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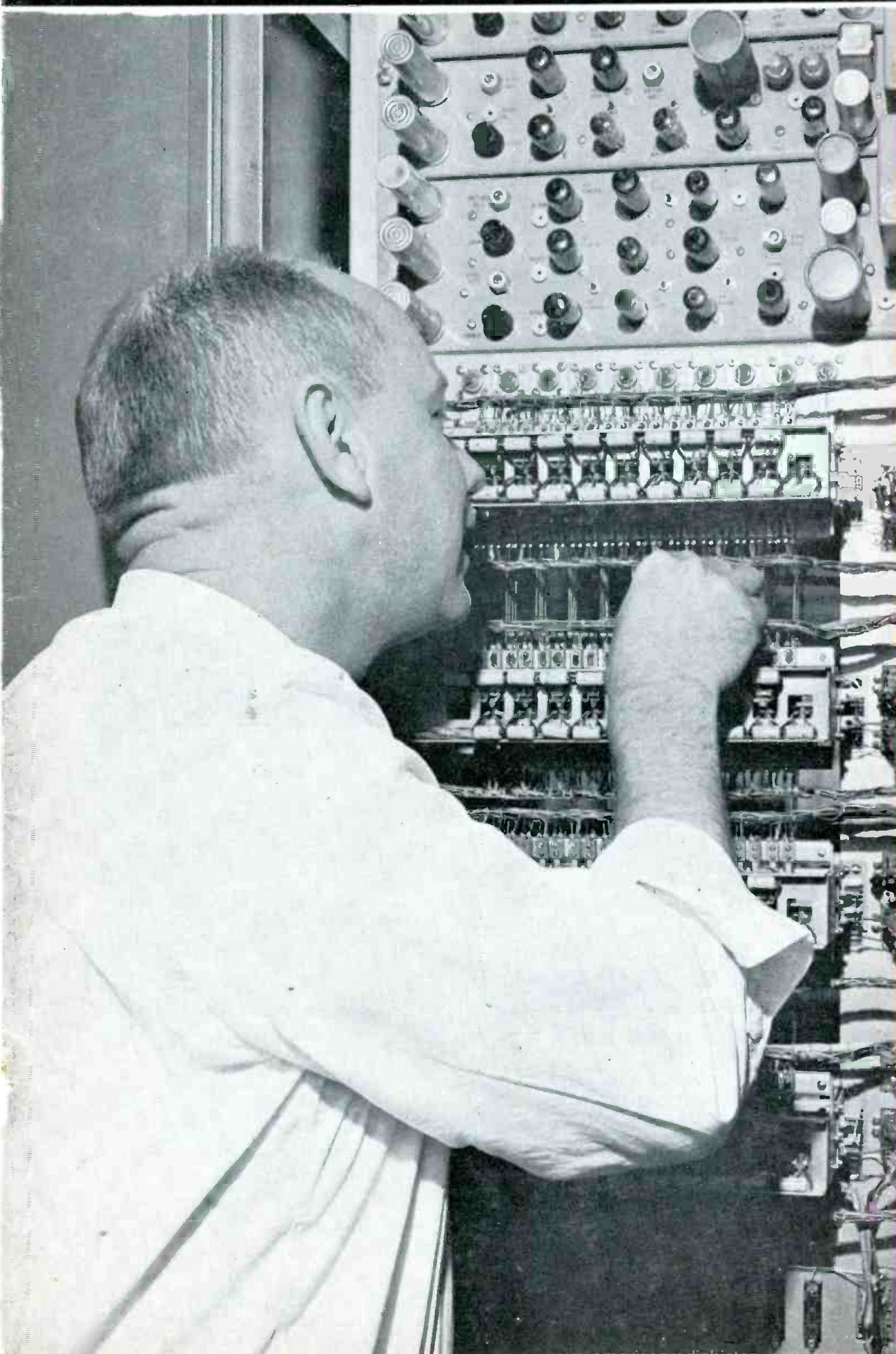

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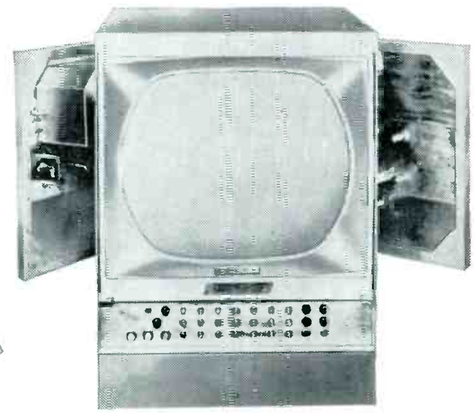

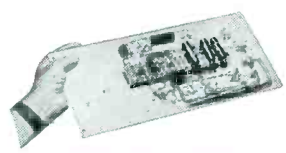

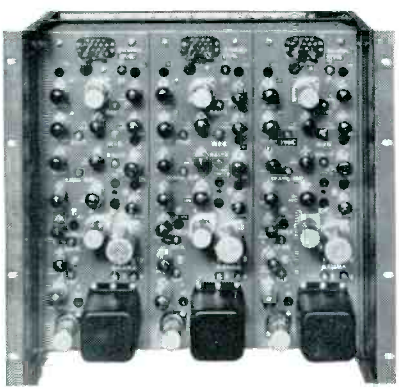

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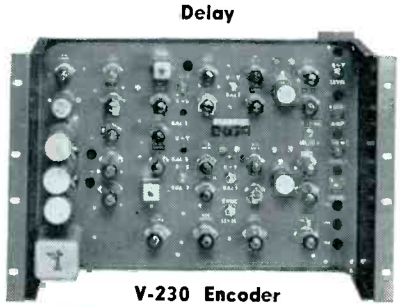

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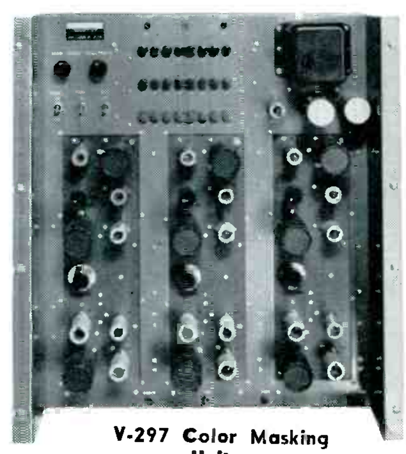

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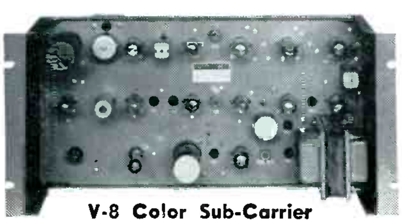

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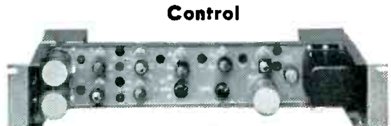

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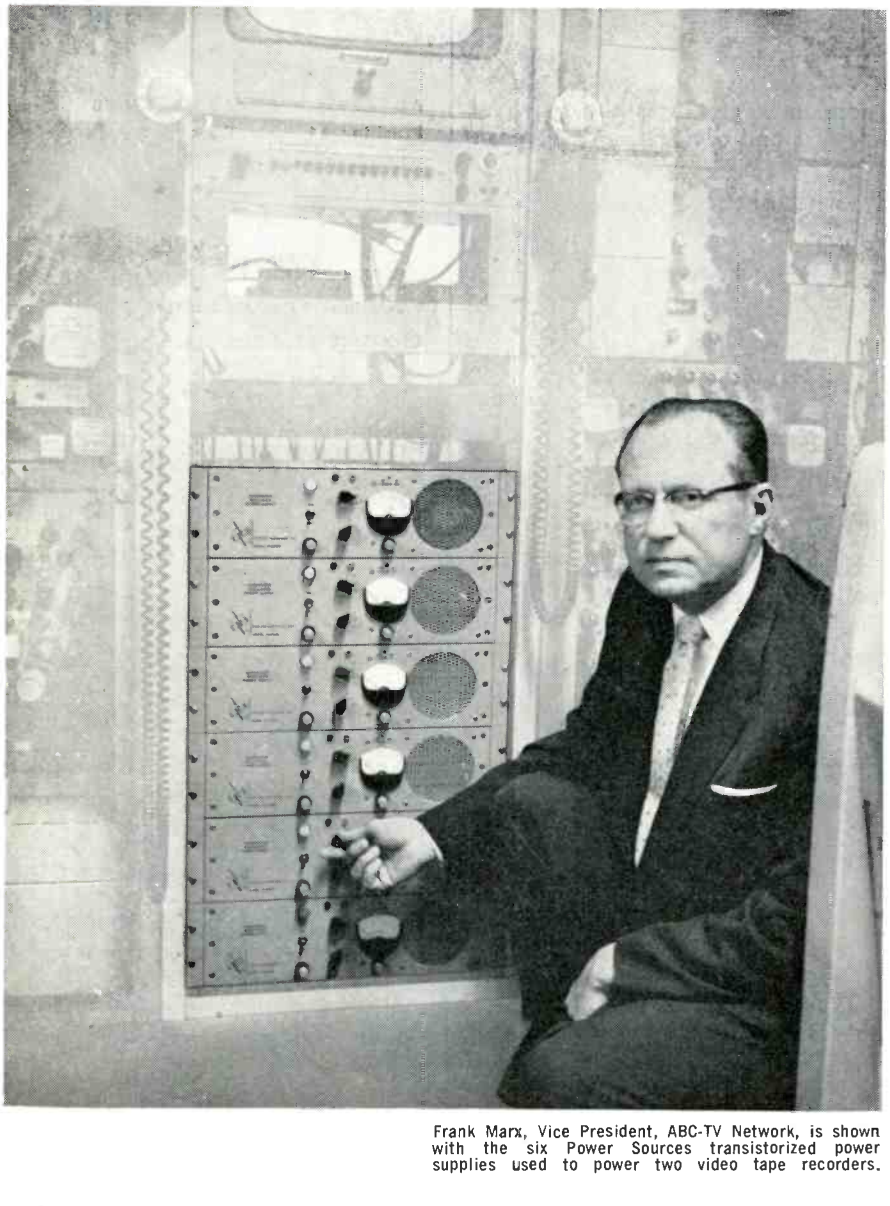

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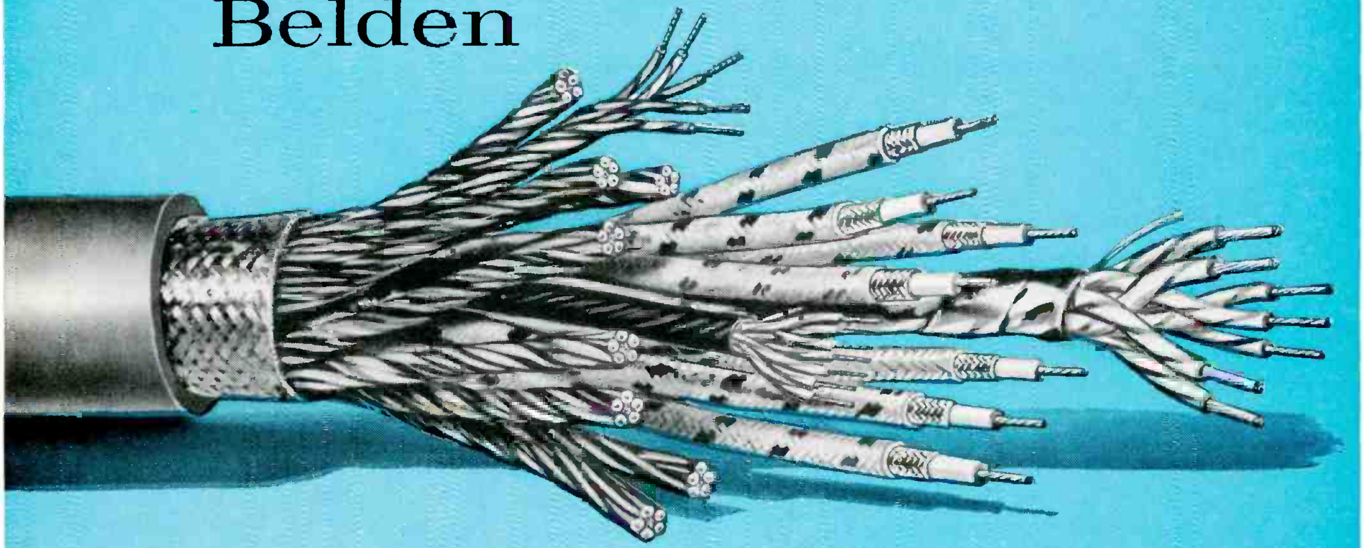

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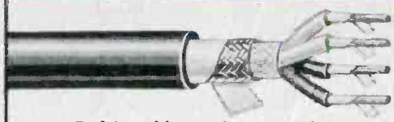

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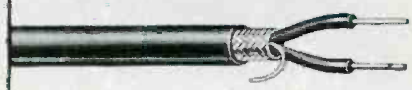

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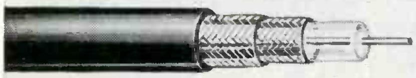

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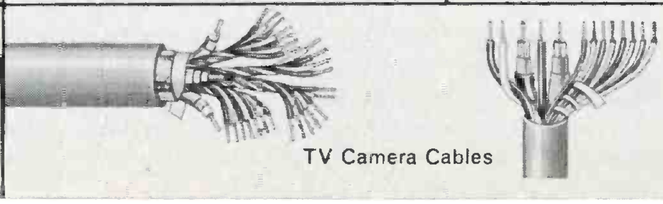

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POWER DIVIDERS FOR DIRECTIONAL

Proper array design and adjustment requires the knowledge of matching networks and dividers.

MANY engineers have often expressed a long felt need for better understanding of power divider systems, particularly as they are in use today. Available literature is very limited, and a survey of the problems encountered in power divider design and adjustment indicates that there are many areas where a more comprehensive understanding of present day power divider devices would lead to more economical designs and easier, more efficient adjustments.

It is the purpose of this article, therefore, to examine power divider systems and illustrate those factors which are of prime consideration. In this way, it is believed that many designs can provide a somewhat more realistic approach, easier adjustments and a better contribution to more economical phasing systems.

The General Power Divider

The power divider section of a directional antenna phasing system is, in reality, two separate and distinct devices as shown in Figure 1. Specifically, there is the power divider proper and a device for matching the impedance of the divider to the desired common point resistance. The point of separation between the two devices is always that point at which the full transmitter power exists for the last time.

In Figure 2 a Thevenin equivalent circuit has replaced the power divider proper. The impedance of the divider is shown consisting of a real, or resistance part, and an imaginary, or reactive part. Except in rare instances, this reactance will always be inductive. The resistance shown here is the real load for the transmitter and if the full transmitter power is to be supplied to the antenna system, the full transmitter power must be dissipated in this resistance. For this reason, the value of this resistance is the all important parameter in the design and adjustment of any power divider. It completely determines the current flow in the circuit.

Power dividers must first of all be capable of dividing power and this power division must be easily adjustable. However, in the final analysis, they must also operate efficiently and require as inexpensive components as is consistent with good engineering practice. And, since efficiency and economy are a function of the currents flowing in the power dividing system, it can readily be seen that the higher this input resistance can be made, the more efficient and economical will be the divider.

This resistance also determines the requirements of the matching network; for, as will be shown later, it is this resistance that must be matched to the desired common point.

Currently, there are three basic types of power dividing circuits in use. For lack of better names, they have been called an "Unequal Resistance Type," a "Shunt Type," and a "Series Type." They are shown in Figure 3, together with their equivalent circuits.

The "Unequal Resistance Type"

The "Unequal Resistance Type" consists essentially of two "L" networks connected back to back, and power division is accomplished by making their input resistances inversely proportional to the two powers. It is not too easily adjusted, because it requires an adjustment of both the series inductances and the shunt capacities to effect the desired power division, and every adjustment is always accompanied by a rather large change in phase shift added to the two lines. This type of power divider is not used very often and is not practical at all except for two tower arrays.

The Shunt Power Divider

The "Shunt Type" of power divider consists of a separate coil

ANTENNA SYSTEMS

By R. S. Bush
Phasing Design Engineer
Gates Radio Company
Quincy, Illinois

EDITOR'S NOTE:

Author R. S. Bush presents a second complete articlce on AM directional antenna elements. "Quantitative Phasing System Specifications" was published in the June, 1961 issue of Broadcast Engineering. This report on power dividers was given as a paper at the 15th Annual NAB Engineering Conference.

shunted to ground for each antenna feed. Full and complete control of the power division is possible if all but one of the shunt coils is made variable. Placing the tap for the highest power output from this divider at the top of one of the coils always produces the highest possible input resistance for any given power division.

In Figure 4, the variation of the input resistance and reactance of this type of divider is shown as a function of the reactance of the two shunt coils. The example is based on the assumption that the input to each of the transmission lines is 50 ohms. From these curves, it is readily seen that the input resistance of the divider increases as the reactance of these coils increase. However, the efficiency curve definitely shows an optimum size for them—in this case, approximately

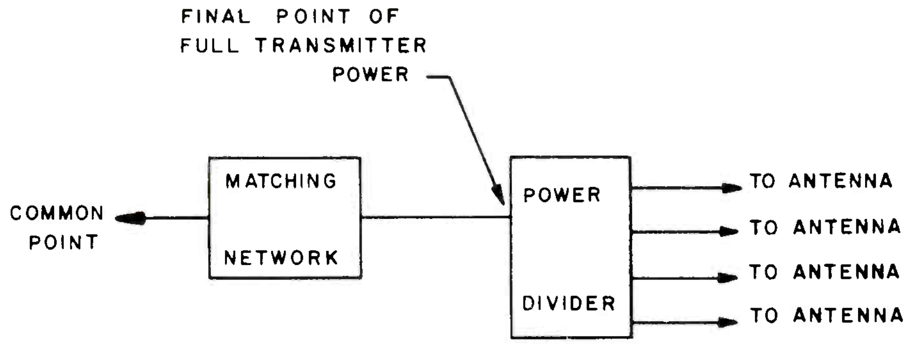

Figure 1—Block diagram of general power divider.

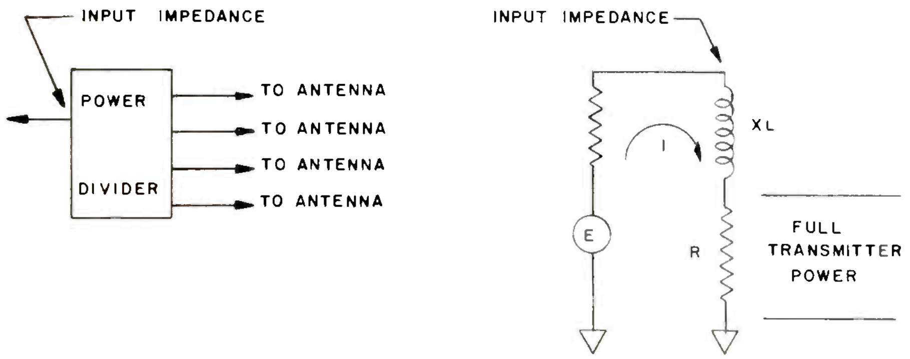

Figure 2—General power divider and its equivalent circuit.

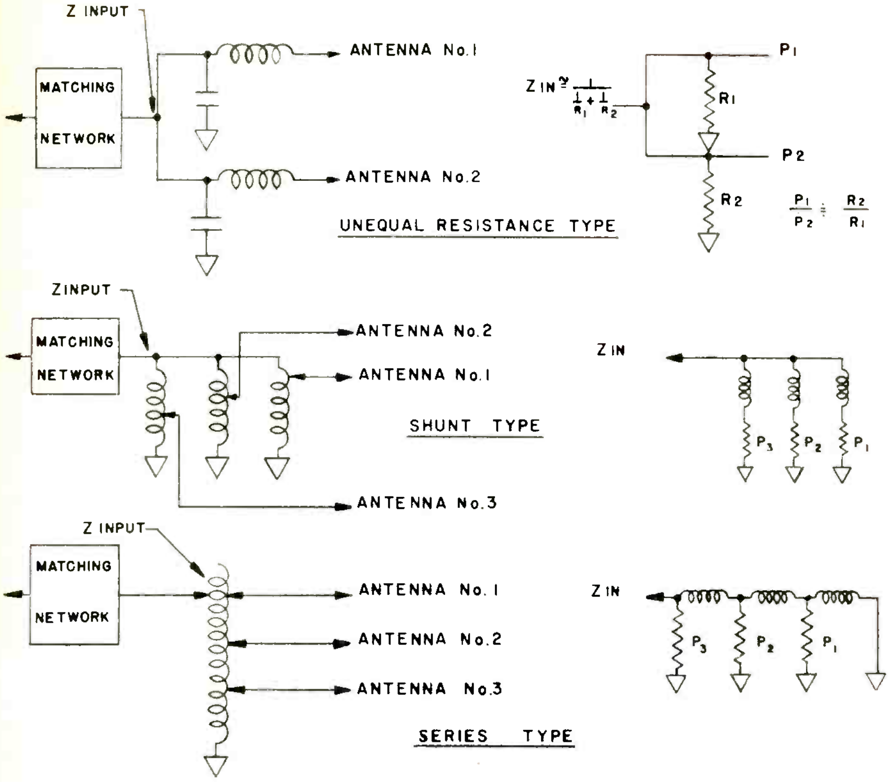

Figure 3

3 to 4 times the transmission line impedances. This is an important consideration in the design and adjustment of this type of divider.

Figure 5 illustrates the variation of the input impedance as a function of the power fed to the lowest power tower, with the transmitter power remaining constant at 1000 watts. The resistance curve, in this figure, is especially significant in that it shows only a small variation as the power division is adjusted from zero to equal powers in both towers. This fact is indicative of the relative ease of adjustment of this type of power divider over a very wide range of power division. This is, definitely, the main advantage of this type.

The primary disadvantage for this divider lies in the fact that as more antennas are added, additional impedances are connected in parallel across the input of this divider. Consequently, from a practical viewpoint, if more than three towers are served with this type, the input resistance becomes very low and the resulting high currents make the shunt divider very inefficient and costly.

The Series Power Divider

The series divider consists of a single coil on which the various antenna feeds are tapped. Practical adjustment of this divider is usually begun by locating the tap for the most power well up on the coil, and then adjusting the lower power feeds, as required, for the desired power division. The input of this divider always occurs at the position of the highest power tap.

For design purposes, however, it is more convenient to fix the lowest tap and adjust those for higher powers. So, in Figure 6, is shown the variation of the input resistance and reactance of this type of divider as the lowest tap is placed higher and higher on the coil. Here, again, an optimum position is indicated as far as efficiency is concerned, although it is not critical as long as this lowest tap is above a certain minimum value.

In Figure 7, the lowest tap is set at a point where the reactance of the coil below the tap is equal to the input to the transmission line feeding from it. The highest tap is then moved further and further up the coil to provide more power to the number one tower. Note the rather sizeable change in input resistance as the power division is changed. Obviously from this curve, this type of divider is a little more difficult to adjust than the shunt type. However, in general, the input resistance can be made higher. Also, as additional antennas are served with this type, the input resistance is not directly shunted by the additional impedances, so that the series divider can always provide a higher input resistance with a large number of towers that can the shunt divider. This fact gives this type of divider a decided advantage over the shunt type for greater than three towers or for systems involving high powers.

One of the most common errors made in power divider design occurs in the practice of making the assumption that the input impedance to the transmission lines is a pure resistance. This is done to simplify the mathematics. However, the design is often concluded with this assumption being considered as a statement of fact.

Now it is a well known fact that, in most directional antenna systems, the transmission lines will be somewhat mismatched in the final adjustment. This mismatch materially affects the operation of the power divider, since the lines provide the load for the divider. To illustrate this, a specification has been chosen that the lines will have an input VSWR of 2 to 1, and the Smith chart in Figure 8 gives the range of input impedance that the lines may have if they fall within this specification.

In Figure 9, both the shunt and the series type of divider have been adjusted for the power division shown and so that they will have equal input resistances when the tranmsission line inputs show a VSWR of unity. This input resistance is represented by the horizontal line in the center of the figure. Now, by induction the maximum effect of the transmission line mismatch occurs when both transmission lines are mismatched an equal amount in the same direction. The two resistance curves represent the variation in the input resistance of each type of divider as the input to the lines varies around the VSWR circle of Figure 8.

Evidently, there can be a considerable variation of the divider input depending upon the extent of the transmission line mismatch. Hence, no power divider design can ever be considered complete unless that design has been computed over a considerable range. It is likewise

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an important point that no power divider design should ever be submitted unless accompanied with a full and complete statement as to the extent of the range over which the power divider design has been considered. The range would be impossible to predict from a simple list of components, and the adjusting engineer could not possibly know within what limits the system was capable of satisfactory performance.

The Matching Network

Probably more variation occurs from one system to another in the matching network than in any other portion of phasing system design. However, as will be shown, all methods are basically the same and aside from requiring more or less components, all perform equally well.

In Figure 10, an "L" network is shown designed to match the given power divider input resistance to the common point. This is the simplest and most economical method, and, if designed with sufficient range, it is the easiest to adjust, since there are only two elements to adjust. Matching devices, no matter how elaborate, serve only the single purpose of matching the divider input to the common point, consequently, the more simple this network can be made, the more efficient and economical will be this portion of the system. The "L" network will always suffice for this purpose if power is to be supplied to more than one tower; for with this stipulation, the input resistance of the power divider can never exceed the common point resistance.

The "T" network, shown in Figure 10, is nothing more than an "L" network with an additional reactance to aid in tuning out a reactance which appears at the junction of the capacitor and the series coils. The "T" network, therefore, provides a slight advantage in adjustment facility at the sacrifice of adding an additional element to adjust.

Probably the most common type of matching system used today is the resonant tank circuit type shown in Figure 11. Here the capacity "C" is tuned to resonance with an additional inductance added to that already supplied by the input impedance of the power divider. The actual operation of this type, however, is best illustrated in the rearranged version shown at the right. Here it is easily seen that this type of network is really nothing more than the "T" type shown in Figure 10.

The fourth matching network, chosen for this discussion, is one that has come into frequent use in recent years. C is tuned to resonance with the power divider input and L, so that a pure resistance of some value higher than the common point appears at point X. This high resistance is then matched down to the desired common point value by an additional "T" network. A parallel resonant circuit with resistance in the inductive branch is exactly equivalent to an "L" network matching the resistance in the inductive branch to the higher resistance appearing across the ca-

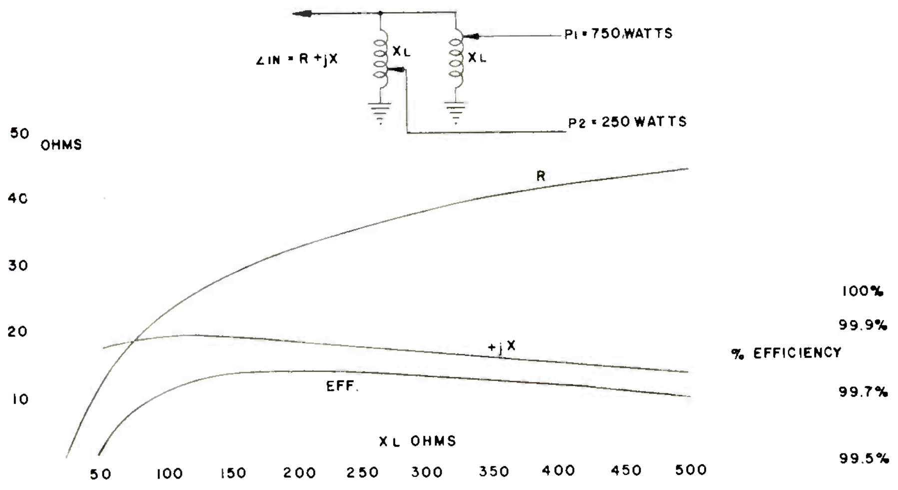

Figure 4—
Shunt Power Divider
Zin vs. shunt inductances
P_1=750 watts P_2=250 watts

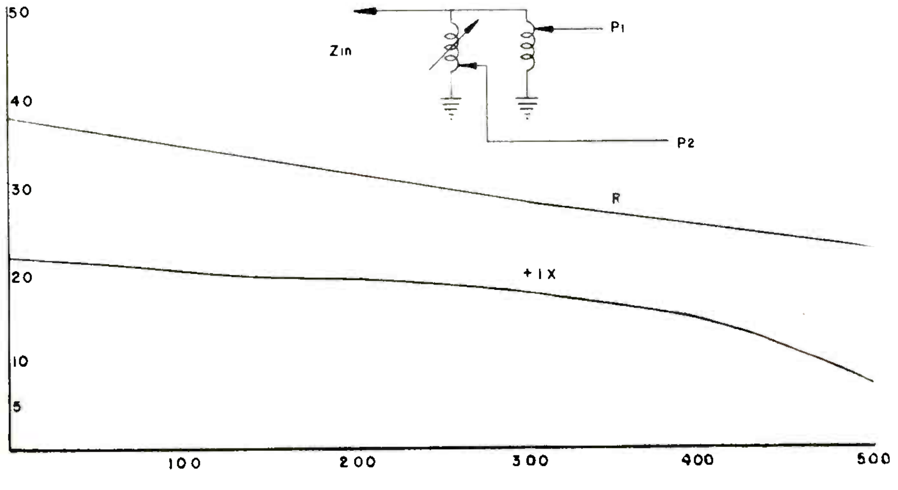

Figure 5—
Shunt power divider
Zin vs. P_2
P_1+P_2=1000 watts
Shunt reactances=175 ohms

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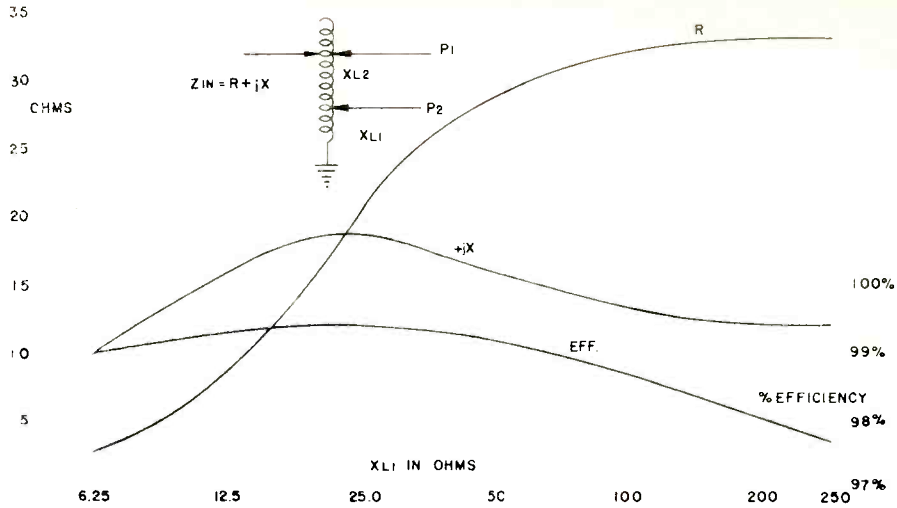

Figure 6—
Series power divider
Zin vs. Xli
P_1=750 watts P_2=250 watts

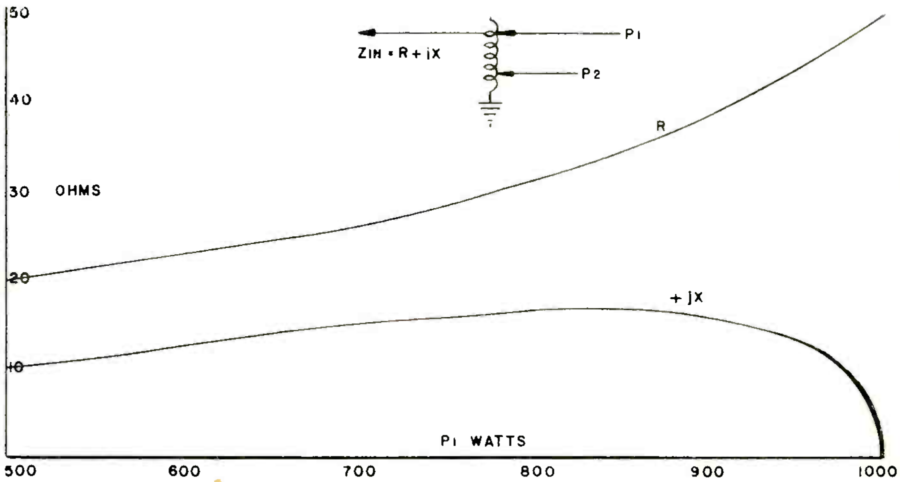

Figure 7—
Series power divider
Zin vs. P_1
P_1+P_2=1000 watts

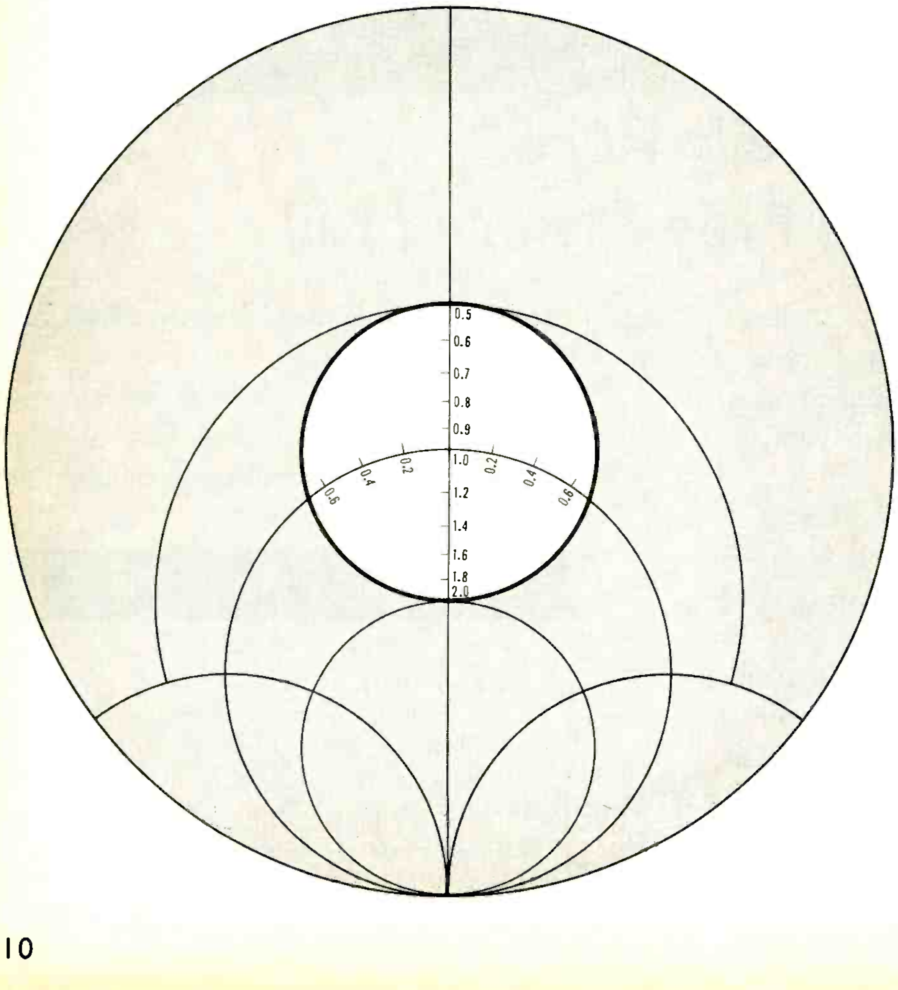

Figure 8—
Transmission line
input impedance
VSWR=2

pacitor. In the illustration shown here, exactly the same component values and the same currents and voltages are computed regardless of whether this circuit is designed as a resonant tank circuit on the basis of circuit "Q," or whether is is designed as an "L" network to match the 28.5 ohms to the 200 ohms. From this, then, it follows that in this type of matching network, we have nothing more than an "L" network preceded by a "T" network to perform exactly the same function as was performed by the simple "L" network shown in the first illustration.

Occasionally the term "Bandwidth" has been used in connection with power divider systems and their associated matching networks. Bandwidth of any phasing systems is a function of the system as a whole. It is effected by the antennas, by the system parameters, and by the adjustment of the complete phasing system from transmitter to antennas. Generally, the greater the ratio of the dissipated energy in

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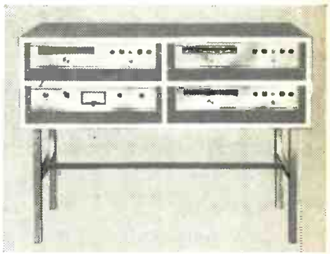

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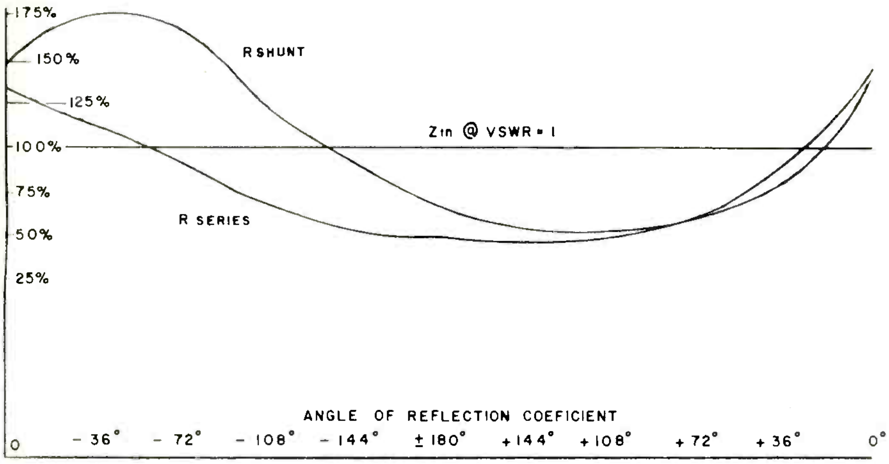


Figure 9—Power divider input resistance vs. transmission line input impedance
VSWR=2
P_1=750 watts P_2=250 watts

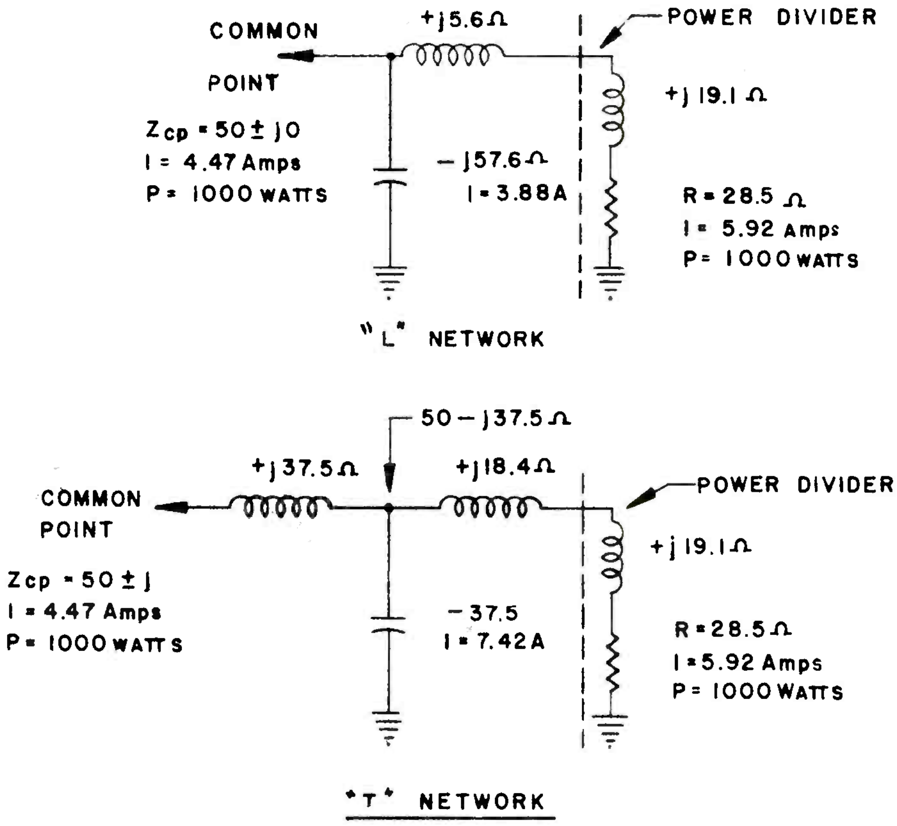


Figure 10—Matching network

any part of the system to the stored energy, the broader will be the bandwidth. In connection with the power divider, the higher the input resistance of the divider the broader the bandwidth. When considering only the matching networks, however, no significant difference could be found from one type to another when all of the mentioned types were considered on an equal basis.

Conclusion

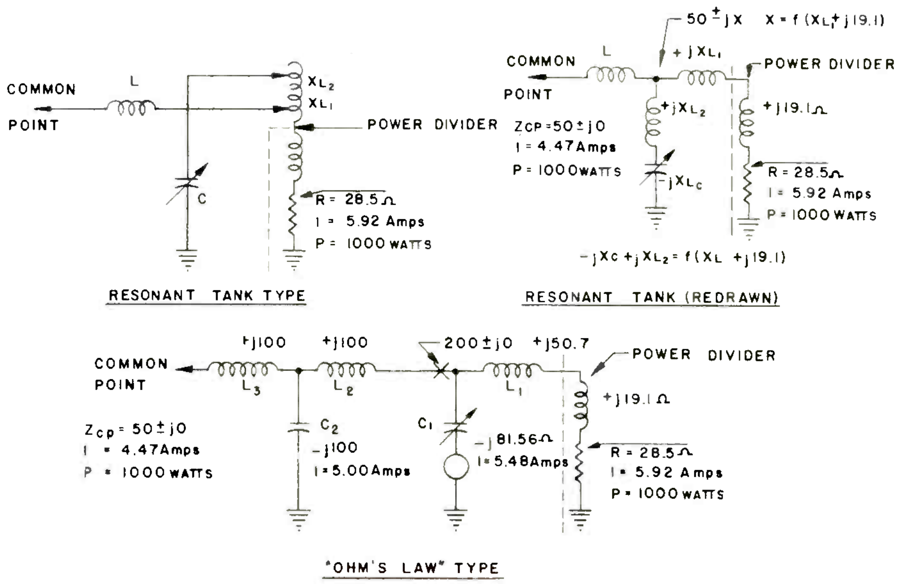
It has been shown that two devices are involved in every power divider design—the divider and a matching network. Of the two most generally used, the shunt type is easiest to adjust and most suitable for two or three tower systems, especially for lower powers. For more than three towers or for high power the series divider is better suited because of its higher input resistance.

The necessity for designing power dividers over a wide range and for specifically stating over what range the design was considered, has been demonstrated as important, because of the wide variation the input resistance may assume with varying adjustment conditions.

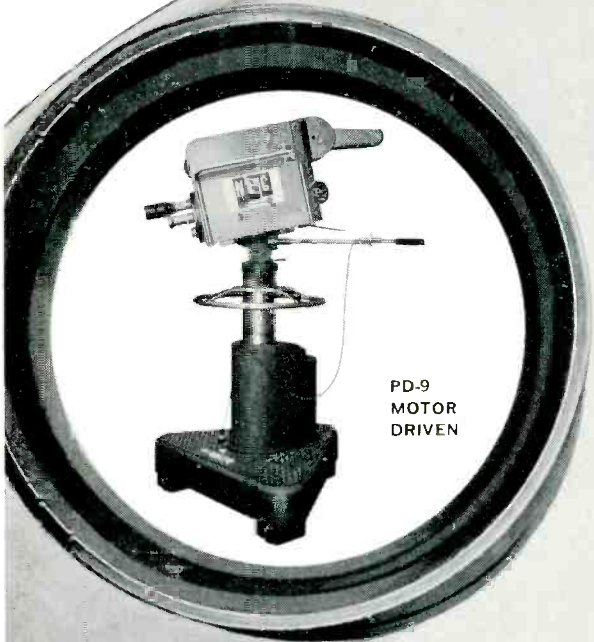
And finally, the matching network should be as sinple as possible, consistent with the ability to match the common point resistance over the full expected range of the power divider input.

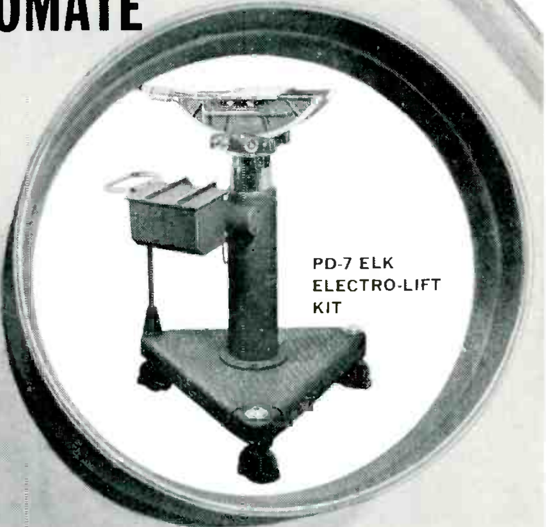
Obviously, the subject of power dividers has been barely touched upon in this discussion. It is believed, however, that sufficient information has been given to stimulate further investigation and in this way much can be done to provide power dividing networks that are easier to adjust, more efficient to operate and contribute to more economical phasing systems.

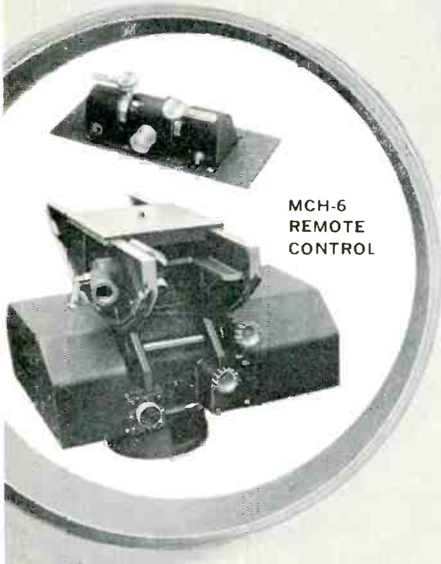
Figure 11—Matching networks



3 NEW WAYS TO AUTOMATE YOUR STUDIO







PD-9 Silent maneuverability... up, down and dolly shots ... with the cameraman in complete control every instant. Raise or lower (19" travel) electrically while dollying and without stooping. Lets the cameraman concentrate on the big picture. For color or monochrome cameras.

PD-7 ELK Transform your easy-glide PD-7 pedestal to full automatic up-down control with the new Electro-Lift Kit. Installs as quickly as you can tighten four bolts, with no machining or drilling. A real low-budget improvement to every studio's operation.

MCH-6 This fully automatic remote-control camera head operates pan and tilt. Control panel is planned for remote operation of lift, diaphragm setting, zoom-lense and focus...all done as if you were behind the camera! Three years in development under commercial studio conditions. Adds a new dimension to closed-circuit TV.

Westwood Division / Houston Fearless Corp.
11851 West Olympic Blvd., Los Angeles 64, California

Give me a fast dissolve to the commercial.

☐ PD-9 ☐ PD-ELK ☐ MCH-6 ☐ FILM PROCESSORS

Name________ Position________

Company________

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WESTWOOD DIVISION HF HOUSTON FEARLESS CORPORATION, LOS ANGELES 64, CALIFORNIA

A VIDEO DISTRIBUTION CONSOLE WITH UNIQUE FUNCTIONAL REQUIREMENTS

By Durwood H. Neuse
TV Studio Supervisor
WRAL-TV
Raleigh, North Carolina

Custom crossbar switcher provides sophisticated operations

ENGINEERS at WRAL-TV, Raleigh, N. C., have designed and developed a video distribution console which meets all modern television station requirements. Two of these consoles have been in use at WRAL-TV over the past two years with completely satisfactory results. Functional requirements of the design included multi-point switching control, with provision for control locations at each studio, auditorium, or even in another building. Anticipating variations in the number of video sources to be switched, we designed the consoles to allow reasonable channel capacity. Thus, flexibility was obtained here as well as in studio operation. Before the design was undertaken, we determined that no equipment meeting the requirements was available commercially.

Distribution of signals at video frequencies requires that the switching device behave electrically as a transmission line at the signal frequency. Thus, insertion of the switching device in the line should introduce no discontinuities. This requires that the lines and the switch should have the same characteristic impedance, or are properly matched, and that the switch is a constant-impedance device.

Video switching of composite and non-composite signals in TV studio operation also requires stringent circuit isolation, color component isolation, channel capacity, switching speed, consideration of cost, and very importantly, reliability.

The heart of the WRAL-TV video switching consoles is a matrix of high-speed crossbar switches manufactured by James Cunningham, Son & Co., Rochester, N. Y. The characteristics of these units were well-known to the WRAL design engineers, because a number of similar crossbar switches had been in use at the station for some time in microphone-selector consoles.

A crossbar switch of the Cunningham design consists of a contact-array in three coordinates. Usually, but not invariably, operation of an X-Y coordinate results in operation of a number of contacts in the Z plane. Thus in a 10 x 10 x 6 array (Type F) there are 10 contacts in each of the X and Y coordinates, arranged in 6 levels. Such a unit may be considered, for most purposes, as a 6-pole, 100-position switch. The switches making up the WRAL-TV matrix are 2 x 10 x 6 (Type P) units with actuator at each crosspoint. Thus, energizing the solenoid closes six sets of contacts in the Z coordinate. These switches are available in a wide range of configurations.

Modern crossbar switches are characterized by low mass, considering the actuating forces available. This provides high operating speed. In the video distribution console, for example, the operate time is less than 5 milliseconds and the release time is about 2 milliseconds; and these figures can be reduced, if needed, by the use of higher driving voltages.

For video switching, it is necessary to have fairly high contact pressure, to achieve low contact resistance, but without significant wear or the build-up of an insulating film. A contact resistance of about 12 milliohms is usual in Cunningham crossbars and this value is held constant to within a few milliohms during years of operation. Contacts are solid gold, and this and the action and contact pressure have completely prevented formation of any insulation interface; furthermore, the contact resistance is apparently insensitive to current variations. It may be of interest here to note that the thermoelectric e.m.f. characteristic of the switches is 0.01 uv/° C. Noise induced in the contacts by the actuators is of the order of 5 micro-volts in a bandwidth of 20 kc.

Since the switch has to operate as an open two-wire line in air, the characteristic impedance was of considerable interest. We found that our type P switches gave us a reflection coefficient of about 1.095 in 75 ohm cable at 70 mc. This was due to capacitive loading in the form of plates proximate to the conductors and to the symmetrical construction.

Circuit isolation for TV video switching must be as complete as possible. In a crossbar switch this

CROSSBAR SWITCHING SYSTEM

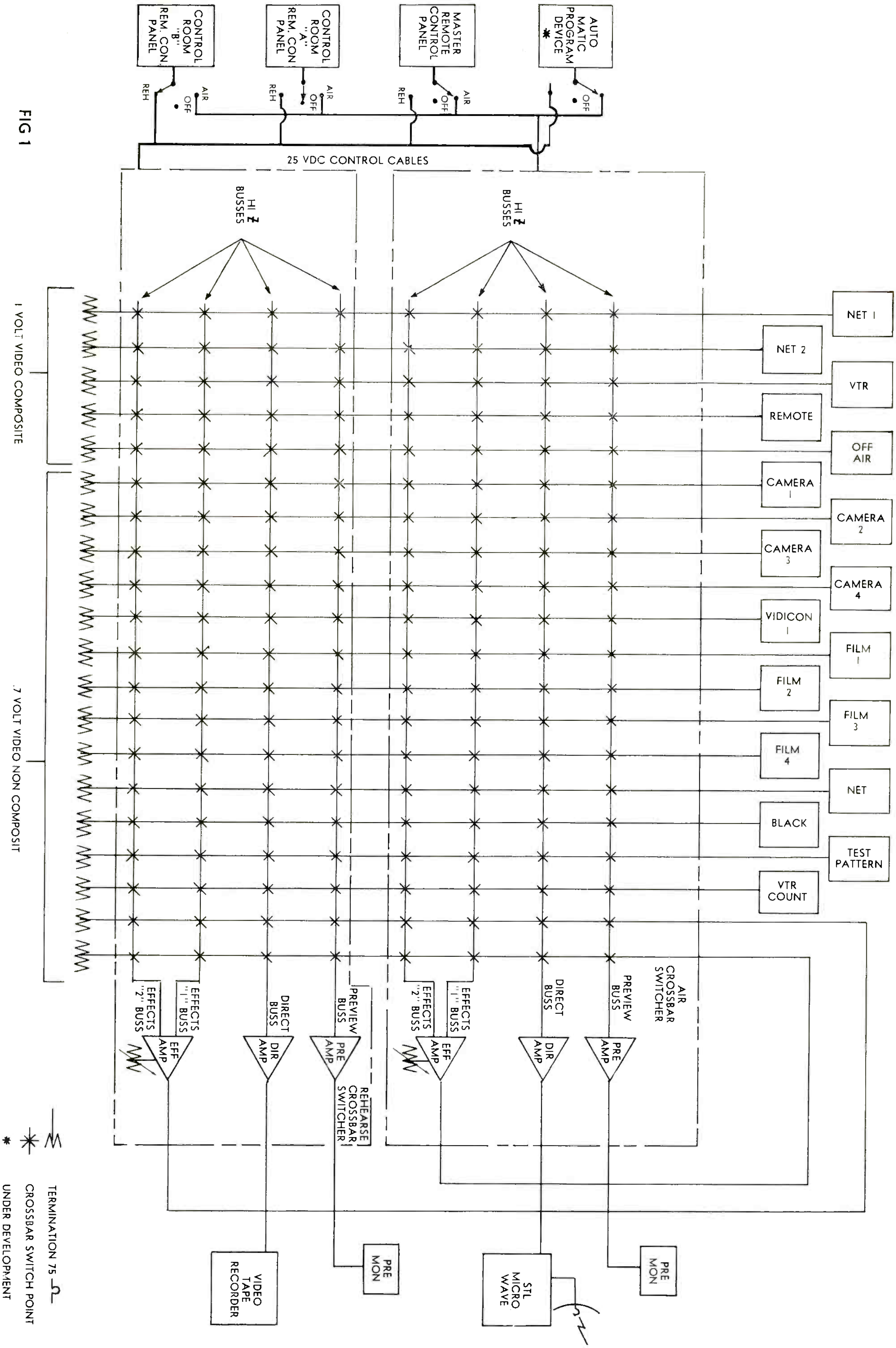
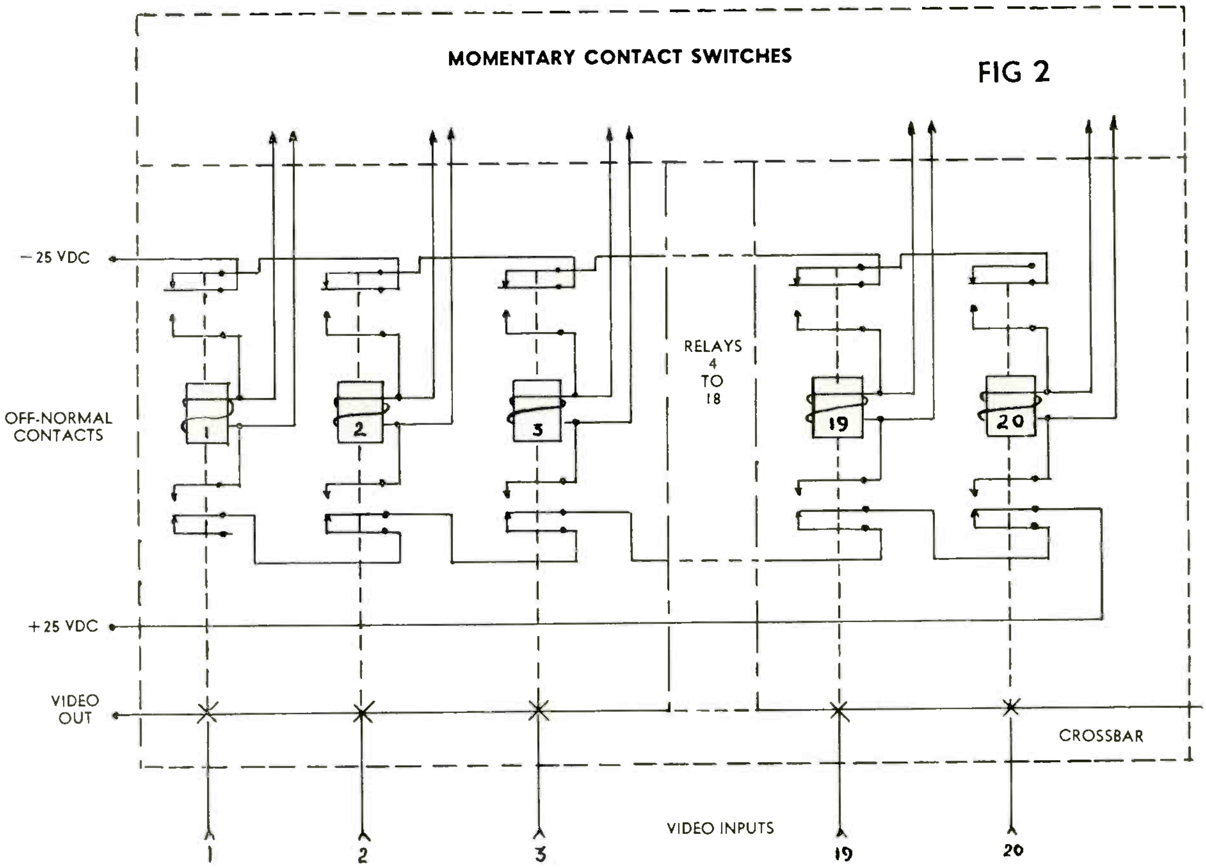


FIG 1



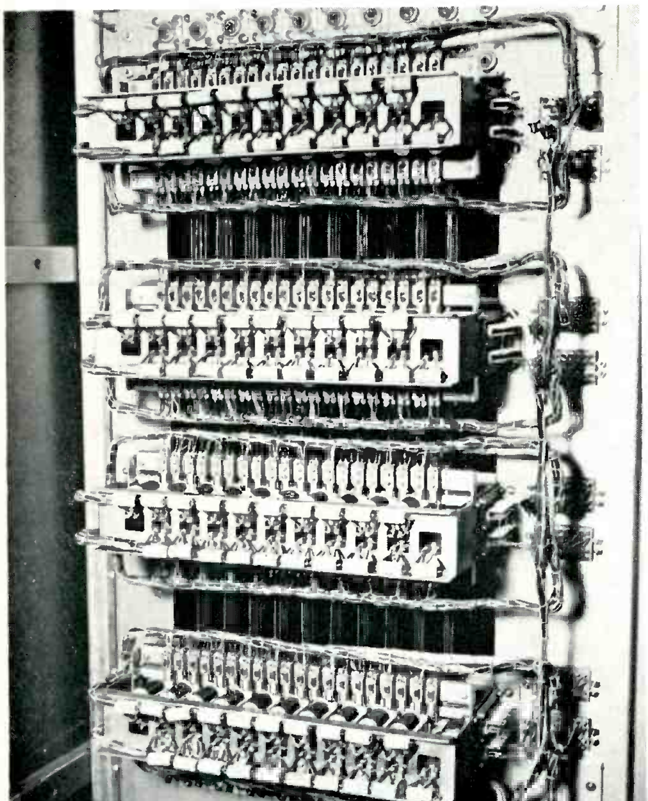


Fig. 3—Close-up front view of the four switchers mounted on a vertical rack panel.

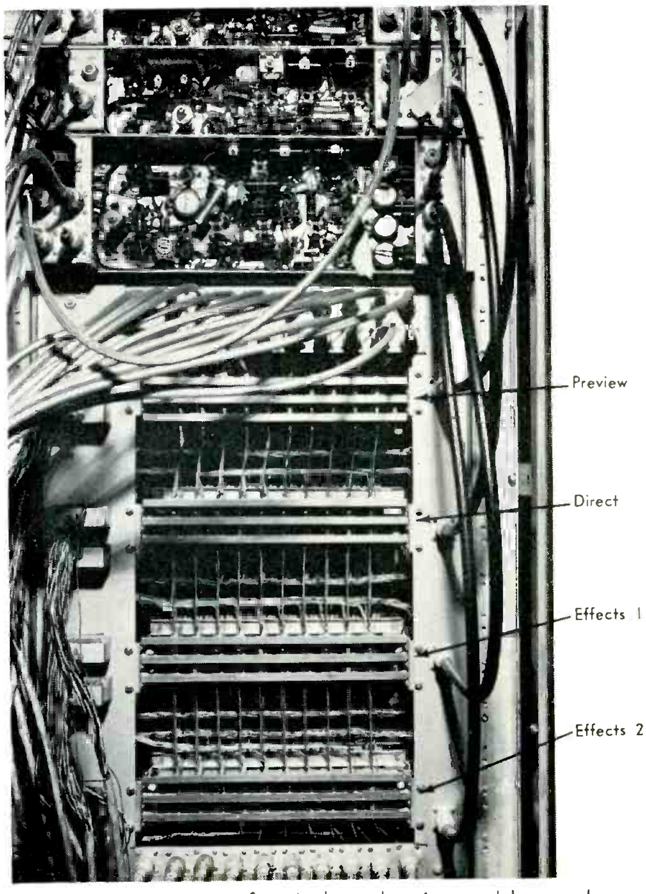


Fig. 4—Rear view of switcher showing cables and control lines. Associated video distribution amplifiers are located above.

depends almost completely on the capacitive coupling resulting from construction. Design of the switch has resulted in the following shunt capacitances: line-to-ground, 14 uuf, link-to-ground, 3.4 uuf; circuit-to-ground, 17.4 uuf; and line-to-line, 12 uuf. The effects of these capacitances at low impedance can be neglected; for example the switch introduces approximately 0.5 degrees of measured phase shift at our switching color subcarrier of 3.58 mc.

As a result, the crosstalk characteristics are excellent. WRAL-TV's crossbars exhibit crosstalk 75 db down between adjacent circuits and between conductors in the same circuit on a 75 ohm line. This is sufficient isolation to permit switching encoded or unencoded video signals.

Two additional requirements were easily filled by the switch: it is an extremely reliable unit with a normal life, without adjustment, of well over 20 million operations per crosspoint, and it is very compact, each unit measuring 3¾" wide, 5 5/16" high, and 12 3/16" long. It weighs about 4½ pounds.

We have used four switches in each console. Each switch is capable of switching twenty separate video sources to a common buss. At each console, the busses are called Preview, Direct, Effects 1 and Effects 2. The four crossbars are wired in parallel, so that video signals can be fed through all four switches without external jumper cables. Paralleling the switches permits us to switch the same video signals to a Preview buss through one crossbar, to a Direct buss throughout another, and to Special Effects busses through the remaining two switches.

The design of the console and the wiring layout give us complete interchangeability. Wiring of all four busses is identical. It is possible to substitute matrices in as little time as 15 seconds.

Figure 1 is a block diagram of the WRAL-TV installation, showing the two consoles, labelled here "AIR Crossbar Switcher" and "REHEARSE Crossbar Switcher." Figure 1 shows 20 video sources, each with its crossbar feed. These are representative of the input situation, but not the output. Even though the crossbar switches are capable of switching 20 sources, remote switching equipment in this case is limited to 16. Therefore, the Off-Air signal, the non-composite network signal, the test pattern, and Net 2 do not appear on the control room switching panels. Because it is a simple matter to wire the block on the back of the switching unit to program any set of the 16 sources, those which have the highest use have been selected. The other sources may be selected by special remote buttons located as required about the station. For example, Figure 1 shows an AIR signal appearing on the crossbar. This signal is programmed in such a manner that it is only possible to energize the crossbar switching point for a Preview bank and thus the AIR signal is never placed on air but is available for use by, for example, the director, if a preview of the AIR signal is desired.

The amplifiers shown as part of the switching consoles are conventional mixing amplifiers. They are fed from the high-Z busses through the crossbars. They are shown here as a part of the video distribution consoles to indicate that the high-Z cable must be kept as short as possible. Actually the diagram of Figure 1 is highly simplified. Not shown, for example, are the patch panels, extra monitors, closed-circuit equipment, etc. The amplifiers have two outputs, only one of which is shown; the output not shown is fed to additional amplifiers for distribution.

Control of the Effects 2 buss crossbar matrix is shown in Figure 2. This operation occurs as follows: A set of Form C off-normal contacts, wired as shown, is added to each actuator of each crossbar switch. Positive "hold" voltage is fed to actuator No. 20, then to No. 19, and so on down to one, in that order, and negative "hold" voltage is fed through off-normal contacts of actuator No. 1 progressively to actuator No. 20. Thus, when switching from right to left, the negative "hold" voltage is interrupted, and when switching from left to right the positive "hold" voltage is interrupted. Because hold voltage is fed to the actuator through the switching contact, and because the off-normal contacts will hold the relay once it is energized, it is possible to use momentary-contact switches, as we have done, to energize the actuator. When the actuator is energized, the

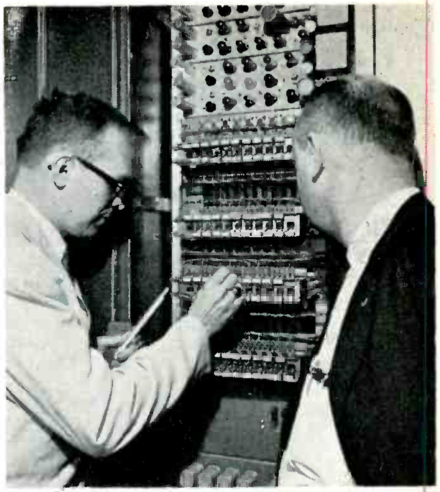
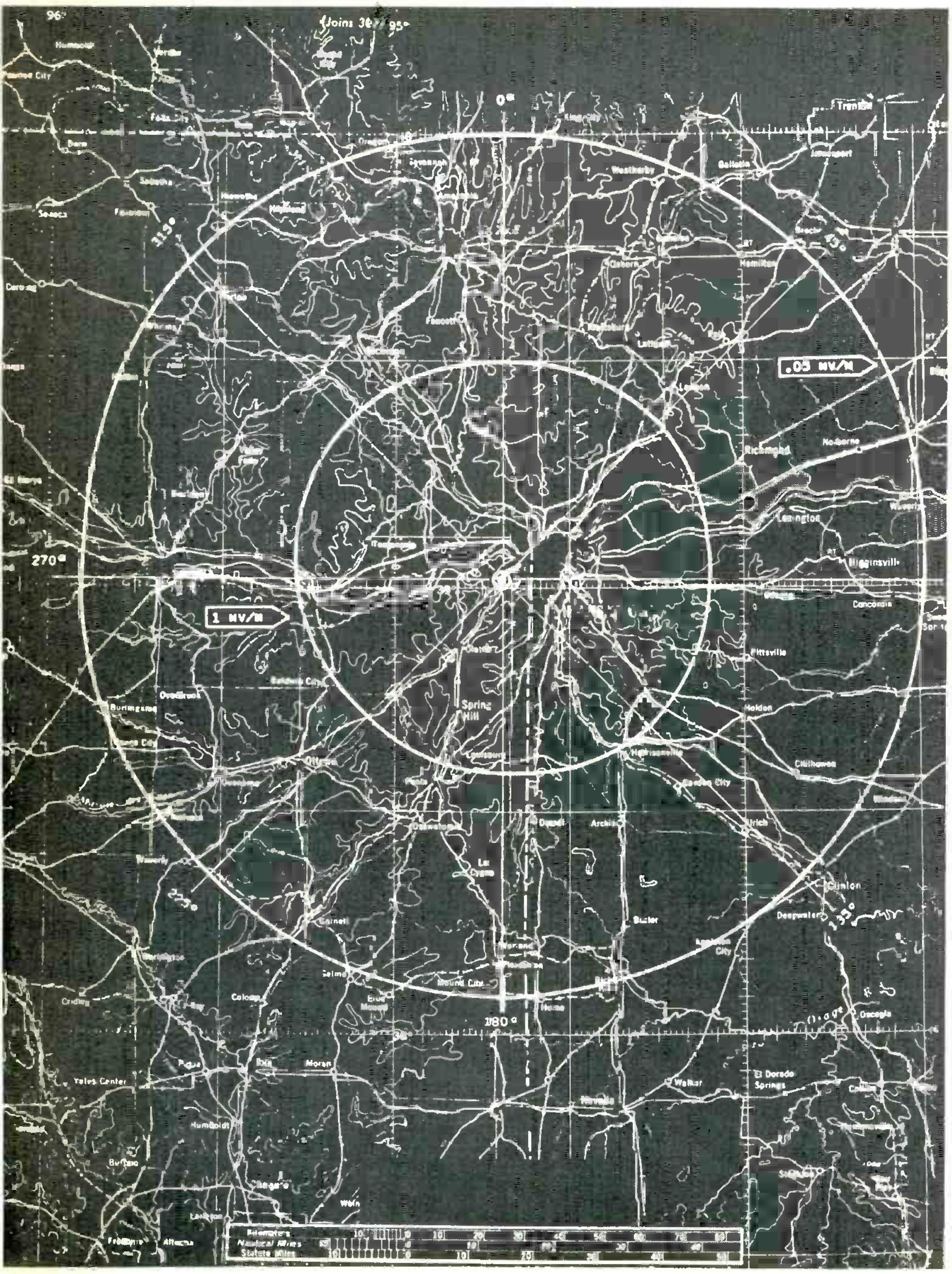


Fig. 5—Author Durwood Neuse (left) and Chief Engineer Duncan are shown making adjustments on the No. 1 Video Effect crossbar switcher.

switching point may be removed from the crossbar circuit, or another switching point may be connected to the circuit, without interruption of the video signal. Thus it is possible to switch between control rooms or between any two separate points.

As noted earlier, the switching speed of a crossbar switch depends upon the electromechanical characteristics of the actuators, which, in turn, depend upon operating voltage. In this arrangement, with 24 volt dc relays operating at 25 volts dc, operate time is 6 to 8 milliseconds and release time 2 to 4 milliseconds. The crossbar is a gap switch (break before make) with an average gap width of 4 milliseconds. Switching speed also depends upon the setting of the Form C contacts on each actuator. These contacts are adjusted for make when the actuator armature reaches one-half of total armature travel. This establishes the switching time at a minimum of 4 milliseconds.

Although some development work is continuing at WRAL-TV, particularly on an automatic programmer, the video distribution system described is fully adequate for all station needs, and has, in fact, even exceeded the rather high expectancy of performance. The design does not have a commercially-available equivalent, and it is doubtful that a commercial unit of very much different design would satisfy all of the requirements initially established for our video distribution system.



The Commission's

WITH the availability of new technical information, and for other reasons, the time has come when the public interest requires the Commission to take a close look at the FM broadcast service, its present situation, and its possibilities for future development — particularly, though not exclusively, in the area pertaining to station assignment criteria. The considerations impelling the present inquiry are principally related to two general questions: (1) whether the present system of station assignments is the one best suited to optimum development of this important broadcast service, or, if not, what changes should be instituted; (2) how the development and expansion of the FM service can be achieved without the serious administrative burdens and great delays inherent in present standard broadcast station assignment principles.

History and development of FM broadcasting. The FM broadcast service has some distinct advantages over the AM, or standard, broadcast service which has developed in the medium frequency range. These advantages stem in about equal part from the propagation and other characteristics of the frequencies used for FM, and the characteristics of the modulation system employed. Because of these factors, FM is relatively free from atmospheric and man-made noise, and interference between stations, even co-channel stations, is both lesser in extent and less objectionable in form than is true in AM. As there is essentially no difference between day and night propagation conditions at the frequencies used by FM, stations have relatively uniform day and night service areas and there is no necessity for the use of different assignment principles day and night, as there is in the standard broadcast band.

FM broadcasting was first authorized by the Commission in 1940, and the first commercial station began op-

Editor's Note:

This report presents some of the views of the Federal Communications Commission as released by the Acting Secretary. The complete proposed rule making, Appendix A, may be found in Broadcast Engineering's regular FCC department, "Amendments and Proposed Changes of FCC Regulations."

New Idea on FM Assignments

A simple, effective allocation plan is the goal of proposed rule making

eration in 1941. In 1945, the service was shifted to its present space in the spectrum, the band of 20 mc from 88 to 108 mc, which is divided into 100 channels each 200 kc wide. These 100 channels are designated by number, from 201 to 300. The lowest 20 of the 100 are reserved for non-commercial educational use. Of the remaining 80, 20, interspersed through the FM spectrum from Ch. 221 to Ch. 296, are allocated for use by low-power "Class A" stations. The remaining 60 channels are allocated for use by higher-powered "Class B" stations. After the initial spurt of 1946 and 1947 growth of the service was slow; in 1955 the number of commercial FM stations stood at 560. However, in more recent years the service has expanded quite rapidly, so that there are now authorized about 1,250 FM stations, of which roughly 190 are noncommercial educational, 110 are low-power Class A, and 950 are Class B.

In 1945, at the time of the shift of the service to its present band, the Commission put into effect a tentative table of assignments, under which particular FM channels were assigned to particular cities.

In August 1958 we abandoned the principle of a fixed table assigning specific channels to specific communities, and deleted the FM Table. FM assignments are now made on the same general basis as are AM assignments—an applicant proposes to use a particular channel, and the only technical consideration is whatever interference will be caused to co-channel and adjacent-channel stations. One of the principal considerations prompting us to the present inquiry is that, in our view, there is need to re-assess the merits of the station assignment pattern evolving under this procedure.

Over-all objectives and problems. The FM service, like standard broadcasting, is an aural medium. We have stated the objectives in the standard broadcast service in the following terms:

(a) Provision of some service of satisfactory signal strength to all areas of the country;

(b) Provision of as many program choices to as many listeners as possible; and

(c) Service of local origin to as many communities as possible.

To some extent, in FM and in AM, these objectives conflict. Fortunately, with a multiplicity of channels it is possible, as has been done in AM, to classify channels and stations so that conflicting objectives can be served. Achievement of the third objective stated, and to some extent the second also, is furthered by provision for a multiplicity of stations. Assignment of a large number of stations to a single channel imposes a limitation, by reason of mutual interference, on the extent of service from the individual station. On the other hand, achievement of the first objective, and to some extent the second, is at least in some situations furthered by provision for stations able to serve wide areas—operating with as high power and antenna height as is practical, and protected from interference out to the point where their signals become too weak to be generally useful, or nearly to that point. Only by this means, it appears, can service be provided to rural areas and sparsely settled portions of the nation. The same result cannot be obtained from assignment of a large number of low-powered, more closely spaced stations, for the reason that a station causes destructive co-channel interference over an area much wider than that within which it renders a useful service, so that there will always be wide gaps between the service areas of co-channel stations. Were stations located ideally from a geometric standpoint, probably these gaps would be filled in by service from stations on other, non-adjacent channels; but stations are not located on this basis. They are located in communities large enough to provide population and economic support. Therefore, it appears there will always be a need for a certain number of wide-area stations, especially in sparsely settled areas. Our specific proposal (in Appendix A) provides for such operation, known as "Class C" stations.

Relationship with AM. To a large extent, in the past we have treated these media separately, looking at each and its problems and development without regard to the other. They are both aural media, however. The differences are purely technological and do not connotate any distinction in the subject matter which may be broadcast with either system. Consideration of some of these technological differences in light of the objectives mentioned discloses that each of the two media has some characteristics lacking in the other. To some extent, they may be treated as complementary, utilizing each to further the objectives it is best suited to serve.

First, it would seem that the FM service, if properly utilized, can afford a suitable means for relieving the tremendous pressure for authorization of local radio outlets in many communities. Applications to this type of station have swamped our AM assignment processes and, in many instances, led to the authorization of AM stations which are marginal from a technical and service standpoint and which must often be limited to daytime operation only. These AM applications, and the hearings involved, have been and are most burdensome; and the stations, when authorized, often cause interference to existing stations in the already overcrowded AM spectrum, and are themselves limited to rather small service radii daytime, and, if operating at night at all, often to only a few miles during that period. In many instances, they can be assigned only on a daytime basis, and thus do not afford to their communities and areas radio service and a local outlet during non-daytime hours. The relatively small number of FM receivers as compared to AM receivers still remains a problem in connection with the development of the FM service. It is also possible that the full potential of that service cannot be realized through use of relatively low-cost FM receivers. But even though these problems exist now, it is to be hoped that they will not remain substantial obstacles over a long period. There is little question that in the long run the over-all need for local outlets can be served far better by FM assignments than by AM stations operating under the severe limitations of the present crowded AM spectrum.

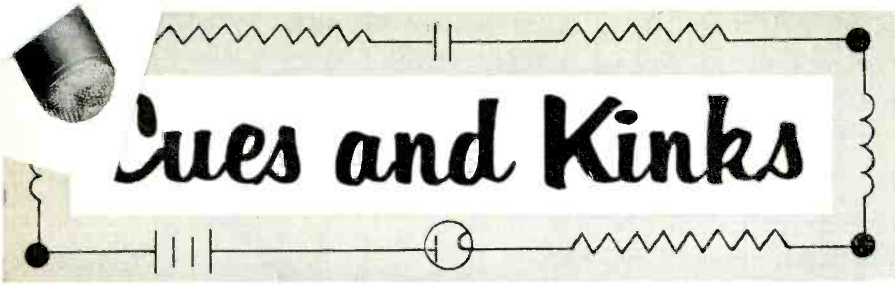
The second respect in which FM development may complement AM is with respect to the nighttime "white areas" in the nation — areas totaling more than 1,700,000 square miles and containing more than 25,000,000 persons—which now receive no primary AM service during nighttime hours and much of which probably will never be able to receive such service. For economic reasons, it may be that the potential assistance from FM unlimited-time assignments serving these areas is limited, but it is to be hoped that some contribution may be made if the FM band is properly utilized.

Station assignment principle and need for an over-all plan. If these objectives —whatever relative importance they may have to each other in any particular situation—are to be furthered to the greatest possible extent, it is imperative that a plan for channel usage be formulated with these objectives in mind and that its operation be continually subject to surveillance to assess the extent to which it is achieving these objectives. An imperative requirement is that the type of assignments to be made on each channel should be determined, and that stations assigned on each should be located so that the maximum number of the appropriate type can be assigned. In other words, there should be spacing between stations such that whatever degree of protection is decided upon will be afforded, but not much more, unless the spacing is to be large enough so that ultimately another station can be assigned between the first two. Otherwise, space is wasted.

Under present assignment principles, an applicant requests a particular frequency, and (provided the proposed operation will provide the necessary coverage to the community of assignment and the applicant is otherwise qualified), the application is granted if no interference is caused within the 1 mv/m contour of an existing station, or if, on balance, it appears that such interference is outweighed by the benefits from the new service. In other words, the assignment of stations is, in large measure, on a random or adventitious basis—the particular channel assigned depending on which one the applicant selects, which (aside from the matter of interference to existing stations) may in turn depend on such factors as seeking the top or middle frequency on the FM dial, seeking a frequency close to others to make the new station more desirable from the standpoint of actual or supposed listener convenience, etc. Probably largely for this reason, there is great variation in the number of existing stations per channel, varying for the Class B channels from 28 (Ch. 260, about in the middle of the band), to 5 (Channel 298, near the upper end). Whatever merit these considerations in channel selection may have, it is questionable, at best, whether they should be permitted to thwart the objective of maximum and optimum use of each channel.

There is considerable doubt that such

(Continued on page 34)



"Cues and Kinks" is a regular monthly meeting place for the minds and experiences of our broadcast engineers. This area is yours, fellows. Contribute your pet project for the benefit of others. Mail your time-saving, problem-solving circuit or idea to: Cues and Kinks, Broadcast Engineering, 1014 Wyandotte St., Kansas City 5, Mo.

A NEMO ALARM

By James E. Gray, Chief Engineer
WYDE Radio, Birmingham, Alabama

HAVING missed commercials on the average of one every two days at the studio during remote baseball games here at WYDE due to the announcer being busy answering the phone, editing news, etc., I decided to install an alarm circuit to alert the announcer of a cue coming at the end of each half inning. This frees him from hanging on to every word of the ballgame and permits him to check out news tips, answer the phone and audition music for his record show following the ballgame. When the third man is out in the inning, the engineer presses S1, alerting the announcer that a break is due in 10 to 15 seconds, and he also can send code to the announcer for a change in plans, such as rain falling, standby for a musical fill.

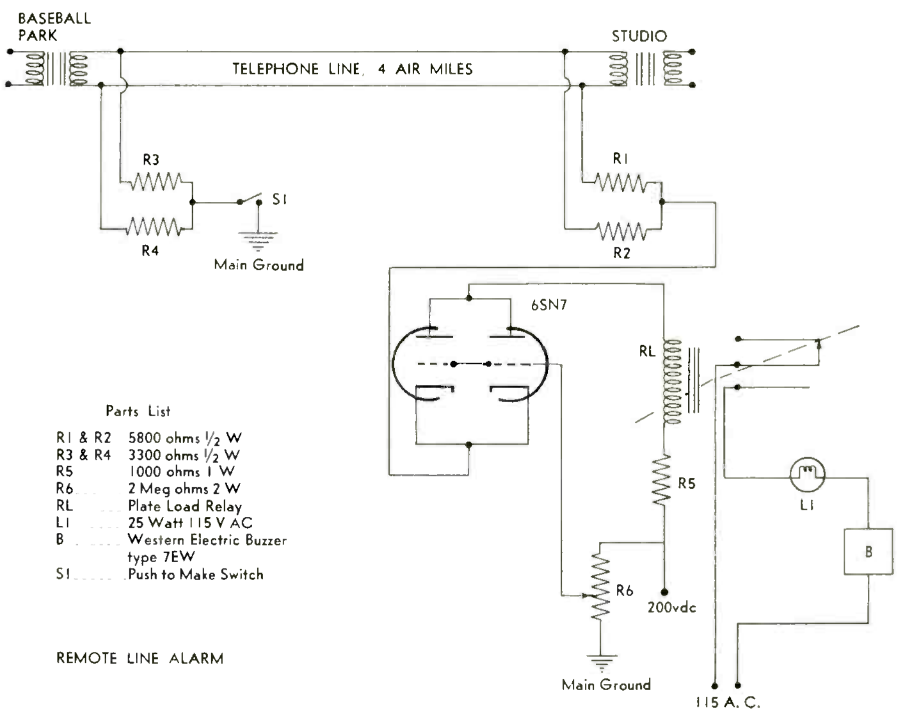
While phantom circuits are not new, I believe I have designed a circuit that can have many applications. The problem was not sending a d.c. current down an audio loop in use, but how to have it on the line without increasing the line noise and ground currents, thereby causing interference to the audio portion that was being aired.

When S1 is closed, the line is grounded to a water pipe or to the ground side of the ac outlet through resistors R3 and R4, completing the circuit for the 6SN7. Plate current flows energizing the relay and activates the lamp and buzzer. The cathode bias developed through resistors R1, R2, R3, and R4, is cancelled out by the positive voltage applied to the grid from R6. B-minus of the tube circuit must be connected to the main ground in order to complete the circuit of the tube. The high values of R1 to R4 are to bridge onto the line so as not to disturb the impedance. Their values are not critical since R6 is varied to nullify the cathode bias developed.

By reversing S1 to a push to break switch you have a circuit whereby if the line is ever broken or disconnected, it would trigger the lamp and buzzer instantly so that action could be taken to have the line repaired. This would be helpful in our Conelrad system where the line from Civil Defense Headquarters to their key station could be out of order for days before it was discovered. The key station would know right away that their line from Civil Defense Headquarters was out of order, which they would not normally discover until their weekly check.

In making tests of this circuit, I patched the line into the console with the gain up full and noting the line noise on the Barker-Williamson distortion meter. After connecting the alarm circuit across the line there was no increase in the amount of line noise.

The circuit has been in use at WYDE for over six weeks with 100 per cent success, not missing a single commercial break. The unit has no effect or interference on the audio portion of the program.



Parts List

R1 & R2	5800 ohms ½ W
R3 & R4	3300 ohms ½ W
R5	1000 ohms 1 W
R6	2 Meg ohms 2 W
RL	Plate Load Relay
L1	25 Watt 115 V AC
B	Western Electric Buzzer type 7EW
S1	Push to Make Switch

REMOTE LINE ALARM

Get the high quality you require with the new General Electric GL-8093 Image Orthicon

GL-8093/ZL-7803—3-inch image orthicon specifically designed with video taping in mind. *This one has it!* High signal-to-noise ratio (peak-to-peak signal vs. [RMS] noise—min.: 38, av.: 50) and improved definition you need for critical video tape recording. Yet, it is competitively priced with standard camera tubes. Key to its high signal-to-noise ratio is an improved target-mesh assembly in the scanning section which improves your picture quality . . . provides sharp transition from black to white without white edges. This also improves flatness of field and corner resolution—helps prevent distortion.

The GL-8093 is especially recommended for critical video tape recording work, such as found in network centers and tape production centers. Its good definition and improved signal-to-noise ratio are important features where numerous copies are made from an original tape, as in many educational programs, and for those productions where you can't settle for less than top quality.

The GL-8093 will save you set-up time—reduce the need for compromise between sharpest focus and minimum background blemishes. It is interchangeable with the 5820, 5820A, 7293, 7293A and 7513. Try this new G-E image orthicon in your own cameras. You'll like the difference it makes in your video tape recording work.

For more information, call your General Electric tube distributor or write for descriptive literature, ETR-2801, to General Electric Company, Room 7246A, Owensboro, Ky.

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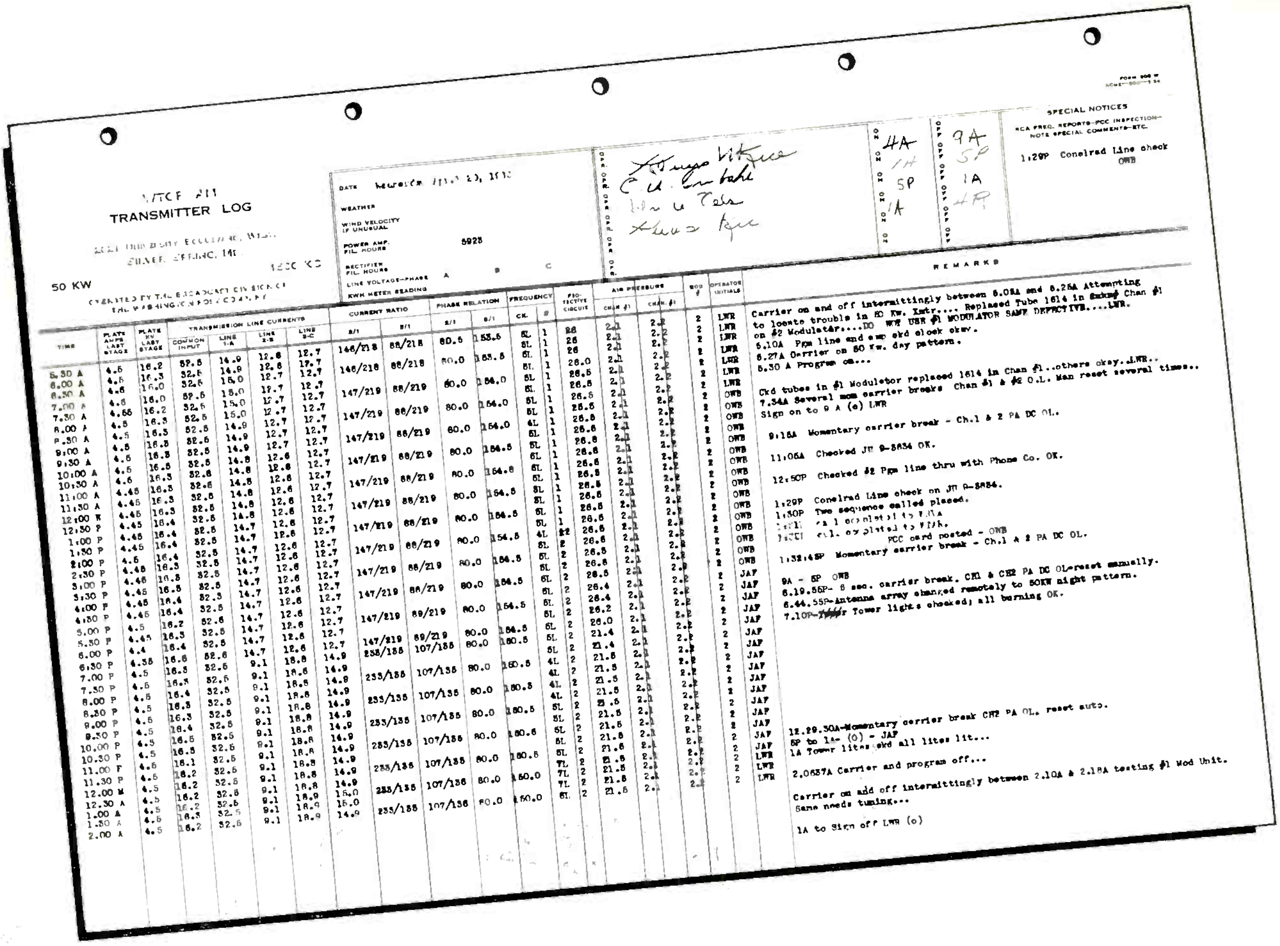
Progress Is Our Most Important Product

GENERAL ELECTRIC


WTCF AM
TRANSMITTER LOG
50 KW
1:29P Conelrad Line check OWB
SPECIAL NOTICES
REMARKS
Carrier on and off intermittingly between 6.08A and 6.25A Attempting to locate trouble in 50 Kw. Xmtr.... Replaced Tube 1614 in Chan #1 ... #1 MODULATOR SAME DEFECTIVE....LWR. on #2 Modulator....DO ... ckd clock okay.
6.10A Pgm line and ... ckd day pattern.
6.27A Carrier on 50 Kw. day pattern.
6.30 A Program on...
Ckd tubes in #1 Modulator replaced 1614 in Chan #1..others okay..LWR.. 7.34A Several ... carrier breaks Chan #1 & #2 O.L. Man reset several times..
Sign on to 9 A (o) LWR
9:15A Momentary carrier break - Ch.1 & 2 PA DC OL.
11:05A Checked JU 9-5834 OK.
12:50P Checked #2 Pgm line thru with Phone Co. OK.
1:29P Conelrad Line check on JU 9-5834.
1:30P Two sequence called placed.
FCC card posted - OWB
1:32:45P Momentary carrier break - Ch.1 & 2 PA DC OL.
9A - 5P OWB
6.19.55P- 5 sec. carrier break. CH1 & CH2 PA DC OL-reset manually.
6.44.55P-Antenna array changed remotely to 50KW night pattern.
7.10P- Tower lights checked; all burning OK.
12.29.30A-Momentary carrier break CH2 PA OL. reset auto.
5P to 1A (O) - JAF
1A Tower lites ckd all lites lit...
2.0557A Carrier and program off...
Carrier on and off intermittingly between 2.10A & 2.18A testing #1 Mod Unit.
Same needs tuning...
1A to Sign off LWR (o)

How many times, as a technician, have you arrived on duty at 6:00 AM to find a hastily scribbled note stuck to the "ON BUTTON" saying, "This and that has been done, plus a new amplifier installed, and it should work okay—but if it doesn't phone me at home." When you, the chief engineer, run down a failure discovered, nearly everyone except you and the supervisors knew this was likely to happen—but the technician just failed to pass on the information.

With increased service in years on the job, the chief engineer may assume all men know the plant equally well. However, the younger men are lost. A plan should be worked out to keep older men alert—younger men eager to learn—and management informed—as well as management keeping all technicians informed as to equipment and operational duties.

The solution? Conferences take up too much time, and it is impractical to see all men at the same time. Memos are seldom read and, if read, may be misunderstood. Personal supervision is too costly. For many years at the radio transmitter, a daily operational log was kept in which all happenings were written so all transmitter men could read what had happened on their days off, and on other shifts.

With the advent of TV, this type of log was used at the TV transmitter, plus a maintenance log used on the all-night maintenance shifts. The idea—the sign-on man began the daily operational log, listed happenings, failures, corrections, etc. Middle shift did the same, and sign-off shift the same . . . each man coming on duty read the logs, and after his days off read the previous two logs, keeping himself up-to-date. This worked fine at the transmitter. The supervisor could make work assignments by writing them on the log, and then their completion was noted on the log.

If this worked for transmitters, why not make it work for studios? This was done: A clipboard with a log form for that location was placed at program sources; namely — the sound stage, projection room, video tape master control, auxiliary transmitter at studio, plus maintenance assignments.

The WMT stations have no job classifications. A man may have several assignments including maintenance during his work day. He begins his first assignment by signing the appropriate log form. He then reads the log or previous logs in case of days off. Any failures while he is on duty are written up—including symptoms and corrections. All technicians use the same procedure. Should supervisors wish to make an

EFFECTIVE MAINTENANCE COMMUNICATIONS

The problems involved in advising operational and maintenance information to and from technical staff.

By George P. Hixenbaugh, Chief Engineer
The WMT Stations, Cedar Rapids, Iowa

Chief Engineer George Hixenbaugh of the WMT Stations gives interesting ideas on the art of staff communication at the 15th Annual NAB Engineering Conference, held this spring in Washington.

additional assignment at a certain location, it is written up and addressed to the technician. Upon completion, the assigned technician writes it up. Possible faults are noted, items required, and so forth, are listed.

The supervisors check all forms when coming on duty, and transfer the eighth report to the file. This permits seven days of forms to accumulate for review by everyone. They are filed with equipment service manuals for future reference. Maintenance and new construction assignments are made on a separate form, which is used in non-emergency cases.

The advantage of this system is that everyone knows what is going on all the time and, equally advantageous, the technicians are doing the communicating with little supervision.

This is what we have learned from the practice of using these logs: Oftentimes better technicians do not write legibly. Since printing would be too time consuming, the typewriter is the solution, even though the "hunt and peck" method must be used. When a failure is corrected, the technician writing up what happened, and how he corrected it, will remember it a long time—just because he wrote it. He also will be sure of what he has said and that it is technically correct; otherwise, he is in for some kidding (usually this being on some good-natured research).

Occasionally younger technicians are afraid to write up a story—fearing they could be wrong. However, they soon learn from reading what others have done. This is fundamental — the experienced teaching the non-experienced.

The fault we have discovered is the failure to write up an incident. Then it is forgotten. Seldom does a failure occur without someone seeing or hearing it, and if it is not on the log—a lot of explaining is necessary by the one who forgot. Neglecting to make a comment on the log occurs, usually, near the end of a work day when there might not be time to write it up. We urge them to make their comments on the log—even if it takes 15 minutes of overtime.

Any major failure with complete explanation is available for supervisors, the chief engineer, and management, immediately. Should a major failure occur, complete details can be on the sales manager's and manager's desks at the beginning of business the following day—thus you are paid for your trouble in setting up this system.

AMENDMENTS AND PROPOSED CHANGES OF F.C.C. REGULATIONS

Authority for the adoption of rules on the subjects specified in Appendix A hereto is contained in sections 4 (i), 303 (a), (b), (f), (h), (r), and 307 (b) of the Communications Act of 1934, as amended.

Pursuant to applicable procedures set out in § 1.213 of the Commission's rules, interested persons may file comments on or before September 5, 1961, and reply comments on or before October 5, 1961. In reaching its decision on the rules and standards of general applicability which are proposed herein, the Commission will not be limited to consideration of comments of record, but will take into account all relevant information obtained in any manner from informed sources.

In accordance with the provisions of § 1.54 of the rules, an original and 14 copies of all written comments and statements shall be furnished to the Commission.

FEDERAL COMMUNICATIONS COMMISSION,
BEN F. WAPLE,
Acting Secretary.

APPENDIX A

OUTLINE OF SUBSTANCE OF PROPOSED RULES RELATING TO FM STATION ASSIGNMENTS, AND ALTERNATIVE PROPOSALS (WHICH MAY BE ADOPTED WHOLLY, EXCEPT FOR LISTED ALTERNATIVES, OR IN PART, OR VARIATIONS OF WHICH MAY BE ADOPTED)

1. *Over-all assignment plan (with certain alternatives specified below).* The Commission proposes the following overall allocation plan, with alternatives as specified:

Classes and facilities of stations. (a) with respect to new FM station assignments, there will be five classes of stations, three commercial and two noncommercial educational, operating on channels designated for each class, with maximum facilities (effective radiated power and antenna height above average terrain), or equivalent, and minimum facilities, or equivalent, as follows:

Class	Maximum facilities—ERP and ht.a.a.t. (or equivalent)	Minimum facilities—ERP and ht.a.a.t. (or equivalent)
Class A (low power commercial)	1 kw ERP, 250 ft.a.a.t.[1]	100 watts ERP, 100 ft. a.a.t.
Class B (intermediate power commercial)	20 kw ERP, 500 ft.a.a.t.	1 kw ERP, 250 ft.a.a.t.
Class C (high power commercial)	100 kw ERP, 2,000 ft.a.a.t.	20 kw ERP, 500 ft.a.a.t.
Class D (low power educational)	10 watts (transmitter output power)	None.
Class E (higher power educational)	Same as for maximum commercial station at same location (i.e., Class B or Class C, depending on plan set forth below).	None.

The maximum ERP stated will be the maximum regardless of height.
[1]Above average terrain.

(b) *Minimum separation between stations—protected service areas.* No new assignments will be authorized at less than specified distances from co-channel and adjacent-channel stations (up to 600 kc removed). These separations are designed to prevent, in general, objectionable interference within a certain distance of the existing station, thus providing that station a particular interference-free service radius and service area. The service radius so protected will vary with the class of station, and will be less for second and third adjacent-channel interference (which does not result in any overall loss of service) than for co-channel and first adjacent-channel interference.[1] The minimum for second and third adjacent-channel assignments will also serve to prevent objectionable overlap of signal strength contours aside from interference.

With respect to co-channel and first adjacent-channel interference, the separations specified represent "protection" to Class A stations to the 140 uv/m contour (43 dbu), Class B to the 178 uv/m contour (45 dbu) and to Class C stations to the 84 uv/m contour (38.5 dbu). All separations are based on the assumption that both existing and proposed stations operate with maximum facilities.

[1]We do not propose to include in the rules themselves any propagation curves or figures for interference ratios or protected service radii. However, our proposal here is, as the Report and Order will set forth if the proposal is adopted, that: (1) the curves used as a basis for the separations are, for estimation of service, the F(50,50) curve for Channels 2-6 and for the estimation of interference, the F(50,10) curve proposed for the same channels in Docket 13340; (2) the interference ratios used are those presently contained in § 3.313(b) co-channel, 10 to one (20 db); first adjacent channel, two to one (6 db); second adjacent channel, one to 10 (—20 db); third adjacent chanel, one to 100 (—40 db); and (3) the service radii protected against objectionable interference, for the various classes of stations, are as follows:

Class	Against cochannel and first adjacent channel (200 kc removed)	Against second and third adjacent channel (400 and 600 kc removed)
	Miles	Miles
Class A	25	10.
Class B	50	25.
Class C	100	35.
Class D	6	6.
Class E	Same as maximum commercial station at same location (Class B or C).	Same as maximum commercial station at same location (Class B or C).

Class	Maximum facilities permitted (or equivalent)	Protected service area radius (miles)	Minimum co-channel spacing (miles)
Class A (low power)	1 kw ERP, 250 ft. a.a.t.[1]	25	115
Class B (intermediate power)	20 kw ERP, 500 ft. a.a.t.	50	190
Class C (high power)	100 kw ERP, 2,000 ft. a.a.t.	100	300
Class D (low power educational)	10 watts (transmitter power) 100 ft. a.a.t.	6	25
Class E (high power educational)	Same as for maximum commercial station at the same location (i.e. if Plan 1 is adopted, same everywhere as Class C station; if Plan 2 is adopted, same as Class B station if in Area 1, or same as Class C station if in Area 2).		

[1]Above average terrain.

EDITOR'S NOTE:

For the basic background on this proposed rule making see the article "The Commission's New Idea on FM Assignments" in this issue.

With respect to second and third adjacent-channel assignments (where the protected service radius is less than for co-channel and first adjacent-channel interference), the minimum separation to be adopted is a double requirement: the new station must be at least the specified distance from the transmitter location of the existing station, and from the nearest point on the existing station's city of assignment. This is to provide stations with interference-free coverage of their cities of assignment.

(c) In order to secure a reasonable efficiency in the assignment of FM channels an applicant shall endeavor to select a channel on which other assignments are not more than 25 miles above the minimum co-channel separations specified in the rules or whole multiples of such separations. In the event this is not possible, the channel providing the next best efficiency should be selected. If the nearest co-channel assignment is over 600 miles distant this requirement need not apply. In no case will assignments be made at less than minimum separations specified.

(d) *Requirements for principal city coverage and avoidance of overlap of commonly owned facilities.* In order to insure adequate coverage of the city to which a new station is assigned, the station's transmitter site shall be no further from the furthest point on that city's boundary than the distance specified in a Table to be adopted for this purpose, with provision for the maximum such distance for the various heights and powers of stations. This Table will be based on the provision of coverage of at least 3 mv/m.

No stations under common ownership will be authorized at distances less than those shown on a Table to be adopted for this purpose, which will provide minimum separations for stations of the various heights and powers. This Table will be based on overlap of 2 mv/m contours.

(e) *Equivalence.* For determining maximum ERP allowed when the antenna height above average terrain is greater than that specified for maximum facilities, a Table adopted for that purpose, giving permissible ERP for the various antenna heights, will be used. *This Table will be based on the location of the station's co-channel interference contour.* For determining minimum

ERP allowed when the antenna height a.a.t. is less than that specified for minimum facilities, a similar Table will be used. This Table will be based on the station's protected service radius. Both Tables will be based on the same propagation curves used for separations.

(f) *Assignment of noncommercial educational stations to channels.* Noncommercial educational stations of both classes (Class D and Class E) will be assigned to Channels 201 to 220, except in Alaska, where these channels are not available for broadcast use and where, therefore, these classes of stations may be assigned to any available FM channels.

(g) *Assignment of Class A stations to channels.* Twenty channels will be reserved (as far as new assignments are concerned) for Class A stations. These 20 channels will be designated on one of two bases, in the alternative:

(1) The 20 channels previously reserved for Class A use (20 channels interspersed through the FM band from channel 221 to channel 296), or;

(2) Twenty channels contiguous in the FM band, except in Alaska and Hawaii, where (because part of the FM band is not available for broadcast use) 10 channels would be so reserved.

(h) *Assignment of Class B and Class C stations to channels.* Class B and Class C stations will be assigned to channels reserved therefore, in accordance with one or the other of the following two plans, in the alternative:

Plan I. Twenty channels will be reserved in the Continental United States except Alaska, and 10 channels in Alaska and 10 in Hawaii, for use by high-power Class C stations. These channels will be either contiguous in the band, or contiguous except for interspersed Class A channels, depending on the alternative adopted under (f) above. Forty channels will be reserved for Class B stations. Under this plan, there will be no division of the country into Areas.

Plan II. Area 1 will include most of the northeastern United States and will be defined on the basis of entire states, including the three southern New England states, New York, Pennsylvania, Delaware, the District of Columbia, New Jersey, Ohio, Indiana, and Illinois. In that Area, the 60 channels not reserved for educational or Class A use will be used by Class B stations, operating with facilities described above. The rest of the United States will be in Area 2. In this area, there will be no new Class B assignments, but Class C stations will be assigned (there will be no Class C assignment in Area 1).

(i) *Relationship of existing facilities to new classification of channels.* To the extent there is any reclassification of channels as a result of the plans discussed in (f) and (g) above, stations authorized at the time of adoption of these rules on channels so reclassified will be subject to the following provisions:

(1) In the case of channels reclassified for use by a higher class of station (A to B, A to C, or B to C), existing stations will be protected under the Table of Separations as stations of the new class provided they operate with at least the minimum facilities provided for that class. If not so operating, they will nevertheless be so protected if within six months they apply for increase to attain the minimum, and as long thereafter as their applications are under consideration (such applications by existing stations). If they do not so apply, or their applications cannot be granted, they will thereafter be protected, under a Table of Minimum Separations, only as stations of the class corresponding to their actual facilities. For this limited purpose, a Table of Minimum Separations will be adopted for minimum separation between co-channel stations of different classes.[2]

(2) All former Class B stations operating in former Area 2 with facilities greater than the normal maximum for Class B, which are by definition new Class C stations, will be protected under Table of Assignment as Class C stations, regardless of the new class of their channel.

(3) If channels are reclassified for use by a lower class of station (B to A), existing stations will be protected, under a Table of Separations to be adopted for this limited purpose, as stations of their earlier higher class, provided they operate with the minimum facilities for this class or apply therefore within six months.[2]

(j) *Applications by existing stations for changed facilities.* The following principles will apply to applications by existing stations for changes in facilities:

(1) Applications for a change in channel will be treated like applications for a new station.

(2) Applications for increase in height and power on the same channel will not be subject to the requirement concerning maximum separations.

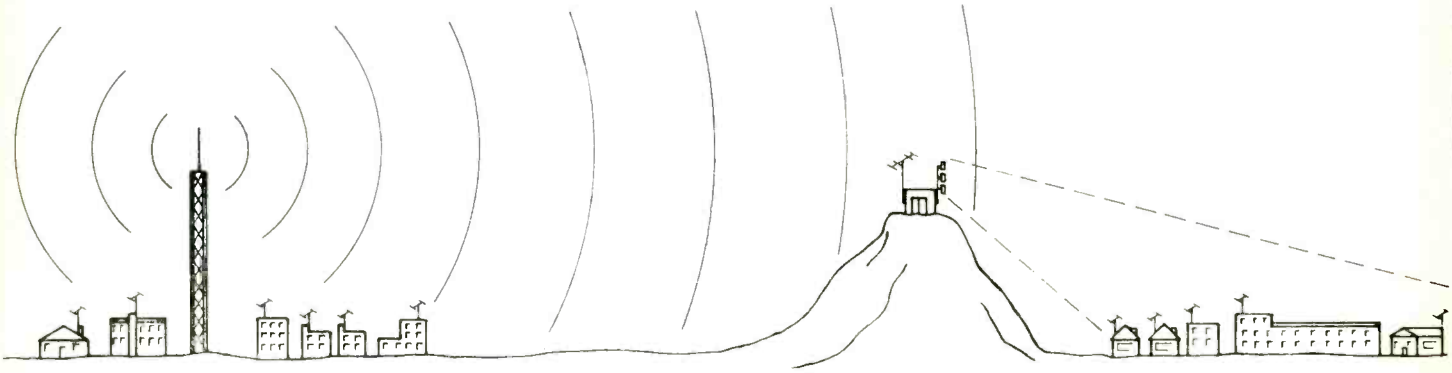
(3) Where a station operates with antenna height greater than that permitted for maximum facilities, it may increase power to the level permitted by the new Table of Equivalence (based on location of the interference contour).

(k) *Fixed standards.* The foregoing principles are fixed standards, like minimum mileage separations in television.

[2]Although the rules would not necessarily so state, the Tables of Separations relating to existing facilities will be based on the same propagation curves, interference ratios, and "protected" service radii as the Table shown.

VHF Translators—Coverage Tool for TV Broadcasters

The technical determination of TV station range, the translator site requirements and design specifications are presented in this report.



By Dr. Bernard Nadler
Project Engineer
Adler Electronics, Inc.
New Rochelle, New York

EDITOR'S NOTE:

Reference to a back issue of this Journal (November, 1960) may be helpful in obtaining further information on the use of VHF Translators . . .

It is generally accepted that TV broadcast advertising rates are in direct proportion to a station's receiver coverage. Great effort and expense are involved in expanding this coverage—both by technical and programming means.

The coverage of a television broadcast station is divided into four general zones. The first two—principal city and grade A zones—are usually characterized by strong signals and, therefore, will not be considered in this discussion. The third and fourth zones—grade B and fringe reception areas—will be considered in detail.

First, we must examine the factors which affect a television station's range.

VHF TV transmitters range in effective radiated output power from a minimum of 100 watts to a maximum of 316 kilowatts. Antenna heights vary from approximately 100 feet above ground to tall tower installations such as that at Cape Girardeau, Mo., which is 2,000 feet above average terrain. In New Mexico several stations with mountain top installations transmit from antennas which are more than 4,000 feet above average terrain.

The transmitted signals are quasi-optical with coverage distances extending only slightly beyond the "line of sight." The formula for path attenuation between two isotropic antennas in free space is:

(1) $Ap = 37 + 20 \text{ Log } D + \text{Log } F$

Ap = Path attenuation in DB
D = Distance in miles
F = Frequency in Megacycles

Assuming a distance of 1,000 miles and using 200 MC as a representative frequency, the path attenuation is 143 decibels.

Further examination is required to determine what power transmission is necessary to operate the ordinary receiver satisfactorily at this range. The transmitter power for a given signal-to-noise ratio at the output of a receiver is given by the following formula:

(2) $$10 \text{ Log } \frac{PT}{PN} = Ap + \frac{S}{N} + N.F. - GT - GR - N.I.F.$$

Where

$\frac{S}{N}$ = Required output signal to noise ratio in DB
N.F. = Receiver noise figure in DB
PN = Noise power input to the receiver
PT = Transmitter terminal power
GT = Transmitter antenna gain in DB
GR = Receiver antenna gain in DB
N.I.F. = Noise improvement factor in DB
AP = Path attenuation in DB

FIGURE 1

INPUT CHANNEL	OUTPUT CHANNEL	INTERFERENCES
3	8	3rd Harmonic in Ch. 8
3	9	3rd Harmonic in Ch. 9
3	10	3rd Harmonic in Ch. 10
4	11	3rd Harmonic in Ch. 11
4	12	3rd Harmonic in Ch. 12
4	13	3rd Harmonic in Ch. 13
6	7	3rd Harmonic in Ch. 7

FIGURE 2

CHANNEL	OSC. MIXER FREQ.	OSC. FUND. FREQ.	2nd HARMONIC	3rd HARMONIC	4th HARMONIC	5th HARMONIC
2	9.9	.....	19.8	29.7	39.6	49.5
3	15.9	.....	31.8	47.7	63.6	79.5
4	21.9	.....	43.8	65.7	87.6	109.5
5	31.9	.....	63.8	95.7	127.6	159.5
6	37.9	.....	75.8	113.7	151.6	189.5
7	129.9	32.475	64.95	97.425	....	162.375
8	135.9	33.975	67.95	101.925	....	169.875
9	141.9	35.475	70.95	105.425	....	177.375
10	147.9	36.975	73.95	109.925	....	184.875
11	153.9	38.475	76.95	114.425	....	192.375
12	159.9	39.975	79.95	118.925	....	199.875
13	165.9	41.475	82.95	123.425	....	207.375

The Johnson noise which exists in the 6 MC television channel is 108 decibels below 1 milliwatt. Using a television receiver with a 5 decibel noise figure and a dipole antenna with no gain, a signal-to-noise ratio of 10 DB would require a transmitted power of only 100 watts to overcome the path loss of 143 DB. A one hundred mile path would require a power of 10 watts. If antennas with gain were used, a 30 DB signal-to-noise ratio could be achieved and a noise free picture would be available.

From these facts it can be deduced that true line of sight is the only limiting parameter, since the earth absorbs energy which strikes it, and skyward directed energy is not refracted. Line of sight can be calculated from the following formula:

(3) $D^2 = HT^2 + HR^2 + 2R(HT + HR)$

Where
D = Distance in miles
R = Radius of earth × 4/3
HT = Transmitter antenna height
HR = Receiver antenna height

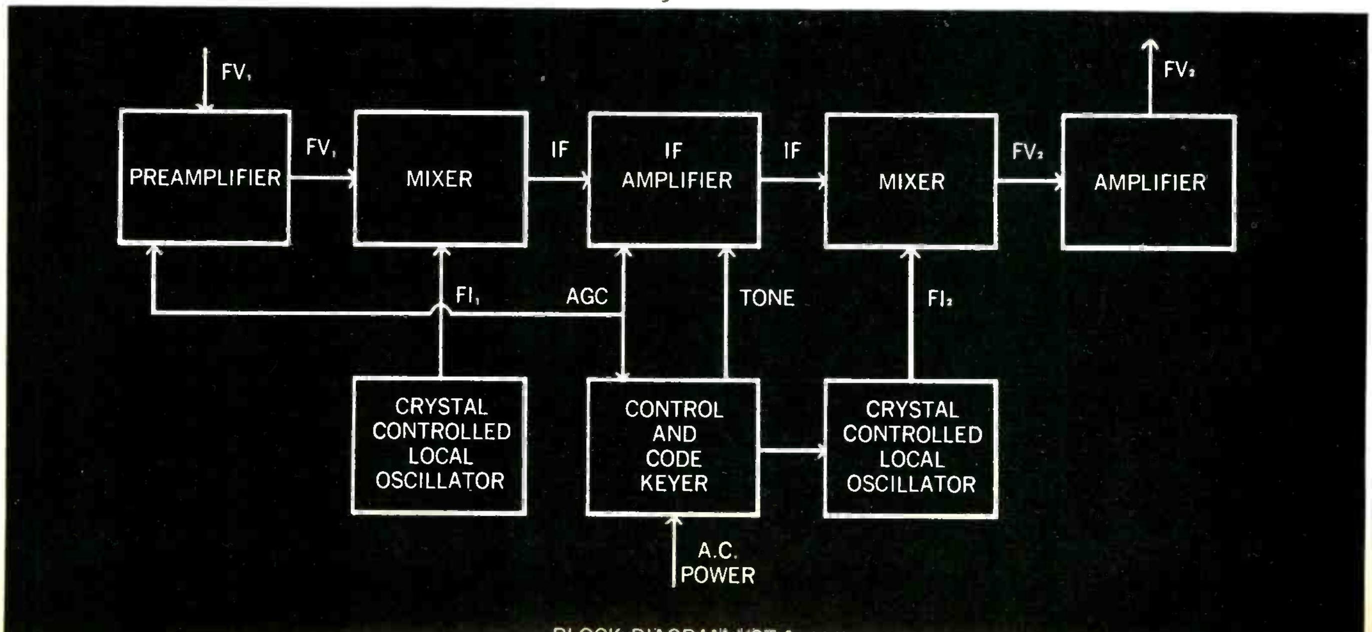
It is apparent that a station's range can be extended by increasing antenna height. However, this method has many limitations. Substantially increased height involves additional transmission line loss and costly installation and maintenance which rapidly become prohibitive. Also, there are legal height limits. If the intervening terrain is mountainous, even the distance to the horizon (line of sight) will be modified—valleys will receive little or no signal. The same is true for cities with large buildings, but this is somewhat overcome by high effective radiated power.

While transmissions extend somewhat beyond line of sight as evidenced by the coverage patterns of existing stations, the principle stated is essentially true. In most cases, the cost of increasing the height of a tower is not justified by the additional coverage gained.

An important new tool which can be used to increase television coverage is the VHF television translator. With 1 watt peak visual power (and effective radiated power in excess of 10 watts), and the various types of antennas available, coverages of from 12 miles at a 75° beam width, to line of sight at narrower widths, can be obtained. This equipment will provide good TV reception in isolated areas. The logical supplier of translator service is the originating station. It is to the broadcaster's advantage to expand his coverage and keep direct control over reception quality.

While the exact details vary from location to location, a translator site

Figure 3



should have an available signal at least 30 DB above the noise level at the input to the translator. With a translator noise figure of 5 DB maximum, this sensitivity should be about —68 DBM or 350 microvolts into 75 ohms. Since good single channel antennas are available with 15 DB gain, and 200 feet of 7/8-inch foamflex has only 2 DB attenuation, a net signal at the antenna of less than 100 microvolts will produce a noise-free picture. 1,000 microvolts will allow a 20 DB fade margin and still keep a perfect picture.

Pole-mounted equipment should be avoided whenever possible. This will eliminate the cost of running power to the top of the tower, and avoid pole climbing to replace components which have failed. In almost every case, it is possible to compensate for the resulting one or two DB transmission line loss.

Additional considerations for selection of a good translator transmitter site are that it be:

1. Near a road, so that the equipment may be readily serviced.

2. Near ac power lines, to avoid the heavy expense of bringing in power over long distances.

3. On a higher elevation than the expected coverage area. This eliminates the necessity of costly high towers while preserving available signal for radiation rather than dissipation in line loss.

4. On the edge of the expected coverage area, since available high gain, inexpensive antennas are highly directional.

5. Where the Prime Station's signal is readily available at a level of at least 350-500 microvolts.

The typical installation will include:

1. A tower or pole high enough to clear any surrounding obstructions. This usually is between 60-100 feet.

2. A good grade receiving antenna cut to the channel of the Prime Station. This antenna should be mounted high enough to receive a good clean signal of at least 350-500 microvolts.

3. A shelter or building to shield the translator from the elements, and especially to protect a technician during preventive maintenance. This could be similar to a tool shed or Butler building approximately 8 x 8 feet in floor area.

4. A translator transmitter manufactured to broadcast quality specifications to insure uninterrupted service for the greatest number of hours and the least amount of servicing expense.

5. An antenna array with a pattern that serves the maximum number of receivers in the coverage area.

6. High grade, low loss transmission line to insure that a maximum signal enters the translator, and that a maximum output signal reaches the transmitting antenna.

The actual installation of equipment can be accomplished in a short time. The building and tower should be erected before the translator arrives at the site. AC power with its normal disconnects should be provided inside the building. The translator transmitter, completely tested and aligned to the proper receiving and transmitting frequencies, is then uncrated. The ac lines are connected to the input plug. The antennas are installed on the tower and transmission line connections carefully made. The translator is then turned on—and with a minimum amount of adjustment will put a signal into the desired area. The timing device is set for proper keying of the translator's coded call letters. From that time on only routine preventive maintenance calls need be made at the translator site by any competent technician. The translator will automatically shut down whenever the Prime Station turns off its signal, and will come on again when the Prime Station's signal is received.

From the discussion of translator applications and installations, it is evident that reliability of operation and ease of maintenance are prime requisites. The Adler VST-1 VHF translator is designed for reliability. Studies show that the mean time to failure of vacuum tubes is the shortest of all the components used in a translator system. In the VST-1, the mean time to failure for the fifteen 10,000 hour tubes used is more than thirty-five hundred hours. This is essentially the mean time to failure for the equipment, since the components other than tubes have a very much longer time to failure. The criterion, established for reliability, is the use of 10,000 hour tubes with a regulated filament supply and operated at 60 per cent or less of maximum ratings. Heat-reducing tube shields are used to further lengthen tube life.

All resistors are capable of dissipating at least twice the actual power and all capacitors are rated for at least 1.5 times their actual voltage. Similar conditions exist for all the other components. This type of design extends the expected failure rate of the entire equipment to only twice per year based on 20 hours per day of operation.

In addition to its reliability features, the VST-1 is designed for ease of maintenance. Modular construction reduces down-time by facilitating servicing. All tubes are removable without the use of tools, and test points for alignment and measurement are readily available.

The translation circuitry is one of the key aspects of the electrical system. A double conversion technique is employed in the VST-1. Commonly available channel amplifiers could work for some channels. However, many channels would be unusable because low channel harmonics would fall in the high channels.

Figure 1 shows the interferences that would occur in a single conversion system. Compared to single conversion, double conversion has many advantages and only one apparent disadvantage. The disadvantage of using two oscillators is outweighed by the fact that gain is more economical at lower frequencies and fewer stages are needed.

Some of the advantages are:

1. With proper design and installation, even adjacent channels will operate from input to output.

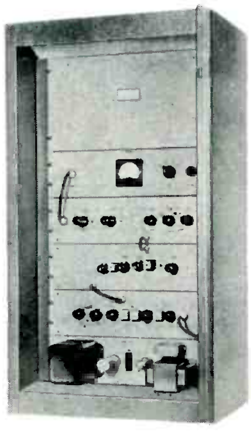


Figure 4—The front view of VST-1 VHF Television Translator.

2. Two identical local oscillators operating in the same environment tend to cancel frequency drifting.

To achieve these advantages the following steps must be taken: (1) proper intermediate frequencies must be selected; (2) output channels shall contain no harmonic lower than the fourth; (3) mixing must be linear to reduce even harmonic components; and (4) only high order harmonics of the oscillator may appear in the output bands, and these must be 60 DB down from the signal.

After examining all the frequency bands, the 44 MC - 50 MC band appears to be the best choice as the intermediate frequency. Its second and third harmonics are out of the television bands. The fourth harmonic of the picture I.F. falls at the edge of channel 8 and the fourth harmonic of the sound I.F. falls in channel 10. Care in balancing and linearizing the transmitter mixer eliminates these problems.

The oscillator frequencies used for conversion to and from the I.F. and harmonics are shown in Figure 2.

Intermediate Frequency Band 44.1-50.1 MC. It is evident from the chart that channel 3 oscillators generate a third harmonic which falls in the I.F. passband and a fourth harmonic in channel 3. Care must be taken to provide extremely low harmonic content in the output of the oscillator to prevent birdies from occurring in the passband. The oscillator which is used to eliminate these problems, and to provide the required frequency stability, is the Butler oscillator.

This oscillator consists of a grounded grid amplifier whose output is coupled to a cathode follower. The feedback path is from the cathode of the follower through the crystal to the input of the grounded grid amplifier. In this particular circuit, the plate of the cathode follower is the screen grid of the 6688 tube. The tube's plate acts as an electron coupled amplifier isolating the oscillator from the load.

A block diagram of the Adler double conversion translator is shown in Figure 3. The signal section is composed of three panels: the receiver or input amplifier, the intermediate amplifier, and the transmitter or output amplifier.

(Continued on page 36)

FM Assignments . . .

(Continued from page 20)

an assignment process will fulfill our objectives, if permitted to continue, to an extent as great or even close to as great as would a more carefully worked out, over-all plan. One set of facts leading to this conclusion is the present spacing between stations. A study recently made of existing spacings on 9 channels and adjacencies, in Zone 1 (the northeast) and immediately adjoining areas, shows that the shortest single spacing between co-channel Class B stations is 94 miles, the average of the shortest Class B co-channel spacing on each channel is 129 miles, and the average of all spacings between neighboring Class B co-channel stations on these channels (excluding certain very long spacings which can have no conceivable effect on service or interference) is 167 miles.

It is likely that, from the standpoint of effective utilization of spectrum space, these spacings leave a good deal to be desired. In terms of present protection concepts—protection usually to the 1 mv/m contour—they are substantially greater than that necessary to afford such protection, yet not quite large enough so that another station could later be assigned in between. This is true whether the situation is evaluated on the basis of present propagation standards—Fig. 1 of § 3.333 of the rules—or new propagation curves adoption of which is contemplated. On the other hand, if some or all stations should be protected to a further point—e.g., the 50 uv/m or 100 uv/m contour—the spacing is too small to afford such protection. In other words, the more or less random basis of making assignments does not appear to have resulted, or to be likely to result in the future, in an over-all pattern of assignments which is reasonably near to the degree of efficiency which must be sought. It appears that a more rational basis—reasonably related to the degree of protection which stations of the various classes should be afforded—is to be desired.

Moreover, the same study reveals that spacings between Class B stations on first adjacent channels (200 kc removed) average 178 miles. This is greater than the co-channel average, and nearly three times the minimum spacing which is required under present standards for Class B stations operating with maximum Zone 1 facilities (about 69.5 miles). Along with the data as to co-channel spacings mentioned above, these facts cast considerable doubt upon the over-all efficiency resulting from present assignment methods.

Another development which has resulted from the present unplanned use of the channels is the great concentration of FM assignments in large cities and immediately adjoining communities. In New York City alone there are 17 FM stations, in Los Angeles 20, and in Detroit 16. Such concentration is not necessarily bad as such; nobody would argue that, under any allocation plan, cities of such size and importance should necessarily be limited to four or five FM services. Nevertheless, when concentration of assignments is carried to the present extent, it is at least questionable whether the provision of a great abundance of service to the inhabitants of these cities has not occurred at the expense of rendition of more needed service, or provision of first or second local outlets, elsewhere, and whether any further concentration of this sort should be allowed. We do not propose herein to change any existing facilities, and we do not make any specific proposal concerning prohibition of any further assignments to such cities or urbanized areas, but we invite comments upon the question of whether, considering the needs which can and should be served by future assignments of FM stations, any new assignments or increased facilities should be permitted in such cities or their metropolitan or urbanized areas.

Effect of individual consideration of applications on over-all service. In FM, as in the standard broadcast service, proposed assignments of new or increased facilities are considered individually, except where two or more applications are mutually exclusive. Each proposal is evaluated on the basis of whether it would cause interference to existing stations, and, if so, to what extent. Whatever the merits of this approach, it has one obvious disadvantage—it does not permit evaluation of the total effect of a series of authorizations upon an existing station or existing over-all service. In other words, a single application before the Commission may involve some small amount of interference to an existing station, but not enough to justify denial of the application on this ground; but the total effect upon the service of the existing station from a series of such grants may be significant. Under this approach, the AM spectrum has become crowded, and probably overcrowded, and, while this situation does not prevail in FM as yet, there appears a possibility that it soon will in some areas. Like the matter of efficiency mentioned above, this possibility appears to indicate the desirability of an over-all plan instead of case-to-case consideration of individual applications.

Administrative problems. One important consideration impelling the present inquiry is that the FM service and its expansion have begun to develop the same severe administrative problems that have beset AM assignment-making for some years. At present, usually the consideration of an AM application for new or increased facilities involves consideration of interference to or from the proposed operation, or both—which means that great effort is required on the part of all parties concerned and the Commission and its staff in determining the location of service and interference contours, counting the populations within service and interference areas, and evaluating the extent of other service available in such areas. In the vast number of hearings now involved in the AM assignment process, very lengthy arguments occur between the parties as to these matters, as to the validity of groundwave measurements offered to establish contour locations, etc. If an application is granted after all of this time and effort, the result is often only a marginal operation—a result which appears disproportionate to the effort involved. The delays involved in this process are too familiar to all. While, because of uniform propagation characteristics the FM assignment process will probably never in any event develop all of the problems now associated with AM, the same tendency has recently appeared—contours must be located, populations counted, and amount of other service established; and hearings on these matters must be held.

It appears that these developments are more or less inherent in any assignment system where in each case interference to existing stations is balanced against service benefits, and in which, therefore, it is difficult or impossible to set up fixed standards which will determine, without elaborate consideration, whether or not a particular application will be granted. The relative absence of such fixed standards in AM has contributed much toward the manifold problems mentioned above, since in their absence all of the detailed factors involved with each application must be considered carefully and at length, and applicants are encouraged to file marginal applications which probably cannot be granted but conceivably will be. To avoid the development of similar problems in FM, in our view it may well be desirable that fixed standards be adopted for future assignments in that service, so that each application can be judged on a strict "go-no-go" basis.

Conclusions as to general approach. In view of the foregoing consideration, we have tentatively reached two conclusions as to the general approach which, it may well be, should be adopted for the future development of the FM service.

These conclusions are:

(a) FM assignments would be based on an over-all plan, designed to insure the optimum and maximum use of each channel and take into account the total effect of all further assignments on existing service, rather than the present system (similar to AM) under which an applicant selects any channel he sees fit, and his application (provided it complies with our rules and he is otherwise qualified) is considered on an individual basis, taking into account only whatever interference problems it may involve without regard to consideration of over-all efficiency and total impact of service.

(b) The over-all plan would be one involving strict standards which will determine without elaborate weighing of various factors whether an application will or will not be granted. Whatever plan is adopted in this proceeding, we are presently of the view that it must be based upon this absolute concept. Our present FM rules (§§ 3.203 (a) and 3.313 (c)) contemplate grants in spite of interference "in order to insure . . . a maximum of service to all listeners," or "in order to provide an equitable and efficient distribution of facilities." It may well be that these discretionary provisions should be eliminated, in line with the approach we presently believe may be more in the public interest.

VHF Translators . . .

(Continued from page 33)

The control, metering and power supply also occupy separate panels. In this way a completely functional unit is available. All that must be done to provide a complete translator is to select the input and output channels. Figure 4 shows a front view of the VST-1.

The input channel section consists of a 6688-tube triode connected and used in a neutrode circuit. The intermediate stages consist of a 6922 dual triode, with each triode connected as a grounded grid amplifier. The output of this amplifier, which has a gain of 40 DB, and a noise figure of 3.5 DB on the low channels and 4.5 DB on the high channels, is fed to a 6688 mixer. This very high gain tube being used as a mixer raises the input gain to 50 DB. The associated circuitry is designed as a triple tuned band pass to provide excellent spurious and harmonic rejection as well as an extremely flat pass band.

The A.G.C. which is an amplified peak detector type operating from the video signal, is applied only to the second grounded grid amplifier and mixer circuits. This provides the control required by the F.C.C.'s specifications and leaves the first stages at ground to produce low noise even at strong signals. Its input and output impedance is 75 ohms, but the input impedance can be adjusted to 50 ohms with a simple relocation of the antenna tap to facilitate flexibility of installation.

The intermediate amplifier is a straightforward, three stage double stagger tuned device. Since this unit will remain the same for all input and output channels, it was felt that a printed circuit board could be used to best advantage.

It has a 75 ohm input and output impedance, a gain of 40 DB, and an A.G.C. control level of at least 20 DB. This amplifier, as well as the receiver, is designed to be unaffected by environmental conditions, A.G.C. variation and tube changes. Realignment is not required when a tube is changed. The A.G.C. detectors and amplifiers are included on this panel. The circuit consists of a video detector, two video amplifiers and a peak detector. To reiterate, this circuit is connected to control two stages in the receiver subassembly and two stages in the intermediate amplifier. With a single setting, this is capable of keeping up to a 50 DB variation in input level to a 2 DB variation in output level. The purpose of maintaining this large control is to insure that the maximum power of one watt will not be exceeded. It also provides for the control of at least 30 DB at all expected setting of the A.G.C. level control.

The transmitter panel consists of a second 6688 mixer, Butler oscillator and two class A linear power amplifiers, consisting of a 6939 stage followed by a 6360 stage. These units are also 75 ohms input and output, but the output impedance is adjustable by means of a variable capacitor. A capability of 4 watts of linear output power is available to insure extreme linearity and to prevent high level intermodulation distortion of the sound by the picture.

In addition, both output amplifiers are push-pull to suppress all even harmonic outputs.

The control, metering and power supply functions follow standard design procedures. The power supply is a line regulated type with circuit breaker protection. The control keyer is the time tested unit used in this manufacturer's U.H.F. translators. Metering of power output and V.S.W.R. are also provided.

The overall system has a gain of 120 DB with A ± 5 DB flat bandpass of 6 Mc. The response is at least 60 DB down 3 Mc on each side of the band edges. The system exceeds, by far, the specifications required by the F.C.C. for this type of translator service. It allows for component aging, temperature variations and fading.

In conclusion, a VHF translator system for extending the coverage of a TV station should be based on:

1. High quality equipment designed to serve the needs of the professional broadcaster.
2. An advantageous site and proper installation.
3. A reliable equipment supplier with the proven experience in all phases of design, manufacture and installation of translator systems.

All of these points will help insure a happy new TV audience as well as a satisfied TV translator operator.

Industry News

Audio Devices Appoints Vaughan Sales Manager

Richard H. Vaughan has been appointed New England sales manager of Audio Devices, Inc., according to an announcement by Bryce Haynes, vice-president in charge of sales.

Vaughan started with Audio Devices in the company's Chicago sales office in 1954. He will handle sales of recording discs and magnetic tapes in the states of Massachusetts, Rhode Island, Connecticut, Maine, New Hampshire and Vermont, replacing Stanley Johnson, who has left the company. A graduate of Beloit College in Wisconsin, Vaughan served as an agent for the Army's Counter Intelligence Corps before joining the company.

Beaumont Station Installs G-E Transmitting, Studio Gear

General Electric Co. has outfitted KBMT-TV, new 316,000-watt Beaumont, Tex., television station, with complete transmitting and studio facilities. Under the contract, the station installed a complete new G-E 50,000-watt, high-channel transmitting package, including amplifying and driving units for the maximum-power station.

Owned by Television Broadcasters, Inc., KBMT-TV is telecasting over Channel 12 as an American Broadcasting Co. affiliate.

Other transmitting gear furnished by General Electric includes a 1,000-ft. tower, antenna and transmission line for the transmitter location. In addition, two complete microwave units were furnished to connect transmitter and studio.

Harman Elected President Jerrold Electronics Corp.

Jerrold Electronics Corp. has announced the election of Sidney Harman as president and chief executive officer. He succeeds the company's founder, Milton J. Shapp, who remains chairman of the board of directors. Shapp has become increasingly active in recent months as a consultant to the Kennedy administration, but will continue his participation in company affairs on a policy-making level.

Harman was president of Harman-Kardon, Inc., leading manufacturer of high fidelity instruments and electronic components for data processing, when the company merged with Jerrold Electronics last February. He was elected executive vice-president of Jerrold in April.

Industry News

Fries Appointed to New Honeywell Post

Appointment of Raymond S. Fries to a new post as manager of manufacturing and engineering of Minneapolis-Honeywell's Brown Instruments division has been announced by Vice-President James S. Locke. The move, Locke explained, "will further strengthen our program of launching new products effectively and rapidly." Brown Instruments is a producer of industrial process instrumentation and is a major unit of the company's Industrial Products group.

In 17 years with Honeywell, Fries has been manager of new products and their manufacture in Minneapolis, manager of the Appliance Controls division at Gardena, Calif., and manager of operations for production facilities of the Commercial division.

Survey Shows FM Stations Planning Stereo Broadcast

A survey of FM radio members of the National Assn. of Broadcasters shows that a total of 79 stations will be airing stereophonic FM programs by the end of this year and 178 by the end of 1962.

On June 27, NAB mailed a questionnaire to nearly 600 FM radio members asking their plans for stereo broadcasting. Replies from 64 per cent of the stations queried produced the following results: 185 stations plan to begin stereo broadcasting; 140 do not plan to go into stereo FM at all; 32 are undecided; and 24 use AM/FM stereo with no indication of FM-only stereo planned. Of the 185 stations who plan to go into stereo broadcasting, two are already doing it, 46 will start in 1962, seven plan to start in the years following 1962, and 77 said they would begin before the end of this year.

An inquiry also was made as to the proposed number of hours stations would be on the air with stereo programs. Responses varied from two to 130 hours per week. Of the stations going into stereo broadcasting, 19 said they would begin operations as soon as equipment is available, or as soon as stereo equipment has passed FCC approval. Stations that would delay starting said the scarcity of FM stereo receivers is the main deterrent.

The survey was conducted by Richard M. Allerton, NAB manager of research.

Vitro Electronics Names Schutz Vice-President

Gerald C. Schutz has been named vice-president of Vitro Electronics, a division of Vitro Corp. of America, 261 Madison Ave., New York 16, N. Y. Schutz will be in charge of engineering and sales activities, according to an announcement by Dr. Donald M. Allison, Jr., president.

Product News

PROFESSIONAL TRANSISTOR TAPE PRE-AMPLIFIER

A new magnetic tape playback pre-amplifier has been announced by Telesound Electronic Associates, 5715 McGee, Kansas City, Mo.

The model UA-100 is completely solid state, said to provide no hum, no heat dissipation, and lower power consumption of eight watts, and is designed to up-date older tape machines for stereo conversion or for multi-track recovery.

The pre-amplifier exceeds broadcast specifications. It has a head input connector to mate with all existing Ampex professional tape recorders and playback decks. Special adaptor connectors are designed to allow the pre-amplifier to match other high quality manufactured tape machines.

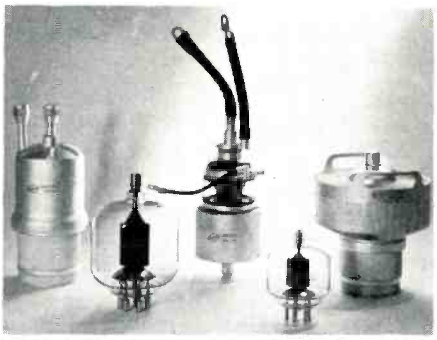
The output impedance is balanced in 600 ohms, with an output level of zero dbm, and the distortion is measured at less than one per cent at maximum output. Adjustable playback equalization is provided, and cross-talk from strong RF fields is non-existent, the manufacturer states.

The new unit is housed in a grey metal case measuring 2⅝ inches high, 6 inches deep and 7⅛ inches wide. The cabinet may be attached to a standard 3½-inch panel for rack mounting. Complete details and specifications are available from T-E-A.

RCA'S SLANT-TRACK RECORDER

The development of a new television tape recorder, designed for low-cost operation with closed circuit TV systems, has been announced by Radio Corp. of America, RCA Bldg., 30 Rockefeller Plaza, New York 20, N. Y.

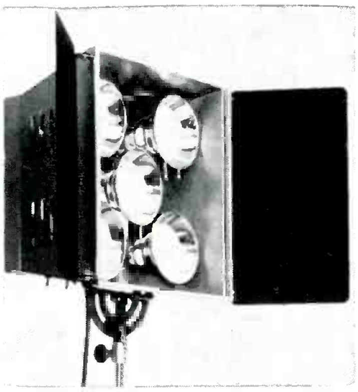
The unit is expected to broaden the use of closed circuit TV for education and training in schools, colleges, hospitals, business and other areas.



NEW ZERO-BIAS TRIODES

Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif., has introduced a new line of compact power triodes for use as zero-bias Class-B linear amplifiers in audio or radio-frequency applications. The new tubes are said to permit elimination of the bias power supply to simplify transmitter circuit designs.

According to the manufacturer, typical power gains of 20 times are realized by the new units in grounded-grid circuits. The small size of the electron tubes makes them suitable for use in compact, single-sideband communications equipment, and are said to provide peak-envelope powers ranging from 500 to 20,000 watts. They include the glass-and-metal 3-400Z, 3-1000Z and 3X3000F7 versions, and the ceramic-and-metal 3CX10,000A7 and 3CV20,000A3 tube types.



NEW GROVERLITE SENIOR LIGHTING UNIT

Natural Lighting Corp., 630 S. Flower St., Burbank, Calif., manufacturer of ColorTran lighting equipment, has announced a new model GroverLite Senior.

Designed to give maximum control for motion picture and commercial/industrial photographic applications, the unit can use a variety of standard lamps. Switches provide two, three or five-lamp selection, and barn doors, diffusion slots and 15-inch cord are included.

A special feature of the unit is that it can now accommodate the new M-6 Color-Flector. External springs, part of the Color-Flector, hold the reflectors in exactly the right position with respect to the lamp, and this permits the use of any bulb, the manufacturer states. Thus the bulb can be changed without necessitating a change of reflectors.

Multiple combinations are possible with the units covering large areas. Size of the unit is 14 x 14 x 8 inches, and the weight is 12 lb.

Product News

AUTOMATIC CONELRAD PROGRAMER

General Electronic Laboratories, Inc., 195 Massachusetts Ave., Cambridge 39, Mass., has developed a Conelrad Programer designed to carry out the complete civil defense alert cycle, automatically. The new unit, called the Rust Conelrad Programer, can be activated by non-technical persons through a push button or remote control to provide the entire cycle required by the FCC.

In operation the programer causes the following sequence to occur: (A) Carrier Off —five seconds. Simultaneously, the regular program is disconnected by internal program relay. (B) Carrier On—five seconds. (C) Carrier Off— five seconds. (D) Carrier On. (E) One-half second after "D", 1,000-cycle audio tone—15 seconds. (F) After total Conelrad alert cycle of 30½ seconds, program relay disconnects from automatic Conelrad programer and returns to normal program line.

The new unit is designed for continuous operation and extra long life using no tubes or transistors. The equipment can be installed on any transmitter within an hour, the company states. Dimensions of the unit are 3½ inches high x 19 inches wide, with a maximum depth of 3½ inches, fitting a standard relay rack.

The programer is available in two models, the 108-42 and 108-42A. The 108-42 is activated by a push button, while the 108-42A incorporates an accessory control relay which by-passes the push button and can be controlled by a remote control system from the studio. Both models provide 24 volts dc to operate external relays during the Conelrad alert cycle.

INSTRUMENTS AND COMPONENTS CATALOG, NO. SH-61

Alford Mfg. Co., 299 Atlantic Ave., Boston 10, Mass., is offering the new 1961, 30-page catalog, which describes the company's r-f instruments and coaxial components; gives characteristics, dimensions, and prices of slotted lines, tapered reducers, adapters, instrument loads, calibrated mismatches, impedance-matching tuners and networks, impedance-standard lines, automatic impedance plotters, transmission-line hybrids, r-f bridges, coaxial switches, line stretchers, variable calibrated attenuators, matching tees, and detector-mixer. Also included is ordering information and list of sales offices.

NEW SONIC ELECTRONIC CATALOG

H. H. Scott, Inc., Instrument Div., 111 Powdermill Road, Maynard, Mass., has announced a new short form catalog featuring the company's complete line of sound measuring and analyzing instruments, industrial amplifiers, speakers and FM tuners. Also contained is information on multiplex adaptors and test equipment.

Advertisers' Index

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.

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Transmission line, styroflex, heliax, rigid with hardware and fittings. New at surplus prices. Write for stock list. Sierra Western Electric Cable Co., 1401 Middle Harbor Road, Oakland 20, California. 6-61 tf

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 31, Temple, Texas. 9-61 tf

Used 50 KW Transmitter, Western Electric 407A-4 in good condition with spares. Priced at one-fourth less than a new transmitter. Can be handled with as little as 10% down. Broadcast Engineering, Dept. BE-4, Kansas City 5, Mo. 8-61 4t

BUY, SELL OR TRADE

Will buy or trade used tape and disc recording equipment — Ampex, Concertone, Magnecord, Presto, etc. Audio equipment for sale. Boynton Studio, 10 BE Pennsylvania, Tuckahoe, N. Y. 4-61 6t

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FOR EXTRA AUDIENCE AND ADVERTISER IMPACT

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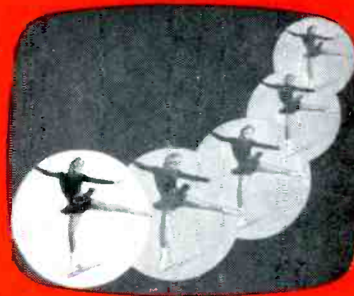
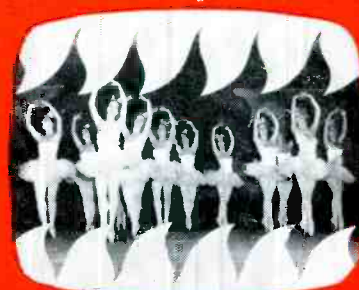
THE ONLY SPECIAL EFFECTS GENERATOR WITH "JOY-STICK" POSITIONER AND BUILT-IN FADER

First, Telechrome provided broadcasters with a vastly improved special effects generator to provide a wider variety of dramatic wipes, inserts, keying, and other special effects. Now, Telechrome engineers makes available the exclusive "Joy-Stick" Positioner and a built-in fader control to give you a complete, integrated Special Effects Center with previously unobtainable versatility. You can now produce fades—many hundreds more special effects—more wipes, keying, inserts and other effects to any part of the TV screen for truly dramatic TV viewing—from one Special Effects Center. Now, right at your fingertips, you can have a new dimension in program creativity—and for a low cost that will surprise you. See for yourself how Telechrome's Special Effects Center provides profitable extras in advertiser and viewer impact. Contact your Telechrome representative for a free demonstration today.



Electronic Spotlight

Insert Placed at Any Position on Raster



Add Motion to Standard Wipes

Electronic Pointer

PORTABLE OR RACK MOUNTED MODELS AVAILABLE.

MODEL 490WA1. *(Top)* Waveform generator. Generates keying signals for different wipes. **MODEL 4905A1.** *(Center)* Switching Amplifier. Combines two picture signals in accordance with applied keying waveform for inserts and fading. **MODEL 490RA1.** *(Bottom)* Remote Control Unit selects and controls desired effects. Designed for console or rack mounting. Easily modified for integration into existing facilities. **Console Unit below: MODEL 490RA1.** Remote Control Unit *(at right hand)*; **MODEL 491** Joy-Stick Positioner *(directly above)* positions inserts at any position on raster, adds motion to standard wipes, serves as electronic spotlight or pointer, etc.

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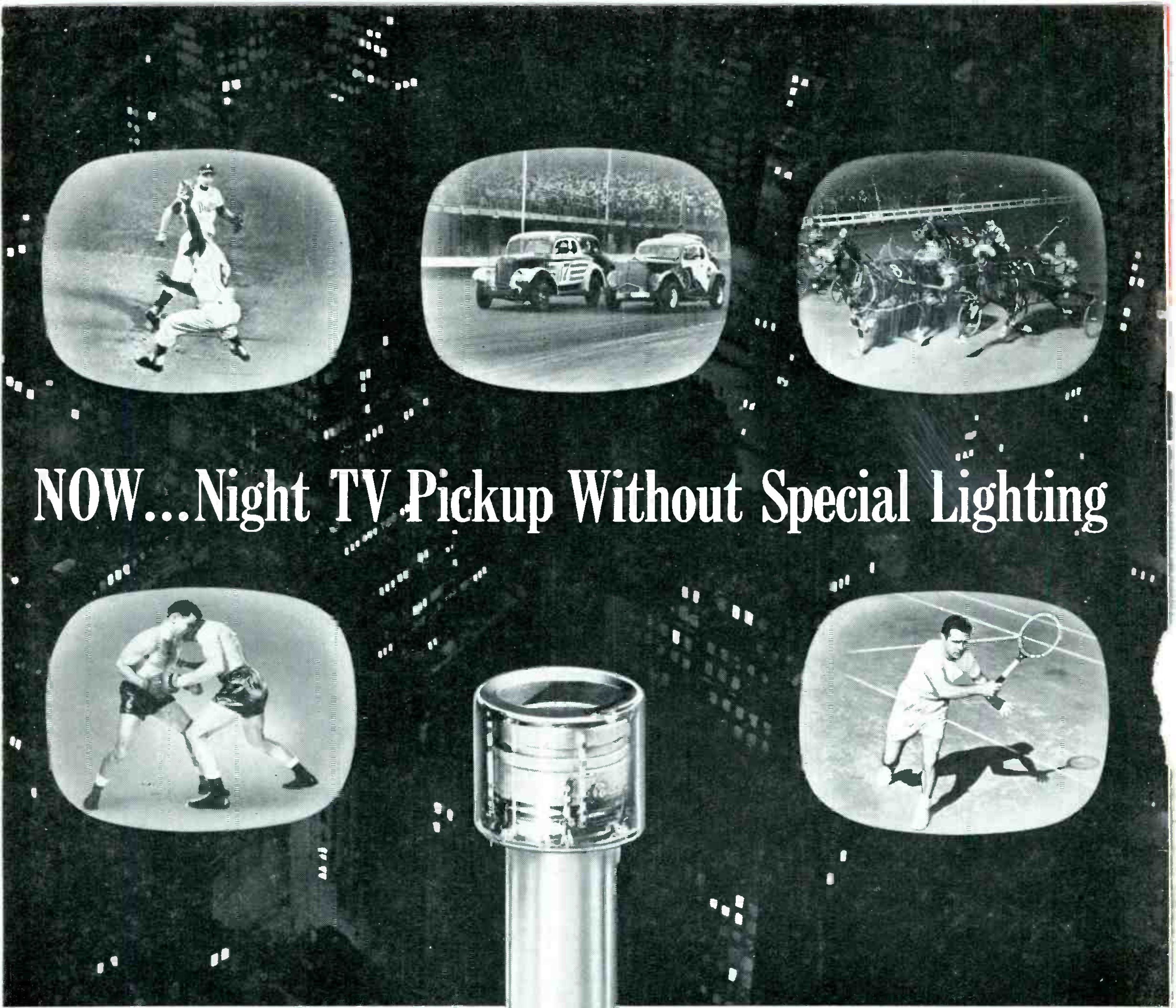

NOW...Night TV Pickup Without Special Lighting

Broadcast-quality pickup at light levels never before possible with supersensitive RCA-4401V1 image orthicon

"Amazing" is the way broadcasters describe the sensitivity of the RCA-4401V1! This is the image orthicon that enabled many stations to move into profitable new fields of evening programming—such as outdoor pickup of sports, concerts, special events—that previously required costly, complex special lighting! Truly the solution to remote nighttime pickup problems, the 4401V1 actually produces a normal broadcast quality picture with illumination of only 10 footcandles on the subject itself with a lens opening of f/8.

RCA The Most Trusted Name in Television

The 4401V1 is but one of the broad RCA family of specialized image orthicons. Others include:

B & W TELECASTING (3" CAMERA TUBES)

5820A New version of the 5820 for B & W studio and outdoor pick-up is destined to be the "standard" of broadcasting.

7293A A field-mesh image orthicon having an image section designed to prevent highlight ghosts. Field mesh-design to improve corner focus and prevent porthole effects.

COLOR TELECASTING (3" CAMERA TUBES)

7513 Features special precision construction and RCA field-mesh design for high quality color and B & W pickup.

4401 For low-light-level colorcasting—studio or outdoor. Available in matched sets of three for maximum performance.

4415 For studio pickup of color at B & W light level.

4416 Set of three tubes consists of two 4415's and one 4415. The 4416 has increased blue sensitivity. Both types have advantages offered by precision construction and field-mesh design. Primarily for studio application at light levels from 50 to 200 footcandles.

TAPE RECORDING (4½" CAMERA TUBES)

7295A A field-mesh image orthicon with high resolution and very high signal-to-noise ratio. For tape and B & W studio use.

7389A A superior-quality field-mesh design image orthicon, with extremely high signal-to-noise ratio, for tape and exceptionally high-quality B & W studio pickup.

Whatever your station's requirements or special problems, there's an RCA Image Orthicon designed to meet them. For information in specific types, see your local RCA Industrial Tube Distributor.