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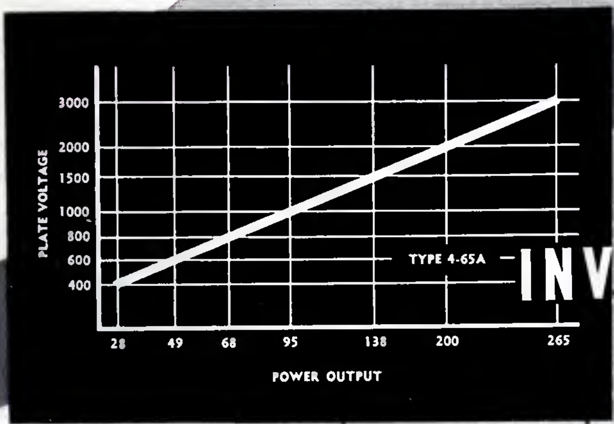

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COVER ILLUSTRATION

The v-h-f transmitting and receiving Death-Valley terminal, two miles from Death Valley Junction, of the Specter Mountain-Death Valley radiotelephone system.
(Courtesy Pacific Telephone and Telegraph Co.)

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FREQUENCY CALIBRATION: 0.9 to 10. Multiplying factors are:

MF	Freq. Range
X10 cps	9 to 100 cps
X100 cps	90 to 1000 cps
X1kc	900 to 10,000 cps
X10kc	9 to 100 kc
X100kc	90 to 1000 kc
X1mc	0.9 to 10 mc

STABILITY: ±2%, 10 cps to 100 kc; ±3%, 100 kc to 10 mc including warmup, line voltage, and tube changes.

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FREQUENCY RESPONSE: Flat within ±1 db, 10 cps to 10 mc.

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COMMUNICATIONS

LEWIS WINNER, Editor

NOVEMBER, 1947

PAPERS AT THE FALL ENGINEERING CONFERENCES

TV Station Monitor

A TV Broadcast Station monitor which provides a constant check on the carrier frequency of the picture transmitter and on the center transmission frequency, and the degree of modulation of sound transmission, was described by M. Silver of Federal Telecommunication Labs, at the National Electronics Conference in Chicago.

Features of the monitor include an inherent noise 75 db below a reference level corresponding to 100% modulation, inherent distortion of .2%, and an accuracy in modulation percentage measurement and any overmodulation indication within ± 5%.

The monitor for the picture transmitter has a crystal-controlled oscillator, whose output is mixed with the signal from the transmitter to produce a 15-kc beat. The 15-kc signal is passed through a series of resistance-coupled limiters, producing a square wave signal, which is applied to an integrating-type counter to provide an output current that is proportional to frequency.

The sound-transmitter part of the monitor also employs an integrating type counter circuit for frequency indication. However, in this instance, the counter operates with a square-wave input of 147 kc, obtained by beating the output of a crystal-controlled oscillator in the monitor with the output signal from the f-m sound transmitter.

For overmodulation indication, a voltage from the rectifier output is applied to the grid of a thyratron. A feed-back circuit is used in the thyratron stage to compensate for variations in the plate supply voltage. Neon tubes are in the load circuit of the thyratron to amplify variations in the plate voltage.

Additional features of the monitor include a high-impedance output for noise and distortion measurements.

Cavity Filters

The Cavity Filter has become a major factor in v-h-f service. At the recent APCO conference in Los Angeles, Daniel Noble, of Motorola, reported that cavity filters can solve the problem of intermodulation, which occurs in adjacent and alternate channel operation, through their use in extremely high-Q ultra-selective circuits. It has been possible to produce a cavity filter with an effective Q of 3600 at 150 mc.

Noble also reported that the cavities have been used successfully to couple several transmitters to one antenna. He cited the case of Captain Bob Batts in Indianapolis, who found it necessary to operate two 250-watt police transmitters and the Fire Department transmitter from a single antenna. Ordinarily such operation would curtail output, with the power more or less divided equally among the two opposed transmitters and the antenna, so that approximately one-third power would be available from each transmitter. The use of a cavity in each transmitter output circuit isolated the transmitters to prevent interaction, and power loss was limited to less than 10%. In addition the transmitters could be operated independently or simultaneously without fear of interaction. The use of the single antenna insured a 1:1 desired-to-undesired signal ratio at the receiving point. Thus the effects of inter-modulation or cross interference were eliminated.

Noble cited another use of the cavity, as a control for desensitizing. He said that in the operation of a transmitter adjacent to a receiver location, a strong signal at the receiver will result in the desensitizing of the receiver, even though no modulation is transmitted through the i-f and demodulation system. The use of the cavity minimizes this, even when the frequency separations between transmitting frequency and talk back are as low as 400 kc.

Citizens Radio Service

Interesting U-H-F Design factors were detailed by R. E. Samuelson of the Hallicrafters Company at the NEC in Chicago, in a report on the *Citizens Radio Service*.

Equipment for this service, which will operate in the *A* bands of 460 to 462 mc and 468 to 470 mc, and in the *A* and *B* bands of 462 to 468 mc, will include master-oscillator transmitters and superregen receivers. Power for the class *A* fixed stations will be from 10 to 25 watts; 1 to 5 watts for mobile systems; .1 to 1 watt for semi-portable stations, and 10 to 50 milliwatts for pocket or handie-talkie sets.

Describing experimental setups, Samuelson said that one transmitter-receiver employed a plate-modulated oscillator using a 6F4 acorn triode in the center of an effective half-wave line with both ends short circuited. An output of 2 watts was obtained with better than 50% plate efficiency. The receiver with a 605-A miniature triode used a self-quenched superregen detector with an input sensitivity of 7 microvolts for a 10 db signal-to-noise ratio. The tuned circuits consisted of short-circuited sections of two-wire transmission lines.

A ½-watt crystal-controlled transmitter was also detailed. Four tubes were used, with a multiplication of 48 from the crystal frequency. A 6F4 triode, mounted directly in a quarter-wave coaxial cavity acted as a doubler.

Two types of antennas were used in most tests. One was a quarter-wave vertical operated above an equivalent ground plane of six radial elements. The second type was a 90° corner reflector with a gain in the forward direction of 12 db over an isotropic radiator.

Covering uses of the *Citizens* equipment, Samuelson said that rural areas will probably see widest use of the system among, for instance, farmers and ranchers. Hunters will not fare too well, for the high attenuation of the dense woods will probably restrict ranges. But the lake fisherman and yachtsmen will find the *Citizens Radio* quite a handy instrument.—L. W.

Figure 1
Exploded view of a flanged line connection.

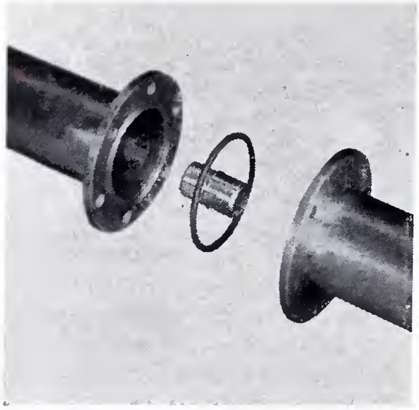
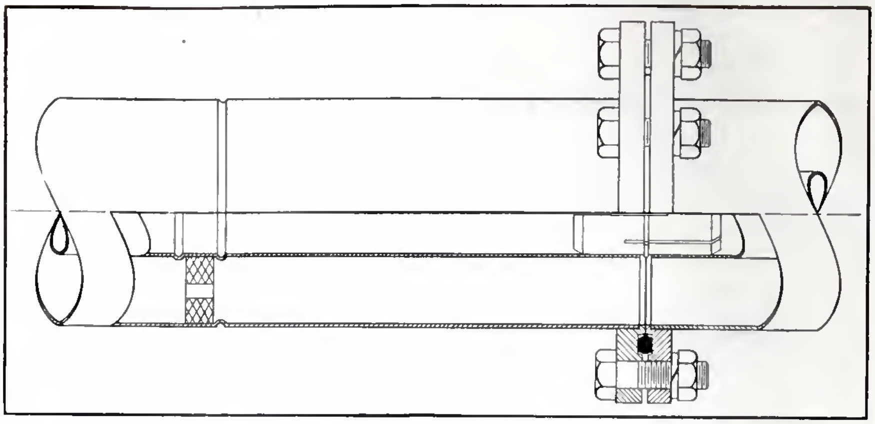


Figure 2
Line drawing of assembled flanged line connection.



F-M and TV TRANSMISSION LINE Installation Problems

Variety of Special Types of Materials, Components, Accessories and Methods Used In Installation of Coaxial Transmission Lines From Transmitter to Antenna. Assortment Includes Special Gas Barriers, Inner Conductors and Line Supports, Elbows, Mounting Fittings, Clamp Connectors, Flanges, Reducers, Pressure Controls, Isolators, etc.

by J. S. BROWN

Assistant Chief Engineer
Andrew Company

One of the many new problems faced by the f-m and tv broadcaster is the proper selection and installation of the coaxial transmission line from transmitter to antenna. The line and fittings are more difficult to handle than those formerly used because of two factors; the need for larger diameter line than is used at a-m frequencies because of higher losses, and the necessity of running the line vertically up the tower to the antenna at the top. Both of these factors tend to increase the mechanical problems.

Electrical standards for f-m and tv transmission lines have been tentatively established by the RMA. At the time these standards were set up it was decided that field installation should be made completely solderless. Field soldering of even small diameter lines is difficult enough, and it becomes a practical impossibility in the case of the larger lines.

The lines are made of hard temper copper tubing in 20′ straight lengths. Flanges are silver soldered on both ends of each length in the factory. The flanges are provided with bolt holes, so that lengths are joined in the field by bolting the two flanges together. Grooves in the faces of the flanges accommodate a round gasket of circular cross section, known as an *O* ring, which makes the joint gas tight.

The *O* ring gas seal, a relatively new development, has an advantage over the conventional flat gasket in that the squeeze applied is controlled by the depth of the grooves in the flanges. By machining these grooves to the proper depth the gasket will make a gas seal but is not squeezed beyond its elastic limit, thereby lengthening in its life considerably.

Inner conductor connection is accomplished by a solderless slotted *bullet,* made of phosphor bronze or similar spring material. An exploded view of a joint is illustrated in Figure 1. A drawing of the joint in assembled form appears in Figure 2.

The inner conductor support is provided by rolling a groove on the flange side of one end insulator in each length of line. When installing the line vertically on the tower, the bead rests on this rolled groove, and since it is also anchored to the inner conductor the weight of that section of inner conductor is supported by the bead. On horizontal runs, successive lengths are installed with the groove at opposite ends, so that the inner conductor is confined in 40′ sections.

A special flange is desirable on such fittings as bends, where alignment of the bolt holes may cause assembly problems in the field. As can be seen in Figure 3, the flange is made in two pieces. The portion that carries the *O* ring groove is silver soldered to the

*Patent applied for.

Figure 3

A 90° elbow. Note sliding flanges.

Figure 4

Expansion joint, sectioned to shown internal construction.

bend, while a second ring containing the bolt holes is assembled loosely on the bend.* It may be rotated to provide proper bolt hole alignment, thus eliminating drilling and filing of bolt holes in the field.

Provision must be made to accommodate expansion and contraction of the line due to temperature changes. Two types are encountered: differential and overall expansion.

Differential expansion occurs when the temperatures of inner and outer conductors are not equal. This condition obtains when, for example, a sudden summer shower will cool the outer conductor from, say, 110° F to 70° F in a few minutes. The inner conductor temperature will require more time to equalize with the outer conductor temperature. The outer conductor, being the cooler, will contract and become shorter than the inner. Damage from this effect is obviated by cutting the inner conductor slightly shorter than the outer conductor. The ends of the inner conductor do not *make up* tight against the shoulder on the inner connector, thereby making provision for the outer conductor to shrink without damage.

Overall line expansion can be provided for in several ways. A method commonly used in the past has been to provide an offset in the line, built up with four 90° elbows and short straight pieces of line. Where it is possible to locate the line so that it changes direction several times, expansion may be easily accommodated. A similar solution is the installation of a straight run of line in a sinuous manner.

While these methods can be used with line installed on the ground, none are completely satisfactory on the vertical run of line on the tower In addition, they are all difficult to install and rather expensive. An expansion joint* has been developed which may be used either on the horizontal or vertical run. It consists of sliding telescoping outer and inner conductors and a sliding gas tight seal. Inner and outer conductors are so designed that a constant diameter ratio is provided at all positions of the joint, thereby eliminating electrical discontinuity. The joint is capable of 4″ of travel, which is adequate for the expansion of 200′ of line over a 200° F temperature differential (—50° F to 150° F). A photo of an expansion joint that has been sectioned to illustrate the internal construction is shown in Figure 4.

Two types of line supports are required for the proper operation of almost any expansion system; a rigid mounting clamp, and a support bracket which allows the line to move axially but not sideways. The use of these fittings in conjunction with the expansion joint on a vertical run of line is illustrated in Figure 5. The line is assembled starting at the bottom. The bottom section is attached rigidly to the tower with a rigid mounting clamp. Successive line sections are assembled, and supported at 15′ intervals with sliding support brackets, until 200′ of line is in place. An expansion joint is then installed, the line section immediately above the joint is again attached rigidly to the tower, and a similar procedure followed. Each 200′ section of line is supported at the bottom end. Flanges between line sections are always in compression, eliminating the possibility of flange distortion and gas leaks that might occur if they were subjected to tension.

Mounting clamps and support brackets must be provided with fittings suitable for attachment to the tower. Since tower construction varies greatly, each installation must be studied separately. A basic support bracket assembly for a 3⅛″ line is shown in Figure 6. This unit is made into a rigid mounting clamp by the use of a copper liner of suitable thickness. A rigid mounting clamp for a 6⅛″ line is shown in Figure 7, and a sliding support bracket appears in Figure 8.

Many new towers are provided with drilled clips or angles suitable for attaching the supports directly. For towers not so equipped additional fittings must be provided. Drilling of tower members in the field is undesirable; first, because in some cases it may weaken the tower, and second, because it is difficult to perform such work on the tower.

Figure 9 shows a clamp assembly for use on towers with angular members. Two malleable iron clamps attach to the tower angle. The clamp screw that grips the tower member is set at an angle slightly different from 90°

*Patent applied for.

Figure 6
Support bracket for 3⅛" line.

Figure 7 (below).
Rigid clamp for 6⅛" line.

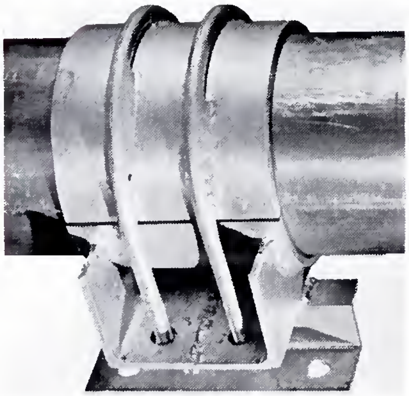


Figure 8 (below).
Support bracket for 6⅛" line.

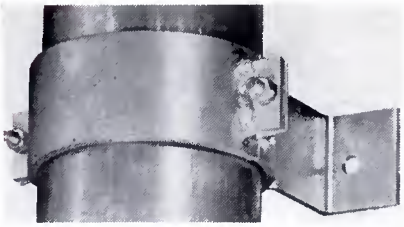
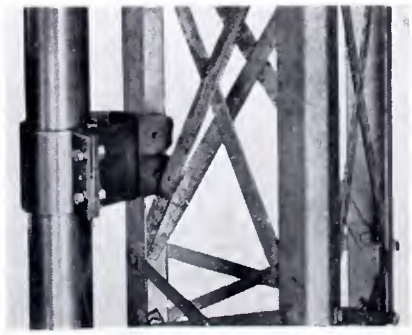


Figure 9
A 3⅛" support bracket attached to angle type of tower.



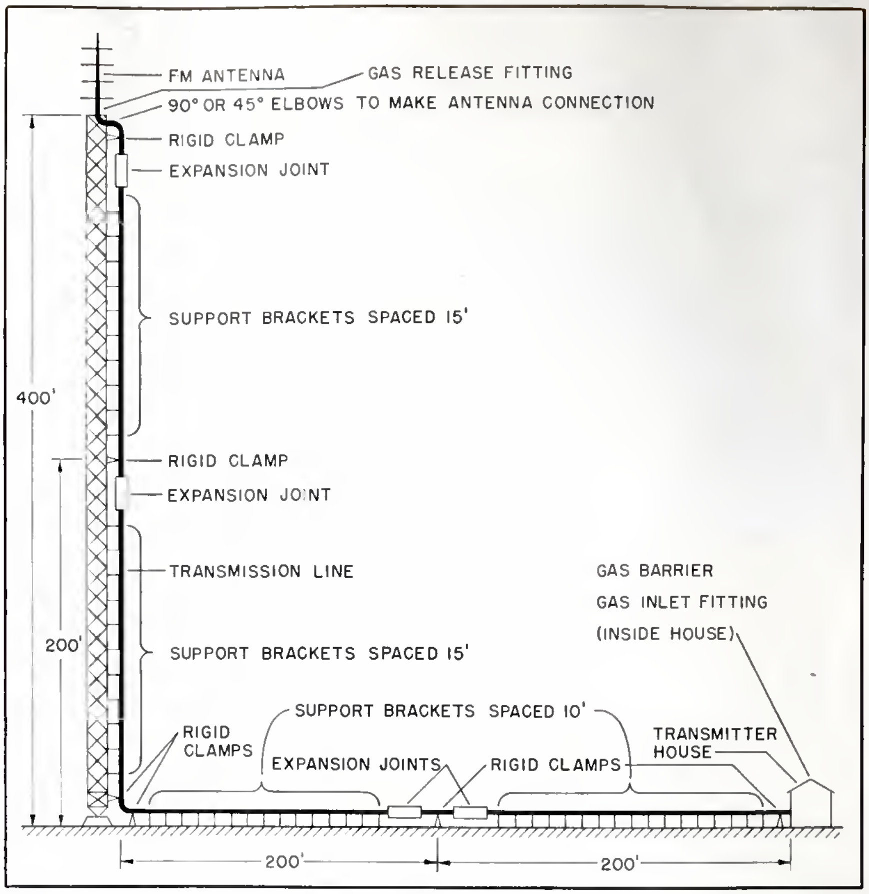


Figure 5
Typical transmission line installation, showing fittings required.

to provide locking action. The clamp shown in Figure 10 is designed for use with towers built up of round members. By changing the size of the U bolt almost any size of tower member can be accommodated.

Location of the transmission line on the tower may be affected by factors other than ease of installation and maintenance. Such problems as the method of making connection to the f-m antenna and interference with obstructions such as code beacons, guy points, lighting conduits, etc., must be studied.

In some localities the location of the line on the tower dictates the type of installation crew that must install it, depending on local labor union rules. For example, in certain areas a line run up the inside of a tower must be installed by members of the electricians' union, while members of the steelworkers' union must install the line if it is run up the outside of the tower. These rules vary widely and should be investigated for each installation.

Changes in direction of the transmission line sometimes present problems. The 90° and 45° bends are available as standard fittings, but a variety of odd angle bends occasionally are required, particularly on towers. For example a tower may be tapered so that a bend of 85° is required to bring the line from the ground onto the tower, and at a point part way up the tower the taper may change, requiring a 2° or 3° bend in the line. Several expediencies may be resorted to for solution.

Two 90° bends, equipped with sliding flanges, may be used to provide a change in direction of any angle, providing an offset in the line perpendicular to the angle can be tolerated. The line drawing, Figure 11, shows this.

This solution, while satisfactory on the ground, is not suitable for use on the tower, because the offset in the line makes the mounting problem difficult. Tests indicate that bends up to 5° in a 20' length of line (3⅛" or smaller) can be easily made by springing the line. Bends for angles greater than 5° should be manufactured to special order. Because of the stiffness of the 6⅛" line, bends over 1° must be manufactured as required.

A difficulty sometimes encountered in 90° bends is that space limitations

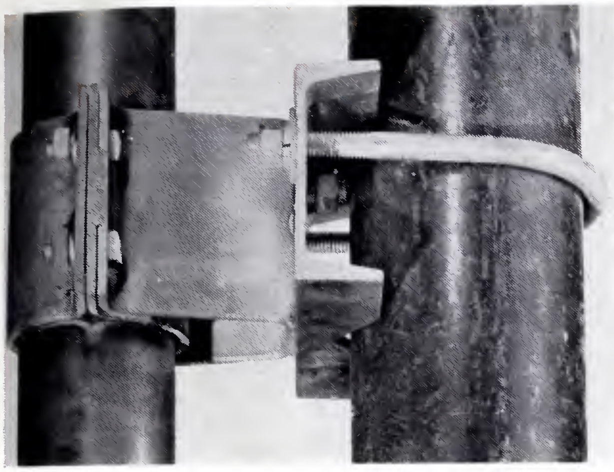


Figure 10

A 3⅛" support bracket adapted to mount on round tower member.

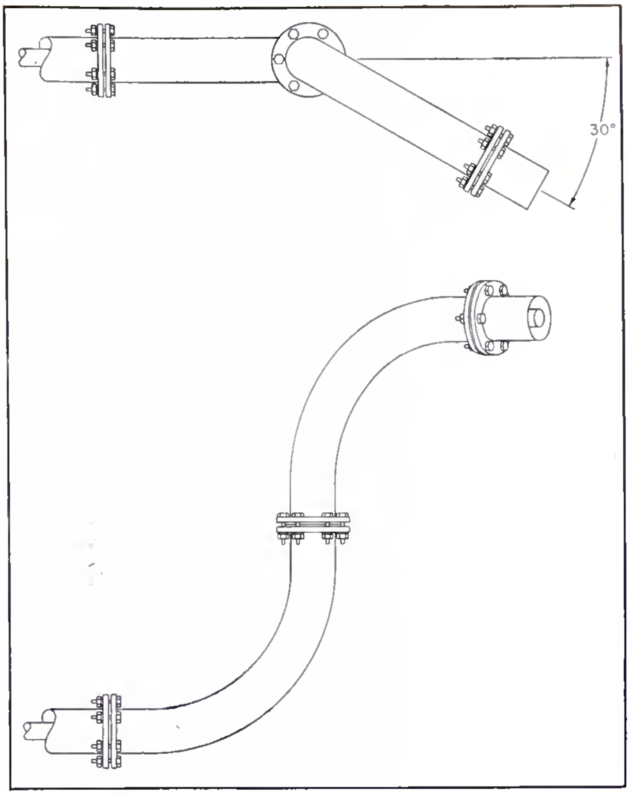


Figure 11

Method of using two 90° elbows to make a 30° turn.

require a sharper bend than the standard elbow can provide, which is fabricated by bending outer and inner conductors. A cast junction with flanges attached provides the answer to the problem. A photo of such a unit is shown in Figure 12. These boxes are compensated to eliminate electrical discontinuity. Although the compensation is frequency-sensitive, it is relatively broadband, and satisfactory performance over the entire 88 to 108-mc f-m band can be obtained with one compensating adjustment. For tv use the box can be compensated at the operating frequency. A measured standing-wave ratio of the unit illustrated is shown in Figure 13.

When the same tower is used both for f-m and a-m it is necessary to provide a means whereby the f-m line may be brought off the tower without disturbing the a-m properties of the tower. There are numerous methods of accomplishing this, and some have been recently described. It is felt by many that the most foolproof and easiest-to-adjust methods are those that do not open the f-m line, but rather use the outside of the outer conductor in an isolating scheme.

The commonest form of this type of isolation consists of insulating the transmission line for approximately one-quarter wave (at the a-m frequency) from the base of the tower, either up the tower or horizontally on the ground. This section of line then acts as a transmission line one-quarter wavelength long, and with the end shorted a high impedance appears across the tower base, allowing the line to be brought off the tower without shorting out the a-m power.

Installation of the insulated section on the tower is effected by the use of insulated mounting clamps and support brackets. A photo of an insulated support bracket for a 1⅝" line is shown in Figure 14. These supports are designed to apply stresses to the porcelain insulators so that the porcelain is always in compression. The necessity for this type of design for the rigid clamp can be appreciated

(Continued on page 39)

Figure 12

Junction box for use where long radius elbows cannot be employed.

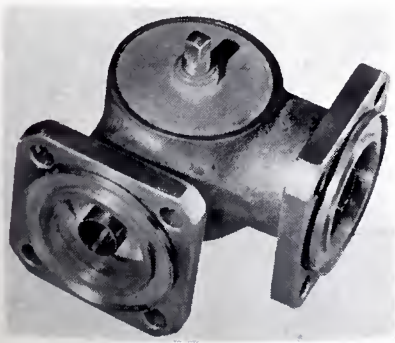
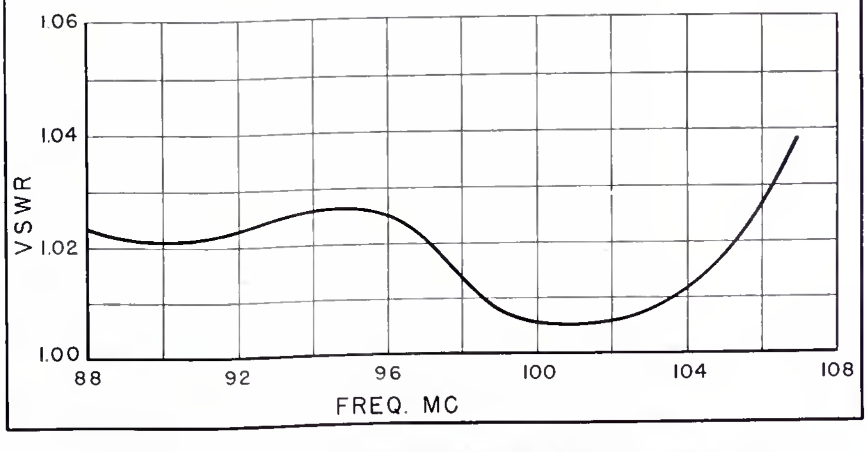


Figure 13

Standing-wave ratio of junction box over the f-m frequency band.



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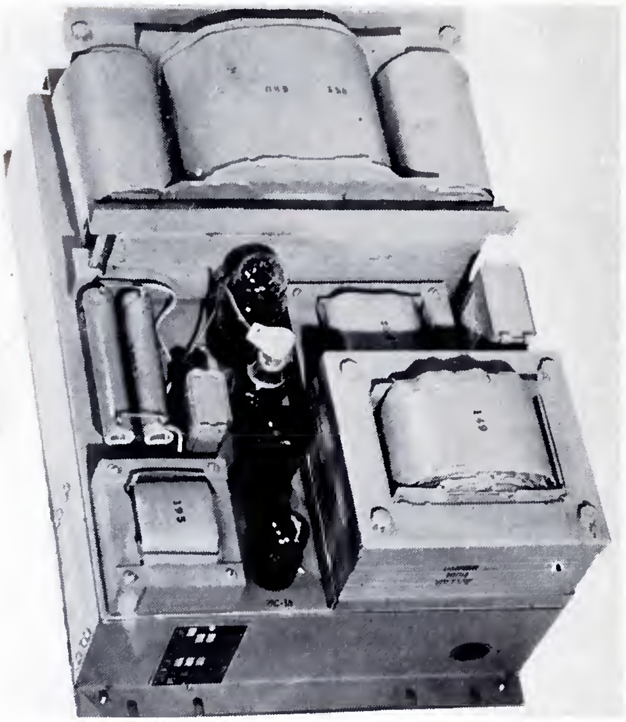


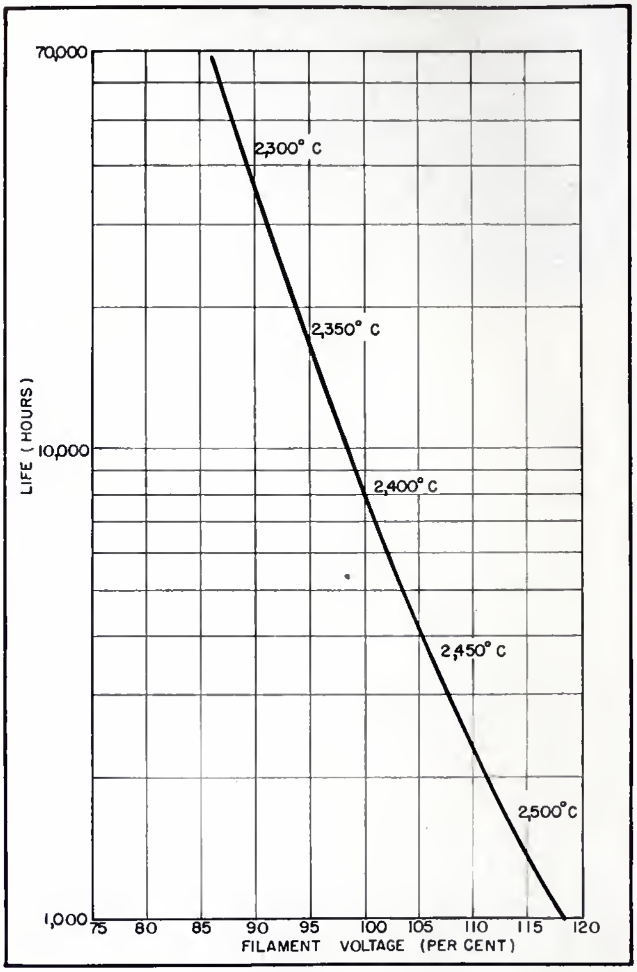


Figure 3
A 2-kva type voltage regulator which has an input voltage range of 95 to 125, an output voltage of 110-120 and an harmonic distortion of 5%, maximum. The unit is offered commercially with a guaranteed regulation accuracy of 2%. This model fits into a standard rack 12¼" x 19".

Figure 1
Plot of life of directly heated pure tungsten filament type tube versus operating voltage.

THE SUBSTANTIAL INVESTMENTS in new a-m equipment and entirely new installations of f-m apparatus, together with other sundry improvements, prompt a review of the application possibilities of voltage regulation and its relationship to station economics. This may be examined in terms of reduced operating expenses over a lengthy period, added quality of performance and confidence in the reliability of operating equipment. The first and third items may be classified as one due to the penalties resulting from time *off the air*.

Considerations Involved in Regulating Filaments

The first consideration is that of regulating the filament voltages, as shown in Figure 1. In this plot, which illustrates the life of a directly-heated filament versus operating voltage, the steepness of the curve demonstrates that applied filament voltage reflects very directly in terms of operating cost. In other words, should fluctuations occur in the order of ±10% in filament voltage, life might be expected to deteriorate by a factor of four times. For a 5% fluctuation, life would be reduced by a factor of two. Thus, it can be seen that with cost of a set of tubes averaging from $200 or $300, even in the relatively low-powered stations, the life factor would not have to be reduced by any great appreciable factor to warrant careful consideration of voltage regulation on the tube filaments.

In the Figure 1 curve, the plot is logarithmic with life in hours versus nominal filament voltage centered around 100%. Thus, it is quite obvious that if the filament voltage is increased 5%, filament life is reduced approximately in half. Accordingly, by making appropriate assumptions, such as the type of fluctuations around a mean normally encountered on power lines, or normal line voltage fluctuations of a normal station, we arrive at the plot of Figure 2, which offers a comprehensive picture of what tube-replacement cost might be in a station with a $1,000 initial investment in tubes.

The tube-life expectancy problem is different in a-m and f-m stations. In the f-m transmitter there are less peak demands. Since we are operating at a constant carrier in an f-m station, the peak plate-current requirements are much less stringent. This factor permits closer operation to the emission limited point, and also closer tube design inasmuch as it is not necessary to provide for peak current. By the same token, if with closer operation and closer design the problem of line voltage becomes all the more critical, more can be gained by maintaining operation at the lowest possible value. As can be seen from Figure 2, the restriction of line-voltage excursions still pays for

In Broadcast Stations

Voltage Regulation Plays Major Role In Station Operations, Offering a Means of Curbing Operating Expenses Over a Long Period, Increasing Transmitter Efficiency and Operational Reliability.

by LEO L. HELTERLINE, Jr.

Chief Engineer
Sorensen and Company, Inc.

itself, even down below ½%, and thus the extreme accuracy control is highly desirable from a dollar and cents viewpoint.

Dual Station Operation

Voltage regulation can also be effectively employed in dual transmittter operation, as for f-m/a-m units.

Proper power-output maintenance is a time-consuming operation, particularly during periods of the day when line voltage is fluctuating quite severely. If the location of the transmitter is at such a point where the power lines are of second order quality, the effect is even more noticeable. Thus, automatic line-voltage control equipment is quite handy and effective.

Regulation of Entire Transmitter

If the entire transmitter is voltage regulated, the need for constant readjusment due to power output fluctuations is eliminated, freeing the operator who would normally have double operating chores. If the same considerations of tube life are also applied, tube maintenance problems can be cut considerably more than one-half.

A typical example of this type of dual operation is found at WSTC and its new companion f-m station, which is now being constructed. In this case it was found feasible to combine most of the transmitting equipment onto one location.

Quality Output and Line-Voltage Regulation

The majority of tube amplifiers and distortion modulators depend, for their effectiveness, on a relatively constant line voltage. Generally, peak performance might occur between 110 and 120 volts. Excursions outside of these values might be greatly detrimental to the operation of the amplifiers, monitors, etc. Thus a voltage regulator can be employed to centralize the effective operating voltage and eliminate line excursion effects.

Regulation accuracy should be as great as possible. This will make it possible to more nearly approach the theoretical life expectancy of the transmitter tubes.

Voltage regulation also permits control of the wave form at the input of transmitters which use voltage-doubling

(*Continued on page 37*)

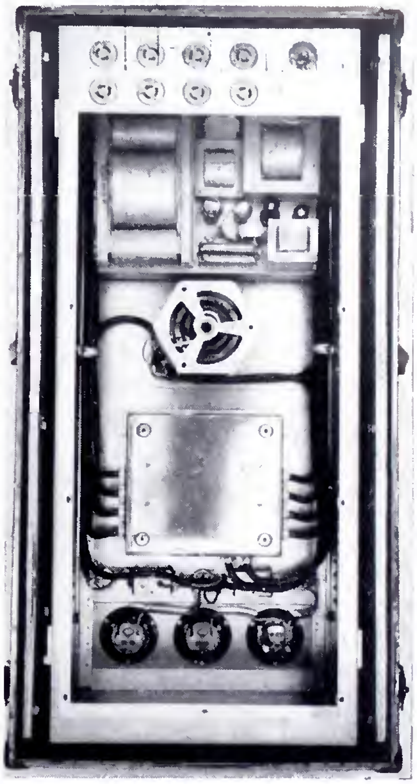
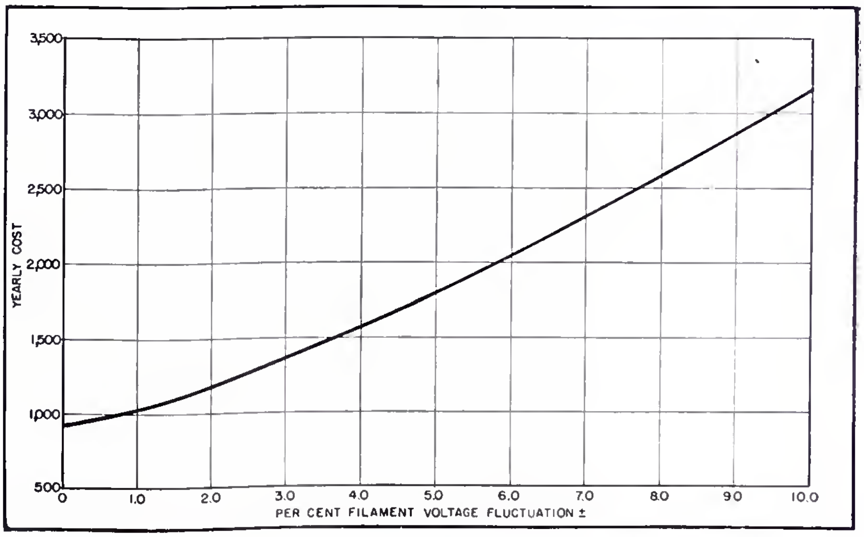


Figure 3*a* (*right, top*)
Voltage control setup of the Columbia Recording Company, used in Mexico City. From top to bottom, power supply, manual regulator, and automatic a-c voltage regulator, Sorensen type 1750.

Figure 4 (right)
The Nobatron-type voltage regulator.

Figure 2
Yearly tube replacement costs versus fluctuation in line voltage, for a set of tubes whose base cost might be $1,000



Transmitting Antenna Inductive Coupling Methods

Theory and Adjustment of Swinging-Link Type of Antenna Coupling.

by SIDNEY WALD

RCA Victor Division
Radio Corporation of America

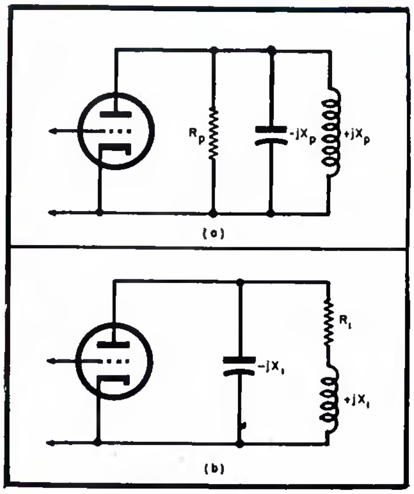


Figure 1*a* (above) and 1*b* (below)
In *a* appears a circuit used to determine the *Q* of a loaded tank circuit, which is the ratio of the equivalent-load resistance to the parallel reactance. In *b* appears a circuit illustrating resistance in series with tuning element that may be considered as a useful load.

Figure 1*c*
A graph showing error for *Q* of 10 or less.

WHEN A RESONANT ANTENNA is coupled to a transmitter through a matched transmission line, it has been common practice to employ an inductively-coupled link to the final tank. There is no doubt that this type of coupling scheme is simple and therefore desirable from a mechanical point of view. Electrically, however, there are certain aspects of the circuit that are somewhat complex and require specific design information. For example, along with the coupling property of the link secondary, we have its unavoidable self-inductance. Thus, although we may have initially started with a resistive load, it is found that, due to the coupling coil, the antenna circuit is reactive. Unless this reactance is somehow overcome, we will be unable to realize maximum power transfer from the tank to the antenna.

Fundamentally, there are two methods of eliminating the effect of this reactance:

(*1*) A variable capacitor may be inserted to tune the secondary to series resonance.

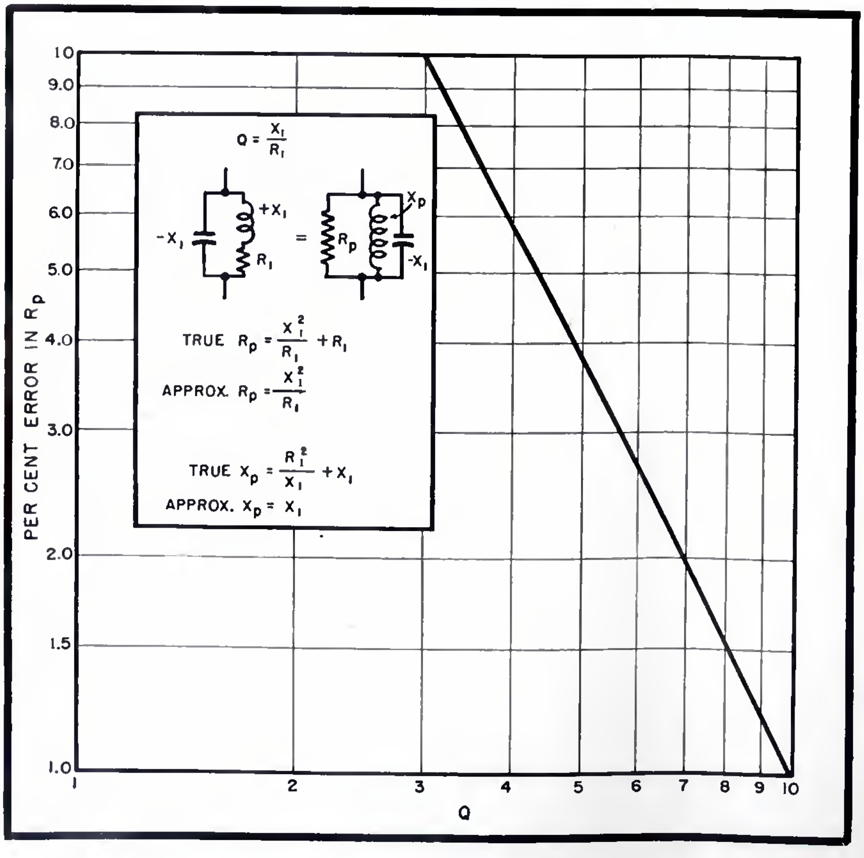
(*2*) The secondary emf may be increased to overcome the reactance drop of the secondary and thus secure rated secondary current. This is accomplished by increasing the coupling and retuning the tank circuit.

In utilizing either of these methods, one must determine the per cent coupling and the inductance of the link coil. Finding that a trial coupling coil does not permit the final stage to draw rated plate current, we may be tempted to discard the first coil and try again. As in all other aspects of equipment development, few will deny the desirability of a rational design procedure which will permit one to arrive at the nearly final circuit parameters the first time. The following analysis is intended to determine, within the limits of engineering accuracy:

(*1*) Whether it is always possible to retune the tank to compensate for the link current reactance.

(*2*) How much additional mutual inductance is required when the antenna circuit is not tuned to series resonance.

To arrive at the answers to these questions, we must first discuss several of the most common and essen-



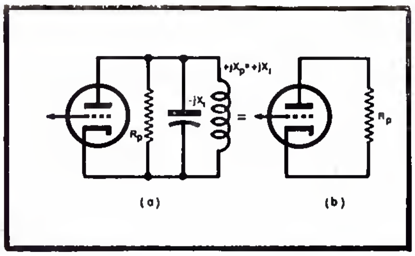


Figure 2*a* and *b*
For a circuit *Q* of 5, it is possible to consider that the circuit of *a* reduces to *b* and the circuit is purely resistive.

tial concepts in transmitter power-amplifier design. These include:

(*1*) Tank circuit *Q*.

(*2*) Parallel plate-load impedance and resistance.

(*3*) Coupled impedance.

Circuit Q

The *Q* of a loaded tank circuit may be defined as the ratio of the equivalent parallel load resistance to the parallel reactance; Figure 1*a*.

$$Q_c = \frac{R_p}{X_p}$$

Of course $-jX_p$ and $+jX_p$ are in parallel resonance but as far as the *Q* is concerned, either reactance is considered separately in relation to R_p to define Q_c.

Parallel Plate Load, R_p

The circuit of Figure 1*b* is shown to contain a resistance R_1 in series with one of the tuning elements. This resistance is considered as having been inserted as a useful load. The resistance of the coil may usually be neglected as it should be very much smaller than the useful series load.

Now due to the transforming action of the parallel resonant circuit, the series resistance R_1 appears to the plate circuit of the tube as a parallel resistance R_p equal to

$$R_p = \frac{X_1^2 + R_1^2}{R_1} \qquad (1)$$

Also across R_p appears the capacitor $-jX_1$ and an equivalent inductive reactance almost equal to X_1. For a circuit *Q* of five or more one may consider that Figure 2*a* reduces to *b* and that the circuit is purely resistive.

Equation (*1*) may also be rewritten as

$$R_p = Q_c X_1 + \frac{X_1}{Q_c} \qquad (2)$$

or

$$R_p = R_1 (1 + Q_c^2) \qquad (3)$$

Figure 1*c* shows the error in R_p which results from using the following approximations:

$$R_p = \frac{X_1^2}{R_1} \qquad (4)$$

$$X_p = X_1 \qquad (5)$$

Thus,

$$Q_c = \frac{R_p}{X_1} = \frac{X_1}{R_1} \qquad (6)$$

Coupled Impedance from Antenna Circuit

When an antenna circuit is inductively coupled to the tank, a series impedance,

$$Z_c = \frac{\omega^2 M^2}{Z_2} \qquad (7)$$

appears in the circuit; Figure 3.

Z_2 is complex, being composed of the antenna circuit resistance, R_2 and the secondary coil reactance X_2.

$$Z_2 = R_2 + j X_2 \qquad (8)$$

The coupled impedance becomes

$$Z_c = \frac{\omega^2 M^2}{R_2 + j X_2} \qquad (9)$$

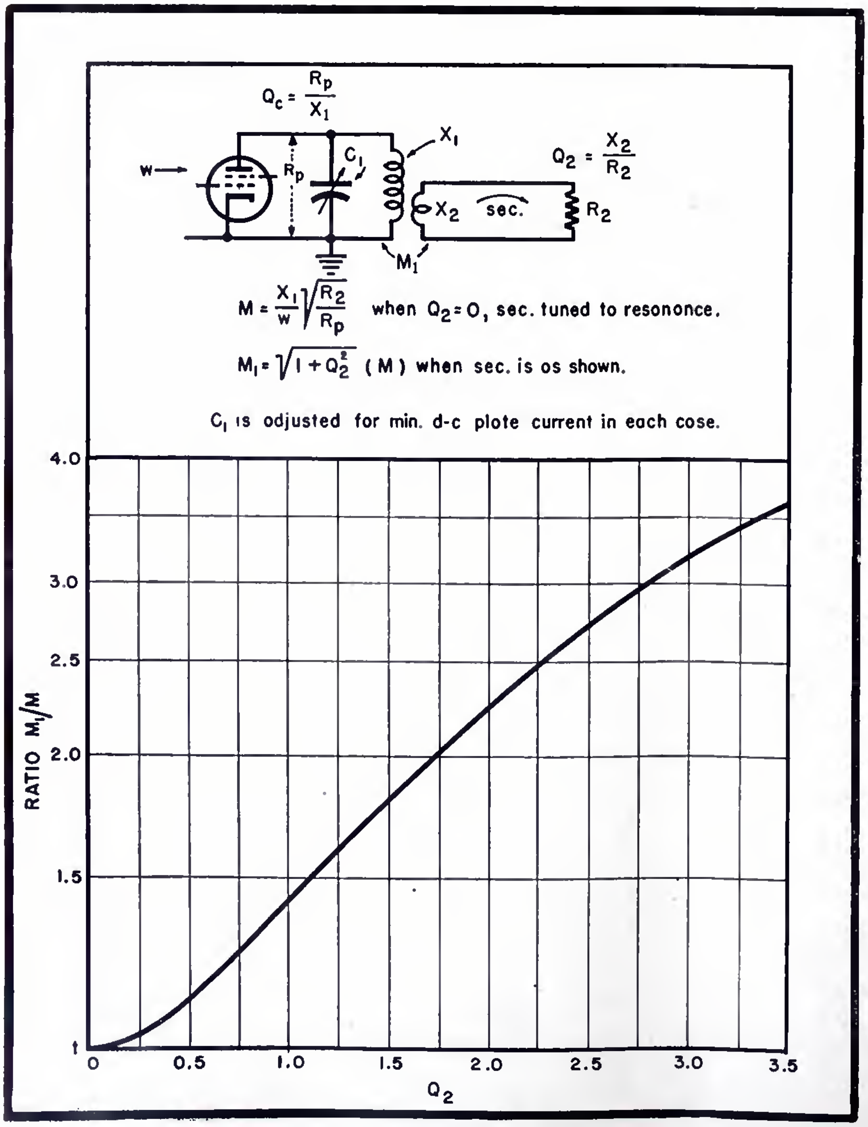
This finally turns out to be

$$Z_c = \frac{\omega^2 M^2}{R_2 (1 + Q_2^2)} - j \frac{\omega^2 M^2}{X_2 \left(1 + \frac{1}{Q_2^2} \right)} \qquad (10)$$

Q_2 is a convenient parameter, X_2/R_2, employed to simplify the algebraic expression.

If we readjust the tank circuit to resonance by adding enough inductive reactance to equal the *j* term in equa-

Figure 2*c*
Plot of M_1/M ratio, showing by what factor the mutual inductance must be increased when the antenna circuit is untuned. The term w is ω.



tion (*10*) the coupled impedance reduces to a pure resistance

$$R_c = \frac{\omega^2 M^2}{R_2 (1 + Q^2_2)} \qquad (11)$$

We may compute R_p then, using the value of R_c as the analog to R_1 in equation (*4*). This results in the effective plate-load resistance taking into account the antenna loading:

$$R_p = \frac{X^2_1 R_2 (1 + Q^2_2)}{\omega^2 M^2} \qquad (12)$$

If we were to assume that the reactance of the antenna circuit had been tuned out by means of a series condenser, Q_2 in equation (*12*) becomes zero, and

$$R_p = \frac{X^2_1 R_2}{\omega^2 M^2} \qquad (13)$$

Equations (*12*) and (*13*), when compared, furnish us with the answer to one of our original questions; how much must the mutual inductance be increased to take into account the untuned antenna circuit. If we let M_1 be the mutual required when the secondary is untuned and *M* the value required when the secondary is series resonant, we have

$$M_1 = M\sqrt{1 + Q^2_2} \qquad (14)$$

Also

$$M = \frac{X_1}{\omega} \left(\frac{R_2}{R_p} \right) \qquad (15)$$

The ratio M_1/M is plotted in Figure 2*c* and shows by what factor the mutual inductance must be increased when the antenna circuit is untuned. A useful expression for the required mutual inductance results if equation (*12*) is solved for *M* and the loaded tank Q_c is inserted:

$$M = \frac{\sqrt{R_p R_2 (1 + Q^2_2)}}{2 \pi f Q_c} \qquad (16)$$

Where: M = mutual inductance, microhenries
f = frequency, megacycles
R_p = parallel plate load, ohms
R_2 = antenna resistance, ohms
Q_2 = antenna circuit Q.

A further simplification comes about if we substitute for M_1 its value $X_m/2\pi f$:

$$X_m = \frac{\sqrt{R_p R_2 (1 + Q^2_2)}}{Q_c} \qquad (17)$$

Where: X_m = mutual reactance between tank coil and link secondary ohms

Equation (*17*) is particularly interesting because, from it, we may learn

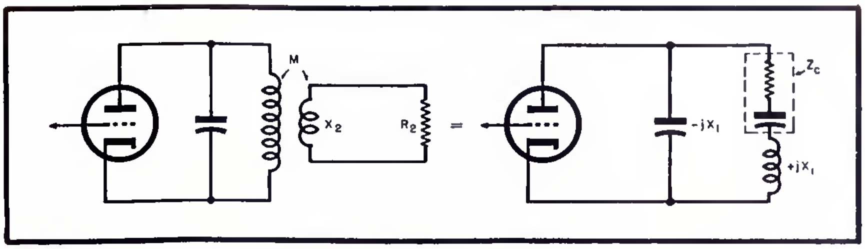


Figure 3
When an antenna circuit is inductively coupled we have a series impedance as we see here.

the behavior of the coupling circuit for different values of antenna resistance. The question of whether the necessary mutual reactance, X_m, decreases or increases with changes in R_2 is often asked. The answer depends upon the value of Q_2, or rather on the relation of Q^2_2 to unity. If Q_2 is small, Q^2_2 may be neglected in comparison to *1* and equation (*17*) becomes, for a given value of R_p, and Q_c

$$X_m = K\sqrt{R_2} \qquad (17a)$$

If Q^2_2 is large compared to *1*, we have

$$X_m = K \left(\frac{1}{\sqrt{R_2}} \right) \qquad (17b)$$

(K is a proportionality factor.)

A numerical example will help one visualize the previous statements. Let us assume a class *C* amplifier which draws 150 plate milliamperes fully loaded and a parallel plate load resistance of 2000 ohms. The circuit *Q* is equal to 10. Then if $Q_2 = 0$ and $R_2 = 50$ ohms,

$$X_m = \frac{\sqrt{2000 \times 50}}{10} = 31.6 \text{ ohms}$$

If R_2 were to be 300 ohms, the other conditions remaining unchanged,

$$X_m = \frac{\sqrt{2000 \times 300}}{10} = 77.5 \text{ oluns}$$

This represents an increase of coupling by a factor of 2.45. Were we to investigate the coupling change under the same conditions except that $Q_2 = 5$, then for $R_2 = 50$ ohms

$$X_m = \frac{\sqrt{2000 \times 50 \times 26}}{10} = 161 \text{ ohms}$$

For $R_2 = 300$ ohms with the same secondary reactance (250 ohms),

$$Q_2 = \frac{250}{300} = .835$$

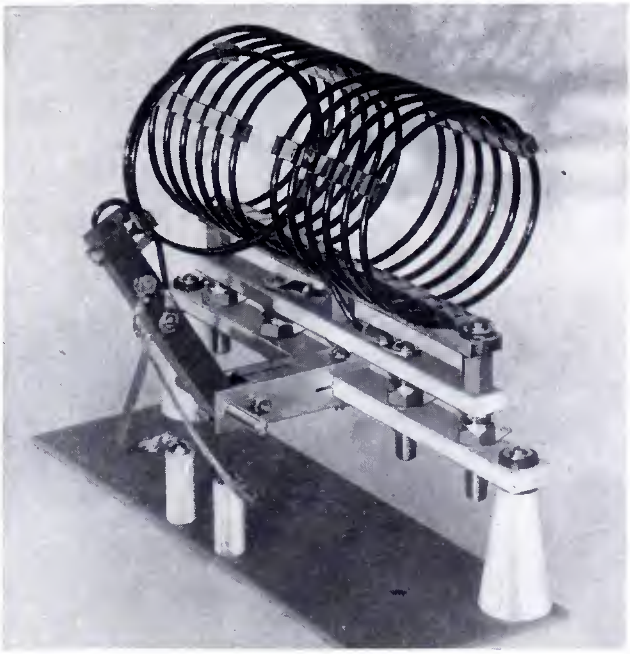
$X_m =$

$$X_m = \frac{\sqrt{2000 \times 300 \times 1.7}}{10} = 101 \text{ ohms}$$

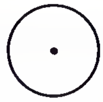
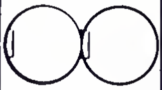
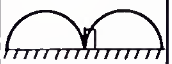
Here for a higher antenna resistance the required coupling has actually decreased by a factor of 0.63.

To find the mutual inductance from X_m we merely divide by $2\pi f$; thus 101 ohms at 30 mc is equivalent to a mutual inductance of 101 6.28 × 30 = .54 microhenries.

A heavy duty inductor with a swinging link; type B & W HDVL.



SUMMARY OF STANDARD REFERENCE ANTENNAS

TYPE OF ANTENNA	VERTICAL PATTERN SHAPE	MV/M FOR 1 WATT AT 1 MILE E_0	MV/M FOR 1 KW AT 1 MILE E_0	POWER GAIN g	db GAIN G	TYPE OF ANTENNA	VERTICAL PATTERN SHAPE	MV/M FOR 1 WATT AT 1 MILE E_0	MV/M FOR 1 KW AT 1 MILE E_0	POWER GAIN g	db GAIN G
UNIFORM SPHERICAL RADIATOR		3.402	107.6	1	0	UNIFORM HEMISPHERICAL RADIATOR		4.811	152.1	2	3.010
CURRENT ELEMENT		4.167	131.8	1.5	1.761	VERTICAL CURRENT ELEMENT		5.893	186.3	3	4.771
HALF WAVE ANTENNA		4.358	137.8	1.641	2.151	QUARTER WAVE VERTICAL ANTENNA		6.163	194.9	3.282	5.161
0.622 λ ANTENNA		4.472	141.4	1.728	2.375	0.311 λ VERTICAL ANTENNA		6.324	200	3.456	5.386
TWO END ON HALF WAVE IN PHASE ANTENNA		5.283	167.1	2.411	3.822	HALF WAVE VERTICAL ANTENNA		7.471	236.2	4.822	6.832

Standard Reference Antennas*

by CARL E. SMITH[1]

Vice President, In Charge of Engineering, United Broadcasting Company

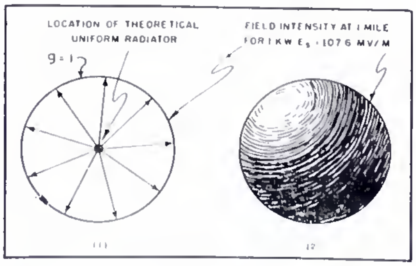
Characteristics of the Omnidirectional Uniform Spherical Radiator, Used as the Standard Theoretical Reference, and the Uniform Hemispherical Radiator Used as a Standard of Directivity and For Computation of Gain and Efficiency.

THE UNIFORM OMNIDIRECTIONAL (spherical) or isotropic radiator, in free space, has been adopted as *the standard reference antenna* (Figure 1) because it has no directivity. This standard, which has come into rather common use in recent years, is defined as a theoretical antenna which radiates waves having the same field intensity in all directions. Actually such a radiator can not be realized, because all antennas have directional properties. In the case of acoustic waves, this standard is represented by a sphere pulsating radially.

The figure of merit or efficiency of all other antennas can be compared with this basic standard, and other secondary standards for free space may be selected and used as convenience demands; Table 1 (above).

Figure 1

A pattern of a uniform radiator which is the theoretical standard reference antenna. At left appears a cross-sectional view of a spherical pattern which has a field intensity gain of *1*, a power gain of *1* (*g* = *1*) and a decibel gain of *G* (*G* = *0*.) At right appears a spherical radiation pattern surface of a uniform or isotropic radiator.



Uniform Hemispherical Radiator

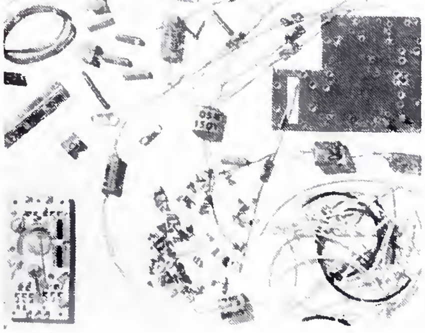
If a uniform radiator is placed at the surface of a perfectly conducting plane, all of the power must be radiated in the hemisphere above the surface of the earth, as shown in Figure 2. For a given power source, the power flow will have twice the intensity of a uniform radiator in free

(*Continued on page* 38)

[1]*Also president of the Cleveland Institute of Radio Electronics.*

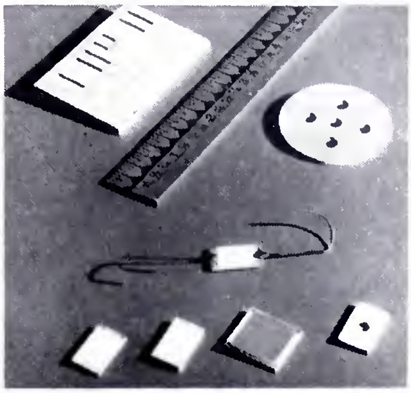
*From the author's book on *Directional Antennas,* published by the Cleveland Institute of Radio Electronics. The book treats in detail several methods of determining directional antenna efficiency, in addition to a systematization of over 15,000 directional antenna patterns.

Printed Circuit Progress



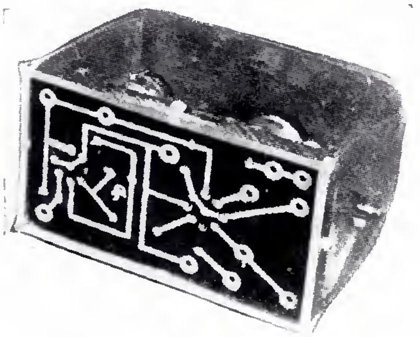
Above: Printed circuit 3-stage amplifier hearing aid, 2¼" long, and containing all of the standard components shown about the unit. (*Allen-Howe Electronics Corp.*)

The Aeronautical Board, in association with the National Bureau of Standards, conducted a 1-day *printed circuit* symposium in Washington during the latter part of October. Members of government and industry appeared to discuss the variety of *printed-circuit* methods, components and complete equipments which had been developed. An editorial review of this session appeared in the October issue of COMMUNICATIONS. A pictorial review of some of the *p-c* developments discussed at the session is presented on this page.

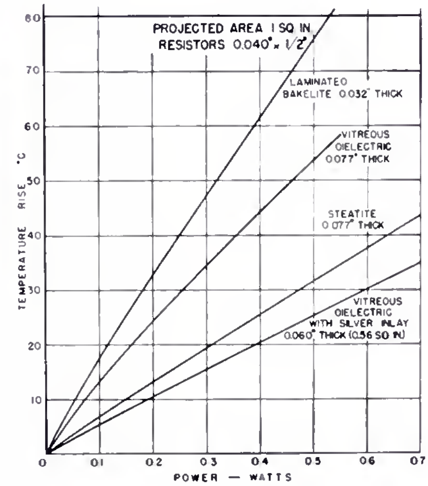


Above: Printed circuit components used in preparing a capacitor. A spraying method is used in this procedure, with a silverpaste as a conductor. (*Remington Arms and E. I. duPont de Nemours.*)

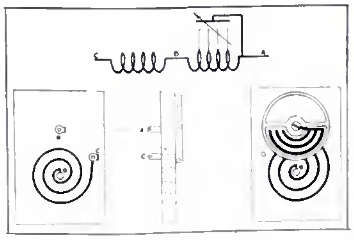
Above: Cast resin plug-in *p-c* unit. The unit contains a complete amplifier with sub-miniature tubes. (*National Bureau of Standards*).



Above: A *p-c* amplifier produced by a spraying, stenciling printed-circuit procedure. Lead thickness averages about .007". (*Spraywire Labs., Inc.*)



Above: Plot of temperature rise versus power of printed resistors for different base materials. (*International Resistance Co.*)



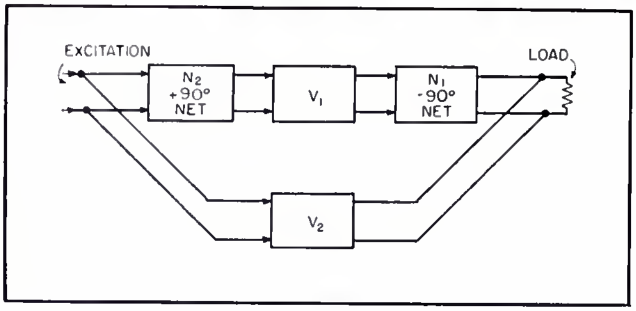
Above: Back, side and front views of a *p-c* adjustable resonant circuit system. (*General Ceramics and Steatite Corp.*)

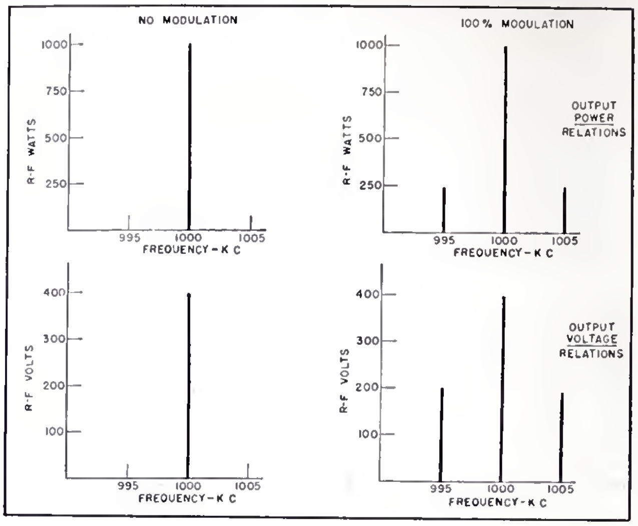
Below: Stamped wiring chassis showing new crossover wiring technique. (*Franklin Airloop Corp.*)

Below: A metal film spiralled-type resistor using a ceramic form base, on which is precipitated pure magnesium silicate, which is used in *p-c* circuit arrangements. (*Continental Carbon, Inc.*)

Below: Printed resistor filament strip produced on a mass production basis. Resistance filament is printed together with silver conducting terminations. Complete resistor complements of circuits and wiring can be printed and punched in one operation. (*International Resistance Co.*)

High-Powered R-F LINEAR AMPLIFIERS





Figures 1*a* (above) and 1*b* (right)

In 1*a* appears a block diagram illustrating how two amplifier channels are paralleled from an excitation source to load. Figure 1*b* shows the magnitude and frequency distribution of the output voltage and power of a typical amplitude-modulated signal. Conditions assumed are: carrier frequency, 1000 kc; rated output power, 1000 w; modulation frequency, 5 kc; and antenna resistance, 160 ohms.

High power amplitude-modulated signals are normally produced by either a class *B* or class *C* amplifier, or by a combination of the two. The class *B* amplifier possesses many advantages of linear amplification, but is limited for high power applications by its relatively low efficiency when operated for linear 100% modulation. The class *C* amplifier, on the other hand, presents two problems; its nonlinearity for grid modulation and its requirements of large amount of audio power for plate modulation.

To overcome the low operating efficiency of the class *B* amplifier and still maintain the many inherent advantages of linear amplification, a circuit was developed by W. H. Doherty,[1] effectively combining a class *B* and *C* amplifier.

The Doherty amplifier, a linear combination of class *B* and *C* amplification, employs two tubes, the first of which operates as a class *B* amplifier *at full efficiency,* and supplies all the output power under conditions of no modulation. The second tube which can be considered as a class *C* amplifier, is biased beyond cutoff and delivers output only when the carrier is modulated.

Figure *1A* shows, in block diagram form, the manner in which two amplifier channels are paralleled from the same excitation source to the same load. Since V_2 (class *C*) is biased beyond cutoff at the carrier level, it is inoperative during periods of no modulation. However, when modulated, V_2 supplies the additional power needed during modulation. The key to the operation of this circuit lies in the use of the 90° network which couples V_1 (class *B*) to the output load. This network, shown in detail in Figure 4, effectively divides the load between V_1 and V_2 when the transmitter is modulated. The 90° network in the input circuit of V_1 compensates for the phase shift in the output circuit network, thereby making the voltages from the two tubes in phase at the load.

[1] Bell Telephone Labs.

100% Amplitude Modulation

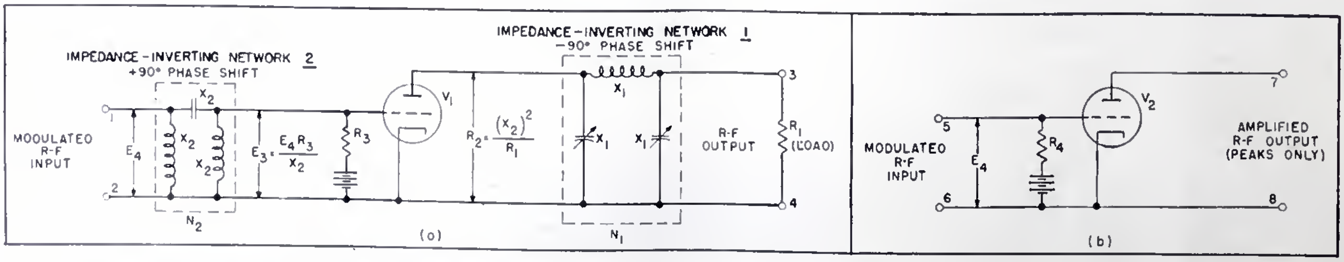
In 100% amplitude modulation it is necessary that the amplitude of the output voltage envelope vary from zero to twice its unmodulated value at the positive peak of modulation. Since the instantaneous output power varies as the square of this amplitude,

$$\left[\text{Power (watts)} = \frac{E^2}{R}\right]$$

the *instantaneous* output power must vary from zero to four times the nominal carrier power. It has sometimes been difficult for the operator, in view

Figures 4*a* (left) and *b* (right)

A block diagram of the V_1 circuits with no modulation is shown in *a*. This tube supplies all the carrier power, and it is biased for class *B* operation. In *b*, we have a block diagram of the V_2 circuit. This tube supplies power only during modulation, and it is biased for class *C* operation. In actual operation, terminals *1* and *5*, *2* and *6*, *3* and *7*, and *4* and *8* are connected.



A Discussion of Circuits Designed to Provide Kilowatts of R-F Power in A-M Transmitters With Low Distortion, Low Residual Noise and High Fidelity. Analysis Covers the High Efficiency Method of Linear Amplification Featured in the Doherty Circuit.

by C. W. CORBETT

Sales Engineer, A-M Transmitters
Radio Division, Western Electric Co.

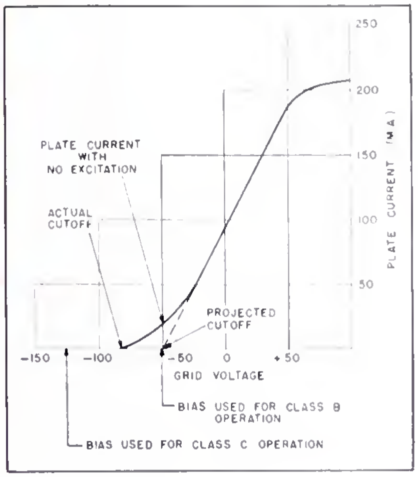


Figure 2

Illustration of a typical linear (class *B*) amplifier biasing system. In this example, the tubes should be biased at 50 volts, d-c. The plate current with no excitation will be approximately 20 ma. The biasing point for class *C* operation is also indicated in this figure.

of this statement, to appreciate why the antenna current increases only 22½%, when 100% sine-wave modulation is employed. This can readily be seen when it is realized that the *average* value of the output power of the transmitter increases only 50% when 100% modulated. The transmitter output consists of an unchanged voltage at the carrier frequency, plus two side bands of half the carrier amplitude (voltage), equally displaced above and below the carrier frequency by an amount equal to the modulating frequency (Figure 1*B*). At full modulation the instantaneous peak of these two side bands taken together will total that of the carrier, and their maximum combined sum with the carrier voltage will be twice the value of the unmodulated carrier, which agrees with our previous statements. However, since the upper and lower side bands are not of the carrier frequency, they will combine with the carrier on a root-sum-square basis, as far as effective values are concerned. Thus, if we assume that the carrier amplitude is unity, the amplitude of each side band will be one-half, and the effective amplitude of the antenna voltage as indicated on an output voltmeter will be

$$E_{ant} = \sqrt{(1)^2 + (\tfrac{1}{2})^2 + (\tfrac{1}{2})^2} = \sqrt{1.5} = 1.225,$$

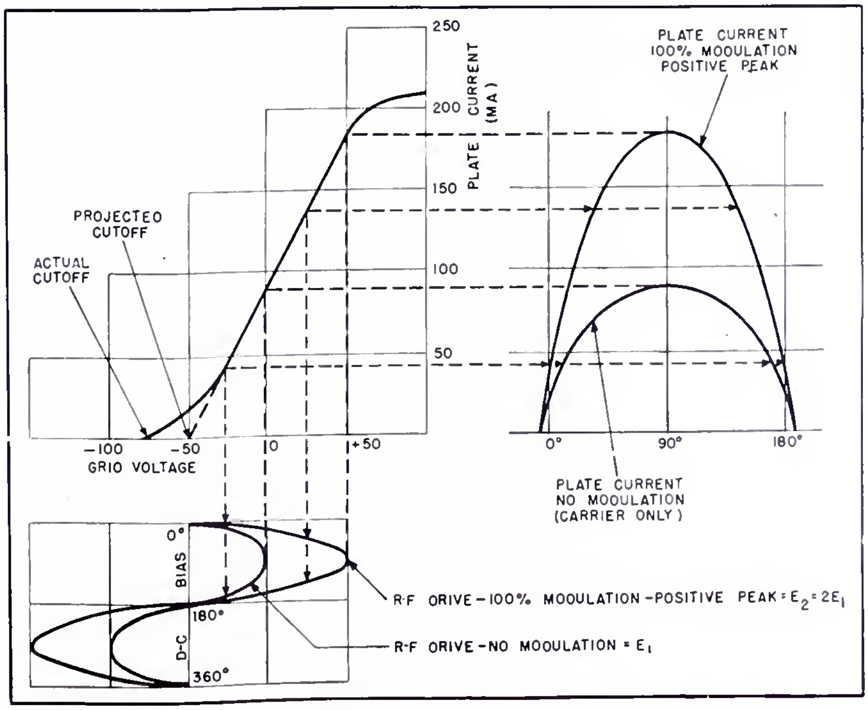
an increase of 22½% over the unmodulated carrier value. The effective antenna current will also increase by this amount, assuming that the antenna resistance is constant. The product of the effective antenna current and voltage gives the average power of the modulated envelope. Thus watts = EI = 1.225 x 1.225 = 1.5, an increase of 50% over the unmodulated carrier power, as indicated.

R-F Power Amplifiers

The maximum efficiency of an unmodulated class *B* or linear amplifier is quite high. Theoretically, an efficiency of 78½% can be obtained, and actual efficiencies (including circuit losses) can be obtained in the neighborhood of 63 to 67%. As shown in Figure 2, the tube is usually biased with a d-c voltage established by what is known as the *projected cutoff* of the grid voltage—plate current characteristic, which is simply an extension of the linear portion of this curve to the zero plate current point. This value is chosen to minimize the distortion caused by the curvature of the characteristic in this region. Since the requirement of 100% modulation is that the carrier power be quadrupled on instantaneous peaks, it is necessary, when using this conventional amplifier, to reduce its output to ¼ its maximum value when establishing the unmodulated carrier power. This is done by reducing the r-f input voltage to half the value required for full output. Figure 3 shows

Figure 3

Curves illustrating the r-f grid-voltage plate-current operating characteristics of a conventional linear amplifier. It will be noted that the peak output current is double for 100% modulation.



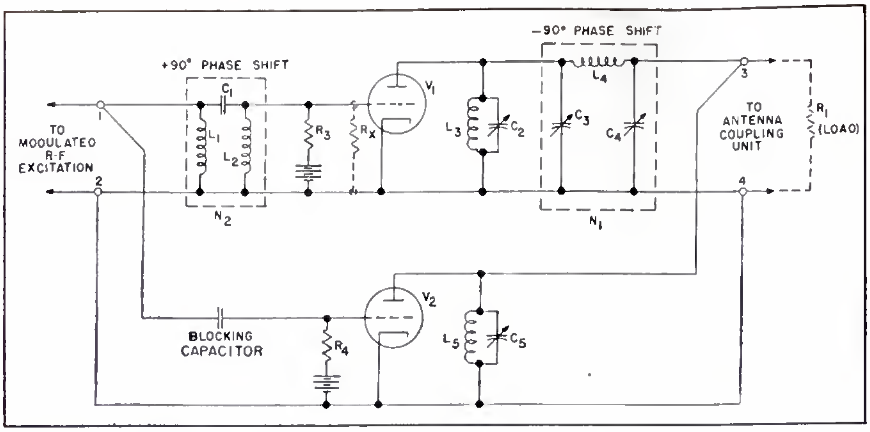


Figure 5

Schematic of the Doherty amplifier. It will be noted that the network capacitor C_3 is in parallel with the tank capacitor C_2 and C_4 is in parallel with C_5. These are combined in the final circuit as shown in Figure 8.

the instantaneous values of grid voltage and plate current over one complete cycle of the r-f voltage for both conditions. It will be noted that plate current flows for only slightly more than half of this cycle, but due to the storage or *flywheel* effect of the output tank circuit, the circulating current in this circuit, and in the load, will be of full sinusoidal form.

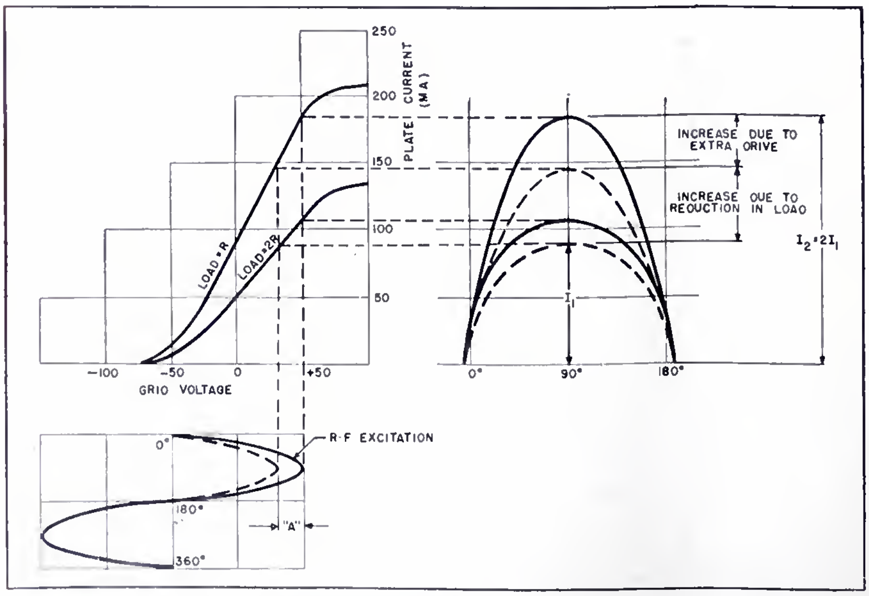
Figure 3 also shows that the unmodulated *peak* plate current is one-half that obtained at full excitation. Since the *average* value of a half sine wave equals the *peak* value divided by π, we see that the average values of these currents are also in the same ratio. The d-c plate voltage remains constant for both conditions, and therefore the power input at zero modulation will be one-half that at 100% drive. Since the load resistance remains constant, the output r-f voltage is proportional to the output current, and thus the output power at the carrier level is $\frac{1}{2} I \times \frac{1}{2} E = \frac{1}{4}$ that obtained with full excitation, and the efficiency will be

$$\frac{\text{Output}}{\text{Input}} = \frac{\frac{1}{4}}{\frac{1}{2}} = \frac{1}{2} \text{ the maximum value, or approximately } 33\%.$$

Class *C* amplifiers have a somewhat higher efficiency than class *B* amplifiers, depending upon the angle of flow of the plate current pulses, but they suffer from one major drawback, namely, they are not linear and cannot be used to amplify a modulated wave. It is thus necessary to modulate directly at the final stage, which requires large amounts of audio power.

Figure 6

Curves illustrating the variation of plate current with load resistance in a linear (class *B*) amplifier. It will be noted that the amplitude of the plate current varies inversely with *R*. The efficiency remains unchanged at approximately 65% as long as the r-f excitation is adequate. To double the plate-current peak value, the load resistance must drop from 2*R* to *R*, and the r-f excitation must increase approximately 40%, as indicated by *A*.



The High Efficiency Linear Amplifier

As stated before, the Doherty amplifier is an effective combination of class *B* and *C* operation which makes possible both high efficiency and linearity. To thoroughly understand the operation of the Doherty circuit, the properties of the 90° network in the output circuit of V_1 must be thoroughly realized. This network, N_1 (Figure 1*A*), acts as an *impedance inverting* network and can most readily be described as the electrical equivalent of a quarter wavelength line.

Briefly, the properties of such a line are: (*a*) Impedance measured at one end of the line is inversely proportional to the impedance connected to the other end; (*b*) voltage applied to either end will cause a current of definite magnitude to flow at the other end without regard to the terminating impedance; and (*c*) there is an effective phase shift of minus 90° from one end to the other (this is independent of the magnitude of the terminating impedances). It is apparent that an actual quarter-wave line at these frequencies would be much too bulky to be included in the transmitter, and thus an equivalent artificial line composed of lumped elements is employed in its stead, as shown in Figures 4 and 5. Of the three effects just mentioned the impedance inverting quality is the one to be desired and is the characteristic upon which the function of the amplifier is based. The −90° phase shift is incidental and is compensated for by introducing in the grid circuit of tube V_1 a second network, N_2 (Figure 1A and Figures 4 and 5), which has a phase shift of +90 degrees. It will thus be seen that the effective total phase shift in the circuit is the sum of these two, or zero, and the outputs of both tubes will combine in phase in the load. This second network, N_2, is also used to advantage in reducing the load on the driver stage and avoiding carrier shift.

Under conditions of no modulation, it is desired that tube V_1 operate at full efficiency as a class *B* amplifier into a plate load of twice the value used for maximum output. Since V_2 is operating class *C* (biased beyond cutoff at the carrier level), it draws no plate current and effectively is an open circuit in parallel with the actual output load resistance (designated as R_1 in Figure 5). This load resistance,

R_1, is chosen to be *half* the value normally required for the load of tube V_1; that is, R_1 is precisely the load impedance that would normally be used for two tubes working in parallel. The impedance-inverting network is so designed that this resistance appears in the plate circuit of tube V_1 as *twice* the value required for maximum output (or $4R_1$) which is the desired condition.

With increasing modulation the r-f drive to both tubes is increased; plate current flows in tube V_2, and it delivers power to the load R_1. Since this increase in power effectively increases the voltage across R_1, the effect on the network N_1 is the same as increasing the actual value of this resistance. This may be seen when we recall that resistance is defined as $\frac{E}{I}$ for any circuit. This increase in the value of R_1 at one end of N_1 effects a proportionate decrease in the resistance appearing at the other end, because of the impedance-inverting property of the network. Inspection of the circuit makes it clear that this actually results in a reduction in the plate load impedance of V_1 and accordingly the current in the plate circuit of this tube increases and so does its power output. Figure 6 shows the variation of plate current with load resistance in a typical case.

(The possibility of operating V_1 and V_2 without employing the impedance-inverting networks seems attractive, until we realize that with the conventional parallel (or push-pull) connection the voltage contributed by V_2 during modulation peaks will effectively increase the combined load resistance, as discussed above. Figure 6 shows that when this happens, the output of V_1 immediately falls off, so that the combined output of the two tubes will not increase appreciably above that of V_1, and consequently this combination will not respond effectively to a modulated wave.)

In actual operation, the conditions are established when at positive peaks of modulation the effective value of R_1 becomes twice the value at carrier level, thus making the load impedance at V_1 half the value for carrier conditions, so that its output is doubled. Thus, half the necessary output power is supplied by V_1, and V_2 is so adjusted that it will supply the remaining half. At intermediate levels of modulation the conditions vary between those obtaining at no modulation and those at full modulation, and actually result in tube V_2 supplying some power at all times when the transmitter is

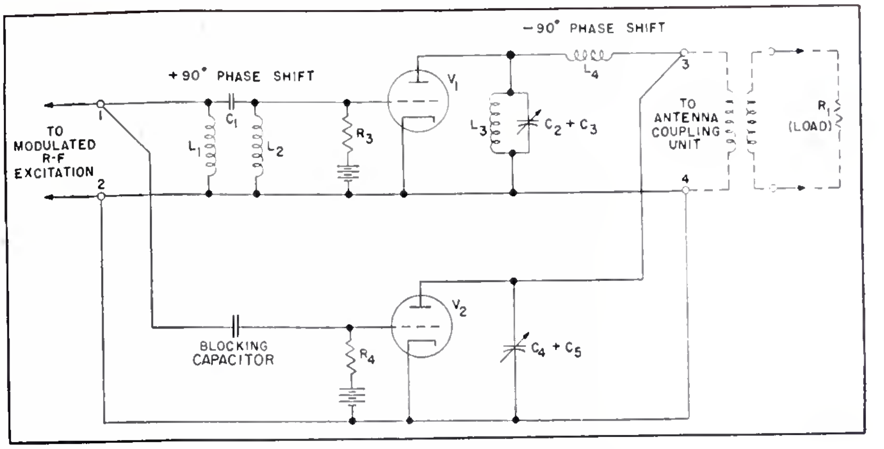


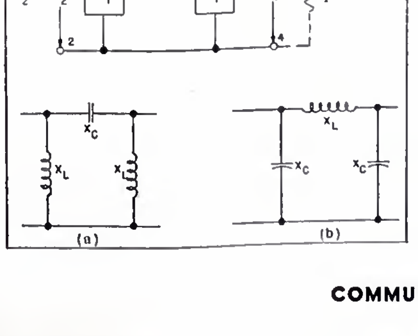
Figure 8
Simplification of output circuit with C_2 and C_3 combined in one unit, and C_4 and C_5 also placed in one unit.

modulated. Figure 6 shows that with a two to one reduction in plate load resistance for V_1 (as provided by N_1 during 100% modulation peaks), it is necessary to increase the excitation only approximately 40% above the carrier value to double the power output of V_1 (indicated by A and I_2 in the figure).

Figure 7 shows two schematics of impedance-inverting networks, to illustrate their simplicity. It will be noted that in each case the series and shunt arms have the same absolute value of reactance, and by simply changing the signs of these reactances, it is possible to obtain either a leading or lagging phase shift of 90°. In the actual transmitter one of each type is used which results in a total phase shift of zero.

The grid-impedance-inverting network, N_2 (Figures 4 and 5), serves a triple purpose. First, it reduces the amount of power required from the driver and makes it easy to obtain

Figure 7
General form of impedance-inverting networks used in W.E. transmitters. In *a* we have the network used in the input circuit arrangement which causes a phase shift of +90°, while in *b* we have the netwnrk used in the output circuit which causes a phase shift of —90°. In these networks, the numerical values of the reactances are equal and are so chosen that X equals twice the value of R_1.



100% modulation. The lowered impedance at the tube side of the network, caused by the grid current flow, appears at the other (driver) end as an increased impedance, due to the inverting properties of the network. The increase of input impedance compensates for the decreased input resistance of V_2 at the peak of modulation, thus insuring adequate voltage drive on V_2.

The second beneficial effect of N_2 is that, due to the action just described, the grid of V_1 is prevented from becoming excessively positive on modulation peaks, thus eliminating the possibility of excessive grid current and temperature. Finally, by designing N_2 to have a leading phase shift, the lagging phase shift of N_1 is cancelled, and the outputs of V_1 and V_2 combine in phase in the load.

The plate network shown in Figure 5 is, in practice, actually combined with the plate tank circuits in the transmitter, as shown in Figure 8. This combination reduces the number of actual components required in the equipment and provides a convenient means of adjusting these networks when tuning the transmitter.

Before discussing actual performance measurements and considerations in general, it would be well to point out some of the other advantages that accrue from the high efficiency linear amplifier. Stabilized loop feedback is possible with this circuit since no modulation transformer with its inherent large phase shift is used. Low-harmonic distortion and noise is realized by the use of loop feedback making possible high-fidelity performance which exceeds the acceptable standards in this respect. A small portion of the r-f is rectified and the audio component is fed in series with the pro-

(*Continued on page* 34)

Personals

ARTHUR H. LYNCH, who has taken up residence in sunny Florida, can be reached at P. O. Box 466 in Fort Myers, Fla. . . . Raymond F. Guy, VWOA life member, is spending considerable time in Washington on engineering matters for NBC. . . . Fred McDermott, with the A. T. & T. program department, was in Washington recently on business matters. . . . Our good wishes to Charles R. Denny, formerly chairman of FCC, on his recent appointment as vice president and general counsel of NBC. . . . We are sure the splendid cooperation of Arthur Batcheller, engineer-in-charge of the FCC New York office, is sincerely appreciated by the radio folks in the area. . . . Eric Bisbee, with the communications section of New York City Police Department, had to work the night of our Fall get-together. . . . "Nicke" Huestis, radio supervisor of the Atlantic Refining Company, was also unable to be with us. . . . E. N. Pickerill enjoyed a vacation in the country recently. . . . We've learned that veteran member J. F. Burns operates amateur station, W3KOU, down Baltimore way. . . . Wylie A. Paul is doing considerable traveling for Mackay these days. . . . A. J. Costigan, our v-p, spent many months at the Atlantic City telecommunications conference. AJC has attended practically every major communications conference in the world during the past quarter century. . . . G. G. Greene is still very active in the operating field, at present being stationed at Mackay station WSL, Easthampton, N. Y. . . . Veteran member Col. Thompson H. Mitchell, executive vice president of RCAC, has been touring Europe recently, studying communications problems. . . . Congratulations to General Van Deusen, formerly Commanding General of Fort Monmouth, on his recent election as president of RCA Institutes. . . . Paul F. Godley, life member, has numerous consulting assignments which keep him away from the Big City. . . . G. N. Mathers, who sailed aboard a barge, Socony 88, in 1921, then went to RMCA and Federal Telegraph Company, is now ashore as radio inspector for Tropical Radio. . . . R. H. Pheysey, who received the VWOA Marconi Memorial Scroll of Honor, is now radio abstract clerk with the United Fruit Company in New York City. . . . Congratulations to Major General Harry C. Ingles, formerly Chief Signal Officer of the Army, on his recent election as president of RCA Communications, Inc. . . . Ludwig Arnson, president of Radio Receptor, is as active as ever in the radio and the electronics field. . . . George Street has returned from Hawaii. . . . B. Frank Borsody, W2AYN, is quite active in the Naval Reserve Electronics Officers' group at the N. Y. Naval Shipyard. . . . Samuel Spector is aboard a ship as an op. . . . We've learned that "Bud" Waite played a major role in the rescue of Admiral Byrd in the Antarctic. He introduced multi-channel gear in France, the Philippines, and in Japan under fire. . . . Ed. K. Price, in the television field engineering group with RCA at Camden, spends most of his time *on the road*. . . . Ed. G. Raser, W2ZI, a commercial operator since 1917, is a collector of odd and interesting pieces of radio gear. He is Atlantic division director of the ARRL.

At the *ham* setup at the recent American Legion meeting in New York City with (left to right): George Bailey, assistant VWOA prexy; VWOA veteran Henry T. Hayden; Dan Lindsay; VWOA honorary member Major-General Frank E. Stoner (Ret.) U. N. chief communications engineer; and Dr. A. L. Walsh.

HENRY T. HAYDEN, JR., served as chairman of the amateur radio committee during the recent American Legion National Convention in New York. He directed an amateur station, installed on the 17th floor of the Pennsylvania Hotel. Three transmitters were used, a 1-kw c-w job on 80 meters, 150-watt c-w on 40 meters, and a 140-watter on 10 meters phone.

Messages were filed at a booth in the lobby which was in communication with the transmitter room via a 2-meter radiophone setup.

Eight hundred twenty-six messages were forwarded to points all over the world during the four days the station was in operation. An emergency network, set up to handle communications during the parade handled 250 messages to the medical center, under the direction of Nils P. Michaelsen.

Dan Lindsay was station manager.

News Briefs

INDUSTRY ACTIVITIES

The Baltimore and Ohio Railroad will install two-way v-h-f f-m radiotelephone equipment on its fleet of seven tugs operating in the New York harbor area.

Radio equipment is used by the B. & O. in its marine operations in Baltimore harbor, and yard operations at New Castle, Pa.

Equipment for the new installation, to be completed by spring, is being made by the General Railway Signal Company, Rochester, N. Y.

Two-way f-m equipment has been installed on four ferryboats and land locations of the Chesapeake Bay Ferry System, near Annapolis, Md., by G. E.

The system is operated by the Maryland State Highway Commission.

Transmitter-receiver sets have been installed in the wheelhouse of each ferryboat, while the station headquarter units are located on the docks and in the State Highway Commission's office at Annapolis.

The ferry system operates on 43.02 mc. Land stations utilize desk-type console 60-watt transmitter-receiver combinations.

Philco radiotelephone 30 to 44-mc equipment permitting three-way conversations between a patrol car, control station and other patrol cars is being supplied to the State of Colorado.

A total of 110 mobile and 20 fixed station equipments will be installed. Control stations will be located at district headquarters in Denver, Greeley, Pueblo, Grand Junction and Durango.

Eighteen members of Hazeltine have received Navy Certificates of Commendation: Basil A. Bels, Robert B. J. Brunn, Charles E. Dean, Orville M. Dunning, John D. Grayson, W. H. Grimditch, Daniel E. Harnett, Charles J. Hirsch, Gilbert C. Larson, Arthur V. Loughren, Knox McIlwain, Fielding Robinson, Bertram H. Rogers, James Stirling, Banjamin F. Tyson, Claude Vermilye, Harold A. Wheeler and James Willenbecher.

The Maxson Corporation has recently acquired all of the common stock of a newly organized Langevin Manufacturing Corp., of which Carl C. Langevin is president. The new company has taken over all of the property and business of The Langevin Company, Inc., with the exception of the latter's West Coast offices which will act as distributors in a sales and engineering service for Langevin products.

All departments of the tv transmitting equipment division of Allen B. Du Mont Labs., Inc., will be consolidated in new quarters located at 42 Harding Avenue, Clifton, N. J.

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PERSONALS

Joseph P. Maxfield, who recently retired from the Bell Telephone Laboratories, has become associated with Altec Lansing Corporation, as a consulting engineer.

(*Continued on page 28*)

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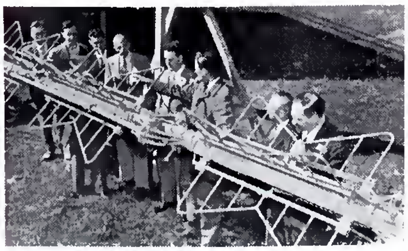
TV SUPERTURNSTILE INSPECTION



Broadcast engineers inspecting a 6-bay superturnstile tv antenna at the RCA Camden, N. J. plant (left to right); R. Craig, WCAU; G. Rix, WWJ; S. E. Leonard, WTAM; F. J. Kelley, RCA, Dallas; E. W. Lewis, WTVJ; J. Kyle, WBMG; C. W. Armstrong, RCA tv engineer W. F. Coleman, WTIC; I. B. Robinson, Yankee Network, Boston; and E. J. Meehan, RCA, Camden.

News

(*Continued from page 27*)

G. L. Hartman is now general sales manager of Belmont Radio Corp.

E. M. Braun has been appointed jobber sales manager for Maguire Industries, Chicago. Mr. Braun will be in charge of all jobber sales for Meissner, Radiart and Thordarson Divisions of Maguire.

G. R. Rivers has been named manager of the RCA tube sales group.

G. H. Myers has been named manager of the newly organized RCA customer service group.

Donald K. deNeuf, formerly operating vice-president of Press Wireless, Inc., has become chief engineer of Rural Radio Network, which recently received FCC permits to construct a six-station f-m broadcasting system to serve 40 rural New York counties.

Norman E. Wunderlich has resigned as executive sales director of the radio division of Federal Tel & Radio Corp., Clifton, N. J.

Mr. Wunderlich has established a consulting radio engineering company at 1337 Fargo Avenue to serve broadcast and radio communications fields.

Hal F. Bersche is now manager of the renewal sales force for the RCA tube department.

Karl E. Bretz has been appointed assistant sales manager of Electrical Reactance Corp.

John J. Moran has been appointed sales manager of the Philco accessory division.

L. K. Alexander has been named assistant manager of the G. E. receiver division.

Stanley C. Kolanowski has been named chief radio engineer of the radio division of Stewart-Warner Corp.

H. B. Macartney has resigned as vice president of The Hammarlund Manufacturing Company, Inc., 460 West 34th St., New York 1, N. Y. Macartney was with Hammarlund for twenty-two years.

H. H. Scott, has formed a new organization, Hermon Hosmer Scott, Inc., of which he will be president and director of engineering. **Henry Chrystie,** who was associated with Mr. Scott at the General Radio Company and later at Technology Instrument Corporation, will be vice president. **Ralph P. Glover,** Oak Park, Ill., consulting engineer, will act as midwestern engineering representative.

Space has been leased for main plant and laboratory at 385 Putnam Ave., Cambridge, Mass.

Raymond B. George has been promoted to the new post of sales promotion manager of Philco.

Sydney Eiges, formerly manager of the NBC press department, has been elected vice president in charge of press at NBC.

Robert F. Holtz, formerly with RCA in charge of broadcast antennas, is now with Paul F. Godley Co., Great Notch, N. J.

Dr. Leo L. Beranek, associate professor of communications engineering and technical director of the acoustics laboratory at MIT, has become a consultant on acoustics for General Radio Company.

* * *

LITERATURE

Insuline Corporation of America, Long Island City, N. Y., has prepared a 52-page catalog, N-48, covering a variety of parts.

The RCA Review department of RCA Laboratories Division, has published the first volume of a new engineering book series, by the director of the patent department, entitled "Patent Notes for Engineers."

Copies of the book may be obtained from RCA Review at a cost of $2.50 per copy.

DeMornay-Budd, Inc., 475 Grand Concourse, New York 51, N. Y., have released a catalog on microwave equipment.

Introductory section of catalog consists of nearly forty pages of technical information, covering "Introductory Concepts to Microwaves" and "Microwave Test Equipment Measurement and Calibration Procedures."

Eitel-McCullough, Inc., 183 San Mateo Avenue, San Bruno, Calif., have prepared a folder describing their a-m and f-m triodes and tetrodes.

Burgess Battery Company, Freeport, Illinois, have issued a four-page bulletin describing their high-current, long shelf-life batteries, type A.M. Offered are use data, battery construction details and a plot of outputs available.

Wheelco Instruments Company, Chicago, have prepared a 16-page technical data book on the electronic scriber.

Diagrams, schematic drawings, charts and listings explain the functions of the new strip chart recorder; deflection, potentiometer and resistance thermometer, recording, etc.

Book is entitled educational bulletin No. 7.

Westinghouse Electric Corporation has published an 8-page booklet describing two-frequency duplex, manual simplex, and automatic simplex transmitter-receiver assemblies.

Copies of this booklet (B-3882) are available from the Westinghouse P. O. Box 868, Pittsburgh 30, Pa.

Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, Calif., have issued a revised fourth edition of the *DP* bulletin, with 24 pages of application photographs, exploded views, dimensional sketches, tabular data, insert arrangements, junction shells, and mounting hole variations.

Electronics Research Publishing Company, 2 W. 46th Street, N. Y. 19, have published a 202-page "Electronic Engineering Master Index, 1946 Supplement." The period covered in this volume, edited by Frank A. Petraglia, is from July, 1945 to December, 1946. Some 7,000 bibliographical listings giving title, author, and periodical are included under more than 400 subject headings.

This edition includes two new sections; a review of trade literature with abstracts of the contents of catalogs available from several hundred manufacturers. The other section, a bibliography of engineering texts, presents a 12-page compilation of some 800 textbooks.

Edition is priced at $14.50.

John F. Rider, Publisher, Inc., 404 Fourth Avenue, New York 16, N. Y., have published a treatise on "High-Frequency Measuring Techniques Using Transmission Lines".

By three members of Collins Radio, E. N. Phillips, W. G. Sterns and N. J. Gamara, the treatise develops the thesis that a shielded transmission line with a continuous slot along its axial length is the most convenient tool for measurements above 100 mc.

Book is priced at $1.50.

Harvey-Wells Electronics, Inc., Southbridge, Mass., have released bulletins describing marine radiotelephone systems for 25 to 100-mile and 75 to 200-mile coverage.

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MAUTNER'S MATH BOOK

Leonard Mautner, research engineer, Allen B. DuMont Labs, presenting one of the first copies of his new book "Mathematics For Radio Engineers" to ye editor.

The book is a practical text on applied mathematics and provides analysis of typical problems encountered in f-m, television, servicing instruments, etc. Chapters are accompanied by graded problems with complete answers.

The Industry Offers

TRIPLETT VOLT-OHM-MILLIAMMETER

A pocket-size meter, model 666-HH, measuring d-c and a-c voltage, direct current and resistance has been developed by Triplett.

The a-c/d-c voltage ranges are 0 to 5000, at 1000 ohms/volt; current ranges are 500 d-c ma, via a 250 mv instrument.

Black molded case, 3 1/16" x 5 7/8" x 2 9/16". Self-contained, plug-in type 1.5 v battery.

* * *

RCA PLUG-IN CARTRIDGE WIRE RECORDER

A lightweight wire recorder, with plug-in cartridge, has been developed by the RCA Victor Division of RCA.

Cartridge contains two lengths of wire, wound on four spools, providing an immediate playback feature.

Recorder, has a timing device calibrated in minutes and fractions of minutes to spot the exact locations of recordings on the wire. Recorder automatically erases previous sounds as a new recording is being made.

* * *

SHALLCROSS MINIATURE PRECISION RESISTORS

Four small-size **akra-ohm** precision resistors have been announced by the Shallcross Manufacturing Company, Collingdale, Pa. Type 136 has a maximum wattage rating of 0.25 and is 1 5/32" long x 3/8" in diameter; maximum resistance is 150,000 ohms.

Types 137, 133, and 134 are 2-, 3-, and 4-section units with 2, 3 and 4 leads respectively and with 0.25 watt maximum load per section. Maximum resistance of 550,000 ohms is available in type 133.

Resistors have 2" tinned copper wire leads.

* * *

UTAH RADIO AUTO-REPLACEMENT SPEAKERS

Three auto-radio e-m replacement speakers, models SE5S6, SE6S6 and SE7Y6, in five, six and seven inch sizes, have been announced by Utah Radio Products, division of International Detrola Corporation, Huntington, Indiana. Each model incorporates a 3-ohm voice coil and 4-ohm field coil. Mountings are square type.

* * *

B&W AUDIO OSCILLATOR

An audio oscillator, model 200, has been announced by Barker & Williamson, Ind., 237 Fairfield Avenue, Upper Darby, Pa. Consists of a modified Wien bridge RC oscillator and a 2-stage inverse feedback output amplifier with self-contained power supply. Designed for distortion or frequency measurements.

Frequency range, 30 to 30,000 cycles in 3 steps. Voltage output, 12.5 v open circuit; 11 v output on 500 ohm load.

Size, 13¾" x 7¼" x 9½".

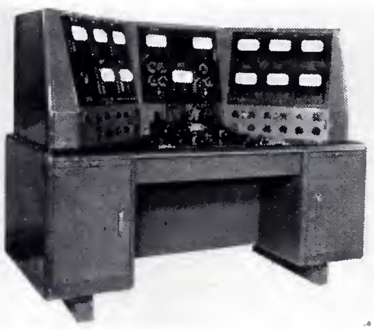
* * *

SYLVANIA CAPACITANCE BRIDGE

A capacitance bridge, type 125, for measurement of capacitance in multi-electrode systems, has been announced by the Electronics Division, Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y. Instrument provides a range of 0 to 100 mmfd through the use of five multipliers and measurement at 465 kc.

Tube complement includes 5Y3G, 7A6 7B4, OC3 and two 7A7. Rated capacitance ranges are: 0-0.01; 0-0.1; 0-10; and 0-100.

The bridge consists of three separate sections including r-f signal generator and power supply; r-f amplifier, detector and vacuum-tube voltmeter; and associated switches, controls and 500-microampere meter indicating bridge balance. Ground to lead or jig capacitance may be turned out when combined values do not exceed 25 mmfd.



KAY ELECTRIC MEGA-MARKER

A Mega-Marker covering the 19 to 29 mc range for the television i-f band has been announced by Kay Electric Co., 34 Marshall St., Newark, N. J. For the f-m i-f band (10.7 mc) a crystal oscillator is incorporated.

The more than 12" of calibrated scale length on the dial is said to provide accuracies of .02 mc.

* * *

MILLEN CRYSTAL HOLDER

A midget steatite crystal holder socket, No. 33302, for use with the midget hermetically-sealed CR7 crystal, has been announced by James Millen Manufacturing Company, Inc., 150 Exchange St., Malden 48, Mass.

Contacts are silver-plated phosphor bronze. Pin spacing, center to center, is .500"; pin diameter, .050".

* * *

G. E. DEVELOPMENTS

A forced-air-cooled triode of lighthouse design, GL-5648, for u-h-f oscillator service and grounded-grid power amplifier applications, has been developed by the tube division of G.E. Cathode voltage, 6.3. Interelectrode capacitances: grid-cathode, 7.25 mmfd; grid-plate, 1.95 mmfd; cathode-plate, 0.035 (max) mmfd.

Maximum ratings under class C telegraphy conditions include a d-c plate voltage of 1,000 volts and plate input of 100 watts.

When used as a grid-separation oscillator at 500 mc power output is 25 watts.

A 3-lens fifty-six pound television camera has also been announced by the transmitter division of G.E.

Camera is 10" wide, 10" high and 20" long. It is mounted on a mobile dolly. Two handle grips on the unit control all its operations.

Camera will produce acceptable pictures at 50-foot-candles and f3.5. Smaller stop openings may be used for greater depth of focus if 100-200 foot-candles are supplied. The unit employs an optical view-finder.

Has nine tubes including the image orthicon; four 6AK5 video amplifiers; one 6J6 video output, one 6AK5 blanking tube, one 6J6 horizontal integrator; one 6BG6G horizontal sweep tube; one 6AS7GT damping tube.

* * *

BROWNING FREQUENCY METER

A frequency meter, model S-5, for checking of transmitters operating between 30 and 500 mc, has been announced by Browning Laboratories, Inc., Winchester, Mass.

A crystal standard in a temperature controlled oven is employed, with a long time accuracy of .001%. Electron-coupled interpolation oscillator is assembled on a 3/16" aluminum plate for mechanical stability and is temperature compensated for minimum frequency drift.

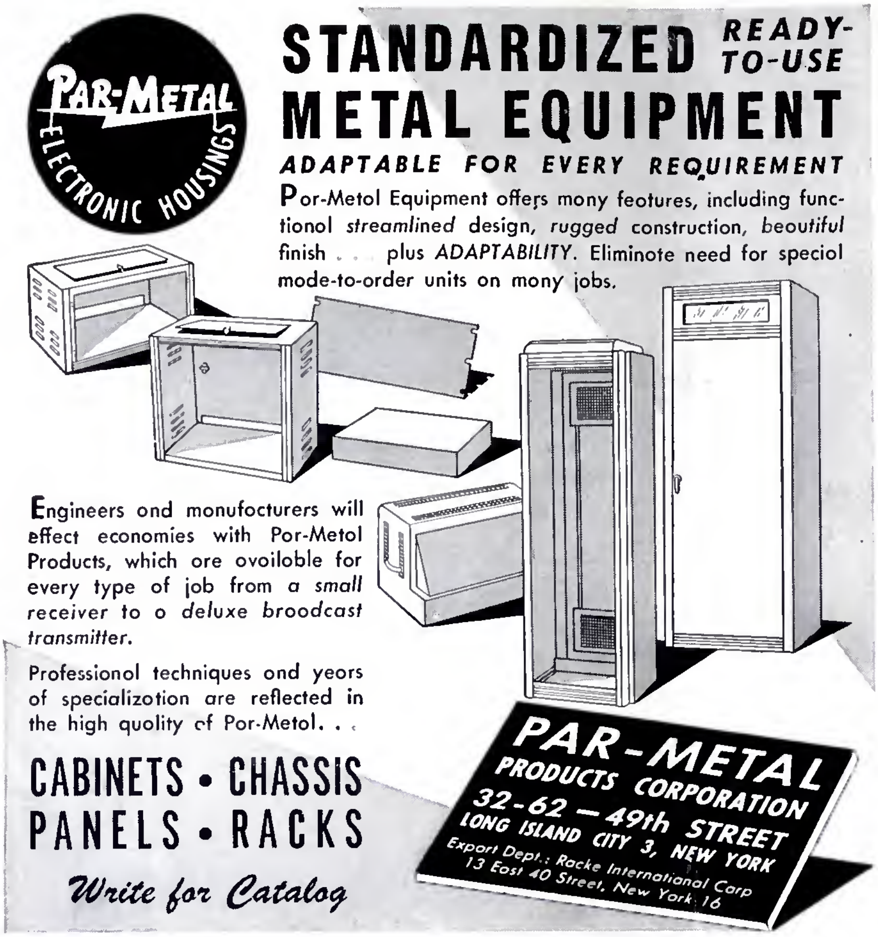
A panel mounted telescoping antenna is employed as a pickup means.

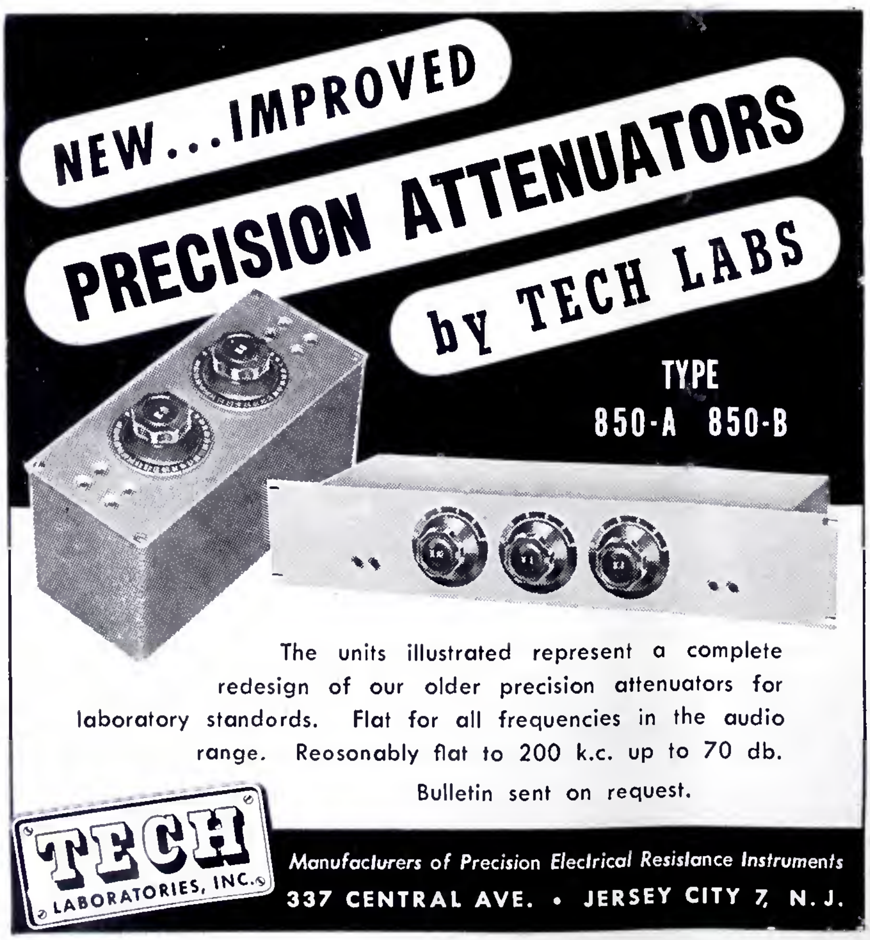
* * *

AEROVOX HIGH-VOLTAGE PAPER TUBULARS

Oil-impregnated wax-filled paper tubular capacitors in 2500, 3500, 5000, 7500 and 10,000 d-c v ranges and in capacitances from .001 to .05 mfd have been announced by the Aerovox Corp., New Bedford, Mass. The smallest unit is a .001-mfd 2500-v, measuring 3/8" dia. x 1½"

(Continued on page 32)





The Industry Offers

(*Continued from page 31*)

long, while the largest is a .003-mfd, 10,000-v, measuring 1⅜" dia. x 3" long. The units have bare tinned copper pigtail leads.

* * *

DUMONT OSCILLOGRAPH CAMERA

A continuous-recording camera, to simplify the photography of cathode-ray oscillograph images, has been announced by the Allen B. Du Mont Labs, Inc., Instrument Division, Clifton, N. J.

Known as the type 314, this instrument built by the Fairchild Camera and Instrument Corp. according to specifications established jointly by Du Mont and Fairchild, is applicable to all standard 5" cathode-ray units.

Camera serves for single-frame exposures of stationary patterns as well as for continuous recording. Its shutter remains open for continuous-record operation, or can be opened momentarily for the brief exposure of stationary or recurrent images. A positive interlock prevents running the film with the shutter closed.

For continuous recording, the film speed is continuously variable from 1" per minute to 5' per second, a range of 3600 to 1.

Camera uses 35-mm film or perforated sensitized paper. The magazine holds 100' of film, but magazines holding up to 1000 feet will be available soon. A fixed-focus lens is used. The camera is offered with a choice of lenses for either high-frequency or average work.

* * *

ELECTRO-VOICE STRING INSTRUMENT CONTACT MICROPHONE

A contact pickup microphone, model 805, that can be used on all vibrating musical instruments, has been announced by Electro-Voice, Inc., Buchanan, Michigan.

Frequency response 40 to 8000 cps. Can be used with any amplifier having a high impedance input. Output level: .1 to 1 volt, depending on type of instrument. The generating element is an inertia-type crystal.

Has snap-on clip. Weighs 2 ounces and measures 2¼" x 1" x 7/16".

* * *

SPRAGUE PHENOLIC MOLDED TUBULARS

A line of phenolic-molded paper tubular capacitors which are said to be highly heat- and moisture-resistant; non-inflammable; and conservatively rated for operation from —40° C to

+85° C have been developed by Sprague Electric Company, North Adams, Mass.

Available types include all popular capacities in 200, 400, 600, 1000 and 1600-volt types.

Sprague engineering bulletin 210 contains complete details.

* * *

DE MORNAY-BUDD STANDING-WAVE DETECTOR

A standing-wave detector (½ x ¼") operating between 23,000 to 27,000 mc, has been introduced by DeMornay-Budd, Inc., 475 Grand Concourse, New York 51, N. Y.

The main block and waveguide extremities are machined from a solid steel block. Square type choke and cover flanges are used for the two waveguide couplings.

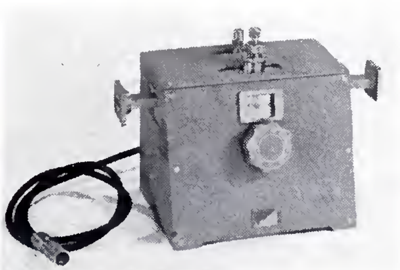
Control knob is fixed in position and, when rotated, a friction drive operates to control the movement of the traveling carriage, which rides on ball-bearings.

Probe section is controlled by two adjustable screws and secured by a locknut and set-screw. A top screw controls the depth of the probe penetration in the waveguide. Center screw controls the tuning of the coaxial section. Bottom locknut locks the coaxial section and center screw. Top (probe) screw is locked by a lock-nut on the side of the center screw.

A 1N26 crystal detector connects through the waveguide auxiliary chamber to a baby N connector.

Scale calibration is in millimeters. A vernier scale, engraved on the back of a curved plastic lens, permits readings down to a tenth of a millimeter per division.

Entire unit is gold-plated.



* * *

ASTATIC CRYSTAL CARTRIDGE

A low-needle talk crystal phono cartridge, type LT, has been announced by the Astatic Corporation, Conneaut, Ohio. Output voltage, 1 volt, avg. at 1 000 cps; minimum needle pressure, ¾ ounce, cutoff frequency, 4,000 cps. Replaceable type T needle with Electro formed precious metal playing tip.

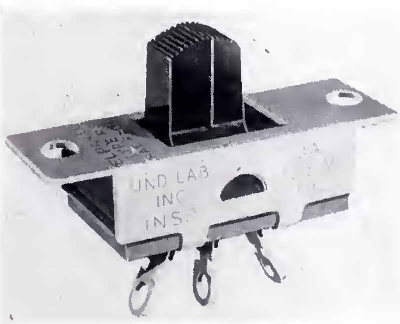
* * *

ELPAR SNAP ACTION SLIDE SWITCH

A 3-amp. 125-v a-c slide switch, type RS, in spdt and spst style has been developed by Elpar Company, Bank & Marlton Ave., Camden, N. J.

Said to have low contact resistance over long life; self-actuating beyond center of throw. Effective throw .140", maximum travel .160".

Length 1.375", width .556", depth .700" excluding knob. Two mounting holes, .136" diameter; mounting centers 1.125".



R-F Amplifiers

(*Continued from page* 25)

gram input to the first audio stage. This stabilized feedback is automatic in operation and independent of transmitter operating adjustment.

Performance Measurement Considerations

To properly evaluate the performance of any amplifier, it is, of course, necessary to properly interpret measurements. In order for these measurements to be authentic, certain precautions must be observed, a few of which are noted herein.

An interesting situation exists when transmitters are operated into a load which varies with frequency; that is, when the load impedance is different at the side-band frequencies (Figure 1*B*) from its value at the carrier frequency. This condition is frequently

---

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933, OF COMMUNICATIONS

Published monthly at New York, N. Y., for October 1, 1947.

State of New York }
County of New York } ss.:

Before me, a notary, in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of COMMUNICATIONS, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York 17, N. Y.; Editor, Lewis Winner, New York, N. Y.; Managing Editor, None; Business Manager, B. S. Davis, Ghent, N. Y.; 2. That the owners are: Bryan Davis Publishing Co., Inc., 52 Vanderbilt Avenue, New York 17, N. Y.; B. S. Davis, Ghent, N. Y.; J. C. Munn, Union City, Pa.; A. B. Goodenough, Port Chester, N. Y.; P. S. Weil, Great Neck, N. Y.; F. Walen, Union City, N. J.; G. Weil, Great Neck, N Y.; L. Winner, New York, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities, are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock, and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

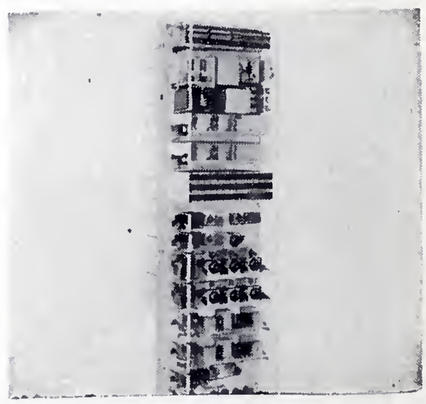
(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me, this 23d day of September, 1947.

(Seal) FRANKLIN B. GOOLD,
Notary Public.

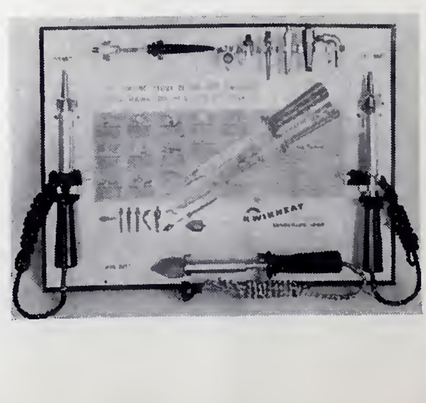
Commission expires March, 1948.

PACIFIC COAST DEVELOPMENTS



Above: A 42-carrier terminal unit designed for two to thirty-five telephone channels on a four-wire frequency-division multiplexing basis over radio link circuits, announced by the Lenkurt Electric Co., San Carlos, Calif.

Below: Kwikheat soldering iron with built-in thermostat, manufactured by the Sound Equipment Corp. of California, Glendale 4.



encountered in the operation of directional arrays.

There are several ways in which the load impedance may vary. The antenna system is usually adjusted so that, at the carrier frequency, this impedance becomes a pure resistance of suitable value. When this has been done, the ideal condition would be to have this impedance stay unchanged at all frequencies for at least 7.5 kc above and below the carrier frequency (the position of the side bands with respect to the carrier at 7500-cps modulation). Under this condition, the voltage and current amplitudes of the side bands (and consequently the side-band power) vary uniformly in accordance with the a-f modulating voltage. A single vertical radiator usually approximates this condition closely enough for satisfactory performance. More complicated radiating systems, however, frequently have impedance characteristics which vary rapidly on each side of the carrier frequency. The impedance may (*a*) rise on both sides of the carrier; (*b*) drop off; or (*c*) rise on one side and fall on the other.

Condition (*a*) will bring about a situation such that when the amplitude of the side-band *voltage* reaches its proper value for the particular level of modulation employed (as measured by a scope, for instance) the amplitude of the side-band *current* will be less than normal, because of the higher resistance. Condition (*b*) leads to the reverse situation; the current reaches its required value before the voltage rises to the proper amount. Both these conditions are likely to be accompanied by loss of side-band power and consequent attenuating of the side-band frequencies in proportion to the variation in load. This effect is greatest at the higher audio frequencies where the side bands are farthest displaced from the carrier and the change in load impedance is most pronounced. Overall loop feedback converts to a large degree this tendency of clipping of high frequencies. Condition (*c*) is a complicated combination of the effects noted above, including the possibility of undesired phase modulation.

Under normal operating conditions where the modulation consists of music, speech, etc., the attenuation of the higher frequencies is the only noticeable effect, because the percentage of modulation at high frequencies is small; but when a transmitter is heavily modulated by tone at high audio frequencies (as is frequently done during tests) non-linear distor-

(*Continued on page 36*)

STEPHENS WCEMA SPEAKER DISPLAY

Assortment of Stephens Mfg. Co. speakers on display at the recent WCEMA Show in San Francisco.

R-F Amplifiers

(*Continued from page* 35)

tion may also take place as a result of the changing load impedance reflected into the transmitter.

Another result of this condition is encountered when attempting to measure modulation percentage and distortion at the higher modulating frequencies. For example, if a scope is connected across a transmission line at a point exhibiting the characteristics noted as condition (*b*), the current wave will become 100% modulated (vary from twice its carrier value to zero) when the voltage wave, as observed on the scope, is modulated possibly only 70%. If the audio input to the transmitter is increased in an attempt to raise this *apparent* low modulation percentage, the actual result will be overmodulation of the transmitter, with its consequent distortion. It may not be possible to completely modulate the voltage wave (as measured at this point) no matter how much the audio input is increased.

The choice of a proper measuring point is most important when making these measurements, since when the impedance coupled to a transmission line varies with frequency from its characteristic impedance, the impedance at the opposite end of the line will vary with the line length, leading to one of the conditions we have mentioned. A more complete discussion of these topics may be found in reference *10*.

These considerations apply to the operation of all transmitters, and are noted here to call attention to some of the matters requiring consideration when measuring the performance of a-m equipment.

References

[1] *A New Power Amplifier of High Efficiency*, Bell Laboratories Record; June, 1936.

[2] *Doherty Circuit—High Efficiency for the Broadcast Transmitter*, Pick-ups; July, 1936.

[3] *A New High Efficiency Power Amplifier for Modulated Waves, Proceedings IRE;* September, 1936.

[4] F. E. Terman, *Radio Engineering*, pp. 539-544; 1937.

[5] C. E. Strong and G. G. Samson (British), *An Experimental 5-kw. Doherty Amplifier*. Electric Communication; January, 1938.

[6] W. H. Doherty and O. W. Towner, *A 50-Kilowatt Broadcast Station Utilizing the Doherty Amplifier and Designed for Expansion to 500 Kilowatts;* Proceedings IRE; September, 1939.

[7] W. H. Doherty. U. S. Patent 2,210,028; August 6, 1940.

[8] F. E. Terman, *Radio Engineers' Handbook*, pp. 455-458 and 538-540; 1943.

[9] *The Doherty High Efficiency Amplifier*, FTR Handbook of Tube Operation, Federal Telephone & Radio Corp.; 1944.

[10] *Notes on Modulation of A-M Transmitters*, Western Electric *Oscillator*; October, 1946.

RCA MIKE EXHIBIT

Pressure, polydirectinnal and velocity type microphones exhibited by RCA at the recent NAB Convention in Atlantic City.

Voltage Regulation

(*Continued from page* 13)

and wave-form responsive circuits. The regulators should have rapid response time as some types of electrical circuits are more responsive to surges than to actual line-voltage fluctuation.

Voltage Regulation in Mobile Equipment

When spot broadcasts are to be made it is difficult to predict the line power conditions which are going to be encountered on location.

A line-voltage regulator of the 2 kva type (Figure 3) can be used for mobile-power control.

D-C Sources

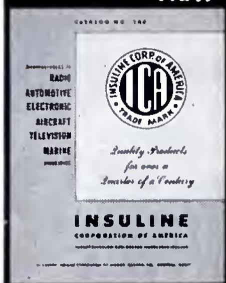
Where transmitters are operated off an independent battery powered source, a voltage regulator which is independent of frequency, is of utmost importance.

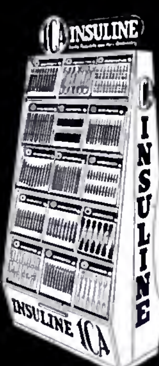
The type shown in Figure 4 can be used for this purpose. This unit is powered from the input line and is independent of line and load. The d-c regulator can also be used for charging purposes. Voltage regulation can also be applied at the input of the turntable power. Such control can minimize the *wows* and *hums*.

Relay Applications

Another application of the d-c low-voltage regulator[1] is as a source for relay actuation. This unit, available in low-voltage models, 6, 12 and 28 volts, permits the use of the lowest feasible voltage so that the *clicks* may be kept to a minimum on *on and off* switching. For dual studio operation, as well as expanding facilities, this low-voltage unit has many possibilities. The regulator will control the extreme range of loads thrown on as various types of program arrangements are employed. As the studio becomes larger and larger, and additional inter-studio, remote, monitor, and console equipment is added, the d-c relay requirement power goes up. A rather high degree of regulation against load is required at the source, since even with excellent regulation at this point, there will be a considerable line-distribution voltage drop due to the low-voltage high-current type of network. The low-ripple-voltage feature of the regulator, namely 1%, reduces electromagnetic coupling and voids trouble at this source.

[1]Nobatron.





Reference Antennas

(*Continued from page 20*)

space, hence the power gain is said to be *2*.

This antenna can be considered as a standard for determining the directivity of antennas located on the surface of the earth, such as broadcasting antennas. It is particularly useful in the computation of the gain and efficiency of directional antenna systems.

Directivity Definitions

On the basis of equal powers, the *directivity* or *directive gain* of a given antenna can be defined as the ratio of the maximum power flow intensity to the power flow intensity of a uniform radiator, when the total power output of both sources are equal:

$$g = \frac{P_m}{P_s} \text{ (equal powers)} \qquad (1)$$

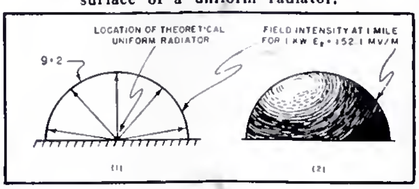
Where: g = directivity or power gain,

P_m = maximum power flow intensity from the directional antenna radiating 1 kw of power,

P_s = uniform power flow intensity from the standard reference antenna radiating 1 kw of power.

Figure 2

Pattern of a uniform radiator at the surface of a perfect reflecting earth. At left is a cross-sectional view of a hemispherical pattern, which has a field intensity gain of *1.4*, a power gain of $g=2$, and a decibel gain of $G=3.01$. At right is the hemispherical radiation pattern surface of a uniform radiator.



Or, in terms of field intensities the power gain can be determined by:

$$g = \left[\frac{E_m}{E_s}\right]^2 \text{ (equal powers)} \qquad (2)$$

Where: g = directivity or power gain,

E_m = maximum field intensity in mv/m from the directional antenna at 1 mile, for 1 kw of radiated power,

E_s = field intensity (107.6 mv/m) from a uniform spherical radiator at 1 mile, for 1 kw of radiated power.

On the basis of equal field intensities the directivity can be determined by taking the ratio of the power radiated, when the maximum field intensity of the directional antenna is made equal to the field intensity of a uniform spherical radiator:

$$g = \frac{P_s}{P_r} \text{ (equal field intensities)} \qquad (3)$$

Where: g = directivity or power gain,

P_s = power radiated (1 kw) from a uniform spherical radiator to produce a given field intensity of E_s (107.6 mv/m) at 1 mile,

P_r = power radiated from the directional antenna to produce the same given maximum field intensity E_m (107.6 mv/m) at 1 mile.

On the basis of decibels, the gain can be computed from:

$$G = 10 \log g \qquad (4)$$

Where: G = decibels directive gain,
g = directivity or power gain.

F-M/TV Lines

(*Continued from page* 11)

when the following approximate weights for 200′ of line are considered:

⅞″ line	14 pounds
1⅝″ line	26 pounds
3⅛″ line	55 pounds
6⅛″ line	140 pounds

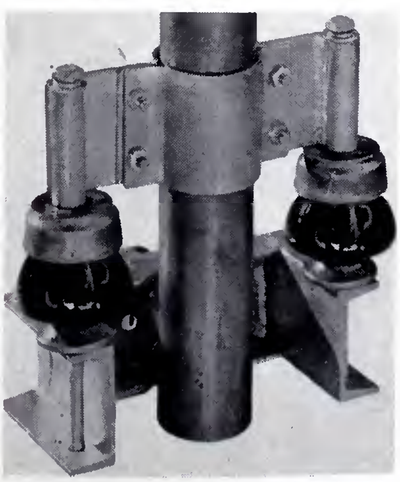
While the support bracket does not support any appreciable weight in normal operation, the possibility of icing over in the winter, as well as the probable accumulation of dirt and foreign matter in the sliding portion of the clamp indicates the desirability of a conservative mechanical design. Accordingly, both the rigid clamp and sliding bracket utilize the same two-insulator type of construction.

A very important safety consideration must be borne in mind in the case of an insulated line on a tower. It should be located with respect to the climbing ladder so that a man climbing the tower cannot come in contact with the line, as a very serious r-f burn could result.

When the insulated section of line is installed on the ground, it may be done in several ways. The simplest is merely to mount the f-m line on standoff insulators for the proper distance away from the tower base. This method has the disadvantage that the line, forming one conductor of an unshielded, unbalanced transmission line section, will radiate at the a-m frequency, which will distort the a-m radiation pattern. Furthermore, this radiation is very difficult to control, making adjustment of directional arrays very difficult. Usual practice is to simulate a coaxial line section, in which the f-m line forms the inner conductor. The outer conductor may be either a wire cage or a metallic hood enclosing the f-m line.

[**To Be Concluded in January.**]

Figure 14
A 1⅝″ insulated support bracket.



ADVERTISERS IN THIS ISSUE

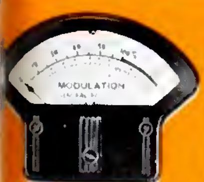
COMMUNICATIONS INDEX

NOVEMBER, 1947

HERE'S THE MONITOR YOU'VE BEEN WANTING

for FM and TELEVISION

In announcing the new Type 1170-A FM Monitor, General Radio brings to a conclusion a development project to make available to FM and Television stations a monitor with the same simplicity of operation, high stability and accuracy, and many-year reliability found in standard AM monitoring equipment in use in hundreds of G-R equipped stations. The G-R FM Monitor is here. It has been designed with the same engineering care . . . manufactured under the same rigid standards . . . and tested with the same thoroughness as all other G-R broadcast equipment. FM and Television stations can use it with the same confidence that AM engineers have shown in G-R equipment ever since monitors became a necessary adjunct to broadcasting.



Percentage Modulation meter, calibrated from 0 to 133 per cent. Additional db scale. Switch selects positive or negative peaks or full-wave indication. For FM, 100% modulation corresponds to 75 kc deviation; for television, internal adjustment changes calibration to 100% at 25 kc deviation.

Frequency Deviation meter calibrated in 100-cycle divisions from −3000 to +3000 cycles. To compensate for long-time drifts and to bring monitor into check with frequency measuring services, zero reading is adjustable over ±3000 cycle range.

Modulation Indicator Level is set by this dial; lamp flashes when modulation level exceeds that to which dial has been set. Dial range 0 to 120% modulation.

R-F Input Level is indicated on this behind-panel meter. Signal and center-frequency meter pilot lamps illuminated when input level is sufficient, and extinguished when level drops too low.

FEATURES

- **TRANSMITTER RANGES** — For both FM and Television Stations — 30 to 162 Mc; or 160 to 220 Mc.
- **CONTINUOUS MONITORING** — Continuous indication of center frequency — requires restandardization only once a day, *not before each measurement*.
- **REMOTE MONITORING** — Equipped for several remote monitoring circuits and for use with a recorder.
- **HIGH STABILITY** — 200 cycles (2 parts per million), or better, with a daily check of electrical zero of meter.
- **LOW INPUT POWER** — 1-volt input at high impedance — amplified to several hundred volts for high level operation to avoid harmful effects of excessive coupling to transmitter.
- **LOW RESIDUAL DISTORTION** — Less than 0.2% at 100 k.c. swing — accurate for measurements to as low as ½ per cent.
- **75-25 KC DEVIATION** — Provided with a single internal adjustment for either 75 kc deviation for FM monitoring, or for 25 kc deviation for television audio monitoring.
- **REMOTE INDICATORS** — Circuits and terminals provided for remote indicators for
  - Center-frequency Indication
  - Percentage-modulation Meters
  - Over-modulation Lamp
  - 600 ohm Unbalanced Aural Monitor
- **F.C.C. SPECIFICATIONS** — Designed and manufactured to meet all F.C.C. monitoring requirements.

TYPE 1170-A FM MONITOR (either frequency range) $1625

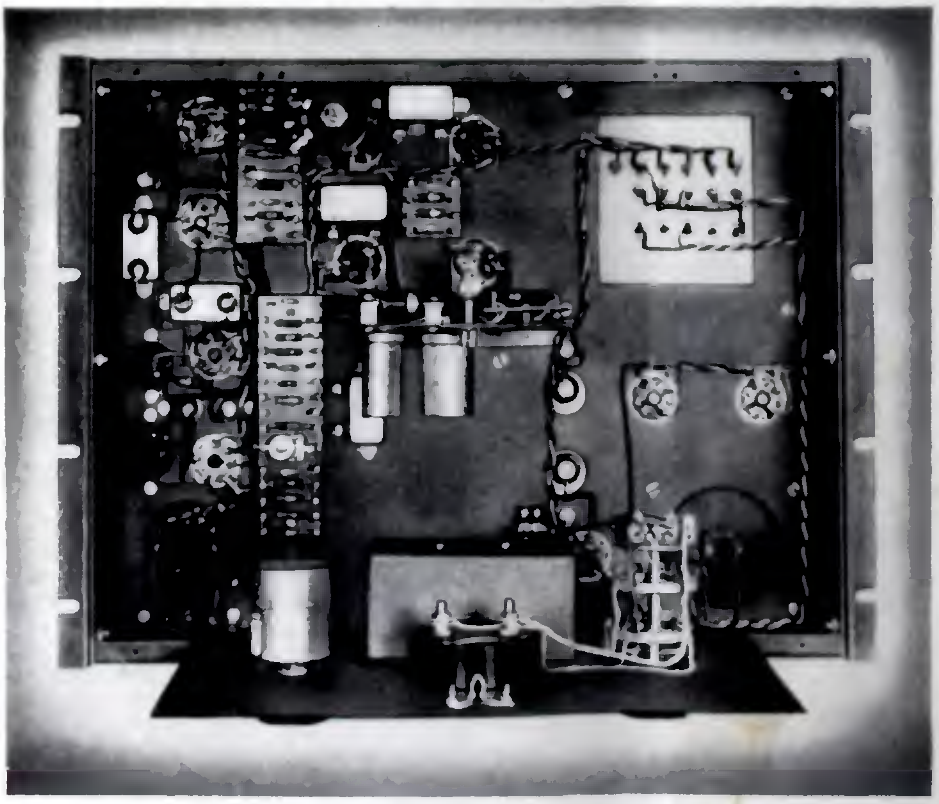
GENERAL RADIO COMPANY

Cambridge 39, Massachusetts

90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38

Presto Presents Something New in Recording Amplifiers...

The new Presto 92-A is a 50-watt amplifier designed specifically for recording work. It answers the need for an amplifier of exceptional quality and performance, and includes a number of outstanding features thoroughly proved in operation:



1 Selector switch and meter provide both output level indicator (not for "riding gain") and plate current readings for all tubes.

2 Chassis is vertically mounted. Removal of the front panel gives access to all circuits without removing amplifier from rack.

3 The output stage has four 807's in push-pull parallel with an unusual amount of feedback. This produces ample peak power with low distortion and an extremely low internal output impedance for best performance from magnetic cutting heads.

Push buttons select any of these recording characteristics: flat, 20-17,000 cps, 78 rpm, standard NAB lateral, NAB vertical — all within an accuracy of ± 1 db. Distortion is only 1½% at full output.

PRESTO

RECORDING CORPORATION

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FREE! Presto will send you free of charge a complete bibliography and digest of all technical and engineering articles on disc recording published since 1921. Send us a post card today.

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS