TELE·TECH

Formerly the TELE-communications TECH-nical Section of

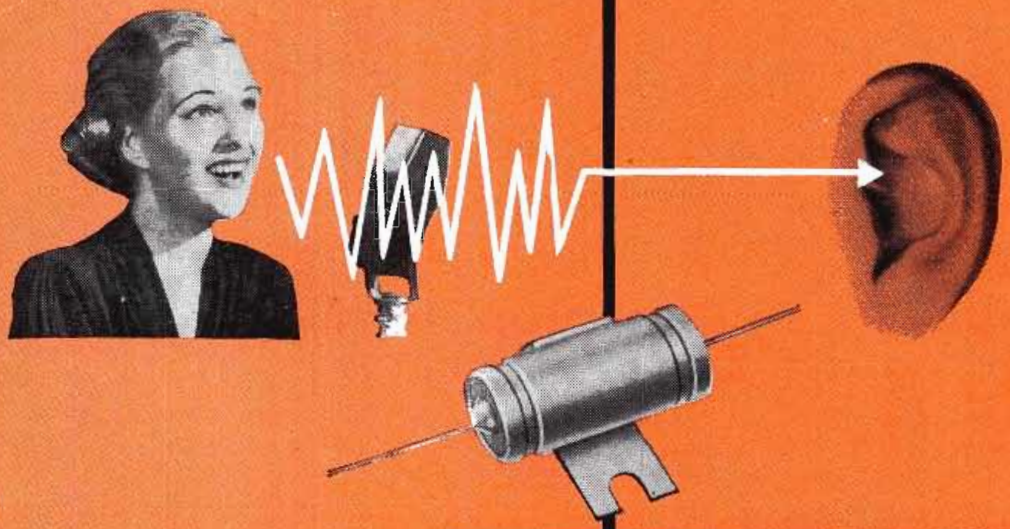
ELECTRONIC INDUSTRIES

DESIGN AND OPERATION OF RADIO · FM · TELEVISION
RADAR AND ALL COMMUNICATIONS EQUIPMENT

December · 1947

IN THIS ISSUE:

CALDWELL-CLEMENTS, INC.



radio interference filtering with C-D *Quietones**

We have designed—and have available—many types of C-D Quietones which are equally effective on both Radio and video bands. They meet every requirement of manufacturers' cost and production schedules. One of these standard types may remove your product from the list of Radio interference generators. If not, we're ready and waiting—with a modern and complete laboratory and experienced engineers—to design and build a Quietone to meet your specific needs. Your inquiry is cordially invited. Cornell-Dubilier Electric Corporation, Dept. J-12 South Plainfield, New Jersey. Other large plants in New Bedford, Worcester and Brookline, Massachusetts, and Providence, Rhode Island.

CORNELL-DUBILIER

WORLD'S LARGEST MANUFACTURER OF

CAPACITORS

Make Your Product More Saleable with C-D Quietone Radio Interference Filters and Spark Suppressors.

* Reg. U.S. Pat. Off.

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ELECTRONIC INDUSTRIES

Editorial Contents

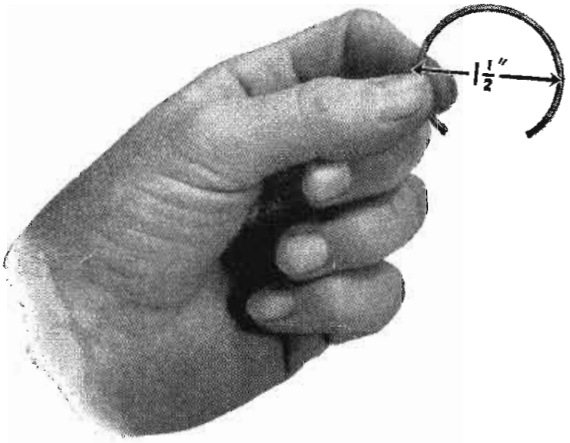
DECEMBER, 1947

CALDWELL-CLEMENTS, INC., Publication Office, Orange, Conn., Editorial and Executive Offices 480 Lexington Avenue, New York 17, N. Y., Tel. Plaza 3-1340

BRANCH OFFICES — Chicago 6, R. Y. Fitzpatrick, 201 N. Wells St., RAN 9225; Los Angeles 5, The Robert W. Walker Co., 684 So. Lafayette Park Pl., Drexel 4388; San Francisco 4, 68 Post St., Sutter 1-5568.

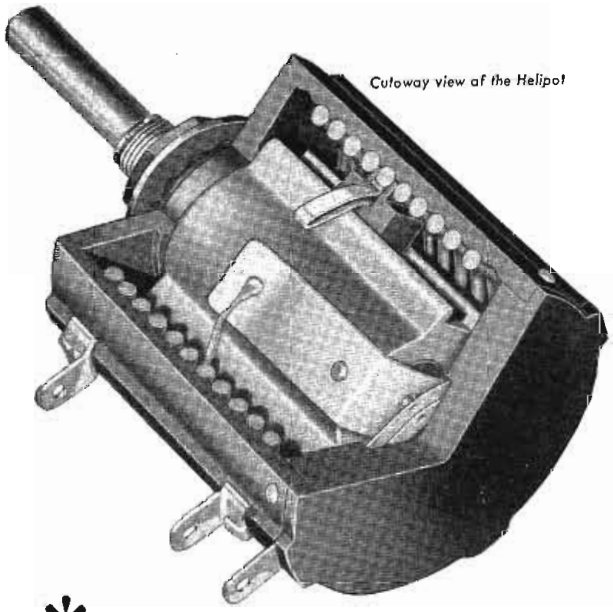
Compare!

Here's the Helipot Principle that is Revolutionizing Potentiometer Control in Today's Electronic Circuits



CONVENTIONAL POTENTIOMETERS have a coil diameter of approximately 1½" and provide only 4" (about 300°) of potentiometer slide wire control.

THE BECKMAN HELIPOT has the same coil diameter, yet gives up to 46" (3600°)* of potentiometer slide wire control—nearly TWELVE times as much!



Cutaway view of the Helipot

***HELIPOTS ARE AVAILABLE IN 3 STANDARD SIZES:**

TYPE A—5 watts, incorporating 10 helical turns and a slide wire length of 46 inches, case diameter 1¾", is available with resistance values from 25 ohms to 30,000 ohms.

TYPE B—10 watts, with 15 helical turns and 140" slide wire, case diameter 3¼", is available with resistance values from 100 ohms to 100,000 ohms.

TYPE C—2 watts, with 3 helical turns and 13½" slide wire, case diameter 1¾", available in resistances from 5 ohms to 10,000 ohms.

The Type B is also available in special sizes of 25 and 40 helical turns, with resistances ranging from 500 ohms to 300,000 ohms, and containing more than 100,000 change-of-resistance steps.

*Data above is for the standard Type A unit.

Some of the multiple Helipot advantages

EXTENSIVELY used on precision electronic equipment during the war, the Helipot is now being widely adopted by manufacturers of quality electronic equipment to increase the accuracy, convenience and utility of their instruments. The Helipot permits much finer adjustment of circuits and greater accuracy in resistance control. It permits simplifying controls and eliminating extra knobs. Its low-torque characteristics (only one inch-ounce starting torque*, running torque even less) make the Helipot ideal for power-driven operations, Servo mechanisms, etc.

And one of the most important Helipot advantages is its unusually accurate linearity. The Helipot tolerance for deviations from true linearity is normally held to within ± 0.5%, while precision units are available with tolerances held to 0.1%, .05%, and even less—an accuracy heretofore obtainable only in costly and delicate laboratory apparatus.

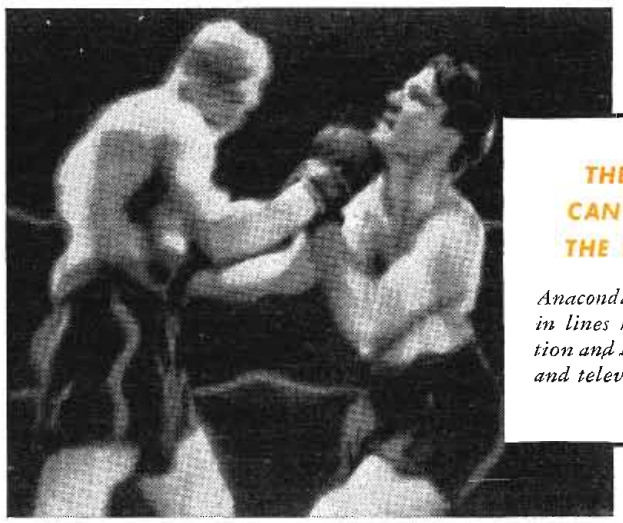
The Helipot is available in a wide range of types and resistances to meet the requirements of many applications, and its versatile design permits ready adaptation of a variety of special features, as may be called for in meeting new problems of resistance control. Let us study your potentiometer-rheostat problem and make recommendations on the application of Helipot advantages to *your* equipment. No obligation of course. Write today.

Send for the New Helipot Booklet!

THE Helipot CORPORATION, 1011 MISSION STREET, SOUTH PASADENA 3, CALIFORNIA

Anaconda—OUT FRONT IN TELEVISION LEAD-IN LINES

TYPE ATV standard FM
and television lead-in lines



THE LEAD-IN CAN MAKE ALL THE DIFFERENCE

Anaconda Type ATV lead-in lines have low attenuation and are matched to FM and television receivers.

Anaconda Type ATV* lead-in lines are designed for minimum signal loss and maximum freedom from distortion in FM and television reception. The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion.

There is a wide selection of correctly engineered lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded—each designed to fulfill the exacting requirements of wide-band reception.

*An Anaconda Trade-Mark

47440

ANACONDA RESEARCH BRINGS YOU A COMPLETE LINE OF HIGH-FREQUENCY CABLES OF ALL TYPES

Make Anaconda your headquarters for high-frequency cables. Write for a useful folder containing electrical and physical characteristics of the complete line of Anaconda coaxial cables. Also, ask for a bulletin giving the characteristics of Type ATV lead-in lines. Address: Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

ANACONDA
from mine to consumer

ANACONDA WIRE AND CABLE COMPANY

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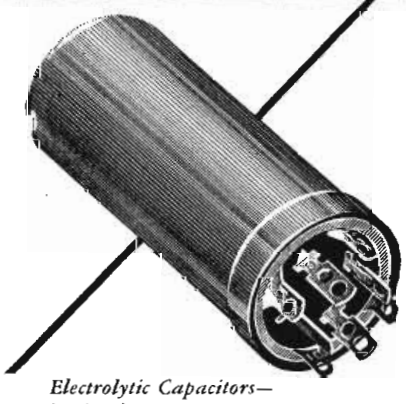
Printed in U.S.A. *Reg. U.S. Pat. Off.

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.

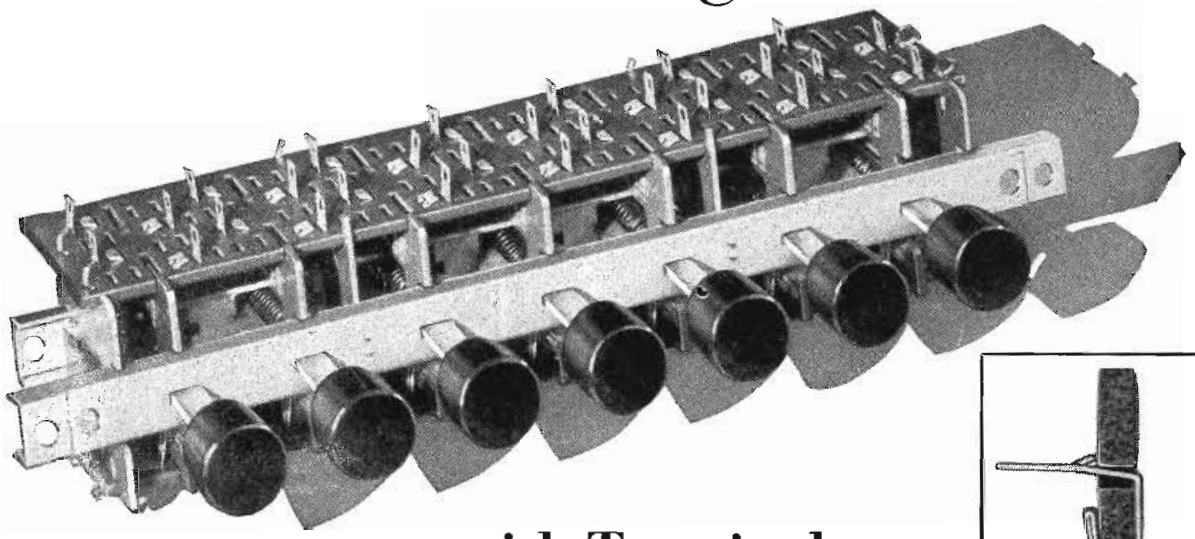
There is no substitute for experience!

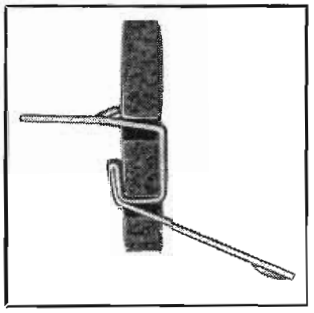
Magnavox

has served the radio industry for over 32 years

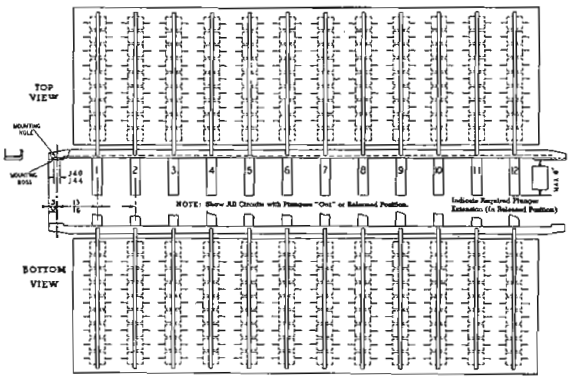
SPEAKERS · CAPACITORS · SOLENOIDS · ELECTRONIC EQUIPMENT

An Infinite Variety of Switching Combinations





...with Terminals That Can't Twist or Pull Free



Ask for MC Specification Sheets

Printed on thin paper to permit blueprinting, these sectional drawings indicate standard and optional dimensions—make it easy for you to specify MC switches built to your circuit requirements.

YOU can choose from 2 to 12 plungers when you order this Mallory MC Push Button Switch—and each plunger gives you a maximum of 32 terminals. *That* means an almost infinite variety of switching combinations: an ideal circuit-selecting medium for such equipment as home and auto radios, coin-operated record players, intercommunications systems and other electronic devices.

But versatility alone doesn't tell the story: complete *dependability* is important, too. And that's what this MC Switch gives you—in details like its high grade phenolic insulation, its frame and latch bar made of heavy gauge durable steel, its silver-plated spring bronze terminals that are securely fastened so they won't pull free or twist.

Notice those terminals in particular! Note the complete absence of rivets or eyelets. See how the unique wrap-around method of fastening also provides constant tension against slider contact shoes—insures good electrical contact with a minimum of noise.

There are a lot more details about this switch. Write for full particulars, being sure to ask for engineering data folder. If special help is required, our engineers will be glad to assist you. And remember—Mallory switches with many standard circuits are obtainable from your Mallory distributor *any time*.

P. R. MALLORY & CO. Inc.

MALLORY SWITCHES

(ELECTRONIC, INDUSTRIAL and APPLIANCE)

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

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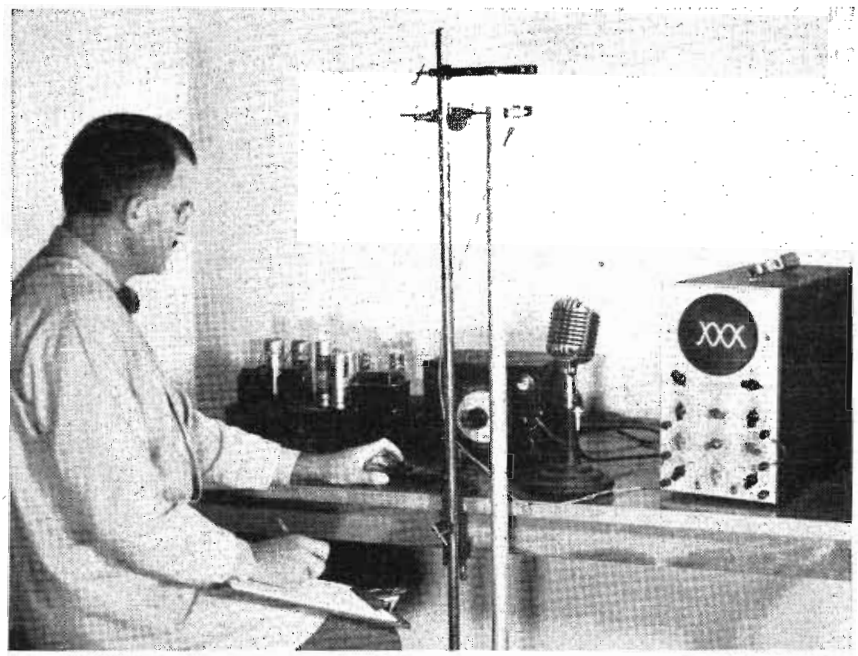


Laboratory set-up for measuring tone of chime tubes. Lissajous figure on screen of cathode ray oscilloscope is being used to determine the frequency (cycles per second) of the chime's fundamental note.

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.

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.

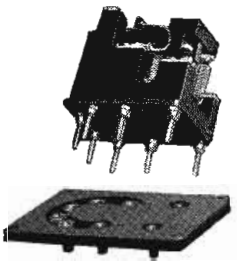
PREFERRED RATINGS

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

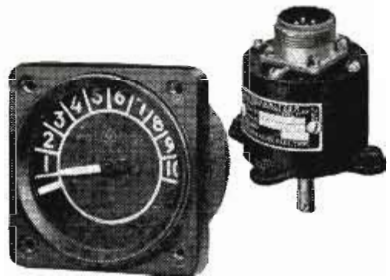
REMOTE POSITIONS THAT ARE ACCURATE

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: 1⅞-inch dial with 1 or 2 pointers, and 2¾-inch dial with 1, 2, 3 or 4 pointers. Dial markings to meet your needs

GENERAL ELECTRIC

Digest

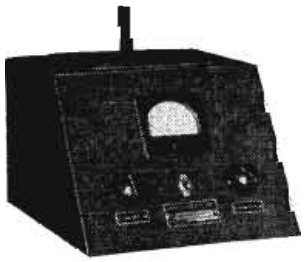
TIMELY HIGHLIGHTS ON G-E COMPONENTS



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

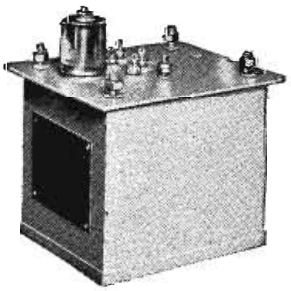
High-speed production testing of small coils is possible with this General Electric low-voltage tester which shows the presence of short-circuited turns in unmounted coils and gives an approximate indication of the number of short-circuited turns. The coil to be tested is simply slipped over the core 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

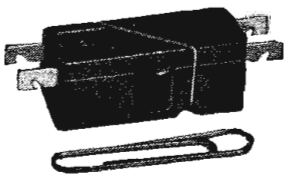
These new, small a-c to d-c power supplies are specially built for precision work with cathode-ray tubes, television camera tubes, radar indicator scopes, electron microscopes . . . or any job where good regulation, light weight and small size are primary considerations. These hermetically sealed, oil-filled 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. H 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 }	

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

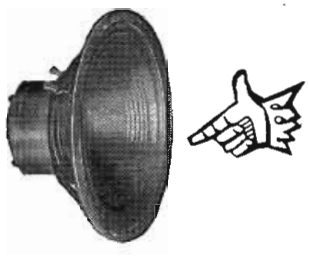
Name.....

Company.....

Address.....

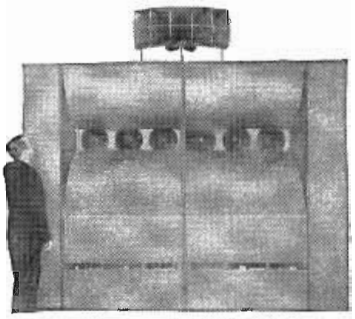
City.....State.....

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

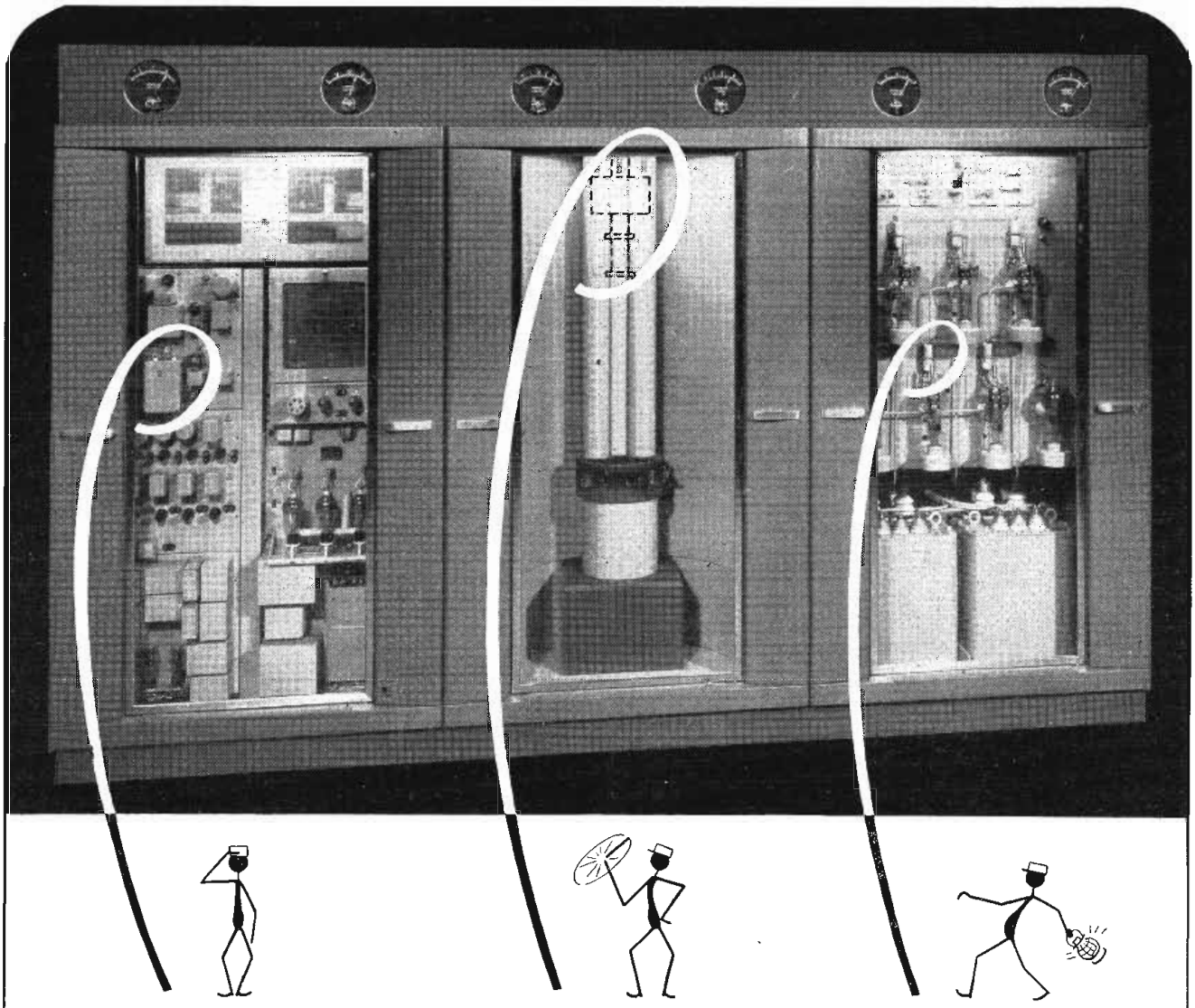
is the **highest**

There is an Altec Lansing
loudspeaker to meet
every need of the audio field.
Inquiries are invited:
write Department T

ALTEC
LANSING CORPORATION

1161 North Vine Street, Hollywood 38
250 West 57th Street, New York 19

You get these 3 FM Watchmen in Western Electric transmitters only



FREQUENCY WATCHMAN

All Western Electric FM transmitters are kept constantly on their assigned frequencies by the Frequency Watchman—a simple, fool-proof, automatic device sensitive to the slightest frequency deviation. With this watchman on guard, stability of the transmitter is governed by the stability of a low temperature coefficient crystal, which varies less than *25 cycles per million* in the temperature range of from 40° to 130° F.

POWER AND IMPEDANCE WATCHMAN

The new RF Wattmeter and Impedance Monitor is available exclusively in Western Electric FM transmitters. It makes possible—for the first time—accurate, direct indication of the actual R. F. power *in kilowatts* fed into your antenna system—plus a simple method of measuring standing wave ratio under full power output. Supplied as standard equipment with all transmitters of 3 kw and up.

ARC-BACK WATCHMAN

Permits realization of the full life of each rectifier tube. By indicating exactly which tube has reached the end of its *reliable* service life, this watchman makes it possible to replace a worn out or faulty tube with the preheated spare and be back on the air —*with assurance*—in a few seconds.

Distributed by GRAYBAR
OFFICES IN 95 PRINCIPAL CITIES

FOR FURTHER DETAILS about the 3 FM Watchmen and Western Electric's new line of FM transmitters, call your local Graybar Broadcast Representative, or write Graybar Electric Company, 420 Lexington Ave., New York 17, N. Y.

Western Electric
— QUALITY COUNTS —

Furnace Brazing Without Flux!

NEW!

GENERAL PLATE

Lo-Flo

(SH7)

SILVER SOLDER

Permits Furnace Brazing at 1350°F

- ***Excellent Wetting Properties***
- ***High Bond Strength***
- ***High Corrosion Resistance***
- ***Jigs Last Indefinitely***
- ***No Cleaning After Brazing***

General Plate *Lo-Flo SH7* silver solder gives you all the advantages of copper brazing plus higher strength, higher corrosion resistance . . . and with furnace temperatures of only 1350°F. to 1400°F. instead of 2000°F. to 2050°F.

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:

GENERAL PLATE DIVISION

of Metals & Controls Corporation

ATTLEBORO, MASSACHUSETTS

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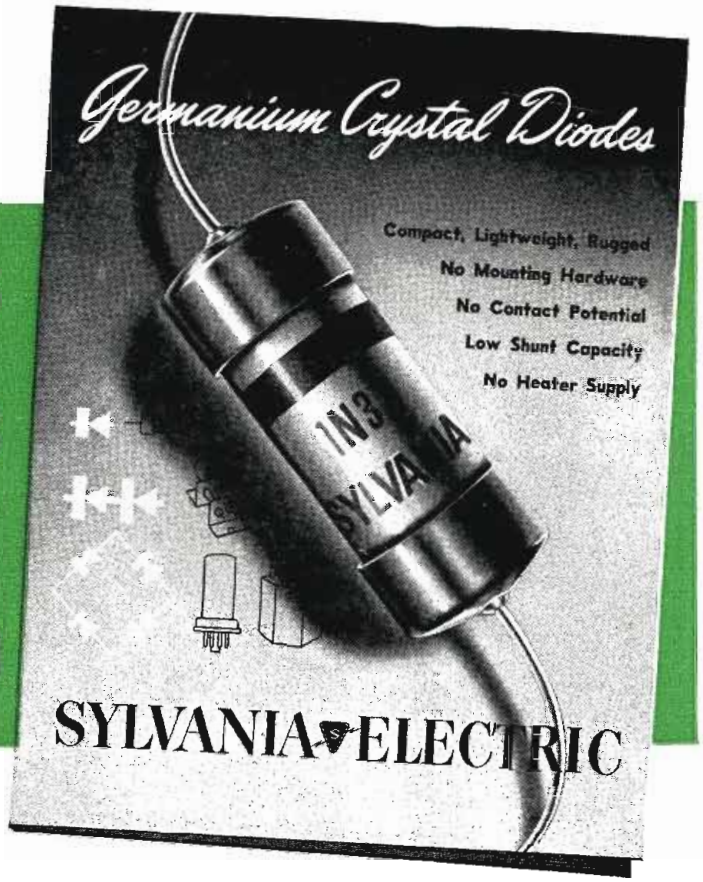
IDEA-SPARKING FACTS *on* GERMANIUM CRYSTALS *from* THE LEADERS IN GERMANIUM RESEARCH



Want concise, useful information on germanium crystal diodes, duo-diodes and varistors?

A new bulletin contains the facts you'll want on these unique circuit elements that are characterized by compact, rugged construction, light weight and low shunt capacity—that eliminate the need for heater supply.

Compiled by Sylvania Electric—pioneers in the field of germanium research and development—the bulletin summarizes mechanical specifications and electrical ratings—together with characteristic performance curves and typical circuit diagrams that may suggest to you many new applications for the Sylvania family of germanium crystals.

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Please send me your bulletin "Germanium Crystal Diodes."

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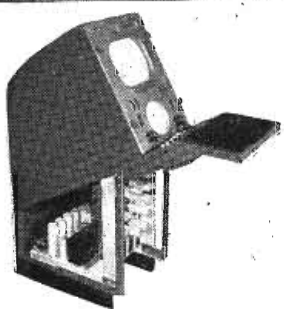
State.....

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

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. 98-L, Radio Corporation of America, Engineering Products Department, Camden, N. J.

- **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)**

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)

TELEVISION BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

PRECISION

MAKES THE DIFFERENCE

National

EST. 1914

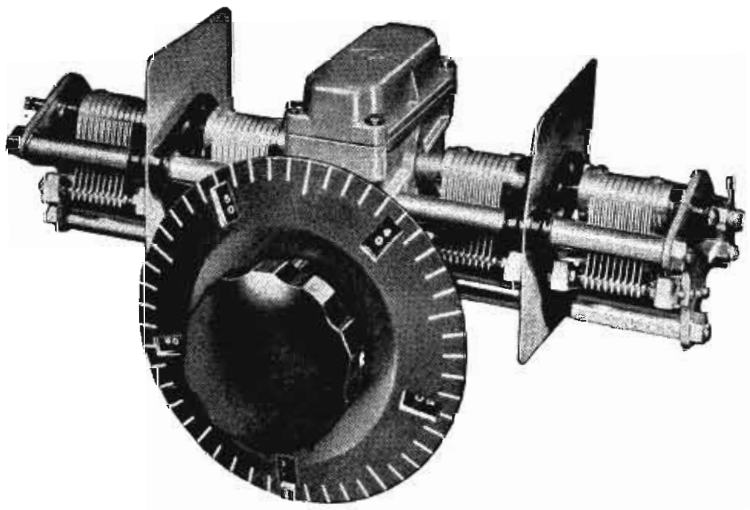
When it comes to constructing equipment that can be depended on to operate under all sorts of conditions, the manufacturer or engineer must have parts whose workmanship he can rely on.

That's why National parts are precision-made with tolerances measured as close as .0002".

On this page is illustrated a precision assembly consisting of a micrometer dial, an enclosed preloaded worm gear drive and a sturdy condenser. They can be furnished separately or in combination — and are good examples of the kind of construction that has effected considerable savings for hundreds of manufacturers.

Send for your copy of the 1948 National catalog, containing these and hundreds of other parts, today.

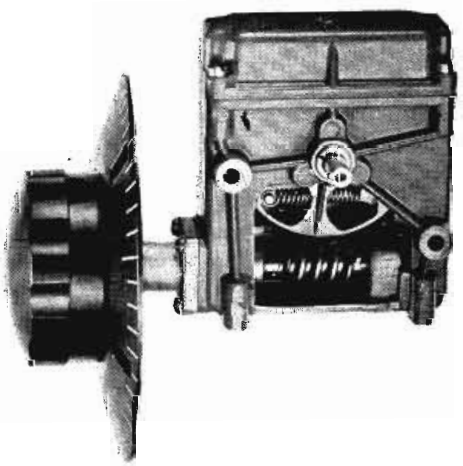
National Company, Inc.
Dept. No. 13
Malden, Mass.



The PW-D micrometer dial with its associated eccentric bushing provides 500 calibration divisions for ten revolutions of the instrument shaft.

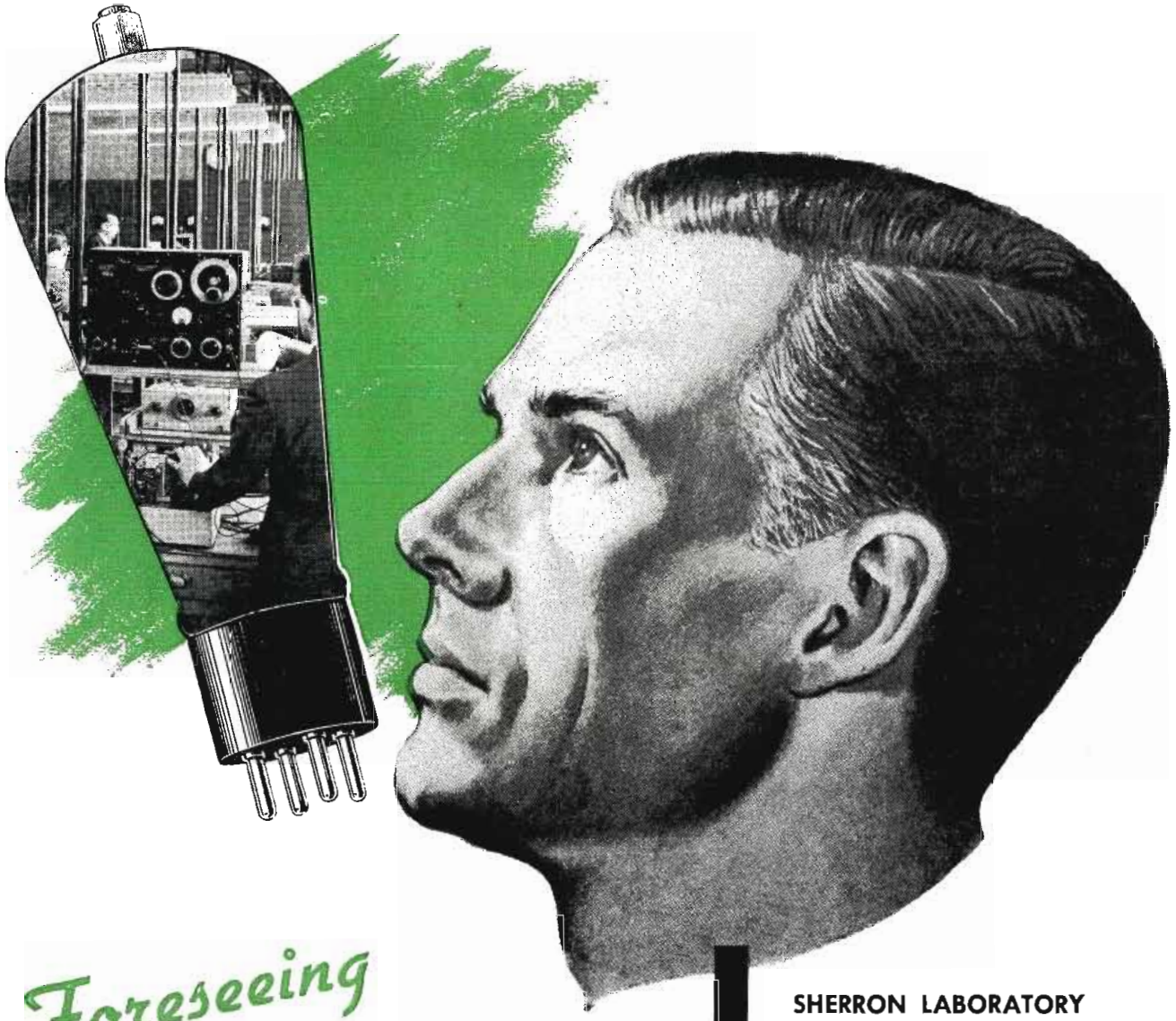
The PW Condenser is of extremely rigid construction with Steatite stator insulation. Plate shape is straight-line frequency when the frequency range is 2:1.

PW condensers are available in 2, 3, or 4 sections in either 160 or 225 mmf per section. A single section PW Condenser with grounded rotor is supplied in capacities of 150, 200, 350 and 500 mmf, single spaced, and capacities up to 125 mmf, double spaced. Multi-section PW Condensers have insulated rotors with 225 and 160 mmfd sections. PW Condensers are supplied for operation parallel to the panel. For applications requiring a precision condenser for perpendicular-to-panel mounting, ask about the National NPW line.



The drive is through an enclosed preloaded worm gear with 20 to 1 ratio.

MAKERS OF LIFETIME RADIO EQUIPMENT



Foreseeing

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.

SHERRON LABORATORY PROJECTS COVER . . .

1. **Ultra and Hyper High Frequency Techniques**
2. **Electron Ballistics**
3. **Thermionic Emission**
4. **High Vacuum Electronic Tubes Techniques**
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6. **Electronic Control for Drone and Guided Missiles**

Sherron Electronics W2XDK

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See these WAA Authorized Distributors for *your* share! Their inventories include many types of unused electronic devices, tubes and equipment.

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The HIGH-FIDELITY RECORDER...

...for the Studio Professionalist

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

RCA Type 73-B

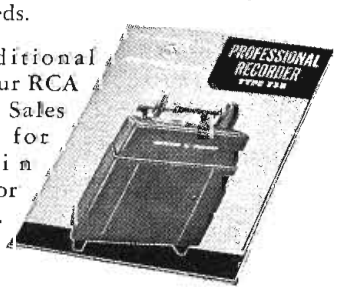
DESIGNED with almost every known device for cutting your high-fidelity reproductions, this professional recorder has everything you need for versatile control of cutting to meet any recording situation.

- 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. 98-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

RCA

BROADCAST EQUIPMENT

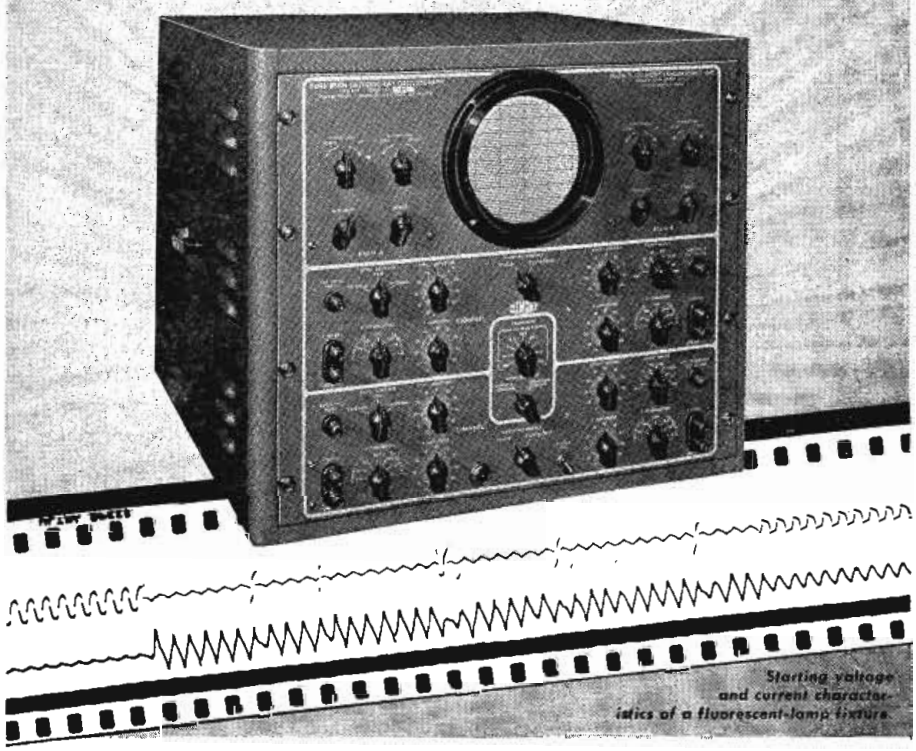
RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

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.

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 saw-tooth 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.

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*

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THE THINGS YOU WANT most in a rectifier — lasting performance and dependability — can neither be seen nor accurately measured. But they *can* be *identified*. . . by the familiar "FTR" trademark. Why? Because Federal was the *first* manufacturer of Selenium Rectifiers in this country — because Federal has pioneered every major advance in their design and construction — and because, for over 9 years, Federal Selenium Rectifiers have continued to set the industry's standards for performance, economy, and long service life.

Whether your product uses DC by the milliampere — or by hundreds of amperes — there's a Federal Selenium Rectifier that's right for the job. For example: The "postage-stamp size" rectifier shown above delivers 5 milliamperes at 2,000 volts DC . . . while the large 48-plate three-phase stack furnishes up to 200 amperes at 30 volts DC, or 25 amperes at 240 volts DC. Both have one thing in common — the traditional Federal quality and dependability. Write today for information on the rectifier for *your* power-conversion requirements. Dept. F466.

An IT&T Associate

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.

Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 1000 Passaic Ave., East Newark, New Jersey

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp. 67 Broad St., N. Y.

TELE-TECH'S TELEVISION-I.R.E.

Show Issue March 1948

Television design and manufacture are the two most important jobs today confronting the radio industry—and TELE-TECH, too, since this magazine serves the industry's technical needs editorially and in advertising. How rapidly television is traveling is indicated by the fact that by March 1948, when the IRE Show will be held in New York, there will be as many as 20 to 25 stations on the air, with several dozen others planned and under construction throughout the United States. Ray C. Cosgrove, former president of the Radio Manufacturers Association, said recently:

> ". . . by June the dollar revenue from television will be greater than from standard broadcasting receiver production."

Frank E. Mullen, NBC executive vice-president, speaking on a program telecast in New York, remarks:

> ". . . within two years' time we should be seeing this program in Hollywood as well as on the East Coast."

During these months of intense full-speed-ahead activity and for many years to come, you can count on TELE-TECH for superb coverage of the field of television and all tele-communications with its audience of 16,000 top design engineers, manufacturing and operating men. Thus coincident with the March 1948 convention and show of the Institute of Radio Engineers, TELE-TECH will publish a special Television-IRE Show Issue giving a comprehensive coverage of new technical phases of television. Advertisers should plan to take advantage of the marketing opportunities this March issue will make available.

TO REACH THE TECHNICAL MEN OF TELEVISION AND TELE-COMMUNICATIONS, ADVERTISE IN TELE-TECH

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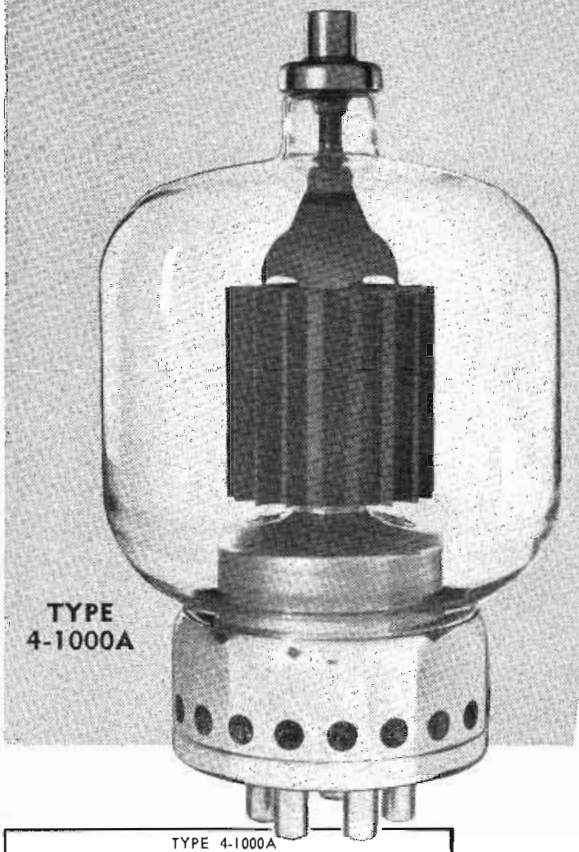


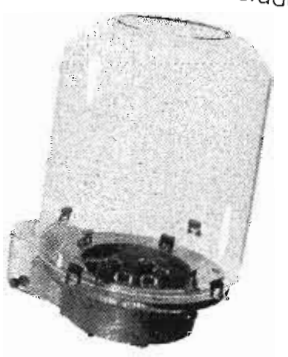
TYPE 4-1000A

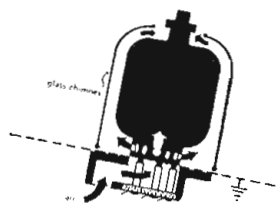
OUTPUT 3 Kw. WITH 14 WATTS DRIVE

Workhorse for communications and industry, the recently announced type 4-1000A is presently the largest of Eimac radiation cooled power tetrodes. High power-gain capabilities, on the order of 230 times, fit the tube to applications requiring high power output with low driving power needs.

The tube has been ruggedly designed to withstand the abuse of the most severe application and abnormal overload. Eimac "know how" of vacuum tube design provides long life expectancy and overall economy of operation. Virtual isolation of the input and output circuits has been achieved, simplifying associated circuit design. Short, low-inductance leads, Eimac's non-emitting grids, and rugged plate impart a high degree of operational stability. High efficiency may be maintained well into the vhf, above 110-Mc. As an example, two tubes operating well within ratings, have provided 5 kw useful output power at 110-Mc.

As a functional accessory, a unique socket design to assist in adequate cooling is available. Illustrated below is the complete unit and a diagram indicating the control of air-flow past the terminals, base seals, around the envelope and to the plate seal. The pyrex glass chimney is included with each socket.





TYPE 4-1000A

ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	7.5 volts
Current	21 amperes
Grid-Screen Amplification Factor (Average)	7.2
Direct Interelectrode Capacitances (Average)	
Grid-Plate (without shielding, base grounded)	0.24 μμfd
Input	27.2 μμfd
Output	7.6 μμfd
Transconductance (i_b = 300 ma., E_b = 2500 v., E_{c_1} = 500 v.)	10,000 μmhos

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Class-C Telegraphy

(Key-down conditions, per tube)

MAXIMUM RATINGS

D-C Plate Voltage	6000 Max. Volts
D-C Screen Voltage	1000 Max. Volts
D-C Grid Voltage	—500 Max. Volts
D-C Plate Current	700 Max. ma
Plate Dissipation	1000 Max. Watts
Screen Dissipation	75 Max. Watts
Grid Dissipation	25 Max. Watts

TYPICAL OPERATION

(Frequencies below 40 Mc.)

D-C Plate Voltage	6000 Volts
D-C Screen Voltage	500 Volts
D-C Grid Voltage	—200 Volts
D-C Plate Current	681 ma
D-C Screen Current	141 ma
D-C Grid Current	41 ma
Screen Dissipation	71 Watts
Grid Dissipation	6.1 Watts
Peak R-F Grid Input Voltage (approx.)	348 Volts
Driving Power (approx.)	14.3 Watts
Plate Power Input	4086 Watts
Plate Dissipation	746 Watts
Plate Power Output	3340 Watts

Follow the Leaders to

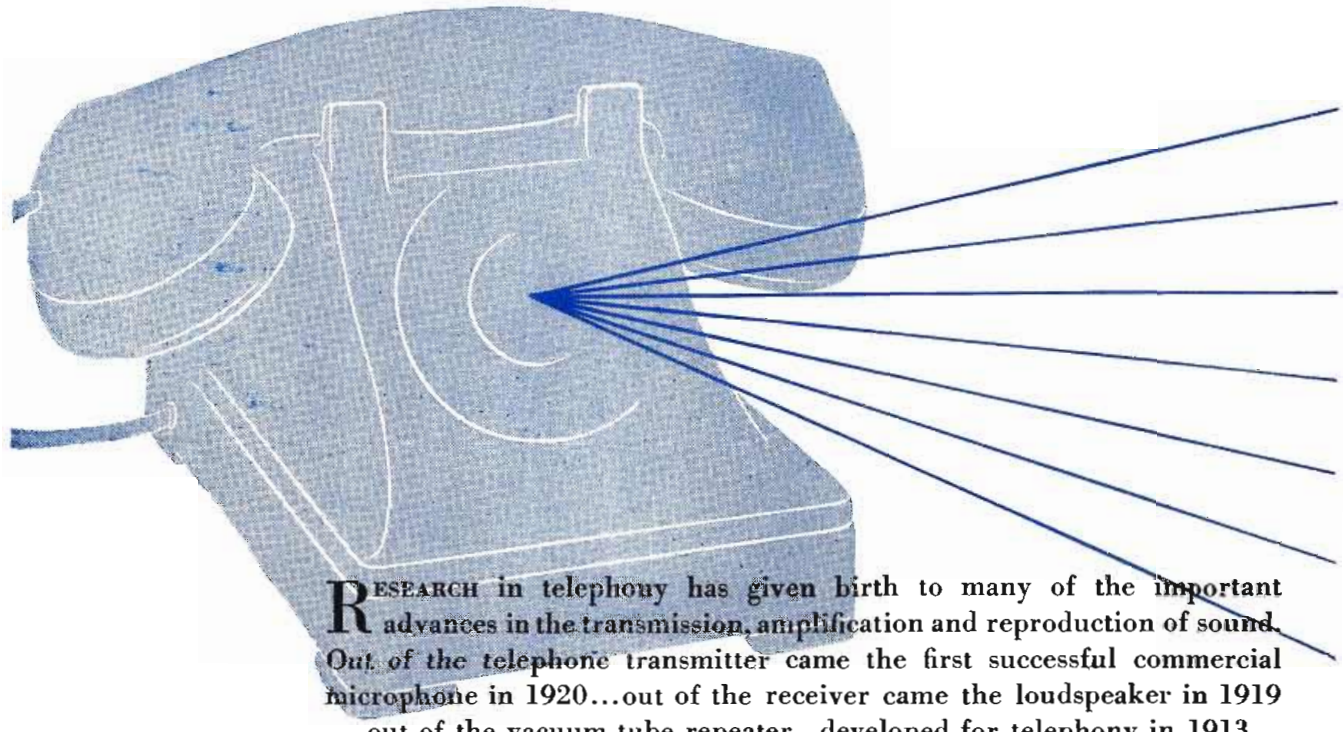
Eimac TUBES

The Power for R-F

Export Agents: Frazar & Hansen, 301 Clay Street, San Francisco, 11, California

EITEL-McCULLOUGH, Inc., 185 San Mateo Avenue, San Bruno, California

Why this team



RESEARCH in telephony has given birth to many of the important advances in the transmission, amplification and reproduction of sound. Out of the telephone transmitter came the first successful commercial microphone in 1920...out of the receiver came the loudspeaker in 1919 ...out of the vacuum tube repeater—developed for telephony in 1913—the modern science of electronics.

It is only natural that Bell Laboratories scientists and Western Electric engineers, working as a team to improve telephony, have pioneered in the design and manufacture of equipment in all of these fields which have sprung from the telephone.

Whether you are interested in radio broadcasting, mobile radio, sound motion pictures, sound systems, radar, hearing aids or radio telephony, you'll find it wise to look to equipment designed and manufactured to fill your needs by the Bell Telephone Laboratories-Western Electric team.

—QUALITY COUNTS—

can lead in all these fields

BROADCASTING
AM, FM

SOUND SYSTEMS
Public Address, Music Distribution, Wired Music

SOUND PICTURES

MOBILE RADIO
Police, Marine, Aviation, Railroad, Urban and Highway Service

HEARING AIDS

RADIO TELEPHONY
Overseas, Ship-to-Shore, Point-to-Point

RADAR

BELL TELEPHONE LABORATORIES
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.

VITROTEX *Magnet Wire*

WITH GLASS FIBER INSULATION

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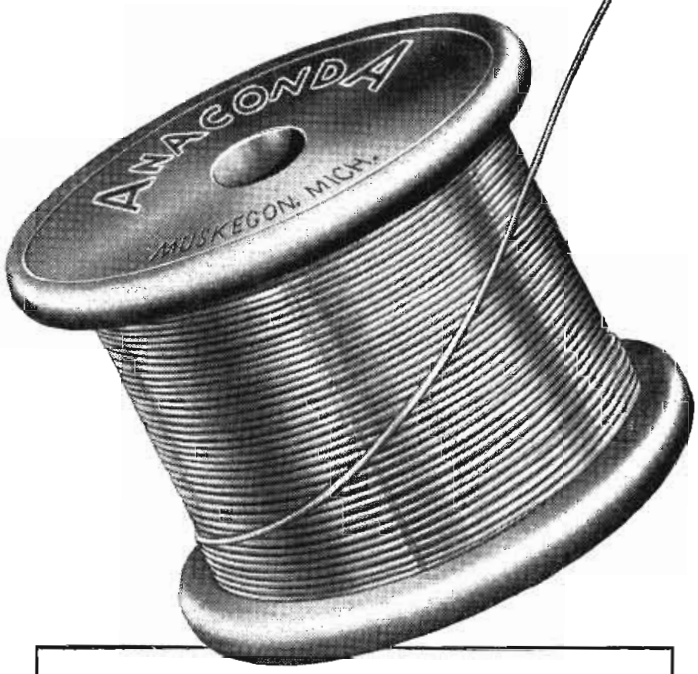

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1. *Withstands high temperatures*
2. *High dielectric strength and insulation resistance*
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4. *High resistance to acids, oils and corrosive vapors*

ANACONDA
from mine to consumer

LOOK TO *Anaconda* FOR ENGINEERED MAGNET WIRE AND COILS

TELE·TECH
Formerly the TELE-communications TECH-nical Section of
ELECTRONIC INDUSTRIES

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

SHAPE OF THINGS TO COME—Receivers which tune themselves, are not too very far in the future. At least one manufacturer is developing such a "signal seeking" receiver for a number of large automobile makers. When the pushbutton is pressed, the receiver automatically cruises along the spectrum highway until it comes to a station of adequate signal strength. Then it stops and tunes itself in. If the listener does not like this program he merely taps the button again and resumes his driving, while the receiver "brain" goes to work for him.

CONVENTIONS TO PHILLY FOR TV—Final deciding factor in swinging both the Republican and Democratic conventions to Philadelphia, was availability of television linkage with 14 stations. These reach all or parts of 13 states, with 42 millions population and 168 electoral votes. Adjoining the convention hall in Phila., multiple TV screens will provide for delegates who can't get seats in hall, in addition to 25,000 invited spectators.

17 MILLION RECEIVING SETS IN '47 is prediction of RMA president Max F. Balcom of Sylvania—an increase of several million over the number of sets made the preceding year, thus establishing a further all-time record. In terms of RMA's goal "a radio set for every room" or four sets per family, President Balcom sees present-day saturation as less than 40%.

TELEVISION PICTURES ARE GETTING BIGGER but there is some indication that the tubes that produce the pictures may get quite a bit smaller. One manufacturer of tubes has a projection type "package" built around a 2-in. tube. Receiver factories, skilled in radio-circuit assembly would buy the optical "package" and build around it. Another top rank receiver manufacturer is understood to have a 2-in. tube projection model in the development stage. Idea is that with these small tubes you get projected pictures the equivalent, in size at least, of those produced on the face of a 12-in. tube which costs a lot more.

750 KW OF AM POWER for each of 20 Class 1-A standard broadcast stations scattered throughout U. S., as requested of FCC by Clear Channel Broadcasters group, would bring high quality reception to large rural areas, overriding local natural and man-made static. Under proposed super-power plan, practically all rural regions of nation would have choice of four program services. (If 750 kw seems high, remember that Russia has several 1000-kw and one 2500-kw broadcast transmitters!)

BEGACYCLES ? ? Already the art has come to the point where we need a new unit to describe thousands of megacycles. Is "begacycles" the aswer? A wavelength of 1 centimeter would be 30 begacycles; 1 millimeter, 300 begacycles, (or shall we say 0.3 tregacycle?) Incidentally, the Greeks did *not* have a word for this one—so we used this neat mathematical relationship: Million is to billion, as mega is to (? ?). *Bega,* of course.

SUNSPOTS have been at a maximum so far this year. This has been indicated by the increased interference over long-distance paths between signals in the 30-44 mc region—Atlantic Coast cops hearing their West Coast brethern and vice versa—and it is likely to get worse. In 1944, sunspots were minimum and it was rarely possible to communicate across the north Atlantic at frequencies above 20 mc. This year with the extremely high sunspot number of 126, transmissions above 50 mc

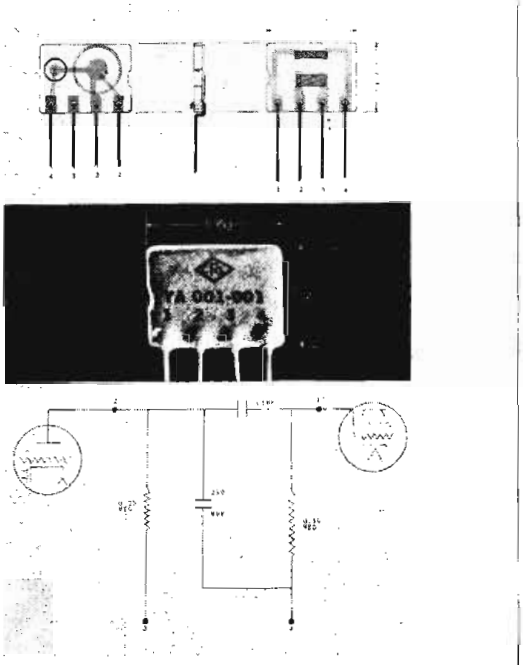
Coming in January — STATISTICS OF RADIO PRODUCTION

For many years the radio magazines published by Caldwell-Clements, Inc., have compiled and issued the accepted basic radio-production and radio-use figures of the radio industry. Compiled and published immediately at the close of the periods covered, these industry estimates have afforded production and sales yardsticks which, time and again, have been fully confirmed months afterwards, when carefully checked census and organization statistics became available.
TELE-TECH for January will continue these industry figures, presenting production and use statistics for 1947, and for the opening of the new year.

have been logged frequently over this path. FM broadcasters, of course, have antennas arranged for low-angle radiation (as do the police, for that matter) and so are not as apt to experience much interference though some has been reported. But for the communications companies more sunspots means more reliability and more signal strength for high-angle radiation.

SCIENTISTS HAVE NOT YET SUCCEEDED in breeding a race of colored electrons but they have, of course, produced the equivalent in fluorescent materials that will glow almost any color under the influence of just ordinary electrons. That's the principle on which a new television tube, styled "Chromoscope", operates. It was revealed at the National Electronics Conference in Chicago. With three screens coated to fluoresce red, blue and green, an observer would see three color images superimposed to give a composite colored image. Getting enough brilliance might cause trouble. DuMont is doing the development work on the tube.

PRINTED CIRCUIT TECHNICS are creating a mild furore. How high interest is running is indicated by the fact that about 700 engineers and designers, many from the Army and Navy, assembled in Washington last month to participate in a symposium on the subject and to learn more about PC. This does not necessarily mean that from the status of a novelty such methods have risen over-night to become a formidable competitor of soldered methods. But PC unquestionably holds worthwhile advantages for certain services. It's up to the engineers to expand the limitations of the method.



This Centralab "Couplate" indicates what can be done with PC— a single component with 4 leads replacing 4 separate components with 8 leads. It is possible to make a printed circuit having 15 capacitors and 15 resistors or more, a total of 30 components, on a plate ¾ in. in area and 1/16 in. thick. For more on PC, see following pages.

RADIO SETS FOR EVERYBODY. Now on paper is a plan for a 1000-kw, 250-kc international transmitter to be located in Central Europe for broadcasting the UN message. Next step would be to help provide inexpensive receivers for the newsbound and radioless people throughout the Continent (and later the world!). The crystal radio set, which is independent of tube and battery replacements, may be the answer. Remember that the pioneer Marconi signal of 1901, with only feeble power behind it, was heard across the Atlantic with just such a crystal receiver. It seems certain that a 1000-kw UN station could offer crystal radio listeners throughout Europe, ample reception for news items.

NOW WE HAVE A RESISTOR ANALYSIS COUNCIL, a new industry service. International Resistance Co. has drawn together a group of electrical and mechanical engineers to act as consultants to designers. One object of the service will be to promote use of standard parts and eliminate costly "specials" insofar as possible.

RAYTHEON HAS RUN AWAY with the ship-borne radar business. Up to Oct. 4, FCC had granted a total of 288 radar licenses. Raytheon supplied 219 of the equipments, which is 76%. Since the war the company reports that it has sold over 300 equipments for ships of all sorts, amounting to a volume of two and three-quarter millions of dollars.

NOT MANY KNOW that the Bing Crosby programs broadcast over an extensive network for Philco, are recorded on tape, edited on the tape and re-recorded on discs. Tape recording facilitates editing, dubbing, etc. and permits cutting out the eggs before they hatch. The tape-to-disc process is said to be much simpler than other methods.

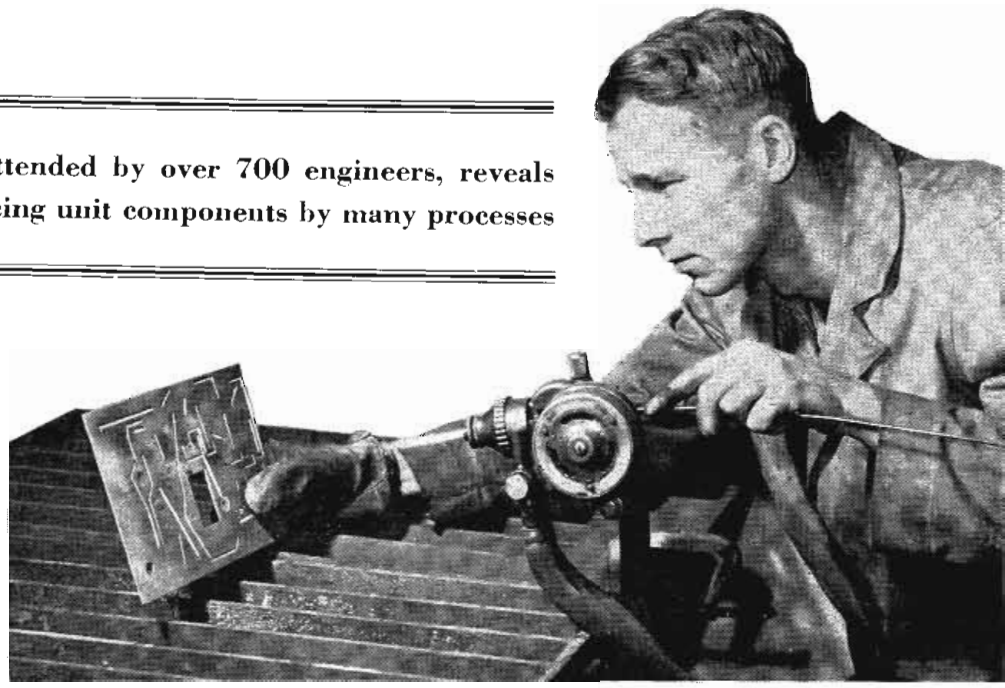
INCIDENTALLY, THERE HAS BEEN quite a rash of wire recorders appearing lately. Some are good, some not so good. So far, RCA is the only one that has adopted the "cartridge" idea for the wire, thus simplifying operation considerably. It is still a difficult engineering job to get really high fidelity on wire at a cost that is not prohibitive insofar as the ordinary user is concerned. Still there are many who would buy such equipment who are not too fussy about both ends of the hi-fi scale.

PATRONS OF PUBLIC HALLS, such as bars and grills do not represent a too discriminating audience. Nevertheless there are those who incline to the opinion that some of the TV receiver installations that are being made are doing television a disservice. Pictures in many cases are unsteady, decidedly poor in quality, lack brilliance and contrast to a point where no inconsiderable number of viewers are turning away in disgust. Unfortunately, the unquestioned pulling power of TV has induced many not fully qualified by experience, ability or proper engineering knowledge to produce big screen receivers for the quick money there is in their production. Some, currently operating, are a travesty on what good design and know-how can do and are doing. If judgment of home television possibilities is to be based on what some bar and grill patrons are seeing, it's just no good for television.

Present Status of PRINTED CIRCUIT TECHNICS

Washington symposium, attended by over 700 engineers, reveals modern methods of producing unit components by many processes

By Dr. A. F. MURRAY, Consulting Editor
TELE-TECH Washington Bureau



Laboratory set-up for metallizing a panel as produced by the Spraywire method

• Many methods can be used for PC; some are now on production lines, others just starting. The most important remaining problem is how to print satisfactory resistors. Not all the components can be printed but the method will produce: condensers, inductors, resistances, shields and antennas. The technic is good at hf and lf.

Paint stencilling and spraying are the methods used with greatest success today. These will produce conductors that will carry up to 5 amps. The reduction in size with PC is unobtainable in any other way. A humorous suggestion has been made that radio manufacturers, in the future, stencil the radio set on the side of the usual cabinet, thus giving the purchaser space in the cabinet to store magazines etc. None of the sponsors of this symposium are in the PC business. It is known that an English radio manufacturer, Sargrove, as reported on page 98, TELE-TECH for June 1947, and on page 52, TELE-TECH for Aug. 1947, is producing a type of PC ac-dc receiver entirely automatically. None of the audience had seen any of these sets in U.S.A.

Patent Situation

Many of the processes were patented long ago and the patents have expired. The National Bureau of Standards has taken out patents which may be turned over to the public. However, firms planning to go in to PC should check the patent situation just as they would before going into any new field.

THE interest of the technical men of the Army, Navy and the radio industry in printed Circuits (PC) was shown to be high by the surprisingly large attendance at the symposium held Oct. 15 in Washington. The Dept. of Interior Auditorium, helding well over 700 persons, was crowded. The sponsor was the Electronic Component Subcommittee of the Aircraft Radio and Electronics Committee of the Aeronautical Board, with the National Bureau of Standards cooperating.

Radio engineering executives must be sure that they do not overlook any good bets nor fail to follow new trends, provided the new methods have fundamental advantages, not just mere novelty. It is seldom that there has been "handed" to them, with a great deal of the research already done at government expense, such an appealing method of assembly as PC. No wonder so many executives traveled to Washington to hear about, and evaluate for their special uses, this newly-introduced (but old in concept) technic of PC.

As an introduction to the subject, the reader might wish to read "Evolution of Printed Circuits for Miniature Tubes", p. 58, TELE-TECH for June 1947 where there is described methods which successfully have produced various radio units. Of course there are many other ways of producing PC, hence this symposium which was so helpful in exchanging ideas; ideas that will start many new radio researchers in this field, all with a head start, toward the goal of more efficient PC units.

In making the following abstracts it is the writer's intention

Complete Resume of PC Technics on Following Pages

to eliminate as much repetition of ideas in the various papers as possible and to report, with sufficient details, the actual processes so they could be followed in the experimental laboratory.

TWELVE PRINTED CIRCUIT PROCESSES

PRINTED CIRCUIT TECHNICS by *A. S. Khouri, Centralab Div., Globe Union, Inc.*

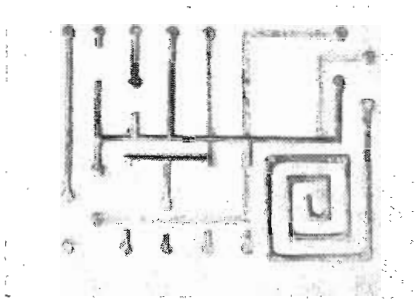
Centralab is in production on Printed Circuits. They make diode filter circuits, amplifier coupling and 3-stage amplifier circuits some of which are found in transceivers, signal tracers, stethoscopes and hearing aids. Usually these printed circuits are formed on a steatite plate as a base upon which the circuit is applied. This also supports small, high-dielectric ceramic condensers and thin resistors. Low-dielectric constant bases are used where undesired capacity coupling between units gives trouble.

A circuit layout drawing is made, photographed, reduced to the desired size and used to make a screen which serves as a mask when silver paint is applied to the ceramic base plate. Firing this silver paint at 1400° F. makes it conducting and bonds it to the base. For resistors, carbon-resin dispersion is baked on at a moderate temperature. Wire leads and capacitors, if needed, are soldered to the assembly which is given a coat of phenolic material for protection against abrasion and expressive humidity.

Considerable skill is required in making the screens. Either silk or steel mesh screening is used. A photo-sensitive emulsion is applied, exposed to light coming through the positive of the photograph of the circuit and the unexposed sections of the screen are washed away. A similar screen is made for the resistors and a small amount of resistor paint is poured over the screen and forced through the openings by means of a rubber squeegee.

Inductances are flat spirals (0.1 micro H. with a Q of 150) or parallel lines. Generally, resonant circuits can be operated from 25 mc to 509 mc.

Utilization of Printed Circuits: (1) For miniaturization; (2) For uniformity and appearance; (3) For permanence, freedom from shock-damage and effects of humidity; (4) For plug-in units, to give ease of servicing; (5) For low cost, (comparison for a simple unit showed a cost of 12.75 units for the printed circuit against 14.5 units for the conventional).



Altair imprinted circuit inlay on Polystyrene, part of circuit being on the top of the plate and part on the bottom

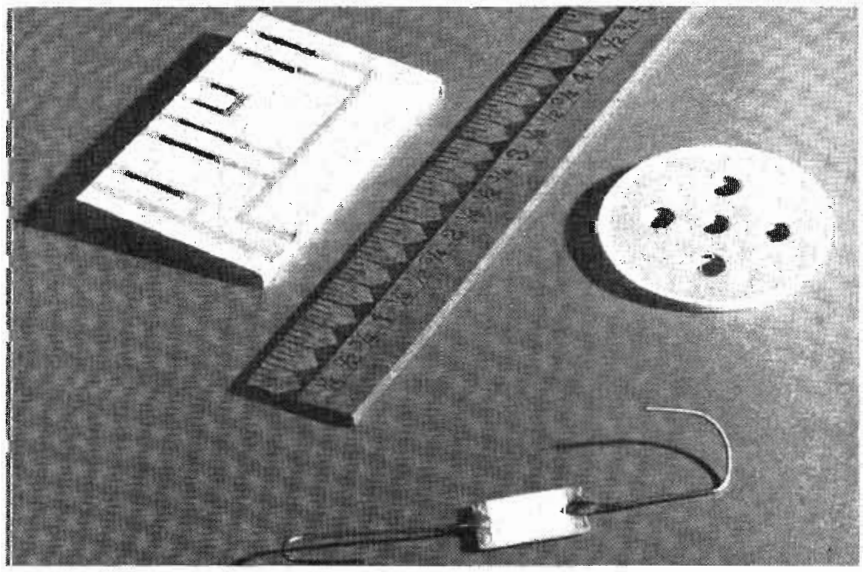
HOT DIE STAMPING by *J. M. Ternes, Altair Machinery Corp.*

To secure an imprinted circuit by this means the conductors are cut from solid sheet silver, as a grid, and firmly attached to a dielectric panel by fusing—all in one operation.

Steel embossing and cutting dies cut grids from silver sheet ranging in thickness from 0.001 to 0.003 in. These grids are used on both sides of the dielectric with rivets or eyelets forming the connections where desired.

The dies are mounted on electrically-heated plates of an embossing press. The grids are held in place by sizing which liquifies under heat. A 15-ton, hand-operated press with a knuckle-joint is used. An inductance of 0.15 michohenries has a Q of 150 at 140 mc. The printing of resistors is being investigated. It is believed circuits can be printed on plastics, wood, phenolics and fibreboard.

Remington PC components including a 2-stage amplifier circuit, 4-capacitor 5-prong cosnector block and a conventional single capacitor unit



STATUS, APPLICATIONS AND LIMITATIONS OF PC by *Dr. C. Brunetti, NBS.*

(The portions of this talk which were not covered in the TELE-TECH article referred to and which were not discussed in detail by other speakers are the only ones noted below.)

The speaker listed all the known methods of printing circuits. They total 26! In summarizing the applications of PC we find they can be used for af, rf and VHF amplifiers, detectors, oscillators, trigger circuits, hearing aids, radar, radio sets and even toys.

Separate the low resistors on one side of the base and high resistors on the other. Avoid unwanted coupling the same way. Tampering with a circuit is readily noticed. This is of value if such action affects a guarantee. If the frequency of a transmitter is fixed at the factory it stays put. A wide variety of subminiature tubes is available for practically every low-power electronic need.

Numerous examples of equipment using PC were shown—for instance, a 3-stage hearing aid amplifier with a gain of 10,000. The most unique sample was a complete radio transmitter, no larger than a dollar watch, which was demonstrated as a personal radio when attached to the wrist by a watchband. A crystal microphone with a pentode amplifier was used to secure grid modulation of the oscillator.

There is still much to be learned about printed resistors and a method for rating power dissipation. In the case of inductors, metallic lines on ceramic show small variations with temperature. Good values of Q are obtained by silver-plating. For larger inductances printed spirals on their bases can be stacked in multiple layers with insulation in between. The maximum inductance of single layer spirals without magnetic cores is about 60 microhenries.

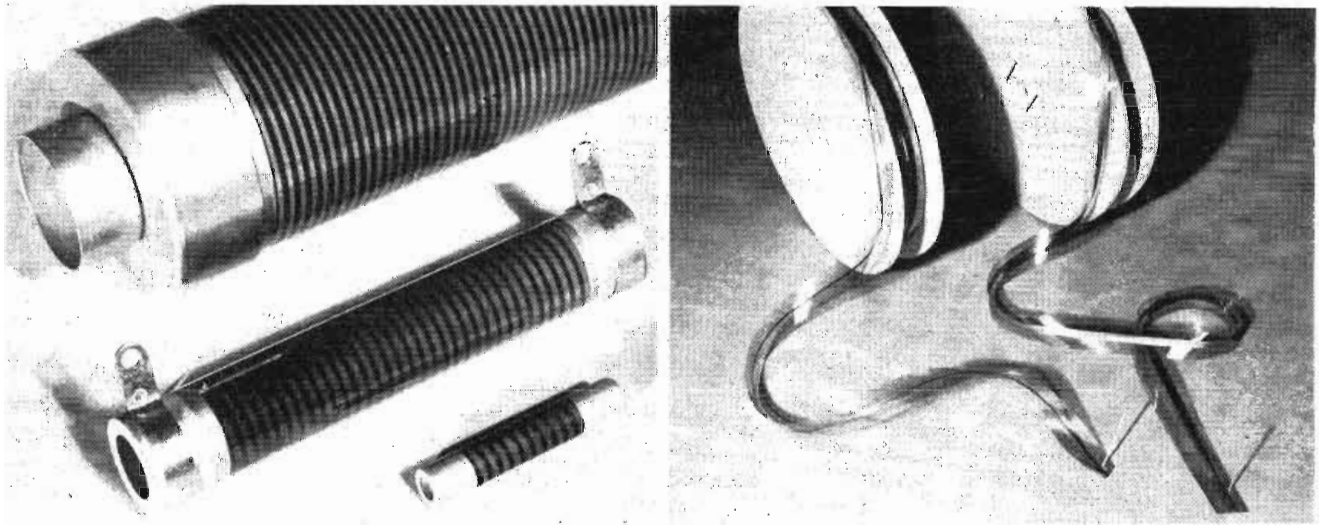
(Copies of Dr. Brunetti's complete talk can be secured by writing to the Editorial Division, NBS, Washington, D. C.)

PRINTED VITREOUS DIELECTRIC UNITS by *C. I. Bradford, Remington Arms.*

This dielectric was brought out during the war as a substitute for mica in capacitors. Single unit capacitors are now being produced which have a 500-volt rating, not much temperature coefficient, and a satisfactory power factor at high temperatures. No changes were noticed in these capacitors at temperatures of 150° C, and at 85° C the unit gives at least 1000 hours of life.

METAL FILMS AND THEIR APPLICATIONS TO RESISTORS AND PRINTED CIRCUITS by *J. W. Jira, Continental Carbon Co.*

It is believed the resistors produced by a process similar to that used in producing the Continental



Left, printed resistance film as applied by IRC to ceramic bodies in a spiral line on the tube. Right, method of applying a resistance film on a flexible cellophane tape by printing in a line varying in width from 1/32d to 1/8th inch

Nobeloy X-type of resistor would prove superior for Printed Circuits. This process follows: The ceramic form consists of pure magnesium silicate, which is sprayed with a solution of metallo-organosol of palladium; the concentration is carefully controlled for this determines the resistance value of the resistor.

The solution may be prepared by reacting with partially hydrogenated abietic acid some sodium hydroxide to form sodium resinate. The resinate is reacted with an aqueous solution of palladium hydroxide under controlled conditions to form a precipitate of palladium resinate. This is washed of residue and force-dried. The dehydrated resinate is dissolved in a balanced organic solvent of very low surface tension, forming metallo-organosol of palladium.

Chemical Processes

After the rods or tubes are coated with this solution they are subjected to a pyrochemical process in which the resinate is caused to revert to pure metal and to precipitate slowly and evenly throughout the surface area of the ceramic. The carbonaceous residue formed combines with atmospheric oxygen forming CO, which with further oxidation forms CO_2 which is easily removed. The affinity of the metal film is such that grinding is the only way it can be removed.

Electrical contact with the resistor is made by soldering leads to the coating at each end made using silver enamel, which is fired. Prior to soldering the unit is given a vitreous enamel coating. This coating accomplishes the following important functions: protects from mechanical abrasion and atmospheric influences; increases the watt rating and gives permanency. Standard enamels were too high in fusion; too alkali, so that they would attack the film; and would craze and spall under load. Research by Continental's engineers produced an enamel that met the requirements. (How this enamel is prepared was not stated.)

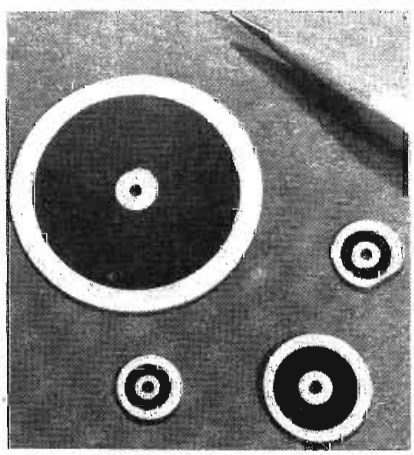
The special enamel is applied to the metal film by the roller coat method. After firing, leads are soldered to the units and they are assorted into groups such as 1, 10, 100, etc. ohms. From these basic values any desired value from 1 ohm to 100 megohms, tolerance plus or minus 1%, may be obtained by a spiralling process.

Aging: after 7 years of continuous operation the resistor remained within 0.1% of initial value; Dissipation: 4 watts per sq. in. as against the carbon-type of 1 watt per sq. in.; Temp.-Coefficient: 0.035% per degree C. New ultra-precision type resistors have a temperature coefficient approximating manganin.

Application to Printed Circuits: Use two masks, the first to provide the wiring conductors and the second the resistors. The first mask would be placed on the ceramic plate and a special metallo-organosol alloy solution sprayed and air-dried. The second mask would be put in place and sprayed with an organosol yielding high resistance metal films. Fire plate to metalize the circuit. Use the second mask again for spraying of vitreous enamel coating over resistors. Refire.

In experimenting with this method, changes in procedure are certain. Since spiralling is not feasible, the resistance value will have to be adjusted by some method such as etching the surface beneath the resistor to secure more surface for the film, thus increasing the resistance. The resistance would originally be made too great and later trimmed down by superimposing a metal of low resistivity upon the film. Condensers and tubes could be soldered into their positions to complete the printed unit.

IRC printed concentric disk resistors



PRINTED RESISTORS by *Jesse Marsten and Alexander L. Pugh, Jr., Int. Res. Corp., Phila., Pa.*

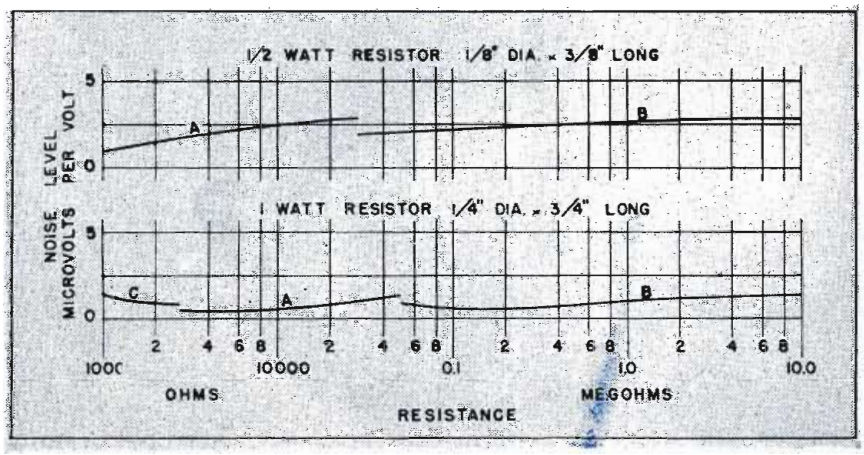
At IRC all of the following types of resistors can be produced by continous printing processes: (1) Conducting film on glass tubing; (2) Films on ceramics, as a spiral around a tube; (3) Films on phenolic sheets which are cured to produce durable film resistors. Resistors can then be punched to have proper resistance and silver terminals applied by spraying; and (4) Films on flexible bases, such as cellophane tape.

Now, to apply these techniques to PC—we can take a sheet resistor, as in (3), and punch it to form, say a 2-stage amplifier. Those portions which are to be conducting are painted over with silver paint, conducting terminations can be applied, properly designed openings can be designed to take other components—and we have a printed circuit.

Resistor Characteristics

In a printed resistor the resin is in the form of a varnish, so curing is essential to produce hardness. Polymerization, involving temperature and pressure, shrinks and fuses the resistor into a tough, hard body. Resistance values are controlled by modifying the ratio of dielectric to conductor in the mixture.

Required characteristics: (a) Mechanical (these are well-known); (b) Electrical: minimum aging, no polarization, no effect of humidity, low temperature coefficient, wide temperature range permissible, good hf characteristic, able to withstand vibration, low noise level, able to carry rated-load without change in



Noise level at rated load resistance of IRC film on glass. Curves A, B and C are for different types of composition

resistance, able to stand salt spray.

How do printed resistors meet these requirements? As to temperature rise, phenolic bases give higher rises than ceramic, but are still satisfactory. The temperature coefficient is satisfactory. As to hf characteristic, the apparent resistance falls off as the frequency increases, due to the Boella effect, but printed resistors are good in this respect because their cross-section is small, the volume is small and the dielectric mass is low.

As to voltage coefficient, (which is a function of the resistance material, length of resistor and resistance value), this should be kept low by using a minimum of dielectric in the resistor. "Noise" will decrease with a decrease in: length, applied voltage, resistance value and with certain materials; keep the dielectric in the resistor at a minimum.

PRINTING CONDUCTORS ON GLASS by *H. S. Cramer, Corning Glass Co., Corning, N. Y.*

Glass has good mechanical and electrical properties, for instance, low thermal expansion, good power factor, non-absorbent, dielectric constant 4 to 9, non-tracking from high-voltage discharge and readily obtainable in plates, tubes, cylinders and special forms.

Metal films can be applied by the vacuum metallizing process and conductors can be formed by firing silver into the glass, resulting in a firm bond. Examples of the use of glass were shown, such as (1) Inductance on glass tube for powdered iron-core permeability tuning, (Q was 180 at 100 mc; temp.-coefficient 7 parts in a million per degree C at 100 mc); (2) Midget trimmer capacity with invar rotor for low drift with temp.; (3) Flat glass plate attenuator. These components were recently developed and indicate that the principle can be expanded to other components.

PHYSICAL ASPECTS OF PC CONDUCTORS by *Dr. L. I. Marton, NBS.*

The speaker described the nature of silver paint both before and after firing, with comments on percent conductivity. The same information was given for metal evaporated in a vacuum.

Various metals were discussed. It is possible that there may be better methods for aging, especially for the materials that can be fired at high temperatures. Investigations should be made of un-fired methods aged by compression instead of temperature.

CONDUCTOR PAINTS by *W. V. Patton, Ceramic Div., E. I. duPont de Nemours & Co., Perth Amboy, N. J.*

Silver preparations for PC are of two types: Air-set (or low temperature bake) and fired-on compositions. The former are for use on phenolics, plastics, wood, leather, cloth, etc., which cannot be heated above 200° F. They consist of a binder, a thinner and conductive silver powder. They produce low-resistance circuits.

The fired-on compositions are fired at 850°-1300° F and are for ceramic base materials such as steatite, porcelain, titanites and glass. They have the advantage of greater adherence than the air-dry material.

Why is costly silver used? All metals that would be considered for this use oxidize, but it happens that silver oxide is conducting and the other oxides are not.

Silver paint can be applied by dipping, brushing, spraying, squeegee or by the silk screen process. For ceramics, the firing at 1220°-1300° F for 6 hours can be done by a decorating lehr or by a continuous belt furnace. For soft glass (1000°-1050°) or pyrex (1100°-1200°) the firing time depends upon such factors as equipment, kiln load, annealing time, etc.

For air-set wiring it is often necessary to copperplate to secure sufficient conductivity. Actually the cost of silver is less than the cost of copper wire plus soldering, for the same typical circuit. When using the squeegee method of printed circuit wiring, 50 units per minute with an area of 4 sq. ft., can be produced per troy ounce of silver composition.

SPRAYING TECHNIC by *G. W. Johnson, Spraywire Labs.*

To produce "spraywiring", heated granular metal is sprayed through a stencil into channels in a dielectric chassis. The operations are: (1) Preparation of stencils; (2) Insertion of eyelets and mounting of components; (3) Sandblasting and metallizing.

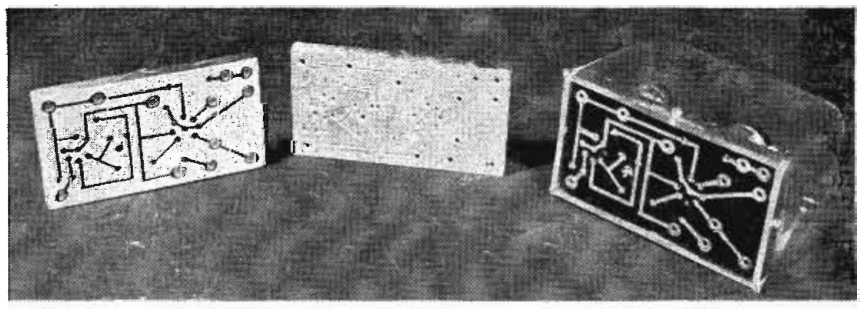
The stencil, conforming with the wiring diagram, is made from special Scotch tape produced by Minn. Mining and Mfg. Co. This can withstand sandblasting and metallizing. Tape stencils, used only once, are cut from continuous strips. They are then salvaged for the metal they contain.

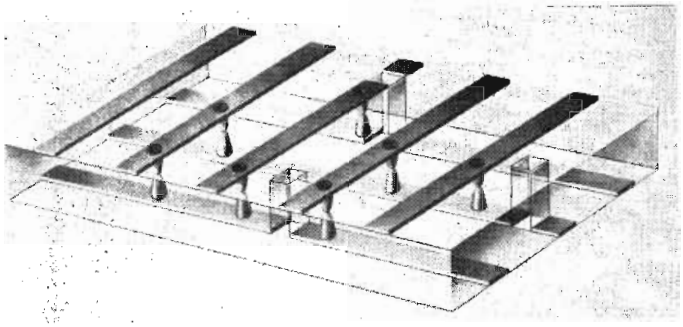
Spacing between adjacent conductors should be at least 1/16 in. The metal eyelets inserted as connectors are metallized into permanent contact with the conductors. After the stencil has been applied, standard sandblasting equipment is used to form grooves in the panel at least 0.010 in. deep. These grooves naturally are slightly recessed which causes the adherence of the conductors.

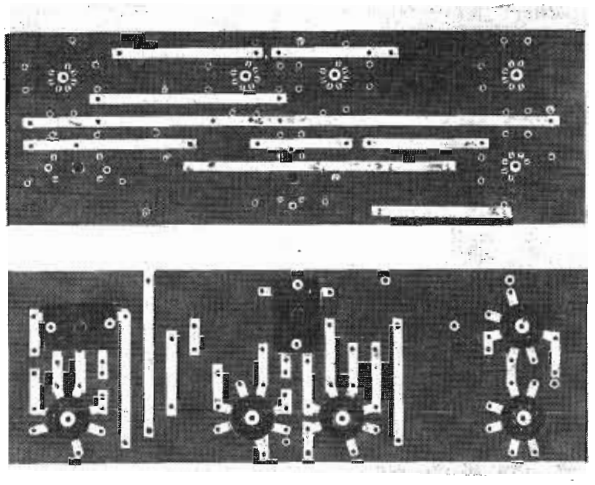
The metallizing technic and equipment is that of the Schoop process. The equipment is made by the Metallizing Eng. Co. Inc., Long Island City, N. Y. Panels are sprayed at a distance of 6 in. from the gun. Two passes are made at the rate of 1 ft. per sec., each pass building up 3.5 mils of metal. For most applications 7.0 mils is sufficient. Minimum width of conductors is 1/16 in.; ⅛ in. is better. Conductors ⅛ in. wide by 7.0 mils thick will carry 17 amps.

Forty-two alloys have been prepared in wire form to use with this metallizing equipment; some of them are high-resistance, such as Nichrome. "Spraywiring" can be applied to plastics, wood, ceramics, glass, etc. A 5-tube receiver constructed in this manner compared favorably with any other commercial receiver of the same kind. Shake tests up to 10 g failed to break any of the spraywire. Lower costs are achieved due to speed in production, cheap materials and reduction in rejects.

Three steps in production of a Spraywire circuit: at left, panel with stencil applied prior to sandblasting and metallizing; center, metallized panel with stencil still in place; right completed circuit with conductors imbedded in bottom of chassis







In one Franklin process holes and slots are perforated in the insulated panel before the stamped wiring is superimposed permitting welded contacts. (Drawing exaggerated to show principle) Right, top and bottom of a stamped wiring panel including sockets for tubes and IF transformers. Panel is completely wired for a 5-tube superheterodyne circuit

STAMPED WIRING by *J. B. Straughn, Franklin Airloop Corp.*

Most radio men are familiar with the Franklin stamped coil antenna. Starting with this idea we can see that stamped wiring can be produced and applied to a thin strip of insulation, say single-X Bakelite, 1/16 in. thick. There will be a series of parallel conductors running horizontally on one side and vertically on the other. Interconnection will be by eyelets or pins punched through the insulation. The copper would be 0.005 to 0.002 in. thick depending on the conductivity required.

Stamped Wiring

Tube sockets could be combined with the stamped wiring. Considerable saving would be possible with such wiring. For instance Franklin believes stamped wiring decks for 5-tube table model radio receivers, including sockets, ready for the components to be attached, would cost only about double the present cost of the sockets alone!

Receivers constructed with stamped wiring showed no change in sensitivity or selectivity from conventional receivers of similar design. The pushbutton switch for the 13 channels on a television receiver can be considerably simplified by stamped wiring.

It would seem that methods of making positive electrical connections through the insulating panel would require the most scrutiny and this feature is getting developmental attention.

MILITARY PROGRAM NEEDS by *B. Blom, Signal Corps Eng. Labs.*

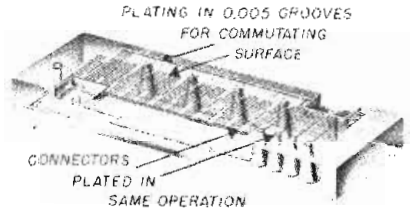
Among the radio apparatus needs of the military services in respect to PC were the following: Unitized construction, increased frequency coverage, lower operating voltages, indifference to humidity and ability to withstand temperature extremes (from —80° F for storage and —65° for operation to 140° F). It was stated that PC would increase mass production, afford unit construction and, after sealing, would be free from humidity troubles.

This was the first speaker to emphasize PC limitations. Some of these are: the restricted frequency range (say from 25 mc to 250 mc); accurate resistance values are not possible because these cannot be selected; use limited to fixed-tune hf circuits and af circuits.

PC IN RADIO RECEIVERS by *A. Gross, Gross Electronics.*

In developing a Handy-Talkie for the Citizens radio band, PC units were used. The total weight of the complete instrument is 2¼ lbs., but the PC portion weighs only 11 oz. Four tubes are the total used. The transmitter output is 0.7 watts, range 1-10 miles. The drain on the 6 v. "A" battery is 150 ma. and on the 135 v. "B" battery it is 25 ma.

Mr. Hornung of Stupakoff C. & M. Co. described the 2-stage amplifier and filter circuit built for Gross Electronics. It is 2¾ by 2 by ¾ in. thick, including the tubes.



Flat commutator with three connecting circuits as produced by Metaplast processes

THE meeting opened with introductory remarks by R. J. Framme, Chairman of AREC subcommittee, followed by brief addresses by Gen. Aukenbrandt, ACO, Hdqts. USAF, and Capt. Akers, USN, BuAer. Dr. Cledo Brunetti, National Bureau of Standards, whose outstanding work on PC for proximity fuzes and other uses has brought him awards and praise, presided and contributed "Status, Application and Limitations of Printed Circuits".

QUESTION AND ANSWER PERIOD

For information on progress on PC in Great Britain see a recent report in the Proceedings of the British I.E.E. It is possible that the British are ahead of us. Q. Can wideband video amplifiers be constructed using PC? Ans. There may be difficulties due to capacitance but this is not insurmountable. Q. What about using flexible resistors? A. Printed resistors are being used for a phonograph pickup where they are flexed. Q. Is there difficulty from "noise" due to printed resistors? A. Yes, at first this was quite bad, now not so troublesome due to better knowledge of how to make quiet resistors.

A large portion of the audience of the PC symposium attended a meeting the following day, where NBS experts told and showed us how to mix and use the casting resin that performed so well in the proximity fuze. A unit, sealed in this resin which has low hf loss, can be thrown out of a second-story window, land on concrete, and continue to function. A description of this NBS development will be found on page 53, TELE-TECH for Sept. 1947.

The most reassuring news to the radio manufacturers came at the end of the meeting, which discussed the rather complicated operation of producing this resin in the laboratory, and it came from the representatives of such chemical producers as Dow, Matheson Alkali and Koppers Co. It was that, within a few weeks these companies and possibly others, would offer, ready-mixed, a compound similar to that which the NBS had developed.

TELE-TECH joins with the radio industry in congratulating Director Condon, NBS and Dr. Brunetti on the excellent and efficient assistance they have afforded the industry in making available their research work on PC and for turning the spotlight on this technic which is displacing some older methods in many electronic applications.

The large number of personal letters of appreciation from well-known men and companies in the radio field, written to Dr. Brunetti after they had returned from the symposium, indicated in a pleasing way that the radio industry responds to the present public-spirited policies of NBS of endeavoring to do all it can to help American industry.

Measuring Instantaneous Frequency of an FM Oscillator

By LOYD E. HUNT, Bell Telephone Labs., Whale Pond Road, Deal, N. J.

A method for lining up an FM transmitter by matching oscilloscope traces and giving accuracy of 500 parts in a million

A method is described for measuring the modulated frequency of an FM signal by comparing it with a calibrated cw signal. This is done by gating the two signals alternately into an FM detector and observing the oscilloscopic pattern produced. The horizontal line formed by the cw oscillator is shifted vertically by varying the frequency of the latter. This permits an alignment with parts of the FM modulation pattern, particularly such prominent features as the black level or the synchronizing peak of a television signal, or the extremes of modulation.

• When a carrier is frequency modulated, its frequency is caused to vary above and below a relatively constant median frequency by an amount depending upon the amplitude of the modulating signal. A knowledge of the amount of this deviation is essential to the adjustment and operation of an FM transmitter. In the method to be described the FM signal is compared with an adjustable cw signal in such a way that the instantaneous frequency at any point in the wave-form of the former may be identified by a corresponding adjustment of the latter.

The output signal voltage of an FM detector is proportional to frequency deviation and when it is applied to the vertical plates of an oscilloscope, the frequency of the input signal is measured by the vertical deflection of the beam.

In the method of measurement, illustrated in Fig. 1, the known and unknown oscillations are introduced alternately into the limiter and frequency discriminator through the medium of an electronic switch. The vertical deflection of the oscilloscope beam is defined in terms of frequency in the following manner.

The diagram (Fig. 2) illustrates the translation of the frequency variations of a modulated carrier into amplitude variations at the output of an FM detector. In the hypothetical case illustrated the carrier is varying over the range 52-60 mc, under the influence of a television signal. This causes the output of the discriminator to vary in amplitude over a range from 0.2 to 0.3 volt. This occurs during one-half of the switching period. During the other half of the period the cw oscillator is connected to the discriminator and the single frequency causes the output voltage to maintain a steady value of 0.16 volt.

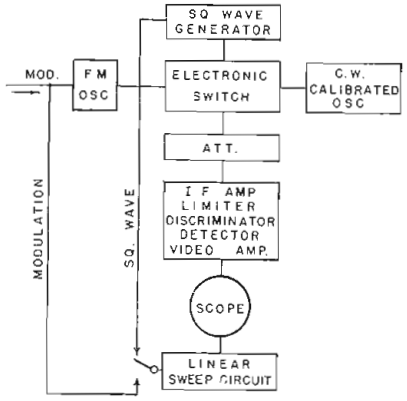


Fig. 1—Block diagram of the electronic switch for operation about a median frequency of 65 mc. It consists of a pair of identical, stagger tuned amplifiers. The output of the square wave generator on the left is applied to the suppressor grids so as to allow the two paths to conduct alternately

If the frequency of the cw oscillator is increased to say 58 mc (corresponding to the black level of the television signal in this example) the output voltage will rise to a steady value of say 0.28 volt, indicated by the broken line. The position of the latter line with respect to the FM pattern defines the instantaneous frequency of that part of the latter which the line intersects as being equal to the frequency of the cw oscillator. This remains true even if the output is coupled to the oscilloscope through condensers which would prevent the dc component being transmitted.

If the horizontal sweep of the oscilloscope is synchronized with the switching rate the oscilloscopic pattern shows the envelopes of the two oscillations side by side as in Fig. 3A. In general, under these conditions, the modulation pattern constitutes a smear of light, perhaps with certain identifiable features, such as the black level and synchronizing peak of a television signal, while the frequency of the comparison oscillator is represented by the vertical position of a straight horizontal line.

The detail of the modulation may be more easily identified if the sweep rate is synchronized with that of the modulation, provided that the latter is of a periodic nature. The result appears in Fig. 3B. For example, if the modulation is produced by a television

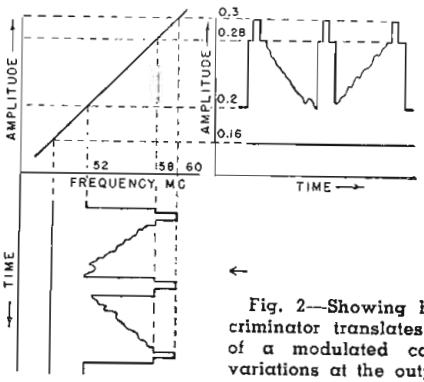


Fig. 2—Showing how a frequency discriminator translates frequency variations of a modulated carrier into amplitude variations at the output of an FM detector

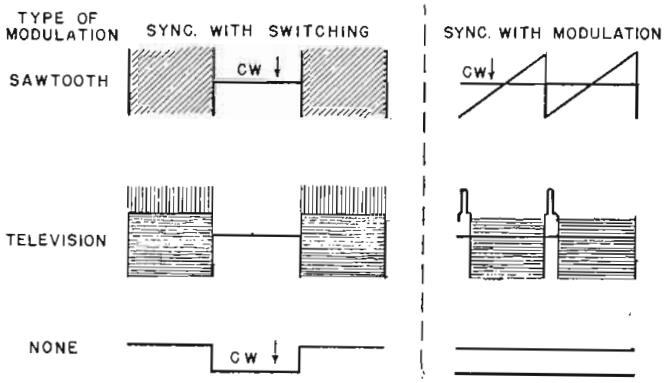


Fig. 3 (A Left, B Right)—Some typical patterns as observed on the oscilloscope

signal, the pattern showing the pedestal and synchronizing pulse will remain stationary and may be more easily studied. The pattern between pedestals would, in general, constitute a smear.

The lining up of the FM transmitter may proceed as follows: The cw oscillator is first set to the desired unmodulated frequency. With the modulation removed, both patterns are straight horizontal lines and the FM oscillator is adjusted until the two lines are superimposed. The modulation is then applied and the oscilloscope-sweep set for either of the two types of presentation illustrated in Fig. 3A.

The electronic switch must be designed with sufficient shielding to prevent interaction between the two waves until they are combined in the final stage. Other precautions also are necessary because the final measurement is made on an amplitude basis. First, the two signals must arrive at the discriminator with equal amplitudes. Accordingly, they should be initially adjusted so that their amplitudes are within the correction capabilities of the limiter. Second, the video system must be able to transmit the modulating frequencies without distortion.

The video system must be designed with time constants sufficiently long compared to the switching rate, to insure a steady pattern.

The switching rate is unimportant provided that the modulation, sweeping and switching rates are not commensurate. For such triple coincidence the pattern is likely to be unsteady. This is easily avoided, since it is relatively difficult to find.

The electronic switch forms an important element in the application of this method of measurement. Fig. 4 shows photographs of one switch that was designed for operation about a median frequency of 65 mc.

The accuracy of this method depends principally upon the ability to match line traces, and on the frequency stability of the calibrating oscillator.

The error, in kilocycles, due to uncertainty of linesetting is given by the equation $e = K \times \frac{W}{D} \times \Delta f$, where

W = line width, in inches

D = peak-to-peak deflection of the signal trace in inches

Δf = peak-to-peak frequency deviation during modulation, in kilocycles per second

K = that fraction of the line width within which matching is possible.

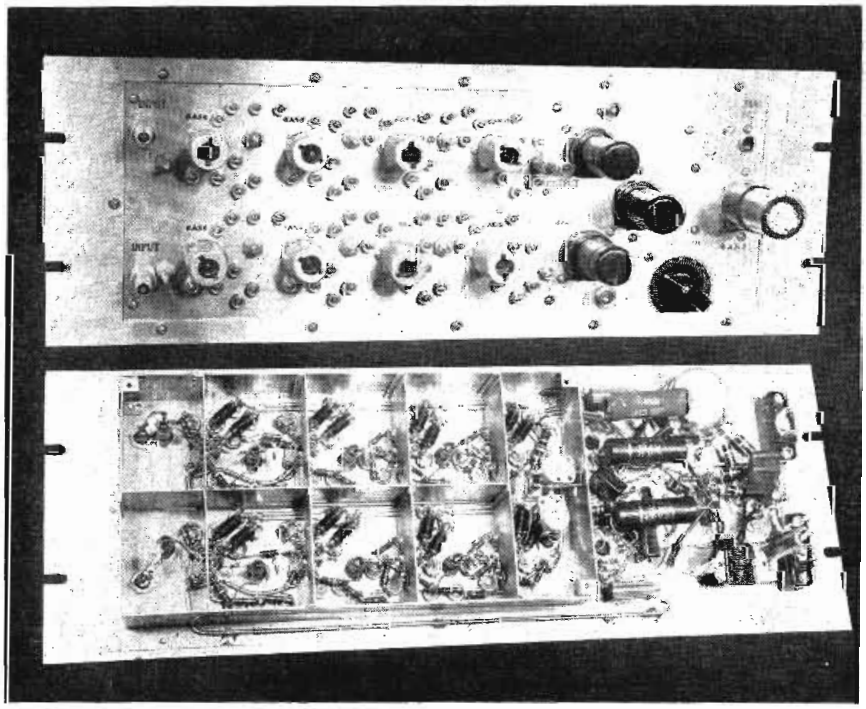
The order of magnitude of the accuracy obtainable can be found by referring to a particular experiment in which the factors were, W = 1/32, D = 1 and Δf = 4000. The misalignment of the traces was less than one-fifth of the line width, making K = 1/5. The experimental error, as computed by the equation was:

$e < \frac{1}{5} \times \frac{1}{32} \times 4000$, or $e < 25$ kc.

A second error was due to the instability of the particular commercial calibrating oscillator used. This oscillator had a frequency drift, over long periods, of less than ±0.0017% or about ±1 kc in 65 mc.

The aggregation of errors did not exceed 26 kc when operating at 65 mc (which permitted an accuracy of better than 0.05%) or 500 parts in a million.

Fig. 4—One form of electronic switch designed for operation about a median frequency of 65 megacycles



Circularly Polarized Antennas for Aircraft Communication

By JOHN P. SHANKLIN, Bendix Radio Division
Bendix Aviation Corp.

Design of ground radiators specified by CAA for aviation work and requiring close adherence to polarization ellipse patterns

GROUND stations which must be used to communicate with aircraft having either vertical or horizontal antennas require a universal type of radiator. The Bendix Type CA-1246 antenna was developed for the Civil Aeronautics Administration to provide circular polarization at ground stations. The design problems involved and the method of analyzing experimental data is of interest, especially in the investigation of the performance of the antenna.

• It was required that the antenna azimuth coverage pattern taken at any vertical angle between 0° and 20° above the horizon in any single plane of polarization exhibit an overall variation no greater than 2 db; that the maximum overall signal variation between all planes of polarization at any single vertical angle between 0° and 20° and any azimuth be not greater than 3 db. It was further required that the standing wave ratio on the 52-ohm coaxial feed cable be less than 1.5 to 1 over the 118 to 122 mc frequency range. The antenna (Fig. 1) was produced in two sizes, 110-112 mc and 118-122 mc. Only the latter is discussed.

In order to develop the general equation for the elliptically polarized wave resulting from the combined radiations of a vertical and a horizontal radiator refer to Fig. 2.

Let: E_V = Voltage of the vertically polarized radiation at some point in space.

E_H = Voltage of the horizontally polarized radiation at the same point in space.

E_{VR} = Voltage due to E_V developed in a plane of polarization at ψ degrees counterclockwise from horizontal.

E_{HR} = Voltage due to E_H developed at polarization angle ψ.

$E_{VR} = E_V \sin \psi$

$E_{HR} = E_H \cos \psi$

In Fig. 3, let β be the phase angle by which E_H leads E_V at the point in space under consideration:

Then $E^2 = E^2_{VR} + E^2_{HR} - 2E_{VR}E_{HR} \cos (180° - \beta)$

or $E^2 = E^2_V \sin^2\psi + E^2_H \cos^2 \psi + E_V E_H \sin^2 \psi \cos \beta$

This equation defines the polarization ellipse in terms of the amplitudes of the vertical and horizontal components and their relative phase angles. For perfect circular polarization E_V must equal E_H and their relative phase β must be $\pm 90°$. Under these conditions: $E = E_V = E_H$.

If E_H leads E_V ($\beta = \pm 90°$) the direction of spin is counterclockwise. If E_V leads E_H the direction of spin is clockwise.

If E_V equals E_H but β is not 90°, an ellipse will result whose major and minor axes will be at angles where ψ equals 45° or 135°. However, the vertical and horizontal field intensities will remain the same as for circular polarization.

If β equals $\pm 90°$ but E_V and E_H are not equal, an ellipse will result whose major axis is vertical if E_V is greater and horizontal if E_H is greater.

To visualize the generation of a circularly polarized wave by means of a loop antenna surrounding a linear vertical radiator, consider the vertical arrow in Fig. 4 to be the current in an elementary length of radiator and the circle to represent the current in a very small loop antenna. Both antennas radiate omni-directionally in the horizontal plane and radiate the vertical pattern shown in Fig. 5 defined by cosine of θ, the vertical angle. The loop, however, radiates a horizontally polarized wave and the vertical antenna a vertically polarized wave.

The phase of the two radiations also differs by 90° relative to the phase of the currents in the radiators. The phase of the radiation from the vertical antenna is in phase with the current in that antenna while the radiation from the loop leads the loop current by 90° if the current direction shown in Fig. 4 is considered as the positive direction. The currents shown in Fig. 4 will result in counterclockwise spin. If either current is reversed the direction of spin will be reversed.

Since the radiation patterns of both antennas are the same, circular polarization will result at all points in space if they are excited in phase and with sufficient power to radiate equal signals.

In the Bendix CA-1246 antenna the loop is composed of three hori-

zontal dipoles arranged in a triangle as shown in Fig. 6a. The vertical radiator shown in Fig. 6b is a $\lambda/4$ antenna which uses the horizontal antenna structure as a ground-plane. This type of construction was chosen for a number of reasons. Small diameter loop antennas are inherently low in radiation resistance hence tune too sharply for the frequency coverage required. They are also too small to furnish a sufficient ground-plane for the vertical antenna to prevent excitation of the supporting mast. As the loop is made larger it must be composed of more radiators in order to maintain circularity of the azimuth coverage radiation pattern. Also if the loop diameter is greater than $\frac{3}{8}\ \lambda$ its vertical radiation pattern is appreciably different from that of the quarter wave vertical radiator.

Current Feed

Either a 3- or 4-dipole loop would have fulfilled the above requirements. However, it was decided to use series or current feed in order to prevent the necessity of an insulator between the ends of adjacent dipoles. Such an insulator would allow ice formation across a high impedance gap and cause bad detuning. Another advantage of current feed is that the dipole impedance may be made more nearly equal to the surge impedance of practical coaxial transmission lines. This results in low standing-wave ratios on the feed cables and the band coverage of the antenna is less critical to resonance in the feed system. The 3-dipole design was chosen because it is the simplest structure which will meet the specifications. It also allows a feed system having cables more nearly matched throughout, using commercially available solid dielectric cables.

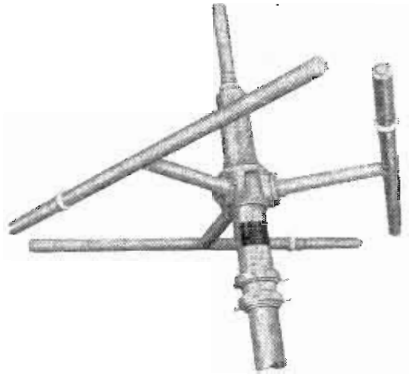


Fig. 1—Bendix type CA-1246 antenna for producing circular polarization

With the dimensions used and assuming a sine wave distribution of current in the dipoles the calculated horizontal coverage radiation pattern of the horizontal antenna is circular within less than 1% variation. Due to the rather large diameter of the dipoles and the fact that the half wave antennas were fed near one end, the current distribution was such as to cause the coverage pattern to be slightly triangular, the maximum overall variation being 6% as measured at a distance of 100 ft.

All tests of the antenna to determine compliance with specifications were conducted with the pickup antenna located 25 ft. from the CA-1246 antenna. At this short distance the pattern (Fig. 7) showed an overall variation of 12%. The zero reference used for the horizontal angle φ is shown in Fig. 6. Since the tests were conducted at 25 ft., it is believed the actual performance at great distances will be slightly better than indicated.

The horizontal antenna exhibits another aberration at first unsuspected: the phase of the radiated signal varies with azimuth. On the assumption that the centers of radiation of the half wave dipoles are at their mechanical centers, the calculated relative phase of radiation varies from 13° advanced phase at 0° azimuth (repeated each 120° of azimuth) to 13° retarded phase at 60° azimuth (and repeated each 120° of azimuth). Calculations made from experimental data indicate the actual overall phase variation to be about 16° or ±8°. The discrepancy is unexplained.

Horizontal Coverage

The horizontal coverage pattern of the vertical quarter wave radiator was expected to be circular. Experimental data showed a 2% periodic variation with maxima at 0°, 120° and 240° azimuth and minima at 60°, 180° and 300° azimuth. As these angles are only 15° of azimuth from the corresponding angles of maximum and minimum radiation from the horizontal antenna as shown in Fig. 7, the effect is slightly compensating.

The experimentally obtained vertical radiation pattern of the horizontal loop is shown in Fig. 8. The pattern in Fig. 8a taken through the 0° azimuth reference angle shows less radiation on the 180° azimuth side than the 0° azimuth side, as was to be expect-

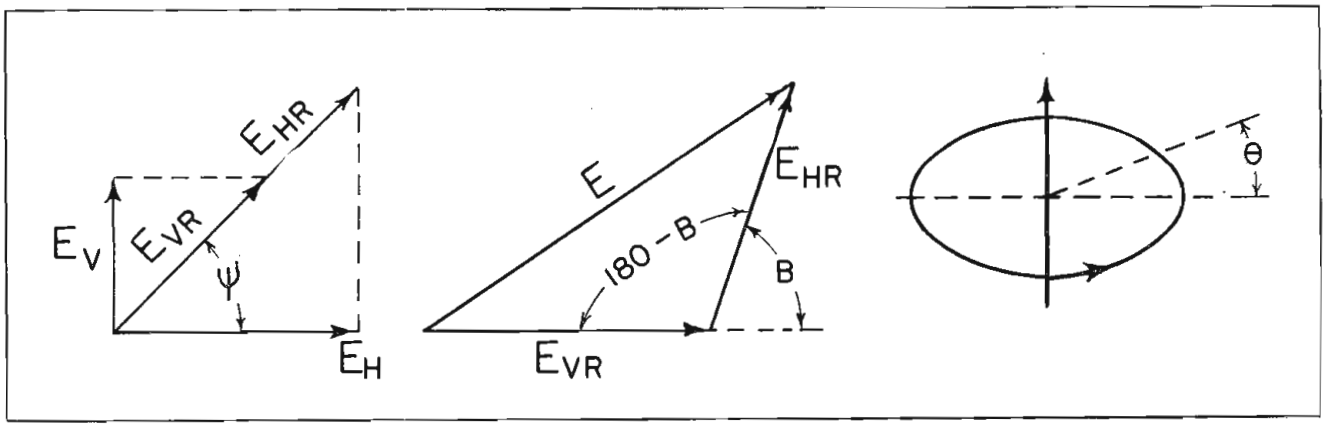


Fig. 2—Transmitter vector diagram for developing general equation

Fig. 3—Receiver vector diagram for developing general equation

Fig. 4—Diagram showing generation of circularly polarized waves

ed from the azimuth coverage pattern of Fig. 7. A slight side to side unbalance is also present in the vertical pattern of Fig. 8b taken through the 30° azimuth angle. The patterns, as expected, are practically circular or a cosine θ function.

The experimentally obtained vertical pattern of the vertical antenna is shown in Fig. 9. The deviation of this pattern from circularity probably was caused primarily by the rather large ground-plane furnished by the horizontal structure of the antenna.

The horizontal and vertical radiators have so far been treated as separate radiators. A schematic of the system used to feed the proper proportion of the power and proper current phases to the various radiators is shown in Fig. 10. Since the vertical radiation pattern of the two antennas is approximately the same, it is feasible to feed approximately equal power to both antennas. The radiator currents should also be in phase.

If feed cables b and c are to carry equal power and match the 52-ohm main feed cable they must present 104 ohms impedance at their junction. As the ¾ wavelength cable b performs the impedance transfer of a quarter wave matching section, the feed impedance of the vertical antenna must be 51 ohms. This impedance was obtained by experimentally determining the proper ratio of dimensions of f and g.

Impedance Problems

In order to present 104 ohms at its input, 53.5-ohm cable c must feed a 27.5 ohm impedance. This 27.5 ohms is the parallel resultant of the three d cables. As cable e is a shorted quarter wave stub it has no tuning effect but only serves as a static drain to ground. The three d cables are half wavelengths, therefore have no effect on impedance matching, but merely serve to transfer the individual dipole feed impedance to the common junction of the d cables. As the parallel resultant of the three dipoles must be 27.5 ohms, their individual impedance must be 82.5 ohms. This impedance was obtained by experimentally determining the proper ratio of dimensions h and i.

TABLE I

Cable In Fig. 10	Standing Wave Ratio
a	1:1
b	1.43:1
c	1.93:1
d	1.13:1

There was a slight interaction between the two antennas. The vertical antenna was first tuned with the three d cables each terminated by an 82.5-ohm resistor.

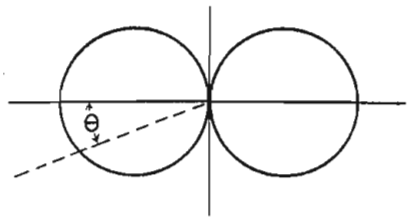


Fig. 5—Vertical radiation pattern of both horizontal and vertical elements

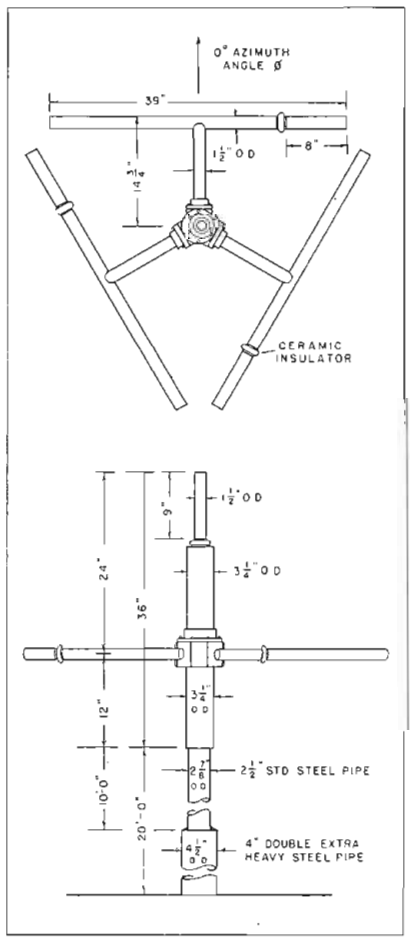


Fig. 6A—Above—Dimensional sketch of horizontal radiator. Fig. 6B, dimensional sketch of vertical radiator

The three horizontal dipoles were then tuned with the vertical feed cable b terminated in a 51-ohm resistor. The whole antenna was then made active and although each antenna had been separately tuned to a practically perfect match, the standing wave ratio on the main feed became 1.4 to 1. Some interaction was expected, since a portion of the ground-plane current of the vertical antenna must pass through the feed points of the horizontal dipoles. That this interaction also had some influence on the relative phase of the radiator currents was later discovered on making space measurements of the circularity of the polarization ellipse radiated.

Phase Corrections

Phase corrections were made by varying the lengths of the three d cables. Since these cables were almost matched, their lengths could be varied with little effect on the distribution of power to the two antennas and the match to the main feed cable. The theoretical standing wave ratios on all cables are given in Table I:

These values were varied slightly in correcting for interaction between the two antennas. However, they serve to show that no undue cable resonance was present. This also contributes to the maintenance of good circularity of the polarization ellipse over a wide frequency range.

The vertical antenna feed cable b was made ¾ wavelength rather than quarter wave to make the total cable length to all feed points in the antenna equal. This also contributes to the maintenance of good circularity of polarization over a given frequency range.

Unfortunately, it was mechanically necessary to use the small RG-58/U and RG-59/U feed cables rather than the larger RG-8/U and RG-11/U cables. The power handling capability of the antenna was thereby limited to a relatively low value. The exact power handling capacity of the antenna is not known. When mounted in an air-conditioned building where reflections probably were present to increase the standing waves on the feed cables, one an-

tenna failed after the application of 350 watts of rf power for one-half-hour. Another antenna mounted outdoors on a hot but windy day withstood 350 watts for two hours without failure. A number of antennas have been subjected to a test consisting of the application of 200 watts for one hour without a failure. Failure occurs by power dissipation melting the polyethelene dielectric in the c cable. This is to be expected as this cable has the highest standing-wave ratio.

TABLE II

	Vertical Angle $\theta = 0°$		Vertical Angle $\theta = 10°$		Vertical Angle $\theta = 20°$	
	A	B	A	B	A	B
ψ 0°	110.0	100.8	118.2	109.2	114.5	109.7
45°	91.0	100.8	104.2	113.0	107.4	116.2
90°	100.0	100.5	101.9	99.5	102.0	100.2
135°	118.5	100.8	115.8	95.7	109.4	92.2

A columns = Averaged relative voltage for azimuth angle φ equal 0°, 120°, and 240°

B columns = Averaged relative voltage for azimuth angle φ equal 60°, 180°, and 300°

ψ = Polarization angle. ψ equals 0° for horizontal polarization and increases in the counterclockwise direction.

Heat Losses

The larger cables could not be used because of lack of space to coil excess cable lengths within the 3 in. central brass tube. In order to safely coil RG-8/U or RG-11/U cable at least an 8 in. diameter chamber is required. It is possible to place such a large chamber in the form of a casting at the bottom of the central tube some distance below the horizontal antenna if a greater power handling capacity is desired.

Since failure of the antenna at high power levels was caused by heat due to power dissipation in the cables, a calculation of this loss was made. Using published losses for these cables when matched and the standing wave ratios shown in Table I, the cable loss was calculated to be 0.185 db. The actual loss will be slightly higher due to the adjustments made to compensate for interaction between the two antennas.

In order to investigate the fields surrounding the CA-1246 antenna accurately a great deal of care in the testing set-up was necessary. To check the circularity of the polarization ellipse, the antenna was mounted in the plastic dome of a wood radar tower 30 ft. above level ground. A 60-ft. telegraph pole was located 25 ft. from the center of the radar tower to carry the signal pick-up antenna. The pole was equipped with a 2 x 6 in. wood member on the side toward the tower and the pick-up antenna was designed to slide up and down this member so as to locate it at various angles of elevation with respect to the CA-12-46 antenna in the dome. The CA-1246 antenna was rotatable on a vertical axis.

The pick-up antenna was of the billboard type consisting of two half wave dipoles in front of a reflecting mat. In order to easily investigate the polarization ellipse this antenna was rotatable on a horizontal axis through its center by means of ropes controlled within the radar tower. It was also possible to tilt the pick-up antenna forward so that its axis of rotation and beam could be directed at the CA-1246 antenna regardless of the vertical angle under investigation between 0° and 20° above the horizon. This arrangement was used for all pattern and ellipse work except for taking vertical patterns. For this the antenna was mounted in the dome with its axis horizontal and rotated on a vertical axis.

Reflection Troubles

The polarization ellipse in particular was found to be critical to extraneous reflections or unwanted paths of transmission between the two antennas It was found necessary to clear the tower floor immediately under the dome of all metal. As the vertical pattern of the CA-1246 antenna has null along its vertical axis, objects near this axis were not objectionable. The directivity of the pick-up antenna was also helpful in eliminating ground and other reflections.

The short 25 ft. distance caused some aberrations particularly of the horizontal coverage pattern of

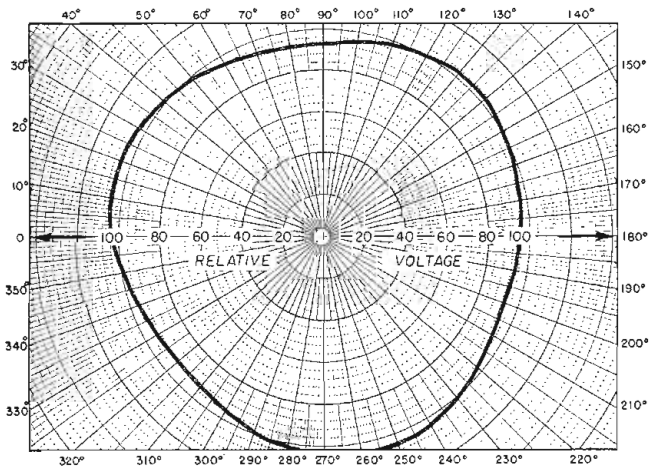


Fig. 7 (Left)—Coverage pattern of the horizontal element. Fig. 9 (Below)—Vertical pattern of the vertical element

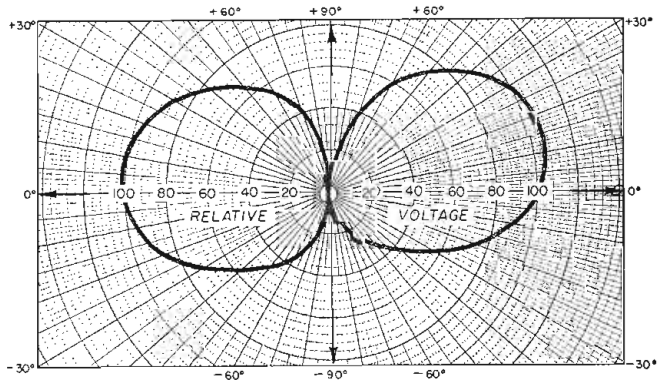


TABLE III

	Vertical Angle $\theta = 0°$		Vertical Angle $\theta = 10°$		Vertical Angle $\theta = 20°$	
	A	B	A	B	A	B
$E_0° : E_{180°}$	1.105		1.160		1.12	
$E_{90°}/E_{0°}$		.997		.910		.914
$E_{45°}/E_{135°}$		1.000		1.180		1.262
$E_{135°}/E_{45°}$	1.303		1.110		1.018	
Cos β	—.259	.00	—.104	+.165	—.019	+.228
β	105.0°	90.0°	96.0°	80.5°	91.9°	76.8°
Angle ψ of major axis of ellipse	150°	Circular	165°	30°	0°	25°
Ratio of major to minor axis	1.32	1.03	1.21	1.21	1.12	1.28
Ratio in db.	2.42	0.26	1.66	1.66	0.99	2.15

the horizontal antenna as mentioned before. But it was helpful in reducing reflections since the direct path between the two antennas was appreciably shorter than any possible reflection path.

The method of analyzing experimental data taken on the polarization ellipse is of interest. The inability of the antenna to produce perfect circular polarization in all directions is due to four factors. (1) The first and most serious factor is the variation of the phase of radiation from the horizontal antenna with varying azimuth. (2) Due to the fact that the center of radiation of the vertical quarter wave antenna is approximately 30° above the center of the horizontal loop, the relative phase of tthe vertical component advances with increasing vertical angle. (3) The non-circularity of the horizontal coverage pattern of the horizontal antenna. (4) Differences in shape of the vertical patterns of the two antennas.

The major portion of development testing was devoted to measuring and analyzing the polarization ellipses from 0° to +20° of the vertical angle θ and from 0° to 360° of the azimuth angle φ. It was found that major difficulties were factors 1 and 2, as both contributed to variations of the relative phase of radiations from the vertical and horizontal antennas. These phase variations cause the major axis of the ellipse to be at the polarization angle ψ equal to 45° or 135°. Since the antenna is used only for communication with aircraft antennas which are primarily either vertical or horizontal, a polarization ellipse with its major axis at 45° or 135° is of little consequence. In such an ellipse the vertical and horizontal signals remain the same intensity as though phasing were perfect.

The CA-1246 antenna was constructed so that the loop current is reversed to the direction shown in Fig. 4. This results in a clockwise polarization spin. For the service for which the antenna is intended this is of no consequence. However, for communication between two circularly polarized antennas they must have the same direction of spin otherwise they will be blind to each other.

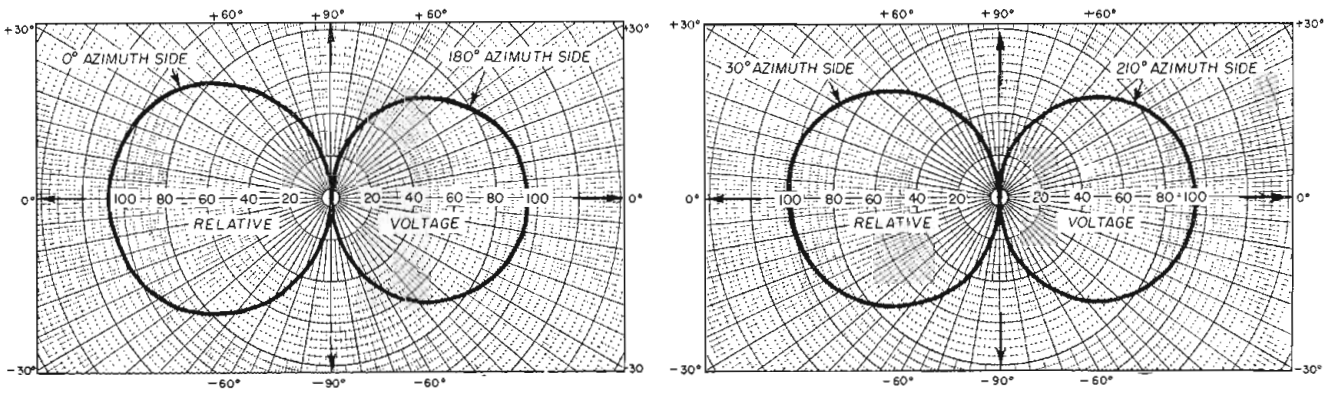
In order to illustrate the ellipse analysis procedure, a typical set of data is presented in Table II. At any single vertical and azimuth angle, the pick-up antenna was rotated on its horizontal axis to investigate the polarization ellipse. Since the received voltage must be an cllipse, only the four readings at 45° intervals shown in Table II were taken. These four readings were then substituted in the first equation for a complete analysis of the ellipse. In fact only three readings are necessary to determine the ellipse. However, the fourth reading served to check accuracy. A sample ellipse determined by column A at 0° vertical angle in Table II is shown in Fig. 11.

Ellipse data were taken only at 0°, 60°, 120°, 180°, 240°, and 300° values of the azimuth angle φ as these were the angles of greatest phase shift. While these values were 15° removed from the angles of maximum and minimum radiation shown in Fig. 6 they resulted in the most eccentric ellipses.

In order to investigate the performance of the antenna, however, a complete analysis of the ellipse is unnecessary. Antenna performance is completely defined by the ratio of the vertical and horizontal radiations E_H/E_V or $E_0°/E_{90°}$ and the ratio of the 45° and 135° radiations, $E_{45°}/E_{135°}$. Such data derived from Table II is given in Table III. Considering the $E_0°/E_{90°}$ and $E_{180°}/E_{0°}$ ratios it is obvious that

(*Continued on page 90*)

Fig. 8a (left) taken through the 0° azimuth reference angle shows less radiation on the 180° azimuth side.
Fig. 8b (right) taken through the 30° azimuth angle shows a slight side to side unbalance



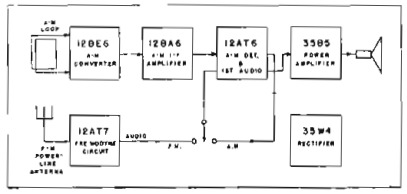
Hazeltine FreModyne FM Circuit

Combining superheterodyne and superregenerative principles, new tuner provides good selectivity and audio output, uses single dual triode

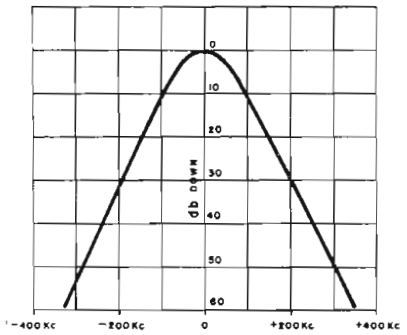
• The Hazeltine FreModyne circuit combines superheterodyne and superregenerative principles to form a sensitive, simple and practical FM detector. It is the result of extended theoretical and practical development work, and is intended primarily for addition to low-price AM receivers. The circuit utilizes only one dual triode to convert the relatively weak FM signals into an audio signal voltage large enough to operate the conventional audio system of AM receivers.

In the FreModyne circuit one triode of the dual-triode tube serves merely as the local oscillator necessary for superheterodyne frequency conversion. The other triode performs four functions, operating as (1) a superheterodyne converter to an intermediate frequency of about 22 mc, (2) a superregenerative IF amplifier of high gain, (3) a converter from FM to AM and (4) a detector delivering audio output. For brevity this triode is hereafter referred to as the superregenerator. The FM signal is converted to AM by side-tuning the receiver.

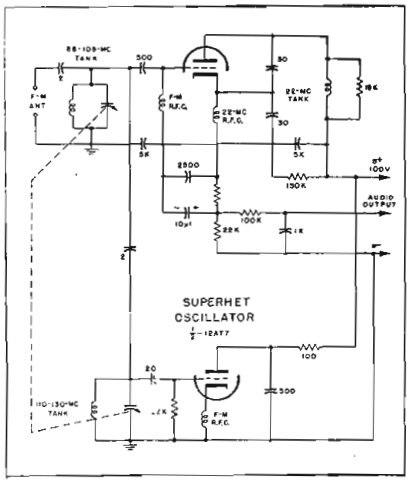
The use of the superheterodyne principle in the FreModyne circuit greatly reduces signal-frequency radiation compared to a conventional superregenerator (approximately 30-40 decibels reduction), and provides more uniform superregenerative operation. The circuit also includes a special automatic stabilizing arrangement permitting the regeneration control of the normal superregenerative receiver to be discarded. This stabilizing circuit also permits a quench wave of special shape to be obtained which gives good selectivity, good audio output, and quite linear FM detection.



Block diagram of typical AM-FM receiver incorporating the FreModyne FM circuit



Curve showing inherent selectivity circuit



Schematic of the FreModyne circuit

Being side-tuned for FM reception, a FreModyne receiver has two responses for each station, both of which represent correct tuning. This compares with three responses in conventional FM receivers, only one of which represents correct tuning. The two responses obtained are quite close together on the dial.

The FM signal picked up by the antenna is applied through a signal-frequency tuned circuit to the grid of the superregenerator. Here it is mixed with the local-oscillator signal, produced by a conventional Colpitts oscillator circuit. The resulting 22-mc signal is amplified by a Colpitts-oscillator type of superregenerative detector, and audio is recovered across a 22000-ohm resistor in the lead from cathode to B minus. After filtering out quench and applying de-emphasis, the audio signal is delivered, ready to be fed to a conventional audio amplifier. A resistor of 1500 ohms and a capacitor of 2500 μμf control the quench wave shape. Another resistor of 150,000 ohms and an electrolytic capacitor of 10 microfarads permit stabilized operation with a large audio output.

A low-priced AM-FM receiver using the FreModyne circuit can be obtained by adding the single FreModyne double triode to a conventional four-tube-plus-rectifier AM receiver. The FreModyne circuit then merely uses the audio amplifier and power supply of the AM set. This arrangement permits simple switching of the audio and plate-voltage supply when changing from AM to FM.

The usable FM sensitivity of the FreModyne receiver in its present stage of development is represented by the quieting sensitivity of the order of 74 decibels below one volt (200 μv) and not by the maximum sensitivity (which includes values with unusable signal-to-noise ratio). A signal weaker than 74 decibels can be heard but at a correspondingly

(*Continued on page* 85)

Economograph for Determining FM Station Costs

By R. C. COILE, Colton & Foss, Inc., 927 15th St. N. W., Washington, D. C.

Blending the economics of FM broadcasting and the mathematics of nomography to get costs of transmitter, antenna and tower

• Let us assume that you are the owner of an existing AM broadcasting station and would like to know how much the basic equipment costs of an FM station might be if you mounted the FM antenna on top of your present tower. An FM Economograph in Fig. 1 gives you a quick answer.

A straight line (1) connecting 10 kw on the Transmitter Power scale with 600 feet on the 3⅛-in. Transmission Line scale intersects the Index Line. Connecting this point by straight line (2) to 4 on the Antenna Gain scale gives the answer of $27,500 at the intersection of line (2) with the COST scale. Keep in mind that these are only equipment costs without installation and that they are average costs (using cost data from nine different transmitter manufacturers, for example, and six antenna manufacturers).

Suppose you are just a prospective FM broadcast owner without any AM tower facilities to help you. Then in addition to the items mentioned you will need a tower. Figure 2 helps you solve this very neatly.

For example, a straight line (1) connecting 50 kw on the Transmitter Power scale with 300 on the 3⅛-in. Transmission Line scale intersects Index A. Connecting this point by straight line (2) to 8 on the Antenna scale intersects Index B. Connecting this point by straight line (3) with 200 ft. on the Tower scale gives the answer of $85,000 at the intersection of straight line (3) with the COST scale.

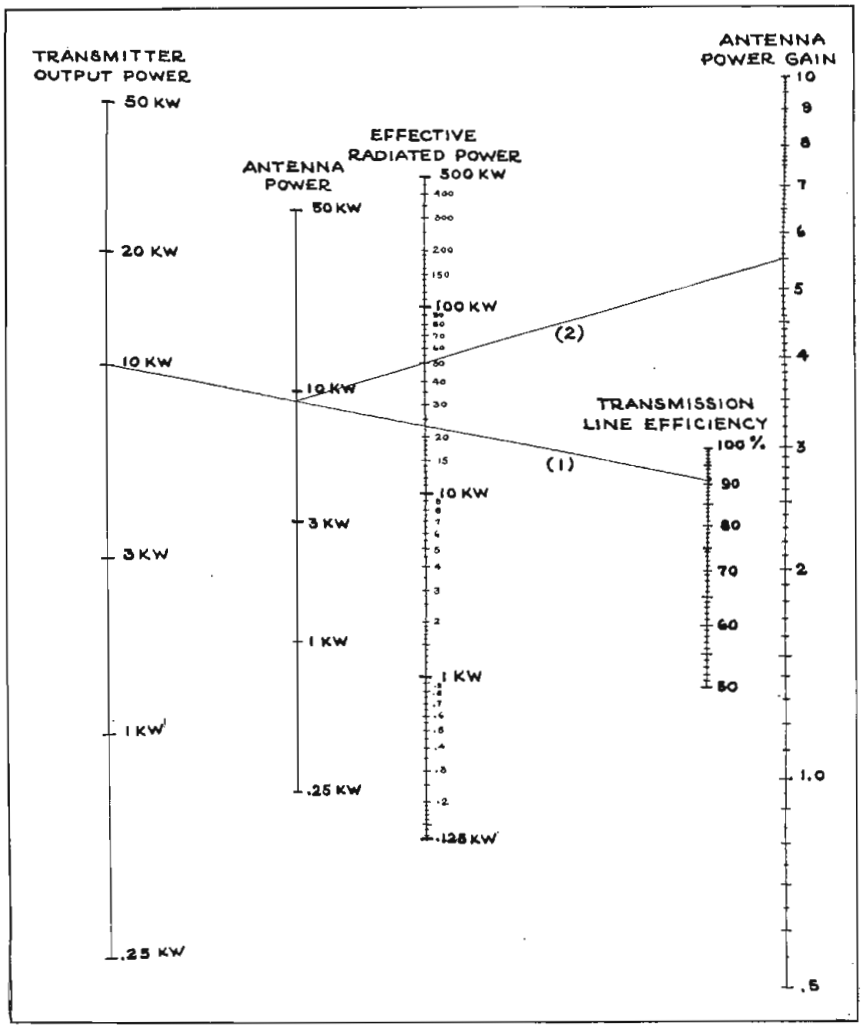
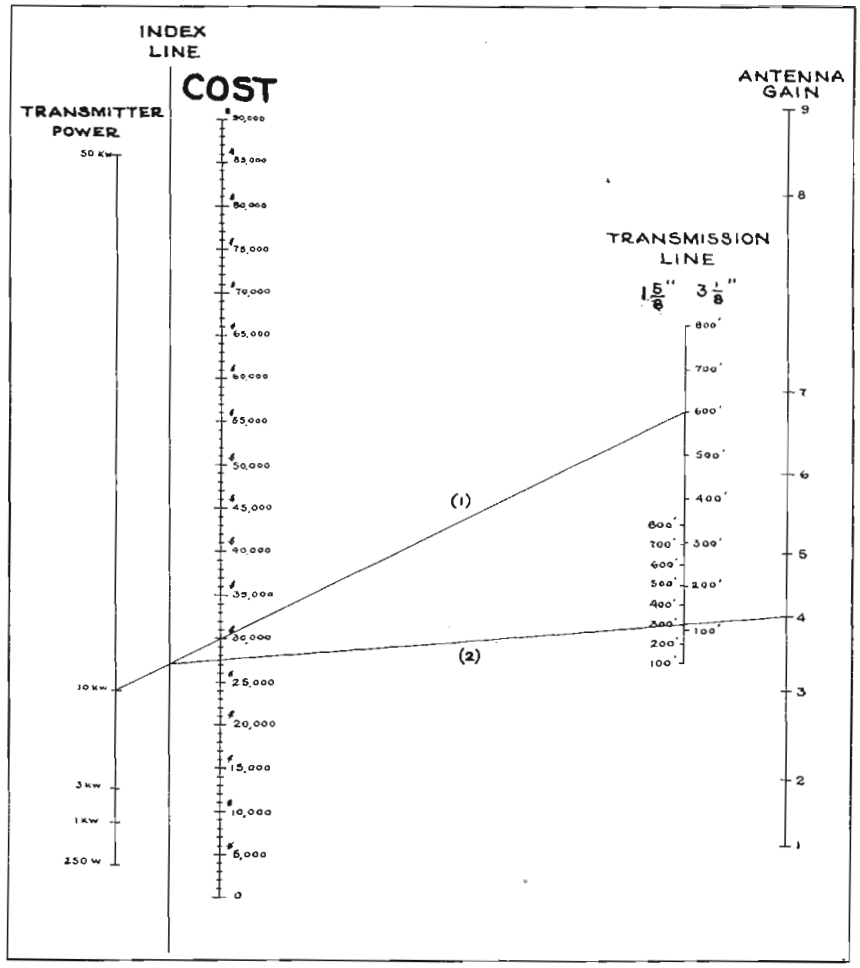
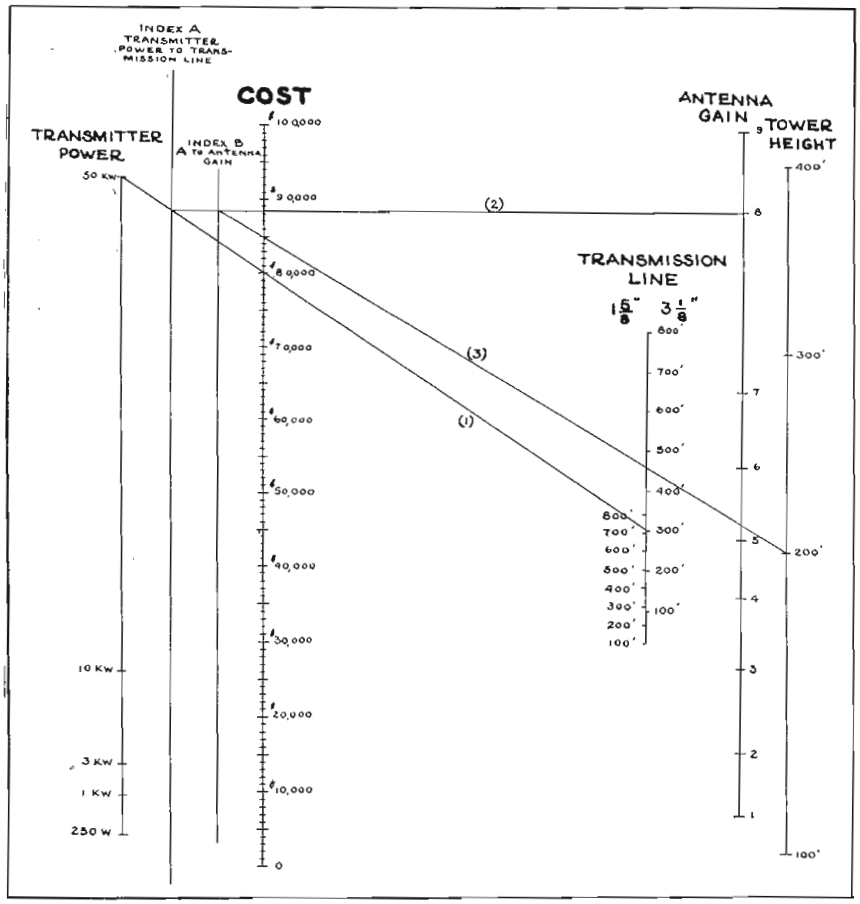


Fig. 3—Simplified method of determining, with close approximation, the effective radiated power of an FM transmitter when other indicated factors are known. (See text for explanation of use of nomograph

Now if you have decided how to spend your money, let us see what sort of effective radiated power you will get for your dollars. The FM Nomograph in Fig. 3 will help you. Straight line (1) connecting 10 kw on the Transmitter Output Power scale with 91% on the Transmission Line Efficiency scale intersects the antenna Power scale. Connecting this point by straight line (2) to 5.5 on the Antenna Power Gain scale gives the answer of 50 kw at the



← Fig. 1—Determining station equipment costs when FM antenna is mounted atop existing AM antenna tower. (See text for explanation)



← Fig. 2—Finding cost of transmitter, transmission line, antenna and supporting tower. (See text for nomograph instructions)

intersection of straight line (2) with the Effective Radiated Power scale.

Now all of these Economographs and Nomographs can be worked backwards as well as forward. One can start with effective radiated power in Fig. 3 and work back to find a combination of transmitter, antenna and transmission line. Then use Fig. 1 or 2 to find the total cost of these components. Another problem might be to start with a certain cost in dollars that one must not exceed and use Fig. 1 or 2 to find combinations of the basic components. Then Fig. 3 can give the radiated power for each combination and the most watts for the fewest dollars would be the wisest choice.

UHF Field Strength Measurements from N. Y.

For the purpose of making field strength measurements at UHF, RCA Laboratories has completed installation work on two oscillators and two antennas in the Empire State building, New York. Dr. G. H. Brown has supplied the following information concerning the equipment.

The directional antenna systems are mounted on a balcony at the 87th floor of the building. One antenna is fed by an oscillator at 510 mc. The oscillator power is 500 watts, and the antenna power gain is 150, so we have an effective power of 75 kw at this frequency. Another antenna, operated at a frequency of 910mc, is fed with 300 watts with a power gain of 150, so the effective power is 45 kw. The oscillators are unmodulated. The antenna elevation is 1061 ft. above ground, and 1109 ft. above sea level.

At present, the antennas are oriented so the beams point approximately 10 degrees north of west, on a radial line which runs from the Empire State building through Montclair and Denville,

(*Continued on page* 86)

Design of Television Transmitters for Low Level Modulation

By J. W. DOWNIE, L. M. EWING, H. B. FANCHER and J. E. KEISTER, General Electric Co.

Simple triodes in grounded grid circuits serve to raise level to desired power. Rapid tuning facilitated by built-in sweep

• Basically the problem of television transmitter design divides itself into that of two transmitters; the *visual* transmitter and the *aural* transmitter. If the frequency ranges are considered, the problem may be further divided in each case into the high frequency and low frequency ranges.

The most significant decision to be made was the method of obtaining the required modulation and transmitter frequency characteristic. The extremely wide band of frequencies, together with the vestigial character of the pass band, coupled with the high average power output capabilities (nearly 60% of the synchronizing peak) required of the transmitter, constitute design requirements considerably different from those associated with sound broadcasting.

For narrow band broadcast transmitters, high level plate modulation is the obvious choice. This permits relatively high efficiency in the power tubes (operating Class C) and a linear high level method of modulation. Audio modulation transformers produce the high voltages required to effectively modulate tubes of any desired power level with an efficient modulator design.

This situation does not hold for a visual transmitter where the band of modulation frequencies is so wide that transformers cannot be used. For television service, the plate voltage for the modulated stage must be supplied directly by the modulator tube across its plate load. This plate load will be extremely low where large tubes with their attendant high capacities are used. For ordinary shunt compensation the load R_L is given by $R_L = \frac{1}{2\pi f_m C_o}$, where f_m = highest modulating frequency (4 mc); C_o = total capacity seen by modulator tube.

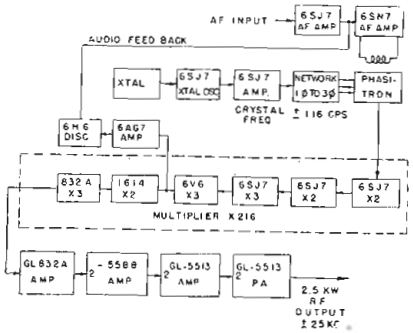


Fig. 1—Block diagram of aural transmitter

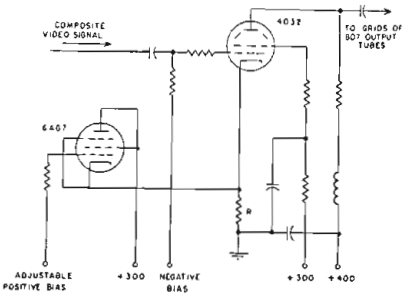


Fig. 2—Modulator sync stretching circuit

For a 5 kw plate modulated transmitter this capacity would be in the order of 200 mmf so the modulator is required to operate into a load of 160 ohms and to deliver 3 to 4 kv which requires 100 kw from the modulator. From this it is obvious that plate modulation is limited to a level of a few watts where the modulated stage and modulator tubes are both small with their attendent low capacities.

After a careful study of all known means based on actual experience and the experience of others, it was decided that plate modulation at a low level (in the order of a few watts) represented the best choice. The power is then raised to the desired level through a series of linear amplifiers whose pass characteristics are so located as to inherently approach the required vestigial sideband curve.

Comparative Efficiencies

The discrepancy between efficiencies of narrow and wide band cases is not as great as might at first be imagined since at these frequencies, particularly Channels 7-13, circuit losses and tube transit time loading automatically bring the effective impedance, gains and efficiencies down. As a result of this choice, it was possible to use simple triodes of more or less conventional design in grounded grid circuits for the higher power amplifier stages.

The modulated stage should be either a neutralized grounded cathode triode or some type of screen grid tube. For low power levels, tubes in the latter category are readily available which will operate well above the highest commercial television band. The compact modulated stage permits excellent isolation between input and output circuits. This, combined with the well known linear character of a plate modulated system, results in an ideal set of circumstances for producing linear modulation down to a level considerably

better than the 15% required by FCC standards.

In order that the modulated stage operate over a fairly constant impedance, it is necessary that the plate circuit be adjusted for 8 mc bandwidth so that both side-bands can be initially generated. Such a circuit prevents undesirable phase shifts about the carrier. Fortunately, this extremely wide band is not required of the larger high power tubes in the chain.

Modulator Design

The combination of the low capacity across the modulator output and the low voltage swing (less than 100 volts) considerably simplifies the modulator problem. Two GL-807's operating as cathode followers are used in the modulator output stage. These transmit both the ac and dc components of the signal and supply the plate power for the modulated stage. This circuit minimizes the effect of load capacity and permits considerable freedom in the choice of tubes for the modulated stage.

Once the modulation has been accomplished, the bandwidth required of the amplifiers is only 4¾ mc in order to produce the standard vestigial sideband signal specified by FCC. In fact, the production of such a signal is an important feature of the amplifier chain in obtaining the standard of 20 db reduction at a point 1¼ mc below the carrier frequency. Each amplifier stage acts as a section of a filter to accomplish this result so that when the signal reaches the end of the chain, it conforms to the standard without the necessity for a separate vestigial side band filter. The decision to build up rf power with a single chain of wide band amplifiers instead of separate rf and video chains made possible a new approach to the well known problems of stability and alignment.

By its nature, a grounded grid amplifier is fundamentally degenerative, and therefore stable, because the input and output voltages are in phase. In a properly designed tube having a low impedance grid structure and low filament to plate capacity, instability occurs only at the higher frequencies, if at all, and then neutralizing is comparatively simple.

It was apparent that grounded grid high power amplifier stages had a great advantage over the more conventional grounded filament type. For this reason and others, two special tubes were designed for television and frequency modulation service; type GL-9C24 for powers up to 5 kw and GL-5513 which is suitable as a driver for the GL-9C24. Both of these types follow conservative design practice and differ from conventional tubes particularly in their grid structures.

Instead of wire leads from the grid basket to the grid seal, a conical flange connects the grid to a ring seal providing the lowest possible grid lead inductance. Thus, the common coupling between the plate currents and filament currents, which flow through the grid lead inductance, is kept to a minimum. At the same time the upper end of the filament structure is shielded from the anode.

To further minimize filament to plate capacity a cap covers the bottom of the grid basket. Thus the cap, grid and supporting structure completely enclose the filament and isolate it from the anode so that in the case of the GL-9C24, which is used as the final amplifier in both low and high frequency equipments, no neutralizing is required in the channels 1-6 set and very little in the channels 7-13. Fig. 3 shows the main features of the rf circuit connections of the channel 7-13 visual transmitter which includes grounded grid high power amplifiers.

In conventional grounded cathode high power amplifiers for wide band operation, it usually is necessary to provide water cooled "swamping" resistors in the grid circuits in order to secure an impedance of the proper bandwidth for the amplifier stage. The high grid impedance of a grounded cathode amplifier cannot be utilized because the grid to filament capacity is so great as to make it necessary to shunt the grid input impedance with a loading resistor, thus providing, a low but uniform impedance across the band.

The input circuit for a grounded grid amplifier, on the other hand, is inherently low impedance because plate current flows in the input circuit. In the application of the GL-9C24, GL-5513 and GL-8002 tubes to rf circuits having bandwidths of 4¾ mc, the impedance is even lower than necessary to obtain the desired bandwidth. This fact is fortunate because the loading of the stage can be controlled without loss of power. This is done by providing an impedance matching circuit in the input to the amplifier having a variable step-down ratio which can be controlled from the front panel.

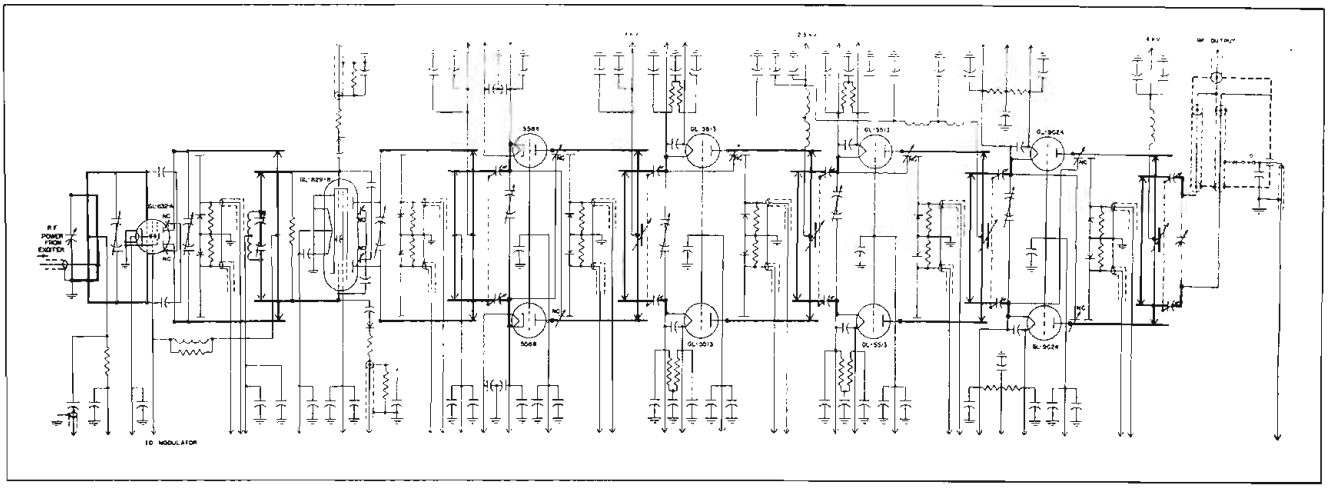
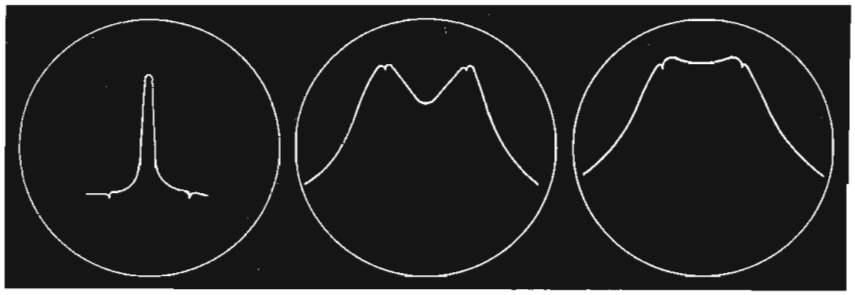


Fig. 3—Schematic of the radio frequency portion of the 5 kw television transmitter for Channels 7-13



Appearance of 'scope traces as transmitter is tuned

With output tuning and loading detuned, plate tuning is adjusted until a spike appears between markers on sweep trace

Output tuning is then adjusted to give an overcoupled bandpass characteristic, too wide and with too deep center dip

Loading control is adjusted, maintaining humps at equal height, until dip in center decreases and bandpass narrows correctly

Fig. 1 shows the typical input circuit for the lower channel visual transmitter.

The low channel transmitter utilizes quarter-wave cathode lines (electrically) or lumped inductances depending on the operating frequency. Three-quarter-wave lines are used in the channel 7-13 transmitter.

In comparing the maximum power output obtainable from a grounded grid amplifier stage as compared with a grounded cathode type, there are three things to consider; the total output capacity, the slope of the load line and the feed-through power. In general, a grounded grid triode amplifier will have less shunt capacity in its output circuit than a grounded filament type because either no neutralizing or very little neutralizing is necessary.

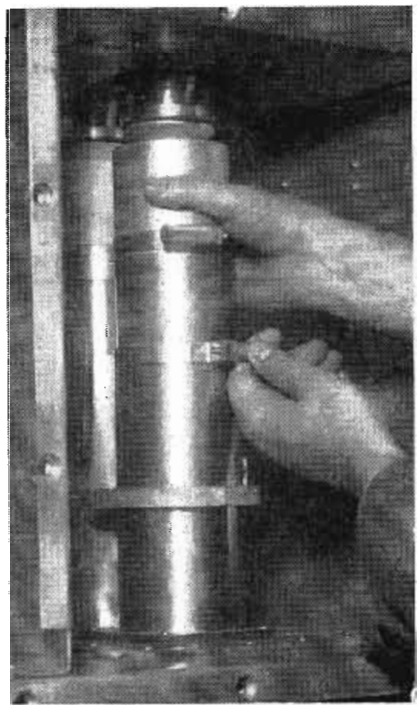
In the case of television applications the output load impedance is lower than the output impedance of the tube. Therefore, any increase in the output load impedance results in more power output and higher efficiency. Since the load impedance is a direct function of the output capacity, any reduction in the output capacity results in a higher impedance.

The second factor, slope of the load line, is in favor of the grounded cathode amplifier. Since the input and output are in series across the load impedance in a grounded grid amplifier, the impedance which the tube sees from plate to cathode is lower than that seen in the case of an equivalent grounded cathode amplifier. The effect of this is to contribute to a slightly lower plate to cathode load impedance which is more than offset by the third factor.

The third factor is feed-through power and is zero in the case of the grounded cathode amplifier because none of the driving current flows in the output circuit but is dissipated in the "swamping" resistors from grid to cathode. In the grounded grid amplifier, however, the input current does flow through the output circuit and appears as power in the output load. The total power developed by the stage, therefore, is equal to the power developed as plate output of the amplifier plus that fed through from the driver.

The combined affect of the foregoing three factors is a higher output from a given triode operating in a grounded grid fashion than in a grounded cathode circuit.

Since the grounded grid amplifier has a low impedance input it would naturally be expected that the power gain would be much less than that of a conventional grounded cathode amplifier. This is true at low frequencies and narrow bands but as the operating frequency is increased toward the limit at which the tube can operate and the pass band is widened out to that used for television transmission, the difference in gains between the two types of amplifiers narrows until they are almost the same. Furthermore, the effect of lower capacitics is to make quarter-wave plate tank circuits possible at the higher frequencies and thus extend the upper useable frequency range of a tube.



Method of removing and replacing the GL-5513 tube in its socket

Although amplifier alignment technic for this type of transmitter differs considerably from conventional narrow band circuits, a straight-forward and simple system has been worked out which reduces the problem to one comparable with the well known meter "peaking" system.

A sweep generator unit is mounted inside the transmitter and is controlled from the front panel. This makes its use convenient and minimizes the effect of undesirable ground currents which might be present in cables to an external unit. The unit consists of an oscillator whose center frequency is approximately that of the carrier but which is swept through a band of approximately ±6 megacycles by a motor-driven condenser connected to its plate tank circuit. Two markers, absorption circuits in the channels 1-6 case and oscillators in the channels 7-13 case, are provided to give indications of points 0.75 megacycle below the carrier and 4 megacycles above it. These points serve as references in the use of the sweep generator.

Following the oscillator is an amplifier which serves both to raise the power level and also to act as a buffer amplifier to eliminate the second and higher order harmonics which might appear in the outputs of the crystal detectors in the external circuit. The amplifier, which is push-pull, then feeds 2 concentric transmission lines which in turn connect to the front panel.

The means for coupling comprises necessary components to

carry the signal from the panel receptacles to any amplifier stage which may be selected and to feed the proper signal in without requiring any physical change or adjustment of the circuit on the part of the operator.

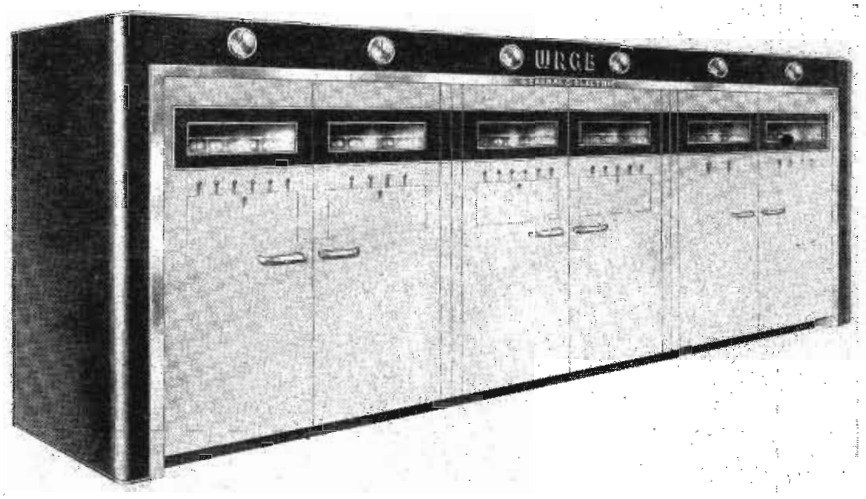
From the sweep generator panel receptacles a pair of "patching cables" can be plugged to any amplifier through its respective sweep input receptacles. Cables then run from these receptacles into two terminating networks which consist of terminations for the rf transmission lines plus crystal detectors capable of sending a rectified signal back along their respective transmission lines proportional to the rf output at the line terminations.

Back in the sweep generator these signals are taken off through video chokes and may be viewed on an oscilloscope for the purpose of determining whether or not the sweep generator is tuned to produce a signal of constant amplitude at the line termination as it sweeps through the band. In the case of the channels 1-6 transmitter these signals also produce a feedback signal to level the sweep output.

Stage Tuning

Thus, with the sweep generator operating, a constant amplitude rf voltage is generated across each 50-ohm terminating resistor as the frequency shifts through the band in accordance with rotation of the sweep driving motor. This low impedance source of rf signal will be undisturbed by the amplifier plate circuit which is very loosely coupled to it. Coupling is in the form of two low capacity high voltage parallel plate condensers which couple a small amount of energy from the rf terminations to the plates of the stage to be tested. These condensers are not only a very small capacity (of the order of ½ mmfd each) which have very little effect on the total output capacity of the stage, but they are also very widely spaced to withstand both the dc and rf voltage present between the tank circuit and ground.

Means for viewing the band pass of one or more stages of the rf amplifier is contained in a crystal situated inside the bazooka (or balanced impedance matcher) connecting the push-pull output stage to the single ended standard transmission line. This detector rectifies a portion of the rf voltage which appears on the output transmission line and its output is connected to a receptacle on the front panel. An external oscilloscope can then be plugged into this receptacle for viewing the bandpass at the transmitter output.



Front elevation of the complete 5 kw transmitter. General arrangement is the same whether the transmitter is for Channels 1-6 or Channels 7-13 though circuits are slightly different

The means for tuning consists of four controls in each interstage coupling circuit, three of which can be operated from the front panel. The fourth, coupling, is semi-fixed, being non-critical in nature. The first three are plate tuning, cathode tuning, and cathode loading.

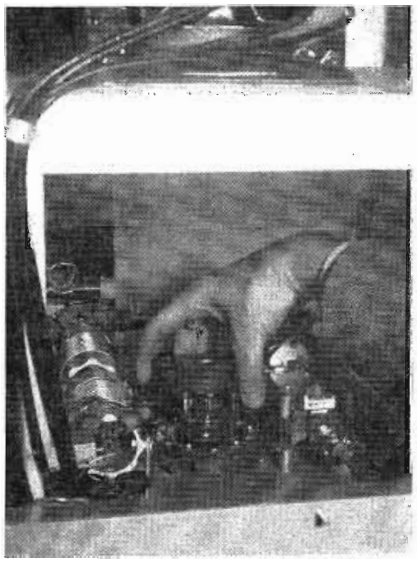
The alignment procedure is basically the same as that used for aligning receiver IF strips. By way of illustration, the alignment procedure of the final output circuit will be given with reference to Fig. 3.

(1) With the output tuning and output loading controls detuned, the tuning control is adjusted until a spike appears approximately half-way between the two markers on the sweep trace in the external scope.

(2) The output tuning control is then adjusted to give an overcoupled bandpass characteristic. This bandpass will in general be too wide and have too deep a center dip.

(3) The loading control is now gradually adjusted and at the same time the two humps at the edges of the bandpass are maintained at equal height by readjustment of the tuning control. As the loading control is adjusted, it will be noticed that the dip in the center of the bandpass decreases and at the same time the bandpass narrows slightly until, when the proper value of output loading capacity is reached, both bandwidth and center dip will be correct.

(4) If, after proper adjustment of the bandpass, it is found that the entire bandpass is displaced in frequency either up or down a small amount with respect to the markers, the plate tuning condenser is adjusted slightly in the proper direction which will move the entire bandpass and at the same time raise one hump and lower the other. Adjustment of the output tuning control will serve to balance up the humps.



GL-8002 socket showing method of removal of the tube

(*Continued on page 87*)

TV Pick-Up From Moving Location

DuMont engineers successfully use remote from ship at sea to broadcast Connolly ceremonies in New York and Washington

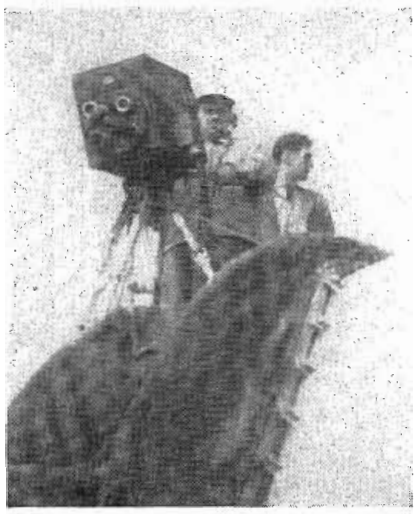
Location of one of the cameras on the deck below turret mounted camera

• DuMont engineers must be credited with a technical triumph for an eminently successful, though unscheduled, television broadcast that brought viewers in New York and in Washington the ceremonies attendant upon the arrival of the transport Joseph V. Connolly in New York harbor on Sunday, October 26, carrying the first of World War II dead. It is believed to be a double-barreled "first"—first from a moving location, and first from sea to land. Engineering problems involved in the broadcast were considerable.

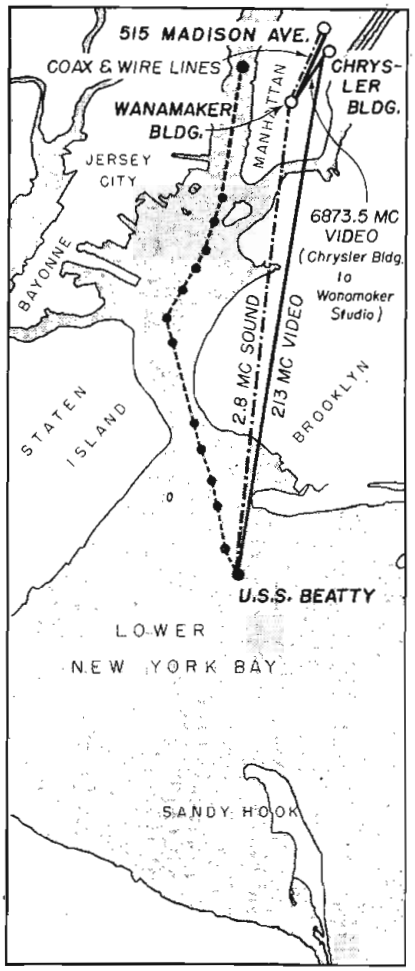
Careful planning, plus wholehearted cooperation from the Navy made the broadcast possible. Following much paper preparation and thorough inspection of possible facilities, WABD engineers installed complete sight and sound receiving and transmitting equipment aboard the US destroyer Beatty at the Brooklyn Navy Yard and sped to sea for a rendezvous with the Connolly 14 miles away in the outer harbor.

Two image orthicon cameras were used for the visual pick-up, one of them, a new Mark II turret head model was installed on a forward gun turret, and the other was located on a dolly on the deck below the turret. Operating personnel for sight and sound included a crew of nine DuMont engineers.

Some idea of the complexity of the problem may be gathered from the fact that it required seven Navy plotters to constantly plot the position of the Beatty in order to keep the transmitting antenna accurately aimed at the receiving antenna installed in a room atop the Chrysler building in New York. The method used is a new Navy technic whereby the position of the Beatty was determined with relation to various channel buoys and by triangulation the Chrysler building receiving antenna was kept on the beam within 1° accuracy. A useable signal could have been obtained had the beam wavered as much as 20°.



The Mark II camera was mounted atop one of the forward gun turrets



Rendezvous between Beatty and Connolly was in outer harbor 14 miles from Chrysler building. Course followed dotted line marked by buoys used for orientation. Paths of separate video and sound are shown by solid and dashed lines

For the broadcast one of the Beatty's radar fire control beam antennas was used. This antenna was automatically beamed in the proper direction by selsyn control from directions originating in the ship's plotting room. Regardless of the movement of the ship, the antenna was always headed in the right direction in both azimuth and elevation.

Only the video broadcast was made from this antenna. Sound was transmitted from a Navy transmitter on a Navy channel at 2.8 mc loaned for the purpose. The power was approximately 25 watts and reception was directly at the DuMont Wanamaker studios and not at the Chrysler building. For liaison and monitoring purposes

(*Continued on page* 91)

Microwaves and Propagation Top URSI-IRE Interest

Broad-band metallic lenses for relay networks and propagation research among major conference topics—Principal papers briefed

• The development, use and future possibilities of broad-band metallic lenses for microwave transmission and relay purposes turned up perhaps greatest interest for scientists and engineers who gathered in Washington in the third week of October for the annual joint meeting of the International Scientific Radio Union (URSI) and the Institute of Radio Engineers. As usual, each of the three days was devoted to a particular topic: (1) Tubes and Microwave Technics; (2) Antennas, Circuits and Measurements; (3) Radio Propagation and Radio Noise.

More and more effort is being put into research on radio propagation as shown by the increase in personnel, to about 250, now employed by the government-financed Central Radio Propagation Laboratory, National Bureau of Standards. A well-known university, for the first time, is offering courses leading to a doctor's degree in Wave Propagation. The first graduate student in this course will come from Canada. But in spite of this growing staff of workers, scattered around the world, the attendance at these meetings appeared to drop below the number normally attending post war meetings. The total number registered was 411. The number of papers, however, remained the same, 45 scheduled, plus 10 supplemental papers. All of the sessions were held in the beautiful, air-conditioned auditorium of the Department of Interior.

In endeavoring to help the reader who was not present, the title of most of the papers, the authors and their connections will be listed. Where possible, a few words of description will be added so that if there is special interest the reader may wish to get more information from the author.

Front view of electronic phase meter developed by Bureau of Standards

Interest in new types of broad-band metallic lenses, as described by W. E. Kock, Bell Telephone Laboratories, Holmdel, N. J. was intense. Some time ago the BTL announced the use of the wave-guide-type metallic lenses, but no public announcement of this improved dielectric-type of lenses had been made previously. This new development, of great potential value in television relaying and other broad-band services, possesses the broad-band characteristics of a true dielectric.

Dielectric lenses could be molded from polystyrene of course but they would be too heavy to handle; whereas the new "metallic dielectric" lenses, consisting of polystyrene "foam" (mostly air bubbles), supporting copper-strip conductors, all carefully formed to give the desired beam width and broad-band features, are light in weight and exhibit an index of refraction which can be made essentially constant over the desired band of microwave frequencies. Several types of lenses were described, including one that was effective for all wavelengths from 1 to 10 cm. The spacing and size of the elements determine the width of the band passed.

For radio and television relay application the three important factors are: high gain; directivity; and impedance match. The source of microwave energy is placed at the throat of a horn-like structure. at the mouth of which is located the metallic lens, acting to focus a very narrow radio beam, with correspondingly high power-gain, upon the distant receiving lens. Directivity curves of a lens 6 ft. by 6 ft. (effective area 60%) were shown in which the beam width was 5° on each side of the center line and the gain over a wide band was 38 to 39.

After the presentation of the paper the author said in conversation that for radio repeater use a lens of 10 ft. by 10 ft. was used. In this case the beam width was 1½° wide and the gain was 40 db. This high gain enables a transmitter of only 1 watt, at 7 cm., to bridge the average relay "jump" of about 35 miles when a similar lens affording a 40 db gain is used at the receiver.

From a practical standpoint it has been found that the light-weight "foam" supports (which can be worked with carpenter's tools) hold the metal strips in the

lens in a permanent manner. For protection from the weather the face of the lens is covered with a thin sheet of polystyrene.

URSI-IRE TOPICS BRIEFED

METEORIC EFFECTS IN THE IONOSPHERE, L. A. Manning, Stanford U.—Waves 10-20 meters long are reflected from meteor trails. Due to Doppler effect these produce audible "meteor whistles".

MAGNETO-IONIC EFFECTS AT HIGH LATITUDES, James C. W. Scott and Frank T. Davies, CDRB, Ottawa.—Ionospheric measurements taken at Clyde, Baffin Land were discussed.

HARMONIC ANALYSIS OF F-2 LAYER CHARACTERISTICS, M. Lindeman Phillips, NBS.—A time-saver for those handling the avalanche of data pouring in from ionosphere stations in the use of Fourier series as a means of condensation and correlation.

SPATIAL AND TIME VARIATIONS IN F-2 CRITICAL FREQUENCIES, T. N. Gautier, NBS.—This was studied by correlating paired values of F-2 the same day under certain conditions and the conclusion inferred was that fluctuations in F-2 do not depend on solar radiation but on terrestrial local causes.

MOTION PICTURES OF IONOSPHERE DURING TOTAL SOLAR ECLIPSE, J. M. Watts, NBS.—A 16-mm film taken at Bocayuva, Brazil, May 1947. Photographs of ionosphere vertical incidence multifrequency records taken before and during eclipse were speeded up 240 times to give, in a striking manner, what happened to the E- and F-layers during the eclipse.

IONOSPHERIC OBSERVATIONS DURING SOLAR ECLIPSE, A. H. Shapley and J. M. Watts, NBS.—During eclipse E-layer dropped to 37% of its normal value. Marked stratification appeared in lower F-region before and after totality. Critical frequency of this region was a minimum at totality. There was a slight depression of the F-2 layer during eclipse interval.

HIGH-FREQUENCY ATTENUATION IN THE IONOSPHERE, J. W. Cox, CDRB, Ottawa.—A 1944-46 study in England of vertical incidence attenuation shows a maximum in daytime at 1.4-1.7 mc.

"EXTRA-RECEIVER" NOISE AT 100 MC, J. H. Trexler, NRL, Wash., D. C. — Photographic recordings were shown in which intensity of noise was plotted in time-azimuth coordinates. Using a large azimuth-scanning antenna, continuous records show noise from electrical storms, man-made interference in cities, the sun and the Milky Way.

MICROWAVE SOLAR RADIATION DURING A TOTAL ECLIPSE, J. P. Hagen, T. B. Jackson, R. J. McEwan, C. B. Strang, NRL.—On May 20, 1947 the microwave solar radiation was fed into an 8-ft paraboloid and to a 10,000 mc radiometer. Throughout totality the radiation intensity dropped to 4% of its normal full intensity; part of this must have been due to the sun's corona.

SOLAR NOISE BURSTS, 10.7 CENTIMETERS, A. E. Covington, NRC, Ottawa.—These are evident when making solar noise measurements. These sharp bursts last one to two minutes and about 75% have been associated with sudden ionospheric disturbances.

ATMOSPHERIC NOISE MEASUREMENT IN THE LOW-FREQUENCY RANGE, R. S. Hoff and R. C. Johnson, U. of Fla.—Atmospherics over the band 10 to 500 kc are studied to learn seasonal variations and the effect of weather.

A METHOD OF MEASURING ANGLE-OF-ARRIVAL, A. W. Straiton and W. E. Gordon, U. of Texas.

WHAT ARE "ANGELS"?, H. B. Brooks, W. B. Gould and R. Wexler, Evans Signal Lab., Belmar, N. J.—Unidentified echoes, or "angels", observed in the atmosphere by "K" band radar might be dust particles or dielectric discontinuities.

OBSERVATIONS OF L-F PROPAGATION DURING SUDDEN IONOSPHERE DISTURBANCES, M. Katzin, NRL and A. M. Braaten, RCA.—At such times when there is H-F fade-out often there is an increase in L-F field strengths.

VERTICAL - INCIDENCE IONOSPHERE MEASUREMENTS AT 100 KC, R. A. Helliwell, Stanford U.—Somewhat different measurement technic, using damped pulse oscillations was described.

SIMULTANEOUS OBSERVATIONS OF FIELD-INTENSITY MEASUREMENTS, H. T. Stetson and G. W. Pickard, MIT.

SHUNT-EXCITED FLAT-PLATE ANTENNAS WITH APPLICATION TO AIRCRAFT STRUCTURES, J. V. N. Granger, ERL, Harvard U.—This type of antenna was used on a P-80 for communication, 2 to 18 mc, giving superior electrical and aerodynamic performance.

CALCULATION OF DOUBLY CURVED REFLECTORS FOR SHAPED BEAMS, A. S. Dunbar, NRL.—The calculation of the shape of the reflector for an aircraft radar system which will produce a beam on the ground that is fan-shaped in the elevation plane and narrow in planes transverse thereto.

FUNDAMENTALS OF RESONANCE, K. A. Pullen Jr. Ballistic Res. Labs. Aberdeen P. Ground, Md.

TESTING REPEATERS WITH CIRCULATED PULSES, A. C. Beck and D. H. Ring, BTL. Holmdel, N. J.—If, when testing equipment ranging from a video amplifier to a complete microwave radio repeater system, a square-wave pulse technic is used it is possible that the slight irregularity in the output pulse, for instance, due to distortion, as seen on a CRO, will not be noticeable. However if this pulse is circulated many times, say 80 times, through the system, then the cumulative effect will be easily observable. The equipment for such testing was shown in block diagram form and discussed.

CRITERIA FOR STABILITY IN CIRCUITS CONTAINING NON-LINEAR RESISTANCE, Capt. L. V. Skinner, U. of Ill.

ULTRA-HIGH FREQUENCY MEASUREMENTS, W. R. Thurston, G. R. Co. Cambridge, Mass.

ELECTRONIC PHASE METER, E. F. Florman and A. Tait, NBS.—Sinusoidal voltages are converted into square waves and applied to two separate phase indicators. The frequency range is 100 to 5000 cycles; the voltage range is 1 to 30 volts.

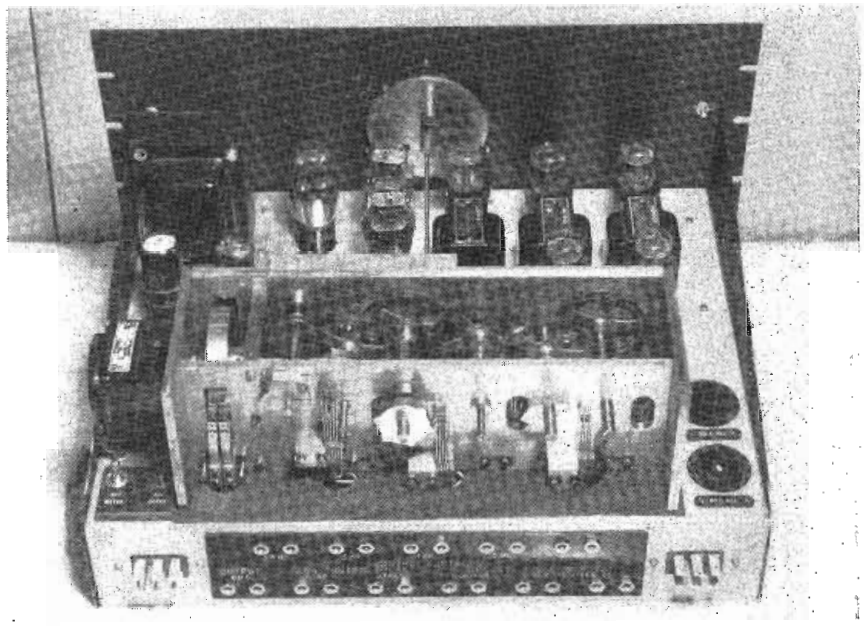
GENERAL EXPRESSIONS FOR THE "Q" OF A CIRCUIT, P. J. Selgin, NBS.—After a discussion, a definition for "Q" is arrived at in terms of the derivative of impedance (or admittance) with respect to frequency.

SOME NOTES ON MODERN QUARTZ OSCILLATOR DESIGN, B. C. Hill, Jr., NRL.

A MAGNETIC PHASE MODULATOR FOR USE IN TELEMETERING, M. G. Pawley, NBS.—A twin-toroid saturable reactor, producing a 20° phase shift with a dc change of 0.1 ma., can be be applied to a time-division or frequency-division system of telemetering with the advantages of simplic-

(*Continued on page* 84)

Rear view of Bustan Seconds Pulse Generator and time interval selector used in the time control equipment of the Bureau's WWV. The one-second contact is made by a cam on the flywheel immediately at the right of the electric motor. Succeeding cams are for longer time intervals controlling station announcements.



Conference Group Intercom System

Automatically amplifying both sides of a telephone conversation for full room coverage without interference from feedback

• Early radio broadcasts were receivable only through the use of headsets and the listener was always shackled to his receiver. Popular demand soon did away with this inconvenience. However with all of the advancement in amplifiers and public address technics the solution to the common problem of amplifying a voice to and from a telephone handset has not been given much attention. The Jordanoff Corp.* has recently demonstrated a practical solution to this problem, the result of five years research. The Jordaphone requires no connections to the telephone system, the usual handset being placed in a special cradle at the top of an amplifier-speaker cabinet. If a dummy handset is used merely to operate the hook, this handset may remain permanently in the cradle and all normal conditions of dialing, talking and listening are done without disturbing it. The user's hands are free, and he can speak or listen from any part of the room even while walking around and speaking at a normal level.

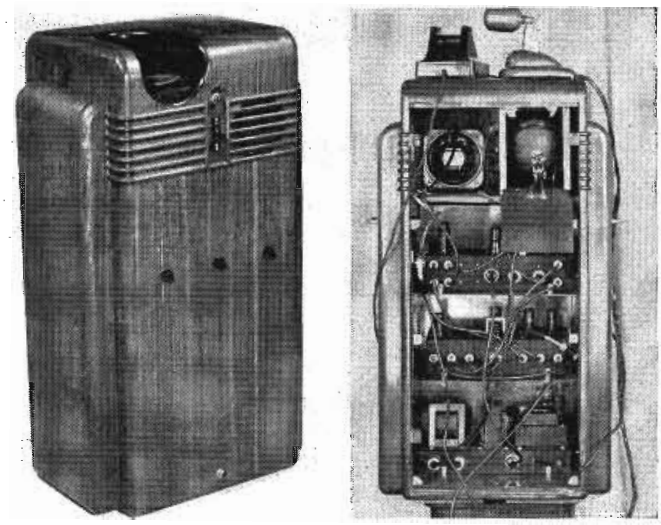
Amplifying both sides of a telephone conversation has several unusual problems which must be considered when applying electronic equipment. A telephone circuit does not have a wide range of amplitude over which satisfactory speech can be handled. In ordinary use the transmitter is designed to be held within a narrow range of positions with respect to the mouth of the speaker. Another problem results from feedback purposely applied to telephone circuits to give naturalness — the so-called "sidetone" circuits, of which there are many versions that always appear in some form or another in each telephone box. Since two telephone instruments are involved there are two sets of "sidetone" signal injections appearing in each normal communication channel to introduce cross modulation between the two sides of the conversation.

In a basic plan for a two-directional system, the acoustic feedback (the speaker's voice and the amplified incoming speech are present at substantially equal levels at all parts of the room) is the main drawback. In normal use feedback between the receiver and transmitter ends of a handset is not present because the path is blocked by the face of the user. This is not true when the speaker and microphone are randomly placed in an office.

In providing maximum convenience for carrying on a group telephone conversation it is necessary to provide much greater latitude in the requirements of a pickup level because of the wider range in distances from the pickup microphone to the speaker, and the greater changes in conversation levels.

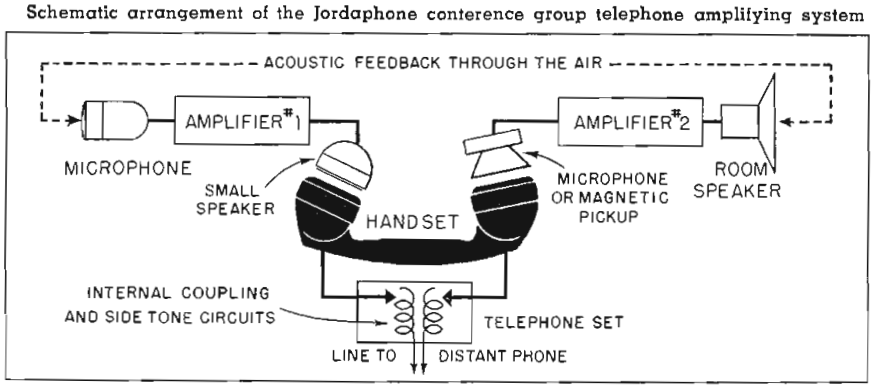
(*Continued on page* 86)

*595 Madison Avenue, New York.



Front of the complete Jordaphone unit showing its general appearance, and a rear view showing disposition of various components

Schematic arrangement of the Jordaphone conference group telephone amplifying system



Temperature Coefficient Effects of RF Coil Finishes

By CHESTER I. SOUCY, Chief Engineer, Electronics Div. Canadian Aviation Electronics, Ltd., St. Hubert Airport, Que.

Analyzing changes in inductance following the use of various products for dust and moisture protection and mechanical stability

• The common object in applying coil finishes is to protect the coils against absorption of moisture.[1] The amount of moisture absorbed will depend upon the relative humidity, the length of exposure, and the water vapor transmission rate of the protective finish. A thick coating of a material with a low transmission rate delays the absorption, but it should be understood clearly that all finishes, in fact, most materials except metals and glass, have some permeability to moisture. Except where components are hermetically sealed in metal or glass enclosures, the absorption of moisture (or loss of previously absorbed moisture) continues until a condition of equilibrium is established for the prevailing ambient humidity.

The best that can be accomplished using materials having the lowest available moisture vapor transmission rates, such as hydro-carbon waxes, is to give short-term protection by delaying moisture absorption during fluctuating periods of high humidity which have limited durations. This has been clearly shown by a number of investigators[2,3] and confirmed by many wartime tests by leading commercial and Service laboratories which are covered by reports that have not yet been made public. Even materials noted for low moisture absorption such as polystyrene may have appreciable moisture vapor transmission rates (polystyrene's transmission rate being equal to that of wood-filled phenolic).

THE effect of finishes on temperature coefficients is a matter that has been commonly overlooked by most radio circuit designers. Finishes affect the coil temperature coefficient of inductance chiefly by altering the contribution of the distributed capacitance to the overall coefficient. In addition, finishes may alter the normal thermal expansion of the conductors.

The effect of absorbed moisture upon the electrical characteristics of the coil depends upon the moisture absorption and electrical properties of the dielectric material forming the conductor insulation or in the coil form. Since the effects of moisture are most pronounced in close wound or multilayer coils, in which distributed capacitance plays a greater part, it is of interest to observe from Fig. 1 the comparative effects of moisture on coils having the same distributed capacitance (when dry) but using litz wire with cotton, celanese, and silk coverings.[4] Cotton is obviously the poorest material and silk the best, as has been long known. At the saturation point (100% RH) none of the coils would be usable, but at 90% RH the cotton covering causes an excessive loss of Q, and therefore of gain, while celanese and silk are just beginning to show definite deterioration.

It is not proposed to discuss here in detail the relative moisture permeabilities of various finishes, since this data can be found elsewhere.[2,3] Also, Eltgroth[5] has shown the effects of surface films of moisture which form on insulating materials (such as coil finishes) even at moderate values of relative humidity. Use of non-wetting finishes such as silicone fluids[6,7] can reduce film formation and surface leakage as well as rf losses due to the presence of moisture in the electrostatic field of the coil. Another effective way to reduce the dielectric losses due to film formation is to apply thick coats of finish, ⅛ to ¼ in., which can be done readily with certain waxes and insulating compounds such as those mentioned later.

Even a non-wetting surface on the finish coat can collect dust which then serves to absorb moisture, to form an electrolyte, and to aid the growth of fungus under severe tropical conditions even on surfaces that were originally non-nutrient. Some waxes have surfaces which attract dust and may therefore benefit from the addition of a smooth finish coat as in some of the finishes described. While a measure of protection against fungus can be obtained by the application of a compatible overall varnish or lacquer spray containing a fungicide, treatment of the components, preferably by the use of materials impervious to moisture and fungus is the best practice. Although fungus can be a serious problem in humid atmospheres such as are encountered in tropical and semi-tropical countries by exposed equipment,

a sifting of the recent war experience shows that the basic problem is one of moisture protection.

The need for finishes to stiffen the assembly of conductors in multilayer coils may not be apparent from a visual inspection. When exposed to temperatures differing from those at which they were wound, the conductors may slip or loosen (particularly end turns), or turns may ride up slightly on the sides of grooves in which they are wound, causing appreciable inductance shifts as well as a variation of the temperature coefficient with temperature.

Mechanical Stability

This effect is illustrated in Fig. 2, covering tests on a 473-kc oscillator coil having a universal winding consisting of 200 turns of No. 39 sse on a ½-in. ceramic form. Curve No. 1 shows the irregular frequency shift during a temperature test cycle. Another similar coil followed a similar curve without the double hump, but likewise ending up with an appreciable shift in inductance, due, perhaps, to equalization of winding tensions or small shifts of conductor positions. Curve No. 2 shows the stabilizing effect of a lacquer finish (Communication Products Co.'s Q-Max) after a drying bake. Curve No. 3 shows the results of a wax flash dip (Zophar Mills No. 1436 wax at a temperature of 130°C, following after a 3-hour baking at 70°C). A very low temperature coefficient resulted from this treatment, but a slight permanent shift occurred during the first temperature cycle. A second temperature test cycle shown by the dotted line indicates that stabilization is complete.

Curves Nos. 1 and 4 of Fig. 7 for unfinished coils show little irregularity of temperature coefficient over a complete hot and cold test cycle. Probably the greater stability of these IF coils wound on ⅜-in. bakelite and Alsimag No. 196 ceramic tubes is due to less rigidity of the stranded litz (6/42) wire used and the greater friction holding adjacent turns together better than in the case of the solid wire in the coils of Fig. 2.

While the following effect has not been noted on multilayer coils tested by the writer, an unexpected trouble was encountered in applying lacquers and cements to single-layer coils having a solid conductor solenoidal winding. As Fig. 3 shows, in Curve No. 2, the thermal drift performance of the coil is normal while heating up, but during cooling it acts as if the lacquer (Sickles Q-Max) causes a restraining effect preventing the conductor (13 turns of No. 22 soft-drawn copper on a ¾-in. grooved ceramic form) from contracting to its original position at normal temperatures.

Another similar coil ("B") performed as shown by curves 3 and 4 on two separate heating cycles, in both cases exhibiting an upward shift at the tail end of the cooling portion of the cycle (where the cooling proceeds at a reduced rate). Curve No. 1 for the same coil as curve No. 2 represents the performance of the bare coil "A" before application of the finish. A wax dip finish for coils of this construction does not exercise any restraining effect on the conductors. This is illustrated in Fig. 5 for a somewhat similar coil of larger wire, No. 20. When applied over a wax coating, an additional coating of cement, such as DuPont Household, causes no irregular performance or changes in temperature coefficient. Other tests on coils wound with No. 27 enamelled wire in a closewound solenoid showed similar effects to those just described when treated

Fig. 1—Effect of moisture on Q of coils as affected by cotton, celanese, and silk covering of litz wire. All coils of equal distributed capacitance. (Meissner)

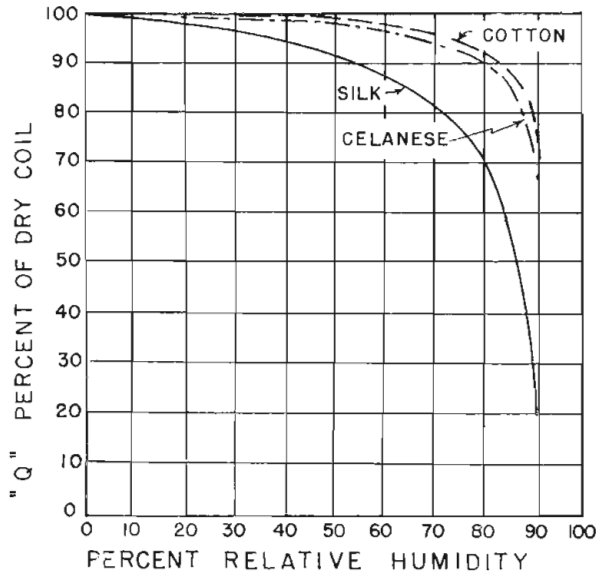
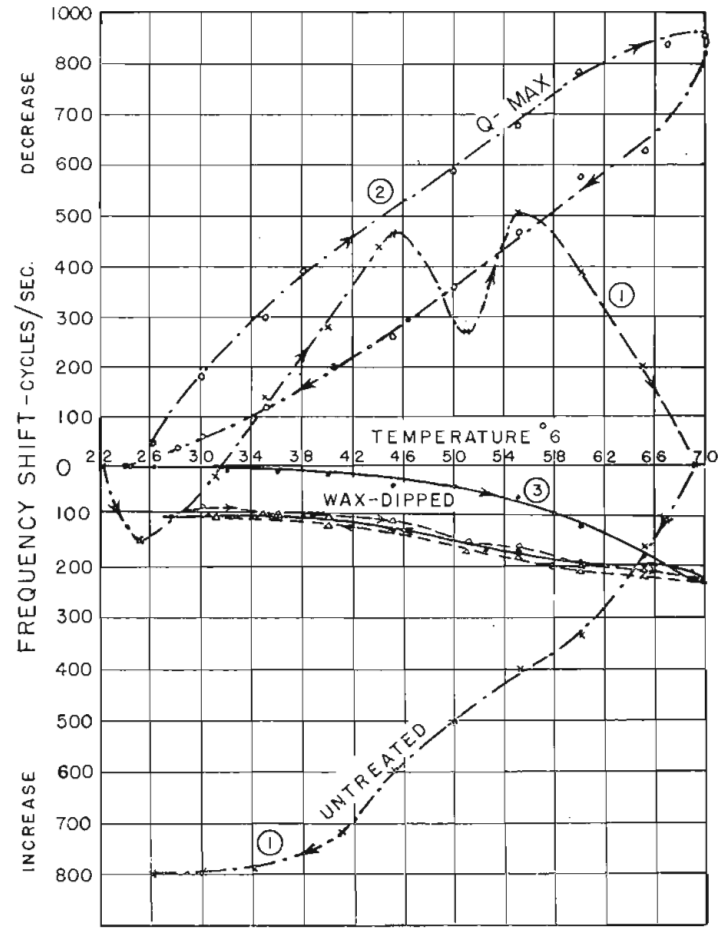


Fig. 2—Stabilization of temperature coefficient and inductance of universal-wound coil by rf lacquer and wax finishes. (Coil 200 turns No. 39 sse, ⅛-in wide, on ceramic form ½-in diam. Test at 463 kc.



with lacquer or wax plus cement finishes.

The "elastic skin" effect was not confined to fine wire coils. For some higher frequency oscillator coils (consisting of 4 turns of spaced conductors on a ¾-in. grooved ceramic form) it was thought desirable to use a cement type finish to provide a thicker coat than lacquer and a smoother one than wax and also preferable to it under exposure to dust as well as free from softening at high temperatures and from cracking at low temperatures particularly under conditions of vibration. The coil represented by Fig. 4 was constructed of No. 20 silver-jacketed invar wire and was given a dip in DuPont Household cement and alowed to dry for three hours. The heating and cooling test was run through two cycles to verify the permanent shift in inductance and the irregular frequency-drift characteristic during the cooling portion. Another test indicated that a similar type of characteristic resulted when a commoner type of winding, namely, No. 20 hard-drawn copper, was used.

Since the wax and cement finish provides dielectric material between conductors having a value of permittivity (dielectric constant) higher than that for air, it is obvious that the distributed capacitance must be increased. Although this finish did not alter the temperature coefficient at the test frequency used, an appreciable increase at the higher coil operating frequencies would occur as these approach toward the natural resonant frequency of the coil.

Multi-Layer Coil Finishes

When all the factors which contribute to the overall temperature coefficient are taken into account, the temperature coefficient of a simple coil can be calculated fairly accurately as shown by Thomas and Bloch. However, considering experimental results given here and the additional complexities involved in multi-layer coils, it seems probable that the temperature coefficients of such coils cannot be predicted solely from the temperature coefficients of expansion for the conductors and coil forms together with consideration of the distributed capacitance and its associated temperature coefficient of permittivity. For example, the following range of temperature coefficients of inductance was found before finishes were applied:

Bakelite forms—
- 1-pie IF coil, universal winding, 6/42 litz ..... 34×10^{-6}/°C
- 3-pie universal wound coil, 7/41 litz 66
- Progressive-wave wound coil, 7/41 litz 28

Ceramic forms—
- 1-pie IF coil, universal winding, 6/42 litz ..... 17.6×10^{-6}/°C
- 1-pie universal wound coil, No. 36 sse, ⅛-in. wide .... 15.
- Same as above, but ¼-in. wide 39.5

Another complexity that should be borne in mind which affects all coils except self-supporting ones without dielectric material between turns is absorbed moisture. The tests and statements regarding temperature coefficients of coils presented here apply to dry coils. Due to the extremely high temperature coefficient of permittivity for water (of the order of -3600×10^{-6}/°C) and its effect of increasing the effective distributed capacitance, very large increases in the temperature coefficient of inductance can be expected as water is absorbed by the finish or other dielectric material surrounding the conductors. However, although no specific data are available on tests of coils affected by absorbed moisture, other impairments of electrical characteristics

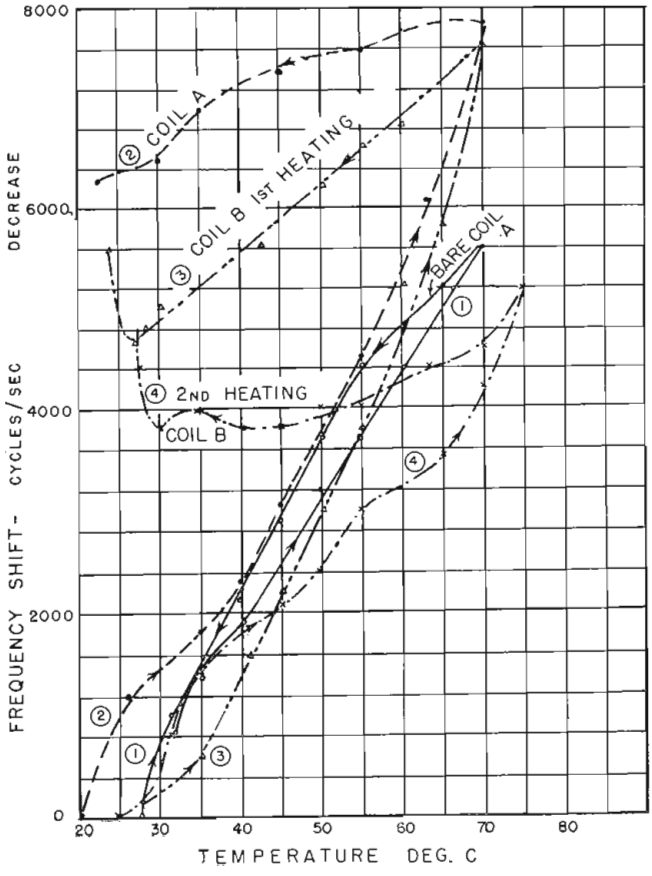
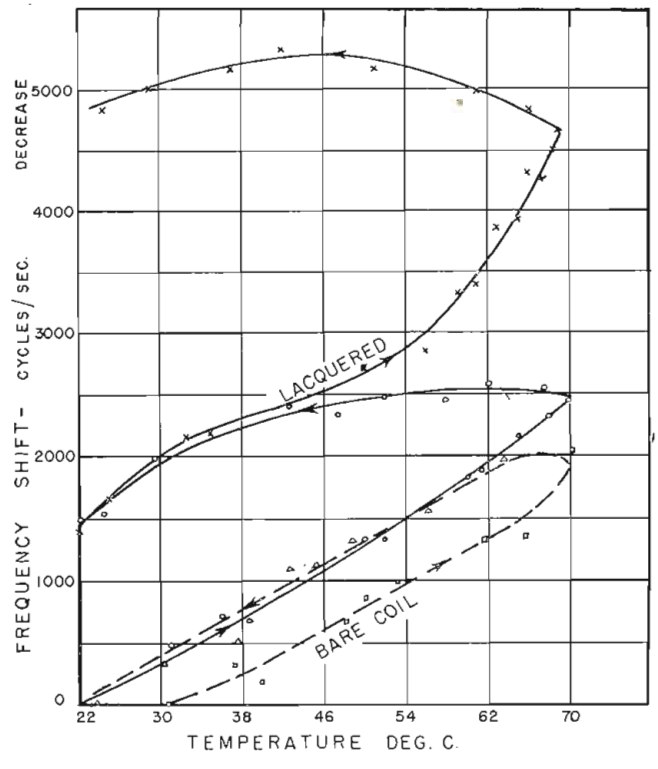


Fig. 3—Effect of rf lacquer on single-layer coils restraining contraction. Tests at 6 mc on coils of 13 turns of No. 22 S.D. copper on grooved ceramic form. Curves 2, 3, 4 are for coils coated with Sickles Q-Max rf lacquer.

Fig. 4—Effect of rf lacquer on S-W coil stability. Test at 6 mc on 4-turn coil on grooved ceramic form wound with silvered invar



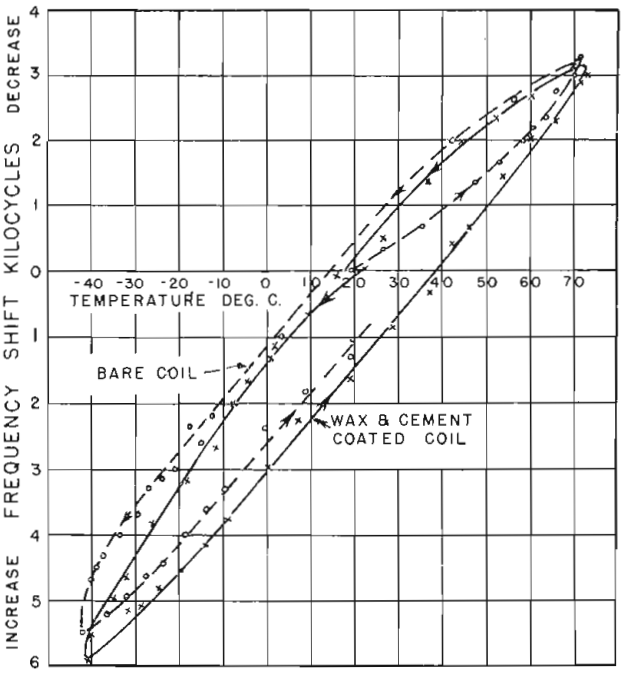


Fig. 5—Finish of wax (Zophar No. 1436) and cement (Dupont Household) on S-W coil does not alter temperature coefficient. Same coil as in Fig. 4. Test at 6 mc.

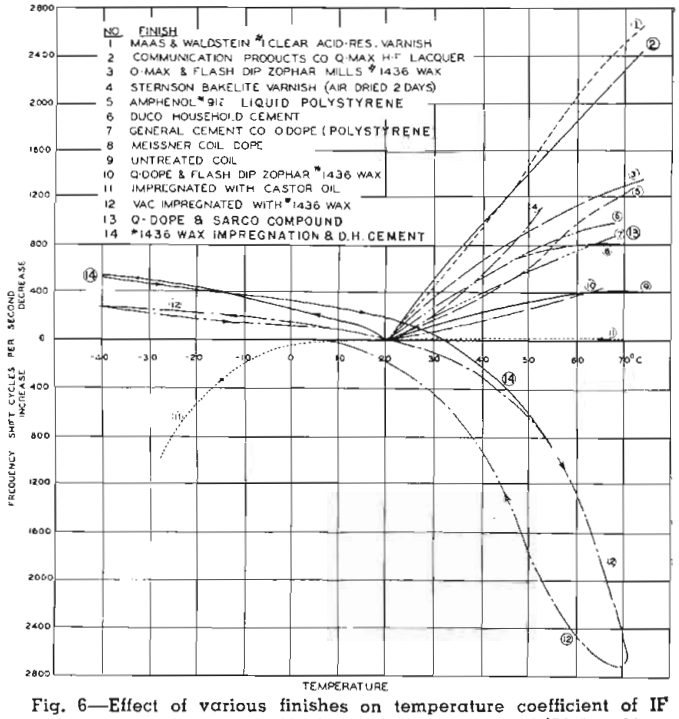


Fig. 6—Effect of various finishes on temperature coefficient of IF transformer coils. Test at 463 kc on 252-turn coil of 6/52 litz, ¼ in wide, on ½-in bakelite tube.

will be equally important or more so than is the increase in temperature coefficient.

Fig. 6 illustrates the results of temperature tests made to determine the frequency drift of an IF coil at 463 kc as affected by various finishes applied after a drying bake to similar coils. The test coils were identical universal-wound coils of 262 turns of 6/42 litz wound with uniform tension on ½-in. diameter XXX bakelite forms. Except for the wax and oil impregnations, the finishes were applied by dipping or thorough brushing.

The untreated coil is represented by curve No. 9 with a temperature coefficient of 25 parts per million per degree C (from the curve corrected for the temperature coefficient of the test chamber). Commonly used varnishes and coil lacquers represented by curves Nos. 1 and 2 increase the temperature coefficient by a factor of nearly 5, and other finishes listed have intermediate values as shown by curves 4 to 8, and 13. Some, like those represented by curves 4, 5, and 8, show nonlinear coefficients. This may be due to changes in either the temperature coefficient of expansion or of permittivity. It is to be noted that the nonlinear test results were not checked further.

Vacuum impregnation with wax is used commonly as a finish for IF and multi-layer coils with universal and other types of windings. The results of a complete hot-and-cold test are given in curve No. 12 for wax, whereas only the heating portion is represented for the other finishes which generally show little change in temperature coefficient at the cold temperatures.

Complete Impregnation

If complete impregnation with wax is produced (as distinguished from a flash dip), a negative coefficient results for the waxes tested. At temperatures below normal room value, curve No. 12 shows that the temperature coefficient is quite low but increases to a large value (up to -600×10^{-6}/°C) with increasing temperature. This effect could be caused by a large temperature coefficient of expansion of the wax as it softens, or by a considerable decrease in the dielectric constant (permittivity) without involving a large change in density due to expansion. The thermal characteristics of the wax used are not known, but refined paraffin and microcrystalline Cerese AA waxes have increases of 15 and 30 times in their thermal coefficients of linear expansion as their melting points are approached, returning to about the original low-temperature values in the melted state but with reductions in permittivity from 2.5 at 24°C to 2.1 at 81°C. for paraffin and from 2.4 at 30°C to 2.1 at 85°C for Cerese AA.

From measurements on capacitors with hydrocarbon wax impregnated paper[11] a variation in the temperature coefficient of permittivity for wax from approximately +350 parts at 10°F (−12.2° C) through zero at about 80°F (26.7°C) to −818 parts at 120°F (49°C) (below the melting point) and −2800 parts per million per degree centigrade at 140°F (60° C) (above the melting point of paraffin) without abrupt changes may be inferred.

Curve No. 11 of Fig. 6 illustrates an interesting result whereby zero temperature coefficient apparently was obtained through impregnation in castor oil (actually, -6.3×10^{-6}/°C, due to the correction for the test chamber drift). Unfortunately, this treatment is not satisfactory for very low temperature use due to freezing of the oil between −12°C and −18°C which causes a rapid increase in the temperature coefficient. In addition, the oil is an unsatisfactory finish for handling and exposure

(*Continued on page* 91)

Horizontal Scanning Generator and HV Supply

By J. F. BIGELOW,
Farnsworth Television & Radio Corp.

Analysis of Farnsworth "Beam Relaxor" which combines oscillator and high voltage generator in one tube giving light, compact unit

• Magnetic deflection systems for television scanning demand very rapid decay of the magnetic field of a transformer during horizontal retrace periods. Utilizing this high rate-of-change of flux to generate high potentials in a winding of modest size, followed by a suitable rectifier, acceleration potentials in the order of ten kilovolts are readily available.

This principle was conceived in this country by Philo T. Farnsworth who applied for basic patents in 1931. In an effort to overcome corona in the windings of the transformer, Farnsworth made an early attempt to enclose the high-voltage winding of a horizontal deflection transformer in vacuum which he termed a "Rectiformer." Coupling was made through glass to an external iron core. The system proved too costly for use in a television receiver.

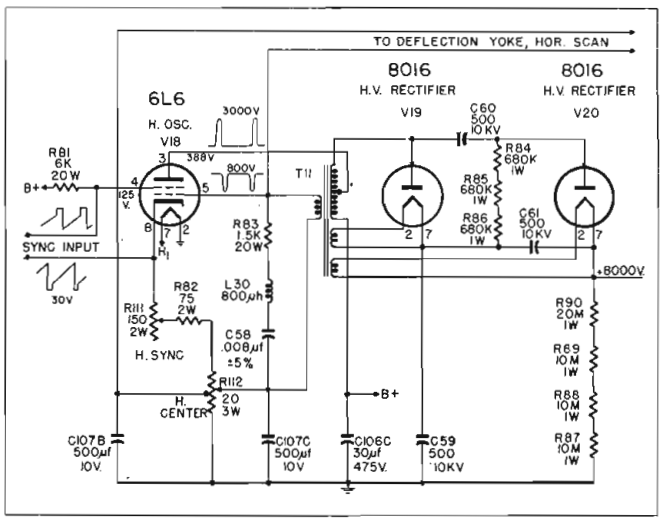
Since then, Farnsworth engineers have fully developed these principles of deflection-high-voltage circuits in what has been termed the "Beam Relaxor," incorporated in Farnsworth television receiving instruments and in the Utiliscope, a wired television system for industrial purposes. Advantages offered by such a circuit include simplicity and dependable operation, combined oscillator and high-voltage generator in one tube, light weight, compactness and poor voltage regulation curve (reasonable safety factor to the serviceman in the event of personal contact).

In analyzing its function, it must be borne in mind that the Ep-Ip characteristics of the beam power 6L6 tube show a sharp "knee," as inspection of these curves will indicate.

Now consider that the grid-cathode voltage is highly negative, the result of high induced voltage in the grid winding of T11 during retrace of the scanning spot. This initial condition is chosen purely because some single portion of the cycle must be chosen. Plate current has been cut off and the magnetic flux of the transformer is collapsing, inducing high potentials to the grid (negative) and to the plate (positive). After the field has collapsed and the induced negative potential on the grid has decreased, the tube begins to conduct current, the rate of flow of which is limited by (1) the plate resistance and (2) the inductance, self and reflected, in the plate winding of the transformer. The flux is now building up and a voltage of reversed potential is being applied to the grid.

This positive potential causes a saturation of the plate current, the saturation being accentuated by low potential upon the plate (most of the supply potential now appears across the inductance). As time progresses and saturation occurs, three factors apply to overcome plate-current saturation: (1) Plate potential rises due to decreased potential across the inductance, (2) positive induced grid-potential decreases (rate of change of flux falls), and (3) negative potential, a function of the cathode resistor, becomes dominant at the grid.

We return to the knee of the characteristic curve and find the tube to be no longer saturated and in an "operative" condition, whereupon an oscillation starts due to the plate-grid feedback circuit of T11. In this oscillation, a negative induced potential is applied to the grid which, being cumulative, drives the grid to



Schematic of the Farnsworth horizontal deflection circuit, termed "Beam Relaxor", and incorporated in TV receiving sets and also in the Utiliscope, industrial wired television system

plate current cutoff. We have thus completed the cycle. Actually, a number of curves are involved, due to the varying grid potential.

A tube not of the beam power type would operate in a similar manner, but since it is not characterized by the sharp knee, the retrace time would not be as rapid and induced potentials not so great. In addition, individual pulses of its free oscillation would not be as consistently evenly spaced, leading to less positive synchronization.

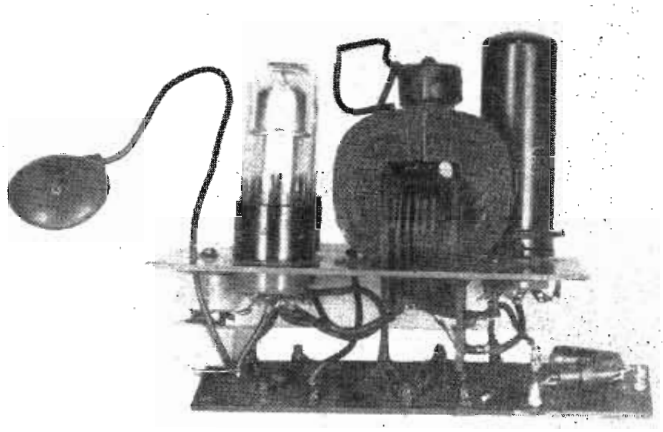
The free-running speed, and therefore synchronization, is determined by R111, the cathode resistor. This, producing negative grid potential, determines at what time the positive (induced) potential shall have decreased sufficiently in order that saturation is no longer existent.

Across a portion of the total cathode resistance, R112, appears a potential which is a function of the average plate current and which is used for centering the picture on the viewing tube screen. One side of the deflection coil being center-connected to R112, the dc potential applied to the other side is of either positive or negative polarity. Thus, the picture may be shifted to the right or to the left upon the screen. In order that the signal path shall not be affected by R112, bypass is provided in C107B and C107C.

Scanning potentials which drive the horizontal scanning coils are taken from the grid winding of T11. Also across this winding are connected R83, L30 and C58 which effect linearity of sweep in the horizontal direction and, should at any time the horizontal scan be non-linear, these three components should be inspected for defect.

V19 and V20 are diode rectifiers whose filaments are lighted by a portion of the energy developed in the beam relaxor circuit. These tubes are very conservative in filament power requirements, drawing only 50 milliamperes.

The rectifier system comprises a voltage-doubling circuit of the cascade type. With approximately 6,000 volts of pulse potential being developed across the extremities of the high voltage winding of



Complete Beam Relaxor unit as it is installel in television receivers anl the Utiliscope

T11, the output of the supply is 12,000 volts at no load! Beam and bleeder currents drop this to 8,000 volts in normal operation. Such a regulation curve assures some margin of safety to the serviceman, should he inadvertently come in contact with a high potential wire. The effect is approximately that of an automobile ignition supply.

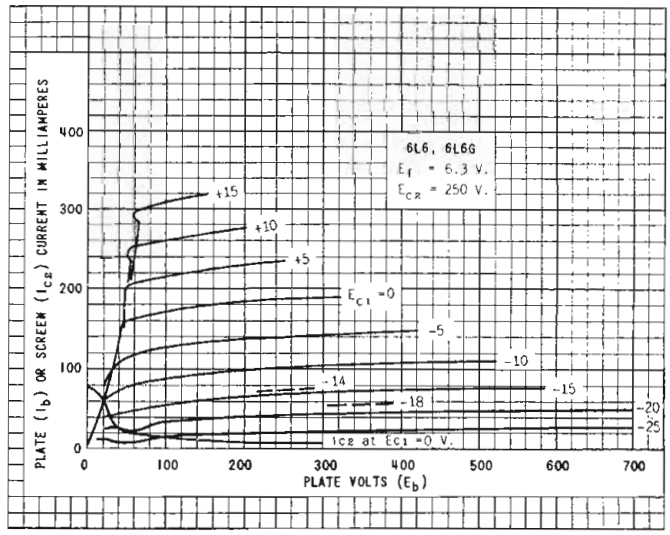
Inspecting the schematic, it can be seen that a positive pulse passes through V19 to charge C59 to approximately the peak pulse potential. In the absence of a pulse, the plate of V20 assumes this same potential through R84, 85 and 86 (6,000 volts). The oncoming pulse then passes through C60 to present to V20 an additional 6,000 volts for a total of 12,000. Thus, C61 assumes a charge of about 6,000 volts. Since C59 and C61 are in series, a total of 12 kilovolts is available at the output at no load.

Such a system might use a single simple rectifier or a cascade multiplier of three, four or more stages to achieve potentials of any reasonable magnitude.

Careful analysis of the system might pose a question concerning stability of the linearizing network. It has been determined that the power dissipated in the resistor, R83, is six watts. In the normal ambient temperature found within a cabinet, a ten-watt resistor would be just within its rating of about seven watts. A large safety factor is provided by the choice of a 20-watt resistor. No variable in this network has been observed in practice.

Corona naturally posed a serious problem in the design of the transformer, T11. However, by careful attention to sharp projections on the iron core, to the windings and coil form, no evidence of corona is present. The entire transformer-bleeder assembly is dipped in Insulex.

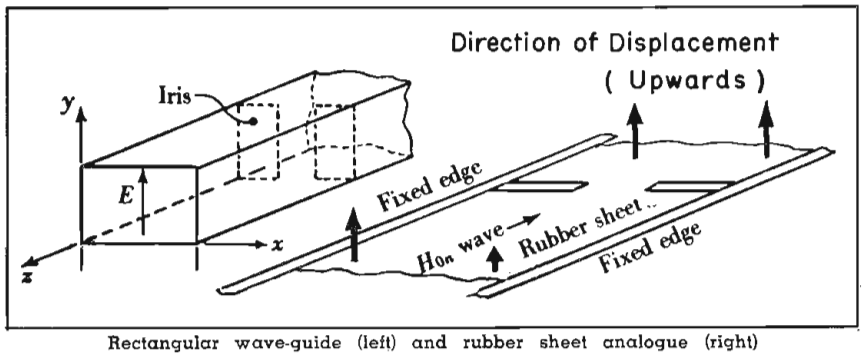
Numerous extended life tests and use in the Utiliscope and television receivers have proven the Beam Relaxor to be dependable and consistent in operation.



Family of curves of the 6L6 beam power tube showing the characteristics "knee" referred to in text

Survey of World-Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad



Rectangular wave-guide (left) and rubber sheet analogue (right)

Rubber Strip Analogy for TE Wave in Rectangular Guide

R. E. B. Makinson, University of Sydney, Australia, (Journal of Scientific Instruments, London, England, July, 1947, pp. 189-190).

The deflections of a stretched rubber sheet clamped at the edges, as illustrated, obey the same equation as the electric field of an H type electromagnetic wave in a rectangular waveguide. There is only one component of the electric field; it points in the direction indicated on the drawing. For equivalent boundary conditions, the vertical displacement of the rubber sheet surface is proportional to the intensity of the electric field.

A 4 ft. by 1 ft. rubber model was clamped at the edges by a wooden frame and excited at one end by a small geared dc motor and crank. The crank oscillated the center of a narrow strip of rubber fastened across the end of the stretched rubber sheet. As the motor speed was increased gradually, the sheet suddenly began to oscillate at the frequency corresponding to the cut-off frequency. The rubber waves may be reflected from a clamped end to form stationary waves; by placing sawdust on the sheet, the oscillations are made clearly visible.

The effects of a slit parallel to the electric field, or of a bend, branch or stub which does not interfere with the direction of the electric field can be studied. Waveguides tapered in the xz plane can be simulated. Blocks of dielectric uniform in the direction of the electric field are equivalent to loading or thickening of the rubber sheet over the corresponding area.—JZ

Electric Strength of Air in CM Range

R. Cooper (The Journal of the Institution of Electrical Engineers, London, England, Part III, September 1947, pp. 315-324).

A method and apparatus is described for the measurement of the electric strength of air at 3.06 and 10.7 cm. Pulses of one microsecond duration and a repetition rate of 400 per second are propagated along a coaxial line for 10.7 cm or a rectangular waveguide for 3.06 cm, each provided with a narrow section where the breakdown occurs. Standing waves are introduced by inserting a discontinuity in a further section of the line or guide which reflects part of the wave. The average transmitted power is indicated by a water calorimeter.

Sparks are first observed when the electric field reaches about 70% of the breakdown value for direct voltages. This value is independent of irradiation, frequency and gap length. However, the frequency of the sparks increases faster with a further increase of voltage if the gap is irradiated. Measurements at reduced pressure are also reported.—JZ

Speed Gage for Fast Ions

W. Altar, M. Garbuny, and J. W. Coltman (The Physical Review, September 15, 1947, p. 528, paper read at the meeting of the American Physical Soc. at Montreal on June 19-21, 1947).

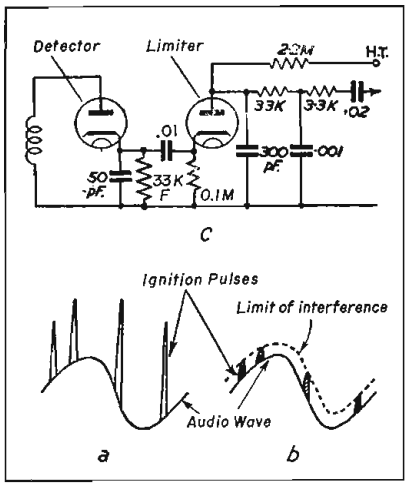
It is intended to measure the speed of highly accelerated ions. For this purpose the ion beam is modulated with 70 mc and, after acceleration, is passed through two gaps. Voltages from both gaps simultaneously excite a high-Q cavity resonant at 70 mc. If the transit time between the two gaps is exactly an odd multiple of one half period, no oscillations will occur in the resonant cavity. From the transit time and the distance between the two gaps, which is known with great accuracy, the accelerating voltage can be determined to 0.1% for a beam current intensity of 10^{-6} amperes.—JZ

Noise Suppression in Television Receivers

W. I. Flach (Electronic Engineering, London, England, October 1947, pp. 326-327).

Short pulse interference, for instance ignition noise, is particularly objectionable in television sound reception. Several methods to eliminate the short pulses, see figure a, were tried and the system illustrated in figure c was found most effective.

The object is to discriminate between the very short interfering pulses and the wanted audio signal. Therefore, a wideband rf channel (80-100 kc) is provided



Circuit for the elimination of srort-pulse interference in television receivers

and the time constant (1.6×10^{-6}) of the diode detector is small; the sharp pulses are passed in their original shape to the limiter which discriminates against short pulses.

For audio frequency signals, the limiter plate voltage will follow the cathode voltage of the rectifier. However, when an interference pulse is superimposed on the audio wave, the limiter plate cannot follow it closely, because of the capacitor connecting it to ground; only a slight overall increase of the audio signal amplitude will result from the short interference pulse, as illustrated in figure b. The two cathodes are isolated by a capacitor for dc to prevent biasing of the detector by the limiter bias. This circuit is incorporated in the Pye postwar receivers.

In a modification used by Murphy Radio, the limiter plate voltage is taken from the rectified audio output of the last amplifier tube. The average plate current of the limiter then varies in accordance with the signal strength, and the limiter action is just as effective on quiet passages as it is on loud passages.—JZ

Wheatstone Bridge in Computers

W. Krasny Ergen (The Review of Scientific Instruments, August 1947, pp. 564-567)

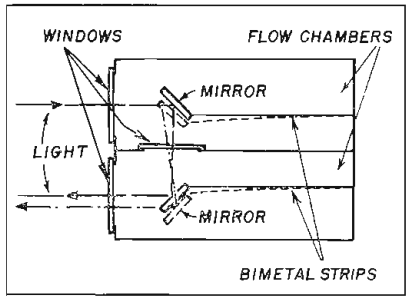
The value of an unknown quantity, $x = ab/c$, can be computed by making the resistors in three arms of a Wheatstone bridge proportional to a, b, and c, respectively, adjusting the bridge for balance either manually or by a servo-mechanism, and reading the value of the fourth resistor off a calibrated scale. The general problem of solving quadratic equations by means of a Wheatstone bridge is investigated. Each bridge arm may be made up of a series of separately adjustable resistors. It is established which specific group of quadratic equations can be solved by this type of bridge.

Extension to higher order equations requires parallel arrangement of resistors. One such bridge for the solution of an equation of the fourth order intended for a Shoran system is described.—WZ

Bimetallic Thermometer for CM Power Measurements

J. Dyson (Journal of Scientific Instruments, London, England, August 1947, pp. 208-210).

The radio frequency power developed, for example, by a magnetron is measured by the change of temperature of a stream of water cooling the load. Experiments are reported to use two bimetal strips arranged as shown in the drawing to indicate the temperature difference in the two flow chambers.



Bimetallic thermometer for measuring CM power

The light path performs the subtraction of the two temperatures. While an equal temperature variation of both water streams will cause a parallel displacement of the beam (dotted lines) the change in only one chamber will result in a change in direction of the reflected beam which is indicated on a scale.

Details of the optical arrangement and of the carefully designed flow chambers are given. The instrument as constructed gives a full-scale reading of about 2.5 deg. C, and the scale can be read to about one part in 500 of full scale deflection; this does not represent the limit of sensitivity. Linear deflection-temperature dependence is obtained.—JZ

Effect of Bending on Selenium Rectifier Disks

P. Selényi and N. Székely, Rectifier Laboratory, Budapest (Nature, London, England, August 9, 1947, p. 197).

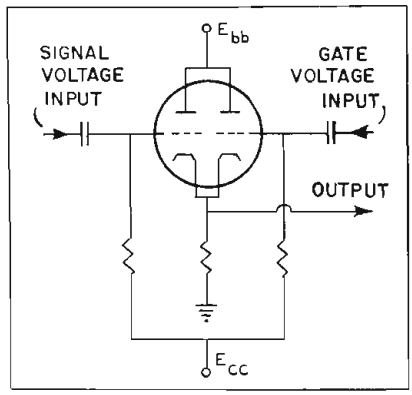
Bending a selenium rectifier disk causes a temporary increase of the current flow in both directions. In the reverse direction, a momentary increase of 300% has been observed, while the increase in the forward direction does not exceed 10%. The effect occurs whether the selenium layer is on the concave or on the convex side. The stronger the bending, the greater the effect. The bent disk loses its current carrying capacity first rapidly then slowly, and after several minutes reaches a constant value. The effect depends on temperature and voltage. An explanation of the effect is presented.—JZ

Cathode-Follower Gate Circuit

J. Kurshan (Review of Scientific Instruments, September 1947, pp. 647-649).

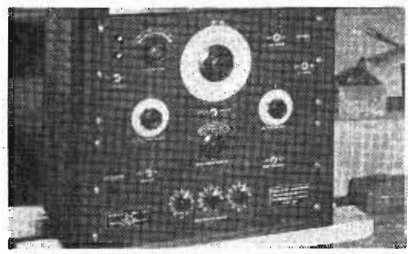
Two triodes connected as cathode followers and operated in parallel with a common cathode resistor, as illustrated, function as a gate circuit. A negative signal pulse affects the output only slightly unless a negative gate voltage simultaneously cuts off the other unit. In the latter case, that part of the signal pulse which coincides with the gate voltage pulse is reproduced in the output.

Originally designed for a special military application, the circuit may be used to isolate the synchronizing signals in a television receiver, to separate the picture signal from the sound signal where a common carrier is used, etc.—JZ



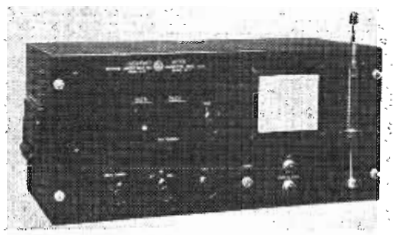
Cathode-follower gate circuit

New Lab and Test Equipment



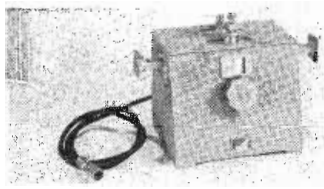
Inductance Bridge

Model 220 incremental inductance bridge permits selection of either the Hay, Owens, or Maxwell circuits by means of a rotary switch. It provides self-inductance, leakage inductance, and incremental inductance measurements regardless of Q with an accuracy of better than 1% in a range of 1 millihenry to 2000 henrys. Any inductance between 1 millihenry and 20 henrys can be tested with any value of superimposed dc between 0 and 1 amp. From 20 to 200 henrys the maximum current is limited to 250 ma, and over 200 henrys to 25 ma. Test voltage is a 60-cycle, .01 to 300 V rms, ac source. Model 220 may be used in conjunction with Model 350 dc power supply and ac signal control.—**Industrial Transformer Corp., 2540 Belmont Ave., New York 58.**



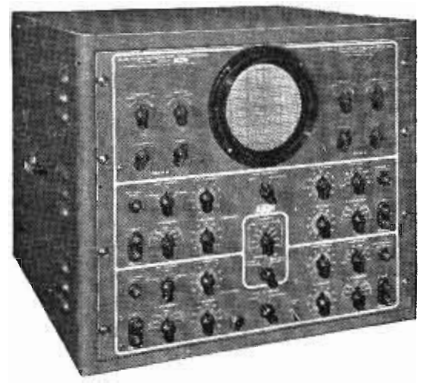
30-500 MC Frequency Meter

Model S-5 frequency meter is for checking transmitters operating between 30 and 500 mc. A crystal standard in a temperature controlled oven is used in conjunction with and electron-coupled interpolation oscillator which is assembled on a 3/16 in. aluminum plate for mechanical stability and is temperature compensated. The meter is supplied hand-calibrated for one, two or three frequencies in the range from 30 to 500 mc with an overall accuracy of .0025%. High mixer sensitivity permits use of the instrument without the need of direct connection to the transmitter. A panel mounted telescoping antenna serves as a pick-up. The steel cabinet may be removed and the instrument used in a relay rack.—**Browning Laboratories, Inc., Winchester, Mass.**



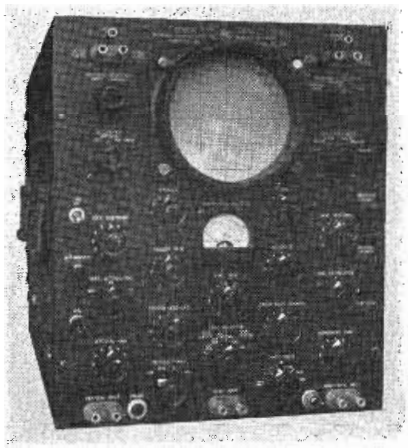
Standing Wave Indicator

This standing wave indicator is designed to operate from 23,000 to 27,000 mc, and has a number of special mechanical features to provide very high precision. The main block and waveguide extremities are machined from a solid steel block. A fixed control knob actuates the movement of the traveling carriage, which rides on ball bearings, by means of a friction drive. Two adjustable screws on the probe section control the depth of the probe penetration into the waveguide and the tuning of the coaxial section. A type 1N26 crystal detector connects through the waveguide auxiliary chamber to a Baby "N" connector. Scale calibration is in millimeters, with a vernier permitting readings down to 1/10 mm.—**Electronics Div., DeMornay Budd, Inc., 475 Grand Concourse, New York 51.**



Dual-Beam Oscillograph

Type 279 dual-beam cathode-ray oscillograph has a two-gun Type 5SP-A cathode ray tube containing two separate, independent electron guns. There are separate controls for intensity, focus, and X-, Y- and Z-axis modulations. Identical linear time bases are provided for each beam, the sweep generators having continuous sweep frequencies of 2 to 30,000 cps. Single sweep is also available for each beam, with automatic beam control to extinguish the spot except during the active sweep time. Provision is also made to apply one of the time base generators to both sets of horizontal deflection plates simultaneously. Correction circuits assure exact superpositioning of both traces. Balanced deflection amplifiers are used for each of the X- and Y-deflection systems. The response of the Y-amplifiers is flat to dc and is 3 db down at 150 kc. The deflection factor of all amplifiers is approximately 1 V dc/in. A built-in voltage calibrator can be switched into either Y-amplifier at any time. For photographic application, the Type 279 is so designed that it may be used with both the DuMont Types 271-A and 314 oscillograph record cameras.—**Allen B. DuMont Laboratories, Passaic, N. J.**

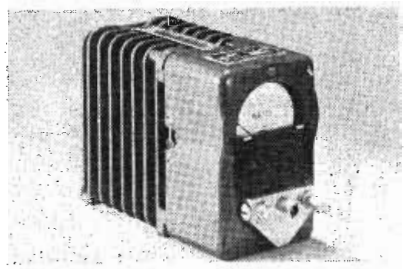


General Purpose Oscilloscope

Model OL-15A omni-purpose 5-in. oscilloscope is designed to provide versatility of operation, dependability, minimum weight and bulk, and faithful presentation of high harmonic content waves. The response curve of the vertical amplifier is linear and without positive slope from 10 cycles to 1 mc to accommodate any type of externally generated sweep voltage. Sawtooth sweep range is from 5 cycles to 500 kc with synchronizing sensitivity permitting sync and viewing of 10 mc rf sine waves. Triggered sweeps of 0.2, 0.5, 1, 5, 20, and 200 microseconds per in. may be initiated by the internal trigger generator or by external pulses. Sweeps and internally generated trigger are phasable with respect to each other. Total weight of the instrument including power supply is 95 lbs.; dimensions are 15¾ x 12¾ x 19¾ in.—**Browning Laboratories, Inc., Winchester, Mass.**

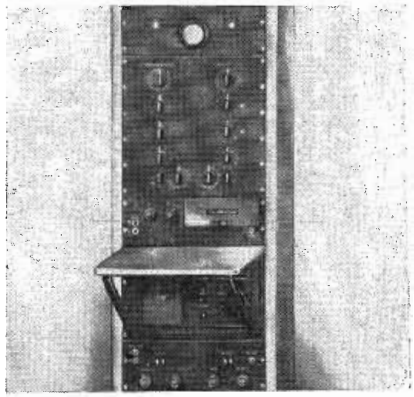
Variable Marker Oscillator

The Mega-Marker is a precision variable marker oscillator covering the ranges of 19 to 29 mc for the television IF band, and for the FM IF band (10.7 mc) a crystal oscillator is incorporated. Accuracies of 0.02 mc may be read off because more than 12 in. of calibrated scale length is provided. Accurate check points are obtained through crystal controlled oscillator.—**Kay Electric Co., 34 Marshall St., Newark, N. J.**



VHF-UHF Wattmeters

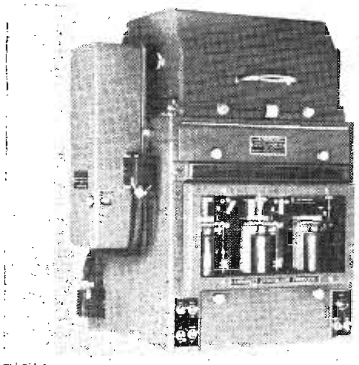
Direct-reading Termaline instruments are designed for power measurements of transmitters in the 30 to 500 mc, 1 to 500 watt ranges. Essentially absorption type wattmeters, the units consist of: (1) a coaxial resistor with an input resistance of 51.5 ohms over a frequency range from dc to 1000 mc. (2) dual or triple voltmeter cartridges, utilizing the 1N21B crystal diode. (3) a dc meter with scales reading in terms of rf power input to the coax. resistor. Accuracy is within ±2%. Model 61 is a fully portable instrument with a dual power range from 0-20 and 0-80 watts. Model 67 is a test bench instrument, which covers the power range of Model 61 and has an additional range of 500 watts full scale. —**Bird Electronic Corp., 1800 East 38 St., Cleveland 14, Ohio.**



Alternating Voltage Comparator

The Arma alternating voltage comparator permits comparison and measurement of ac voltage and phase angle with an accuracy of 1 part in 50,000 in the frequency range of 50 to 1250 cps. The range of applications of the comparator includes measurement of vectorial ratios essential to computer development; transformation ratio of transformers and networks; power factor and Q of transformers, resistors, capacitors, and inductors.—**Arma Corp., 254 36th St., Bklyn. 32, New York.**

TELE-TECH INDEX FOR 1947 ON PAGE 92

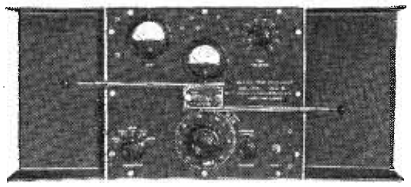


Automatic Recording Oscillograph

Designed for automatic recording of unanticipated faults or for staged system testing, type RS-9 oscillograph will automatically record as many as 100 transients without attention and over extended time intervals. Upon occurence of a fault, the instrument will start and reach full recording speed in 1/500 second. When the fault is cleared, it will stop recording and reset automatically. Using 12 type OA-2 galavanometers, the unit records up to 12 quantities simultaneously. These may be neutral current, phase currents and voltages, and power. The oscillograph can be used as a portable instrument or for permanent switchboard installation with back-of-board connections. The record magazine will accommodate a 200-ft. roll of sensitized paper, 10 in. in width.—**Hathaway Instrument Co., 1315 South Clarkson St., Denver 10, Colo.**

Telephone Service Meter

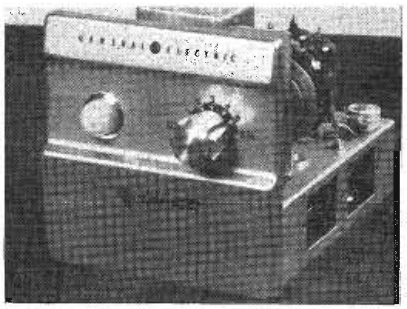
Model 614-A telephone service meter, designed specifically for telephone work measures dc and ac voltage and current, dc capacitance and may also be used for approximating an artificial load. Auxiliary scale provides an inductance range of 1 to 100, 1000 and 10,000 henries and an ac resistance range of 25-3 megohms. Meter operates from a self-contained 6 V dry cell. Case, 9⅝ x 8⅛ x 6 in. has separate compartment for test leads and spare battery.—**Shalleross Mfg. Co., Collingdale, Pa.**



Marker Test Oscillator

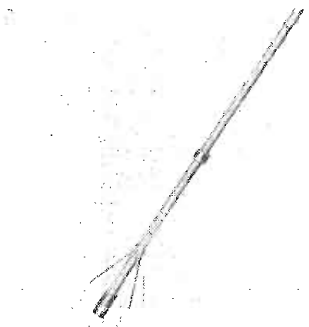
Designed to serve as accurate generator for routine checking of marker receivers by semi-skilled personnel, Model ES436 marker oscillator tester utilizes a crystal controlled oscillator followed by two frequency triplers to provide a final frequency of 75 mc. Fifty per cent modulation is provided at 400, 1300, and 3000 cps, selected manually or automatically in sequence by means of a motor driven switch. The 3000-cycle modulation is repeated twice, first at full output, followed by a signal 6 db lower for threshold observation. A gear-driven coaxial attenuator provides attenuation up to 85 db below 0.5 V. Coupling to the aircraft antenna is made by means of a collapsible dipole antenna. A coaxial line assembly is also furnished for coupling directly into the receiver or antenna line. The unit is powered by self-contained batteries.—**The Pioneer Electric & Research Corp., Forest Park, Ill.**

Communications Components



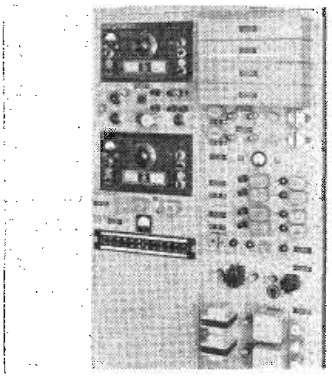
Personal Plane Transmitter

Type AT-3A VHF personal plane transmitter, for tower and radio ranges operates on any of the six vhf radio channels for non-scheduled aircraft. Weighing only two lbs 9 oz. the unit provides a power output of one watt, operating from a 12 V battery. It has 100% modulation and A3 emission. Dimensions are 4⅜ in. high; 4¼ in. wide; and 5 11/16 in. deep.—**G-E Transmitter Div., General Electric Co., Electronics Park, Syracuse, N. Y.**



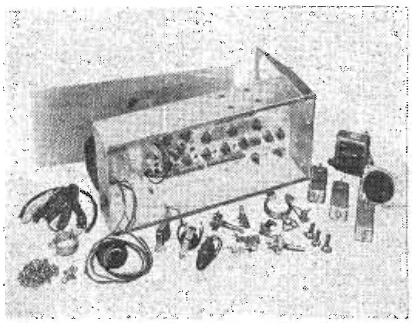
VHF Mobile Antenna

Type MS-171 antennas are vhf units covering the airline and railroad radio communications frequency ranges. The vertically polarized, full-wave broad-band antennas have a low angle of radiation and appreciable vertical gain. Type MS-171A covers the airline range of 122 to 136 mc, while type MS-171B covers the mobile communications range of 152 to 162 mc. The units consist of a vertical length of 1½ in. standard weight steel pipe and six ⅜ in. hexagonal steel rods threaded into the vertical member at an angle of 30°. A gain of 2.6 db over a half-wave dipole antenna is obtainable. Standing wave ratio for the MS-171A is no higher than 2:1 throughout its frequency range and for the MS-171B no higher than 1.7:1 in its range, when standard RG-8/U, 52-ohm coaxial cable is used.—**Bendix Radio, Div. of Bendix Aviation Corp., Baltimore 4, Md.**



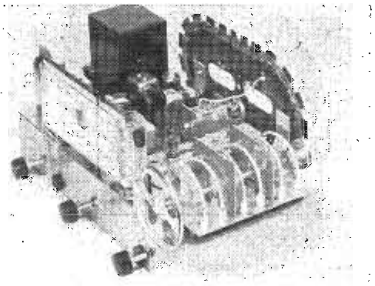
Frequency Shift Receiver Terminal

Type A-4601 dual diversity receiver terminal accepts a frequency shifted signal from two communications receivers and converts it either to tone, neutral or polar dc, keyed in accordance with telegraphic intelligence. The recording device, may be radiotype teletype, or a high speed telegraph tape recorder. A crystal oscillator and BFO unit provides stable high frequency and beat frequency injection voltages to both receivers. The audio response from each receiver is thus identical in frequency. The input filters have a range of 1850 to 3250 cycles. The response is down 70 db at 1700 cycles, and 60 db at 3400 cycles. A frequency shift between 600 and 900 cycles may be used. The three stage limiter amplifier has a constant output with inputs in excess of ten microwatts. All amplitude modulation is removed in these limiter stages. The discriminator filters are essentially channel filters, separately passing the high and low audio frequencies which correspond to mark and space frequencies. Mark and space frequencies are separately amplified rectified, and added differentially in the discriminator-amplifier-rectifier units. The dc output of the discriminator-rectifiers is mixed in double diodes so connected that the cleanest signal is used for keying, and the poorer signal rejected. A wave-shaping amplifier is provided in the terminal for a clean square keyed tone. The oscillator is conventional in design, and furnishes an 1800 cycle tone.—**Heintz & Kaufman, Ltd., 50 Drum St., San Francisco.**



Television Kit

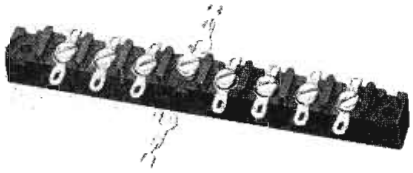
A low-cost simplified television kit has been made available for demonstration and instruction. A 3-in picture tube with an accelerating voltage of 1000 is utilized. Size has been held to a minimum by using miniature tubes. Six stations may be tuned in between 44 and 88 mc.—**Espey Mfg. Co., Inc., 528 E. 72 St., New York 21.**



AM-FM Tuner

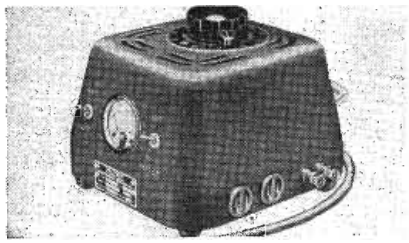
The "Approved" AM-FM tuner model 311 provides a tuning range of 540—1650 kc on AM and 88—108 mc on FM. Sensitivity of the unit is 10 microvolts/meter on FM, 20 microvolts/meter on AM; FM bandwidth is 150 kc, AM bandwidth 7.5 kc. Frequency drift is negligible after 10 minutes. The separate FM section has a tuned stage of RF (6AG5) followed by a tuned det.-mixer-oscillator (6J6), two IF amplifiers (6SH7's), 7C7 limiter and 6AL5 discriminator. FM-tuning is accomplished by means of arc-shaped tuning rods having a small inductance attached at the end. The AM section is standard. A 300-ohm line, Di-pole terminated antenna is required for FM reception; a built-in loop is provided for AM. —**Approved Electronic Instrument Corp., 142 St., New York.**

Parts for Design Engineers



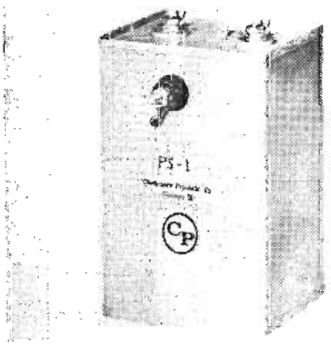
Locking Terminal Block

This new block is provided with lock-in solder-type spade lugs which are recessed into the body of the device. When the binder screws are tightened, lugs are held rigidly in place against a shoulder of the plastic material forming the block. Factory assembled in any number of terminals from 1 to 18.—**Curtis Development & Mfg. Co., 1 North Crawford Ave., Chicago 24, Ill.**



AC Power Supplies

Two new Voltbox ac power supplies, Model UC1M and UC2M, contain in one cast-aluminum case a Powerstat variable transformer, a voltmeter accurate to 2%, three output receptacles, binding posts, "on-off" and "line-load" switches. Type UC1M for use on 115 V, 50/60 cycle ac, has a continuously adjustable output voltage from 0-135 at a maximum curent of 7.5 amps. Type UC2M, for 230 V ac, can be continuously varied from 0 to 270 V with a maximum current of 3 amps. For users who already have a Powerstat variable transformer type 116 or 216, two Voltbases are available which have all the features of the Voltbox with the exception of the variable transformer and "line-load" switch. The transformer can be mounted by means of tapped holes provided in the base.—**The Superior Electric Co., 6106 Laurel St., Bristol, Conn.**

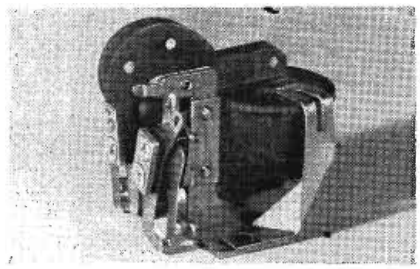


Power Supplies

High voltage, low-current dc power supplies are available in two models: Hivolt PS-1 and PS-2 provide 2400 V dc from the 118 V, 60 cycle, ac supply. Type PS-1 is designed to charge capacitors for use in photoflash and spectrographic analysis equipment. The PS-2 is intended as high voltage supply for oscilloscopes, television receivers, etc. The units weigh 2¼ lbs., and are hermetically sealed.—**Condenser Products Co., 1375 N. Branch St., Chicago, Ill.**

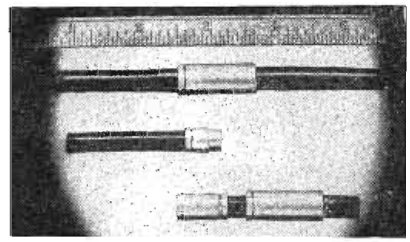
Coaxial Line Relay

Designed for SPDT switching of 50 ohm coaxial lines Advance series 7200 ac relays, when used with RG-8U coaxial cable, have a standing wave ratio of 1.02. They are provided with an inspection port for easy access to internal ¼ in. silver contacts. The units are equipped with 3/16 in. silver external contacts for simultaneous control of indicator lights and other associated ciruits.—**Advance Electric & Relay Co., 1260 West 2nd. St., Los Angeles, Cal.**



Miniature 400 cycle Relay

Available in standard mounting or Stratopaxed, Hy-G 400-cycle aircraft relay has a wide operating voltage range and high stability against vibration and shock. The relay is capable of operation over a range from 85 to 150 V. with coil voltages ranging from 25 to 400 V. It weighs 3½ oz. with the standard mounting and 10½ oz. Stratopaxed.—**Cook Electric Co., 2700 N. Southport, Chicago 14, Ill.**

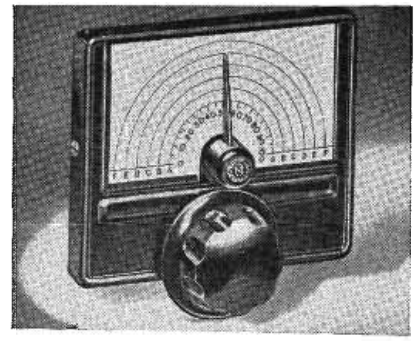


Miniature Connector

The miniature connector with an overall diameter of 23/64 in. and overall length of 1¼ in. is designed for either RG 58/U or RG 59/U cable. The unit has a voltage rating of 500 V peak wih low loss. No special tools are required for assembly of the solderless connector. The separator force of the quick disconnect lock is ample for normal requirements. A panel mounting plate is optional.—**H. H. Buggie & Co., 2145 Madison Ave., Toledo 1, Ohio.**

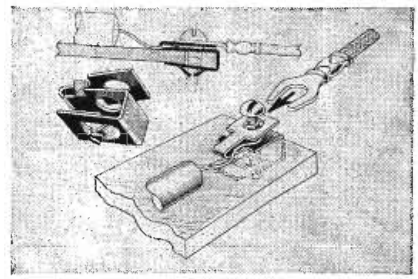
High-Voltage Paper Capacitors

Similar in construction to the Aerovox paper tuhulars available in 400 to 1600 V ratings, these series 84 extended voltage additions are now available in 2500, 3500, 5000, 7500 and 10,000 V dc working, and in capacitances from .001 to .05 mfd. Units have bare tinned copper pigtail leads waxed ends and protective jackets.—**Aerovox Corp., New Bedford, Mass.**



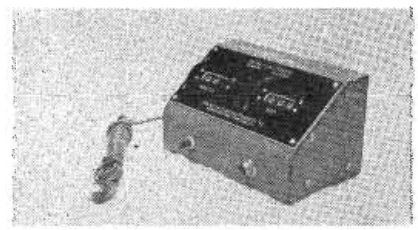
Instrument Dial

Intended as companion unit to its standard model, this midget vernier multi-scale instrument dial measures only 3¼ in. x 4 in. It has a vernier ratio of 8 to 1 and is furnished in black art metal.—**James Millen Mfg. Corp., Malden, Mass.**



New Fastener

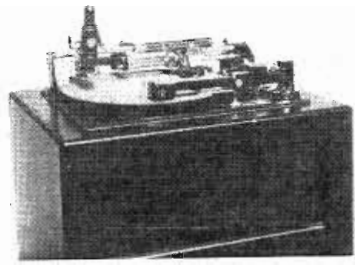
A new type Speed Nut has recently been developed for use on electrical terminal boards to facilitate the inter- connecting of capacitors and resistors. The "U" shape of the nut slips over the terminal board and holds itself over clearance hole. A screw is then partially run down through the SPEED NUT and board to anchor wires in place, one at a time, under the partially tightened nut until all are attached. Screw is then tightened only once to complete the entire connection. Leads with a spade terminal are placed directly under the head of the screw. Single-strand pigtails from capacitors and resistors are looped under the top member of the nut, around the screw, and positioned by the turned-up tabs at the bend. Any one of the leads can be removed from the terminal without disturbing the others.—**Tinnerman Products, Inc., 2111 Fulton Road, Cleveland 13, Ohio.**



Film Counter

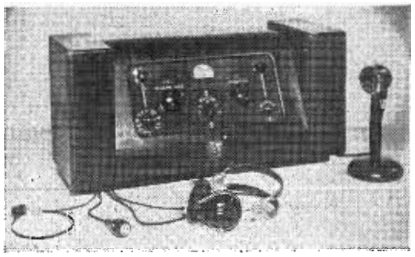
Capable of measuring elapsed time in fractions of a minute and in ft. of film passed, this film counter is designed for use in motion picture viewing, dubbing, recording, narrating, etc. The unit, which can be located remotely from a projector, or recorder, uses two precision counters and two synchronous motors. It can be started and stopped any number of times during a thousand ft. reel and will track eorrectly. Time or footage counter can be reset separately. The standard model is for operation on 110 V, 60 cycles, ac, and for use with 35-mm film.—**Arlington Electrieal Products, Inc., 18 W. 25 St., New York 10.**

Sound and Recording Equipment



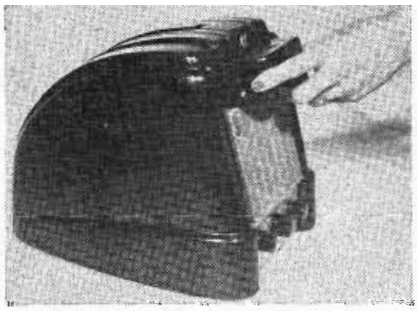
Console Recorder

Fairchild Unit 539 console recorder is in the moderately-priced field. A synchronous drive meets requirements for direct lateral recording on discs up to 17¼ in. at 33.3 rpm by worm-and-gear reduction direct from the center, and at 78 rpm through a friction-ball-race step-up. One lead screw permits selection of 96, 112, 120 and 136 lines per inch, in or out. A microscope with light is mounted on the lathe mechanism. Unit 541 magnetic cutterhead and unit 542 lateral dynamic pickup are standard equipment. The recorder is also available as portable instrument.—**Fairchild Camera and Instrument Corp., 86-06 Van Wyck Blvd., Jamaica 1, N. Y.**



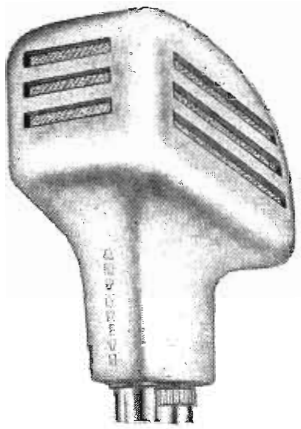
Hearing Loss Test Equipment

Through use of a meter-calibrated speech circuit, model 50-E audiometer controls the level in speech tests to permit hearing loss measurements for both bone and air conduction. The range for bone conduction measurements in the middle frequencies extends from 512 to 4096 cycles. A calibrated masking control regulates equal masking effect at all frequencies. A "malingering" control eliminates the need for additional accessories.—**The Audio Development Co., 2833 13th Ave., South, Minneapolis 7, Minn.**



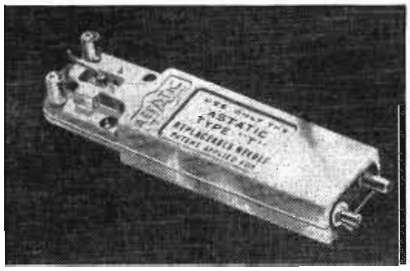
Wire Recorder

Utilizing a "plug-in" cartridge, the RCA wire recorder records up to one-hour. The cartridge, which contains two lengths of wire wound on four spools, permits immediate playback without rewind. An indicator light shows the correct level for recording. Any portion of the record can be located by means of a timing device calibrated in minutes and fractions. The unit automatically erases previous recordings as new ones are made. Frequency range extends from 100 to 5000 cycles. The complete unit, consisting of amplifier, constant-speed motor drive, 5-in. PM speaker, and microphone, weighs less than 25 lbs. and operates on 110 V, 60 cycles, ac.—**RCA Victor Div., Radio Corp., of Ameriea, Camden, N. J.**



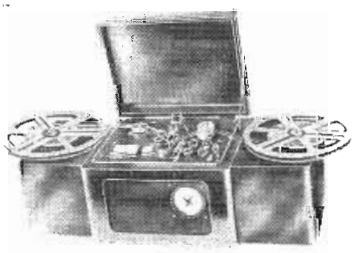
Velocity Microphone

The Amperite ribbon microphone is for either close talking or distant pickup. It has a frequency respouse range of 50 to 11,000 cps within ±2 db with a harmonic distortion of less than 1%. Output of the unit is —62 db; angle discrimination is less than 5% in the range from 60 to 10,000 cps. Two models are available high-impedanee model RBHG, and model RBLG with an impedance of 50-200 ohms. The microphone is supplied with cable connector and a switch.—**Amperite Co., Inc., 561 Broadway, New York 12.**



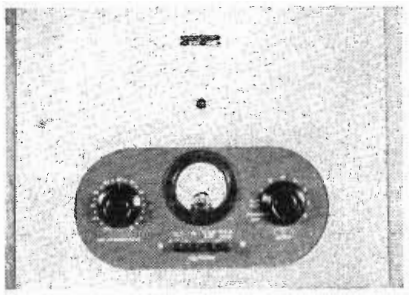
Phono Cartridge

Type "LT" crystal phono cartridge, a low-needle talk reproducer in the low-price field, has an output voltage of 1 V avg. at 1,000 cps. Cut-off frequency is 4,000 cps.; minimum needle pressure ¾ oz. The cartridge is provided with a type **"T"** needle with "electro formed" precious metal playing tip.—**The Astatic Corp., Conneaut, Ohio.**



Tape Recorder

Model 900D Maguetape recorder provides for eight hours of recording. The unit permits a choice of response ranges from 70 to 9000 cycles for 3¼-hour recording at a tape speed of 7½ in. per second; 80 to 5000 cycles for 6-hour recording at a speed of 4 in. per second; and 100 to 3500 cycles for 8-hour recording at 3 in. per seeond. By utilizing an optionally available built-in program timer, 32 quarter-hour program hours may be recorded automatically on a single reel. A constant speed drive keeps speed variations of the tape at less than 0.2% during operation.—**Magnephone Div., Amplifier Corp. of America, 396 Broadway, New York 13.**

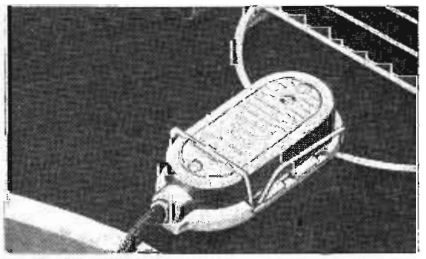


Recording Amplifier

Presto 92-A recording amplifier provides a power output of 60 watts, with distortion less than 1½% at 50 watts output. Gain is 83 db for 500-ohm input and 68 db for 15,000-ohm input bridging a 500-ohm line. One meter and a selector switch permit indication of output level and plate currents of each of the tubes. The output stage consists of four 807's in push-pull parallel. Frequency response is flat within 1 db from 20 to 17,000 cps. Four pushbuttons select any of the following recording characteristics: flat response (20 to 17,000 cps); 78 rpm lateral; NAB lateral; and NAB vertical. Front panel of the 92-A is removable, giving access to circuits, while tubes may be reached from the rear of the relay rack. The unit operates on 110 V, 50-60 cycles, ac. —**Presto Recording Co., 242 West 55 St., New York.**

Replacement Speaker

Three new radio replacement speakers, Models SE5S6 and SE7Y6 are available in five, six and seven inch sizes. Each electrodynamic unit incorporates a 3-ohm voice coil and a 4-ohm field coil. Speaker mountings are square.—**Utah Radio Products, Huntington, Ind.**



Contact Microphone

A new contact pick-up microphone (model 805) can be used on all vibrating musical instruments. Frequeney response 40 to 8000 cps; output level: .1 to 1 V, depending on type of instrument. The generating element is an inertia-type crystal, sealed against moisture and acoustic feedback.—**Electro-Voice, Inc., Muchanan, Mich.**

WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by Tele-Tech's Washington Bureau** ★ ★ ★

ARMED SERVICES RECOGNIZE IMPORTANCE OF TELEVISION—TELE-TECH's Washington bureau has learned that the Signal Corps, Air Forces and Naval Communications are so cognizant of the huge value of the new radio services of television, FM, facsimile and microwave transmission in battlefield and combat communications that they are concentrating training programs on these fields as well as their research and procurement plans. The day of the oldtime radio operator in his former concept is passing and now the engineer and the technician are in demand—that is the keynote of the new military training. It is realized by the armed services' top command that television will grow by leaps and bounds in the next few years and the military officers follow with great interest such predictions as that of NBC executive vice-president Frank Mullen who forsees nationwide network television within the next two years.

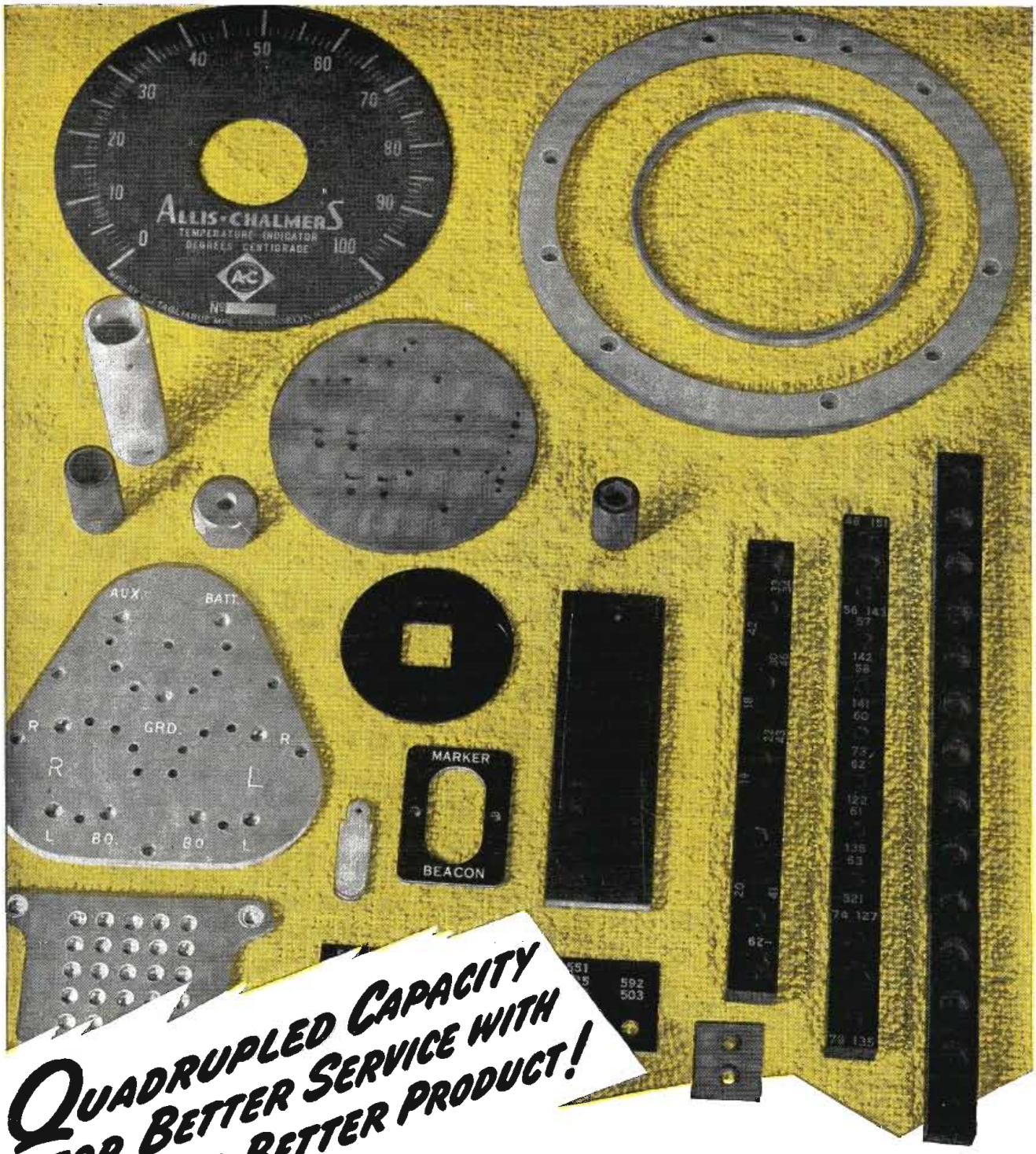
WARNING TO PROSPECTIVE AM BROADCASTING ASPIRANTS—Because it is unable under its statutory mandate to order broadcasting applicants to refrain from filing such requests, the FCC recently issued an important 115-page document, entitled "Economic Study of Standard Broadcasting", which sounds a warning that the best chances of success in AM broadcasting are local part-time stations in communities where there is no station now. Like the advice of former FCC Chairman Denny, now NBC vice-president and general counsel, at the NAB Atlantic City convention, the FCC report advised that the bonanza days of broadcasting are over and applicants should be careful in embarking on station operation. Radio manufacturers, the FCC report did not bring out, have an important role, however, in the future of the broadcasting industry because the sale of more receivers to home owners and in automobiles and on trains will be of primary help in its success. National Radio Week has definitely been stimulating the sale of home receivers, Washington government agencies have felt, and even won the endorsement of President Truman. Manufacturers, interested in the FCC Economic Report, can obtain it by writing the secretary of the Federal Communications Commission, Washington.

POSSIBLE FUTURE PATTERN OF BROADCASTING—The Clear Channel Broadcasting Service through its engineering director, John H. DeWitt, Jr., president of Nashville Station WSM, gave the FCC a new pattern for broadcasting in the United States—twenty AM stations with 750 kw power to carry broadcasts and network programs into every sector of the nation and local broadcasting to be handled by FM stations. Plan may win favor at Commission and become part of the future NARBA discussions.

FCC STRUCTURE NEEDS OVERHAULING—Back in 1934, when the Communications Act creating the FCC was enacted by Congress, there was no way of forecasting the huge and many-sided present-day burden of work that would be piled upon the seven members of the Commission. Through no fault of the Commissioners who rank high in caliber among executive officials in Washington, this is causing today harmful delays for all branches of the radio industry in the Federal agency's determination of important policies and allocations' blueprinting (i.e. Television Channel No. 1 proposal during mid-November and mobile services' hearings early in December).

HOW IT WILL COME—With the 1948 Presidential elections next November, Congress will be loath to take up such a non-political or "vote-bearing" question as the FCC troubles. But during the session of Congress, starting in January, 1949, after the election, Congress will undoubtedly start consideration of probably two methods of solution. One could be the establishment of two Commissions—one to handle broadcasting matters and the other for communications and mobile radio. Actually the better solution in the opinion of many observers would be to enlarge the membership of the FCC, along the same lines as the Interstate Commerce Commission which has 11 Commissioners. This would provide enough Commissioners adequately to man the three Divisions and at the same time the entire Commission could work on problems common to all communications and radio. This "fence-mending" really should occur now as during the next two years the "engineer" Commissioners Jett and Webster and key staff officials will be called on to participate in many international conferences and board meetings, including NARBA and the Mexico City shortwave parleys, which are more important than the day-by-day grist of the Commission's work. The seriousness of the situation has been exemplified by the recent State Department action cutting down the American participation at many of the 18 conferences of the next two years.

ROLAND C. DAVIES
Washington Editor



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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., 4657 SPRING GROVE AVE., CINCINNATI 32, OHIO

News of the Industry

IRE Elects Slate

Dr. Benjamin E. Shackelford, manager of the license division of RCA International Division is the new president of IRE Dr. Reginald L. Smith-Rose, superintendent of the radio division of National Physical Laboratories, England, is vice-president. The annual election also returned these regional directors:

Director-at-large: James E. Shepherd, research engineer of the Sperry Gyroscope Co., Inc.; Dr. Julius A. Stratton, MIT.

North Atlantic Region: Herbert J. Reich, Dunham Laboratory, Yale University.

North Central Atlantic Region: John V. L. Hogan, president of Interstate Broadcasting Co.

Central Atlantic Region: John B. Coleman, RCA Division, Camden, N. J.

East Central Region: John A. Hutcheson, Westinghouse Electric Corp.

Central Region: Theodore A. Hunter, Hunter Mfg. Co., Iowa City.

Southern Region: A. Earle Cullum, Jr., consulting radio engineer, Dallas.

Pacific Region: Frederick E. Terman, dean of the School of Engineering, Stanford University.

Canadian Region: Frederick S. Howes, associate professor of electrical engineering and consulting engineer at McGill University, Montreal.

TBA Schedules TV Clinic, Dec. 10

Television Broadcasters Association is to hold a TV clinic in New York on December 10. The gathering, which is to be at the Waldorf-Astoria, is to be a closed meeting open only to members of TBA. There will be no exhibits.

There are to be two panel meetings. One, open only to active TBA members will discuss:

Getting a Television Station on the Air.
Local Television Station Programming.
The Network Story: Relays, Coaxial, Stratovision, Kinescope Recording.
Engineering Problems of Local Remotes.
The FCC Views Television Expansion.

The panel open to members and affiliates will discuss:

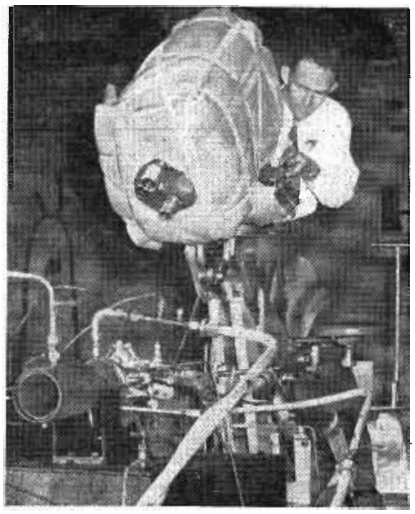
Eastman Kodak's Quick Developing Film Process.
GE Co's Microwave Relay.
The Advertising Agency Views Television.
Talent Answers Television's Challenge.
AT&T's Plans for Television.

Following a luncheon meeting at which TBA's awards will be made, there will be a reorganization meeting of the board of directors.

Theater TV for England

A theater television system is planned for London and its suburbs and may get going during 1948. A. G. D. West, director of British Cinema-Television, Ltd. plans to link up a series of theaters to show TV programs originating in the BBC studios in Alexandra Palace, in the Pinewood film production studios and in a new studio to be erected. The plan is to use projectors based on a modification of the Schmidt optical system with a throw of 40 ft. to a screen 12 x 16 ft. in dimensions. British standards are now based on a 405-line picture, but a picture of 900 to 1200 lines is the objective.

INDUSTRIAL TELEVISION



Monitoring camera set up in test pit for viewing liquid rocket motor firing at Aerojet Proving Grounds, Azusa, Calif. Viewers were in a room 700 ft. remote from the tests. Camera, of course, was unattended during firing tests. (See page 67).

Radio Exports Rise

Brazil was America's best customer for radio receiving sets in 1947 to date according to the Bureau of the Census which has just released figures. That country bought $7,905.589 worth of receivers as compared with only $1,145,363 in 1946. Total exports to all countries were $34,751,743, an increase of $28,231,438. Argentina bought the most tubes, accounting for $1,404,577 of a total of $8,041,929. Best buyer of capacitors, resistors and inductors was Brazil, figures being $1,034,150 for capacitors, $182,368 for resistors and $231,119 for inductors. Total exports of all receivers, tubes, parts and components touched $56,-513,010, which is up $30,563,957.

National Conference Studies New Technics

At the National Electronics Conference, a country-wide forum where current advances in the application of electron tubes was held at Chicago Nov. 3-5, some 2,500 engineers met to discuss the latest in the art. Over 80 papers were given during the three-day session, usually with four sessions going concurrently.

The program was particularly concerned with calling attention to basic principles and research projects on new lines of activity. A great many of the papers were on subjects that were unknown to engineers a few years past. During the stress of military equipment production during the past decade, many useful effects were discovered and put on the shelf temporarily. These are again being investigated and progress toward their utility is noted in the case of many of them.

As tube applications are found in industry, a wide variety of interests every line of research, commerce and had to be satisfied by the program committee. With four parallel programs at least one was devoted to industrial applications and another to some form of microwave technics. Other sessions were concerned with communications, instruments, antenna innovations and a report of new designs, nucleonics, FM, television, audio system problems, etc.

A survey of the highlights of the papers given will appear in the January issue of TELE-TECH and a complete report is to be assembled and published by the Conference as the third volume of its Proceedings, to appear in 1948. The National Electronics Conference, Inc., is a not-for-profit organization, sponsored jointly by Illinois Institute of Technology, Northwestern University, University of Illinois, and the National Organizations of the American Institute of Electrical Engineers and the Institute of Radio Engineers. The Chicago Technical Societies Council is a cooperating society.

New York-Boston TV Link

Linking New York and Boston, AT&T's Bell system formally opened its microwave channel November 13

(*Continued on page 69*)

CONVENTIONS AND MEETINGS AHEAD

December 10—Television Broadcasters Association. Clinic for members. Waldorf-Astoria, New York. Will Baltin, secretary, 500 Fifth avenue, New York.

March 22-25—IRE Convention and Radio Engineering Show. Grand Central Palace and Hotel Commodore, New York.

April 24—Regional Television Conference, IRE Cincinnatti Section. Cincinnatti, Ohio.

May 10-15—Radio Parts and Electronic Equipment Shows, Inc. Shows, Hotel Stevens, Chicago.

Television Used in Rocket Tests

Picture on Page 66

Television was used for the first time anywhere to observe the testing of high thrust rocket motors at the Aerojet Proving Grounds, Azusa, Calif., early in November. It provided views as close as two feet to observers seated comfortably in the conference room 700 feet. from the test pits. Developed by the Aerojet Engineering Corp., subsidiary of the General Tire & Rubber Co., to provide safer and more adequate test viewing facilities, this method of television test details was successfully demonstrated with the cooperation of electronic engineers of the General Electric Co., which furnished the television equipment.

The demonstration is the culmination of a requirement of the Naval Air Missile Test Center at Point Mugu, and is the first time that observers have been able to witness at extremely close range details of rocket engine operation during firing and be provided with comfort and freedom from hazard. Aerojet engineer Ernest Vogt supervised the development of this new test observation technic and was aided in the initial demonstration by C. G. Pierce, electronics engineer, General Electric, and B. L. Dorman, chief test engineer of Aerojet.

Concord Encyclopedia

With parts, components, test equipment and various supplies again in the market in good volume, the 1948 catalog (No. 9-47) just issued by Concord Radio Corp., Chicago and Atlanta, is a well-illustrated guide as to what is available. In addition to the usual tremendous assortment of essential parts, there is a 12-page section devoted to amplifiers and equipment for PA work including the Multiamp line which is expandable through plug-in units from 30 to 75 watts. An addition to the book is a 16-page section devoted to special values in parts and components.

Movie Engineers Study Theater TV

Theatre television projection systems was one of the main subjects of discussion at the 62nd semi-annual convention of the Society for Motion Picture Engineers at the Hotel Pennsylvania, October 20-24, 1947. The engineers saw a demonstration of the RCA theater television projection unit using a 6 x 8 ft. screen and televising a live talent show picked up on a table model TV receiver.

This projector is the forerunner of another larger experimental model which will be designed to produce a television screen image 18 x 24 ft. in size. The new unit will have a 15 in. kinescope operating at a potential of 80 kilovolts, using a 42 in. spherical mirror and a 36 in. aspherical correcting lens. This will be the largest Schmidt type reflective optic system in the world except for the unfinished 72 in. Schmidt telescope at Mt. Wilson.

Screen gains up to six or more are

PERSONNEL

Norman E. Wunderlich, who has been executive sales director of the radio division of the Federal Telephone & Radio Corp., Clifton, N. J. for the past two years, has severed that connection. He has established a business of his own for radio consulting and laboratory work at 1337 Fargo avenue, Chicago.

Irving Mcgeff has been appointed a project engineer with the United States Television Mfg. Corp. He was formerly connected with Philharmonic Radio Corp.

Major General Roger B. Colton (retired) has been elected vice-president of the Federal Telephone & Radio Corp.

Stanley C. Kolanowski has been made chief radio engineer of the Stewart-Warner Corp., Chicago. He joined the company in 1935 as a specialist in speaker design, before that was with Operadio and Griggsby-Grunow.

Dr. James J. Pyle has been elected to the board of directors of the Locke Insulator Corp. He is also a director of GE's plastics division laboratory, Pittsfield, Mass., first joined GE in 1939.

Major-General George L. Van Deusen has been elected president and a director of RCA Institutes. He succeeds Major General Harry C. Ingles who served as the head of the Institutes until his recent election as president of RCA Communications, Inc.

Robert York Chapman has been appointed executive engineer of the David Bogen Co., New York. Since 1945 he has been associated with the U. S. Naval Underwater Sound Laboratory, New London.

Robert P. Lamons has been appointed eastern representative of The Andrew Corp., Chicago, will headquarter in New York. Before joining Andrew in 1945, Lamon served as project engineer for Western Electric.

Paul H. Merriam has become associated with the D. M. Stewart Mfg. Co., Chattanooga, Tenn. as electronics development engineer. Until re-

cently he was head of the electrical section of the engineering laboratories of the Glenn L. Martin Co.

W. K. Burlingame has been made field operations manager for Telicor (formerly Telicon) Corp., New York. He was formerly national service manager for DuMont.

Joseph P. Maxfield has joined the Altec Lansing Corp., as a consulting engineer. He was long connected with Bell Telephone Laboratories, recently retired from that organization.

John M. Cage has joined the teaching staff of the school of electrical engineering of Purdue University as professor of electrical engineering in charge of electronics. Latterly he has been manager of industrial electronics for Raytheon Mfg. Co.

Fleming Johnson has been made production manager for the J. P. Seeburg Corp., Chicago. More recently he has been vice-president in charge of manufacture of the eastern division of International Detrola Corp., Detroit.

L. G. Burnell has joined his brother's organization, Burnell & Co., Yonkers, N. Y., as a partner and chief engineer. He was formerly chief engineer of United Transformer Corp., New York.

Giannini, Rosen Join

The G. M. Giannini Co., Pasadena, Calif., has become associated with the radio engineering products division of Raymond Rosen Co., Philadelphia. Both companies are now engaged in government research work on guided missiles. The association will permit the Giannini company to produce complete systems for transmission of signals from guided missiles and pilotless aircraft. The Rosen company produces radio telemetering and other electronic devices.

New York—Boston TV Link

(*Continued from page 66*)

for experimental use. The link is to be used for simultaneous transmission of telephone, television and other services and involves the use of repeaters on seven high hills between the two cities. The recently developed Bell metal lens antennas are used at both ends of each link section. Opening ceremonies in New York linked together all New York's TV broadcasters with Philadelphia's two stations, Baltimore's new station, the three stations in Washington and GE's Schenectady station in what is believed to be the longest TV tie-up yet attempted.

obtainable with a lateral projection angle of 60 degrees and a vertical angle of 20 degrees. Some home TV screens have gains as high as twelve but the viewing angle is narrow and unsuitable for conventional theater buildings.

The controversy between the exhibitors and the TV equipment manufacturers on the subject of theater television involves many interesting aspects taken by both sides which point up the fact that there are still many obstacles both economic and technical to be overcome.

From the technical side, projection systems are still not up to the motion picture standard. This is indicated mainly by the fact that there is still a division of opinion on the types of theater television projection systems now in use. This problem divides itself into two categories: (1) projecting a large size image directly from the television receiver tube, (2) photographing the image on the television tube, processing the film, and then projecting it as an ordinary movie film.

From the exhibitors' side, theater builders complain that the cost of such television equipment added to present-day high costs of construction would raise the admission price so much that patrons simply will not attend. A builder reported that a 600-seat theater in the New York area would cost $200,000 to build, including the real estate. The television projection system and accessories would cost about $25,000. Other cost factors would be: (1) syndication costs. (2) maintenance and personnel charges, (3) television transmission line charges (coax, waveguides, or radio relay). They also point out the difficulties of programming television shows along with the regular film features.

The British have been going right along with theatre television as a government subsidized project. Main transmissions will take place from Alexandria Palace, north of London, and will beam to approximately a half dozen larger theaters equipped with the necessary projection systems. The cost of such operations at the present time is on the order of 2½ million dollars, even though the revenue from approximately twenty thousand sets throughout the London area based on a license charge of $5 per set per year is only $100,000.

There are still many problems to be solved in theater television. Standards is one. Is the 525 line resolution satisfactory or should resolution equivalent to film projection be sought? This would require between 900 and 1200 lines and a correspondincrease in bandwidth. What are the relative values of instantaneous and delayed film projection of TV shows? What minimum brightness is acceptable? Should the transmission be interlaced or sequential? The equipment manufacturers are waiting to see what the exhibitors need, and the exhibitors are trying to build their shows around existing equipment.

Dr. Frank G. Back, of the Research and Development Laboratories, inventor of the Zoomar lens (for 16 mm) announced the completion of development on the Zoomar lens for

35 mm. Dr. Back outlined the difficulties encountered in the development of the 35 mm equipment, asserting that it was not simply a matter of multiplying everything by two. One of the main difficulties was the matter of keeping down equipment weight, since twice the weight of the 16 mm equipment would make the 35 mm equipment cumbersome and unmanageable. The 35 mm Zoomar lens will find application in television studios and especially on-the-spot television pickups where it is necessary to obtain long shots and closeups without the necessity of moving heavy equipment.

Eastman Kodak displayed a 16 mm motion picture camera for recording television programs on film. This equipment was especially built for photographing the image of a cathode ray tube at a rate of 24 frames per second. The camera will find use in telecasting stations and in television theaters. It mounts a 1200 ft. film magazine and has a coated f/1.6 lens of 2 in. focal length. Its main uses will be to record television shows (1) for later telecast, (2) legal records, (3) for TV theater and (4) for institutional public relations and advertising.

Robert E. Lewis of the Armour Research Foundation, described a method of producing synthetic sound on film. Lewis described some experiments using ordinary India ink and other varying colors and drawing complicated wave shapes and variable densities on film. He stated that the result was in the nature of animated music, similar to cartoon film and that it was somewhat difficult to predict to any degree of accuracy what the outcome of any effort would be. He stated that the amount of work necessary to produce such a film is comparable, if not greater, to that required to produce a cartoon film but it may find some application later on. This points up the advances made in the musical world through the means of radio and electronic methods. Electronics equipment was first made to produce pure notes of varying frequencies and these in combination as played out on the keys of the electronic instrument would simulate the organ and other instruments.

However, now we have the creation of music directly from drawn wave shapes on film and then scanning it with an audio optical system. In effect, the music animator creates music without the use of the customary cleffs and sharps and other standard musical notations. It does, however, require long experience in obtaining the varying pictures and delicate shadings of tone and volume in order to produce something that sounds like music. Probably, the greatest advantage of the synthetic sound on film process is the precision of timing that is possible. For example, one second of time is represented by ½ ft. of 35 mm film. This will permit the plotting of sound to at least the nearest 200th of a second if necessary. The entire subject is still very much in a development stage and it would seem that no large-scale use for this form of recording music is in sight.

NEW BULLETINS

DC Voltmeters Signal Booster

This 4-pg. folder issued by L. S. Brach Mfg. Corp., Newark, N. J., describes the Puratone signal booster, designed to eliminate interference and noise for store demonstrations of AM, FM and television sets. Carrying three antennas on the same mast, the device provides 30-40 db gain on FM and 40-60 db gain on AM.

Label Catalog

"Tools of Business" is the first full-size label catalog issued by Ever Ready Label Corp., 141 E. 25 St., New York 10, since prewar days. The 32-pg. catalog is designed for use by label buyers with limited knowledge of label production, design, paper and costs.

Studio Oscillograph

Of interest to workers in the television field bulletin 690, issued by Allen B. Du Mont Labs., Passaic, N. J., provides detailed data on type 280 cathode-ray oscillograph for television studio and transmitter installations. Specifications, diagrams and typical oscillograms are included.

Mobile Radio Equipment

An 8-pg. descriptive folder and a 2-pg. specification sheet on model 21TR11 Raytheon mobile radiophone has been issued by Belmont Radio Corp., 5921 W. Dickens Ave., Chicago 39, Ill. Detailed data is given on the complete system including receiver-transmitter, power supply, control panel, selective calling system, etc.

Transmitting Tetrode

Raytheon RK-6D22, a new transmitter tetrode which provides 1000 watts rf output with 3000 volts plate supply and 22 watts grid drive, is described in an 8-pg. engineering data folder T-955, issued by Raytheon Mfg. Co., Waltham, Mass.

Variable Reluctance Pickup

Specification sheet ESD-13 on the GE variable reluctance pickup is available from the GE Specialty Div., Wolf Street Plant, Syracuse, N. Y. The 4-pg. data sheet is intended for inclusion in the General Electric Electronic Specialties Manual.

Interference Films

Bulletin MI-318, published by Fish-Schurman Corp., 230 E. 45 St., New York 17, contains descriptions and spectro-photometric curves of the FS multi-layer interference films. These dichroic and achromatic beam splitters find applications in radar cameras, tri-color television, etc.

Noise Reducing Antenna

Designed for all wave reception from 500 kc to 30 mc the noise-reducing Vertrod antenna consists of a 3-section, hard aluminum mast, mounted on a sturdy rotary base. A series of loose-leaf bulletins, available from Vertrod Corp., 60 E. 42 St., New York 17, describes various models of antennas including an adjustable dipole for FM and television.

Molded Iron Cores

A series of data sheets, supplied in a loose-leaf binder, summarizes the magnetic, mechanical and electrical characteristics of various grades of Moldite iron core materials, manufactured by National Moldite Co., 25 Montgomery St., Hillside 5, N. J.

Telephone Systems

Of particular interest to engineers engaged in housing projects the 8-pg. bulletin No. 162, issued by Auth Electric Co., Inc., 34-20 Forty-Fifth St., Long Island City, N. Y., is designed to aid in the selection and specification of telephone systems, door chimes, bell systems and mail boxes for all types of dwellings.

Color in Industry

"Color Dynamics" is an interesting 32-pg. pamphlet intended to promote industrial efficiency through the scientific utilization of color principles. A large number of plant applications illustrate the part color dynamics can play in avoiding fatigue and in-

creasing safety. The booklet is available from Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh 19, Pa.

Rivet Catalog

Complete information on the use of split and tubular rivets is contained in a new industrial catalog, issued by Chicago Rivet & Machine Co., 9600 West Jackson Blvd., Bellwood, Ill. A wide variety of automatic rivet setters with specifications are listed in 48 pages of the pamphlet.

Microwave Equipment

A new reference manual and catalog on microwave equipment issued by DeMornay-Budd, Inc., 475 Grand Concourse, New York 51, N. Y., contains nearly forty pages of technical information. Divided into two chapters, the headings are: "Introductory Concepts to Microwaves" and "Microwave Test Equipment Measurement and Calibration Procedures." This section is illustrated with diagrams, charts and photographs, and contains a wealth of useful data in the form of reference tables. All types of test equipment and standard component X and K band parts, together with specialized and custom-built parts, are described and illustrated. As new pages are published they will be automatically sent to all registered catalog owners.

Recordings Report

Indicating an increasing use of sound systems and recording and playback equip- in public and private schools, the Radio Manufacturers Association has published a report prepared jointly by RMA and the U. S. Office of Education setting forth basic standards which school personnel may use in selecting equipment suitable to their needs. Under the title of "School Sound Recording and Playback Equipment", the report is a sequel to a similar report titled "School Sound Systems", published by RMA a year ago in cooperation with the U. S. Office of Education. The new report is the work of a Joint Committee on Standards of School Audio Equipment of RMA and the U. S. Office of Education.

Transformer Line

Crest Transformer Co., 1854 West North avenue, Chicago, has issued a new 8-page catalog of standard radio transformers. Included are descriptions, illustrations and prices of input, output and power replacement types, as well as mike, line, driver, line regulating transformers and a complete line of filter chokes.

High Frequency Cable

This high frequency cable chart gives complete specifications on coaxial cables varying from 25 to 125 ohms in characteristic impedance and on two twin-conductor cables, all manufactured by Anaconda Wire & Cable Co., 25 Broadway, New York.

Vibrator Data Book

P. R. Mallory & Co., Inc., Indianapolis, Ind., manufacturer of vibrators, is distributing the first "Vibrator Data Book" ever published. This new work discusses fully a wide range of design and application problems for vibrators and vibrator power supply in its 135 pages of text illustrated with 64 charts and diagrams. The book contains descriptions of basic structures, designs and vibrator characteristics. It discusses fully the selection of correct types for specific problems; outlines the latest information on applications; describes and illustrates the circuits involved and covers in detail the modern inspection procedures. The text is amplified with 16 pages of pertinent tables, charts, graphs and formulas. Loose-leaf Vibrator Characteristic Data Sheets are included with all copies of the Data Book ordered by manufacturers' engineers. These sheets are supplied to Radio Service Men only on special request. The data book is available through all Mallory distributors or direct from P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., at $1.

Photoelectric Cells

This 12-pg. brochure on self-generating photoelectric cells includes characteristics, applications and design factors, as well as standard specifications and illustrations of various shapes and sizes. Selenium Corp. of America, 2160 East Imperial Highway, El Segundo, Cal.

American Standards

An entire new listing of its 874 standards is available without charge from the American Standards Association, 70 East 45 St.,

New York 17. The new listing includes a number of additional revised standards.

Abstracts on Electrical Contacts

The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., has issued the "1946 Supplement to the Bibliography and Abstracts on Electrical Contacts". This latest 26-page supplement, available at 75 cents per copy, gives replacements and new references for 1940 to 1944 and cover publications in 1945 and 1946.

Insulation Resistance Testing

New information on insulation resistance testing and instructions for the use of the "Megger" insulation testers, safety precautions etc. are contained in manual 21J-15, available from James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

Radio Wire Products

Cornish Wire Co., 15 Park Row, New York City, is distributing its first post-war catalog of electrical, radio and industrial wires, cables and specialties.

Relays and Control Units

A 12-pg. catalog (No. 7) fully illustrating and describing the Phil-trol line of relays designed for electronic and industrial control, signal and traffic control, radio and communications, has been published by Phillips Control Corp., 612 North Michigan Ave., Chicago 11.

Electrical Laminations

Comprehensive information on Thomas & Skinner's stock lamination dies and data on weights, characteristics and suggested applications of electrical steels are contained in a new Electrical Laminations handbook, published by Thomas & Skinner Steel Products Co., 1127 East 23 St., Indianapolis, Ind.

High Voltage Resistors

Bulletin G-1, issued by International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., contains complete specifications and characteristics of Type MV high voltage resistors which are available in eight terminal types and in ratings from 2 to 90 watts.

Ceramic Materials

The characteristics, electrical and mechanical properties and industrial applications of special ceramic materials are discussed in a 32-pg. treatise, published by General Ceramics and Steatite Corp., Keasby, N. J. A brief bibliography on ceramic materials also is included.

Marine Radar

An explanation of the principals of Radar and its applications, as well as installation views of radar equipment and actual radar scope photographs are contained in a 8-pg. radar booklet on marine radar, issued by Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

Resistance Standards

A complete line of resistance standards and resistance bridges including Wheatstone, Kelvin, Mueller and Limit bridges are described in a 12-pg. illustrated technical bulletin, published by Rubicon Co., Philadelphia, Pa. Standard resistors described include Bureau of Standards and Reichsanstalt types, as well as standard shunts and a wide range of decade resistance boxes.

New RMA Standards

Six new RMA Standards publications for insertion in the RMA handbook of standards have been published by Radio Manufacturers Association, 1317 F Street, Northwest, Washington 4, D. C. They include REC-105 on disc home recording, REC-108 on colorcoding (supplementing material on sheet 410), REC-109 in intermediate frequencies (supplmenting Standard M3-167), REC-110 on lead-in lines for television receivers, REC-111 on "Chassis pickup of vehicular receivers", and ET-108, a joint RMA-NEMA Standard for tube type designations.

Laminated Plastics

A 64-pg. booklet containing complete information on manufaeture, applications and properties of all types of Textolite laminated plastics has been published by the Plastics Div., General Electric Co., Pittsfield, Mass. Electrical, physical and mechanical properties of 44 different grades of sheet material are listed.

Tube Catalog

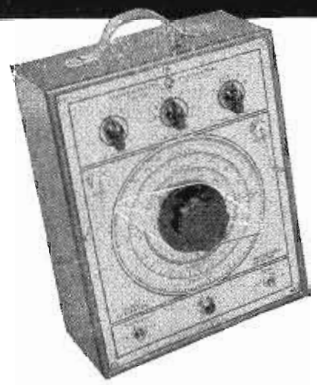
The latest available technical information on the Hytron transmitting and special pur-

(*Continued on page 77*)

Signal Generator

designed for

RADIO SERVICEMEN



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AM and FM coverage — direct-reading dial — five bands — special calibration scale.
Rugged construction — steel cabinet — leather handle — stainless steel panel — planetary drive.

The Model 700 has the advantages of much more expensive Signal Generators. It has been manufactured with precision and care. Its moderate price makes it a popular choice by radio servicemen.

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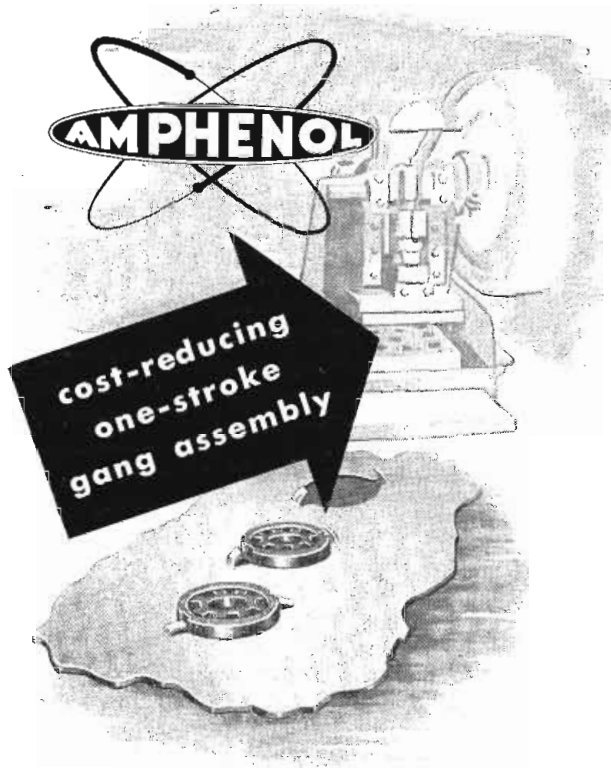
Designed for the rigors of commercial service in all types of radio communication . . . broadcast, mobile, aircraft, police. Precision made for utmost in stability, dependability, trouble-free operation. Calibrated within .005 per cent of specified frequency . . . range 1.5 to 10.5 MC. Temp. coefficient less than 2 cycles per megacycle per degree centigrade. Weighs less than ¾ ounce Gasket sealed against contamination and moisture. Meets FCC requirements for all above services. See your jobber—Petersen Radio Company, Inc., 2800 W. Broadway, Council Bluffs, Iowa. (Telephone 2760.)

PR *Precision* **CRYSTALS**



CHASSIS LOCK SOCKETS

No. 68-8L LOCTAL SOCKET

No. 68-8 OCTAL SOCKET

147 SERIES MINIATURE BUTTON SOCKET

Amphenol Chassis Lock Sockets furnish radio manufacturers with one effective answer to soaring production and labor costs. They eliminate riveting, mounting plates, and other auxiliary socket support devices, and their attendant labor, yet the socket is firmly seated in the chassis.

A simple redesigning of the chassis die permits one-stroke punching of all socket holes, and simultaneous shearing and forming of integral lugs on each. Sockets then are placed in the chassis from the top. A multiple jig presses lugs against socket shoulder supports of all at one time. This securely locks each socket permanently into place. Closer spacing of sockets permits more compact design.

Amphenol engineers cooperate fully in the tool development required in changing over to faster, lower-cost production with Chassis Lock Sockets. Write, phone or wire for full details.

Punch-press and laboratory hand dies are available for mounting Chassis Lock Sockets

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F Carrier Increases Phone Line Capacity

For the small independent telephone companies faced with the problem of increasing the capacity of short-haul toll lines without additional metallic circuits, General Telephone Service Corp., 80 Broad St. New York has completed the development of a low-priced unit carrier system designated as GTC-411 carrier.

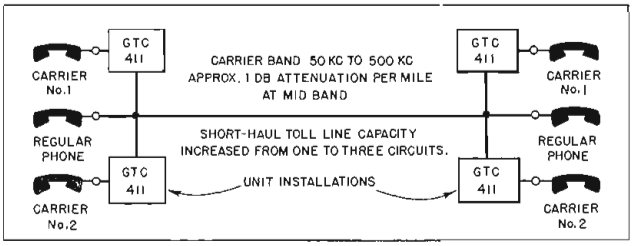
Feature of this equipment is its operational flexibility. When a small telephone company needs to add another circuit on a toll line, a GTC-411 unit is plug-in connected. When the demand changes, the unit is connected to another new circuit. Conventional carrier systems now in use by large telephone companies, are much more complex and cannot be moved without entailing major costs and installation time.

Technically, the GTC-411 unit is designed to overcome line attenuations up to 40 lb. Carriers operate in the frequency range from 50 to 500 kc. At midrange and under normal line conditions, the attenuation is approximately 1 db per mile. This means a range of about 40 miles. However, many toll lines range from 10 to 20 miles, and it is for this group that the GCT-411 was designed.

The unit is made up of five panels: transmitter, receiver, distribution, terminal and power supply. The transmitter power output is in terms of milliwatts; its signal is frequency modulated. Variations in line attenuation caused by changes in weather cause only a 1 to 2 db variation when the attenuation is within the 40 db range. If the system is used at a subscriber location, the terminal panel is omitted.

The GCT-411 can be adapted to give ringdown-toll service, remote-community service, or subscriber service. It can be installed in the central office or at the end of the entrance cable. For subscriber service, the unit can be used for magneto service, CB service, or full-dial service.

Schematic of arrangement of circuits which permit low-cost "pocket" carrier units to treble capacity of telephone toll lines.



Engineer E. H. B. Bartelink and assistant radio engineer E. Daskam, Jr., with one of the new General Telephone carrier units.

Reorganize Airadio

Jay Sullivan, formerly vice-president and general manager of Airadio, Inc., Stamford, Conn., has been elected president of the company. He succeeds J. B. Cobrain who has sold his interest in the company to Sullivan and others. Kenneth M. Piper, formerly assistant vice-president of Bausch & Lomb Optical Co., Rochester is vice-president. E. C. Timmerman remains as secretary.

Hallicrafter $169 TV

A television set to sell for $169.50 and having a 7-in tube has been developed for early year delivery by Hallicrafters Co., Chicago. It is a table model with 19 tubes, will cover all 13 channels.

(Continued from page 74)

pose tubes is summarized in this 4-pg. catalog, published by Hytron Radio and Electronics Corp., 76 Lafayette St., Salem, Mass.

Noise Suppressor

Superseding all previous literature on the Type 910-A dynamic noise suppressor this 8-pg. bulletin, issued by Technology Instrument Corp., Waltham 54, Mass., contains additional detailed information regarding installation, auxiliary apparatus, and final specifications. Operating features and constructional details are included.

Audio Equipment

The complete line of Langevin audio equipment is illustrated on a handy reference data sheet, distributed by The Langevin Co., 37 West 65 St., New York 23. Illustrations and chief specifications for a large variety of broadcast amplifiers, horns, transformers are given.

Microphones and Pickups

Two 1947-48 catalogs, issued by Shure Brothers, Chicago, Ill., contain information on newly developed microphones and pickups. Catalog 157 describes microphones, including the new multi-impedance "Unidyne", "Sonodyne" and "Econodye" dynamic microphones, and the "Monoplex" and "Versatex" crystal microphones. Catalog 158 illustrates the new "Muted Stylus" pickup, cartridge and needles, the cartridge replacement "Pack", and the Shure Lever-type cartridges.

Multi-Channel Transmitters

Three new multi-channel communication transmitters for ground-to-air and point-to-point service are completely described and illustrated in a booklet issued by Federal Telephone and Radio Corp., 100 Kingsland Road, Clifton, N. J. A transmitter buying chart, showing expansion of basic equipment through use of interchangeable units, is also included.

FM-AM Capacitors

Four new catalog data sheets have been issued by General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J., for insertion in the General Instrument catalog. The sheets contain complete specifications for the models 2012 and 2022 FM-AM tuning capacitors.

Limiting Amplifier

The operating characteristics of the GE Type BA-5-A limiting amplifier are described in a 12-pg. booklet EBR-99, prepared by the Transmitter Div., General Electric Electronics Dept., Electronics Park, Syracuse, N. Y. The publication, complete with schematic drawings and diagrams, lists operational and constructional features of the amplifier.

Tube Guides

A revised edition of the "Quick-Reference Chart on Miniature Tubes" covers RCA's line of 48 miniature types, featuring functional classification of the various types. The chart, Form MNT-30A, may be obtained from Commercial Engineering, Tube Dept., Radio Corp. of America, Harrison, N. J. The Tube Dept. has also issued a "Quick Selection Guide" on transmitting and industrial tubes, which provides technical data, dimensions and other information on more than 200 types.

Replacement Transformers

Transformers and component parts for the radio industry, neon transformers, power transformers for electrical fence control etc., are described in the 8-pg. replacement transformer catalog, published by Crest Transformer Corp., Dept. O, 1834-36 W. North Ave., Chicago 22, Ill. Specifications, dimensions, prices and illustrations are included.

Intercommunications

"How to solve Communications Problems" is an 8-pg. booklet, issued by Executone, Inc., 415 Lexington Ave., New York 17, which illustrates and summarizes features and applications of the company's extensive line of intercommunications equipment for industrial plants and offices. Typical installations are diagrammed.

Permanent Magnets

General information and technical data on characteristics, design, properties and applications of GE permanent magnets are contained in a 36-pg. booklet, published by the Metallurgy Div., General Electric Chemical Dept., Pittsfield, Mass.

NEW BOOKS

Mathematics for Radio Engineers

By Leonard Mautner, Research Engineer, Allen B. DuMont Laboratories, published by Pitman Publishing Company, New York, 1947, 327 page, $5.00.

The text is intended for the practicing radio engineer and technician as well as for engineering students, and the topics are selected with a view to meet their needs. Also mathematical theorems are frequently illustrated by examples from the radio, electronics, radar or related fields.

Chapters on logarithms, circular trigonometric functions, complex algebra, hyperbolic functions and determinants, are followed by a discussion of differential and integral calculus, the method of series expansion, and differential equations. The last chapter deals with Fourier series. Problems are appended to each chapter, and the solutions will be found at the end of the book.

Principles of Electrical Engineering

By T. F. Wall, D. Sc., D. Eng., Lecturer-in-Charge, Department of Electrical Engineering, University of Sheffield, published by the Remsen Press Division, Chemical Publishing Co., Inc., Brooklyn, N. Y., 1947, 563 pages, $8.50.

The book comprehends the basic principles of electrical engineering with emphasis on the similarity between heavy current and communication engineering. Fundamental rules and engineering practice are closely interrelated. A large amount of information is presented and new developments are included. The text can be recommended for its concise and clear representation as well as for its reliable and thorough treatment of the subject. It may prove particularly useful as a reference book for practicing engineers. The successive chapters deal with the systems of units, the structure of atoms and electrical properties of matter, the electrostatic laws, networks, thermo- and piezoelectricity, magnetism, electromagnetism, ac systems and the use of complex quanties, oscillating systems, some graphical methods, wave-form analysis, and skin effect.

Electrical Engineering Problems and Their Solution

By T. F. Wall, D. Sc., D. Eng., Lecturer-in-Charge, Department of Electrical Engineering, University of Sheffield, published by the Remsen Press Division, Chemical Publishing Co., Inc., Brooklyn, N. Y., 1947, 312 pages, $5.

This book is the companion volume of the "Principles of Electrical Engineering". Carefully selected problems and their solution drawn from the entire field of applied electricity and magnetism are presented. The complete reasoning, not just an outline, is included in each answer.

Sound in Canada

A Canadian office has been established by Sound Apparatus Co., 233 Broadway, New York. It is at 2235 Addington avenue, Montreal, is in charge of Harris Pound.

Radio For Railroads Gathers Momentum

Three major railroads have installed radiotelephones in crack passenger trains to provide voice communication for the first time between trains on the run and any telephone connected to the Bell System.* They are the Chesapeake and Ohio, the Pennsylvania, and the Baltimore and Ohio.

Special telephone booths in the lounge or dining cars will lock out normal train noises and insure privacy. Both the PRR and the B & O will lease equipment from the Bell Telephone Co. These mobile transmitters and receivers will send and receive FM transmissions from already installed fixed stations of the Bell System along the right of way.

The C & O will not use space radio like the other two; instead, it will use the induction principle of transmission along wayside wires. Induction radio equipment manufactured by Aireon Mfg. Co. will cost an estimated $358,900 including installation costs. The route between Orange, Va., and Cincinnati, O., will be lined with booster stations to maintain a constant signal level.

Rates for the radiotelephone service will closely follow the schedule for automobile radiotelephone. These rates run a nickel per message-unit. The MU is a factor of time and distance.

The railroads found their first use for radio as an aid to train operation and yard and terminal traffic control. Already nearly 700 mobile units and 75 land stations in the 158-162 Mc band contribute to the safety and efficiency of rail operations. Within the next ten years, 75 to 100,000 radio sets may be required for some 70,000 mobile installations as well as other fixed-station installations.

Ionosphere Recorder

● A new instrument for the automatic recording of ionospheric phenomena, which are of great practical importance in radio propagation, has been developed by the Central Radio Propagation Laboratory of the National Bureau of Standards. The wide fluctua-

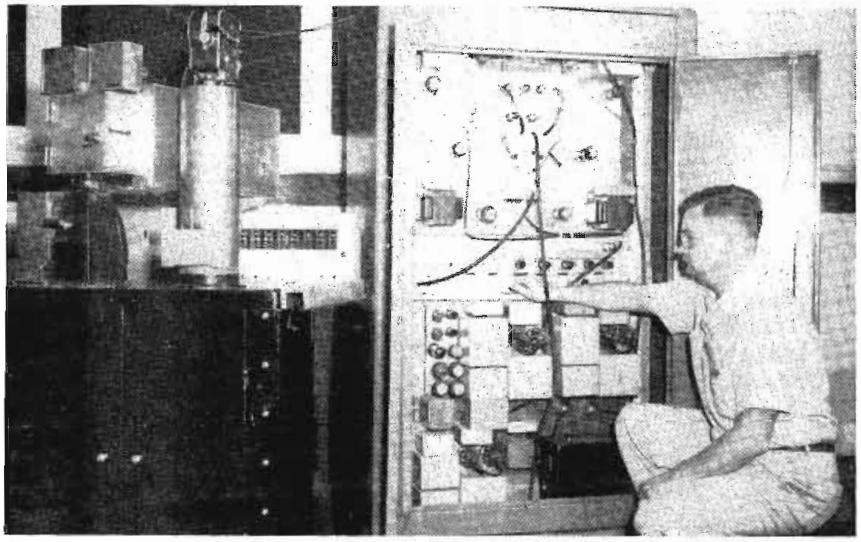
*Tele-Tech, January, May, 1947

tion in ionosphere characteristics, that is, changes in its degree of ionization due to varying amounts of ultraviolet light from the sun, causes radio propagation to vary daily, seasonally, and over the sunspot cycle. By systematic analysis of these changes over the entire surface of the earth, the National Bureau of Standards predicts ionospheric conditions three months in advance. Such predictions permit accurate calculation of the best radio frequency to use at any given time between any two points on the earth.

The Model C2 recorder was designed to utilize the so-called multi-frequency technic of intestigating the layers of the ionosphere beginning at 60 and extending to more than 100 miles above the earth's surface. Pulse transmissions are used similar to those employed in radar, except with varying probing frequency. The frequency is plotted against the time delay of the echoes from the ionosphere, an interval corresponding to twice the height of reflection. One sweep in frequency from the lower to upper limits produces each ionosphere record in a time interval of as little as 7½ seconds.

The equipment is the first completely automatic recorder to use successfully the heterodyne pulse transmitter. The entire frequency range from 1.0 to 25.0 mc is covered continuously without band-switching by beating a fixed frequency pulsed oscillator (30 mc) and a variable frequency oscillator (31 to 55 mc) together in a low-level mixer. The difference frequency is amplified by a wide-band amplifier, which delivers several kilowatts of peak pulse power to a wideband antenna. In this way a frequency range of twenty-five to one can be covered simply and quickly by varying the frequency of a low-powered oscillator through less than a two-to-one frequency range.

The receiver consists of a 30 mc amplifier preceded by a balanced input mixer. The mixer input is untuned and the antenna is capacity-coupled to its grids. Voltage from the transmitter variable frequency oscillator, when mixed with incoming reflected pulses of



The indicator-recorder of the new automatic ionosphere recorder developed by Bustan's CRPL is at the left with the transmitter-receiver in the cabinet at the right.

variable frequency, produces pulses of constant frequency equal to the frequency of the fixed frequency pulsed oscillator in the transmitter (30 mc). Thus the receiver is in tune with the transmitter throughout its frequency range.

The normal type of indication is similar to the radar "A" scan, except that received pulses are applied to the oscilloscope grid instead of to one set of deflecting plates, and thus appear as bright or dark spots rather than as "pips". A special 35 mm camera, driven by the motor that operates the transmitter variable frequency oscillator, provides a continuous film record. The image of the sweep line is oriented at right angles to the direction of film travel, so that the graph of height of reflection (time delay) versus frequency is recorded on height scales of 0-500, 0-1000, or 0-4000 kilometers.

The monitoring oscilloscope is normally provided with a long-persistence screen of the P7 type. In addition to the modified "A" scan, it also receives a quadrature sweep generated by a position potentiometer driven by the variable frequency oscillator drive motor. In this way an indication similar to the radar "B" scan is produced having both frequency and height coordinates upon which the ionosphere record appears. Thus visual observation is possible simultaneously with the 35-mm film recording of the main oscilloscope.

A standard 16-mm motion picture camera is provided to photograph the monitoring oscilloscope. When a series of 16-mm film records, made at 7½ or 15 second intervals over a long period of time, are projected, a striking accelerated version of the changes taking place in the ionosphere is observed.

Radio Predictions Instructions

Instructions for the use of the Bustan monthly periodical, "Basic Radio Propagation Predictions — Three Months in Advance." (CRPL Series D), have been prepared in the form of a separate manual which is now available as NBS Circular C465. The purpose of this manual is to explain how the monthly predictions may be used in calculations of usable and working frequencies for sky-wave transmission. Maximum usable frequencies and optimum working frequencies may be computed over any path for any time of day during the month in question.

Prediction charts are included for two recent months and sample problems are given for four paths, with a discussion of differences in results because of length of path, the ionosphere layer controlling reflection, season of the year, and degree of solar activity. An attempt is made to emphasize that the most important case of all, namely, transmission by the F2 layer over a transmission path more than 4000 km in length, can be calculated in a very simple manner. The pamphlet also contains other useful data, including tables, charts, and specimen work sheets. Circular C465 may be obtained from the Superintendent of Documents, Washington, at 25¢ a copy.

RADIO PATENTS AND THE COURTS

Editor Tele-Tech: Many thanks for your letter wherein you say: "I hear that Hazeltine has developed a valuable and interesting F.M. circuit", and your request for a release of its technical features.*

First of all, let me say that my regard for the influence of your publications is very high and under different circumstances, yours would be one of the first publications to be considered when we release any technical information for publication on this or any other invention made in our laboratories.

Unfortunately, we are confronted with a very difficult situation—namely, how to protect our interest in the amount of time, money and effort we spend in research as well as the interests of our licensees who help to support this work. In the years gone by, this could be achieved through the respect which was generally accorded to patents and the reasonable prospect of having a patent sustained in court proceedings against infringers.

"Flash-of-Genius" Theory

In recent years, the so-called "Flash-of-Genius" theory of invention has made it almost impossible to have a patent validated by the courts. More and more, one finds the thought—"his advance over the prior art, if any, required only the exercise of the skill of the art"—expressed as a reason for invalidation.

If you think I am exaggerating consider this excerpt from the decision of a court of appeals invalidating a patent:

"That Lewis has shown mechanical ingenuity in adding the anxiliary steam strippers is not open to doubt, but has he displayed inventive genius? This is the crux of the case at bar in view of the fact that no exact anticipation is displayed in the prior art. His disclosures seem the result of a regular development of the art of fractionating hydrocarbons, he adding an ingenious and commercially valuable step. But, in the light of the development of the prior art, we cannot conclude that the end which Lewis achieved was the result of that incandescent and illuminating instant in which the mind grasps a hitherto undisclosed principle and with it achieves a new result whether by new tools or old. Lewis must be held not to have displayed inventive genius."

In other words, anyone is at liberty to take full commercial advantage—free of cost—for the time, effort and money, which Lewis spent in finding the "ingenious and commercially valuable step," of which there was no exact anticipation in the prior art. In this case, the inventor fulfilled his part of the patent law bargain by making a full disclosure of his invention. He gave the public something it had never had before, but was denied any reward for his efforts.

Claim "Mere Exercise of Skill"

It would seem that any experienced and ingenious scientist or engineer could not possibly make an invention because there is every possibility that whatever he does, in the eyes of the court, will be merely the exercise of his skill in the particular art he is working in. Evidently, it is only the ignoramous who has any chance of being struck with the "Flash-of-Genius". Unfortunately for us, all of the Hazeltine inventions and developments have been made by scientists and engineers.

In view of the modern trend in court decisions and the avidity of copiers to reap the financial rewards flowing from the work of others, we are confronted with the necessity of protecting our interests and the interests of our licensees to the best of our ability.

In keeping with this policy—which we think is both fair and reasonable—we have decided that the technical details of our inventions will be made known only to our licensees and in such manner as to give them the opportunity to introduce the inventions to the public so as to get the first commercial advantage to which they and we are entitled. The existence of the Hazeltine Laboratories over the past twenty-three years has permitted the small manufacturers to maintain their positions in an industry that is highly competitive.

We intend to give this system a fair trial. We have no doubt infringers will rush to produce receiving sets embodying the inventions as rapidly as they can after the licensed sets have been introduced to the public. Some of the infringers may even bring suit

*See "Hazeltine FreModyne FM Circuit," page 41 this issue.

against us under the declaratory judgment act because we made this invention, and because they may believe that, under present conditions, they will have better than an even chance to defeat the patent by alleging that none of our experts have been touched with the "Flash-of-Genius".

In the highly technical radio-electronic art, continuous research in fully equipped laboratories is a necessary pre-requisite to substantial advances in the art. The cost of maintaining such laboratories is very great. If the present trend which permits the non-creator to reap an unearned reward from the efforts of others continues, those who have maintained such laboratories will be confronted with the necessity of either abandoning research or else looking into the possibility of secret processes to protect their investments.

This is a somewhat lengthy letter, but I felt it was necessary to give you the reasons, as frankly as I could, why we must at this time, hold up the general publication of the technical details of any such device as the one you mention, despite the fact that we may have already fulfilled all the requirement of the Patent Law.—Hazeltine Electronics Corp., Jack Binns, Vice President.

Changes in Electrical and Photometric Units

In accordance with decisions of the International Committee on Weights and Measures, the National Bureau of Standards will introduce as of January 1, 1948, revised values of the units of electricity and of light. While the definitions of the units and the methods of fixing their magnitudes will be different from the present practical systems, the changes in magnitude will be so small as to affect appreciably only measurements of high precision. In certificates for standards and instruments issued by the Bureau during 1947 values will be given in both the old and the new units.

The electrical units of the "international" system will be superseded by those of the "absolute" system derived from the fundamental mechanical units of length, mass, and time by use of accepted principles of electro-magnetism, with the value of the permeability of space taken as unity in the centimeter-gram-second system or as 10^{-7} in the corresponding meter-kilogram-second system. Actually all of the common electrical units fall into the mks system.

The international units now in use were intended to be exact multiples of the units of the centimeter - gram-second electromagnetic system; but to facilitate their reproduction the ampere, the ohm, and the volt were defined by reference to three physical standards, namely, (1) the silver voltameter, (2) a specified column of mercury, and (3) the Clark standard cell. This procedure was recommended by the International Electrical Congress of 1893 in Chicago and was incorporated in an Act of Congress of July 12, 1894. However, modifications of the international system were found to be necessary for several reasons.

The original proposals were not sufficiently specific to give the precision of values which soon came to be required, and the independent definitions of three units brought the system into conflict with the customary simple form of Ohm's law, $I = E/R$.

The units of the new system will actually be maintained, as were the old international units, by groups of standard resistors and of standard cells, and the change to be made is most simply represented by stating the relative magnitudes of the ohms and of the volts in the two systems. The relations accepted by the International Committee on Weights and Measures at a meeting in Paris in October, 1946, are as follows:

1 mean international ohm = 1.00049 absolute ohms.

1 mean international volt = 1.00034 absolute volts.

The mean international of units to which the above equations refer are the averages of units as maintained in the national laboratories of the six countries which took part in this work before the war. The units maintained by the National Bureau of Standards differ

slightly from these average units; the conversion factors for adjusting values of standards in this country will be as follows:

1 international ohm (U.S.) = 1.000495 absolute ohms.
1 international volt (U.S.) = 1.00033 absolute volts.

Other electrical units will be changed by amounts shown in the following table:

1 international ampere = 0.999835 absolute ampere
1 international coulomb = 0.999835 absolute coulomb
1 international henry = 1.000495 absolute henries
1 international farad = 0.999505 absolute farad
1 international watt = 1.000165 absolute watts
1 international joule = 1.000165 absolute joules.

The factors given should be used in converting values given in international units in National Bureau of Standards certificates to the absolute system.

URSI-IRE Meeting

(*Continued from page 50*)

THE MEMORY TUBE AND ITS APPLICATION TO ELECTRONIC COMPUTATION, A. V. Haeff, NRL, Washington, D. C.—This interesting tube has for its purpose the retention, for any desired period up to many hours, of images of illuminated objects such as numerals produced by a computer or light traces on a radar screen. In appearance the tube resembles a television camera tube having a length of about 24 in. and a diameter of 5 in. At one end is the light-sensitive target on which the image is impressed. At the other end is located three guns, one for scanning, one for "holding" and one for "reading" the retained image. Electrostatic deflection is used. The image to be retained falls on the photosensitive screen where it is scanned by one of the three beams in a manner similar to the television camera tube. To fix or retain this image the "holding" gun (the beam from which is undeflected) sprays the entire screen with electrons. If it is desired to view the retained image on an associated CR viewing tube, the image on the memory tube is scanned by the "reading" beam which thus is able to furnish an output voltage, which when amplified, causes the image to be seen on the CR viewing tube which is scanned in synchronism with the "reading" beam.

MODES IN INTERDIGITAL MAGNETRONS, J. F. Hull, Signal Corps Eng. Labs., Bradley Beach, N. J.—Equations for the resonant frequencies and external Qs of the modes in conventional and inverted interdigical magnetrons were derived.

WIDE-BAND VELOCITY-MODULATED AMPLIFYING TUBES, E. Touraton, B. Zwobada and C. Dumousseau, *Laboratoire Central de Telecommunications, Paris, France.* — Modifications in the electron optics of klystrons considerably widen the frequency band over which a constant power gain can be obtained. Experimentally, a gain of 15 db, with a variation of only 1.5 db was obtained over a 50 mc band with an output power of 10 watts.

THE PROPAGATION OF ELECTROMAGNETIC WAVES ALONG HELICAL WIRES, Philip Parzen, Federal T. Labs., Nutley, N. J.

ANALYSIS OF PULSES WITH FREQUENCY SHIFTS DURING THE PULSE, R. T. Young, NRL.

RESULTS OF THE FLIGHT TESTS OF A COURSE LINE COMPUTER WITH OMNI RADIO RANGE AND RADIO DISTANCE MEASURING EQUIPMENT, F. J. Gross, CAA Exp. Station, Indianapolis, Ind. —This newly-developed equipment will permit a straight-line course to be selected by the pilot of a plane flying within 100 miles of a specially-equipped ground station and thereafter the computer will continuously supply Left-Right meter indications to the pilot, plus continuous indications of the distance to any desired destination on that track.

DIELECTRIC CONSTANTS OF H_2O, D_2O AND NITROBENZENE AT 3.2 CM, A. H. Ryan, NRL.—A definite difference in dielectric properties of water and heavy water was found using a modified shorted waveguide method.

CONDUCTIVITY OF IONIZED GASES IN THE MICROWAVE REGION, L. Goldstein and N. Cohen, Federal Tel. Labs., Nutley, N. J.—It is known that ionized gaseous media, under appropriate conditions, will conduct rf with but little attenuation. The particular case treated is that in which a gas discharge plasma, with variable charge density, is part of the center conductor of a coax line through which rf energy, distributed in a large spectrum, is to be controlled.

MICROWAVE Q MEASUREMENTS IN THE PRESENCE OF SERIES LOSSES, L. Malter and G. R. Brewer, NRL.—Measurements of Q involving a parallel resonant circuit should be corrected for series losses, if accurate determination is desired at the higher frequencies.

MICROWAVE TEST EQUIPMENT, W. J. Jones, Signal Corps Eng. Labs., Bradley Beach, N. J.—The development of this equipment through the war years was discussed, together with accuracies and efficiencies. Present developmental program of the Armed Services to overcome deficiencies was mentioned.

RF COMPONENTS FOR MILLIMETER WAVELENGTHS, Harold Herman, NRL. —RF components for the measurement of frequency, impedance, power, attenuation and propagation constants at 26-75 kilomegacycles and the extreme mechanical accuracy required, was discussed.

RADIO DIRECTION FINDER SET AN/CRD-1, Wm. Todd, Signal Corps Eng. Labs., Bradley Beach, N. J.—Auto-tracking metero. direction finder used for radio-sonde data, operating on 1,725 mc was described, together with some of its features which permit an accuracy better than 0.05° in elevation and azimuth.

Hazeltine FreModyne

(*Continued from page* 41)

poorer signal-to-noise ratio. For example, an 83-decibel (70-μv) signal gives approximately 20 decibels signal-to-noise ratio. The amount of radiation is considerably less than that of conventional superregenerative receivers and somewhat less than many conventionally designed medium-priced FM receivers.

The selectivity of the FreModyne circuit is better than that of many conventionally designed receivers. It is sufficient for good rejection of local stations, particularly when the receiver is side-tuned on the appropriate side of the desired signal, that is, away from the interfering signal.

The FreModyne circuit discriminates against impulse noise such as due to automobile ignition. The use of superregeneration makes the receiver periodically sensitive for short intervals, so that is completely ignores many impulses occurring between these intervals. The detector characteristic is logarithmic so that the large-amplitude noise pulses that are not ignored, are crushed or compressed.

Many manufacturers of radio receivers have started the design and production of FreModyne models. Production in large numbers is expected.

Typical FM performance data for an AM-FM set using the FreModyne circuit follows: (Values are averages for several Hazeltine and licensee developmental receivers).

Test Conditions: Frequency — average performance over 88-108 mc band; dummy antenna—300 ohms; standard output—0.05 watt; standard modulation: ±22.5 kc at 400 cycles.

Quieting sensitivity (S/N = 30 db) ..... 74 db (200 μv)

Maximum sensitivity (using 400-cycle filter) ..... 102 db (8 μv)

Audio power output (max. vol. —60 db. input) ..... 1 watt

Radiation: Oscillator frequency

14 μwatts (65 mv r-m-s); signal frequency (a short pulse of 10% duty cycle); peak pulse power 19 μwatts (75 mv r-m-s); average power 1.9 μwatts.

Field Measurements

(*Continued from page* 43)

N. J. and close to Cranberry Lake, N. J. This radial was selected because it runs over very hilly terrain and because it is the same radial used for the 67.25 and 288 mc measurements last summer. The signal is on the air from 10 in the morning until 4 in the afternoon on weekdays. Later, the antennas will be rotated so the beam will point at Princeton. Along this radial, the terrain is comparatively smooth.

Conference Intercom

(*Continued from page* 51)

In the Jordaphone system the basic difficulties of feedback are handled by a pair of electronically-controlled voice relays that reduce the gain of the listening channel to a point where it can not interfere during the speaking interval. This voice relay is adjusted to hold over the normal waits between syllables and sentences but to drop back so as to hold the line open for either party to continue if a definite hesitation occurs.

The system is housed in a well appointed walnut floor stand, so that a desk is unencumbered with any equipment except the telephone unit and a microphone. The amplifiers and their controls, housed below, are engineered for efficient, high quality reproduction and may be operated continuously.

The cradle on which the handset rests has both a self-contained microphone (below the receiver unit) that drives the local speaker amplifier, and a special microphone that delivers the amplified local speech to the transmitter end of the handset. The unit has adjustable levels of operation which can be set to handle voice at short, medium and long range distances away from the microphone location. The speaker section is likewise adjustable so that the service can be extended, if desired, to

serve the hard of hearing. A speech filter attenuates those frequencies produced by the operation of typewriters, etc., to quiet the signals from noisy locations.

The instrument enables complex organizations as well as individuals to speak with any or all of their associates on a single phone call. It is not necessary that the station called have one of the instruments. Checks have shown that the system can be applied to group conferences where it speeds up business by delivering clearer telephone speech, with more people participating, thereby banishing the necessity for repeating fragments of conversation to a diversified group.

TV Transmitter Design

(*Continued from page* 47)

The output circuit is then aligned.

The next step is to transfer the sweep patch cables from the final stage receptacles. From now on none of the three controls on the final stage output is disturbed, the three controls between the fourth and fifth amplifiers being adjusted using the same procedure described before. This time the center dip will be greater by the amount introduced by the fourth stage amplifier. It should be noted that during these adjustments, full plate voltages are on the stages which have been aligned so that any reaction on proceding stages is already present as succeeding adjustments are made. Therefore, once through the transmitter, no further change need be made in any of the circuits before placing the set in operation.

The tuning procedure is repeated for each of the lower powered stages in succession for a total of 5 in all. The only remaining circuits are the output of the modulated stage and input to the first amplifier. These circuits require special treatment.

In order to plate-modulate the modulated stage properly, it is necessary that its output circuit be tuned to a full double sideband bandpass characteristic corresponding to 8 mc, that is, four megacycles above and below the carrier. In order to measure this bandpass, a special pair of receptacles has been provided on the control panel for the external scope. They are connected to two crystals, one on each side of the push-pull circuit at the input to the first amplifier. These rectify the rf signal on the grid to display on the scope the amplitude characteristic of the intercoupling circuit between the modulated stage and the first amplifier.

It should be noted that the first amplifier is a grounded cathode stage in both transmitters. One of the reasons for this is that it is necessary to isolate the 8 mc input circuit of the first amplifier from its output. This is to prevent the following amplifiers, which are tuned mainly to the upper sideband, from having any effect on the impedance seen by the plates of the modulated stage. Upon completion of this last operation of alignment of the output of the modulated stage, the transmitter is ready for operation. All that is necessary is to turn the Output Test Detector switch to Operate and the Sweep switch to Off. By following the foregoing procedure the alignment

of the entire transmitter can be completed in a few minutes.

Accuracy of the markers can be checked very easily, if desired, by setting the Sweep switch to turn on both the sweep generator and the modulator at the same time then feeding, in turn, 0.75 and 4 mc from a video signal generator into the video input to the transmitter. By plugging the external scope into one of the receptacles used in examining the alignment, the normal bandpass and markers can be seen, plus the carrier with the video frequency as side bands. Since the carrier frequency is set by a crystal and the video signal generator has comparatively small error, the markers can be easily set to the accuracy required.

The modulator chassis is a vertical panel 19½ in. wide and 14 in. high. It consists of a video amplifier, which raises the signal from 1 volt peak-to-peak to approximately 80 volts peak-to-peak, dc insertion circuits, a sync stretcher and a "relay control" tube. Output tubes are a pair of GL-807's operating in a cathode follower circuit which connects directly to the modulated stage and supplies both ac and dc components.

The "sync stretcher" is a device for controlling the percentage of sync in a composite video signal. There are two reasons why it is necessary. First, the requirements of RMA state that the blanking level shall be 75% of peak sync in the studio output, and 75% of peak sync in the transmitter modulated output (the latter also being an FCC requirement). Since in practice a transmitter never modulates all the way to zero (100%) there is a "minimum white" signal which, added to the composite video signal, even with perfect linearity, results in a modulated output having a blanking level greater than 75%.

Sync Stretcher

The second reason is that in selecting radio frequency amplifier tubes of economical size for the required power level, some compression of the sync signal takes place. For these two reasons then it is necessary to increase the proportion of sync in the modulator in order that the blanking level will be exactly 75% of peak sync in the rf output. Fig. 3 is a schematic diagram of the way in which this is accomplished.

Tube Functious

The input feeds a black negative signal to the grid of a Type 4D32 tube. The sync stretching tube is a 6AG7 with its cathode connected in parallel with the cathode of the 4D32 across a common cathode resistance R. The sync stretching tube grid is set at a dc potential from a control on the operating console.

During the video portion of the transmission, the sync stretching tube is cut off because its cathode is too far positive to allow any current to be conducted. However, when the signal swings blacker than black, that is into the sync region, both cathodes drop toward ground potential and if the grid voltage of the sync stretching tube is adjusted to stretch sync, this tube will then begin to carry current. This current, flowing through the common cathode resistance R, increases the negatives bias on the 4D32 and produces a higher posi-

tive voltage in its output circuit.

A "relay control" tube is used to prevent overloading of the radio frequency tubes in case the input sync signals fail. A 5 kw visual transmitter is never required to develop more than 3,000 watts of average rf power under any operating condition (this is blanking level with sync signal). If, however, the sync signal should fail, as might be caused by a fault in the video cable to the transmitter, the dc insertion circuit would set a continuous level at peak sync.

In case of such failure a 6J5 "relay control" tube draws sufficient current to operate a relay which in turn makes the normal dc level setting circuit inoperative and sets a predetermined dc level at or below the blanking level. At the same time a pilot light flashes on the console notifying the operator of the condition. This feature is valuable not only in case of failure of the input signal but also for adjusting the transmitter when no video signal is available, since any operating level can be set by a manual control. It, also, facilitates making certain FCC tests which are concerned with frequency characteristics but do not require composite signals.

The television aural transmitters are air cooled frequency modulation equipments employing the phasitron modulator used in FM broadcast transmitters [1] [2] [3] [4] with only those changes required by different FCC specifications, RMA standards, and general design arrangements for good appearance and operation when installed with the visual transmitters.

Phasitron Modulator

Detail considerations for use of the phasitron tube in the FM broadcast modulator have been given in a previous paper[2]. Briefly, for the carrier swing of ±75 kc, at a modulation frequency of 50 cycles, an angular phase shift of 1500 radians is required. The phasitron permits a phase swing of ±3.5 radians without exceeding 1.5% distortion. Thus, multiplication of 432, obtained by use of four doublers and three triplers, is a satisfactory figure for FM broadcast service. Carrier frequency range 88 to 108 mc results in a frequency range for the modulator of 203 to 250 kc.

Television aural service, however, has 100% modulation specified as ±25 kc swing. In addition, the FCC recommends "satisfactory operation" at ±40 kc swing. Limits on distortion are the same as those for FM broadcast service. For the smaller swing of ±25 kc instead of ±75 kc, the FCC has specified an FM noise level of —55 db for television aural service compared with —65 db for FM broadcast service.

The authors wish to acknowledge the contributions of their associates, F. J. Bias, A. C. Gunn, J. L. Jones, A. J. Rhodehamel, C. A. Wadsworth and D. F. Warner, in the development and product design of these units.

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(1) Robert Adler, "Phasitron Modulator", FM and Television: December 1945.
(2) F. M. Bailey and H. P. Thomas, "Phasitron FM Transmitter", Electronics, vol. 19, pp. 108-112; October 1946.
(3) Robert Adler, "A New System of Frequency Modulation", Proceedings I.R.E., vol. 35, pp. 25-31; January 1947.
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Circular Polarization

(*Continued from page 40*)

had the signals radiated from the two antennas been equal the average ratio in the A columns should be equal to the average ratio in the B columns and this common ratio should be greater than unity. This results from the fact that the signal from the horizontal antenna varies with azimuth, and the signal from the vertical antenna should be adjusted to the mean value of these variations. However, in spite of this obvious misadjustment, the poorest ellipse eccentricity attributable to power unbalance is shown by the 1.16 ratio in the A column when θ equals 10°. This will cause only a 1.3 db. signal variation as compared to the 3 db. allowable limit.

Considering the $E_{45°}/E_{135°}$ and $E_{135°}/E_{45°}$ ratios in Table III the effect of change of phase of radiation with azimuth in the horizontal antenna and the phase change caused the high center of radiation in the vertical antenna are obvious. The corresponding values of the relative phase of radiation angle β obtained from the first equation also are given. At any vertical angle the range of phase variation of the horizontal radiation may be obtained by subtracting the value of β in the B column from its value in the A column. This yields an average value of 14.7° for this set of data. A large number of tests have placed the value nearer to the previously mentioned 16° overall variation.

The range of phase variation between the two antennas due to the high center of radiation of the vertical antenna may be obtained by subtracting the value of β in the A column where θ equals 20° from its value in the A column where θ equals 0°. The B columns should yield a similar result. The average of such calculation from Table III yields 13.5° overall phase variation. A large number of such tests has placed the value at 12°. By simple trigonometry this places the center of radiation of the vertical antenna at 34° above the center of radiation of the horizontal antenna.

The ellipses of Table III were further investigated by the use of the first equation to determine the exact value of ψ for the major axes. These values are given, Also, the ratio of the major to minor axis at this angle is given. It is obvious that in ellipses having the greatest eccentricity, namely A column where θ equals 0° and B column where θ equals 20°, the major portion of ellipse eccentricity is caused by phase variations since the voltage ratios at the 45° points are almost equal to the ratio between the major and minor axes.

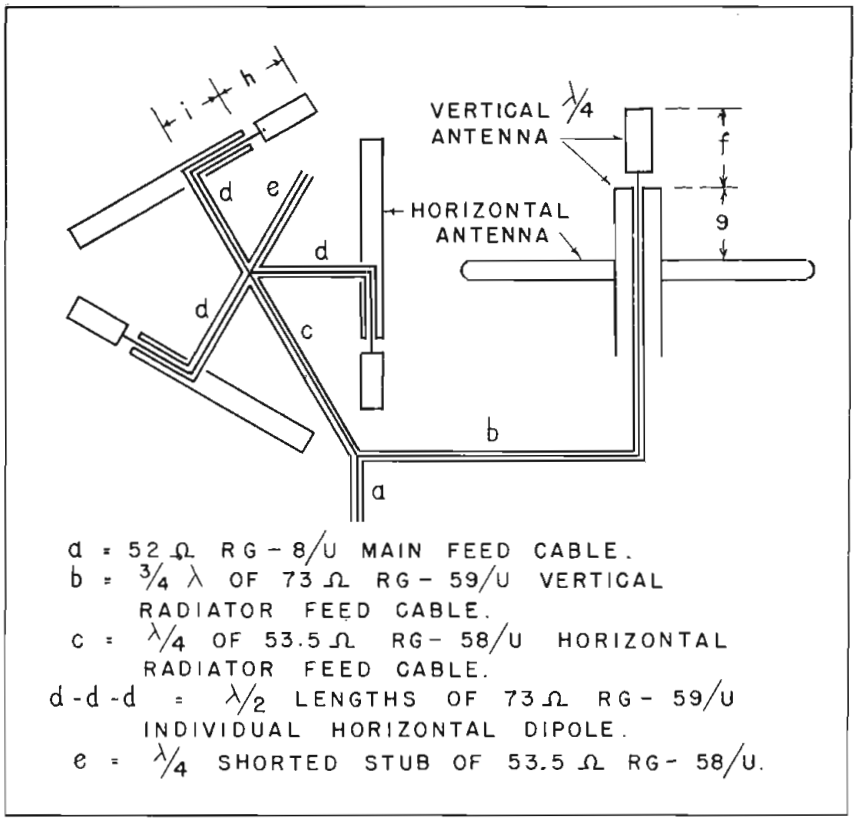

Fig. 10—Schematic of the feed cable system giving critical dimensions

Difficulty with manufacturing tolerances was anticipated because of the sensitivity of the polarization ellipse to phase variations, and variations in velocity of propagation and physical length of the cables. As a safety measure, all cables of each type for each antenna were cut from the same roll of cable. Little difficulty was actually experienced as tests on a number of production antennas showed them to vary only slightly in eccentricity of the polarization ellipses produced.

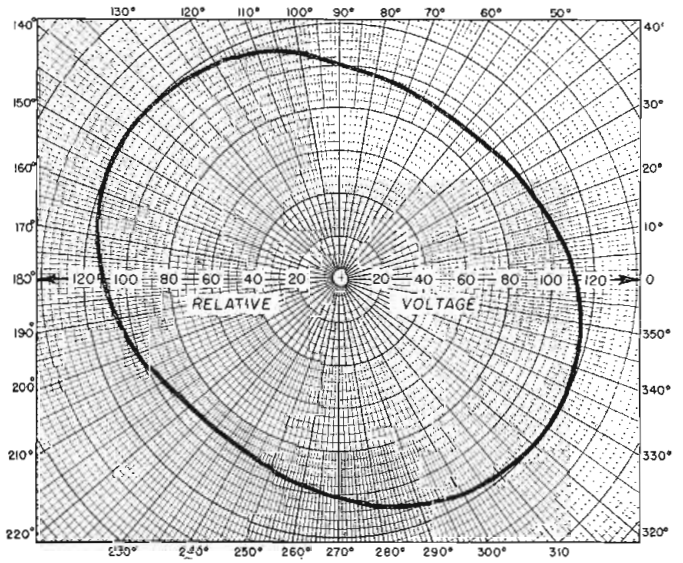

Fig. 11—Representative polarization ellipse taken at zero azimuthal and zenithal angles

TV Pick-up

(*Continued from page 48*)

complete transmitting and receiving equipment operating at about 60 mc had been installed at both ends of the link. In addition operating crews had the advantage of emergency Navy equipment set up for the purpose. This was used only once during a few moments when the 60-mc equipment was busy.

The frequency used for the video broadcast across the 14-mile stretch to the Chrysler building was 210 mc and the power was approximately 25 watts. Incidentally, all power was obtained directly from the ship's mains and it is stated that both frequency and regulation were maintained within close limits.

6873.5 MC Link

From the Chrysler building, picture signals were beamed to the Wanamaker control at a frequency of 6,873.5 mc and a power level of 100 milliwatts. From there the signal was transmitted by a combination of coax and telephone line to the WABD transmitter at 515 Madison Avenue. At the transmitter video and sound were monitored and mixed. At the same time the complete broadcast was put on the New York-Washington coaxial cable and broadcast by DuMont's WTTG in the Capital.

The actual broadcast was started at 9:40 a.m. It covered the rendezvous between the ships and the various military and religious services which were held on the Beatty. The sign-off was at 11 a.m.

RF Coil Finishes

(*Continued from page 55*)

adherence of most finishes as an additional coating.

The optimum finish devised during these tests to obtain stability, uniform control, and a reasonable low temperature coefficient is illustrated by curve No. 10. This finish consisted of a combination of Q-Dope liquid polystyrene (General Cement Co.) applied after a drying bake and followed, when dry, by a flash dip in No. 1436 wax (Zophar Mills) at 250°F with the coil preheated to 200°F.

ANNUAL INDEX

To TELE-TECH For 1947

The Annual Index has been arranged by subjects for easy reference to related topics. The first figure indicates the month in which the article appeared; the second figure indicates the page.

with the coil preheated to 200° F. This combination allows the wax which contributes a negative temperature coefficient to penetrate only a sufficient amount into the coil and textile covering of the conductors to neutralize the positive contribution added by the lacquer.

Zero Coefficient

The resulting temperature coefficient is practically the same as the original coil, and a mechanically stable combination is provided. A similar combination of the wax and another RF lacquer, Q-Max, shown by curve No. 3, has a higher temperature coefficient, while curve No. 13 for a combination of Q-Dope and a thick coat of Sarco Compound has the same overall effect (on this type of coil, and at this frequency) as Q-Max.

The wax coating can be built up in thickness by additional flash dips, thereby increasing the moisture resistance and reducing the effect of surface moisture films mentioned above. With two controlled flash dips in wax, a coil with practically zero temperature coefficient has been produced experimentally, but, due to the danger of over compensation with a resulting variation of coefficient with temperature, this was not attempted for production use on critical military equipment.

Curve No. 12 of Fig. 6 covering wax impregnation is of considerable interest in connection with commercial and domestic radio receivers which are not required to operate at extreme hot or cold temperatures. The average temperature coefficient of inductance is minus 70 parts per million per degree C over the range from 20 to 50°C. Since circuit distributed capacitance, tube interelectrode capacitances, variable capacitors, fixed IF tuning capacitors, and (often most important of all) bakelite wafers of switches and tube sockets have fairly large positive temperature coefficients of capacitance, considerable compensation can be derived by using the wax impregnation finish (assuming that a wax of similar characteristics is used).

(To be concluded)

TELE-TECH

Advertisers, December 1947

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

WAVE PROPAGATION

BOOKS REVIEWED

AUTHOR INDEX

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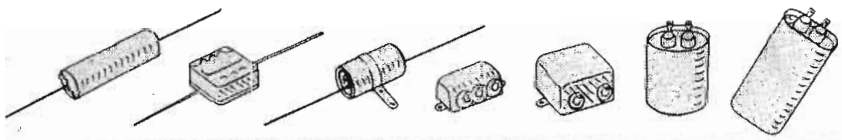

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SC 477

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3D22	5551	673	OC3/VR105
884	5552	816	OD3/VR150
2050	5553	857-B	
5563		866-A	
		869-B	
		8008	

*Miniature type

CATHODE-RAY TUBE AND CAMERA TUBE TYPES					
BULB DIAM.	TELEVISION		OSCILLOGRAPH	PICKUP	MONOSCOPE
	Directly Viewed	Projection	PI Screen		
2"			2BP1	5527	
3"			3KP1	(2P23	
			5UP1	(5655	
5"		5TP4			2F21
7"	7DP4				
	7JP4				
8"				1850-A	
10"	10BP4				

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		
8025-A	4-125A/4D21	
9C21	8D21*	
9C22		
9C25		
9C27		

*Twin type

PHOTOTUBE TYPES		
GAS	VACUUM	MULTIPLIERS
1P41		
921	922	931-A
927	929	
930		

RECEIVING TUBE TYPES									
RECTIFIERS	CONVERTERS	VOLTAGE AMPLIFIERS						TWIN DIODES	POWER AMPLIFIERS
		TRIODES			PENTODES				
		Single	Twin	With Diodes	Sharp Cutoff	Remote Cutoff	With Diodes		
MINIATURE									
	1R5			1U5	1D4	1T4			3S4
									3V4
6X4	6BE6	6C4	6J6	6AQ6	6AG5	6BA6			
				6AT6	6AU6	6BJ6		6AL5	6AQ5
				6BF6					
35W4	12BE6		12AU7	12AT6	12AU6	12BA6		12AL5	35B5
117Z3					12AW6				50B5
METAL AND GLASS									
1B3GT/8016	6SA7	6J5	6SC7	6SQ7	6SJ7	6SK7	6SF7	5V4-G*	6K6GT
5U4G			6SL7GT	6SR7		6SS7		6H6	6L6G
5Y3GT			6SN7GT						6V6GT
6X5GT									6BG6G
35Z5GT	12SA7			12SQ7		12SK7			35L6GT
									50L6GT

*Recommended only for television damper applications.

For complete technical data on these preferred tube types, refer to the RCA HB-3 Handbook.

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