COMMUNICATIONS

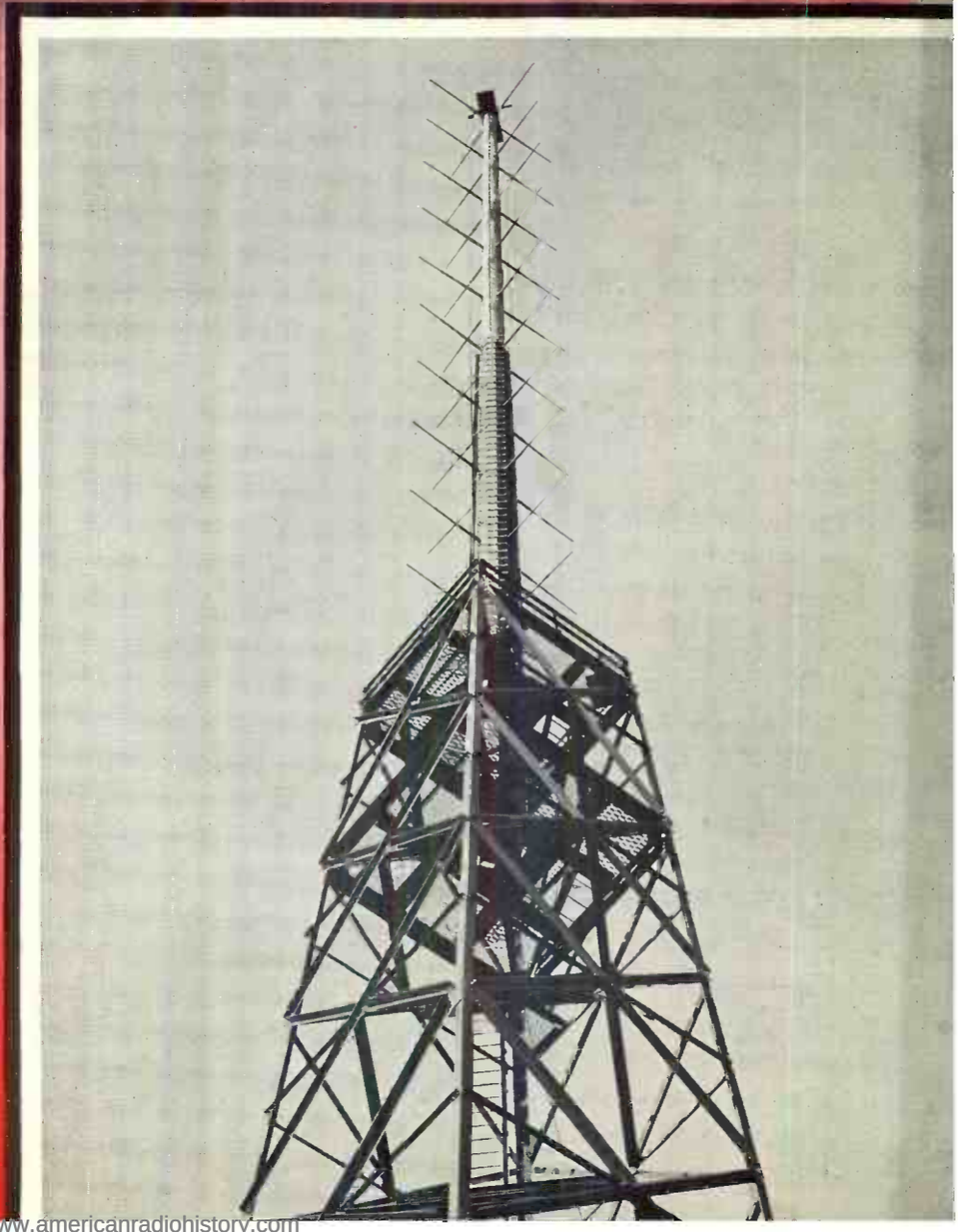
BROADCAST
ENGINEERING
CONFERENCE

FREQUENCY
MODULATION

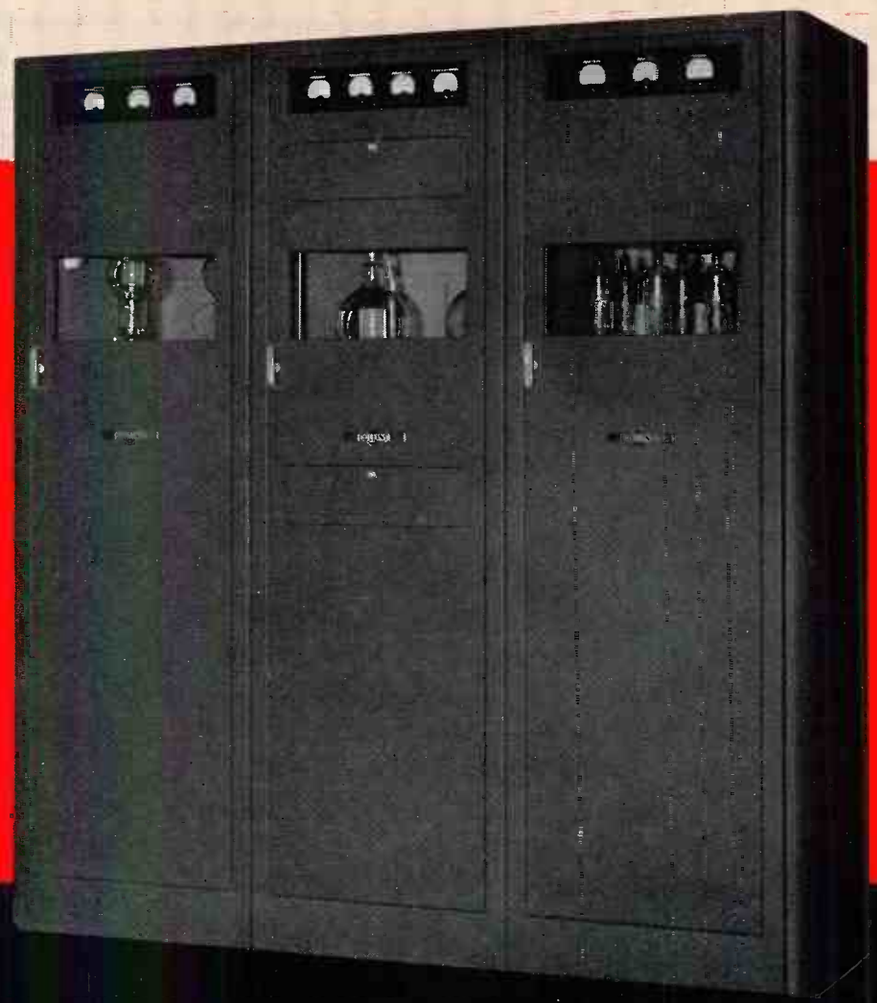
RECORDING

DECEMBER

1 9 4 0



Collins 231D Autotune Transmitter



THE 231D 3000 watt Transmitter is basically similar to the 231C Transmitter except that the output is increased by means of appropriate modifications in certain units. Many of the units are identical in both transmitters and the same control arrangements are used.

Power Output: 3000 watts nominal rating. For continuous duty (h-f broadcast) service the actual carrier output power may be set at 3000 watts over the entire frequency range. For intermittent duty (airline, military, etc.) the output may be set as high as 5000 watts at frequencies below 8000 kc and as high as 3500 watts at frequencies above 8000 kc.

Frequency Range: 2500-15,000 kc or 4000-20,000 kc.

Antenna Impedance: Either unbalanced or balanced output connections can be supplied, but provision for both unbalanced and balanced termination is not possible. When unbalanced output is specified, the frequency range is limited to 2500-15,000 kc and antenna impedances of 70-600 ohms up to 60° phase angle can be accommodated. When balanced output is specified, the frequency range of the transmitter is 4000-20,000 kc and permissible antenna impedances are 300-1200 ohms with up to 60° phase angle.

Power Requirements: For 3000 watts nominal output (4000 watts Class C input).

A_1 Key Open	2.1 kw	2.5 kva
A_1 Key Closed	6.5 kw	6.7 kva
A_2 or A_3 Carrier Off	2.6 kw	3.0 kva
A_2 or A_3 Carrier On	7.0 kw	7.3 kva
A_2 or A_3 100% Mod.	9.6 kw	10.0 kva

Weights and Dimensions:

Power Bay—Size 24″x24″x78″ high; weight 700 lbs.

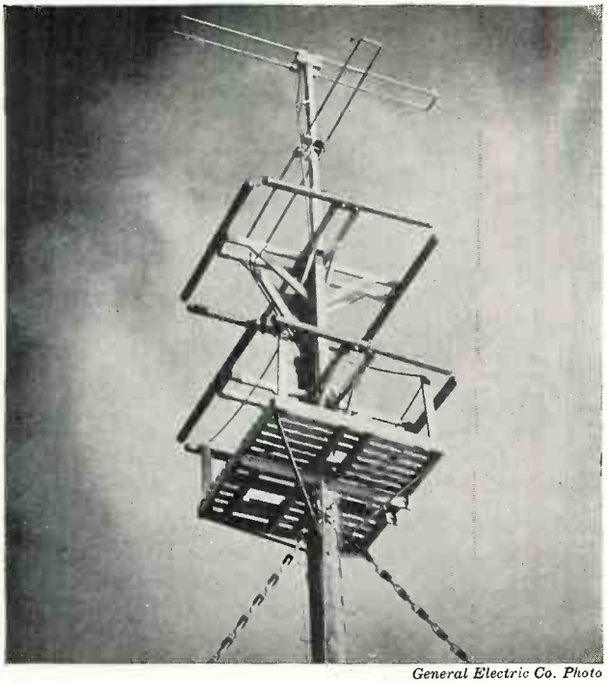
Autotune R. F. Bay—24″x24″x78″ high; weight 540 lbs.

Modulator Bay—24″x24″x78″ high; weight 570 lbs.

404B Power & Control Unit—27¾″x22⅛″x30⅝″; weight 580 lbs.

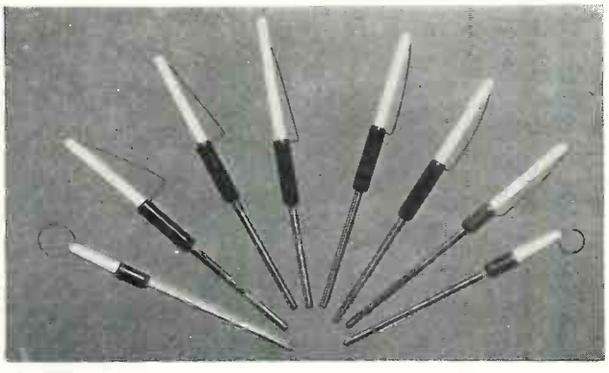
COLLINS RADIO COMPANY

CEDAR RAPIDS, IOWA . NEW YORK, N. Y. 11 WEST 42 STREET



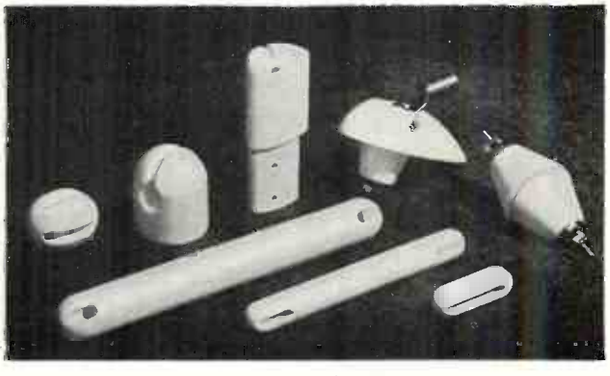
General Electric Co. Photo

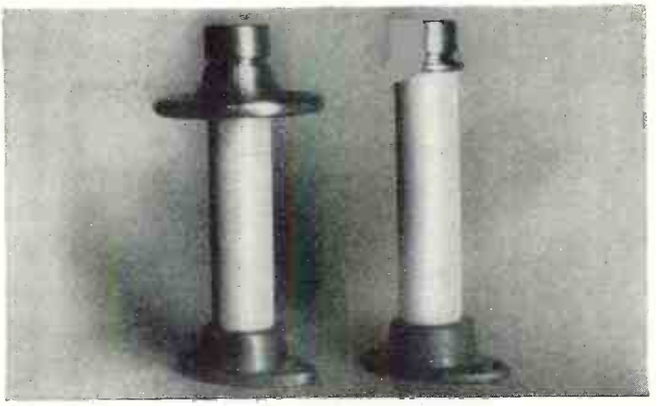
▲ THIS NEW G-E DUAL-PURPOSE ANTENNA for television and FM transmission in a single compact unit symbolizes the service of Isolantite to the two newest branches of the radio industry. Isolantite engineering in insulator design has played an important role in anticipating the special requirements of these new developments.



▲ UNUSUAL UTILITY of Isolantite* extends into virtually all fields of electronics. The insulators illustrated here were specially designed for the requirements of these electrotherapeutic instruments.

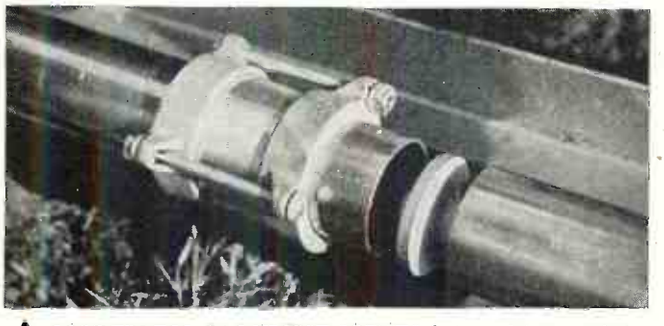
▼ STRAIN INSULATORS are streamlined for airplane service — another instance of Isolantite's leadership in insulator design. Isolantite's high strength is a double advantage in aircraft service: it gives mechanical protection against shocks and stresses, permits the use of small, weight-saving sections.





▲ NEW CORONA SHIELD on Isolantite stand-off insulators represents a still further improvement over previous designs. Shield is of spun aluminum. Insulators are engineered to relieve electrical stresses at top — point where stress is ordinarily at a maximum.

INSULATION HIGHLIGHTS



▲ SOLDERLESS GAS-TIGHT JOINTS for coaxial transmission lines manufactured by Isolantite, Inc., are accomplished by the patented Raybould coupling. A gas-tight seal is effected simply by tightening nut. End seals, junction boxes and many other special fittings employing this patented device are available for radio purposes exclusively from Isolantite, Inc. (Isolantite coaxial transmission lines are sold nationally through Graybar Electric Co.)

**Registered trade-name for the products of Isolantite, Inc.*

ISOLANTITE

CERAMIC INSULATORS

ISOLANTITE, INC. FACTORY: BELLEVILLE, NEW JERSEY

SALES OFFICES: 233 BROADWAY, NEW YORK, N. Y.

COMMUNICATIONS

DECEMBER
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Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer.
Registered U. S. Patent Office
Member of Audit Bureau of Circulations

VOLUME 20
NUMBER 12

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

The ten-bay turnstile antenna array of frequency-modulated station WIXOJ. Dedicated on Friday, December 13th, by John Shepard 3rd, president of The Yankee Network, this station will service an area within a 100-mile radius of Paxton, Mass.

• Editorial Comment •

THE Fourth Broadcast Engineering Conference has been scheduled for February 10 to 21, 1941, at the Ohio State University, Columbus, Ohio. While tentative data appears on page 20 of this issue, the complete program of the meeting will appear in our January number.

ANOTHER gathering of importance will take place on January 9, 10 and 11, at the Hotel Pennsylvania, New York City. This will be the Sixteenth Annual Convention of the Institute of Radio Engineers. While the complete program was received too late for inclusion in this issue, a brief list of some of the technical papers will be found on following pages.

From all indications this promises to be a record breaking assemblage of radio engineers. The program of the technical sessions seems to confirm this belief, for among the subjects to be covered are television, frequency modulation, magnetic recording, tubes, telegraphic facsimile, receiver design, measurements, cathode-ray tubes, electron multipliers, etc.

FOR cooperation requested by the government in connection with the National Defense Program, the Radio Manufacturers Association has formed a committee on National Defense Procedure. J. S. Knowlson, president of RMA, has appointed the following men to the committee: Paul V. Galvin (Chairman), Dr. W. R. G. Baker, F. R. Deakins, W. P. Hilliard, Fred D. Williams, and Bond Geddes.

This committee was appointed at the request of Dr. Stacy May, director of the Bureau of Research and Statistics of the Council of National Defense. It will cooperate with government agencies in connection with radio requirements, including Army, Navy, British Procurement, civilian needs, and the like, of the defense program.

AN interesting item appears in a recent issue of the NAB Reports to the effect that 64 American engineering colleges will soon establish 250 short, intensive training courses, including radio engineering. These courses are designed to meet any shortage of engineers in the National Defense Program.

BRYAN S. DAVIS
President

JAMES A. WALKER
Secretary

Published Monthly by the
BRYAN DAVIS PUBLISHING CO., Inc.
19 East 47th Street
New York City
New York Telephone: PLaza 3-0483

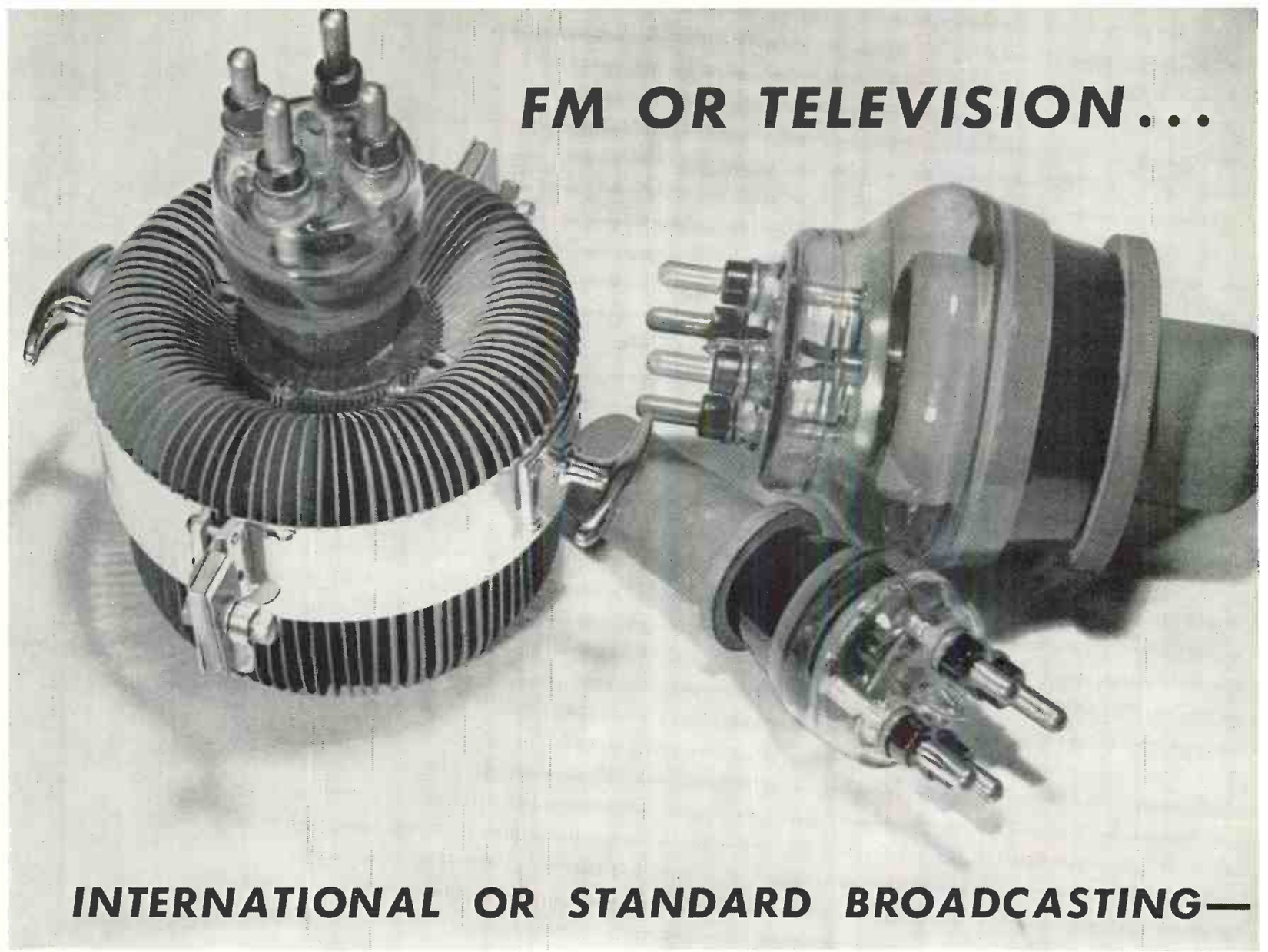
PAUL S. WEIL
Advertising Manager

A. GOEBEL
Circulation Manager

Chicago Office—608 S. Dearborn Street
Telephone: Wabash 1903

Wellington, New Zealand—Te Aro Book Depot
Melbourne, Australia—McGill's Agency

Entered as second-class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada, $3.00 in foreign countries. Single copies: twenty-five cents in United States and Canada, thirty-five cents in foreign countries.



Here Is High Efficiency at High Power

Primarily developed for the new high-frequency services, GL-889-R, GL-889, and GL-880 provide superior performance for *all* present-day broadcasting.

GL-889-R

High efficiency and economical forced-air-cooling are now available to the entire realm of broadcasting with the G-E developed GL-889-R. Its small size and short leads make it especially valuable for ultra-high-frequency operation.

At frequencies up to 25 megacycles, a pair of 889-R's is capable of 8,000 watts output plate-modulated, or 20,000 watts class C telegraph. For FM service, 10,000 watts output is very conservative operation.

Internal design is the same as the GL-889. GL-889-R's are used as output tubes in G-E 10,000-watt FM transmitters.

GL-889

Twenty-five years of G-E tube manufacturing experience contributed to the successful design of the GL-889—the tube which started a new trend in u-h-f construction. The GL-889 incorporates dual grid leads for separation of neutralizing and excitation circuits. It is fully shielded to prevent electron bombardment of the glass envelope.

Its compact construction makes possible short internal and external leads. Low driving power is required.

Water-cooled, it is rated at 10,000 watts output, class C telegraph, and 4,000 watts output in plate-modulated class C service.

GL-880

General Electric's GL-880 stands alone today in the field of high-power u-h-f transmitting tubes. Its unique construction—utilizing a re-entrant anode—resulted in a decrease in internal lead length of 10 inches compared with existing designs. Full ratings apply up to 25 megacycles. Reduced ratings to 100 mc.

A pair of GL-880's gives an easy 50,000-watt output in 42- to 50-mc FM broadcast service. Low driving power is required. The G-E 50,000-watt FM broadcast transmitter, excited by a 3,000-watt amplifier, uses push-pull GL-880's in the output stage.

Technical information sheets on all G-E tubes are available through our local G-E representative. Place your next order for tubes with him. There are G-E sales engineers in 80 principal cities. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

161-16

Communication in

SEISMIC PROSPECTING

By P. M. HONNELL
Southern Methodist University

SEISMIC prospecting is that branch of applied geophysics which utilizes elastic waves for the delineation of subterraneous contours. Certain types of geological structures are known to be associated with accumulations of oil, and the main efforts of seismic crews are directed towards the discovery and mapping of such oil "traps".

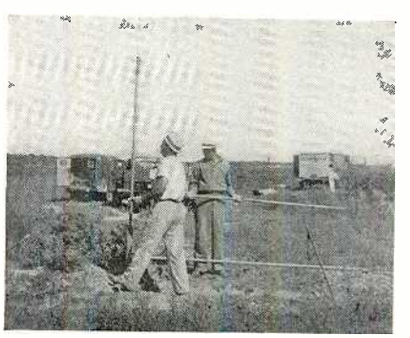
Before considering specifically the role of communications in seismic prospecting it may be well to review briefly the general technique, which, incidentally, resembles somewhat superficially the determination of ionosphere virtual heights.

The general procedure followed is to initiate a sharp pulse of elastic waves by the electrical detonation of a small dynamite charge placed at a depth of 50 to 500 feet. The emitted pulse is received as a series of more or less overlapping pulses arriving by diverse paths, some directly from the shot-point, others from the various underlying refracting and reflecting geological strata. The reception of these waves is effected by transducers, often called geophones, which convert the received wave pulses to electromotive forces which are amplified and recorded oscillographically. Since the time of emission and of arrival of the pulses—that is, the events—are of primary importance, little attention is paid to the wave shapes of the received pulses except as an aid in the visual identification of reflections. A multiplicity of geophones are invariably used, with separate recording amplifiers and oscillographic traces for each single or small group of geophones. This aids materially in the identification of reflections and gives greater control on the reflecting surface. Accurate timing lines on the oscillographic record are obtained from precision forks. From the timed events, the measured distance along the ground, and measured or assumed velocities, the depth to the various reflecting horizons can be computed and the subsurface structures contoured.

Communication facilities are required in seismic prospecting for: (1) the technical control of operations, and (2) the transmission of seismic events. Both wire and radio communication are provided for the performance of these functions, and are utilized as circumstances dictate.

The factors determining whether wire or radio communication will be used are the mobility and portability of the apparatus. For refraction shooting which may demand a distance of several miles between the shot-point and the recording-point, radio communication is eminently suitable. Radio operation is also advantageous in reflection shooting with spans of a thousand feet or so between shot-point and recording-point, especially when a very rapid coverage is required. In this case, the time to lay down and pick up wire lines may be prohibitive. When the shot-point is at the center of the spread of recording geophones—essentially vertical shooting and vertical reflections—then wire communication is quite practical. In certain areas, such as the marsh lands of some Gulf states, it is impractical to either haul or drive carriers with much equipment; in these circumstances the light weight wire telephone equipment makes such communication the only practical means. Finally, radio is the only feasible method of communications over shallow water.

Fig. 2. Loading charge into casing.



Control of Operations

While the tactical command of a seismic prospecting party resides in the party chief, who has general supervision of the entire party, the actual technical control of operations in the field devolves upon the technician operating the recording apparatus, usually called the recorder. This is a natural procedure since the recorder has the responsibility of obtaining satisfactory seismic records, and it is in a great measure his ingenuity and experience which enables him to bring out those features on the seismogram which the computers especially desire. Thus it is that the recorder specifies the size of dynamite charge to be placed in the shot-hole, gives the command to fire or detonate the charge, and decides when a sufficient amount of data have been obtained at a given recording location to move on to the next shot-point. These commands to the shooting crew are given by voice or tone telegraph radio communication, or by wire telephony.

Certain other remote control operations, such as detonating the explosive charge from the recording position, or operating the seismic recording amplifier auto-gain controls from the shot-point, are performed by relays actuated by wire or radio. Only the latter will be considered here.

Transmission of Seismic Events

The measurement of the velocity of propagation of elastic waves requires the determination of two events: the time at which the waves are initiated at the shot-point and the time of arrival of these waves at the recording-point. For simplicity and to minimize errors, it is

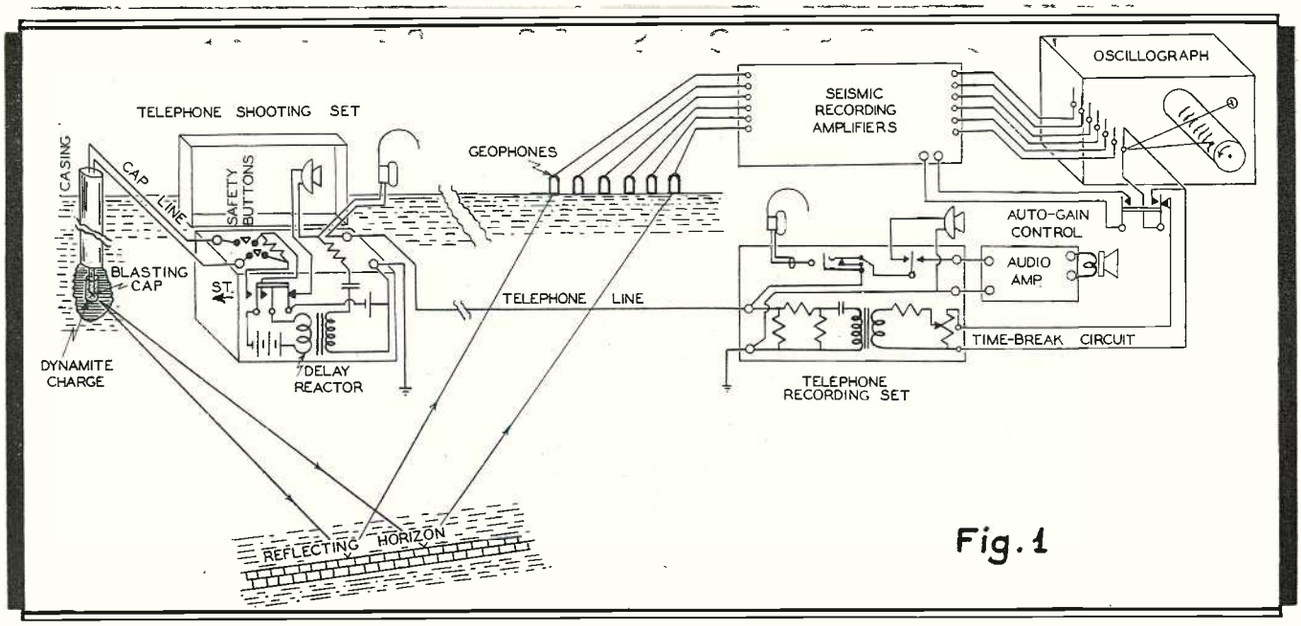


Fig. 1

Diagram of the wire telephone system.

desirable to have all events on the same record; thus the transmission of the initiation event, called the "time-break," from the shot-point to the recording oscillograph is one of the primary functions of the communication facilities.

In some instances, particularly in refraction shooting, it is desirable to transmit by radio the arrival of the first elastic wave pulse at the surface adjacent to the shot-point, as well as the time-break, to the distant recording oscillograph. This is accomplished by modulating the carrier of the transmitter by means of the amplified output of a geophone near the shot-point. As this is a very specialized technique, it will not be considered further.

Wire Communication

The use of wire communication between shooting and recording crews makes feasible very simple equipment to achieve the desired results. Small gauge wire with ground return constitutes the circuit. Often the wire, after being once used, is abandoned; this is especially true in marshy or other territory difficult to traverse. The essentials of the transmission system, much simplified, are shown in Fig. 1 and comprise the telephone shooting set, telephone recording set, and the recording oscillograph. The geophones, recording amplifiers, timing forks, etc., complete the seismic equipment.

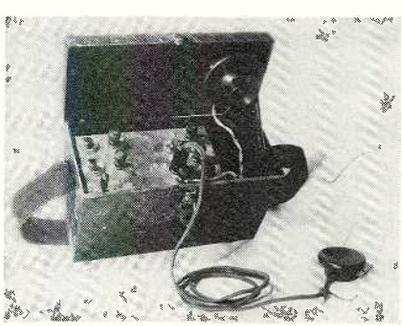
The shooting procedure is as follows: the shooter lowers the dynamite charge and electric blasting cap through the casing to the maximum depth possible (see Fig. 2), and notes that a sufficient head of water is present over the charge to assure a maximum energy transfer from the exploding dynamite to the earth. He then informs the recorder by telephone of the size of charge and its depth. Upon instructions from the recorder, the shooter connects the cap wires to the shooting set, illustrated in Fig. 3, and is then ready to explode the charge. When the recorder has the amplifiers properly adjusted and notes that seismic unrest is at a minimum, he orders the charge fired. The shooter then immediately depresses the safety buttons and throws the shooting switch on the shooting set; this closes the battery circuits and detonates the charge.

The essential seismic information is the instant at which the charge exploded. This is obtained by means of the delay reactor which introduces a sufficient time delay between the close or "make" of the shooting circuit, and the fusing of the bridge wires in the blasting cap, the "break", to give a characteristic pattern to the recorded event. This time-break is transmitted to the recording-point and recorded on the oscillograph together with the received seismic wave pulses.

The recorder has available suitable controls for adjusting the amplitude of the time-break on the oscillograph, headphone or loudspeaker for telephone reception (the latter is quite preferable inside a truck on a summer day!) and other controls for adjusting the gain of the seismic recording amplifiers.

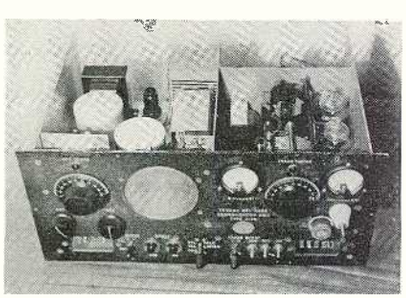
Radio Communication

The Federal Communications Commission licenses radio stations in the geophysical service on channels between 1600-1700 kilocycles per second, to which has lately been added an ultra-short-wave band. Since the distance between the shot-point and the record-

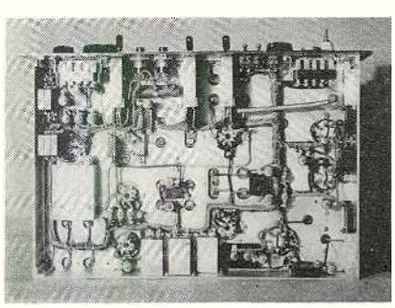


Above: Fig. 3. Telephone shooting set.

Fig. 4. Front view of the communications receiver.



Below: Fig. 5. Underside of receiver chassis.



point is of the order of a thousand feet in reflection shooting and a few thousand yards in refraction shooting, a carrier power of ten watts is usually ample.

Various types of radio transmitters and receivers are in common use; simplicity is, however, the keynote of their design. Thus the receivers are often of the tuned-radio-frequency type, since extreme selectivity is unnecessary as radio interference is not common, and the gain in a single radio-frequency stage is sufficient. Transmitters utilizing suppressor-grid modulation are particularly adapted to the time-break modulation circuits. A complete communication unit is shown in Fig. 4; the receiver of this unit utilizes a 6K7 tuned radio-frequency stage, 6C5 regenerative detector and 6V6 audio output stage. The transmitter has an 802 crystal oscillator driving a pair of paralleled 802 tubes as suppressor-grid modulated class-C amplifiers. A 6C5 tone oscillator and speech amplifier feeds a second 6C5 transformer coupled to the 802 suppressor-grids. The delay reactor secondary circuit passes the sub-audible frequencies required for efficient carrier modulation by the time-break, and is connected directly between suppressor-grids and bias battery. Since a radio set normally includes all essential elements for wire communication these units function both as radio and as wire telephone sets by proper switching arrangements.

Extreme rigidity and suitable support of the apparatus is necessary to minimize vibrations, since all such equipment is subject to extreme mechanical

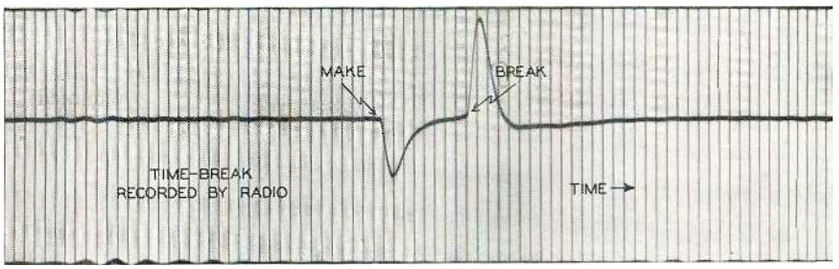


Fig. 7. Oscillogram of typical time-break recorded by radio.

shocks. Dirt roads and cross-country driving is not exactly smooth riding in the trucks required for such heavy going. All component parts must be securely fastened to a rugged assembly and the wiring firmly anchored. The under side of the chassis, Fig. 5, shows the complete lack of pig-tail connections, and the absence of condensers and resistors floating around in the wiring. Only the best quality of components will long withstand complete deterioration in the terrific heat and humidity prevalent in the Gulf coast areas.

The radio system is schematically represented in Fig. 6. The sequence of operations is similar to that followed in wire communication except that commands and information can be transmitted by tone telegraphy as well as by speech with the radio system.

When desirable, the seismic recording amplifier auto-gain control can also be operated remotely by radio. The purpose of this control is to vary the gain of the recording amplifiers at a predetermined rate such that the strong elastic waves first reaching the recording equipment will not be amplified to the same extent as the reflections arriving from great depths, thus equalizing all amplitudes on the oscillographic record. This requires careful and unvarying timing of the controls. The proper sequence of operations is accomplished by the use of a slow release relay to close the shooting circuit, and a fast relay to open the auto-gain circuits. The auto-gain relay at the receiver is operated from rectified tone modulation. To detonate the charge, the shooting switch is first thrown to the "set" position; the slow release relay is then energized and tone modulation of the transmitter actuates the recording auto-gain relay. The shooter then throws the switch to the "shoot" position and depresses the safety buttons. This terminates the tone modulation and the recording gain relay releases, starting the auto-gain control in the recording amplifiers. The de-energized slow release relay drops out 0.3 second later, closing the shooting battery circuit and exploding the charge. The time make and break modulate the carrier concur-

Diagram of the radio communication system.

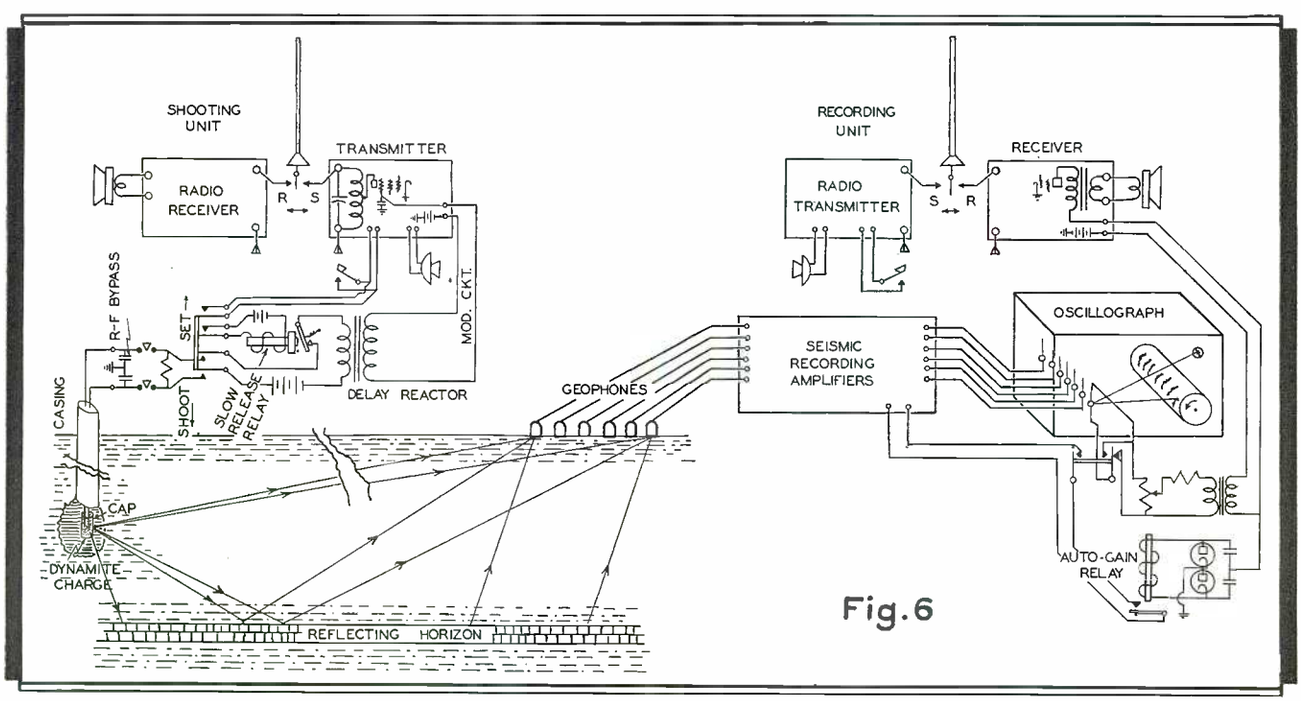


Fig.6

rently and are recorded by the oscillograph.

A time-break recorded by radio is shown in Fig. 7. The typical interval of 40 milliseconds between the make and the break of the cap circuit, caused by the delay reactor inductance and the proper choice of shooting battery voltage, clearly identifies this important event on the oscillogram.

Safety of Personnel

The greatest care must always be exercised to prevent the accidental explosion of blasting caps or dynamite. The design of shooting apparatus must therefore be such as to supplement the caution exercised by the shooting crew. To that end, safety buttons—both of which must be depressed by the shooter—as well as the closing of the shooting switch are required to detonate the charge. Furthermore, if the shooter cannot see the casing—for instance when operating a shooting radio transmitter mounted in a truck—a second pair of safety buttons is mounted such that an assistant can view the shot-hole while closing the circuit. This reduces the possibility of the presence of personnel near the casing during the explosion. As a final precaution, all cap wires are kept shorted and grounded until a short time before the charge is to be detonated. Thunderstorms have been know to explode blasting caps when lengthy cap lines are utilized, especially in the vicinity of wire fences. It is best to discontinue operations temporarily under such circumstances.

A further precaution must be exercised with radio systems, particularly those mounted in trucks. The capacitance of the truck body to the earth is fairly small so that the cap line extending to the grounded shot-hole casing acts as a fairly efficient counterpoise. This has two undesirable effects: The closing of the safety buttons or shooting switch detunes the transmitter, and appears as a spurious carrier modulation which may obliterate the timebreak. Secondly, dangerously high radio-frequency currents often exist in the cap line, resulting in the accidental or premature detonation of the charge. The remedy is to by-pass each cap wire to the truck chassis, thus effectively short-circuiting the line to metallic circuit radio-frequency currents. Of course, longitudinal radio-frequency currents are still present in the line, but these do not contribute to the presence of appreciable currents through the blasting cap, and renders the radio apparatus as safe as the telephone shooting set. The price of safety, however, is constant vigilance by all concerned with the handling of the explosives, for mechanical safety devices can never be considered as infallible.

IRE CONVENTION PAPERS

- January 9, 10, 11
- Hotel Pennsylvania

IRE CONVENTION PAPERS

THE following is a list of the papers to be presented at the technical sessions of the annual convention of the Institute of Radio Engineers, to be held at the Hotel Pennsylvania, New York City, January 9-11 inclusive:

(1) "Recent Developments in the RCA Electron Microscope," by J. Hillier and A. W. Vance, RCA Maunfacturing Company, Inc., Camden, N. J.

(2) "The Handling of Telegrams in Facsimile," by R. J. Wise and I. S. Coggeshall, Western Union Telegraph Company, New York, N. Y.

(3) "Measurements of the Delay and Direction of Arrival of Echoes from Nearby Short-Wave Transmitters," by K. G. Jansky and C. F. Edwards, Bell Telephone Laboratories, Inc., New York, N. Y.

(4) "An Evaluation of Radio-Noise-Meter Performance in Terms of Listening Experience," by C. M. Burrill, RCA Manufacturing Company, Inc., Camden, N. J.

(5) "Spurious Responses in Superheterodyne Receivers," by E. Kohler and C. Hammond, Ken-Rad Tube and Lamp Corporation, Owensboro, Ky.

(6) "Intermediate-Frequency Values for Frequency-Modulated-Wave Receivers," by D. E. Foster and G. Mountjoy, Radio Corporation of America, License Division Laboratory, New York, N. Y.

(7) "Signal-Noise Relations in High-Transconductance Tubes," by J. R. Nelson, Raytheon Productions Corporation, Newton, Mass.

(8) "Improvements in B-Battery Portability," by H. F. French, National Carbon Company, Inc., Cleveland, Ohio.

(9) "Magnetic Recording and Some of Its Applications in the Broadcast Field," by S. J. Begun, The Brush Development Company, Cleveland, Ohio.

(10) "New 1-Kilowatt Television Picture Transmitter," by J. Ferguson, Farnsworth Television and Radio Corporation, Fort Wayne, Ind.

(11) "Versatile Multi-Channel Television Control Equipment," by D. E. Norgaard and J. L. Jones, General Electric Company, Schenectady, N. Y.

(12) "New Designs of Television Control-Room Equipment," by J. Schantz and W. Ludwick, Farnsworth Television and Radio Corporation, Fort Wayne, Ind.

(13) "A Coaxial Filter for Vestigial-Sideband Transmission in Television," by H. Salinger, Farnsworth Television and Radio Corporation, Fort Wayne, Ind.

(14) "Three New Ultra-High-Frequency Triodes," by K. C. DeWalt, General Electric Company, Schenectady, N. Y.

(15) "A Recently Developed Circuit for the Generation of Power at U-H Frequencies," by A. L. Nelson, Farnsworth Television and Radio Corporation, Fort Wayne, Ind.

(16) "Radio - Frequency - Operated High-Voltage Supplies for Cathode-Ray Tubes," by O. H. Schade, RCA Manufacturing Company, Inc., Harrison, N. J.

(17) "After-Acceleration and Deflection," by J. R. Pierce, Bell Telephone Laboratories, Inc., New York, N. Y.

(18) "Analysis of Voltage-Controlled Electron Multipliers," by B. J. Thompson, RCA Manufacturing Company, Inc., Harrison, N. J.

(19) "Behavior of Electron Multipliers as a Function of Frequency," by L. Malter, RCA Manufacturing Company, Inc., Harrison, N. J.

(20) "The Orbital-Beam Secondary-Electron Multiplier for Ultra-High-Frequency Amplification," by H. M. Wagner and W. R. Ferris, RCA Manufacturing Company, Inc., Harrison, N. J.

(21) "Some Factors Affecting Television Transmission," by M. E. Strieby and C. L. Weis, Bell Telephone Laboratories, Inc., New York, N. Y.

(22) "Brightness Distortion in Television," by D. G. Fink, McGraw-Hill Publishing Company, New York, N. Y.

(23) "A Phase-Curve Tracer for Television," by B. D. Loughlin, Hazeltine Service Corporation, Little Neck, N. Y.

(24) "Special Oscilloscope Tests for Television Waveforms," by A. V. Loughren and W. F. Bailey, Hazeltine Service Corporation, Little Neck, N. Y.

(25) "Program-Operated Level-Governing Amplifier," by W. L. Black and N. C. Norman, Bell Telephone Laboratories, Inc., New York, N. Y.

(26) "Drift Analysis of the Crosby Frequency-Modulated Transmitter Circuit," by E. S. Winlund, RCA Manufacturing Company, Inc., Camden, N. J.

(27) "Frequency - Modulated Emergency Equipment," by G. M. Brown, General Electric Company, Schenectady, N. Y.

(28) "Commercial 50-Kilowatt F-M Broadcast Transmitting Station," by H. P. Thomas and R. H. Williamson, General Electric Company, Schenectady, N. Y.

General Considerations of
THE CRYSTAL CUTTER

By T. E. LYNCH & S. J. BEGUN
The Brush Development Co.

HOME recording is not new. Several years ago an attempt was made by a well-known concern to market a device for this purpose, but the attempt apparently was not successful, and it was not until the middle of 1939 that the effort was revived by the industry; this time, more successfully, it appears. The performance of these units was such that almost immediate public acceptance followed, and now virtually every radio manufacturer has entered the new field.

Naturally, a number of problems relatively new to the radio industry are involved, and one of the most essential of these is the cutter. It is with this device that this investigation will treat.

Most of the present recording combinations use crystal cutters as well as crystal pickups—a combination simple to engineer and of relatively good quality.

There is no practical limit to the excellence which can be obtained with the crystal cutter, if price is no object. Professional studios, with their careful temperature control, air conditioning, and engineering skill, are able to obtain and use crystal cutters of negligible distortion and widely extended frequency range.

To the general public, however, where price is of importance, a system, to be acceptable, must incorporate the following features:

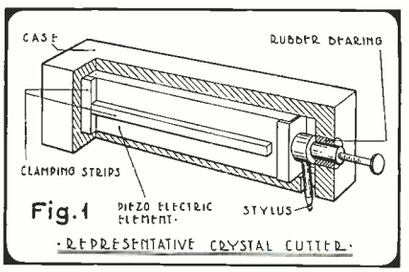
(1) Simplicity and dependability of operation
(2) Reasonably wide frequency range
(3) Harmonic content below the obviously audible distortion limit.

To these requirements, the radio manufacturer adds another three; namely:

(4) Sensitivity high enough to operate from a normal radio amplifier
(5) Ease of equalizing the cutter
(6) Ease of coupling the cutter to the usual output stages used in radio receivers.

The Crystal Cutter

Before investigating these points in detail, it is in order to concern ourselves briefly with the fundamental operating principle of the crystal cutter. Fig. 1 is a cut-away drawing of representative crystal cutter used as the basis for this paper. It will be seen that it consists mainly of an element of Rochelle salt crystal, held firmly at one end to a light metal case, but free to move torsionally at its other end. This free end has clamped to it a simple bearing and chuck mechanism, as shown. The bearing is normally of rubber or one of the newer, more durable rubber substitutes, while the chuck is ordinarily small, and of some light metal, such as aluminum.

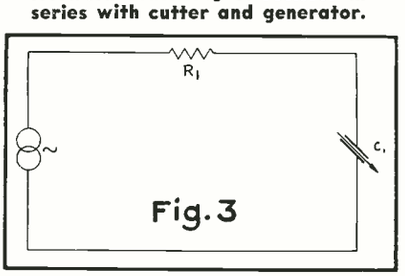


Showing the construction of a representative crystal cutter.

Because of the low specific weight of the Rochelle salt crystal, and the simplicity of connecting parts, this lends itself to very lightweight construction.

To restrain the crystal from vibrating in more than one mode, it is customary to restrain it slightly along its axis of motion, and this is done in Fig. 1 by the strip of damping material which is cemented along the length of the salt element. This strip also serves to add some damping to the system, which is useful to reduce the peak of the resonance frequency of the crystal. This resonance frequency, however, because of the normal high stiffness of the crystal, is always high, and generally is out of the normal frequency range, so the damping material ordinarily exerts no appreciable influence on the cutter, which performs through its usual frequency range as a stiffness-controlled device.

Network consisting of resistor in series with cutter and generator.



In the representative cutter shown, the Rochelle salt element is properly foiled and electrically connected so that a voltage applied to the terminals causes the element to stress torsionally.

It is a characteristic of the Rochelle salt crystal, that for practical purposes, it is electrically equivalent to a condenser. It is also characteristic that the mechanical flexure caused by the piezoelectric effect is proportional, within limits, to the charge applied to the crystal. It is of significance that this proportionality is not dependent upon temperature. In other words, the sensitivity of the Rochelle salt crystal, when expressed as the ratio of flexure to charge, is not a function of temperature. Since the flexure is a function of charge, and the Rochelle salt crystal is electrically equivalent to a condenser, we may determine its voltage sensitivity directly from the familiar formula for charge on a condenser: $Q=CE$. This means, of course, that the flexure is a function of the voltage applied to the crystal. The capacity of the Rochelle salt crystal is, however, to some extent a function of temperature, and from this it is seen that the sensitivity, when expressed as the ratio of flexure to voltage, is slightly a function of temperature. This fact is of considerable importance, and will be discussed from a practical point at greater length later.

Summarizing, the fundamental points about the crystal cutter are:

(1) It is a stiffness-controlled device.
(2) It is a voltage-driven motor.
(3) With respect to charge, its sensitivity is not dependent upon temperature.
(4) It lends itself to simple and lightweight mechanical construction.
(5) In calculating equalizers, or response, it may be considered, for all practical purposes, to be a simple electrical condenser.
(6) The capacity of the Rochelle salt condenser is affected by temperature.

Simplicity and Dependability of Operation

From the point of view of the public, nothing can be more important than that they cut a record, with a minimum of effort, and with little more skill than is required to operate a radio. All other considerations must be secondary to this. This at once imposes the limitations that the cutter must not require critical adjustment and must be independent in its performance of such factors as temperature and humidity, depth of cut, and material being cut.

Temperature Dependence

Some controversy has developed with regard to the effect of temperature change upon the response of crystal cutters. This temperature effect, in general, may be divided under two classifications: namely, the temperature effect upon the motor mechanism of the cutter, and the temperature effect upon the damping material. The total temperature dependence of any cutter is, of course, the result of these two effects. Concerning damping, it appears that no viscous damping material is free from serious temperature dependence, and since it does not seem feasible to use any non-viscous damping in a cutter, it follows that any cutter with a high damping must also be troubled with a considerable degree of temperature-sensitivity dependence.

Concerning the crystal motor, the matter is not so simple. The Rochelle salt element would, if unrestrained, have a great temperature dependence, and the sensitivity, when defined as the ratio of flexure to voltage, might vary considerably through the normal temperature range.

Unrestrained crystals are never used, however, in normal crystal devices, for crystals are normally used in pairs called "Bimorphs", or multiples, in such a way that a very high order of mutual restraint is applied to the crystals. This restraint reduces the temperature dependence very materially, and as a matter of fact, for most applications, no further correction is necessary, although, if more correction is required, it may be obtained in the following manner: It has already been pointed out that, with respect to charge, the sensitivity of the crystal cutter is not dependent upon temperature. It is only necessary, therefore, to include the cutter in a network supplying it with a constant charge, instead of a constant voltage. A simple condenser in series with the cutter supplies essentially such a network. The smaller this capacity is with respect to the cutter capacity, the more nearly a constant charge system will be obtained. A practical value for this capacity is equality with the average capacity of the cutter, and with such a value, temperature dependence reaches almost negligible proportions. This network reduces the sensitivity of the cutter somewhat, but, for the value mentioned above, this reduction is not serious, being about 3 db, when the cutter is properly matched to the generator.

Summarizing, the important points outlined are:

(1) Temperature-sensitivity dependence in a cutter is the result of damping-temperature dependence and motor-temperature dependence.

(2) The usual crystal motor mechanism has a slight temperature-sensitivity dependence, which can be reduced to negligible values.

The usual crystal cutter, by virtue of the high stiffness of the Rochelle salt element, requires practically no damping, and it may be said that throughout its operating range, below resonance, the response is controlled by the characteristic of the Rochelle salt element. There is therefore no damping problem, and the entire sensitivity-temperature dependence is that of the crystal motor, which, as has already been pointed out, is not excessive for most applications, and can be reduced where severe requirements are to be met.

For the crystal cutter, the highest sensitivity is found at a temperature of 75° F. and both above and below this temperature the sensitivity falls off slowly, varying ±3 db between temperatures of 60° to 100° F.

When the series condenser is added to the crystal cutter, the temperature dependence practically vanishes, dropping to ±1 db within the temperature range of 60° to 100° F. The absolute sensitivity of the crystal is reduced 3 db by this correction.

The crystal motor fails abruptly at a temperature of 130° F., and in all applications where temperatures of this order are to be encountered, therefore, the crystal cutter is not recommended. Below this critical temperature, however, the crystal does not suffer any damage whatsoever, and can, for example, be continuously subjected to a temperature of 120° F.

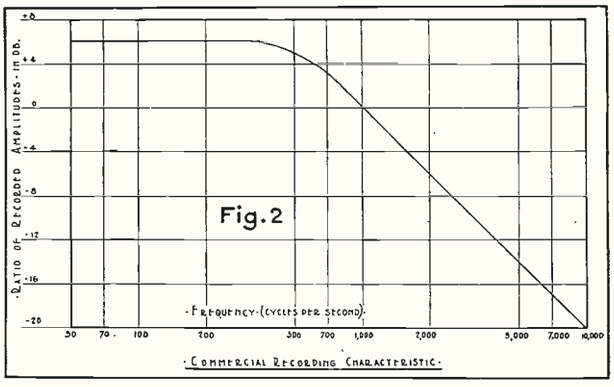
Humidity Dependence

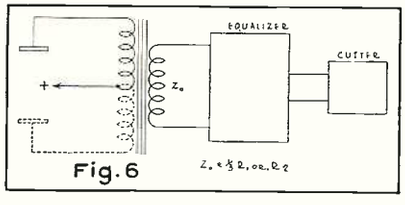
There is no reason why a crystal cutter should be troubled by humidity. The unprotected Rochelle salt crystals are, to be sure, seriously affected by humidity, but the salt crystals used in commercial devices are always very carefully waterproofed, so that this is not a problem.

As a matter of fact, during the period of development of crystal cutters in 1939, sample crystal cutters were continuously exposed to a humidity of 90% at a temperature of 90° F. for more than 100 hours. All this time the cutters were supplied with the highest operating voltage, to test them under most severe conditions. No breakdown whatsoever occurred. Such a temperature and humidity over such a long period of time are greatly in excess of any which would be encountered in normal use, of course, and it is therefore safe to conclude that for all practical applications, moisture and humidity protection will be ample.

At the same time, however, some damping materials are somewhat hygroscopic, and will be affected by moisture,

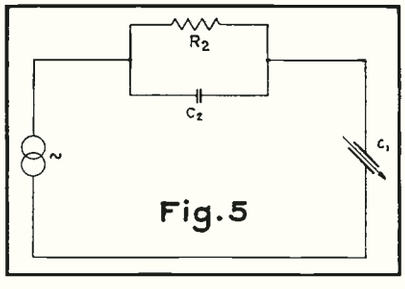
Characteristic used in shellac pressings. Note that constant amplitude is obtained up to about 500 cycles, thereafter constant velocity.





Showing method of coupling circuits of Figs. 3 and 5.

Network capable of supplying characteristic of Fig. 4.



but there is no evidence available to support the conclusion that this is a problem in any current crystal cutter.

Load Independence

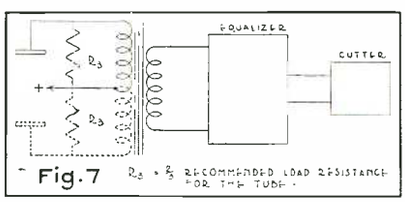
It is obviously out of the question to require of the casual user that he be able to adjust a recording machine for the proper depth of cut, when using different disc materials or differently pointed cutting styli (sharp as are steel styli, or rounded as are sapphire styli). A practical home recorder should be capable of making a usable record in any of the materials now on the market without any additional adjustment. This means, of course, that the load imposed upon the cutter will vary within wide limits, and since most of the cutting load is resistive, such a load will function as a widely varying external damping. The amplitude of motion depends upon the complete damping of the system. In order that this amplitude of cut shall not be a function of the disc material or cutter stylus shape, as, of course, it shouldn't, it is necessary that the internal impedance of the cutter shall be larger than the greatest external load which may be applied.

In other words, the internal impedance of the cutter must be so high that variations in load will not cause any appreciable change in the cutter's performance. The usual crystal element is well suited for this requirement, since the Rochelle salt slab is exceedingly stiff, and therefore gives to the crystal cutter an extremely high internal impedance for the normal operating frequency range.

Frequency Range

For most practical requirements, a frequency range from 80 to 5000 cycles seems the maximum that is demanded of the radio industry at the present time. The frequency characteristic used for recording, for the time being, is an approximation to the characteristics used in professional pressings. This is a constant velocity characteristic above about 500 cycles, and in constant amplitude characteristic below this point. This takes into consideration the characteristics of the pickups used at present, and is designed to give the best overall performance of the complete recording-reproducing process.

It should also be pointed out that the usual constant velocity recording characteristics may be greatly modified in the near future, since the traditional method is somewhat deficient with respect to signal-to-noise ratio. The industry supplying commercial pressings is already, to a certain extent, modifying this traditional characteristic insofar as the high frequencies are being boosted during the recording process. The manufacturers of standard pressings are doing this to a considerable extent; the recording characteristic for transcription recording, is also making use of this procedure. In the light of this trend, it would seem desirable to select



Circuit permitting use of pentode or beam power tubes.

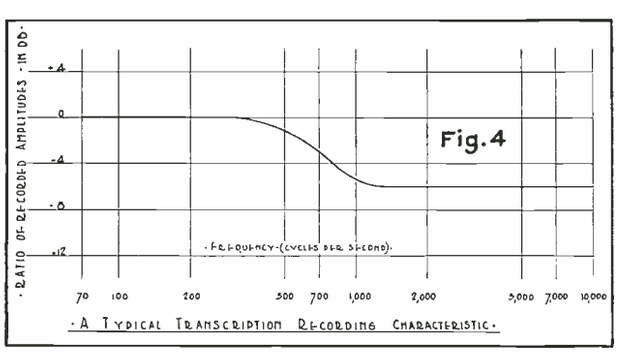
a cutter with extreme flexibility of equalizing.

The crystal cutter lends itself to easy equalization, as will be pointed out later, and practically any response can be obtained with it by means of inexpensive condensers and resistors.

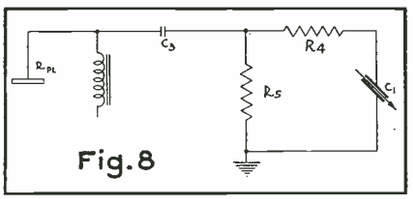
Because of lack of standardization with respect to recording characteristics, an arbitrary reference characteristic must be established. Therefore, the crystal cutters should be designed for a flat frequency response with respect to their operating principle. That is, the crystal cutter should cut a constant amplitude frequency spectrum for a constant voltage. With this basic operating curve, equalization for almost any frequency response is possible with a minimum of parts, as will be explained under the next section of this paper.

Equalization

Given the flat frequency response which seems desirable in a cutter, what are the networks which must be used



Characteristic used to reduce surface noise. Note that constant voltage is required to 500 cycles, constant current to 1000 cycles and constant voltage thereafter.



An equalization circuit that does not require a transformer.

to provide any desired frequency characteristic of cut? Two such frequency characteristics will be taken up in some detail, but the same principles apply to any practical response.

First, is the characteristic which has been in use in shellac pressings for the past several years. This characteristic is shown in Fig. 2, and it is seen that constant amplitude obtains up to about 500 cycles, and thereafter constant velocity.

Now the crystal cutter normally cuts a constant amplitude for a constant voltage, and a constant velocity for a constant current. With these fundamental operating points in mind, the crystal cutter equalizer must function to supply the cutter with a constant voltage to 500 cycles, and thereafter, with a constant current. Such a network is shown in Fig. 3 and consists of a single resistor in series with the crystal cutter and the generator. The design formula for this resistor is:

$$R_1 = \left| \frac{1}{2\pi f_1 C_1} \right|$$

$f_1 = 500$ cycles
$C_1 =$ capacity of the crystal motor.

Let us now examine the somewhat more complex characteristic described previously in this paper, and which is being approached by many of the commercial recording studios today. This curve is shown in Fig. 4, and has for its chief advantage the reduction of surface noise in the recording.

Assuming a first inflexion in the curve is at 500 cycles, and the second inflexion is at 1,000 cycles, what shall be the values of the network to equalize a crystal cutter for such a characteristic? Required is a constant voltage to 500 cycles, a constant current to 1,000 cycles, and thereafter a constant voltage again. A network capable of supplying such a characteristic is shown in Fig. 5, and the design formulae are:

$$(1)\quad R_2 = \left| \frac{1}{2\pi f_1 C_1} \right|$$

$$(2)\quad R_2 = \left| \frac{1}{2\pi f_2 C_2} \right|$$

where $f_1 = 500$ cycles
$f_2 = 1000$ cycles

(Continued on page 26)

New 27-145 MC. FM-AM Receiver

By S. GORDON TAYLOR

ENGINEERS, hams and experimenters who have been delving into and pioneering the ultra-high-frequency ranges have, naturally enough, found it necessary to develop their own receiving equipment to a very large extent, even though such receiving equipment might be only incidental to their main purposes, and the necessity for such development work has meant just that much time and effort lost to their primary objectives.

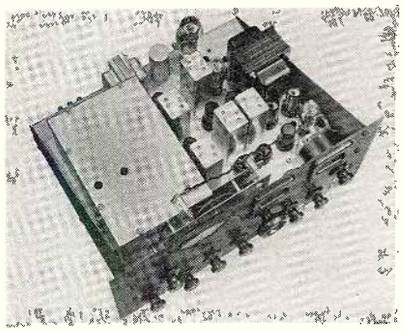
To many of these, and to others who have been restrained from undertaking studies in the u-h-f ranges because of the lack of generally available receiving equipment, the introduction within recent months of an all-purpose AM-FM receiver designed to cover the frequency range of 27 to 145 mc, and providing average sensitivity of 2 microvolts or better, will be of special interest.

This receiver is a product of Hallicrafters, Inc., the culmination of a long period of research and development carried on by F. W. Schor, u-h-f specialist, and several of his co-workers in the Hallicrafters laboratory.

The object of this work was to produce a receiver which would provide, throughout the u-h-f ranges, reception facilities approaching as closely as possible (or desirable) those provided on the lower frequencies by modern communications-type receivers, and in addition to meet the special requirements imposed by the types of services now operating in the u-h-f ranges, including frequency-modulated transmissions. By

Above: Front view of the FM-AM receiver.

Below: Top view of receiver with cabinet removed. Note shielded r-f assembly.



accomplishing these aims, a universal u-h-f receiver of widest utility would be made available to meet the varied requirements of those who are working in these ranges.

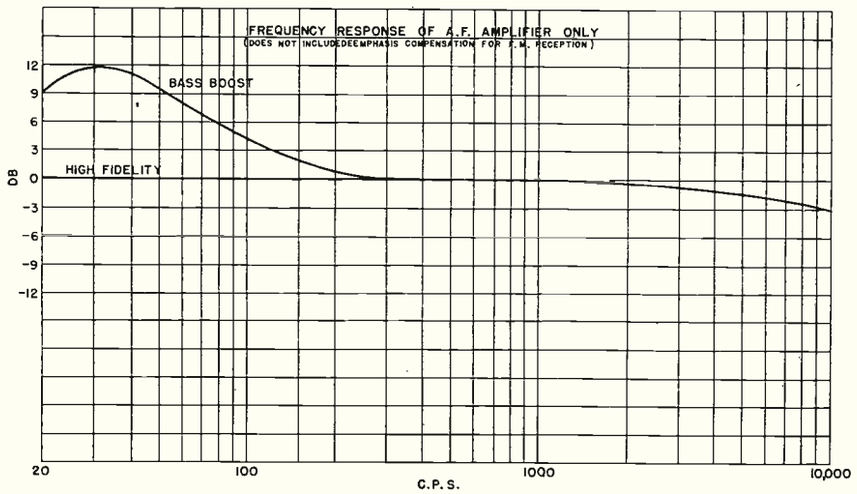
The extent to which these aims were achieved in the Model S-27 and something of the methods employed in their attainment is indicated by the following description.

Basically the S-27, fifteen-tube receiver is of the communications type in both appearance and circuit design, with various controls that provide flexibility in application and operation. The tuning range is continuous from 27 to 145 mc and is split into three bands of 27 to 46, 45 to 84, and 81 to 145 mc. Although band-changeover is accomplished by switching, a feat considered by many earlier workers to be utterly hopeless at these frequencies, sensitivity (at 50 milliwatts output) of better than 1 microvolt is maintained to 46 mc, better than 2 microvolts to 84 mc, and 2 to 4 microvolts in the 81 to 145 mc range.

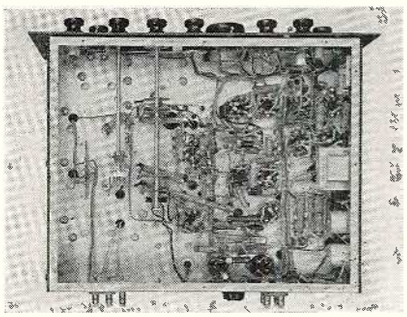
Signal selectivity is, of course, less than that of low-frequency receivers, nor is there the need for extreme selectivity at frequencies above 30 mc. Wide channels, guard bands, etc., make this unnecessary. Image selectivity is important and has received special consideration in this design with the result that the image ratio at 30 mc is 7000 to 1, and at 100 mc is 100 to 1. Signal selectivity in the reception of amplitude-modulated signals varies from 13 kc at 2X down, to 123 kc at 1000X down in the sharp i-f position and in the broad position the corresponding values are 58 and 348 kc. In the FM position the bandwidth at the input to the limiter tube is 218 kc at 2X down.

The frequency response of the audio system alone, as shown in Fig. 2, is flat within 3 db from 20 to 10,000 cycles and in FM reception this represents the

Fig. 2. Audio amplifier characteristic curve.



View of receiver with base plate removed. Note wiring and assembly.



overall response as well except that a high-frequency de-emphasizer circuit included in the discriminator diode output lowers the h-f response to compensate for the high-frequency accentuation inherent in FM transmissions. Between the 4 positions of the tone control switch, and the broad and sharp positions of the i-f selectivity switch, the operator is provided ample leeway in adjusting the overall frequency response to meet the requirements of different types of AM reception and different noise levels.

Operating flexibility is quite comparable with that provided in the lower frequency receivers. For instance, there are thirteen controls on the front panel as follows: r-f gain, a-v-c off-on, antenna trimmer (to compensate for loading effect of different types of antennas at different frequencies), broad-sharp i-f band-width selector, a-f gain, automatic noise limiter off-on, AM-FM changeover, beat-frequency oscillator off-on, b-f-o heterodyne pitch control, send-receive standby switch, 4-position tone control, band-selector switch, and tuning control. The illuminated windows above disclose the main tuning dial (fully frequency-calibrated for all ranges), the band-spread or vernier dial, and a meter which serves as a calibrated "S" and db meter when the receiver is employed for AM reception, and as an aid in precise "centering" of the carrier when tuning FM stations.

Along the rear apron of the chassis are connections for doublet or standard antennas, 500-ohm and 5000-ohm output connections, connections for an external standby switch or relay, and a power receptacle into which batteries or a battery and vibrator supply may be plugged for mobile or other operation where line supply is not available. Using a-c line supply a dummy plug inserted in this socket completes connections to the internal power supply.

• • •

This close-up of the r-f assembly with its shield cover removed shows the method adopted to keep leads short. The gang switch is the heart of the assembly, with the coils mounted directly on it and tubes and tuning gang closely concentrated around it.

• • •

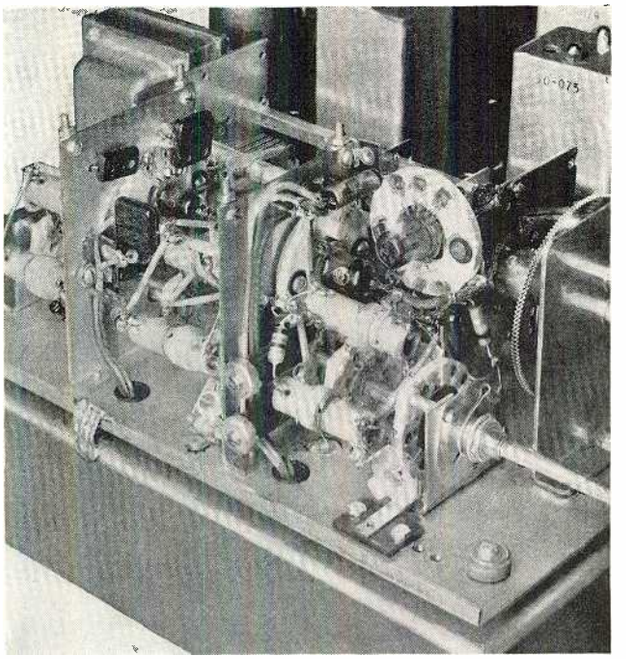
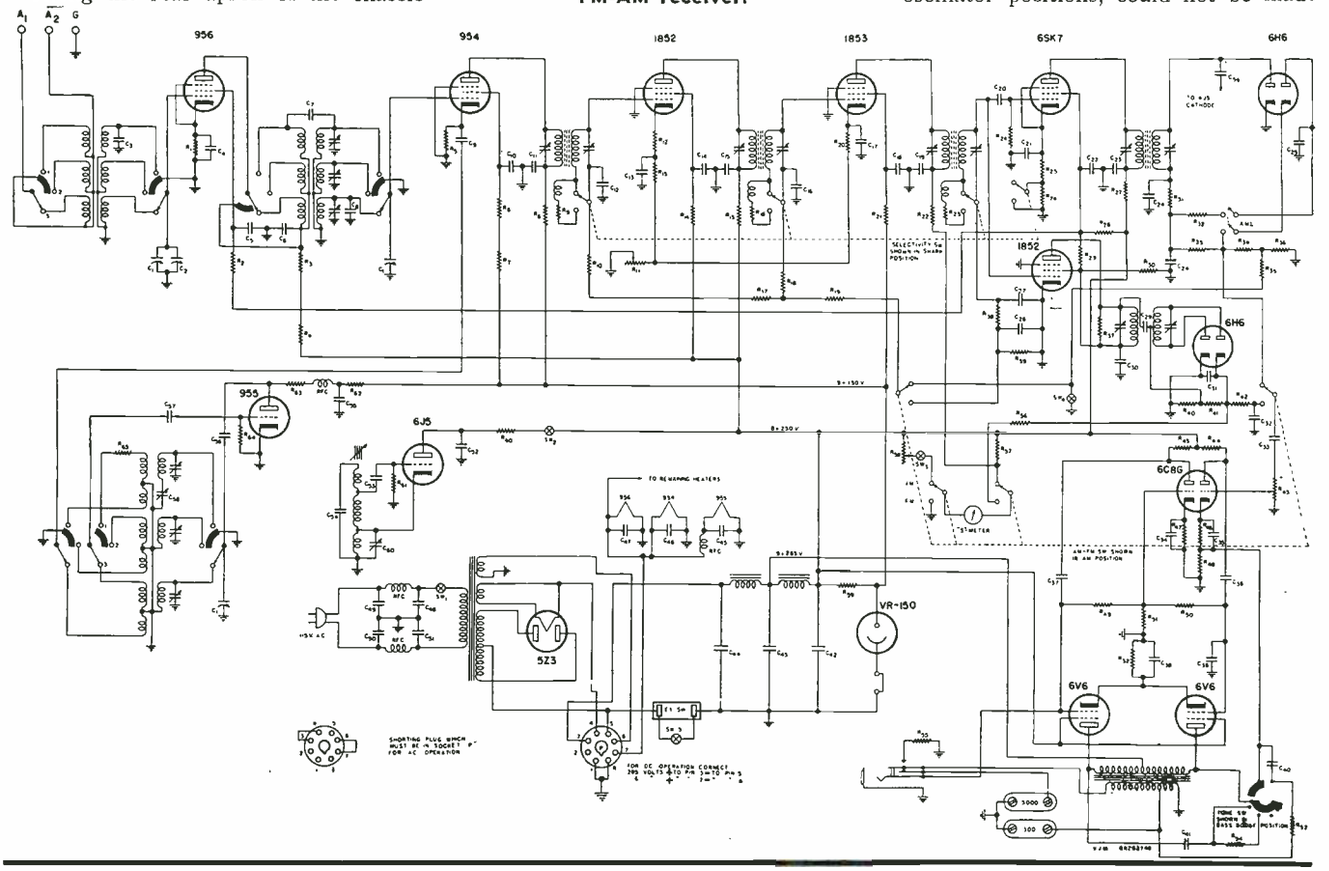


Fig. 1. Schematic diagram of the FM-AM receiver.



R-F Design

The circuit is somewhat orthodox, as will be seen from an examination of Fig. 1. But of course, the schematic circuit is one thing, the actual design details of the receiver another. For instance, it was found that the usual tube types, if used in the r-f, mixer, and oscillator positions, could not be made

to provide the required gain, frequency range and uniformity of sensitivity. For this reason "acorn" tubes were selected for these positions and their reputed tendency to be short-lived is overcome by operating them at a plate voltage of only 150.

R-f tuned circuits at these frequencies are naturally extremely critical, not in their tuning, but in their electrical and physical demands. The total "lumped" inductance for a tuned circuit in the highest range, for instance, consists of less than two inches of wire in the form of a tiny 2-turn coil. Without extreme care in layout, to keep all leads short, the leads themselves would provide so much inductance (and capacity) as to definitely limit the high-frequency end of the tuning range.

Inherent circuit capacities must likewise be held to a minimum. With the tuning capacity range limited to about 55 mmfd by both theoretical and practical design considerations, it is obvious that the inherent capacities, including leads, trimmers and the tuning condenser minimum must be very low value if a reasonably wide tuning range is to be achieved.

In spite of these considerations, it was found possible to obtain tuning ratios of close to 2 to 1. This is, of course, largely a matter of physical layout of the circuit components. The tuning gang, coil switch, coils and tubes are so arranged that the coils mount directly on the switch terminals, and leads from the switch to the tuning condenser are in some cases less than ¼" in length. Yet with all this, approximately one third of the effective inductance in the highest frequency range is in the switch and tuning condenser.

To obtain uniform conversion gain and avoid undue oscillator loading it was necessary to abandon all the conventional oscillator coupling circuits, as well as the conventional tubes. In the first place it was found that the oscillator must employ a circuit which permits the cathode to be directly grounded, otherwise serious hum modulation results. It was found, too, that the usual forms of coupling between oscillator and mixer resulted in low conversion gain, failure of the oscillator to operate throughout its range, or severe limiting of the oscillator tuning range. This was true of direct coupling, coupling employing a resistor common to both circuits, and various methods of injector and suppressor coupling. The method finally arrived at utilizes a small pickup coil of ½ to 2 turns connected to the mixer cathode through a 300 mmfd capacity, and tightly coupled to the oscillator coil. This impresses from one to three volts between mixer cathode and ground, and results in unusually stable and uniform conversion gain throughout the entire tuning range of the receiver. Actual measurements are shown in Fig. 3.

The entire assembly of the r-f, oscillator and mixer stages is mounted on a separate sub-chassis which is separately shielded and attached to the main chassis by point supports to prevent the transfer of mechanical vibration—a prolific source of microphonic disturbances. One of the accompanying illustrations shows this assembly with the shield removed.

Tuning is by means of a single "wheel" control centered on the front panel. Although the gear ratio is 100 to 1 there is freedom from backlash—due at least partly to mounting the main shaft on ball bearings at both ends rather than depending on the more conventional, single bushing arrangement. Moreover, because a quick spin will keep the tuning control rotating by its own momentum, large frequency jumps can be quickly made. On the other hand, the large diameter of the tuning wheel makes critical tuning easy. Even in the highest frequency range, for instance, it requires two full revolutions of the wheel to tune through the 2½-meter ham band, and this involves finger movement of approximately 14 inches. To tune through the 5-meter ham band requires almost five complete revolutions of the knob, and the 10-meter band six revolutions.

The tuning calibration is maintained stable, regardless of line variations, by supplying the oscillator and mixer voltages through a circuit regulated by a VR-150 voltage regulator tube. The screen voltage of the 2nd i-f tube is likewise supplied through this same circuit in order that the "S" meter, which operates in the plate circuit of this tube, will remain independent of line variations, measuring only the plate current variations resulting from changing from a-v-c voltages and therefore providing a direct measure of carrier level.

In tuning FM signals, this meter is automatically shifted to serve as a voltmeter across the total discriminator diode load circuit. Zero position of the meter in this application is about quarter way down the scale in order that both positive and negative voltages will be indicated as such. In tuning through

(*Continued on page* 24)

Fig. 3. Radio-frequency gain curves of receiver.

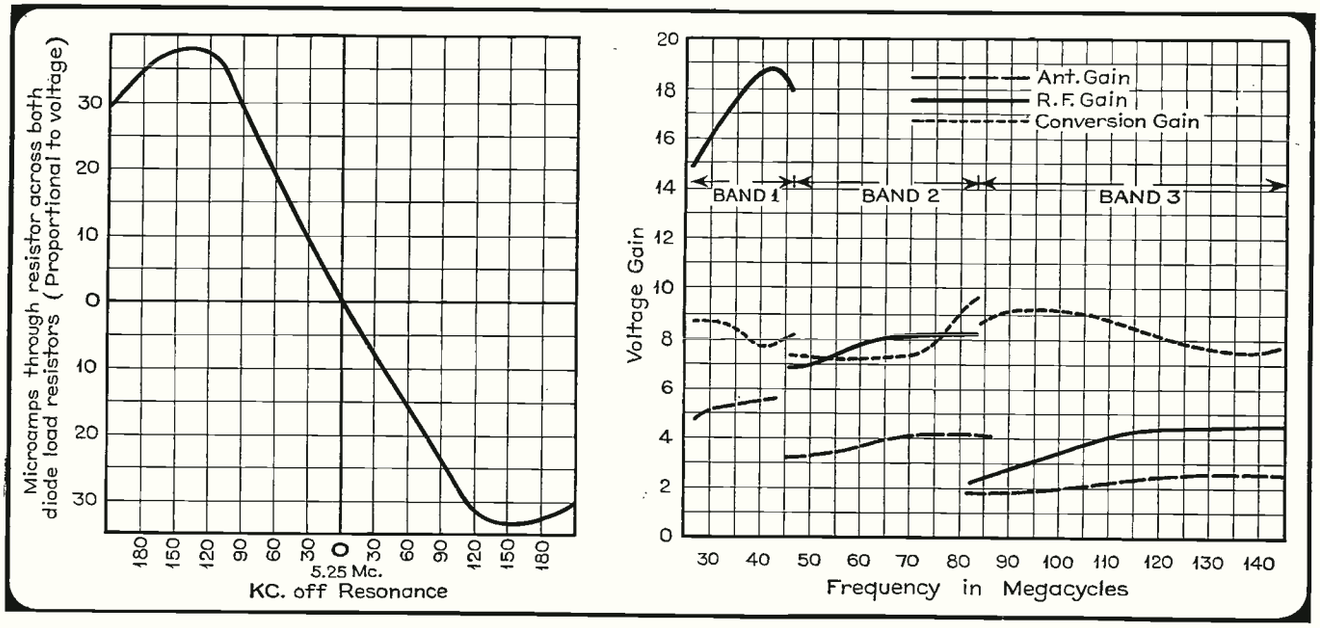


Fig. 4. Detector characteristic of FM discriminator.

IMPROVING THE HOME RECORDER

By F. E. WILLIAMSON
Chief Engineer
Permo Products Co.

For many years the volume market radio combination manufacturer did not turn his interest to home recorders, and this field was occupied by the professional engineer, radio station, recording studio, etc. However, schools, voice instructors, and many others learned that the operation of instantaneous recorders was not too complicated, and manufacturers of recorders soon made equipment moderately priced which any person with average common sense and intelligence could operate to good advantage. Due to continual expansion, a substantial industry of no small magnitude was developing because of the actual need of instantaneous recorders. Curiously enough, this same industry has been able to survive and still does not show any alarming reduction in spite of the introduction of inexpensive home recorders. Therefore, rather than having a detrimental effect, it is the belief of many that home recording has broadened the interest and scope of instantaneous discs so it should behoove the manufacturers to offer improvements in this equipment rather than to see how possibly cheap it can be made and still be represented as an instantaneous recorder simply to attract sales.

The home recorder without question is here to stay, although peak sales may indicate exceptional interest of the layman and novice. Also this additional item to the radio-phono combination has enough application and merit to warrant its continued consideration. In the recent past, the quality offered by these low-priced recorders has been on a barely acceptable minimum standard. Will the manufacturer improve this product so that the equipment becomes an absolute essential and of value to every purchaser? Will the manufacturer build this equipment down to a minimum price structure or will the quality be "upped" in proportion to the combination's usefulness?

The public on the whole has been educated to a reasonably good quality basis through the phonograph, radio, and sound film reproduction, resulting in an appreciation of better music, and radio sets as a general rule have expanded along the constructive basis of increasing the fidelity range, giving better tone. These considerations are just as important in the home recorder. Poorly built home recorder equipment discourages the user because in the greater percentage of cases, the quality obtainable by the layman is below the older radio sets to which he became accustomed. Without doubt, the recording unit, working in combination with the radio-phonograph set offers versatility and additional pleasure for the layman, as well as usefulness to the music student, instructor, etc., and the probability of maintaining a better dollar volume gross can be assured by improving the quality of this combination set-up.

Unfortunately, sales departments are likely to insist that the engineering

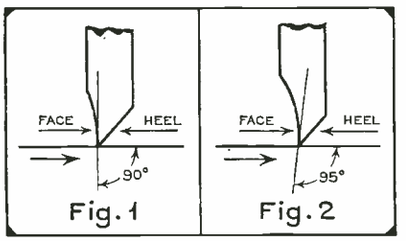


Fig. 1. Cutting stylus ground with cup face. Fig. 2. Stylus operating at 95° angle.

department reduce cost. Instead of shaving a few cents on the turntable motor, suspensions, cutting head, pivot bearings, etc., the engineer should be permitted to add slightly to the cost on these items and improve the mechanical quality so that when the instrument is placed in the hands of the layman or user, intelligent and understandable recordings can be made with gratifying results. Rather than treat this new-born industry lightly, cogitation should reveal that there is a definite and real requirement for such equipment, and while it may not equal the volume of ordinary radio sets, it will, if cultivated properly, form the greater portion of the combination phonograph unit. The user may build up his own library of recordings—symphonies, speeches and selected programs. Along with the recreational value of the instrument, at parties and so forth, the application of this instrument is manifold.

Much improvement can be made on home recorders now being offered, and it is the purpose of this article to point out some of the things which have a vital bearing on the performance of the equipment. No elaborate discussion will be made here of the effects of resonant suspension due to 60 and 120-cycle vibration and rumble from the motor, poor bearing and pivotal construction, etc., inasmuch as these are very common problems and their solution is readily attained. However, most recording turntables in the low-priced class on the market today need improvement, and certainly next year's models should show definite strides to overcome the ill-effects of table rumble, and so on. Much improvement could be made, also, in increasing the fidelity of the average recording system, that is, from the quality of the disc to the cutting needle, transducer head and amplifier or input system. One outstanding improvement necessary in most recorders is the reduction of the distortion factors. Although many factors have a bearing on the accumulated distortion figure, no small percentage of this is due to poor amplifier recording characteristics. The tendency to use pentode beam power amplifiers which are not designed to accommodate the mis-match of the cutting head at different frequencies sometimes causes cross modulation and distortion. It should be remembered that distortion occurs rapidly on peak requirements. The professional recording engineer fully well realizes that in order to make a recording "crakle" with crispness, low distortion and plenty of clean, smooth "highs" are necessary without resonant peaks in the useful recording range. This point seems to have received little consideration by most of the design engineers or if so they usually overlook the ill-effects of the reproducer play-back system, which is altered when the user places any type of needle in pickup.

Most everyone is conscious of the poor quality of some of the cheap recording motors, which causes "wows" in the recording and an over-abundance of rumble. This is a manufacturer's specification problem, however, but one which is easily improved upon, and the design engineer should positively insist upon better motors and tables if he is going to improve the quality of his equipment.

The quality of the blank disc naturally affects the quality of the recording, although it is possible to make intelligible recordings on good equipment even with relatively poor discs. If the recording equipment has been carefully designed, the disc problem usually resolves itself into one of background noise, "spots" or a cut-off limit of the higher frequencies. Although warped or uneven discs introduce additional troubles, these are barely separable from the mechanical troubles in present day equipment, and thus the real troubles are somewhat masked and result to some extent in the service man blaming the cutting needle, cutting head, loose pivots, etc. If the discs are badly warped, naturally the vertical angle of the cutting face of the needle is constantly being changed during the cutting cycle. Likewise, the depth of cut will vary, resulting in poor and uneven tone quality, tendency to "chatter", etc.

Assuming that we have an acceptable turntable assembly, recording head, pivot arm, and feed screw mechanism without play, burred gear sectors, etc., then, aside from the electrical input and efficiency of the mechanical conversion head, the fundamental factors affecting a recorded groove are (1) quality of the cutting needle (2) horizontal and (3) vertical angles of the cutting needle face and (4) depth of groove cut. Since we must allow for considerable tolerance in variation of the flatness of the discs, the cutting head assembly should be so located that with a standardized type cutting needle with standard face angles, detrimental effects will be reduced to a minimum. Reviewing our fundamental cutting principle, it is well-known that if the tip of the cutting stylus is "toeing in" toward the direction of motion of the disc material, then we have the possibility of a digging in noise, causing the stylus to bounce. This is accentuated with uneven disc faces. Going to the reverse extreme, if the cutting edge of the needle tip is dragging too much, we will have an increase in surface noise and a possible "birdie" or high frequency whistle. If we design the head for vertical operation of the cutting stylus and cutting needles such as are shown in Fig. 1 are used on this adjustment, the results should be satisfactory provided we have a quality stylus with clean edges and properly ground cutting angles. It should be remembered that we are concerned with the face angle of the cutting needle at the extreme tip or cutting edge in this type needle. One source of annoyance, however, is that cutting styli ground in this manner vary in production in the amount in which the face is ground down so that throughout the production run of a quantity of styli of this type, we have the maximum and minimum variations in cutting face vertical angles, as shown in Figs. 1 and 2. Therefore, if the cutting head is designed for vertical operation of the cutting needle face tip section, then the stylus shown in Fig. 2 will have a "toeing in" effect for this same adjustment. The stylus in Fig. 1 will be satisfactory and beyond certain limitations, styli as shown in Fig. 2 will be unsatisfactory to the consumer in the field. This excessive "toeing in" in most cases would not be detrimental if perfectly flat discs were used, but since most blanks in the cheaper class are warped or do not lie perfectly flat, the "toeing in" will be accentuated and the equipment will thus not operate properly unless a better disc is used or the stylus changed (see Fig. 3). It is not considered practical to have equipment in the home recorder class with heads adjustable for vertical angle stylus adjustment so, therefore, the equipment manufacturer should have acceptable limitations on the cutting stylus shipped out with each new instrument.

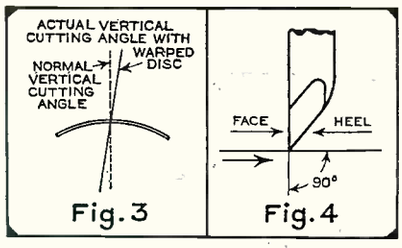
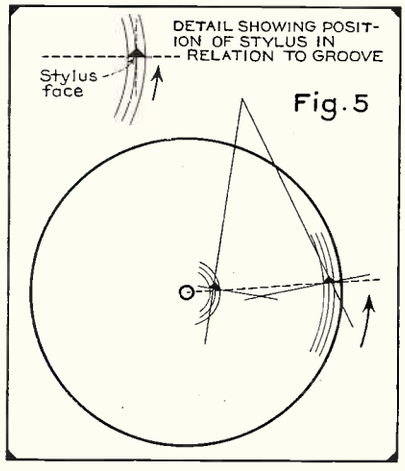


Fig. 3. Effect of warped disc on vertical face angle. Fig. 4. Stylus ground with face parallel to vertical axis.

Recent improvements in alloyed cutting styli permit standardizing the cutting angles, which are easily controlled in production. This stylus is shown in Fig. 4. The stylus cutting face is ground parallel to the stylus shank axis, and can be carefully controlled. This new needle now permits a standard factory setting of the cutting head so that the adjustment made on final inspection need not be tampered with in the field.

The horizontal angle of the cutting stylus or the amount the cutting face is rotated with respect to the stylus vertical angle naturally will have an effect on the ability of the stylus to help throw the thread, or shaving. A stylus ground with the face rotated only three degrees will be satisfactory on the average recording blank. Unfortunately, however, styli in the past were ground with many variations and throughout a number of needles in production may have varied as much as three to eight degrees. Three degrees would cause no ill-effects, but when rotated as much as eight degrees, and especially when used on pivoted straight arms ill-effects may be noticed on the innermost grooves, if not present on starting the recording at the outside of the record. This can easily be understood when one considers that cutting head stylus chucks vary slightly in production and the positioning of the stylus in the chuck will consequently also vary slightly. A few burrs resulting from broaching the chuck will also affect the exact horizontal face angle, but if this variation is on the positive side, then this slight variation in horizontal angle will not be noticeable if the cutting stylus is held to specified limits. It is best practice for the recording head manufacturer to control his production so that the chuck locates the stylus toward the positive angle and then depend upon the proper limits of the cutting stylus and disc surface tension to do the rest.

Showing operation of stylus with pivoted straight arm.



A stylus with 90-degree vertical face angle located in a straight cutting arm with pivoted axis will be off tangent on the inner grooves, as shown in Fig. 5. This will increase the distortion of the recording through pinch effect and wave form distortion. The design of a good pivoted type cutting arm reverts back to the off-set pick-up discussion which was brought out some time ago on reproducing sound-on-disc. The same reasoning also applies on the initial recording.

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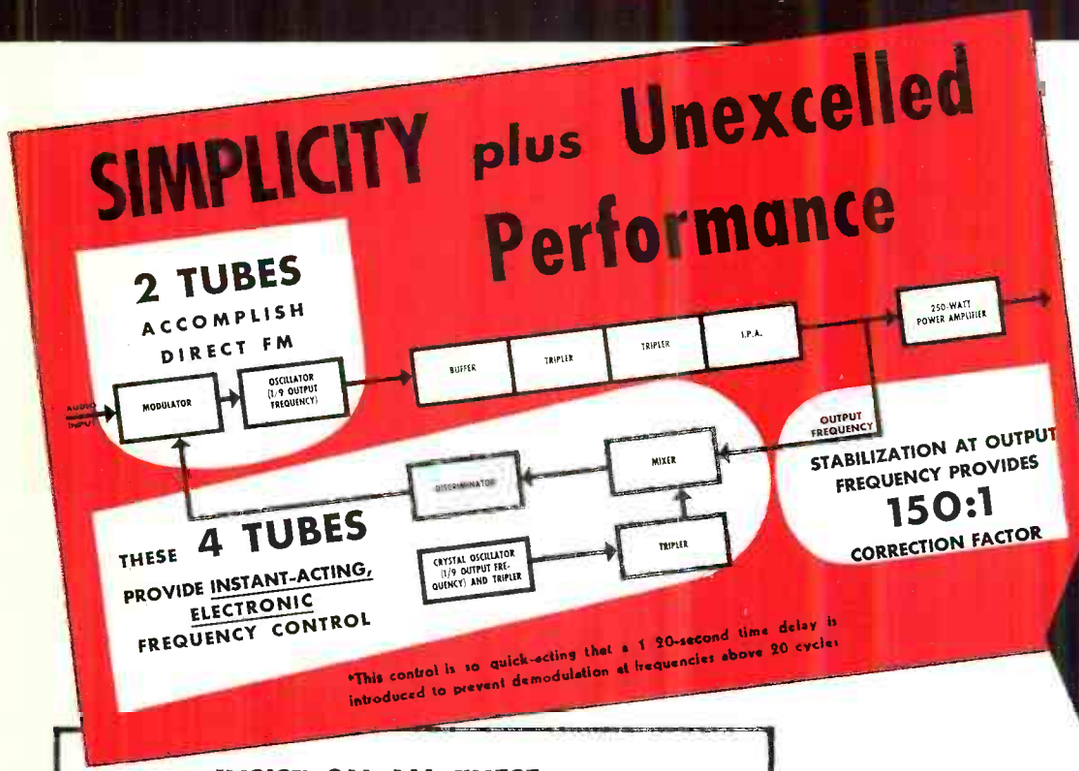

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GENERAL ELECTRIC

160-10

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

Season's Greetings

ON behalf of our officers, directors and our entire membership we express our most sincere wishes that all may enjoy a Merry Christmas and a Happy New Year.

16th Annual

The Sixteenth Annual Dinner-Cruise of our association will be held at the Hotel Astor in New York City on Tuesday evening, February 1, 1941. We urge all to cooperate and assure this being the most outstanding Cruise success in our history. It will be splendid if our chapter groups find it feasible to participate in this anniversary celebration by holding their Cruise on the same evening. Further details of the plans will appear next month. In the meantime, please keep the date in mind. We want to see you all there.

Boston

We have received a most interesting report of the Testimonial Dinner tendered "Wireless Pioneer" Bill Beakes by the Boston Chapter recently at which function the "Wireless Pioneer" Gold Medal, recently awarded him by our association, was presented. Our sincere appreciation for the grand job—done on short notice—by Guy Entwistle, in arranging the dinner and furnishing the details for publication herein.

Guy's report follows:

"On Friday evening, November 8th, 1940, at the Hotel Manger, Boston, Mass., the local 'Yankee Chapter' of the Veteran Wireless Operators Association was privileged to honor the pioneering activity of one of its members. Most of the local chapter members assembled at short notice and presented the special 'Wireless Pioneer' Gold Medal award to William E. Beakes, President of the Tropical Radio Company, whose activities in wireless dates back to 1902 when he was with the United States Signal Corps. In 1904, Bill Beakes, as he is often called by his friends, participated in the first experiments involving trans-Atlantic radio telegraph transmission between the old Brandt Rock station 'BO' and MacRihanish, Scotland. These tests were to prove the inventions and research of another local Boston inventor, Reginald A. Fessenden. Beakes was the first to hear the signals from America and rightly holds the distinction as one of America's pioneer radio operators—a true veteran. Among his associates with the Fessenden Company in the early days were such well known personalities as A. J. Pannill, Arthur Isbell, Harry C. Gawler, each of whom has made a name for himself since those early years.

"Later Mr. Beakes joined the United Fruit Company where he was to make a name for himself in its radio division, the Tropical Radio Telegraph Company, for which company the same Fessenden also supplied equipment. It was with the Tropical Radio Co. that Mr. Beakes undertook the development of radio communications in the Latin American countries, where today one of the most efficient and complete systems of both radio telegraphy and radio telephony exist, due to his untiring and energetic efforts. His activities also include the marine radio service of the United Fruit Company with over one hundred radio equipped vessels.

"In those early days of this Century, short waves, which are universally used today to pierce through static so prevalent in the Tropics, were still unknow and the difficulties of radio communication in the Tropics even when comparatively short distances were involved can well be imagined. Today largely due to Mr. Beake's efforts, the countries of the Caribbean from Guatemala through to Panama and Columbia are equipped with the most modern radio telegraph and radio telephone apparatus.

The meeting was called to order by Chairman Jim Barnes who, after greeting the members and honored guests, turned the ceremonies over to the toastmaster, Julius A. Loyal of RCAC.

"Numerous members of the communications fraternity such as RCA, MacKay, Tropical Radio, United Fruit Company, Postal Telegraph, Western Union, U. S. Army, U. S. Navy, Boston Edison Company, as well as members from the local broadcasting stations were present. Mr. Williams local Superintendent of MacKay Radio told of incidents when he and Mr. Beakes were riding through the jungles in a flat car to establish some of the early stations. Mr. Harris, chief engineer, Tropical Radio, spoke of the respect and affection of the engineering department for their chief, Bill Beakes. Telegrams poured in from all parts of the Tropics via Tropical from Chicago and New York via Postal and Western Union from Mr. Beakes' personal friends co-workers and acquaintances all over North and Central America as well as from ships at sea.

"All this had a visible effect on Mr. Beakes who was touched by the remembrances. Mr. Beakes had recently passed through a serious illness, and it was a very appropriate time to bestow upon him such honors.

"After hearing from several representatives of other communication companies such as Mr. Donagher, Postal Telegraph; Mr. Benjamin Titow, manager of the Local RCAC; Mr. Barrett of Commercial Cables; Colonel T. H. Van Horn, Signal Officer, First Corp Area (who served in the Philippines as did Mr. Beakes); Lieut. R. T. Smith, Asst. DCS of the Boston Navy Yard, 1st District; Mr. H. Rowe, vice-president in charge of engineering for the United Fruit Company; J. R. Kansas, executive assistant to the vice president, United Fruit Company; W. V. Lamprey of United Fruit Co.; R. V. Howley, vice president, Tropical Radio; Bart McCarthy, Federal Communication Commission; Harry Hood, chief operator of TRT at Hingham, Mass.; personnel director of Boston Edison Company and many other notables, the "Wireless Pioneer" Medal Award was presented to Mr. Beakes by Mr. R. V. Howley, vice president of Tropical Radio, a co-worker with Mr. Beakes. Mr. Howley praised the sterling mental and spiritual qualities of his chief and explained the wonderful sense of loyalty and consideration that the members of his organization had for the "Chief".

"The reading of the congratulatory telegrams was done by John McNamara, one of the regular WBZ staff announcers. Julius A. Loyal, commercial representative of RCAC acted as toastmaster and did an excellent job. The usual run of stories and anecdotes were interpersed between the speeches.

"Among others in attendance were: Mackay Radio: Williams, Serrezze, Foster; FCC: McCarthy; Tropical Radio; Hood, Heaps, Rogers, Gunlack, Demitra, Mulvey; United Fruit Co.: Beakes, Howley, Rowe, Lamprey, Kansas; RCAC: Titow, Loyal; U. S. Army: Col. T. H. Van Horn; U. S. aNvy, Lieut. R. T. Smith; Boston Edison Co.: Ferguson, Erickson, Archibald; WBZ: McNamara; VWOA: Powers, Kent, Stockelberg, Barnes, Lazenby, Erickson, Tierney, Greene, Entwistle, Beane, Dennis and Wilbur.

"The Program Committee included Messers Loyal, Entwistle, Barnes, McCarthy, Lazenby and Stockellberg."

A splendid job fellows and thanks to Guy for the report.—Mc.

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BOOK REVIEW

HANDBOOK OF CHEMISTRY AND PHYSICS, 24th edition; Chemical Rubber Publishing Co. of Cleveland, 1940; *2,564 pages, simulated leather binding,* $3.50.

Continuing to grow, the invaluable *Handbook of Chemistry and Physics* has been re-arranged as well as enlarged. In the edition just released the listing of physical constants of organic compounds has been restored to the convenient tabular arrangement. More than 300 new compounds have been added to the listing.

Of special interest to manufacturers and engineers in the communications field is the new revision and enlargement of the listing of commercial plastics. Twenty-seven plastics manufacturers are named, and forty-nine commercially available plastics identified by trade name and chem-

(*Continued on page* 29)

BROADCAST ENGINEERING CONFERENCE

THE Fourth Broadcast Engineering Conference has been scheduled for February 10 to 21, 1941, at Columbus, Ohio, and is under the direction of Dr. W. L. Everitt, Professor of Electrical Engineering in charge of instruction in communication at Ohio State University.

The Conference will be held under the auspices of the Ohio State University and will have the official cooperation of the National Association of Broadcasters.

The Third Conference held in February of this year attracted 248 engineers from 35 states. The prominence of the speakers for the Fourth Conference indicates that the steady growth of attendance will continue.

E. K. Jett, Chief Engineer of the FCC, will address the Conference on the timely subject "Communication in National Defense."

A. D. Ring, Assistant Chief Engineer of the FCC in charge of broadcasting will again conduct the "General Discussion and Question Box" concerning broadcast engineering regulation problems. This was one of the most popular sessions last year. New problems that have arisen since that time and Mr. Ring's interesting method of presentation promises to make this an outstanding session.

Discussion about frequency modulation has been accompanied by much discussion on "high fidelity". Harvey Fletcher, of the Bell Telephone Laboratories, is the leading research worker on the response of the human ear and his paper "Hearing, The Determining Factor for High Fidelity" should serve to put in quantitative form many of the conceptions concerning "high fidelity".

Frequency modulation will occupy a prominent place on the agenda and the F-M sessions will be introduced by the dean of wide-band proponents, Major Edwin H. Armstrong of Columbia University.

The National Television Standards Committee was formed late this summer with the official cooperation of the FCC for the purpose of forming television standards agreeable to the whole industry. Dr. W. R. G. Baker, of the General Electric Company and Director of Engineering for the Radio Manufacturers Association, is Chairman of the Committee and he will discuss the formulation of standards. It is anticipated that the work of the Committee will be concluded by Conference time.

Of recent interest has been color television, brought to the foreground by Dr. Peter Goldmark, who is in charge of television engineering for the Columbia Broadcasting System. Dr. Goldmark will describe the color system he has developed and demonstrated for CBS.

A new feaure of the Fourth Conference will be laboratory periods during which the members of the Conference will have an opportunity to make broadcast station measurements with the latest test equipment. Manufacturers will supply the equipment and instructors. General Radio Company and the RCA Manufacturing Company have already promised cooperation in this new venture, and several others have signified their intention to do so.

The program for the Conference will be completed by the last of December and will be published then.

Dr. Everitt, Director of the Conference, is the author of the book "communication Engineering" used in some 60 schools. He received his Ph. D. from Ohio State University in 1933 and he is a fellow in The Institute of Radio Engineers and the American Institute of Electrical Engineers. Dr. Everitt has been Professor of Electrical Engineering in charge of instruction in communication at Ohio State since 1926.

Those who are interested in the Conference should address Dr. W. L. Everitt, Director of the Conference, Ohio State University, Columbus, Ohio, and they will be placed on the mailing list to receive further details concerning the Conference.

RECORDING TRUCK By Dr. Ralph L. Power

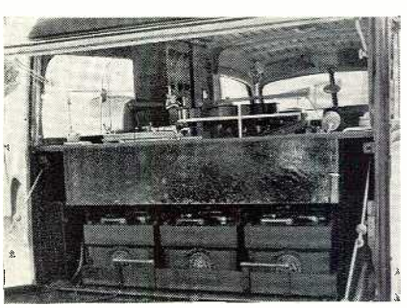
THE idea of sound trucks, of course, is not new. Neither is the scheme of installing recording equipment in cars and traveling about the country to get on-the-spot happenings. But apparently little concerted effort has been made to make uniform or standardized installations in equipment of this type. By far and large such apparatus has been of the custom built order, or a grouping of assorted apparatus.

Now, however, the Universal Microphone Co. has made available a complete setup that can be installed in short order. The entire assembly is especially designed to fit into a V8 station wagon, since this car model has been found to be popular, lightweight in construction, speedy and roomy enough for personal belongings. Operation of this recording equipment is from 110 volts a-c or from 32 volts d-c.

The recording machine used in this equipment is of the professional type. It is mounted on a metal-bound ten-ply veneered table. This table, in turn, is mounted on three screw-type jacks which are rubber cushioned.

There are no additional accessories needed in this station wagon installation, since the equipment also includes a small 500-ohm battery-operated remote amplifier, hold-downs for the carriage and motor, levels, jacks, lights over both amplifier and turntable, a tool chest, individual tool holders, etc.

A rear view of the sound truck, showing batteries and recording equipment.



An inside view of the truck showing the professional recorder and associated equipment. Remote amplifier is also furnished.

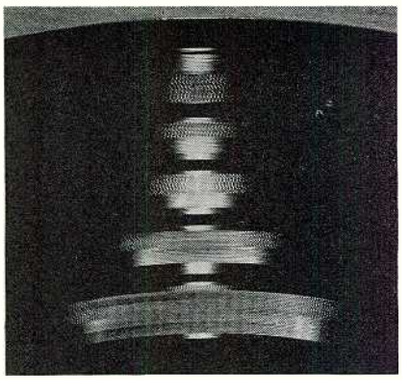


Fig. 3. The 1000 cycle and 5000 cycle pattern.

Extended Experimental Study of

THE OPTICAL PATTERN

By C. J. LEBEL

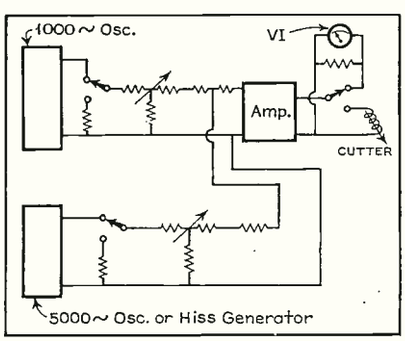
SOMETIMES an idea is adopted very uncritically. The optical pattern effect used so widely is a good example of this. Published originally in 1930, there has been little further investigation, though the pattern has been in general use.

In connection with some development engineering it became desirable to study further the implications of Buchman and Meyer's work.

In any test record we have three disturbing factors: Hum—as represented by amplifier hum and recording machine vibration; surface noise; direction of cutting stylus motion if not precisely lateral. The first two show up as a very narrow pattern when no signal is impressed. A number of engineers have adopted the practice of directly subtracting the width of the "noise pattern" from the pattern width of the noise plus signal. To check the accuracy of this practice as well as to facilitate certain experimental studies an investigation was undertaken. The experimental tests preliminary to a full mathematical analysis proved so illuminating that data on them is presented herewith.

It will be recalled that the discoverers showed that for a single frequency pattern, width is directly proportional to velocity. Further, they stated that a second tone (specifically, a harmonic) would show up as a brighter inner line.

Fig. 1. Circuit used for combining tones.



A photo purported to show this effect, though not very clearly.

Three amplifications of this are discussed: two tones combined, an infinite number of tones combined, and diagonal stylus motion.

The first study was of the effect of combining two tones—specifically, 1000 and 5000 cycles. The circuit of Fig. 1 was used. A 1000-cycle band was cut,

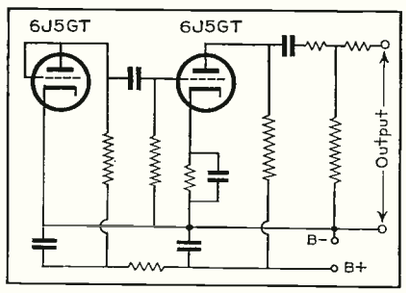


Fig. 2. Circuit of the hiss generator.

then a 5000-cycle band, then both simultaneously. It will be noted that a special mixing system was used to assure freedom from interaction of one oscillator on the other. The cutter used had knife edge bearings, laminated armature and polepieces, and heavy damping. Its linearity was excellent. The amplifier linearity was as satisfactory, push pull 2A3's with fixed bias being used. Good quality instantaneous recording blanks were used for all tests.

Tests were made by cutting a 1000-cycle band, then 5000-cycle bands at various levels. Then combinations of 1000 cycles at fixed level with the previously determined levels of 5000-cycle tone were recorded. In all cases it was necessary to work well within the cutter's linear range. The resulting pattern widths were measured, and the interrelations computed.

There was no evidence of the existence of any inner lines or inner patterns. Careful examination showed only the clear boundary of the main pattern in each case. Occasionally imperfect lighting would develop shadow bands on the pattern, but as soon as the lighting was made parallel and uniform this disappeared. It is possible that some effect exists, but no evidence thereof developed.

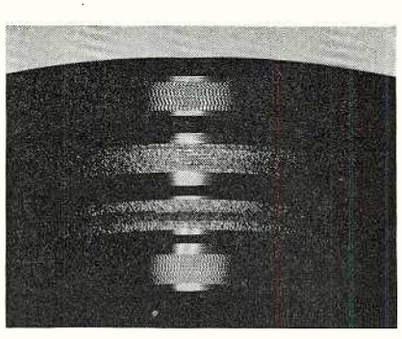
A second study was made in similar fashion, combining 1000 cycles and hiss. The noise resulting from operating a diode beyond the saturation was used. It is recognized that this provides a continuous sound spectrum (an infinite number of frequencies) with a substantially uniform energy distribution. No studies have been made of the energy distribution of surface noise on an *instantaneous* recording and so it cannot be said categorically that the result was identical. It is safe to say that the result was similar in character (judging by ear) and satisfactory for the purpose, for it was a continuous spectrum. Fig. 2 shows the circuit of the hiss generator. While there was no trouble with hum pickup there was considerable microphonic effect, and it became necessary to place the unit on heavy felt within a massive cast aluminum box.

This second study was definitely not as accurate as the first. The pattern of a hiss does not have a sharp, well-defined edge and so measurements were inherently less precise. In part this could be overcome by averaging many readings, which was done.

It is interesting to observe that a record of hiss has the same dull looking groove walls that a record would have when cut by a dull stylus. The resemblance is striking.

The results did not conform to any particular relation with great precision. However, there was a pretty close cor-

Fig. 4. The 1000 cycle and hiss pattern.



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- LOW TEMPERATURE RISE

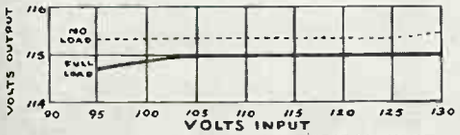
AUTOMATIC VOLTAGE REGULATORS

95-130 VOLT INPUTS . . . 110, 115, 120 VOLTS OUTPUT ± 1%

The UTC automatic voltage regulator is NEW. It involves no moving parts and effects instantaneous correction for either transient or chronic line voltage fluctuations.

STANDARD TYPES

Type No.	Capacity VA — 60 Cyc.	Net Price
AR-1	15	$12.00
AR-2	30	15.00
AR-3	60	21.00
AR-4	120	28.00
AR-5	250	46.00
AR-6	500	67.00
AR-7	1000	110.00
AR-8	2000	200.00



CHARACTERISTICS OF TYPICAL UNIT

Designs for 220 volt service available at 25% increase in price, for 50 cycle units increase price 25%; for 42 cycles, 35% increase; for 25 cycles, increase price 100%. Special secondary voltages available to customers' specifications at small increase in price.

SPECIAL UNITS

The unique design of these regulators makes possible the construction of special units with relative ease. The output can be arranged to provide filament and plate voltage, or any other special voltages that may be required. Write for details.

UNITED TRANSFORMER CORP.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

relation with the root mean square, which is—

$$A^2 = \sqrt{C^2 - B^2}$$

where A = width of pattern from tone A
B = width of pattern from tone B
C = width of composite pattern.

This, of course, is the same relation as is used in combining two a-c voltages of different frequencies.

No pretense is made that this formula necessarily must hold in completely rigorous fashion. It does hold for any ordinary work and for any common engineering tests of a precision less than that involved when width measurements are made by cathetometer. A mathematical study now in progress will develop a more rigorous, but undoubtedly more cumbersome result. There is no doubt that direct arithmetic correction (by pure subtraction) is incorrect.

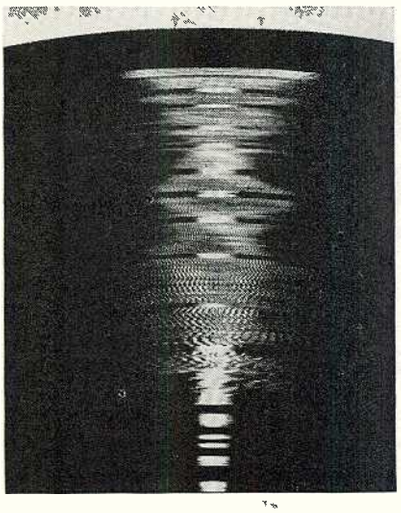


Fig. 5. Diagonal motion pattern.

Finally we have a rather interesting effect shown in Fig. 5. For the record and the original observation the writer is indebted to the Harvard Film Service and its head, J. R. Brewster. Here the opposite sides of the pattern are not alike; in fact, are quite different, indeed. This peculiar effect results when the bearing construction is not satisfactory, allowing the stylus to move up and down as well as laterally. The commercial cutter which produced this has a metal bearing for the vibrating system, but lack of shaft rigidity seems fatal to its effectiveness.

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FM-AM RECEIVER

(*Continued from page* 14)

an FM signal, the meter goes through a complete cycle of operation. Starting at its normal zero position it first indicates rising voltage of one polarity, drops through zero to indicate voltage of the opposite polarity and finally drops to the no-signal zero position again as the limits of the signal are passed. At the point where zero is passed, between the voltage peaks of opposite polarity, the receiver is tuned to precise resonance as this indicates a completely balanced condition of the discriminator circuit. It is only when thus tuned that freedom from distortion and static will always be obtainable.

The I-F Amplifier

While the tuned r-f stage is depended upon for gain and therefore for its contribution to sensitivity and better signal-to-noise ratio, its contribution to signal selectivity is, of course, very small. This must be achieved in the i-f amplifier. In this amplifier there is also the need for wide band-pass in FM reception. To best meet all these requirements a frequency of 5.25 mc was selected. This places images 10.5 mc apart, and while the selectivity of individual tuned circuits operating at this frequency is relatively low, the combined effect of several such cascaded circuits is ample for the AM selectivity requirements at the ultra-high frequencies.

There are four i-f stages in all, that is if the FM limiter stage is considered as an amplifier. Of these the first two are common to both the AM and FM channels, then each of these channels has an additional stage of its own. The first three transformers, including six tuned circuits, are of the expanding type with the result that in the "broad" position the selectivity characteristic of the signal at the output of the second stage is 218 kc wide at 2X down, which is entirely ample for effective limiter action in the following FM circuit. In the "sharp" position the selectivity is increased greatly and while too sharp for effective FM reception is better suited for AM reception.

The additional i-f stage in the AM channel includes another pair of tuned circuits, designed for maximum selectivity. The transformer following the limiter tube in the FM channel is, on the other hand, purposely arranged, by careful balance of coupling and loading, to maintain the wide, flat characteristic required in order that the discriminator output voltage will vary linearly with variations in signal frequency and thus provide distortionless detection. The result is the FM detection characteristic of Fig. 4.

While the AM circuit, from the 2nd i-f stage to the point where the two channels again come together at the audio amplifier stage, is quite conventional, it is well to remark that the noise limiter circuit which utilized the second section of the diode is unusually effective in reducing not only ignition noise but a wide variety of other types of noise interference. The reason is that this type of automatic limiter circuit works best following circuits in which the higher frequency components of the noise impulses are passed readily. This means that it is more effective following a 5.25 mc amplifier than following a more selective 465 kc amplifier, for instance.

This is fortunate because a receiver operating in the range from 30 to approximately 75 mc is particularly susceptible to ignition noise. But for the reason mentioned the S-27 suffers less from this type of interference than receivers using the same type of noise limiter on lower frequencies where such noise is ordinarily less troublesome.

The FM and AM channels become one again at the input to the resistance-coupled, phase inverter audio stage which is self-balancing. The push-pull output stage using 6V6G's employs inverse feedback with the result that, with the tone control set in the "high-fidelity" position, the response characteristic is extremely flat and distortion reduced to a minimum. Shifting the tone control switch to the "Bass Boost" position raises the low-frequency response about 12 db as indicated by the upper curve of Fig. 2. The tone control also affords "Low" and "Normal" response positions to provide different degrees of high-frequency cut-off to meet the different requirements of communications operations.

Operating Features

Operation is much like that of any communications-type receiver. The fact that the S-27 is also capable of receiving FM signals introduces no complications because all necessary switching operations are performed by the one FM-AM change-over switch on the front panel. This shifts inputs to the first audio tube, changes over the function of the meter, and changes the a-v-c line from one source to another. Other controls and switches are set as they would be for high-quality AM broadcast reception, and that's all there is to it.

The input circuit is designed to match transmission line impedances between 75 and 100 ohms, making it most suitable for use with twisted-pair or concentric lines. However, efficient energy transfer will also be obtained with open lines of up to 400 ohms. Where pick-up efficiency is not deemed important, an "L" type of antenna, or random length of wire may be used by connecting it to the "A1" antenna terminal and grounding the "A2" terminal to the adjacent "Gnd" terminal.

Outputs of 500 and 5000 ohms are provided as well as a headphone jack.

OVER THE TAPE . . .

NEWS OF THE COMMUNICATIONS FIELD

NEW EQUIPMENT

The Delta Broadcasting Co., Escanaba, Michigan, goes on the air January 15, 1941, under the management of Mr. Gordon Brozek. This company has purchased from Gates Radio & Supply Co., Quincy, Illinois, complete 250-A transmitter, limiting amplifier, SIE-27 speech equipment, remote equipment and vertical radiator. New equipment has been purchased by Station WGRM, of Greenwood, Michigan (recent new affiliate of N.B.C.), which has placed its order with Gates for a Model S251 transmitter. The new Neuces Broadcasting Co., of Corpus Christi, Texas, whose station has been recently licensed, has placed an order for a Model S251 transmitter with Gates Radio & Supply Co.

C-D CAPACITOR CATALOG

Just off the presses is the Cornell-Dubilier 1941 radio capacitor bulletin No. 185A in which are listed and illustrated all types of capacitors for radio applications, including mica, paper, wet and dry electrolytics, Dykanol, etc. Information on each type includes full ratings, sizes with dimensional drawings, and prices. All items are classified and arranged for accurate and speedy reference. Cornell-Dubilier Electric Corp., South Plainfield, New Jersey.

JENSEN SOUNDROOM

Having nearly ten times the enclosed volume of the next largest similar structure, the new "free-space" soundroom of the Jensen Radio Mfg. Co., is nearing completion. According to Hugh S. Knowles, Jensen vice-president and chief engineer, the new soundroom will permit a more accurate determination of the response and directional characteristics of loudspeakers at low frequencies and will greatly facilitate precision acoustical measurements.

GENERAL ELECTRIC BULLETINS

General Electric Co., Schenectady, N. Y., have made available two new bulletins. One of these, Bulletin GEA-3327A, gives data on a new 250-watt broadcast transmitter. The other bulletin, GEA-3484, describes a 1000-watt frequency-modulated broadcast transmitter.

TURNER VIBRATORS

The Turner Company, Cedar Rapids, Iowa, announces that it is now licensed to manufacture vibrators for car and other portable radios under James Patents No. 1,940,496 and No. 2,113,726 and other patents pending. Turner will be in production and ready to make delivery January 1, 1941.

FEDERAL TELEGRAPH BULLETINS

The Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J., have made available three bulletins giving operating data and ratings on their F-127-A, F-129-B an F-342-R transmitting tubes. Copies may be secured by writing to the above organization.

BRADLEY CATALOG

A new catalog issued by the Bradley Laboratories, 82 Meadow Street, New Haven, Conn., shows the complete line of "Luxtron" photo-electric cells as supplied to manufacturers of photo-electric measurement and control devices, or to individuals. Listed types include both mounted and unmounted cells, round or rectangular, in a variety of sizes and in several different terminal arrangements.

NATIONAL UNION SELECTIVE SERVICE POLICY

Mr. S. W. Muldowny, president of National Union Radio Corp. has informed the various employees of the company of the policy adopted towards those employees who volunteer or are drafted for one year military service. This includes one month's salary, carrying of group insurance, and provision for re-employment. Notice has been given to all employees as follows: Monthly and semi-monthly employees will be paid one month's salary. Weekly salaried employees will be paid four weeks salary. Hourly employees will be paid 160 hours at their normal base rate (four full weeks pay).

The above provisions cover all employees having more than one year's seniority; those having less than one year's seniority will be paid one-half the preceding amounts. The company will pay the entire group life insurance premium for a period of one year and forty days. Employees will be credited with seniority while in the service in the same manner that the seniority would accumulate if they were working. At the conclusion of the one-year service period, the company will re-employ former employees called to the service in the manner and under conditions set forth in the Selective Service and Training Act of 1940.

FORMICA DATA BOOK

The "How, Where and Why" of Formica is given in a well-illustrated, handsomely bound booklet issued by The Formica Insulation Co., Cincinnati, Ohio. Data is given on the use of Formica in the electrical, radio, X-ray, telephone, aeronautical, and other fields. In addition the manufacture of this product is described in some detail, and tables of properties cover the physical, chemical and electrical properties of the various grades of Formica. Information is given on the decorative grades of this material, as well as to machining, punching, sawing, drilling, tapping, threading, turning and milling of this product. Copy of the booklet may be secured by writing to the above organization.

HEWLETT-PACKARD EXPANDS

The Hewlett-Packard Co., Palo Alto, Calif., has just taken space in an adjoining building to provide additional manufacturing facilities. This is the second move for this company within less than a year. The entire building into which the concern moved only a few months ago from a former location is now devoted to offices and laboratory, while the second building will contain the machine shop, stock room and assembly lines.

CHANGE OF ADDRESS

Harvey Radio Laboratories, Inc., have recently occupied new quarters. The new address is 447 Concord Ave., Cambridge, Mass.

G-E BULLETIN

The General Electric Co., Schenectady, N. Y., have just issued a bulletin on their line of frequency-modulation communication equipment (receivers and 25-watt transmitters). Write to the above organization for Bulletin GEA-3480.

"PICKUP FACTS"

The most recent issue of "Pickup Facts" contains some interesting data on needle point pressure, vibratory momentum, groove skating, as well as information on the "relayed-flux" Microdyne pickup. Copies may be obtained by writing to the Audak Co., 500 Fifth Ave., New York City.

RCAC APPOINTMENTS

Six executives of R. C. A. Communications, Inc., a service of the Radio Corporation of America, were elected vice presidents at a meeting of the RCAC Board of Directors, W. A. Winterbottom, vice president and general manager of the company, announced. Those elected and their new titles follow: John B. Rostron, vice president and traffic manager; C. W. Latimer, vice president and chief operations engineer; H. H. Beverage, vice president in charge of research and development; F. W. Wozencraft, vice president and general counsel; L. G. Hills, vice president and controller; A. B. Tuttle, vice president and treasurer.

FINCH TO DBC

Finch Telecommunications, Inc., Passaic, N. J., manufacturers of facsimile equipment, has been named to the newly-created Domestic Broadcasting Committee, a technical branch of the Defense Communications Board. The announcement was made November 25th in Washington, D. C., by members of the Defense Communications Board after it had been decided to establish 11 similar technical committees.

NEELY OFFICE

Norman B. Neely, west coast manufacturers agent, recently opened an office at 420 Market Street, San Francisco, California. Mr. Homer E. Beren, sales engineer, will be in charge of the San Francisco office spending his full time in the Northern California territory. Mr. Beren graduated from Stanford University in 1935, receiving his degree in electrical engineering.

GARRARD CATALOG

Garrard Sales Corp., 296 Broadway, New York City, have made available Catalog No. 40. Rather complete data is given on record playing equipment. Write to the above organization to secure a copy of this catalog.

CRYSTAL CUTTER

(*Continued from page* 11)

$$(1-2)\ \frac{1}{2\pi f_1 C_1} = \frac{1}{2\pi f_2 C_2}$$

$$1000\ C_2 = 500\ C_1$$

$$C_2 = .5\ C_1$$

The partial solution of the design formulae shows that the network consists of a single resistance and a low-valued and inexpensive condenser.

Coupling Networks

It will be recalled that the networks analyzed in the last section were hypothicated upon a generator impedance of zero. How will a practical generator, consisting of a vacuum-tube amplifier, complicate this situation? The first solution is more or less obvious: make the vacuum-tube amplifier approach this ideal of a zero-impedance generator. This source impedance cannot be completely zero, of course, but it is effectively zero if its absolute magnitude is no larger than one-third of R_1 or R_2 in the respective circuits. (Simple calculations can justify these conclusions, but for brevity's sake, will not be included here.) Therefore, from the point of view of the cutters, the circuits of Figs. 3 and 5 are satisfactory, providing only that the generators have a suitable coupling device, such as a transformer, so that the impedance looking back into the amplifier from the terminals to the equalizer have approximately the value shown above. This is shown in Fig. 6.

From the point of view of the tube, however, such a simple solution is not entirely proper, since the tube now looks into an impedance much higher, in each case, than it is designed for. Triode output tubes can tolerate this mismatch without excessive distortion, but where pentode or beam power tubes are used, a further correction is required. This correction is simple, and is shown in Fig. 7, where the tube is terminated in its proper impedance, and at the same time the equalizers operate out of practically a zero-impedance generator.

Sensitivity

The preceding solution is perfectly satisfactory from the point of view of response, but it has one limitation in that it is not particularly efficient. It is seen at once that such a solution provides a considerable mismatch between the tube and cutter. Where sufficient power is available, this probably represents the simplest solution, particularly where pentode or beam type output tubes are used. Such tubes are rather critical as to proper load, and generate excessive harmonic distortion when badly mismatched.

Low plate resistance triode output tubes are not critical as to load resistance, and considerable mismatch between tube and load is permissible without objectionable distortion. A considerably more efficient coupling circuit can be evolved, therefore, if triode output tubes are used.

Referring to Fig. 3, it will be remembered that the response shown in Fig. 2 could be obtained by placing in series with the crystal cutter and the zero impedance generator a resistor having the value $R_1 = \left| \frac{1}{2\pi f_1 C_1} \right|$, where C_1 was the capacity of the cutter and f_1 was 500 cycles. A vacuum tube can be considered to be a zero-impedance generator in series with the plate resistance of the tube. This plate resistance can be used, therefore, for R_1 in the above formula, providing a proper coupling transformer is used. If R_{PL} is the plate resistance of the tube, then a coupling transformer between tube and cutter having the following turns ratio is required:

$$\frac{n_P}{n_s} = K \sqrt{\frac{R_1 - R_s}{R_p + R_{p1}}}$$

where k is the coupling coefficient of the transformer, and is generally close to unity; $\frac{n_p}{n_s}$ is the turns ratio; and R_p and R_s are the ohmic resistances of the windings.

This network is very efficient and, using it, a power output of the usual ratio is amply sufficient to operate the normal cutter to full amplitude.

There is one more possible type of equilization. It will be recalled that the types of equalization thus far outlined require a coupling transformer between tube and cutter. The high impedance at the low frequencies adapts the crystal cutter to a very simple circuit without a transformer. This circuit is shown in Fig. 8, and it will be seen that the

circuit constants are related one to another by the following:

$$R_4 + R_{p1} = \left| \frac{1}{2\pi f_1 C_1} \right|$$

C_1 = capacity of crystal cutter
f_1 = 500 cycles
R_5 = 100,000; is used only to prevent a d.c. potential from building up across the crystal
R_{p1} = plate resistance of tube
$C_3 = 3\ C_1$.

Such a circuit, when used with a triode, is not only adequate from the point of view of sensitivity, but also is free from distortion, and the simplicity of parts makes it the better solution from the point of view of price and performance.

Distortion

It has already been pointed out that the use of pentode or beam power tubes may lead to complications, unless very careful attention is paid to matching such tubes to their loads. For an amplifier of normal power capacity and negligible distortion, the use of triode output stages is highly recommended. To be more specific, two output triodes in push-pull are characterized by ample output for normal use and by very little distortion.

It is an unfortunate fact, however, that price considerations frequently limit the quality which can be built into the audio system of a radio and such devices have a considerable amount of distortion. These sets continue to sell, however, and as a matter of fact, it is extremely difficult to determine how much distortion is tolerable in an audio system designed for the general public. But if recording is to be added to these machines, it must be remembered that the same audio system functions twice: once for recording, and once for reproducing, and the resulting distortions may well be beyond tolerance. This, of course, places added weight upon careful choice of a cutter which is free from distortion, since it is obviously extremely important not to add to the distortion of the normal amplifier any undue cutter distortion.

Distortion in crystal cutters may be generated in three ways: either in the motor mechanism, in the damping, or in the coupling from motor to recording disc. The third way is ordinarily negligible in the normal cutter. Unfortunately, however, the second point is very important, and to it may very often be traced the major portion of distortion. It is a fact that normal damping materials as generally used are non-linear in their force-displacement ratio. This means, of course, that any

cutter which has enough damping to control its response must be troubled with considerable damping distortion. It has been pointed out that the usual crystal cutter has such a high natural internal stiffness as to require but relatively little damping, with consequent little damping distortion.

Concerning the generating element itself, the crystal system is inherently likely to produce distortion if it is operated to its saturation point. With the normal crystal system, other design considerations require a crystal size large enough so that normal operating voltages do not approach conditions of appreciable distortion.

For a typical recording characteristic (i. e., constant amplitude to 500 c-p-s and constant velocity above this frequency and a stylus displacement of .0007" below the turnover frequency), the distortion of a crystal cutter of good design showed a distortion of 4% for 100 c-p-s, 3.5% for 200 c-p-s, and 1% for frequencies above 200 c-p-s. These distortions occurred at a typical room temperature of 73°F. For slightly lower or higher room temperatures. they will be even further reduced.

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BOOK REVIEW

(*Continued from page* 18)

ical composition. Electrical properties of each are given in terms of d-c resistivity, dielectric strength, dielectric constant at 60-1000 cycles and at 10^6 cycles; power factor at 60-1000 cycles and at 10^6 cycles. Other details listed are the forms in which the plastic is available (as powder, tube, sheet, etc.); suitability for compression or injection molding, blowing, extrusion, machining, and so on; clarity and color possibilities; thermal properties including heat distortion, softening point, thermal conductivity and thermal expansion; mechanical properties as to elasticity, tensile strength, impact strength, and hardness in Brinell number rating; chemical properties relating to the effect upon the plastic of sunlight, ultra-violet light, aging, moisture and reagents. A comparator table makes possible a quick check of the advantages and disadvantages of the various types of plastics with reference to 19 outstanding qualities.

An entirely new tabulation, not found in previous editions, has been assigned 65 pages and entitled "Physical Constants of Industrial Organic Compounds."

The new listing of physical constants of inorganic compounds occupies 520 pages and is, as said, in tabular form. Metal salts of organic acids are now included in the 155 pages of organic compounds; nevertheless the metal-organic tables cover 35 pages.

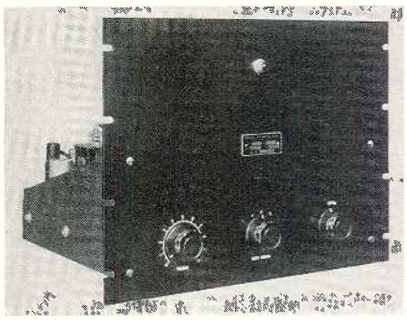
The new volume retains all the well-known listings of fundamental quantities and units used in physics, chemistry and mechanics; its convenient conversion tables of temperature, lengths, transmission units and so on; has added the latest tube types to its listings of radio, telephone and industrial tubes, has improved its data on photography and retained its convenient tables of wire cross-section and resistivity.

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATIONS FIELD

RECORDING AMPLIFIER

In the accompanying illustration is shown the new Presto 88-A 50 watt recording amplifier. The frequency response of this unit is matched to the characteristics of both the Presto 1-C cutting head and Presto recording discs. Combined with the above units and the 160-A automatic



equalizer, the 88-A makes available a recording system which will reproduce a frequency range from 50-9000 cycles. A selector switch permits pre-emphasis of high-frequency response to match the NBC orthacoustic system or the other recording systems standardized in most stations. Complete information may be secured from Presto Recording Corp., 242 W. 55th St., New York City.

VACUUM-TUBE VOLTMETER

In the accompanying illustration is shown a vacuum-tube voltmeter announced by Measurements Corp., Boonton, N. J. Features of this unit are described as follows:

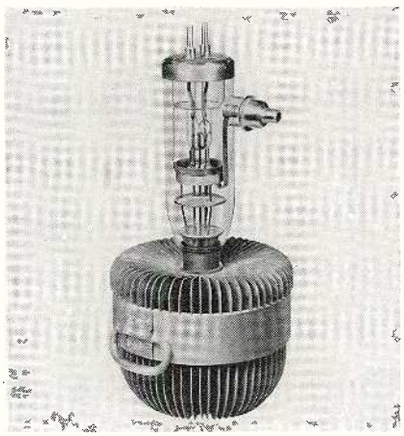
D-c voltmeter: Stabilized, balanced, degenerative amplifiers eliminate "zero drift"—no change of zero with range selection. Very high input resistance—less than 10^{-8} amperes grid current on all ranges. Provision for reversal of polarity—convenient in taking discriminator curves, etc. Linear scale calibration on all d-c ranges.

A-c voltmeter: Balanced diode circuit eliminates annoying zero drift on a-c ranges. Compact, low-loss, low capacity probe designed for minimum loading at high frequencies. Blocking condenser to separate a-c from d-c potentials applied to probe. On a-c the instrument is a peak voltmeter calibrated to read r-m-s values of a sine wave or 71% of the peak value of a complex wave.

Push-button selection of five ranges are available. These are 1, 3, 10, 30, 100 volts full scale, either a-c or d-c. The accuracy is said to be 2% of full scale on each range both a-c and d-c. Power supply is from 115 volts, 60 cycles.

FEDERAL TUBE

In the accompanying illustration is shown the Federal F-342-R air cooled transmitting tube. This triode is intended for use as an r-f power amplifier or oscillator. The maximum frequency of the tube is given as 4 mc. Maximum plate dissipation ratings are 10,000 watts for Class B



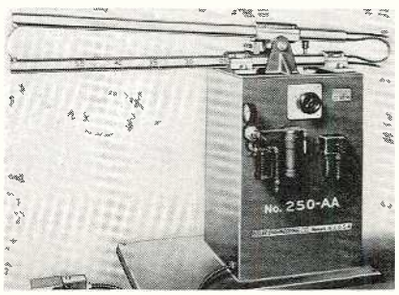
r-f power amplifier telephony and Class C r-f power amplifier and oscillator telegraphy, and 7000 watts as Class C r-f power amplifier telephony plate-modulated. A data sheet may be secured from the Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.

DUREZ 1910

A new development in high impact phenolic molding compounds has recently been completed by Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y., to be known as Durez, 1910. This is the third in their new series of 1900 materials. Durez 1910 has a particle size comparable to dry rice and may be preformed easily. It flows freely through standard feeders. Specific gravity is 1.45. Bulk factor is 3.6:1.

LONG-HORN SPOT WELDER

The Eisler Engineering Co., 740-770 So. 13th St., Newark, N. J., has placed on the market a long-horn spot welder No. 250-AA for deep sheet metal work. The new feature on this machine is that both upper and lower horns can be lengthened or shortened to meet the requirements of the size and type of work. The new horn adjustment makes it possible to weld light and heavy work and deep metal parts. The markings on the horn represent the kva ratings—when the horn is placed on the 25 kva mark it represents 25 kva, etc. The



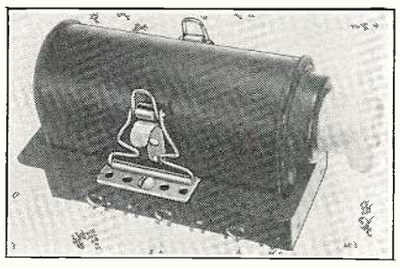
model illustrated is a 25 to 50 kva air-operated welder.

SYNTHETIC ENAMELS

A new line of synthetic enamels that air-dry so hard in 24 hours that they will not "paper print," is announced by Maas & Waldstein Co., makers of industrial finishes, 438 Riverside Ave., Newark, N. J. These new finishes which are known as Coprene enamels, have a chlorinated-rubber base. They air-dry dust-free in a very few minutes and become very hard over night under normal application conditions. The hardening is not merely a surface change, but is said to extend through the entire coating, thus making it resistant to handling, wrapping, etc. Similar hardening can be obtained by force-drying for 1 hour at 200° F. Coprene enamels are supplied in clear, black, white, and colors, and also in silver, copper, and other metallic lustres.

POWER PLUGS AND SOCKETS

Bulletin 500 has just been released by Howard B. Jones, 2300 Wabansia Ave., Chicago, illustrating and describing their new 500 Series Power Plugs and Sockets. These plugs and sockets are designed for 5000 volts and 25 amperes, and are made in 2, 4, 6, 8, 10 and 12 contacts. All sizes are polarized so that it is impossible to make incorrect connections, even when using several sizes on a single installation. The cap is arranged so that a standard cable clamp can be used; connections are easily and quickly made, and cap body can



be removed for inspection without disturbing wiring. The design of the unit prevents the fingers from coming in contact with the prongs while they are still in contact with the socket terminals, preventing the possibility of shock or injury.

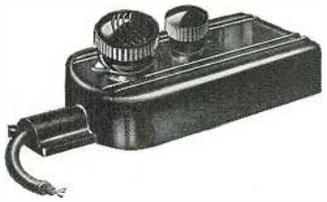
SEMI-COMMUNICATIONS RECEIVER

A new type of receiver has been introduced by the Echophone Radio Corp., 201 East 26th Street, Chicago, in its Model EC-1 "Commercial." Its distinction lies in the fact that while in general it is of the a-c/d-c "compact" type, and serves all the purposes of this type, it also provides a number of features usually found only in receivers of the "communications" type. Its tuning range is continuous from 545 kc to 30.5 megacycles, it includes a separate band-spread scale and pointer, actuated by a separately controlled electric band-spread

system. The four rotating knobs include those for main tuning, band-spread tuning, volume control and band-switch. In addition three toggle switches include a headphone-loudspeaker switch, a beat-frequency oscillator switch which automatically cuts out the avc system when the b-f-o is switched on (to permit c-w code reception), and a stand-by switch.

MUSICAL INSTRUMENT PICKUP

The Turner Co., Cedar Rapids, Iowa, is placing on the market a new magnetic pickup for musical instruments, Model MM. A novel clamp has been designed for this pickup, to fasten it securely to



violins, banjos, guitars, or any other stringed instrument, without the use of tools or adhesives. The Turner Company has also just released a new catalog with illustrations, descriptions and list prices of their complete line.

RAYTHEON TUBES

Raytheon announces several additions to the receiving tube line. These recently developed tubes are the types 6SD7GT, 6U6GT, 7L7 and 7N7. The 6SD7GT and 6U6GT fall into the bantam category while the 7L7 and 7N7 are of the lock-in type. These new types may be briefly described as follows: Type 6SD7GT is a semi-remote cutoff relatively high transconductance pentode for use as an r-f and i-f amplifier. Type 6U6GT is a beam power amplifier designed for reasonably high output at lower supply voltage than normally required. Type 7L7 is a lock-in

base sharp cut-off relatively high transconductance pentode for use where the higher transconductance types are not required. Type 7N7 is a lock-in base twin triode having separate cathode leads with consequently increased circuit versatility. Technical characteristic data sheets describing the foregoing types are available from the Raytheon Production Corporation, 55 Chapel St., Newton, Mass.

RECORDING NEEDLE

In the accompanying illustration is shown a new type cutting needle introduced by the Recoton Corp., 178 Prince St., New York City. This needle, which may be

resharpened, has two patented edges, one cutting and the other polishing. Further information may be secured by writing to the above organization.

MALLORY A-C CAPACITORS

A new line of a-c motor starting capacitors has been announced by P. R. Mallory & Co., Inc., Indianapolis, Ind. Less weight, smaller size and lower cost are the features of these new units, it is said. Complete hardware for mounting is included with each condenser.

SWITCH-CONTACT SERVICE KIT

General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill., have announced a

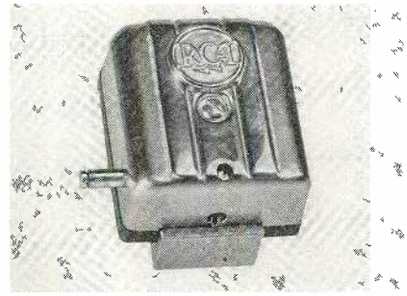
kit of materials for cleaning noisy attenuators, tuners and switch contacts. Consists of contact cleaner and lubricant.

PHOTOTUBE BOOKLET

Information on phototubes and their applications is being distributed to engineers, servicemen, amateurs, students and experimenters throughout the country by RCA transmitting tube distributors. The material, in simplified form, is presented interestingly in a 16-page booklet prepared by the RCA Manufacturing Company, Camden, N. J.

RECORDING HEAD

The RCA MI-4887 high-fidelity recording head is shown in the accompanying illustration. This magnetic unit is primarily intended for use on composition coated discs, but can be used on wax since it does not depend on the record material for



damping. Each unit is said to be held within close frequency limits, not departing from an ideal response curve by more than 2 db between 50 and 10,000 cycles. Literature may be secured by writing to the RCA Manufacturing Co., Inc., Camden, N. J.

L & N ENGINEERS STUDY TUBES

Reflecting the rapidly increasing use of radio and electron tubes in non-radio fields, RCA Institutes, Inc., have announced the beginning of a six-months lecture course in the theory and application of electron tubes before an engineering group of the Leeds and Northrup Company in Philadelphia.

As a feature of its complete line of electric measuring instruments the Leeds and Northrup Company develops and builds electronic precision instruments for measuring and controlling processes in manufacture. Twenty members of the company's staff, all highly trained and competent engineers, will take the RCA Institute's course. Presented by Albert Preisman, Assistant Chief Instructor, the course is designed to aid the Leeds and Northrup engineers in meeting the constantly widening utilization by industry of precise measuring and control.

RCA TUBES

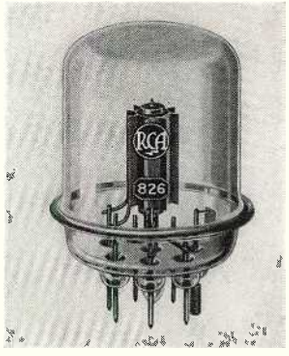
The RCA Radiotron Division, RCA Mfg. Co., Inc., Harrison, N. J., have made available the following new tubes: RCA-3S4 power amplifier pentode (miniature type); RCA-815 transmitting push-pull beam power amplifier; RCA-826 transmitting triode (for ultra-high-frequency use); RCA-866-A/866 half-wave mercury-vapor rectifier; RCA-1625 transmitting beam power amplifier (with 12.6-volt heater); RCA-1626 transmitting triode (with 12.6-volt heater).

The 3S4 is intended for use in the output stage of light-weight a-c/d-c/battery-operated portable equipment. This new tube has essentially the same characteristics as the miniature type 1S4 but is designed with a filament having a center tap to permit of either a series-filament or a parallel-filament operating arrangement. The series arrangement requiring only 50 milliamperes has been provided especially for equipment utilizing a source of rectified power for the filament supply.

The 815 is a new push-pull beam power amplifier designed for radio amateur use at ultra-high frequencies. Its efficiency and high power sensitivity permit full power input with very low driving power. A single 815 operated in push-pull Class C telegraph service is capable of handling a

power input of 75 watts with less than ¼ watt of driving power at frequencies as high as 150 megacycles. The total maximum plate dissipation of the 815 is 25 watts. The 815 is also useful as a modulator and as a multiplier. A single 815 can modulate another 815 as power amplifier. In multiplier service, the 815 can be used as a doubler or tripler and at the same time drive an 815 as power amplifier. Mechanical features of the 815 include its balanced and compact structure of beam units, close electrode spacing, short internal leads to minimize lead inductance and resistance, and a "Micanol" wafer octal base. The heaters of the 815 are arranged for either 12.6 or 6.3-volt operation.

The 826 transmitting triode has been designed especially for use at ultra-high



frequencies. It may be used as an oscillator, r-f power amplifier, and frequency multiplier at maximum ratings at frequencies as high as 250 megacycles and at reduced ratings at frequencies as high as 300 megacycles. Maximum plate dissipation of the 826 is 60 watts in Class C telegraph service. The 826 features a double-helical filament center-tapped within the tube so that effects of filament inductance can be minimized. In addition, two short, heavy leads are brought out from the grid and from the plate to individual terminals in order to reduce the inductance of these internal connections. All terminals are placed at one end of the bulb

so that short leads can be used in neutralizing circuits.

866-A/866 is a new half-wave, mercury-vapor rectifier to supersede the well-known RCA types 866-A and 866. This new tube combines the ability of the 866-A to withstand high peak inverse voltage and the ability of the 866 to conduct at relatively low applied voltage. The 866-A/866 employs a ceramic cap insulator and is constructed in a dome-top bulb. This construction minimizes danger of bulb cracks caused by corona discharge. An edgewise wound ribbon filament made of a new alloy material provides a large emission reserve and improved life. Two 866-A/866's operating in a full-wave rectifier are capable of delivering to the input of a choke-input filter a rectified voltage of 3180 volts at 0.5 ampere with good regulation.

The 1625 transmitting beam power amplifier is similar to RCA-807 but it has a 12.6-volt heater and a 7-pin base. Because of these features, the 1625 is particularly suitable for use in aircraft radio transmitters. In these transmitters and other equipment subject to vibration and shock, the 7-pin base provides ample friction to hold the base in its socket. The high power sensitivity of the 1625 makes it especially useful in frequency-multiplier service where high harmonic output is essential. It may also be used as a crystal-oscillator and buffer amplifier in medium-power transmitters with an input up to a half-kilowatt. The 1625 can be operated at maximum ratings at frequencies as high as 60 megacycles and at reduced ratings at frequencies as high is 125 megacycles. Its maximum plate dissipation rating is 30 watts (ICAS).

The 1626, a transmitting triode of the indirectly-heated type with 12.6-volt heater, is designed especially for r-f oscillator service in applications requiring unusual stability of characteristics. The maximum plate dissipation is 5 watts. The 1626 may be operated at maximum ratings at frequencies as high as 30 megacycles, and at reduced ratings at frequencies as high as 90 megacycles. Because of its 12.6-volt heater rating, the 1626 is particularly suitable for use in aircraft radio transmitters.

QUIETONE FILTERS

Types IF24 and IF25 Quietone filters are designed for application to fluorescent lamps and similar appliances to eliminate radio interference. Features are adapted to convenience in installation, it is said. Cornell Dubilier Electric Corp., South Plainfield, N. J.

RECORDING HEAD

In the accompanying illustration is shown the new Webster R-83 recording head

designed for home recording apparatus. This unit is said to have less than 1½%

distortion at 400 cycles, and to cover a frequency range from 30 to 6000 cycles without equalization. Standard impedance is 8 ohms at 400 cycles, although 1, 3, 6, 200 and 500 ohm units are available on request. A data sheet on this recording head may be obtained by writing to the Webster Electric Co., Racine, Wisc.

FAIRCHILD RECORDER

In the accompanying illustration is shown the Fairchild 199-3 recorder mechanism. This equipment contains provision for change of pitch and direction of cut, minute

timing scale, two-speed drive, cutting head and pickup. Complete information may be secured from the Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.

CBS SELECTIVE SERVICE POLICY

Salary and insurance payments for employees of the Columbia Broadcasting System who are called into active military service, together with a company policy for their subsequent re-employment, were announced Nov. 16. The CBS plan provides for the payment of from one month's to six months' salary for all regular full-time employees, based upon the term of their employment by the company prior to the date of entering the armed services of the United States, according to the following scale:

Less than 1 year's employment—1 month's salary.

More than 1 year and less than 3 years' employment—2 month's salary.

More than 3 years and less than 4 years' employment—3 months' salary.

More than 4 years and less than 5 years' employment—4 months' salary.

More than 5 years and less than 6 years' employment—5 months' salary.

More than 6 years' employment—6 months' salary.

In addition to these salary payments, the company will assume the cost of premiums payable by employees under its co-operative insurance program during the required year of military training.

The CBS plan for re-employment of staff members after termination of their military service provides that it will be the policy of the company, except in unforeseen circumstances, to reinstate employees in the positions which they previously occupied.

A Columbia official explained that the compensation plan and the re-employment policy would apply to all regular full-time employees who are called to active military or naval service for the United States, prior to January 1, 1942, pursuant to the Selective Service Act or as present National Guardsmen or members of the Naval Reserve. The plan will be made retroactive to cover employees who have already entered military service. A further feature provides that employees may, at their own option, receive the entire bonus payment to which they are eligible in one amount on the date of entering military service, or in designated installments, and that any employee may designate either himself or any other person to receive installment payments.

The benefits of the entire plan will apply not only to employees of the Columbia Broadcasting System itself, but likewise to its wholly owned subsidiary companies, Columbia Artists, Inc., and the Columbia Recording Corporation.

RECORDING HEAD

In the accompanying illustration is shown the Astatic X-29 crystal recording head for use on coated blanks, wax and thermoplastics. Said to be suitable for home

recorder applications, it will record frequencies up to 6000 cycles. Measuring 1⅜" by ⅝" by 3¾", this unit has a weight of 7 oz. A data sheet on this head may be secured by writing to the Astatic Microphone Lab., Inc., Youngstown, Ohio.

PORTABLE RECORDER

In the accompanying illustration is shown the Webster-Chicago Model W-1205 recorder. This unit is completely self-contained in one luggage style carrying case. It includes such features as crystal head,

slanting control panel, monitor speaker, recording amplifier with volume and tone controls, and play-back arm. It cuts 98 lines per inch at 78 r-p-m. Complete information may be secured by writing to Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.

RCA TUBE PRICES REVISED

A general revision in the prices of RCA receiving tubes to bring them into line with current manufacturing costs has been announced by L. W. Teegarden, manager of the tube and equipment division of the RCA Manufacturing Co. Net prices of some types have been increased slightly, while others have been reduced.

The new prices concentrate approximately 40% of the renewal tube business in the 90c and $1 list price brackets. Slightly less than 28% of the renewal business is now in the 60-cent to 80-cent bracket, while the balance of 32% is in the $1.20 to $2.75 category.

PORTABLE RECORDER

In the accompanying illustration is shown the Speak-O-Phone portable recorder, Model 1-52-A. This unit employs a heavy-duty constant speed motor which gives turntable speeds of 78 and 33 1/3

r-p-m. Provision is made to record on aluminum or acetate discs up to 12". A crystal microphone and a magnetic cutting head are provided. Further data may be secured from Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York City.

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IN MARCH of next year, most broadcasting stations shift to new frequencies, requiring a corresponding change in frequency in their frequency monitor. In preparation for this shift, why not modernize your entire monitoring equipment to take care of the F.C.C. Rule allowing only 20-cycle tolerance for all broadcasting stations? The G-R Type 25-A Frequency Monitor is approved by the F.C.C. for the new Rule and bears F.C.C. Approval No. 1461.

So why don't you kill two birds with one stone and shift to the new frequency and to the new tolerance in your monitoring equipment and get it over with?

Many new electrical and mechanical features are incorporated in the G-R Frequency Monitor. Some of these are:

1—**Large deviation meter with 30-0-30 cycle scale**
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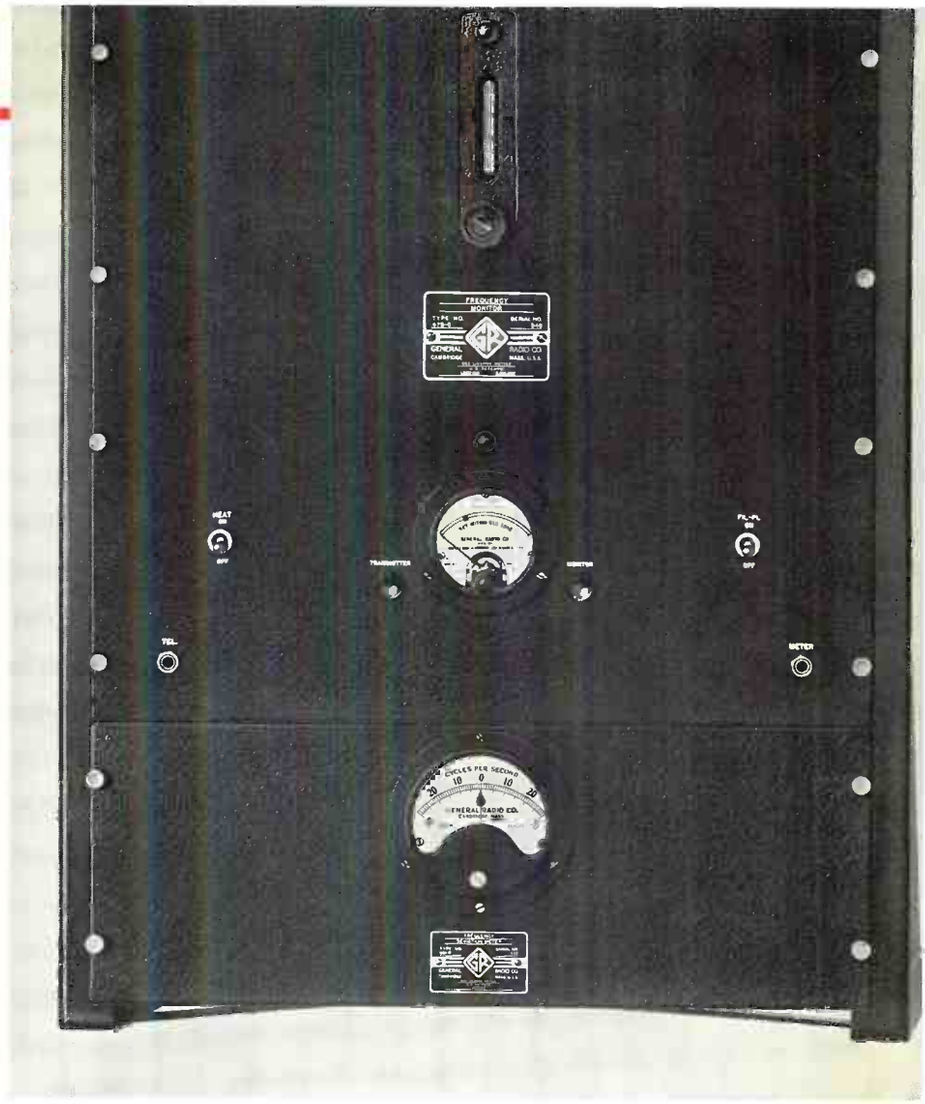

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GENERAL RADIO CO., Cambridge, Massachusetts

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Type 516-C and Type 684-A Antenna Measuring Equipment

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not only for the studio or laboratory but equally for the moderate price field with the unlimited opportunities this field presents for culture and enjoyment.

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