENSERS & WORKING VOLTS/DC
2x1mfd/400V/12 for $1; 3x.1m/400V/10 1.00
1mfd/400V/12 for $1; 2mfd/400V/6 for.. 1.00
.5mfd/500VGE/12 for $1; 1m/500VGE/10 for 1.00
.05mfd/600V/30 for $1; 2x.05m/1600V/25 1.00
3x.05mfd/600V/15 for $1; 3x.22m/600V/15 1.00
.1mfd/600V/10 for $1; 2x.1m/600V/10 for 1.00
3x.1mfd/600V/10 for $1; 2x.25m/600V/10 1.00
3x.25mfd/600V/10 for $1; .5m/600V/12 for 1.00
2x.5mfd/600V/8 for $1; 1.22m/600V/10 for 1.00
.1mfd/1000V/5 for $1; .25m/1000V/4 for. 1.00
1mfd/1000V/3 for $1; .05m/1500V/2 for.. 1.00
2x.1mfd/1500V 2 for $1.25; .5m/1500V/ .75
.1mfd/2000V/2 for $1.50; 0.1mfd/3000V.. 1.25
.03mfd/7500V/$1.98; 15m/35V/elect/15 for 1.00
Silver Mica .02681 or .0490 W.E./4 for... 1.00

CONSISTS OF TWO JAN NEW 866A TUBES, TRANSFORMER GARDNER ELEC CASED 2.5V 10 AMP, 115V/60cyinpt. H.V. insltd 9000V wkg similar to illustrated unit, "TAB" Tested 16000 VAC Test: Same mtg as KENYON T389—SOCKETS CERAMIC JOHNSON 224.
"TAB" SPECIAL $5.95
TRANSFORMER ONLY for Two 866A's..... $3.95
872A's COMB. TRANSFORMER, sockets.... 12.00
872A TRANSFORMER 115 60cy........... 6.95
3x2.5V/12A/12KVins 115/60cy inpt....... $.95
3x5V/16A/20KVins 220V/60cy inpt....... 16.95
WL561 RECTIFIER tube 50,000V/750ma/ (LP$125) 25.00

5mfd/600WV oil cndsrs ....2 for $.98
MICROSWITCHES; 2 for 39¢..TEN for 1.49
GE Safety Switch 69¢ @.......2 for 1.00

OSCILLOSCOPE 3" KIT 3BP1 includes transf 115V/60cypri,375VCT/110ma, 1320V, 5V/3A,2.5V/3.25A,6.3V/-2.75A new TUBES 3BP1, 5Y3GT, 2V3G Rect, Condsrs, Choke low H. V. Supply Complete $15.95
NATIONAL XS-2 feed thru insltr..2 pr. .25
POWER SUPPLY RELAY RACK TELETYPE SYSTEM, W. E. KS5825 SELENIUM RECTIFIER 115to230V/50-60cys inpt outpt .4Amp/115VDC/ .5% ripple 19.95

Lacing Cord #9............per lb. $1.49
Microswitch Spdt. 35¢ @....Ten for 3.00
Motor Bodine Reduction 115V...... 4.95
GE Motor 220 Vac/1-3HP/60c New..10.95
Delay Line Network & Filter:
W.E. D164855/650 ohm, delay 4, 1.2, 3.4, 0.5 microsecds............ 9.95
W.E. D168435/½ microsecd.......... 4.50
Millen 1 Microsecd delay line....... 2.95
W.E. D164869 unbal. low pass F.... .98
W.E. D170396 Bead Thermistor...... .90
W.E. D159314/600 ohm in & outpt 5100 cy. cutoff filter cased....... 9.95
GE Telv. 0.4m'sec. pulse Transf....... 1.49
Utah Television pulse Transf......... 1.49
Audo Band Pass Filters 20DB cutoff HiQ 60 or 90 or 150 cycle cased & shelded $1.95 ea.............3 for 4.50
Crystals Rochelle mtd..........4 for 1.00
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Power Rheostats 25 Watt 400, 500, 2500, 2500 ohm 69¢ @....Four for 2.49
Power Rheostats 50 Watt, 8, 60 100, 225 ohm 98¢ @..........Four for 3.49
Fuses 250 ma/3AG............48 for 1.00
Fuses 200 ma/8AG...........50 for 1.00
Fuses 4 Amp/3AG............50 for 1.00

GENERAL RADIO 566A WAVEMETER
Direct Reading 0.5 to 150 mc's 600 to 2 mtrs.
ACCURATE DIAL Calibration, five Plug in coils
NEW GR (LP $60)
SPECIAL $29.95

VARIABLE CONDSR Millen 150mmf/3000V & 2 non-Ind 12ohm/40Watt resist, Knob, clips PO/SC/A2T Phantom Ant New..... $1.00
SIMPLEX RUBBER CO-AXIAL SPLICE.10 or 1.00
COIL 5Prong slugtuned 2to2.7mc's...10 for 1.00
COIL THREADED & wound 2½" dia/61 turns for Collins tapped PIANT netwk.2 for 1.49
Condsr Var splitstator 90MMF per sec...... .98
KIT G&P Tube caps ¼, ⅜, 9/16".50 for 1.49
KIT SOCKETS 8, 7, 6, 5, 4prong, etc.50.for 2.49
KIT COIL FORMS small HF........50 for 1.00
KIT IRON core Slugs & screw.......50 for 1.00
KIT ELASTIC Stop NUTS Asstd.....75 for 1.00
KIT LUGS LARGE Radio type......100 for 1.00
KIT LUGS SMALL Radiotype......500.for 1.00
KIT MOTOR BRUSHES Asstd.......100 for 1.00
KIT VITREOUS WW Resistors......20 for 1.00
KIT CONTROLS Pots AB/J Asstd...10 for 2.00
KIT POWER RHEOSTATS 25&50watt..6 for 3.49
KIT ROTARY SWITCHES Asstd.....6 for 1.75
KIT KNOBS ASSTD WITH Bushings.25 for 1.25
KIT FUSES ASSTD BUSS & L. F..300 for 1.95
KIT GROMMETS RUBBER....100 asstd for 1.00
KIT SPAGHETTI Sleeving Asstd...75ft for 1.00
KIT SILVER CONDENSERS........30 for 1.50
KIT SILVER & MICA CONDENSERS.50 for 2.00
KIT RESISTORS BT½&1W/50to2Megs 100 for 2.50

"TBY" VIBRAPACK, STORAGE BATTERY 4V & MANUAL COMPLETE NEW $9.95
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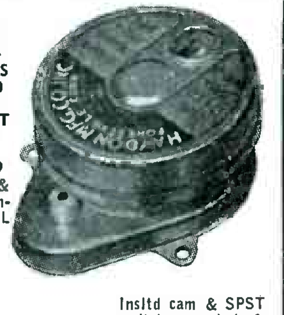
Used VIBRAPACK $4.50; Used S'BAT. 3.95
HEINEMAN CIRCUIT BREAKERS 10ma —3—50—35—40Amp each......... 1.25
Dual/10Amp/$2.95; KLIXON/60Amp... .89
SQUARE D25Amp Toggle.............. .69
ANT Relay Hif/SPNC/115V/60cy..... 1.95
S. DUNN D.P.D.T. 115V/60cy/15A... 1.95
$2 Min. order FOB N.Y.C. Add Postage all orders and 25% deposit. Worth 2-7230. Send for catalog. Specialists in International Export, School, College & Industrial trade. Money-back "TAB" Guarantee.

CLOCK MOTOR



SYNCHRONOUS 110V/2.2W/60 cy. AC/1RPM/ 86 Rev. SHAFT ⅜" lghth/.125 dia.
SPECIAL $2.49
Insltd Cam & SPST switch unmounted SPECIAL $.49
C'MOTOR SYNCHRONOUS AC/10V/60cy SHAFT ½"lgth, thd 6/32 SPECIAL 69¢, Two for 98
Insltd cam & SPST switch mounted & with motor 89¢
SOUND POWERED TELEPHONE NEW.......$9.95
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RM13G Remote Telephone tube Amplifier 115VAC/60c & Handset & Ringer for Xmtter operation, phone, CW or tone or Telephone Communication includes DB mtr & line transformer 14.95
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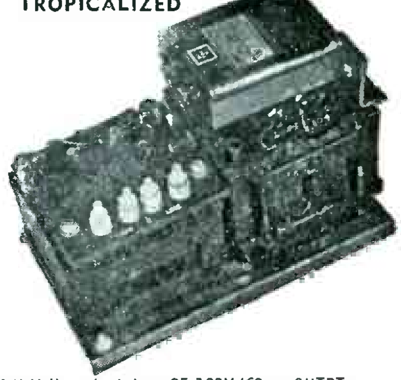
KURMAN 1000cycle hummer adj.......... .98
HEADSET H-16/WE 509 Hilmped 10000 ohm 3.49
H23 HANDSET RCVR, MICROPHONE...... 3.95
HS30 HEADSETS 79¢ ea. Two pr. for...... 1.50
EE65 TELEPHONE TEST SET for talking, signaling & testing lines & equip, portable self contained includes fan mtr. Tests Volts 50 resist 22 ohms to 2 megs....... 19.95
EE8 TELEPHONE & RINGER INTERCOM for Telephone handset portable or fixed....... 9.95
RC58B Complete tape facsimile decipher....100.00
BC 918B Recorder Scanner P/o RC58B..... 30.00
AN/GCQ-1 Code practice equipment & 6 keys & speaker amplifier 115V/60c op........ 8.95
TG10/20 Watt PP6L6 amp. 115V/60cy&Cab 20.00
Telephone INVERTER & CONVERTER inpt 43-47VDC, Outpt 75-90V/20cys W. E. 18.00
TELERING BD-90 TELKOR model H inpt 110 V/60cy, Outpt 90V/20cy new Csd.... 7.95
RINGER TELEPHONE Holtzer Cabot 6V 20cy/6ma or equiv. $1.49 ea......Two for 2.49
PLUGS PL68/WE110A Complete..Seven for 1.00
PLUG PL55 & CORD ea 25¢......TEN for 2.00
KEY S. C. COMPLETE 25¢........TEN for 2.00
SWITCHBD U4/GT siglite dual plug for Telephone use, takes place switchbd has neon glolamp & Radium idty frame..10 for 2.00
HS-16A HEADSET 600ohm Telephone, etc. .69
HEADSET & MICROPHONE NAVY TBY LN. 2.95
WIRE AN insltd #10 Std'd flexible.1000ft 12.95
LAB SIGENERATOR TM61056 OAK CASE 15-25 & 180-230mcs, Cal attntr to 100000microV. modulated 400to8200cys or non mod. inpt 115V/60cy NEW COMPLETE XTAL DIODE INPT............ 59.95

RAYTHEON VOLTAGE REGULATOR

CASED NEW S. C. TROPICALIZED



Adj-Voltage Inpt taps 95-130V/60cy. OUTPT 115V .58Amps ONE HALF/1% REGULATION. WT20 lbs. 6-1/8H8¼L5⅝"W-OVERLOAD PROTECTED, RUGGED DSGN. "TAB" SPECIAL $14.95

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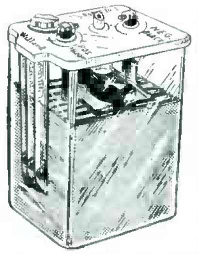

NEW WILLARD PLASTIC STORAGE BATTERY—NON SPILL BB54/ER-27-2/2 VOLT/30 Amp hrs BALL Indicator Type FOR SCR 593/728A,GEPortables "TAB" SPECIAL $1.79, 2 for $3.30; Bottle acid qt 95¢; one gal (95 oz) R'Exp only........$2.95

* * * * * * * * * *

STORAGE BATTERY BB206/U WILLARD Nonspil 2V/26Amp hrs, SPECIAL $1.25 TWO For $2.25; TEN FOR $10.00.

* * * * * * * * * *

BATTERY BURGESS 3V/F2BP/1947 date..$ .25
Test Set Supreme 542 VOM/24 ranges *LN..15.95
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TS Same as WESTON 697 VOM & Case....20.95
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Crystal Diodes 1N21@50c...............3 for 1.25
Crystal Diodes 1N23 or 1N26@$1........3 for 2.00
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I-222 Crystal calib Signal Generator Freq-meter. Monitor, 8 to 15 & 45 to 77mcs dual osc, covers IF ranges FM & Television 2nd, 3rd, 4th harmonics useable to 230mcs Six tubes, 115V/60 cy inpt Complete..........39.95

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TRANSFORMERS 115V/60 cycles inpt:
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1000VCT/110ma, 6.3V/5A, 5V/3A, 4x6.3V/ .65 4.25
1000V/45ma, 795VCT/80ma, 3x5V/3A, 6.3VCT/ 1A. 6.3V/.3A Hmtclly cased, HVinsltd..... 7.98
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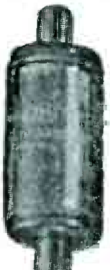

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2mfd/2000WVDC ......2 for 3.98
3mfd/2000WVDC ......2 for 5.98
4mfd/3000WVDC 5.00
2mfd/5000WVDC 10.00
4mfd/5000WVDC 15.00
2mfd/12500WVDC 25.00
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8mfd/660VAC/2000WVDC ... 2.95
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GE 100MMF/7500V 4.95
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"IF" TELEVISION OR FM Dbl slugtuned Hi-freq dsgn, Constant Q, 11.4 to 13.4 mc's ....Two for $ .98
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WE Diaphragms ES671349 for Drivers...... 3.95
RCA Bull Speaker *LN....................14.95
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IRC. SHALLCROSS, WE MEPCO, INST. RES. CO., OHMITE FOR METERS BRIDGES, AMPLIFIERS

*½%	**5%	†10%	(Rest †%)
2000**	4300**	5100**	12000**
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ABOVE SIZES 30c each asstd....... 10 for $1.98

1	2	3	4	5
6	10	12	20	25
30	37	45	55	60
70	80	100	101	107
120	125	150	160	165
182.4	200	209.4	220	230
240	250	266	280	286
300	320	340	400	426
440	452	480	500	520
540	550	550	600	612
640	700	750	800	850
900	910	1000	1030	1100
1110	1150	1175	1200	1250
1260	1330	1350	1500	1600
1650	1800	1900	1960	2000
2080	2142*	2300	2400	2485
2490	2500	2600	2635	2800
2850	2860	2900	3000	3100
3290	3500	3730	4000	4300
4440	4444	4500	4720	4850
4885	4900	5000	5025	5210
5270	5500	5730	6000	6300
6500	7000	7500	7613	7700
7950*	8000	8250	8500	9000
9710	10000	10500	12000	14600
15000*	17000	18000	19000	20000*
21500	23000	30000*	40000	50000
95000	68000	75000	80000	91000

ABOVE SIZES EACH 45c......TEN FOR $3.00

147000	150000	166750	175000	185000
201000	229000	250000	254000	265000
268000	294000	314000	333000	333500
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478000	500000	575000	600000	654000
700000	750000	900000		

ABOVE SIZES EACH 60c......TEN FOR $5.00

950000	1 MEG	1.200	2 MEG	2.855
3 MEG	3.673	4 MEG	4.230	4.250
4.5 MEG	5 MEG	9.050	10 MEG	11.55
12.83	20 MEG			

ABOVE SIZES EACH 90c......TEN FOR $6.95

VICTOREEN VACUUM PRECISION RESISTORS
.83 MEG 1 MEG 1.5 MEG 2 MEG 3 MEG 3.75 MEG 0.25 of 1% accy Hivolts ea $1.00
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IRC NAVY PRECISION 2 MEG 1/5 of 1% Caged.................................. 4.95
WESTON 456 Twin Galvoma 4" accy ½ of 1% Hidamping 40–0–40 & 10–0–10 ma........ 10.95

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TU47, 48, 50, 51, 52 tuning units HT4 @.... 3.95
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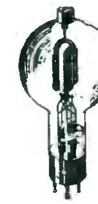

1E7G	$ .89	6SL7	.69		
1L4	.98	6SN7	.68		
1P5G	1.08	6V6	.97		
2A5	.60	6X5	.75		
2X2	.81	6Y6G	.87		
2V3G	.75	7C5	1.00		
3A4	.52	12A6	.60		
3B7/1291	.49	12AH7	1.00		
3S4	1.00	12K8	.84		
5R4G	.70	12SA7	.58		
5T4	.97	12SG7	.82		
5U4G	.63	12SK7	.69		
5W4	.97	12SR7	.69		
5Y3G	.41	12SQ7	.62		
5Z3	.55	35L6	.62		
5Z4	.89	35Z5	.52		
6AB7	.89	50L6	.64	954	.40
6AC7	.65	30	.74	955 & S..	.64
6AG5	.97	80	.41	956	.90
6AG7	.90	15E	1.95	958A & S.	.90
6AK5	.75	3C24/24G	.74	991	.39
6AL5	.81	100TS	2.90	12SH7	.87
6B4G	1.20	VR105	.74	1299/3D6	.49
6B8G	1.00	VR150	.74	1613	.89
6C4	.65	2C26	.74	1616	2.90
6C5	.48	2C40/446A	.88	1625	.49
6C6	.73	3B24	.74	1641/RK60	.89
6C8G	.74	304TL	5.95	2050	.81
6D6	.61	307A	3.25	9002	.80
6E5	.69	450TL	18.00	9004	.54
6F6	.69	WL531	25.00	9006	.67
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6G5/6H5	.90	703A	3.95	5AP1	3.55
6G6	1.08	717A	.89	5BP1	3.37
6H6	.58	723	2.95	5BP4	3.37
6J4	1.45	725	2.95	5CP1	2.25
6J5	.62	807	1.30	5FP7	4.50
6J6	.54	808	2.00	7BP7/1813	2.90
6J7	.81	813	9.00	VT127	2.95
6K7	.66	815	2.20	631P1/SN4	3.75
6K8	.81	826	1.45	CK1005	.49
6L6	1.15	829B/3E29	2.90	2J21	16.00
6L7	.97	836	1.47	2J32	18.00
6N7	1.20	837	2.25	2J55	18.00
6SA7	.43	864	.60	2K29	6.95
6SC7	.84	866 & S...	1.00	20X672	2.95
6SG7	.54	872A	2.75	199698	2.95
6SJ7	.63	931A	1.87	289881	2.50
CE206/2RA6	3.95	CE215/2RA15	10.00	805	3.70
				845	3.70

For Breakages & open filaments no guarantee.
MAZDA S6/115V Bulb 10 for $1.45; 49/2V/60ma ....10 for $.90
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SCR585 WALKIE TALKIE *LN.............39.95
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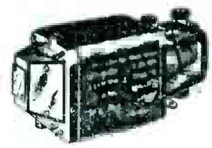
AN/ARN-5/BC733 RCVR 335mcs less tubes *LN 9.95
SCR/610 Recvr & Xmtter *LN.............20.00
COILS for BC191 or VFO TU5, 7, 8, 9, 10 @ 2.70
COILS for BC223, TU22, 26 etc............. 2.70
WILCOX CW3 & set coils....................14.50
CW & F3 coils 5-10 or 9-16mc's each....... 2.70
RT-APN-1 Altimeter less tubes..............12.95
BC456 po SCR274 MODULATOR less tubes.. 1.69
BC453 po SCR274 RCVR 190-550KC *LN... 6.95
BC454/3-6mcs RCVR with tubes *LN........ 4.50
RC455/6-9mcs RCVR with tubes *LN........ 4.50
BC457-458-459 XMTTER *LN each.......... 5.95
Dynmtr PE94A Bendix inpt 24-28V, outpt 300V/260ma. 150V/10ma. 14.5V/5A. inpt & outpt filters, V'Regulator & S'Relay for SCR522 .... 9.95
Dynmtr DA3A inpt 28V, outpt 300V/260ma 150/V10ma, 14.5V/5A Cont Duty—For SCR522—Can be used as 110VAC motor Hi Torque 3.85
Dynmtr DM4, inpt 12 & 24V, outpt 225V/100-ma 440V/200ma, Cont Duty, rugged dsgn, fields can be paralled for 6V operation or use as motor.................................. 5.95
Dynmtr inpt 28V/1.4A, outpt 250V/60ma cont duty, wgt 2 lbs: operates on 12V fields in parallel, also 110V motor............Two for 1.80
Dynamotor 12 & 24V inpt, 275V/110ma & 12V/3A outpt Alnico P'Magnet unit........ 1.95
FILTERS IN & OUTPT for Dynmtrs.......... .49

DYNAMOTOR NEW HIEFF P'MAGNET ALNICO 12/24V inpt TAB TESTED GTD 6V inpt 3 Amp, output 240V/100ma or 125ma int duty. Rated 500V/50ma at 12 of 24V inpt. "TAB" **Special $3.49**



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GE MW 22-2—SCREEN—WHITE, MEDIUM PERSISTENCE — MAX. Plate volts 5000—Magnetic Focus—Magnetic Deflection—Heater 6.3 volts at 6 amps.—15" long.

Price $17.95

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We have a large quantity and variety of I.R.C. Precision resistors down to 1/10% tolerance and listing up to $5.00 ea. These are made available for .35 each for any of the following Ohmages and types:—

WW-3

Ohms	Quantity
50	1858
70	3470
100	210
110	290
125	228
130	883
750	2833
1000	2376
2200	1803
2230	322
7500	309
10000	2226
12000	2014
14460	172
15000	5231
17000	3028
20000	11872
20520	141
26500	714
33000	2612
40000	210
41800	209
46000	1488
50000	371
54500	1435
920000	1536
100000	950
109000	1316
120000	407
4.3	870
5.1	2541
6	305
13.333	1690
10	467
12	378
14	309
20	1498
22	674
35	1037
53.96	258
280	445
1200	100
4000	723
8400	20

WW-4

Ohms.	Quantity
10.2	623
290000	193
53.32	295
988	339
23.29	200
600000	2086
250000	1378
120000	988
80000	1320
84000	3934
4000	174
33.22	245

WW-5

Ohms.	Quantity
1500	893
4000	893
1 meg	6310
700000	1269
750000	351
800000	1140
84000	2104
100000	2262
125000	1364
200000	236
220000	9307
268000	449
500000	972

WW-7

Ohms.	Quantity
100	200

WW-13

Ohms.	Quantity
15000	548
22000	258
40000	81
110000	202

ALSO THE FOLLOWING WIRE WOUND RESISTORS

FERRULE TYPE RESISTORS SPRAGUE

			Glass Type Size
339	25000	Ohms.	6½" long x 1" dia.
66	30000	"	6½" long x 1½" dia.
102	40000	"	6½" long x 1½" dia.
203	50000	"	6½" long x 1⅛" dia.
100	100000	"	6½" long x 1⅛" dia.

Price—.25 ea

I.R.C. METALIZED FILAMENT INSULATED RESISTORS

188	Type	F2	1000	Ohms.	2 Watt.
500	"	"	2500	"	"
2004	"	"	10000	"	"
1424	"	"	250000	"	"
155	"	F3	10000	"	"
165	"	"	18000	"	"

Price—.05 ea

I.R.C. ADJUSTABLE TYPES POWER RESISTORS

					Price
836	Type	ABA	200	Ohms.	.18 ea
874	"	DGA	2500	"	.25 ea
1512	"	DGA	10000	"	.25 ea
385	"	DHA	100	"	.25 ea
912	"	DHA	500	"	.25 ea

I.R.C. FIXED TYPES RESISTORS

425	Type	AB	4000	Ohms.	.10 ea
1159	"	CB	1000	"	.10 ea
218	"	CB	1500	"	.10 ea
127	"	DF	1650	"	.12 ea
683	"	EL	250	"	.15 ea
279	"	EM	350	"	.15 ea
486	"	EM	1600	"	.15 ea
309	"	EM	4900	"	.15 ea
215	"	EM	5000	"	.15 ea
67	"	EM	7500	"	.15 ea
256	"	EM	10000	"	.15 ea
286	"	EN	2500	"	.15 ea
1556	"	EP	5000	"	.15 ea
424	"	EP	7500	"	.15 ea
331	"	ES	1000	"	.25 ea
1616	"	ES	5000	"	.25 ea
490	"	HA	10000	"	.35 ea
273	"	HA	50000	"	.35 ea

EDLIE ELECTRONIC INC.

135 LIBERTY ST. *BArclay 7-4763* NEW YORK 6, N. Y.

TUBES

RK 73, High Voltage Rectifier tube can replace 2x2, 2V3, etc.

Characteristics:

Octal base
Filament 2.5 volts at 4.25 amps.
Max. peak universe voltage 13000
Max. operating current 30 ma.
Large quantity available.
Lists at $12.50, Price $.48 each.

A list of other good buys at tubes follows:—

	Price
1632	$.38
1629	.38
12A6	.32
50	.65
VR90	.45
VR105	.45
1626	.45
1631	.45
1633	.45
1644	.65
1L4	.38
3A4	.38
3Q4	.38
6B8	.48
836	.65
CK1005	.48
9002	.48
9003	.48
3D6/1299	.48
6Y6	.38
724B	.38
1R4/1294	.48
12K8	.48
7F7	.48
6V6	.48
7N7	.48
12SF5	.48
12SL7	.48
12SN7	.48
3FP7	1.45
fFP7	1.95

RELAYS

	Price
G. E.—2 circuit; coil 10 volts DC contacts 50/20 amps 115 volts AC	$ .85
Oak—Rotary type 8-28 Volts DC 3 single break, 3 make—1 break and make	.85
G. E.—#B101W3, coil 170 ohm, 20 volts D.C. contacts—3 single break	.65
RBM—#55526, coil 275 ohm, 20 volts DC Two Pole—one double throw, one single throw	.65
G.E.—#D106F3, coil 180 ohm, 24 volts DC. Double Pole, Double throw	.65
Allied—#BD12D 180 ohm coil, 20 volts DC. 4 Pole Double Throw	.65
Clare—#818062, Coil 150 ohm, 9 volts DC Double Pole, Single Throw	.85
Allied — #BOYX-20, Coil 130-260 ohms 12-24 Volts DC—opens one circuit—closes other	.95
Ward-Leonard—Heavy duty keying type 2000 ohm coil, 70 volts DC	1.25
Allied—#B013D35, coil 250 ohms, 24 volts DC Heavy Contacts—opens one circuit—closes other	.95
Clare — #814680 — Miniature, 300 ohms, 24 volts DC Four Pole—two throws	.95
Leach—#1054, coil 260 ohms, 24 volts DC Heavy contacts, two pole single throw + Holding contact	.95
RCA—Vacuum Relay. Relay contacts will break 3000 volts and carry 10 amperes Solenoid resistance 200 ohms, 24 volts DC—Excellent as R.F. antenna relay	.95

TRANSFORMERS

Primary = 117 Volts 60 cycles
Secondaries = 1100 Volts C. T. at 200 MA.
5.0 Volts 3 Amps.
6.3 Volts 3 Amps.
2.5 Volts 8 Amps.
Overall Dimensions 4½" square x 5" Price $4.95

Primary = 220 Volts 50–60 cycles
Secondaries = 500 Volts C. T. 65 MA.
5.0 Volts 2 Amps.
6.3–12.6 Volts 2 Amps Price $1.95

Primary = 117 Volts 60 cycles
Secondaries = 600 Volts 200 MA.
6.3 Volts 10 Amps.
5.0 Volts 3 Amps. Price $4.95

Primary = 117 Volts 60 cycles
Secondaries = 750 Volts 120 MA.
6.3 Volts 4 Amps.
5.0 Volts 2 Amps. Price $3.95

Television or Oscilloscope 2000 volt D.C. supply. Completely wired and tested, NOT SURPLUS. Will deliver better than 2000 volts filtered D.C. at 1 milliampere. Complete with tubes at the unbelievably low price........$7.45

Safety Interlock Switches, ideal for Television Receivers, Transmitters, etc. ....Price $ .15

CIRCUIT BREAKERS—"KLIXON"

Thermal type with automatic reset
Rating— 5 Amperes ....Price $ .55
Rating—60 Amperes ....Price $ .55
Voltage Regulator for 12—15 volt systems
Leece-Neville #23508 ....Price $1.25

Filament Pri. Volts	Sec. Volts	Sec. Current	Price
117 v. 50–60 cycles	6.3	7A	
	6.3	.8A	
	6.3	.6A	
	6.3	.6A	
	5.0	3A	
	5.0	3A	
	5.0	3A	

Overall dimensions 5"x5x4½" $1.95

FILAMENT

117 50–60 cycles	6.5	8A	
	6.5	.6A	
	5.0	3A	
	2.5	1.75A	

Overall Dimensions 3–7.8x4½x5" 1.45

FILAMENT

117
50–60 cycles 5.0 3A
Overall Dimensions 3¾x2x2¼" .95

117 Tapped Sec. 3.5 to 6.8 in 5 steps 1A
Overall Dimensions 1¼x1¾x2" .75

PLATE TRANSFORMERS

117 850 C. T. 250 MA.
Overall dimensions 5x5x4½ $3.95

117 800 C. T. 200 MA.
Overall Dimensions 5½x5x5 2.95

Magnetron Filament Transformer—Insulated for 7,500 volts. Pri.—115 volts 60 cycles
Sec.—6.3 volts @ 1 ampere
Sec.—2.5 volts @ 1.75 amperes
G.E. type K35–J51
Overall Dimensions 5¼x4¾x4 Price $1.25

VIBRATOR TRANSFORMERS

For Auto Radio or Mobile Transmitter Use
6 or 12 400 C. T. 150 MA.
Overall Dimensions 3¾x4½x3½ 1.45

Multi-Tap Transformer
Input 105–115 volts 25–60 cycles
Secondary voltage tapped from ¼ to 75 volts suitable for use on tube checker, etc.
Overall Dimensions 2½x3x4 Price $1.95

RECORD-SCRATCH FILTER

One of the best scratch filters we ever had. Note these desirable features:

- Suppresses needle scratch on all records—approximately 25 lb. attenuation
- Old records sound new again
- Scratch frequency range adjustable within the range of 3000 to 5000 cycles
- On-off cutout switch
- Very compact—housed in a shielded aluminum container only 1½" square by 3½" long
- Exceptionally Priced—only $1.65

TIME DELAY RELAY

Thermal vacuum type
S. P. S. T. 100 ohm coil
24 Volts AC/DC
90 Second delay Price $.95

EDLIE ELECTRONIC INC.

135 LIBERTY ST. BArclay-7-4763 NEW YORK 6, N. Y.

R-H-S SPECIALS OF THE MONTH

I. F. COILS

(3 mc) Slug-tuned, shielded. Input, Discriminator, Interstage, BFO. Each coil 69c

OUTPUT & LINE TRANSFORMER

Pri: 8500 ohms—Sec #1-8 ohms, Sec. #2-0-128-500 ohms. Response: 300-5000c. UTC—type G1........ $1.49

SELENIUM RECTIFIERS
Full Wave Bridge Type

INPUT	OUTPUT		
up to 18v A. C.	up to 12v D.C	1 Amp.	$1.95
up to 18v A.C.	up to 12v D.C	5 Amp.	4.45
up to 18v A.C.	up to 12v D.C	10 Amp.	7.45
up to 18v A.C.	up to 12v D.C	15 Amp.	9.95
up to 18v A.C.	up to 12v D.C	30 Amp.	14.95
up to 36v A.C.	up to 28v D.C	1 Amp.	3.45
up to 36v A.C.	up to 28v D.C	5 Amp.	7.45
up to 36v A.C.	up to 28v D.C	10 Amp.	12.45
up to 36v A.C.	up to 28v D.C	15 Amp.	18.95
up to 115v A.C.	up to 100v D.C	.25 Amp.	2.95
up to 115v A.C.	up to 100v D.C	6 Amp.	6.95
up to 115v A.C.	up to 100v D.C	5 Amp.	19.95
HALF WAVE TYPE			
up to 196v A.C.	up to 158v D.C	.075 Amp.	$1.95
up to 395v A.C.	up to 350v D.C	.075 Amp.	2.95
up to 396v A.C.	up to 330v D.C	.110 Amp.	3.95

OIL CONDENSERS:
Standard Brands, A-N Inspected
All Ratings, D.C.

1mfd.	600v..	$0.35	2mfd.	2000v..	$1.75
2mfd.	600v..	.35	3mfd.	2000v..	2.75
4mfd.	600v..	.60	4mfd.	2000v..	3.75
8mfd.	600v..	1.10	15mfd.	2000v..	4.95
10mfd.	600v..	1.15	.1mfd.	2500v..	1.25
1mfd.	1000v..	.60	.25mfd.	2500v..	1.45
2mfd.	1000v..	.70	.5mfd.	2500v..	1.75
4mfd.	1000v..	.95	.05mfd.	3000v..	1.95
8mfd.	1000v..	1.95	.1mfd.	3000v..	2.25
10mfd.	1000v..	2.10	.25mfd.	3000v..	2.65
15mfd.	1000v..	2.25	5mfd.	3000v..	2.85
20mfd.	1000v..	2.95	1mfd.	3000v..	3.50
24mfd.	1500v..	6.95	12mfd.	3000v..	6.95
25mfd.	2000v..	1.05	2mfd.	4000v..	5.95
.5mfd.	2000v..	1.15	1mfd.	5000v..	4.95
1mfd.	2000v..	.95	.1mfd.	7000v..	2.95

SPECIAL 2 mfd. 3000v. **$4.45**

HIGH CAPACITY CONDENSERS

2x3500 mfd—25WVC $3.45
4000 mfd.—30WVDC 2.95
1000 mfd.—15WVDC .... .99
2000 mfd.—50WVDC 1.95

ART/13 MODULATION KIT

Consists of driver, speech amplifier, sidetone amplifier assembly and modulation transformer. With complete diagram for the famous ART/13 transmitter.

SUPER BUY at............. **$8.95**

PORTABLE F M TRANSMITTER (SONOBUOY)

Operates on standard 67½v Minimac and 1½v Flashlight cells. Frequency 72 mc (easily doubled to 144 mc). Complete with 5 tubes and diagram. (Less batteries.)

EXCEPTIONAL BUY at.......... **$12.95**

GIBSON GIRL TRANSMITTER (SCR-578B)

Emergency life transmitter. 100% complete; includes balloon, hydrogen generator, kite, signal lamp, antenna and instruction manual. Self-powered merely by turning crank. Automatically transmits S.O.S. on 500 cycles.

FULLY GUARANTEED **$29.95**

SK-IM RADAR

Receiver — Indicator
115v 60 cycle operation
175-225 megacycles.
Complete with all tubes.

Brand New $187.50

SOLA
Constant Voltage Transformer

Pri: 190 to 260v 60 cyc.
Sec: 115 volts @ 1.74 amps.
Rated 250 V. A.

Brand New...... **$29.95**

TUBES (*Brand New*)
Army-Navy Inspected

1B24	$ 4.95	311	$ 1.98
2AP1	2.25	371B	5.95
2C40	1.19	450TH	39.95
2D21	.89	703A	7.95
2V3G	1.25	705A	3.95
2X2	.84	715B	7.95
3AP1	3.00	721A	4.35
3BP1	2.95	726/AC	7.50
3E29	2.95	801	1.49
5BP1	3.95	802	1.98
5BP4	4.95	803	8.95
5CP1	3.95	804	9.95
5JP1	11.95	805	4.95
5LP1	8.95	806	14.95
5R4GY	.98	807	.95
5Y3	.41	808	2.95
6AB7	.99	809	1.50
6AC7	.99	810	5.95
6AG5	.99	811	1.95
6AG7	.99	812	3.15
6AJ5	.99	812H	6.90
6AK5	.90	813	8.95
6AL5	.99	814	4.45
6AR6	1.29	815	3.95
6B4G	1.29	826	2.25
6C4	.69	829-A-B	3.00
6C5	.49	832	2.25
6F6	.89	833A	39.50
6F6G	.59	834	2.95
6J4	1.50	835	2.95
6J5	.55	836	1.75
6J6	.89	837	2.50
6L6	1.23	838	3.95
6L7	.98	841	1.20
6N7	1.02	861	69.50
6SH7	.59	866	.75
6SL7	.89	872A	2.50
6SN7	.69	884	.98
6SR7	.89	885	.98
7A4	.81	902	2.25
7F7	1.25	913	3.00
7L7	1.59	954	.75
9JP1	3.95	955	.75
10Y	.98	956	.75
12X3	1.50	957	.75
15E	1.50	958	.75
HK24G	1.75	959	.75
28D7	.98	1005	.69
80	.75	1616	2.95
35T/TG	3.50	1619	.75
VR90	.75	1624	.90
VR105	.75	1625	.75
VR150	.75	1626	.75
100TH	7.95	8001	6.49
100TS	3.00	8003	9.95
211	1.25	8005	4.95
75T	2.95	8011	1.95
250TH	14.95	8016	1.65
257B	6.49	8025A	4.95
304TH	9.95	1654	1.98

SCR-522 100-156 MC. RECEIVER AND TRANSMITTER
Licensed for Railway and Taxicab Use

The ideal all purpose transmitter-receiver for work in the 100-156 mc. spectrum. Four channel pushbutton operation, crystal-controlled, AM, phone, mobile or fixed station service. Ideal for amateur, aircraft, marine, railroad, taxicabs, police and experimental. Amplitude modulated—High transmitter output. Receiver has 10 tubes and transmitter has 7 tubes including two 832's. 60 cycle operation. Complete conversion instructions and schematic furnished with each unit. Tube complement 2—832; 3—12A6; 1—6G6; 2—6557; 1—12J5GT; 1—12C8; 1—9002; 3—9003; 1—12AH7GT and 3—12SG7. Complete with tubes **$14.95**

BC-375-E TRANSMITTER

Operates from 200 kc—12.5 mc complete with all tubes, dynamotor, six tuning units and one antenna tuning unit.

LIKE NEW **$39.50**

TRANSFORMERS—115 V 60 CYC.
HI-VOLTAGE INSULATION

1600v at 4ma; 700v at 150ma; 6.3v at 8A	$8.50
3710v at 4ma; 2x2.5v at 3A	9.95
2500v at 10ma	6.50
2150v at 15ma	6.50
1750v at 4 ma; 6.3v at 3A	7.95
1540v at 4ma; 340-0-340 at 240ma	7.50
550-0-550v at 150 ma; 5v at 3A; 2x6.3 at 5A amp	7.95
500-0-500v at 100ma; 5v ct at 3A	4.95
442-0-442v at 1000ma	9.95
425-0-425v at 150ma; 6.3v at 7.5A; 6.3v at 3A; 5v at 3A	5.95
400-0-400v at 200ma; 5v at 3A	4.95
350-0-350v at 150ma; 6.3v at 6A; 5v at 3A; 78v at 1A	4.95
350-0-350v at 35ma-XLNT for VOLT-DBLR	1.49
300-0-300v at 65ma; 2X 5v at 2A; 6.3v at 2½A; 6.3v at 1A	3.49
325-0-325v at 120ma; 10v at 5A; 6.3v at 7A	3.49
350-0-350v at 85ma; 2X 5v at 2A; 6.3v at .6A; 6.3v at 3.75A	7.50
250-0-250v at 100 ma; 2X 6.3 at 4A; 6.3v at 5A; 6.3v at 1A	4.95
2.5v at 2A; 5v at 3A	2.95
2.5v at 10A	8.25
5v at 115A	9.95
5v at 190A	17.50
6.3v at 6.6A	8.25
6.3v at 3.1A	1.95
6.3v at 21.5A; 6.3v at 2A; 2.5v at 2A	6.95
1600v @ 2ma; 2.5v @ 1.75A; 6.3 @ .6A	9.95

FILTER CHOKES
HI-VOLTAGE INSULATION

4 Hy at 250ma	$1.98	12 Hy at 300ma	$3.95
10 Hy at 250ma	2.49	15 Hy at 100ma	2.95
10 Hy at 400ma	4.95	15 Hy at 125ma	3.25
12 Hy at 100ma	2.95	30 Hy at 70ma	1.95
4 Hy at 600ma	5.95	.1 Hy at 5 Amps	6.95
10 Hy at 200ma	1.98	15 Hy at 75ma	1.49
200 Hy at 12ma	1.39	10/20 Hy at 85ma	1.95

BLOWER

Hi-air blast, designed for transmitting tube service. Motor operates on 100-125v 60 cycle at 7000 RPM. Noise free with self contained chokes and filters. Enclosed in satin finish, aluminum cabinet. Measures 4" high x 2¾ x 3¼". Many uses.

SUPER BUY at.............. **$5.95**

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

All merchandise guaranteed. Mail orders promptly filled. All prices F.O.B. New York City. Send money order or check. Shipping charges sent C.O.D. Minimum order $5.00.

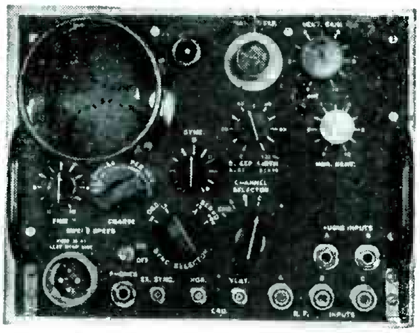
RADIO HAM SHACK Inc.
63 DEY STREET • NEW YORK 7, N. Y.

ATTENTION
INDUSTRIALS—LABS—SCHOOLS—AMATEURS

Let us quote on components and equipment that you require. We have too many items to be listed on this page. Place your name on our mailing list now for new catalog.

PAN-OSCILLO-RECEIVER

Ideal for laboratory, television and general service work



Model AN/APA 10

Performs work of four units

1. **PANORAMIC ADAPTOR:** For use with any receiver with I.F. frequency of 405-505 kcs., 4.75 to 5.75 mcs., and 29-31 mcs.
2. **OSCILLOSCOPE:** Visually checks received signals, monitors transmitter output — percentage modulation, carrier wave-shape, etc.
3. **SYNCHROSCOPE:** External inputs provide synchroscope action.
4. **RECEIVER:** Three inputs provide facilities for use with convertors to cover wide range of frequencies to 10,000 mcs.

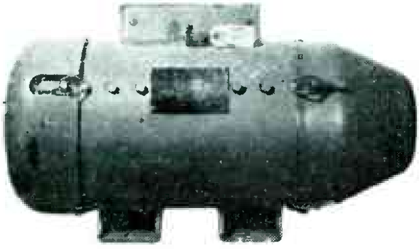
FEATURES:
- 3" scope tube
- 21 tubes
- Aircraft type construction
- Variable sweep 35-40,000 cy
- Weight 40 lbs.
- Transformer built in for 110 V. 60 cycle operation.
- 2 I.F. stages—double conversion.
- 2 Video stages in push pull to vertical plates.
- Pentode output audio monitor.
- Multi-Vibrator horizontal sweep (radar type).
- Horizontal sweep amplifiers P. P. to horizontal plates.

Surplus equipment tested and guaranteed in perfect operating condition. We have sold hundred of these units during the past year to leading schools, laboratories, amateur operators all over the world.

Price $97.50

(Mail $1.00 for 80 page Technical manual and instruction book)

MOTOR GENERATORS



Brand new. Built by Allis Chalmers to rigid specifications of the U. S. Navy.

K.V.A. output 1.250	R.P.M. 3600
K.W. output 1.	Cont. Duty Ph. Single
P.F. .80	Cycles 60
Volts input 115 D.C.	Volts output 120 A.C.
Amps input 14	Amps output 10.4

Length 26"; width 12-7/8"; height 13". Compound accumulative A.C. and D.C. fields. Centrifugal starter. Splashproof covered. Frequency adjustable to load, plus or minus five cycles.

Price $87.50

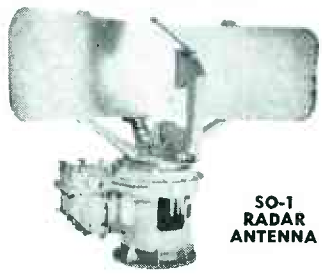
Identical Machine, but 230 volts D. C. input, $125.00

Set of Replacement Spare Parts for Either Machine $29.50

SYNCHROS: *(Selsyns—Autosyns, Etc.)*

G.E. Selsyn Control Transformers, model 2J5FBI. 115-55V. 60 cy.
Bendix Cal. 18300, 115 volt 60 cycle.
Bendix repeaters, type II-2, C-69406-1, 115 V. 60 cy.
Bendix transmitters, type I-1, C-69405-2
G.E. differential generators, type 2J5SI, 115 V. 60 cy.
Electrolux synchro repeaters, type 2J5S1, C78863, 115 V. 60 cy.
Bendix, Mod. 4, type 5SF synchro motors, 115 V. 400 cy.
Bendix synchro repeaters, type X Cal-5328A-1, 115 V. 60 cy.
Diehl synchro transmitters, type IV C-78414, 115 V. 60 cy.
Esco synchro repeaters, C-56776-1, 110 V. 60 cy.
Ford Inst., Type 5 SDG, 400 cy. differential.
Navy Ordinance types 5F, 5G, 5CT, etc.
Many other types, sizes of synchros in stock

RADAR EQUIPMENT



SO-1 RADAR ANTENNA

SO-1 Antenna Assembly Comprises:
- A drive mechanism including a drive motor and gear train.
- A synchro 400 cycle generator with gear train and mechanical differential.
- A rotating radiator system including a right angle radiator nozzle, a reflector in the form of a paraboloidal section, R.F. fittings for coupling the rotating system to a stationary waveguide.
- A supporting pedestal and base plate.

Brand new packed in export cases.

Price $90.00

These antenna assemblies have many uses as replacements on vessels now using SO-1 equipment, experimental radar and microwave work, amateur beam rotators, etc.

SO-8 Antenna assemblies also available, brand new and export packed.

Price $120.00

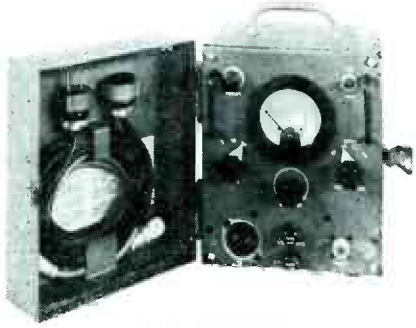
S.G. Radar. Parts and spares.
S.O. 3 Radar. Complete sets of tender spares.
S.Q. complete portable units manufactured by General Electric Co. Brand new and ready to operate on 90-130 volts, 60 cycles, 320 watts. Choice of A, B, or P.P.I. presentation. 300 yards minimum range; max. 3, 15, 45 miles. 10 cm. Ideal for schools, laboratories, small boats, etc.
RADAR CRYSTALS—98.35 kc

TRANSMITTING EQUIPMENT

BC-325 types B & C. Freq. range 1.5 to 18 mcs. Output 400 watts C. W. or 50 watts phone. 110 V. 60 cy., used but in excellent operating condition.
Components for T-4/FRC and T-5/FRC transmitters as follows:
MD1/FRC Modulator Units
SA-2/FRC Switch Panels
O-2/FRC Oscillator Units
AM-2/FRC Amplifiers

All prices quoted are F.O.B. Tuckahoe, N. Y. (About 20 miles north of New York City). All merchandise guaranteed. Immediate delivery subject to prior sale.

LABORATORY EQUIPMENT



Model TS-487/U

Peak to Peak V. T. Voltmeter

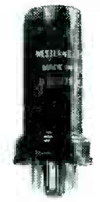
Designed by Radiation Lab M.I.T. and built by McGuire Industries for the Navy. Range 3-10-50-volts, complete in grey metal cabinet with coax input cable, A.C. cable, spare fuses and pilot lights.

Price $49.50

Measurements Corp. Model 62 Vacuum tube volt meter, standard signal generators, 300-1000 mcs.
Ferris Crystal Calibrator, Model 34A.
Hewlett Packard Interpolation Oscillator, Model 6225B.
Weston #1 Precision 0-150, 0-1500 milliammeters in leather cases.
G. E. Model LU Radar test set.
General Radio 700A wide range B.F.O.
General Radio 539A Variable Condenser.
Hewlett Packard 505B Tachometer.
Hewlett Packard 506 Tachometer optical head assembly.
Shallcross 621H Limit Bridges.
General Radio 805-C Standard Signal Generator
General Radio 783-A Output Power Meter
Hewlett-Packard 205-A.G. Audio Signal Generator
Millen 90505 Sec. Freq. Standard.

(All Lab. equipment priced from 25 to 50% off manufacturers prices.)

RELAYS & SWITCHES

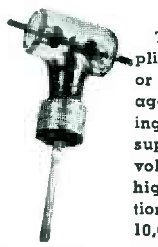


W. E. D-168479 Relay

Western Electric D-168479 mercury-contact Relay enclosed in sealed metal tube base.

A high speed switching relay for use where large amounts of current are used, and in servo mechanical systems. Will operate at 100 times per second and is also employed in vibrator power supplies for square wave generators.

Price $9.75 ea.



Sperti Vacuum Switch

This switch has many applications such as switching or interrupting high voltages, antenna circuit switching at high altitudes, power supply switching for high-voltage vacuum tubes and high-speed keying operations at any voltage up to 10,000, or current up to 5 amperes, frequency up to 30Mc., or any power factor.

Price $2.95 ea.

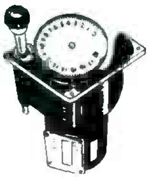
STRUTHERS DUNN, types IBXX129, IBXX-107, 1XBX105
WESTERN ELECTRIC, type D124001

ELECTRONICRAFT, INC.

5 WAVERLY PLACE — ***Telephone: Tuckahoe 3-0044*** — **TUCKAHOE 7, NEW YORK**

FINEST QUALITY "Communications" LOWEST PRICES

MICROWAVE TEST EQUIPMENT



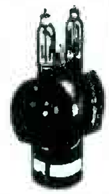
Wave guide experimental kit. Consists of: One direct-reading wavemeter, app 2600-3400 mc. (cavity type); One dummy load w/crystal probe. One line stretcher full wave; two wave guide to RG 18/U coax couplers; two 1' sections w/flanges. Complete $250.00

10 CM ECHO BOX, complete with micrometer adjust cavity & resonance indicator. Type TS 238/GP. With calibration chart.........$105.00

10 CM WAVEMETER. Model "SL". Micrometer adjust cavity with microammeter resonance indicator. Includes 115 VAC operation converter section. In grey metal carrying case, complete with cables & spares. Made by Western Electric.$135.00

W.E. I #138 A. Signal generator, 2700-2900 Mc. range. Lighthouse tube oscillator with attenuator & output meter. 115 VAC input, reg. Pwr. supply. With circuit diagram................$50.00

MICROWAVE TUBES



3J31 (1 cm)....................$17.50
3J31 MAGNET 8.00
2J26 (10 cm)................ 25.00
2J32 (10 cm)................ 25.00
MAGNET for 2J32............ 10.00
2J38 (10 cm) with magnet..... 37.50
WE 700 A (L band).......... 45.00
WE 720 BY (S Band) 1000 KW 25.00
2K25-723 AB Klystron.......... 7.75
QK 59, QK 60, QK 62 Tunable packaged Magnetrons. 10 cm..ea. 45.00

RADAR SETS

SO9-10CM. SURFACE SEARCH 4, 20 and 80 mile ranges; Raytheon, 250 KW peak power input to 2J27 magnetron. Complete set including: spare parts, tubes, wave guides and fittings....$2,000.00

SO13-IDENTICAL TO SO9. Complete set, used. Consists of: transmitter and receiver, PPI scope modulator, motor alternator, rectifier, power unit and new rotating antenna................$375.00

SN RADAR-GE, low power, 5 and 25 mile ranges. Uses GL464 as pulsed oscillator, 5" "A" scope, "S" band. Extremely compact: ideal for demonstration and laboratory work. 115V 60C operation. Used, excel. Cond......................$600.00

SPECIALS

10 CM. RF Package. Consists of: SO Xmtr.-receiver using 2J27 magnetron oscillator, 250 KW peak input. 707-B receiver-mixer........$150.00
Modulator-motor-alternater unit for above... $75.00
Receiver rectifier power unit for above....... $25.00
Rotating antenna using dipole feed and parabolic reflector for above. New less hood.......$75.00
Used $45.00
RT39APG15 Transmitter-receiver. Lighthouse tube oscillator, .5 KW. App. 2700 Mc. operation. With lighthouse and TR tubes............$100.00
Motor-Gen. Pu 43/A
Input: 24- 28 VDC @ 62 A. Output: 115 VAC. 7 A., 800 C.P.S.......................... $15.00

HIGH VOLTAGE TRANSFORMERS

Transformer & Choke Assembly

W.E. # D-122895: Trans. Pri: 115 VAC, 60 Cycles, 1 Phase. Secondary: 17,600 V @ 144 Ma. CHOKE: 4000 Hys @ zero current, 250 Hy. @ .1A, Resistance: 4500 ohms. Oil-filled case. New $74.50
2.5 KVA Amertran Rectifier: Input: 208 V. 3 PH., 50/60 cycles. Output: 0-25,000 V @ .1 A. Regulation: 10%, Ripple: 2.5%.

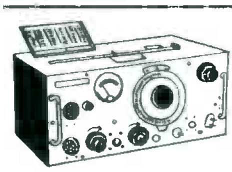
140-600mc Directional Antenna

140-310mc cone and 300-600mc 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

WIRE RECORDING MAGAZINES

Magazine for KS 12009 recorder, made by W.E. Comes with wire for ½-hour recording. Has elapsed time indicator, recording and erase features. Size: 14¾" L x 7" W x 5¾" H. Less Drive Motor $49.50

TEST SET 159 TPX

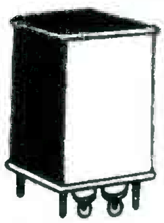


Measures frequency between 150 and 200 mc by heterodyne method. Power output of transmitter can also be measured directly. Measures DC voltages up to 500 V in 2 ranges. Operates on 110 V. 400 cycles, but mere replacement of power transformer makes it operable on 110 V. 60 cy. Complete with all tubes and marker crystal. New $49.50. Necessary 115V 60 cy parts extra......$5.50

DYNAMOTORS

PE 73 CM. Power supply for BC 375. Input: 28 VDC, Output: 1000 VDC @ 350 Ma. Starting relay, filter, etc. $4.95
BD 77KM. Power supply for BC 191. Input: 14 VDC, Output 1000 VDC @ 350 Ma. New, with spare fuse links, etc.$5.95
PE 101C, Input: 13/26 VDC @ 12.6/6.3 A. Output: 400 VDC @ 135 Ma., 800 VDC @ 20 Ma. (9 VAC @ 1.12 A)........................$3.49
(Mfrs.: Write for quantity prices & Discounts on above items.)
PE 86 Input: 28 VDC. Output: 250 VDC @ 60 Ma. Westinghouse $1.95
PE 77, Input: 12 VDC. Output 275 VDC @ 110 Ma. 500 VDC @ 50 Ma...................$3.25
DAG 33A: Input: 18 VDC @ 3.2 A. Output: 450 VDC @ 60 Ma...........................$2.45
DM 33 A. Input: 28 VDC @ 7 A. Output: 540 VDC @ 250 Ma. Power supply for modulator for SCR 274 N.............................$3.95
Dyn. Model 23350. Input 27 VDC @ 1.75 A. Output: 285 VDC @ 75 Ma...............$1.75
DM-21: In 14 VDC 3.3 A. Out 235 VDC 90 Ma. with filter $2.59
DM-25: In 12 VDC 2.3 A. Out 250 VDC 50 Ma. $2.49
DM-34: In 14 VDC 2.8 A. Out 220 VDC 80 Ma. $2.49
DM-42: In 14 VDC. Out 515/1030 VDC 215/260 Ma. & 2/8 VDC..............................$3.95

TRANSFORMERS



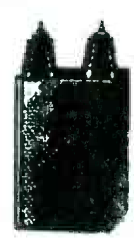
(Filament Transformers)
All Primary 117 V, 60 cycles
#5058: 6.3 VCT @ 2 A, 6.3 VCT @ 2 A, 6.3 VCT @ 2 A..........................$2.45
#5126: 5 VCT @ 3 A, 5 VCT @3 A, 5 VCT @ 6 A..$3.25
#5100: 6.3 VCT @ 1.2 A, 5000 V test...............$2.45
#5085: 6.3 V NCT @ .6 A, 6.3 V NCT @ 1.5 A....$1.85
#5056: 6.3 VCT @ 9 A, 6.3 VCT @ 2.2 A, 6.3 VCT @ 2.2 A..........................$3.75
#5057: 6.3 VCT @ 1 A, 5 VCT @ 3 A, 5 VCT @ 3 A $2.75
UX 6899: 5 V @ 5.5 A, 5 V @ 5.5 A, 29,000 Volts Test $24.50
Fil. Xfmr. to supply filament current to surplus equipments using 12 Volt tubes. Pri: 117 V 60 cy. Sec: A wide range of voltages up to 26 V @ 2 A.....................................$1.50

LINE VOLTAGE REG 2 KW Saturable reeactor type Pri 95-130 v 60 cy Sec 115 v 60 cy. 17.4 A 2 Kw 100% PF...........................$160.00
LINE VOLTAGE REG Pri 92-138v 57/63 cy. 1ph 15 A Sec 115v 7.15A 82 Kv 96% PF.......$135.00
Self-Contained Unit in Grey Cabinet.

POWER CHOKES

6 Hy @ 150 Ma................................$2.00
6 Hy @ 300 Ma................................$4.50
1 Hy @ 800 Ma. 7.5 Ohms......................$8.95
Dual Choke: 2-2 Hy @ 100 Ma...................$.90
Dual Choke: 7 Hy @ 75 Ma 11 Hy @ 60 Ma.$1.95
11 Hy @ 60 Ma.................................$1.95

OIL CONDENSERS

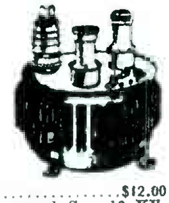


.25 mf @ 20000 VDC Aerovox $17.50
1.5 mf @ 6000 VDC Aerovox $12.50
1.0 mf @ 25 KV.......$60.00

MICA

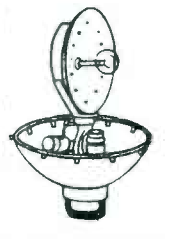
.08 mf @ 1500 VDC, Sprague MX60 ....$11.50
.03 mf @ 2000 VDC, CD 551A-50 ....$12.75
.045 mf @ 2000 VDC, Sangamo, G1 ....$12.75
.00015 mf @ 20 KV, Aerovox 1970-404 ....$25.00
.0001 mf @ 20 KV, Sangamo G3 ....$25.00
.0051 mf @ 15 KV, Sangamo G4.............$25.00
.006 mf @ 10 KV, Sangamo G3.............$17.50
.002 mf @ 15 KV, Sangamo................$20.00
Isolating Capacitor, Cornell-Dubilier PL 1417. 106-110 mmf @ 10 KV AC (peak) Each....$3.50
MFRS: Send your requirements for bathtubs, Micas, Hardware, resistors, & connectors.

PULSE TRANSFORMERS



All Standard Name Items
Type K2450A Will receive 13 KV, 4 micro-second pulse on pri., secondary delivers 14 KV Peak power out 100 KW GE.....$15.00
HI Volt. Magnetron Input transformer W.E. # D-166173 with cooling fins...................$12.00
U 4298E—Pri. 4 KV, 1 microsecond Sec. 16 KV. 16 amps. Fil. pri. 115v. 400 Cycle Raytheon.$15.00
Hi Volt input pulse Transformer W.E. #D169271 $9.95
Pulse, Input, line to magnetron K2748A.... $12.00
Utah Pulse or Blocking Oscillator Transformer: Freq limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅛ x 19/32......$.75
GE # K 2731. Repetition Rate: 635 PPS, Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28 KV. PK. Peak Output: 1800 KV., Bifilar: 2.75 Amp. $19.50

MICROWAVE ANTENNAS



Relay System Parabolic reflectors apprx. range: 2000 to 6000 Mc. Dimensions 4. -5' x 3' New......$85.00
Dipole for above........$5.00
TDY "Jam" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New $100.00
SO Surface Search Radar rotating antenna, 10 cm. 24" dish, complete with drive and selsyn motors.
New $90.00
Used $45.00
3 CM. ANTENNA WITH DISH 14½". Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanism. Complete. New $65.00

MICROWAVE PLUMBING

10 Centimeter

10 Cm McNally cavity. Silver Plated. Type SG. ....$3.00 Ea.
Sand Load (Dummy Antenna) wave guide section with cooling fins, app 23" high............$28.00
Rigid Coax Directional Coupler CU-90/UP 20 DB drop, has short right angle, about 8"........$5.50
Coax Rotary Joint with mounting plate.......$8.00
Dipole Antenna in lucite ball, for use with parabolic $5.00
Flexible Coaxial Connector, rigid coax to rigid coax ⅞" diam..............................$2.50
10 CM Dipole and Reflector with type "N" Fitting $2.75
Waveguide to flexible coax coupler (RG 18 U), with flange. Gold plated. App 10" high........$17.50
Crystal Mixer, "S" Band. Complete with Type "N" fitting and 1N22 crystal...............$3.85
Rigid coax slotted section CU-60/AP..........$5.00
Stub-supported rigid coax, gold plated, 5' lengths. Per 5' length..............................$5.00
10 Cm waveguide. 5'9" choke to cover.
Per section $12.00
Per set of 4 sections......................$45.00

3 Centimeter

Wave Guide Sections 2.5' long, silver plated with choke flange $5.75
Wave Guide 90 deg. bend E Plane 18" long..$4.00
Wave Guide 90 deg. bend E plane with 20DB directional coupler $4.75
Wave Guide 18" long "S" curve..............$2.00
Rotary joint wave guide in/out choke to choke..$6.00
Rotary Coupler choke input; round guide output.$5.25
S-Curve Wave Guide 8" long cover to choke....$2.50
Wave Guide 2.5' long, silver plate, 180 deg. bend choke to cover..........................$5.95
Duplexer Section using 1B24.................$10.00
Wave Guide lengths per foot..................$1.50
Pick-up loop with adjustable tuning section, used in duplexer $1.50
3 CM Wavemeter Maguire 1539TFX..........$15.00
3 CM stabilizer cavity, tunable transmission type. Model 1551 TFX 11 GA)..................$20.00
3 Cm waveguide, 1 ⅛" x ½". 15 Ft. lengths available. Per Ft.................................$1.50

1.25 Centimeter

Wave Guide Section 1" cover to cover..........$2.00
T Section choke to cover......................$4.50
Mitred Elbow cover to cover...................$3.00
Mitred Elbow and "S" sections choke to cover..$3.50
Flexible Section 1" long choke to choke........$3.00
Tunable Cavity with Coax input and output....$6.00

Connectors

UG 21/U, Type "N", Male....................$ .85
UG 86/U, Gold Plated.......................$ .95

Mail orders promptly filled. All prices: F. O. B. New York City
Send Money Order or Check. Rated firms send P. O. Shipping charges only sent C. O. D.
Send for our latest microwave flyer, also our complete parts catalog.

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Varistors $.95 Ea.
(Western Electric)
D-167176
D-170225
D-162356

Thermistors $.95 Each
(Western Electric)
D-167332 Bead
D-170396 Bead
D-163392 Button

SURPLUS BARGAINS!

WESTON MODEL 271

Large Fan Shaped MICROAMMETER

Another of the famous Weston fan shaped line. Very large scale 5.8" long. These meters were made by Weston to General Radio specifications, with special mirrored scale and knife edge pointer. Accuracy 1%.

0—600 Microamps
170 M.V.
Coil Res: 250 Ohms

Your Price $12.50
10 for $100.00

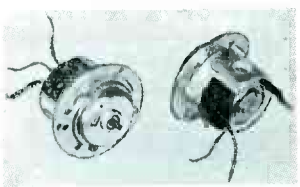
PORTABLE A.C. AMMETER

WESTON #528

Double range ammeter. 0—3 Amps and 0—15 Amps. Two of the very useful ranges for your Lab. or shop. Complete in genuine leather case with test leads.

Your Price $12.25

"MIDGET" SELSYNS



SOLD OUT

TRANSTATS—3 K. V. A.

Type RH. Input: 115 V 10%. Output: 115 V. Max. Amps: 26 A. Made as a line voltage corrector 10% of input voltage, or can be connected to give plus 20% or minus 20% of input. Can also be reconnected to be used as an isolated type stepdown with variable secondary. Input: 115 V. Output: 0-36 Volts at 30 Amps.

A Real Buy at $18.00

(same type, but .25 KVA. Input: 103-126 V.; Output: 115 V.-2.17 A.)

Price $6.50

D. C. VOLTS

0—15 V. 2" Westhse BX-33 .... 2.75
(black scale)
0—15 V. 2" Simpson #125 .... 2.95
0—20 V. 2" Weston 506 .... 2.95
(1000 Ohms/V)
0—15 V. 3" Westhse NX-35 .... 3.95

0-150 V. Weston 301 . . . . . 4.50
(Blk Seale-Metal case)

0—150 V. 3" G.E. DO—41 .... 4.75
0—50 V. 4" Westhse NX-37 .... 6.00
0—150 V. 4" Weston 643 .... 6.75
(Black scale—flush—metal)

All meters are white scale flush bakelite case unless otherwise specified.

OHMMETER

Weston — 689 1-F
Convenient pocket size with sturdy leather case, for low resistance readings. Double Scale.
0-10 Ohms Full scale.
0-1000 Ohms Full scale.
Size: 5"x2-7/8"x1-7/8".

Your Cost $14.75
(with case & batteries)

SELENIUM RECTIFIERS

Full Wave Bridge

Federal Type #	Approximate Rating Input Max.	Approximate Rating Output Max.	Amps.	PRICE
10B1CV1	18 V.	14 V.	.5	.98
10B2CV1	36 V.	28 V.	.5	1.50
4B3CV2	48 V.	36 V.	.5	2.75
5B2AV1	36 V.	28 V.	1.6	4.25
5B2AV5	36 V.	28 V.	8	11.75
11BA6AM1	120 V.	100 V.	1.6	11.95
9DO612R	150 V.	115 V.	1.6	14.50

D. C. MICROAMPS

0-100 Microamps, res. 100 Ohms 3" Rd. Westinghouse NX/35 $7.95

0-150 Microamps—2" rd. G.E.—DW51 or Whse NX33. Res: 500 Ohms.
Your Cost $3.75

D. C. AMPS & MILLS

0-1 Ma 2" G.E. DW41 .... $3.75
(special scale)
0-1 Ma 2" Weston 506 .... $3.75
0-2 Ma 2" Sun 2AP525-5 .... 2.25
0-5 Ma 2" Dejur S-210 .... 1.95
0-25 Ma 2" G.E. DW41 . . . 2.95
0-30 Ma 2" G.E. DW41 . . . 2.95
0-100 Ma 2" sq. Simpson 127 ..... 2.95
0-500 Ma 2" G.E. DW41 .... 3.25
0-1 Ma 3" sq. Westhse RX-35.
(Scale: 1.5 KV) 4.25

GENERAL ELECTRIC DO-41
0-1 Ma.—Scale: 3 K.V. (Blk)
Your Price $3.85

0-1 Ma 3" sq. Weston 301 .... 5.25
(Scale: 1.5 KV)
0-1 Ma 3" G.E. DO-53 .... 4.75
0-1 Ma 3" sq. Weston 301 .... 6.00
0-15 Ma 3" Westhse NX 35 ...... 2.95
(Scale: 15/150/300)
0-30 Ma 3" Weston 301 Metal case $3.75
0-30/120/600 Ma. Weston Model 280 portable—slightly used 4.75
0-1 A. 3" sq. Weston 301 .... 5.50
0-10 A. 3" sq. Triplett 2.50
(in wooden case)
0-10 A. 3" Simpson #25 .... 4.50
30-0-30 A. 3" Simpson #25 .... 4.50
0-300 A. 3" Roller-Smith 4.95
(Fl. Bake. Type TD-50 MV)
(with ext. shunt)
0-300 A. Same as above 2.25
(without shunt)
0-300 A. 4" Weston 643 .... 8.50
(fl. metal bl. scale-ext. shunt)
0-300 A. 4" same as above 5.50
(without shunt)

SPECIAL METERS

Frequency Meter—350/450 CPS Aircraft type 4" Weston Model 637 .... $4.95
Resistance Thermometer—30°F to 230°F. Complete with res. bulb. aircraft type—2" Weston #727 .... $4.75
Weston Thermometer #221-D—4" rd. 50°F—300°F—2½" stem $4.95

WESTON MODEL 269 FAN SHAPED METER

One of the Weston popular fan shaped line. Exceptionally long scale for size of instrument. Accuracy — within 1%. Scale length—4". Spade pointer. Here is a good movement for special purpose instruments. Comes with blank scale with arc drawn in. Ready for plotting calibration points. Can be used to make up any range of volts, amps, MA., etc. Full scale deflection—5 M.A.—40 M.V.
List $29.83

Your Cost $8.95
10 for $75.00

OHMMETER

Simpson #282

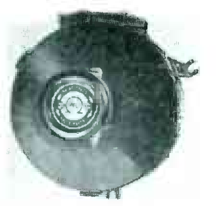
One of the famous Micro-tester lines. Has wide range .2 to 10 megohms. Ranges: 1000 ohms, 10 ohms center; 10,000 ohms, 100 ohms center; 100,000 ohms, 1000 ohms center; 1 Megohm, 10,000 ohms center; 10 Megohms, 100,000 ohms center.

Complete with batteries.

Your Cost $11.75

HEAVY DUTY RHEOSTAT

WARD LEONARD



10 ohms — 9.2 Amps —9.2 Amps (Not tapered). 14" Dia. Complete with handle and legs for rear of panel mounting.

Your cost $5.95

RECTIFIER TUBES

6 Amp. (Tungar type) for battery chargers, rectifiers, etc.

Your Cost $1.50
(minimum order of 10 tubes)

A. C. VOLTS

0-10 V. 2" G.E. AW-42 .... $2.95
0-10 V. 3" G.E. AO-41 .... 3.75
0-150 V. 2" Simpson 155 .... 2.95
(metal case)
0-150 3" G.E. AO-41 .... 4.50
0-150 V. 3" Simpson 55 .... 5.95
0-75 V. 4" Weston 642 .... 6.75
(Surface Metal Case)
0-300 V. 4" sq. Triplett 3.25
(431A 300/600 V. scale)

A. C. AMPS

0-1.5 A. 2" Weston 507 (RF) 3.50
0-2 A. 3" Westhse RT-35 (RF) ... 3.95
0-3 A. 3" Westhse NA-35 .... 3.95
K (scale: 120 A.)
0-30 A. 3" Triplett (metal) 2.95
0-5 A. 4" Weston 642 (surf.) 7.95
(surface-metal)
0-5 A. 4" sq. Triplett 431A 2.95
(scale: 150/300)

All meters are white scale flush bakelite case unless otherwise specified.

POWERTRON Electrical Equipment Co.

119 LAFAYETTE STREET **Phone: WOrth 4-8610** **NEW YORK 13, N. Y.**

HIGH PRECISION 100 Kc. CRYSTALS

Exceptional Frequency Stability ± 15 cycles from —50° to +80°c (.0015) 10G Vibration Test. Calibrated at 30°c Brand New, Mounted in Sealed Cases as Shown

Price $3.95 each

INVERTERS

Pioneer Type 12123-1-A. D. C. input 24 Volt, 12 Amps., RPM 12000. A. C. output 115 volts, .05 Amps., 400 cycles.

Price $49.50 each

ALTIMETERS

Type AN/APN-1. Complete. New.

Price $59,50 each

MAGNETIC COMPASSES

Kollsman type B 16. New.

Price $14.95 each

POSITION TRANSMITTERS

G.E. Type TJ-9-PDN.

Price $1.95 each

STANDARD SIGNAL GENERATOR

General Radio. Model 805 C. Complete with instruction book. Like new. (Catalog price $1,350.00.)

Our price $985.00

MAST BASE INSULATORS

Type MP22. Ideal for marine or mobile. WHIP antenna supports.

Price $1.75 each

All prices quoted are F.O.B. Tuckahoe, N. Y. (About 20 miles north of New York City). All merchandise guaranteed. Immediate delivery subject to prior sale.

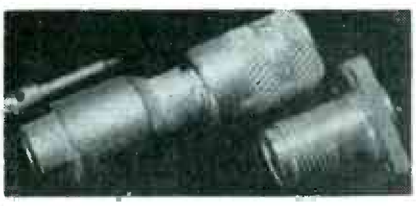
PRICE LIST—METERS

Mfgr.	Model No.	Type	Scale	Body Dia.	Case	Unit Price
Gen. Elec.	AEN216	D.C. Milliameter	0–50	2 1/8"	rd. 2 5/8" bake.	$2.65
Cramer	RT21H	Elapsed time, 110 volt 60 cycle	00000	2 7/16"	rd. 3 1/2" bake.	3.95
West. Elec.	D-170198	D.C. Milliameter	0–80	2 3/4"	rd. 3 1/2 bake.	2.65
West. Elec.	D-167092	D.B. meter, 1 MW in 600 ohms	FS 1MA AC—4 to +6	2 3/4"	rd. 3 1/2" bake.	4.95
Marion In		D.C. Kilovolt meter for use with 1 meg. external resistor	0–1	2 3/16"	rd. 2 3/4" bake.	2.65
Triplett		D.C. Milliameter	0–150	2 1/8"	sq. 2 3/8" bake.	2.95
West'hse.	NX35	D.C. Milliameter	0–800	2 3/4"	rd. 3 1/2" bake.	3.35
Mission Water Heater		Frequency Meter	58–62 cycle	2 3/4"	rd. 3 1/2" metal	3.95
Sangamo Weston	507	D.C. Milliameter	FS 1.2MA 0–100	2"	rd. 2 7/16" metal	2.65
J.B.T.	30-FX	100 to 130 volt Frequency Meter	46–64 cycles	2 5/8"	rd. 3 1/2" bake.	3.95

ELECTRONICRAFT, INC.

5 WAVERLY PLACE TUCKAHOE 7, NEW YORK

Telephone 3-0044



CoAx CONNECTORS

pictured **BABY "N"** UG 85U

UG 21U regular "N" UG 22U
83-1SP • UHF plug • 83-1SPN
83-1R socket • angle 83-1AP

only 40¢ ea. special!

HAROLD H. POWELL

3512 Spring Garden St. Phila. 4, Pa.

TELEVISION EQUIPMENT

Surplus Television cameras and transmitters from Army Guided Missile program; see I.R.E. June 1946.

Transmitters operate 260 to 320 Mc. Complete with all tubes, schematic.

Cameras have auxiliary units, all tubes including camera tube and f/1.9 lens.

An unusual opportunity for colleges, radio schools, experimental stations to obtain scarce equipment at a moderate price.

VILLAGE RADIO EQUIPMENT CO.

201 West 16th St., New York

HIGH FREQUENCY INDUCTION HEATERS

Lepel—7.5 Kw. gap type, water-cooled.
Ecco—5.5, 6.5, 8, 12 Kva. gap type and 35 Kva. tube type, water-cooled.
"Bombarders" are slightly used, condition excellent. Prices reasonable.

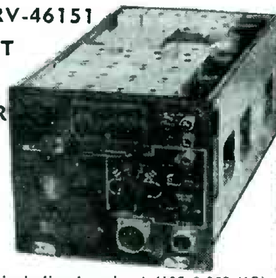
AMERICAN ELECTRICAL SALES CO.
65-67 E. 8th St. New York, N. Y.

NEW WILLARD RECHARGEABLE STORAGE BATTERY

New 6 Volt battery in spill-proof clear plastic case, housed in metal case for easy mounting. Applicable for a wide range of uses where battery power is needed. Shipped dry. Uses standard battery electrolyte available everywhere.

Price, each	$4.35
Lots of Ten	3.35
Without metal case, each	3.85
Lots of Ten	2.85

NAVY-CRV-46151 AIRCRAFT RADIO RECEIVER



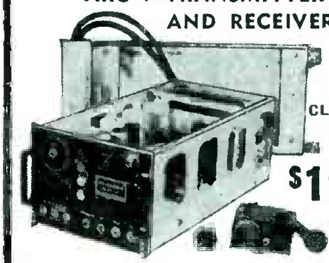
INCLUDING CASE

$17.95

Four bands, including broadcast (195-9,050 KC). Circuit is six-tube superheterodyne with mechanical band change or remote operated electrical band change. Remote band change and tuning controls included, making this set readily adaptable to mobile ham use. Powered from self-contained 24 V. DC dynamotor.

The sets are complete with tubes, mounting rack and remote controls. NO CABLES.

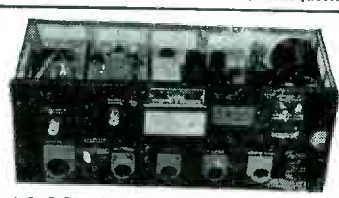
ARC-4 TRANSMITTER AND RECEIVER



INCLUDING CASE

$19.95

Operates on any of its 4 predetermined crystal controlled frequencies in the range of 140 MC. Complete with tubes, remote control, junction box, shock mounting base and connecting plugs. This unit is ideal for amateur UHF or mobile telephone. Operates from self-contained 24 V. DC dynamotor. 12 V available upon request.



RADIO ALTIMETER APN/1

A complete 460 mc. radio receiver and transmitter which can be converted for ham or commercial use. Tubes used and included: 4-12SH7, 3-12-SJ7, 2-6H6, 1-VR150, 2-955, 2-9004. Other components such as relays, 24V. dynamotor, transformers, pots, condensers, etc., make this a buy on which you can not go wrong. Complete as shown in aluminum case 18"x7"x7¼".

$8.95

TERMS: CASH WITH ORDER
F.O.B. Indianapolis, Ind.

AMERICAN SURPLUS PRODUCTS CO.

537 N. CAPITOL AVE.
INDIANAPOLIS, IND.

RADIO TRANSMITTERS

50 Watts to 10 Kilwatts, at Unusual Savings.

Immediate Delivery from Stock

6-10 KW Low and Intermediate Frequency Bunnel Transmitter, 150 to 550 KC. A1 emission, 10 KW output at higher frequencies (above 250 KC). Consists of BC-365F Exciter-Driver (300 watts), PA-1A Power Amplifier, RA-1A Rectifier, AT-1A Antenna Tuning Unit with pre-fab (knock-down) tuning "house", with all spares such as tubes, meters, capacitors, resistors, transformers, etc. All NEW Equipment, in original factory packing. Operates from 220 volts, 3-phase, 50-60 cycles AC. Four (4) complete units available. Priced at less than one-fourth original.—$8,000.00 each.

Model 600-B, 600 Watt Radiotelephone transmitter, mfd by Temco for the Navy (shore station). 600 watts on phone, 1 KW on CW; frequency range 1.5 to 20.0 mc. Provision for multi-channel operation. Includes separate Remote Control and Speech Amplifier unit. Operates from 220 volts, 1-phase, 50-60 cycles AC. With tubes —no spares. Only one unit available. Price, **$2,000.00.**

300 Watt, Low and Intermediate Freq. BC-365F Transmitter, as described for driver of 10 KW unit above, range 150-550 KC. New Eqpt. Complete with all spares, Price **$400.00** each.

350 Watt Airport Tower Control Radiotelephone transmitter, mfd. by Aircraft Accessories Co. Model RC-52. Two channels, separate transmitter for each (common power supply). Range 1.5 to 7.0 mc. Almost new condition. Includes separate Remote Control Panel unit, tubes, but no spares. Only one available. Price **$1,000.00.**

BC-751-A, 100 W. VHF Radiotelephone Transmitters. 108 to over 110 mcs, 4-channel transmitter used for ground-localizer (airports), A2 and A3 emission. Single 5 ft. heavy gauge cabinet contains power supply (110V., 50-60 cycles AC), modulator and audio oscillator stage, and complete RF panels. All frequencies crystal-controlled, some crystals supplied. Most tubes are in each transmitter, but all (total five transmitters available) are clean, though slightly used, and in good working order. No spares or antenna equipment. Priced very low at .... **$300.00 each**

Collins 75 Watt Autotune Transmitter, Model TCB. 10-channels instantly available by dial-telephone selection at transmitter or remote position. A1, A2, or A3 emission. Frq. range 1.5 to 12.0 mc. Operates from 110 volts, 1-phase, 50-60 cycles AC. Complete with all spares (tubes, transformers, autotune motors, crystals, capacitors, etc.), remote operating unit, handsets, etc. Condition used, but clean and operating. Only two available. Priced way below cost, ea. **$750.00.**

Ship All-Range Transmitters, 125 Watts Output on CW or ICW; 40 watts on phone. Model TCE, mfd. by Westinghouse. Range 300 Kc to 9.05 mc, accomplished by plug-in tuning units (6 total, to cover range), each preset to desired operating frequencies. Supplied complete with MG set (for 230 volt DC operation), motor controller, remote control unit, large steel chest of spares, and 6 plug-in tuning coil units. All new eqpt. Only 5 sets available, at low price, ea. **$200.00.**

50 Watt Tower Control Radiotelephone Transmitters, Model BC-329. Range 150 to 450 KC. Transmitter, Modulator and power supply all in one compact cabinet. Operates from 110 volts, 1-phase, 50-60 cycles AC. Condition used, but clean and operating. Less tubes. Ten units available. A real bargain at **$75.00** each.

ELECTRONIC BARGAINS

115 DC to 115 VAC Rotary Converters. Made by Esco for shipboard use. Type R182. Output very conservatively rated at 125 VA, but these units are so ruggedly built and oversize that they will withstand a 50% overload easily. With input and output filter attached. 120 units available, all export packed in wooden cases. Lot price, each **$27.00**

Dual 6 V. Vibrator Packs. Made by Galvin-Motorola for 25 W. mobile transmitters. 6 volt D.C. input, output 540 volts D.C. at 160 ma; with slight wiring change output can be transformed to 300 volts at 300 ma. Each pack has two vibrators and two OZ4A gaseous rectifier tubes for instantaneous operation. New and individually packed. Approximately 370 units available. Each **$9.00.**

Dual-Blower with Motor, large transmitter use. Operates from 110 volts, 60 cycles AC. Price **$11.75** each.

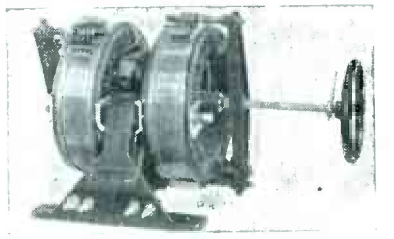
Many other items. Write your needs.

Prices quoted are f.o.b. N.Y.C. All material subject to prior sale! Equipment inspection invited!

TELEMARINE COMMUNICATIONS CO.
533 W. 24th St. New York, N. Y.

Industrial Power Supply Equipment

TRANSFORMERS



T-103 (above) Voltage regulator transtat. Max KVA output 11.5, 50/60 cyc. 0-115 V. 100 amps or 230 V. 50 amps **$75.00**
Net Wt. 134#

T-101 (left) Plate Transformer. Amertran. Primary 115 V. 60 cyc. 10.4 KVA. Secondary 17600 V. .520 Ma. 35 KVA test **$65.00**
Net Wt. 500#

T-102 Filament Transformers. American Transformer Co. Type WS .050 KVA. 50/60 cyc. Single phase. 35 KVA test. 12 KV D. C. operating. Primary 115 V, Secondary 5 V, 10 amps with integral stand-off insulator and socket for #371, 872 etc. rectifier tubes.. **$12.50**
Net Wt. 15¾#

T-104 Voltage Regulator Transtat 115 V. 60 cyc. Max. KVA .25, single phase, voltage range 103-126 volts max. amps 2.17 for filament voltage control **$9.50**
Net Wt. 15#.

CAPACITORS

C-107 G.E. or Westinghouse Capacitor. Cat. #14F59. Inesteen 1 mfd. 25000 V. D. C. **$36.00**
Net Wt. 65#
C-132 Aerovox, 10 mfd. 600 volt. D.C Oil filled **$1.00**

CHOKE COIL

R-106 Amertran Disc Type. Line volts 15000 V. D. C., Ripple frequency 120. 149 ohms, resistance .020 D.C. amps at 900 henrys 48% ripple. .52 amps D.C. at 25 henrys 48% ripple......... **$42.00**
Net Wt. 280#

RESISTORS

R-123 160000 ohm wire wound resistors, 200 watts .... **$.90**
R-148 5000 ohm wire wound resistors, 200 watts .... **$.90**
R-153 1000 ohm wire wound resistors, 200 watts .... **$.90**

RELAYS—CONTACTORS

RC-110 I.T.E. Magnetic contactor. Cat. #KJ4206. 115 V. 60 cyc. coil. Single pole 115 A. 600 V. with barriers, Adj. time delay and remote contact control trip **$10.95**
Net Wt. 47½#
RC-117 Westinghouse Time Delay, current relay. Type SC-M. .2 to 1 amp A.C. or D.C. **$12.95**
Net Wt. 3#
RC-112 Allen-Bradley. Cat. #810. Magnetic overload relay. 6.3—18.1 amps, 600 v. max **$7.95**
Net Wt. 2¾#
RC-111 Allen-Bradley. 115 V. 60 cyc. coil. D.P.S.T. Contactor 15 amps. **$4.95**
Net Wt. 1¼#
RC-105 Monitor Controller Co. Magnetic Contactor. 115 V. 60 cyc. coil. 100 amp. 600 V. Double Pole with barriers. 150 A. & 30 A. Renewable fuses **$8.95**
Net Wt. 32#
RC-115 R. W. Cramer Co. Time Delay Relay. Type TD2 120S. 1 min. interval. 115 V. 60 cyc. Synchronous motor driven. Contact rating 10 amp. 115 V. Single Pole.................. **$4.95**

TUBES

TU-147 #371A or 371B High Voltage. High vacuum rectifier tubes (used). Filament guaranteed **$1.50**
T-117 New........................ **$5.95**

METERS

M-144-5 R. W. Cramer Co. Running Time Meter. Type RT2H. 115 V. 60 cyc. with .001 mfd. condenser. Flush mounting. 9999.9 hrs........... **$5.95**
M-141 Weston Model 476, 0.130 V. A.C. voltmeter. Flush type, calibrated for steel panel mounting............ **$4.95**
M-140AB Weston Model 476 Full scale A.C. Ammeter, 3 amp. Calibrated 0-120 V. flush mounting, with Weston 40/1 current trans............... **$8.50**
M-116 Weston Model 476 Filament voltage indicator. 0-130 V. Movement with 115 V. mark, flush mounting, calibrated for steel panel **$3.95**
M-143AB Weston Kilovoltmeter, Model 301, 20 KV. 1000 ohms per volt. Flush type calibrated for steel panel mounting. with 20 meg. 20 KV Weston resistor. Complete with clips and stand-off insulators **$18.00**
M-142 Weston Model 301 D.C. Milliammeter. 0-800 MA. Flush type. Calibrated for Steel panel mounting.......... **$4.45**

MOTOR AND BLOWER

MB-156 Motor blower units. Direct connected. 4" inlet. 4" exhaust, 1/20 H.P., 115 V. 60 cyc., 1750 R.P.M. Capacitor start. Mfg. by Champion Blower Co. Cat. #0-CE .... C.F.M... **$21.50**
Net Wt. 39½#

HEATERS

H-149 Chromolox Strip Heaters, 300 W., 115 V. (¼"x1½"x12") **$1.00**

ELECTRICAL INTERLOCKS

E-114A Cory-Yale Interlock #B986—Single **$1.95**
E-114B Cory-Yale Interlock #B1536—Dual **$2.95**

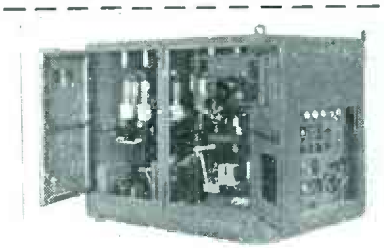
SURGE PROTECTORS

S-109 Sundt Surge Protectors #5134 with #5130 tube, 125 V. D.C. **$1.25**

POWER SUPPLY UNIT

P-100 High Voltage D.C. Power Supply Unit. Primary 115 V. 60 cyc. Output 0-15000 V. D.C. @ .5 amps. **$200.00**

Net Wt. 2040#



All merchandise guaranteed in "as new" condition. Add approximately 20% to net weights for estimated shipping weights. Terms are 30% with order, balance C.O.D. All prices are f.o.b. Oakland Warehouse. Write for additional detailed information on any of the above items and for special quantity discounts.

1527 E. Seventh St. **EPCO** *Los Angeles 21, Calif.*

Surplus Equipment

Signal Generator, Measurements model 84, 300 to 1000 megacycles, 1 to 100,000 microvolts metered output, pluse and cw modulation, 115 volts 60 cps, in good working order.

Signal Generator, Measurements model 78B, 15 to 25 and 150 to 230 megacycles, 1 to 100,000 microvolts metered output, 400 and 8200 cps modulation......$90.00

Microwave Generator, TS 14/AP for Sa band, power meter for internal and external metering, variable pulse width and delay, calibrated attenuator, $250.00

Microwave Generator TS 13/AP for Xa band, power meter for internal and external metering, calibrated attenuator.

Fluxmeter TS-15/AP, 1000 to 10,000 gauss, for .6" and 1.3" to 1.5" gaps, new, $60.00

RADAR JAMMER, T-26/APT-2, 435-715 megacycles, 110 volts, 400 cps, new....$40.00

Crystal Mixer Assembly, 10 cm......$3.00

Tunable Mixer Assembly, 10 cm......$5.00

Tunable Mixer cavity, 2000-4000 mc...$5.00

Oscillator, 1000-3000 cm, 2C40, calibrated, $50.00

Oscillator Butterfly, 300-1000 mc, mounted socket and W.E. 703A Tube.......$11.00

Mixer Butterfly, 80-300 mc..........$3.00

Oscillator, 10 cm tunable, variable attenuator, with klystron and thermistors, $40.00

Attenuator TPS-51PB-20, fixed 20 db, $3.50

Attenuator CN-50/APN, 30-100 db, calibrated $15.00

Type N Connectors, UG 12, 21, 24, 25, 27, 29, 30, 58, 83, 86, 245 U and UHF Connectors SO239, PL259, M359, UG266U, immediate delivery.

RG-9/U and RG-8/U cable with UG21/U connectors at ends 4.5' long.......$2.00

GENERAL RADIO PRECISION WAVEMETER, Type 724-A, range 16 kilocycles to 50 megacycles, V.T.V.M. resonance indicator, complete with accessories and carrying case, new.............$200.00

RDF Equipment DP-15, 100-1500 kc, for ship use, complete with pedestals, azimuth scale, loop assembly, used, 110 v 60 cps $160.00

Radio Compass Receiver, Bendix MN26-A, 150-1500 kc, 12 v, new...........$40.00

Dynamotor G.E. 12 v, 1000 v 350 ma out, new $15.00

Dynamotor DM43, 24 v, 550/1000/2/8/ volts at 250/280 ma, new................$8.00

Transformers, 115 v 60 cps primaries:

1. 7500 v 35 ma ungrounded, Thordarsen suitable for doubler..........$15.00
2. 6250 v 80 ma ungrounded, G.E. .$12.00
3. 2 secondaries at 500 volts 5 amps each $50.00
4. 1120 v 600 ma c.t., 2 x 5 v 6.2 amps c.t. 3 kv ins. 6.3 v 3 amps 1700 v ins. 6.3 v .3 amps. 1.7 kc ins. potted $15.00

Pulse input transformer, permalloy core, 50 to 4000 kc, impedance ratio 120 to 2350 ohms $2.80

Pulse transformer, 3 windings, impedance 0 to 5000 ohms, turns ratio 1:1.1....$0.50

Ceramic feed thru capacitors, threaded, 50 mmfd................$5.00 per hundred

Electro Impulse Laboratory

P.O. Box 250

Red Bank, New Jersey

RELIANCE SPECIALS

RADAR TRANSMITTER-BC-1072-A: Operates on 115 volt, 60 cyc., freq. range 150 to 200 mcs.

CONTAINS:

Blower—115 V., 60 cyc., 28 watts, 1525 R.P.M.
Variac—Gen. radio type, 200 B, 100 watts
4 Transformers—
117 V Pri; Sec. 3500 V
117 V Pri; Sec. 6.3 V@2.1 A, 312 V Center tap each side, 5 V@3 A
117 V Pri; Sec. 4 V@16 A, 2.5 V@1.75 A
117 V. Pri; Sec. 6.3 V@1.2 A, 700 V either side of center, 5 V@3 A
2 Chokes
11 Tubes, including 6J5, 2X2, 6SN7, etc.
Meter—G.E. 3½", 0-5 Kilovolt and 0-10 M.A., D.C.
Circuit Breaker—115 volt, 15 amp.
5 Condensers—(1) .1 mfd, 7000 V. (2) 2 mfd., 1000 V, (2) 4 mfd, 600 V
2 A.C. Relays
Contains many other useful parts too numerous to list. Contained in metal case and wood chest. This transmitter is used. Shipping weight 245 lbs. $22.50

OCTAL SOCKETS—Wafer—Bakelite ....4c each, per 100	$3.50
14 PIN SOCKET for Cathode Ray Tube	40c
ACORN TUBE SOCKET..........	14c
3 PIN SOCKET FOR CRYSTAL HOLDER	20c
CIRCUIT BREAKERS—2A—30c; 3A—35c; 5A—45c; 6A—50c; 15A..	85c
WATERPROOF PUSH BUTTON SWITCH—1 red button, 1 black button, SPDT, in metal case 3" x2¾"x4¼"	$1.50
CUTLER HAMMER FUSEABLE SAFETY SWITCH—108475D1, in metal case 6½"x8¼"x10⅞".......	$4.50
MICRO SWITCH—Push Button—Normally open—45c each., 10 for	$4.00
ALUMINUM SWITCH—Push Button—ROUND—Normally open, ⅝ dia. x ⅞" long..................	10c
PYRANOL CONDENSERS	
.2 mfd. 10,000 V. D.C..............	$2.00
.1-.1 mfd. 7,000 V. D.C...........	1.85
4 mfd. 3,000 V. D.C..............	3.25
4 mfd. 2,500 V. D.C..............	2.65
.2 mfd. 750 V. A.C. (2,200 V. D.C.)	.40
4 mfd. 2,000 V. D.C..............	2.00
4 mfd. 1,000 V. D.C..............	1.00
3 mfd. 1,000 V. D.C..............	.90
14 mfd. 600 V. D.C................	1.70
4mfd. 600 V. D.C..................	.70
1 mfd. 600 V. D.C.................	.29
SELSYN MOTORS—115 V, 60 cyc., 4½" long x 3½" dia. transmitters for remote control..............pair	$6.75
SELSYN MOTORS (Transmitters) —50 V. 50 cyc................pair	$4.50
SELSYN DIFFERENTIAL MOTORS—50 V, 50 cyc.........each	$1.25

ALLEN HEAD SET SCREWS—

2—56x1/16"	6—32x⅛"
4—40x⅛"	6—32x3/16"
4—40x3/16"	8—32x⅛"
4—40x¼"	8—32x3/16"

Per hundred	1.50
Allen wrenches for above screws, 2c each	
BALL BEARING, FAFNIR 33K5 —3/16" hole x ½" OD...........	25c
BALL BEARING—similar to Fafnir S1KDD7, ¼" hole, ⅝" OD....	35c
BRASS BINDING POST—EBY—with 8-32 screw mounting, per hundred	$2.50
SLIP RING ASSEMBLY—5 silver plated rings on molded bakelite rotor. Stator holds 2 silver carbon brushes for each ring. Rotor 3⅞" OD, fits 1¾" shaft. Complete with brushes	$2.00
CHROMALUX STRIP HEATER—115 V, 750 W, semi-circular 20"x 1½"	75c
STEEL JUNCTION BOX—watertight, 14 ga. steel, 17"x25"x6½". Screw type hinge on lid. Approx. 50 lbs.	$2.75
PRECISION RESISTOR—MEPCO —522,000 ohms, 1 watt, ½% accuracy	18c
TRANSFORMER—R.C.A., Pri. 440 V.—220 V. 60 cyc.; Sec. 230 V.-115 V. 60 cyc.; 6 KVA...........	$12.50
HIGH VOLTAGE POWER TRANSFORMER — Westinghouse U.S.N. =CAY-30741-A, oil filled, Pri. 105-115-125 volts, 54 to 66 cyc. Sec. 18,000 V. @ 15 mils; 15,000 V. @ 20 mils; 2½ V. @ 5 A. (Can be used in a precipitron)..........	$30.00

POSTAGE STAMP MICAS

.01 mfd. 300 V	500 mmf. 500 V
.0012 mfd. 500 V	.0022 mfd. 500 V

All values $4.00 per 100

F.O.B. Philadelphia. Minimum Order $3.00

RELIANCE MERCHANDIZING CO.

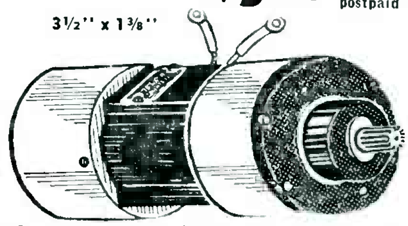
Arch St. Cor. Croskey., Phila. 3, Pa.

Telephone—RIttenhouse 6-4927

At last: a synchronous Alnico Field reversible D.C. motor which will run over ONE WEEK on a 6 volt flashlight battery. Geared down to ½ rev. per minute. Mounted with two G.E. Switchettes and a relay. Fuse holder and extra fuse, two Bristol wrenches to change timing cams, two 220 ohm resistors furnished to run on 12 or 24 volts. Only 500 available.

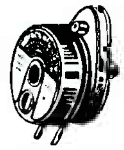
$5.50 postpaid

3½" x 1⅜"



Operates on Flashlight batteries, speed depending on the voltage. Fairly strong on 6 volts, full power and speed on 27 volts. Designed to be used in bombsights, automatic pilots, etc. 250 RPM. A bargain at...... **$5.00**

HAYDON SYNCHRONOUS TIMING MOTOR



to operate switches, etc. can be had either 1 Rev. per hour or 1 Rev. per minute at this SPECIAL PRICE **$3.85**

Many other speeds available at $4.95

EST. 1923 **BLAN** EST. 1923

Experimenters and Inventors Supplies

64 Dey St., New York 7, N.Y.

Model S-1028 Portable Landing Field Beacon. Designed for continuous operation from either 105-125 volts DC or 60 cycle AC, producing a high intensity, short duration, intermittent flashing light. May be easily converted for commercial photographic use. Shipping weight 191 lb. $150.00

I-222A, Signal Generator and Hetero-dyne Wave Meter. Fundamental oscillator frequency range from 8-15 mc and 45 to 76 mc. Calibration charts supplied covering 8-15 mc and 135 to 230 mc. By using harmonics of the oscillator, continuous coverage from 8 to 230 mc is possible. Complete with operating cables. No service department or Laboratory can afford to be without one at $42.50

McElroy TP-890B Tape Pullers. Operates on 110 volt 60 cycle AC. Speed adjustable. Uses standard 16 mm 400 foot motion picture reel. Brand New completed with instruction book but less tape reel......$32.50

Tape Stand for holding standard rolls of tape $2.50 ea

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Acorn tube sockets similar to Johnson 265.$0.14
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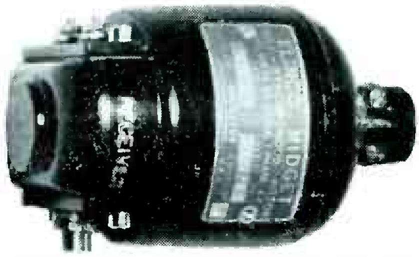

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.009.......	.003.......	.00012.....	.00051.....
.0082......	.0022......	.000075....	.0005......
.0068......	.002.......	.000047....	.00047.....
.0062......	.0015......	.000043....	.00046.....
.006.......	.027.......	.00005.....	.00043.....
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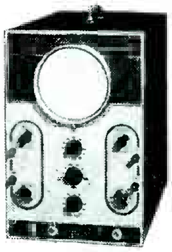
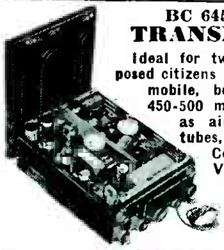


BC 645 GENERAL ELECTRIC TRANSMITTER-RECEIVER



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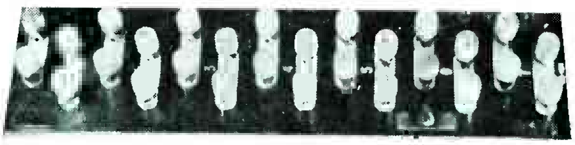

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INDEX TO ADVERTISERS

SEARCHLIGHT SECTION
(Classified Advertising)

ADVERTISERS INDEX

Index to electronics Volume XX

January to December issues, inclusive, 1947

Cumulative Index (April 1930—December 1944) available at 75 cents

McGraw-Hill Publishing Company

330 West 42nd St., New York City, 18

LS SERIES

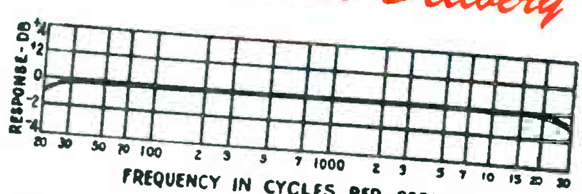
The Ultimate in Quality

UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability. Wartime restrictions having been lifted, and UTC production running at full capacity, we now offer these transformers for immediate delivery.

UTC Linear Standard Transformers feature...

- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse couplings.
- **Reversible Mounting** . . . permits above chassis or sub-chassis wiring.
- **Alloy Shields** . . . maximum shielding from induction pickup.
- **Multiple Coil, Semi-Toroidal Coil Structure** . . . minimum distributed capacity and leakage reactance.
- **Precision Winding** . . . accuracy of winding .1%, perfect balance of inductance and capacity; exact impedance reflection.
- **Hiperm-Alloy** . . . a stable, high permeability nickel-iron core material.
- **High Fidelity** . . . UTC Linear Standard Transformers are the only audio units with a guaranteed uniform response of ± 1.5DB from 20-20,000 cycles.

For Immediate Delivery



Typical Curve for LS Series

Type No.	Application	Primary Impedance	Secondary Impedance	Max. Level	Relative hum-pickup reduction	Max. unbalanced DC in primary	List Price
LS-10	Low impedance mike, pick-up or multiple line to grid.	50, 125, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	+15 DB	−74 DB	5 MA	$25.00
LS-10X	As above	As above	50,000 ohms	+14 DB	−92 DB-Q	5 MA	$32.00
LS-21	Single plate to push pull grids Split primary and secondary	8,000 to 15,000 ohms	135,000 ohms; turn ratio 3:1 overall	+14 DB	−74 DB	0 MA	$24.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125, 200, 250, 333, 500/600 ohms	50, 125, 200, 250 333, 500/600 ohms	+17 DB	−74 DB	5 MA	$25.00
LS-30X	As above	As above	As above	+15 DB	−92 DB-Q	3 MA	$32.00
LS-50	Single plate to multiple line	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	+17 DB	−74 DB	0 MA	$24.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20 watts			$28.00
LS-57	Same as above	5,000 ohms plate to plate and 3,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20 watts			$20.00

The above listing includes only a few of the many units of the LS Series. For complete listing — write for catalogue.

United Transformer Corp.

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93 - "Portable Inductive Radiophone"
LF system, railroad use

Announcing the new list of

RCA Preferred Type Tubes

The types on this new list of RCA *Preferred* Tubes fulfill the major engineering requirements for future equipment designs. RCA *Preferred Types* are recommended because their general application permits production to be concentrated on fewer types. The longer manufacturing runs reduce costs—lead to improved quality and greater uniformity. These benefits are shared alike by the equipment manufacturer and his customers.

RCA Tube Application Engineers are ready to suggest the best types for your circuits. For further information write RCA, Commercial Engineering, Section R-40- L, Harrison, N. J.

GAS TUBE TYPES

THYRATRONS	IGNITRONS	RECTIFIERS	VOLTAGE REGULATORS
2D21*	5550	3B25	OA2*
3D22	5551	673	OC3/VR105
884	5552	816	OD3/VR150
2050	5553	857-B	
5563		866-A	
		869-B	
		8008	

*Miniature type

POWER AMPLIFIER AND OSCILLATOR TUBE TYPES

TRIODES	PENTODES	BEAM POWER
5588	802	2E24
5592	828	2E26
6C24		807
811		813
812		815*
826		829-B*
833-A		832-A*
889-A		
889R-A		
892		
892-R		
8000	**TETRODES**	
8005	4-125A/4D21	
8025-A	8D21*	
9C21		
9C22		
9C25		
9C27		

*Twin type

CATHODE-RAY TUBE AND CAMERA TUBE TYPES

BULB DIAM.	TELEVISION: Directly Viewed	TELEVISION: Projection	OSCILLOGRAPH: PI Screen	PICKUP	MONO-SCOPE
2"			2BP1	5527	
3"			3KP1	(2P23	
			5UP1	(5655	
5"		5TP4			2F21
7"	7DP4				
	7JP4				
8"				1850-A	
10"	10BP4				

PHOTOTUBE TYPES

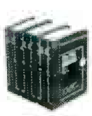
GAS	VACUUM	MULTIPLIERS
1P41	922	931-A
921	929	
927		
930		

RECEIVING TUBE TYPES

RECTIFIERS	CONVERTERS	VOLTAGE AMPLIFIERS – TRIODES: Single	TRIODES: Twin	TRIODES: With Diodes	PENTODES: Sharp Cutoff	PENTODES: Remote Cutoff	PENTODES: With Diodes	TWIN DIODES	POWER AMPLIFIERS
MINIATURE									
6X4	1R5	6C4	6J6	1U5	1U4	1T4		6AL5	3S4
35W4	6BE6		12AU7	6AQ6	6AG5	6BA6		12AL5	3V4
117Z3	12BE6			6AT6	6AU6	6BJ6			6AQ5
				6BF6	12AU6	12BA6			35B5
				12AT6	12AW6				50B5
METAL AND GLASS									
1B3GT/8016	6SA7	6J5	6SC7	6SQ7	6SJ7	6SK7	6SF7	5V4-G*	6K6GT
5U4G	12SA7		6SL7GT	6SR7		6SS7		6H6	6L6G
5Y3GT			6SN7GT	12SQ7		12SK7			6V6GT
6X5GT									6BG6G
35Z5GT									35L6GT
									50L6GT

*Recommended only for television damper applications.

For complete technical data on these preferred tube types, refer to the RCA HB-3 Handbook.



RCA Laboratories, Princeton, N. J.

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