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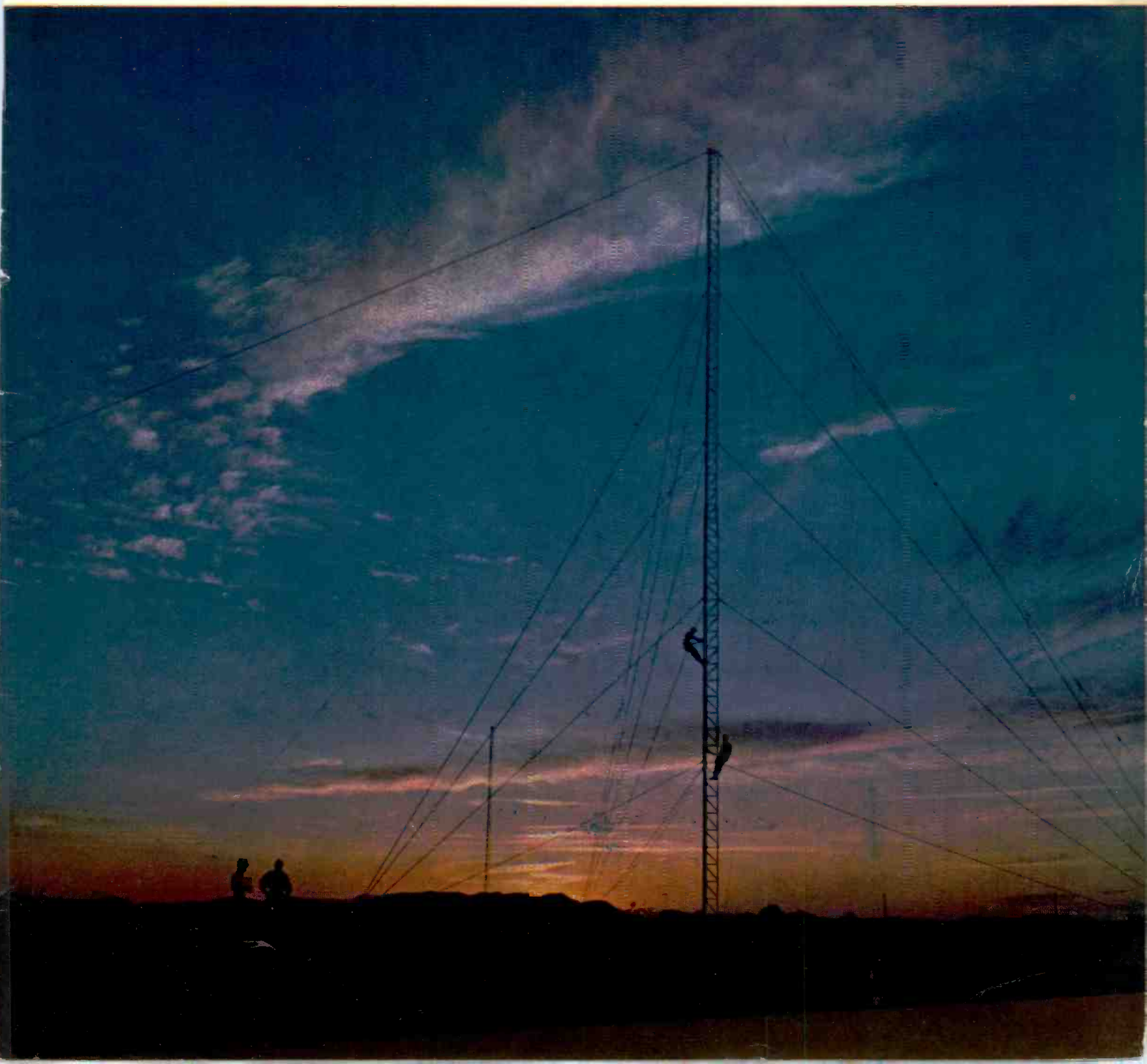
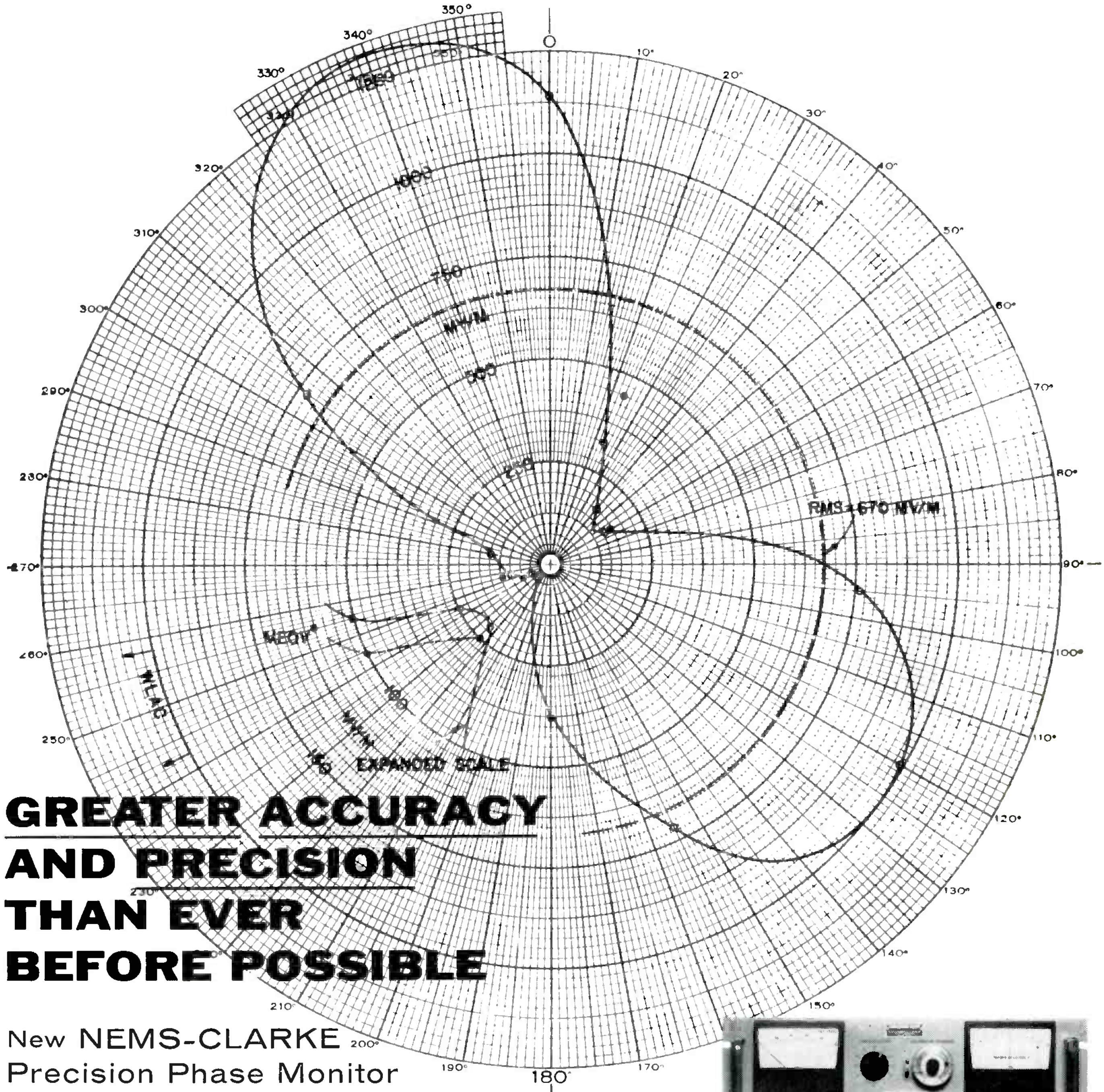
ANNUAL ANTENNA ISSUE

Contents devoted to antennas, transmission, and associated subjects including — equipment, operation, and design.

Broadcast Engineering

the technical journal of the broadcast-communications industry





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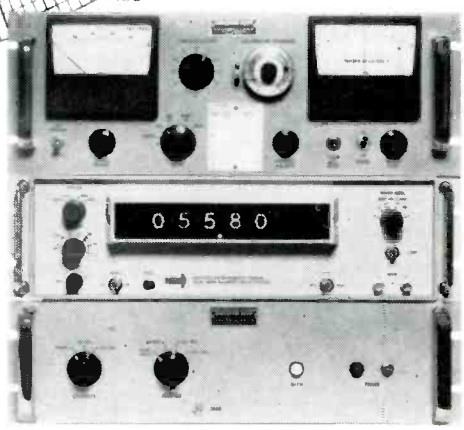

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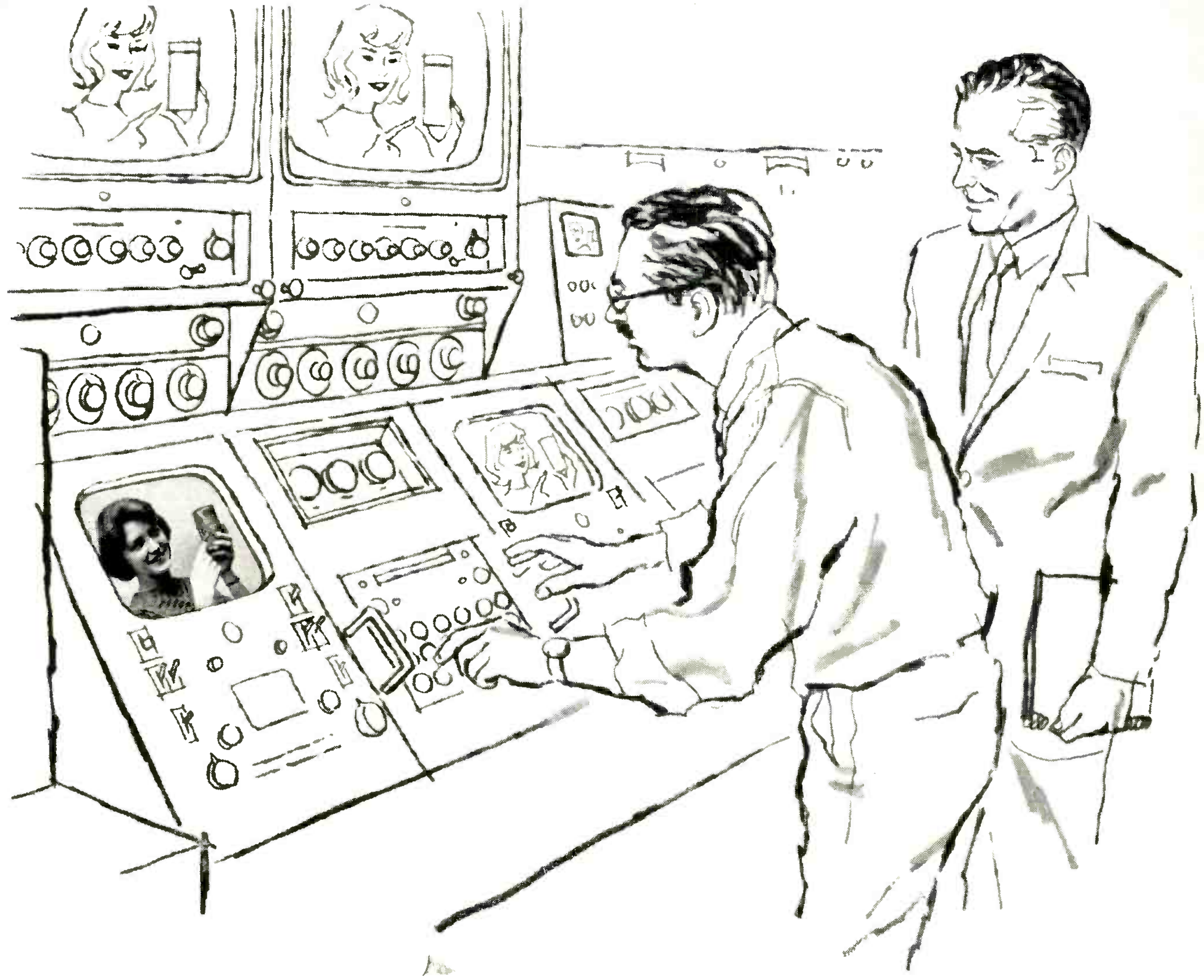

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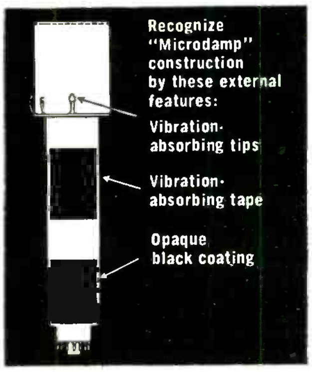

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LETTERS to the editor

DEAR EDITOR:

With the advent of the new FCC Rule concerning maintenance logs, it has become necessary to make up a new form. I'm sure there are as many formats as there are stations, but perhaps an exchange of ideas regarding items to be included in the printed portion of the log would be helpful.

I have enclosed a copy of our log. If other engineers send theirs in to you, might we have a page of those that seem to have the most merit?

Doug Hutton
Chief Engineer, KBFM, Lubbock, Texas

Yours is the second maintenance log we have received, Doug; the first appeared in the Engineers' Exchange department of the August issue. We will continue to carry such items from time to time, unless the samples begin arriving in wholesale quantities. In that event, we'll compile them into a feature on maintenance logs. How about it readers? It's up to you. —Ed.

K B F M Maintenance Log

Background Music, Inc.
503 Great Plains Bldg.
Lubbock, Texas 79401

98.3 mc
3600 watts ERP

Week beginning Sunday, ________

Daily tower light inspection required by Para. 17.38(b) FCC R&R

Date ____ Signed ____ Time ____ Cond. ____

FAA notification ____

3 month tower inspection required by Para. 17.38(d) FCC R&R

Date ____ Signed ____ Cond. ____

Notes: ____

I hereby certify that I have made the inspections of all transmitting equipment in use required by Para. 3.284(g) of the FCC Rules and Regulations, and noted below all repairs needed and/or made.

Date ____ Signed ____ Date ____ Signed ____

Notes: ____

Freq. Measurement: Xtal 1 was ____ Mon. read ____
Xtal 2 was ____

Conelrad test alert received from ____ at ____ on ____ by ____

DEAR EDITOR:

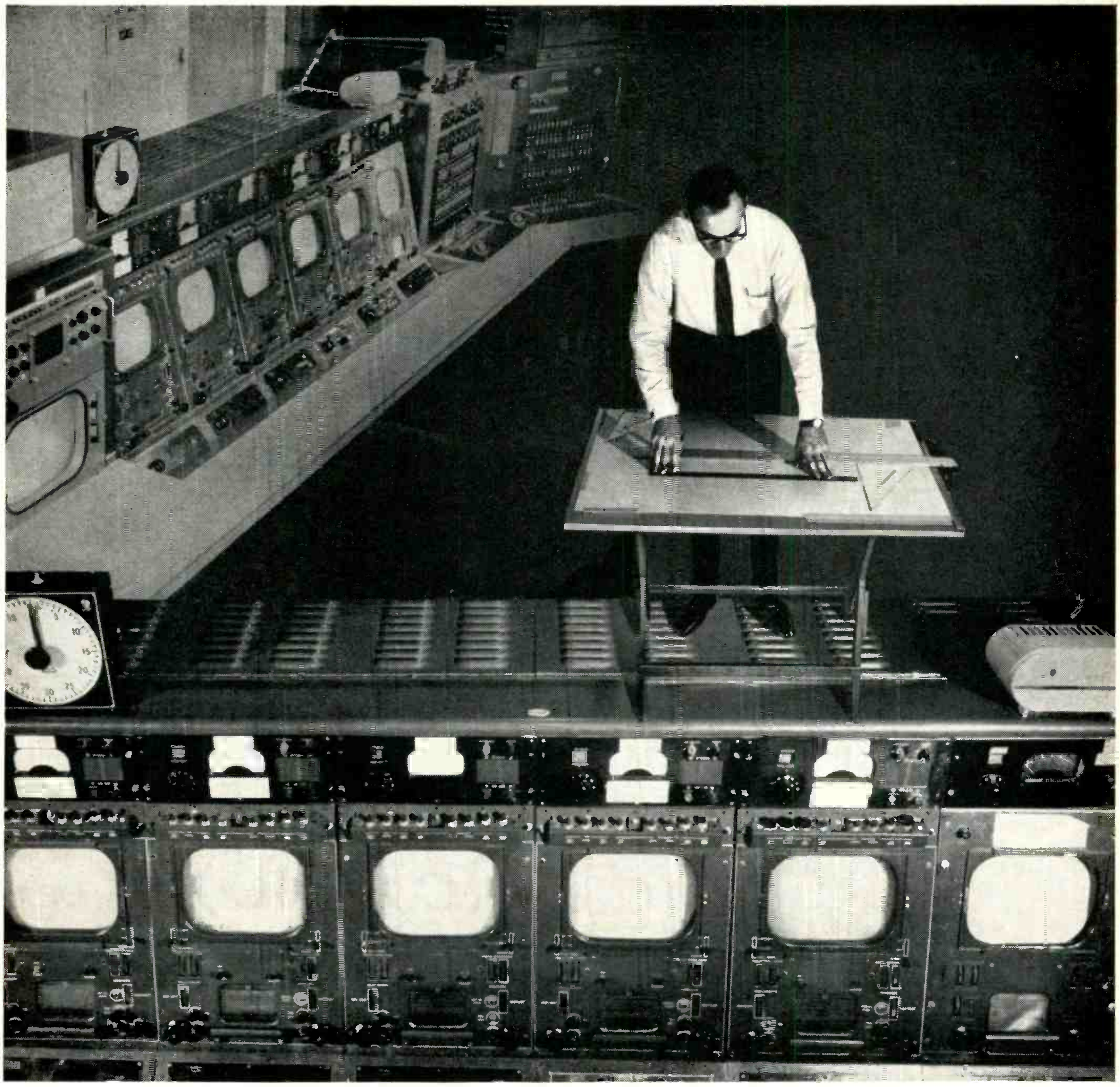
I read with interest Mr. King's article, "A Rotating Cartridge Rack." A question has been raised at this station as to whether the console pictured in the lower left corner of page 20 is a Gates "Dualux," and if so what modifications have been performed on it.

When I switch both amplifier channels of our "Dualux" into one output line, as seems to be shown in the picture, a serious mismatch occurs.

Could you please satisfy our curiosity on this matter?

PERRY E. AHAFFAH
Chief Engineer, WAJP, Joliet, Ill.

The console pictured is a "Gatesway," not a "Dualux," Perry. Please watch for a letter from Mr. King, with further information, in the February issue.—Ed.



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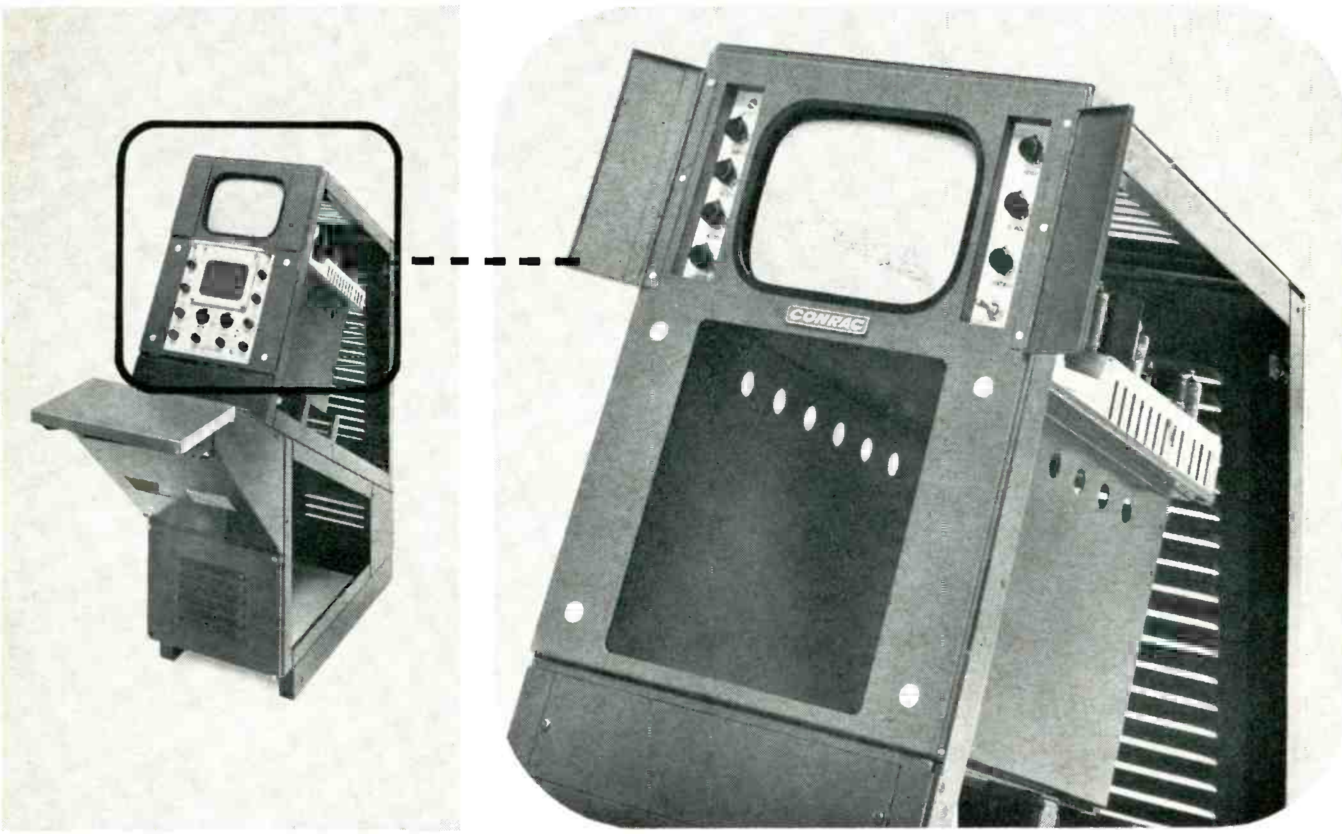

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OPERATING A DIRECTIONAL ANTENNA

by Elton B. Chick* — Part Two. How to tune an antenna system for proper directional characteristics.

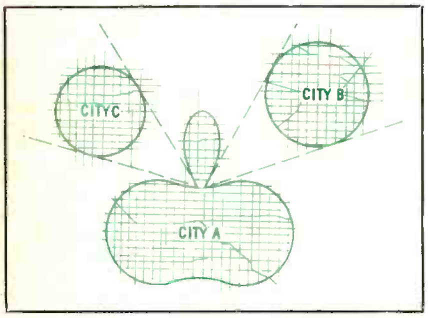

Fig. 1. Directional antenna system in city A protects the stations in cities B and C.

Among the violations of FCC Rules and Regulations are frequent incidents involving improper operation of directional antennas. The operation of a directional antenna, while not especially difficult, may present a rather complex problem for the inexperienced engineer; if not well instructed, he may unknowingly allow improper operation of the system. Perhaps, this has been due, in large measure, to a lack of material that deals strictly with operating a directional antenna. Much is available on the design, adjustment, and maintenance of directionals, but there seems to be little in the way of operating instructions. An engineer is responsible for proper operation to both the station licensee and the FCC, so he has an obligation to learn the appropriate rules and procedures for the system he is working with.

Unfortunately, the wide variety of designs does not allow a single set of operating instructions to cover all the details of every system. However, there are certain basic rules and procedures that do apply in most cases. These fundamentals will be an important aid to the new engineer. Also, a review may be helpful to the more experienced. This article outlines and explains the more important of these basic principles.

The Directional Antenna

The directional antenna is a special radiating system that must control both the direction and intensity of its radiations. Such control is desirable or necessary for several reasons. For example, limiting radiation in the direction of other stations on the same or an adjacent frequency helps eliminate interference. Also, directional control may avoid wasting signal in unpopulated areas.

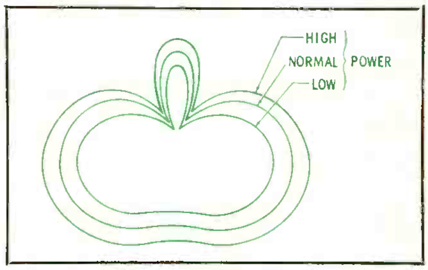

Fig. 2. Pattern size changes primarily as a result of the transmitter power changes.

Fig. 1 illustrates how the directional antenna is used. Here a directional pattern provides service to a city A while protecting adjacent-channel stations in cities B and C. From this sketch it can be seen that both the shape and size of a directional pattern are important. The work of operating a system lies in controlling these two factors: pattern shape and pattern size.

The size of a directional antenna pattern is controlled primarily by the power fed to the system. Fig. 2 shows the effects of power changes. FCC Rules set definite limits on power, thus regulating the pattern size.

Another important factor in directional antenna operation is shape control. With constant ratios between transmitter power and tower current, the phase relationships between towers will determine the pattern shape by cancellation in certain directions (nulls or minima). Fig. 3 illustrates this effect where the parameters are all constant except the phase of tower No. 2. The phase changes of this tower, and the effect on the pattern, are shown in the sketches.

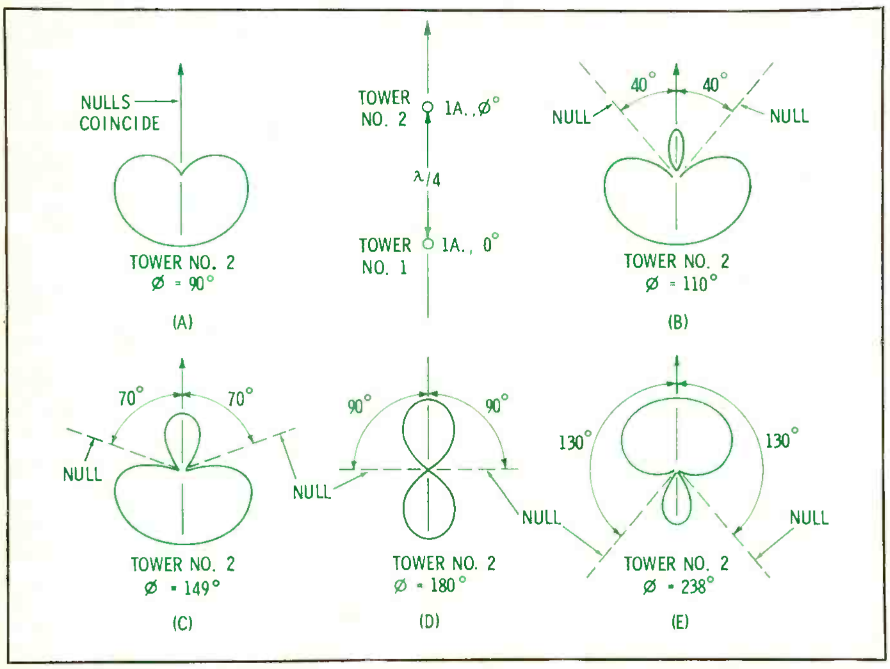

Fig. 3. Pattern variations resulting from changes in phase of tower number 2.

*Assistant Director of Engineering, Rounsaville Radio Stations, Atlanta, Georgia.

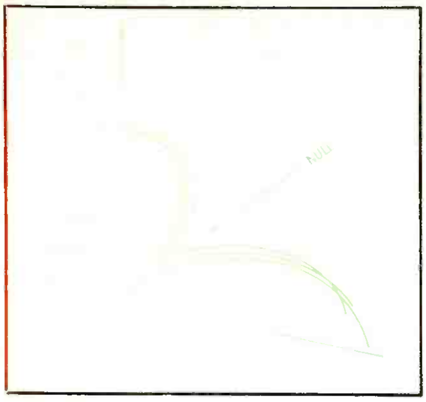

Fig. 4. Diagram of null or minima depth, as affected by changes in current ratios.

An additional factor which will concern the directional antenna operator is the ratio of currents in the various towers of a system. Generally, the current ratio will determine pattern shape by affecting the depth of the nulls. Fig. 4 shows how this can occur. As the current ratio approaches unity (1) the null becomes deeper; that is, it is drawn in to the station as cancellation becomes more complete. To either side of unity, the null is filled.

The Common Point

The common point may be considered as the power source for a directional antenna, since it is common to all the towers and is the point at which total power to the system is measured—see Fig. 5. The common point is usually in the phasor cabinet, taking the circuit form shown in Fig. 6. Here a T-network is used to match transmitter output impedance to the phasing and branching equipment. Such an arrangement prevents reactance from being reflected back to the transmitter tank circuit and presents a resistive load. The use of the "T-net" also allows the common point resistance to be controlled at a value which will result in convenient ammeter readings.

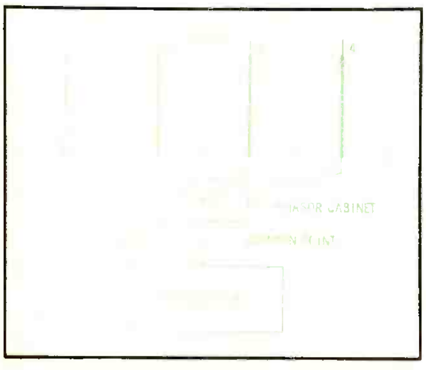

Fig. 5. Common point for power checking.

The common point resistance is adjusted and measured as a part of the initial directional antenna tune-up. The impedance is measured at several frequencies above and below the operating frequency and the data is plotted on a graph (Fig. 7), to provide a more accurate value. It can be seen that the T-net has been adjusted for zero reactance at the operating frequency, while the resistance is determined according to FCC Rule § 3.54(c).

The operator of a directional antenna is required to maintain the station's total power, at the common point, as near the licensed value as is practical. This does not mean the power must be kept at an exact value at all times, but FCC Rule § 3.57(a) states that it must in no case be allowed to exceed limits of 10% below or 5% above the licensed value. This is controlled by adjusting transmitter power output.

The common point current required for a given power is calculated as follows:

$$I_{cp} = \sqrt{\frac{W}{R}}$$

where,

I_{cp} is common point current in amps,
W is licensed power in watts,
R is licensed common point resistance in ohms.

For example, a station licensed for a power of 5,000 watts and a common point resistance of 50 ohms would require a total RF current of:

$$I_{cp} = \sqrt{\frac{5{,}000}{50}} = 10 \text{ amps}$$

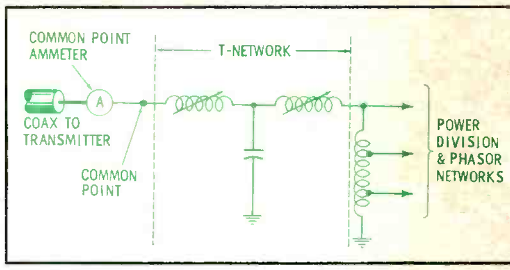

Fig. 6. Circuit diagram of phasor unit.

To determine the minimum and maximum common point currents which correspond to the minus 10% or plus 5% power limits, the same equation is used. In the above example:

5,000 X 1.05 = 5,250 (maximum power)

$$I_{cp}\ (\text{max.}) = \sqrt{\frac{5{,}250}{50}} = 10.24 \text{ amps}$$

5,000 X 0.95 = 4,500 (minimum power)

$$I_{cp}\ (\text{min.}) = \sqrt{\frac{4{,}500}{50}} = 9.49 \text{ amps}$$

Once these values are calculated, they can be listed on a chart and kept at the place where the common point meter is read. To summarize the above example:

Common Point Currents

Minimum	9.49 amps
Normal	10.00 amps
Maximum	10.24 amps

If, during operation, currents reach limits beyond those listed above, true power can be calculated from the formula:

$$W = Icp^2$$

The operator of a directional antenna should understand that licensed power may be somewhat lower than the actual power fed into the common point. If he were ac-

• Please turn to page 35

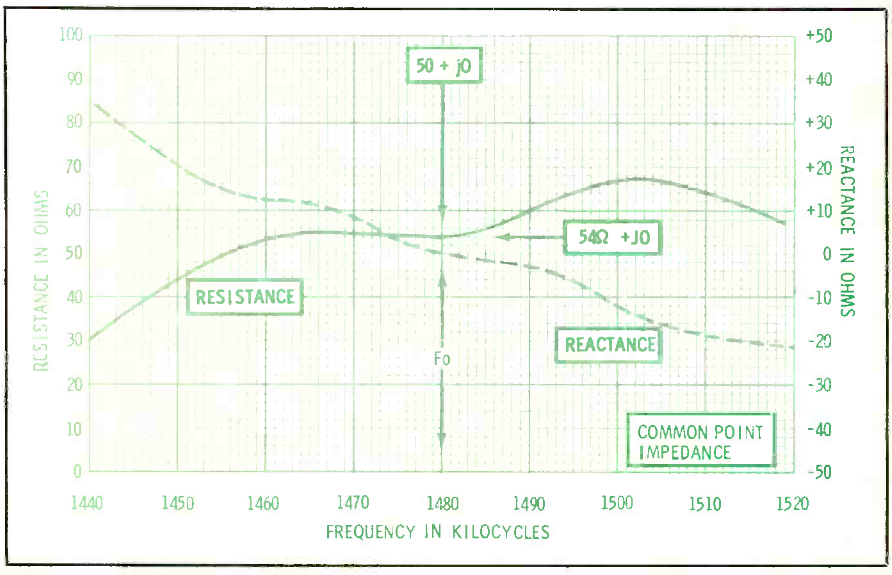

Fig. 7. Graph of several common point values above and below the station frequency.

ANTENNA MATCHING NETWORK DESIGN

by George M. Frese* — Requirements for antenna matching networks, and methods for their design.

The RF network used to match a transmission line or transmitter to the tower is not a complicated device, yet there is always the need for a simpler design method. Quite often the procedure used is as follows: The tower impedance is measured with an RF bridge (required by the FCC), to determine the licensed value of operating current. Then, with the RF bridge shifted to its input terminals, the basic network is connected to the antenna. The manufacturer of the tuning unit usually provides a sufficient number of coils and capacitors for almost any tower impedance (although occasionally a circuit modification is necessary). Next, connections and coil clips are juggled until the "magic number" of 50 ± J0 (in this example) comes up on the bridge dials. Everybody is happy with the results and the job has been completed.

Yet, by such a procedure several important electrical characteristics of the network are overlooked. Voltage and current ratings of capacitors and coils can easily be exceeded, even though these components are normally considered adequate for the power used. You cannot assume the RF network parts are of sufficient rating to handle the load—the tuning solution such as that above may produce higher voltages or currents than are needed to do the matching job.

Still another electrical characteristic overlooked by the above procedure is bandwidth. Usually the three reactive elements do not produce poor bandpass over 20 kc; but some antennas can be quite sharp and require compensation for best results. The network may have incorporated within it intermodulation, reradiation rejection, or harmonic filters. The common input point of a directional antenna system can be particularly faulty with regard to bandwidth. This defect is detrimental to the station's ability to radiate full modulation power and it cannot be compensated for by an automatic level device, transmitter adjustment, or any other control of modulation characteristics.

This article is intended to give a basic procedure for design of RF antenna-tuning networks. This fundamental concept can be expanded to include: voltage and current rating through the reactive elements, solutions for lowest voltages and currents, bandwidth, and phase delay through the network. To start with, however, we shall be concerned with the values of capacitance and inductance needed in the mesh.

*Professional Radio & TV Consulting Engineer, Wenatchee, Wash.

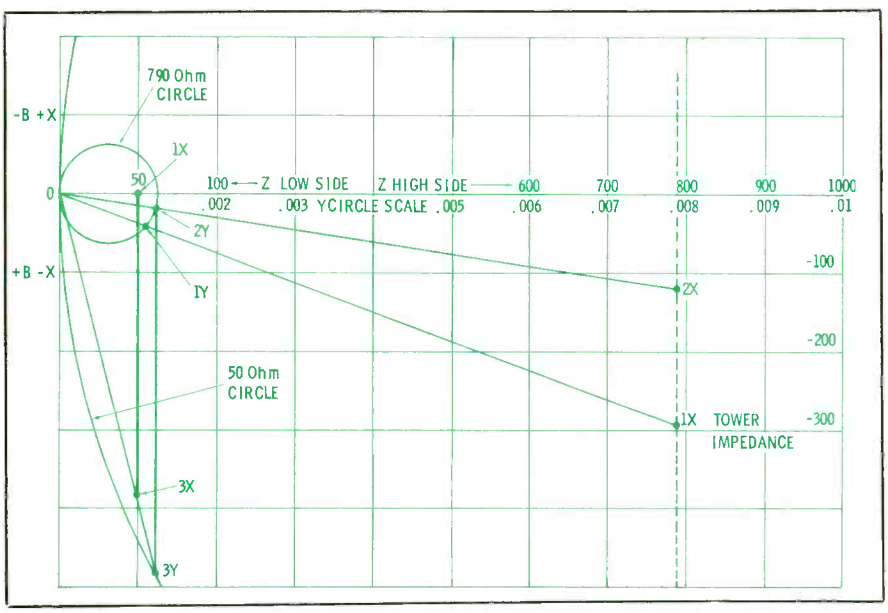

Fig. 1. Impedance and admittance graph for matching the 340' tower to 50 ohms.

Procedure for Design

Step 1. A good way to begin the design is to make up a table of Y and Z versus capacity and inductance (mfd and μh) for the frequency involved. Table 1 is our example. This is not really an essential part of the design procedure, but will prove helpful in determining component value from the graphs.

Step 2. The tower base impedance must be known at the outset. Measured values are desirable, but if unavailable, values derived from the tower height-versus-impedance curves can be substituted. For examples in this design we will use measured impedances of two towers, both operated on 1230 kc. Table 2 contains the required data.

Step 3. Draw an impedance admittance graph as shown in Fig. 1 and 2, as follows:

1. Mark the graph paper with appropriate scales. With a large impedance transformation, you may have to use two impedance scales.
2. Draw the admittance circles; these represent a constant resistance. The 790-ohm circle has for its diameter an admittance of .00127. The 50-ohm circle has

Table 1. Y, Z, Mfd, μh for 1230 kc.

Z	Y	MF	Uh
10	.10	.013	1.3
12.6	.0794	.010	1.6
15.7	.063	.0082	2.0
20.0	.050	.0065	2.6
25.2	.0398	.0052	3.3
31.6	.0316	.0041	4.1
39.8	.0252	.0033	5.2
50.0	.020	.0026	6.5
63.0	.0157	.0020	8.2
79.4	.0126	.0016	10
100	.010	.0013	13.0
126	.00794	.0010	16
157	.0063	.0082	20
200	.0050	.00065	26
251	.00398	.00052	33
316	.00316	.00041	41
398	.00252	.00033	52
500	.0020	.00025	65
630	.00157	.0002	82
794	.00126	.00016	100
1000	.0010	.00013	130

for its diameter an admittance of .02. The 50-ohm circle need not extend to the right beyond the .00127 diameter, since there are no solutions beyond an admittance of .00127 ohms.

3. Place point 1X at 790 — J 289 ohms (tower impedance).
4. Draw a line from point 1X to the 0 reference. Where the line crosses the 790-ohm circle mark point 1Y. This is the admittance of the tower, as read on the admittance scales.
5. As the X value of element A is varied (Fig. 1), impedance progresses from point 1X to 2X, while admittance goes from point 1Y to 2Y. Notice, a wide range of values for Xa can be used, but the value chosen here provides the best all around solution—for reasons given later.
6. Now transform the resistive component by adding susceptance element B and establishing point 3. This is a vertical capacitance line starting at point 2Y on the 790-ohm circle and ending at point 3Y on the 50-ohm circle. Point 3Y is the admittance looking into point 3. To obtain impedance, draw a line from point 3Y to reference 0. The impedance value occurs where this line intersects the 50-ohm resistance line, at point 3R in Figs. 1 and 2.
7. To obtain our final answer of 50 ± J0 at point 4, we need to add element Xc. This is a line from point 3X to zero reactance point 4X. (We do not require point 4Y; it is off the right hand side of the graph at Y = .02.)

Step 4. Determine the values of elements (a), (b), (c), in Fig. 3.

1. Element (a) measures +175 ohms (between points 1X and 2X). From Table 1, this is approximately 23 μh.
2. Element (b) measures +.00465 ohms (between 2Y and 3Y), approximately .006 mfd.
3. Element (c) measures +192 ohms (between 3X to 4X), approximately 25 μh.

Another Design

A second example is given for the Chelan KOXI tower but without the step-by-step description. All that is needed for this solution is Table 1, Table 2, Fig. 2, and Fig. 3. The solution to Fig. 2 is as follows:

1. Element (a) is +6 ohms, approx. .8 μh.
2. Element (b) is—.009 mhos, approx. 14.5 μh.
3. Element (c) is +51 ohms, approx. 6.5 μh. (Note—in this solution all elements are inductances.)

From the graphs, many solutions for transforming the tower impedance to 50 ohms are evident—even for this simple T network. As stated earlier, there are also other electrical characteristics of the network to be considered. Some of these are: voltage-and-current-leg values, solutions too close to the edge of possible transformations which should not be used, bandwidth correction (may be desirable), or a specific phase angle which may be required as in the case of a DA system.

Voltage and Current in Each Element

With the graphs, it becomes a simple matter to determine values for voltage and current in each element. Below is a sample calculation for the KREW network operating at 1.0 kw.

$$I_{in} = \sqrt{\frac{W}{R}} = \sqrt{\frac{1{,}000}{50}} = 4.47 \text{ amps}$$

$$E_{in} = IR = 4.47 \times 50 = 223.5 \text{ volts}$$

$$E_c = I X_c = 4.47 \times 192 \angle{+90°} \text{ volts} = 858 \angle{+90°} \text{ volts}$$

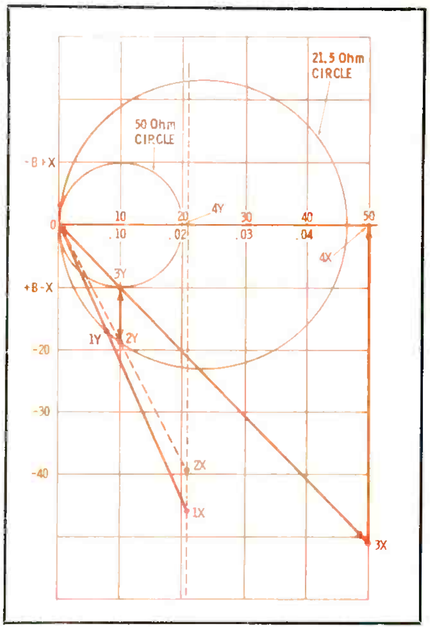

Fig. 2. Impedance and admittance graph for matching 150' tower to 50-ohm line.

$$E_b = 223.5 \angle{0°} - 858 \angle{90°} = 887 \angle{-75.4°} \text{ volts}$$

$$I_b = EB = 887 \times .00465 = 4.12 \text{ amps}$$

$$I_c = \sqrt{\frac{W}{R}} = \sqrt{\frac{1000}{790}} = \sqrt{1.26} = 1.125 \text{ amps}$$

$$E_c = IX = 1.125 \times 175 = 196.8 \text{ volts}$$

The above are unmodulated carrier values. For instantaneous peak values, multiply each by 2 × 1.414 = 2.828.

Notice it is desirable in design to keep the reactive lines short so that small low-voltage coils may be used. The admittance line should also be short in order to maintain element (b) current low. It is usually desirable to find a design using the 15° to 45° portion of the high-resistance circle. Solutions between 0° and 15° are poor because of tuning element limitations.

The phase angle of the network must also be considered. It is the angle of current in point 1 compared to the angle of current in point 4. It is solved on the graph

• Please turn to page 32

Table 2. Measured Tower Impedance.

KC	R	X	1/R
	KREW — 340 ft.		
1220	830	—244	.00120
1230	790	—289	.00127
1240	750	—343	.00133
	KOZI — 150 ft.		
KC	R	X	1/R
1220	21.0	—49.2	.0476
1230	21.5	—45.5	.0465
1240	22.0	—42.0	.0455

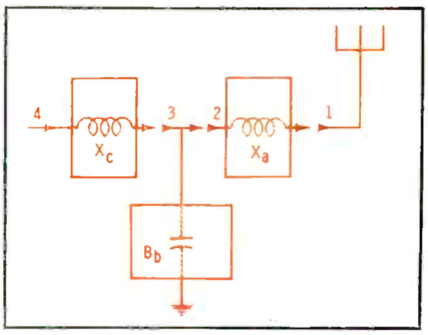

Fig. 3. Basic antenna matching network.

UHF TV TRANSMITTING ANTENNAS

by Peter Onnigan* — General introduction to UHF radiators and brief descriptions of some currently available systems.

Currently available UHF TV transmitting antennas, which provide the broadcaster with a means for radiating high power into his service areas, are discussed here. These radiators are for use in the FCC 470- to 890-mc bands.

UHF Radiator Characteristics

In order to more fully understand the operation of UHF TV antennas, several basic factors should be explained. These include polarization, power gain, horizontal and vertical radiation patterns, as well as power handling capacity. The input voltage standing wave ratio (VSWR) and pattern response over a narrow band are also important.

Polarization

Radiation from a UHF TV antenna consists of two components, the magnetic field and the electric field. When the electric field lies entirely in one plane, containing the direction of propagation, the resulting electromagnetic wave is said to be linearly polarized. When that electric field is parallel to the earth's surface, the radiation is said to be horizontally polarized. If the field is perpendicular to the surface, the radiation is vertically polarized.

There are several other modes of polarization, resulting from combinations of vertical and horizontal, which change with phase and frequency. These include elliptical and circular polarization, and left hand/right hand linear polarization.

In UHF television, the FCC rules currently require horizontal polarization of all radiated power emanating from installations 1 kw or higher in power. When transmitter power is below 1 kw, any type of polarization may be used. In Europe and some other areas of the world, CCIR technical specifications permit vertical polarization in Band IV stations (UHF). There appears to be very little technical difference between vertical and horizontal polarization in the UHF range, when line-of-sight transmitter-to-receiver conditions exist.

Gain

Gain and directivity are interrelated. Directional characteristics of an antenna are expressed in terms of a gain function (db or power-gain ratio). TV antenna gains are expressed as the ratio between maximum radiation intensity produced by the radiator in question and that produced by a reference dipole in the same direction, with the same power input.

The quantity closely associated with gain is directivity. This is defined as a ratio of **maximum** radiation intensity to **average** radiation intensity. In the case of a theoretically perfect antenna (one without losses), gain and directivity would be the same. It would radiate the same signal strength in all directions. In practice, however, this does not occur; all antennas radiate in some directions better than others.

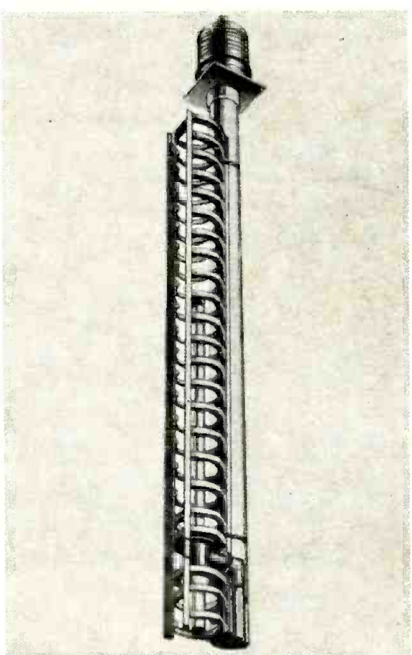

Fig. 1. The slotted-ring UHF TV antenna.

The basic radiator in most UHF TV antennas is an omnidirectional element. By stacking these antennas vertically, the gain in certain directions can be increased, but at the cost of power in other directions.

Next in order is the matter of effective antenna area, or as it is commonly referred to in the trade, aperture. The properties of receiving antennas are similar to those of transmitting antennas—the larger the antenna area, the more signal it will capture. As a consequence of the reciprocity theorem, the larger the transmitting antenna the more it will radiate in certain directions.

When antennas are vertically stacked, the horizontal pattern remains the same while the vertical pattern becomes narrower. When the vertical pattern approaches 1°, problems of support-tower stability, antenna loss, and coverage tend to outweigh the advantages of additional gain. The vertical half-power beamwidth of a UHF omnidirectional TV antenna may be found by dividing 61 by the gain ratio.

Nulls

In UHF TV, high effective radiated powers are employed to overcome free-space, receiving-antenna, receiver-front-end, and propagation losses that are the nature of UHF. The most economical way to achieve high UHF erp is through the use of a high gain antenna. As pointed out above, the high gain presents problems in the vertical radiation pattern, which can be overcome in several ways. These include null fill-in, where some of the peak power is put into the first null direction, to overcome close-in coverage problems. Another method is to provide nonequal power distribution

*General Manager, Jampro Antenna Co., Sacramento, Calif.

to the antenna aperture. While this practice reduces the overall gain of the antenna, it provides a much smoother power distribution below the horizon.

Contoured Patterns

Another scheme is to custom tailor the radiation to solve specific coverage problems. In one recent UHF TV installation (KERO-TV channel 23, Bakersfield, California), General Electric Co. designed an antenna to provide a power gain of 75 when fed with a 25-kw transmitter. This antenna has 1.5° of electrical beam tilt and another 1.5° of mechanical beam tilt. It has a horizontal half-power beamwidth of 120°. Using ten "zig-zag" panels mounted around a rectangular supporting tower, this GE antenna radiates an effective power of 1.76 million watts in the maximum lobe direction!

Voltage Standing Wave Ratio

The VSWR, a figure of relative merit for performance of antenna systems, has not been specified by the FCC or the EIA. However it is generally accepted that TV antennas should have a VSWR of 1.1 to 1, or better, throughout the 6-mc operating bandwidth; this same value applies to the transmission line that feeds the antenna. In practice, slightly higher values can be tolerated for very short transmission lines, while ratios better than 1.1 to 1 are advisable for transmission lines longer than 100′.

There is also the possibility of vector addition of the VSWR values; a particular portion of the line—and the antenna—may exhibit 1.1:1, but the overall system at a given frequency may be much higher. Thus, the system should be 1.08:1 or better at visual carrier, ±1.25 mc, and 1.1:1 over the remainder of the channel.

To be meaningful, this system performance indicator must relate to the quality of the picture that is transmitted. The antenna system must faithfully reproduce the series of pulses which make up the TV picture. There are several methods for measuring the VSWR of the antenna and transmission line. These include the UHF admittance method (Smith chart conversion), Z impedance meter (phase and magnitude), and the directional coupler. A recent variation of the latter employs a pulse generator to energize the antenna system through a coupler, and a scope to observe the returned energy. This method is very informative in locating the distances where the discontinuities occur, but does not provide a highly accurate numerical value of the VSWR. Accuracy can be obtained by the use of a directional coupler (high directivity), a signal generator with low harmonic output, and a VSWR readout meter.

The VSWR at the aural frequency is not overly important, since FM carrier bandwidth is very narrow—1.1:1 is more than adequate.

The VSWR is a relationship of the actual impedance to the 50-ohm transmitting system (in some cases, 75 ohms). This also turns out to be the ratio between the highest voltage and the lowest voltage, measured over several wavelengths.

Power Handling Capacity

The power rating of a UHF TV antenna is determined somewhat by its design, and more so by the size and type of material used in its construction. In addition, there is a further limit of safe operation. This is based on VSWR, during normal operation and under subnormal conditions such as icing. If the VSWR of the antenna rises, its safe power-handling capacity goes down.

The most common limiting factor for power capacity is the effects of heating. RF loss (resistive) in antenna material, which shows up as heat damage and burning, results in reduced radiated power.

Nearly all UHF antennas currently available have a single input line. Thus the power being fed to them must be diplexed aural and visual power. To determine power capability, aural power is added to 0.6 peak visual power. Thus a 12.5-kw peak visual transmitter would produce nearly 6.25 kw of aural power and 0.6 × 12.5 kw = 7.50, or a total heating power of 13.75 kw. The antenna power rating must therefore be better than 13.75 kw to safely handle the power.

Available Antennas

Slotted Ring

The patented slotted ring antenna, produced by Alford Mfg. (Fig. 1), is a development of the balanced transmission line principle shunted by a series of small diameter rings. The coaxial feed line runs to the lowest ring, and through the center of the assembly to the uppermost, where the inner conductor is short circuited. In operation, these two shorts present an extremely high VSWR on the coax. This high standing wave excites the rings, which in turn radiate. Due to the distance (0.4 wavelengths) between feed point and shorted ends, the current distribution is fairly uniform; the result is excellent aperture illumination. One bay of this slotted ring antenna is 1.5 wavelengths long and has a power ratio of approximately 4.

In multiple bay arrangements, the

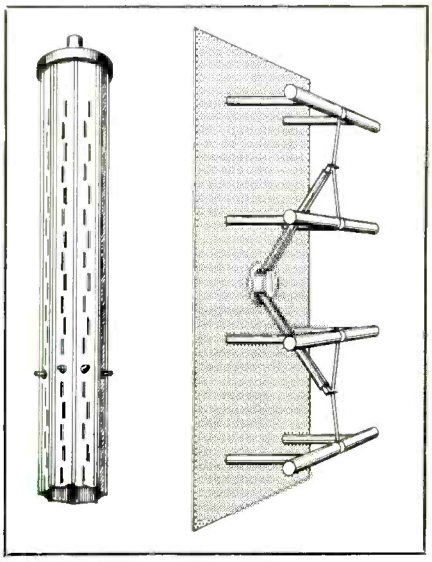

Fig. 2. Multiguide UHF slot antenna (left), and a UHF dipole antenna panel.

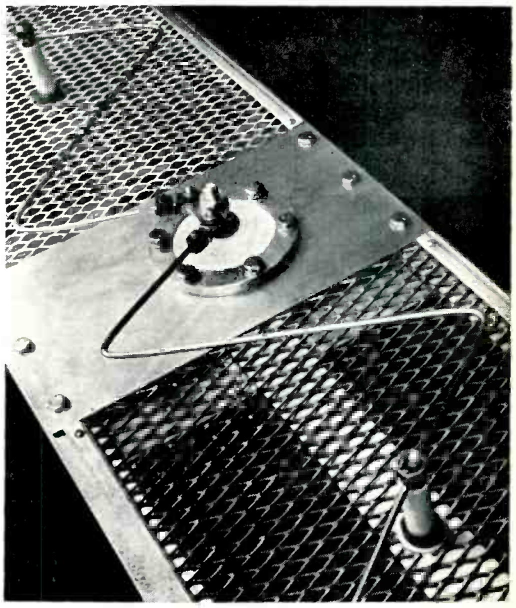

Fig. 3. A "Zig-Zag" transmitting antenna.

several points are fed through a power splitting device. This permits uniform aperture illumination with control of the vertical pattern.

The Alford UHF antenna is protected by a plastic radome and is thus immune to detuning effects of ice, snow, and moisture. The basic design permits control of the horizontal pattern for both omnidirectional and directional applications.

UHF Dipole and Multiguide Slot

An Italian firm, Complementi Electronici S.P.A. (Co. El.) of Milan, Italy, offers two types of UHF antennas. One, a dipole, consists of numerous individual dipole panels (Fig. 2), power dividers, and aluminum coax branch feeders. The quantity and arrangement of these components is dependent on the desired power gain, horizontal pattern, and vertical pattern. Each UHF dipole panel comprises four fullwave broadband dipoles mounted on a solid reflecting screen.[1] Two of the dipoles are fed in phase with a 73-ohm balanced line. Groups of these lines are fed through baluns to obtain the correct phase and impedance. The complete panel is fitted into a polyester radome for weather protection. Since each dipole is a full wavelength, it is supported in the center with a grounded arm. This type of construction provides excellent lightning protection.

The Co. El. dipole antenna system permits high gain with high input power, and is capable of excellent directional and circular patterns. The panel construction also permits complete control of the vertical pattern, which can be different in two or more azimuth directions. The antenna is capable of extremely wide bandwidth due to the arrangement of phase delays at common power dividers.

Co. El. has recently introduced another type of UHF antenna, using several waveguides side by side. The slotted radiators are arranged in a cylindrical arrangement to obtain circular radiation pattern. The entire assembly is enclosed in a round fiberglass cylinder for weather protection. The "Multiguide" UHF Slot Antenna (Fig. 2) is designed for channels 14 to 83. The maximum power handling capability is 100 kw, with gains from 11 to 52 available. The VSWR is held to 1.07 (in some cases better).

Fig. 4. Slotted cylinder UHF TV antenna.

Helical

An antenna developed to take advantage of a minimum number of feed points and a simple supporting structure is the General Electric helical antenna. This antenna consists of a steel pipe around which are wound the helices. The tubular steel mast not only supports the radiating elements, but provides a ground plane. Two traveling waves are generated at the feed point and travel in opposite directions at the same speed; one goes upward on the helix and the other downward. The pitch and diameter of the steel tube and helix are chosen to provide in-phase currents in any given azimuth direction—at every turn. An integral number of wavelengths is chosen for each turn, so that a minimum number of tube diameters may be utilized for the entire UHF band. Each bay of this antenna consists of approximately 6 turns above and below the feed point, with the turns of the two helices wound in opposite directions. This opposition tends to cancel most of the vertically polarized radiation components, resulting in horizontal polarization only. The opposite ends of the helix are grounded for deicing currents and lightning protection. Most of the radiation takes place in the first few turns near the ends which are closely spaced to achieve uniform illumination of the antenna aperture. The average power gain ratio is about 5, while the feed point impedance is about 100 ohms.

The individual bays are fed through a coupling probe arrangement by the main feed coax, which runs inside the supporting tubular mast. Impedance matching and vertical pattern contouring is also accomplished at the impedance matching mechanism. With this type of antenna, extremely wide bandwidths are obtainable for 1.1:1 VSWR, as well as high power capability.

Helical arrays are usually series fed at the bottom. However, in the ten-bay antenna, GE feeds the system at the middle, with the upper five bays and the lower five bays each receiving one-half the total power split at this center point. The ten-bay GE antenna has a typical height of about 96′ on channel 32, for a power gain of 50. Rated at 60 kw input power, this antenna is capable of 3 megawatts erp.

The helical antenna design permits vertical pattern contouring for specific coverage problems, as well as horizontal shaping.[2] One extremely important advantage of the latter is a provision for changing the horizontal pattern easily after installation.

"Zig-Zag" Antenna

GE recently introduced the "zig-zag" UHF antenna (Fig. 3), consisting of rectangular sections, each with two radiators spaced a fraction of a wavelength from the panel. This antenna employs the traveling-wave principle to excite the entire panel from a single feed point in the center. The Zig-Zag conductors serve not only as the RF radiating elements, but also as heating and deicing units. The complete array is normally made up of several panels, which can be arranged to provide an almost unlimited variety of patterns—with especially high degrees of horizontal directivity. These range from wide vertical patterns to narrowly tilted and heavily contoured beams. Extremely high gains —up to 75—are available, with practical directional patterns; input power ratings extend to 60 kw.

Slotted Cylinder Antenna

The slotted cylinder antenna (Fig. 4), first manufactured for UHF TV by RCA, is an outgrowth of the old FM pylon.[3] The antenna employs a vertical slot cut into the wall of a steel tubular mast, combining the functions of a radiator and supporting structure in one heavy cylinder. The feed system is a coaxial line consisting of copper tubing for the inner conductor and the steel mast as the outer conductor. The RF is coupled from the field inside the coaxial line to the radiating slot by means of an aluminum bar bolted to the inside edge of the slot. In

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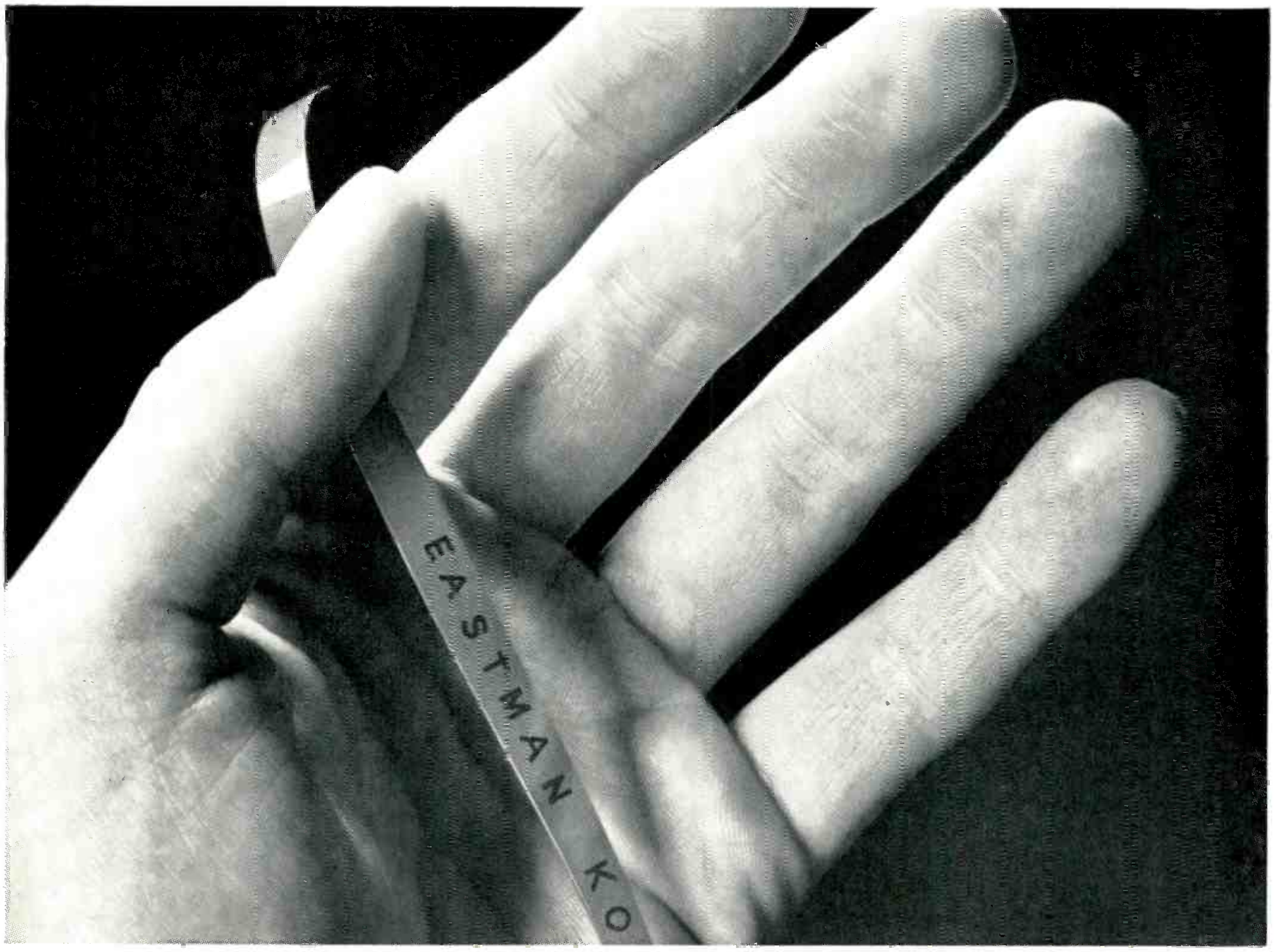

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HELIPORTABLE BROADCAST SYSTEM

About the Cover

This month's cover shows Signal Corps personnel descending from a 50-kw log periodic transmitting antenna, under the setting Arizona sun. The radiator is part of a complete helicopter transportable broadcast system tested last year by the Strategic Communications Command.

Cover photo courtesy Gates Radio Co., subsidiary of Harris-Intertype Corp.

The U.S. Army's test site in the desert near Yuma, Arizona, was the focal point of a 5,000-mile radio experiment. One of the most complete mobile broadcasting systems ever conceived underwent a thorough two-month field test, conducted by personnel of the Strategic Communications Command, a field agency of the Office of the Chief Signal Officer, Department of the Army. From this program may result a louder, faster-responding, "voice" for psychological warfare units during possible future crises.

Two powerful 50,000 watt transmitting stations, portable down to the antenna towers, were airlifted into the mesquite flats by helicopter (Fig. 1). For eight hours every day, they picked up programs originating in the mobile system's complete broadcasting studios set up 1,000 miles away at Fort Lewis, Washington. The programs were immediately rebroadcast to standard household receiving sets in the Panama Canal Zone.

Designated AN/TRQ-20, the portable radio center was designed and manufactured by the Gates Radio Co., subsidiary of Harris-Intertype Corp. To make the test more realistic, the facility was divided into two sections, as it would be under crisis conditions. The main studio-control complex at Fort Lewis represented a rear area, while the larger transmitting system in Arizona simulated a forward-based installation located close to enemy territory. The sites were connected by a two-way communications link, using single-sideband techniques. Under actual tactical conditions, messages could be aimed at either the civilians of a foreign country, or at members of an enemy's armed forces. Since it is designed for ease of operation and maintenance in the field, the system can be set down anywhere in the world and be on the air in a matter of hours.

Fig. 1. Helicopter carries radio shelter.

General Description

While the entire system does a multipurpose but integrated job, it is basically broken up into several sections. These sections consist of complete broadcasting and communications facilities for: A 50 kw mediumwave broadcasting station; a 50 kw shortwave broadcasting station; a combined radio receiving station for program relay; complete studio facilities for broadcasting, recording, and production; 2.5 kw single-sideband HF equipment to provide STL over distances of 600 to 1200 miles.

Diesel-powered generators provide all power needs in the field. Studio and control shelters, where personnel are on duty, have individual heating and air-conditioning units. The shelters are 12′ long, 6′ wide, and 6′ high, and are limited to a maximum weight of 4,000 pounds to permit transportation by Mojave class helicopter.

Studios

The main studio control center consists of the following: one teletype/announce shelter, one control shelter, one studio shelter, one HF SSB keying link shelter, six vertical log-periodic transmit/receive antennas, 20 kw generators, fuel tanks, cable, dollies, and jacks.

The teletype/announce shelter houses a complete "news room" and announce studio (Fig. 2). It is divided into two rooms. In the announce portion, the setup includes console, microphones, turntables, intercom, news teletype, and accessories. In operation, the shelter is positioned so the announce booth window faces into the control room in the control shelter.

The teletype portion of the shelter houses four reperforators and four teletypewriters on pull-out shelves. There are also patch panels, intercom, speaker, and teletype accessories.

The main studio control shelter houses a fully equipped control room. It functions as the nerve center of studio control complex. The installation includes: a two-channel audio console, three audio tape recorders, two turntables, limiter, monitoring equipment, intercom, storage space, and accessories. In the rearward room are four racks housing two additional tape recorders, three reperforators, three teletypewriters, patch panels, intercoms, and auxiliary equipment. In operation, this shelter is positioned so the large double-paned windows overlook the studio on one side, and the announce booth on the other.

The studio shelter (Fig. 3) is just what the name implies—a roomy, sound-proofed broadcast studio. It is equipped with microphones, patch panel, intercom, monitor speaker, tables, chairs, clocks, and on-air lights.

Fig. 2. Forward portion of TT shelter.

Fig. 3. Psychological warefare announcer broadcasts from an air-conditioned studio.

The keying-link shelter actually consists of two identical enclosures. Each houses one full SSB HF link facility. The shelters are equipped with workshop areas, receivers, test equipment, patch panels, monitors, and a 2-30 mc 2,500 watt SSB transmitter with associated equipment. These shelters, and their power equipment, are situated a short distance from the other group of enclosures. Each link in the complex employs three vertical log-periodic transmit/receive antennas.

Radio Monitoring Facility

Consisting of two monitor shelters, tripole antenna field, and power units, the monitoring facility provides receiving and recording capabilities in the AM range of 0.5 to 30 mc, and in the FM band from 50 to 260 mc. The system can also receive Helscriber and Teletype transmissions. Each shelter contains six tape recorders, seven receivers, monitor amplifiers, multicouplers, teletype equipment, Helprinter, and auxiliary devices.

Short-Wave Facility

One of the forward-located transmission systems is the 50 kw short-wave broadcast facility. This complex is made up of several shelters (Fig. 4) comprising: transmitter control, studio, rectifier, modulator, control, power amplifier, and dummy antenna. In addition to the vertical log-periodic link antennas, the facility employs a 50 kw horizontal log-periodic transmitting antenna (Fig. 5) designed for 3 to 30 mc.

Fig. 4. The 50-kw VHF transmitter shelters.

The shelters are assembled in three groups—transmitter, studio, and link. The signals from the rearward-located studio control complex are picked up by the STL and fed to the studio, where they are further processed or passed directly to the transmitter.

Mediumwave Facility

The other high-power broadcasting system is the mediumwave 50 kw facility. It is made up of shelters similar to those of the shortwave facility. The mediumwave system is quite similar to a standard broadcast station since it consists of a studio, STL, transmitter control, and 50 kw broadcast transmitter for operation on any single frequency between .54 and 1620 kc. The antenna in this case is a 150′ crank-up unipole-type vertical radiator, mounted on a skid.

Summary

Lessons of World War II and Korea pointed out a need for radio communications between United States military forces and the people of occupied areas. The mobile broadcasting facilities used in Korea operated well, but were restricted to ground movement in large vans. Further need for compact facilities with airlift capability was indicated in Lebanon, Laos, South Viet Nam, and other trouble-spots in the world.

The information collected and techniques developed last year during the field experiments with the heliportable broadcast system answer many questions about strategic communications. Another task was accomplished—equipment and techniques were tested that will be available for use in standard broadcast station operations. Information gathered may lead to new methods in remote operation, maintenance, and use of auxiliary power in radio and television broadcast stations. ▲

Fig. 5. GI tightens transmission line unit.

A REVIEW OF THE ITU CONFERENCE

by Elliot P. Fagerberg* — A summary of the events and decisions at the international meeting on Space Radio Communications.

Broadcasting in the Space Age was greatly advanced by the successful five week Space Radio Communications Conference of the **International Telecommunications Union** (ITU) which took place in Geneva, Switzerland, ending November 8. This was the feeling of delegates from all the 70 participating nations and numerous international organizations that attended the conclave.

Communication satellites played a prominent role in the Conference. Using the American Telephone and Telegraph **Telstar** as a relay, Gerald C. Gross (ITU Director) and U. Thant (UN Secretary General) opened the parley with a two-way overseas telecast exchange of greetings. Telephone calls were made regularly to officials in Washington, D. C., and at the UN in New York from delegates at the Conference Hall in Geneva via the NASA **Syncom** satellite, which orbits at an altitude of 22,000 miles above Brazil.

*Consulting Author, Geneva, Switzerland.

Of considerable interest to the broadcasting service is the emphasis placed on communications satellite frequencies. Of the total set aside for all types of space services, 2,800 mc of spectrum space were assigned for communication satellites.

Although no frequencies were specifically allocated for radio or television transmission directly from satellites, many measures of vital importance to broadcast engineering were adopted. For example, the Conference unanimously called upon the ITU to accelerate the development of "satellite transmissions for direct reception by the general public of radio and television broadcasts . . ."

The Conference recommendation (initiated by representatives of the UN and UNESCO) took for granted that this public use of satellite transmissions for direct reception may be possible in the future. Consequently, they recommended that the CCIR (International Radio Consultative Committee) expedite its studies of the technical feasibility of broadcasting via satellites and make early suggestions regarding the optimum technical characteristics of the systems to be used, what bands would be technically suitable, and whether and under what conditions those bands could be shared between the broadcasting satellite and terrestrial services.

(**Note** — The CCIR considered this problem further at its joint conference with the CCITT (International Telephone and Telegraph Consultative Committee) on the International Telecommunications Plan which convened at Rome from November 25 to December 11.)

The Space Communications Conference, itself an implementation of the United Nations General Assembly Resolutions on the Peaceful Uses of Outer Space, also unanimously adopted a recommendation urging the development of international communication satellite systems shared equitably by rich and poor nations alike.

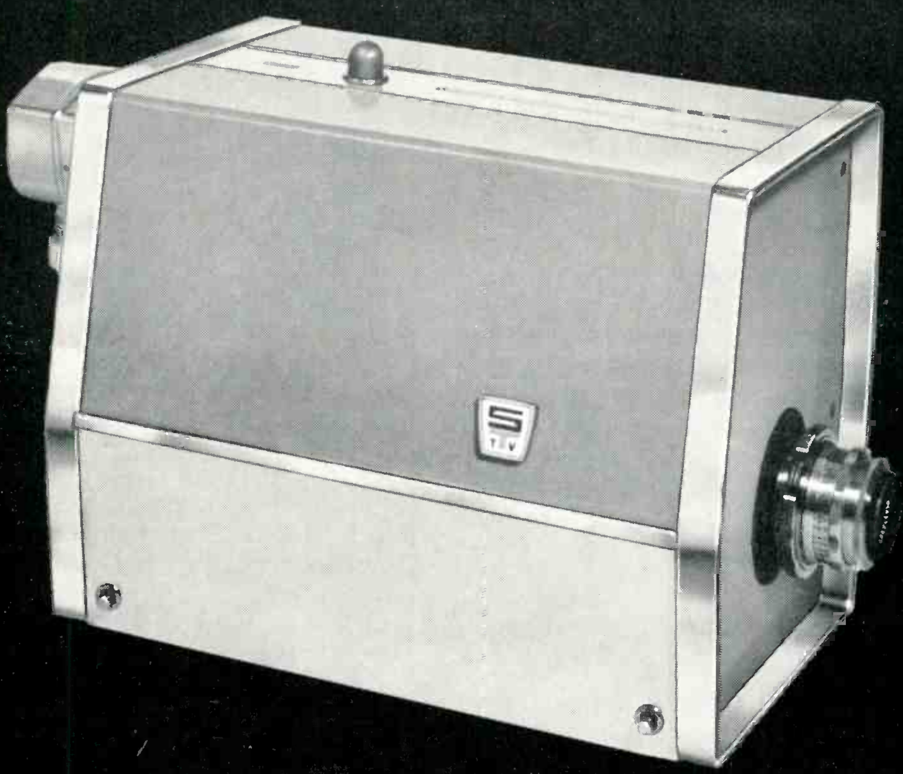
The text of this recommendation, introduced by the Israeli delegation, points out that "the unanimous belief of members of the United Nations that communication satellites should be organized on a global basis with nondiscriminatory access for all nations . . . (leads to the recommendation) . . . that the utilization and exploitation of the frequency spectrum for space communication be subject to international agreements based on principles of justice and equity permitting the use and sharing of allocated frequency bands in the mutual interest of all nations."

Likewise, unanimously adopted was a resolution introduced by Yugoslavia which asked the ITU to take vigorous action to enable newly emerging countries of the world to participate in Space Communications Systems.

Geneva site of the 1963 Conference on Space Communications held by the ITU.

Technical Considerations

Also important for radio broad-



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Gunnary Pederson, Chairman of the 1963 Conference, inaugurates a satellite call.

casting are the elaborate technical parameters prescribed by the conference for space services sharing bands with terrestrial and aeronautical stations. The power limitations imposed on communication satellite stations in the revised radio regulations, according to some radio engineers interviewed by your Consulting Author who attended the Conference, may stultify their operation. These engineers felt that such restrictive parameters were not necessary to prevent harmful interference with the fixed and mobile services that share the same bands.

Because of Doppler shift and plasma formation, it was considered necessary to provide frequencies for many space services in the already congested spectrum between 1 and 10 gc. Hence, it became necessary to allocate most of the frequencies to space service on a shared basis with existing fixed and mobile stations. This sharing dictated the establishment of elaborate technical criteria. Based on nearly five years of preliminary preparation by the International Radio Consultative Committee (CCIR), most of these criteria are set forth in the adopted Radio Regulations.

The criteria included such specifications as choice of sites and frequencies (which must observe recommendations of CCIR); power limitations, which range to a maximum of +65 dbw; minimum angle of elevation (3°); and power flux density limits at the earth's surface. Other considerations were outlined, and recommendations made concerning their implementation. The Radio Regulations now include tables of interference probability, site-shielding factors, and transmission losses.

JAMPRO

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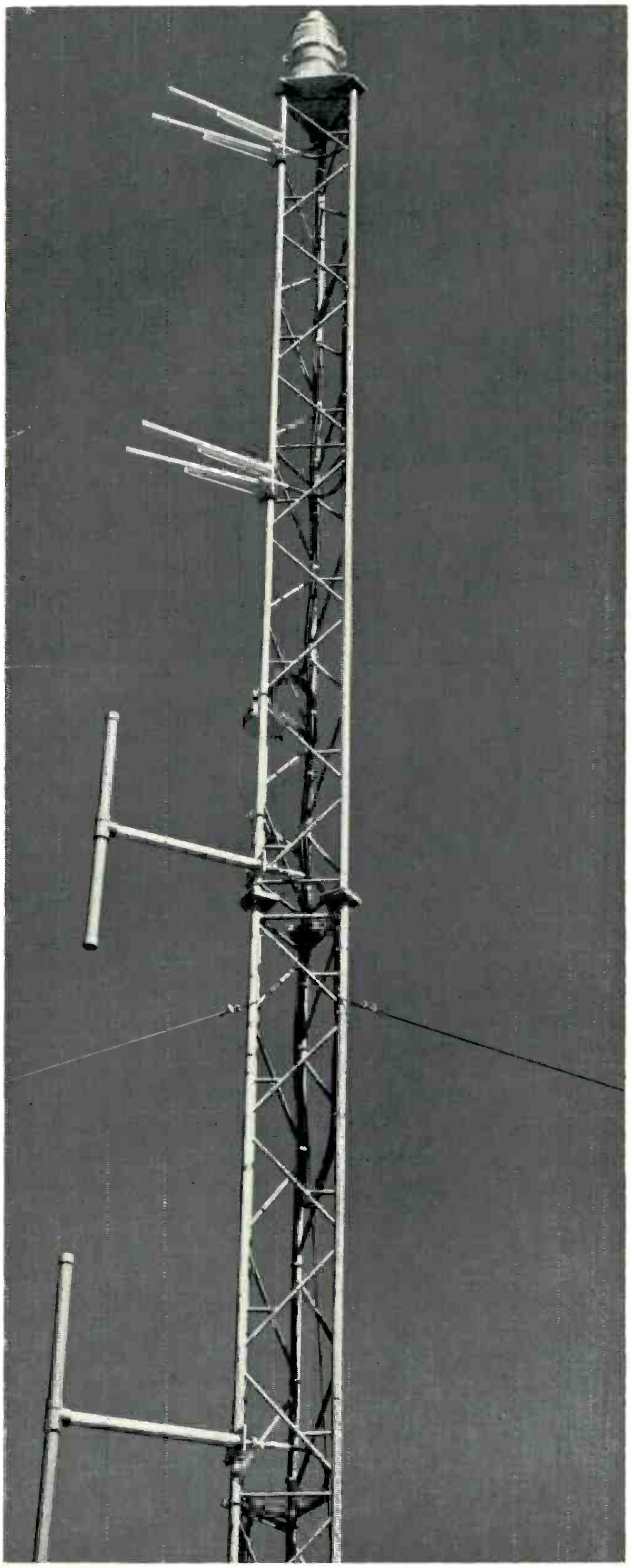
The JAMPRO dual polarized antenna is available in several combinations of vertical to horizontal gain ratios. For class A stations, the equal number of horizontal to vertical is most appropriate. For class B and C stations other combinations may be more desirable.

Power ratings are equal to standard horizontally polarized JAMPRO FM antennas, and vary from 10 to 25 kilowatts. Power gains are available up to 7.0 for the horizontal and vertical.

*U.S. PATENT PENDING



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SACRAMENTO 28, CALIFORNIA

Circle Item 17 on Tech Data Card

Delegates from many countries and world organizations gather.

Headquarters building of International Communications Union.

Frequency Allocations

In revising the 1959 International Radio Regulations, great pains were taken by the ITU Conference to protect all frequencies of the broadcasting service. This is indicated by modifications of the ITU Table of Frequencies which earmark **for Broadcasting** a number of bands: 68-73 mc (shared with fixed and mobile services in the Western Hemisphere); 73-74.6 mc may continue to operate on a noninterference basis with the Radio Astronomy Service; 170-174 mc (shared with fixed mobile in Asia and Australasia); 174-216 mc (exclusive in Africa and Europe, except that 183.1-184.1 mc may be used for space research); 174-216 mc (shared with fixed and mobile in the Western Hemisphere, Asia and Australasia); 470-890 mc (exclusive in Western Hemisphere, except that "the 608-614 mc band is reserved exclusively for the Radio Astronomy Service **until** the first administrative Radio Conference after January 1, 1974"); 606-790 mc (exclusive in Europe, but in the African Broadcasting Area 606-614 mc "may be used in the Radio Astronomy service"); 610-890 mc (shared with fixed and mobile services in Asia and Australasia where the 610-614 mc band may also be used for radio astronomy); 890-942 mc (shared with fixed and radiolocation services in Europe and Africa, and with fixed, mobile, and radiolocation in Asia; this band is **not** assigned for Broadcasting in North America); 942-960 mc

...broadcast audio equipment that is exciting the industry

Circle Item 21 on Tech Data Card

MICROPHONES

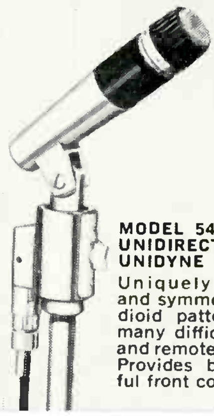
Specially designed for exacting studio applications. Extensively field-tested, many in use by leading radio and TV stations.

MODEL 576 OMNIDIRECTIONAL DYNAMIC

Only ¾" diameter! 40% smaller diam., 60% smaller area than popular dynamic omnidirectionals. Virtually flat from 40 to 20 Kc. Rugged steel case.

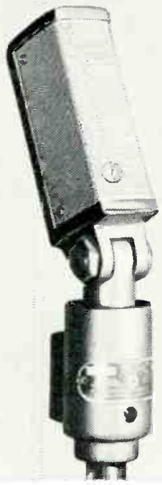
MODEL 570 LAVALIER DYNAMIC

Outstanding on the job. Specially shaped response cuts "chest boom" . . . provides unequalled presence. Non-metallic "Flex-Grip" hanger . . . silent, secure. Only ¾" diam.



MODEL 546 UNIDIRECTIONAL UNIDYNE III

Uniquely uniform and symmetrical cardioid pattern solves many difficult studio and remote problems. Provides broad useful front coverage.

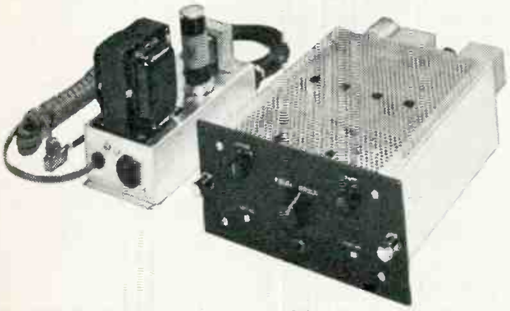


MODEL 333 UNIDIRECTIONAL RIBBON

Extremely rugged. Exceptionally attractive and compact. Ideal for music (stereo or mono) and general applications on stand or boom. Super cardioid, flat wide-range response.

CIRCUITRY

Shure stereo equalizer and preamplifiers are praised as MAJOR contributions to upgrading station quality by broadcasters.



SE-1 STEREO TRANSCRIPTION PREAMPLIFIER

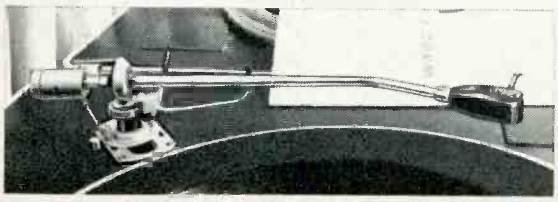
Provides precise RIAA equalization from magnetic phono reproducers at line levels. Separate high and low frequency response trimmers. Lowest distortion, noise level, susceptibility to stray RF fields.

M66 BROADCAST STEREO EQUALIZER

Passive equalizer compensates recorded frequency to three playback characteristics: RIAA, flat, roll-off. Provides precise equalization from magnetic pickup at microphone input level.

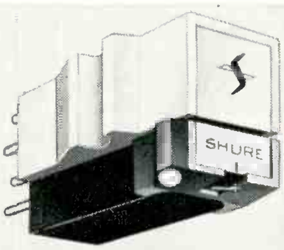
TONE ARMS & CARTRIDGES

World standard for quality sound.



SHURE SME "THE BEST PICK-UP ARM IN THE WORLD"

Utterly beyond comparison. Supremely accurate, proved reliable in quality music stations.



STEREO DYNETIC Phono Cartridges

First choice on every count—standard in the quality music stations.

Write directly to Mr. Robert Carr, Manager of Professional Products Division, for personalized assistance, technical data, samples for testing: Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill.

(shared with fixed in Europe and Africa, and fixed and mobile in Asia; **not** for Broadcasting in the Western Hemisphere).

The Conference succeeded in allocating frequencies for most of the various space services. In addition to those set aside for communication satellites, the following frequency bands were allocated for other space services:

Decametric Waves—15,762-15,768 kc; 18,030-18,036 kc.

Metric Waves—30.005-30.010 mc; 37.75-38.25 mc; 73-74.6 mc (radio astronomy exclusively); 136-137 mc; 137-138 mc; 143.6-143.65 mc; 149.9-150.05 mc; 267-273 mc.

Decimetric Waves — 399.9-400.05 mc (radionavigation satellites); 400.05-401 mc; 401-402 mc; 460-470 mc; 1,400-1,427 mc; 1,427 - 1,429 mc; 1,525 - 1,535 mc; 1,535-1,540 mc; 1,660-1,670 mc; 1,664.4-1,668.4 mc.

Megacycle Frequency Bands — 1,690 - 1,700 mc; 1,700 - 1,710 mc; 1,770-1,790 mc; 2,290-2,300 mc; 2,690-2,700 mc.

Centimetric Waves — 4,400-4,700 mc; 4,990-5,000 mc; 5,250-5,255 mc; 5,670-5,725 mc; 8,400-8,500 mc; 10.68-10.7 gc; 14.3-14.4 gc; 15.25-15.35 gc.

Gigacycle Frequency Bands — 15.35-15.4 gc and 19.3-19.4 gc (radio astronomy exclusive).

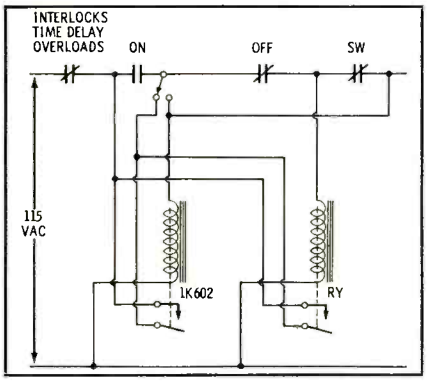
Millimetric Waves — 31-31.3 gc; 31.3-31.5 gc; 31.5-31.8 gc; 31.8-32.3 gc; 33-33.4 gc; 34.2-35.2 gc.

Some of the foregoing allocations are exclusive, some are shared. All take into consideration communications needs throughout the world.

The Future

All revisions of the Radio Regulations adopted by the 1963 ITU Conference will become effective January 1, 1965. While the primary aim of the parley was to satisfy the frequency needs of space communications until 1980, most delegates indicated an awareness that another such conclave would probably be necessary before 1970. Moreover, a resolution was adopted unanimously requesting the ITU Administrative Council to call such a conference whenever its annual review revealed a need for "further agreements for the international regulation of the use of radio frequency bands for space communications." ▲

ENGINEERS' EXCHANGE



Carrier Interruption for Pattern Switching

by Harvey Inman, Staff Engineer, WEOL-AM-FM, Elyria, Ohio

We recently installed a new RCA BTA 1R1 as an alternate main transmitter. The station operates with a directional antenna system, employing separate patterns for day and night. When the pattern is switched the carrier must be momentarily interrupted to prevent arcing across the antenna relay contacts. In the older transmitter, this is done by removing plate voltage from the exciter. It seemed desirable, however, to use the control circuits of the new transmitter for breaking the carrier.

The BTA 1R1 plate contactor is electrically latched, its auxiliary contacts bridging the On switch when actuated—any interruption of supply voltage will allow it to drop out. Switch SW, normally closed, is opened when the button is pushed to change patterns. A 115-volt AC relay, RY, is added with its n/o contacts across the On switch.

When the On switch is operated, the plate contactor (1 K 602) is actuated and its auxiliary contacts are connected across this momentary On switch. At the same time, RY is energized and its contacts are placed across the On switch. When SW is opened briefly during pattern change the plate contactor is de-energized, removing plate voltage from the transmitter. However, RY is still energized, the On switch is still bridged, and voltage is reapplied to the plate contactor when SW is closed again.

Overloads, the opening of any interlock, or operation of the Off switch will allow both the plate contactor and the auxiliary relay to drop out, thus removing power.

Care of Frequency Monitors

By D. Thurman Gardner, Chief Engineer, WXVA, Charles Town, West Virginia.

A review of frequency monitor maintenance may be "old hat" to the OT's, but may prove helpful to inexperienced First-Class operators.

We shall look at preventive maintenance first. A judicious check of all tubes is, at least, a wise move. As with most equipment, any tube that shows a marked weakening or loss of emission should be replaced. This may prevent a costly failure on the air. If desired, an emission chart may be kept for each tube in the unit (except for gaseous regulators, of course). By referring to this chart, tube condition can be readily determined.

When the oscillator tube becomes defective, be sure to insert a carefully selected replacement — never employ a used tube in this circuit. It is usually necessary to retrack the monitor following replacement of the oscillator tube. Always allow the tube to stabilize or "cook" for a while before attempting calibration. This will avoid the need for repeating the adjustments later. If the crystal-stabilized frequency has stayed within one or two cycles according to the report from your monitor service—and this report has been consistent over a period of several months — you may adjust the zeroing trimmer to restore the meter reading to its value prior to tube failure. A note of caution: do not vary the transmitter crystal trimmer to obtain a zero monitor reading. It was the **monitor** oscillator tube you replaced, not the transmitter oscillator. Now if the monitor oscillator is operating correctly, a 1000 cps tone should be present at the aural monitor jack.

Another occasional troublespot is the crystal oven thermostat, which may stick or need adjustment. When resetting the thermostat, make each correction small and allow ample time for the heat stabilizing process to complete a few cycles. Approach the desired temperature gradually, making your adjustments smaller as the correct point is reached.

For proper operation it is important to maintain the input signal at the correct level. I have seen many monitors struggle to do the job, while the input stages were being overloaded by too much signal. Erratic readings, noted particularly on modulation peaks, indicate this condition. To correct, alter or decouple the pickup loop. If it is not adjustable, insert a pad at the monitor input terminals.

In the event monitor recalibration becomes necessary, be sure the unit is operating properly and has had sufficient time to warm up before you call the monitoring service. When they are on the phone:

1. Set the transmitter trimmers so the service has a zero reading.
2. Set the monitor trimmer to zero.

Make note of the readings for several days following adjustment. It is normal for some transmitters to drift a cycle or two during warm-up and during operating periods; weather may have some effect. However, if you perform maintenance regularly, watch the reports from the monitoring service, and take prompt action when problems arise, no pink tickets for off-frequency operation should come in.

No circuit troubleshooting procedures have been given here, since frequency monitors are designed to be relatively trouble-free for years. However, as with any broadcast equipment, when problems arise, voltage, resistance, and current readings will reveal many monitor troubles. The power supply is often considered the first place to begin checking. Clearing up difficulties here will often correct what seems faulty elsewhere in the circuit.

	SYMPTOM	CORRECTION
1.	Readings unsteady or unstable.	Input level is incorrect.
2.	No reading; inspection shows correct level.	Faulty input tube or circuitry.
3.	Meter reads erratically; level is correct, input stage okay.	Check diodes and meter circuitry.
4.	Erratic readings; level, input stage, and meter circuit okay.	Check voltage regulator and rectifier tubes.

NEWS OF THE INDUSTRY

FCC Releases 3rd-Class Study Guide

The FCC has released a special study guide and reference booklet to be used in preparing for the Radiotelephone Third Class Operator Permit with Broadcast Endorsement. Effective January 1, 1964, stations must employ for routine maintenance persons holding at least radiotelephone third-class permits endorsed for broadcast. The study booklet contains sample questions that show the scope and nature of the examination. Included is reference material, in the form of extracts from FCC Rules and Regulations, which may be used in formulating answers to most of the examination questions. Elements 1 and 2 must be successfully completed prior to the issuance of a third-class operators permit, and element 9 for the broadcast endorsement. Each element consists of 20 questions—5% will be allowed for each correct answer. Each element will be scored separately, with a score of 75% required for passing. The study guide, dated November, 1963, may be obtained from the Federal Communications Commission, Washington, D. C., 20554. A detailed summary will appear in a subsequent issue of BROADCAST ENGINEERING.

Transmitter Firm Purchased

Standard Electronics Corp. has been bought by William H. Zillger, its former vice-president and general manager. Under the direction of the new owner, corporation executive offices and promotion and research facilities will be located in a new plant in Manalapan Township, Monmouth County, N. J., on or about January 1, 1964. Temporary headquarters are in operation now in Red Bank, N. J. Standard Electronics Corp. specializes in the manufacture of television and radio transmitting equipment for the broadcasting industry and military use. The company designed and built the first 50 kw television transmitter in the world for WOR-TV, and has many high-power transmitter installations in cities throughout the United States, as well as Canada, Mexico, South America, and other foreign countries.

Acquisition Planned

A proposal by **Ampex Corp.** to acquire the outstanding stock of **Mandrel Industries, Inc.,** was announced by William E. Roberts, president of Ampex, and James F. Coonan, Mandrel board chairman. This action, subject to formal agreement and the approval of shareholders, was unanimously approved recently by the boards of directors of both Ampex and Mandrel. Mandrel, through its domestic divisions and foreign subsidiaries, offers services and products principally to industries concerned with the earth sciences, food processing, and petroleum exploration. It is the world's leading geophysical service organization. Another of its divisions is the leading producer of precision photoelectric color sorting machines for food processing.

Engineering Supervisor Dies

Funeral services were held recently for Frederick J. Molchin, Chief Engineer of WTTV (Indianapolis-Bloomington). The 32-year-old Molchin was also engineering supervisor for the entire Sarkes Tarzian chain of broadcasting outlets. He was **shocked fatally** while working on a television transmitter at the company's Fort Wayne station, WPTA.

Radio Stations Sold

The sale of Radio Station **WGHN**, Grand Haven, Michigan, is announced by Richard D. Gillespie, President. The purchasers are Messrs. Douglas J. Tjapkes, General Manager of WJBO; Mr. George Klies, Promotion Manager of WJBL; and Mr. William Mokma, a Holland, Michigan businessman.

Whitehall Stations, Inc., licensee of Radio Station WTAC, Flint, Mich., has purchased Radio Station **KSO,** Des Moines, Iowa, from BFR Stations, Inc. KSO, opesating with 5000 watts on 1460 kc, is one of the real old timers that began operation in 1921. It was at one time owned by the Des Moines Register and Tribune, but was sold under the duopoly ruling.

Radio Station **KWRE,** Warrenton, Mo., has been purchased by Kaspar Broadcasting Co. of Missouri. Mr. Vernon J. Kaspar owns and operates Radio Station WILO, AM and FM, Frankfort, Ind., which he acquired on October 1, 1959. KWRE operates with 1000 watts on 730 kc.

Microwave TV System for Egypt

An extensive microwave system, following the course of the Nile River from Cairo to Aswan, is to be built by Collins Radio Co. The 500-mile communication link will make television available for the first time to most of the Egyptian people. According to an agreement signed recently by officials of the United Arab Republic and Collins, the system will be provided within 18 months. The contract calls for an initial installation of microwave equipment from the Egyptian capital to the ancient city of Luxor, about 375 miles up the Nile. The UAR's Ministry of Culture and National Guidance said it is Egypt's intent to extend the system southward to Aswan in sufficient time to provide live television coverage of the High Aswan Dam Festivals in 1966.

Radio Stations Sold

Radio Station **KFDM,** Beaumont, Texas, has been sold by **Beaumont Broadcasting Corp.** to **Radio Beaumont, Inc.** KFDM, 5 kw on 560 kc, has been owned and operated by the sellers since 1939.

Sale of **WMRT-AM-FM,** Lansing, Mich., by **Stokes Gresham, Jr.** and associates to the **William R. Walker** group was announced recently. Present Walker stations: daytimer WMRT operates on 1010 kc with 500 watts, WMRT-FM is on 100.7 mc and uses 92 kw. Sale is subject to approval of the FCC.

PERSONALITIES

Arthur T. Cestaro, designer of the "GEL Autolog" automatic transmitter recording system, has been appointed broadcast product manager for **General Electronic Laboratories, Inc.**

James W. (Bill) Mansfield, formerly production coordinator of the Army's "Big Picture" television series, has joined the staff of the **National Association of Broadcasters.** Mr. Mansfield, who recently retired from the Army, will become manager of the NAB's Audio-Visual Department which is part of the NAB Public Relations Service.

Alex Quiroga, color and technical coordinator in Hollywood for **National Broadcasting Co.,** has received this year's Herbert T. Kalmus Gold Medal Award of the **Society of Motion Picture and Television Engineers.** The award — established in 1955 in honor of the developer of the Technicolor process — recognizes outstanding technical achievement in color motion pictures for theater or television use.

BROADCAST ENGINEERING Broadens Editorial Staff

Now swinging into action for B-E is a specially selected staff of Consulting Authors. These experts, chosen from many phases of Broadcasting, are authorities in one or more aspects of broadcast operations and electronics. Collectively, they will bring to the magazine a more thorough coverage of the industry both at home and abroad, since they will be located all over the United States and in strategic parts of the world.

As a source of timely news and feature articles, the new special staff will help make BROADCAST ENGINEERING an even better magazine for our thousands of readers. From the vast resources of the Consulting Author staff will come reports on industry meetings, shows, conventions, regional events, new installations, techniques, government rule-making, modern equipment, and significant trends.

All this is in addition to the down-to-earth technical articles B-E publishes on subjects of value to readers active in all forms of broadcasting, recording, and the associated fields (translators, ETV, CCTV, CATV, microwave, professional sound).

Here is a list of currently appointed Consulting Authors:

Donald L. Coleman—Massachusetts
Elton B. Chick—Ohio
Sim S. Eagleson, Sr.—Florida
J. Gordon Elder—Canada
Elliott P. Fagerberg—Switzerland
Patrick S. Finnegan—Indiana
James French, Jr.—Colorado
Melvon G. Hart—Missouri
Robert A. Jones—Illinois
Robert Kastigar—Illinois
Bill Kessel—Texas
John D. Lenk—California
Ed Murdoch—Florida
Frank B. Ridgeway—New York
George C. Sitts—New York
L. Spencer—Canada
Edward Tong—Louisiana
John J. Walsh—Tennessee
Philip Whitney—Virginia

Network Design

(Continued from page 13)

by measuring the angle between point 3 and point 2.

Bandwidth Correction

The first step in bandwidth correction is the determination of impedance (resistance ± J reactance) looking into the matching network (Fig. 3, point 4) versus frequency, for at least 10 kc each side of the assigned carrier. For new networks, start with the tower impedance for the pertinent frequencies and work through the "impedance and admittance graph" (such as Fig. 1 or 2). It is assumed at this point that the graph has already been solved for the operating carrier frequency. Remember that the reactive and susceptive component values will change slightly with frequency. Table 3 gives typical results for 1230 kc with the 340′ and 150′ towers. This data can also be obtained or further verified by measuring the input point of an existing system with an RF bridge. Table 3 indicates the correction.

Table 3 shows in the case of KREW that there would be a loss of sideband power at 10 kc of approximately 4.35%. In addition to this loss there may be some phase shift of the sidebands; the amount is further dependent upon transmitter tuning, loading networks, and transmission-line length between transmitter and antenna matching network. If present, this phase shift will cause increased audio distortion of the modulated envelope. In the case of KREW, distortion measured 4.3% before correction and 2.4% after correction.

Bandwidth correction is accomplished by inserting additional reactive (or susceptive) elements into the basic network of Fig. 3. The

Table 3. Network Input vs. Freq.

KC	R	X	Theoretical Power loss due to mis-match	Max Phase Shift
340 ft. — KREW				
1220	50.2	−22	4.7%	23°
1230	50.0	0	0%	0°
1240	49.6	+20	4.0%	22°
150 ft.—KOZI				
1220	53.8	−7.5	.6%	13°
1230	50.0	0	0%	0°
1240	45.9	+10	1.6%	13.5°

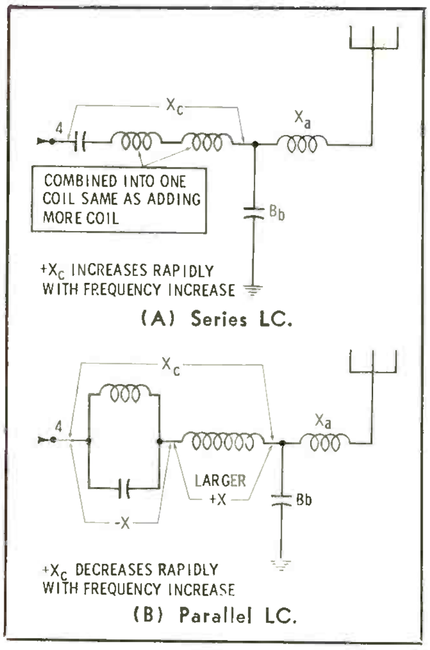


Fig. 4. Methods for bandwidth correction.

values of Xa, Bb, and Xc should remain unchanged on the carrier frequency; but on the sideband frequencies there should be a more rapid change of X or B than results from purely inductive or purely capacitive elements. If the resistance component does not need attention, as in our example of the 340′ KREW tower, only the reactive component of the input impedance need be corrected. Fig. 4B shows the circuitry needed for the KREW tower network.

If the resistive as well as reactive components need correction, series LC circuitry or parallel LC circuitry should be added in Xa or Bb legs, or both. From a study of Figs. 1 and 2, it is a relatively simple matter to determine what circuitry is needed to bring the input impedance back toward 50 ± J0 for the entire frequency band of concern. The final network will be tuned with the RF bridge for sideband matching as well as the usual matching on the carrier frequency. The results of bandwidth correction can be checked by several methods.

1. Connect the transmitter into a purely resistive dummy load. Modulate the transmitter near 100% at several frequencies (e.g., 1000, 3000, 5000, and 10,000 cps), and measure the demodulated audio distortion. Then apply the real load and remeasure distortion. The increase in distortion will help reveal the load bandpass characteristics.
2. With the dummy antenna connected, modulate the transmitter near 100% at 10,000 cps and record the antenna current. Then change to the real load and remeasure using the same modulation power. If, in the real load, there is some decrease in antenna current, sideband power loss can be calculated.
3. Using a highly selective narrowband receiver with an output meter, measure the intensity of each individual sideband into the dummy load and the same modulation characteristics, for each case.

(Note: When changing loads it may be necessary to readjust loading and tuning to obtain the same input current and voltage, and the same efficiency. The RF current may not be exactly the same.)

The desired result is more modulation power with cleaner quality into a good receiver. Following the procedures and suggestions described here should lead to these characteristics. ▲

Directional Antennas

(Continued from page 16)

some of the currently available UHF slot antennas, the slot is energized by a coupling loop. In some higher gain units, a conventional copper transmission line is used to couple the upper half of the slots, while the lower half is excited by RF existing between the outside of the coax, and the inside of the tube.

The slots are approximately 1" wide and 1.3 wavelengths long. In the omnidirectional types, three slots spaced at 120° are used. Adjacent layers of slots are spaced vertically about 1 wavelength apart, and rotated 60° around the axis of the cylinder. This scheme permits great mechanical strength in the cylinder, while still providing an omnidirectional pattern.

Where a wide cardioid pattern is useful, the slots are placed on one side of the cylinder.[4] The use of collinear slots permits excellent horizontal pattern control. Power splitting is used to control the vertical pattern, where null fill-in or beam tilting is required. Mechanical beam tilting is also used, but is not very popular because it results in a tilt upward in the direction opposite to the downward tilt. Electrical beam tilting resulting in downward tilt in all directions is more desirable.[5]

The UHF slot antennas are capable of accepting large amounts of transmitter power; ratings up to 100 kw have been indicated.

Conclusion

The several types of UHF TV transmitting antennas used in the United States were briefly described. No attempt has been made to compare their various qualities. This range of available antennas gives the consulting engineer and broadcaster a choice in equipment. It is hoped that some light has been shed on the various designs.

References

1. Directional Antennas for Television Broadcasting; IRE Transactions on Broadcasting; Pages 13-19, August, 1960.
2. Directional Patterns from Electrically and Mechanically Tilted Antennas, Ronnie Fisk; IRE Convention Record, Part 7, 1962.
3. Characteristics of the Pylon; FM and TV, September, 1946.
4. The patterns of Slotted Cylinder Antennas, G. Sinclair; Proc. of IRE, December, 1948.
5. UHF Transmitting Antennas, H. Korner; Siemens Review, September, 1962.

▲

Transmitting Antennas

(Continued from page 11)

tually to measure the common point resistance in the above example, a value of 54 ohms would be found. Therefore, the actual measured power into the common point could be $10^2 \times 54$, or 5,400 watts.

FCC Rule § 3.54(e) allows additional power for directional stations to compensate for phasing network and line losses. The measured value of 54 ohms is multiplied by 92.5% (.925), reducing it to 50 ohms. This reduced value is specified in the station license as the licensed common point resistance. (It would be well at this point to mention that many of the operating values and legal limits are listed in the station's license. This document should be studied carefully and the information kept in mind. Many cases of improper operation exist solely because no one has bothered to consult the station license.)

From the foregoing it is apparent that the transmitter for a directional antenna station must be capable of delivering at least 7.5% more power than the licensed value, if full-power operation is to be achieved.

Another point of interest here is the difference between the true and the apparent transmitter efficiency. In calculating true efficiency, allowance must be made for whatever additional power the transmitter delivers to compensate for losses. In the previous example of a 5,000-watt station, you might measure a PA plate voltage of 4,800 volts and a plate current of 1.4 amps. The input would thus be 6,720 watts.

For an output of 5,000 watts the apparent efficiency would be:

$$\frac{5{,}000}{6{,}720} \times 100 = 74.4\%$$

The true efficiency, however, would be:

$$\frac{5{,}400}{6{,}720} \times 100 = 80.4\%$$

The common point ammeter, in addition to measuring the station's power, serves as a good indicator of transmitter and antenna trouble. Correlating common point current, transmitter efficiency, and antenna base currents will almost always give a good indication of a malfunction in some part of the system. Exceptions sometimes occur during unusual seasonal variations.

In the event the common point ammeter fails, or when its accuracy becomes questionable, the instrument must be repaired or replaced with a spare which meets FCC requirements. When no spare of the proper type is available, operation may continue for up to 60 days without the meter, provided the FCC is given proper notice and the duration of such operation logged in accordance with FCC Rule § 3.58(b).

More to Come

The preceding information is important to any transmitter engineer who is responsible for a directional antenna system; it will help you to understand better the principles of operation. In the next installment, Part 2, you will learn how phasor and tuning units are handled, how to interpret phase readings, how to use current ratios, and how to be sure the directional pattern complies with the requirements of the station license. ▲

NEW PRODUCTS

Battery Charger/Eliminators

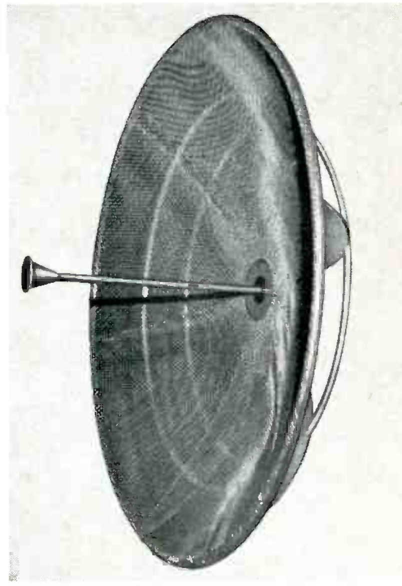
Two portable charger/power-supply units that double as direct power sources for battery operated instruments and equipment are now available from Hughes Electronics Co. The battery chargers are designed for safe charging of high cost nickel-cadmium, silver-zinc, or similar batteries used to power motion picture cameras, field tape recorders, surveying instruments, and field transmitters and receivers. Of modified constant-potential type, the units have built-in current limiting, AC and DC fusing, and output meters for safe recharging of batteries overnight or for extended periods without damage to the cells. Both models accept an input of 115 volts ± 10%. Model HEA12-3 has an output of 15.7 volts @ 3 amps. The dual output of Model HEA12-3B6M is 13 volts @ 8 amps or 15.7 volts @ 3 amps. Housed in rugged, cast aluminum cases and weighing 12 lbs. complete, the devices are priced at $179.50.

Circle Item 42 on Tech Data Card

Higher Ratings for Heliax

Andrew Corp. announces a 50% increase in average power ratings for ⅜" and ⅞" Heliax cables, and a 20% increase in new 1⅝" type H7-50A. These cables now use a new higher-temperature insulating material recently introduced in the 3" and 5" cables. The insulation permits greater average power ratings and a significant reduction in attenuation over comparable cables. All air-dielectric cables now feature the new material. Heliax power ratings as well as rigid copper line ratings, are now based on a 60°C inner conductor temperature rise over 40°C ambient temperature.

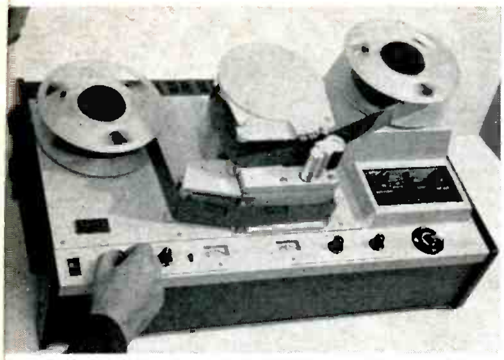
Circle Item 43 on Tech Data Card



Plane Polarized Antennas

Applications in bands from 1700 to 2450 mc may be satisfied by a wide range of plane-polarized antennas now available from TACO, a subsidiary of the Jerrold Corp. Six models, each sensitive to a specific band, are available with either spun or mesh reflectors. The latter models are fabricated with ¼" mesh to insure good front-to-back ratios and provide reduced loading at high wind velocities. The feed provides symmetrical primary illumination yet retains wide impedance bandwidth characteristics. Although the input is a standard ⅞" EIA flange with 90° elbow, adaptors are available for other transmission line sizes. Feeds may be mounted from front or rear, and rotated for polarization adjustment.

Circle Item 44 on Tech Data Card



Portable Broadcast Television Recorder

A portable broadcast television tape recorder weighing just under 100 pounds has been developed by **Ampex Corp.** Designated VR-660, the recorder is designed for mobile and studio use by network, local commercial, and educational broadcasters. The all-transistorized recorder incorporates electronic features which enable it to produce television pictures meeting FCC standards for broadcast, without additional equipment. It is available in both a 60 cps version for operation in the United States, Canada, and certain other nations, and a 50 cps version for compatibility with power standards elsewhere in the world. The 60 cps version offers the lowest tape consumption available, operating at 3.7 inches per second, and can record up to five hours of continuous program material on a single 12½" reel of standard 2" television tape. Deliveries of the equipment will begin early in 1964, with the price set at $14,500.

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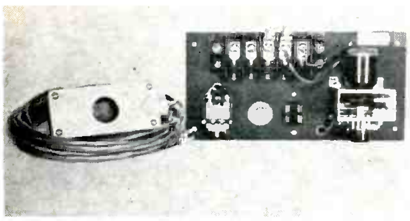


Photoelectric Panel for Tower Control Units

A tubeless photoelectric panel, for direct replacement in existing control and alarm units for microwave tower lighting, has been made available by Hughey & Phillips, Inc. The panel and photocell are readily interchangeable from an electrical and mechanical standpoint and match the appearance of panels in existing units. Operation of the circuit is identical to the company's new line of tubeless "Fully compensated" photoelectric control units, all of which provide exceptional stability over a temperature range of −40°F to +150°F, and through line variations from 90 to 130 volts.

Circle Item 46 on Tech Data Card

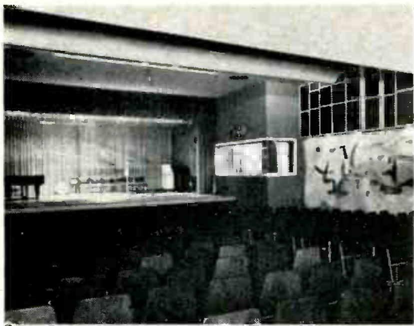
Video Distribution Amplifier

A completely transistorized video distribution amplifier for a full range of television studio applications with both color and monochrome signal systems has been put on the market by **RCA.** The TA-23

Circle Item 27 on Tech Data Card

Circle Item 28 on Tech Data Card

Circle Item 34 on Tech Data Card



Next Month

audio, video, acoustics:

ENGINEERS' APPROACH TO LIVE MUSIC PICKUP

Considerations in planning remote broadcasts.

ACOUSTICS FOR RECORDING STUDIOS

Planning guide for new broadcast and recording studios.

CATV TODAY, A LOOK AT THE FIELD

Survey of conditions, equipment and techniques.

VTR - CUE

Device for recording television tape leaders.

Plus: ***Technical Talks, Engineers' Exchange, New Products, and a host of other timely features.***

Reserve your copies now! Fill out and send in the convenient subscription card bound in this issue, and receive the Broadcast Engineers' Maintenance Guide free of charge.

dual-output amplifier is small enough to permit eight units and a regulated power supply to be mounted in a studio rack frame only 5¼ inches high, one-fifth the space required for tube-type units. The new amplifier generates only one-twentieth of the heat produced by tube-type equipment. A number of TA-23 amplifiers may be bridged together to provide multiple output feeds from a common signal source. Other uses include gain recovery following an equalized cable, and the distribution of color subcarrier signals in color TV systems.

Circle Item 47 on Tech Data Card

Label Maker

The Model 6-E Label Maker by **Rotex Div., Avery Adhesive Products, Inc.,** is a hand-operated tool that prints individual self-adhesive labels. Producing large-letter professional labels, the device will print any desired words or numbers, in the wide range of distinctive colors of vinyl label tape available. The permanent raised-letter labels can be made to either blend or contrast with their background. The labels present a professional appearance for labeling electrical panels, controls, cameras, instrument housings, transport equipment, and other broadcasting and telecasting equipment.

Circle Item 48 on Tech Data Card

Wireless FM Microphone

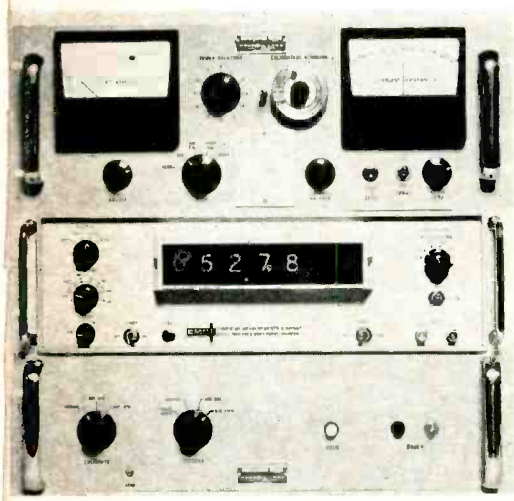
Kinematix, Inc., has announced the first FM wireless microphone operating in the FM broadcast band under a new FCC ruling effective July 1, 1963. Called the "IMP II," the microphone is small enough to be concealed in a cigarette pack, yet will transmit up to 200 feet to any FM receiver, without wires or background noise. The transmitter frequency is adjustable between 88 and 108 mc. The unit is lightweight (7½ oz., including its leather case) and may be used with its own built-in pinhead mike or any low-impedance microphone. IMP II is available without built-in microphone for $39.95, or with microphone for $49.95.

Circle Item 49 on Tech Data Card

Turntable Preamplifier

Sparta Electronic Corp. has introduced a turntable preamplifier which is equalized for the RIAA curve when used with variable reluctance cartridges. The TEP-2 is completely transistorized and uses low-noise, temperature-compensated circuitry. To insure accurate impedance match between the load and output stage, a premium-quality output transformer is supplied. Included is a two-position rotary switch, with mounting plate, which can be connected to the equalizer to provide additional high frequency rolloff for noisy records. The preamplifier and power supply are contained on a single printed circuit board, securely mounted in a two-piece steel box.

Circle Item 50 on Tech Data Card



Phase Monitor

The Nems-Clarke PPM-101 Precision Phase Monitor, by **Vitro Electronics**, is designed for use with critical directional antenna arrays, where resolution and stability are of paramount importance. Phase angle readings are presented on the in-line readout panel of a digital counter directly in degrees, with a resolution of 0.1°. Current ratio between towers is read on the current ratio meter as a deviation from normal value, with a resolution of 0.1%. Provision is also made for individual sampling loop current measurements. The nuvistorized and transistorized circuitry is enclosed in completely shielded plug-in modules. The use of plug-in input components makes the system adaptable to any number of towers from two to twelve. Self-calibration features are included in both the phase and current ratio meters.

Circle Item 52 on Tech Data Card

ENGINEERS' TECH DATA SECTION

AUDIO & RECORDING EQUIPMENT

62. AUTOMATIC TAPE CONTROL—Check list outlines preventive maintenance for tape cartridge equipment.
63. BROADCAST ELECTRONICS—Packet contains specs and prices for tape cartridge system.
64. CINE-SONIC SOUND—Brochure describes tape cartridge service; catalog sheet lists tape sizes and reels to fit any type machine.
65. COUSINO ELECTRONICS—Bulletins describe audio repeaters and continuous loop "Echo-Matic" tape cartridges.
66. FERRODYNAMICS—Spec sheets detail line of magnetic tape reels, kits, and correspondence tape for miniature recorders and dictating machines.
67. HARMAN-KARDON—20-page catalog on public address and sound equipment is also a "how to" manual.
68. UNIVERSITY—Three separate catalogs cover microphones, public address loudspeakers, and hi-fi speaker systems.
69. 3M—Bulletin "Playback" carries items of interest to engineers and operators concerned with professional quality audio recording and playback.
70. MILES REPRODUCER—Bulletin describes "Walkie-Recordall-64," a miniaturized voice-actuated recorder.
71. RCA—Data sheet gives physical and magnetic properties of magnetic recording tape.
72. SAXITONE TAPE SALES—1963 Winter catalog contains cumulative listing of 4-track stereo tapes, in open reel and cartridge types.
73. TURNER—Spec sheet covers 150/30,000-ohm microphone, giving specifications and applications.
74. VIKING OF MINNEAPOLIS—Catalog sheets list line of tape recorders for portable and studio applications.

COMPONENTS & MATERIALS

75. ALLIED RADIO—1964 Consumer Products Catalog Number 230 lists lines of hi-fi and electronic gear.
76. AMPEREX—Condensed semiconductor catalog lists line of PADT transistors; includes basic specifications.
77. ATLAS SOUND—Data sheet outlines "Columair" sound column speakers for use in studios and auditoriums.
78. BELDEN—Blueprints give detailed descriptions of TV camera cables.
79. BRADY—Catalog lists line of self-sticking labels and markers for wires, cables, and components.
80. CORNELL-DUBILIER—144-page component selector guide describes line of capacitors, filters, delay lines, relays, vibrators, and power supplies.
81. INDUSTRIAL ELECTRIC REELS—Spec sheets on line of motor-driven and hand-wound microphone cable reels.
82. KEMLITE LABORATORIES—Brochure on "Second Generation Flashtubes" includes specifications and other information.
83. ONAN—Booklet is entitled "How to Select and Install Standby Electric Plants."
84. PERMOFLUX CORP.—Specifications brochure lists line of high fidelity headphones for audio engineers,

acoustical engineers, professional musicians, and general audio use.

85. QUAM-NICHOLS — New high-fidelity catalog portrays line of speakers and other components.
86. RAULAND—Spec sheets on display tubes, scan converter storage tubes, image intensifiers, and projection tubes.
87. SANGAMO—20-page bulletin covering line of transmitting type mica capacitors.
88. SPRAGUE — Product catalog covers electronic components for industrial, military, and commercial applications.
89. SWITCHCRAFT—Product bulletin describes new single-row phenolic jack panels, 1400 and 1500 series.
90. TERADO—Sheet depicts wide line of 60-cps mobile power inverters and several types of battery chargers.

RADIO & CONTROL ROOM EQUIPMENT

91. ALTEC LANSING—Brochures present commercial speaker systems and line of playback and speech-input equipment for recording and broadcast studios.
92. FAIRCHILD—Group of technical bulletins with means, methods, and products for broadcast stations.
93. KARG LABORATORIES—Tech sheets on 12-channel FM monitor and multiplex signal generator, including several article reprints from trade magazines.
94. ROTRON—Data sheet on new cabinet cooling panel designed to fit standard 19" relay rack.
95. SPARTA—Spec sheet on broadcast turntables and accessories including solid-state preamplifier.

REFERENCE MATERIAL

96. HAYDEN BOOK CO.—New 1964 catalog lists and describes books published by John F. Rider and Hayden Book Co.
97. INTERNATIONAL ELECTRONIC RESEARCH—25-page report is entitled "Heat-Dissipating Electron Tube Shields and Their Relation to Tube Life & Equipment Reliability."

STUDIO & CAMERA EQUIPMENT

98. BLONDER-TONGUE — Product brochure describes transistorized vidicon camera with 8" viewfinder screen.
99. HOUSTON FEARLESS — Brochure gives complete specs on line of TV camera mounting equipment.
100. TELEVISION ZOOMAR—Product brochure on "Angenieux-Zoomar" ten-to-one ratio lens for use on Image Orthicon cameras.

TELEVISION EQUIPMENT

101. EITEL-McCULLOUGH — Features and specs brochure covers line of klystrons for UHF-TV transmitters and water loads for power dissipation.
102. ELECTRA MEGADYNE—New literature is on EMI Type 203 4½" Image Orthicon camera and EMI Type 201 Vidicon Camera.
103. ELECTRONICS, MISSILES & COMMUNICATIONS — Brochure describes 2500-mc transmitter for ETV applications.
104. INTERNATIONAL NUCLEAR—Line of transistorized video equipment is described in catalog.
105. JERROLD ELECTRONICS — Catalog sheet on wide-band microwave equipment from 6 to 15 kmc covering transmission of: high bit-rate computer data, radar video, off-the-air TV pick-up, TV broadcast STL, and high definition CCTV.

Circle Item 38 on Tech Data Card

Professional Services

Classified

Advertising rates in the Classified Section are ten cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra. Check or money order must be enclosed with ad.

The classified columns are not open to the advertising of any broadcast equipment or supplies regularly produced by manufacturers unless the equipment is used and no longer owned by the manufacturer. Display advertising must be purchased in such cases.

EQUIPMENT FOR SALE

Commercial Crystals and new or replacement crystals for RCA, Gates, W. E., Bliley and J-K holders; regrinding, repair, etc. BC-604 crystals. Also A. M. monitor service. Nationwide unsolicited testimonials praise our products and fast service. Eidson Electronic Company, Box 96, Temple, Texas. 9-61 tf

ENGINEER. Advisory capacity, must know thoroughly all phases of storecast receivers, design, alignment and most of all their installation. Can be presently employed, should have test equipment for same. Write P. O. Box 6731, Cleveland, Ohio. 12-63-2t

GOVERNMENT SURPLUS, NEW 10 CM. WEATHER RADAR SYSTEM—Raytheon, 275 KW peak output S band. Rotating yoke P.P.I. Weather Band 4, 20 and 80 mi. range. Price $975 complete. Has picked up clouds at 50 mi. Wt. 488 lbs. Radio Research Inst. Co., 550 5th Ave., New York, New York. 8-63 6t

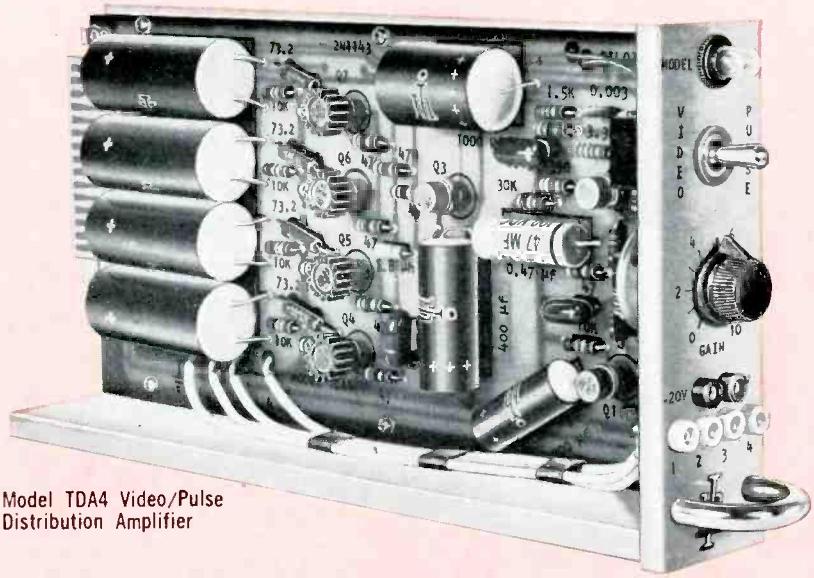
Established California antenna manufacturer is looking for aggressive sales manager. Applicant must have demonstrated at least 5 years of broadcast equipment sales background; have knowledge of technical broadcast equipment; progressive upgraded sales abilty; plus administrative abilty in past positions. Our applicants personal life, must stand investigation. This new position will require permanent residence in California with some light traveling. This is a top management position requiring mature thinking, experience and qualifying background. We offer growth, salary plus commission to right man, besides fringe benefits. Send complete resumé with recent photo. Write Broadcast Engineering. Dept. 102. 1-64 1t

Will buy or trade used tape and disc recording equipment—Ampex, Concertone, Magnecord, Presto, etc. Audio equipment for sale. Boynton Studio, 295 Main St., Tuckahoe, N. Y. 1-64 tf

TRANSMITTING TUBES FOR SALE—Immediate Delivery on 6076 Power Tetrodes, at $235 each, 3X2500F3—$170, 450TL—$35, 4-125A—$22.50, 872A—$5.25, 575A—$15.50. Also **SPECIAL HIGH QUALITY ENGLISH ELECTRIC 6166**—$840. All tubes are factory new, 1000 hour warranty, from the largest wholesale supplier of broadcast tubes. **Inquire** about our special quotes for complete spare tube kits. **CALVERT ELECTRONICS, INC.**, Dept. BE-1, 220 E. 23rd St., New York 10, N. Y. (212) OR 9-1340.

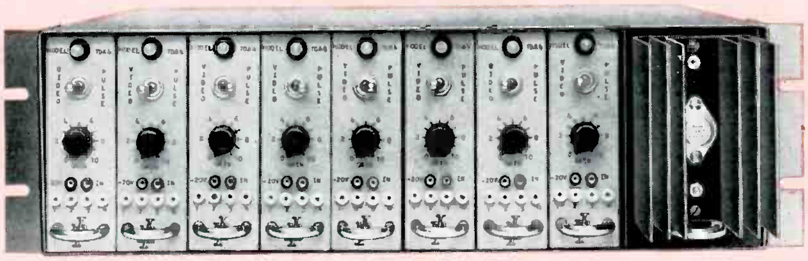
Recording Studio disposing of all equipment, which includes Ampex, Presto, Berlant, Bek-O-Kut, Bogen cutting and recording equipment, Shure, Altec, Stephans, Turner mikes and other miscl. related items. Complete list on request. All units in first class operating condition. Certified discs cut from lathes or tapes will be mailed to authentic, serious, interested purchasers. Contact Clyde Schultz, Ace Recording Studio, 659 Memorial Dr. S.E., Cedar Rapids, Iowa. 1-64 1t

Advertisers' Index



Model TDA4 Video/Pulse Distribution Amplifier

Model TDA4's with TPS4 Power Supply and TMF4 Mounting Frame



THE MODEL TDA4 VIDEO / PULSE DISTRIBUTION AMPLIFIER PROVIDES 32 OUTPUTS IN JUST 5¼ INCHES OF PANEL SPACE!

Completely transistorized and in plug-in modules, the TDA4 meets the most exacting specifications of monochrome and color distribution systems.

Compact and rugged, eight TDA4's and a TPS4 Power Supply provide 32 outputs at the rear of the mounting frame. The front of each amplifier is equipped with a pilot lamp, a gain control, video-pulse function switch and six test jacks.

While the older tube-type distribution amplifiers with only 30 output signals and producing 3200 watts of heat occupy a 50 inch rack, eight TDA4's occupy only 5¼ inches of panel space, provide 32 individual output signals and dissipate 35 watts of heat.

The initial design of the TDA4 was based on the time and use proven success of the now famous TDA2. The TDA4 uses exactly the same circuit and components as the TDA2.

The TPS4 Power Supply module is also completely solid state and provides 20 volts, regulated, to all eight amplifiers. It is designed so most of the heat dissipation is at the front of the cabinet.

TDA4 Video/Pulse Distribution Amplifier	$275.00 each, f.o.b. Nashville, Tenn.
TDA4K Video/Pulse Distribution Amplifier with sync mixing	$310.00 f.o.b. Nashville, Tenn.
TPS4 Power Supply	$275.00 each, f.o.b. Nashville, Tenn.
TMF4 Mounting Frame	$175.00 each, f.o.b. Nashville, Tenn.
TME4 Module Extender	$ 40.00 each, f.o.b. Nashville, Tenn.

Write for complete information and specifications Department T-4

INTERNATIONAL NUCLEAR CORP.

INTERNATIONAL NUCLEAR CORPORATION

608 Norris Avenue

Nashville 4, Tennessee

Circle Item 41 on Tech Data Card

RCA CARTRIDGE TAPE SYSTEM

Automatically Triggers Playback Units, Tape Recorders, Turntables, and Other Devices

Here's a unique built-in feature! The Recording Amplifier of the RT-7B Cartridge Tape System generates two kinds of cue signals. One is used to automatically cue up each tape, at the beginning of a program, the same as in ordinary units. The other signal, a special Trip-Cue, can be placed anywhere on the tape. This will cause the playback unit to trip and start other station equipments.

You can preset two, or a dozen or more RCA tape units, to play sequentially. You can play back a series of spots or musical selections, activate tape recorders, turntables, or other devices capable of being remotely started. (In TV use Trip-Cue is ideal for slide commercials. Tape announcements can be cued to advance the slide projector.)

You'll like the RT-7B's automatic, silent operation, its compactness, high styling, perfect reproduction. Cartridge is selected, placed in playback unit, forgotten until "air" time, then instantly played. Cueing and threading are eliminated. Cue fluffs are a thing of the past!

Transistor circuitry, good regulation for precise timing, low power consumption, are among other valuable features.

See your RCA Broadcast Representative for the complete story. Or write RCA Broadcast and Television Equipment, Dept. E-367, Building 15-5, Camden, N.J.

RCA® THE MOST TRUSTED NAME IN ELECTRONICS