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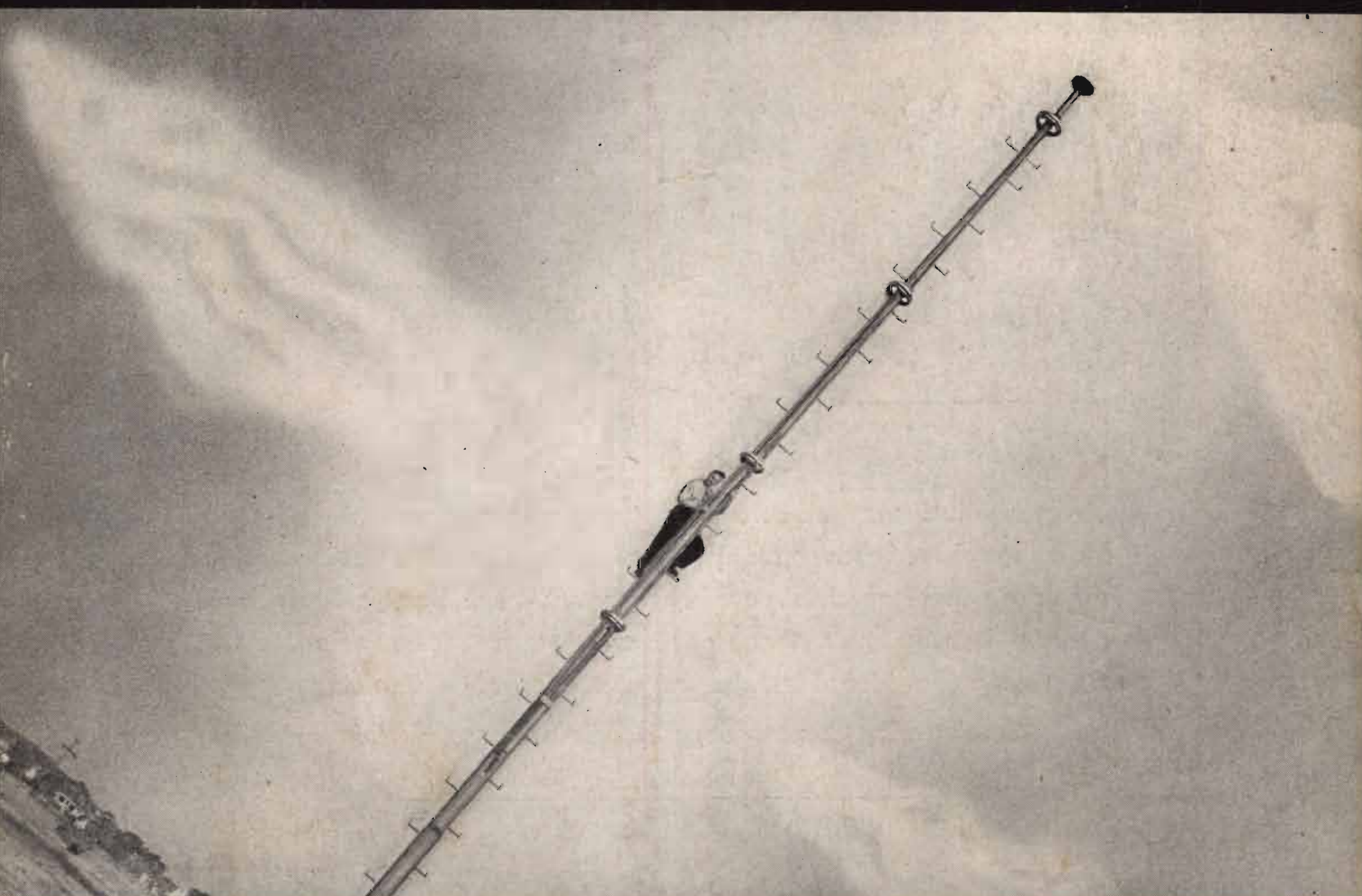

DECEMBER

★ BRITISH POSTWAR MARINE RADAR ★ ANNUAL INDEX FOR 1946

★ A REPORT ON THE ROCHESTER FALL MEETING

1946

LEWIS WINNER, Editor

F. WALEN, Assistant Editor

We See...

TELEVISION'S FUTURE received quite a thorough probing at the December FCC u-h-f color standards hearings in Washington, with reams of testimony offered by industry on the virtues of the current monochrome v-h-f system, projected u-h-f 3-color sequential and simultaneous methods and the v-h-f/u-h-f bands for general television services.

In a five-day session, engineers and executives of operating and planned television stations and manufacturers disclosed that over $5,000,000 have been spent during the past two years in research, development and production of equipment for monochrome and color v-h-f and u-h-f telecasts.

In urging the adoption of immediate u-h-f color standards for the sequential system which would operate in twenty-seven 16-mc channels on the 480 to 920-mc bands, CBS stated that their method in its present state is "practical and capable of rendering the public a high type of service . . . equipment for both broadcasters and public can be manufactured now . . . and no other set of standards, hypothetical or real, can assure as high a quality of television services for the u-h-f band." Several manufacturers, including Westinghouse and Zenith, supported this view.

Defending the present setup, representatives from RCA said that the current standards and frequency allocations established by the FCC after extensive and careful study on its part and upon recommendations of the RTPB, were agreed upon as adequate and proper for postwar television. And today, they said, we have a well developed television service that has been engineered to a point where it's capable of excellent reproduction in a home. They accordingly urged the Commission to give its full support to this presently operating proven service and defer adoption of any u-h-f color standards.

Analyzing the two methods of color transmission, simultaneous-method experts declared that the sequential system requires two separate stations if both color and monochrome services are to be maintained; the simultaneous color system can be interchanged with black and white on either of the u-h-f or v-h-f channels. These experts also declared that actually less bandwidth is required than for the sequential system, and the simultaneous method affords greater flexibility for network operation. Notwithstanding the progress made, there are still endless color transmission problems to solve, and appropriate standards could never be prepared now, but perhaps in four or five years, these experts emphasized.

The RTPB panel on u-h-f color television, the RMA television systems committee, TBA, as well as several manufacturers including Farnsworth, and Philco also supported the postponement of color standards.

To provide additional accurate background for judgment, members of the Commission agreed to visit New York City and view a new DuMont direct-view electronic color tube and a monochrome tube that can be viewed in sunlight, and also attend a 25-mile CBS live-color telecast, during closed sessions.

January will see additional cross-examining sessions and then will come the decision . . . an all-important decision all industry awaits anxiously . . . and one which the FCC promises will be made very quickly. We hope so! — LW

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DECEMBER, 1946 VOLUME 26 NUMBER 12

COVER ILLUSTRATION

A 4-bay circular f-m antenna mounted on a radar pedestal so that it can be turned for tests to determine field patterns.
(Courtesy General Electric)

Published monthly by Bryan Davis Publishing Co., Inc.
52 Vanderbilt Avenue, New York 17, N. Y. Telephone MUrray Hill 4-0170

Bryan S. Davis, President — A. Goebel, Circulation Manager
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Wellington, New Zealand: Te Aro Book Depot. Melbourne, Australia: McGill's Agency.

Entered as second-class matter Oct. 1, 1937 at the Post Office at New York, N. Y., under the Act of March 3, 1879. Subscription price: $2.00 per year in the United States of America and Canada; 25 cents per copy. $3.00 per year in foreign countries; 35 cents per copy.

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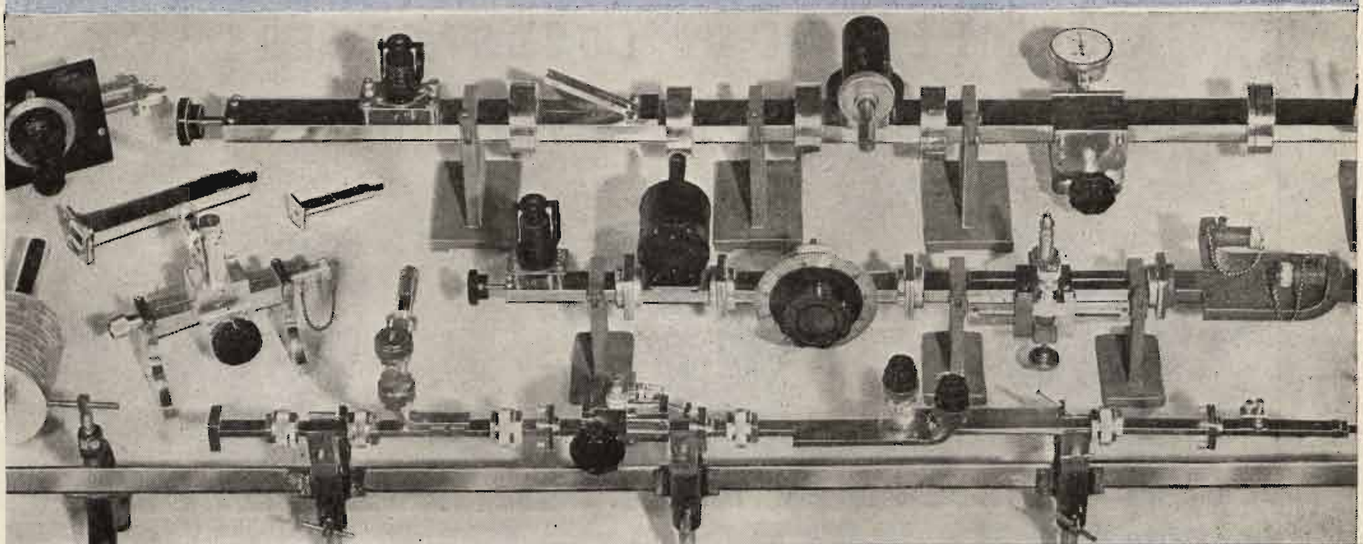

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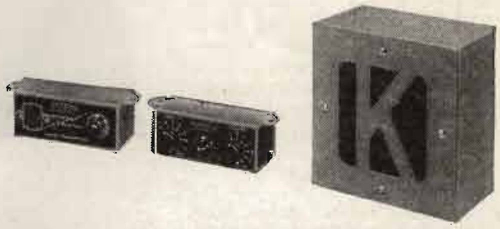

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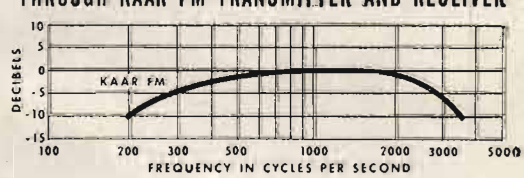

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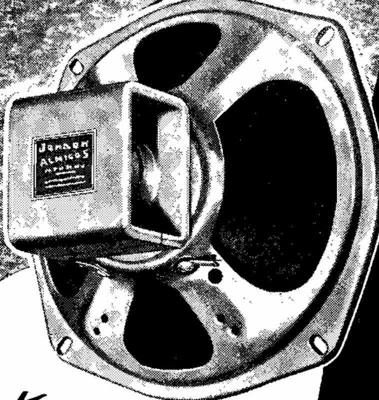

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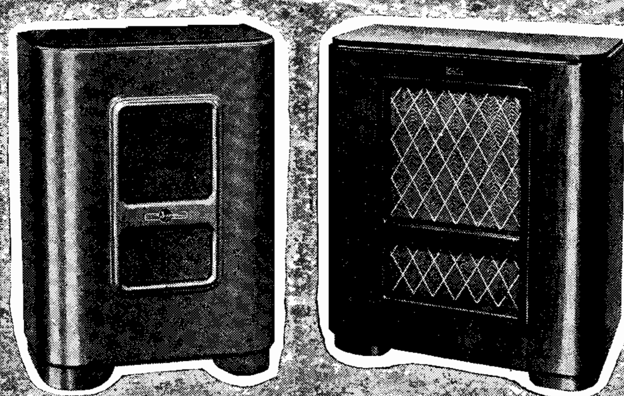

Model A-81—for Model P8-SH speaker
Model A-121—for Model P12-SH speaker

Model D-121—for Model P12-SH speaker

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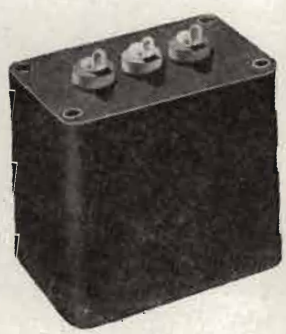

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COMMUNICATIONS

LEWIS WINNER, Editor

* * DECEMBER, 1946 * *

POSTWAR MARINE RADAR In Great Britain

Analysis of Equipment Requirements . . . Pulse Durations, Horizontal and Vertical Beam Widths, Types of Polarization, Sea Clutter Controls, Transmitting Powers, Performance Monitors, Scanners and Frequency Ranges.

by M. G. SCROGGIE

Consulting Radio Engineer
London, England

THAT CENTIMETRIC RADAR is of such value to ships as to be practically indispensable, was the unanimous conviction of the twenty-two maritime nations represented at the International Meeting on *Radio Aids to Marine Navigation* held in London in May. The anti-collision function of radar is invaluable in all waters; in addition radar greatly assists coastal navigation and pilotage in restricted waters.

There was also agreement, however, that the usefulness and reliability of radar sets falls off very steeply with reduction in cost, and attempts to economize by relaxing specifications would almost certainly bring the whole thing into disrepute with navigators. Discussing wartime radar experts at the meeting agreed that generally the equipment designed for war applications were not suited for merchant shipping. For instance pulse durations of the order of 1 microsecond or more are useless. Naval radars were also found of little use, since they were designed to cover aircraft location, with scanner mountings needlessly complicated. Most wartime equipment required great operating and servicing skill, much more skill than many merchant shipowners would be inclined to provide.

Realizing this, the British Government in the summer of 1944 set up a body which after trials and inquiries wrote a minimum performance specification for marine radar. This was issued for the guidance of shipowners and manufacturers. Britain's Admiralty Signal Establishment proved the practicality of the specification by

Figure 1
Scanner-height curves.

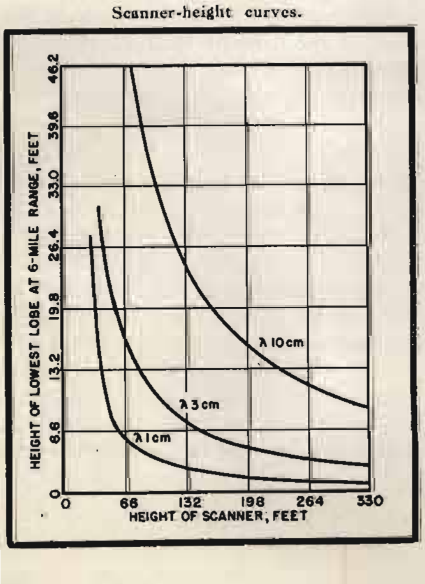


Figure 1a
Scanner and driving motor.

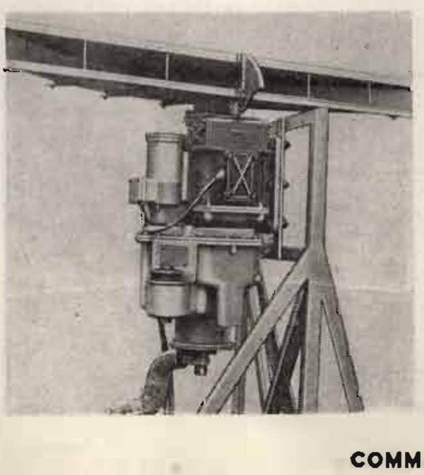
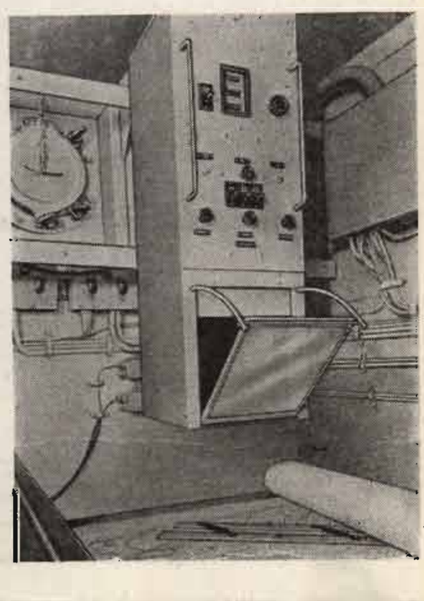


Figure 1b
Chart comparison unit permitting superimposition of ppi picture on chart.



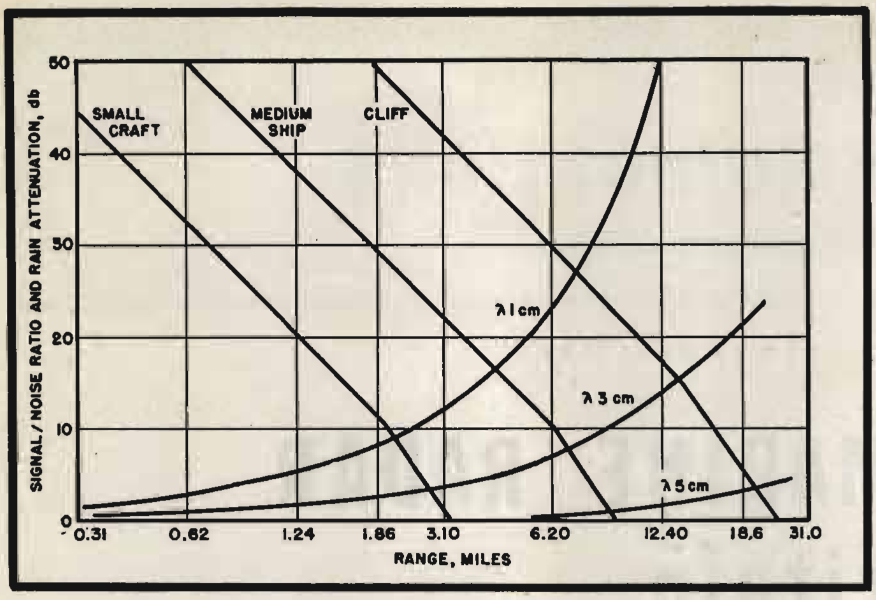


Figure 2
Signal-noise ratio, in db, of echoes from objects of various sizes, and attenuation, also in db, due to heavy rain at various wavelengths. Intersection of curves indicate approximate limiting ranges during rain.

building a model and demonstrating it at the International Meeting.

In developing this model, frequency problems were studied carefully. Two factors were found to favor choice of a short wave.

(*1*) For a scanner of given aperture, the beam can be narrower horizontally, giving better azimuth discrimination.

(*2*) For a scanner of given height, objects can be detected closer to the water. (Figure 1 shows the height, at a 6-mile range, of the lowest lobe of radiation. From this the scanner height and wavelength necessary to detect low objects can be judged.)

Two factors were also in favor of long waves:

(*1*) Reduction of masking by rain and clouds.

(*2*) Improvement in magnetron efficiency.

The question resolved itself into choosing the shortest wave that was not too badly affected by weather. In Figure 2[1] appears weather data indicating how rain affects radar range. The effect on 1-cm waves is too drastic for their use in a general-purpose radar, which ought to be able to detect a medium ship at not less than about 6 miles regardless of rain. While 5 cm is quite satisfactory as regards weather, a rather unwieldy scanner is necessary. The choice therefore fell on 3 cm, for which magnetrons, waveguides and other components are available. Accordingly the 9320-9600 mc band has been selected for marine radar by the United States and Britain.

It may be that for shore radar, where it is practicable to use large scanners mounted quite high, a rather longer wave may be chosen to give immunity from atmospheric attenuation. On the other hand, for small craft, short-range radar on 1 to 2 cm is likely to be the most useful.

[1]From paper presented by H. E. Hogben of Britain's Admiralty at International Meeting.

Pulse Duration

Another topic carefully analyzed was pulse duration. The importance of minimum range can hardly be overemphasized. The pulse in many wartime radars obscured objects up to about one-third of a mile from the ship. For pilotage in restricted waters something like one-tenth of this figure is required, which fixes the pulse at not more than about 0.25 microsecond, preferably less. Shortness of pulse is needed also for adequate range discrimination, so that aspects of ships and the details of coastlines, for example, can be discerned.

Horizontal Beam-Width

Azimuth discrimination, another design feature, was found to be less easily achieved. Detection of coastlines and other objects is of slight value if they are not easily recognizable or if the echoes of separate buoys and vessels are coalescent. Experience shows that a horizontal beam-width of 2½° is about the greatest that should be considered, and the improvement with a 1° beam is very marked.

If *W* is the width of the scanner mirror, and θ is the horizontal beam width between half-amplitude points, in degrees, then

$$W = \frac{k\lambda}{\theta}$$

With an even distribution of power over the antenna aperture, *k* is 60, so for a 3-cm wavelength and 1° beam, the mirror would have to be 180-cm wide. Unfortunately this is not enough, because with uniform power distribution the side lobes are only 14 db down on the main beam. Ideally, side lobes ought to be at least 40 db down to give freedom from spurious echoes. By adjusting the distribution of power so that it tapers off from center to sides of the scanner, the side lobes can be reduced, at the cost of broadening the main beam for a given aperture. A suitable compromise, making $k = 100$, gives a theoretical lobe reduction of 30 db. In practice about 25 db can be achieved. On this basis, the aperture for a 1° beam is 300 cm, a rather unwieldy size to rotate at the desired speed of at least 25 rpm and preferably up to 60 rpm. A 150-cm scanner, giving a 2° beam, was regarded as a good compromise.

Other Equipment Requirements

Vertical beam-width selection provided quite a problem. There was the choice of using a pencil beam, which necessitates stabilization against rolling and pitching of the ship, or a fan beam, which brings in more clutter from sea, rain and clouds. Although the latter are far from welcome, the difficulties and cost of stabilization will

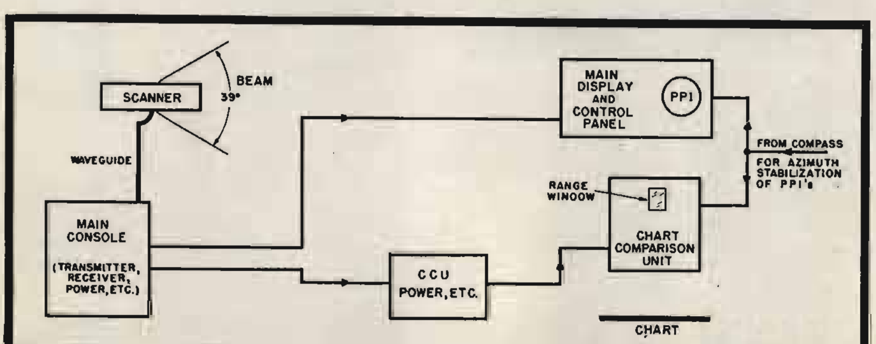


Figure 3
Admiralty postwar marine radar system.

generally force the choice of the fan. A vertical beam-width of 20° to 40° was considered reasonable.

Polarization

Horizontal polarization has been found to give substantially less sea clutter than vertical, and is therefore preferred.

Sea Clutter

Owing to the very narrow range of amplitude discrimination of a *ppi*, fairly critical adjustment of receiver gain is necessary to pick out desired echoes from sea clutter. The gain appropriate to one part of the *ppi* results in echoes elsewhere being either suppressed altogether or lost in saturation. Thus some form of automatic gain control is essential if the whole of the *ppi* is to be useful simultaneously.

An empirical relation between peak power of clutter echoes, P, and controlling factors *is*

$$P = k_1 e^{-k_2 R}$$

Where: R is range

k_1 is proportional to transmitter power, square of antenna gain, pulse duration, and horizontal beam width, and

k_2 depends on height of scanner, wavelength, and roughness of sea.

Of these factors, the variables are range and roughness. In the swept gain system, the gain is made to vary in the desired way with range by utilizing the approximately exponential grid-plate characteristics of a suitable tube. Sea roughness is taken care of by a manual control, as regards variation in time. Roughness usually varies also with azimuth, however, and in any case the clutter depends on the aspect of the waves, being weaker down wind than into wind.

To allow for this, there is the alternative system which reduces gain according to the echo strength, the time constant being several times greater than pulse duration in order not to suppress desired echoes. The disadvantage of this device is that echoes from extensive formations such as land are, as it were, differentiated, and made less recognizable. This second method was found therefore better suited to shore radar.

Transmitter Power

With the high antenna gain resulting from a beam-width of not more than, say, 2°, it was considered that a pulse power of 10 kw at 3 cm was enough. The types of 3-cm magnetrons actually available may be the determining factor.

Performance Monitoring

Navigators will no doubt rightly look on radar with some reserve until its reliability is established beyond question. They cannot be expected to place much faith in it so long as the slightest uncertainty exists whether clearness of the *ppi* means absence of obstructions or falling off in efficiency of the radar. Those studying the problem found that speedy and unmistakable indication must be provided should there be any appreciable deterioration in radar performance. Over a certain range of degraded performance, the radar may still be useful, so long as warning is given; below that level it should cut out altogether.

General Design Features

The design of display, controls, facilities, layout, etc., must be closely studied from the point of view of merchant ship officers. It was found necessary to provide facilities for superimposing *ppi* pictures on charts of various scales, quick measurement of range and bearing of any echo, and compass stabilization of *ppi*, with radial shipshead marker. Wartime needs were found to have sufficiently emphasized provision against extremes of climate, plus salt water and smoke.

Admiralty Model

The units comprising a complete installation, based on the merchant-ship study, are shown in Figure 3. Although functionally the chart comparison unit is optional, its practical value makes it indispensable. There may, in fact, be a preference for combining it with the main control panel, omitting the other form of display.

Scanner

The scanner consists of a cheese-type mirror, aperture 150 x 7.5 cm, fed by waveguide horn, giving a beam 2° x 39°, with side lobes 26 db down at the operating frequency and 23 db at the ends of the frequency band. A ½-hp motor rotates it at a speed variable from 20 to 70 rpm for experimental purposes. Condensation in the waveguide, which would cause excessive losses, is prevented by electrically heating throughout its length and blowing air through it.

The main console was designed like a steel filing cabinet, out of which the sections can be slid for inspection. It is normally locked up, with a steel shutter over all preset controls. It contains a motor-generator; hydrogen thyratron modulator; r-f head including transmitter, crystal, local oscillator, afc unit, and i-f amplifier; remainder of receiver, including swept gain and instantaneous agc (both are fitted, for comparison); power packs, and regulating gear. There is also a monitoring device by which voltage readings at twenty key points, picked off in rapid succession by a continuously rotating uniselector, can be displayed as vertical lines on the *ppi* tube. Normally adjusted to equal height, these lines show up any irregularity at a glance.

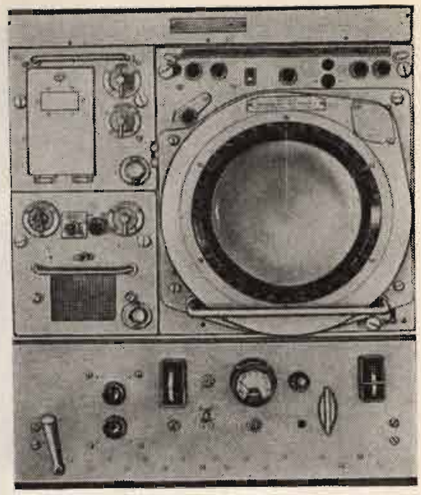


Figure 4
Main ppi. Entire system is controlled from this point.

The modulator generates one thousand .2-microsecond pulses per second, applied to the magnetron cathode through a 1:4 pulse transformer.

There are altogether 11 i-f stages, and distribution to the other units is at an i-f of 45 mc to avoid the difficulties of covering the required 8-mc bandwith with variable frequency distribution. The first stage is a neutralized triode, for maximum signal-to-noise ratio.

Main Display and Control Panel

A 9" *ppi* is azimuth-stabilized from gyro-compass or magnetic transmitting compass, so that a fixed scale with north at the top reads bearings with

(*Continued on page* 41)

Figure 5
Optical principle of the chart comparison unit.

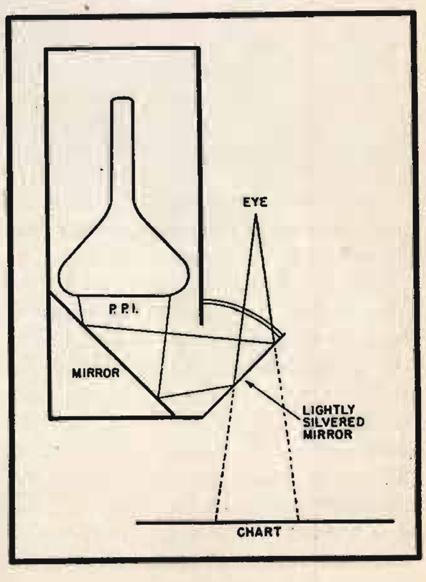


Figure 1
Setup in live-end dead-end studio.
(*Courtesy Ralph H. Jones Company*)

Figure 2
Eliminating unwanted pickup from live end or side walls with a cardioid or unidirectional microphone.
(*Courtesy Ralph H. Jones Company*)

Placement and Operation of MICROPHONES IN BROADCAST STUDIOS

Analysis of Fundamental Microphone Arrangements That Can Be Used as a Basis for Complex Placements.

by JOHN B. LEDBETTER

Studio-Transmitter Engineer, WKRC

Correct placement of a particular microphone depends on a number of variable factors such as the acoustic characteristics of the studio, type and placement of talent, directive response of the microphone, and the size of the audience. Because these factors are so widely variable no fixed rules or placement diagrams can be depended on to produce the desired effects in every application. Each program arrangement or variation thereof must be treated as an individual case and set up accordingly. Stringed instruments, especially bass viols, for example, are rather susceptible to humidity and temperature changes, and may thus require placement farther away from the microphone on damp, rainy days to maintain setup balance and to prevent predominance of the lower-frequency ranges. There are, however, basic setups and arrangements which have been worked out over a period of years and have proved most satisfactory in their individual applications.

In actual setups it is advisable to use as few microphones as possible for any given pickup, since microphones placed at different points in the same sound field introduce a certain amount of phase distortion. For small groups, orchestras or dance bands one microphone usually is sufficient, and in a number of cases has proven adequate for larger groups and even for complete concert orchestras. Proper overall balance is obtained by selective grouping of instruments and talent and the results checked by actual monitoring tests.

In featuring one or more instruments it is at times desirable to use an extra microphone for each featured instrument or section and fading the microphone in at the mixing panel.

In setups for a soloist with piano accompaniment an RCA 44-BX or similar velocity microphone is usually used. Placing the vocalist at a distance of from four to six feet from the microphone prevents excessive peaking of certain notes and eliminates the sibilant effect usually noticed at lesser distances.

A satisfactory balance between piano and voice is usually obtained by placing the piano, with top raised, about twelve to fifteen feet away with its open side facing the microphone.

In Figure 1 appears a typical setup for a small group in a *live-end dead-end* studio, with the group placed in the dead end, facing the live end and using a 44-BX bidirectional microphone; W. E. *8-Ball* used for sound effects. Sound reenforcement from the live wall may be controlled by tilting the microphone forward or turning slightly to either side. The stand may also be lowered a foot or so below the speakers' lip level and the face of the microphone tilted upward. Some announcers prefer this method in general speaking since it seems to allow a more natural stance. Unwanted pickup from the live end or from side walls of the studio may be eliminated by using a cardioid[1] or unindirectional microphone[2] and arranging the group as shown in Figure 2. Vocalists and announcers are usually instructed to stand at least two, and preferably three feet from the ribbon type of microphone to prevent accumulation and predominance of low frequencies. On the cardioid and unidirectional microphones close-talking may be ac-

Figure 3
Dance orchestra setup; violins 6' from microphone, saxophones 4' to 6' behind violins, brass sections 6' to 10' behind saxophones.
(Courtesy WLW)

Figure 3a
Orchestral pickup with suspended cardioid and velocity piano-bass microphone.
(Courtesy WLW)

complished by standing close and speaking into the side of the microphone, that is, in the plane of its ribbon and thus operating only the pressure unit. With dynamic microphones[3] approach may be made to within one foot of the diaphragm without producing undesirable effects.

The arrangement in Figure 3 for dance orchestra is generally satisfactory in studio setups. The violins are placed at a minimum of six feet from the microphone, the saxes about four to six feet behind the violins, and the brass section removed six to ten feet behind the saxes, depending on their loudness. A second microphone may be employed when it is desired to feature muted trumpet or trombone or other special effects. The guitar, ordinarily placed about three or four feet from the microphone, may be placed on the soloist's side opposite the brass or drums if these instruments predominate, or an extra feature microphone may be added. The piano usually is placed at a distance of about twelve feet, with its top raised and the open side facing the microphone. A second piano may be placed at an equal distance and within the same angle of pickup on either side of the microphone, and then moved toward or from the microphone until the proper balance between pianos has been obtained.

For the same orchestra setup in a band-shell or remote pickup where audience and background noise is relatively high a more satisfactory pickup may be obtained by using a cardioid or unidirectional microphone placed in the same pickup position as the 44-BX velocity shown in Figure 3, but with the dead side facing the source of objectionable sound. This type of microphone also allows a higher level to be fed into the audience loudspeakers before a feedback point is reached. The announcer is allowed to assume a *close-talking* position at the side and about a foot away from the microphone when announcements are to be made over background music. It may be found advantageous to place him directly in front of the microphone, or, if the music level cannot be sufficiently controlled during his announcements, it may be necessary to provide the announcer with a separate microphone, placed with its dead side toward the band to maintain the proper levels between band and announcer.

A typical symphony (Figure 4) requires a wide-angle pickup of approximately 140° to 150°, and for this application a directional microphone[4] is most suitable. The cardioid, with its pick-up angle of 120° may be used satisfactorily by placing several feet farther from the orchestra. When background noises and acoustic conditions permit, two bi-directional microphones may be used for pickup, these being placed side by side and separated by at least six feet and turned so that their individual pickup angles of approximately 90° will collectively provide uniform coverage over the required area. By this means a weak section can be compensated for by increasing the gain of that particular microphone. A more perfect balance may often be accomplished by raising the unidirectional microphone to a height of six or seven feet and moving farther away from the group.

[1]W.E. 639-B.
[2]RCA 77.
[3]W.E. 618-A, 633-A (salt-shaker), 630-A (8-ball).
[4]W.E. 77A or 77B.

A similar arrangement employing a 44-BX velocity is used for pickup of the large choral group, (Figure 5); an extra microphone has been provided for the announcer and master of ceremonies.

Microphones as Sound Reenforcement Media

Tangible sound reenforcement is used to give greater depth and *body* to broadcasts and to provide a satisfactory sound level for the audience. It is usually obtained through one of two methods: (*1*) conjunctive, and (*2*) direct. The first is commonly used in remote or portable setups and consists of a bridging coil connected across the remote amplifier output circuit and feeding into the *phono* or second stage of the usual type of public address amplifier. A variable pad or fader is placed across the secondary of the bridging coil to control the reenforcement level. The second method is preferable in studio and similar installations of a permanent nature. The reenforcement in this case is accomplished by the use of separate microphones, usually concealed in the wings of the stage or near the footlights and feeding directly into the sound system, the level being controlled from a mixing panel in the control room.

Microphone Phasing

When two or more microphones are used simultaneously, the proper phasing of each instrument in relation to the other becomes a matter of prime importance. One microphone out of phase will result in a hollow or *boomy* effect and prevent perfect overall balance.

It is assumed that all microphones

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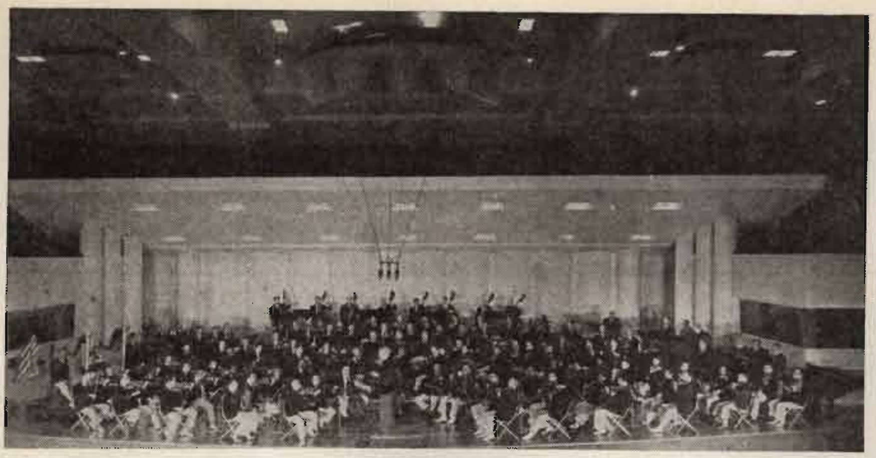


Figure 4
Wide-angle pickup for a symphony.
(*Courtesy WLW*)

in regular use at a particular station are, or have been, properly phased. Certain conditions arise, however, such as in the purchase of a new microphone or the return of a repaired unit from the factory, that may alter this phasing.

Condition of phase may easily be determined by the *comparative-level* connected to the regular input channels of the mixer. With the faders of both channels set at the same level, a reading is taken of the output of the first microphone. With the first fader still open, the second microphone is switched into the circuit. An increase of level as noted on the *volume indicating meter* indicates the second mi-

Figure 5
Choral group setup with unidirectional microphone 6′ to 7′ from group. Extra microphones are used for announcer and commentator.
(*Courtesy Stockdale*)

method in which two microphones, one the microphone under test and the other known to be correctly phased for its regular operations, are placed side by side, the front of each facing the same direction, and their outputs crophone is in phase with the first, while a decrease in level denotes the opposite.

Three methods are commonly used to reverse the phase of a velocity microphone: (*1*) reversing the cable leads at the microphone terminal block; (*2*) inserting a patchcord in the circuit in question with one end of the cord inverted, and (*3*) use of a line-reversing switch.

The first method is used when a microphone is to be phased permanently and is accomplished by removing the screws which hold the microphone grille in place and removing the cover to expose the terminal block in the bottom of the case, immediately above the microphone coupling transformer. The two cable leads connected to the transformer primary are reversed and resoldered.

The second method is used when it is necessary to reverse the phase of a particular microphone after a program is on the air. Patchcords (WE type) are simply inserted in any convenient part of the circuit ahead of the mixer, as *Microphone Out* to *Amp In* or *Amp Out* to *Key In* with one end of the cord inverted. With patch cords of the single-circuit type, where two cords are used to patch a given circuit, reversal is made by transposing the leads at one end of the cord. The possibility of a momentary break in the program or an instantaneous circuit *pop* may be avoided in patching by waiting for a convenient pause in the program, then *keycutting* or by closing the fader at the instant patch insertion is made. The same end may be accomplished prior to the air time simply by rotating the microphone through an angle of 180°.

At the transmitter it is often found that when the polarity switch of the modulation monitor is set to read positive peaks, one particular voice peaking *zero* level may register 100%, yet another speaker giving the same audio level may modulate only 60%, or less. However, on reversing the polarity of the program line the second speaker is found to also modulate 100%. This condition, known as *extended positive peak modulation* and due to the peculiar harmonic content of some voices, particularly male, is usually more noticeable when one announcer or speaker follows the other on the same microphone. A line-reversing switch installed at the transmitter end of the program line is used to reverse polarity when necessary and thereby equalize the modulation peaks of each type of voice. Use of such a reversing switch is limited to the transmitter, since the studio engineer usually is provided with no means of checking actual modulation percentages.

Figure 6
Typical setup for a quizz program.
(*Courtesy WKRC*)

A Graphical Analysis of the CATHODE-COUPLED AMPLIFIER

by MURRAY S. RIFKIN

Research Laboratories
Sperry Gyroscope Company

Method Provides Dynamic Characteristics of Cathode-Follower Grounded-Grid Amplifier to Facilitate Design Work.

A MATHEMATICAL ANALYSIS of the cathode-coupled amplifier will reveal the gain of the circuit over the linear portion of the output-input voltage curve, but will not be useful in determining the amplitude limiting characteristics and quiescent operating conditions of the circuit. A graphical method of analysis can be applied to accomplish the latter functions by obtaining a curve relating output voltage to input voltage, thereby enhancing the usefulness of the circuit.

In Figure 1 appears the basic circuit under discussion throughout this analysis. Tubes of different types may be used for each stage; however, the practical case of similar tubes will be considered. Symbols used are:

- T_1 cathode-follower stage
- T_2 grounded-grid stage
- R_k common cathode resistance
- R_L plate-load resistance of T_2
- e_s instantaneous input signal voltage
- e_g instantaneous cathode-grid voltage of T_1
- e_k instantaneous voltage across R_k
- e_L instantaneous voltage across R_L
- e_o instantaneous output voltage
- i_1 instantaneous plate current in T_1
- i_2 instantaneous plate current in T_2
- E_{bb} plate supply voltage

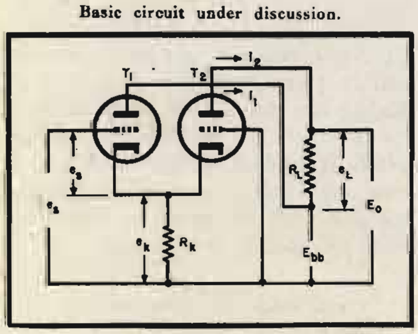
Rapid Method

A method which yields a first approximation of the output-input voltage curve will be described first; reference is made to Figure 2 in which idealized tube characteristic curves are shown.

Using the I_b-E_b family of curves, a load line is drawn for each of the two

(*Continued on page* 42)

Figure 1
Basic circuit under discussion.



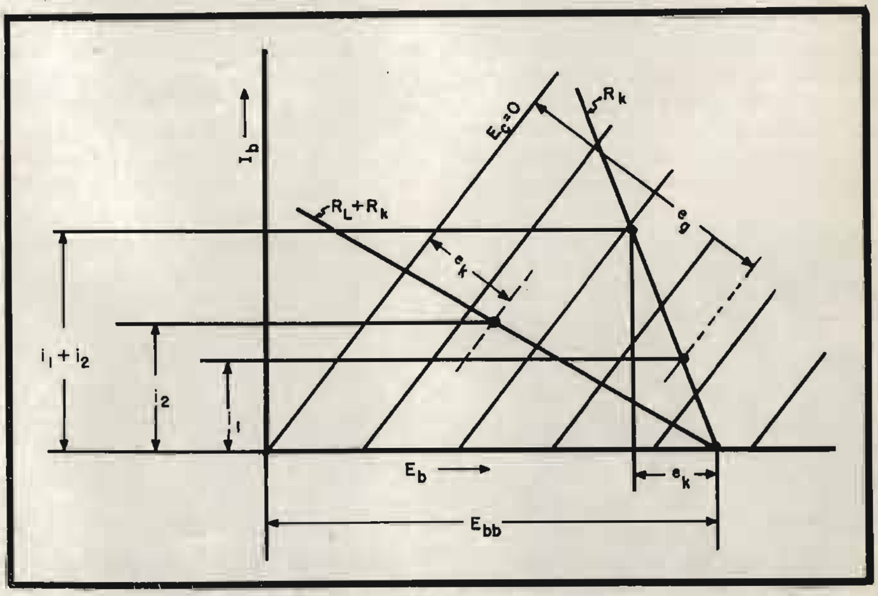
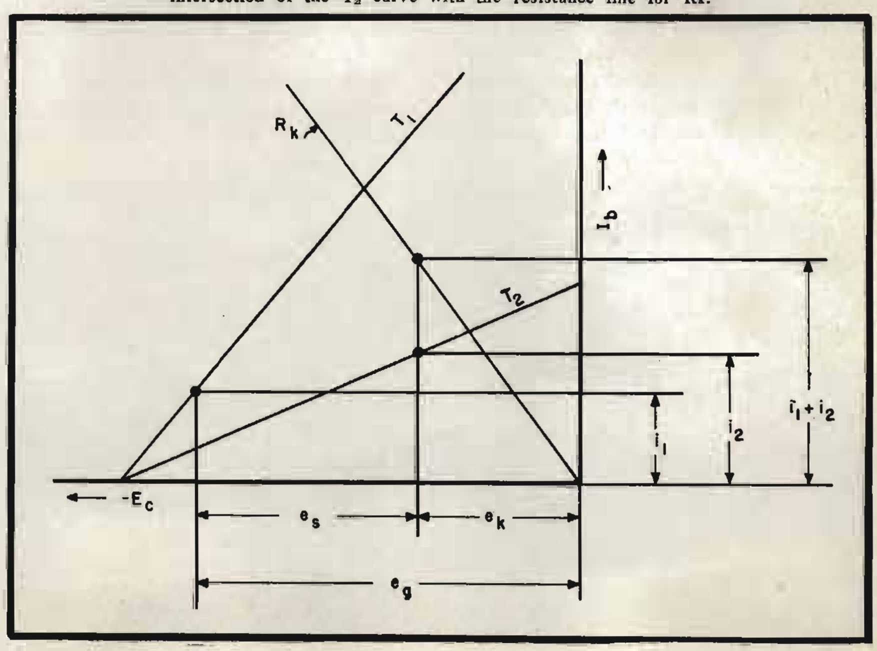


Figure 2
Idealized tube-characteristic curves.

Figure 3
Curves illustrating that the plate current of T_2 varies between zero and the value of current at the intersection of the T_2 curve with the resistance line for R_k.



A Report On The 1946

G. L. Beers (right) of RCA Victor, demonstrating latest image orthicon camera to ye Editor at the Rochester Fall Meeting. Mr. Beers presented a demonstration of the camera and associated equipment at the meeting.

TELEVISION RELAYING

Paul H. Reedy

Engineering Research and Development Dept., CBS

THE TRANSMISSION OF COLOR as well as black and white television signals from one point to another presents a new and unique set of problems to the television engineer. Since the first postwar transmission of color television signals from the Chrysler Building in the fall of 1945, all known practical forms of relaying have been employed by CBS.

Chrysler Building-Madison Ave. Link

In November 1945, the first CBS color television transmitter was installed on the seventy-first floor of the Chrysler Building. This unit required a composite television signal input of approximately 1 volt peak to peak for full modulation and developed a peak power output of 100 watts. Signals originating at 485 Madison Ave., N.Y.C., were transmitted to the Chrysler Building via a New York Telephone Company coaxial-cable installation. This coaxial cable was equalized to a little more than 10 mc. Since such equalization is accomplished by attenuation of low frequencies, the loss in a given length of transmission line is rather high. Thus it was necessary to use a repeater amplifier with a gain of approximately 24 db at 15 Vanderbilt Avenue in Grand Central Terminal. A signal level of 6 volts peak to peak delivered to the input of the cable produces about ⅜ volt at the input of the repeater amplifier, the output of which produces 6 volts peak to peak which is delivered to the Chrysler Building at a 1 volt peak-to-peak level.

Noise Level Control

Noise is present on the coaxial link due to both inductive pickup and ground currents. If no special balancing methods or clamping techniques are employed, the signal-to-noise ratio is approximately 40 db at the input to the transmitter modulator. This noise varies periodically with time, different cycles occurring regularly throughout a 24 hour period. In practice, a noise level of 3% can be tolerated, but it is desirable to keep this down to 1% or less, if possible.

A *clamper* on loan from the Bell Labs used at the Chrysler Building, has solved the problem, providing an improvement of 16 db in the signal-to-noise ratio.

Coaxial-line transmissions are further complicated by cross modulation of line noise with the composite television signal. In the non-linear network elements, if such an effect does occur as a consequence of overload, wrong operating points, etc., the noise present on the coaxial line is divided non-uniformly in amplitude in the tips of super sync, blanking and white levels. In such a case, line clamping does not remove the difference component of noise present in the video signal. The importance of this factor should not be overlooked. To prevent cross modulation it has been found necessary to limit the output swing of 829-Bs, used as cathode followers in the line and repeaters, to 6 volts peak to peak across 75 ohms.

Short Range Radio Links

Low power u-h-f or v-h-f wide-band radio links provide an auxiliary method of relaying color signals from studio or mobile equipment to the main transmitter. However, since a greater number of circuit elements are required, alignment and maintenance duties are increased. In addition, interfering radio frequency signals may be present, over which the engineer has no control.

A few weeks ago a 530-mc crystal-controlled color-relay transmitter was placed in operation by CBS. On sync peaks the power output is 35 watts. Double side band operation is employed with an r-f band width of ± 10-mc flat.

The video-modulator has five stages: 6AB7, 6AG7, 6YG, two 807s in parallel with d-c insertion on the grid and an 829-B cathode follower with d-c insertion on its grid. One volt of video peak to peak is required for 85% modulation of the transmitter.

There are seven stages in the r-f section: 6L6 crystal tri tet, 6L6 tripler, 829-B tripler driving a pair of 8025s as a doubler, buffer amplifier and final cathode-modulated amplifier. The final r-f stage is cathode-modulated by an 829-B video cathode follower. The crystal in tri tet operates at approximately 4.907 mc.

The 3C22s are used in a buffer-amplifier stage and final cathode-modulated output stage.

To minimize transmitter hum, d-c obtained from rectified and filtered a-c, is used to supply the heaters of the modulator unit. Measurements show *on-the-air* hum to be approximately 50 db down in voltage.

The r-f unit includes a tuned preselector, local oscillator and crystal mixer. Pre-selection is achieved through the use of a tunable r-f band-pass filter which is ganged to the local oscillator.

Presidents of the IRE, past, present and president-elect, during a visit to the COMMUNICATIONS booth at the Fall Meeting: Dr. W. L. Everitt, Dr. F. B. Llewellyn and Dr. W. R. G. Baker.

COMMUNICATIONS *in 1947 will feature*

TELEVISION AND F-M BROADCASTING

Television

Transmitters and Receivers
Measuring Equipment
Cameras and Field Equipment
Antennas and Towers
Tubes
Components

F-M

Transmitters and Receivers
Mobile Equipment
Instruments
Tubes
Antennas
Components

tion as a low-frequency black and white picture transmitted over the same link. In such a case, the ratio of vertical to horizontal resolution in the color picture is approximately 3 to 1.

In the early summer of this year, CBS conducted several long distance color television tests between New York and Washington, D. C. and back over an A. T. & T. coaxial cable loop. Color signals, originating at 485 Madison Ave. were fed via coaxial cable to 15 Vanderbilt Ave. At this point, the signal could be sent either directly to the high-frequency color transmitter, W2XCS, or via the Washington loop and then to the transmitter. Simultaneously, the facilities of the low-frequency CBS black and white television transmitter were utilized to make comparisons of color versus black and white pictures on the air, first directly and then via the loop.

Engineers from Bell Labs, A. T. & T. and the N. Y. Telephone Company were present as observers.

A TRK-12 low-frequency black and white receiver and a CBS u-h-f color receiver were used in making the tests. The same slide subject matter was transmitted, first on the low-frequency black and white, and then in u-h-f color without the use of the Washington loop. This test was then repeated, using the loop. As expected, use of the Washington loop did not appreciably affect the low-frequency black and white pictures, but did reduce the horizontal resolution in the color pictures. Next, the same subject matter was presented simultaneously on both receivers, the low-frequency black and white picture directly via WCBS-TV and the u-h-f color picture via the Washington loop. This was, of course, the crucial test. The observers preferred the color picture to the black and white, in spite of reduced bandwidth considerations.

Finally, a color film was transmitted for the purpose of making further observations. During this run, the Washington loop was switched in and out at irregular intervals, the observers not being informed as to the exact instant of switching the loop. It can be stated that it was difficult to ascertain which mode of transmission was in use when viewing the picture from a distance of about eight times picture height. At viewing distances of ten or more times picture height it was almost impossible to detect any difference during the film sequence.

Radio Link Long-Distance Transmissions

To determine the effect of radio links over long distances tests were recently initiated, in cooperation with Bell Labs., using their microwave relay links between 463 West Street and Murray Hill, New Jersey. Color signals originating at 485 Madison Avenue were sent via coaxial cable to the color transmitter, W2XCS, in the Chrysler Building.

A dipole with a flat reflector was used at 463 West Street to receive the color signals. The demodulated output from a standard r-f/i-f video unit was fed to the Bell Lab. relay racks, where the signal was used to frequency modulate a low-frequency oscillator which, in turn, modulated the first microwave carrier. The signal was transmitted through a chain of 4 repeaters operating in the 40,000-mc region. After this 84-mile relay trip, the signal was demodulated and fed to the video section of a standard CBS 10" direct-view color receiver.

(Reedy Paper)

Image orthicon live-pickup camera designed for mobile use. With this camera but 60 foot candles are required for illumination for satisfactory color pictures. Minimum usable illumination is 15 foot candles. This compares with 400 and 100 foot candles, respectively, required when using the standard orthicon camera.

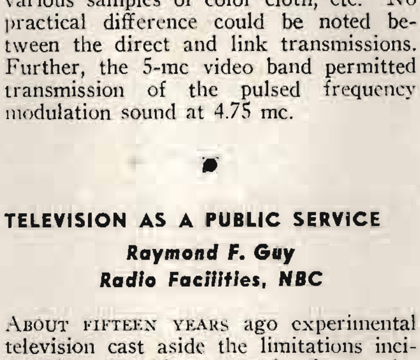
Both slides and live pickup were shown over this link. Since the video bandwidth of the microwave link was about 5 mc, a slight loss of horizontal resolution resulted. However, this was not at all serious on ordinary subject matter, slides, a singer from live pick-up, various samples of color cloth, etc. No practical difference could be noted between the direct and link transmissions. Further, the 5-mc video band permitted transmission of the pulsed frequency modulation sound at 4.75 mc.

TELEVISION AS A PUBLIC SERVICE

Raymond F. Guy
Radio Facilities, NBC

About fifteen years ago experimental television cast aside the limitations incidental to operation at carrier frequencies of about 2200 kc and moved to the more appropriate region above 40 mc. About eleven years ago it cast aside the limitations of mechanical scanning and adopted all electronic scanning. In a few years of fruitful development, the industry adopted certain standards including 525-line horizontal interlaced scanning. The system was quite thoroughly field tested during the years of experimentation and, when it was launched as a new public service on July 1, 1940, its foundations were solid and its future was very bright.

Raymond F. Guy, radio facilities engineer of NBC, who discussed television as a public service at the Rochester Fall Meeting.



But the early intervention of the war nipped its growth in the bud.

The FCC, of course, having in mind not only international and domestic problems of common frequency usage and sharing but also the postwar problems arising out of the war-born services, foresaw the need to review the existing frequency allocation structure, and plan for the post-war future. Out of this need grew the RTPB, which was charged with the task of recommending to the Commission the technical standards and the frequency allocation framework for all radio services.

These recommendations were presented. Commercial television standards and rules were to some degree modified, Television frequency allocations while shifted about somewhat, remain in the portion of the spectrum originally allocated.

At long last television faces a limitless paved highway devoid of traffic lights and speed limits.

Transmitting and receiving equipment of improved design has been developed, is being manufactured and will flow in volume in the months immediately ahead. The problems that remain before television becomes a truly national service are in essence problems of equipment shortages. They are predominantly problems of receiver production. The public is hungry for television service and television receivers.

The broadcaster awaits a market for his service which can be only provided by the sale of receivers and this bottleneck is on the threshold of solution.

Merchandisers of receivers are in substantial agreement that in 1947 nearly a million good serviceable television receivers will be sold to the public at a fair price.

In the scope and stature of the service that can be rendered television is far ahead of any other important public service at the time it was introduced. No other important public service has had so many birth pains before the public had an opportunity to avail themselves of it. This is only too evident when one considers the automobile, the telephone, the telegraph, the railroad, the air transport industry, the communications industry, the movies, etc.

Philosophy of Television Programming

Television is new, and it has been necessary to establish a philosophy of program presentation peculiar to itself. The traditional approach and terminology used in sound broadcast programming cannot be followed in television.

With television it is possible figuratively to transport people visually and auditorily to events and have them witness things as they happen from choice vantage points. Television incorporates all the elements of immediacy and spontaneity and preserves the sense of the unexpected when it takes its audience to any location where action is taking place—or might take place. It has no competitors in this respect, nor will it ever have any.

Canned entertainment serves its purpose and will continue to be popular. But to restrict television to that type of material would not be satisfying a human need that had gone unsatisfied before. It would not exploit *television's* outstanding characteristics.

In television, as in sound broadcasting, the theatre or the motion picture, the *program* is the important thing. All else is but a means to that end.

The elementary rules of picture composition will apply in television as they apply in photography, motion pictures or painting. Interesting television is not going to be provided by the neophyte or the amateur any more than would be the case in making pictures. Only those skilled in the arts of dramatic production, composition, lighting, set de-design, costuming, make-up, continuity and showmanship will be able to turn out the finest in television entertainment. Network television studios of the future will become workshops vast in proportion and luxurious in equipment. The demand for writers, directors, actors, and skilled craftsmen, the contingent staff of engineers, technicians, sales and service men, advertising agency personnel, those occupied in the construction and maintenance of program facilities, etc., are going to produce a vast new industry.

Television may borrow the techniques of other existing media but integration in an entirely new way will be necessary.

Networks

One of the greatest public services to be provided by television will be the broadcasting of events as they happen. Obviously inter-city network connections will be necessary to bring such events to the nation. The cost of top-flight especially prepared television programs will be so great that network syndication may be a pre-requisite to their unlimited growth and support.

Commenting on network circuits, L. G. Woodford, of A.T.&T, said recently:

"Early in 1944, the American Telephone and Telegraph Company announced a five to six-year construction program involving 7,000 route miles of coaxial cable. That program is now being compressed into about three years, and additional routes have been added to the enlarged program, so that by about 1950 we expect to have some 12,000 route miles of this broad-band cable in service.

"As of October 1, about 2,700 miles of coaxial cable were in the ground, and construction is moving forward rapidly at a rate which will approach 3,000 miles next year.

"The coaxial *tubes* first used in 1936 were about ¼" in diameter. Because of the wider frequency bands now contemplated, the diameter of the tubes now being put into the cables has been increased to ⅜". These larger tubes permit us to station the auxiliary repeaters eight miles apart, instead of five and a half miles, and to put the main repeater stations as much as 150 miles apart, as compared to 90 miles in the case of the earlier cables.

"We are not placing our reliance solely on coaxial cable, however. Bell Labs. are also conducting extensive development work on radio-relay systems. One such system is now being installed between New York and Boston and is expected to be available for experimental use next spring. Should radio-relay systems prove advantageous for use either alone or in conjunction with coaxial cables, they will, of course, be utilized where indicated.

"For carrying programs from remote pick-up points to the broadcasters' control rooms, both radio and wire methods have been developed.

"It has been found that ordinary telephone wires can be used for this purpose when special amplifying and equalizing equipment is provided, and the wires are cleared of all branching connections. This method has the great advantage that the wires already exist to most all points of interest. (Such circuits have been in use in New York.)

"We expect the embryonic network which now connects New York and Washington with two-way television facilities to be extended to Boston next year, using radio relay. We expect also to make available two additional one-way television circuits between New York and Washington next year. In 1947 we will push westward towards Pittsburgh, and hope to be able to connect such cities as Cleveland, Buffalo, Detroit, Chicago and St. Louis by the end of 1948 or shortly thereafter. Other cities in this general area probably can be connected not much later than this.

"A new type of repeater now in development will permit transmission of telephone and television simultaneously on the same coaxial conductors. The repeater will make it possible to transmit a band of frequencies about 7 mc in width. This compares with about 3 megacycles, which is the limit of the repeater now in use. The entire band could be used for television or it could be divided into say a 4-mc band for television and 3 for telephone."

It is thus apparent that it will not be long before there will be a national network.

The first steps in the fruition of the NBC national network plans are now being taken. The Eastern leg of this network is expected to consist of a Westinghouse station in Boston, affiliated stations in Providence, and Schenectady, an NBC station in New York, affiliated stations in Philadelphia and Baltimore and an NBC station in Washington. The Washington station should be ready for operation about the end of this year.

Television's Future

Discussing the potentialities of television in a recent talk, Niles Trammel, president of NBC, stated that television promises to be the greatest medium of mass communication yet evolved with unparalleled opportunities for services of entertainment and education.

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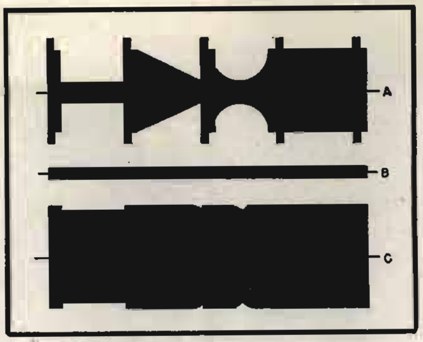
TELEVISION SOUND CHANNELS

R. B. Dome
General Electric Company



(Dome Paper)

Analysis of limiter action and affect on picture modulation. At *A* appears a picture-modulated wave with a minimum modulation of 15% of the peak of the synchronizing pulses. At *B* appears the f-m sound carrier with a level of 7.5% of synchronizing pulses. What the 4.5-mc wave looks like as a result of *A* demodulating *B* is shown at *C*.

SEVERAL PROPOSALS have been made in the past to permit the use of a common amplifier channel in a television receiver to simplify the receiver and to render the operation free from disturbing effects of local oscillator hum, frequency-modulation and frequency drift with warm-up and voltage changes. Most of these proposals were based on some form of multiplex or *time-division* systems of transmission wherein the sound signals modulate the picture carrier during the horizontal blanking interval when no picture information is being transmitted. In these systems separation of sound and picture is effected at the receiver by employing a time-gated amplifier which opens up only during that portion of the time devoted to the transmission of the sound accompanying the picture.

These methods are weak for two reasons: (1) The amount of power devoted to sound is relatively small, and thus the signal-to-noise ratio will not be as good over as long a range as if more average power had been used. (2)—Failure of the gated amplifier to synchronize properly in noisy locations means a further decrease in average signal-to-noise ratio or reduced service range.

The disadvantages of these systems may be overcome by the use of a frequency-division system with simultaneous transmission of picture and sound signals exactly as in the manner used today in black and white television.

In this system the video signal modulates one carrier frequency with amplitude modulation while the sound signal modulates another carrier frequency with frequency modulation. Both carriers are on continuously, i.e., no gating is used.

It is possible to use a conventional receiver arrangement wherein a local oscillator beats the two carrier waves down to two intermediate frequencies. The receiver is split into two i-f channels, a wide one for the picture, and a narrow one for the sound. Separate second detectors are employed: a simple rectifier for the picture and a discriminator-detector for the sound. There are, however, three objections to this type of receiver: (1) Frequency modulation of the local oscillator at power frequency rates can take place and will then be transferred to the sound i-f carrier wave and will show up in final detection as an unwanted component. (2) If the local oscillator frequency drifts excessively with warm-up or with changes in line voltage, the signal at the discriminator may wander so far away from the balance point that the signal may become

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Other frequencies by special order
★ Simultaneous channel operation, in following maximum combinations:
3 Channels telegraph
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★ 400 Watts plus carrier power
★ REMOVABLE R.F. HEADS are protection against frequency obsolescence. All connections to the transmitter are by means of plugs and receptacles. Instant removability means quick and easy maintenance.
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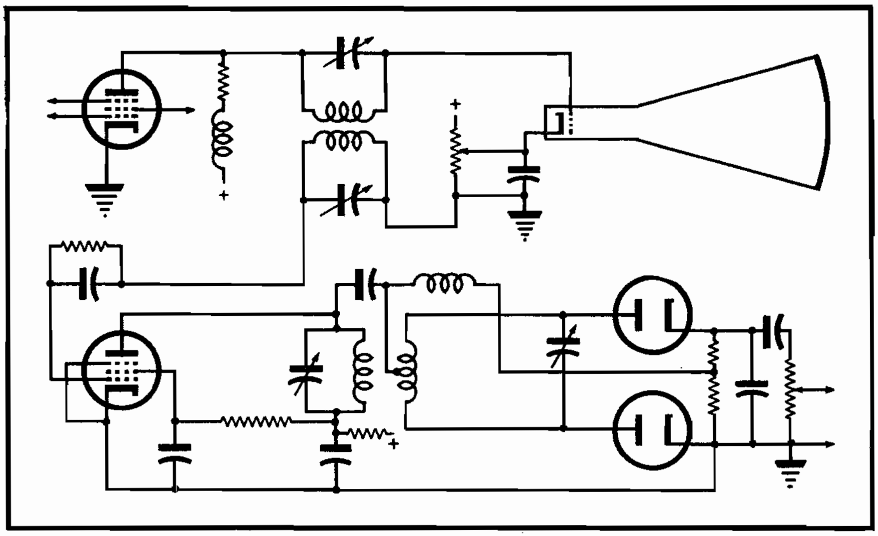


(Dome Paper)
Video amplifier with primary connected between final video stage and picture tube. Primary circuit is tuned to difference frequency of 4.5 mc. Secondary is fed to tube which serves as limiter amplifier feeding discriminator transformer and balanced detector.

noisy or distorted or even lost entirely. (3) The system is subject to microphonics in that the movement of oscillator tube elements or oscillator circuit elements may produce frequency modulation which is detected along with the desired signals.

A carrier-frequency difference receiver has been found more satisfactory for simultaneous transmissions. This type makes use of the frequency difference between the picture and sound carriers.

The carrier frequency difference receiver does not depend on any precise local oscillator frequency for its successful operation. Instead, the high frequency which is finally to be detected is the difference between the picture and sound carrier frequencies. In black-and-white television in the channels between 44 and 216 mc, this frequency difference is 4.5 mc.

The receiver uses one i-f channel broad enough to pass both the picture carrier and the sound carrier plus the necessary side bands of each carrier. So that the wave applied to the second detector can be dominated by the picture i-f carrier to successfuly demodulate the sound i-f carrier, some attenuation for the sound i-f will be necessary. Absorption trap circuits coupled to the i-f coils can be used. A pair of such circuits with the proper *Qs* and couplings will result in an i-f response with a *shelf* several hundred kc wide with its center about the mean sound i-f. The shelf height should be comparable to the minimum level expected for the picture carrier. If the picture transmitter does not modulate downward to any point below 15% of the voltage difference between peak of the synchronizing signals and zero the receiver slope will reduce this to 7.5% since the picture carrier should be half-way down the slope. Thus if the sound carrier amplitude is equal to the black level of 75%, the shelf should be 7.5%/75% or one-tenth of the maximum height of the i-f response.

With this treatment to the input to the second detector, the sound carrier will appear to the picture carrier as just another side band so that in the detector output there will be found, in addition to the video frequencies, a 4.5 megacycle signal frequency-modulated with the sound. The 4.5 megacycle wave will be amplitude modulated to some extent by picture modulation, but this may be removed by the employment of suitable limiter circuits.

The whole output of the second detector may be amplified by the usual video amplifier. Thus the video and sound channels are still common. Separation of sound and picture may be made at the conductor leading from the video amplifier to the picture tube.

This will prevent that frequency from appearing as picture modulation on the cathode-ray tube screen. At the same time it will provide a circulating current of considerable strength in the primary.

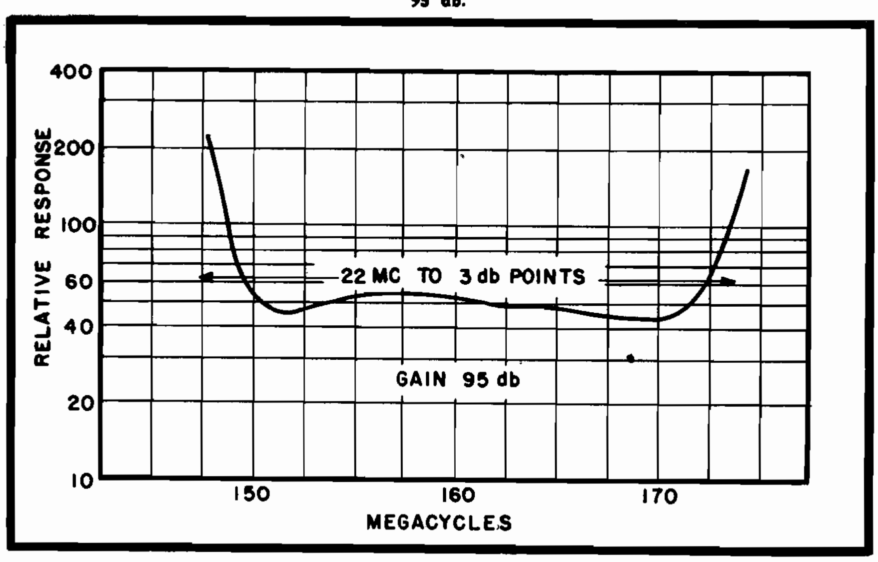
Nominal amounts of drifting of the local oscillator frequency is of no consequence because the 4.5-mc frequency has been determined by quartz crystals at the transmitters and presumably this difference frequency is held accurately to within ± 5 kilocyles. Hum modulation or microphonics in the local oscillator do not affect the sound signal because any change in the sound i-f is accompanied by an equal change in the picture i-f.

A carrier-frequency difference receiver has been in operation in Bridgeport, Connecticut, some 52 airline miles from New York television stations. It has proved to be very stable and reliable in performance. Push-button or selector switch tuning is possible without readjustment of the local oscillator because of the wide range of permissible variation in local oscillator frequencies.

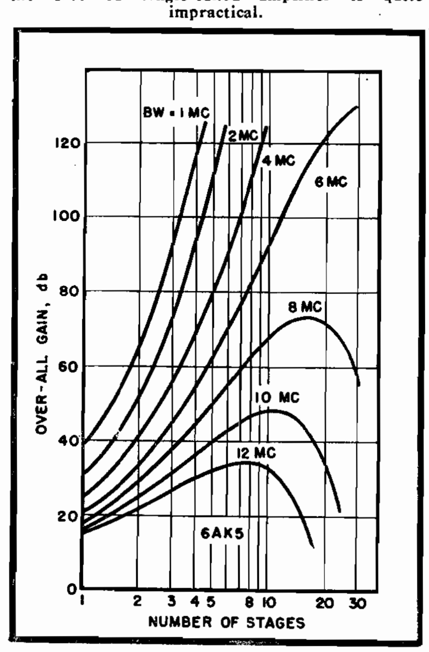
Requirements of Transmitters

Any phase or frequency modulation on the picture carrier would in this system be directly transferred to the 4.5-mc beat frequency and ultimately detected. It is therefore important to place a limit on the amount of frequency mod-

(Lebenbaum Paper)
Selectivity curve of a 160-mc amplifier, with a gain, including loss in the second detector, of about 95 db.



(Lebenbaum Paper)
Number of stages required to realize given bandwidths and gains using cascaded single-tuned coupling. With gains of 100 db and bandwidths greater than 4 mc, it can be seen that the cascaded single-tuned amplifier is quite impractical.



ROCHESTER FALL MEETING

Highlights of Papers Presented by Reedy, Guy, Dome, Lebenbaum and Hill.

by LEWIS WINNER

Editor

An image rejection of 40 db or more is achieved over the 480 to 920-mc tuning range. The local oscillator uses a 6F4 acorn triode. Tuning is accomplished by the use of a folded parallel plate transmission line, which is ganged to the preselector.

Other features include feeding of the crystal mixer unit into a standardized stagger-tuned i-f amplifier, using six type 6AK5s, a 1N23B crystal as a second detector, a 6AC7 amplifier and two 6AG7 cathode followers in the video section, one of which is used for monitoring.

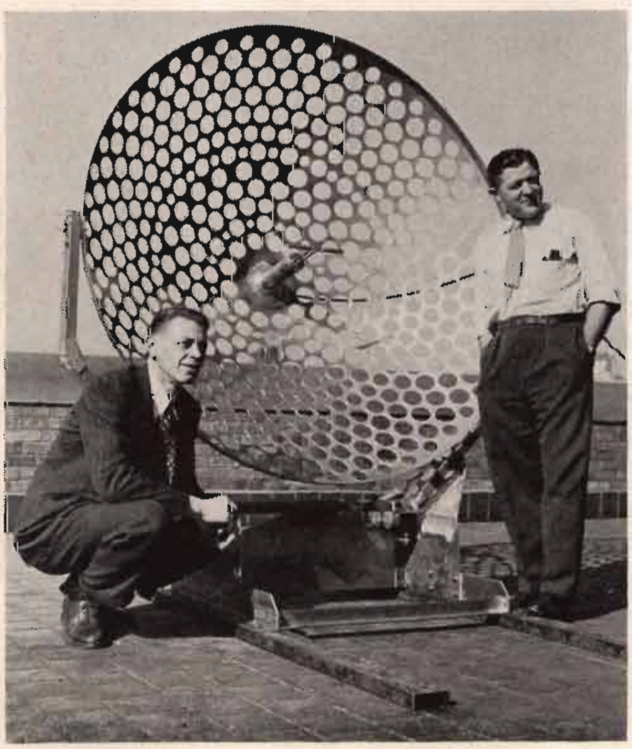
This radio-relay link will probably be used as a permanent spare to supplement the coaxial-cable link. Accordingly, a second such link operating at about 1300-mc and with an output of .15 watt, is now under construction, which will be used in conjunction with a new image orthicon mobile unit. Power gain of the transmitting antenna over isotropic will be 75. A video bandwidth of 10 mc will be maintained to permit full color definition.

Long Distance Color Transmissions

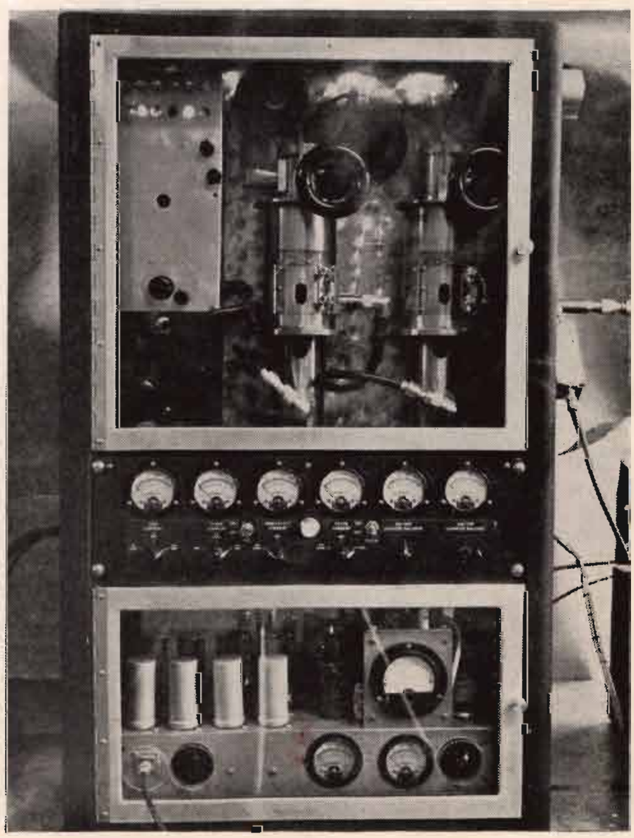
Since color television signals require a video bandwidth of 10 mc for full definition, we are concerned with the degree of bandwidth reduction that can be tolerated before the picture quality is appreciably affected by lack of definition. Studies carried out in Germany before the war, using synthetic back and white and color systems, throw some light on this subject. One and the same subject matter, both in color and in black and white, was reproduced with different degrees of detail by varying the circle of confusion in the projected images; this was brought about by carefully controlled de-focusing of the projection lens. The tests, carried out with several pictures and involving a number of observers, indicated that a black and white picture with 350 lines or more, has the same amount of apparent definition as the corresponding picture in color with ⅓ of the number of picture elements. Thus, a 525-line color picture would be equivalent to at least a 900-line black and white picture in terms of apparent resolution.

Existing commercial coaxial-cable links, such as that between New York and Washington, D. C., have a video bandwidth of slightly less than 3 mc. Thus, based on the German observations, a color television picture transmission from New York to Washington should possess the same apparent defini-

(Reedy Paper)
Relay link 6′ paraboloid transmitting antenna with a gain of 25 and bandwidth of 22°, at lower half points, atop 485 Madison Avenue, New York City. Corner reflector with a power gain of 10 over isotropic is used at receiving end on 72nd floor of Chrysler Building, New York City. John Wilmer, head of the CBS transmitter group, is at left and Jerry Adams, CBS transmitter engineer, at right.



(Reedy Paper)
The 530-mc radio-relay transmitter recently installed by CBS. The two cavities at upper right are 3C22 buffer amplifiers and a 3C22 final cathode-modulated output.



Relays BY GUARDIAN

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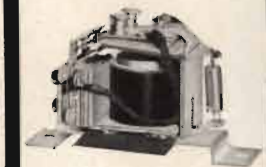
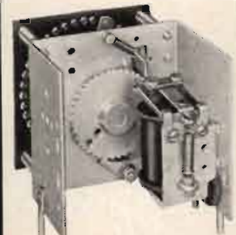
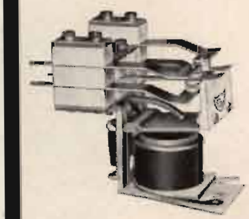
Series 500
Midget Relay
Use this relay where space, weight and maximum power delivery are primary factors. Sturdy. Offers many contact combinations. Maximum contact control capacity 8 amps. Fits in approximately 1½ cu. in. space.



Series 150
Suitable where a small A.C. control relay is needed or if exposed to possible maladjustment. Equipped with "special" spring tension contacts which "make" before the armature fully completes its travel. Remaining armature movement is taken up by the contact coil spring insuring a firm, wiping contact.



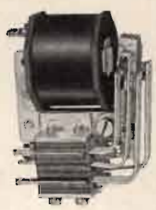
Series R Stepper
Three basic types for A.C. and D.C. operation: (1) Continuous rotation, (2) Electrical reset, (3) Add and subtract. For automatic circuit selection including automatic sequence; automatic wave changing on short wave transmitters; business machines; totalizers; conveyor controls, etc.



Series A-100
High Frequency
A1SiMag insulated, compact, low cost. For antenna changeover; break-in; hi-voltage keying; remote control of receiver and transmitter and other high frequency applications.

Series 120
A small, compact relay. An economical unit designed for control up to single pole double throw. Unique armature assembly prevents arcing. Low priced, yet high in quality and performance.

Series 1-A Solenoid
The series 1-A Solenoid by Guardian is one of numerous types for intermittent and continuous duty. Applications include valve control and operation; electrical locking; clutch and brake operation; material ejection; spray gun operation among others.



Series 40 A.C.
Laminated Relay
Designed to produce maximum output with minimum current input. Typical uses include control of call system bells; auxiliary for automatic radio tuning; remote control of fractional motors; safety devices; instruments; sound movie auxiliaries.

Guardian Switches
Switch assemblies by Guardian are unlimited, ranging from a single set of contact blades up to multiple stacks. The Guardian Featherub Switch shown is actuated mechanically. Operates on manual, roll-over or cam action. There are hundreds of others. Contact blades are obtainable in phosphor bronze, tinned to withstand salt spray test, or standard Guardian phosphor bronze.

Introducing a new product? Redesigning an established favorite? You may be thinking in terms of a "special" electrical control. Yet, a *basic* type Guardian Relay—Stepper—Contactor—Solenoid—or Switch Assembly (each adaptable to many variations) may meet your "special" control requirements with utmost efficiency. In such applications where *standard* Guardian units become "specials," the savings in time and money are substantial and you beat delivery schedules in the bargain. We urge you—study the *standard* Guardian units pictured and described above—there are many more fully illustrated in the Guardian Relay catalog giving complete operating details and variable contact data for each. Your copy is waiting. Write.

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ulation permissible on the picture carrier. Since the peak frequency deviation of the sound carrier frequency has been set at ± 25 kc, the limit on the picture transmitter should be about ± 100 cycles maximum, which corresponds to a modulation of ± 0.4% or 48 db below 100% modulation on the sound transmitter.

Another transmitter requirement is that some picture carrier must always be present. This is necessary in order to continuously detect the sound carrier. The present standards read that the transmitter shall be capable of modulating down to 15% of peak synchronizing level on maximum *white*. The standard may be modified to read *at least to 15% but not greater than 10% for downward modulation*. This will provide a 10% safety zone perfectly adequate for the system's operation.

It is recommended that the peak deviation of the sound transmitter be increased to ± 40 kilocycles from the present ± 25 kilocycles. This will aid in masking any inadvertent f-m present on the picture carrier and is within the modulation capability of sound transmitters built according to FCC standards.

In conclusion, it is recommended that the RMA propose to the FCC that the standards for the picture transmitter be modified so as to permit the carrier frequency difference system of sound reception to be used. Such standards would in no way make obsolete present receivers which employ two i-f channels and hence no hardship case will arise.

•

WIDE-BAND I-F AMPLIFIER ABOVE 100 MC

Matthew T. Lebenbaum
Airborne Instruments Laboratory, Inc.

In the Development of wide-range tunable superheterodyne receivers in the u-h-f and s-h-f regions one of the important performance characteristics is the image rejection ratio. If a tunable receiver is to be truly a *single-dial, single-signal receiver,* all spurious responses, the most important of which is the image response, must be eliminated or reduced to such an extent that under practical operating conditions these responses are below the level where objectionable interference may be encountered. Two major components which provide attenuation to the image response are an r-f preselector and an i-f amplifier which removes the image frequency sufficiently far from the desired signal frequency so that the selectivity of the r-f preselector may be used advantageously.

To determine the image rejection obtained with a given intermediate frequency, it is only necessary to find the ratio of the response in the r-f pass band to the response at two times the intermediate frequency from the pass band.

Design Parameters

In designing an i-f amplifier, it is necessary to know the frequency, bandwidth, gain, and off-band rejection.

In one set of receivers designed, a minimum image rejection ratio of at least 60 db was found to be necessary.

For this purpose a 3-cavity preselector was chosen, and an i-f amplifier, cen-

(*Continued on page* 50)

PREVENTIVE MAINTENANCE for Broadcast Stations

Part VI of Series Presents Analysis of Preventive Maintennance Techniques Applied to Tube, Base and Pins, and Sockets.

by CHARLES H. SINGER

Assistant Chief Engineer
WOR-WBAM

CONTINUING OUR APPLICATION of *fitcalm* preventive maintenance techniques, the procedures used for tube base and pin maintenance will now be analyzed.

Tube Base and Pins

(*1*)—*I*nspect: The base of the tubes and the base pins should be free of discoloration due to overheating, dirt, corrosion and other foreign matter to assure a good electrical connection. The soldered tip must be kept in good condition with the contact surface clean. In some cases the heat generated at the pin connection to the socket prong, due to a faulty or poor connection, is sufficient to melt the solder from the tip of the pin. This of course applies to those pins carrying heavy currents. Any pin connections found in this condition should be resoldered.

(*2*)—*C*lean: Tube base should be cleaned with a clean dry cloth. The base pins can be cleaned with No. 0000 sandpaper or a cloth depending on their connections. The sandpaper should be wrapped around the pin and gently rubbed along the surface. Excessive pressure is not needed; neither is it necessary to grip the pin tightly with the sandpaper. The pins should be clean and bright.

Tube Socket Maintenance

(*1*)—*F*eel: Immediately after the equipment is shut down, it is necessary to feel the filament socket spring contacts and prongs (of the large tubes only) for evidence of overheating. If overheating is apparent, there is a poor contact at the point where the heating occurs. The tube should be removed, contact surfaces cleaned and socket springs adjusted as required.

(*2*)—*I*nspect: When tube sockets are inspected, they should be examined for dirt, cracks, corroded or discolored connections and contact springs, loose mountings, and loss of tension in the contact springs. The socket spring connectors should be clean and have sufficient tension to make a good connection to the tube base pins.

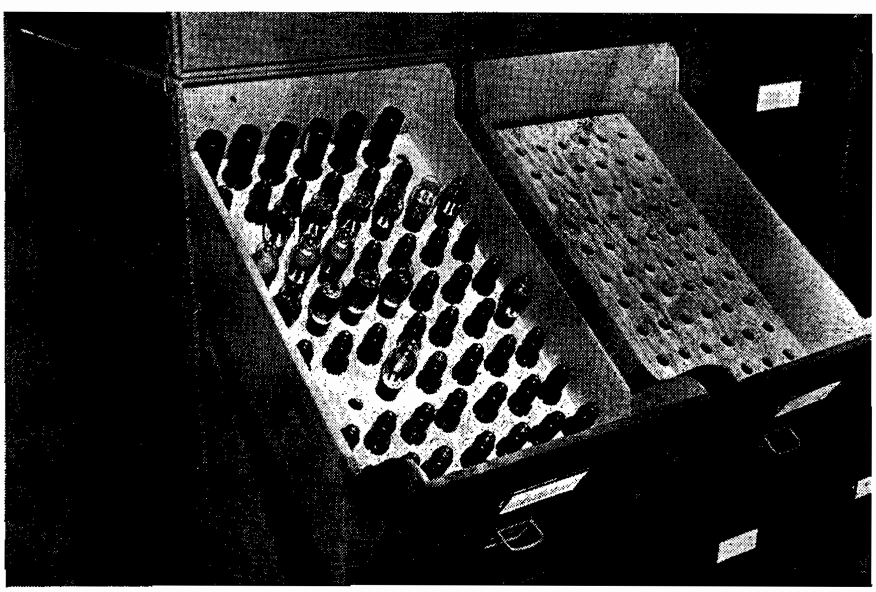
The firmness of tubes in their sockets or mountings must be determined by inspection. The inspection should be made by pressing the tubes down in their sockets, not by partly withdrawing them or moving them from side to side. Movement of a tube in its socket may cause trouble where it did not exist before. Such practice tends to weaken base pins and to spread the socket contacts.

The sockets of the tubes should be inspected at the same time the tubes are examined. It is usually unnecessary to remove tubes for socket inspection but a socket should always be carefully examined at the time of a tube replacement. A close examination of the springs and connections on the under side of the socket should be made. The springs should be examined for signs of corrosion or overheating which may result from poor electrical contact between the tube and socket.

When removing and inspecting tubes, it must be remembered that some tubes are held in place with a socket latch, which must be unhooked when tubes are removed and rehooked, when the tubes are reinserted, to hold the tubes in position. Some chassis employ a retaining ring or a clamping ear to grip the base of the tube and hold it in place. If a tube shakes loose it must be pressed down firmly and the

(*Continued on page* 44)

Double transfile for storing of tubes. Note the wooden platform in file boxes for tube mounting.



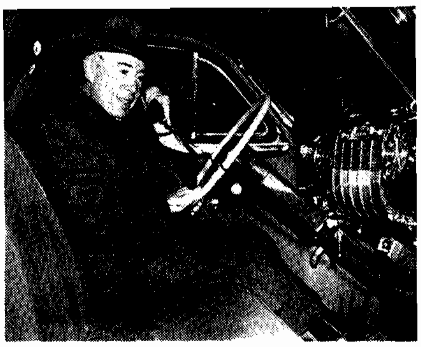
VWOA LIFE MEMBER E. H. Rietzke, president of Capitol Radio Engineering Institute, has again made school-engineering headlines by securing an accredited correspondence and residential course standing from the Engineers' Council For Professional Development. This is the first home-study course that has ever been accredited by this committee and EHR is to be congratulated for achieving this recognition.

EHR has been a member of the Technical Institute Committee of ECPD representing the member schools of the National Council of Technical Schools, of which he is president.

Among the outstanding engineer societies recognizing the ECPD are the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, The Engineering Institute of Canada, The Society for the Promotion of Engineering Education, American Institute of Chemical Engineers and the National Council of State Boards of Engineering Examiners.

Among the outstanding educators who visited C.R.E.I. to study their procedures and act on ECPD recognition were Dr. H. P. Hammond, dean of the School of Engineering, Pennsylvania State College; Dr. Hibschman, head of the Department of Electrical Engineering, Pratt Institute; and Dr. Baker, dean of engineering, International Correspondence Schools.

MANY VWOA LIFE MEMBERS are now serving on important committees of the industry. E. A. Nicholas, president of Farnsworth Television & Radio Corp. has been named to serve on the RMA-NAB Joint Committee, which will study manufacturing and broadcasting problems jointly. Honorary member Paul Galvin, president of the Galvin Mfg. Corporation, is also a member of this important committee. . . . Life member Louis Pacent, president of the Pacent Engineering Company, was recently named to serve on the Board of Admissions of the AIEE to represent the radio engineering profession. LP has been an outstanding member of the radio world for over a score of years and is very familiar with the professional requirements of the industry. . . . Our good friend John V. L. Hogan is now serving on the F-M Executive Committee of the National Association of Broadcasters. This committee was formed at the recent NAB meeting in Chicago and will serve to advise the industry on f-m practices and procedures.



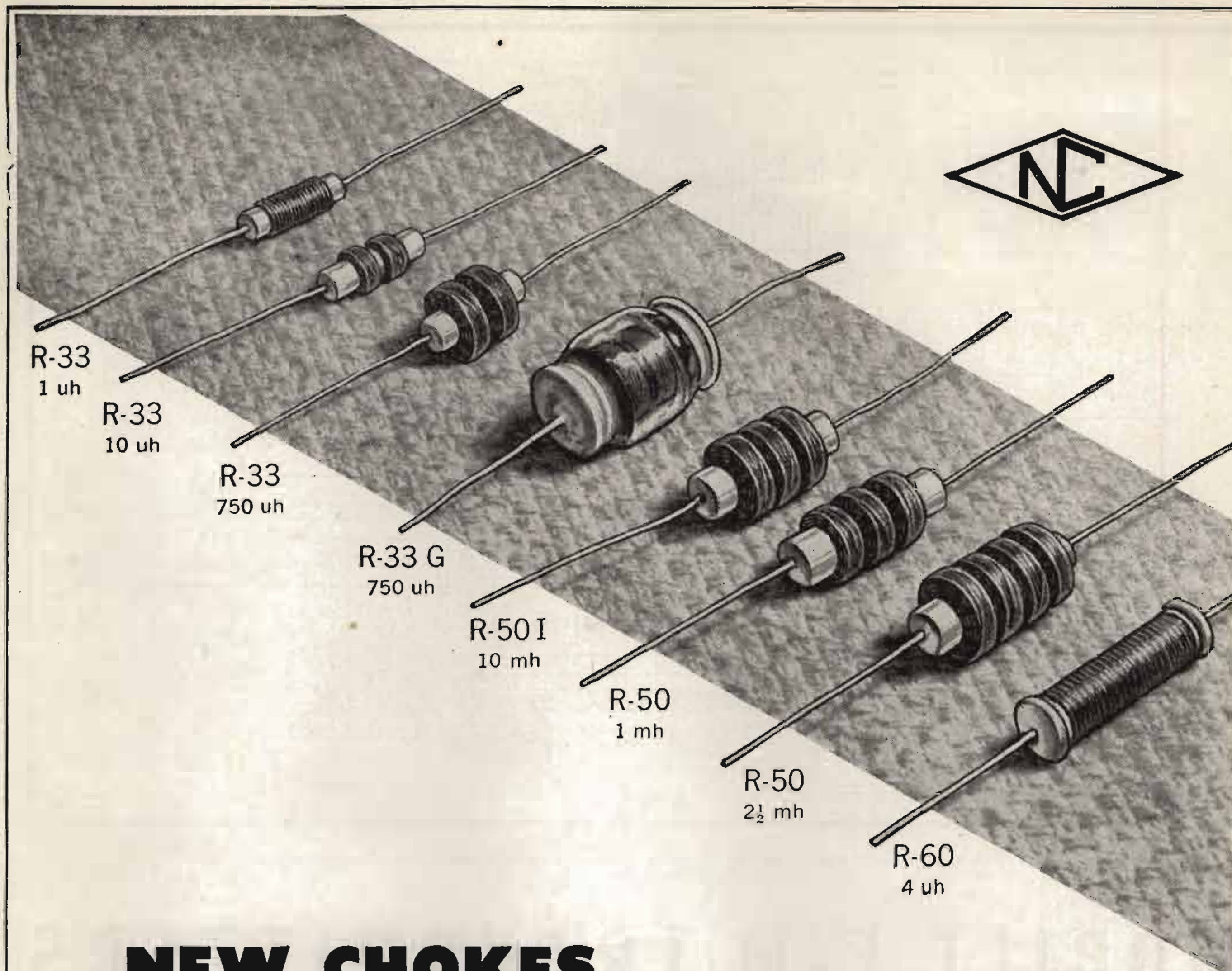
Honorary VWOA member Paul Galvin, president of Galvin Manufacturing Corporation, testing the recently inaugurated Illinois Bell Telephone System auto radiotelephone service. The service, operating on 152 to 162 mc, uses a 30-watt f-m transmitter and receiver in car and 250-watt central station transmitter developed by Motorola.

HONORARY MEMBER WILLIAM S. PALEY, chairman of the board of Columbia Broadcasting System, presented one of the outstanding talks at the recent NAB conference in Chicago. WSP pointed out the importance of good programs on the air. To prove his point, he has initiated a special series of programs over CBS that will serve to analyze program practices today. He plans to take you and me right in to the thick of the production problem and let us see what problems face them and how the station proposes to solve them. You and I will be asked to present our views on this very important subject.

HONORARY MEMBER JAMES L. FLY, formerly chairman of the Federal Communications Commission, will soon become a broadcast station owner. He has invested in a station in the Southwest and will assume quite an active management. JLF is well known for his intense interest in the broadcasting industry, having served on the FCC for nearly seven years and received the acclaim of the industry for his outstanding activities during this period.

HONORARY MEMBER REAR-ADMIRAL R. E. BYRD, who was recently honored by the USN for his outstanding activities during the war, is now on his way to the Antarctic in one of the most important exploration events of the year. He will provide this country with important information on the air, sea and land possibilities of these polar sections. Admiral Byrd is an old hand at this work, having visited these areas many times before. He is one of the most experienced naval scientific explorers today and will provide our nation with all of the vital data which they are seeking.

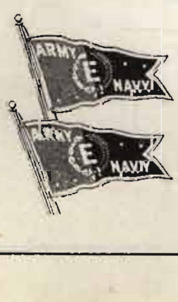
HONORARY AND LIFE MEMBERS OF VWOA are continuing their engineering conference activity these days. Life member Jerry Taylor, president of Central Radio and Television Schools was quite active at the recent TBA conference in New York. . . . George Bailey, the assistant to the VWOA prexy and secretary of the IRE, attended the recent Fall Conference of the IRE in Rochester. . . . Efforts are now being made to hail Dr. Lee DeForest on the 40th anniversary of the audion-tube invention with a banquet in January, 1947. Doc certainly deserves this tribute in view of his outstanding contribution to the radio communications art and, undoubtedly, there will be a large turnout if the gala affair can be arranged. Here's our vote for the banquet.



NEW CHOKES

The enlarged line of chokes now offered by National includes many new sizes and types and provides units suited to specialized as well as standard applications. Many popular new chokes are illustrated above, including the R-33G which is hermetically sealed in glass. Other models cover current ratings from 33 to 800 milliamperes in a variety of mountings carefully planned for your convenience. These as well as old favorites like the R-100 are listed in the latest National Catalogue.

NATIONAL COMPANY, INC., MALDEN, MASS.



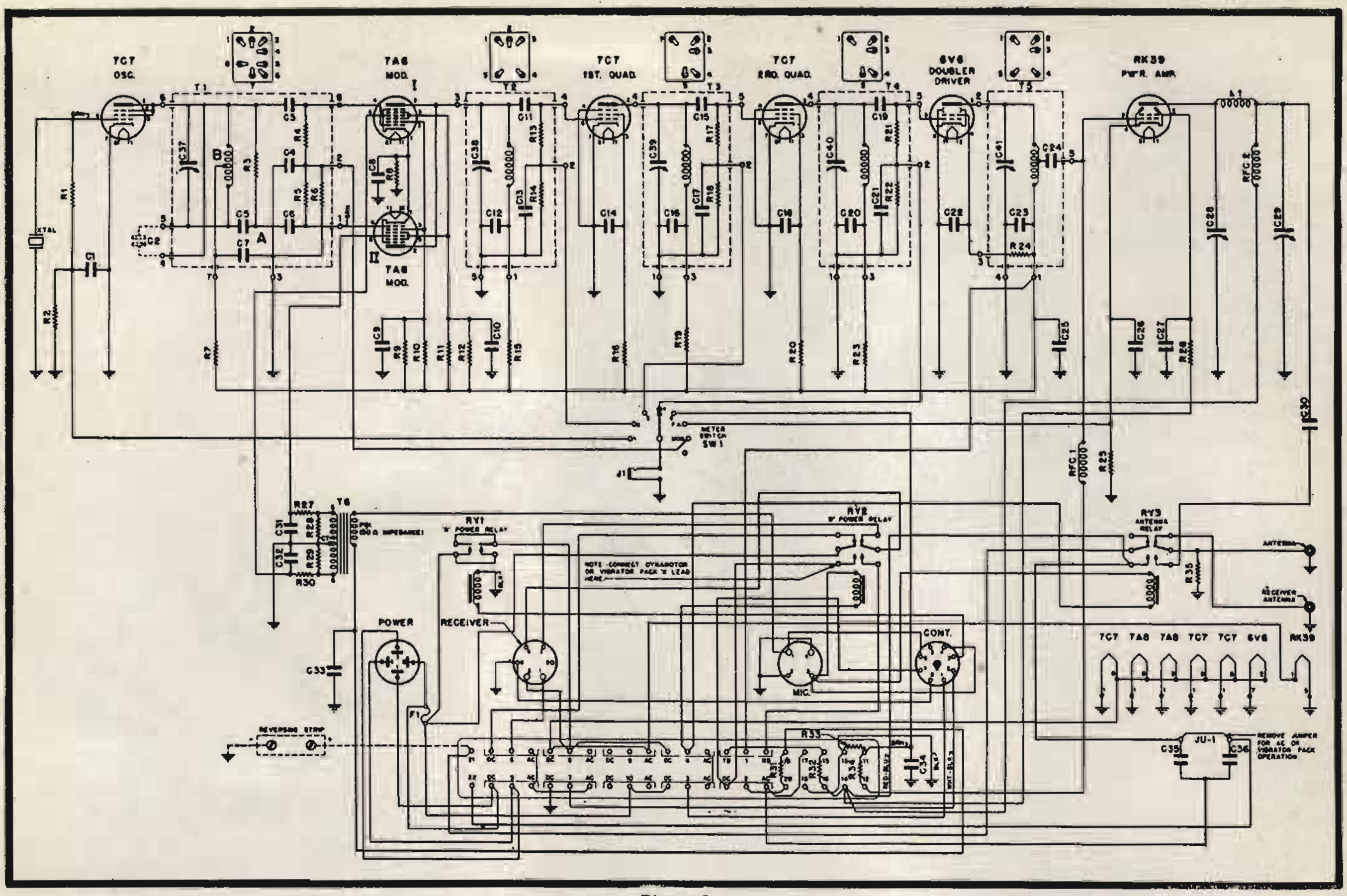


Figure 2
Circuit diagram of a 30-watt mobile transmitter using a crystal-generated, phase-to-frequency modulation method.
(Courtesy Galvin)

MOBILE F-M TRANSMITTERS

by N. MARCHAND*

Consulting Engineer
Lowenherz Development Company

Part XI of Discussion of F-M Transmitters Offers Data on Mobile-Communications-Systems Design Features Including Such Developments as Squelch and Selective-Calling.

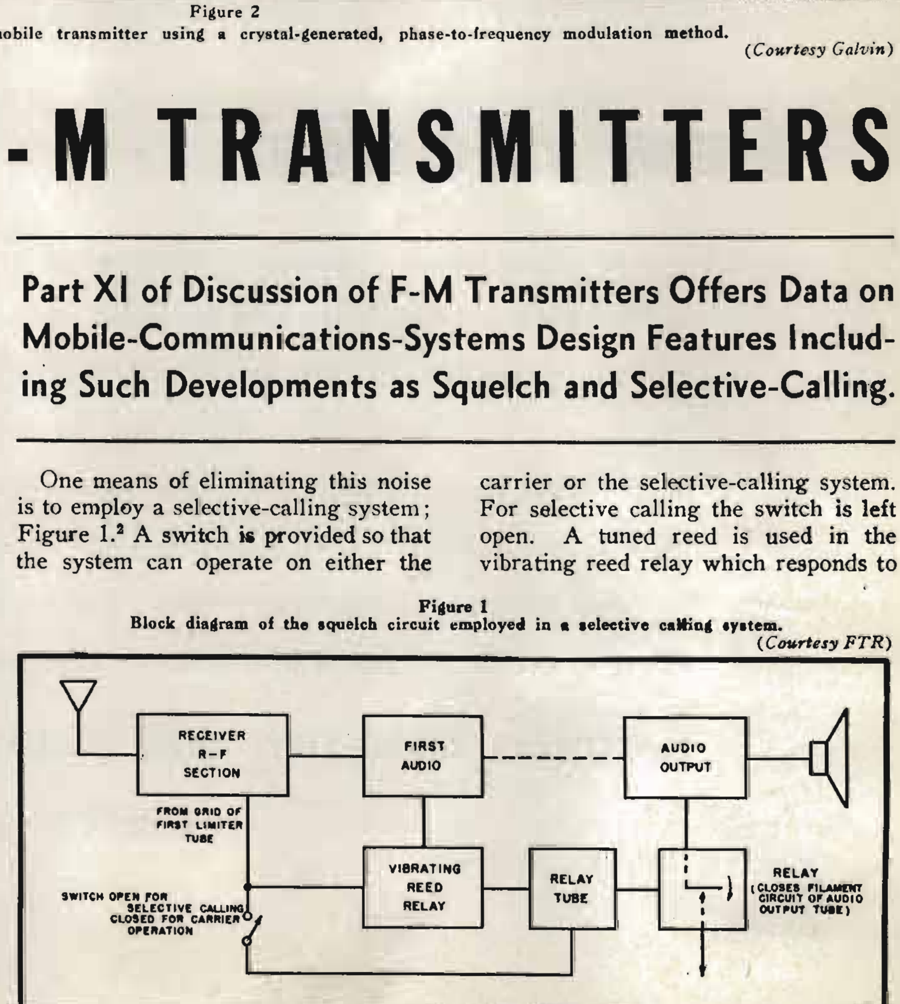
In our previous discussion[1] it was pointed out that squelch circuits are necessary to mute outputs when there is no transmission.

One way of accomplishing this is to amplify and rectify the noise picked up on the receiver and, using the resultant d-c voltage, bias one of the audio amplifier tubes to cut off. When the carrier is applied, a quiet signal is produced which removes this voltage and allows the audio circuit to open up.

It is usually also necessary to provide a system which will distinguish between wanted and unwanted signals. Very often an adjacent or an alternate channel signal may provide sufficient carrier to open the squelch circuit but not enough for a quieting signal. This produces a blast of noise which is extremely disturbing.

One means of eliminating this noise is to employ a selective-calling system; Figure 1.[2] A switch is provided so that the system can operate on either the carrier or the selective-calling system. For selective calling the switch is left open. A tuned reed is used in the vibrating reed relay which responds to

Figure 1
Block diagram of the squelch circuit employed in a selective calling system.
(Courtesy FTR)



*Instructor in Graduate Electric Engineering courses, Columbia University.
[1]October 1946, Communications.
[2]Federal Telephone and Radio Corp.

only one frequency. This frequency is obtained from the first audio amplifier. The contacts for this relay are in series with the contacts of another relay which is actuated by the rise in voltage on the grid of the first limiter tube.

When a signal is received the voltage on the grid of the first limiter rises and closes one relay. If a tone of the proper frequency is transmitted it closes the vibrating reed relay also. When the two relays are closed they actuate another relay in the filament circuit of the final output tube. This tube employs a quick heating filament and in a few seconds the receiver is ready to receive the transmission. The relay is then held in place as long as the carrier is on so that the tone can be removed and the signal transmitted. If the proper tone is not received when the carrier is on then one of the primary relays remains open and the receiver remains squelched.

If operation on only the carrier is desired then the switch shown in the illustration can be closed and the selective calling portion of the system removed. Now all that is necessary to operate the filament relay is a rise in voltage of the first limiter grid. This is caused by any carrier at the proper frequency. The filament relay will then close and actuate the receiver.

When selective calling is employed, the receiver will not receive any signal except that one which is employing the tone to which the vibrating reed is tuned. In addition to offering insensitivity to extraneous signals, the system provides for multi-tone receiver control; one tone may turn on the receivers of the police patrol; another, the fire patrol; still another, ambulances; and so on.

50-Watt Mobile Transmitter[3]

In Figure 2 appears a circuit diagram of a 50-watt mobile f-m transmitter, using a 7C7 as a crystal oscillator, a pair of 7A8s as modulator, a 7C7 as the first quadrupler, another 7C7 as the second quadrupler, a 6V6 as the doubler driver, and a RK39 as the final power amplifier.

The modulator is another type of phase modulator which in combination with a resistor-capacitor modifying circuit in the audio input produces frequency modulation at the output. Since low-frequency response is not too important in a communications transmitter, large phase deviations are used in the modulator. It is possible to obtain a frequency deviation of 15 kc with a multiplication factor of only thirty-two.

[*To Be Continued*]

[3]Galvin Manufacturing Company.

Index, COMMUNICATIONS, 1946

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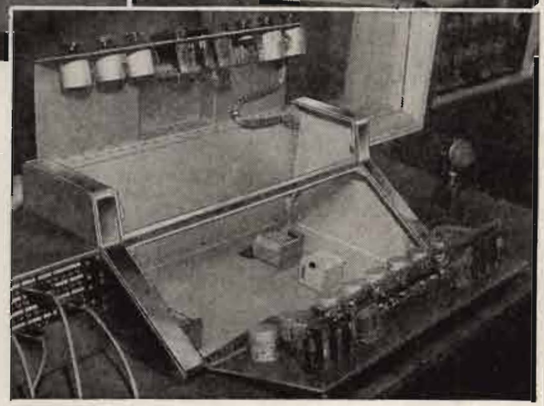

Constance Bennett, broadcasting her own program, "Constance Bennett Calling," over ABC network (Upper right) From the studio in Radio Center, recently opened in Hollywood, California, serving the broadcast industry, the program is picked up through the mixer console (above) and piped direct to the network master control.

It's What's Inside That Counts

Arranged to suit your specific requirements, new Cinema Variaten mixer consoles are again available. We put in only what you need. As shown above at Radio Center, Hollywood's newest broadcasting facility, several different Cinema consoles channel programs originating in the various studios or the auditorium seating 300 people.

Flexibility is the chief advantage of Cinema engineered consoles. Because of this, they can be used for a wide variety of purposes. These new Cinema consoles are available with or without preamplifiers. They can be made for any number of channels and can include a complete switching system.

Such a console can become either a mixer control in recording, re-recording or broadcasting studios, or can be easily adapted as a master control or complete speech input system for small AM or FM stations.

Our engineers are available to discuss your equipment needs. Call on Cinema today. Our representatives are: Turney & Beale, 40-08 Corp. Kennedy St., Bayside, Long Island, New York; Wright Engineering Co., 4241 Melbourne Road, Indianapolis, Indiana.

Any Number of Positions

Many types of Variaten attenuators, in impedances of from 30 to 600 ohms, either ladder, balanced ladder or bridged "T" circuits, VU or VI meters, jack strips, patch cords, switches, and other accessories can be supplied.

Manufactured and Sold in the West by:

VARIATEN

CINEMA ENGINEERING COMPANY

ESTABLISHED, 1935

1510 W. VERDUGO AVE., BURBANK, CALIFORNIA

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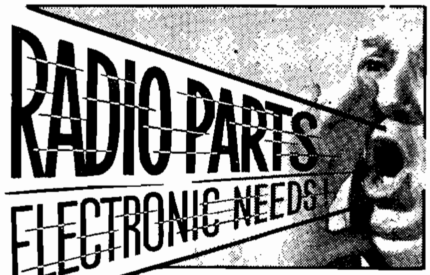
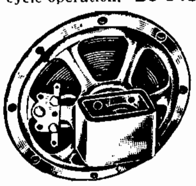
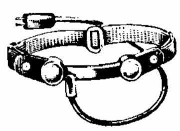
(*Continued from page* 35)

(*Continued on page 38*)







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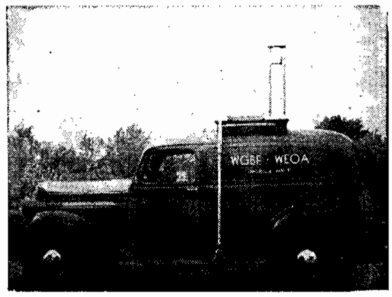

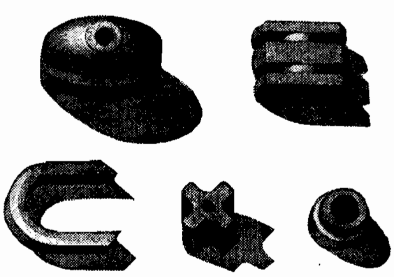

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CORRECTION

In the paper "Conditions For Transfer of Maximum Power," by Professor H. E. Ellithorn, appearing in the October 1946 issue of COMMUNICATIONS, the captions for Figures 2 and 3 were reversed. Figure 2 should have showed how decibels may fall below maximum power and Figure 3, the percent of maximum power delivered when the load resistance does not match the source resistance. The sentence: "If $Z_s = 100 \angle 45$ and $R_r = 20 \angle ?$" should have read "If $Z_s = 100 \angle 45$ and $Z_r = 20 \angle ?$."

MARINE RADAR

(*Continued from page* 11)

respect to true north. The ships heading is shown by a bright radial line, for which a contact is fitted on the scanner.

Another contact overrides the manual and automatic gain controls over a 15° sector astern to provide a standard gain adjustment for performance monitoring. Mounted near the scanner is a waveguide horn which picks up radiation from the main transmitter and applies it to a crystal for measuring the transmitter power. This crystal also provides a triggering voltage to a modulator firing a spark gap, which generates a pulse that is fed back out of the horn and picked up by the scanner and receiver and used for checking receiver performance. The transmitter and receiver results are multiplied electronically, and if below a certain preset level the *ppi* is cut off. Failure of the monitor itself has the same effect; so although there is a slight risk of the *ppi* being put out of action when it is working properly, it cannot possibly continue when it is below standard.

Sweep linearity is better than 1% of maximum range, and minimum range is 50 yards. Maximum ranges are 2,000, 15,000, and 45,000 yards. A servo system employing magslip transmission and velodyne drive rotates the trace within an error of 0.5°. There is provision for expanding the center, for example, to facilitate entering narrow channels between buoys.

A *chart comparison unit* has also been provided. Operating principle of the unit is shown in Figure 5. The light intensity on the chart, and the scale of the *ppi*, are continuously variable, so that the *ppi* picture can be fitted to the chart. The ranges of echoes are measured by a motor-assisted continuously variable marker ring, and are displayed in illuminated figures at the window near the top of the unit. Range accuracy is 50 yards; bearing accuracy, 1°.

Many demonstrations of this equipment have shown that information provided by it alone is sufficient for a ship to be piloted confidently through crowded channels. Range and azimuth discrimination are such that the two masts and the funnel have been separately picked out in the echo from a not very large ship.

Credits

The writer is indebted to the Admiralty Signal Establishment and especially to H. E. Hogben for much of the data appearing in this paper.

GRAPHICAL ANALYSIS

(Continued from page 16)

values, R_k and $R_k + R_L$, from the point E_{bb}. A value for e_k is assumed and indicated on the E_b axis as shown. The total current flowing through R_k to produce this voltage is found at the intersection of e_k with the load line for R_k. Since the grid voltage of the grounded grid stage T_2 is e_k, the plate current for this stage may be found at the intersection of the proper grid voltage curve with the load line for $R_2 + R_L$. Interpolation may be necessary between grid voltage curves, causing this first method to be somewhat inaccurate. The plate current, i_1, for T_1 must be the difference between the total current through R_k and the plate current i_2 of T_2. If the current, i_2, for the chosen value of e_k is greater than the total current, then a point beyond the cutoff grid voltage of T_1 is indicated, and a larger value for e_k should be used.

The voltage between grid and cathode of T_1 may be found at the intersection of i_2 with the load line for R_k. The signal voltage required to produce this grid voltage is found by applying Kirchoff's laws to the input loop where

$$e_s = e_k + e_g$$

considering ground as a reference point. The current, i_2, multiplied by the plate load resistance, R_L, is the voltage, e_L, developed across R_L. The output voltage is, therefore

$$e_o = E_{bb} - e_L$$

The values found for e_s and e_o for the assumed e_k may be plotted as one point on the output-input voltage curve, and additional values for e_k are chosen until the final curve may be drawn. Unless the slope of the R_k load line is appreciable, i.e., R_k must be relatively large, only a few points on the final curve may be determined with accuracy and the remainder of the curve must be interpolated. For greater accuracy a second method must be used.

Complete Method

For this analysis a dynamic I_b-E_c curve must be drawn from the I_b-E_b characteristic, showing the curves for T_1 and T_2 plotted on the same set of coordinates as shown in Figure 3 where idealized transfer characteristics are used for simplicity. A line is drawn from the origin, having a slope

$$-1/R_k$$

The grid voltage at the intersection of the R_k resistance line and the curve for T_2 represents the smallest e_k that

may be chosen, since for values smaller the grid of T_1 is driven beyond plate current cutoff in which region the overall gain is zero, indicating the presence of amplitude limiting action. Therefore, a value of e_k must be chosen which is equal to or greater than the value at the above intersection. The plate current i_2 is found at the intersection of e_k with the T_2 curve. A pair of dividers may be used to establish i_1 which must be the difference between i_2 and the current at the intersection of e_k with the resistance line R_k.

The dividers, set to the value of i_1, are now fitted to the T_1 curve so that the intersection of the current i_1 and the T_1 curve may be found. The grid voltage at this intersection is e_g, the total voltage between cathode and grid of T_1. The required signal voltage e_s may now be found as described in the preceding method. The output voltage will again be

$$e_o = E_{bb} - e_L$$

and a point on the output-input voltage curve may be plotted. The operation is repeated with different values of e_k until the curve is complete.

Inspection of Figure 3 will show that the plate current of T_2 will vary between zero and the value of current at the intersection of the T_2 curve with the resistance line for R_k. The gain of the circuit is zero beyond either of these limits, and is substantially constant within the limits. The use of different supply voltages for T_1 and T_2 will cause the output-input voltage curve to be shifted along the e_s axis, thus altering the amplitude limiting characteristics without changing the gain appreciably.

The quiescent operating conditions are determined at the value of e_k when e_s is zero. This value of e_k represents the self-bias voltage developed across R_k with zero signal at the grid of T_1. The quiescent plate voltages and currents for each tube may be found at the same value of e_k in either of the two methods of analysis described.

It is suggested that the rapid method be employed when an approximation of the operating characteristics of a circuit are sufficient. For an accurate analysis the complete method is recommended.

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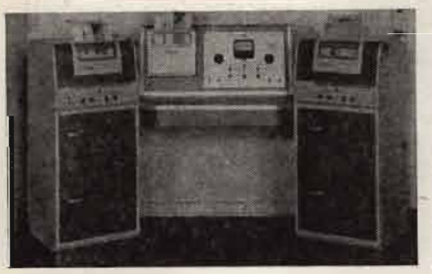
FINCH FACSIMILE UNITS



Above, complete studio facsimile equipment recently developed by Finch Telecommunications. Unit consists of monitor-control desk, two broadcast facsimile scanners, each with monitor-receiver power units, amplifier and selective switching arrangements. Below, console facsimile model, developed for home installation. Model also includes f-m receiver. Finch facsimile recording is at 28 square inches per minute, 105 lines to the inch or four 8½" x 11" pages every 15 minutes.

PREVENTIVE MAINTENANCE

(*Continued from page* 26)

clamping ear or retaining ring replaced securely.

(*3*)—*T*ighten: Any loose or poor connections to the socket terminals must be tightened or resoldered. Socket mountings must be tight at all times. A loose socket mounting may result in irreparable damage to a tube. When tightening the mounting screws which hold the ceramic sockets, excessive pressure must not be applied. Too much pressure may crack the socket.

(*4*)—*C*lean: The socket mounting, terminal connections and spring contacts should be free of dirt, corrosion, oxidization or any other foreign matter. The insulated portion of the socket should be cleaned with a clean dry cloth. For cleaning the spring contacts, No. 0000 sandpaper or crocus cloth should be wrapped around a small stick approximately the size of the tube pin. The stick is inserted between the springs and twirled around. All free dirt and dust resulting from this treatment should be removed with a brush, cloth or air blast.

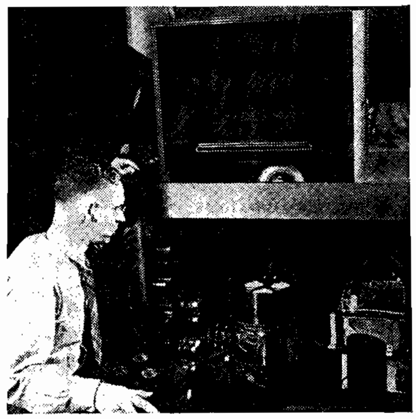
(*5*)—*A*djust: Loose socket spring contacts should be adjusted. However, adjustments must not be made unless inspection indicates clearly that they are necessary. Adjustments should not be made by bending the contact springs. Instead, the tips of the long-nose pliers should be placed on the *outer* tension spring near its point of attachment to the socket base; then gentle pressure should be applied in the direction in which increased tension is desired. This action should be repeated as the pliers are moved toward the contact end of the spring. The result will be a slight bow in the tension spring, but the desired effect will be produced.

Tube Removal and Storage

When it is necessary to remove a tube from its socket extreme caution should be used. Connections to the grid or plate caps or terminals must always be removed first. A tube should never be jarred.

It is important to store tubes carefully after they have been removed from their sockets. They should not be placed on flat surfaces without proper precautions to prevent their rolling off and falling to the floor or ground. They should not be placed on the floor where they might be kicked or stepped on. Longer life will be experienced from all tubes if they are stored in a vertical position.

RCA ELECTRONIC COLOR TELEVISION



Karl Wendt with the trinoscope projection assembly of the recently-developed RCA electronic color television receiving system. The assembly consists of three 3" kinescopes to receive red, blue and green images.

PRESTO RECORDING EXHIBIT

Exhibit of the Presto Recording Corp. at the recent NAB Meeting in Chicago.

NEWS BRIEFS

FCC GRANTS CP's TO ACME NEWSPAPERS, HARRISBURG TAXI, YELLOW CAB AND ILLINOIS BELL

Acme Newspapers, Inc., have received permission to construct an experimental class 2 station near Cleveland, Ohio, for the development and testing of facsimile equipment in a point-to-point service. Acme also expects to arrange for additional observation reception points, some of which may be located in Europe and South America. Frequencies: 3492.5, 4797.5, 6425, 9135, 12862.5, 17310 and 23100 kc on temporary basis; power 1000 watts; A4 emission.

School District No. 9, Glacier County, Montana, has been granted authority to construct seven provisional stations for communication with its rural schools located in isolated areas on the Blackfeet Indian Reservation. Communication with these schools is impossible during a large portion of the year because of bad roads, heavy snows and lack of telephones. Frequency 31.02 mc, conditionally; power not to exceed 50 watts; A3 and special emission for f-m.

Harrisburg Taxicab & Baggage Co., Harrisburg, Pa., has received a CP for an experimental class 2 radiocommunication system to serve 35 taxicabs. While the company will operate the system, the Bell Telephone Co. of Pa. will own, install and maintain the radio equipment. Temporary and conditional use of 152.27 mc for the land station and 157.53 mc for the mobile units, with 120 and 60 watts power respectively.

Illinois Bell Telephone Co. has received CP's for one land and 32 mobile units to test a railroad radio communication system in cooperation with the Atchison, Topeka & Santa Fe Railway Co. Initial tests will be in the vicinity of Chicago and west of Chillicothe, Ill. Frequency will be 154.57 mc with 60 watts power.

Dr. George J. Weems has received construction permits for one land station and one mobile unit, to be operated in the vicinity of Huntingtown, Md. The applicant, a practicing physician, will test communications between his own land station and his car to furnish a better medical service in that rural area. The land station will operate on 152.15 mc, and the mobile unit on 157.41 mc, on temporary basis; power 120 watts.

The Yellow Cab Company has received permission to test communications systems in connection with operation of 1000 taxicabs in Los Angeles and 600 in San Francisco. The 152.27-mc band will be used with 60-watts power.

Winfield Morton has been granted permission to build two temporary radiotelephone stations to serve an isolated ranch area in New Mexico; a station at Santa Fe to link another at Abiquiu, 50 miles distant. Emission, f-m; 250 watts power; 39.54 megacycles.

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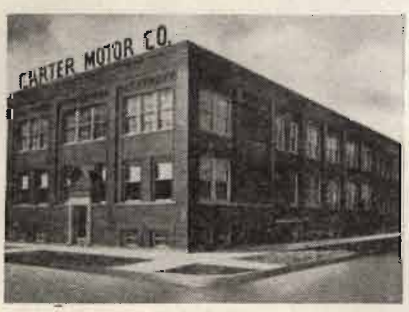
CARTER MOVES TO NEW FACTORY

Carter Motor Company are now located in enlarged quarters at 2644 N. Maplewood Avenue, Chicago.



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SYLVANIA APPOINTMENTS

Jerome R. Steen has been named director of quality control for the lamp, fixture, wire products, tungsten and chemicals, radio tube and electronic divisions of Sylvania Electric Products, Inc.

Mr. Steen joined the staff of Sylvania in

(*Continued on page* 46)

NEWS BRIEFS

(*Continued from page* 45)

1931 as supervisor in charge of finished tube quality control.

Milton E. Lauer is now product manager of the Sylvania radio tube division.

J. R. Steen

M. E. Lauer

* * *

COOK ELECTRIC HANDBOOK

A 72-page *Telephone Terminal and Protection Handbook* has been published by the Cook Electric Company, 2700 Southport Ave., Chicago, Ill.

Practices outlined conform to the engineering and operating standard of the independent telephone industry.

Handbook, 4¼" x 7½". contains over 100 diagrams and illustrations.

* * *

COLLINS NOW AERVOX CHIEF ENGINEER

Joseph L. Collins has been appointed chief engineer of Aerovox Corporation, New Bedford, Mass. He was formerly head of the electrolytic engineering division.

* * *

L. G. THOMAS NOW SOLAR V-P

Leslie G. Thomas has been elected vice president in charge of manufacturing of Solar Manufacturing Corporation, 285 Madison Avenue, N. Y. 17, N. Y.

Mr. Thomas was formerly vice president and works manager of IRC.

* * *

OPERADIO APPOINTS FRED D. WILSON G-S-M

Fred D. Wilson has been named general sales manager of Operadio Manufacturing Co., St. Charles, Ill. Mr. Wilson has been in charge of jobber sales of the company's commercial line and trade-marked equipment.

* * *

RALPH POWELL FORMS NEW CO.

Ralph C. Powell has formed a national organization to develop and market electro-mechanical products. The company will operate under the name of Ralph C. Powell and Co., Inc., 57 William Street, N. Y. 5, N. Y.

* * *

SUPERIOR ELECTRIC CATALOG

A 12-page catalog describing variable-voltage transformers, automatic voltage regulators and test units has been prepared by the Superior Electric Company, 713 Laurel Street, Bristol, Conn.

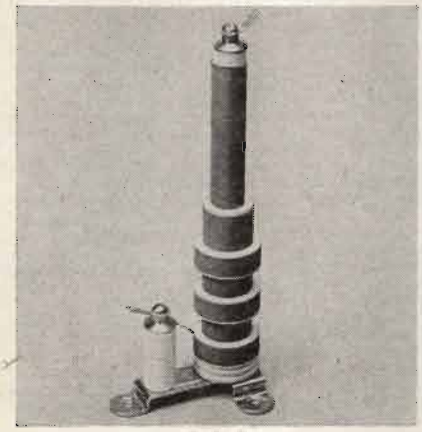
Described are manual-control and motor-driven, cased and uncased and oil-cooled variable-voltage transformers, automatic voltage regulators and regulated ac power supplies and remote positioners.

THE INDUSTRY OFFERS . . .

NATIONAL CHOKES

A choke, R175, suitable for parallel-feed as well as series-feed in transmitters with plate supply up to 3000 volts modulated or 4000 volts unmodulated, has been announced by National Company, Malden, Mass. Reactance is said to be high throughout the 10 and 20-meter bands as well as the 40, 80 and 160-meter bands.

Inductance, 225 microhenries, distributed capacity .6 mmfd, d-c resistance 6 ohms, d-c current 800 ma, voltage breakdown to base, 12,500 volts.



* * *

COLLARO RECORD CHANGERS

Collaro British-made a-c automatic record changers with magnetic pickup, model 196, are now available in this country through Micro-Sonic Corporation, 44 West 18th Street, New York 11, N. Y. Records may be repeated, automatically, via a single control. Reject, stop and starting operations are also incorporated in the same control. Instrument stops automatically after the last record is played.

Changer will play up to eight 10" and 12" records, intermixed.

Mounted on a 14" x 16" base plate. D-c resistance is 2,000 ohms; impedance, 50,000 ohms.

* * *

BROWNING LAB. FREQUENCY METER

A 100-kc to 50-mc frequency meter has been announced by the Browning Laboratories, Inc., 742-750 Main Street, Winchester, Mass. Instrument features ±.025% accuracy, instrument dial 6" in diameter readable to one part in 1000, and transformer-type power supply. Oscillator range is 1 to 2 mc in five bands, each tuning 200 kc. Built-in crystal calibrator. External signals are coupled to the meter through a telescoping antenna which also serves as a carrying handle. Dimensions: 13½" x 7⅝" x 6⅞".

* * *

RCA TELEVISION TEST EQUIPMENT

Television receiver and transmitter test equipment has been developed by the RCA engineering products department.

The equipment, which supplies a television test signal of known quality, is composed of

(Continued on page 48)

THE INDUSTRY OFFERS . . . —

(*Continued from page* 47)

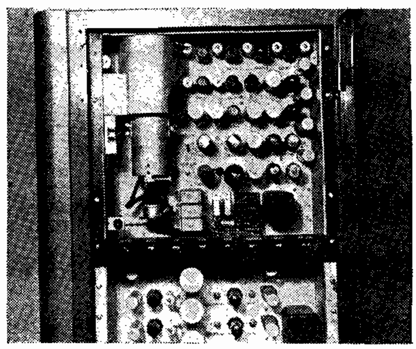
three inter-related units: a synchronizing generator; timing center; a monoscope camera, which delivers a test pattern, and a distribution amplifier, which amplifies and mixes the timing pulses of the synchronizing generator and impulses of the monoscope camera for delivery to the several test positions on the production line.

The synchronizing generator produces a complex waveform which carries four different impulses. These actuate the electronic scanning circuits in the television transmitter. A built-in oscilloscope on the synchronizing generator makes it possible to monitor the various waveforms generated by the equipment.

The monoscope camera provides a convenient means for producing a composite test pattern, simulating the signal received from the air.

The synchronizing generator furnishes the five fundamental timing and synchronizing impulses necessary for the operation of the RMA standard 525-line, 30-frame interlaced television scanning system. The five output signals are: (1) horizontal driving signal which actuates the generator supplying voltage to the horizontal elements of the pickup tube: (2) vertical driving signal which triggers the sawtooth wave generator supplying voltage for vertical scanning; (3) synchronizing signal, which is a composite wave performing three different functions related to keeping the other signals in step; (4) kinescope blanking signal, which is added to the transmitted video signal to blank out the return path of the scanning beam in the picture tube of the home receiver; and (5) oscilloscope driving signal, which triggers the built-in monitoring oscilloscope of the synchronizing generator.

The pulse-forming unit generates all of the four different timing frequencies. It also provides a means whereby these frequencies (which are all derived from a single master oscillator) may be *locked in*, either with the local 60-cycle power line frequency or with a crystal oscillator.



Monoscope in RCA test unit.

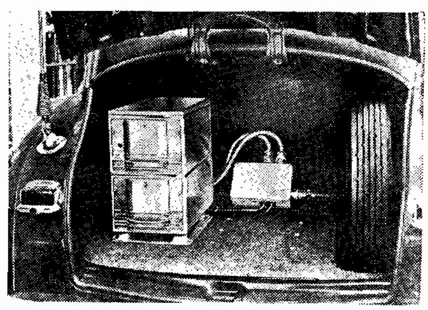
• • •

KELLOGG MOBILE RADIO UNIT

A mobile radiotelephone unit for the 30 to 40 mc band featuring a selective-calling circuit—permitting selection of any one of a possible total of 84 mobile units by the central office operator, has been announced by the Kellogg Switchboard and Supply Co., Chicago, Ill.

Mobile handset unit is equipped with a *busy* light, and a push-to-talk switch which operates antenna changeover relay and connects the plate supply voltage from dynamotor to final output tube.

Both receiver and transmitter employ *drawer type* construction.



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FAIRCHILD MOTOR

An a-c single-phase synchronous capacitor 3,600-rpm motor, with a maximum of 2.4

watts output, starting torque of .75 ounce inches and running torque of .90 ounce inches at 117 volts, has been announced by the Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

Weighs 18 ounces. Outside diameter of 2 41/64", overall length of 2 5/32". Has a .156" shaft diameter.

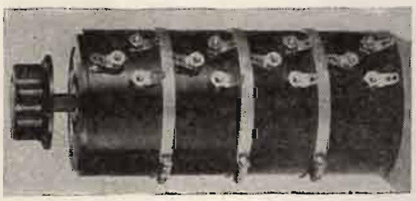
* * *

TECHNOLOGY INSTRUMENT PRECISION VARIABLE RESISTORS

A line of precision variable resistors for standard and lab work has been announced by Technology Instrument Corporation, 1058 Main Street, Waltham, Mass.

Standard model is type RV3. Laboratory model, type RVL3, is provided with a dial plate so as to be direct reading in ohms to within an accuracy of ±1% ±½ dial division.

Models have adjustable stop permitting 360° rotation if desired, reliable rotor take-off assembly, precious metal contacts, and a nesting feature which permits ganging in a self-supporting assembly. Standard models are available in sizes ranging from 100 ohms to 100,000 ohms and have a power-handling capacity of 9 watts.



ROCHESTER MEETING

(*Continued from page* 25)

tered at 160 mc with a 20 mc-bandwidth was designed.

The overall gain required is a function of the receiver application. For general monitoring of a portion of the r-f spectrum, which was desired, reception of signals down to noise level is required. Sufficient gain must therefore be included to bring the receiver noise up to a level at which the second detector is operating linearly. The total gain is thus a function of the noise figure of the receiver. Thus the 160 mc i-f amplifier had a voltage gain of between 90 and 100 db from input grid through the second detector.

The design of amplifiers operating above 100 mc is one which is as much a mechanical problem as an electrical one if lumped constant interstage networks are to be used. These networks must be kept compact with the fewest and shortest leads possible. If the design deviates from these requirements, regeneration troubles invariably arise. A highly desirable type of coupling consists of a single-tuned network with tube and stray capacitances as the shunt capacitance and a variable inductance for tuning. The disadvantage of this system is that the gain-bandwidth product is low as compared to more complex networks, the offband rejection is also low, and the overall bandwidth of a series of single-tuned stages becomes rapidly smaller as the number of stages is increased. If single-tuned circuits are used, and if both high gain and large bandwidth together are required, the resultant amplifier rapidly becomes uneconomical and under certain conditions impossible of construction.

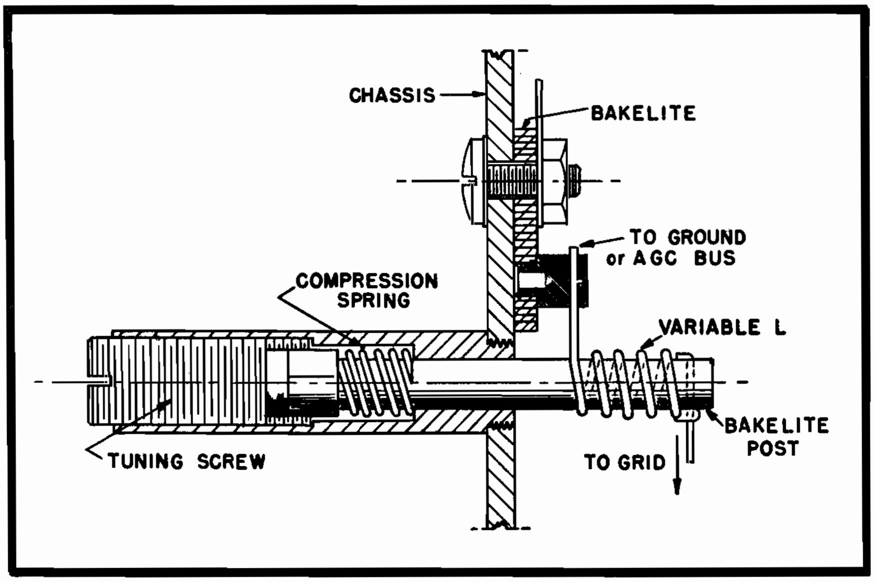
Stagger Tuning

To retain the simplicity of the single-tuned amplifier but to obtain the desirable gain-bandwidth product and slower *narrowing* of the overall bandwidth, multi-tuned networks or *stagger tuning*[1] can be used. By properly adjusting the tuning frequencies and damping of the individual single-tune stages, results approaching those obtainable with multi-tuned coupling with little sacrifice of simplicity may be obtained.

At frequencies above 100 mc, the effect of grid-plate capacitance becomes of increasing importance. The effect of this feedback path is to distort the selectivity curve, tilting the curve with greater gain at the low end of the band and less at the high. At frequencies below 100 mc, it is usually sufficient to compensate for the conductive and susceptance components of the fedback admittance by retuning grid circuit to proper frequency and adjusting damping.

The advantages of stagger-tuning may be realized at frequencies up to 200 mc using conventional tubes and lumped components providing certain compensation is made in the theoretical values obtained from standard design formulas.

[1]H. Wallman, *Stagger Tuned I-F Amplifiers*, Radiation Laboratory, Massachusetts Institute of Technology, Report 524; February 1944. R. F. Baum, *Design of Broad-Band I-F Amplifiers*, Part I, *Journal of Applied Physics*, Vol. 17, pp. 519-529, and Part II, pp. 721-730.



(Lebenbaum Paper)
Coil used at 200 mc. Inductance variation is accomplished by spreading the turns of a beryllium copper spring coil. The rod diameter is ⅛".

A NEW FREQUENCY-MODULATED SIGNAL GENERATOR

D. M. Hill
Boonton Radio Corporation

With the Definite assignment of f-m and television in the 54 to 216-mc bands and the corresponding increased commercial use of these bands has come an accelerated need for v-h-f test equipment. To meet this commercial and lab requirement, too, the signal generator shown below was developed.[1]

The generator can be amplitude or frequency modulated either separately or simultaneously. Output voltage is continuously variable from 0.1 microvolt to 0.2 volt.

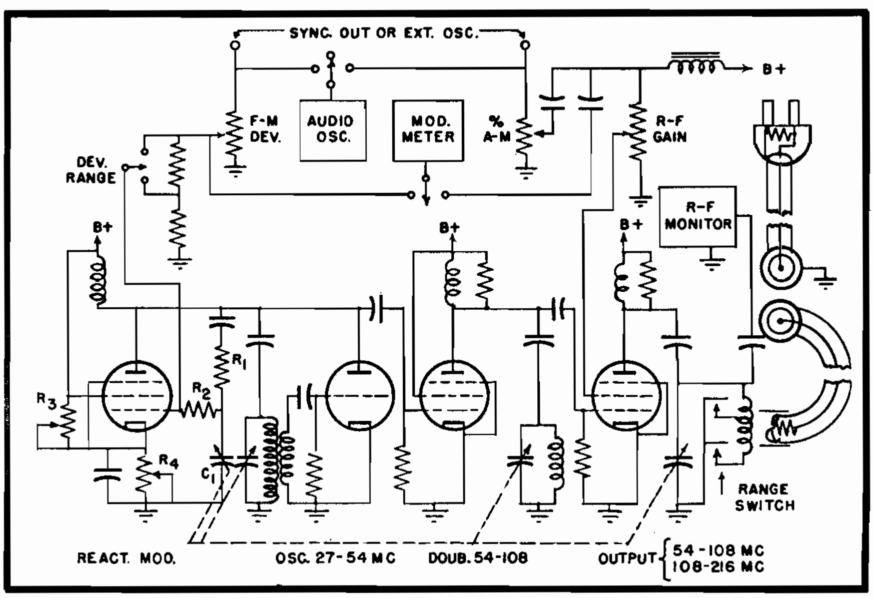
A doubler stage is used in the generator to permit the oscillator and reactance modulator to operate at the relatively low frequency of 27-54 mc where stray and residual impedances of components and wiring are not as troublesome as they are at higher frequencies. Another advantage of the doubler stage is its gain which saturates the output stage and causes it to limit, thus removing any spurious a-m produced during the frequency modulation of the oscillator.

Another generator feature is the output stage which can be used either as an amplifier for the 54 to 108-mc range or as a doubler for the 108 to 216-mc range permitting a 4:1 frequency coverage with a minimum of r-f switching, the only switching being the switching of the ground point on the output tank coil.

The tuning capacitor is driven by a gear train so that the tuning dial makes almost a complete revolution over each frequency range. A vernier dial rotates

*Development carried out by Murray Crosby, W. D. Loughlin, Ernest Porter and D. M. Hill.

(Hill Paper)
Circuit diagram of the f-m signal generator. First tube, at lower left, is reactance modulator. Second tube is oscillator operating from 27 to 54 mc. Third tube is the doubler stage covering 54 to 108 mc, and fourth tube is the output which operates as an amplifier for the 54 to 108-mc range or as a doubler for the 108 to 216-mc range. Output, obtained by means of a mutual inductance or piston attenuator, is monitored by an r-f voltmeter of the *set-to-line* type.



24 times for one rotation of the main dial. This is useful for selectivity tests and accurate frequency adjustments.

Reactance Modulator

A modified *bridged T* phase shifting circuit attenuates r-f voltage fed back to the grid of the reactance tube at the proper rate to maintain the deviation constant over the frequency range. With fixed components in the phase-shifting circuit, the deviation is constant within ±6% over the 2:1 oscillator frequency range.

When the output stage is switched to the high-frequency range of the generator, a section of the range change switch is used, in conjunction with a precision voltage divider, to halve the modulating voltage so that the output deviation will remain constant. Under this condition the f-m distortion is smaller—less than 3% at 240-kc deviation.

No blocking capacitors are used in the reactance-modulator grid circuit so that modulation frequencies down to d-c can be employed; response is down .5 db at 15 kc.

A full-wave rectifier with IN34 crystals is used in the modulation meter.

Amplitude modulation is produced by screen modulating the output stage. About 45 v across 7500 ohms was found to be required for 50% a-m. The modulation meter is calibrated at 30% and at 50%. Due to a variation in the modulation depth with output frequency, the calibration accuracy is about ±10%.

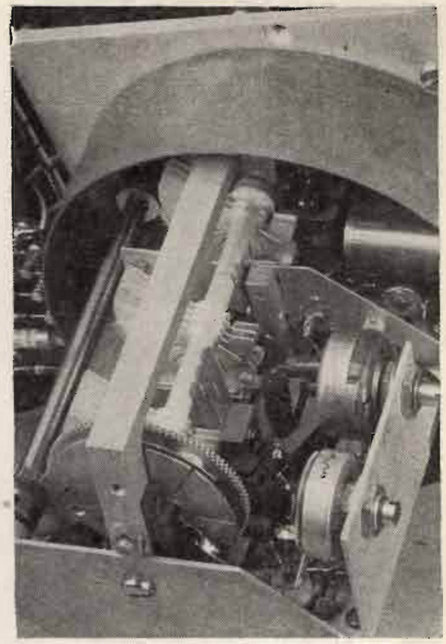
A IN34 crystal voltmeter is used as an r-f monitor. The advantages are low capacitance with no zero set being required. A disadvantage is a decrease in the rectification efficiency with increasing frequency. However, by using a damped series resonance in the circuit, the frequency error is reduced to ±2% over the 54 to 108-mc range and ±3.5% on the 108 to 216-mc range.

Spurious Outputs and Modulations

The *Q* of the output tank circuit is adjusted to minimize spurious output voltages without introducing too much spurious a-m on frequency modulated signals. The strongest spurious output freqency is half the output frequency on the high frequency range. This is about 35 db down. Other spurious outputs were found to be generally more than 40 db down.

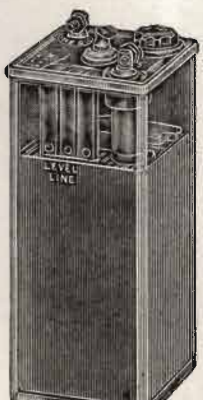
The amplitude modulation introduced on frequency modulated signals by the *Q* of the output tank was found to be generally less than 3% at 75-kc deviation, 6% at 240-kc deviation.

Since the f-m and a-m circuits are entirely separate, metered separately, and have a negligible interaction, both types of modulation can be applied simultaneously to this instrument to test the amplitude modulation rejection of limiter-discriminator circuits, ratio detectors, etc.



(Hill Paper)
Variable-capacitor arrangement used in f-m signal generator.

[Highlights of other Rochester meeting papers by Nicholson, Cornell, Lamson, Anderson and Tarzian covering an a-m/f-m comparison, metallized capacitors, measurement methods for ferromagnetic materials, wire recorders, and high-frequency a-m stations, respectively, will appear in the January issue of COMMUNICATIONS.*]*



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The Eimac 750TL is a medium-mu triode designed for high efficiency operation whether used as a modulator, oscillator or amplifier. This is an unusually versatile tube capable of many kilowatts of output.

Successful high frequency operation of this triode is assured by unusually low interelectrode capacitances, heavy leads, and a big tough cathode.

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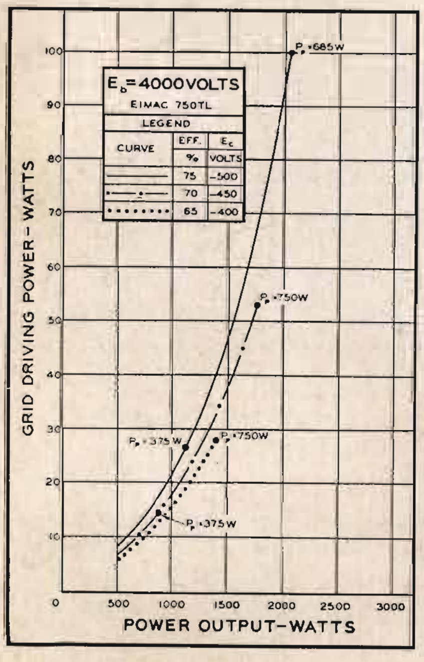

At frequencies below 40 mc, or as a Class-B modulator, the 750TL operates at high plate efficiencies, thus permitting r-f and a-f outputs of many times the plate dissipation rating.

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As Class-B modulators, a pair of Eimac 750TL's will produce a typical maximum-signal plate power output of 3500 watts, with only 30 watts grid drive.

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These big, powerful 750TL's are built for long, trouble-free service for a wide variety of uses. Many Eimac 750TL's installed months and years ago are still going quietly and efficiently about their business. Why not ask Eimac today for a price and data sheet giving full details of this versatile triode. Naturally, there is no obligation. Eitel-McCullough, Inc., 1298F San Mateo Ave., San Bruno, Calif. Export Agents: Frazar and Hansen, 301 Clay St.,

GENERAL CHARACTERISTICS

Eimac 750TL

Filament: Thoriated tungsten
- Voltage . . . . 7.5 volts
- Current . . . . 21.0 amperes

Amplification Factor (Average) . . . 15

Direct Interelectrode Capacitances (Average)
- Grid-Plate . . . . 5.8 uufd
- Grid-Filament . . . . 8.5 uufd
- Plate-Filament . . . . 1.2 uufd

Transconductance (I_B=1.0 amp., E_B=5000, E_C=−100) . . . 3500 umhos

Frequency for Maximum Ratings . . 40 Mc

Base . . . . . Special 4 Pin No. 5003B

Basing . . . . RMA type 4BD

Maximum Overall Dimensions:
- Length . . . . 17.0 inches
- Diameter . . . . 7.125 inches

Net Weight . . . . 2.75 pounds

Shipping Weight (Average) . 8.0 pounds

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