TELE·TECH

Formerly the TELE-communications TECH-nical Section of

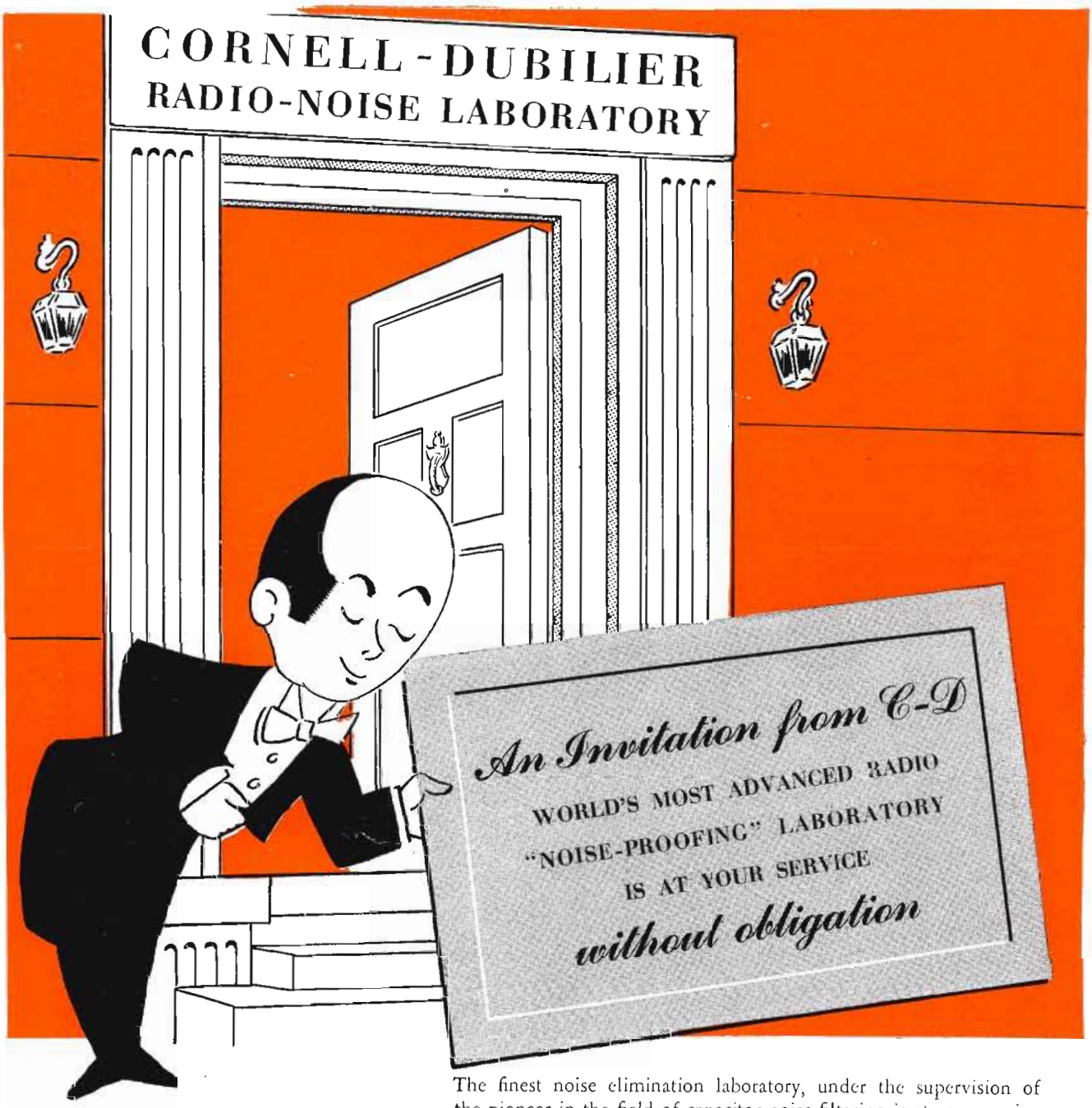
ELECTRONIC INDUSTRIES

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

August · 1947

IN THIS ISSUE

CALDWELL-CLEMENTS, INC.



The finest noise elimination laboratory, under the supervision of the pioneer in the field of capacitor noise-filtering, is at your service.

A simple way to accept this invitation from Cornell-Dubilier: — send a sample of the equipment or appliance you want noise-proofed to *our* laboratory — make full use of its facilities — consult with our engineers as though they were on your own payroll. *That's the way to solve your noise and spark suppression problems quickly and efficiently.* There is absolutely no charge for this service.

No other capacitor manufacturer can equal C-D's thirty-seven years of experience in the design and manufacture of noise filters and spark suppression devices for every conceivable type of electronic and electrical equipment. Cornell-Dubilier Electric Corporation, Dept. H7, South Plainfield, N. J. Other large plants in New Bedford, Brookline and Worcester, Mass., and Providence, R. I.

Make Your Product More Saleable With C-D Quietone Interference and Spark Suppressors

1910 1947

CORNELL-DUBILIER

WORLD'S LARGEST MANUFACTURER OF

CAPACITORS

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TELE-TECH

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ELECTRONIC INDUSTRIES

AUGUST, 1947

Editorial Contents

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

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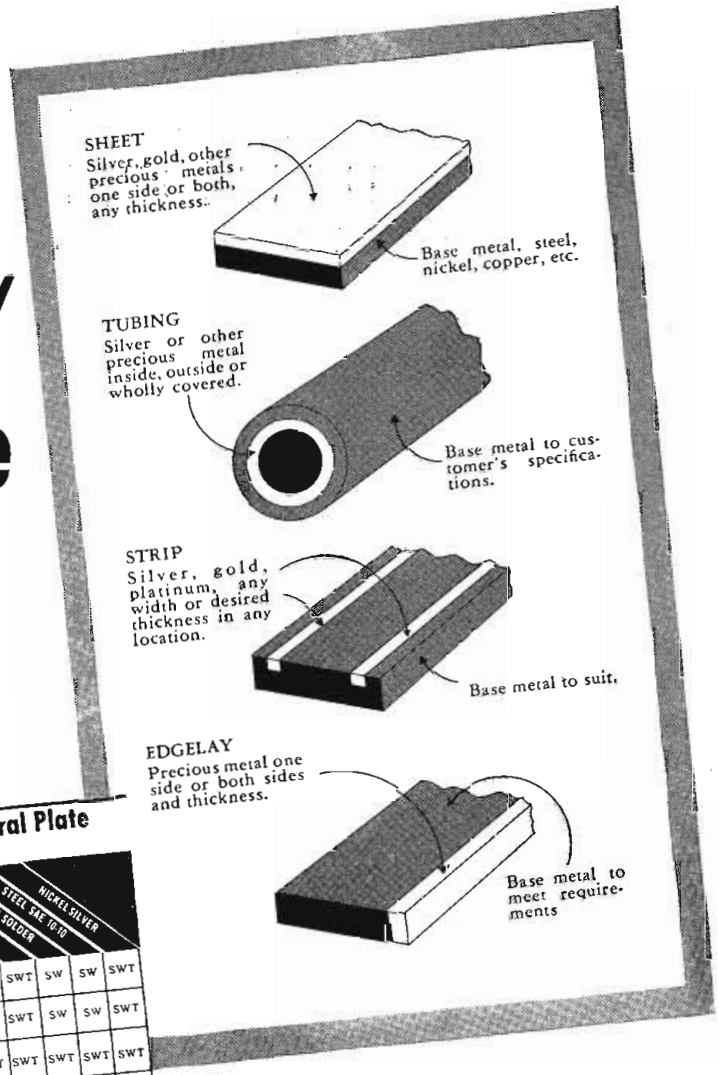
On the spot where you need it...that's why

General Plate Laminated Metals Save You Money



A few typical combinations produced by General Plate

OTHER Combinations on Request

S = SHEET W = WIRE T = TUBING

	Platinum	Palladium	Gold	Silver	Aluminum	Brass	Copper	Beryllium Copper	Iron	Invar	Stainless Steel	Phos. Bronze	Monel	Nickel	Silver Solder	Steel SAE 10-10	Nickel Silver
Platinum			SWT	SWT		SWT	SWT		SW	SW		SWT	SWT	SWT	SW	SW	SWT
Palladium			SWT	SWT		SWT	SWT		SW	SW		SWT	SWT	SWT	SW	SW	SWT
Gold	SWT	SWT		SWT	SWT	SWT	SWT	SW	SWT	SW	SW	SWT	SWT	SWT	SWT	SWT	SWT
Silver	SWT	SWT	SWT		SWT	SWT	SWT	SW	SWT	SW		SWT	SW	SW	SWT	SWT	SWT
Aluminum			SWT	SWT		S	SWT										
Brass	SWT	SWT	SWT	SWT	S				SW	SW	S	SW	SW	SWT	SWT	SWT	
Copper	SW	SWT	SWT	SWT	SWT				SWT	SW		S	SW	SWT	SWT	SWT	SWT
Beryllium Copper			SW	SW							S	S	S	SW	SW	S	
Iron	SW	SW	SWT	SWT		SW	SWT						S	S	S		SW
Invar	SW	SW	SW	SW		SW	SW		S			S	S		S	S	
Stainless Steel			SW			S			S	S				SW	SWT	SWT	SW
Phos. Bronze	SWT	SWT	SWT	SWT		SW	S		S	SW							SWT
Monel	SWT	SWT	SWT	SW		SW	SW		SW	S	S	SW				SW	SW
Nickel	SWT	SWT	SWT	SW		SWT	SWT		SW	S	S	SWT				SW	SW
Silver Solder	SW	SW	SWT	SWT		SWT	SWT		S			SWT	S	S		S	SWT
Steel SAE 10-10	SW	SW	SWT	SWT		SWT	SWT				S		SW	SW	SW	S	SW
Nickel Silver	SWT	SWT	SWT	SWT			SWT		SW	SW	S	SWT	SW	SW	SWT	SW	

Because General Plate Laminated Metals give you silver or other precious metal only where you need it . . . at the point where precious metal performance is required . . . they save you money — especially with today's high cost of precious metals.

In addition, these metals give you such outstanding advantages as better electrical conductivity, high corrosion resistance, easier fabrication, greater strength, easier soldering or brazing.

General Plate Laminated Metals will help simplify your design problems and increase performance in such products as electrical equipment, chemical apparatus, radio and electronic devices.

Investigate versatile, cost-saving General Plate Laminated Metals, today. Write for information.

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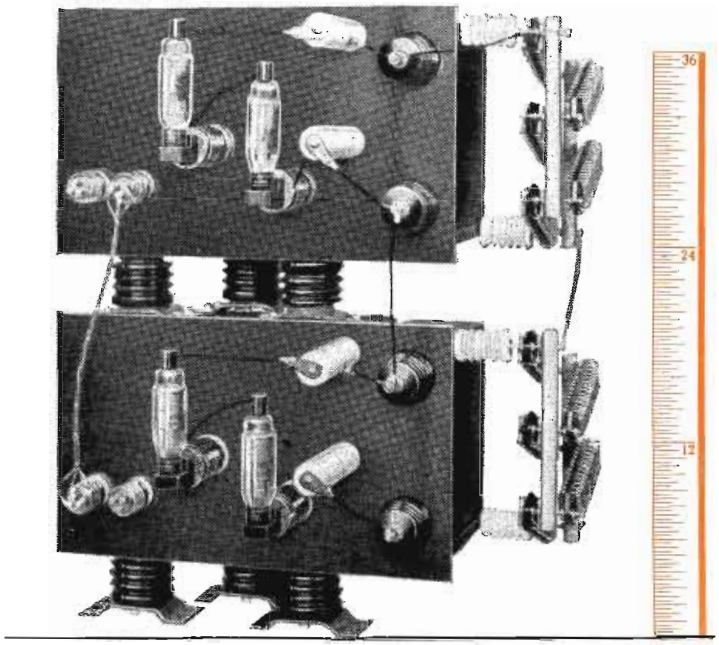

This unit, 40 inches high, delivers 70 kv., d-c. Consists of two basic Kenotron-tube rectifier units.

Now SMALL RECTIFIERS FOR D-C VOLTAGES up to 165 KV

New, within the last year, is this small cascade-type rectifier for generating smooth high d-c voltages. Suitable for laboratory and factory for testing and as power supply. Features: versatility, reliability, reasonably priced and long tube life with much lower cost of replacement tubes. Operates from 115-volt, single-phase, 60-cycle power supply.

Basic unit is a 35-kv, 30-ma (continuous) rectifier, with necessary transformers mounted in an oil-filled steel tank. Basic unit is 32″ wide, 18″ deep and 20″ high. Up to five units can be stacked, giving d-c voltages up to 165 kv. Output voltage ripple, peak to peak, will not exceed 0.1% per milliampere.

Control Panel Optional. This unit can be supplied with a control panel which will provide smooth output voltage control over the complete range from zero to maximum. Accuracy of output voltage, with this panel, is ± 5 per cent of full scale; accuracy of current indication, ± 2 per cent. Overcurrent protection is included.

Suitable for integral mounting. Because of its small size, this rectifier can often be mounted within the enclosure housing your own product. Such integral mounting is usually preferable from all standpoints—lowers cost, saves space, and improves appearance of the entire assembly.

Standard units, in regular production. These cascade rectifiers are built up of standard units that are in regular production. They can be shipped on shorter schedules than are normal for this general class of equipment.

For prices and specific information, address inquiries to our nearest office, or to *Apparatus Dept., Section A401-49, General Electric Co., Schenectady 5, N.Y.*

GENERAL ELECTRIC

401-49

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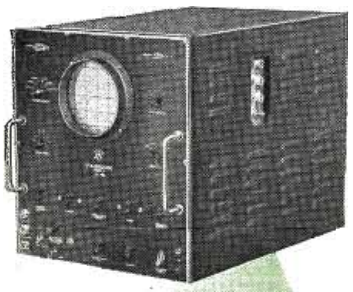
SYLVANIA LABORATORY EQUIPMENT

SYNCHROSCOPES



The Sylvania Synchroscope Model 5 is essentially a 5" cathode-ray oscilloscope for examining detailed structure of a portion of a periodic waveform. It incorporates a trigger generator which develops periodic pulses for synchronizing purposes. Fields of application include radar, television, pulse-time-modulation, loran, supersonics, geophysical exploration. Also available: Models 5E, P4, P4E.

THERMISTOR BRIDGES

The Sylvania Thermistor Bridge Model TBN-7SE is a radio frequency bridge providing direct reading RF power measurements. Bridge is independent of frequency; designed for continuous operation at normal laboratory ambient temperatures.

Model TBN-6SE is a radio frequency bridge providing direct reading low RF power measurements. It consists of a precision Wheatstone bridge circuit; a stabilized source of 2,000 cycle power supplying the bridge; a source of stable d-c power for substitution measurement of the RF power; and amplifier for indicating balance or degree of unbalance.

With the Model TBN-6SE, full scale meter indications from 25 microwatts to 2 milliwatts are obtainable with a high degree of accuracy.

VACUUM TUBE BRIDGE TEST EQUIPMENT

Capacitance Bridge Type 125 permits measurement of interelectrode capacitances in vacuum tubes and other multi-electrode systems. Provision is made for balancing out and measuring the direct conductance associated with the capacitance under test.

Vacuum Tube Bridge Test Set Type 129 is designed to measure the dynamic characteristics—mutual conductance, plate resistance and amplification factor—as well as the static characteristics of receiving type vacuum tubes. Several power supplies, with provision for metering them, are arranged to supply a 561-D General Radio Vacuum Tube Bridge. Operator fatigue has been minimized in this set by console-type control and meter arrangement.

SPECTRUM ANALYZERS

The Sylvania Spectrum Analyzer provides a convenient means of studying the energy spectrum of microwave generators operating as pulsed oscillators or modulated CW oscillators. Output of magnetron, klystron, rocket and similar UHF and SHF tubes can be readily investigated. Models available: TSS-4SE for 3,000 Mc region; TSX-4SE for 9,300 Mc region; TSK-2SE for 24,000 Mc region.

WRITE FOR COMPLETE TECHNICAL INFORMATION

SYLVANIA ELECTRIC

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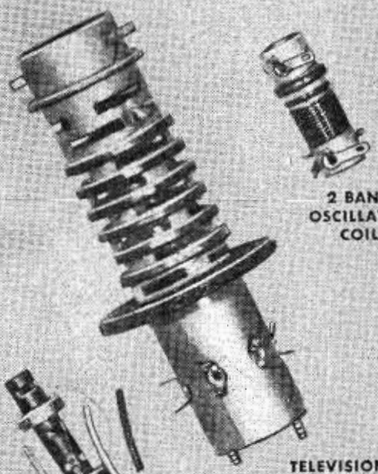
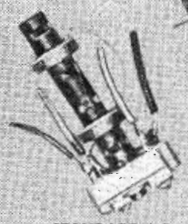
ELECTRIC PRODUCTS CORP.



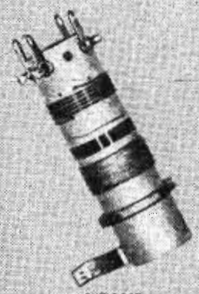
2 BAND OSCILLATOR COIL

TELEVISION HI-VOLTAGE COIL



STANDARD I-F TRANSFORMER 455 kc

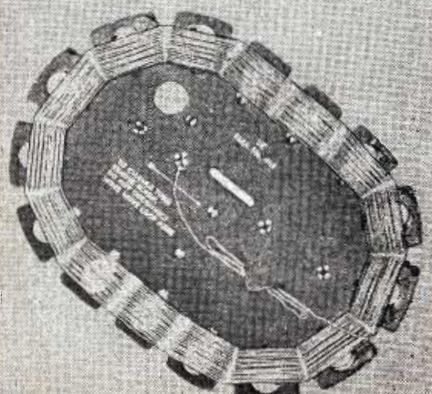
OSCILLATOR TRANSFORMER 35-50 kc



3 BAND ANTENNA COIL

2 BAND ANTENNA COIL

3 BAND OSCILLATOR COIL



LOOP ANTENNA

These electronic components are examples of the superiority of SUPER design and craftsmanship techniques. Built into each is the kind of durable quality and performance that compliment the units in which they are used.

In addition to the components described, SUPER will build to customer specification.

USE OF THE FOLLOWING SUPER ELECTRIC CO. COMPONENTS *Indicated by dots*	420 mmf RMA STANDARD GANG			365 mmf RMA STANDARD GANG			35 mmf	
	TUNING RANGE			TUNING RANGE			TUNING RANGE	
	535–1620 kc	1.6–5.6 mc	5.6–19.25 mc	535–1620 kc	2.0–6.0 mc	6.0–18.0 mc	88–112 mc	TELEVISION
OSCILLATOR COIL	•	•	•	•	•	•	•	•
LOOP ANTENNA	•			•				
ANTENNA COIL	•	•	•	•	•	•		•
R-F INTERSTAGE TRANSFORMER	•	•	•	•	•	•	•	
BAND PASS ANTENNA COIL (Double Tuned)	•			•				
BAND PASS R-F COIL (Double Tuned)	•			•				

STANDARD I-F TRANSFORMERS 455 kc

STANDARD F-M COILS

I-F 10.7 mc (¾" x ¾" and 1¼" x 1¼" Square Can)
COMBINATION AM-FM I-Fs, 455 kc and 10.7 mc

TELEVISION COILS

VIDEO I-Fs 12.75 mc and 26.4 mc
VIDEO I-F ASSEMBLIES CENTER FREQUENCY 23.52 mc
SOUND I-Fs 21.9 mc

SOUND DISCRIMINATOR — 21.9 mc

VIDEO PEAKING AND FILTER COILS

LOOP ANTENNAS *by* SUPER

1. MULTI-BAND COMBINATION LOOP ANTENNA AND RADIO BACK
2. BROADCAST LOOP ANTENNA AND RADIO BACK COMBINATION WITH PHONE JACK, OUTSIDE ANTENNA CONNECTION, ALIGNING TRIMMER
3. HIGH Q LOOP ANTENNA, POLYETHYLENE INSULATED WIRE
4. BASKET WEAVE LOOP ANTENNA

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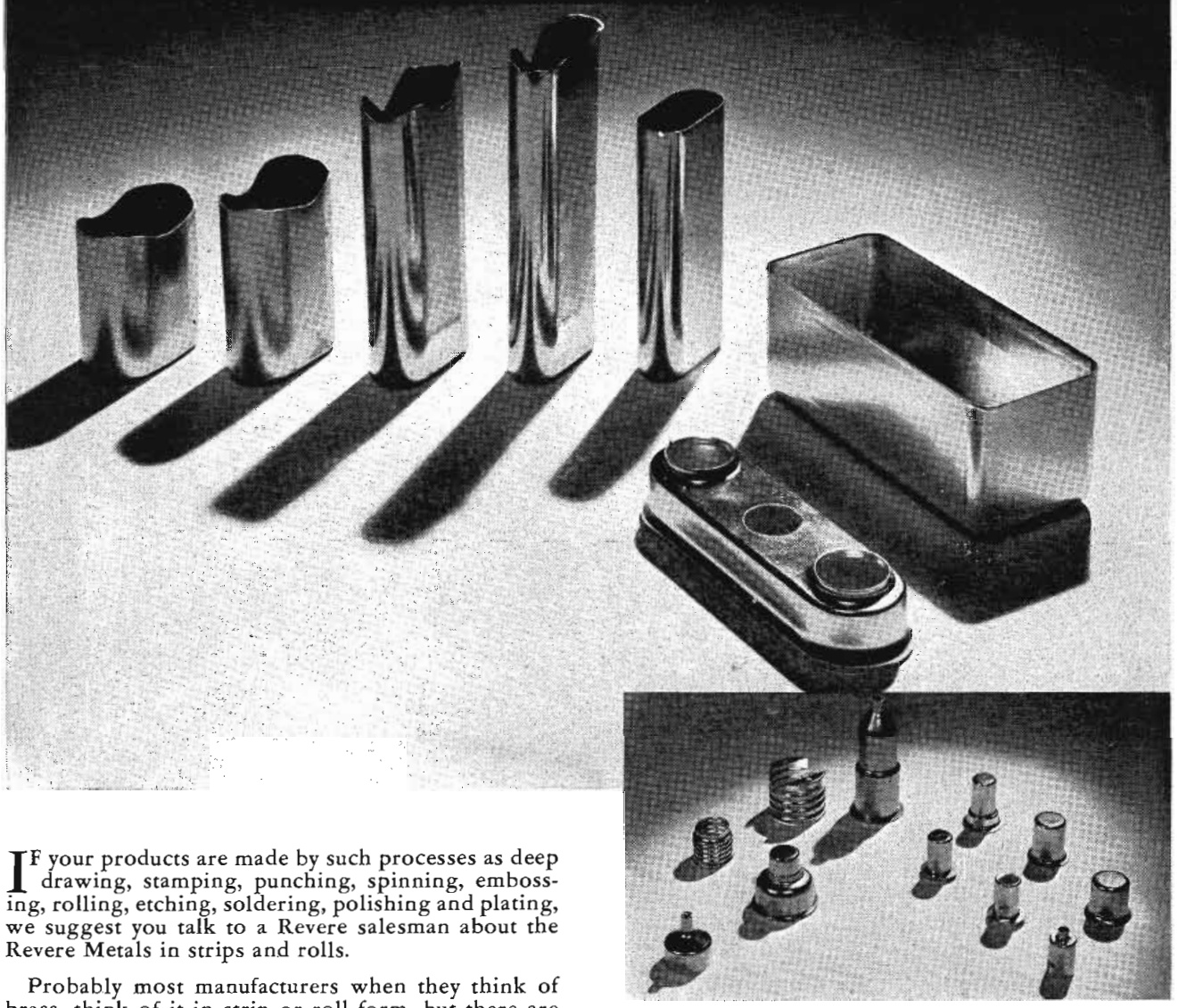

IF your products are made by such processes as deep drawing, stamping, punching, spinning, embossing, rolling, etching, soldering, polishing and plating, we suggest you talk to a Revere salesman about the Revere Metals in strips and rolls.

Probably most manufacturers when they think of brass, think of it in strip or roll form, but there are other things to be considered, such as alloy, temper and finish. Revere produces strips and rolls in brass, also copper, bronze, nickel silver and cupro-nickel, and each is available in a range of physical characteristics.

Specification may seem obvious to you, or it may not. In any case, it is suggested that you permit a Revere salesman, and if necessary a Revere Technical Advisor, as well, to study your production methods and end products. Revere customers in numerous cases have been able to effect important economies by following our recommendations for changes in such things as alloy, gauge, temper, and dimensions of strips and rolls. For example, a change in temper may reduce the number of anneals, and a reduction in width may cut material costs and lessen the amount of scrap. Strips and rolls are exceptionally useful forms of the Revere metals, and Revere will gladly cooperate with you in studying the important subject of specification.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

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Why this team can bring

ACTIVE DEVELOPMENT of loudspeakers moved forward after World War I, when Western Electric produced the 196W, employing a non-magnetic diaphragm driven by an armature. First used in the Victory Loan campaign of 1919, the 196W took part in the national political conventions of 1920, the presidential inauguration of 1921, and the burial of the Unknown Soldier later the same year. Success of these pioneer public address systems rested not only on loudspeakers but also on high quality microphones and amplifiers—all Western Electric developments.

Continual progress in the intervening years has kept pace with the development in Bell Telephone Laboratories of telephone transmitters and receivers for the Bell System. Fundamental to both loudspeakers and telephones have been the Laboratories' pioneering studies in sound, speech, hearing and the theory of vibrating systems.

Sound distribution systems, sound motion pictures and radio broadcasting—all have benefited from the teamwork which has done so much to make possible today's efficient, powerful, wide-range loudspeakers.

1919. New York's Victory Loan celebration pioneered the art of reaching tremendous audiences. 113 Western Electric speakers made possible this mass demonstration of the new art.

1924. Non-directional, small in size, yet extremely wide-range for its day, the 540 cone speaker designed for broadcasting was so popular for home receivers that it became a symbol of early radio.

1926. The 555 Receiver, with its large wooden horn, contributed to the success of sound motion pictures. From this single-unit loudspeaker grew the high quality wide-range theatre speaker systems of today.

1937. The introduction of the 750 series of loudspeakers provided the first really wide-range direct radiator. With the proper mounting, this speaker covers a frequency band from 80 to 10,000 cycles. Still a popular speaker.

you loudspeakers like these

728B 12" direct radiator, 30 watts continuous capacity. Frequency response 60 to 10,000 cps.

757A two unit system, using 728B plus separate high frequency speaker. Frequency response 60 to 15,000 cps.

756A 10" direct radiator, power handling capacity 20 watts, response 65 to 10,000 cps.

755A 8" direct radiator, 8 watts capacity. Response 70 to 13,000 cps.

TODAY Western Electric offers a complete line of wide-range direct radiators, high frequency speakers, horns and multi-unit systems all designed by Bell Telephone Laboratories. There's one to meet your requirements for highest quality sound whether you want an eight inch, eight watt speaker, or a giant theatre-type system with 120 watts capacity.

No matter which you select, you get the benefit of a broad experience which long antedates the public address art.

— QUALITY COUNTS —

Distributed by GraybaR
OFFICES IN 95 PRINCIPAL CITIES

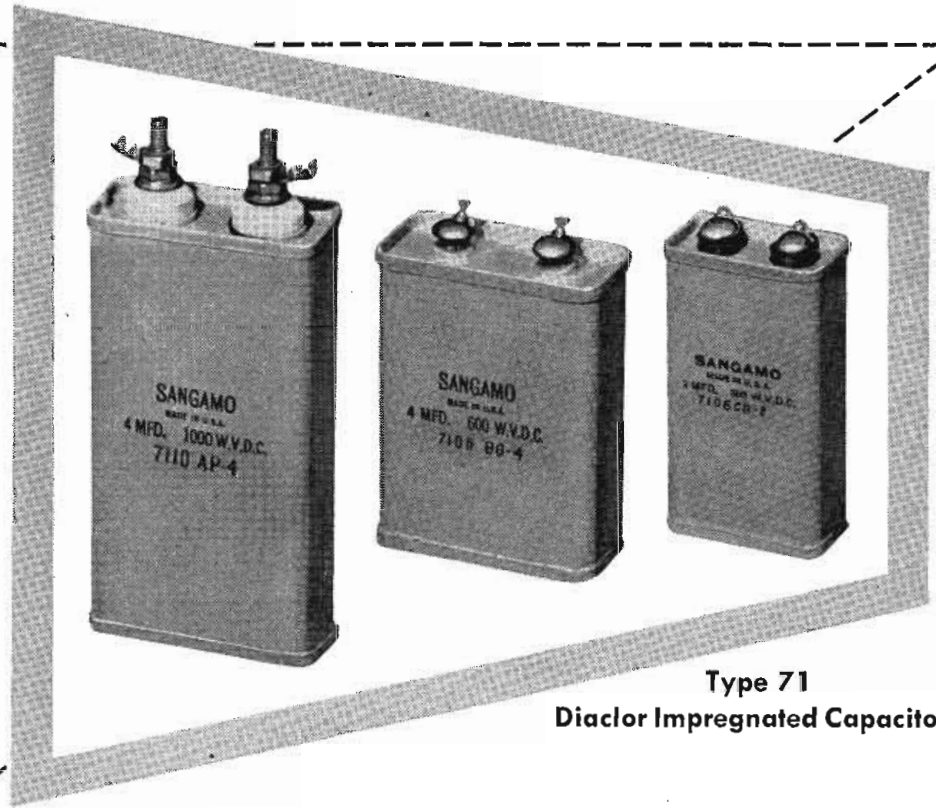
1943. Battle announce speaker designed for the United States Navy hit a new high in intelligibility and power. Used on all types of Navy ships, they passed commands to fighting men over the noise of battle.

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.

SANGAMO

CAPACITORS
PAPER
MICA • SILVER



Type 71
Diaclor Impregnated Capacitors

CREDENTIALS *that* QUALIFY

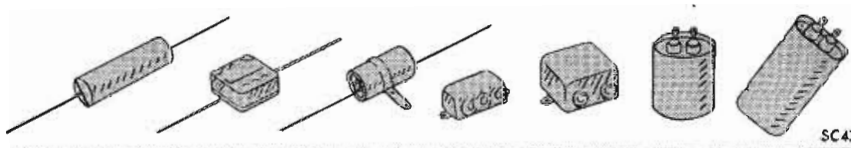
• Diaclor Impregnated to Assure Greater Uniformity of Production • Stable Capacity Over a Wide Range of Temperatures • Excellent By-Pass and Coupling Qualities • Available Within a Range of 600 to 6000 Volts Working, or Higher . . . these are the credentials that qualify Sangamo Type 71 Diaclor Impregnated Capacitors as Blue-Ribbon entries for broadcast and aircraft transmitters, industrial applications, and in high-voltage circuits of all kinds.

Diaclor, the chlorinated dielectric used by Sangamo, permits greater uniformity of production because of its controllable characteristics. *Smaller sized capacitors, for use where space is at a premium, are made possible because of its high dielectric constant.* Fire hazard due to accidental leakage is eliminated because Diaclor is non-inflammable and non-explosive.

Type 71 capacitors have high insulation resistance and low direct current leakage. They can be supplied with either composition rivet, screw type, hermetically-sealed pyrex glass or stand-off porcelain terminals, and with your choice of four types of mounting brackets. They are available in a wide range of capacities.

Sangamo manufactures a complete line of paper, mica, and silver capacitors for every radio and electronic application. A quarter of a century of experience in building better capacitors, with new and more exacting requirements and greater accuracy demanded each year, give Sangamo capacitors—of all kinds—Credentials that Qualify!

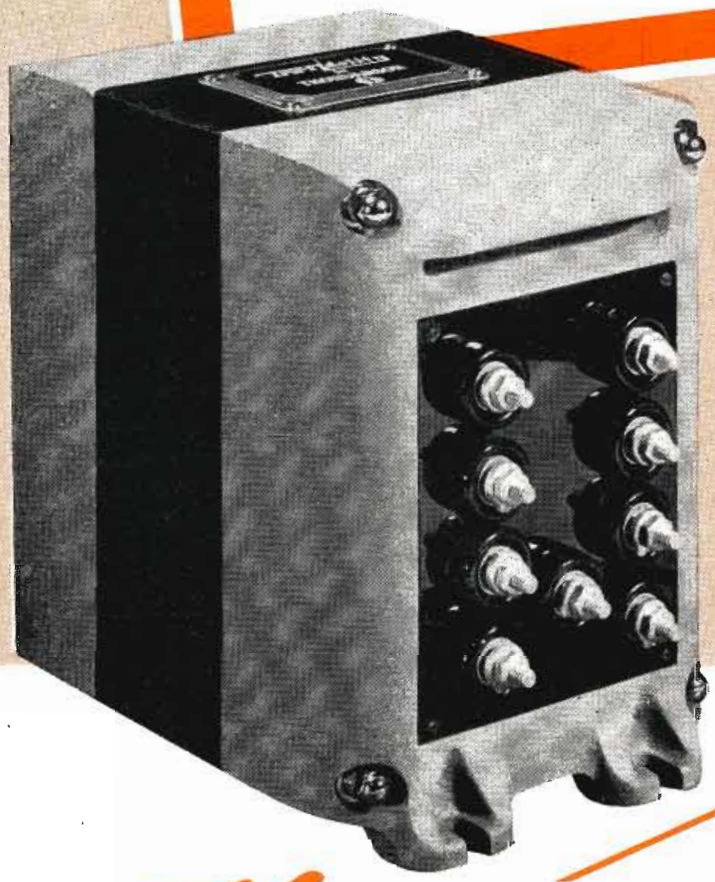
Write for the new Sangamo Capacitor Catalog.



SC473

SANGAMO
ELECTRIC COMPANY
SPRINGFIELD • ILLINOIS

THORDARSON TRANSFORMERS



A GUARANTEE OF QUALITY PERFORMANCE FOR OVER HALF A CENTURY!

For over fifty years Thordarson has led the field in the development of fine transformer equipment. The first to build transformers for specific industrial applications, this company has also pioneered many improvements in manufacture, among them the superior coil and core materials used throughout its entire line. Thordarsan's vigorous policy of research and development, together with an unusually high production standard, has made its name a guarantee of quality... an assurance of trouble-free performance among engineers everywhere.

Our technical staff is available to assist you with your transformer problems. We are especially equipped to handle those transformers which require a high degree of engineering skill and which must be manufactured to very rigid specifications. Send us full details as to your requirements today.

Thordarson

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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.

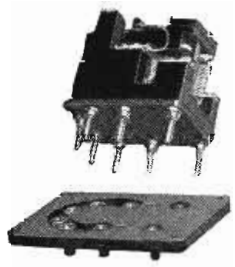
PREFERRED RATINGS

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 7/64	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 6/16	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.

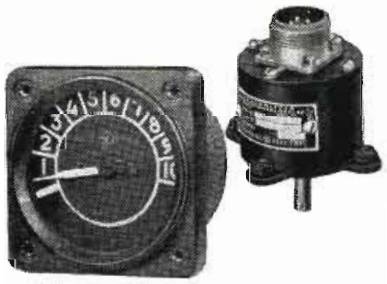
REMOTE POSITIONS THAT ARE ACCURATE

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

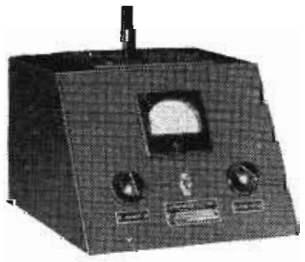
TIMELY HIGHLIGHTS ON G-E COMPONENTS



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

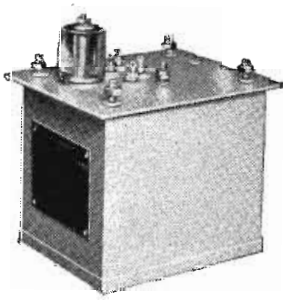
High-speed production testing of small coils is possible with this General Electric low-voltage tester which shows the presence of short-circuited turns in unmounted coils and gives an approximate indication of the number of short-circuited turns. The coil to be tested is simply slipped over the core 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. B 642-15
Apparatus Department, Schenectady 5, N. Y.

Please send me:

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

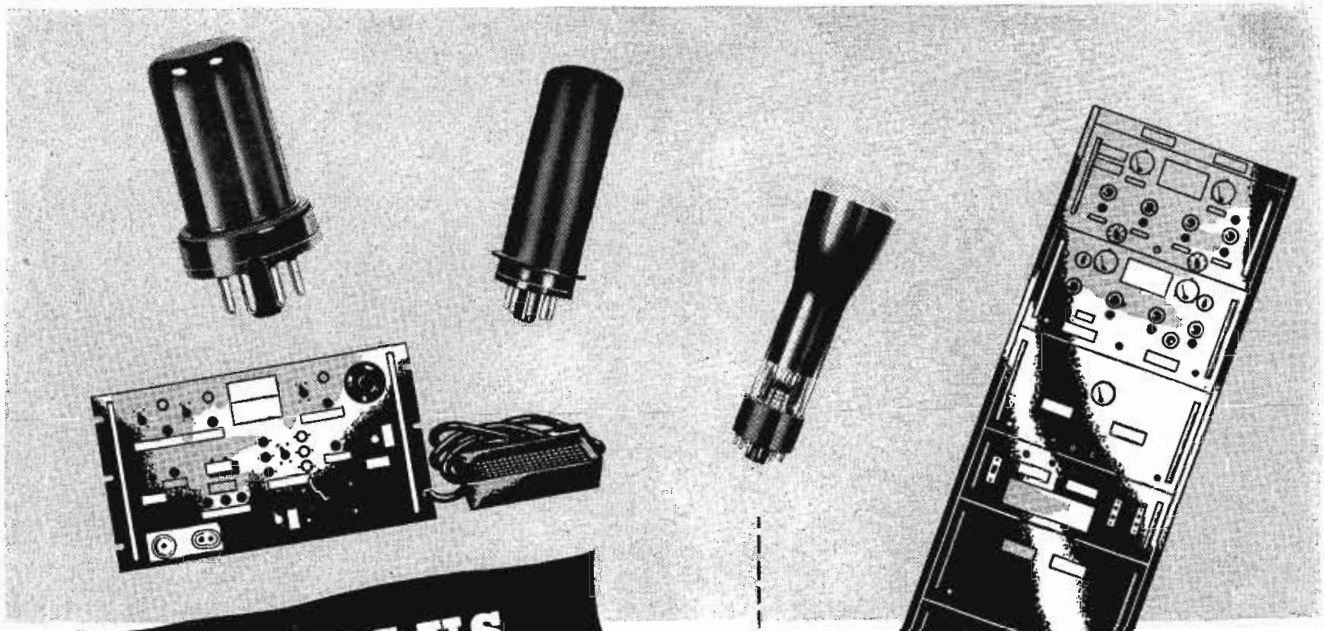
NOTE: More data available in Sweets' File for Product Designers

Name.....

Company.....

Address.....

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



SURPLUS ELECTRONIC EQUIPMENT

MANUFACTURERS
JOBBERS
WHOLESALERS

The War Assets Administration, through its network of Approved Distributors, is offering electronic tubes, devices and equipment which were declared surplus by the Armed Forces. Take advantage of this great opportunity to fill your present and future needs at fraction-of-cost prices. Most inventories still permit wide selection.

Purchasing of this equipment has been simplified to a high degree. The WAA Approved Distributors listed at right were appointed on a basis of their ability to serve you intelligently and efficiently. Write, 'phone or visit your nearest Approved Distributor for information concerning inventories, prices and delivery arrangements. You'll find you can "Save with Surplus."

OFFICE OF AIRCRAFT AND ELECTRONICS DISPOSAL

WAR ASSETS ADMINISTRATION

Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cincinnati Cleveland • Dallas • Denver • Detroit • Fort Worth • Helena • Houston • Jacksonville Kansas City, Mo. • Little Rock • Los Angeles • Louisville • Minneapolis • Nashville New Orleans • New York • Omaha • Philadelphia • Portland, Ore. • Richmond St. Louis • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane • Tulsa

1282

BOSTON, MASS.
Automatic Radio Mfg. Co., Inc.
122 Brookline Ave.
Technical Apparatus Co.
165 Washington St.

BUCHANAN, MICH.
Electro-Voice, Inc.
Carroll & Cecil Sts.

CANTON, MASS.
Tobe Deutschmann Corp.
863 Washington St.

CHICAGO, ILL.
American Condenser Co.
4410 N. Ravenswood Ave.
Belmont Radio Corp.
3633 S. Racine Ave.

EMPORIUM, PENNA.
Sylvania Electric Products, Inc.

FORT WAYNE, IND.
Essex Wire Corp.
1601 Wall St.

HOUSTON, TEXAS
Navigation nstrument Co., Inc.
P.O. Box 7001, Heights Station

LOS ANGELES, CALIF.
Cole Instrument Co.
1320 S. Grand Ave.
Hoffman Radio Corp.
3761 S. Hill St.

NEWARK, N. J.
National Union Radio Corp.
57 State St.
Standard Arcturus Corp.
99 Sussex Ave.
Tung-Sol Lamp Works, Inc.
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NEW ORLEANS, LA.
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NEW YORK, N. Y.
Carr Industries, Inc.
1269 Atlantic Ave., B'klyn.
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353 W. 48th St.
Emerson Radio & Phonograph Corp.
76—9th Ave.
General Electronics, Inc.
1819 Broadway
Hammarlund Mfg. Co., Inc.
460 W. 34th St.
Johanns & Keegan Co., Inc.
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Newark Electric Co., Inc.
242 W. 55th St.
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Radio Parts Distributing Co.
128 W. Olney Road

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SALEM, MASS.
Hytran Radio & Electronics Corp.
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SCHENECTADY, N. Y.
General Electric Co.
Bldg. 267, 1 River Road

WASECA, MINN.
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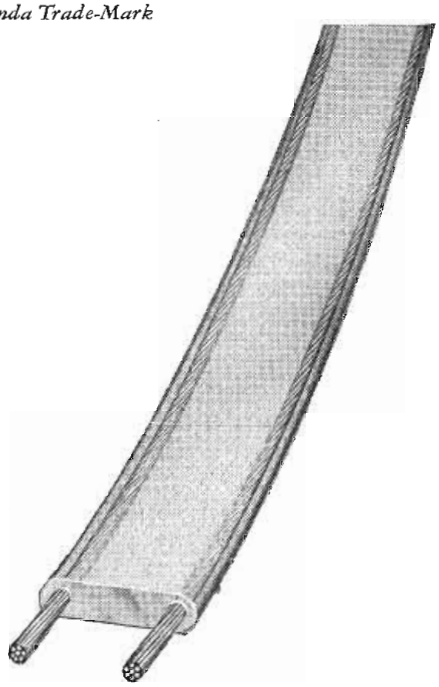
Anaconda

type ATV* FM and television lead-in lines

THE WELL BALANCED DESIGN of conductors and dielectric in Anaconda Type ATV lead-in lines fulfills the exacting requirements of wide-band reception. For FM and television reception, these lead-in lines minimize the effects of attenuation and impedance mismatch—providing maximum freedom from distortion.

Anaconda offers to the industry a wide selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded—each designed for a particular application. 47441

An Anaconda Trade-Mark



Now you can choose!

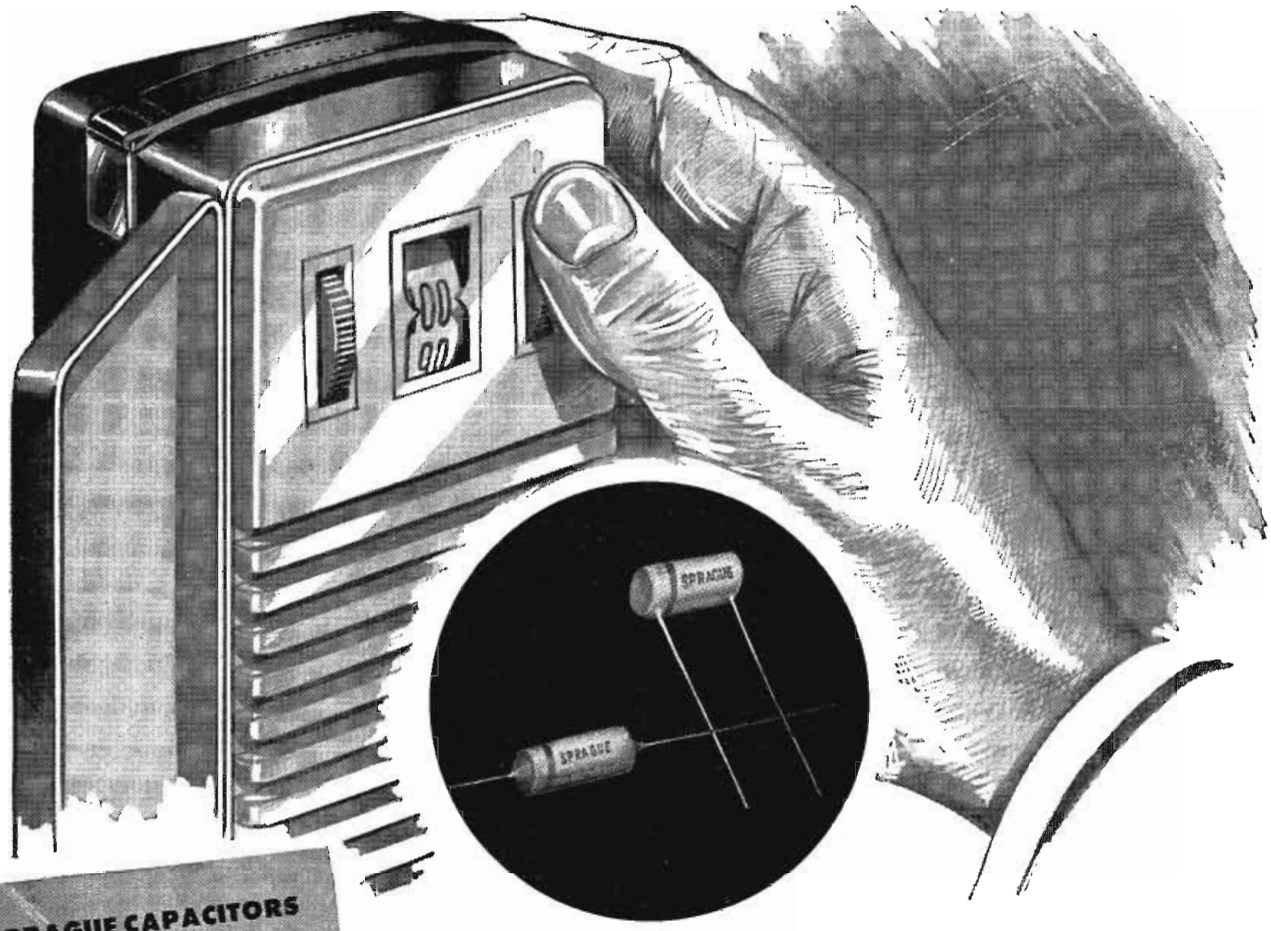
THIS OR THIS

For Uniform Transmission Characteristics Use Anaconda High-Frequency Cable

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

ANACONDA from mine to consumer

ANACONDA WIRE AND CABLE COMPANY



SPRAGUE CAPACITORS

Dry Electrolytic
High-Voltage Networks
Mica Dielectric
Motor Starting
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Power Factor Correction
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*Vitamin Q Dielectric

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Meg-O-Max High-Resistance High-Voltage Types
Precision Meter Multipliers, etc.

Write for Catalog on any type.

DEPENDABLE * MIDGETS

Sprague * Midget Capacitors are the first small size paper dielectric tubulars to operate dependably at 85°C., to have adequate humidity protection, and to be priced for widespread use in small radios and other electronic equipment. Made by new processes and of new materials, they are a direct result of Sprague experience in engineering reliable capacitors for the proximity fuse and other small wartime electronic assemblies. Write for Sprague Data Bulletin 202. Samples gladly submitted to your specifications.

SPRAGUE ELECTRIC COMPANY, NORTH ADAMS, MASS.

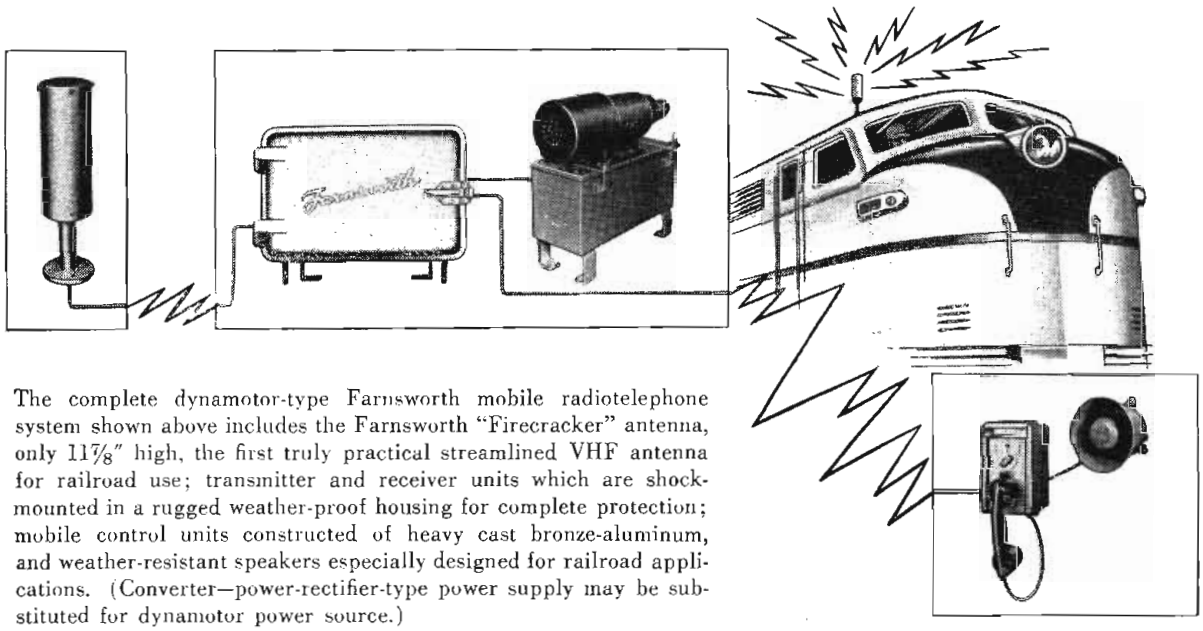
SPRAGUE

PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS

*Trademarks Reg. U. S. Pat. Off.

Farnsworth

RADIOTELEPHONE SYSTEMS BUILT *specifically* TO MEET RAILROAD SERVICE REQUIREMENTS



The complete dynamotor-type Farnsworth mobile radiotelephone system shown above includes the Farnsworth "Firecracker" antenna, only 11⅞" high, the first truly practical streamlined VHF antenna for railroad use; transmitter and receiver units which are shock-mounted in a rugged weather-proof housing for complete protection; mobile control units constructed of heavy cast bronze-aluminum, and weather-resistant speakers especially designed for railroad applications. (Converter—power-rectifier-type power supply may be substituted for dynamotor power source.)

RADIO has already demonstrated its usefulness in railway operations. The design of proper specialized equipment for the practical application of this dependable communications tool in railway service is, however, dependent upon a thorough knowledge of the uuique and exacting requirements of railway operation.

Because Farnsworth engineers have secured this knowledge through their pioneering accomplishments in adapting radio to railroad operations, Farnsworth is today producing VHF communications systems that have been *specifically designed and precisely developed for railway service.*

Standardized design and unitized construction are only two of many important engineering results of Farnsworth's pioneering, long-term development and field-testing program in railway radio communications. They give Farnsworth equipment these practical features:

- The same receiver, transmitter, and in some cases, power supply and remote control unit, is usable for mobile, wayside or relay installations, thus providing complete interchangeability of basic equipment.
- Because all connections are made by a single, break-away plug, transmitters, receivers and power converters can be instantly disassociated for purposes of maintenance or relocation without manually disconnecting a single wire.
- Personnel unlicensed by the FCC and without technical training can replace all units of Farnsworth systems.

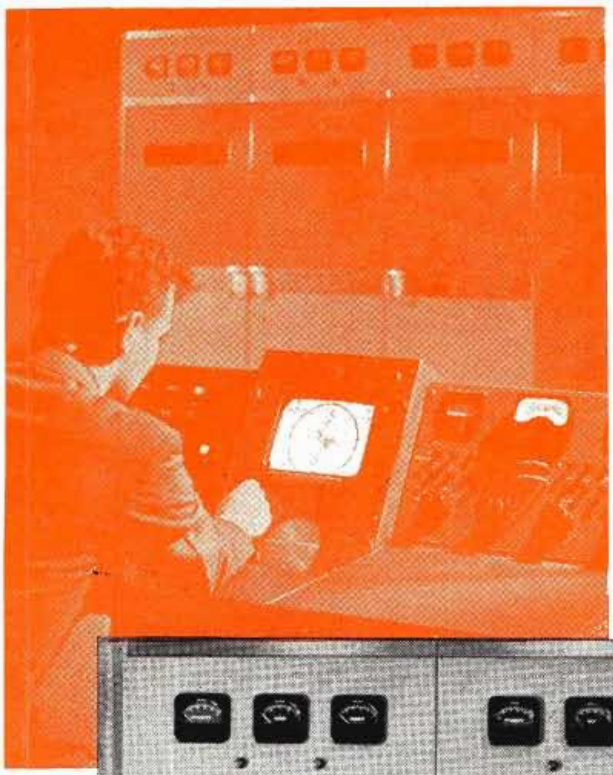
Only Farnsworth radiotelephone systems offer all these vital service and maintenance advantages. For complete information write Farnsworth Television & Radio Corporation, Dept. TT-8. Fort Wayne 1, Indiana.

Farnsworth

Television · Radio · Phonograph-Radio

Farnsworth Radio and Television Receivers and Transmitters • Aircraft Radio Equipment • Farnsworth Television Tubes • Mobile Communications and Traffic Control Systems for Rail and Highway • The Farnsworth Phonograph-Radio • The Capehart • The Panamuse by Capehart

Already chosen to bring



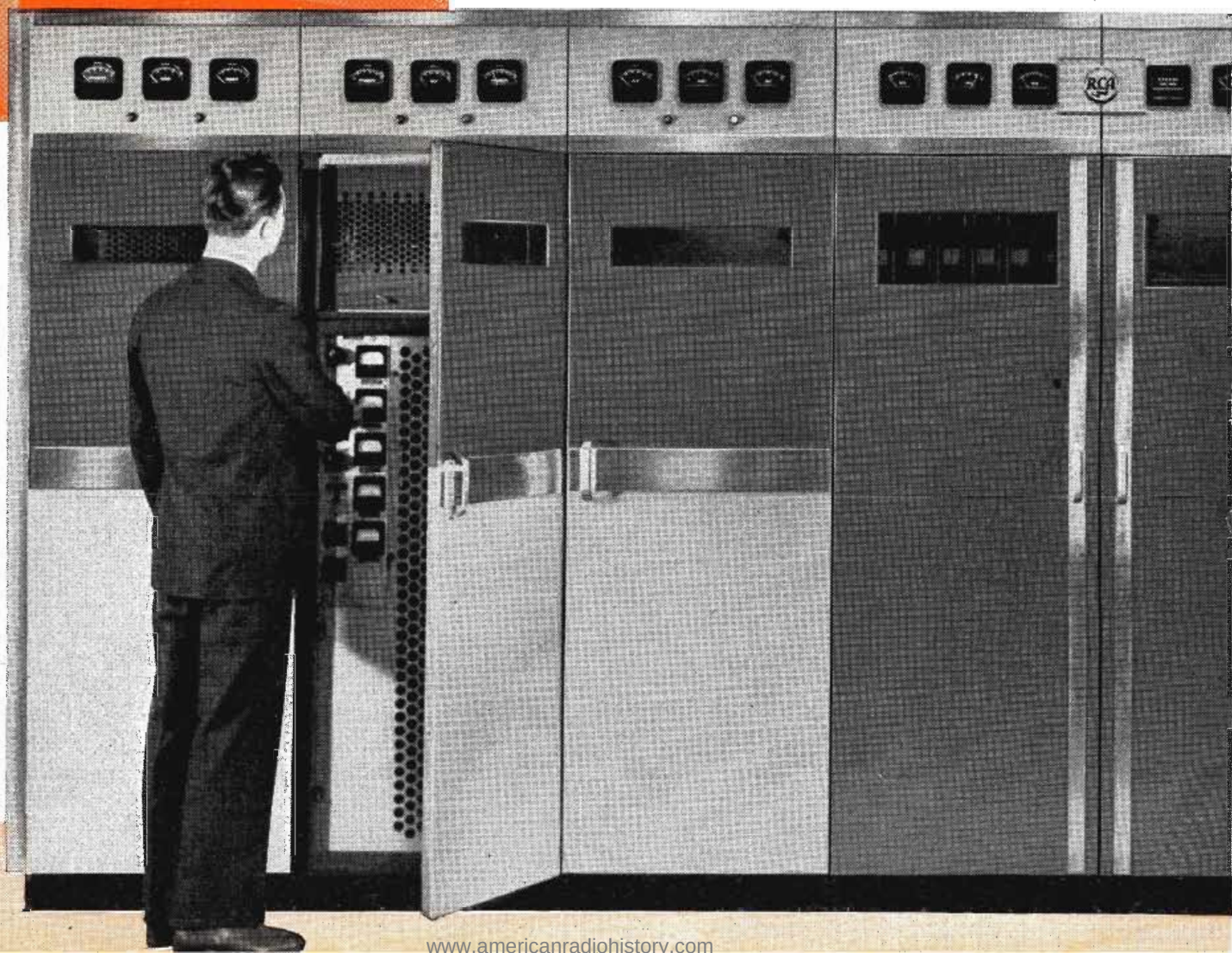
Deliveries of RCA's 5-kw "All Channel" television transmitter now being made to 21 top stations

Here's the transmitter that is putting television on the map *now* . . . in many of the nation's key cities.

Announced only four months ago, 21 leading broadcasters have already recognized its design advantages with orders. Four transmitters have already been shipped . . . and it is expected that the others will be shipped this year. The combined radiated power of these stations will blanket approximately 50,000 square miles . . . bring *clear, high-definition* television pictures within reach of 38,143,000 people.

Stage-by-stage, this transmitter has everything you might want for your new station. Here are the highlights:

FINGER-TIP CONTROL for all operating and monitoring functions. Monitoring facilities permit observation of the picture and its waveform. New RCA console handles both sound and picture signals—simplifies getting transmitter on the air and keeping it there.

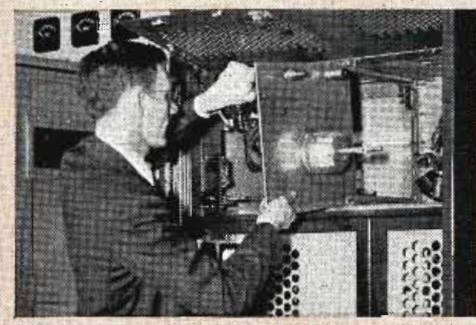


television to 38,000,000 people

• Covers all 12 metropolitan channels and assures a full 5-kw signal on each channel • Divides into eight relatively small, lightweight units (25 by 36 by 80 inches) for easy handling and installation and flexible station layout • Facilitates inspection and servicing with its "walk-in" type construction • Simplifies transmitter operation due to similarity in design between the sound and picture transmitters • Eliminates complicated tuning adjustments — a high-level modulation system permits the use of meter-tuned, narrow-band drivers . . . *only one* modulated stage to adjust • No neutralization of modulated PA stage • Employs radically new tubes in the output stages — RCA 8D21 twin tetrodes — permitting unusually small r-f drivers • Requires fewer spare tubes — only 15 types.

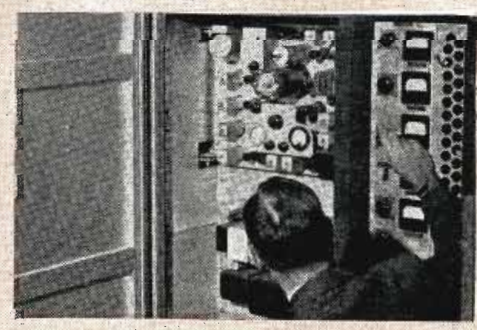
From every standpoint, the RCA TT-5A is comparable in convenience, performance, and operating economy with today's finest AM transmitters.

Be sure to get your copy of the new bulletin which fully describes and illustrates its many advantages to the station engineer, manager, owner, and audience. Write Dept. 98-H.

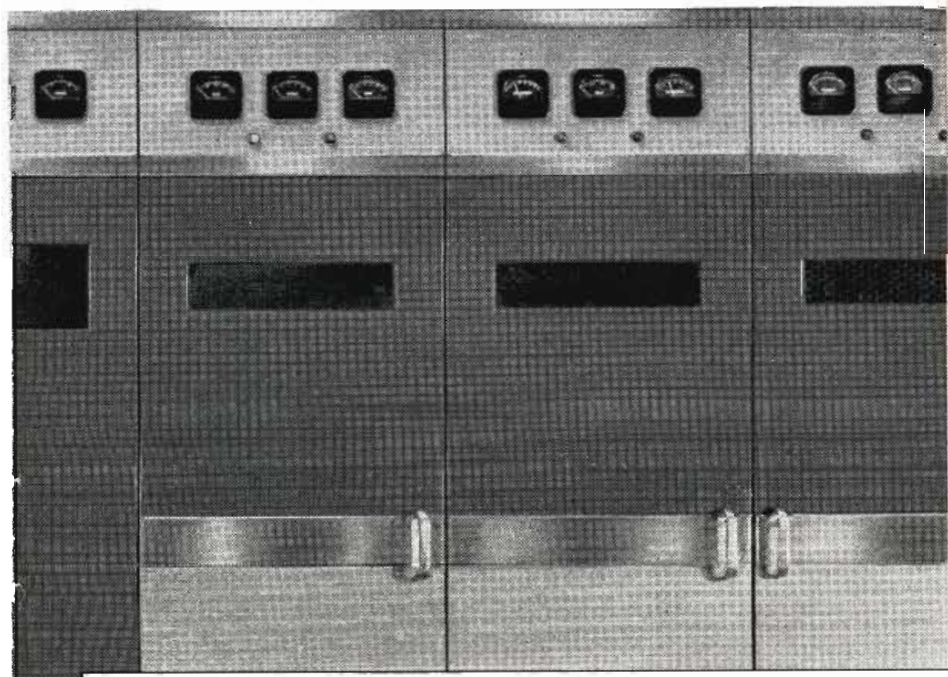


SIMPLIFIED TUBE CHANGING—When a PA tube change is necessary, the tube and special mounting plate can be removed as a unit and a spare assembly slid into place and connected in a matter of minutes.

WALL-MOUNTED UNITS afford easy access to all tubes and wiring. Rear doors further increase ease of reaching all components. Illustration above shows portion of the aural transmitter's r-f driver unit.



THE "DIRECT FM" EXCITER for the sound channel. Uses only four r-f tubes; does not involve phase multiplication. Inherently capable of lower noise and distortion than any exciter yet developed.



TELEVISION BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

SHERRON offers you an All-Inclusive ELECTRONICS SERVICE

RESEARCH

DESIGN

DEVELOPMENT

ENGINEERING

MANUFACTURING

For Efficient, Economical Production

Are your present manufacturing processes proving too costly? Are outmoded methods exacting a heavy toll in waste time, manpower, materials? You'll find Sherron's all-inclusive electronics service worth looking into.

There's the Sherron laboratory. A full-fledged service in itself, noteworthy for research and development facilities. No mere auxiliary department, but a vital function in the integrated Sherron operation.

A full complement of seasoned electronics engineers and physicists are on hand to initiate your project. Practical, realistic, their job is to explore new ideas, track down new applications to make the tool of electronics do a better job for industry.

Their creative and fact-finding talents, meshed with the skills and resources of Sherron's manufacturing staff, can benefit you in many ways. Why not arrange for a talk with the Sherron management? You will find it worth-while and revealing.

TYPES OF CUSTOM BUILT SHERRON TEST EQUIPMENT

GENERAL TEST EQUIPMENT:

(A) Vacuum Tube Test Equipment — Automatic Production Tube Test Equipment. Electronic Reject circuits provide only positive rejects. Eliminates meters, places quality control in hands of quality control men. (B) Other characteristic test sets for receiving, small transmitting and power tubes, cathode-ray and kinescope tubes. Basic characteristic tests — dynamic and static — and bridge measurements are incorporated. Designed and manufactured to individual needs on custom built basis.

TELEVISION TEST EQUIPMENT:

(A) Television Signal Synthesizer. Includes generating, viewing and transmitting test equipment. Sync generators, monoscopes, shapers, timers, wide band oscilloscopes, air monitors, measuring devices and field survey equipment.

COMPONENT TEST EQUIPMENT:

(A) Focusing and deflection coils. (B) Resistor and condensor testing. (C) Wire and insulation test equipment. (D) Relays, transformers, chokes and other iron components.

All the above available on custom built basis. Designed, developed and manufactured to customers' specs and needs.

INSTRUMENTATION AND MEASURING DEVICES:

(A) A.C. Bridge Measuring: Radio frequency Cathode-ray Null Detector—1 mc operation. Cathode-ray Null Detector — 1000 cycle measurements. (B) D.C. Vacuum Tube Voltmeters and Ammeters: Measurements of minute voltages and currents necessary for laboratory research. (C) Multi-Wave Shape Generator: Source of several wave shapes, including negative and positive pulses and a trigger pulse; used in testing amplifiers at audio and video frequencies. (D) Computers and Calculators: Summing amplifiers — impedance matching networks. (E) Control of Measurements: Flow indicators — sorting, counting, etc. — Measurement of chemical titrations — electronic measurement of surface strains, stresses, films, non-linear surfaces.

All the above designed and manufactured to customers' requirements and specs on custom built basis.

Sherron Electronics W2XDK

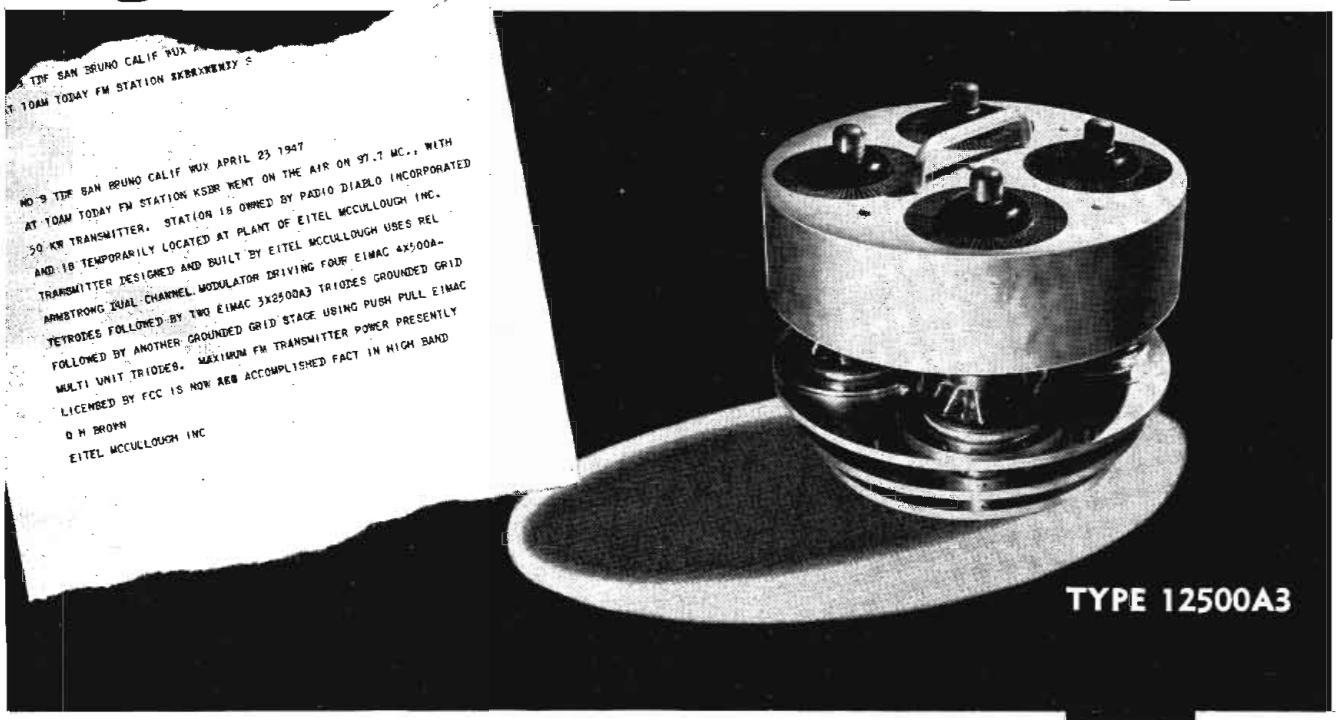
SHERRON ELECTRONICS CO.

Division of Sherron Metallic Corporation

1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK

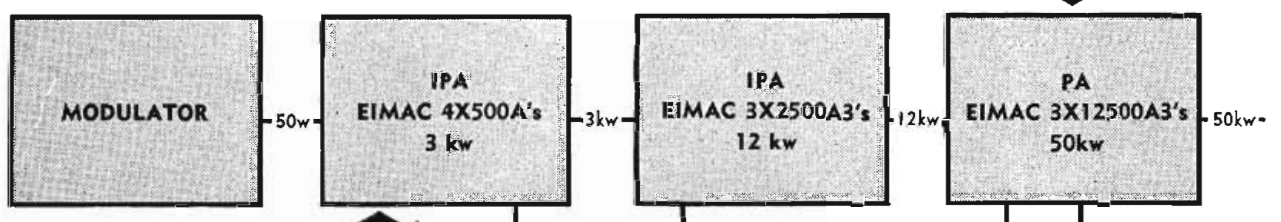
50kw. FM..

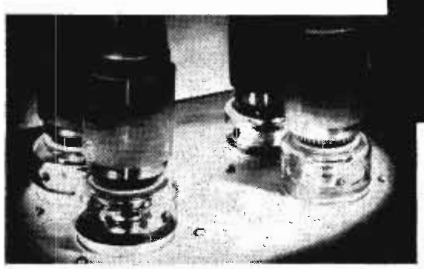
High Band FM Comes Of Age..



NO 9 TDF SAN BRUNO CALIF WUX APRIL 23 1947
AT 10AM TODAY FM STATION KSBR WENT ON THE AIR ON 97.7 MC., WITH
50 KW TRANSMITTER. STATION IS OWNED BY RADIO DIABLO INCORPORATED
AND IS TEMPORARILY LOCATED AT PLANT OF EITEL MCCULLOUGH INC.
TRANSMITTER DESIGNED AND BUILT BY EITEL MCCULLOUGH USES REL
ARMSTRONG DUAL CHANNEL MODULATOR DRIVING FOUR EIMAC 4X500A-
TETRODES FOLLOWED BY TWO EIMAC 3X2500A3 TRIODES GROUNDED GRID
FOLLOWED BY ANOTHER GROUNDED GRID STAGE USING PUSH PULL EIMAC
MULTI UNIT TRIODES. MAXIMUM FM TRANSMITTER POWER PRESENTLY
LICENSED BY FCC IS NOW AN ACCOMPLISHED FACT IN HIGH BAND
O H BROWN
EITEL MCCULLOUGH INC

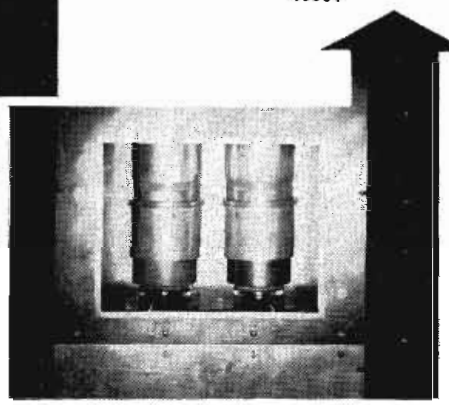
Here's How It Is Done . . .





Above. Four Eimac 4X500A tetrodes in push-pull parallel raise the power level from 50 watts to 3 kilowatts.

Right. A pair of Eimac 3X2500A3 triodes in a grounded-grid circuit provide 12 kilowatts of driving power for the final amplifier.



OPERATING CONDITIONS
(Two Tubes)

D-C Plate Voltage	4000 volts
D-C Plate Current	14.4 amperes
D-C Grid Voltage	-620 volts
D-C Grid Current	1.9 amperes
Driving Power (Approx.)	12 kilowatts
Plate Dissipation (total)	15.4 kilowatts
Plate Power Input	57.6 kilowatts
Useful Power Output	54.4 kilowatts
Apparent Efficiency	94 per cent

[1]Actual power delivered to water-cooled load. Amplifier output estimated to be 3 kw higher, due to resistance and radiation losses between amplifier and load.

ON THE AIR

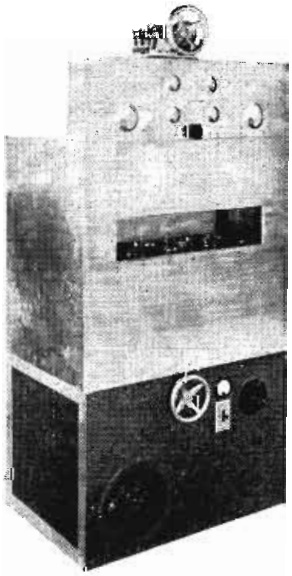
...with Eimac Tubes, Of Course...

When KSBR put the first 50-KW high-band FM transmitter on the air Eimac tubes were in every important socket. This was only natural, as Eimac tubes have been associated with every FM transmitter development, including the original historic 1935 demonstration before the IRE.

KSBR's 50-KW amplifier was designed and built by Eimac to demonstrate the capabilities of the new Eimac 3X12500A3 multi-unit air cooled triode. A pair of these new triodes in a grounded-grid circuit easily delivers 50-KW at high-band FM frequencies, with power to spare. Performance of this sort is made possible by sound vacuum-tube engineering. Because of its unique multi-unit design, the 3X12500A3 combines high power capability with close electrode spacing and low lead inductance, thus making it possible to produce high power at VHF with low plate voltage and high over-all efficiency. These same features make the 3X12500A3 an outstanding performer at low frequencies.

Data on the 3X12500A3 and the 50-KW amplifier are available. Write to

EITEL-McCULLOUGH, INC.
176 San Mateo Ave., San Bruno, California



The final amplifier at KSBR—the amplifier that made FM history—consists of little more than two Eimac 3X12500A3 triodes and a pair of shielded, low-loss tank circuits.

The unit is extremely compact considering its power capabilities. Width 36"; Height 70"; Depth 25".

TYPE 3X12500A3
ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	7.5 v
Current	192 amp.
Amplification Factor (Aver.)	20
Direct Interelectrode Capacitances (Av.)	
Grid-Plate	95 μμf.
Grid-Filament	240 μμfd.
Plate-Filament	5 μμfd.
Transconductance (e_b = 3000 v, i_b = 4a)	80,000 μmhos

PRICE $700

TYPE 3X2500A3
ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	7.5 v
Current	48 amp.
Amplification Factor (Av.)	20
Direct Interelectrode Capacitances (Av.)	
Grid-Plate	20 μμf.
Grid-Filament	48 μμf.
Plate-Filament	1.2 μμf.
Transconductance (i_b = 830 ma, E_b = 3000 v)	20,000 μmhos

PRICE $165

TYPE 4X500A
ELECTRICAL CHARACTERISTICS

Filament: Thoriated tungsten	
Voltage	5.0 v
Current	13.5 amp
Screen-grid amplification (Av.)	6.2
Direct Interelectrode Capacitances (Av.)	
Grid-Plate	0.05 μμf.
Input	12.8 μμf
Output	5.6 μμf.
Transconductance (i_b = 200 ma., E_b = 2500 v, E_{c2} = 500 v)	5200 μmhos

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Another "FIRST" *for Western Electric*

NEW Arc-Back Indicator in Western Electric FM Transmitters spots faulty mercury vapor rectifier tube surely . . . instantly!

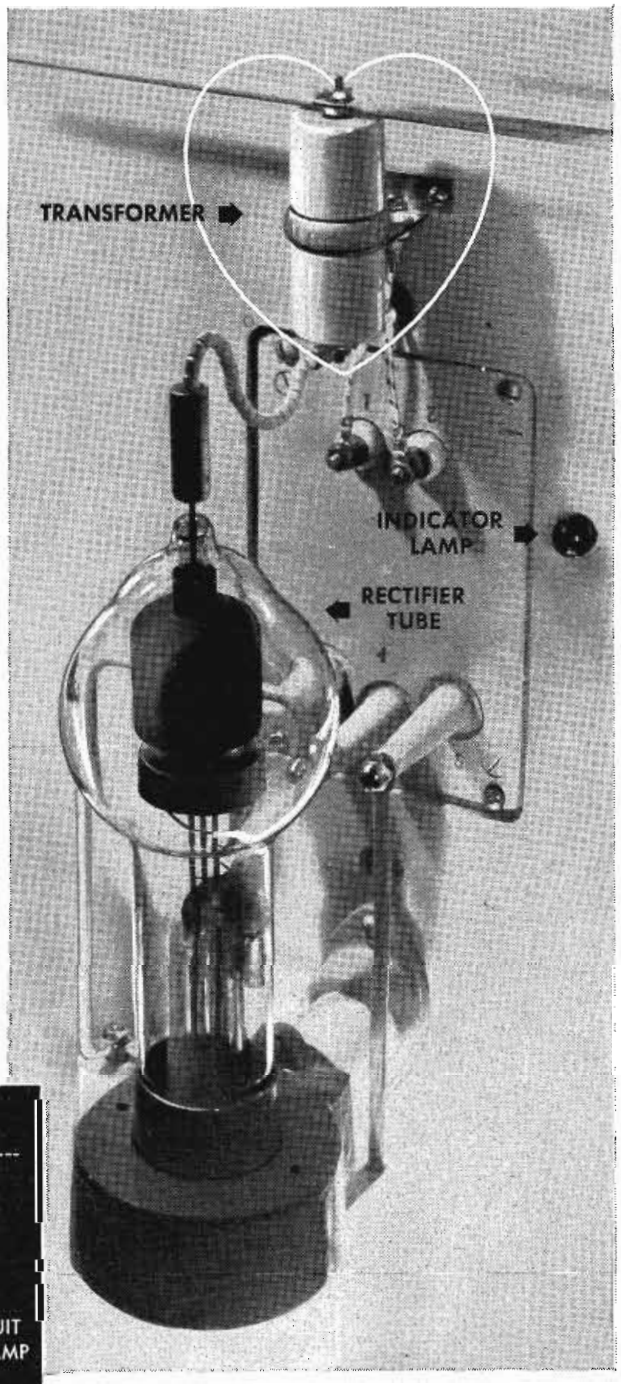
Arc-backs in mercury vapor rectifier tubes are rare—but when one occurs it is *essential* that you locate the faulty tube *at once.*

And that is exactly the function of the new Arc-Back Indicator, an exclusive feature of Western Electric FM Transmitters of 10 kw and higher powers.

Gone is the uncertainty as to which tube is at fault, for the Arc-Back Indicator shows you *instantly* . . . enables you to get back on the air in a fraction of the usual time.

The new Indicator is only one of the *major* features which put Western Electric FM Transmitters in a class by themselves. The Power and Impedance Monitor—which gives an accurate, direct measurement of the actual RF power fed to the antenna system and, in addition, a method of measuring standing wave ratio under full power output—is another. The Frequency Watchman for precise, dependable frequency control is a third.

Investigate Western Electric before you buy any FM transmitter. The Western Electric line ranges from 250 watts to 50 kw in power. Call your local Graybar Broadcast Representative, or write Graybar Electric Co., 420 Lexington Ave., New York 17, N. Y., for full information.



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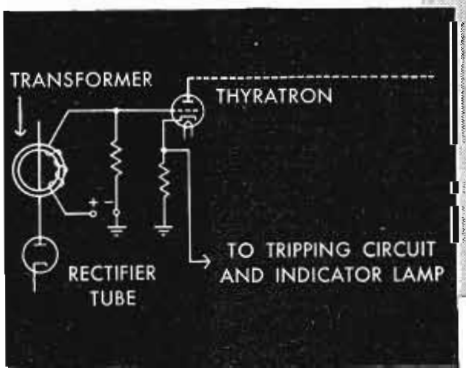


Heart of the new and exclusive Arc-Back Indicator circuit is a saturated toroidal transformer which responds only to reverse current in its associated rectifier tube. When an arc-back occurs, the voltage from the transformer fires a small thyratron tube which removes high voltage and lights the proper indicator lamp, visible through the glass front door of the TRANSVIEW design transmitter. In case of a string of "sympathetic" arc-backs, only *one* indicator lamp is fired—the one associated with the rectifier in which the *original* arc-back occurred.

— *QUALITY COUNTS* —

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.

High Standards for TV Sound

With television starting its mass entry into American homes, the quality of the accompanying sound becomes increasingly important.

Many proposals have been made for various types of diplex transmission for the sound accompanying the TV picture. These new methods undoubtedly have a great future in communication in general. But so far, for TV sound, trials have indicated inferior quality.

Attempts to lower the power used for the sound until its range does not exceed that of the video transmitter, also helps lower the quality of the audio channel.

Instead of whittling down sound specifications, a cardinal commandment in the TV decalog should be "Let television service enjoy the highest-quality sound available".

Mass Production Penalties

Mass production involves so many economic advantages as to require no elaboration—but it also has its penalties. It becomes too costly to change in order to keep step with progress. With hundreds of thousand of dollars tied up in tools, dies, inventory and engineering costs, a manufacturer can hardly be criticized for side-stepping the need for junking it all. It just isn't being done. So while big-run production makes for lower costs, lower prices to the public and a bigger market, it nevertheless functions to stymie progress in keeping with technical development. Often comparative smallness has its compensations; it becomes possible, and economically feasible, to move just about as fast as the brains of the organization can think.

Youth to the Fore

Recent highly technical radio meetings have revealed strikingly the active part very young radio specialists are now playing in our art. Today to the front are youthful scientists, names unknown to most of the industry, the products of Radiation Lab and other wartime laboratory training.

These youngsters, a fine-looking group on the whole, know their subjects so thoroughly that they are able fluently to "talk" their contributions, without notes or prepared papers. For college men they rate "fair" as speakers; some have that spark of enthusiasm coupled with good diction, that sets them apart as excellent in public address. Some suffer from the fault of tiresome monotone, not loud enough to fill the room. Which reminds us that radio men would be helped by a course in public speaking.

Facsimile Really Speeds Up!

Possibilities for facsimile loom larger. To thoughtful engineers it has long appeared inevitable that television principles must eventually take the place of slower methods of facsimile transmission. The day of the "printing press of the air" may be dawning, for with the tremendous speeds credited to newly developed RCA equipment, to be demonstrated this month, and announced as being capable of "more than a million words a minute", the radio daily becomes a possibility. Obviously, equipment capable of such an accomplishment likely will be too bulky and certainly too costly for mass use in homes and will remain so for quite a time. Meanwhile, though, TV-facsimile methods can take an extremely important place in the business world of communications, and probably will.

ONE WORLD! – OF AVIATION RADIO

—"It will become possible within the next five years for aircraft to operate in every part of the world with the same system of radio guidance and the same instrumentation. Once having attained that uniformity, the world will never again suffer it to be lost."—Dr. Edward P. Warner, president Interim Council, International Civil Aviation Organization, Montreal.

Circularly Polarized Waves Give

By THOMAS B. FRIEDMAN, Cleveland Institute of Radio Electronics, Cleveland, O.

Design theory, practical application and advantages of the principle in reducing effect of reflections and otherwise improving reception

• Considerable interest recently has been evoked by the circular polarization method of wave propagation. Circular polarization was used to a limited degree in the recent war in conjunction with airborne jamming equipment, where it was desired to jam enemy radars in all planes of polarization. For peacetime applications this system offers many potential benefits in comparison to the plane-polarized wave radiation from conventional antennas. The use of this mode of polarization will of course be confined to the vhf and higher frequency ranges where the antenna structures will not be excessively large.

A brief description of circular polarization may be helpful before describing its applications. The electromagnetic field radiated by any antenna expands spherically into space with the speed of light. For a theoretical isotropic (non-directional) antenna located at the surface of the earth the configuration of the electric and magnetic flux on the surface of a hemisphere centered on the antenna may be visualized as in Fig. 1.

Polarization Defined

Here the vertical lines represent the electric field, and the horizontal lines at right angles, the magnetic field. The directions of both fields are transverse to the direction of propagation. In this example, the radiation is defined as being *vertically polarized*. If the current axis of the antenna is rotated 90°, then the positions of the fields are interchanged and the radiation becomes *horizontally polarized*.

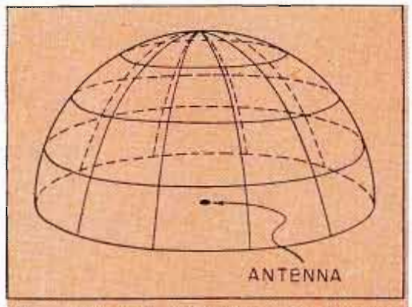
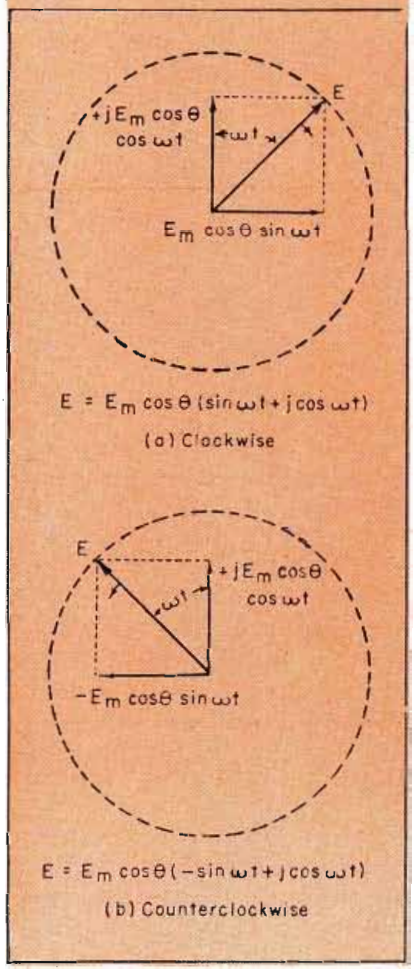


Fig. 1—Idealized conception of spherical wavefront. A small section of the surface is considered as a plane wavefront



When only a small portion of the spherical surface is considered this can be regarded as a plane-polarized wave, with the direction of polarization specified by the direction of the electric field vector with respect to the earth's surface. For practical purposes the ideal isotropic antenna field is replaced by directional radiation in the vertical and horizontal planes.

Mechanical rotation of a dipole antenna on its center axis would establish a plane-polarized field rotating from horizontal to vertical and back to horizontal again. This conception affords a simple approximation of the fundamentals of circular polarization, although in practice the actual field rotation is accomplished electrically, and the field rotates at an angular velocity equivalent to that of the carrier frequency.

Circular Generation

A circularly polarized wave can be generated by the transmission from the same antenna of two plane-polarized waves of the same frequency and equal strength, and which are in space and time quadrature. The resultant combination of these two plane-polarized waves is a field which may be conceived as having a vector of constant length rotating at an angular velocity ω in a plane normal to the direction of propagation. If the two plane-polarized fields are not exactly equal in strength, or do not have the proper phase rela-

Fig. 2—Rotation of a constant length vector as the resultant of two sinusoidal quadrature components 90° out of phase

Better FM Service Area Coverage

tionship, the more general case of elliptical polarization results.

Actually, the field rotation is not a physical phenomenon: the two quadrature fields exist independently in space. However, the voltage in a receiving antenna immersed in a circularly polarized field is found from the principle of superposition, i.e., combining vectorially the voltages due to each individual field.

The variation in intensity of the horizontal and vertical fields is in accordance with the equation:

$e_h = E_{mh} \sin \omega t$

$e_v = E_{mv} \sin (\omega t + 90°) = E_{mv} \cos \omega t$

where

e_h = instantaneous value of the horizontally polarized field

e_v = instantaneous value of the vertically polarized field

$E_{mh} = E_{mv}$ = maximum instantaneous value of each field

ω = angular velocity of the carrier wave = $2\pi f$

Considering a receiving antenna located in a plane perpendicular to the direction of propagation. The total voltage E induced in the antenna is found to be:

$E = E_m (\sin \omega t + j \cos \omega t)$ (clockwise rotation)

$E = E_m (-\sin \omega t + j \cos \omega t)$ (counterclockwise rotation)

This shows that the induced voltage in the receiving antenna remains constant, regardless of its position relative to the horizontal or vertical components of the wave.

Fig. 2 illustrates the two quadrature vectors generating the rotating vector E. The direction of rotation shown is in accordance with the IRE standards (for elliptical polarization) which specify that the observer looks in the direction in which the wave is traveling and notes the direction of displacement.

A perspective visualization of circular polarization is given in Fig. 3. In Fig. 3A the horizontal vector at the end of the helix is maximum at time t_1 and the vertical component is zero. One quarter cycle later the vertical field

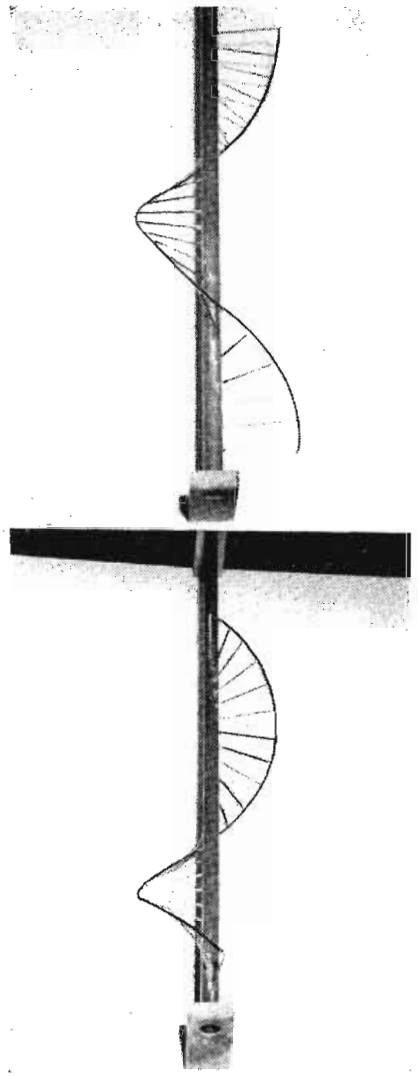


Fig. 3—(Above) At time T_1 the field is horizontally polarized (end of helix). (Lower) One-quarter cycle later a maximum vertical field exists at same point

vector at the same point has reached maximum intensity, and the horizontal component has diminished to zero. In between these two points the resultant vector has been due to a combination of the vertical and horizontal fields, and has rotated from the horizontal to vertical position.

The tip of the resultant vector is seen to generate a helix which is pushed out into space at the velocity of light. The helix passing over the antenna induces a voltage which varies from a positive maximum through zero to a negative maximum, and then back again, exactly as with an antenna cut by a plane-polarized wave. With circular polarization though, the maximum induced voltage is the same, no matter what the relative position of the receiving antenna to the electric field, so long as the antenna is in a plane parallel with the wave front.

The equations above are the simplest ones for circular polarization, and are necessarily modified in practice by the radiation characteristics of the transmitting antenna in the horizontal and vertical planes, and the elevation angle of the receiving antenna. If the transmitting antenna is nondirectional in the horizontal plane, but has a vertical radiation characteristic $f_1(\theta) = \cos \theta$ in the vertical plane then another form of the circular polarization equation is:

$E = E_m \cos \theta (\sin \omega t + j \cos \omega t)$

This illustration has been given for a two-phase field, radiated from a two-element circularly polarized antenna. However, any number of fields can be superimposed to yield a circularly polarized wave if the proper phasing of the polyphase field is supplied. For example a three-phase field radiated from a three-element antenna as shown in Fig. 4 would be circularly polarized if the following condition applies:

$E = E_{m1} \cos \omega t + E_{m2} \cos (\omega t + 120°) + E_{m3} \cos (\omega t + 240°)$

where E_{m1}, E_{m2} and E_{m3} are maximum fields of equal intensity.

Similarly the completely generalized case for a polyphase field due to k radiating elements located at a theoretical point source can be given by the expression:

$$E = E_{m1} f_1(\theta, \phi) \sin (\omega t + \beta_1) + E_{m2} f_2(\theta, \phi) \sin (\omega t + \beta_2) + \ldots + E_{mk} f_k(\theta, \phi) \sin (\omega t + \beta_k) + \ldots + E_{mn} f_n(\theta, \phi) \sin (\omega t + \beta_n)$$

$$= \sum_{k=1}^{k=m} E_{mk} f_k(\theta, \phi) \sin (\omega t + \beta_k)$$

where

E = mv/m the instantaneous total vector field intensity measured at a unit distance in a plane at right angles to the direction of propagation

E_{mk} = mv/m the maximum vector field intensity produced by the k^{th} radiating element at unit distance

θ = elevation angle from a reference plane

ϕ = azimuth angle on the reference plane

ω = angular velocity

t = time in seconds

β_k = time phase angle of E_{mk}

In general such a field would be elliptically polarized, as in Fig. 5, and would approach circular polarization only for critical values of phasing and intensities. Circular polarization is merely a limiting case of elliptical polarization and in practice it is found that slight deviations from the circular field occur even when all precautions have been taken to assure radiation of the fields in equal strength and with proper phasing.

System Advantages

This difference makes it impractical to specify rigidly that radiation be circularly polarized and the relevant FCC standards refer to a wave which is "circularly or elliptically" polarized. In many cases the wave is very nearly circularly polarized and for simplification in discussion can be referred to in general terms as a circularly polarized wave.

The advantages of using a circularly or elliptically polarized wave for transmission might best be understood if certain properties attendant with plane-polarized waves are first enumerated. Among those considered is the necessary alignment of transmitting and receiving antennas and the effects of wave interference in reducing signal strength at certain points, together with the introduction of time-delayed signals, due to multipath reflections. The latter case is important in television.

If two dipoles are aligned as in Fig. 6, and one used for transmission and the other reception, the maximum induced voltage in the receiving dipole will be observed when this antenna is parallel to the transmitting dipole. Now if the receiving dipole is rotated through an angle α in the plane normal to the direction of transmission the voltage pickup will diminish by the factor sin α until, when the two antennas are at right angles to each other in parallel planes, the theoretical pickup will be reduced to zero.

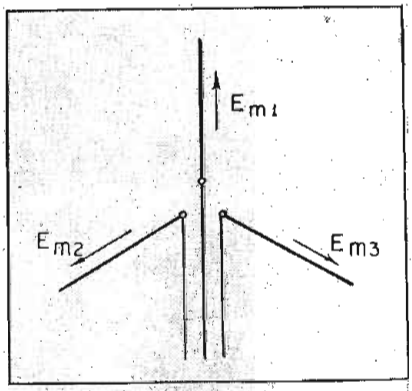


Fig.4—Three-element three-phase antenna for radiating circularly polarized waves

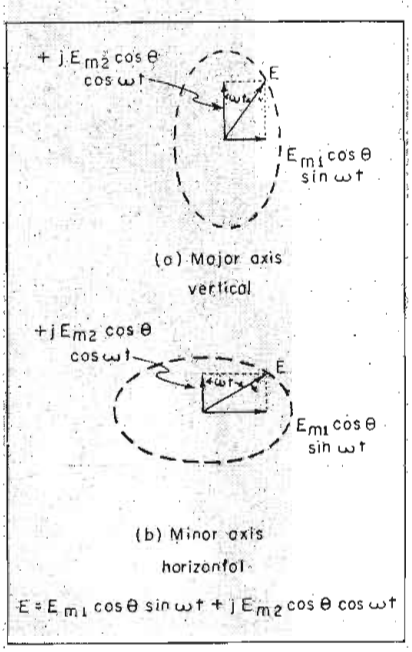


Fig.5—Elliptical patterns usually resulting from polyphase wave transmission

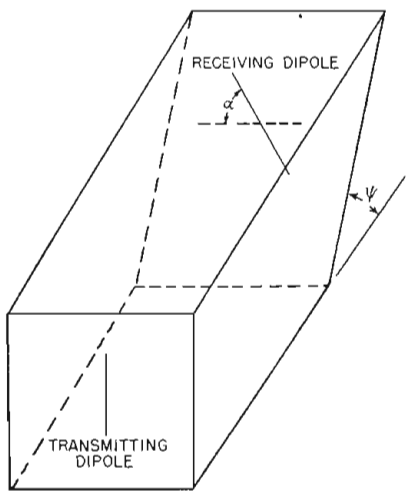


Fig.6—Variation in voltage pickup for two dipoles with change in relative alignment

Similarly if the receiving antenna is rotated in the plane passing through both dipoles the pickup will again drop off according to the factor sin ψ where ψ is the angle of the dipole with reference to the transmitting antenna. This angle becomes 90° when the end of the receiving antenna points directly at the transmitting antenna, and again the pickup is zero. Therefore, for any position of the receiving antenna relative to the transmitting antenna the voltage pickup varies as follows:

$$E = E_m \sin \alpha \sin \psi$$

where E_m is the voltage pickup when the two antennas are parallel.

If a circularly polarized transmitting field is present the factor sin α is eliminated and the voltage pickup of the receiving antenna is:

$$E = E_m \sin \psi$$

This simple identity reveals that a theoretical *plane* of zero voltage pickup for plane-polarized transmission has been reduced to a theoretical *point* of zero pickup if a circularly polarized field is radiated. Actually reflections from the ground and various structures will modify these relationships so that some slight field pickup is possible no matter what the antenna position.

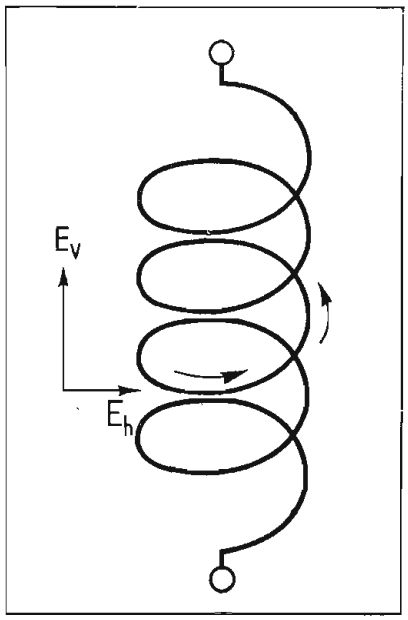
By the use of circular polarization, therefore, the receiving antenna is allowed an additional degree of freedom in placement as compared to restrictions imposed upon the placement of an antenna for receiving plane-polarized transmissions. This additional freedom may be of particular value when considering the problem of FM transmission to a very large number of receiving locations from several FM transmitting stations in the same area.

The myriad receiving antennas are certain to be positioned at random angles, and when it is considered that the various transmitting antennas will lie at dif-

ferent azimuthal angles from any receiving location it appears that an antenna at the receiving point with marked directional qualities may be undesirable. As present FCC FM standards specify horizontal polarized transmissions as the basis for allocations, the use of a simple non-directional vertical antenna would not give optimum reception and a non-directional horizontally polarized antenna requires somewhat complex structures not always possible in the average home. Circular polarization would appear to offer a means of resolving the difficulty of providing adequate service to all locations.

Its advantages are further emphasized when considering the case of the built-in dipole and power cord antennas in home radios, and the vertical automobile whip antenna. In the former case it is probable that many FM receiver purchasers will demand a set requiring no external receiving antenna, having been influenced by the virtual disappearance of external antennas for AM broadcast band reception. While it would be possible to position the FM receiver physically for optimum performance, the receiver location and alignment usually is dictated by the housewife on esthetic grounds of room appearance and not on electrical field

Fig.8—Helical antenna which will radiate directional or non-directional circularly polarized waves



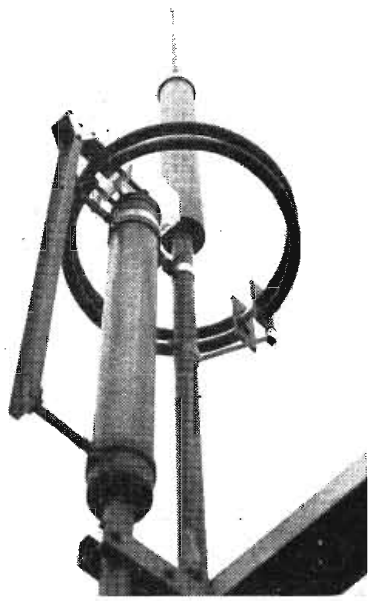


Fig.7—Non-directional two-element antenna for radiating circularly polarized waves (United Broadcasting Co.)

considerations. Thus in the residence a circular polarized wave may be able to better satisfy these conflicting demands than if plane-polarization is used.

Mobile Receiving Antennas

The advent of the automobile FM radio is undoubtedly near at hand, and the problem of providing satisfactory service to car listeners cannot be ignored. For the car, even more than in the home, the requirement is for an antenna which is non-directional in the horizontal plane. While there are numerous solutions to the problem of obtaining a non-directional horizontally polarized antenna, the necessary structure (at 100 mc) is hardly adaptable to the automobile, and continuance of the whip antenna, now almost universally used for AM auto reception, is indicated.

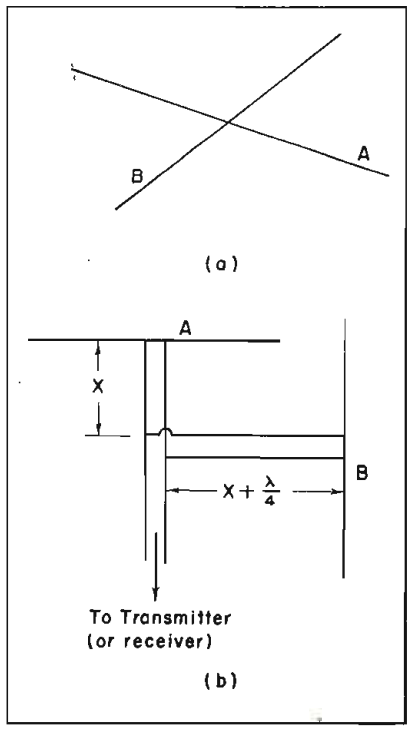
Stations using only horizontally polarized transmission to serve the public may give most listeners adequate service, but inferior service to the motorist. In this regard it should be remembered that for low receiving antenna heights, such as will be encountered on the automobile, vertical polarization has a higher field strength than horizontal.

A logical solution to these various problems could be the use of circularly polarized transmission. In fact it may be the best practical solution unless the FCC FM polarization standards are altered to allow vertical or diagonal polarization, or some engineer is able to design an unobtrusive horizontally polarized non-directional antenna for mounting on a car.

Up to this point the discussion has been concerned with a field ideally radiated over an obstructionless earth. When considering the effect of the numerous structures from which the waves will be reflected, or inside of which the receiving antenna may be located, there may be a rather considerable modification in the observed results. Both advantageous and disadvantageous factors can be expected to appear.

A complete evaluation of the diverse or similar results found when using plane- or circularly polarized waves must of necessity be based on a sufficiently large number of actual field strength measurements, taken at locations and in positions where the effects of the two forms of radiation are to be compared. Existing knowledge on this matter is rather meager, and often more qualitative than quantitative. The engineering staff of the United Broadcasting Co., Cleveland, Ohio, is now engaged in a field strength meas-

Fig.9—Crossed dipole arrangement for radiating two-phase circularly polarized waves



urement project which, it is hoped, will considerably enlarge the available information on the topic and enable more accurate decisions to be made in regard to the use of this form of radiation. Several points are being investigated, of which some will be mentioned here.

Intensity Measurements

One of the studies will involve measurement of the standing wave patterns from the horizontal and vertical fields while a measuring car is in motion. In built-up areas it has already been found by several investigators in the vhf range that wave interference due to reflections from buildings sets up a rather marked standing wave pattern. Recording instruments show that sharp nulls and high peaks follow each other with fair regularity as the receiving antenna is moved in the field. Thus an automobile may experience rapid fading, or a fixed receiver may be so placed as to be situated in a null area.

Considering either the vertical or horizontal plane-polarized component of a circularly polarized field it is evident that the same standing wave pattern will exist whether or not the quadrature field is present. The problem is to find out if the nulls and peaks of the two patterns are in general sufficiently displaced from each other so that one component will be able to "fill in" the field at points where the other component has dropped to a low level. An averaging effect between the two standing wave patterns would give a more uniform field over a wide region.

Another matter to be investigated is the pickup of a randomly placed antenna located inside a building. Purely theoretical statistical computations have indicated that the gain of a randomly placed plane-polarized receiving antenna located in a circularly polarized field will be appreciable as compared to the signal induced in the same antenna randomly placed in a plane-polarized field whose strength is equal to one of the quadrature components of the circularly polarized field.

In many of the randomly positioned antennas the gain corresponds to a substantial increase in the effective radiated power of the transmitter. The gains considered for all antennas vary in a statistical manner, but in no case will the antenna in the circularly polarized field have less pickup than if it were in a plane-polarized field. A noticeable improvement in signal strength will accrue to the majority of receivers.

The free space conditions may be modified considerably when the receiving antenna is located inside a building, and do not lend themselves as readily to theoretical analysis. Field strength measurements on both plane- or circularly polarized waves have been made inside a number of representative residences. It is found that a plane-polarized wave upon passing into a building often has its polarization shifted by the metallic wiring and plumbing in the walls of the structure. In the general case the plane-polarized wave outside the house is

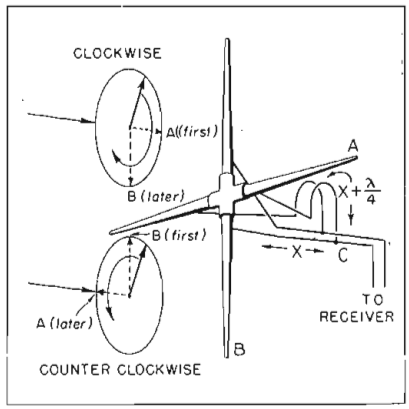


Fig. 10—Manner in which a circularly polarized antenna used for reception will discriminate against a wave of opposite rotation to that for which the antenna is connected

converted into an elliptically polarized wave inside, and in extreme cases the plane of maximum pickup is at right angles to the plane in which the wave was propagated. More often the maximum field inside the house occurs at some random angle.

When a circularly polarized wave enters the building it is also distorted and becomes an elliptically polarized wave. In effect then a building may be said to possess "built-in" elliptical polarization properties.

The United Broadcasting Co. engineering studies are utilizing transmissions from the antenna of Fig. 7, which is the radiator for experimental station W8XUB owned and operated by this company. By means of antenna feeder switching arrangements the antenna can be used as a straight horizontally polarized antenna, a vertically polarized antenna or a circularly polarized antenna as desired. Fields of equal strength can be radiated in the horizontal or vertical planes either singly or simultaneously as demanded. When only one field is radiated the transmitter power is reduced so that the energy not required, because of the elimination of one field, disappears.

Television Applications

The various plane and circularly polarized measurements made at several locations have been recently evaluated statistically and indicate that a noticeable gain exists when circularly polarized transmission is used. These experimental measurements are being extended until it is shown positively that a sufficiently large sample has been taken to reduce the weighted statistical error to a low value.

In addition to the modified concept due to the influence of buildings the effects of ground reflection also can be considered for circularly polarized radiation, particularly with regard to reversal of the effective direction of rotation. This matter may be of importance in television applications, but is not presently being considered in the tests described herein.

If reflection of a clockwise circularly polarized wave will reverse the phase of one field by 180°, but not the other, then the direction of rotation of the field will be counterclockwise. Further, if a clockwise circularly polarized receiving antenna is used, then the reflected component may be rejected and only the direct component accepted. Such a scheme could well be advantageous in television, where multi-path time-delayed reflections show up as "ghosts" on the receiving screen.

This proposal was actually tested several years ago in conjunc-

(*Continued on page* 100)

Multi-Channel Selective Calling

By R. C. FERRAR and J. M. LANXNER, Engineers
Federal Telephone & Radio Corp.

Frequency-sensitive reeds operated by low-frequency sub-carrier signals permit individual calls to any number of receivers from four to thousands

● A new electronic selective calling system capable of providing a large number of channels for mobile radiotelephone equipment has been developed by Federal Telephone and Radio Corp., Clifton, N. J. This system, known as "Selecto-Call," can be incorporated in all Federal mobile receiver chassis and, as a result, a special selector unit is not required in the automobile; thus effecting a saving in overall weight and size of the equipment.

The Selecto-Call circuit enables a suitably equipped control station to contact, at will, any specific mobile unit or group of mobile units to the exclusion of the others in the system despite the fact that all receivers are tuned to the same frequency. This is accomplished by incorporating in the mobile receiver frequency sensitive decoders each of which responds to a particular frequency within the range of 153 to 442 cycles per second. In normal or standby operation the audio system of the receiver is silenced and when the proper decoder signal is received either the audio is automatically turned on or a buzzer is actuated, alerting the mobile receiver operator to the fact that there is a call for him.

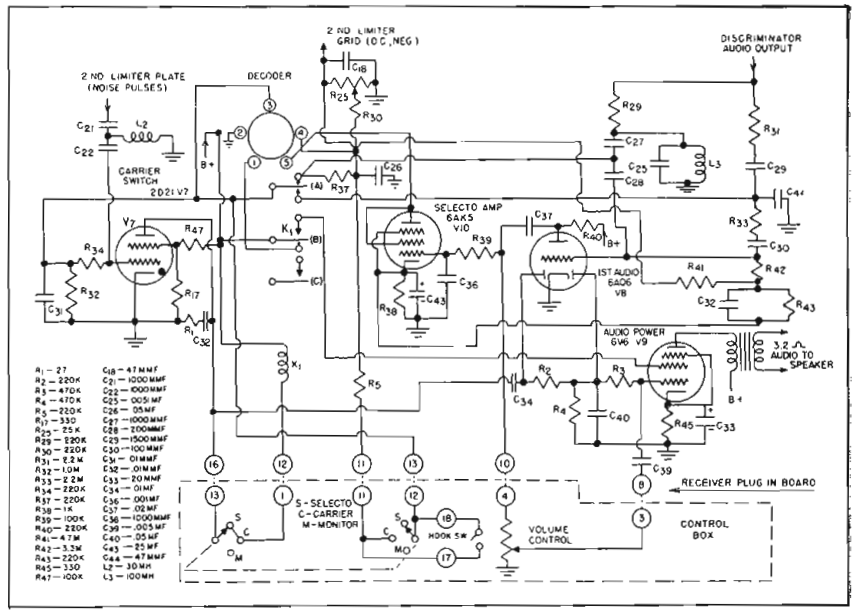
There are three general types of mobile equipment now in operation. One, known by Federal as the FTR emergency communications equipment, is designed to meet the requirements of police, fire and ambulance departments, and other such services. In this equipment, each system is provided, upon request, with four mobile channels and it is possible to contact any one of these groups without disturbing the others.

The selective calling system described in this article is not limited in application to mobile equipment. It should also find application in point-to-point communications and wherever remote indication is desired. The system can be modified to suit individual requirements such as increasing the number of channels to 10,000 and providing "lock-in" circuits so that each channel approaches a "private" line status rather than all channels being, in effect, on a "party" line.

The second general type of selective calling, designed primarily for taxicab dispatching, is called the "810 Line and Common Call Selecto-Call". This system has a maximum of 810 channels and also provides one common decoder signal so that all mobile units can be contacted at the same time in one operation. This type of equipment can only be used in applications where the central station can exercise complete control over the operation of the mobile units; otherwise interference between mobile transmitters would be inevitable.

The third general type is designed to provide mobile telephone facilities to the public. Here the problem is more complex. Whereas all mobile units in this system could be operated on one frequency and each unit provided with an

Fig. 1—Schematic diagram of the Selecto-Call circuit in the mobile radio telephone equipment developed by Federal Telephone and Radio Corp., Clifton, N. J.

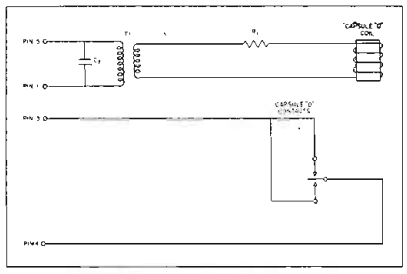


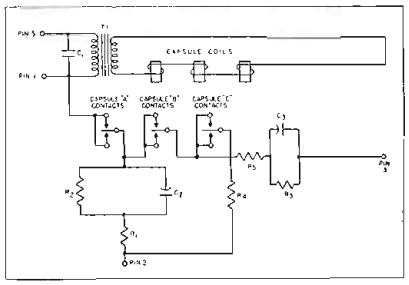
individual channel as in the 810 line equipment, this is impractical since, in effect, it means that 1,000 or more subscribers would be on one "party" line. Obviously the service rendered under these conditions would be poor. For this reason about 80 channels are assigned to one frequency.

However, when the system in one city is coordinated with that of another city an increased number of channels is necessary. Assume that New York and Washington provide mobile telephone facilities and both operate on the same series of frequencies. This is possible since signals originating in the Washington area could not normally interfere with those originating in the New York area. Assume also that a New York mobile subscriber, whose phone number is 326, travels to Washington. If the number 326 has not been assigned to any of the Washington subscribers, then the New York subscriber can be reached in Washington without causing any confusion. Thus a nationwide mobile telephone service is planned, a fairly large number of channels may be necessary.

Basically the same selective calling system is used for all these applications. Fig. 1 is a simplified schematic of the Selecto-Call circuit. However, before the operation of this circuit can be understood a brief description of the signal transmitted by the central station is necessary.

The audio frequencies to which the decoders are sensitive are between 153 and 442 cycles. Direct phase modulation of the rf carrier with frequencies as low as those in the 153 to 442 cycle range can be done only with very low deviations, and is therefore not practical. Instead, a sub-carrier system is used in which the low frequency signal amplitude modulates a 7,000 cycle sub-carrier which in turn frequency modulates the rf carrier. In this 7,000 cycle range no frequency modulation difficulties are encountered. At the receiver the FM signal is converted back to amplitude modulated audio by the discriminator circuit. This accounts for the 7,000 cycle band press filter to be described subsequently.





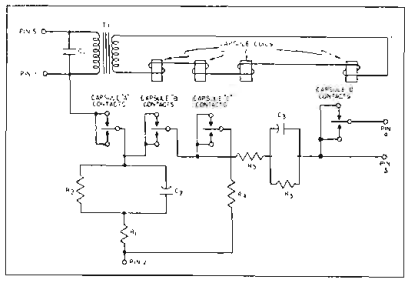


Fig. 2—Schematic of the 4-channel decoder unit

Fig. 3—Schematic of the 1000-channel decoder unit

Fig. 4—Schematic diagram of the 810-line and common call decoder

Returning to the operation of the Selecto-Call circuit in the receiver. The receiver is a conventional double-conversion, crystal-controlled 14 tube superheterodyne. When in standby position the audio system is silenced by a squelch circuit which maintains control until the proper decoding signal is transmitted by the central station or the receiver audio is switched to a non-selecto-call controlled position and "on-frequency" signal is being received.

System Operation

From Fig. 1 it can be seen that while in standby position (receiver audio silenced), relay coil K_1, which operates contacts A, B, C, is held closed by the plate current flowing through the 2D21 thyraton V7. The relay will open, energizing the audio system through these contacts, when plate current through the thyraton is stopped. The method of controlling the flow of thyraton plate current is the key to the entire operation of the squelch circuit.

The grid bias on the thyratron, which controls the flow of plate current, is derived from two sources. One source is the 2nd limiter grid bias voltage and the second source is the output of the 2nd limiter plate. The 2nd limiter grid voltage is always saturated either on noise or on an "on-frequency" signal and is always of negative potential. The voltage from the 2nd limiter plate when no signal is present, on the other hand, consists of noise pulses, the positive peaks of which exceed the steady negative voltage derived from the 2nd limiter grid. The resultant instantaneous voltage on the thyratron grid is thus made positive, permitting the tube to fire, draw current and close the plate relay K_1.

Closing the relay operates the contacts and causes the following to occur:

1. Contact (A)
   (a) The output of the discriminator is placed across the C31-R32 network which shorts out the speech frequencies. This does not effect the 7,000 cycle signal, however, since isolation is provided between the short circuit and output of discriminator. Thus only the amplitude modulated sub-carrier is fed to the grid of the 1st audio amplifier V8.
   (b) Negative voltage is removed from thyratron grid;
2. Contact (B)
   (a) The B+ voltage is removed from the screen grid of the audio amplifier.
   (b) Plate voltage is supplied to the Reed amplifier V10.

Now consider the action of the circuit when an "on-frequency" signal is received. As in any conventional FM receiver the signal is amplified, limited and then detected by the discriminator. If the modulation consists of speech, it is effectively shorted to ground at the center of a speech band-pass filter connected to the output of the discriminator. Sufficient isolation is provided between this short and the discriminator to avoid interference with the 7,000 cycle band

pass filter also connected to the discriminator output for Selecto-Call modulation. If the modulation consists of a 7,000 cycle sub-carrier with a tone or a sequence of tones, corresponding to the decoder number, as amplitude modulation, it is passed, with relatively low attenuation, through isolating resistor R29, fixed tuned circuit L3 and C25, coupling capacitor C27 and isolation capacitor C28, to the grid of V8, the 1st audio amplifier, a type 6AQ9 tube.

When the receiver is in standby condition this tube, V8, operates as a grid leak detector. This is true since its grid bias is derived from the cathode circuit of amplifier tube V10 and the 2nd limiter grid. When the relay is closed, V10 draws current and applies a positive potential across grid leak resistor R42 through R43, which is sufficiently large to drive the junction of R42 and R43 positive. This results in practically zero bias on the grid of the 6AQ6 where the 7,000 cycle signal is demodulated.

The demodulated and amplified tone or tone sequence is fed from the plate of V8 through coupling capacitor C37 to a filter consisting of R39 and C36, which reduces the 7,000 cycle component present in the V8 output. The call-tone frequencies are then applied to the grid of the cathode biased Reed amplifier. This tube, a 6AK5, serves as an amplifier for the call-tone frequencies. The output of V10 is applied directly to the primary of T_1, (Figs. 2, 3, 4), the transformer in the decoder.

If the call-tone frequency or sequence of frequencies correspond to the code number of the decoder, it becomes operative and a negative voltage is applied across the grid of the thyratron, V7, cutting it off. The manner in which the decoders function to apply the negative potential will be described later.

When the plate current in V7 is cut off the relay coil operates

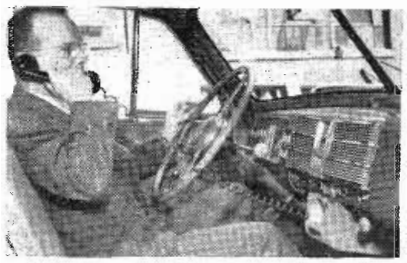


Fig. 5—Typical installation of radio telephone equipment using Selecto Call system for selective calling of mobile units

and the position of the contacts is reversed. The results are as follows:

1—The negative voltage generated across the second limiter is applied directly to the grid of the thyratron. The thyratron plate current is cut off as long as the negative voltage is greater than any positive peak of noise from the second limiter. This noise, is, of course, reduced or totally absent in the presence of "on-frequency" signals. (Contact A).

2—The plate voltage is disconnected from the Reed amplifier tube V10, thus removing the source of positive voltage from the grid resistor of V8 and allowing it to function as a class A amplifier with negative bias obtained through resistor R41 from the second limiter. (Contact B).

2—The short to ground from the speech band-pass filter at the output of the discriminator is removed and the 7,000 cycle band-pass filter is shorted to ground at its center, where the short does not interfere with the speech circuits.

4—B voltage is applied to the screen grid of the audio amplifier, energizing the receiver audio.

When the attendant at the called receiver removes the microphone or handset from the hook switch to answer or to place a call, the Selecto-Call circuit is by-passed and the call tones need not be repeated during a two-way push-to-talk conversation. This is accomplished by connecting the negative voltage from the second limiter through contacts (contact C in Fig 1) on the hook switch directly to the grid of the thyratron V7 which in the presence or absence of noise from the second limiter de-energizes or energizes the receiver audio output in a manner depending only upon the absence or presence of radio frequency signals as previously described. A Selecto-Call switch, if provided as part of the system, places the receiver in the carrier-controlled condition in the same manner as the hook switch does.

The main difference between the three general types of mobile equipment previously described occurs in the decoder circuit. Figs. 2, 3, and 4 are schematic diagrams of the four-channel decoder, 810

(*Continued on page* 97)

Fig. 7—Selecto Call decoder unit is plugged into existing Federal mobile receivers in a manner similar to the insertion of a tube, thus is easily removable for servicing

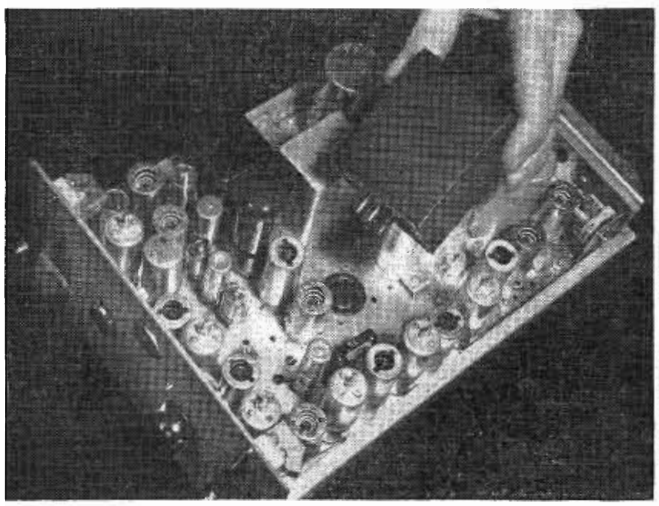
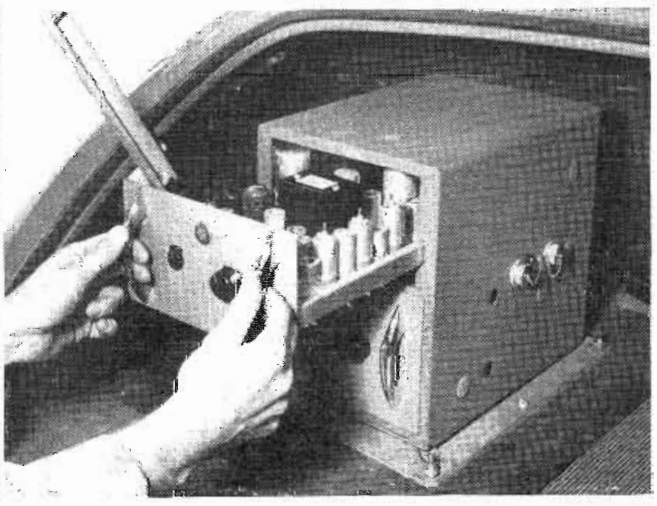
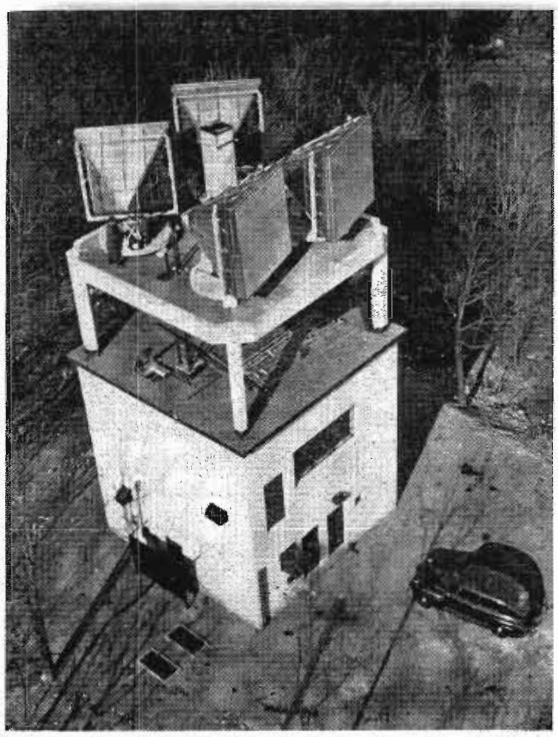


Fig. 8—Typical installation of Federal's mobile equipment in the trunk compartment of an automobile showing the position of the selector unit in the withdrawn receiver



FCC Studies TV Relays



Bell System radio relay tower on top of Jackie Jones mountain, Haverstraw, N. Y. which is part of the New York to Boston system soon to be put in operation

• Engineering - wise, inter - city television relaying methods are not too difficult, and, as most everyone knows, there are several ways in which pictures and sound can be spread around to make network operation possible. But in any case the cost of the spreading around will astonish many station operators and may give pause to not a few of them.

Those are two of the things that broadcasters who attended the June 9 public hearing staged by FCC, to look into the matter of relaying possibilities and probabilities, learned and carried home with them. For the first time they were brought face-to-face with actual rates they will be expected to pay if they elect to use common carrier methods. Briefly, AT&T, which is the Bell System, has set these rates, which will become effective August 1:

For one-way picture transmission, broadcasters will pay $40 per circuit mile per month for service 8 hours a day, 7 days a week — plus a connection charge of $750 per month per station connected. If desired, occasional service can be arranged for $1.25 per circuit mile for the first hour, plus a connection charge of $250. A station connection is required for transmission into or from an inter-city channel. In addition, broadcasters would pay the regularly established rate for an audio channel which is $6 per airline mile per month for Class A stations and $9 for Class AA. In other words, if a broadcaster used a one-way video channel for 32 hours a month the cost would be $10,940 for the New York-Washington facility.

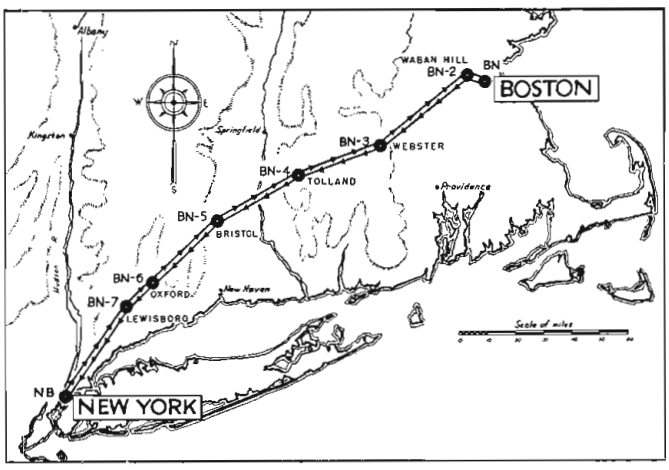
Cable Investment

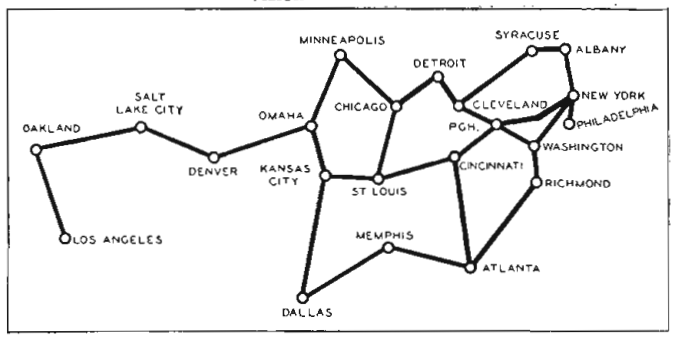
Communication engineers realize that the great amount of development, planning, material, labor and testing that has gone into this relatively short cable represents a huge investment. There are operating and upkeep costs as well as a return on the investment expected by the American Tel. & Tel. Co. Actually the rate charged for TV relaying would be higher if the New York-Washington coaxial cable, long used on an experimental basis, was not used for multi-channel telephony while not carrying television programs. However the announced tariff will be a heavy burden on TV at this time. It is sufficiently high to encourage independent broadcasters to establish their own radio relays.

But to get a complete picture of this FCC conference, ably presided over by George E. Sterling, chief engineer of FCC, let us note events as they occurred. The purpose of the meeting was to acquaint present and prospective TV broadcasters with the plans of the common carriers for inter-city relaying and to allow the carriers, in turn, to learn the present and future needs of the broadcasters. The conference did a great deal to clarify and to throw into relief this vital problem facing television —network operation.

The first report was from the Bell System representatives, who

FOUR TELEVISION





Left—Route of the Raytheon New York-Boston relay operated until recently on an experimental basis and easily again put in operation. Right—Map of proposed Western Union network now practically complete between New York, Philadelphia, Pittsburgh and Washington. System can be adapted for television transmissions

for Inter-City Network Systems

Common-carrier rates seen encouraging broadcasters to develop own microwave facilities—Many existing experimental relays capable of expansion

gave the progress on coaxial and radio relay facilities. Approximate dates when various cities would have service were mentioned. The cable connecting New York City, Philadelphia and Washington is now in operation. It transmits video frequencies up to about 3 mc, as contrasted with about 4 mc for most TV transmitters.

Instead of the coaxial cable, a series of radio relays are used to link New York City with Boston. Operation is expected in the near future. The next radio relay circuit to be built will be between New York City and Chicago. Following the route shown on the map this will have the improvements of: a new type of shielded lens antenna capable of operating uniformly over the band 3700 to 4200 mc; band pass filters which divide this band into 6 two-way channels and finally amplifier refinements which will allow 35 repeaters to be used in the 900 mile circuit and still keep the noise below the level that causes disturbance. It is too early to predict the frequency band to be transmitted.

CONFERENCE SUMMARY

1—*Network operation is vitally important to the future development of television.*

2—*Radio relays appear the most economical interconnection method.*

3—*FCC should assign a block of frequencies adequate for the service.*

4—*Relay service by common carrier will be offered by the Bell System certainly; by Western Union probably; by Raytheon possibly.*

5—*Broadcasters are ready to establish their own radio relay systems. (Philco and GE now have them.)*

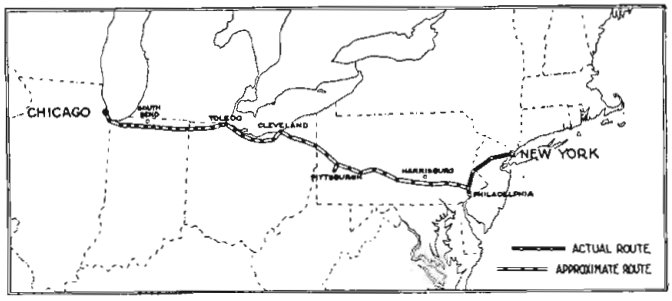
6—*Many TV broadcasters will be without network programs for some time.*

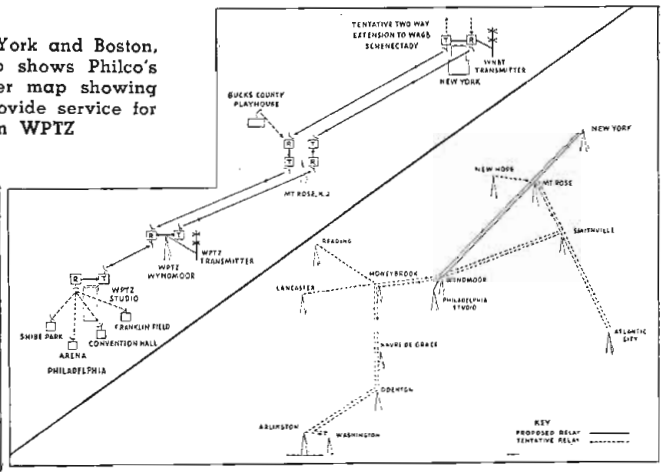
Explaining that Western Union has operated an experimental radio relay system between New York and Philadelphia since 1945, and that during the summer of this year a second system connecting New York and Philadelphia together with a much larger system connecting New York, Pittsburgh and Washington will be placed in operation, Radio Research Engineer J. Z. Millar introduced a chart to show future plans.

He pointed out that since the cities selected for reperforator switching centers within the telegraph network are all large places, it is not surprising that connections are planned for 22 of the 36 cities mentioned in Public Notice 7762. As mentioned previously, the system between New York, Philadelphia, Pittsburgh and Washington (which also includes a station just a few miles north of Baltimore) is practically complete. Western Union has either optioned or purchased tower sites as far west as Minneapolis and Kansas City, as far south as Atlanta, and toward Dallas. Surveys have been completed in other sections, particularly on the west coast. With the exception of Boston, New Orleans, Seattle and Miami, the

NETWORK SYSTEMS

Below—The Bell System now operating a radio relay between New York and Boston, soon to expand the network to include Chicago. Right—Upper map shows Philco's present radio relay between New York and Philadelphia, the lower map showing manner in which this microwave relay easily can be extended to provide service for a number of other communities which might be served from WPTZ





remaining cities could be reached by short extensions to the planned network, as required by telegraph volume, television, or other service requirements, but even these four cities which require long extensions can be connected if the requirements are established.

A spokesman for Raytheon explained that they had plans for common-carrier service from San Francisco to Los Angeles, and two years ago had experimented with a link between New York and Boston which could be re-established in six months. At present Raytheon has no relays operating, although the ground work for satisfactory transmission by microwaves has been laid. They frankly question the economics of TV relaying, and ask "Can it be made to pay?" Estimates indicate that 1 to 1.5 billion dollars income would be needed to support four national networks.

DuMont Labs., operating TV stations in New York and Washington, prefer to have their programs relayed by common-carrier provided the facilities are available when needed and the charges not excessive. Engineer T. T. Goldsmith then suggested that, if say 8 broadcasters joined forces, a network could be cooperatively established, for instance linking: New York, Trenton, Philadelphia, Reading, Lancaster, Wilmington, Baltimore and Washington. This radio net it was estimated could be operated in two-way service, 28 hours a week, at a cost of $5 per hour per station. If 4 channels were available, the cost would drop to $2 per hour per station. This rate would allow amortizing the equipment costs, which were estimated at $211,000. Construction would require 9 months.

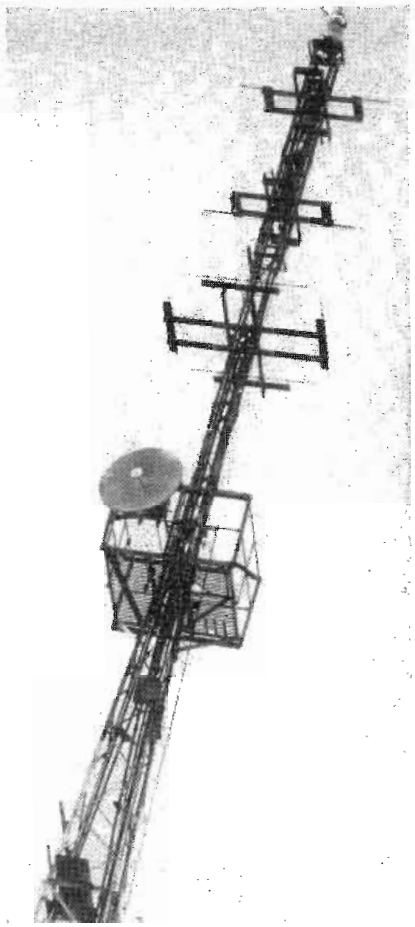
Philco Corp. has operated its New York-Philadelphia relay* for some time, and has established a Philadelphia - Washington link. They believe that TV broadcasters can set up and maintain their own networks at a cost much lower than that announced by the Bell System. It was pointed out that the 3 mc channel width offered by the Bell System was too narrow. It should be 4 mc.

GE's Radio Relay Net

The General Electric Co. announced that it has a one-way microwave relay system, for both picture and sound, operating between New York and Schenectady. This may be extended to Syracuse and Rochester. The relay points of the operating net are illustrated. In their presentation to the FCC they wisely point out the fundamental importance of supplying TV programs to the smaller stations not equipped to originate elaborate programs. Five to seven networks may be established for this purpose. Microwave relays are the most economical. It is necessary to provide sufficient frequencies in that portion of the spectrum where development work already has been done, so that satisfactory relay equipment can be made available without development delay. It is vitally important that the frequency bands now set aside by the FCC for relaying TV not be disturbed.

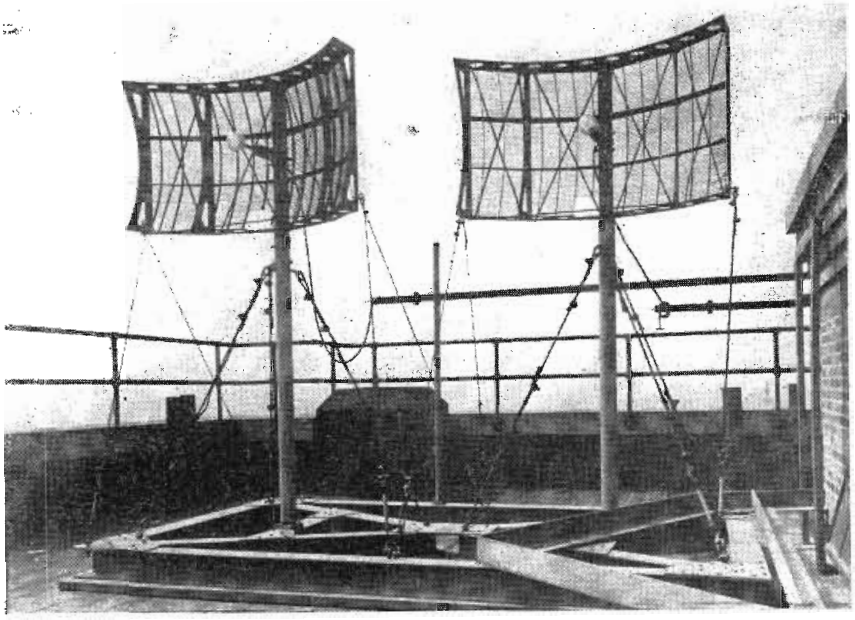
Chief of FCC's engineering section, Plummer, asked each TV licensee, or permittee, the approximate date his station would be ready for, or desired, common-carrier network service. After each statement, a check was made with the Bell System's plans to see if their service would be ready by the date mentioned. It was evident, that even with the good progress now being made in installing relay

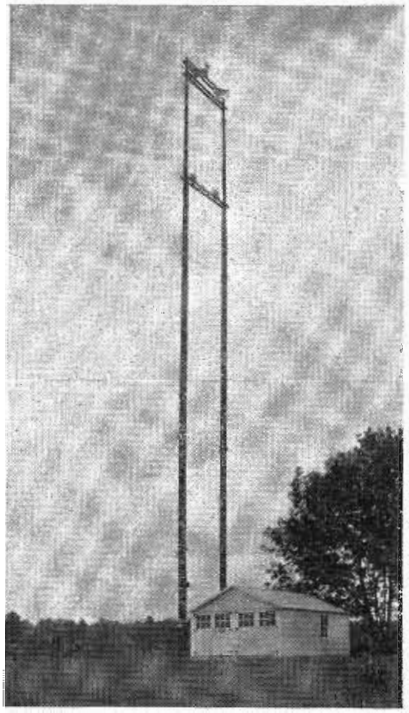
*Though the Philco microwave relay system has been in use for some time to transmit programs from WNBT in New York to WPTZ in Philadelphia, it was used for a northbound transmission for the first time on June 17 when WPTZ relayed Princeton's commencement exercises to WNBT; program was then routed over the AT&T coaxial cable and broadcast in Washington by WNBW.

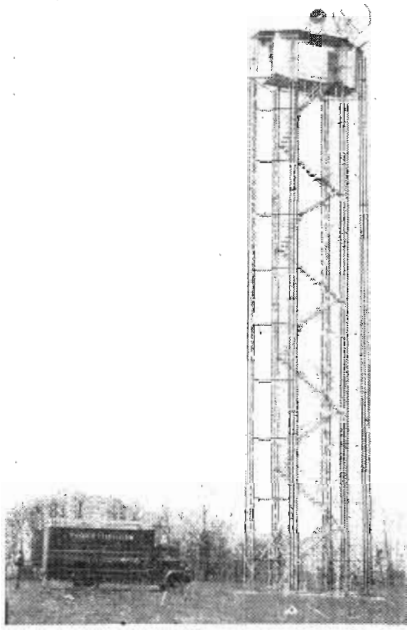


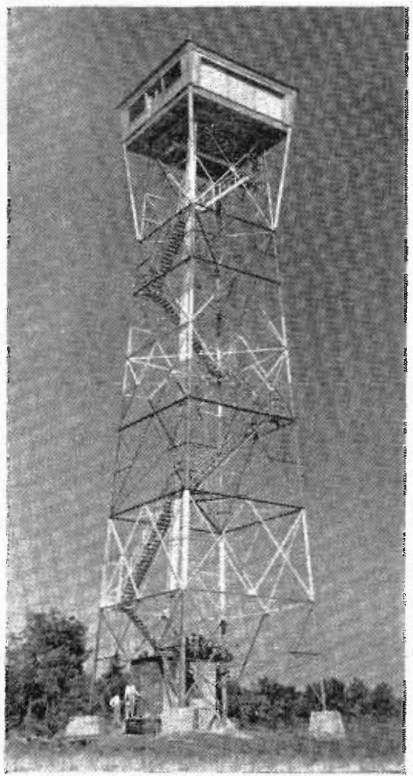
Parabolic reflector and antenna system of Philco experimental microwave television relay system shown mounted at center of tower just above platform

Close-up of the transmitting and receiving antennas at Raytheon's New York Terminal









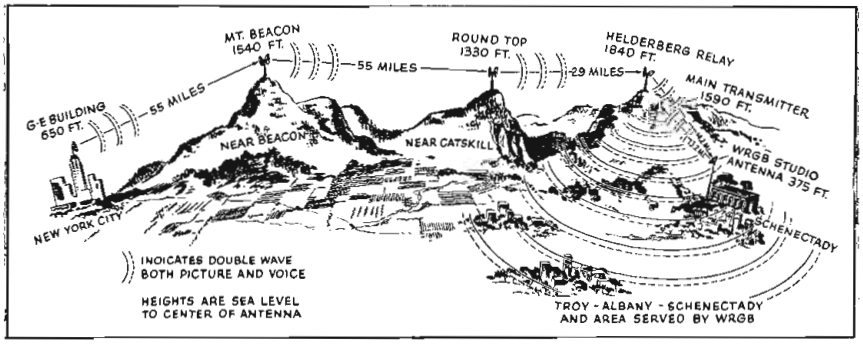
Left—Typical Raytheon automatic microwave repeater station at Lewisboro, N. Y. Center—Philco's tower at Mt. Rose, N. J. for microwave relay system operating at 1350 mc. Right—View of General Electric's Helderberg mountain tower

facilities, it would be impossible to have common-carrier service ready by the time the majority of the TV broadcasters thought they would go on the air.

Statements from the broadcasting chains, ABC, NBC, and CBS, indicated that they all will use common-carrier to supply TV programs to their own stations in the several cities where they will be located.

In spite of the many difficult angles to this perplexing problem of connecting our vast country by a television web it is confidentially predicted that we can look forward to the time when the stars performing in Hollywood will appear on the television screens in New York City, and the fashions of Fifth Avenue will be observed by the ladies of Dallas! This prediction is based on today's results in transmitting pictures over the coaxial cable between New York and Washington, and also upon the ability demonstrated in the past by the various groups of engineers now developing inter-city radio relays.

Topographical presentation of the GE microwave relay between New York and Schnectady



Advantages of PCM for Radio Relays

Communications engineers who have studied the characteristics of the Pulse Code Modulation system reported last month, developed by engineers of the Bell Telephone Labs., and have tested its capabilities believe that the PCM system is naturally best suited for communication over relay networks. As stated in the previous report, this system is particularly suited for circuits where long chains of repeaters are encountered, each of which might contribute appreciable noise. The system functions through the use of pulses having only off-on characteristics and so may be regenerated or restored to their original form if done at points along the system before the wave shape has been distorted too much.

Experimental evidence indicates that speech transmitted over the PCM system at a constant level could be transmitted with only three or four digits in the code unit. However, when the volume range varied it was necessary to add more digits. Based on the B.T.L. tests it was reported that the number of digits required depends not alone upon the speech quality required and volume range but also upon the background noise present in the input signal.

Wide Band Oscilloscope Amplifier

By C. E. HALLMARK*, Senior Member, and R. D. BROOKS*, Associate Member, I. R. E.

Balanced push-pull direct-coupled stages provides characteristics necessary for square wave analysis and television applications

• Faithful oscilloscopic display of a television picture signal wave form imposes a number of severe requirements on the performance of the oscilloscope signal amplier. Among these are time of rise and overshoot both of which are dependent upon the high frequency (amplitude and phase) characteristics of the amplifier. The actual time of rise permissible in the oscilloscope amplifier will depend upon the characteristics of the television signal to be displayed—resolution, number of scanning lines per second and subject matter in the image.

In general, the oscilloscope signal amplifier will be required to have a somewhat shorter time of rise than that represented by the steepest wave front in the signal. The exact factor is not known to the writers but experience has shown that a time of rise of approximately 0.06 microseconds is adequate for displaying the signal resulting from a test chart televised on the present standard 525-line system. Such performance permits an accurate display of any wave front which can be transmitted within the 4.5 mc bandwidth limitation set forth by the FCC.

The question of permissible overshoot in the oscilloscope signal amplifier is somewhat more arbitrary. Ideally, of course, it should be zero. Practically, if the overshoot is kept below 3%, with the above time of rise the oscilloscope is useable for most television application purposes.

*Farnsworth Television & Radio Corp., Fort Wayne, Ind.

FOR television oscilloscope signal amplifier use, a balanced direct-coupled amplifier is described which has a net bandwidth of 15 megacycles and extends down to zero frequency. The maximum time of rise and overshoot are respectively 0.04 microseconds and 2% and the response to a one cycle-per-second square wave is faithful to within 1%. The output voltage will give 3½ in. deflection on a tube operated at 6kv. Amplitude distortion is less than 10%.

Another requirement involves the low frequency performance of the oscilloscope signal amplifier. In order to study the functioning of such elements as clippers, dc restorers, clamps, etc., it is frequently required that the oscilloscope used be capable of displaying a 60 cycle per second square wave with a tilt of less than 1%. This implies not only the use of long time constants in the oscilloscope signal amplifier coupling circuits but also somewhat precise compensation.

It has been the writers' experience that while such compensation can be achieved, it is difficult to retain over a long period of time due to drift in certain of the compensating elements. From this standpoint, therefore, it appears most desirable to extend the frequency response of the amplifier downward to zero frequency. Such a characteristic also permits the accurate display of a television signal wave form containing a dc component.

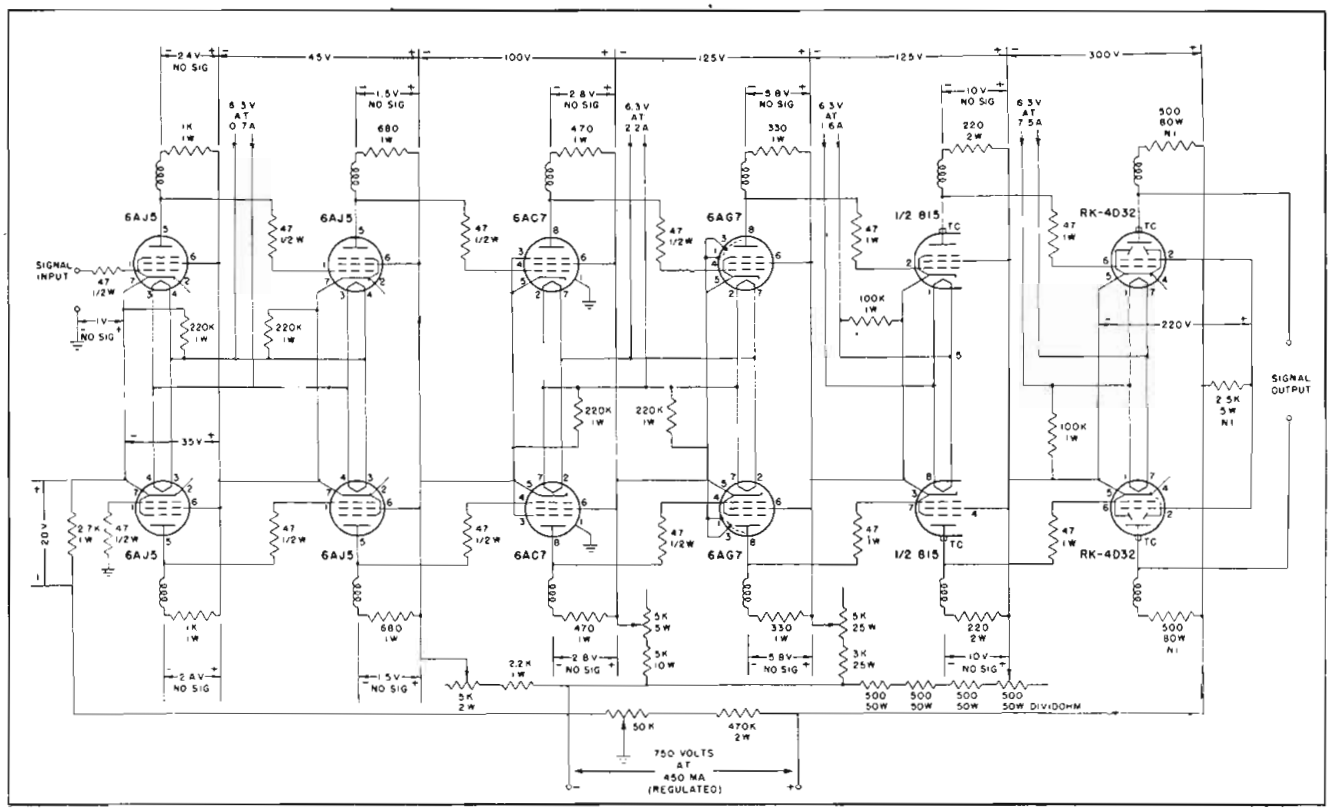
Circuit Arrangement

The schematic diagram of one version of the amplifier (less peaking elements) which meets all the above requirements is illustrated. The load resistor values are based on a theoretical cut-off frequency of 31.8 mc and fractional section (half-section or less) constant-k peaking. If no peaking is used, the time of rise will be approximately 0.06 microseconds and the overshoot will be identically zero. A time of rise of 0.04 microseconds with an overshoot figure of less than 2% can be achieved by use of suitable shunt peaking.

The signal input is unbalanced and the first stage is a cathode coupled dc phase inverter. Successive stages are balanced direct coupled, the plate and screen supply for each being derived from the cathode potential of the stage following. The difference current between adjacent stages is bled off through a suitable cathode resistor.

All stages operate Class A, the bias for each (except the phase inverter) being developed by the dc drop in the plate load resistors of the preceding stage. Bias for the phase inverter stage is determined by the adjustable potentiometer across the power supply. Centering is accomplished externally by adjustment of the input grid average potential with respect to ground.

It is noted that amplitude distortion tends toward cancellation



Schematic diagram of one version of the amplifier (less peaking elements). No capacitors are used, the balanced arrangement giving high frequency stability

in any pair of stages. The extent to which this effect is realized depends upon the similarity of tube characteristics over their respective normal operating ranges. Note that no capacitors are used in this circuit. High frequency stability is achieved by virtue of the balanced arrangement.

Low frequency performance and stability with respect to supply voltage will be apparent upon consideration of the direct current path through the amplifier. Any disturbance in the supply voltage is rapidly attenuated as it progresses toward the input terminals of the amplifier. Actually, it has been found that a plus or minus 50-volt disturbance in the 750-volt supply does not appreciably affect the amplifier performance other than its output stability.

Signal level control is provided at a point external to the amplifier. Overall sensitivity is approximately 0.2 volts per inch and maximum deflection is approximately 3½ in. using a Type 5RP1 cathode ray tube operated at 6 kv acceleration. Plate supply input is 750 volts at approximately 450 milliamperes. Non-inductive load resistors in the power stages are constructed by paralleling a suitable multiplicity of two-watt composition resistors.

Other versions of this amplifier for meeting different requirements have been successfully constructed. One in particular has a 300-volt power supply at a current drain of 150 milliamperes. This design results in sufficient output over an 8 mc band to give full scale deflection on a five-inch oscilloscope operating at 1500 volts. The time of rise is approximately 0.08 microseconds with negligible overshoot.

Dozen Transmitters Service India's 400 Millions

To serve India's 400 millions as well as Burma, Malaya and Indonesia, All-India Radio concentrates about one dozen transmitters in New Delhi, using the All-India Radio House for administration and program orientation. In addition to this cluster of transmitters, there are radio stations in some of the larger coastal areas—Bombay, Karachi, Bangalore and Calcutta.

The All-India Radio House, a new structure of circular design, contains the latest equipment in broadcasting, much of it American, and boasts one of the most modern studio arrangements from both an engineering and acoustical viewpoint. Programs are broadcast in the twelve official languages of that country and serve a people who speak over 100 dialects.

In an interview with studio engineer, M. Bala, and his principal assistant, engineer Motai, it is reported that the voice of All-India Radio carries considerable weight from a political point of view. Through this voice by means of efficient propaganda the many different peoples of that country may be hewed to the political plank of the faction in control of the broadcast system.

Radar System for Airport Traffic and Navigation Control

By FRED J. KITTY, Project Engineer, Bendix Radio Division, Baltimore, Md.

Based on wartime Navy GCA, "Quonset Installation" combines advantages of many systems to provide for surveillance, height-finding and instrument approach — Part 1

THE manifold problem of aircraft traffic control and navigation has been the subject of much discussion in recent years. A specific and important ramification of the overall subject is that of airport traffic control and instrument landing under conditions of very poor visibility and low ceilings. Proper control of aircraft in the airport zone, as well as bringing them in to a safe landing under any weather conditions, are problems of primary importance.

• Many schemes have been presented for realizing the solutions to the problems briefly outlined. It is the purpose of this article to describe one system, which was built for the U. S. Navy as one solution to the problem. This system is a complete airport radar system and has designated Radar Set AN/FPN-1 (XN-2). The design objective is the correct solution to the twin problems of airport surveillance, traffic control and instrument approach. The FPN-1 has recently been installed at the Quonset Point (R.I.) Naval Air Station and is now undergoing evaluation tests.

The "Quonset Installation" is based fundamentally on the wartime Navy G.C.A.[1] During operation of the G.C.A. by the U.S. Navy, many ideas have been evolved to improve the design and operation of the system. Most of these improvements have been incorporated in the design of the AN/FPN-1 system, which represents in many respects a radical change over the original G.C.A. equipment.

The AN/FPN-1 (XN-2) is a fixed ground radar system for airport surveillance, height finding, traffic control and instrument approach under all conditions of visibility. Fig. 1 is a sketch representing the overall system installation. System characteristics are tabulated in Fig. 2.

The search and height finding systems provide range, azimuth-bearing and altitude data on all aircraft in the vicinity of the airport out to a range of 30 nautical miles and up to 12,000 ft. altitude. This information enables the search operator to locate and identify all planes in the covered area, control traffic of all aircraft by direction, and guide individual aircraft into position from which a proper approach to the runway may be made. There is provided with the system means for installing a VHF direction finder (DBF). When the aircraft pilot communicates with the radar on the 100-156 mc band, the DBF-1 indicator shows the plane's bearing. By this means the search operator may quickly identify each of the aircraft under his control.

The precision system presents accurate and continuous information regarding the location of incoming aircraft in range, azimuth-bearing, and elevation with respect to the predetermined glide path. This information is translated by the radar set to lateral and vertical deviations from the selected glide path, and the pilot of the incoming aircraft is instructed verbally by radio as to corrections he must make to keep on the glide path. Through these instructions the pilot is guided to a height of 75 ft. or less above the runway and to within 50 ft. of the runway's center line.

Included in the FPN-1 are two VHF transmitter-receivers, two HF transmitters and two HF receivers, providing two-way communication with the aircraft in the 2-9 and 100-156 ms bands. These are standard types. Successful use of the radar set requires only that the pilot of the aircraft be able to communicate with the radar set operators in one of the two available communication bands.

All units are permanently installed at fixed locations except the trailer which houses a portion of the precision landing equipment. This unit may be located at either of two positions. In this way landings may be controlled on either of two runways. The search transmitting and receiving equipment is located on a 67-ft. tower. The height finder transmitting and receiving equipment is mounted on a separate 67-ft. tower with the antenna housed in an electrically transparent radome located atop the tower.

All indicators and communication equipment are located in a single room in the airport control tower building. Since the trailer and two tower locations are completely unattended during opera-

1. The Story of G.C.A. by C. F. Porterfield, "Airtrails"—June and July, 1947

tion, full remote control facilities are provided at the indicator location for the radar operators. Thus the operators remotely control the following functions for all three systems; primary power, antenna receiver tuning, receiver gain, and many others.

In order to accomplish remote control and proper transmission of radar data, cables and wires have been run from the indicator room of each of four locations; search tower, height finder tower, and the two alternate precision trailer positions. Thus for the first time a complete, integrated, remotely controlled radar system is at the fingertip control of operators at a single location. Previous systems have provided complete facilities (i.e., including a height finder) or partial remote control but not completely integrated and operable from a single location.

Radar Set AN/FPN-1 (XN-2) may be divided conveniently for discussion into three distinct systems; search, height-finding and precision. The function of the search system is to survey the area in the vicinity of the airport, the height finder to determine the elevation of aircraft detected by the search system, the precision system for guiding the aircraft to an instrument approach.

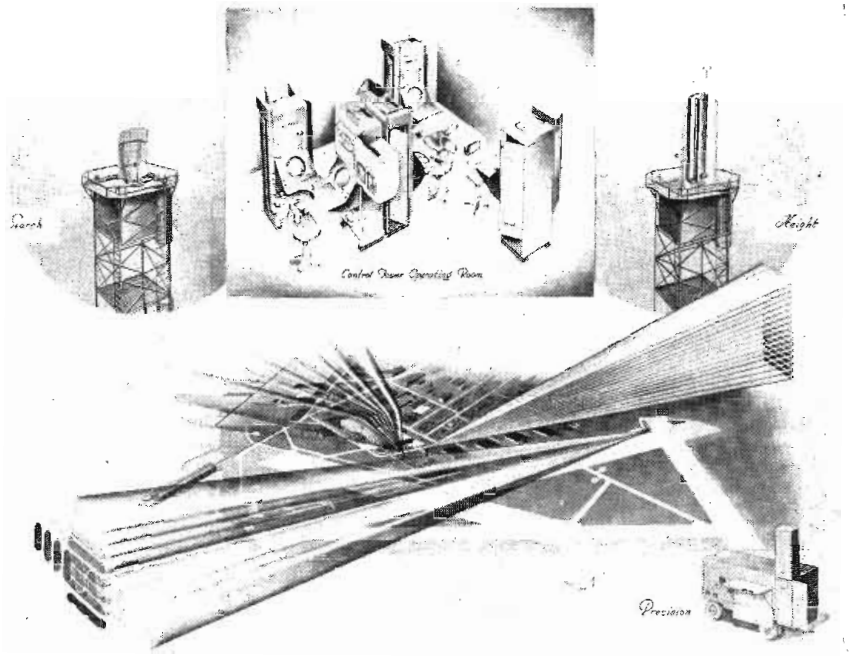


Fig. 1—Artist's conception of AN/FPN-1 (xn-2) installation. Relative locations as well as details of Search, Height-finding and Precision systems are shown. Functions of each are indicated by types of antenna patterns and scans. Control tower insert shows all the radar indicators

The search system components are in two distinct and separate locations: (1) Atop the 67-ft. search tower and, (2) In the indicator room, in the building which houses the airport control tower. The two locations are separated by approximately 500 ft.

Mounted in a room at the top of the search tower are the power distribution rack (Fig. 4) (containing the connector panel, the synchronizer and the 28-volt power supply for the search antenna tilt motor), the transmitter rack (Fig. 3) (containing the HV power supply, the transmitter modulator, the synchroscope and the radar receiver), radio frequency transmission lines and the pedestal which drives and supports the radar antenna. The antenna is

FIG. 2 — TABULATION OF "QUONSET INSTALLATION" CHARACTERISTICS

A. Primary Power Requirements:
(All at 115 v. ac, 60 cycle, 1 phase)
1. Indicator room ... ...2.4 kw, 3.2 kva, 20 a.
2. Search tower .....3.2 kw, 4.6 kva, 40 a.
3. Height finder tower ....2.7 kw, 4.4 kva, 38 a.
4. Precision system trailer.4.4 kw, 5.2 kva, 45 a.

B. Operating Frequencies:
1. Radar:
Search system .....2880 ±20 mc.
Height finder system .....9150 ±10 mc.
Precision azimuth system .....9040 ±10 mc.
Precision elevation system ....9010 ±10 mc.

2. Communications:
HF transmitting .....2 - 18 mc.
HF receiving .....1.5 - 9 mc.
VHF transmitting .....100 - 156 mc.
VHF receiving .....100 - 156 ms.

C. Power Output and Transmitter Type:
1. Radar:
Search system, 2J30 magnetron..200 kw min.
Hgt. finder system, 2531 tunable mag. ..... 45 kw min.
Precision az. system, 2J51 tunable mag. ..... 45 kw min.
Precision elev. system, 2J51 tunable mag. ..... 45 kw min.

2. Communications:
HF band .....100 w.
VHF band ..... 8 w.

D. Radar Receiver Characteristics:
Search: Superheterodyne
Local oscillator 2K28 Klystron
Inter. frequency 30 mc.
Automatic frequency control
Sensitivity time control
Fast time constant
Height finder, precision azimuth and precision elevation: Superheterodyne
Local oscillator 2K25 Klystron
Intermediate frequency 30 mc.
Automatic frequency control
Sensitivity time control
Fast time constant

E. Indicator Range Scales:
Search—6, 10, 20 and 30 nautical mi.
Hgt. finder—20 nautical miles slant range, 12000' altitude
Precision azimuth and elevation—6 nautical mi.

F. Pulse Data—All Radar Systems:
Pulse repetition frequency .....2000/sec.
Pulse duration .....0.5 microsecond
Duty cycle 0.001

G. Antenna Beam and Scan Characteristics:
Search:
(a) Beam dimensions:
Elevation—Approximately "cosecant squared" pattern along top from 3° to 10° in elevation, with nose of beam at 2¾°.
Azimuth —4½° maximum at ½ power points.
(b) Scan—speed 30 to 35 rpm in azimuth
Range 360° continuous
Nose of beam adjustable (remotely controlled) to 10° above horizontal in elevation.
Height Finder:
(a) Beam dimensions:
Elevation—0.6° at half power points
Azimuth —3.6° at half power points
(b) Scan:
Elevation speed—1 scan/second
Range —½° below horizontal to 19½° above (20°)
Azimuth —Any azimuth position as selected by operator.
Precision Azimuth:
(a) Beam dimensions:
Azimuth —1° at half power points
Elevation—2° at half power points
(b) Scan: Azimuth speed—2 sweeps/sec.
Range —20° (5° to right of runway)
(15° to left of runway)
Elevation —Any position from 1° below horizontal to 6° above as selected by elevation operator.

Precision Elevation:
(a) Beam Dimensions: Elevation—0.6° at half power points
Azimuth —3.6° at half power points
(b) Scan: Elevation speed—2 sweeps/sec.
Range —7° (1° below horizontal to 6° above)
Azimuth —Any position from 5° to right of runway to 15° to left as selected by azimuth operator).

H. Accuracy:
Search: Azimuth—±1.5°
Range —±3% of sweep range in use
Height Finder:
Elevation—±500 ft.
Range —±6% of true range
Precision:
Elevation—±0.5% of range
Azimuth —±1% of range
Range —±3% of true range

I. Indicators:
Search: Two 12" plan position indicators
Hgt. Finder: One 12" range height indicator
Precision: One 12" E.P.I. azimuth indicator
One 12" E.P.I. elevation indicator
One 12" Error indicator

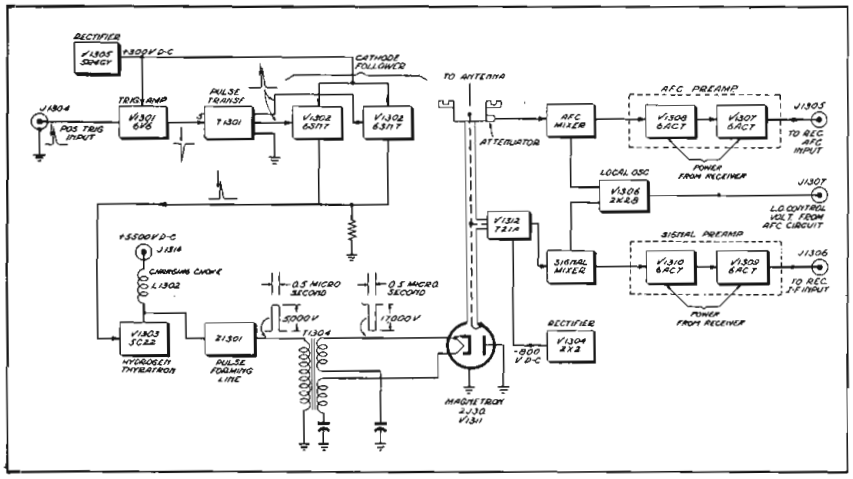


Fig. 6—Block diagram of the transmitter modulator

mounted on top of the pedestal, in the open air immediately above the transmitter room.

Installed in the indicator room is the search indicator rack, (Fig. 5) (containing the search indicator, the servo amplifier, and a filter unit for removing the 2 kc pulse note from the communications equipment). An identical search indicator is mounted in the approach indicator rack. Facilities for communication, by radio, with aircraft and by land lines with the search tower are available at the indicator room.

The basic 2000-cycle trigger for the entire system is derived from the search synchronizer. This trigger is fed to four output channels in the synchronizer and produce a negative trigger to operate the receiver S.T.C. (sensitivity time control) circuit, a positive trigger to start the synchroscope circuits, a position trigger to operate the radar modulator, and a positive trigger to start the two search indicator sweep circuits. This last mentioned trigger is mixed in the synchronizer with the video output of the receiver so that only a single coaxial cable is required for transmission of data between the search tower and indicator house.

The trigger to the search indicators not only serves to start the indicator sweeps but is also fed to an amplifier the two outputs of which are applied to the height finder and precision synchronizers so that the entire radar system is synchronized. By proper cable patching in the indicator house and switching the synchronizers to internal or external operation as required, any one of three synchronizers may be used as the "master" trigger source for the entire system. It should be emphasized that this may be accomplished entirely at the control position. There is no necessity for going to any of the three remote positions.

Power Supply

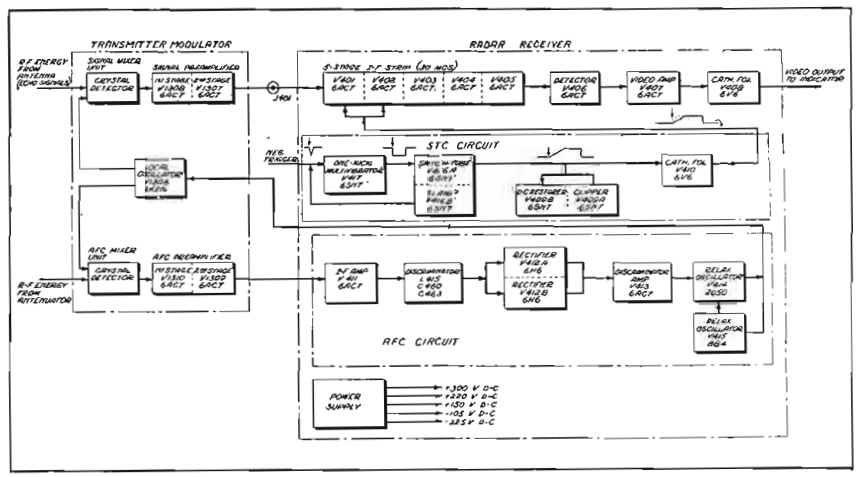
The high voltage power supply consists essentially of a pair of type 705A half wave rectifiers connected in a voltage doubling circuit. This unit furnishes 5500 volts dc plate power at 150 ma for operation of the 5C22 hydrogen thyratron modulator tube in the transmitter modulator unit. (Fig. 6) The application of this dc voltage to J1314 causes the pulse forming line to be charged to 11,000 volts through the charging choke. When this point is reached the positive trigger from the synchronizer is applied to the 5C22 grid through a trigger amplifier circuit. This causes the line to discharge through the 5C22 and the pulse transformer. In discharging, the line produces a positive 10,000-volt pulse, 1/2 microsecond in length, half of which, or 5000 volts, is applied across the primary of the pulse transformer. The pulse transformer amplifies and inverts the input pulse. The resulting 17,-000-volt negative pulse is applied to the cathode of the 2J30 magnetron. This process is repeated 2,000 times per second.

When the cathode of the magnetron is lowered 17,000 volts with respect to the anode by the application of the pulse from the pulse transformer, the tube goes into oscillation for the 0.5 μs interval during which the pulse is applied. A coupling loop extracts power from the magnetron for transmission through coaxial line and waveguide to the antenna. The peak power output from the magnetron is a minimum of 200 kw.

The 721B T-R tube fires at the start of each transmitted pulse and by thus serving as an electronic switch prevents the high power pulse from damaging the sensitive crystal detector (IN21B) in the signal mixer unit. Upon completion of the transmitted pulse the T-R tube returns to the unfired state and thereby allows all echo signals received in the antenna to pass to the signal mixer unit.

An attenuator located in the rf plumbing extracts a small amount of rf energy from the transmitted pulse and applies it to the AFC mixer (IN21B) for con-

Fig. 7—Block diagram of the radar receiving equipment



trolling the operation of the AFC circuit.

The echo signals received by the antenna are applied to the signal mixer crystal through the T-R switch, very little being lost in the magnetron as a result of its high cold impedance. Both the AFC and signal crystals are capacitively coupled to the output of a single type 2K28 Klystron local oscillator which operates at a frequency 30 mc above that of the magnetron. As a result of the heterodying action in the crystal detector and mixer a 30 mc IF is obtained from each of the two mixer units. The output of the signal mixer is applied to the two-stage signal preamplifier and then to the receiver IF input circuit, while the output of the AFC mixer is applied to the two-stage AFC preamplifier and then to the receiver AFC input circut. The two preamplifiers are identical in construction but the IF band pass characteristic is different for each. This is accomplished by different settings of three tuning slugs.

RF energy from the transmitter is fed to the bottom of the antenna mount through a rotating joint. At the top of the mount a horizontal rotating joint permits tilting of the reflector mounting plate with resultant raising or lowering of the beam. A coax to waveguide joint feeds rf energy into the bottom of a five-foot section of S band waveguide, in the upper end of which are mounted two dipole antennas which radiate toward the reflector.

The antenna mount houses a drive motor B1501 which drives the antenna assembly at 30-35 rpm through a 5:1 reduction gear assembly. The driven gear in turn drives a synchro generator (selsyn) B1503 which supplies positioning data for the deflection coil on the indicator tube. The antenna assembly is mounted on a plate which is hinged so that it may be tilted with respect to the fixed mount. A motor B1502, controlled by a switch at the search operator's position in the indicator room, tilts the antenna mounting plate and thus the angle of elevation of the beam. A synchro generator (selsyn) B1504 geared to the tilt mechanism refers tilt data to a synchro meter at the search operator's position. This meter indicates directly, in degrees, the angle of the "nose" of the antenna pattern.

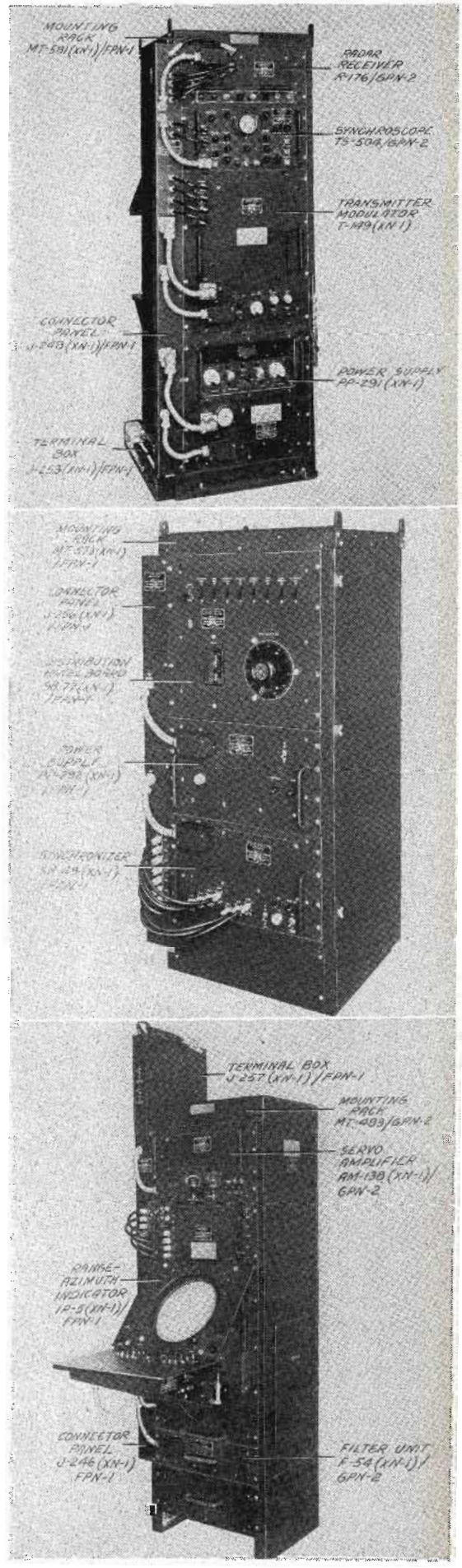
Fig. 3 (Top)—General view of the rack containing the search transmitter. Fig. 4 (Center)—Front view of search tower power distribution rack. Fig. 5—Search indicator rack

The antenna dipoles radiate into the reflector, an eight foot parabolic dish whose sides have been truncated for an overall width of 5 ft., 2½ in. The reflector consists of edge mounted 1/16 in. stainless steel slats mounted on 1¼ in. centers. At the search transmitter frequency the slatted reflector behaves electrically like a solid sheet and the energy is therefore reflected in the desired direction. The horizontal slat construction affords a minimum of wind resistance and the antenna-reflector combination is able to withstand winds up to 115 miles per hour. By properly adjusting the amount of defocusing and power supplied to each dipole an antenna pattern is produced which has very good sky coverage, produces a minimum of ground return and is less than 4.5° wide in azimuth at the half power points.

Radar Receiver

The primary function of the radar receiver (Fig. 7.) is to amplify the IF signals received from the signal preamplifier in the transmitter modulator unit and convert these signals to video pulses for application to the control grid of the indicator tube. To accomplish this purpose a 5-stage IF strip having a band-pass of approximately 4 mc, symmetrical about an IF frequency of 30 mc is used to feed a second detector and video amplifier. A cathode follower stage is used to provide low impedance receiver output. The cathode follower output is applied to the synchronizer where it is mixed with the indicator trigger for transmission through 500 ft. of 120-ohm coaxial cable to the search indicators.

The STC (sensitivity time control) circuit is incorporated into the design to provide a voltage pulse which is synchronized with the transmitted rf pulse and which increases the receiver gain with



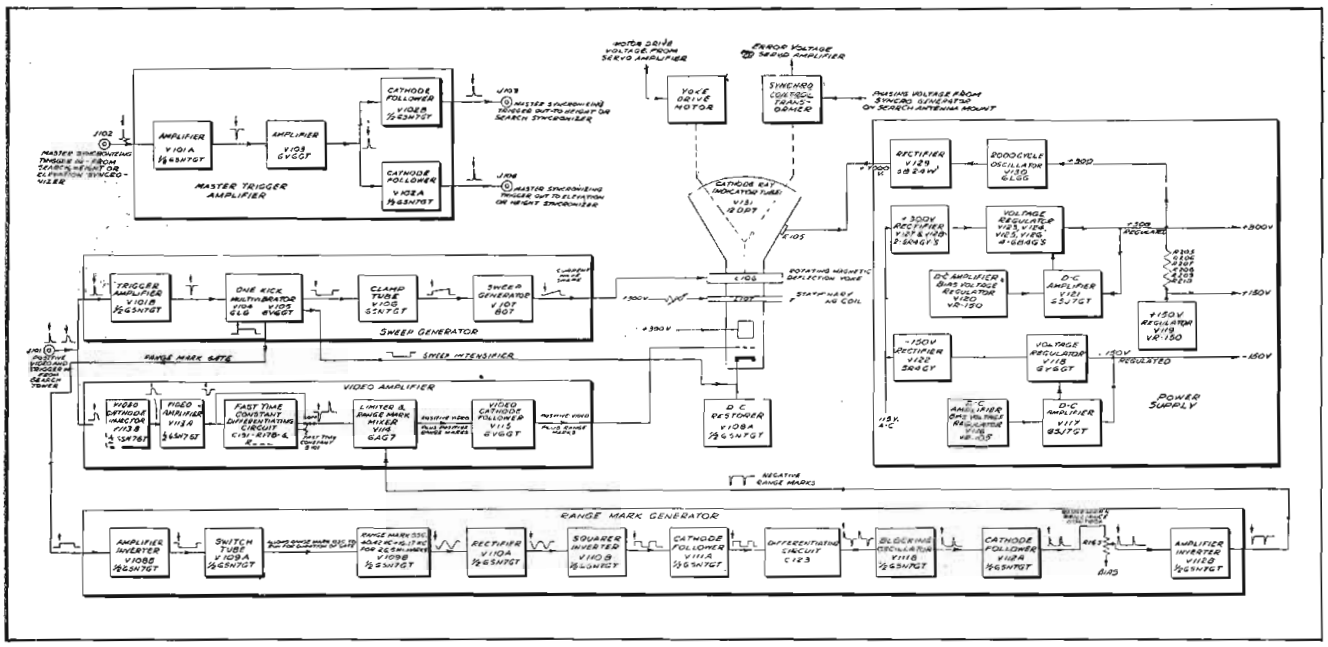


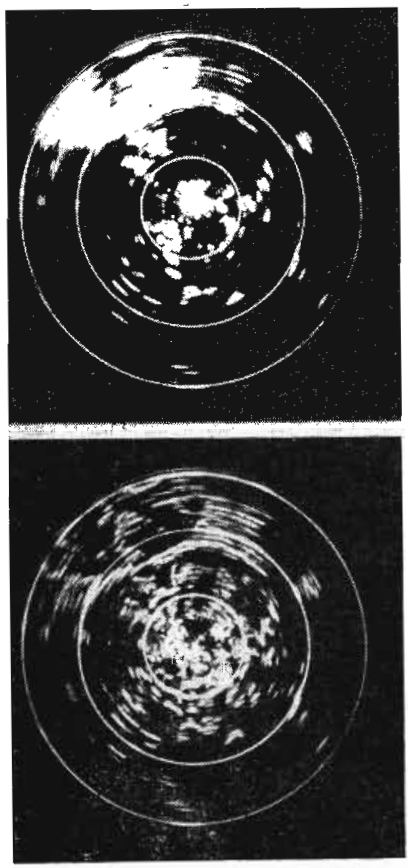
Fig. 8—Block diagram of "Quonset Installation" search indicator equipment

respect to time along a fourth power curve beginning with minimum receiver gain (as controlled by the operator) at the time of transmission of the pulse and rising to maximum gain during a pre-selected interval of time following the transmitted pulse. This action results in small amplification for strong signals from nearby objects and greater amplification for weaker signals, received at a later time from distant objects, and thus produces a much clearer indicator presentation by avoiding a brilliant area at the beginning of the sweeps. A trapezoidal pulse having a linearly rising leading edge and a vertical trailing edge is generated in the STC circuit and is applied to the plates and screens of the first and second amplifier tubes in the IF strip producing the fourth power gain variation.

In general, magnetron transmitter tubes are subject to considerable frequency shift due to variations in loading, temperature, etc., which may cause as much as a 10 mc shift. As a result it is necessary to introduce some sort of automatic frequency control circuit in order to maintain a constant 30 mc IF input to the receiver. The AFC circuit produces a voltage which converts IF deviations into a correction voltage which is applied to the repeller of the local oscillator tube to vary its frequency. For example, should the transmitter frequency rise, the IF will fall and the AFC will apply a correction voltage to the local oscillator to shift its frequency until the IF is again 30 mc.

The AFC circuit consists of an IF amplifier, a frequency discriminator circuit whose output voltage, amplitude and polarity depend upon the IF frequency, an inverter and two gas-filled thyratrons whose output voltages control the frequency of the local oscillator.

Fig. 9—(Above) Appearance of 6-mile Plan Position Indicator with FTC off and Fig. 10 the same screen and indication with FTC on



The synchroscope is mounted in the transmitter rack between the receiver and the transmitter modulator and provides a convenient means for viewing waveforms in the radar set, since it is designed for use either as a synchroscope or as an oscilloscope. In normal operation the synchroscope is synchronized with the radar system and a portion of the video output from the receiver is fed to its input. Thus it may be seen that the synchroscope can be used as an "A" scope for initial tuning operations. Another identical synchroscope, for test purposes, is provided in the indicator room.

The directional coupler provides a convenient piece of rf test equipment. It is possibe use this device to extract rf energy from or to feed rf energy into the system. Thus various transmitter and receiver measurements are possible.

The echo box provides a convenient means for checking overall system performance. When connected to the directional coupler the echo box (a resonant cavity) will oscillate for a period of time, feed energy back into the system,

(*Continued on page* 102)

WHAT BROADCAST ENGINEERS WANT FROM FCC

CLEAR CHANNEL BROADCASTERS RECOMMEND:

A—That the Commission amend its regulations to consider skywave, both day and night, as well as ground-wave in making allocations.

B—That Class I-A stations be protected from interference at all times to their 100 microvolt per meter contours calculated for 750 kw. Also the same protection for at least four Class I-B stations.

C—That a minimum separation of 1,200 miles from the dominant station be required for daytime and limited stations operating on clear channels. Further study should be given the power and hours of operation of these stations to insure the protection mentioned in B above.

REGIONAL BROADCASTERS RECOMMEND:

A—That the FCC reduce the number of Class I-A channels for high-power stations and reallocate these channels to Class II stations, 1 kw maximum power, unlimited time, thereby eliminating the duplicate offerings of network programs by unreliable skywave. Skywave signals would be replaced by steady ground-wave signals from local transmitters. Also this would permit an increase in Class IV stations and in the operating time of Class II stations.

B—Reserve the remaining few Class I-A channels to serve large areas which can not support local stations, transmitters to be located at points where high power is really needed, not just anywhere in the U.S.A.

C—That FCC take notice of: the time difference between the point of transmission and the co-channel daytime station; the desirability of having characteristic programs from local stations to fill the needs of local listeners; rules to allow the largest number of daytime and limited stations to operate.

D—That the secondary service areas claimed by the clear channel group do not exist because of atmospheric disturbances and hence need not be protected. The testimony by the clear channel group does not give the complete picture because information is lacking on adjacent channel interference, noise levels, fading, and the effect of foreign stations. The FCC should resume clear channel allocations without reference to daytime skywave until such time as it receives records or evidence of sufficient dependability to determine accurately its effect on broadcast station co-interference.

How Daytime Skywave Reflections Affect Cleared Channels

• It is the nighttime skywave, reflected from the ionosphere, that makes possible long-distance nighttime reception from broadcasting stations in the 550—1600-kc band. But can such reflected radio waves be received in *daytime?* Despite assertions to the contrary, the answer is "Yes". In fact, the effects of daytime skywave caused the Federal Communication Commission to hold a hearing on this subject June 4, 5 and 6 to collect evidence affecting clear channel assignments. The information offered at this hearing is of interest to two types of TELE-TECH readers; the scientists and the broadcasters.

The scientists will note that such reflection, at these frequencies, from the ionosphere in the presence of the sun's rays may be hard to explain. Everyone is free to work out his own theory. At the hearing, very little information was offered as to *why* reflection took place. It was stated that the E-layer and the D-layer were responsible. In looking for clues, therefor we must search among the mass of reception data presented. This was obtained mostly from FCC listening posts and covers the period 1939 to 1944.

So many variables affect daytime skywave that only general points can be brought out here. From the exhibits it is believed that:

(1) Noonday signal intensities are highest in winter and lowest in summer.

(2) Skywave has been recorded up to 884 miles in winter but no signal was reported over this path during any other season. Over paths longer than this, little skywave was noted at noon.

(3) Probably noontime low frequency fields are stronger than high frequency fields, but more observations are needed. We have no accurate transmission formula for the calculation of these midday signals because of the effect of frequency and the seasons. There are transition periods morning and evening, extending from 2 hours before to 2 hours after sunrise (SR) or sunset (SS).

(4) During these transition periods, skywave, similar to that at nighttime, is noticed up to about 1200 miles. Midday skywave has different characteristics.

(5) During transition periods the skywave on high frequencies is more intense than that on the lower frequencies.

(6) Frequency-effects 2 hours after SS are small. At this time we can assume night time conditions prevail.

For *proof* that there is daytime skywave, examine Fig. 1, (from the CCBS exhibit) and note the signal strength at 752 miles dur-

ing daylight hours. Of course it is realized that the ground-wave of the transmitter concerned would be limited in distance and could not have a range exceeding say, 325 miles, so that these daytime signals observed at greater distances must be due to skywave. Fig. 1 shows actual measured field strengths at Grand Island, Neb. (FCC listening post) produced on 700 kc by WLW in 1944.

These three curves, from top to bottom, represent received signal intensity in microvolts per meter observed in percent of total time, 10%, 50% and 90% respectively. The reason for this method of reporting is to make the job easier, statistically. These curves show the steep drop in signal at SR and the non-symmetrical rise at SS; also noon intensities on the 50% curve have decreased below those measured at night by a ratio of about 1 to 200, but they may be usable in areas of low noise level.

To show graphically the calculated interference effects resulting from daytime skywave, observe in Fig. 2 the map of service area of station WNBC, New York. This example was chosen, from the exhibit of NBC, because a large percentage of listeners live in the

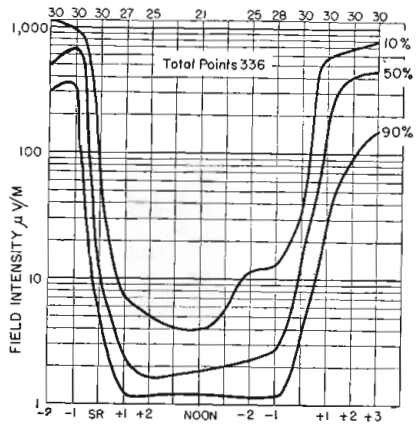


Fig. 1—Curves of variation of field strength with time, showing daytime skywave reception at 752 miles. Curves are the average of 336 points. The "10%" curve indicates reception for 10% of the total time

area shown. As you know, WNBC operates with 50 kw on 660 kc, a clear channel; that is, it is the dominant station on this channel to which the FCC has also assigned WESC, Greenville, S. C., (5 kw, daytime) 630 miles away; KSKY, Dallas, Texas, (50 kw, daytime) 1390 miles and there is an application from Columbus, Ohio, (1 kw, daytime) 490 miles.

The map indicates that only the white area within the 3.91 MV/M contour will be free from interference shortly after sunset.

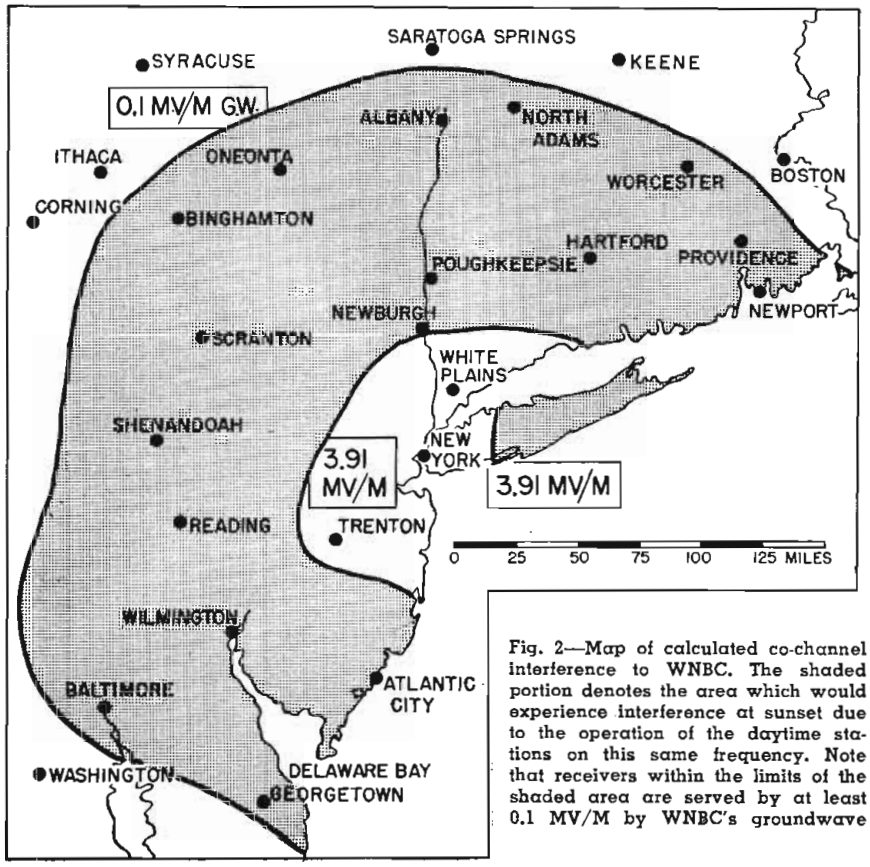


Fig. 2—Map of calculated co-channel interference to WNBC. The shaded portion denotes the area which would experience interference at sunset due to the operation of the daytime stations on this same frequency. Note that receivers within the limits of the shaded area are served by at least 0.1 MV/M by WNBC's groundwave

Listeners within the shaded 0.1 MV/M ground-wave contour have a right to expect good reception from WNBC, but due to the operation of stations on the same frequency in Greenville, Dallas (and possibly later Columbus) there will be interference evidenced by distortion, low beat-notes or "cross-talk".

The growth, and later the subsidence, of this interference, expressed in millivolts per meter, as sunset approaches and recedes is illustrated in Fig. 3. There is some lee-way between the best and the worst conditions, so assuming we are pessimists we will follow the solid curve (only because it is labeled for us) and find that as early as 2 hours before sunset there is some interference which grows steadily stronger up to about 1 hour after SS at which time WESC and Columbus go off the air because they operate in daytime only. But the interference from KSKY follows the curve upward until this more westerly daytime station also closes at almost 2 hours after SS (plus 22 minutes) in New York. The time separation between New York city and Dallas is 1 hour, 32 minutes, West.

These interference effects of daytime skywave interest the broadcaster. He knows the Clear Channel matter has been before the FCC for sometime and its several and intricate problems will not be settled before at least another hearing.

The FCC must now decide if it is sufficiently strong and occurs often enough to be objectionable to those able to and desiring to listen to the dominant station. If the decision is in the affirmative, then changes may be made in the AM standards resulting in the possible shift or removal of some daytime and limited stations now on clear channels.

If, on the other hand, it is found by the Commission that "objectionable interference" does *not* exist, then FCC will proceed to assign daytime stations as in the past. Incidentally, the U.S. Court of Appeals in Washington has set dates to hear cases of some of those who own stations on clear channels who are appealing deci-

sions which place alleged interfering daytime stations on their channels.

A brief description of this three-day hearing in Washington on daytime skywave follows. Commissioners Durr, Wakefield and Hyde were present. Com. Hyde presided and Plotkin was counsel for FCC. Into a large conference room crowded scores of broadcast engineers, consultants, lawyers and station owners. Before this group there appeared as the first witness Vandivere, FCC analyst. He offered his analysis of data from FCC listening posts, collected over a period of years and received over well-selected paths across the U. S. See Fig. 4. After listening to more than four hours of testimony and after reading his summary, just what he thought about the matter in hand is not clear but it is believed he admits there is skywave but thinks other factors have an important influence.

The next witness, J. H. DeWitt, Jr., of the Clear Channel Broadcasting Service, which represents 16 independently-owned clear channel stations, using the same reception data as the previous witness, showed by curves and maps that skywave in daytime *could* cause serious inroads upon the areas reached by some of the member stations of CCBS. DeWitt's thorough knowledge of the problem, coupled with his clear thinking, made him an excellent witness. His lengthy testimony was completed the following day and he was followed by J. V. L. Hogan, representing WQXR, New York city. Hogan pointed out the interference caused his listeners in daytime by WTOD, Toledo. This was done by means of an informal log of his observations at his home and by letters from listeners. (Two days later these letters were referred to when a question of admissibility of evidence arose. Chairman Hyde accepted these letters for the record although later he ruled against accepting a group of almost similar listener reports, in the form of *affidavits*, when offered by a witness on the other side.)

W. S. Duttera for NBC described his calculated curves and maps

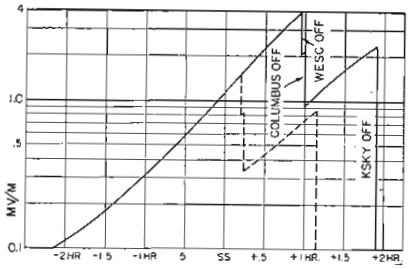


Fig. 3—Curves showing the rise and recession of interference to WNBC as sunset at New York approaches and recedes. Interference from the three indicated daytime stations stops when the most Westerly transmitter goes off the air

showing the effect of daytime skywave upon the areas in which listeners could get good signals from the several clear channel stations his company controls. Incidentally, future plans for 750 kw transmitters on clear channels were frequently discussed by witnesses during this hearing. Duttera recommended that rules for Class II stations be amended to protect the 0.1 MV/M contour of the dominant Class I-A station in daytime. J. W. Wright of CBS said the skywave in daytime should be taken into account and agreed with the recommendations of NBC and CCBS.

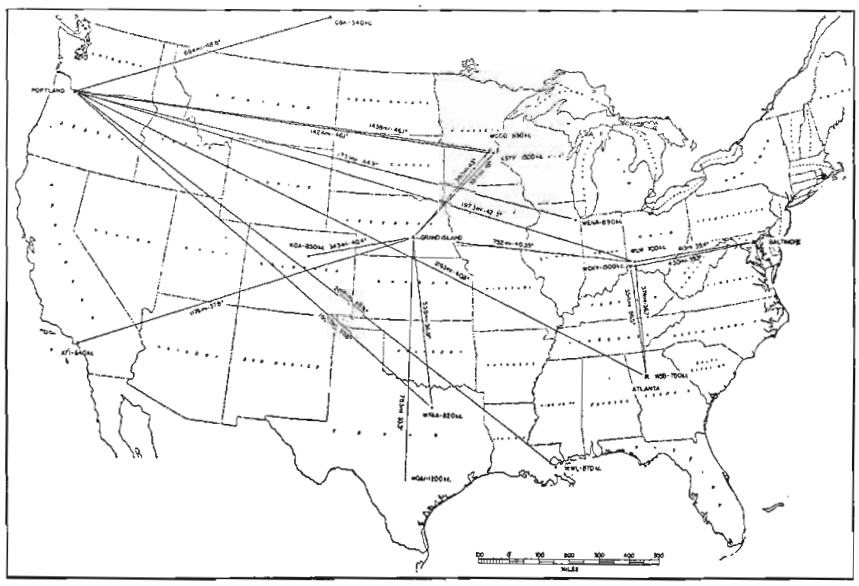
There followed in succession A. D. Ring, consulting engineer, who discussed his calculated diurnal curves of skywave interference; C. R. Evans of KSL, who introduced a curve of measured reception from KSL and also offered a report of listener preference as to stations. The latter had been secured by the Broadcast Measurement Bureau and was reluctantly accepted as evidence by the FCC in the absence of a supporting witness who could testify to the collection of the data it contained.

J. C. Hanner of WCPS, Tarboro, N. C. testified for this regional station to the effect that his informal survey, together with the reports of a number of listeners, indicated no interference between his station and WJR, Detroit, both on the same frequency, under the conditions in question. The chief engineer of station WARL, Arlington, Va. testified that co-channel interference did not trouble reception from his station at 125 miles. Plotkin's questions put to this witness and Com. Hyde's remarks indicated that the FCC discounted informal, or even semi-technical observations of reception, such as those offered by Hogan and Hanner and others.

Apparently radio engineers with approved equipment and accurately-calibrated field strength measuring apparatus are needed to furnish qualified, FCC-recognized information on reception in various areas.

Before the hearing closed E. W. Allen, Jr. of the FCC Technical Information Service entered testimony concerned, among other matters, with the very important subject of atmospheric noise level as a limitation to the use of daytime skywave.

Fig. 4—Map illustrating the aransmission paths over which the FFC has collected daytime reception data



Variation of an RC Parallel-T Null Network

By H. S. McGAUGHAN, Cornell University
Ithaca, N. Y.

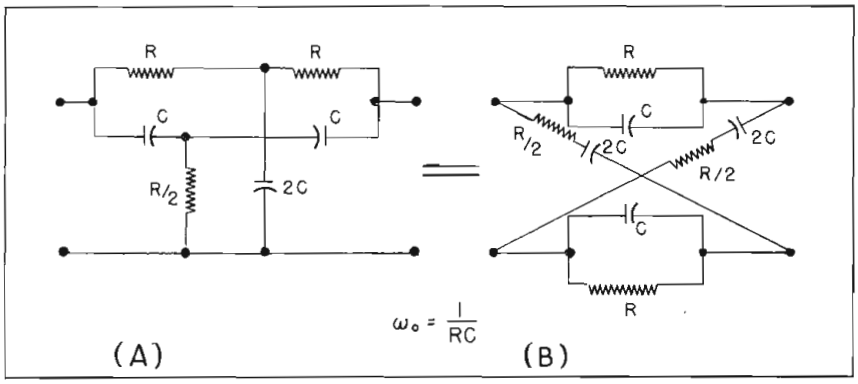
Circuit modification gives increased flexibility of response characteristics and better selectivity without increased amplification

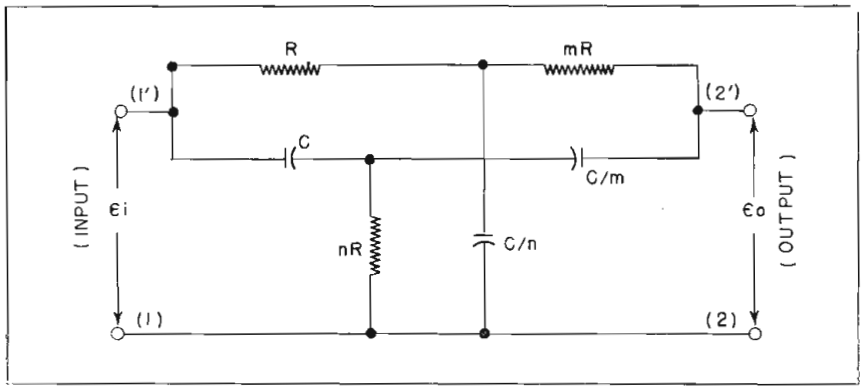
WHEN used in the negative feedback loop of an amplifier, this network produces either a frequency selective amplifier or an oscillator depending upon the choice of circuit parameters. An unsymmetrical null network is shown which provides greater selectivity than is possible with the conventional symmetrical network under the same conditions of amplification.

• This partial generalization of the familiar RC parallel-T null network results in several interesting properties which broaden its applications. Variation of network parameters is restricted to maintain the center-frequency independent of the parameter variation which simplifies network equations.

In recent years a number of articles have appeared illustrating applications of the familiar RC parallel-T network.[1 2 3 4] In most of these applications the circuit is used as a null network exactly equivalent to the symmetrical Wien frequency-bridge as shown in Fig. 1-A and B. It has also been pointed out that the network of Fig. 1-A may be modified in some respects and still maintain its null characteristics.[4 5] Further changes have been made in this network to provide a transmission characteristic which no longer has a null, but has a finite output voltage 180° out of phase with the input signal.[6] This latter property has applications to the design of RC tuned oscillators. Most of these modifications have required a change in the midband frequency from the simple equation noted in Fig. 1.

Fig. 1—Parallel-T null network and equivalent Wien bridge
Fig. 2—Generalized form of parallel-T network





In this analysis, the usual circuit elements in the parallel-T network are modified by the introduction of two general parameters m and n. Complete generalization of the network requires the introduction of two additional parameters but the increased complication of analysis does not warrant this step.

The voltage transmission ratio of the network of Fig. 2 is

$$\frac{\epsilon_o}{\epsilon_i} = \frac{g + ja}{g - jb} \qquad (1)$$

where $a = 1 - n - \frac{n}{m}$,

$$b = \frac{1}{n} + \frac{1}{m} + \frac{n}{m} + n,$$

and $g = RC - 1/\omega RC$.

It may be shown by differentiation that a minimum in the absolute value of the transmission ratio, $\frac{\epsilon_o}{\epsilon_i}$, occurs when $g = 0$. If the frequency for this condition is defined as ω_0, then

$$\omega_o = 2\pi f_o = \frac{1}{RC} \cdot \qquad (2)$$

$$x = \frac{\omega}{\omega_o} = \frac{f}{f_o} = \omega RC \qquad (3)$$

$$\text{and} \quad g = x - \frac{1}{x} \cdot \qquad (4)$$

Equation (1) may now be expressed in terms of the generalized frequency variable g defined by equations (3) and (4).

It will be noted that g is a function only of the generalized frequency, x, while a and b are functions only of the parameters m and n. Furthermore, the choice of m or n has no effect on ω_o, the mid-band frequency or frequency of minimum transmission. Substition of $x = \dfrac{f}{f_o}$ allows complete analysis of the network without specification of R, C, or ω_o.

A clearer insight into the operation of this network is obtained by rationalizing equation (1) to give

$$\frac{\mathcal{E}_o}{\mathcal{E}_i} = \frac{g^2 - ab}{g^2 + b^2} + j\frac{g(a+b)}{g^2+b^2} = U + jV. \qquad (5)$$

$$\left[U - \left(\frac{1}{2} - \frac{a}{2b}\right)\right]^2 + V^2 = \left[\frac{1}{2} + \frac{a}{2b}\right]^2. \qquad (6)$$

In (6) the frequency variable g has been eliminated from the expressions U and V, as defined in (5). Equation (6) represents a family of circles with centers located on the U axis with the right hand crossing of each circle with the U axis passing through the point $U = 1$. Location of the circle centers depends upon a and b which are functions of m and n. As an example, let $m = 1$ with n variable to obtain the family of circles shown in Fig. 3. In this illustration, lines of constant x, obtained from equation (5), are superimposed to show the dependence of $\varepsilon_o/\varepsilon_i$ upon frequency. In the interpretation of these curves the input voltage, ε_i, is represented as the unit vector laid off on the U axis from the origin to the point (1,0), while the output voltage, ε_o, is given in relative magnitude and phase by the vector from the origin to a point on one of the circles determined by the frequency x and the value of parameter n.

In most applications, values of $\varepsilon_o/\varepsilon_i$, which lie on the real axis to the left of (1,0) are of primary interest. The values of this ratio which lie on the real axis are given by

$$\left.\frac{\mathcal{E}_o}{\mathcal{E}_i}\right]_{x=1} = -\frac{a}{b} = \frac{n^2(1+m) - mn}{m + n + n^2(1+m)}. \qquad (7)$$

Equation (7) is obtained by substituting $g = 0$ (i.e., $x = 1$ or $\omega = \omega_o$) in equation (5). Two conditions from equation (7) are

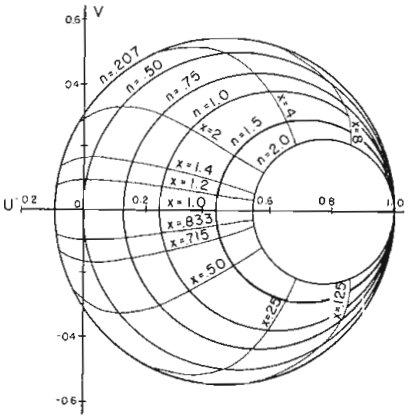


Fig. 3—Polar plot of $\varepsilon_o/\varepsilon_i$ for $m = 1$

worthy of particular attention. First, to produce a null network, equation (7) must equal zero. In this case

$$\left.\frac{\mathcal{E}_o}{\mathcal{E}_i}\right]_{x=1} = 0 \qquad (7a)$$

$$\text{when} \quad n = \frac{m}{1+m} \qquad (8)$$

$$\text{or} \quad m = \frac{n}{1-n} \qquad (9)$$

$$0 \leq n \leq 1 \ . \qquad (10)$$

$$\text{and} \quad 0 \leq m \leq \infty \ . \qquad (11)$$

since m and n must both be positive, (8) and (9) restrict m and n to the ranges indicated in (10) and (11).

The second important condition is that for which equation (7) assumes a maximum negative value. By differentiation of (7) it can be shown that

$$\left.\frac{\mathcal{E}_o}{\mathcal{E}_i}\right]_{x=1} = \text{maximum negative value}$$

$$\text{when} \quad n = \frac{m}{1+m}(\sqrt{2}-1) \qquad (12)$$

$$\text{or} \quad m = \frac{n}{(\sqrt{2}-1) - n} \ . \qquad (13)$$

$$\left.\frac{\mathcal{E}_o}{\mathcal{E}_i}\right]_{\substack{x=1 \\ \max(-)}} = \frac{2\sqrt{2} - 3}{1/m + 2(\sqrt{2}-1)}, \qquad (14)$$

Substitution of (12) in (7) gives (14) which will have numerically increasing negative values as m becomes larger. In the limiting case

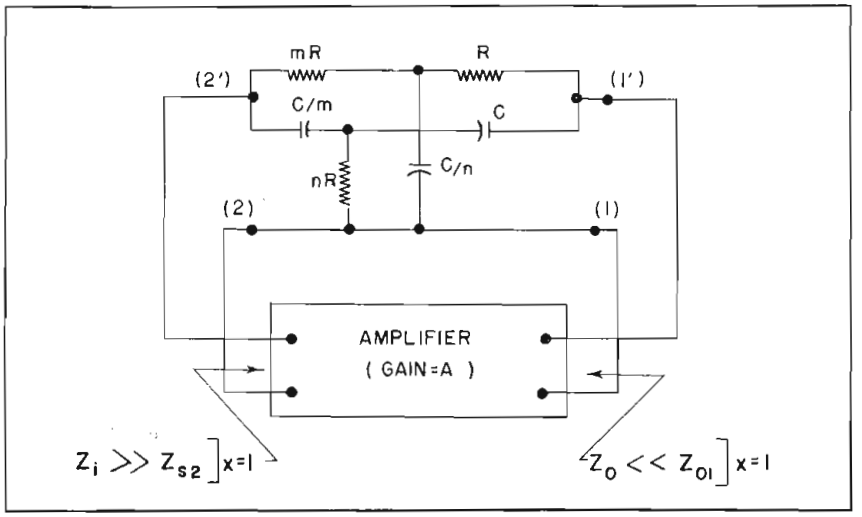
$$m = \infty, \quad n = \frac{m}{1+m}(\sqrt{2}-1) = (\sqrt{2}-1)$$

$$\text{and} \quad \left.\frac{\mathcal{E}_o}{\mathcal{E}_i}\right]_{\substack{x=1 \\ \max(-)}} = -0.207. \qquad (15)$$

In (15) the voltage output is about one fifth of the input and of the opposite sign. This network in the limiting condition has an output, at the reversed phase point, which is as large as, or larger than, most of the single-sided RC phase-shift networks recommended for use in oscillator circuits.

The circuit of Fig. 2 may be used as the negative feedback network on a conventional amplifier to produce a frequency selective amplifier or an oscillator, depending on the choice of m and n. The analysis up to this point has assumed that the network is driven from a constant voltage source with the

Fig. 4—General circuit for oscillator or frequency selective amplifier



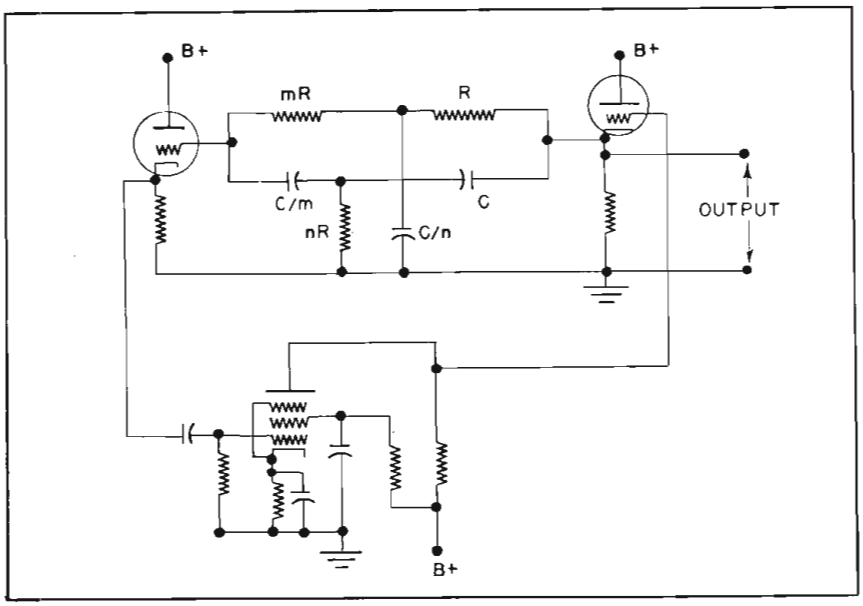


Fig. 5—Oscillator or amplifier using direct-coupled cathode-followers for impedance matching

far terminals open-circuited. The impedance looking into the input terminals of Fig. 2 is therefore Z_{01}, the open-circuit input impedance. The impedance looking back into the output terminals, assuming a zero impedance driving source is therefore Z_{s2}, the short-circuit output impedance. To preserve the symmetry of the voltage transmission ratio and the attendant simplification thus obtained, it is necessary that the amplifier output impedance be low compared to Z_{01}, while the impedance terminating the output of the network should be large compared to Z_{s2}.

General equations for Z_{01} and Z_{s2} are rather cumbersome, while evaluation of these functions at the mid-band frequency is simpler and more useful. With $x = 1$ (i.e., $\omega = \omega_0$) these impedances become

$$Z_{01}\Big]_{x=1} = \frac{R}{\sqrt{2}} \frac{m+n+n^2(1+m)}{m+n(1+m)} \angle -45^\circ \qquad (16)$$

$$Z_{s2}\Big]_{x=1} = m\frac{R}{\sqrt{2}} \frac{m^2+n^2(1+m)^2}{m^2+mn+mn^2(1+m)} \angle -45^\circ. \qquad (17)$$

$$\text{let } n = \frac{m}{1+m}p, \qquad (18)$$

$$\text{where } (\sqrt{2}-1) \leq p \leq 1,$$

$$Z_{01}\Big]_{x=1} = \frac{R}{\sqrt{2}} \frac{1+m\left(\frac{1+p^2}{1+p}\right)}{1+m} \angle -45^\circ \qquad (19)$$

$$Z_{s2}\Big]_{x=1} = m\frac{R}{\sqrt{2}} \frac{1+m}{m+\left(\frac{1+p}{1+p^2}\right)} \angle -45^\circ. \qquad (20)$$

Equations (19) and (20) result from substituting (18) in (16) and (17). Restrictions on p given under (18) limit equations (19) and (20) to the most useful range of impedance values. This choice of p arises from equations (8) and (12), from which it is evident that $p = 1$ produces a null network, while $p = (\sqrt{2}-1)$ produces the network having a maximum negative response at the center-frequency ω_0.

To investigate applications of this network, consider the general circuit shown in Fig. 4. The amplifier in this case should consist of an odd number of stages to provide the necessary 180° phase shift. In most cases a single stage amplifier is employed to reduce the possibility of undesirable phase-shift within the amplifier.

The first application to be considered will be the operation of the circuit of Fig. 4 as an oscillator. In this case it is necessary to restrict the parameter n to the range

$$\frac{m}{1+m}(\sqrt{2}-1) \leq n \leq \frac{m}{1+m}. \qquad (21)$$

This restriction, which may be deduced from (18), insures that the transmission ratio is negative at the mid-band frequency. To produce sustained oscillation, it is only necessary to adjust the amplifier gain to exactly compensate for the feedback network loss at the mid-band frequency.

It is worthy of note that a reduction in n below the lower limit specified in (21) also produces a negative transmission ratio at the required frequency. This range of n can be shown to be less useful by a further study of the transmission ratio curves of Fig. 3. As n decreases below the lower limit of (21), the circles for constant n decrease in size, and the left hand crossing with the negative real axis is displaced toward the origin. The curves of constant frequency are tangent to the circle giving maximum negative response and thence turn inward, terminating at the origin as n approaches zero. It is thus obvious that operation in this range produces less frequency selectivity, since a given change in frequency will produce a smaller change in the phase-angle. This section of Fig. 3 has not been reproduced since a three-dimensional plot would be required.

With the data available it is now possible to set up a logical procedure for designing an oscillator:

1. Choose a value of the parameter m from a consideration of the data given in Table I.

2. Find the minimum amplification required for oscillation using (22) which is the negative reciprocal of equation (14).

3. Choose A or n within the ranges shown with (22).

4. Solve for A or n from (23).

$$A_{min} = \frac{\frac{1}{m}+2\sqrt{2}-2}{3-2\sqrt{2}}. \qquad (22)$$

$$A_{min} \leq A \leq \infty$$

$$\text{when } \frac{m}{1+m}(\sqrt{2}-1) \leq n \leq \frac{m}{1+m}.$$

$$A = \frac{b}{a} = \frac{m+n+n^2(1+m)}{mn-n^2(1+m)} \qquad (23)$$

A in (23) is the negative reciprocal of equation (7). The solution for n in (23) is a quadratic giving two possible values for n. As explained earlier, it is usually desirable to choose the value of n greater than $(\sqrt{2}-1)\ m/(1+m)$.

From Table I it is evident that

$$Z_{01}\Big]_{x=1} \approx \frac{R}{\sqrt{2}} \angle -45^\circ \qquad (19a)$$

$$\text{and } Z_{s2}\Big]_{x=1} \approx m\frac{R}{\sqrt{2}} \angle -45^\circ \qquad (19b)$$

are sufficiently close approximations for most design purposes. To aid in meeting the impedance conditions indicated in Fig. 4, it is possible to choose R relatively large to make Z_{01} for $x = 1$ large

compared to the amplifier output impedance. In the next step choose m small to reduce Z_{s2} for $x = 1$ to a value small compared to the input impedance. It should be realized that reducing m to obtain

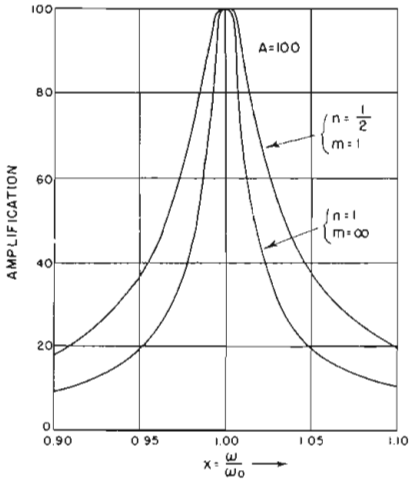


Fig. 6—Frequency response of selective amplifier using parallel-T null feedback network

these conditions raises the amplification required. In general, it is desirable to make the amplifier gain considerably higher than the minimum value and then choose the parameter n correspondingly. This means, that with reference to Fig. 3, the oscillator will be operating on a characteristic corresponding to a circle crossing the real axis only slightly to the left of the origin. This operation insures greater selectivity due to the increased rate of change of phase with frequency around the oscillation frequency.

In some applications where the desired impedance conditions cannot be met by simple amplifier stages, the circuit of Fig. 5 has proven very convenient. In this circuit, the direct coupled cathode follower tubes V_1 and V_2 serve to isolate the feedback network. Tube V_1 supplies a low impedance source for driving the network, while the open grid of tube V_2 supplies a very high terminating impedance. At reasonable audio frequencies V_2 may often be omitted since R can be made small, and the grid resistor of amplifier tube V_3 may be made large compared to Z_{s2} for $x = 1$. At very low frequencies, practical limitations on the physical size of condensers requires large values of R. In this case V_2 is usually necessary to maintain a high terminating impedance. If the amplifier tube V_3 has a reasonably low output impedance, V_1 may often be omitted.

When a frequency selective amplifier is desired, this network usually is used as a null network. Greater selectivity may be obtained by allowing the circuit to become slightly regenerative, but this step is seldom carried out due to the dangers of instability. It is therefore practical to confine the discussion of selective amplifier design to the circuit using a null type feedback network.

For the null network, (8), (9), (7a), (2), (19a) and (19b) hold. Equation (1) for the voltage transmission ratio may be considerably simplified by substituting for m the expression in (9) which restricts the network to a null type circuit. After suitable manipulation, equation (1) becomes

$$\frac{\varepsilon_o}{\varepsilon_i} = \cos\theta\,\varepsilon^{j\theta} \qquad (24)$$

$$\text{where } \theta = \tan^{-1}\frac{2}{n\left(x - \frac{1}{x}\right)}.$$

Equation 24 represents a circle centered on the real axis with its circumference passing through the origin and the point (1,0). It will be found that maximum amplifier selectivity is obtained when the rate of change of amplitude with frequency, evaluated at $x = 1$ in (24), is a maximum. (25) was obtained by differentiating the absolute magnitude of (24) with respect to the frequency variable x.

$$\frac{d}{dx}\left|\frac{\varepsilon_o}{\varepsilon_i}\right|\Bigg]_{x=1} = n. \qquad (25)$$

Thus it is to be expected that an increase in n will improve the amplifier characteristics. The limiting upper value for n is unity, for which m becomes infinite.

Using the standard equation for amplification with feedback, the frequency response of this selective amplifier may be easily calculated. Since the feedback is in the negative sense we may assume a negative sign on the transmission ratio and

$$A_f = \frac{A}{1 - A\left(-\frac{\varepsilon_o}{\varepsilon_i}\right)} = \frac{A}{1 + A\cos\theta\,\varepsilon^{j\theta}} \qquad (26)$$

$$\left|A_f\right| = \frac{A}{\sqrt{1 + (2A + A^2)\cos^2\theta}} \qquad (27)$$

(27) represents the absolute value of amplification.

The simplicity of equations (26) and (27) is obtained by assuming ideal impedance conditions as indicated in the previous analysis. These conditions are met for all practical purposes in the circuit of Fig. 5.

In most previous applications, as a frequency selective amplifier, this network has been used with $m = 1$ and $n = \frac{1}{2}$. Under these conditions increased selectivity may be obtained by increasing the amplification. This procedure may not be carried on indefinitely because of the instability resulting from slight variation in circuit components. Greater selectivity may be obtained by increasing m to a large value without additional increase in gain. This feature is illustrated in Fig. 6 where two curves are plotted for $m = 1$ and $m = \infty$ with $A = 100$. The latter curve is the limiting curve which

(*Continued on page 95*)

TABLE I

m	n		Z_{01} for x=1 $R/\sqrt{2}/-45°$		Z_{s2} for x=1 $mR/\sqrt{2}/-45°$		A	
	min	max	min	max	min	max	min	max
∞	0.414	1.00	0.828	1.00	1.00	1.00	4.82	∞
10	0.376	0.909	0.844	"	0.980	"	5.40	"
5	0.346	0.833	0.856	"	0.962	"	5.98	"
2	0.276	0.667	0.886	"	0.935	"	7.71	"
1	0.207	0.500	0.914	"	0.905	"	10.61	"
0.5	0.138	0.333	0.943	"	0.878	"	16.45	"
0.2	0.069	0.167	0.971	"	0.851	"	33.85	"
0.1	0.0376	0.0909	0.984	"	0.839	"	63.0	"
0	0	0	1.00	"	0.828	"	∞	"

British Printed and Sprayed Circuits

Electronically controlled machine is fed molded plastic panels and delivers complete circuits with resistors, capacitors and inductors

• A new mass-production method for radio receivers* used by John Sargove Ltd. and Sargove Electronics Ltd., Sir Richards Bridge, Walton-on-Thames, Surrey, England, is described in detail in the January-February issue of the Journal of the British Institution of Radio Engineers.

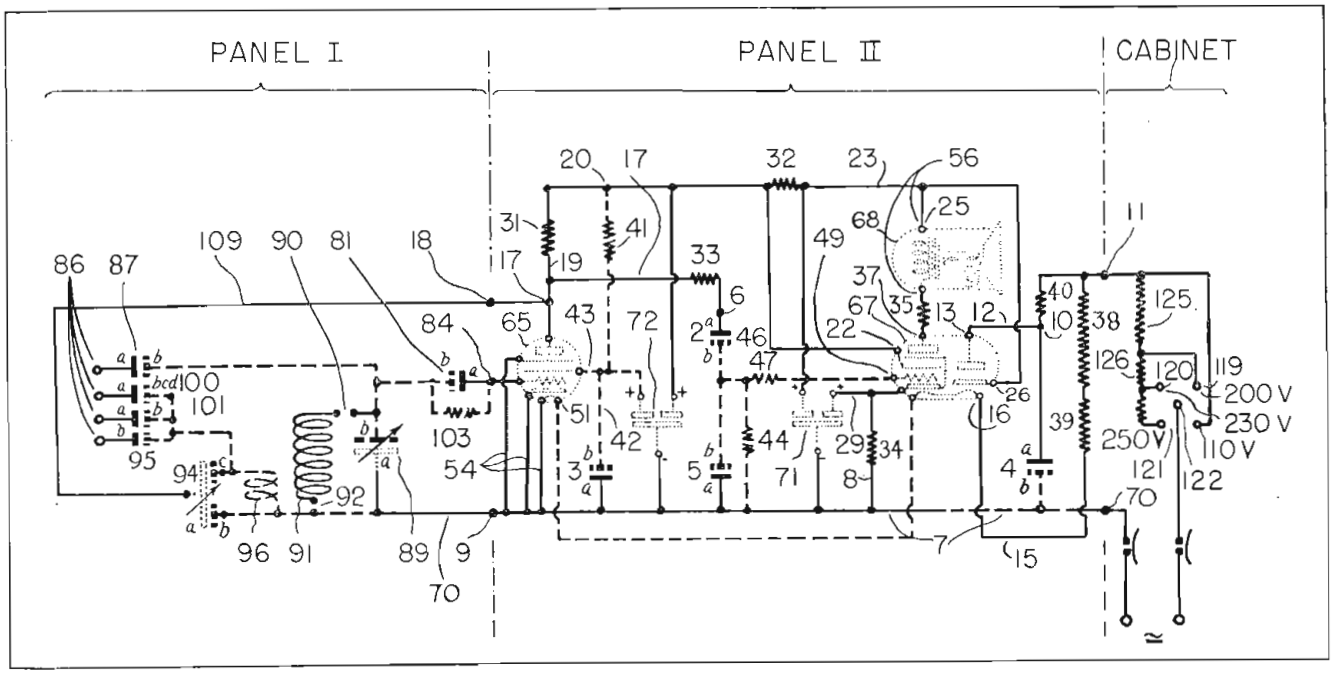
The method is fully mechanized and uses extensive electronic control systems; it is economical and fool-proof with regard to wiring mistakes. Tedious assembly and wiring operations are reduced, testing is automatic. The conventional separate conductive circuit components such as capacitors, inductors, and connecting wires are replaced by an integral metal deposit on a preformed plastic panel. Resistive elements are formed by graphite deposits on the same panel. Most electric circuit elements consist of conductive and insulating material deposited on both sides of the panel; only tubes, loudspeakers and electrolytic or variable capacitors have to be inserted at a later stage in the production line.

Connecting wires consist of metal deposits in grooves; inductors are formed by metal deposits in spiral grooves; two opposing metallized indentations in a plastic panel constitute a capacitor, the thin dielectric web of the plastic panel between the indentations serves as dielectric; graphite deposits on the panel take the place of conventional resistors. All metal deposits are situated in grooves, recesses or depressions on both sides of the molded plastic panel. This feature permits both sides of the performed panel to be simultaneously covered with a metal layer, e.g. by spraying or electroplating. Subsequent milling removes the excess metal on both panel faces leaving only the metal lying beneath the surface level in the grooves and indentations. Consequently the grooves and indentations of the molded plastic panel determine the position of conductive elements and their inter-connections; as a modification of the die for the panel is necessary for a variation of these elements, wiring mistakes are eliminated.

Resistors on the same side of the panel may be produced simultaneously by spraying the surface with a graphite suspension through a suitably shaped stencil or by printing at the desired places on the

*(See also Tele-Tech, June 1947, p. 68)

Fig. 1—Circuit diagram of the ac-dc receiver in which most of the essential components are printed or sprayed on the panels illustrated in Fig. 2



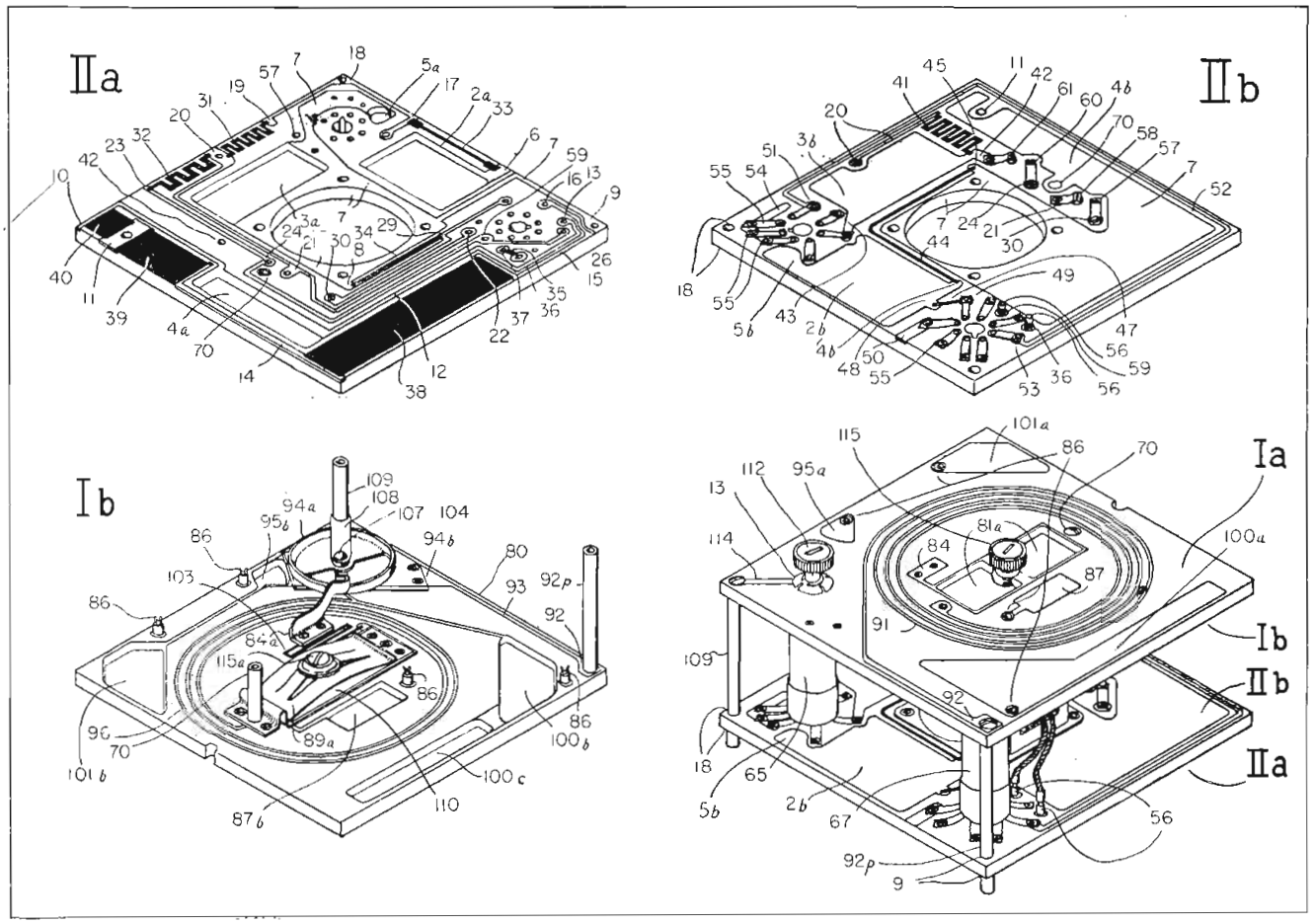


Fig. 2—The two panels on which the components and circuit wiring are printed or sprayed, both sides of the panels being processed. Interconnections betwe en panels are made by means of eyelets or rivets

panel with an overlap of the graphite and the metal deposits. Circuit elements on opposite sides of a panel may be conductively connected by an eyelet, a thin rivet, or a hole in the panel filled with metal during the spraying operation.

Actual production operations involved are: (1) molding the plastic panel; (2) metallizing on both sides; (3) milling the surface of the plate to remove excess metal; (4) spraying one graphite mixture through suitable stencil; (5) spraying another graphite mixture onto other side of panel through another stencil.

Fig. 1, illustrates the circuit diagram of an AC-DC receiver manufactured by the new method. It is built up of two 7-inch panels with part of the circuit deposited directly on the inside wall of the cabinet. In Fig. 2 both sides of both panels are shown. All elements situated on the sides Ia and IIa are indicated by full lines in circuit diagram. Fig. 1, while reverse side elements on Ib and IIb are shown by dashed lines. Capacitor plates are marked "a" or "b" depending on which side they are located; on Ib and IIa the capacitor plates are formed by deep indentations and shown as such, capacitor plates on Ia and IIb are flush with the panel once the metal is sprayed on and milled off. Resistors are solid black. Dotted lines on Fig. 1 indicate elements to be inserted separately.

On side "a" of panel II, see Fig. 2, the numerals 2a, 3a, 4a, 5a are deep metallized indentations which constitute the plates marked "a" of the capacitors indicated by identical numerals on Fig. 1. References 6 to 30 on IIa are shallow grooves or recesses filled with metal and intended to serve as conducting paths and termination lobes of sockets and eyelets; some corresponding references will be seen in circuit diagram Fig. 1.

Reference 7 on IIa indicates the system ground, a metal deposit extending over an extensive irregularly-shaped area of the panel and in direct contact with a similar metal deposit, 7, on the other side of the panel; the conducting connection is a large cylindrical hole in the center, the wall, 7, of which is metallized. This deposit 7 is integral with grounded capacitor plates 3a, 5a and 4b. Capacitor plates 2b and 5b are formed by one metallized indentation. Reference numerals 31-35, 38-40 on IIa indicate resistors. Resistor 41 on IIb is deposited over the terminal of conductor path 20 which is conductively connected to conductor path 20 on the reverse side of the panel through an eyelet 20 in a small hole in the panel.

Screening against hum voltages is readily effected by interposing the grounded electrode or another low-hum electrode between the element to be protected and a possible source of disturbance. For instance, grid-leak resistor 44 on IIb for the second tube is surrounded by capacitor plates 2b and 3b and grounded deposit 7.

Socket connections are made by means of suitably shaped metal eyelet punchings 55, IIb. Two

(*Continued on page* 96)

Gain Chart for Cathode Followers

By GLADDEN HOUCK, Project Engineer,
Sorensen & Co., Stamford, Conn.

Simplicity of circuits, economy of components, low distortion and wide frequency response give advantages for broadcast use

• Scarcity of electronic components has fostered development of many new methods and materials. These innovations in many cases are proving more useful than their original counterparts. Cathode followers, as applied to broadcast consoles, consolettes and allied units, are an example in point.

The difficulty in obtaining good quality output transformers for line drivers led several of the Intercollegiate Broadcasting System stations to use cathode followers for many circuits. Some early designs were below standard for transformers, although most of them have shown how well this circuit can be applied. It was during the design of these cathode follower circuits for these applications that a cathode follower gain chart was developed.

An interesting application of this circuit in broadcasting has been in line drivers, where push-pull circuits similar to that in Fig. 1 are desired. This circuit has shown adequate response (20 to 20,000 cps). The distortion, due to the absence of iron core inductances in the circuit, is largely independent of frequency. Thus, the inter-modulation distortion components are much lower than with transformers. A carefully designed line driver, similar to the one described in the sample problem, will deliver approximately +15 vu output at less than ½% distortion. This has been found to be acceptable for line drivers, mixers and other similar circuits, where 600-ohm line impedances are desired at low distortion and at less than the specified output level.

In broadcasting stations several similar stages cascaded have distortion. It is best to keep individual stage distortion low. These are typical station uses: (1) The pad or attenuator drivers; (2) The line drivers; (3) The level limiter output; (4) The transmitter line amplifier. The last two are usually located in the transmitter console.

If each of these cases has ½% distortion, the total for a typical station arrangement may be as much as 2% distortion. Usually, however, the mixer attenuators are operated at lower levels than zero vu so that their combined distortion is much lower. This can be done with the line driver circuit described, or it can be achieved by a single-ended circuit, similar to the typical circuit shown in Fig. 2.

Fig. 1—High fidelity push-pull cathode follower circuit for broadcast station line drivers

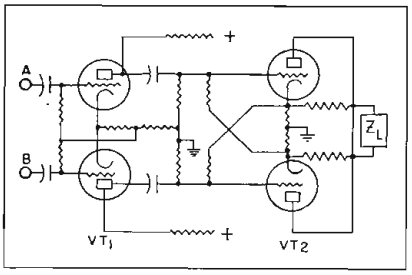
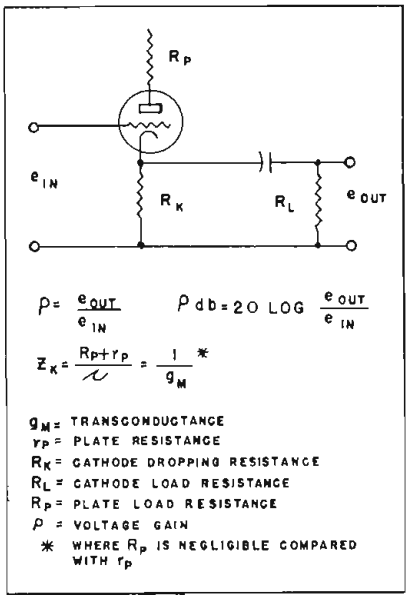


Fig. 2—Typical single-ended cathode follower circuit and fundamental parameter relations

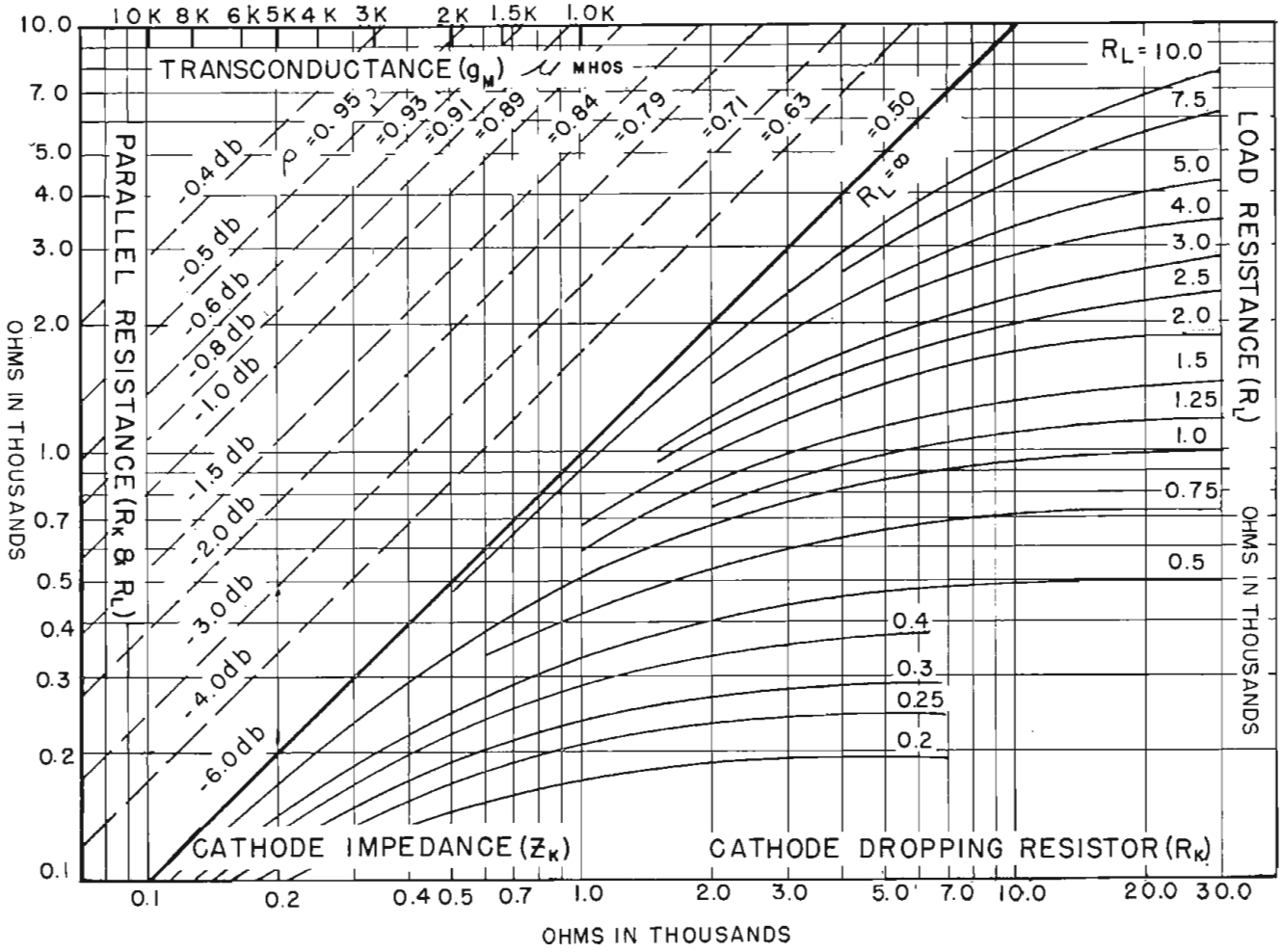


A blocking condenser is inserted between the pot attenuator and the cathode follower to prevent dc from flowing into the mixing circuit. It is best to keep these impedances low as circuit capacities are extremely large, and thus will attenuate the higher frequencies. It is also desirable to keep the potentiometer impedance moderately high so as not to require too large a blocking condenser; 10,000 ohms is the usual value. Electrolytic condensers usually are not satisfactory.

The usual tube for this type application is the 6J5 (or 6SH7) which will yield one volt output at less than ¼ of 1% distortion. The single-ended circuit is not recommended for line drivers because it produces a dc potential across the line.

The balanced circuit of Fig. 1 is most suited for this application since the center tap of the circuit is practically at ground. If the power supply B— is connected at a suitable negative potential from ground, there is no dc potential above ground on these lines, which is often desirable. However, in some instances this potential may be useful for remote switching. An example of this is the operation of a small amplifier located in a remote position. In this case a relay is connected between center tap of the input coil and ground.

As demonstrated in the sample



INSTRUCTIONS FOR USING CATHODE FOLLOWER CHART

1—Find the value of R_K on the lower scale and follow the line vertically until it intersects the required load resistance curve R_L.

2—From this point, follow resistance line to the left until it intersects the vertical line which is the cathode impedance of the tube. For convenience, a transconductance scale calibrated in micromhos can be read at the top of the chart.

3—The intersection of these two lines will meet at an appropriate loss line. Loss lines are drawn at a 45° angle from the horizontal and have loss in db in the lower left corner and amplification ratings in the upper right corner.

4—If the load and cathode-dropping resistors are combined, the 0.5 ρ (amp. factor) or 6 db loss lines should be used for R_L. Other steps are the same. This line is the infinite impedance load line.

NOTE: .This chart has been compiled for pure resistance loads. Thus, it does not take into account effects due to reactance in the load circuit.

problem, the L pad loss of the cathode follower circuit can be computed. The single-ended cathode follower also can be used at a remote point if the dc potential between the cathode and B— is applied through a relay.

It can be seen how cathode followers are easily applied to broadcast units. Their advantages of low distortion and wide frequency response often outweigh the disadvantage of increased plate supply power. Because of their small reactance effects, isolation pads are not as important as with transformers in similar circuits.

As an example of the use of this chart, consider the design of a push-pull line driver unit using 6J6 twin triodes with the two triodes of each tube in parallel.

Since the line impedance into which each tube will be operating is 300 ohms approximately, assume a twin triode resistance about ten times that value; 2.7K is an RMA standard value that will be appropriate. The transconductance of 6J6's connected as above is 10,000 micromhos. In push-pull circuits of this type, it is common practice to calculate each side separately, since one-half the load is fed by one of the push-pull tubes.

The internal cathode impedance of the cathode follower $1/g_m$ is approximately 100 ohms. Since this is less than the 300 ohm load, a 200 ohm series resistance (R_s) is added to improve matching. This is good practice for cathode followers since as class "A" amplifiers, they operate best with load impedances a few times larger than their internal impedance. Find the parallel resistance of R_k and R_1 plus R_s. It is approximately 430 ohms. Tracing this parallel resistance line to the intersection with the cathode impedance line of 100 ohms, we find 1.8 db loss for the cathode follower.

The attenuation from the 200 ohms series resistance can be similarly calculated with the same chart as follows:

Consider the load as described in step 4 of the instructions. At the intersection of this resistance with the cathode impedance line of the value equivalent to the 200 ohm series resistance, we find 4.5 db loss. Thus the loss due to both the cathode follower and its series pad is 6.3 db.

Design of Magnetic Tape Recorders

By RICHARD H. RANGER, President, Rangertone, Inc., Newark, N. J.

Frequency response and dynamic range greatly improved through critical control of size of oxide particles and their dispersion

• Magnetic recorders, both tape and wire, have come a long way since Norwegian Vladimir Poulsen started experimenting with the principle back in 1899. In the 48 years that have intervened steady improvements have been made in frequency response; noise in the system has been reduced practically to the vanishing point, being no greater now than the thermal noise in vacuum tubes; mechanical operation has been improved to the extent where full advantage can be taken of the long-playing and great dynamic range of the system. The Germans did a lot with tape recording; but it remained for American engineers to take up where the Germans left off and bring the equipment to its present highly refined form.

Army Intelligence went into Germany along with the battle-stained GI's and found the magnetic tape recorder in wide use in the German broadcast networks. Two versions of the recorder, the Magnetophone and the Tone-schreiber, had been developed to a remarkable degree. The most advanced model of the Magnetophone was designated the K-7. Only one of these machines has been introduced into this country, and it is located in the research laboratories at Ft. Monmouth, New Jersey. The writer was a member of one of the investigation teams working in Germany and made it his business to gather to the fullest possible degree all the information available on magnetic tape recording and return it to this country. A report covering this work has been made to the Department of Commerce, and will shortly be available to the public.

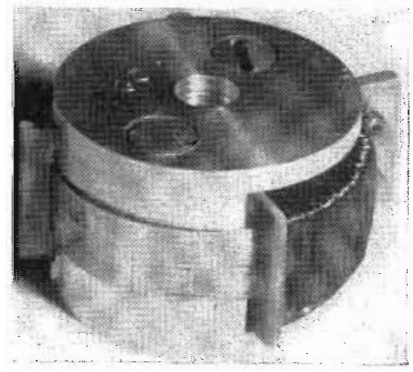


Fig. 2—Close-up of recording head in which the hairline gap is filled in with beryllium copper

The Rangertone magnetic tape recorder is essentially an Americanized version of the German Magnetophone. Thus it represents the culmination of the efforts of persons widely separated in space and time. It has, of course, been thoroughly redesigned to make use of American parts, and to fit in with American systems and studio practices. Some significant improvements over the German design were made, especially in the matter of the drive mechanism and control systems.

Fig. 1 shows the overall response of the recorder, running at a normal tape speed of 30 in. per second, and a reduced speed of 18 in. per second. The 13 in. reels provided with the machine hold sufficient tape to produce recorded programs in the following lengths:

TAPE SPEED (in. per sec.)	PROGRAM TIME (min.)	FREQUENCY RESPONSE (cps)
30	25	40—12,500
30	30	40—10,000
18	50	60— 7,000

Fig. 2 is a photo of the head assembly. A careful inspection will show these component parts: laminated core, coil, and gap. The gap itself is filled in with a non-magnetic shim of beryllium copper. The winding and impedances of

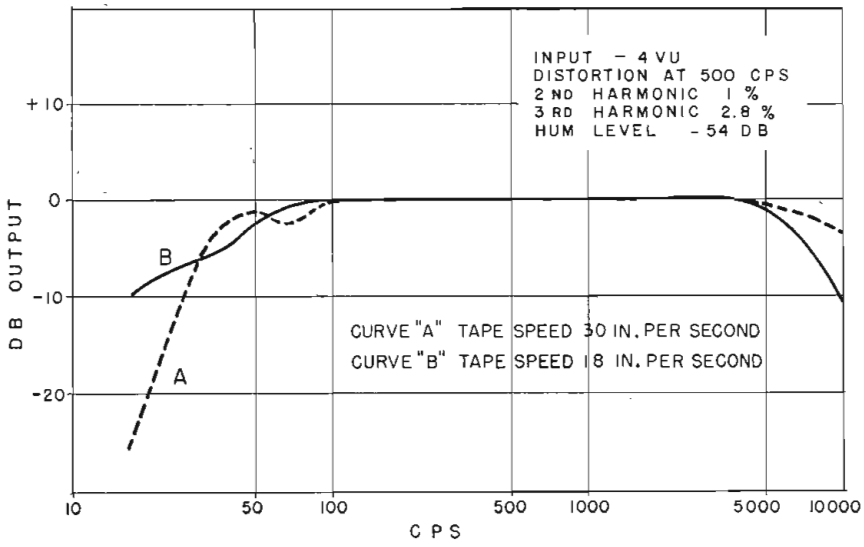


Fig. 1—Audio response characteristics of Rangertone magnetic tape recorder plotted at two tape speeds

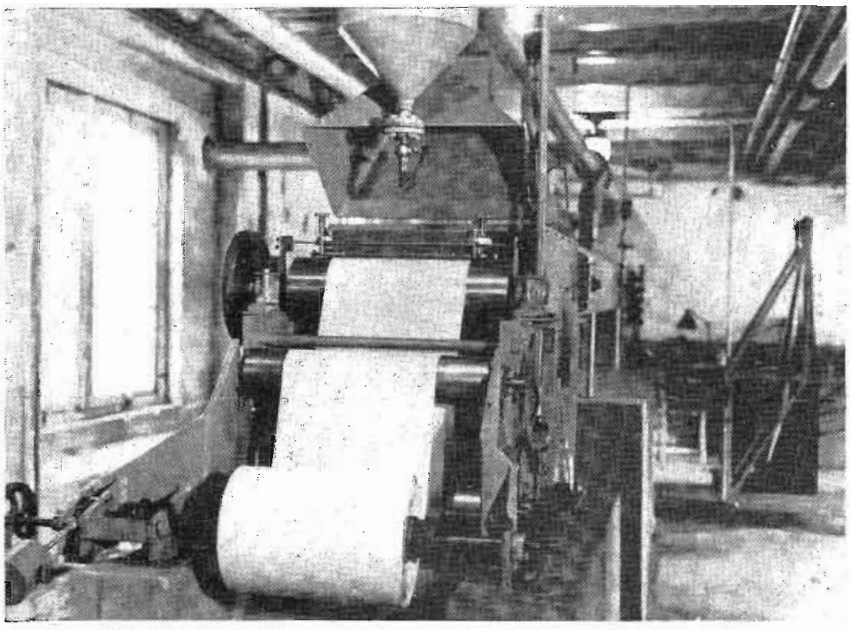


Fig. 3—Type of equipment used by the Germans in Ludwigshaven in the production of Luvitherm Magnetophone LG tape

these heads are as indicated in the following table:

Head	Turns	Resistance Ohms	Impedance Ohms
Erase	100	1	2,000
Record	600	10	11,000 at 70 kc 560 at 1 kc 58 at 100 cycles
Playback	600	10	560 at 1 kc 58 at 100 cycles

In general it may be said that the playback head is the most critical of the three in the sense of gap size, and alignment. The gap size being in the order of four-tenths of a mil across, it is obvious that a slight misalignment will result in a variation from the perpendicular greater than the width of the gap in going from top to bottom of the ¼ in. tape. This cannot be allowed, since optimum response is attained only when the gap is perfectly perpendicular to the motion of the tape passing the head. Adjustment is accomplished by means of set-screws in the head assembly. With the machine completely assembled and in operation, a standard tape recorded at 6,000 cycles at 80% full modulation is run off. The head may then be adjusted to the correct position by observing the response.

For the record head, an audio signal of 1.5 to 2 milliamperes is combined with a high frequency bias of 4 milliamperes to obtain the best results. The action of the bias current is to improve the linearity of the magnetic remanence in the tape by cutting the effect of the hysteresis loop loss which would result if only record current were used.

The gap size and energizing current of the erase head are comparatively non-critical. The current necessary is largely dependent upon the magnetic properties of the tape used. The German iron oxide tape needs some 80 milliamperes of 70 kc energy to do a thorough job of demagnetizing the tape. The erase head produces an alternating flux which diminishes uniformly from maximum intensity to zero, leaving the tape magnetically neutral.

The performance of the entire machine depends in great measure on the actual magnetic properties of the tape. In this field, we obtain valuable guidance from German development work. The first German tape produced, known as type "C", was a coated tape on a cellulose acetate base. This tape was made in one operation on an endless nickel belt. At one end, the base was cast on the nickel belt, which moved at low speed. By the time the belt had reached the end of the machine the acetate base was dry enough for a coating, a a binder with the magnetic oxide, and a plasticizer. The base was then stripped off and cut into appropriate tape sizes. The tape thus produced was extremely accurate in physical dimensions and had good response characteristics. However, it was soon learned that the plasticizer dried out the tape causing it to become brittle and subject to breakage under normal operating tensions.

The Germans next developed an impregnated tape in which the magnetic oxide was uniformly distributed throughout the base, a polyvinylchloride, trade-marked "Luvitherm". This process used no plascticizer and therefore eliminated dehydration. A number of disadvantages appeared in this product also, diminished tensile strength being the main one. Homogeneous distribution of the oxide particles in the base reduced the tensile strength. To improve strength, the particle concentration was reduced, but then the frequency response was impaired. Further, another undesirable factor was introduced which has

(*Continued on page* 99)

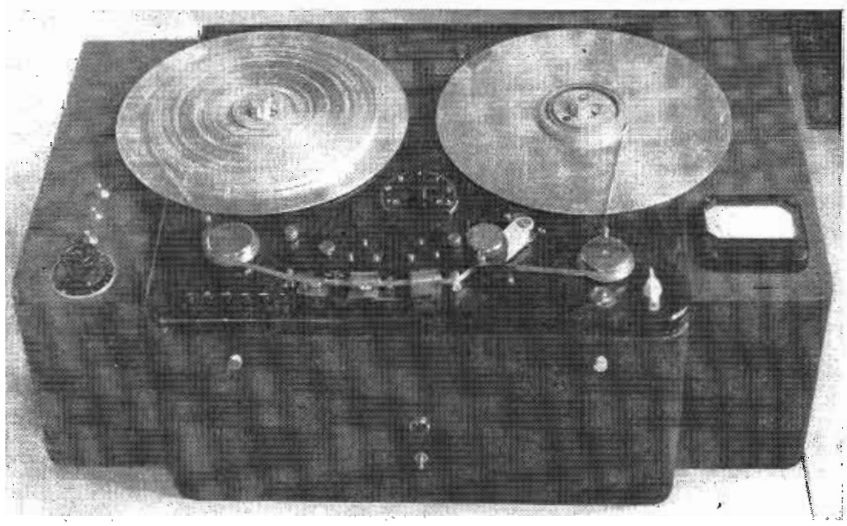


Fig. 4—Production model of Rangertone high-speed magnetic tape recorder

Design of Tuners for AM and FM

By LLOYD M. HERSHEY, Engineer in Charge,
Home Receiver Div. The Hallicrafters Co., Chicago.

Automatic frequency control, using dual triode as oscillator and reactance tube corrects for mistuning and drift; pushbutton tuning

• The Hallicrafters basic 15-tube chassis is used in a combination FM-AM receiver with an automatic record changer. Five mechanically operated pushbuttons are provided for FM operation and five for AM. The frequency bands covered are:

FM (High Frequency Band)
88 to 108 mc
AM (Broadcast Band)
540 to 1740 kc
AM (Full Short-Wave Band)
5.8 to 18 mc
AM (Short-Wave Spread Band)
9 to 12 mc
AM (Short-Wave Spread Band)
15 to 18 mc

This basic 15-tube chassis is available in several different cabinets, with two different speaker combinations, thus offering a considerable range of choice of cabinet style and speaker performance with manufacturing economies effected by the use of only one basic chassis.

A chassis similar to the basic 15-tube chassis, model S-47, soon will be available in a metal cabinet. This chassis is intended for use in custom installations where the speaker will be housed in a separate cabinet. It is designed for use only with separate antennas. The general construction and design features of the S-47 and the basic 15-tube chassis from the rf stage to the output transformer are almost identical.

The built-in antennas furnished with models EC-403 and EC-404 include a loop antenna for broadcast reception and a novel (inverted L) dipole for FM reception. The FM antenna also serves as the built-in pickup for short-wave reception.

The loop antenna comprises only about one-half of the total broadcast antenna secondary circuit inductance. The effects of electric fields originating near the receiver (ignition noise, commutator noise, etc.) thus are minimized while the effectiveness of the antenna on the signals from radio stations is only slightly reduced.

The inverted L antenna used on FM exhibits less directional effect than the more conventional types

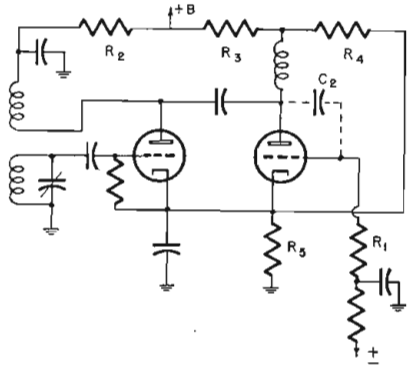


Fig. 1—Simplified diagram of the oscillator and reactance tube circuits

of folded dipoles, and has substantially the same amount of signal gain.

Tuning is accomplished by two independent three-gang variable capacitors, one used exclusively on FM and the other on AM. Each variable capacitor has its own set of five pushbuttons. In this manner, the switching of high-current carrying leads is avoided and maximum circuit performance assured on the FM band.

Short-wave band-spread tuning is provided in the four most popular short-wave broadcast bands. This is accomplished by means of capacitances in series and shunt with the AM variable capacitor and the short-wave coils.

The styling of the cabinets required that the push-buttons be parallel to the plane of the main chassis. In order to accomplish this, the antenna, rf amplifier and oscillator circuits are mounted on the tuner sub-chassis, which is bolted to the main amplifier chassis at right angles to it. This allows production to be run in two parallel lines, with the joining of the two chassis occuring as a final assembly and wiring operation just prior to the phasing operation.

The accuracy requirements of the pushbutton settings on the new FM band are about two times as severe as on the AM broadcast band; electrical drift requirements are about ten times as severe. Also, when a conventional FM receiver is tuned through a station a spurious response is encountered on each side of the desired response. These factors make the conventional FM receiver very difficult for the layman to tune. It has even been noted that some of the best known manufacturers have produced FM receivers whose oscillators drift noticeably during the warming-up period (about the first fifteen to forty-five minutes after turning on). A small amount of drift results in distortion and necessitates retuning. One model was observed in a dealer's showroom which drifted completely off the station.

An automatic frequency control (AFC) circuit is provided on the

FM band in the basic 15-tube receiver chassis. It produces a correction factor of about seven times on any mistuning or oscillator error. Also, the AFC is arranged so that it "takes hold" before the spurious response point is reached on either side when tuning to an FM station, and prevents the spurious responses from being heard. Tuning an FM receiver with properly adjusted AFC is no more difficult than tuning a regular broadcast station on the AM band, and once tuned into the "take-hold" region the signal remains properly tuned in until the dial setting is changed to bring in another station.

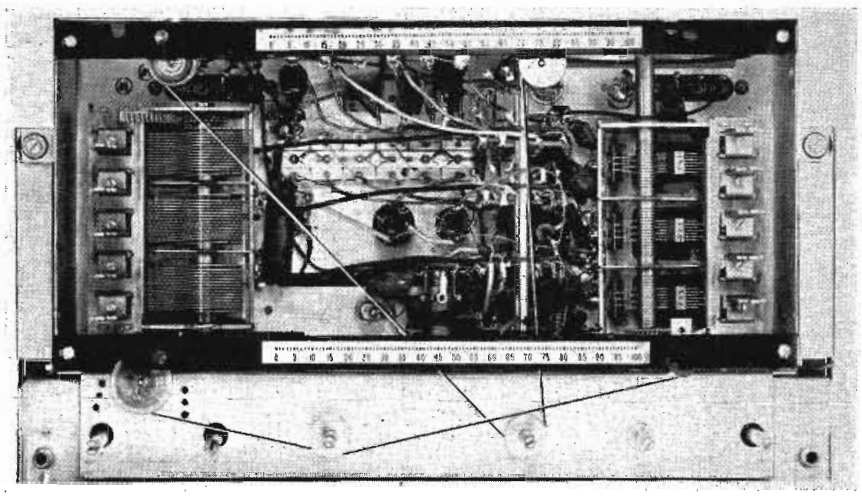
A dual-triode (6J6) tube is used as the oscillator and AFC reactance tube. Since the use of a triode reactance tube is believed to be novel, it will be described briefly.

Oscillator Circuit

The oscillator circuit is conventional. The oscillator plate is coupled through a small capacitor to the reactance tube plate, then fed through the reactance tube's plate-to-grid capacity, C_2, to the grid. The resistor R_1 with the reactance of C_2 forms a phase shifting network, so that the voltage on the reactance tube grid is shifted by about 45 degrees from the plate voltage.

This grid voltage is amplified by the reactance tube by an amount approximately proportional to the dc voltage applied to the grid from the frequency detector output. The plate voltage is shifted nearly 180 degrees from the grid voltage and added to the oscillator plate voltage again through C_1, thus producing a shift of the oscillator frequency. It will be noted that the reactance tube's nominal operating bias is obtained from the combined oscillator plate, reactance tube and bleeder resistor currents in the cathode resistor R_3. These currents are combined so as to produce a reactance tube characteristic with a wide range of linearity.

The intermediate frequency amplifier uses composite IF transformers and is conventional except for the use of resistance coupling between the last two tubes. This permits a gain of about 8 db in the last stage without serious detuning of the last circuit due to impulse noise acting on the grid of the last tube and producing phase distortion. In other words, a better signal-to-impulse-noise ratio is obtained.



Front view of tuner chassis with cover removed leaving the coils and variable condensers available for adjustment and alignment

Another novel feature of the receiver is the frequency detector system which was developed in the Hallicrafters laboratory. The transformer itself is a conventional three circuit transformer and is inherently well balanced to reduce noise. The time constants C_1R_1 and C_2R_2 are long as compared with the lowest audio signals to be handled, and the resistors R_1 and R_2 are large compared with the internal impedance of the diode. It is of interest to note that a dc path to ground from the input side of the balanced diode detector for either polarity of current is provided through the two detector diodes when one of them is inverted. The addition of a load resistor on the input side of the diodes would increase the damping of the second tuned circuit and reduce the ratio of AFC output to audio output.

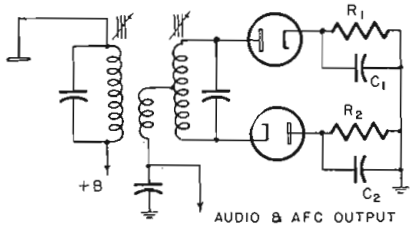


Fig. 2—Circuit diagram of the frequency detector, and below, a front view of the complete AM-FM receiver

The audio system as used in this receiver has unusually low distortion. The total harmonic distortion of signals in the middle register is about one percent. This, of course, does not tell the full story. Recent investigations have indicated that intermodulation distortion is far more disturbing than harmonic distortion. Tests on this chassis indicate that it is well within the "safe" limit with about 3% of intermodulation distortion at ordinary listening levels.

The audio system consists of four stages. The first stage uses a 6J5 tube; treble tone control is accomplished in its plate circuit. The four-step treble control also expands the last two 455 kc IF transformers on AM.

The second audio stage also uses a 6J5 tube. In its plate circuit three degrees of bass boost are provided by means of shunting resistors on the tuned bass-boost choke. Tone control clicks are eliminated in both treble and bass switching by providing resistor networks which maintain the same potential across the capacitors or choke regardless of the position of the control.

(*Continued on page 95*)

Survey of World-Wide Reading

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

Model of Charged Particle Moving in Sationary Magnetic Field

J. Loeb, Ingénieur en Chef au Laboratoire National de Radioélectricité (L'Onde Électrique, Paris, France, January, 1947, pp. 27-31)

This method used to trace trajectory of a charged particle in a magnetic field,—similar to the rubber model for an electrostatic field,—is based on the fact that two systems obey identical equations. The analogous system, called Hodoscope, consists of a flexible, direct-current carrying wire placed in a constant magnetic field. In other words, the equilibrium position of the wire is identical with the trajectory of a charged particle moving in the same stationary magnetic field. Under conditions to be specified, the wire will bend into the shape of the path the particle travels.

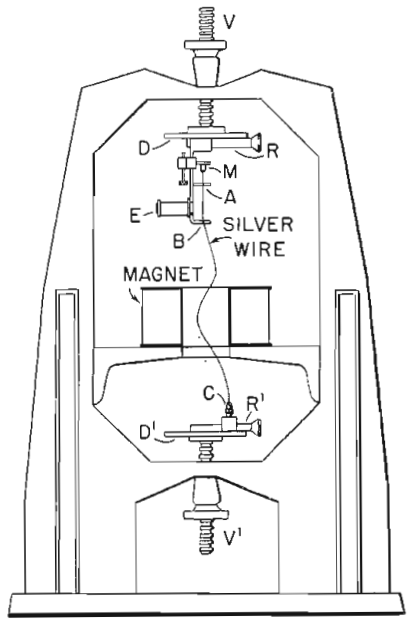
Consider a plane path and a uniform magnetic field: The particle will trace a circle and the wire will assume a circular shape. It appears that the analogy holds in this special case; for the general case it can be proved by means of the calculus of variations.*

The two curves, particle path and wire shape, will be identical, provided: $mv = eF/I$, where m, v, e, are the particle's mass, velocity and charge, respectively, while I and F are the current and the tension of the wire. As v, the magnitude of the particle velocity is constant for a particular particle in a magnetic field, and I and T are constant along one particular wire, the relation can be met. It determines the dimensions for two equivalent systems.

The analogy between the charged particle and the wire model holds only if gravitational force and stiffness are negligible compared with the force exerted by the magnetic field on the wire. Light weight and flexibility were therefore of importance in the choice of the wire for the Hodoscope constructed at the Laboratoire Nationale de Radioélectricité. A silver wire, 0.02 mm in diameter capable of carrying a 500 ma current was finally selected. Assuming a field of 600 Gauss, the gravitational force will amount to one thousandth of the magnetic force and the elastic force will be even smaller; their omission is thereby justified.

The apparatus illustrated was intended for the study of aberrations in magnetic lenses. The terminals B and C of the wire may be placed at a desired point and their position read to 0.1 mm. Their vertical adjustment is made by means of the screws V and V'; as the angular position is read on a graduation marked on discs D and D' and their radial distance from the center of the discs regulated by slides R and R'. The chuck, M, can be lowered or raised to vary the length of the wire.

Hodoscope: The direct-current carrying wire assumes the shape of the path a charged particle would travel in a similar magnetic field



To measure the tension, T, standing waves are produced in the portion of the wire between A and B. A variable-frequency current through coil E generates a field which causes the wire to vibrate. The tension, T, can then be established from the distance between two oscillation nodes, the frequency of oscillation and the linear mass of the wire.

If two points A^1 and C^1 are associated picture image points of one another, the smallest displacement of one of the wire terminals results in a considerable deformation of the original shape of the wire. It is possible to find the image of each point of a given figure and so establish the aberration of a particular magnetic lens structure. Such measurements have been carried out at the Laboratoire Nationale de Radioélectricité.

Further applications of the Hodoscope are suggested: Study of cathode ray oscillograph with magnetic electron concentration or deflection, study of the magnetic mass spectrograph (Aston), study, the non-accelerated portions of the ion trajectories in the Dees of a cyclotron, study of charged particles in the earth's magnetic field, etc. In general all problems involving a charged particle mov-

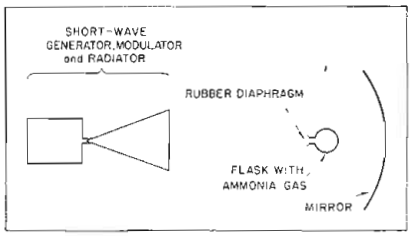
*For the variation principle compare "Electron Optics and the Electron Microscope" by Zworykin, Morton, Rainberg, Hillier, Vance, p. 353, (10.26). In the present instance the velocity, v, is constant and the variation of the first term of the integral is identically zero for all paths of the same lengths; only the second term is therefore considered in the above analysis. (Editor's note).

ing in a stationary magnetic field may be simulated by the Hodoscope.—JZ

Ammonia Flask "Receiver" for 12 mm Waves

Physical Society's Exhibition (Wireless World, London, England, June 1947, pp. 196-197).

The General Electric Co. demonstrated the absorption and heating of ammonia by means of the following arrangement: A 12 mm wave beam was modulated at audio frequency and projected against a mirror which focused the beam on a flask containing ammonia gas, as illustrated. The gas was heated and



Ammonia flask "receiver and detector" for 12 mm waves

cooled at the rhythm of the modulation and consequently expanded and contracted at audio frequency. The rubber diaphragm at the mouth of the flask vibrated at this frequency and by placing the ear close to the mouth of the flask, the sound could be heard. The ammonia-gas-filled flask and diaphragm received and detected radio waves.—JZ.

Metal-Ceramic Seals for UHF Tubes

M. Kuhner (Le Vide, Paris, Frances, January 1947, pp. 194-204)

If the glass in an electron tube is replaced by ceramic material, the technique of sealing the ceramic material directly to the metal becomes of importance. A brazing technique which permits a seal between ceramic material and metal was developed by Telefunken, a German concern, for the manufacture of high frequency disc-seal tubes. The ceramic metal seal is further suggested for the construction of velocity-modulation tubes and for sealing Coaxial cables at a voltage anode.

The advantages secured by the use of ceramic material for the tube envelope are as follows: the ceramic material stays rigid and maintains its original shape during sealing without the use of assembly jigs so that close tolerances are assured; the loss angle of the ceramic material at 60 Mc is approximately one-tenth of the loss angle of glass; dielectric loss in glass increases rapidly with temperature, while dielectric loss in ceramic material increases only slowly at conventional operating temperatures.

The electrical characteristics of high-frequency disc-seal tubes produced by Telefunken by the metal-ceramic sealing technique described vary by 15% to 20%. The ceramic has a dielectric constant of 5.5, a loss angle of $6\text{-}8\times10^{-4}$ at 60 Mc and a thermal coefficient of expansion equal to $65\text{-}70\times10^{7}$.

The ceramic-metal seal requires a non-porous, low-loss ceramic material which seals to metal and has a similar temperature coefficient of expansion. A special metal-coated ceramic material and special iron-nickel alloys have been developed by Telefunken, which are sealed by brazing with pure silver solder. The composition of the ceramic paste is 10.20 kg steatite, 1.44 kg kaolin, 0.48 kg zirconium, 0.24 feldspar with potassium. It is essential that no alkaline earths are present in the mixture. The ceramic is coated with a molybdenum-iron mixture. Zirconium assures the great adherence of the ceramic material to its molybdenum-iron coating, Feldspar prevents porosity of the ceramic material. The manufacturing process of the ceramic material and of the iron-molybdenum mixture is described in detail as well as the coating process.

If the metal surrounds the ceramic cylinder, the alloy is composed of 54% iron and 46% nickel (Feni 46) while a composition of 58% iron and 42% nickel is used for metal inside a ceramic cylinder. The iron-nickel surfaces are coated with silver for better high-frequency conductivity. The silver covered iron-nickel alloys can be brazed with pure silver solder to the molybdenum-nickel coated ceramic pieces.—JZ.

Nickel Substitute

Report on New Vacuum Tube Techniques (Fiat No. 500), H. M. Stationary Office (Electronic Engineering, London, England, April, 1947, p. 123)

The Telefunken Co. has developed a specially coated aluminum-iron sheet free from zinc which serves as a substitute for nickel in radio tube electrodes. The aluminum layer is approximately 0.01 mm thick. The surface of this sheet changes form normal aluminum brightness to a dull dark grey on heating to 600°C in vacuum, and this surface is an excellent radiator compared with the blackened surfaces at present in use. Gas is absorbed during the process. The nickel substitute cannot be used with evaporated cathodes—JZ.

Input resistance of RF Tubes

McDermid and J. W. Whitehead (Journal of Scientific Instruments, London, England, March, 1947, pp. 79-80).

The input resistances of the tubes listed in the accompanying table have been measured in the range of from 15 to 50 mc by means of a Marconi Q-Meter, type TF 329. The table is self-explanatory.—JZ

Input resistance for several high frequency tubes for range from 15 to 50 mc

Frequency (Mc/s)	Input resistance in thousands of ohms							
	6SK7	6SG7	6AC7	RCA 9001	Ken Rad 9001	6SH7	6AB7/1853	6SJ7
50	7·4	3·8	2·18	8·55	10·2	4·0	4·4	5·1
48	—	—	—	54·2	17·5	—	—	—
46	—	—	—	96·5	30·0	—	—	—
45	9·8	6·1	6·0	—	—	5·8	6·7	6·4
44	—	—	—	148·0	51·0	—	—	—
42	—	—	—	224·0	99·0	—	—	—
40	13·7	11·5	13·0	399·0	171·0	9·1	12·0	8·1
38	—	—	—	> 1000	390·0	—	—	—
36	—	—	—	> 1000	> 1000	—	—	—
35	20·0	23·0	18·0	—	—	14·0	18·0	11·0
30	32·0	42·5	26·0	—	—	24·0	32·0	15·0
25	54·0	135·0	42·0	—	—	46·0	66·0	20·0
20	93·0	450·0	75·0	—	—	100·0	160·0	28·0
15	160·0	790·0	165·0	—	—	280·0	470·0	51·0
Input capacity in tube socket ($\mu\mu$F.)	8·5	10·0	11·5	4·0	4·0	10·0	9·0	8·0
R_a (mΩ)	0·8	> 1	0·7	> 1	> 1	0·9	0·7	1·5
g_m (μmhos)	2000	4000	5000	1400	1400	4900	5000	1650

Modulation Characteristics of Concentrated Arc Lamps

W. D. Buckingham and C. R. Deibert (Journal of the Society of Motion Picture Engineers, April 1947, pp. 324-342).

A detailed account of the modulation characteristics at audio frequencies of the concentrated-arc lamp using an incandescent zirconium oxide cathode* is given. Lamps in sizes ranging from 2 to 100 watts are manufactured. The 2-watt lamp has a source diameter of 0.003 in. and a brightness of about 100 candles per sq. mm. It can be modulated to 85% or better over the audio frequency range. Percent modulation as a function of audio frequency for the important spectral ranges is discussed. Performance for different wattage lamps with and without optical filters is illustrated. Lamp impedances are plotted as a function of frequency.—JZ

Microwave Absorption by Oxgen and Water Vapor

J. H. Van Vleck and Gilbert W. King, R. M. Hainer and Paul C. Cross (three separate articles in the Physical Review, April 1, 1947, pp. 413-443)

The oxygen molecule is paramagnetic and therefore is expected to absorb microwaves. Quantum-mechanical considerations indicate an absorption maximum at 0.5 cm, a minor absorption maximum at 0.25 cm, and a non-resonant absorption effect.

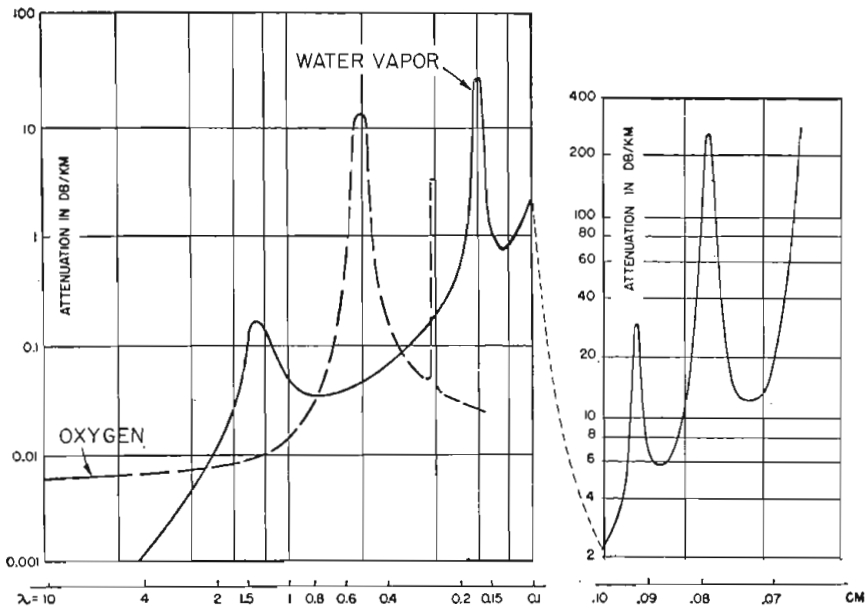
The absorption line of uncondensed water vapor has a sharp peak, (0.2 db/km per gram of H_2O per cubic meter) at a wavelength of 1.35cm; there are a great number of absorption lines at shorter wavelenghts.

In the figure are plotted the absorption curves of oxygen and of uncondensed water vapor—assuming that 1% of the molecules in the atmosphere are water—as a function of frequency. In a temperate climate approximately this amount of water is present as vapor in an average day. The curve for water illustrates that water vapor absorption in the millimeter region is so high as to seriously interfere with the transmission of electromagnetic waves except over exceedingly short distances.

Observations with 1.3 cm radar waves established the attenuation effect of water vapor. The absorption coefficient of water for 1.3 cm waves of water vapor in air, at a concentration of 1 g/m^3 and at 14.5°C is approximately 0.5×10^{-6} per centimeter.—JZ.

*See Tele-Tech April, 1947, p. 63.

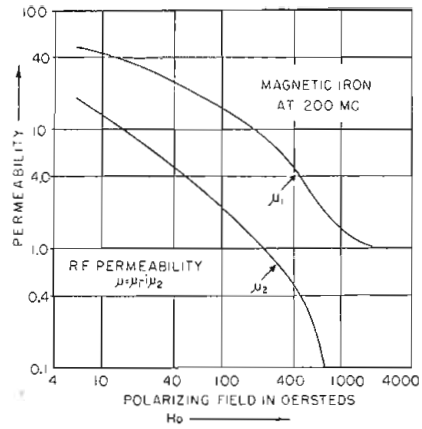
Attenuation in db/hm of electromagnetic waves by water vapor and by oxygen



Permeability of Iron at 200 Mc

M. H. Johnson, G. T. Rado, and M. Maloof (Physical Review, March 1, 1947, pp. 322-323)

The complex permeability of magnetic iron was determined at 200 Mc by measuring the Q-value and the resonant frequency of a half-wave coaxial resonator part of whose center conductor consisted of the substance under examination. Both resonant frequency and Q-value were measured as function of a polarizing magnetic field parallel to the high frequency magnetic field. The figure illustrates the values for the real and imaginary part, respectively, of the complex permeability of iron at 200 Mc.—JZ.

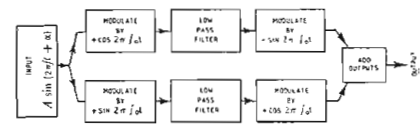


Permeability of iron at 200 mc

Narrow Band-Pass Filter

N. F. Barber (Wireless Engineer, London, England, May 1947, pp. 132-134).

The band-pass filter described uses the heterodyne method where the frequency band to be filtered is heterodyned to a low-frequency region, passed through a low-pass filter and then converted to the original higher frequency range. In the conventional heterodyne band-pass filter, the phase of the input is shifted in the process; also for equal frequency and a 90 deg. phase difference between the input and the heterodyning wave, the corresponding output will be zero.



Block diagram of narrow band-pass filter

To avoid these disadvantages, the present set-up supplies the input signals to two independent channels. They are heterodyned with the same wave in phase quadrature, passed through a low-pass filter and heterodyned again with the two heterodyning waves interchanged and one with the opposite sign. The outputs of these two channels are added.—JZ

WASHINGTON

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

TELEVISION APPLICATIONS TO DOUBLE—FCC Chairman Charles R. Denny informed the Senate Appropriations Committee that during the next year the FCC forsees a doubling and "perhaps trebling" of television station applications. Denny also predicted that manufacturers would begin the production of television receivers in quantity to support the construction of the new video outlets. The Commission has been following with the closest attention the progress of the sale of television receivers, particularly the drives of RCA and Philco in the lower-priced sets. Network relaying by coaxial cable and by microwave radio systems, subject of two significant FCC engineering conferences, was an uppermost topic under study by the Commission staff this summer. Latest TV development—Zenith's "phone vision"—is now before the FCC and the Commission is interested in furthering the progress of this method, if it is proved entirely feasible.

AVIATION FARES WELL AT ATLANTIC CITY—One radio service on which general agreement for space to meet its requirements was reached at Atlantic City was aviation communications and navigation aids. Except for some conflicts of frequency bands, sought by the two broadcasting services, aviation got practically everything it desired, recording a substantial increase over the allocations at the 1938 Cairo Conference. Maritime radio also was given a fairly good deal after considerable "hauling and pulling" in lengthy committee sessions as Soviet Russia was not too kindly disposed toward large segments of frequency space going to this service. Fixed point-to-point communications had its bands trimmed sharply, but with the postwar technological improvements of single sideband and multi-channel transmission, it is felt that the fixed servces will be able to carry on all right

WORLD RADIO BLUEPRINT — The master plan of radio frequency allocations for the world was slated to be well laid out during the early part of August at the Atlantic City Conferences. While the important International Frequency List allocations in all probability cannot be completed at the current conference but will have to await either another smaller parley or work by the new International Frequency Registration Board, it was anticipated that the allocation of bands by services would be well formulated.

TROPICAL BROADCASTING DEMANDS — The broadcasting demands — tropical and high frequency (short-wave) — were extremely large from many foreign nations, but compromises came about during the final weeks of July so as to dove-tail the broadcasting requirements into the needs of the other vital radio services. The tropical nations which had sought space far above that viewed before the conference, became willing to engage on a shared basis with other services, particularly after the Central and Latin American nations joined with the United States, Canada, United Kingdom and Scandinavian maritime countries. The high frequency broadcasting blueprint also was brought down into a reasonable pattern so that aviation and marine radio did not suffer.

NEW FCC COMMISSIONER—A "regular" and conservative Republican, Congressman Robert Franklin Jones of Lima, Ohio, took over a Commissionership on the FCC during mid-July. Because of his desire to concentrate upon the improvement of administrative governmental functioning and with his background of energy and intelligent determinations during his Congressional career of over eight years, Washington observers almost unanimously feel he will greatly strengthen the stature of the Commission. Congressman Jones replaced Commissioner Ray C. Wakefield after the latter's name sent to the Senate in the latter part of May had been withdrawn without an explanation by President Truman.

CITIZEN'S RADIO SERVICE—Tests of complete production models, submitted by radio manufacturers, have been conducted this summer by the FCC Laboratory at Laurel, Md., and the results are anticipated to provide a considerable impetus in the sale of this equipment with the stamp of government approval to the public desiring short-range radio communications and even pocket-size radio sets. Technical rules and standards are to be finally promulgated by the FCC after the manufacturers and interested groups had submitted their views on the proposed technical requirements on August 4.

ROLAND C. DAVIES
Washington Editor

New Books For Communications Engineers

Technical Dictionary

(Electrical Engineering, Radio, Television, Electrical Communication) by Hans Thali, published August, 1946 by H. Thali & Co., Hitzkirch (Lucerne), Switzerland, Volume I, English-German-French, 277 pages, Swiss Francs 18.75.

As indicated by the full title "Technical Dictionary of the terms used in electrical engineering, radio, television, electrical communication, including the most used terms of acoustics, illumination, methematics, materials, mechanics, optics, heating, etc.", the expressions collected in this dictionary were selected to meet the particular needs of electronic engineers.

The 13,500 words and 750 abbreviations presented will facilitate the understanding of current foreign language literature in the communications and related fields. It is intended to compile similar German-English-French and French-English-German editions.

Radar Engineering

By Donald G. Fink, Executive Editor, Electronics, Published by McGraw-Hill Book Co., Inc. 1947. 644 pages, $7.00.

As stated in the preface, "this book is intended to provide a general compilation of radar information in a single volume." This rather extensive and complicated project has been carried through with remarkable thoroughness and completeness. The text not only contains a considerable amount of information of recently declassified material but also an excellent background of high frequency theory and technic. This way of representation permits engineers and technical workers in the radar and related fields to understand the new developments.

The text is divided in a first chapter, "Radar Fundamentals", dealing mainly with concepts, methods and principles of high frequency apparatus, (such as pulse generation and transmission, transmission lines, wave guides, and resonant cavities, radiators, wave propagation, and radar targets) and in a second chapter, "Radar Circuits and Components", devoted to the technical details of the apparatus and circuits used in radar systems. It includes a description of military equipment, explaining its operation and stating its performance. Basic pulse circuits, rf circuits, timers, transmitters and radiators, receivers, indicators and scanners, rf measurement and test equipment are some of the tropics treated. An 18-page, alphabetic subject index facilitates location in the text of material on an interesting problem, device or circuit.

Electronics for Industry

By W. I. Bendz. Published 1947 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 501 pages, Price $5.00.

This book deals with electronic control circuits in a practical, non-mathematical manner taking up most of the industrial applications. It also covers the fields of power rectification, and induction, and dielectric heating. The author is a Westinghouse engineer and the book is designed principally for engineers whose training with power equipment has been directed toward electronic apparatus. It takes up the basic circuits that are the basis of most control installations as to fundamental principles with emphasis on the resulting equipment arrangements. Types and functions of electronic tubes, the fundamentals of rectifiers, amplifiers and oscillators, basic control circuits and the application of high-frequency for induction and dielectric heating are all discussed.

Television Receiving Equipment

By W. T. Cocking (Second Edition). Published February, 1947, for WIRELESS WORLD by Iliffe & Sons Ltd., Dorset House, London S. E. L. Size 4⅜ in. (wide) by 7 in. (F8vo), 380 pages, 210 illustrations. Price 12/6d + 5d postage.

While no fundamental changes in British commercial television practice have been introduced of late a number of important detail improvements in technic are covered in 48 additional pages to this edition.

Contents include: Principles of television — the Cathode-Ray Tube and Voltage Supplies — Deflection Methods — Saw-Tooth Oscillators — Video-Frequency Amplification—Amplification — RF Amplification — Superheterodyne Systems — Sync Separation and Sound Reception. Also included are other chapters on receiver problems and servicing methods.

Musical Acoustics

By Charles A. Culver, Ph.D., formerly, Head of the Department of Physics, Carleton College, published by Blakiston Co., Philadelphia, Second Edition, 1947, p. 215, $3.

Basic features of the physical laws of sound, such as its nature, its propagation, interference, resonance, pitch and sound quality, are explained with particular attention to features of interest in connection with musical instruments. Concepts used in music are treated and several instruments discussed. One chapter deals with the acoustics of rooms, another with electronic instruments. Recording and reproduction of music also are presented.

Design and Equipment Data

QUARTZ CRYSTALS

A variety of "Stabilized" type quartz crystals are presented in a 4-pg. folder available from James Knights Co., Sandwich, Ill. For each type, photographs, dimensional sketches, and descriptions are given. Specifications for the FS-344 frequency standard are also included.

TRANSFORMER COMPONENTS

A handy 34-pg. booklet, issued by United Transformer Co., 100 Varick St., New York, contains information on the complete line of UTC transformers for broadcast, amateur, laboratory, and replacement purposes. Included are the "linear Standard" studio transformers, equalizers and filters, the "Ouncer" high fidelity audio units, Varitrans, public address components, Varimatch transformers, and replacement units.

INSULATING GUIDE BOOK

A 44-pg. guide-book containing numerous charts and property-tables on diverse types of insulating materials has been published by Mitchell-Rand Insulation Co., 51 Murray St., New York 7. Some of the types included in this large compilation of data are Fiberglas tape, sleeving and tubing, cotton, asbestos, varnished tubing and sleeving, friction tape, mica plate and tape, transformer compounds, soldering pastes, etc.

PRECISION RESISTORS

A 4-pg. bulletin, illustrating 19 types of precision resistors and including a free sample, has been issued by Precision Resistor Co., 336 Badger Ave., Newark 8, N. J. The folder is intended to serve as guide for wire-wound resistor applications.

HEAT RESISTANCE OF ALLOYS

The material in this engineering pamphlet on "The Influence of Minor Elements on the Heat resistance of Standard Alloys," translated from the German "Metalle und Legierungen fuer hohe Temperaturen," has not been previously available in English and should prove of interest to metallurgists and engineers. In 14 pages a variety of experiments dealing with effect of minor additions on the durability of diverse alloys are discussed and the results are evaluated. The treatise is replete with charts and tables. It is distributed free by Ceroum Metals Corp., 522 Fifth Ave., New York 18.

TEST EQUIPMENT

The complete line of electronic circuit test equipment, manufactured by Triplett Electrical Instrument Co., Bluffton, Ohio, is described in a new 12-page, catalog, Form 5146-T. Included are three models of volt-ohm-milliameters, three types of tube testers, two signal generators, an appliance tester, a polarity and phase tester, and the model 2450 electronic circuit tester.

BROADCAST TRANSMITTER

Raytheon's new 5 kw AM transmitter is completely described and illustrated in an 8-pag. folder available from Raytheon Mfg. Co., Broadcast Equipment Div., 7517 North Clark St., Chicago 26, Ill. A large number of photographs, circuit diagram, and specifications are included.

FINISHES FOR ALUMINUM

To indicate some of the possibilities and combinations of surface finishes, Reynolds Metals Co., Dept. 27, 2500 So. Third St., Louisville 1, Ky., has published "Finishes for Aluminum" in two volumes. Section One is wire bound and contains 108 pages devoted to cleaning treatments, mechanical and chemical surface finishes, electrolytic oxide tretments, diverse coatings, and special finishes. Section Two, supplied in a separate loose-leaf binder, supplements this information.

(Continued on page 94)

Tele-Communications 'round the World

By ROLAND C. DAVIES,
Tele-Tech Washington Bureau

News of engineering matters of importance and of markets in various foreign fields

DOMINICAN REPUBLIC SURVEYS BROADCAST STATIONS—A survey recently made by the Office of the Director General of Communications of the Dominican Republic showed a total of 22 radio broadcasting stations operating in that country, with 14 located in the capital city of Ciudad Trujillo, 4 in Santiago, 2 in Puerto Plata, and one each in San Cristobal, San Pedro de Macoris and La Romana. Amateur stations total 17, with 14 of them operating in Ciudad Trujillo. The Republic of El Salvador in a recent survey recorded 18 standard and short-wave broadcasting stations with thirteen of them operating in the capital city of San Salvador.

BRAZIL ESTABLISHES CEILING RADIO PRICES—Retail ceiling prices on radio receiving sets have been established by the Brazilian Licensing Service for imported products and were recently published in the Official Gazette. Maximum prices, which are f.o.b. the seller's warehouse, range from 13,770 cruzeiros (one cruzeiro equals approximately 5.3 cents, U. S.) for a Hammerlund ASP 200A set with long and short wave, 18 tubes and a metal cabinet to 950 cruzeiros for an Emerson 507 type, 5-tube, long wave set in a bakelite cabinet. Products of some seventy manufacturers are included in the list. Among the U. S. companies listed are RCA, Philco, Motorola, Admiral, Farnsworth, Stewart-Warner and Hammerlund. Most expensive radio-phonograph combination on the ceiling price list is the RCA QU-61 type, 5F, 8-tube, long and short-wave, housed in a console cabinet, at 10,400 cruzeiros.

HUNGARIAN RADIO SURVEY—A table published by the Central Bureau of Statistics of the Hungarian Government lists 294,000 radio receiving sets in the country licensed as of January this year. Of this number 136,000 were in the City of Budapest. According to the Hungarian (Magyar) Radio, however, the number of sets in April was 308,000, with 25% equipped for shortwave reception. The same authority estimates the average number of listeners per set at five, pointing out that families in the provinces are large and also large groups congregate to listen to broadcasts in villages where only one receiver is available.

DANISH RADIO INDUSTRY SLOWED—Destruction of the radio manufacturing plant "Torotor", at Ordrup, a Copenhagen, Denmark, suburb, is reported to be severely handicapping the Danish radio industry. The plant has been manufacturing spare parts for a number of other Danish radio assemblers, as well as radio receivers for export to various European countries. It is extremely doubtful that the plant will be put back into operation, as all the machinery has been severely damaged and cannot be replaced except by purchase abroad, which the management is said not to be contemplating at present even if the government would grant the necessary import licenses and foreign exchange. The plant was previously put out of operation during the war by saboteurs in reprisal for collaboration by the owners with German occupation authorities.

INDIA TO BAR BAD SETS—An article, appearing in the April, 1947, issue of Radio Services, a monthly Bombay magazine, strongly urges the government of India not to issue import licenses for radios to persons or firms who have no established place of business and no facilities for giving technical advice and post-sale servicing. It also calls upon the All India Radio Merchants Association of Bombay and radio distributors' associations in the United States and the United Kingdom to safeguard the interests of the listening public and the trade as a whole against the activities of

opportunist importers in India and their counterpart exporters in America and the United Kingdom. The editor of the magazine has indicated that he intends to write direct to radio trade associations in the United States to attempt to prevent further consignments of sets to India of poor and unknown quality, which has in the past resulted in many disappointed customers.

DOMINICAN REPUBLIC TO MAKE RECORDS—A new company organized in the Dominican Republic last month is reported to be the first commercial producer of phonograph records in that country. Principal stockholders of the company, which has a paid-in capital of $50,000, also control important radio broadcasting stations. According to public announcements, its principal activities will be to acquire rights to musical compositions of both domestic and foreign composers and the recording of music and sale of records, although the company will also engage in printing and sale of sheet music.

GUATEMALA RESCINDS BROADCASTING TAXATION — An executive resolution of 1945 providing for licensing charges and taxation of commercial radio broadcasting stations in Guatemala was rescinded recently after station owners in the country vigorously protested an order of the Ministry of Finance last month giving them fifteen days in which to pay all taxes and fees on a retroactive basis. It is understood that the government, in rescinding the resolution and order, took the attitude that if they were carried out all broadcasting stations in the country would be in financial difficulties.

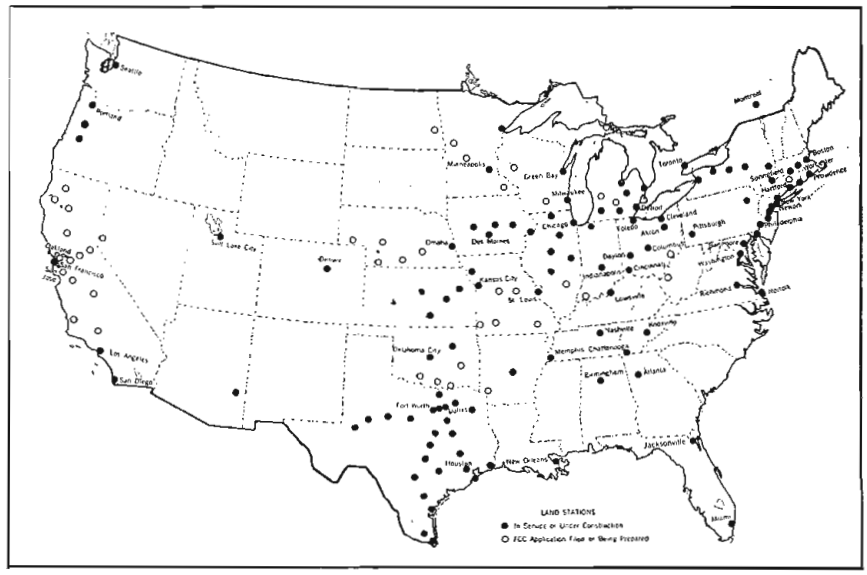
JAPANESE SHIP-SHORE COMMUNICATIONS — The Japanese coastal radio system was opened last month for ship-shore communications with American and British ships. The service will be made available to other Allied powers as they request it.

SHORTWAVE IN CUBA MOSTLY AMATEUR — Figures recently compiled show that in Cuba amateurs own the most shortwave receivers in operation, with 326, the Cuban Army is next with 140; followed by aviation with 64. Others and the number of stations in use include: interior services (United Fruit Co. and others) 5, Cuban Navy, 50, public services (Cuban Telephone Co., Press Wireless, Corporacion Inalumbrica Cubana and others) 44.

CHINESE MINISTRY HAS APPROVED 26 RADIO STATIONS— To date 26 privately-owned radio broadcast stations have been approved for operation by the Chinese Ministry of Communications. They are located at Nanking, Shanghai, Hangchow, Chekiang, Ningpo, Wusih and Kiangsu, and operate with power varying from 50 to 500 watts.

POLISH RADIOPHONE CIRCUITS TO SOUTH AMERICA — The Polish Ministry of Posts and Telegraphs announced recently that it has resumed radiotelephone connections with seven South American countries. The Polish radiotelephone circuits now extend to Argentina, Brazil, Paraguay, Chile, Bolivia, Colombia and Peru. Calls to the South American Points are put through Zurich and Prague.

MOBILE RADIO TELEPHONE SERVICE EXPANDING



Subscriber mobile radiotelephone service is rapidly expanding on a nationwide basis. Note how this new application of radio has developed along the East Coast and the Midwest. Proposed future sites indicated by open circles shows the activity on the West Coast, particularly California.

Continual improvement is sought for that portion of the radio equipment which is rented to the subscriber for installation in his automobile. Small size, light weight, low battery drain and durability are problems which merit maximum effort. These limitations are possible only at the expense of limited range for the mobile units. The only alternative is to saturate the service area with many fixed station receivers. As the mobile unit moves out of the range of one listening post another nearer receiver takes over.

The monthly service rate for an automobile radiotelephone is approximately $22. Included in this rate are 120 message-units. A message-unit is a radiotelephone measure of time and transmission distance. Each unit represents five cents, and 6 to 8 are needed for the average call. A seven message-unit call, for instance, costs 35 cents.

Mobile units are installed in about 85 vehicles in the New York area. Predominant use is for commercial services. To serve these mobile units as well as others as subscriptions are increased, 120 fixed-station units are spotted throughout the service area.

Users who know their own telephone demands must provide adequate battery and generator capacity for equipment operation. The radiotelephone gear in the vehicle belongs to the New York Telephone Co. as in the case of the home telephone. Installation charges amount to $25.

Level-Governing Audio Amplifier

Shortened attack time permits use of maximum compression with minimum degradation of quality, low output distortion and noise

• In AM radio broadcasting, overmodulation caused by occasional peaks of modulating voltage may cause only spasmodic harmonic distortion that may not be perceptible even to critical observers. If a number of such peaks occur in rapid succession, however, interference in adjacent transmission channels as well as noticeable distortion will result. On the other hand, as high a degree of modulation as possible is desirable in order to keep the average signal level at the receiver as high above the noise level as possible.

The Western Electric company's new 1126C amplifier is the latest design in a line of program-operated level-governing audio amplifiers designed by Bell Telephone Laboratories to supply the broadcasting industry with equipment which will automatically minimize overmodulation of the radio transmitter. The 1126C is a further improvement over previous models 1126A and 1126B.

In commercial FM broadcasting, 100% modulation is defined by the FCC as a frequency swing of ± 75 kc about the carrier frequency. Accordingly, FM receivers are designed for this amount of frequency swing, and in general the discriminators are linear only over this range. Overswing on the FM receiver discriminator produces distortion similar to that incurred when the output capacity of a sharply overloaded amplifier is exceeded. If this condition is to be avoided, overmodulation at the transmitter must be prevented.

These problems and methods for their solution have been discussed in previous articles by Bell Telephone Laboratories engineers.[1] The conclusions reached have been that the most suitable solution is the use of a program-operated level-governing amplifier of the peak limiter type.

The function of a peak limiter type of level-governing amplifier is to reduce its gain quickly when an overload peak occurs and to restore to normal gain relatively slowly when the peak is over. The 1126 type amplifiers accomplish this by means of a control circuit which reduces gain of the input stage of the amplifiers when peaks exceeding a predetermined amplitude occur. Attack time is the time required after the onset of an overload peak before the circuit reduces gain. Since attack time varies with the type of input and the amount of compression used, there has been no industry-wide

[1] W. L. Black and N. C. Norman, "Program-Operated Level Governing Amplifier." Proceedings of the I.R.E. Vol. 29, pp. 573-578, Nov. 1941. W. L. Black, "Use of a Program Peak Limiter in FM Broadcasting." Western Electric Oscillator, July, 1946.

Fig. 1—Front view of WE 1126A program-operated level-governing amplifier

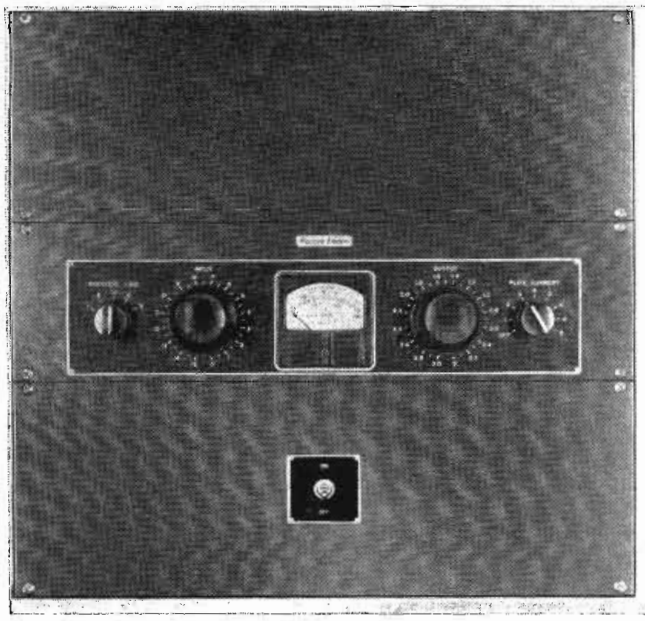
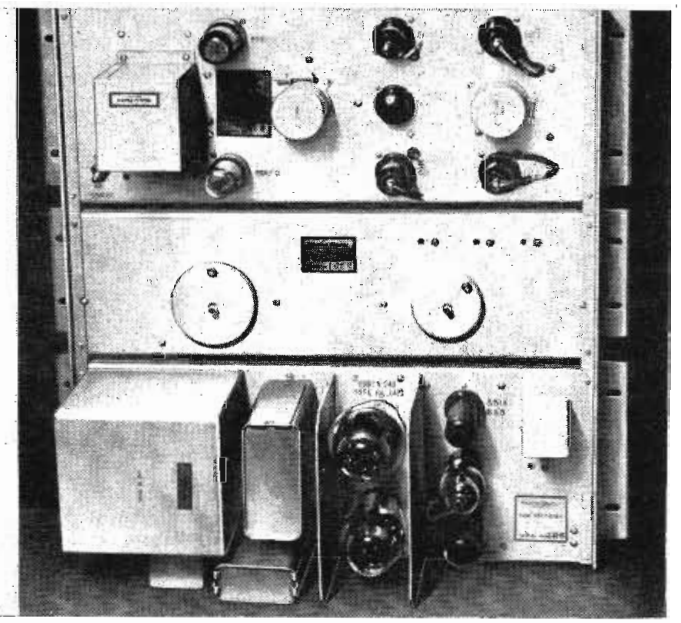


Fig. 2—Rear view showing amplifier at top, control in center, and rectifier



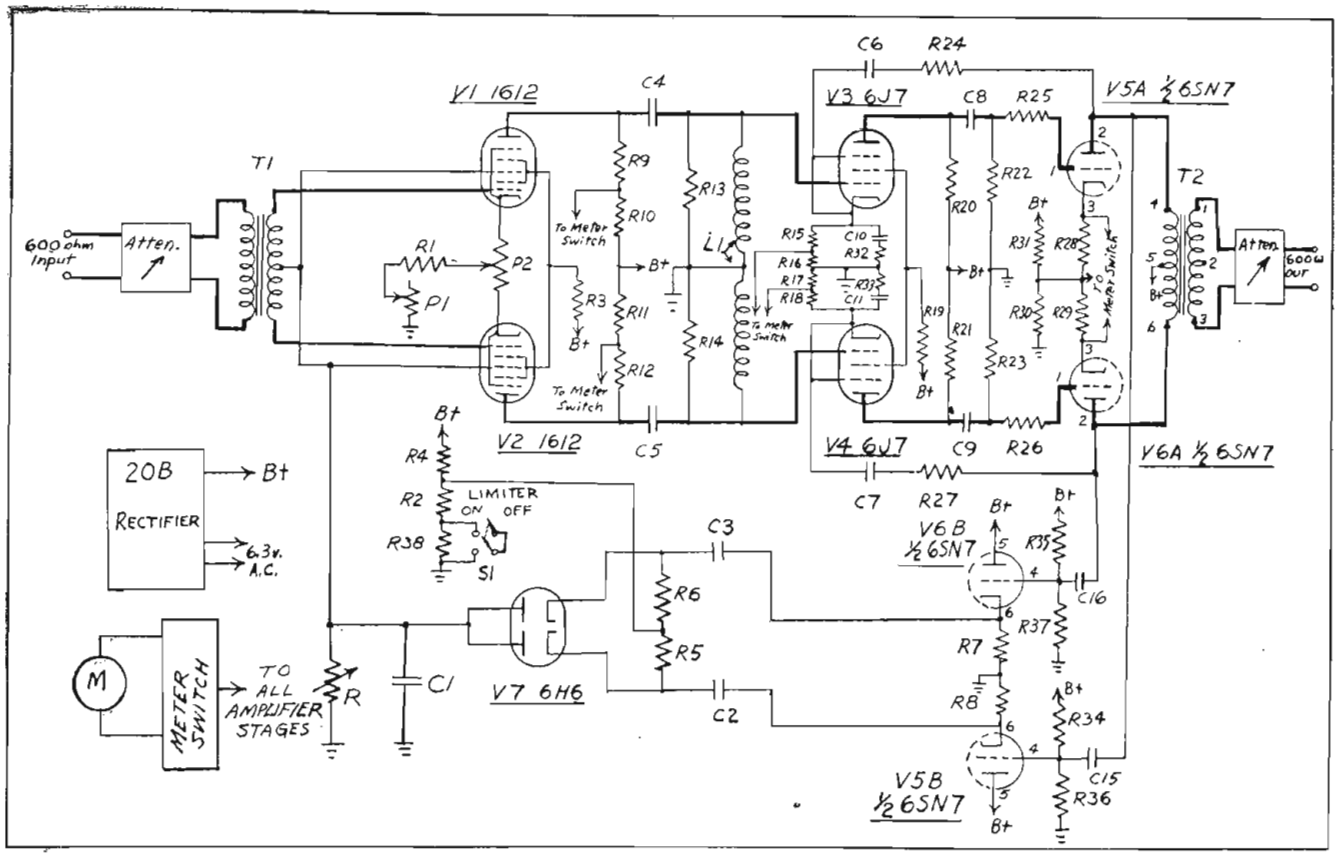


Fig. 3—Simplified schematic of the 1126C level-governing amplifier which incorporates a new control circuit providing a shorter attack time with more effective isolation of the control circuit from the output stage

agreement on its definition or measurement.

It is desirable that attack time be very short, for when it is made short, it is possible to use more compression on program material with a minimum degradation in quality. The use of some compression on occasional peaks of excessive amplitude will not cause noticeable degradation, but the use of a large amount of compression will cause reduction in quality. It is preferable for the highest quality programs, where very wide dynamic range is desired, to keep the amount of compression to a minimum.

Peak Limiting

The 1126 series of peak-limiting amplifier has been used extensively with satisfactory results both in installations where the avoidance of overmodulation has been stressed and in systems where the maximum obtainable increased modulation level consistent with no disturbing overmodulation has been the criterion. The 1126A was the first of the series. The use of this equipment in the field indicated the desirability of a few minor changes, and the 1126B resulted. The 1126A consisted of the 126A amplifier, the 20A rectifier, and the 298A control panel. The 126B amplifier contained the same circuit as the 126A with the exception of two additions, potentiometer P2 (see schematic of 1126C, Figure 3) and a disabling switch to permit convenient disabling of the limiting action during adjustment of P2 and when the use of the equipment as a straight amplifier was desired. P2 was inserted to provide adjustment for dynamic balance of V1 and V2 to minimize low frequency (20 cycles or less) shock disturbances sometimes produced in compressor type amplifiers by sudden abnormally wide variations in the average program level which cause the control circuit to "pop" in and out of deep compression.

The 20B rectifier differs from the 20A mainly in the provision of a different power transformer to permit operation at power line frequencies as low as 50 cycles per second. It supplies regulated plate voltage and ac filament voltages. The 298A control panel, used in all three of the 1126 series, contains a variable attenuator for the 600-ohm input circuit, a variable attenuator for the 600-ohm output circuit, and a meter with a switch arranged for easy measurement of the average plate or cathode current of each amplifier tube and the dc voltage from the rectifier unit. This meter is also used as a compression indicator. Potentiometer P1 is used in adjusting the meter to a reference level.

Control Circuit

The 1126C amplifier consists of a 298A control panel, a 20B rectifier, and a 126C amplifier. The three push-pull stages of audio amplification remain essentially the same as the preceding types, but the control circuit is a new design providing a shorter attack time with more effective isolation of the control circuit from the output stage of the amplifier. Fig. 3 is a simplified schematic of the 1126C.

One side of both the input and output circuits is normally grounded to assure operating stability under all conditions. Three

fixed attenuators are built into the input circuit of the 1126C amplifier and may be easily connected for the amount of attenuation desired.

The audio frequency signal, after passing through the attenuators, is impressed upon the primary of the transformer T1. This input transformer supplies signal to the No. 1 grids of V1 and V2, which are operated in push-pull. The output of V1 is applied to the grid of V3 through the coupling condenser C4, while the output of V2 is applied to the grid of V4 through C5. L1 is provided in the grid circuits of the second stage to provide a low dc resistance (with high ac impedance) path to ground for rapid discharge of C4 and C5 on sudden peaks. Condensers C8 and C9 are interstage coupling condensers, and resistors R25 and R26 give additional protection against overmodulation by providing grid clipping of peaks of unusually large amplitude.

Negative Feedback

Negative feedback to limit distortion and extend the flat portion of the frequency response characteristic is provided by R24 and C6, R27 and C7, and the cathode circuits of V3 and V4. Bias voltage in the final push-pull stage is obtained by means of the divider to B+ consisting of R30 and R31. The output of V5A and V6A is applied through the output transformer T2 to the fixed output attenuators, which may be connected for the desired amount of attenuation, and then to the variable attenuator on the 298A Control Panel. Resistors R10, R11, R16, R17, R28, and R29 are placed in the circuit as meter shunts for electron tube current measurements at the various positions of the meter switch on the control panel.

The output of V5A is also applied to the grid of V5B through condenser C15. V5B is a cathode follower stage, with no plate load resistor and a relatively large unby-passed cathode resistor. A cathode follower has a high input impedance, so V5B provides very little loading of V5A, and the plate V5A is virtually isolated from the circuit which loads V5B. The cathode of V5B is the low impedance source of the signal voltage which is applied through C2 to one cathode of the diode V7. In order to maintain V5B at the proper operating point, it is necessary that the grid be placed at a positive potential. This is done by means of the B+ voltage divider, R34 and R36.

V6B is a stage identical to V5B, and its cathode is connected through C3 to the other cathode of V7. Since a push-pull signal is applied to the grids of V5B and V6B, the output at the cathode is also push-pull. This is similar to the connection of a center-tapped transformer to a diode rectifier in an ordinary dc power supply, so V7 is actually a fullwave rectifier with the signal voltage from V5B and V6B as the ac supply.

Since electrons can flow through V7 only when the cathode voltage is more negative than the plate voltage, the application of a positive dc voltage at the cathode can prevent any current from flowing and thus make the control circuit inoperative. Such a voltage is applied by means of the divider to B+ consisting of R4, R2, and R38. When the limiter switch S1 is in the off position, this positive voltage is high enough to prevent any limiting action from occurring. In this case adjustment of P2 is facilitated, and the unit may be used as a straight high quality amplifier if desired.

With R38 shorted by the switch, however, the positive voltage at the cathodes of V7 is reduced to a value where overload peaks will be high enough to overcome them, causing V7 to conduct and its resistance to decrease to a low value. When this happens, the condenser C1 will charge negatively, placing a negative bias on the No. 3 grids of V1 and V2, thus reducing the gain of the input stage and reducing the output level. C1, therefore, is charged from a source of low impedance.

Since attack time is dependent upon the time required to charge C1, this low impedance source is very important in providing the extremely short attack time of the 1126C. In the 1126A and 1126B, single triodes were used for V5 and V6, and the control diode was fed directly from the plates with 10,000-ohm resistors in series to

(*Continued on page 95*)

Electronic Beacon for Coast Navigation

The first of a series of electronic beacons, which may eventually replace the time-honored lighthouse has been built by General Electric Company for the United States Coast Guard. The beacon is designed to supplement lighthouses during periods of fog, rain, snow and sleet. The radar beacon, powered by a "lighthouse" tube, sends out a continuous beam in the 3200 mc range, which may be detected by radar-equipped ships. Signals from the beacon appear as a bright ray on the radar indicator showing the direction of the beacon in the same way that the conventional lighthouse is located by the beam of light it emits. Application of the experimental unit, which consists of a small, portable microwave transmitter and antenna, is also expected to aid radar navigation on coast lines where the surfaces are flat and give poor radar reflection on the screen of existing equipment. Several of these units in lighthouses along the coast would give the navigator a triangular fix, a very accurate position indication.

The "electronic beacon", manufactured by General Electric Co., Syracuse, N. Y., is designed to assist or to supplement lighthouse service

News of the Industry

Balcom Heads RMA

Max F. Balcom, vice-president and treasurer of Sylvania Electric Products, Inc., Emporium, Pa., was elected president of the Radio Manufacturers Association at the 23rd annual convention of that organization. He succeeds Ray C. Cosgrove who has served for the past three years. Treasurer Leslie F. Muter (Muter Co., Chicago) was re-elected, as were vice-presidents Paul V. Galvin, J. J. Kahn, and Allen Shoup. Two new vice-presidents are W. J. Barkley (Collins Radio Co.) and R. E. Carlson (Tung-sol Lamp Works). New directors are H. L. Hoffman (Hoffman Radio Co.), Harry C. Sparks (Sparks-Withington Co.), E. N. Wendell (Federal Telephone and Radio Co.) and W. A. MacDonald (Hazeltine Electronics Corp.) Bond Geddes was re-elected executive vice-president and secretary. With the addition of 12 new members, RMA membership has reached its highest peak at 347.

Relay Makers Organize

Manufacturers of relays have banded together to form the National Association of Relay Manufacturers. First president of NARM is Ralph T. Brengle, Potter & Brumfield Sales Co., Chicago. Other officers who will have charge of the destiny of the new organization are: Vice-president C. P. Clare, Clare & Co., Chicago, and Secretary-treasurer, J. J. Rowell, Guardian Electric Mfg. Co., Chicago. The relay industry comprises some 80 manufacturers — a considerable number of whom build relays in addition to other types of electrical and electronic equipment.

Coast Electronic Show

The West Coast's 3rd Annual Electronics Trade Show is to be held in the Hotel Whitcomb, San Francisco, during the three days, September 26, 27 and 28. The show is sponsored by the West Coast Electronic Manufacturers Association. It will immediately follow the regional sessions of the Institute of Radio Engineers, which are scheduled to be held at the Palace Hotel on September 24, 25 and 26. It is expected that both gatherings will establish new records for attendance. Manager of the Electronics Trade Show is Dave Ross, 395 Page Mill Road, Palo Alto, Calif.

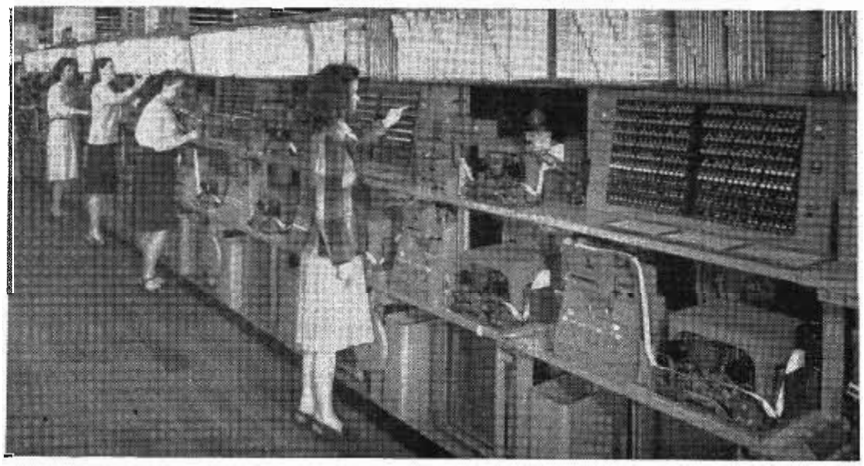
High Power TV

Radio Station WGN in Chicago is soon to have the highest powered television transmitter. A General Electric 5 kw video transmitter is being installed and it is expected that WGNA will have a test pattern on the air this Fall. Effective radiated power of the transmitter will be increased to 18.4 kw through the use of a special G-E antenna.

Zenith Proposes Paid "Phone Vision"

To provide the television audience with something remotely akin to long-known but little-used "wired" radio, Zenith Radio Corp., Chicago, has publicized what is described by president E. F. McDonald, Jr., as "Phone Vision", a system by which standard television receivers would receive regular TV broadcasts and, upon payment of a suitable fee, might also receive special broadcasts tied in either with the telephone lines or a power line. McDonald explains it this way: "Phone Vision operates by sending a 'key' signal over either a telephone or electric line. Without this key signal the picture on the screen is a hope-

(*Continued on page 81*)



TELETYPEWRITER CIRCUITS in Western Union's new Philadelphia communications center, just put in service, are completely pushbutton operated. Incoming messages are automatically typed and reperforated, then shunted direct to destination. Beamed microwave relays soon will supplant wires between New York, Philadelphia, Pittsburgh and Washington, with radio system eventually to be extended coast to coast

CONVENTIONS AND MEETINGS AHEAD

August 7-8 — Institute of Aeronautical Sciences, annual summer meeting, Los Angeles.

August 26-29 — Pacific General Meeting, American Institute of Electrical Engineers, San Diego Hotel, San Diego, Cal.

September 8-12—Second National Instrument Conference and Exhibit—Hotel Stevens, Chicago.

September 12-13—Frequency Modulation Association, National Meeting, Hotel Roosevelt, New York.

September 15-18—Annual convention National Association of Broadcasters, Convention Hall, Atlantic City.

September 24-26—West Coast IRE convention, Palace Hotel, San Francisco.

September 26-28—West Coast Electronic Manufacturers' Association third annual Electronics trade show, Hotel Whitcomb, San Francisco.

October 1-11—National Radio Exhibition, Olympia, London, England.

October 20-24—Society of Motion Picture Engineers, Theatre Engineering conference, Hotel Pennsylvania, New York.

November 3-5—National Electronics Conference, Edgewater Beach Hotel, Chicago.

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

another "break" in the bottle-neck...

After the speaker the next major limitation in the ordinary sound system is the output transformer. New techniques in inter-modulation testing have shown it to be the factor causing non-linear distortion in many commercial amplifiers.

But the same Altec Lansing that developed the famous Duplex Speaker with its wide range, undistorted reproduction, also gives you a line of output transformers which will deliver POWER within 1 db of rating from 40 to 10,000 cycles; POWER within 2 db of rating from 25 to 15,000 cycles; and POWER within 3 db of rating from 20 to 20,000 cycles. This outstanding feature of power handling capacity is practically exclusive with Altec Lansing.

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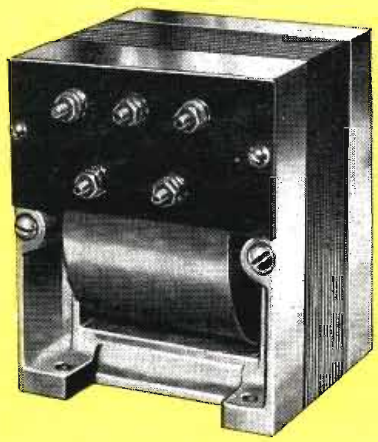

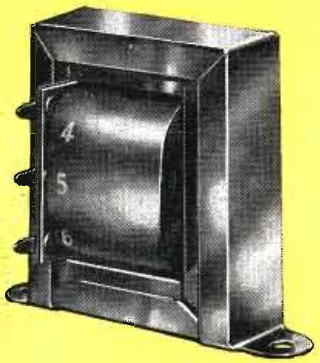

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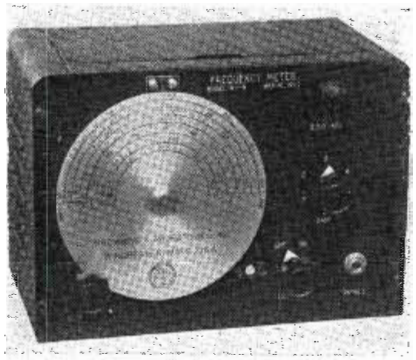
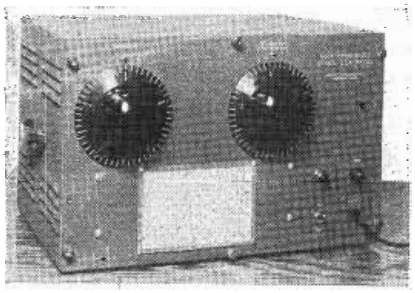


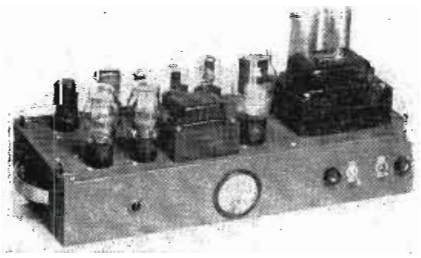
Frequency Meter

Model MJ-9 amateur frequency meter is direct reading for all bands, from 3.5 to 148 mc, with separate coils for each band except the 144 to 148 mc range, which is covered by harmonics of the 20.5 to 21.5 mc band. A 500 kc crystal controlled oscillator is used as a reference standard. Overall accuracy of the unit is .05% at all frequencies. The unit may be used as a substitute for the crystal oscillator to provide variable frequency operation. **—Browning Laboratories, Inc., Winchester, Mass.**



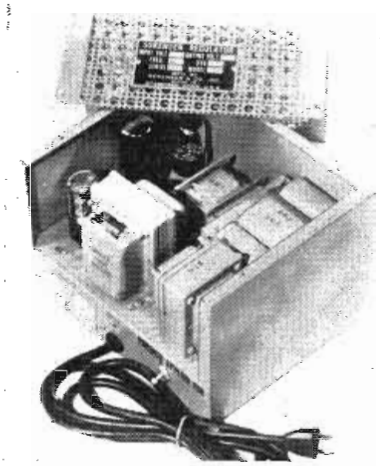
VHF Signal Generator

Providing a frequency range of 140 to 170 mc, model 196 TS high frequency signal generator has constant output through use of feedback circuits and an output adjustment directly calibrated in db. Leakage is only about .2 microvolts. Since the output is constant over the entire frequency range and independent of line voltage variations of ±10%, the signal generator simplifies the procedure of taking response curves since it is not necessary to reset the carrier level when frequency or attenuator settings are changed.—**Harvey Radio Laboratories, Inc., 439 Concord Ave., Cambridge 38, Mass.**



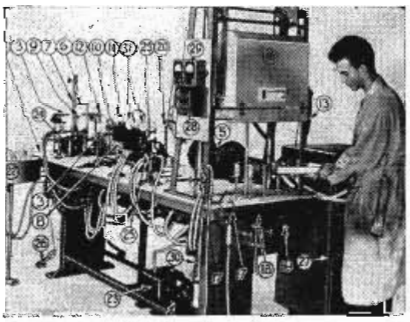
AC Power Source

Model 101-1N inverter is a crystal controlled AC power source, available for 60 cycle standard frequency or other precise output frequencies. It is 7x17x8½ in. and weighs 27 lb. Accuracy of the output stage, which uses two 2050 thyratrons, is two parts in a million per degree C. If greater frequency stability is needed a type of crystal, which is vacuum-sealed, is used, giving a stability less than one part in a million. The unit delivers a power output of 50 watts at 60 cycles. A smaller inverter, model 52-AK, is suitable for use as a subassembly in the manufacture of other apparatus. It consists of a crystal, a 6SJ7 crystal oscillator tube, and two 6SN7GT frequency dividers. A crystal is used having temperature characteristics suitable for the desired frequency stability.—**Ernst Norrman Laboratories, Williams Bay, Wis.**



Voltage Regulator

This low cost portable AC voltage regulator has an input voltage range of 95 to 125 volts ac with an output of 115 volts. Regulation accuracy of model 150 is ½ of 1%, maximum harmonic distortion being 5%. Load range of the unit is 10% to 100%, frequency range 50 to 60 cycles, and power factor range is 70% lagging to 90% leading. Maximum recovery time of the regulator is 6 cycles. Supplied in a gray enamel case, 9 x 7½ x 6 in.—**Sorenson & Co., 375 Fairfield Ave., Stamford, Conn.**

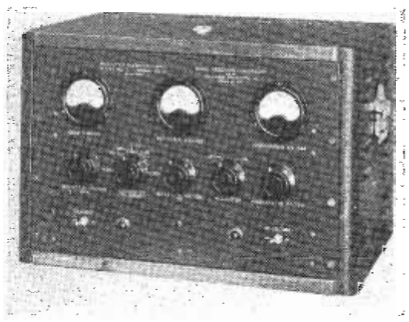


Tube Manufacturing Unit

Capable of performing all operations required for making incandescent lamps, electronic tubes, vacuum switches, photo-electric cells, etc., this new-type electronic laboratory uuit consists of a steel fabricated table, upon which the necessary machines and tools are located. Intended for experimental and researeh labs, colleges, etc., the unit permits such glass working operations as glass cutting flare and stem making, sealing-in, exhausting, basing, soldering, welding and vacuum testing.—**Eisler Engineering Co., Newark 3, N. J.**

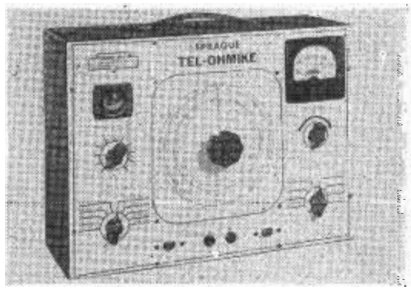
Clip-On Volt-Ammeter

Consisting of a current transformer and a 2½ in. dial type instrumeut with seleetor switch this Clip-On volt-ammeter has five current ranges of 0-10-25-100-250-1000 amps. aud two voltage ranges of 0-150-600 volts. The instrument will take eables up to 2¼ in. diameter and cao be used on bare conductors up to 600 volts ac. Good damping is assured by use of rectifier type moving coil instrument.—**Ferranti Electric Co., 30 Rockefeller Plaza, New York 20.**



Klystron Power Supply

Model 3 Klyston power supply is a voltage-regulated instrument for coutinuous duty. The unit provides an accelerator voltage, adjustable from 800 to 1200 v. dc, a reflector voltage variable from 0 to 475 volts dc with 25 v. vernier control, and a beam current from 0-50 ma dc. Modulation frequency can be adjusted from 400 to 4500 cps. Model 3 has 11 tubes and provides 115 V. ac at the rear of chassis for an external cooling motor. **—Televiso Products Co., Chicago 34, Ill.**

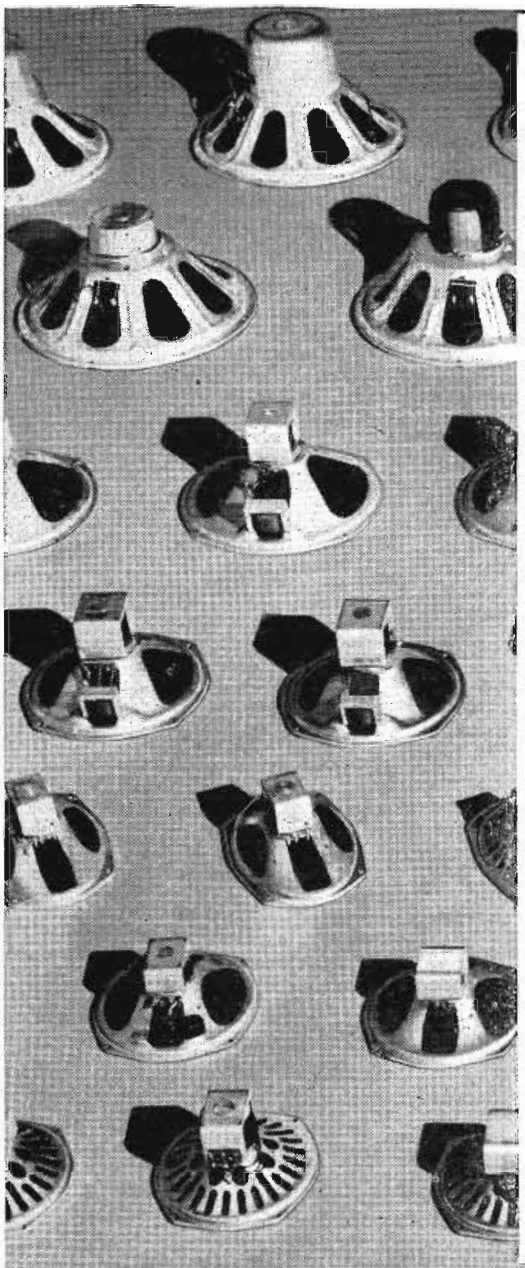


Capacitance-Resistance Meter

The new model TO-3 of the De Luxe Telohmike capaeitor-resistor checker has been provided with a "speedy Check" feature, which enables the operator to locate open, intermittent, or shorted capacitors without removing them from the circuit. The direct-reading bridge-type instrument has a capacity range from 10 mmfd. to 2000 mfd. in 4 steps, a dc voltage range from 0-15, 150, 750 v. and a current range from 0-1.5, 15 and 75 ma. Insulation resistance may be read to 2500 megohms. Power factor range is from 0-50% at 60 cycles.—**Sprague Products Co., North Adams, Mass.**

SWR Meter

When connected in a transmission line of any impedance between 70 and 300 ohms, Model MM1 Micro-Match will indicate standing wave ratio of the line at any point, and when terminals are reversed, will indicate the rf power being fed down the line. The instrument operates on any frequency from 3 to 30 mc and with any transmitter power from 10 to 1000 watts.—**M. C. Jones Electronics Co., 96 North Main St., Bristol, Conn.**



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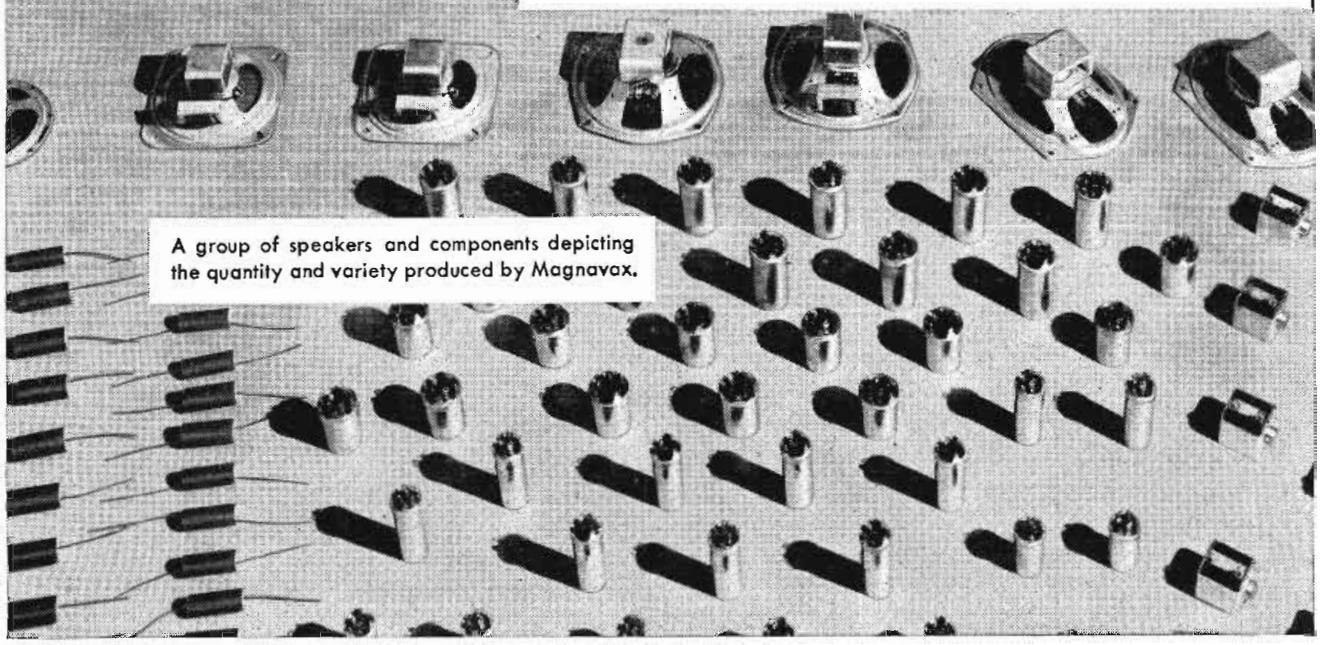
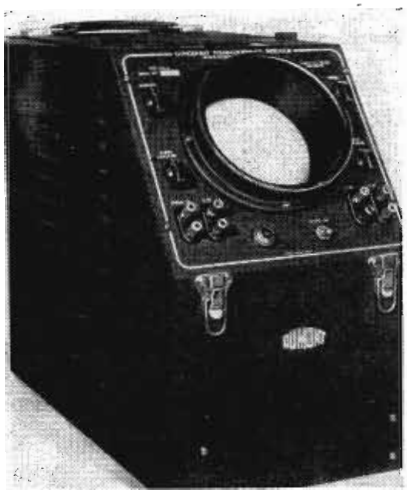


A group of speakers and components depicting the quantity and variety produced by Magnavox.



Polar Coordinate CR-Indicator

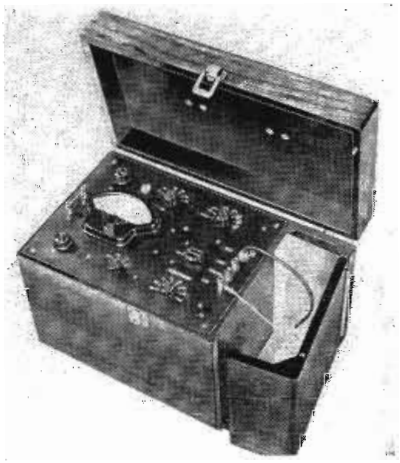
Useful for studying all types of rotating machinery and for plotting phenomena on a circular time basis, the Type 275-A Polar Co-ordinate cathode-ray indicator is provided with a 5CP-A CR tube indicator, operated at an accelerating potential of 3000 volts to produce a very bright pattern. Frequency response of the radial amplifier is essentially flat from less than 2 cps. to 30 kc. Approximately .5 volt is required to provide deflection to the center of the circle. Circle amplitude is constant from 60 cps to ½ cps without phase shift. Panel controls include intensity and focus, power switch, radial-amplitude and circle-amplitude controls, and input terminals. The instrument weighs approx. 65 lbs.—**Allen B. DuMont Labs., 2 Main Ave., Passaic, N. J.**

Oscillograph Power Supply

Suitable for any application where high voltage at low current is required the Du Mont Type 263-A high-voltage power supply is especially useful in conjunction with cathode-ray oscillographs, for observation at extremely high writing rates. Housed in a metal cabinet the portable unit comprises an rf oscillator with power supply, an rf step-up transformer, a half-wave rectifier and filtering and metering system. Type 263-A provides continuously variable positive dc output from 5,000 to 10,000 volts with loads up to 200 microamps. Regulation is within 20% from no load to 200 microamp. load. Ripple voltage is less than 0.5%. The unit weighs 24 lbs. and consumes 100 watts.—**Allen B. DuMont Labs., 2 Main Ave., Passaic, N. J.**

Variable Frequency Oscillator

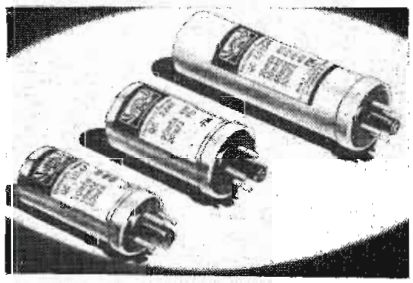
V.F.O.-21 variable frequency oscillator is self-contained and provided with plug-in coils covering the frequency range of all amateur bands. It is a dual purpose unit having both VFO operation and provisions for switching to crystal operation. Output of the unit is sufficient to drive low and medium power beam tubes.—**Bud Radio, Inc., 2118 East 55 St., Cleveland, Ohio.**



High Sensitivity Ohmmeter

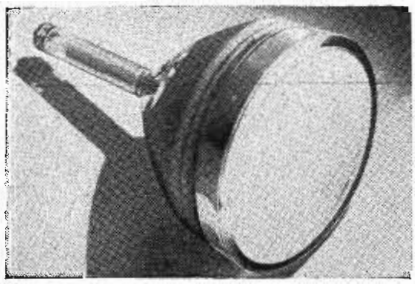
Permitting precision measurements of unusually small currents and high resistances the Beckman UltrOhmeter has a current sensitivity to as low as 2×10^{-14} amperes full scale. This high current sensitivity makes possible measurement of resistance up to 1×10^{16} ohms directly under actual conditions of operation. A built-in standard voltage source provides voltages for resistance measurements in steps from 0.5 to 20 volts. Time response of the instrument is maintained at approx. 2 seconds. The unit can also be used as a high impedance dc voltmeter under sensitivities from 20 millivolts to 5 volts with a maximum of 10^{11} ohms input impedance. The instrument is completely battery-operated.—**Beckman Instruments, National Technical Laboratories, 820 Mission St., South Pasadena, Cal.**

Parts for Design Engineers



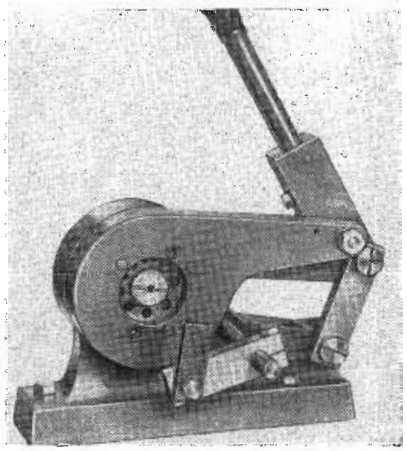
Plug-In Capacitors

Where quick changes are required, hermetically sealed Type QC plug-in electrolytic capacitors are provided with a 4-pin octal-base mounting permitting ready replacement in standard tube sockets. Units are available in values of 10 to 80 mfd., either single or multiple section, for 450 volts dc. working. Multiple units for 150 dc. WV are available in 20 mfd. and 40 mfd. values. — **Cornell-Dubilier Electric Corp., South Plainfield, N. J.**



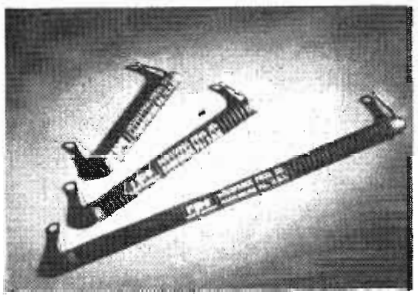
Television CR-Tube

The type 10FP4 ten-inch television cathode ray tube is provided with an aluminum-backed screen to increase clarity and brilliance and prevent development of ion spots and intercept cathode glow. Utilizing magnetic focusing and deflection the tube has a maximum rating of 10,000 volts anode voltage, 410 volts on the accelerating electrode (grid No. 2), and —125 volts on the control electrode (grid No. 1). The tube has a small-shell 7-pin duodecal base, an overall length of 18 in. and a deflecting angle of 50°. Focusing coil current is about 100 ma. dc.—**Tube Div., General Electric Co., Schenectady, N. Y.**



Rod Cutter

Scientifically designed for accurately cutting or "parting-off" round materials without distortion the Di-Acro rod parter is available in two sizes with capacities of ⅜ in. and ⅝ in. cold rolled steel bars. Small diameter rods required in the manufacture of delicate instruments can be cut off to close tolerances with the rod cutter. The machine is suitable for cutting metals, plastics, fibre, rubber, wood and bi-metals.—**O'Neil-Irwin Mfg. Co., 348 8th Ave., Lake City, Minn.**

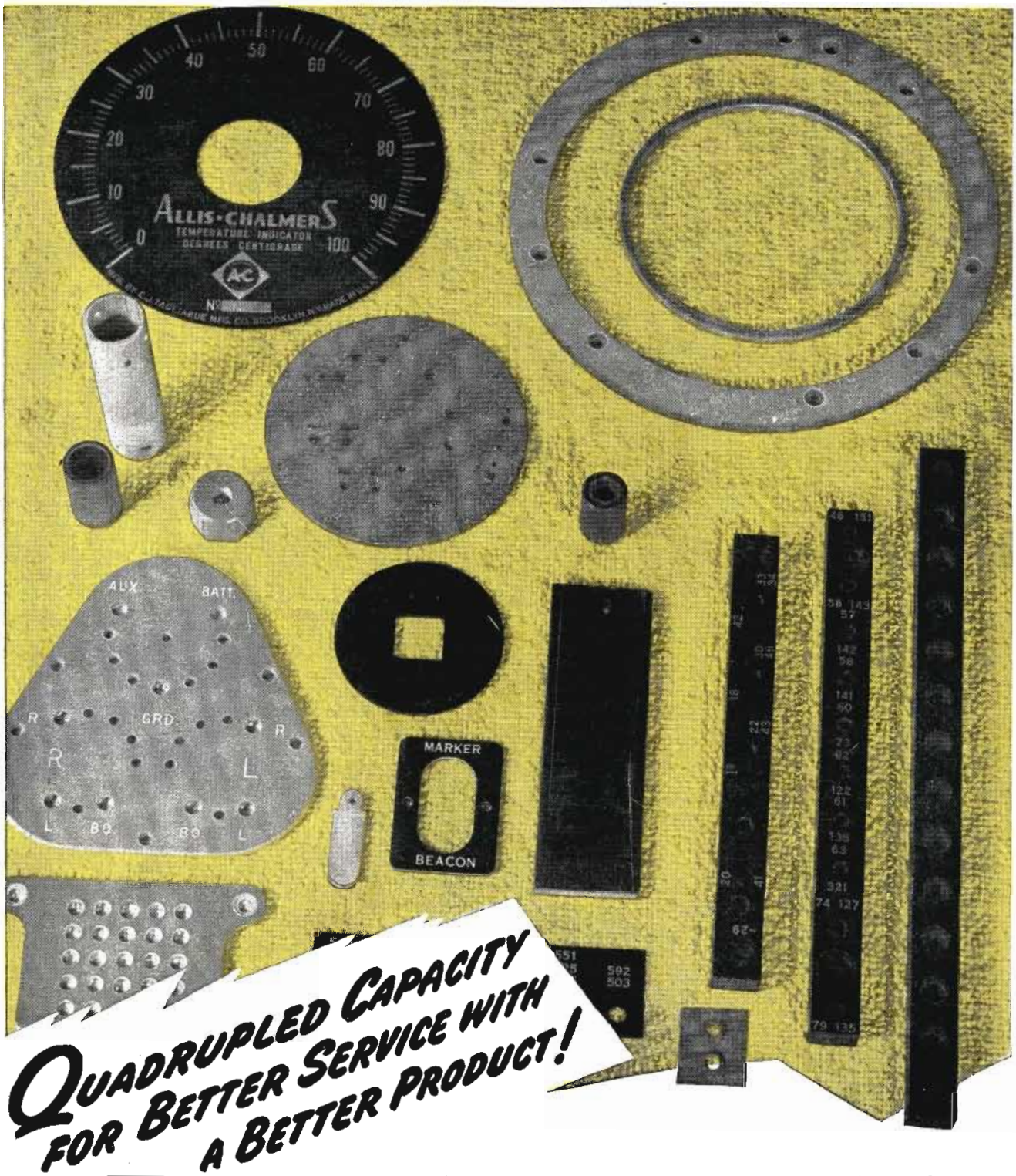


High Voltage Resistors

These stable, compact high voltage resistors can be applied in resistance values as high as one million megohms. At present three types are available: type BBM rated at 2 watts and 7,500 v., type BBR with a power rating of 3 watts at 15,000 volts, and type BBV with 5 watt rating at 30,000 v. The high voltage resistors can be furnished in tolerances of ±15%, ±10% or ±5%. A tolerance of ±2% is available in matched pairs. The units may be machine screw mounted, and assembled to make tapped units or matched pairs. Special mounting insulators and brackets are available.—**Resistance Products Co., 714 Race St., Harrisburg, Pa.**

Insulating Varnish

For use on all types of wound coils Synthite AJR-7 all purpose insulating varnish has the ability to cure rapidly and completely at temperatures lower than those usually required. The varnish is especially adapted for use on coated magnet wire such as Formvar, Formex, Nylon and glass. The material can be applied by either atmospheric dip or vacuum impregnation and will produce good results whether baked under infra-red or in conventional gas or electric heated ovens. It is available in containers from 1 gal. to 55 gal. drums.—**John C. Dolph Co., Dept. 18, 1060 Broad St., Newark 2, N. J.**



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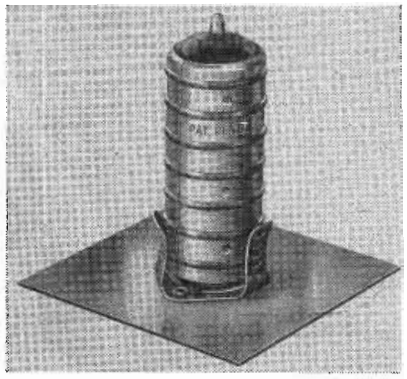
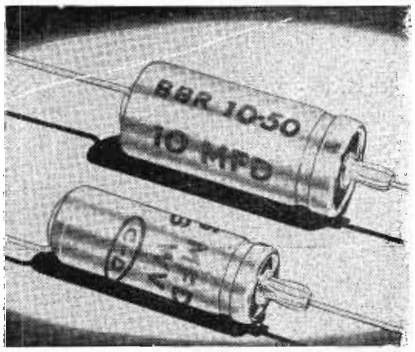


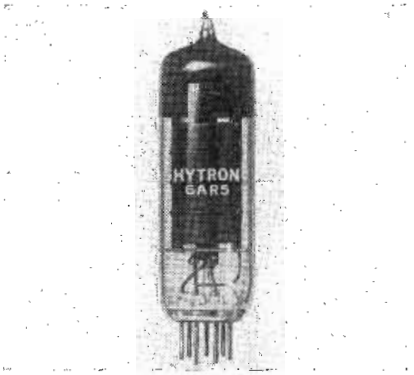
Miniature Tube Shields

Made of tin, terne plate or aluminum and available in short, intermediate and long sizes Mini-Shield flexible shields for miniature tubes are designed to fit the smallest diameter tubes, and have a ¼ in. overlap to permit expansion around larger diameter tubes. Three rows of dimples, which space the shield slightly from the tube to permit free air circulation, maintain steady pressure on the tube, preventing vibration or rattling. The shields are also available with blackened inner surfaces for low temperature operation.—**Staver Mfg. Co., 33-21 85 St., Jackson Heights, N. Y.**



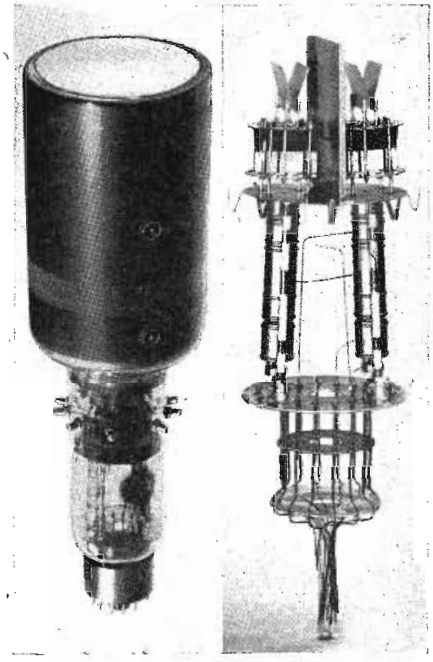
Miniature Capacitors

Type BBR capacitors are a new miniature version of the type BR electrolytic tubulars. The units are hermetically sealed in cylindrical aluminum containers and are available in capacitance values ranging from 50 mfd. at 3 V. dc. working voltage to 16 mfd. at 90 V.DC.W. Dimensions vary from ⅜ in. diam. x 1-1/16 in. length to ½ in. diam. x 1-7/16 in. length.—**Cornell-Dubilier Electric Corp., South Plainfield, N. J.**



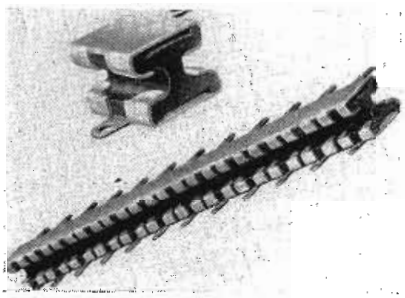
Miniature Pentode

Particularly efficient for use in automobile and home receivers because of its low heater power and low plate current Hytron type 6AR5—a miniature version of the Type 6K6GT—has high power sensitivity and efficiency. Maximum plate and screen potential of the tube is 250 v., plate dissipation being 8.5 watts. Heater voltage is 6.3 volts, current .4 amps.—**Hytron Radio & Electronics Corp., Salem, Mass.**



Two-Gun Cathode Ray Tube

Having completely independent gun and deflection plate structures the Du Mont Type 5SP two-beam cathode-ray tube is intended for applications where two related or independent phenomena are to be presented on a single screen for simultaneous observation. The two guns are contained in a 5 in. envelope available in P1, P2, P4, P7 and P11 screens. Deflection plate leads are brought out through the glass envelope wall to minimize shunt capacitance and prevent interaction due to lead coupling. The electrode voltage ratings are similar to those of type 5CP1.—**Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J.**



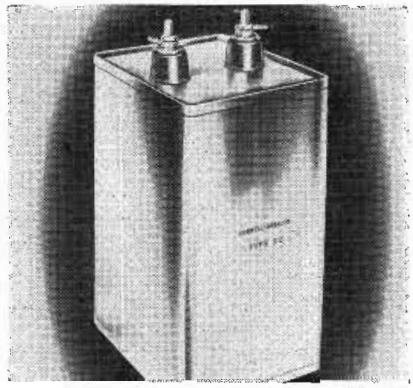
Vibration Mounts

This light-duty vibration mount is capable of handling dead weight loads as low as ½ lb. per lineal inch of mounting strip. Utilizing the vibration dampening properties of rubber-in-shear, the mounts avoid the possibility of overloading by use of a special "X" design of the rubber element, which acts in compression when the load exeeeds the rated capacity. Rexon mounts are furnished in strips 12 in. long, to be cut into any length section in inch multiples.—**Hamilton Kent Mfg. Co., Kent, Ohio.**

Aircraft Antenna Wire

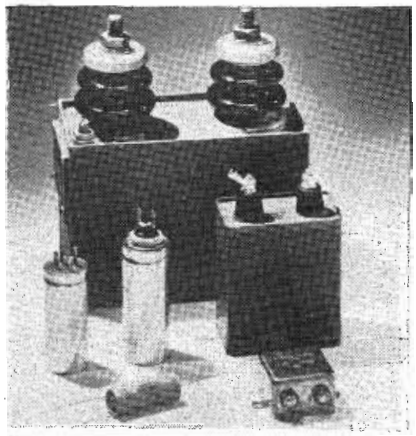
Desigued to overcome precipitation static in aircraft communication, Intelin type K-1064 insulated aircraft antenna wire was developed and applied to Army and Navy aircraft to reduce corona discharges of static potentials. The Copperweld eonductor provides high tensile strength while its polyethylene insulation assures weather resistant service. Outside diameter is .0508 in. Tensile strength is 127,000 psi minimum.—**Federal Telephone and Radio Corp., Newark, N. J.**

Look for New Sound and Recording Equipment on Page 80



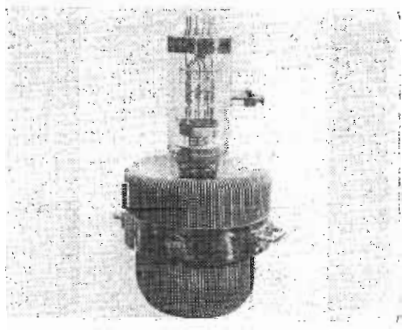
Television Capacitor

Type GC television capacitors are impregnated and filled with Dykanol and hermetically sealed. Specifically designed for filter applications in television receiver circuits, the units are available in various capacity and voltage ranges to meet specific needs.—**Cornell-Dubilier Electric Corp., South Plainfield, N. J.**



Capacitors

Designed especially for use in FM and television transmitters an entire new series of capacitors comprises plug-in and standard electrolytic capacitors, paper tubular types, high voltage impregnated and oil-filled types, etc. Catalog No. 1083 contains more detailed information and specifications for each type.—**Industrial Condenser Corp., 3243-65 N. California Ave., Chicago 18, Ill.**



Power Triode

Type 9C29 heavy duty AM power triode, has been developed for use in 50 KW broadcast transmitters, has a thoriated tungsten filament. For modulation the tube is capable of delivering 40 KW audio output with very little grid driving power. Operating at a filament voltage of 15 v. and current of 135 amps., the 9C28 has maximum ratings of 12,000 v. plate voltage, 10 amps. plate current and 100 KW plate input. Another available thoriated tungsten filament type tube is the 9C30 which is designed for rf amplifier applications at frequencies up to 20 mc.—**Federal Telephone and Radio Corp., Clifton, N. J.**

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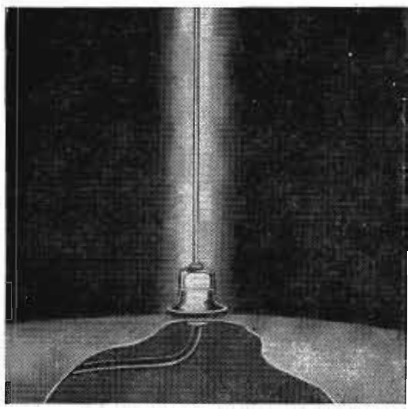
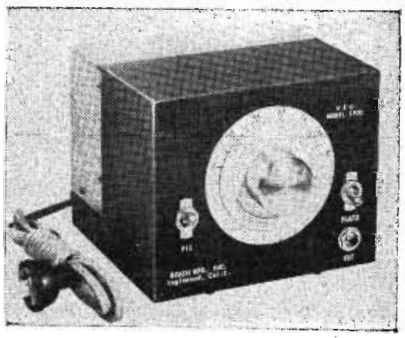
Communications Components



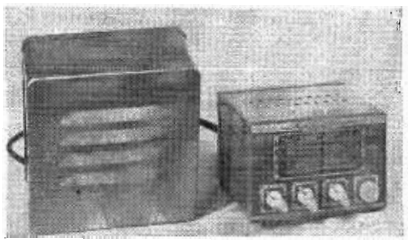
Mobile Radio Antenna

A rattlefree, weatherproof single hole mount is obtained for this whip antenna by adapting a self-threading plug to a watertight sealing assembly which is fastened to the mounting surface. Accurate maintenance of relative positions of the outer and inner conductors minimizes electrical discontinuity at the junction of cable and whip and insures smooth transmission of electrical energy from the coaxial cable to the antenna.—**H. H. Buggie & Co., Toledo 1, O.**



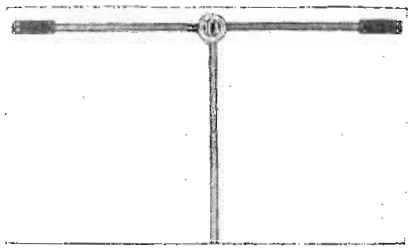
Variable Frequency Oscillator

Utilizing an improved type of electron coupled circuit which maintains the cathode at ground potential model 1700 variable frequency oscillator features high stability, logging accuracy and rugged mechanical qualities. Fundamental range is from 3350 to 4000 kc, directly calibrated in 25 kc steps. Vernier ratio is 7.5 to 1, providing more than 30 in. of dial area. Output of the unit is about 1 watt over the entire range. It operates on 115 v., 50-60 cycles, ac.—**Beach Mfg., Inc., Inglewood 3, Calif.**



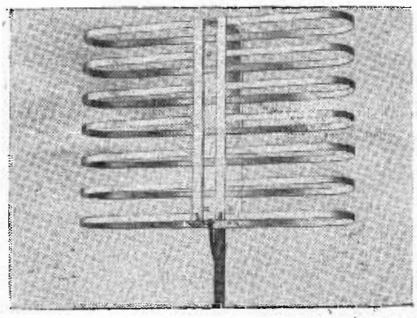
Mobile Communications Receiver

A new type of communications receiver is furnished in three models: Model 80A is designed for amateurs, being provided with two amateur bands in addition to the standard broadcast band. Model 80B covers the most-used aircraft frequencies. Band I is the range band from 190 to 450 kc; band II is standard broadcast, and band III covers from 2.4 to 6.8 mcs, including the 3105 and 6210 kc frequencies used by private aircraft. Model 80C, designed for the export market, covers the more commonly used frequencies in foreign countries. The 80 series has a tuned rf stage on all bands. Sensitivity is less than 5 microvolts for .5 watt output on all frequencies.—**Eckstein Radio & Television Co., Minneapolis 2, Minn.**



Folded Dipole Antenna

Consisting of two folded dipole elements spliced to a standard 300 ohm twin lead transmission line, the ICA FM dipole will match all 300 ohm input receivers and operate on other receivers with relatively little loss due to mismatching. Flattened end insulators permit use of the antenna indoors under a carpet or on room molding as well as outdoors at distances up to 150 ft. Losses in the line are .85 db per 100 ft. at 100 mc, which is of no consequence for ordinary FM reception.—**Insuline Corp. of America, 32-06 35th Ave., Long Island City 1, N. Y.**



FM and TV Antennas

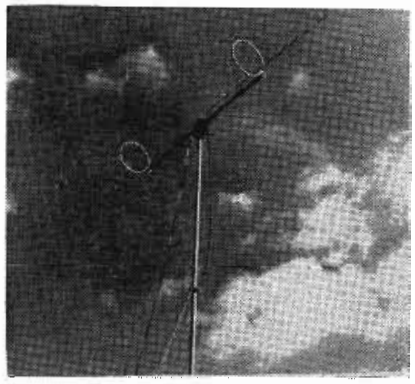
First of a line of FM and television antennas model 150 FM antenna is designed for the 88 to 108 mc band and has an omnidirectional pickup pattern, requiring no special orientation. High sensitivity—3 db over conventional dipole—assures improved reception at the outer limits of the FM broadcast range. The antenna is of all aluminum construction and small in size contributing to low wind resistance.—**The Rauland Corp., 4245 North Knox Ave., Chicago, Ill.**

Telegraph Equipment

Frequency shift telegraph equipment comprising keyer-converter, receiver and exciter, now being made available, provides an effective 15 to 20 db increase in circuit signal-to-noise ratio and permits use of lower powered transmitters. The type 216-S keyer-converter is designed for changing the output of the FSK receiver to polar voltage and is capable of keying speeds in excess of 500 words per minute. Type 87-R receiver is designed for FSK telegraph reception. It is crystal-controlled and adaptable for dual or triple diversity operation. The type 177-T, also fully crystal-controlled with provisions for three frequencies, is for keying transmitters by frequency-shift method.—**Erco Radio Laboratories, Inc., Garden City, N. Y.**

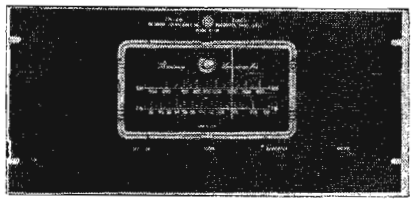
FM and TV Antenna

Covering all television and FM bands from 44 to 216 mc FMTV44216 antenna is factory pre-tuned and requires no field adjustments. Response pattern is normally broadband and non-directional; reflectors are available. The antenna, made of polished aluminum, is ruggedly constructed for all-weather service.—**Interstate Mfg. Corp., 138 Sussex Ave., Newark 4, N. J.**



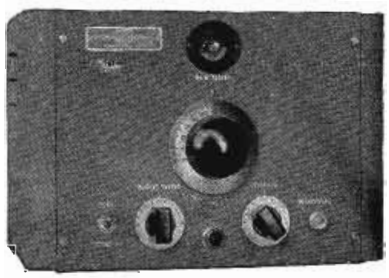
Television Antenna

Covering both television bands and the permanent FM band model 300 all wave television-FM antenna consists of a relatively thin dipole, ½ wave long at 70 mcs., placed near a thicker dipole which is ½ wave long at 128 mcs. The short, thick dipole is connected at its end through inductive rings to the midpoints of the thin dipole section. Standing wave ratio is 4 to 1 or less in the low television band and under 2.8 to 1 in the high band. Directional response is approximately the same for all frequencies. It is designed for operation with a 300 ohm transmission line.—**Tricraft Products Co., 1535 North Ashland Ave., Chicago 22, Ill.**



FM-AM Tuner

Supplied in rack panel style for commercial applications model RJ-14 FM-AM tuner uses separate circuits for FM and AM thus eliminating dual purpose components. The AM section is a superheterodyne and is provided with an RF stage. The FM section, which covers the 88 to 108 mc band, uses the Armstrong circuit with dual limiters. RF stage, mixer and oscillator tubes are of the miniature type. FM antenna input is 300 ohms balanced to ground and it connected to function also as AM antenna. A self-contained power supply operates from 115 volt, 60 cycles, ac.—**Browning Laboratories, Inc., Winchester, Mass.**



Exciter-Modulator

A combination variable frequency exciter and reactance tube modulator for amateurs has been developed to provide output on 10, 20, 40 and 80 meters, with provision for CW keying in all bands. A regulated power supply is self-contained, and a visual indicator of deviation for narrow band FM modulation is included.—**Columbus Electronics, Inc., 229 So. Waverly street, Yonkers, N. Y.**

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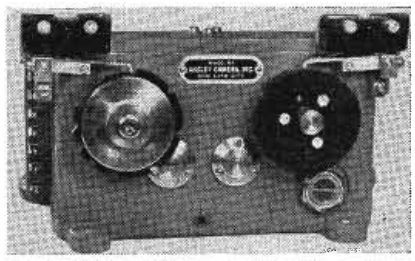
Television RF Unit

Designed as a complete unit on a separate plate for simple insertion into a television set, this RF unit is wired and pretuned at the factory. Pre-tuning is done according to geographical area. RF unit has three channels with provision for two more. It uses a 6C4 oscillator, 6AC7 converter. It has a 6-8 mc bandwidth. Comes complete with 6C4 and 6AC7 tubes.—**Transvision Inc., 385 North Ave., New Rochelle, N. Y.**

Beacon Antenna

Intended for two-way radio communication in the 152-162 megacycle band the multi-element high-gain beacon antenna Type EY3A has a power gain about 2½ times that of an ordinary coaxial dipole. Contained in a non-metallic weatherized housing, the antenna is symmetrical and offers a circular azimuth pattern. Terminal impedance of the unit is 50 ohms. It weighs about 37 lb. and may be mounted on a mast or tower with a two point support.—**Transmitter Div., General Electric Co., Electronics Park, Syracuse, N. Y.**



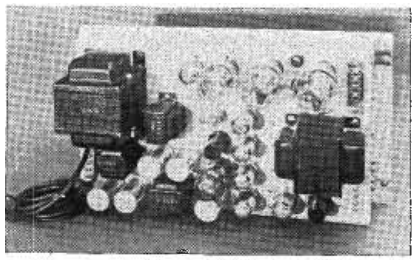
Automatic Keyer

Designed primarily for keying aeronautical radio range transmitters, Akeley Model 100 automatic keyer is a motor-driven switching device provided with specially cut code wheels mounted on slow and high speed shafts. In usual application the slow-speed code wheels transmit a dash followed by a space during which the high speed code wheels transmits four characters with an average length of two dots and two dashes. Driving motor is a 1/50 hp., 1500 RPM, capacitor type unit for operation on 110 v., 60 cycles, driving the two cam discs at different speeds (approx. ¾ and 12 RPM) —**Akeley Camera Inc., 175 Varick Street, New York.**

Keying Relay

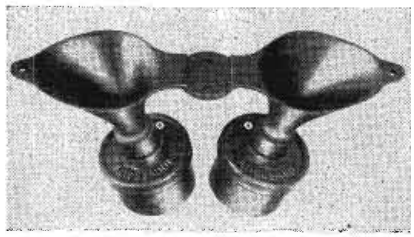
Designed for minimum space requirements this series of keying relays will withstand 10 G harmonic vibration without false contacting and will operate reliably under a wide range of temperature and humidity conditions. Core is Armco iron, armature of balanced construction, mounted on a stainless steel shaft, running in oilite bronze bearings. Electrical contacts are designed to handle 5 amps. at 115 volts ac, with various contact arrangements being available. Model RX-1074-1—one of the series—is equipped with a 5000 ohm coil current and will respond to 20 pulses per second on a 5 ma coil current when connected to 90 volts dc through a series resistor.—**Signal Engineering & Mfg. Co., 153 W. 14 St., New York 11.**

Sound and Recording Equipment



Amplifier System

Ranging from simple portable sets to extensive multiple channel installations in professional recording studios the Fairchild unitized amplifier system comprises a dozen or more units matched for rack mounting. Presently available are the No. 620 power amplifier and the No. 621 microphone pre-amplifier. The power amplifier has a frequency response of 30 to 15,000 cps within 1 db and an output of 35 watts with a total distortion of less than 5%. The plug-in 621 pre-amplifier is powered for an external source, available in the power amplifier and has the same frequency response. Gain is 40 db, which can be adjusted to 34 db.—**Fairchild Camera & Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.**

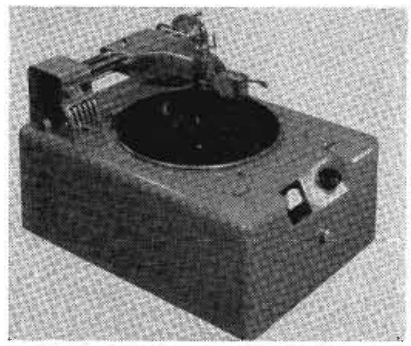


Twin HF Speaker

Intended for use in radio receivers or sound systems in conjunction with any efficient 12 in. cone speaker, this die cast twin horn high frequency speaker has a response range from 2,000 to 15,000 cycles and a power handling capacity of 16 watts. Horizontal distribution angle of the unit is 100°, vertical distribution 50°. Dividing network consists of a simple high-pass filter connected to the horns. Provision is made for adding a volume control to balance the response. The mounting space required is 2-¾ in. high x 9-½ in. wide.—**University Loudspeakers, Inc., 225 Varick St., New York, N. Y.**

Frequency Record

D61A constant velocity frequency record is now offered in a double faced duplicate recording. The 12-in., 78 rpm recording is Vinylite and recorded in three parts. First section gives a continuously rising tone of 50 to 10,000 cps. Frequencies are voice-announced in 15 breaks. The second section consists of a 1000-cycle tone recorded in steps of 2 db from +8 to +18 db. The final section provides a 400 cycle tone recorded at +18 db, with zero reference established at an arbitrary level.—**Universal Microphone Co., Inglewood, 2, Cal.**



Professional Recorder

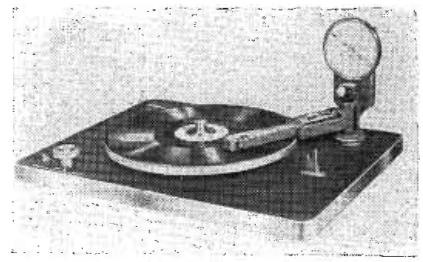
Designed for use by radio stations and professional recording studios the Robinson recording machine chassis is built on a heavy cast aluminum bedplate and is provided with a control panel for VI meter, fader and switches. The chrome plated aluminum cutter carriage is available in two styles to accommodate any existing cutting head. Five levers projecting from the pitch-change box permit a choice of 85, 100, 120, 130 and 140 lines per inch, adjustable during recording. Two toggle levers are provided for selection of inside out or outside in recording and for changing turntable speed from 78 to 33-1/3 rpm. The turntable is belt-driven by a heavy-duty constant speed motor. Two styles of steel cabinets are available: one (10 in. deep) for portable or bench use, the other with ample room for associated equipment for fixed station use.—**Robinson Recording Laboratories, 3022 Sansom St., Philadelphia, Pa.**

Input Transformer

For coupling low impedance microphones to standard hi-impedance amplifier inputs Amperite cable type input transformer permits microphone lines up to 5000 ft. in length with little loss in output or frequency response. Special shielding eliminates hum-pickup. Frequency response is within 2 db from 50 to 12,000 cps.—**Amperite Co., 561 Broadway, New York 12.**

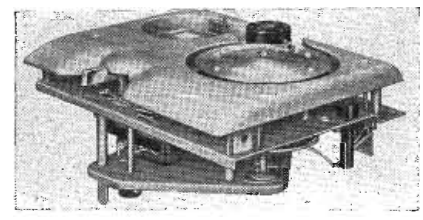
Portable Transcription Table

The RMC transcription player, model TP-16C, is a portable unit, designed for transcription records up to 16 in. at 78 or 33⅓ rpm. It is available with Para flux magnetic reproducer, with interchangeable heads for vertical, lateral, or universal use with the same arm and equalizer. The motor is a constant-speed, heavy duty type, installed on a full floating mount panel. A control switch on the panel permits selection of 78 or 33⅓ rpm.—**Radio-Music Corp., East Port Chester, Conn.**



Recording Equipment

This line of professional recording and transcription equipment has a turntable equipped with a record lift which suspends the record a fraction of an inch above the turntable for ease in cueing. A groove indicator mounted on the playback arm allows the operator to locate a preselected word or sound on the record. Direct drive to the center of the turntable through a specially designed gear provides 33⅓ and 78 rpm. A recording drive, consisting of overhead precision lathe assembly with variable pitch from 80 to 150 lines per inch, is available. The pickup arm will accommodate any standard cartridge, including the GE variable reluctance reproducer.—**Gray Research and Development Co., Elmsford, N. Y.**



Wire Recorder

Model 79 wire recorder mechanism is a foundation unit, around which a complete wire recorder can be built. It consists of an efficient wire transporting mechanism and is equipped with a triple-purpose recording head, which records, erases, and plays back. The mechanism is powered with a 4-pole, shaded pole, self-starting induction-type motor, operating on 105-125 volts, 50-60 cycles, ac. It records at 2 ft. per second and rewinds at seven times that speed. A standard size spool permits continuous recording of one hour. — **Webster-Chicago Corp., 5610 Bloomingdale Ave., Chicago 39, Ill.**

Phone Vision

(*Continued from page 70*)

less blur. It will work equally well with color television, projection receivers or black and white".

The avowed purpose of the plan is to make it profitable for broadcasters to transmit "top flight material that might otherwise be seen only in theaters". Idea would be for the person desiring a special feature, presumably previously announced, to tune the picture in after the usual manner and then tell his telephone operator to transmit the "key" frequency, which she would do. Thereupon the subscriber would be billed a fee in accordance with the nature of the entertainment. In short, broadcasters would transmit a "pay - as - you - see" feature programs in addition to usual run-of-the-mine material.

Million Words a Minute By "Ultrafax" Facsimile

Marking the wedding of facsimile and television, Radio Corporation of America has permitted the public to have meagre details of its "Ultrafax" equipment which is designed to transmit and receive printed material, pictures, etc., at the almost incredible rate of more than one million words a minute. Such brief details of the equipment as have been revealed were contained in a statement by Niles Trammell, president of National Broadcasting Co., at a hearing in Washington on the White Bill, which proposes extensive changes in the administrative set-up of FCC.

Trammell described the new system as a "radio-mail system" which will surpass radio telegraphy, cables and air mail in speed of operation. "Each printed page," he said, "is treated as a frame of a television picture and flashed through the air to be reproduced by new high-speed photographic processes at the receiving end." In explanation of the enormous speed possible, he pointed out further that by means of Ultrafax it would be possible to transmit twenty 50,000 word novels from New York to San Francisco in only sixty seconds.

England to France TV Relay Proposed

Possibility of construction of a cross-Channel television link between England and France and exchange of programs between the two countries has been opened by an "entente cordiale" recently reached between the British Broadcasting Corporation and French television authorities. The agreement was reached as a result of a visit of BBC television producer Eric Fawcett to France, where he obtained one of the French television cameras, highly regarded by the British as being more flexible and capable of a wider variety of shots than those in use in England.

It is pointed out that whereas, at Alexandra Palace, two cameras have to be used for certain shots, in the French system one camera suffices. The difference is largely that the French camera can move from distant shots to close-ups at the touch of a switch. French television is generally regarded in England as being the farther advanced as, in addition to the greater camera flexibility, the pictures have a definition of 800 lines as compared with BBC's 400.

French Office for U. S. Aviation Radio

Through the American Embassy in Paris, Air France has suggested the establishment of a commercial office there to be maintained by various American electronics manufacturers whose equipment is being used by the airline. Purpose of the office would be to assist the airline with maintenance of the equipment and also with nomenclature and delivery dates for spare parts. Items of U. S. equipment installed in planes of Air France were mentioned as including Bendix transmitters and receivers, RCA radio altimeters, Collins transmitters and General Electric and Western Electric transmitters and receivers.

Australia Tests FM

Chiefly with a view to bringing regular radio programs to people in the "out-back", the Research Department of the Australian

Postmaster General's Department is reported to be investigating the possibilities of FM broadcasting for that area. All development of FM is in the hands of the Commonwealth government at the present time, and the Postmaster General announced that an experimental FM broadcasting station had been completed and was carrying out tests in Melbourne and that similar stations would be established soon in Sydney and later on in other capital cities. He emphasized, however, that several years probably would elapse before FM broadcasting could supplement, much less replace, existing stations and that the adoption of this method as a means of providing a regular service should be deferred pending the outcome practical tests in capital cities and further investigations abroad by his department.

FM for Dayton Cops

Dayton, Ohio, is the latest city to install radio equipment operating in the 152-162 mc band for its police operations. The installation is one of the largest in the Middle West, the complete system to include at least four 250-watt transmitters and receivers. The main transmitters are to operate on either of two frequencies for transmitters and about 160 mobile communication with police personnel at 156.33 mc or at 155.73 mc for communication with the State Police network. All equipment is frequency modulated and was manufactured by the Federal Telephone & Radio Corp., Clifton, N. J.

Revise FM Rules

During the past month Federal Communications Commission made a number of fundamental changes in its rules and regulations governing the operation of FM broadcast stations by putting in effect a number of alterations which were proposed as long ago as last April. Under the new rules which became effective on July 1, the Class B channels which had been temporarily withheld have been released as have four Class A channels which were previously similarly reserved. Under the old plan

one out of every five Class B channels available to an area to which at least five had been assigned, had been withheld from assignment. The ruling has the effect of releasing Class B channels in 76 cities in 36 states.

The other amendment, designed to resolve interference problems, will intersperse Class A and Class B stations throughout the FM frequency band to provide a normal minimum separation of 800 kc between stations in the same city and a minimum of 400 kc separation between stations in nearby cities in a few areas where the demand for such facilities so require.

Citizens Radio Rules

The official title of "Citizens Radiotelephone Service" has been shortened to "Citizens Radio Service" and FCC now proposes to issue rules under which that service may be operated. Under the proposed rules there are to be three classes of stations, Class A for fixed locations exclusively operating between 460-462 mc; Class A and Class B stations for fixed, mobile and portable service operating between 462-468 mc; Class A stations for fixed, mobile and portable use operating between 468-470 mc. The frequency tolerance for Class A stations is to be $\pm 0.02\%$; in the case of Class B stations, all operations including tolerance and communication band must be confined to within $\pm 0.4\%$ of 465 mc. In any case, the communication band for Class A stations is not to exceed 200 kc and the permissible power for the three classes of stations is to be 50 watts, 10 watts and 50 watts respectively. Typed approval of equipment is required before it is to be accepted for authorization.

Flexible Waveguides

Technicraft Laboratories, Inc., has been formed in Waterbury, Conn., for the production of flexible waveguides and to continue the research and development work on electrical and electronic devices previously carried out at the American Brass Co. Officers of the new organization, all formerly employes in the technical department of the American Metal Hose

branch of the American Brass Co., which now his discontinued the manufacture and production of flexible waveguide assemblies are: Alfred M. Winchell, president; Alton R. Anderson, vice-president; and Ellsworth T. Candee, secretary - treasurer. Technicraft has purchased the microwave and electronic laboratory facilities of the American Brass Co., as well as the necessary production equipment.

Radio Measurements During Total Eclipse

Among the scientists in Brazil who observed the effects of the total eclipse of the sun on May 20th was a group of radio men from the Central Radio Propagation Laboratory of the U. S. Bureau of Standards at Washington.

There is little novelty left in examining the behavior of radio transmission during an eclipse because often in the past such measurements have been made, both by skilled operators and by broadcast-receiver owners. But what is the effect, in the path of totality, upon the height of each ionosphere layer?

Ionosphere Measurements

To answer this question the U. S. Bureau of Standards sent to Brazil portable ionosphere measuring equipment which makes possible the measurement of layer heights at a more rapid rate than heretofore. Usually layer heights are ascertained by transmitting a brief pulse of radio energy upwards and noting, on a photographic record, the time required for the return of the pulse after it is reflected from the reflecting layer, (probably 180 miles above the earth), as in radar. Various layers reflect various frequencies, so in order to obtain the desired information on the situation in the ionosphere the transmitter is arranged to emit pulses at various carrier frequencies. Sometimes this variation is in steps but a continuous variation is preferable. To secure this, rotating cams often are used to slowly but continuously vary the frequency of both the transmitter and receiver.

Chicago IRE Elects

Karl Kramer was elected chairman of the Chicago section of the Institute of Radio Engineers at the meeting of that organization. Other officers elected were: Vice-chairman, Kenneth Jarvis, consulting engineer and Secretary-treasurer, Don Haines, Hytron Radio Corp.

DuMont Consolidates

The instrument and tube sales division of Allen B. DuMont Laboratories, Inc., has been moved to a new home in the company's Building No. 16 at 1000 Main Ave., Clifton, N. J. This will put these two departments under the same roof as the production and engineering personnel.

Concord Supplement

Concord Radio Corp., Chicago (901 W. Jackson Blvd) and Atlanta (265 Peachtree St.) has issued a catalog supplement of 72 pages covering parts, components and equipment. Sound equipment section covers the line of Multiamp add-a-unit amplifiers.

Philco Projection TV Set

Wide interest among television people has been aroused by Philco's new projection model 2500 with its "dark background" picture 15 by 20 in. achieving an image brilliance some four times that of earlier projection sets. A diagrammatic sketch of the arrangement of the 20,000-volt 4-in. tube, Schmidt lens, reflecting mirror, and inclined specular ("micro-lens") screen, was shown in the March issue of this magazine, page 41.

Production models have now been demonstrated before audiences in several cities, confirming earlier claims that the large bright picture is clearly visible in daylight or in a lighted room. The 2500 is priced at $795 plus excise tax of $1.41 plus installation-warranty charge of $85.

Magnavox Adds

Construction of a new factory has been started by the Magnavox Co., at Paducah, Kentucky. The plant, to employ approximately 1,000 will be devoted in the manufacture of various components of speakers, transformers and other electronic equipment.

Nelson Takes Nelson

The Nelson Electric Corp, newly formed in California has taken over the business of A. L. Nelson & Co., west coast manufacturer of radio transformers. Manufacturing facilities are located att 1620 Euclid Street, Santa Monica.

PERSONNEL

Stanley Bracken, executive vice-president of the Western Electric Co., has been elected to succeed Clarence G. Stoll on his retirement September 30. Stoll has served as president of the Company since 1940 and his retirement brings to a close a distinguished career of more than 44 years in Western Electric. Bracken brings to his new assignment more than 35 years of experience in the company's manufacturing organization.

Clark C. Rodimon, for more than a decade intimately connected with the American Radio Relay League, has joined the National Co., Malden, Mass. During the war he directed Raytheon's field engineering programs, will concentrate on development of amateur and government gear for National.

Clark C. Rodimon Robert K. Dixon

Robert K. Dixon has been appointed product manager of broadcast equipment in the commercial products division of the Raytheon Mfg. Co., Waltham, Mass. He has been connected with Submarine Signal Co., Raytheon affiliate, formerly was with CBS and NBC affiliate WJAC.

Myron J. Morris has been appointed to head the installation and maintenance Department of United States Television Mfg. Corp. He comes from Electronic Corp. of America, where he was service manager, during the war he was an electronic engineering and radar specialist assigned to both War and Navy Departments.

Nicolas Anton, until now vice-president in charge of manufacturing for the Amperex Electronic Corp., Brooklyn, N. Y., has been elected president of the company. Dr. A. Senauke, retiring president, has become chairman of the board of directors.

Lester L. Kelsey has resigned as vice-president of The Hallicrafters Co., Chicago, to become vice-president and general sales manager of The Dayton Acme Co. and two subsidiaries, The Osborne Register Co. and The M. L. Andrews Co., Cincinnati, Ohio.

General A. W. Marriner, formerly director of the aviation department, International Telecommunication Laboratories, has been named assistant technical director for the International Telephone and Telegraph Corp., New York. He joined IT&T on May 1, 1946, having retired from the Army Air Forces after more than 28 years of service.

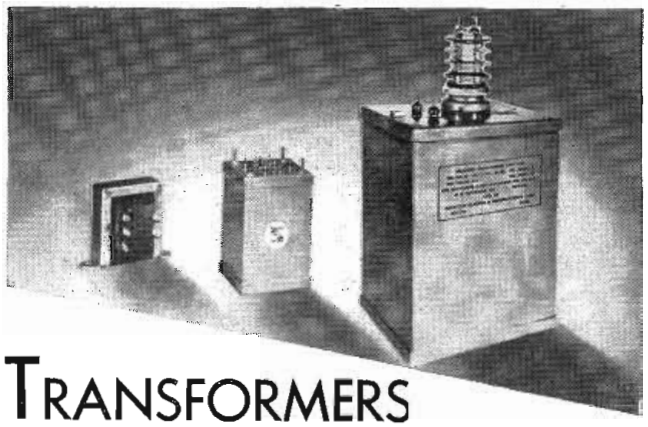
Martin V. Kiebert, Jr. has been appointed consultant on aircraft telemetering, instrumentation, stabilization, servo mechanisms and remote control for the clients of Sherman Fairchild and Associates New York. Between 1939 and 1941, Kiebert was affiliated with Jansky and Bailey and then with McNary and Chambers, both consulting engineers, Washington, D. C.

W. A. Ellmore M. V. Kiebert

W. Austin Ellmore, formerly associated with Utah Radio as vice-president in charge of engineering and sales, has been appointed chief engineer and sales manager of Crescent Industries, Inc. Chicago.

P. C. Sandretto has been named director of aviation for International Telecommunication Laboratories. In 1930, he joined the aviation radio division of Bell Telephone Laboratories and in 1932 he became superintendent of the United Air Lines communication laboratories.

Merrill A. Trainer has been appointed manager of RCA television equipment sales, in which position he will supervise the sale of television transmitters, studio equipment,



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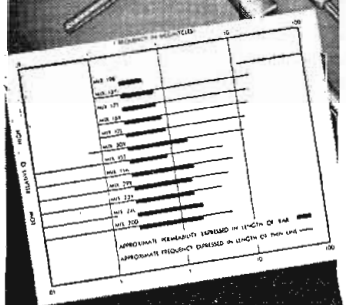

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antennas, and television microwave relay equipment. Prior to his appointment he was in charge of the company's television terminal equipment development.

Lieutenant-General James G. Harbord has resigned as chairman of the board of RCA but will remain as honorary chairman. His place on the board has been taken by President David Sarnoff, who takes on these additional duties.

Ralph L. Corey has been elected vice-president of Great American Industries, Inc., 230 Park avenue, New York. He will be general manager of the corporation's Connecticut Telephone & Electric Co. division, Meriden, Conn.

C. John Phillips has joined Pittsburgh Plate Glass Co., Pittsburgh as manager of product development. He was sales manager of the Electronic Sales Department of Corning Glass Co.

John D. Woodward has been promoted manager of the RCA aviation engineering products department of the company. He will supervise development and engineering of aviation communication and navigation equipment.

Edward Maged has joined University Loudspeakers, Inc., New York. He was formerly sales engineer for the David Bogen Co., New York.

Terry P. Cunningham has been appointed advertising manager of the radio tube, electronics and international divisions of the Sylvania Electric Products, Inc. He has been sales manager of the home radio division of Colonial Radio Corp., a Sylvania subsidiary.

Warren Master has joined the engineering staff of the Richardson-Allen Corp., New York as a rectifier engineer. For several years he has been associated with the Federal Telephone and Radio Corp.

Edward R. McCarthy has been appointed general sales manager of Sorensen & Co., Stamford, Conn. Before joining Sorensen, he was affiliated with Pneumatic Products, Inc., in a sales and engineering capacity.

Charles J. Pannill has retired as president and a director of Radiomarine Corp. of America. He joined the RCA organization in 1928.

Rear Admiral Ellery W. Stone has been elected a vice-president of the International Telephone and Telegraph Corp. For more than 20 years he has served in various executive capacities with the IT&T system.

Fulton Cutting has been appointed assistant to the president for research and professor of physics at Stevens Institute of Technology. He was formerly president and chairman of the board of Colonial Radio Corp.

Antony Wright has been appointed chief engineer of United States Television Mfg. Corp., New York. He was formerly manager of the television receiver engineering section of Radio Corp. of America, had been with RCA for 19 years.

George J. Maki has left the engineering staff of Collins Radio Co., Cedar Rapids, Ia. to set up a business of his own as radiotelegraph consultant. He will operate from Moraga, California.

Dr. Melville F. Peters, formerly in charge of research at Titeflex, Inc., Newark, N. J., has been appointed chief engineer. Before joining the Titeflex organization in 1943, he was a principal physicist at the Bureau of Standards, Washington, D. C.

Proper Paints For Printed Circuits

In regard to the June article on "Evolution of Printed Circuits for Miniature Tubes" by Dr. A. F. Murray readers have asked where silver paint can be secured. The National Bureau of Standards advises that they obtain this paint from E. I. Dupont de Nemours & Co., Ceramics Div. Electro-Chemical Dept. Wilmington, Del. and Metaplast Co., 205 W. 19th St., New York City 11, N. Y.

Different types of paint are available for different materials. For instance, on Masonite one would try Dupont's Conductive Silver Coating Material No. 4635 or Metaplast Co.'s Silver Coating No. 13A.

There are several types of plastics and it is desirable on each to use paint that has the proper solvent for the material. The solvent slightly attacks the surface

of the plastic thus forming a strong bond. One type of coating that has wide use on styrene, wood and paper is Metaplast No. 13S.

United Nations Facsimile

The United Nations news dissemination center at Lake Success, mecca of multi-language news copy, has hurdled a formidable barrier by replacing its teletype circuit, responsive only to the Roman alphabet, with a wire line facsimile loop between the General Hall at Flushing and the Council Chambers at Lake Success.

News copy written in Chinese, Russian, Arabic, Hebrew, Sanskrit, and with other non-Roman languages, can now be transmitted with equal facility. Personnel of the news processing and distribution center, receive news copy from Flushing and prepare it for domestic and overseas without tedious interpretations and translation.

The facsimile equipment, manufactured by Finch Telecommunications Co., produces highly satisfactory reproduction at a rate of approximately 100 words per minute using a 5000 cycle wire line. With a higher quality line or radio loop, this speed could be increased considerably.

Facsimile copy received in the original form is less susceptible to alteration without detection. This condition is highly desirable for security reasons. Noises or other electrical disturbances on the line which cause teletype to garble, do not destroy the legibility of the facsimile reproduction.

Hitherto, first draft copy edited

One of the Finch facsimile machines installed at UN for multi-language transmission

at the originating point had to be retyped before it was put on the teletype machine. With facsimile the first draft is transmitted with pencilled corrections which are plainly visible and understandable at the receiving end saving much time and labor.

When the United Nations broadcasting facilities are installed, frequencies will be available to set up a radio facsimile loop between Flushing and Lake Success to replace the wire line. When this is done, it is anticipated that speed of reproduction and transmission of intelligence will reach as high as 500 words per minute.

Henry B. Kroger, of the Finch Engineering Department, reports that installation of the facsimile system between the two United Nations centers, has speeded up operations in the processing and distribution of multo-language news of United Nations activities.

Signal Assn. Grows

The Army Signal Association has added another chapter to its organization, this time in Philadelphia. President of the new chapter is W. W. Watts, vice-president of the Radio Corp. of America in charge of the RCA engineering products department, Camden. Associated with him are first vice-president G. R. Freehafer, vice-president and general manager in the Eastern area for Bell Telephone Co. of Pennsylvania; second vice-president W. H. Knowles, chief engineer, International Resistance Co.; secretary G. O. Peters, electrical engineer, Army Communications Service Division, Signal Corps Plant Engineering Agency; and treasurer W. F. Denkhaus, assistant engineer for the Eastern area for Bell Telephone Co. of Pennsylvania.

Solar Consolidates

Solar Mfg. Corp. and its wholly owned subsidiary, Solar Capacitor Sales Corp. has moved its general offices to its main Eastern plant at 1445 Hudson Boulevard, North Bergen, N. J. The offices were formerly located at 285 Madison Avenue, New York.

Design and Equipment Data

(*Continued from page* 64)

with 120 pages of shop data on materials, equipment, preparation, procedure and control for more than 30 finishing processes. Both volumes are available at $2.

HIGH VACUUM PUMPS

Useful in many industrial high vacuum applications, type RP rotary piston pumps are designed to maintain a vacuum within 10 microns absolute on blank flange test in dry pumps. Specifications, illustrations, efficiency curves, and description of seven sizes varying in capacty from 15 to 750 cfm. are given in a 12-pg. folder available from Beach-Russ Co., 50 Church St., New York 7.

RECEIVING TUBE DATA

A new comprehensive technical manual containing basic application data for 545 types of radio receiving tubes used by circuit designers and repairmen is available at 85 cents from Sylvania distributors or from Sylvania Electric Products, Inc., Emporium, Pa. The 378 pg. manual includes characteristic curves for common types, resistance coupled amplifier data, interchangeable tube charts, shield connections, typical receiver and amplifier circuits, and a glossary of tube, circuit and FM terms. The data book is bound with a ring type plastic spine.

EQUIPMENT AND COMPONENTS

A comprehensive catalog in a durable loose-leaf binder, available from General Instrument Corp., 829 Newark Ave., Elizabeth 3, N. J., contains descriptions of a variety of radio components manufactured by the company. The book is divided into four tabbed sections, "Capacitors", "Record changers", "Speakers", and "Engineering data". The capacitor section includes variable air capacitors, push button tuning mechanisms and actuators. Each division has an introductory section, a glossary, and complete electrical and mechanical specifications, dimensions, photographs, curves etc. for a variety of models. The back of the book is devoted to useful general, mechanical and electrical engineering data in tabular and chart form.

SELENIUM RECTIFIERS

Uses of selenium rectifiers in the plating fields and general industry, their operation and advantages are explained in a loose-leaf catalog issued by Richardson-Allen Corp., 15 W. 20 St., New York 11. Included are variable rectifiers and platers, basic and double unit rectifiers, and dc spot light rectifiers.

AIR TRIMMERS

Adapted particularly for manufacture of VHF, FM, and television receivers, the Norelco air trimmer eliminates the "knee" in the capacitance curve, thus making critical adjustments unnecessary. Other advantages and construction of the trimmer are described in a 4-pg. folder issued by North American Philips Co., 100 E. 42 St., New York.

Design of Tuner

(*Continued from page 59*)

The third audio stage consists of the 6SQ7 driver tube and a 6SQ7 inverter tube, which drive the 6V6GT output pentodes. About 10 db of degeneration is provided from the speaker voice coil to the driver amplifier's grid. This degeneration performs two useful services. First. it produces the lowered output resistance necessary to damp the speaker adequately, and second, it substantially reduces distortion products originating inside the feedback controlled portion of the amplifier. Additional feedback is provided to the grid of the first af amplifier primarily as a hum reducing measure.

Frequency Response

The 15 in. speaker used with this chassis in some models has a specially treated cone which enables it to respond to somewhat higher frequencies than are usually reproduced by a speaker of this diameter. Specially treated cones are also used in the two 10 in. speakers used on the higher priced models. In this manner a greater high-frequency range is obtained because of the smaller diameter cones. At the same time, staggering of the cone resnoance frequencies produces an improvement in the low-frequency response. These two speakers are connected in parallel across the output transformer secondary, and with the exception of the cone resonance frequencies, the speakers are identical.

Alignment of these receivers must be accomplished with the front cover removed from the tuner chassis. This leaves the coils and variable condensers available for adjustment or for repairs in case of defective materials, etc. Alignment at prescribed frequency is obtained by setting the right hand edge of the pointer carriage in line with the proper number on the strip numbered from 0 to 100. The pointer carriages are shown in the photograph just about in line with the edges of the variable condensers.

New Components
Page 72

Parallel-T Network

(*Continued from page 51*)

may be approached when m is made very large.

When the general circuit of Fig. 5 is used with a null type feedback network, the signal input is applied in series with the top input terminal of the amplifier. Often this may not be practical. In experimental amplifiers of this type, it has been found practical to apply the input signal either to the cathode circuit of the amplifier or on the screen grid of the first amplifier tube.

Advantages gained by this modication of the familiar parallel-T null network are (1) increased flexibility of response characteristics, (2) unsymmetrical input and output impedances to facilitate matching, (3) reduction to a limiting value of 4.82 in the minimum gain required for oscillation, and (4) in the case of the frequency-selective amplifier, increased selectivity without increased amplification. All of these advantages may not be obtained simultaneously since imposed restrictions make some of them incompatable. The most important features must be determined largely by the individual design problem.

REFERENCES

1. H. H. Scott, "A New Type Selective Circuit and Some Applications", **Proc. IRE,** Vol. 26, pp. 226-236; Feb., 1938.
2. W. N. Tuttle "Bridged-T and Parallel-T Null Circuits for Measurements at Radio Frequencies" **Proc. IRE,** Vol. 28, pp. 23-80; Jan., 1940.
3. G. J. Thiessen, "RC Filter Circuits", **Journal of the Acoustical Society of America,** Vol. 16, pp. 275-279; April, 1945.
4. A. E. Hastings, "Analysis of a Resistance-Capacitance Parallel-T Network and Applications", **Proc. IRE,** Vol. 34, pp. 126P-129P; March, 1946.
5. F. E. Terman, "Radio Engineers' Handbook", pp. 918-919; McGraw-Hill, 1943.
6. W. G. Shepherd and R. O. Wise, "Variable-Frequency Bridge-Type Frequency-Stabilized Oscillators", **Proc. IRE,** Vol. 31, pp. 256-268; June, 1943.
7. E. L. Ginzton and L. M. Hollingsworth, "Phase-Shift Oscillators", **Proc. IRE,** Vol. 29, pp. 43-49; Feb., 1941.

Level Governing

(*Continued from page 69*)

isolate the control circuit from the output stage. The source in this case had an impedance consisting of the isolating resistor, plate circuit of V5 and V6 and the diode V7.

With the use of the cathode-follower stages, the source impedance of V5 and V6 hvae been eliminated from the control circuit. The cathode resistance of V5B

and V6B is but 400 ohms and the speed with which C1 can be charged is now limited only by this resistance and that of the diode itself. Since attack time is now extremely short, the limiting action is so rapid that overmodulation is not allowed to occur long enough even during the first portion of a sudden peak to cause noticeable distortion.

The recovery to full gain after a peak has caused a momentary reduction in gain is dependent upon the discharge time of C1. Since electrons cannot flow from plate to cathode of V7, the discharge takes place through the resistor R. R is variable in steps, and C1 actually consists of two condensers, one of which may be removed to shorten recovery and attack time if desired. Recovery time is made adjustable because optimum recovery time is different for different types of program material.

The 1126C, like its predecessors, meets the requirements for the highest quality broadcast program material with very low output distortion and noise level. In addition, the shorter attack time of this amplifier permits the use of more compression with a minimum degradation of quality.

Printed Circuits

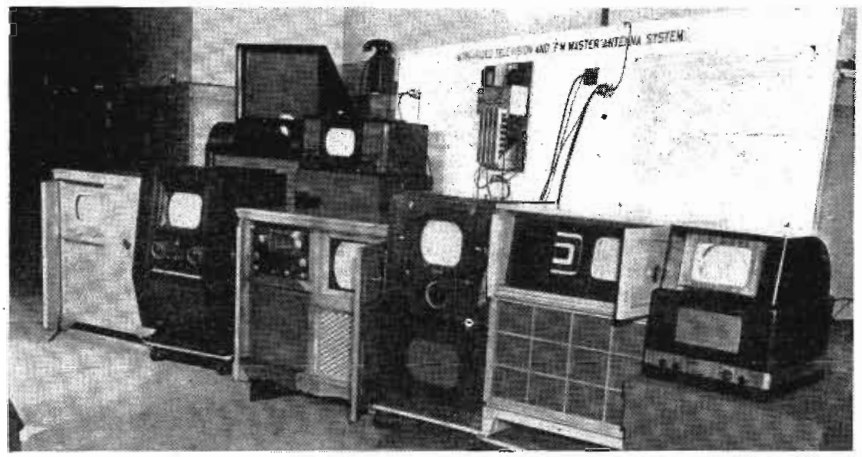
(*Continued from page 53*)

sockets 56, also IIb, provide loudspeaker connections; sockets 57, 58, 60 and 61 are for the plug-in electrolytic capacitors 71 and 72. A protective layer of lacquer is sprayed onto the finished panel.

Panel I contains two oppositely positioned spiral grooves 91 and 96 which are inductively coupled through the plastic material of the panel. Pillar 92p connects the metallized termination lobe 92 of tuning coil 91 to the grounded metallized termination lobe 9 on IIa. 87, 95, 100, 101 are input capacitors. Spring contact 84s, Ib, contects resistor 103 and capacitor plates 81a, to the control grid of tube 65. Two eyelets fastened in the metallized lobe 84 connect the two sides of the panel. Supporting pillar 70 grounds the inner terminal of inductor 96.

The main tuning capacitor knob 115 on Ia is attached to a screw 115a, see Ib, passing through a threaded hole in panel I. Capacitor plates 81b and 89b are formed by the same metal deposit; in the view of Ib, this metallized area is covered by a dielectric plate 110 associated with the springy expansion capacitor plate 89a, indicated by dotted lines in Fig. 1. This spring-like flexible variable capacitor vane 89a is fastened by means of eyelets to the panel; pillar 70 provides the ground connection to deposit 7 on 11b. When knob 115 is rotated, it compresses spring leaf 89a against mica 110 and metal deposit 81b, thereby increasing the value of the variable tuning capacitor 89.

The other knob 112, on 1a, controls the rotary capacitor vane 94a, on Ib, of the rotary differential capacitor 94. The metal deposits constituting the fixed plates 94b and 94c of this capacitor are covered by the dielectric plate 104, see Ib; the metal deposit 94c is a continuation of the deposit 95b. Supporting pillar 10g, also indicated by numeral 109 on the circuit diagram supplies positive feedback to the



These eight modern television receivers, plus a Philco not in the picture, were used to demonstrate Telicon multiple outlet receiving antenna system. They are (Lower row) U. S. Television, Dumont (two models), Remington, Stewart-Warner and Viewtone. Behind at left are a Telicon projection model and an RCA table model

rotatable capacitor plate 94a by connecting it to point 18 on IIa which is connected to the plate of tube 65.

A voltage dividing network permitting operation on 110 volts, 200 volts, 230 volts and 250 volts is deposited on the inside wall of the molded cabinet for the receiver.

Automatic processing of the molded plastic plates in an electronically controlled apparatus assures rapid and economic production. Preliminary surface treatment, metallization, face-milling, testing, graphite spraying through stencils, cleaning, insertion of sockets, further testing, aging, is all fully automatic and supervised by electronic controls in the electronic circuit making equipment (E.C.M.E.). Simple circuits or a large variety of standard subassemblies of more complicated units may be produced by this method. The molded panel is fed into the machine which delivers it ready for the insertion of tubes, loudspeakers and electrolytic capacitors.

This production method is flexible and permits a great number of modifications. For instance the graphite may be first deposited in shallow depressions of the plastic panel and then the metal printed with conductive paint onto the graphite and panel wherever required. This reversed method is recommended for complicated resistor networks for instance in oscillograph or television receivers.

A range of values from 1 ohm tc 10 megohms can be easily covered by three different graphite suspensions. Low valued resistors can be made to dissipate 10 to 20 watts. Large wattage resistors may be sprayed on the inner surface of the cabinet where provisions for heat dissipation are readily made. Capacitances up to 30 μ F per sq. cm, are obtainable with Bakelite and values up to 0.03 μ F per sq. cm. with suitable ceramics. Rotor switches may be readily provided by interrelated metal deposits on a main plate and on an associated rotatable circular plate inserted in a hole of the main plate.

Multi-Channel Selective Calling

(Continued from Page 33)

line decoder and 1000 channel decoder respectively. In each case actuation of the decoder closes a contact which connects a negative voltage across the grid of the thyratron V7 cutting it off.

The four-channel decoder operates in the following manner: A signal applied across pins 5 and 1 of the decoder develops a voltage across the primary of T1. Capacitor C1 functions to peak the response of T1 to the frequencies in the range of 153 to 442 cycles. The voltage induced in the secondary

winding of T1 causes a current to flow in the load resistor R1 and in the coil of the frequency selective capsule. If the current is of the same frequency as that of the reed in the coil, the reed will vibrate and intermittently make contact between pins 3 and 4 respectively —enabling the application of the negative voltage to the grid of the thyratron. If, on the other hand, the current in the capsule coil is not of the frequency of the reed, the reed will not vibrate and pins 3 and 4 remain unconnected.

The 1000-channel decoder is somewhat more complicated since the additional channels are obtained by using different combinations of the available decoder frequencies. In this decoder the secondary of T1, as shown in Fig. 3, is connected to the series arrangement of three frequency selective reed coils. For this decoder to operate, the reeds of capsules A, B and C must become energized in that order i. e. the first audio signal entering the decoder over pins 5 and 1 must be of the frequency to which capsule A responds, the second of the frequency to which capsule B responds and the third of the frequency to which capsule C responds. To illustrate the operation of this decoder assume that (1) the positive terminal of a battery (negative terminal grounded) is connected to pin 1; (2) a capacitor shunted by a resistor is connected between pin 3 and ground; and (3) that a sequence of three audio frequencies to which capsules A, B and C are tuned are applied in that order to pins 5 and 1.

When the first signal is received, the reed of capsule A will vibrate, intermittently closing capsule A contacts and causing the voltage from pin 1 to charge capacitor C2. Resistor R1 limits the current flowing in the network and bleeder resistor R2 is of high enough value to maintain the charge across C2 after reed A has stopped vibrating and until the second audio frequency of the sequence enters and vibrates the reed of capsule B. Vibration of reed B, intermittently closes capsule B contacts and transfers the charge from capacitor C2, through current limiting resistor R5, to capacitor C3 and the capacitor assumer to be connected between pin 3 and ground. This capacitor is actually C31 in circuit shown on Fig. 1. Bleeder resistor R3 across C3 is of high enough value to maintain the charge of C3 until the third audio signal sets reed C into vibration. Resistor C32 the shunting resistor, however, is not large enough to maintain the charge across C31 over this period of time, and by the time the reed C starts vibrating, capacitor C31 is effectively discharged.

When reed C starts vibrating, it intermittently shorts the capsule C contacts shorting C3 to ground via current limiters R4 and R5 This causes a negative flow of current through C31. The effect is to apply a potential, negative with respect to ground, to pin 3 of the decoder which is connected to the grid of the thyratron. From the

above discussion it follows that if the signals entering the decoder are not of the correct frequency or of the correct order, the decoder will not perform its function of applying to pin 3 a negative potential.

The main difference between the 1000-channel decoder and that of the 810 line unit is that the 810 line system makes provision for a common decoder signal. In this case four capsules are connected in series across the secondary of T_1. The capsules in positions A, B and C act in the manner described above. Capsule D shown on Fig. 4 functions to accomplish the same result when a single audio signal, to which the reed in capsule D is tuned, is applied across pins 1 and 5 of the decoder.

Design of Magnetic Type Recorders

(*Continued from page 57*)

been termed the "echo" factor.

It was discovered that the strong magnetic remanence of one layer of tape would affect the oxide particles in adjacent layers, reproducing the magnetic pattern at a lower level and resulting in an "echo". The effect, of course, weakens with each succeeding layer and is not usually measureable after the third layer. The extent of the disturbance depends upon the original intensity of the signal recorded and the presence or absence of a signal recorded on the adjacent layers. Where no signal is present on the under layer, the "echo" is about 20 db down from the original signal. This impregnated tape was designated as "L" tape.

The final tape produced in Germany was known as the "LG" tape. Development of this tape was continued after the end of the war, and the machine developed for the process is shown in the accompanying photo. The "LG" tape, also a "Luvitherm" base, combines good overall response with high resistance to breakage. The "echo" effect, while still present, is greatly lowered, being about 45db down. This effect is "set" five minutes after recording, and will not increase after this time. It is only noticeable when the original signal is so loud as to overload the tape, and when adjacent layers are entirely free from original. It might be noted here that the effect of overloading the tape is to dampen the recorded signal, rather than to distort it.

Capitalizing on the study of the German tapes, we have confined our efforts to the production of coated tapes with a plastic base. In the production of the plastic tape, the base is taken in rolls of considerable width and then stretched to the limit of its elasticity. This operation results in a tape which is extremely stable in its physical dimensions, its subsequent elongation in use being of the order of ½ of 1% after 500 playbacks.

The magnetic oxide is heat-treated and placed in a binder solution. The oxide will not normally remain in a state of suspension so it is necessary to maintain constant agitation while it is being spread on the plastic base. The binder

causes a slight degree of dissolution of the tape which firmly anchors the oxide particles.

Critical factors in the production of tape are the size of the individual oxide particles and their dispersion over the tape surface. In general it may be said that optimum results are obtained when the size of each particle of oxide approaches 1 micron in diameter. Uniformity of dispersion, both in grouping of particles and in density also is important. A portion of tape equal to the size of the gap in the playback head contains an oblong box measuring roughly 14 microns deep, 40 microns wide, and ¼ in. in length. This box will contain approximately 2,000,000 oxide particles—an indication of particle dispersion.

No discussion of a magnetic recorder is complete unless we consider what it means to the broadcasting industry in terms of practical use. Of course, high fidelity and low noise mean greater vitality to recorded sound. This is an important factor. Of at least equal importance, however, is the fact that magnetic recording, with its increased facility of handling, creates a new opportunity for program composition. Material recorded and not wanted can be erased, and new material dubbed in. High tape speeds afford easy editing. The first sentence in this paragraph, for example, would record on about 14 feet of tape. This wide spread makes it an easy matter to locate a particular word or even a syllable.

Splices in the tape are made simply and produce no objectional bumps. Deterioration of response with continued playback is negligible. A hundred playbacks will produce a level drop of only 1 or 2 db. The noise level does not increase with repeated recordings. All these factors mean that the recording engineer may edit, erase, dub, and re-record to whatever extent is necessary, and still come up with a final product perfect in content and timing with the original high fidelity and low noise level.

The Rangertone machine (Fig. 4) has been designed to take advantage of the facility of tape recording and to furnish simple, positive controls. A six-button control panel has individual stops for the operations of RECORD, REWIND, PLAYBACK and STOP. A RELEASE button clears the panel. A SYNCHRONIZE button allows the speed of the machine to be slowed slightly in order to synchronize its operation with that of a similar machine for use in programs which would run beyond the normal playing time of the tape. A safety factor is provided against accidental erasing of the tape; both RECORD and PLAYBACK buttons must be depressed in order to energize the erase current. In the REWIND position, control is established through a 5-position switch on the right of the top panel. This allows movement of the tape forward and backward as slow or fast speeds. Thus, it is easy to shuttle the tape back and forth when locating a spot on the tape for editing purposes. The rewind ratio to record speed is 7½ to 1. Forward (free movement of the tape) speed to record speed, depends upon the diameter of the tape spool on the take-up reel. In general it may be said to be between 4 and 5 to 1.

Circular Polarization For FM

(*Continued from Page 30*)

tion with propagation tests made from the Empire State Building. However, at the time it was found that this reversed condition existed only for certain angles of incidence. Moreover, the reversed wave would be elliptically polarized due to the different coefficients of reflection of the two components. Accordingly a reflected component would still be introduced in the receiver along with the line of sight wave because a clockwise circularly polarized receiving antenna will only completely reject a wave whose direction of rotation is counterclockwise. Adoption of horizontal polarization was thus recommended at the time by the Empire State investigators, and is now in general use.

Several practical arrangements of antenna systems are available for the radiation and/or reception of circularly polarized waves. Two

such systems have already been illustrated in Figs. 4 and 7. The latter antenna has a circular folded dipole in the horizontal plane and a vertical antenna centered within the loop. Substantially uniform radiation has been measured in all directions, although the field is slightly elliptical at some azimuth angles. The feeder to one antenna is a quarter-wave length longer than the feeder to the other to give the necessary 90° phase difference between the two fields.

Another antenna which will radiate circularly polarized waves is the helix of Fig. 8. The properties of the antenna are determined by the pitch and diameter of the helix, and depending upon the dimensions chosen circularly polarized radiation can occur either along the axis of the helix, for directional radiation, or at right angles to the helix axis for non-directional radiation.

Power Gain

One simple arrangement long in use as an element of the familiar turnstile antenna consists of the crossed dipoles of Fig. 9. This is one bay of the turnstile and radiates circularly polarized waves in an up and down direction where they are of no consequence insofar as propagation to the listener is concerned. The two dipoles are fed 90° out of phase by the transmission line arrangement shown in the figure. One branch line from the common junction point is ¼ wavelength longer than the other to give the desired phase shift. This antenna cannot radiate omni-directional in the horizontal plane, and while it may be useful for point-to-point transmission, or for reception, other systems must be devised for directing broadcast service to all points of the compass.

An indicated requirement for a practical circularly polarized antenna which can be used for FM broadcasting is that it have a substantial power gain in the horizontal plane. Presently available FM transmitting antennas for plane-polarized radiation have power gains running up to 9 or more, thus affording large economies in transmitter power. The problem of designing circularly polarized antenna with substantial horizontal gain is presently being attacked by the Research Foundation of the Ohio State University in collaboration with the engineering staff of the United Broadcasting Co. Prototypes have been constructed which satisfy this requirement.

Fig. 10 shows the way in which a circularly polarized antenna used for reception will discriminate against a wave of opposite rotation to that for which the antenna is connected. The two antenna feeders from the horizontal and vertical elements are connected together at C. The distance AC from one element is one quarter wavelength longer than distance BC from the other element. An arriving wave which is rotating so as to induce a voltage first in A and then B will be accepted, as the additional time required for the wave to rotate from A to B is balanced by the time required for the wave to travel the extra quarter wavelength from A to C. Both waves from A and B arrive at C in the same phase and are additive.

If the wave is rotating in the opposite direction it first induces a voltage in B which travels to C. The wave picked up in A has taken another quarter cycle to reach there from B, and then takes a quarter cycle more to travel down the longer feeder to C. It therefore arrives 180° out of phase with the wave from B and cancellation occurs.

The author wishes to thank the engineering staff of the United Broadcasting Co., for its co-operation in the preparation of this article.

BIBLIOGRAPHY

Circular Polarization Tests — Submitted to FCC on October 8, 1946 as Report No. 1 on Experimental Station W8XUB—Engineering Staff, United Broadcasting Co.

FCC Public Notice 534, November 8, 1946—Amendment of Engineering Standards concerning FM broadcasting

Helical Antenna for Circular Polarization—a paper orally presented by H. A. Wheeler at the 1947 IRE National Convention

Circularly Polarized Antennas — a paper orally presented by W. Sichak and S. Milazzo at the 1947 IRE National Convention

Helical Beam Antenna — John D. Kraus — "Electronics", April 1947

Antenna and Transmission Lines at the Empire State Television Station — N. E. Lindenblad—"Communications", May 1940 and April 1941

A Study of Ultra-High-Frequency Wide-Band Propagation Characteristics—W. E. George "Proc. IRE", January 1939

Ultra-High-Frequency Propagation — M. Katzin—"Proc. Radio Club of America", September 1939

Circular Polarization for Antennas—Carl E. Smith—"Broadcasting", October 21, 1946

Hyper and Ultra-High Frequency Engineering—Sarbacher and Edson, John Wiley and Sons, 1943

Standards on Radio Wave Propagation — Definitions of Terms—1942 Supplement to "Proceedings of the IRE."

Airport Radar

(*Continued from Page* 44)

and thus produce a "ring" on the "A" scope. The length (or duration) of this ring determines the merit of system performance.

Indicators

As stated above there are two search indicators Fig. 8, one for the search operator and the other for the approach controller. The indicator unit utilizes a 12-in. cathode ray tube to provide a plan position (PPI) type of presentation of the area scanned by the antenna beam. The video signals and trigger from the remote search tower are applied to the video amplifier and sweep generating circuits.

The positive video signals (½ to 3 volts approximately) are amplified in the two-stage video amplifier circuit. The range marks are mixed with the video in the second stage. The output of the stage is fed through a cathode follower tube to the control grid of the cathode ray tube (video at approximately 30 volt level). The interstage coupling between the two amplifier stages contains a FTC (fast time constant) circuit. The circuit which may be switched in at will, consists of a series of capacity and shunt resistance with the combination having a short time constant.

With the FTC off the coupling network between stages has a long time constant and the video pulses receive faithful reproduction. Thus, if long blocks of signals (such as those resulting from prominent landscape features, clouds, mountains) are present they will be passed by the interstage coupling circuit and will create large illuminated areas on the CRT screen, thus obscuring any individual target echoes present in that particular area (Fig. 9). However, with FTC "on", the coupling circuit will differentiate the large blocks of signals and only the amplitude variations of these signals will be presented on the scope. Thus the "clutter" will be broken up and individual echoes (such as aircraft signals) will be presented in the previously solidly bright area, (Fig. 10).

The function of the sweep generator circuit is to generate a time base sweep on the indicator tube for each trigger applied to the circuit. The time base sweep voltage generated is a trapezoidal voltage waveform which when applied across the cathode ray tube deflection coil, produces a sawtooth current waveform in the coil. The coil, wound on an iron core yoke placed around the neck of the CRT, produces a magnetic field which varies uniformly with time and therefore deflects the spot on the tube screen from the center to the outer edge with a uniform velocity. The direction of spot deflection is dependent upon the deflection yoke position and, since the yoke rotates in synchronism with the antenna (see below), the time base sweep rotates through 360° on the tube screen about the center of the tube as an origin.

The sweeps produced may be (at the option of the operator) 6, 10, 20 or 30 nautical miles. A negative gate and a positive gate equal in length to and synchronized with the indicator sweep are generated in this circuit for application to the cathode ray tube cathode and to the range mark circuits. The former serves to brighten the scope during the sweep period while the latter serves as a switch to cause the range mark circuits to operate during this period.

In order to calibrate the indicator tube in range electronically, negative voltage pips are generated and applied through the video amplifier to the grid of the CRT, to produce intensity modulation of the sweep at equally spaced intervals. Due to the rotation of the sweep trace these range marks appear on the screen as concentric circles whose radii are calibrated in range. The range mark circuit generates either 2- or 5-mile range marks automatically selected, the 2-mile marks for the 6- and 10-mile ranges, the 5-mile marks for the 20- and 30-mile ranges. Pro-

TELE-TECH

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vided in each search indicator are facilities for remote controlling IF and STC gain in the receiver. The search operator's table contains a remote receiver tuning control. By means of a switch the AFC output may be disconnected from the local oscillator and the frequency of the l.o. then remotely controlled by manual means.

Synchro System

The function of the PPI synchro system is to control the voltage supplied to the PPI deflection yoke drive-motor in such a manner that the yoke rotates in synchronism with the antenna, thus producing the desired indicator sweep rotation.

The voltages induced in the stator windings of synchro generator B1503 are applied to the stator windings of synchro control transformer B102 (in indicator) and induce a voltage in its rotor winding. The rotor is geared 1:1 to the rotating deflection yoke driven by motor B101. As long as the rotors of B1503 and B102 are rotating in synchronism and in phase no error voltage is induced in the control transformer rotor winding. However, should the yoke drive motor tend to advance or retard the control transformer rotor with respect to the generator rotor, an error voltage is induced in the control transformer rotor. The magnitude of the error voltage will depend upon the amount of angular deviation between the two rotors. This error voltage is applied to the servo amplifier which is mounted directly above the indicator. In the servo amplifier the error voltage is utilized to control the ac power to the yoke drive motor B101 and thereby alter the motor speed in the direction necessary to bring the two synchro rotors in phase.

Search Operation

In operation the search operator sits before two indicator tubes—the search and the height finder. The search indicator supplies range and azimuth information on aircraft targets. By means of a hand crank any target on the search scope may be interesected by a cursor line. The same crank also sets (through a servo system) the azimuth position of the height finder scan. Thus the height finder will automatically display the target selected by the operator and supply altitude information to supplement the range and azimuth information already available. By this method all aircraft within the range of the radar may be accurately located.

The search operator has a switchboard available which gives him control of ten HF and ten VHF communications channels. By these means he can guide any selected aircraft to the proper approach path, while stacking other aircraft in traffic patterns to await their turn to land. The DBF (a VHF direction finder) allows the search operator to properly identify the plane under his control. The search operator normally guides incoming aircraft until they appear on the six-mile precision tubes.

(The next installment will cover the Height Finding and Precision portions of the AN/FPN-1 equipment).

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The equipment required for operation of the RCA-5527 is relatively simple and inexpensive. Magnetic deflection coils are dispensed with, keystoning and shading circuits are not required, and an inexpensive short-focal-length lens can be used in the camera unit.

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GENERAL:

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Heater Current	0.6 Amp.
Image Size (4 x 3 aspect ratio)	1.4" Diagonal
Mounting Position	Any

TYPICAL OPERATION:

Signal-Electrode Voltage	800 Volts
Grid-No. 4 and Grid-No. 2 Voltage	800 Volts
Grid-No. 3 Voltage for Focus	125 to 250 Volts
Grid-No. 1 Voltage	Adjust for best picture
Max. Grid-No. 1 Voltage for Picture Cutoff	—75 Volts
Max. Deflecting Voltages (Peak to Peak)*	
DJ_1 and DJ_2 (Vertical)	120 Volts
DJ_3 and DJ_4 (Horizontal)	100 Volts
Min. Peak-to-Peak Blanking Voltage	30 Volts
Signal-Output Current (Approx.)	0.025 Microampere
Output Resistor (Approx.)	1 Megohm

*To scan picture of 1.4" diagonal (4 x 3 aspect ratio)

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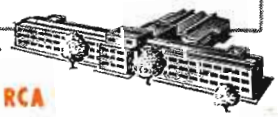

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