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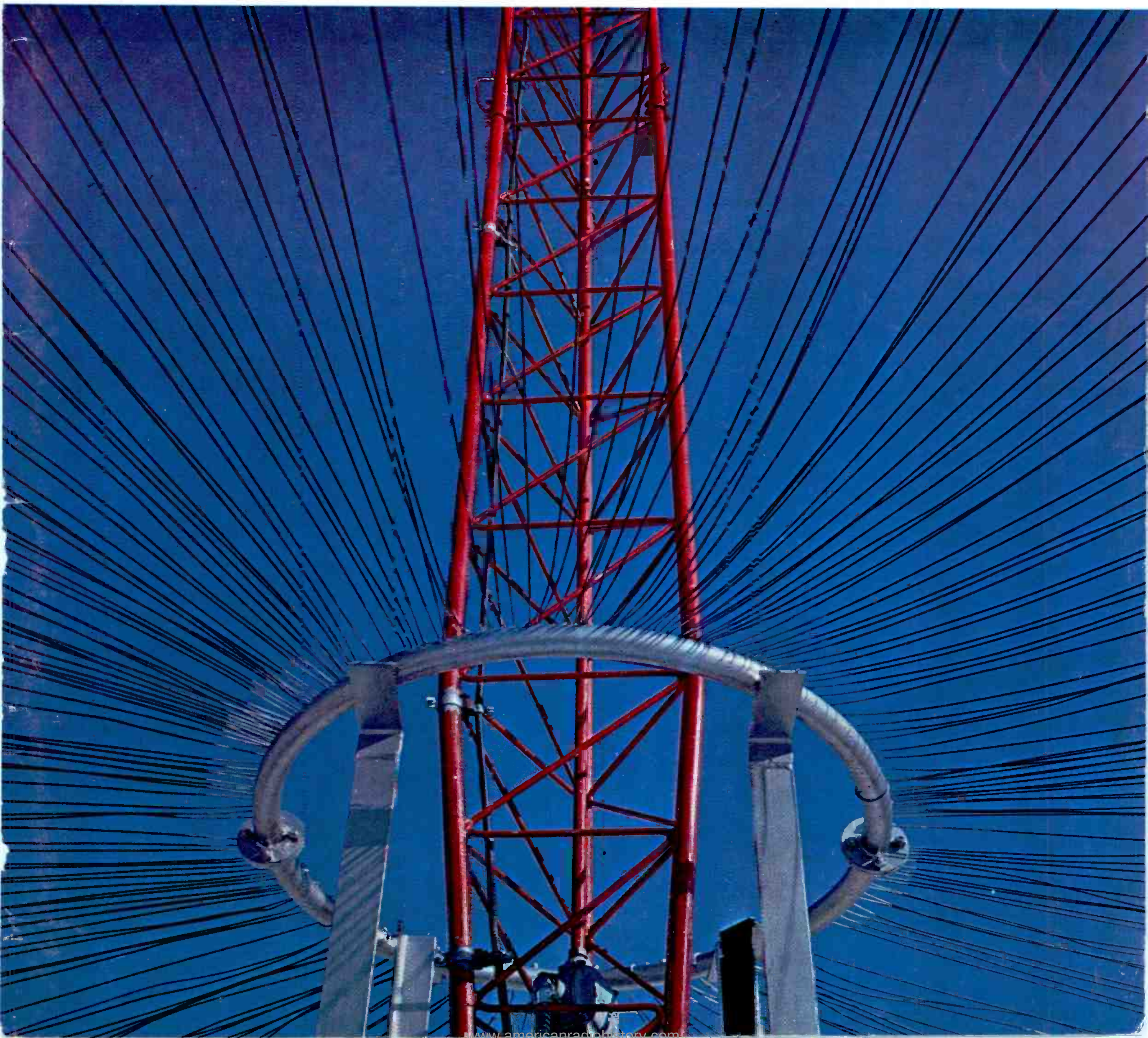
the technical journal of the broadcast-communications industry



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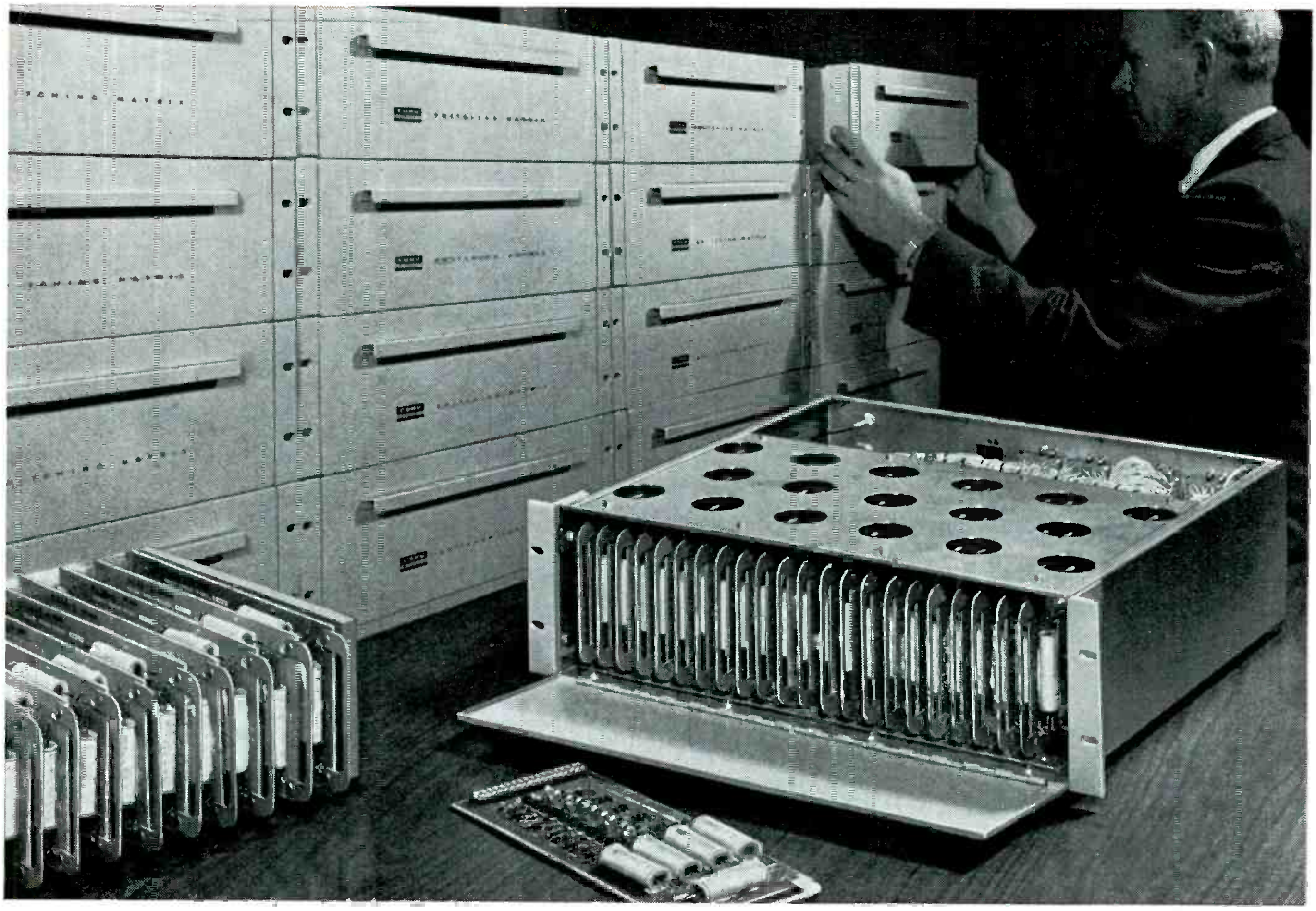

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Volume 8, No. 2 **February, 1966**

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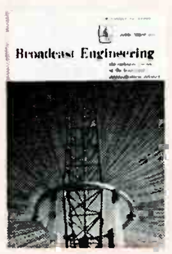
At WIBC, Indianapolis, the ground radials for each tower are attached to the fence, and wires extend across the enclosure to a ring around the tower base. This arrangement enabled us to photograph the view on our cover to call attention to the comprehensive feature on grounding that begins on page 17.



ENGINEER'S EXCHANGE

Finding Momentary Shorts in Inductors

by Walter L. Johnson, Jr.
Chief Engineer, WGOL
Goldsboro, N.C.
and WELS Kingston, N.C.

Almost all broadcast engineers have encountered a filter choke or transformer that developed a short to the core or metal case of the inductor. Sometimes these shorts occur only momentarily and are quite difficult to locate—especially when any one of several chokes and transformers could be the cause. Usually, the trouble is even more exasperating because when the short occurs it only "kicks" the transmitter off the air by throwing an overload relay. This really makes things bad if the relay is not of the reset type and the station is remote controlled.

We recently encountered such a problem at one of our stations. The transmitter would operate perfectly; then suddenly it would leave the air. Sometimes we could restore power simply by operating the plate "on" switch. Sometimes we would have to wait a few minutes before the plate would stay on. We made all kinds of tests but could find no cause of the problem. The condition continued for several days: sometimes the transmitter would stay on all day; sometimes it would leave the air only once in a day; other times it would go off as many as four or five times. We even went so far as to spend a couple of days in the shack watching the transmitter. When the transmitter would go off, no amount of testing would show any cause; furthermore, pressing the plate switch would instantly return the station to the air with no indication of any trouble.

During all our testing, we were able to eliminate practically everything except the filter chokes and some of the transformers. Since it

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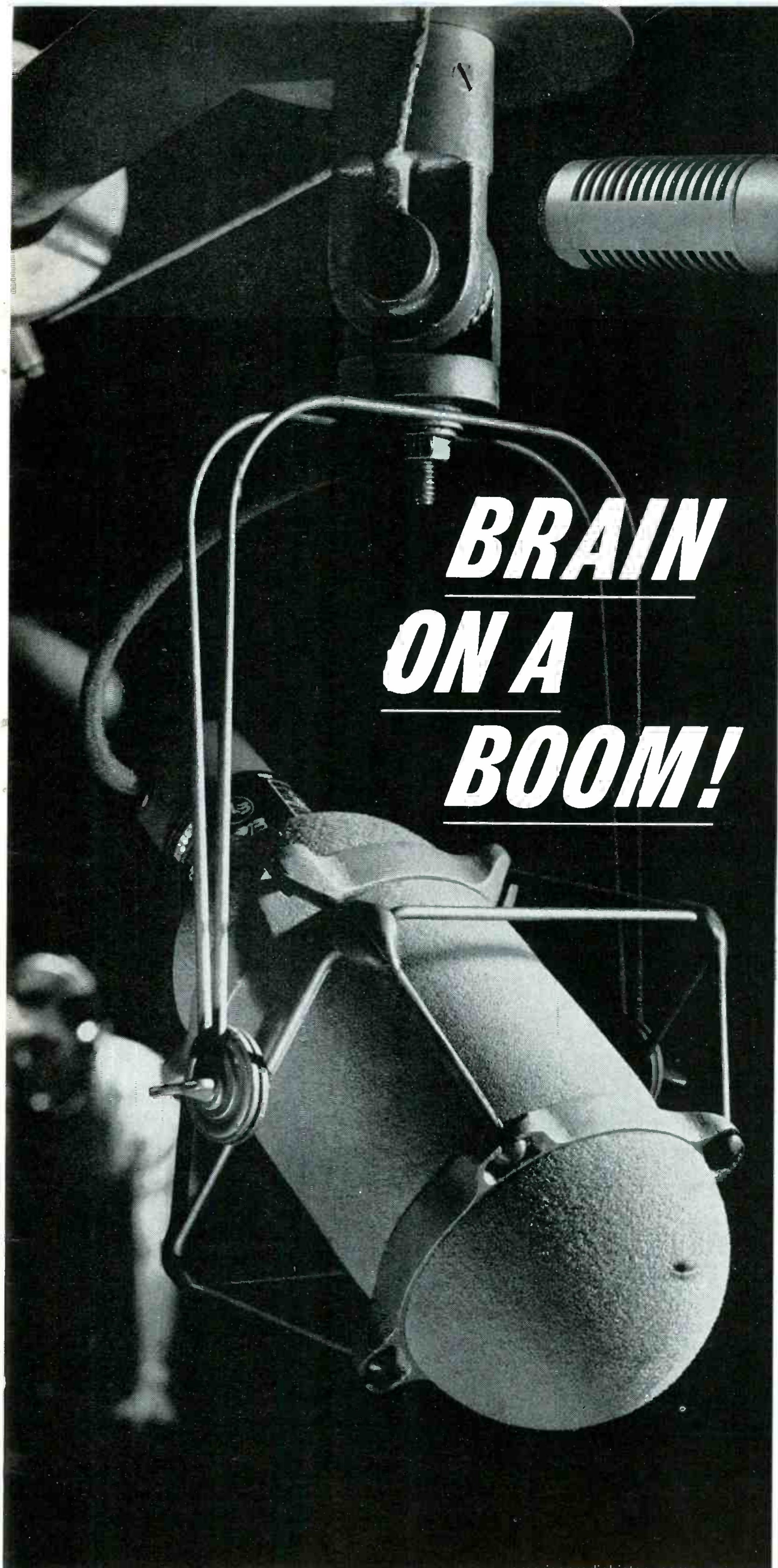
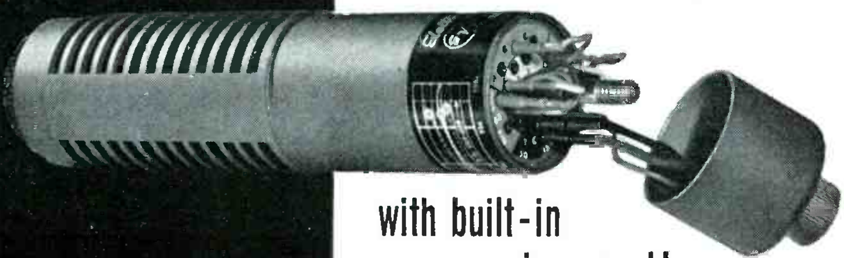


New E-V Model 668 Dynamic Cardioid Boom Microphone



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NEW! MODEL 667A identical to Model 668 except sharp cutoff filters and HF-rolloff eliminated. List price: Model 667A, $345.00; Model 668, $495.00 (less normal trade discounts).

* Patent No. 3115207 covers the exclusive E-V Continuously Variable-D design.

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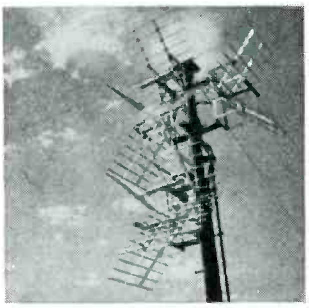

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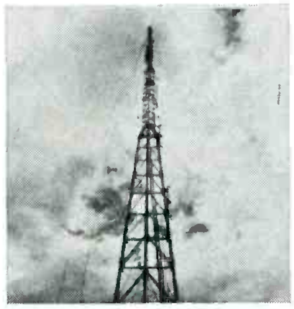

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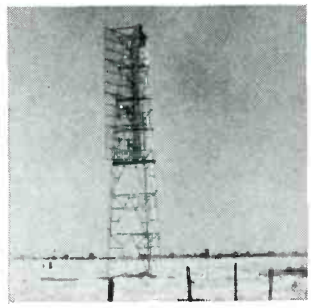
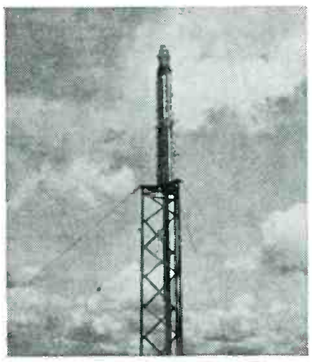


ALEPPO, SYRIA
Troposcatter (VHF)



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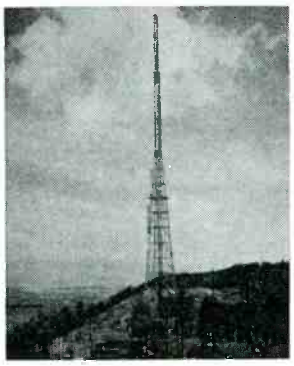

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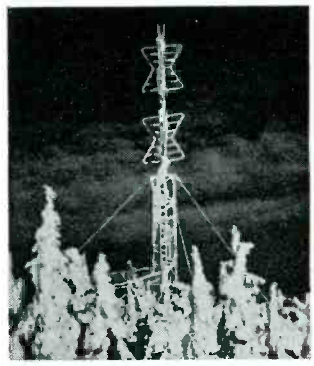

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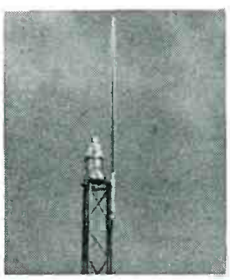

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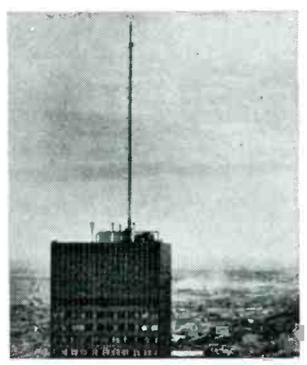

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STATION-BREAK AUTOMATION FOR TELEVISION

by Patrick S. Finnegan, Consulting Author, Chief Engineer, WLBC AM-TV, WMUN FM, Muncie, Indiana—There are ways to eliminate the "panic period."

Commercial television broadcasting generally follows a format in which programs are separated into half-hour or one-hour segments. During the break periods between segments the station is identified. Also during these periods, local advertisers have an opportunity to advertise their products. This is especially true for network-affiliated stations which utilize mostly national programming that is nationally sponsored.

Local advertisers have the same right to television exposure as do national concerns, and they are eager to buy time. The normal time allotted by a network for station advertising breaks is about 70 seconds. In an effort to accommodate more local sponsors, the station often subdivides this time interval into 10- and 20-second announcements. The result has been to place much work and pressure upon station operating personnel during these short periods known as the "panic periods."

Panic periods they are! Not only is money involved (station revenue), but station prestige is at stake. A commercial announcement that is "goofed" will require a make-good —if possible. Moreover, an irate sponsor may cancel his schedule completely, and reverberations are felt at all levels of station operation. Station prestige requires that locally produced announcements should be as well produced as network programs and commercial.

At network TV stations, there is relative inactivity between break periods. When the break commences, however, a myriad of split-second switching actions must be accomplished perfectly, and there is always another unrelenting deadline approaching. At the independent station, the panic period can be even more demanding; the personnel must close one locally produced show, handle the break period, and begin another locally produced show. This can multiply switching operations tremendously!

Most stations can derive benefits from the use of automation during panic periods in proportion to the amount of commercial content aired, the time of day, and the complexity of the station operation. Of course, a station which carries network programs, switches away for a local public-service announcement and ID, then switches back to the network will not be justified in the purchase of an expensive automation system for this simple sequence.

Degrees of Automation

General broadcast automation can be divided into four categories: simple, intermediate, full, and total automation. The same definitions can be applied to panic-period automation because many of the present-day systems, although used for the panic period, are capable of expansion to more complex station automation system.

Simple automation is defined as use of those items of equipment that are arranged to do simple or single operations by themselves or can be run by remote control. Every station uses this form of automation in various places, such as with slide and film projectors or audio cartridge-tape machines.

Intermediate automation is defined as use of equipment that activates other equipment, either in sequence or concurrently. This overall program operation for the most part is manual. Various home-designed systems and complex systems

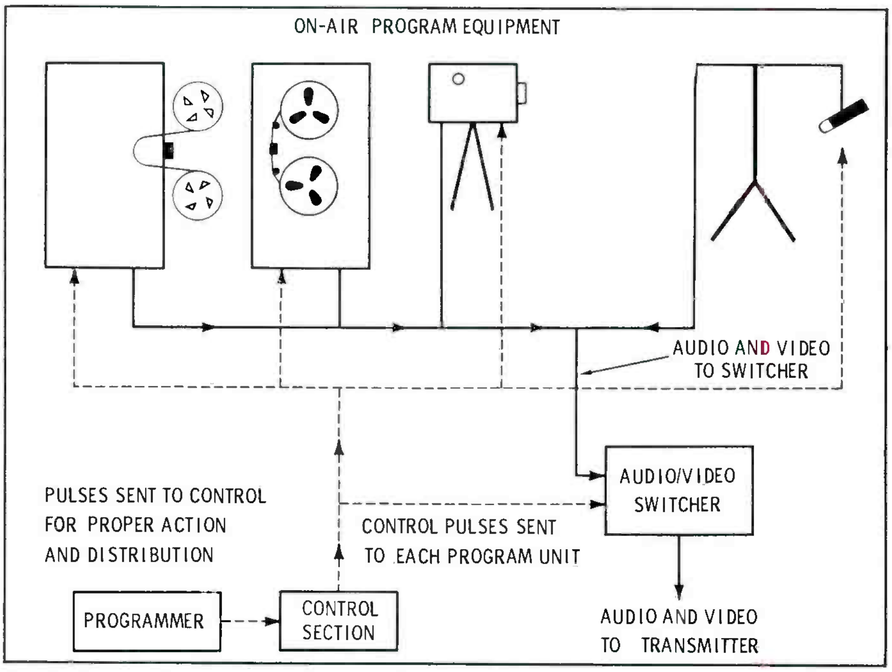

Fig. 1. Automation system's three sections: programmer, control, on-air equipment.

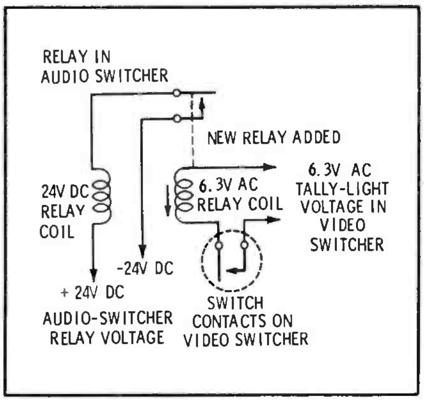

Fig. 2. Diagram shows use of a relay for voltage conversion between systems.

used only for the break period fall into this category. Such systems are by far the most numerous in use today.

Full automation can be defined as a system which controls the complete day's programming, separately but automatically, requiring little attention.

Total automation carries full automation into all departments, such as traffic, accounting, scheduling, etc.; all station functions are tied into one integrated system.

System Requirements

Regardless of the type of system a station wishes to build or buy, there are certain basic requirements that should be met in order to reach the final objective of effective programming.

Manual Take-Over

Since no system or any of its parts is perfect, failures do occur. These failures may be caused by faulty equipment components or human error such as supplying incorrect information into the programmer. Any system sets up circuit and switching paths according to the

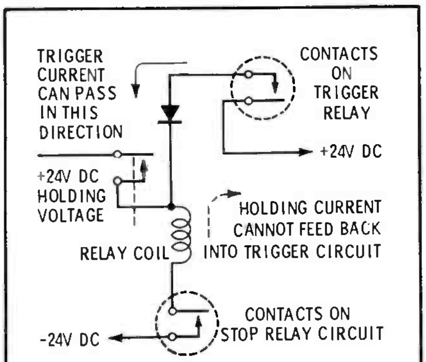

Fig. 3. Diode serves as gate to keep equipment voltage from trigger bus.

information supplied to its control center. It cannot, for example, distinguish the incorrect slide that an operator may have loaded into the slide projector. Any system, therefore, must be capable of instant take-over by the operator.

Last-Minute Changes

This requirement is important for those systems which control longer segments of TV programs. For example, suppose two hours of programming have been prepared, but a few minutes before air time, a spot is to be cancelled or changed. The operator should be able to make the change easily and simply, then run the period automatically.

Equipment Capability

The "on-air" equipment must be capable of being operated automatically and should be compatible with other equipment in the system. Most present-day equipment will meet this requirement, but care must be exercised when trying to incorporate older equipment with new. Some older film projectors, for example, require five to seven seconds to stabilize. If the system does not permit this long a preroll, the projector will be aired in its unstabilized mode with poor "on-air" quality. Another compatibility problem can arise in start and running methods. Older methods may require a switch or relay to be turned on and remain on until it is desired to stop the item of equipment. Many present-day models require only a momentary DC voltage pulse to start and another similar pulse to stop the equipment. The two types of equipment cannot be used together successfully in a system without modification of the older equipment. Almost all equipment that requires a manual, mechanical start will not work in an automation system, without extensive changes.

Switcher

Both video and audio switchers must be relay, crossbar, or solid-state types. Many older switchers are the direct type; that is, the push button on the console carries the video (audio), as well as other voltages, directly through its contacts. Such switchers, although they can be adapted to perform a number of simple automation functions, cannot be used in a more complex system without extensive modification. These modifications, in effect, convert them to relay switchers.

Timing or Clock System

Any system must either be run by a clock-timing device or be sequenced from one piece of equipment to the next. The timers may be independent clock systems or synchronized to the station clock. A sequencing system requires that pulses be sent back from each item of air equipment when it completes airing its portion of the sequence. This pulse starts the next equipment item.

Readouts and Indicators

A readout system is a most desirable feature. This system helps the control operator to know exactly what is going on and at what time in relation to the other events in the same period. Otherwise, he would be required to watch a clock constantly and keep track of times to insure that each event is occurring as scheduled.

Indicators are also an important feature in that they indicate to the operator what is on the air, what is in preroll or run-out, and if an event is ready for use. There will be times during any period when three different machines may be in some phase of operation at once. The operator must know, for example, whether a machine is in run-out or has simply failed to stop. Otherwise, it could run past the next item that may be on the same tape or reel of film. Also, some warning is needed when a machine is not in the proper mode to run when called. This could happen if an operator inadvertently failed to switch the control circuits back to the remote mode after loading a film projector.

Programmer

Simple systems require only preset switches to be properly set beforehand. More complex systems, however, require that some type of programmer be used. The programmer sets up the switching and routing paths that will be required once the operation is begun. Programmers may be simple, such as pin boards, or complex, such as the computer punched-tape readers.

Systems

The complex automation systems, whether used for panic-period or full-day automation, are made up of three sections: the on-air station equipment, control section, and programmer or computer section. (See Fig. 1).

The on-air equipment is the normal station program equipment: VTR's, film and slide projectors, etc. Such equipment must be stable, reliable, adaptable to remote control, and capable of supplying cuing pulses to other equipment, stopping, and cuing itself as may be required by the system in use.

The control section routes pulses to the audio and video switchers, sets up circuit paths, and sends start/stop pulses to the on-air equipment, controlling operation.

The programmer or computer accepts information from the control operator, punched paper tape, or punched cards. At the appropriate times, it sends pulses to the control section as system operation commences. Some of the sophisticated systems have a solid-state video and audio switcher integrated into the programmer.

Hardware

Many stations have built a number of circuits and modified equipment to provide a variety of simple switching functions. These are generally of the preset and audio-follow-video variety. Some have also built very extensive, complex systems. With a little imagination and a few relays, the station engineer can devise many automatic functions with his existing equipment to make it more versatile.

An example is a simple arrangement to handle a commercial announcement requiring several slides with accompanying audio. This can be an effective presentation. Operation is as follows: The video-switcher button is operated to air the slide camera. A control pulse from the switcher, which may be a DC voltage pulse, tally-light voltage, or blanking pulse from the station sync generator (or some type of trigger) is supplied to switch the program channel of the audio tape machine on and trip the cartridge to run. As the presentation proceeds, tones on the auxiliary track of the tape provide a switch impulse to the slide projector, which in turn changes slides.

When working with older equipment and picking up some voltage source for a trigger, exercise care to keep voltages compatible. (See Fig. 2). It is possible to encounter a 6.3-volt AC tally and 24-volt DC audio-relay voltage. It is necessary to use a relay for "voltage conversion" in such circumstances. The 6.3 volts AC from the video switcher operates the coil of a new relay whose contacts in turn carry the audio-relay voltage.

A silicon diode can be used effectively as a DC gate in "home-made" systems (Fig. 3). One may have an item of equipment which requires only a momentary contact or DC pulse to trip the equipment on. To isolate the trigger circuit from the equipment-voltage circuit, the simple diode gate may be used. In the diagram, DC is fed through the start-circuit contacts, the relay coil, and the stop button to its return path. This will cause the relay to operate, closing a set of normally open contacts; these contacts supply DC to the coil to keep it energized as long as the stop circuit is closed. When the stop circuit is opened, the coil will relax and cannot be energized until the next pulse triggers it on. The diode must be placed in the circuit correctly to be effective. The forward, or low, resistance must face the trigger pulse, while the back, or high resistance must face the holding voltage. Both the start and stop switches may be contacts of other relays.

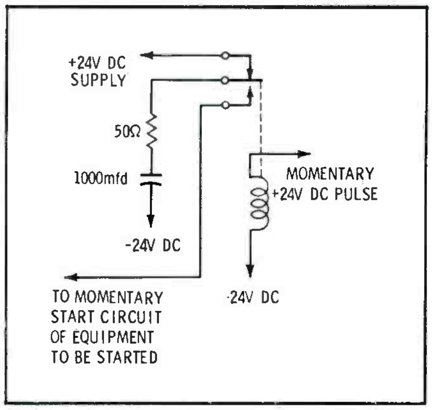

Fig. 4. A charged capacitor can be used to provide a momentary starting pulse.

A capacitor may be used to provide a momentary voltage pulse to start some item of equipment (Fig. 4). A situation could develop in which a spare set of contacts is available on a relay that will remain on for a longer period of time than the particular machine to be started. A capacitor can be charged while the relay is de-energized. When the relay operates, the charge in the capacitor is dumped into the start circuit. A large value of capacitance should be used; a small series resistance is necessary to limit the surge on the power supply when charging begins. If the resistor is too large in value, the discharge will be too slow, and the circuit will not work. The values listed will work satisfactorily.

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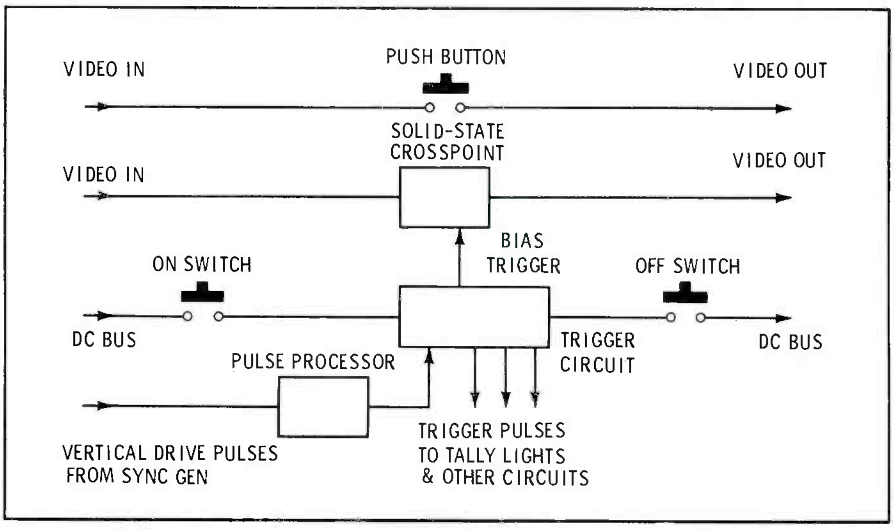

Fig. 5. Comparison between operation of direct and solid-state video switchers.

FM OVERMODULATION AND THE FCC

*by **Robert A. Jones**, Midwestern Regional Editor, LaGrange, Ill.*—Understanding what overmodulation is can help you prevent it.

There seem to be more and more reports of FM stations being cited for overmodulation and improper operation, particularly when employing stereo modulation. Therefore, it may be helpful to review briefly what the process of frequency modulation is.

The FM Process

First, by definition FM is a process in which the RF amplitude is held constant and the output frequency of the transmitter is made to vary about the "carrier" or "rest" frequency at a *rate* corresponding to the audio frequency of the modulating signal. The extent to which the frequency varies from the carrier or rest frequency is proportional to the *amplitude* of the modulating signal. The FCC defines 100% modulation (see Section 73.310 [a]) as: "a frequency swing of plus or minus 75kc." Thus the ratio of the actual frequency swing to the frequency swing defined as 100%, expressed in percentage, is called the percent modulation.

It is also valuable to define a few other common FM terms. For example, the center frequency (rest frequency) is the frequency of the emitted wave without modulation. Deviation is the number of cycles per second that the FM signal changes above or below the carrier frequency. The frequency swing, then, is the sum of the cycles per second above and below the carrier frequency, and the rate of change is the number of times per second the swing goes above and below the rest frequency.

Fig. 1 shows a comparison between an RF carrier amplitude modulated by a sine-wave audio voltage and a carrier frequency modulated by the same audio wave. In amplitude modulation, the resultant RF modulated wave varies about the zero axis at a constant rate, but the amplitude of the individual RF cycles is proportional to the amplitude of the modulation voltage. In frequency modulation, the same modulating voltage, of one polarity, causes the carrier frequency to decrease, illustrated by the fact that the individual RF cycles of the carrier are spaced farther apart. A modulating voltage of the opposite polarity causes the frequency to increase, as shown by the RF cycles being squeezed together — more cycles are completed in a given time interval.

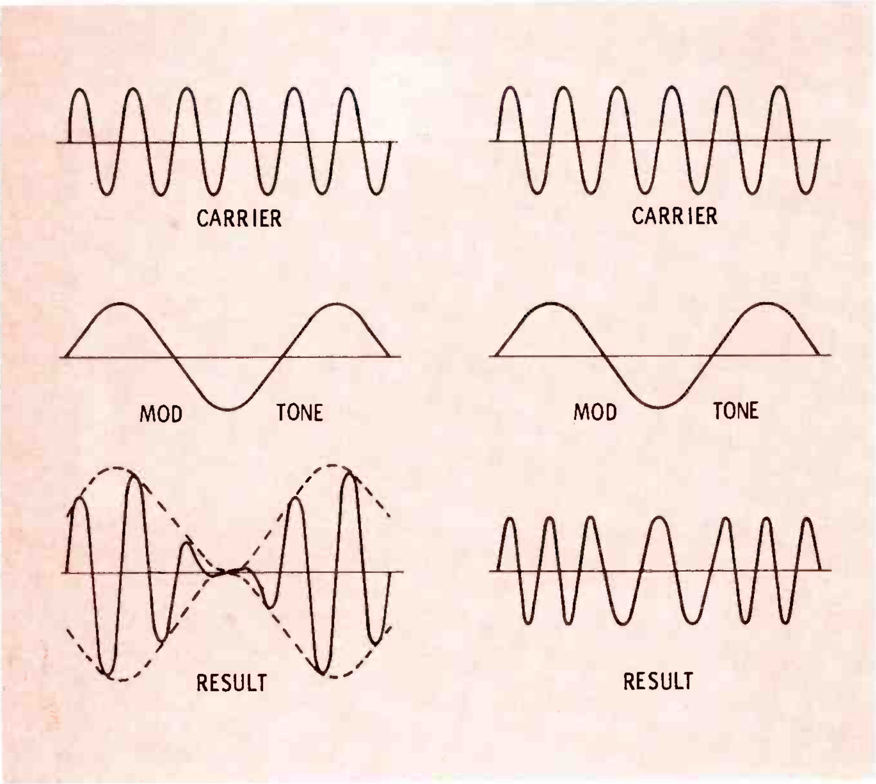

Fig. 1. Comparison of the effects of two types of modulation on carrier wave.

A common characteristic of FM and AM waves is that both types of modulation result in distortion of the RF carrier. That is, after modulation the RF cycles are no longer sine waves (see top of Fig. 1), as they would be if no frequencies other than the fundamental carrier frequency were present. It may be shown that in the AM waves illustrated in Fig. 1, there are only two additional frequencies present; these are the familiar "side frequencies," one located on each side of the carrier and spaced from the carrier by a frequency interval equal to the modulation frequency (Fig. 2). The amplitude of the sidebands varies with percent modulation, but the carrier does not.

The frequency-modulated carrier wave in Fig. 1 is also distorted, but in this case, many more than two additional frequencies are formed. The first two are spaced from the carrier by the modulation frequency. The additional side frequencies are spaced outward from these and from each other by the same interval. Theoretically, there are an infinite number of side frequencies formed; but, fortunately, the strength of those beyond the frequency swing of the transmitter under modulation is relatively low.

One possible set of side frequencies that might be formed by frequency modulation is shown in Fig. 2. Unlike in AM, the strength of the carrier- frequency component varies widely in FM, and it may even disappear entirely under certain conditions. This variation of carrier-component strength is very useful in the calibration of FM modulation monitors.[1]

As defined above, deviation is the amount of frequency swing on each side of the unmodulated or "resting" carrier frequency. Deviation is ordinarily measured in kilocycles, and in a properly operating FM transmitter it will be directly proportional to the amplitude of the modulating signal. When a symmetrical modulating signal is applied, equal deviation on each side of the carrier frequency is obtained during each cycle of the modulating signal. If a transmitter operating on 1000kc has a frequency shift from 1000kc to 1010kc, back to 1000kc, then to 990kc, and again back to 1000kc during one cycle of the modulating wave, the deviation is 10kc and the frequency swing is 20kc. This 10-kc deviation can be (and normally is) produced in commercial FM broadcasting by some audio tone of less than 10kc. By definition, the ratio of the deviation to the audio modulating frequency is the *modulation index*. If in the above example the audio tone were 2kc, then the modulation index would be 5, since the deviation (10kc) is 5 times the modulating frequency (2kc).

The relative strengths of the FM carrier and the various side frequencies depend directly on the modulation index, and these relative strengths vary widely as the modulation index is varied. In the preceding example, for instance, side frequencies occur on the high side of 1000kc at 1002, 1004, 1006, 1008, 1010, 1012 kc, etc., and on the low-frequency side at 998, 996, 994, 992,990, 988 kc, etc. In proportion to the unmodulated carrier strength (100%), these side frequencies have the following strengths, as indicated in Fig. 2, with a modulation index of 5:

1002 and 998—33%
1004 and 996—5%
1006 and 994—33%
1008 and 992—39%
1010 and 990—26%
1012 and 988—13%

The carrier strength (1000kc) is 18% of its unmodulated value. Changing the amplitude of the modulating signal will change the deviation; thus the modulation index will be changed, with the result that the side frequencies, while still located in the same places, will have strength values widely different from those given above.

The deviation ratio is similar to the modulation index in that it involves a ratio between the modulating frequency and deviation. In this case, however, the deviation in question is the peak frequency shift obtained under full modulation, and the audio frequency to be considered is the highest audio frequency to be transmitted. Thus, for commercial FM broadcasting stations, a maximum audio frequency of 15,000cps to be transmitted requires a deviation ratio of 5 for a peak deviation of 75,000cps.

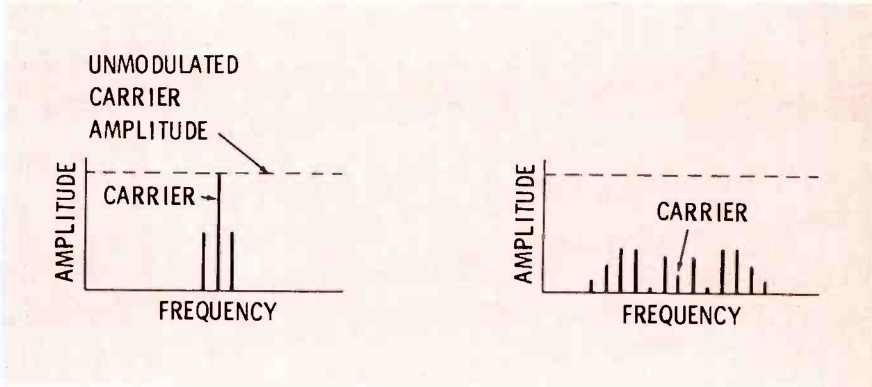

Fig. 2. The sideband composition varies greatly with the method of modulation.

Determining Percent Modulation

By employing a somewhat complex equation involving Bessel functions, the amplitude in each side frequency and the carrier can be computed. Fig. 3 shows what happens to an RF carrier that is frequency modulated by a constant audio-frequency tone, but with different modulation levels. The modulation index is shown to the left of each spectrum diagram. For a modulating index of zero (upper left diagram) there is only the carrier, with no sidebands. It is of interest to compare the diagrams in Fig. 3. As one can see, with increasing modulation indexes (level of audio tone applied), the carrier amplitude changes drastically, and the number of side frequencies increases. With a modulation index of 2.4, the carrier is absent. This then would be the first carrier zero point and is

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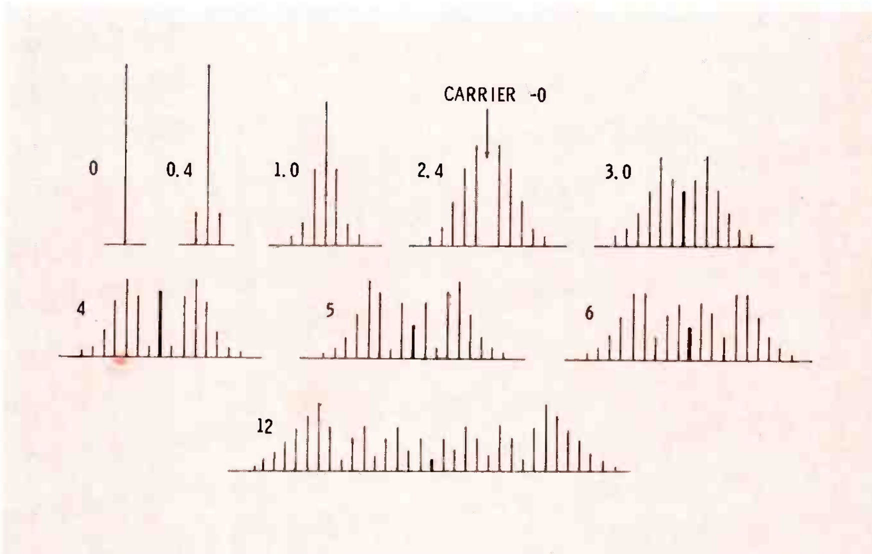

Fig. 3. The carrier amplitude decreases to zero for certain modulation indexes.

[1] "Calibration of AM & FM Modulation Monitors," Nov. 1964 BE, page 12.

CENTRAL CANADA BROADCASTERS' CONVENTION

by Len Spencer,
BE Consulting Author, Montreal, Quebec

L to r are G. Roach, eastern zone captain; L. Gilbeau, past chairman; N. Farr, chairman; H. Graves, papers chairman.

Mr. Clive Eastwood of CFRB, Toronto.

Another well attended Central Canada Broadcasters' Engineering Convention was held in Montreal last October. Mr. Norman Farr and his associates are to be congratulated on the papers presented, and a special nod of recognition is due Mr. E. Mott and R. Causeland for arranging the many details including the entertainment provided at the closing banquet.

One of the outstanding papers was presented by Mr. Clive Eastwood, engineering director for station CFRB, Toronto, who described the station's newly completed AM and FM studio complex. Eleven studios, news room equipped with weather radar, both AM and FM record libraries, and all ancillary services including the administration offices are installed on one 20,000-square-foot floor.

The salient feature of this installation is the elimination of all racks and jack bays from studio control rooms. Amplifiers are built into the equipment, and all switching of the 50 line inputs into each control studio is made by relays. A control-desk switcher is installed in each studio control room.

W. C. Marchand, of CKLB, Oshawa, Ontario, described an eco-

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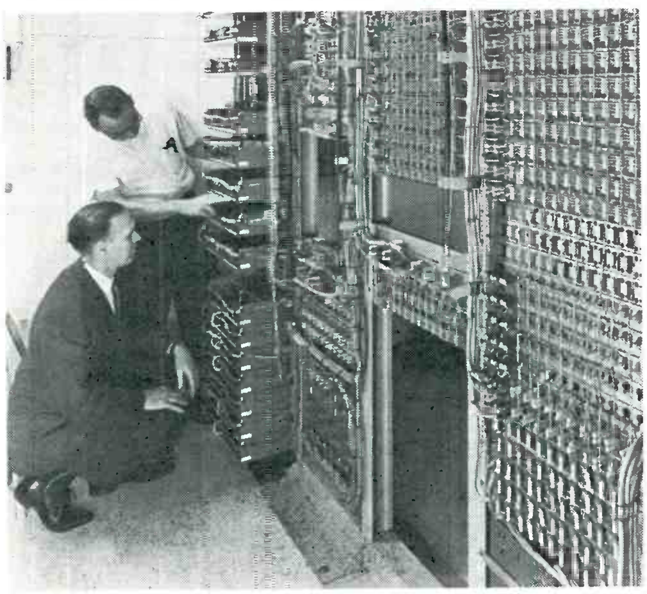
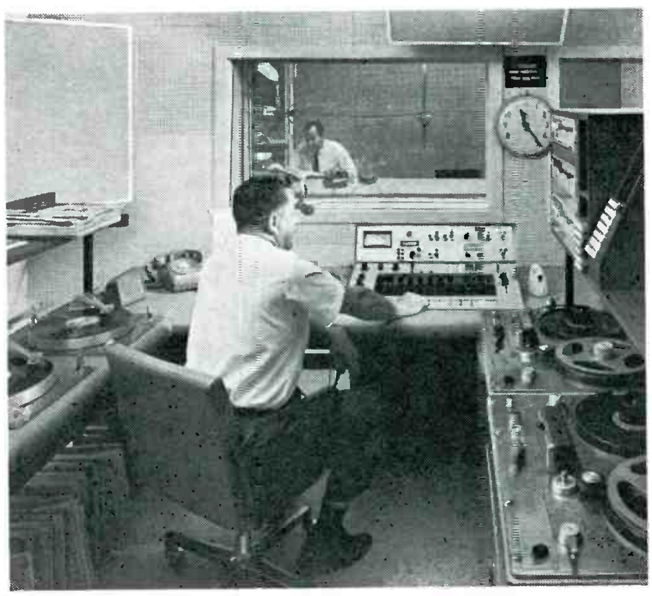
Mr. E. Mott of station CJAD, Montreal.



Relay racks in the new equipment room at radio station CFRB.



Turntables, tape equipment, audio console in CFRB control room.

REMOVING THE MYSTERY FROM GROUNDING

by Thomas R. Haskett
Central Regional Editor

A thorough coverage of all aspects of grounding applicable to broadcasting.

The process of grounding is not always clearly understood by broadcast engineers. Very little literature exists which thoroughly describes grounding procedures from more than a single, limited viewpoint. To an electrician, grounding means one thing; to a designer of radar equipment, it means quite another. We will attempt here to cover the theory and practice of grounding as employed in broadcast stations.

Fig. 1 shows four common ground symbols found in schematic diagrams. The general symbol for ground is shown in Fig. 1A. Occasionally this symbol is used to refer to a physical connection to the earth itself; in most cases it refers simply to the chassis frame. Two European ground symbols are illustrated in Fig. 1B. Some audio circuits use a ground bus which is physically insulated from the chassis, and the symbol for this is shown in Fig. 1C. Such a bus may or may not be connected to the chassis at one point only. The symbol in Fig. 1D indicates connection to the chassis frame, whether or not the chassis is connected physically to the earth. In some AC-DC receiver circuits, symbol A or C is used to represent the common B− return bus, whereas D is used to represent the receiver chassis.

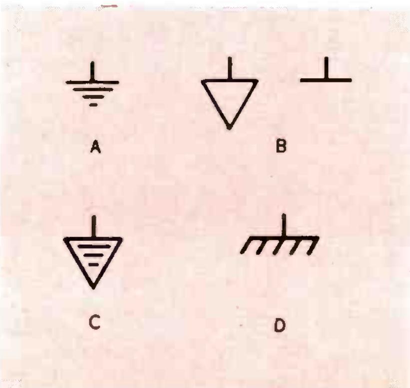


Fig. 1. Schematic symbols for ground.

Fig. 2 illustrates the basic principle of grounding. It is the circuit designer's intention that the cathode of V1 and one end each of R1, C2, and C3 be connected to a common reference point designated as *ground* (whether or not that ground is physically connected to the earth). Another way of stating this is to say that there is to be zero ohms of resistance between one side of C2 and the cathode of V1. Of course, if there is more to the circuit (power supply, output stage, etc.) and various components in these other sections also are connected to ground, then it follows that there must be zero ohms from these points to the other grounded points.

It is important that there be as little resistance (or impedance) as possible along a grounding path, for any resistance will cause an IR drop, or potential difference, to appear between the two ends of the grounding conductor. Those points which are intended to be grounded would then be at some potential above true ground.

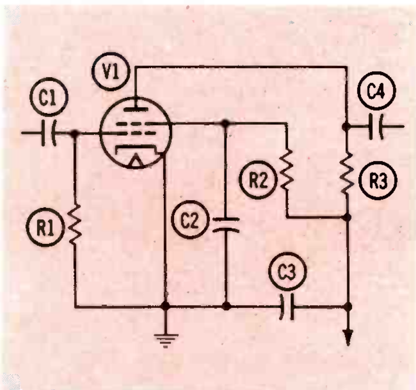


Fig. 2. Grounding in an amplifier stage.

Table 1. Resistance of Metallic Conductors

Metal	Resistivity (ohms/ circular mil foot)
Good conductors	
Silver	9.796
Copper	10.37
Gold	14.55
Aluminum	16.06
Fair conductors	
Tungsten	33.22
Molybdenum	34.0
Zinc	36.0
Brass	45.0
Nickel	60.0
Pure Iron	60.14
Platinum	63.8
Tin	69.0
Phosphor Bronze	70.0
Poor conductors	
Steel	95.0 to 308
Lead	132
Mercury	575

DC Grounding

In a DC circuit, returning a point to ground is usually quite simple. The size of the grounding conductor and the material of which it is composed determine the effectiveness of the ground path. No electrical conductor has zero resistance, and some metals have more resistance than others. Table 1 gives the resistivity[1] of various metals used as conductors. It should be noted that with the exception of silver, which is quite expensive, copper is the best conductor; it is therefore the most popular wire material for electrical conductors. Grounding is no exception to this rule, and the best grounds are made with copper.

[1]Resistivity is the resistance of a sample of material having specified dimensions.

The size of the conductor used depends on the distance to be covered: the longer the path through which current flows, the higher the resistance of the conductor will be. For DC and low-frequency AC (up to a few thousand cycles per second), the resistance is *inversely* proportional to the cross-sectional area of the path the current must travel; that is, given two conductors of the same material and having the same length, but differing in cross-sectional area, the one with the larger area will have the lower resistance. Table 2 illustrates the variation in resistance for various conductor sizes.

The resistance of practically all metallic conductors increases with increasing temperature.

The specific resistance of the earth's material, whatever it may be, is made negligible by the earth's gigantic size. This indicates that all *perfect* grounds are to zero potential (that of the earth), and there is no DC power loss in the ground. However, obtaining a perfect ground for DC is not easy, for resistance is encountered at the point of conductor connection to the earth. While good connections to the earth are obtainable in water, a low-resistance ground connection in soil is usually secured only with difficulty. To minimize contact resistance, several ground electrodes may be laid in parallel.

It is sometimes found that a measurable current will flow in a conductor grounded at each end. Three influences may cause such a current:

1. A more or less steady potential difference which exists day after day: Peculiarities of the subsoil produce electrical-potential strata which are partially insulated from the bulk of the earth's structure. In an area where an electric railway uses the earth as the return for its DC power, this current flow causes a gradient in the subsoil and produces a residual current.
2. A very slow alternating voltage (10 to 20 cycles per hour) generated by moving terrestrial electromagnetic fields: The extreme cases are associated with magnetic storms and auroras. These phenomena are often called *earth currents*.
3. Atmospheric static: The conductor acts as an antenna and picks up this induced voltage.

Power-Frequency Grounding

The resistance of a conductor is not the same for AC as it is for DC. When the current alternates, there are internal effects that tend to force the current flow mostly in the outer parts of the conductor. This decreases the effective cross-sectional area of the conductor, with the result that the resistance increases. For power and audio frequencies, this increase in resistance is almost negligible.

For AC, the earth exhibits reactance as well as resistance, and its impedance to AC can be of practical importance even at 60 cps. AC potential gradients can be maintained even in sea water.

Power-line grounds are used chiefly to reduce the shock hazard. They also make it possible to reduce the transmission of unwanted interference by the use of grounded filters and bypass capacitors. The usual power line is grounded at the pole transformer feeding the building, with the result that the AC lines in the building have one side grounded. With equipment that has the chassis connected to one side of the AC line, it is possible to connect the *hot* side of the line to the chassis—then if the technician stands on a damp concrete floor and touches the hot chassis, he will be between the

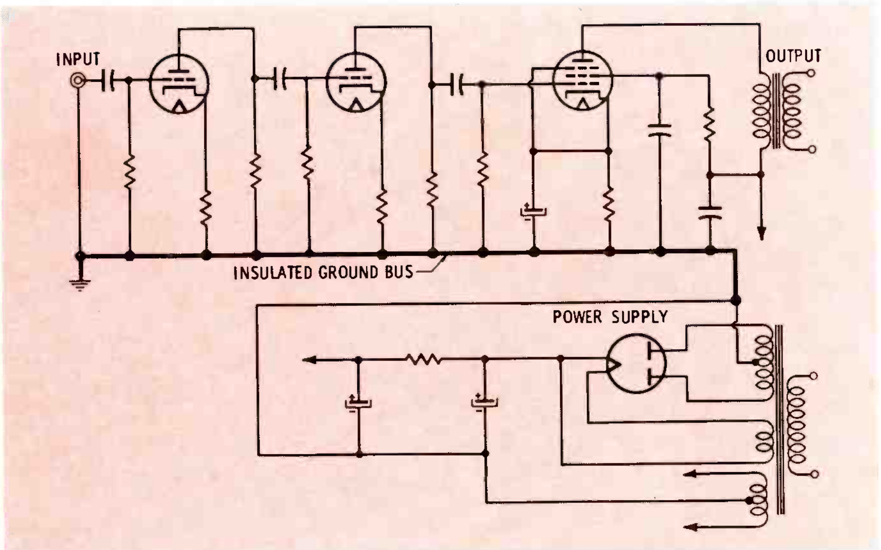


Fig. 3. In an audio amplifier, a bus should be provided for ground terminations.

hot and ground sides of the line. For this reason, isolation transformers are often used. Such a transformer removes the ground from the AC line, and a chassis cannot be hot with respect to the earth.

When a new or modified AC service is being run into a station building, it's wise to make certain the insulating crew sinks a separate ground, apart from the existing station RF and/or audio ground.

Audio-Frequency Grounding

In the spectrum from 20 to 20,000 cps, the total resistance or impedance of a grounding conductor is the algebraic sum of the DC resistance and the AC reactance. There is also the phenomenon of skin effect, which makes the AC resistance greater than the DC resistance. This topic will be examined in detail later. At audio frequencies, perhaps the prime consideration in grounding is the avoidance of hum—spurious pickup of 60-cps signal from the power line and 120-cps signal from full-wave power-supply rectifiers.

The simplest way to understand audio grounding procedures is to think of all audio grounds as "flowing" in a single direction only. In an audio amplifier (excepting only the simplest and cheapest), random chassis grounds should never be used. An insulated ground bus of No. 16 or 14 solid copper wire should be run through the underside of the chassis (Fig. 3). All ground returns should terminate on the bus, which should then be securely bolted to the chassis at the input terminals. The bus should be laid out in more or less a straight line, or perhaps an L shape, so that low-level stages are closest to the point where the bus attaches to the chassis, and high-level stages are farthest from that point. The attachment of all power-supply ground returns to the bus should be farthest from the input terminals.

Once an item of audio equipment has been securely grounded within itself, it must be connected to the rest of the station system. Conventional rack mounting provides contact between the equipment chassis and the rack itself, which is then grounded. However, you should never rely on this mechanical ground, for it can produce poor contact. A separate, insulated wire should be run from the input terminals (same point as internal ground bus) of each piece of equipment to what is known as the *rack* or *unit ground*. See Fig. 4. The unit ground bus should be about No. 12 or No. 10 bare wire. (It can also be strap.) It should be run the length of the rack, console, or other equipment housing, and be bolted to the rack or frame at one point only. Except for this point, the unit ground should be insulated from the rack and held stiffly in place.

Each rack, console, or equipment housing constitutes one subsystem.

Table 2. Resistance of Copper Conductors

Conductor	Ohms per 1000' at 68° F
No. 18 wire	6.385
No. 10 wire	0.9989
No. 4 wire	0.2485
No. 000 wire	0.06180
2" x 0.032" strap	0.1239
4" x 0.032" strap	0.06178

All the subsystems in a particular control room or control-room-studio combination constitute a system. For consistency, the rank of various components, subsystems, and systems must be established. Within each rack, the following principles apply: The shield of any cable which connects to a terminal block should be grounded to the TB ground bus. (Refer again to Fig. 4.) If a cable connects to a jack field but *not* to a terminal block, the shield should be grounded to the jack field ground bus. Cables which tie pieces of equipment directly together, such as amplifiers and power supplies, amplifiers and equalizers, etc., should have their shields grounded through a separate insulated wire directly to the rack or unit ground bus.

Any miscellaneous equipment, such as VU-meter panels, transmitter remote-control panels, line attenuators, etc., should have their metal frames, chassis, cabinets, and the like tied through separate insulated wires to the rack or unit ground bus. Nothing should float; every piece of metal that is not designed to be active and carry signal or power impulses should be tied through a separate insulated wire to the

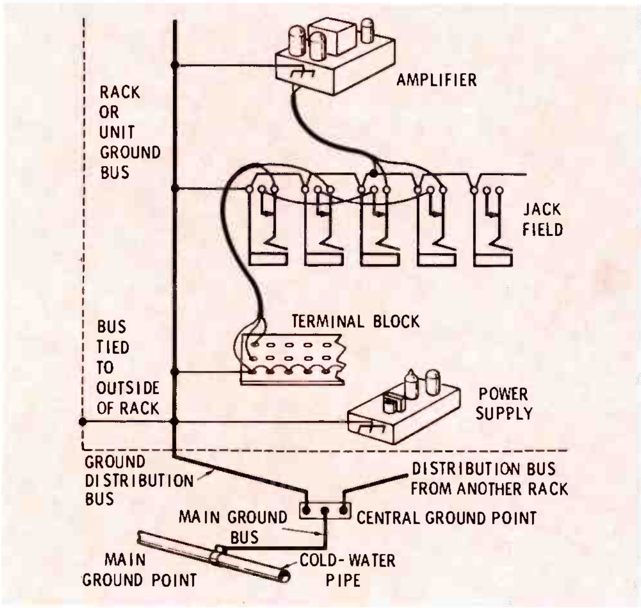


Fig. 4. Equipment in rack should be connected to unit ground.

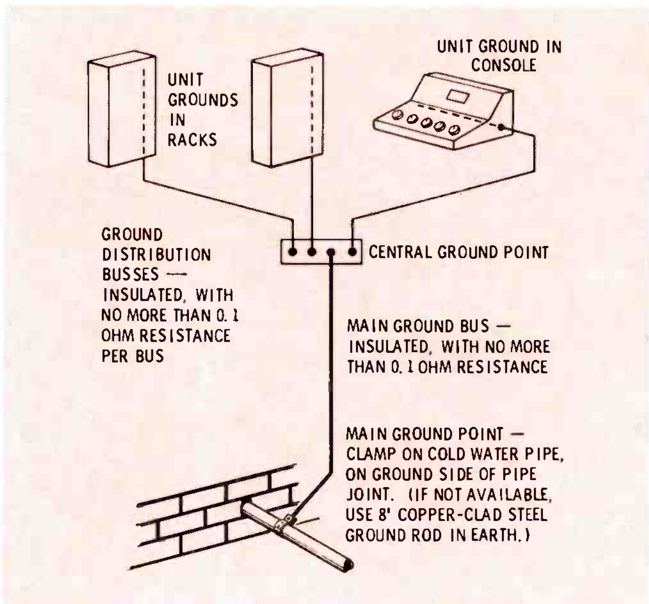


Fig. 5. Unit ground buses connect to a central ground point.

nearest unit ground bus. If it isn't supposed to be insulated, ground it! Some console tables have metal molding around the edge of the table top, and on several occasions it has been necessary to run a special ground wire to this molding. Additionally, each turntable frame should be grounded separately, apart from the signal-pickup cable.

Refer to Fig. 4 and Fig. 5. Each unit ground bus should continue unbroken (use a single piece of wire) to the *central ground point*. This point should be located near the physical center of the studio area so that the *ground distribution busses* (which connect the various subsystems into a single system) will all have approximately the same length. This will assure that whatever small potential develops across each bus, all will be equal. The total resistance of each distribution bus should not exceed 0.1 ohm. Each bus must be covered with insulation so that there is no possibility of chance grounding to conduit, trough, etc.

In complex studio plants, it is possible that there may be two or more equipment areas that are physically separated one from another. Each would then constitute a separate system. In this case, it would be well to have a central ground point for each system, and then join them into a master system at a *master ground point* somewhere midway between the two areas. This again would make all ground drops approximately equal.

From the central or master ground point, a *main ground bus* is run to the *main ground point*, which is the point of physical connection to the earth. It is important that existing ground points, such as those used by the AC service or the telephone company, be avoided. An AC ground point often has a large alternating current flowing through it because of an unbalance in a multiphase power lead. This, in turn, may create an appreciable AC voltage drop at the ground point or in the main ground bus, which will result in hum throughout the audio system. The telephone ground usually carries interference from talk circuits, ringer pulses, beeper recorders, and particularly from teletype lines feeding news machines. Such interference can easily appear on the audio circuits if the telephone ground is used.

In locations where a community water distribution system is used, obtaining the main ground point will be easy. If the distance is small (say 10 to 20′) from the central ground point to a point where a cold-water pipe enters the earth, a connection may be made—on the ground side of any pipe joints—by means of a pipe strap. File, sandpaper, or scrape the pipe down to bare metal, and tighten the strap so that good contact is made. Solder if necessary, and you may want to tape with rubber or plastic tape to prevent oxidation, especially if there is considerable dampness. Don't use a hot-water pipe or gas pipe, for these don't provide as direct a connection to the earth, and gas pipes often have insulated joints. A cold-water pipe is usually part of an extensive network of buried piping.

If no suitable pipe is available close by, or if it is already being used by the power or telephone company, a special ground will have to be installed. The simplest method is to drive an 8′ copper-clad steel ground rod or spike into the ground as close as possible to the central ground point. This will often do the job, but for noisy locations or installations using extremely sensitive equipment, it may be necessary to employ several ground rods, spaced several feet apart and strapped together at the top with a large copper conductor. Wrap the conductor or strap around each ground rod and solder using silver solder and a gas torch. The more metal that contacts the soil, the less will be the interface resistance between each rod and the earth, and the better the ground will be. It is desirable to use a site with considerable natural moisture, for this increases coupling to the soil. Sometimes, in lieu of rods, a copper sheet or plate, at least 5′ x 5′, is buried a few feet below the surface. It makes an excellent ground.

In extreme cases, to provide for maximum coupling to the earth over a long period to time, it is possible to increase chemically the conductivity of the soil in the immediate vicinity of the grounding rod. Dig a hole about a foot deep and two or more feet in diameter. The ground rod (or rods) is sunk in the center of the hole, which is then filled with dry rock salt, magnesium sulphate, or copper sulphate. The package is then flooded with water and finally covered with soil and sod, if desired. Fifty lbs of treating material will last for two or three years.

If a studio installation is made on the upper floors of a tall building it may be impractical to run a ground bus down to the earth. In such a case, an alternate—although less desirable—arrangement, is to connect the central ground point both to the water mains and to the steel structure of the building.

One of the most important considerations concerning audio grounding relates to the practice of wiring and grounding microphones. The usual microphone output level is around −60 dbm, and at this extremely low level it is quite easy to pick up unwanted hum and interfer-

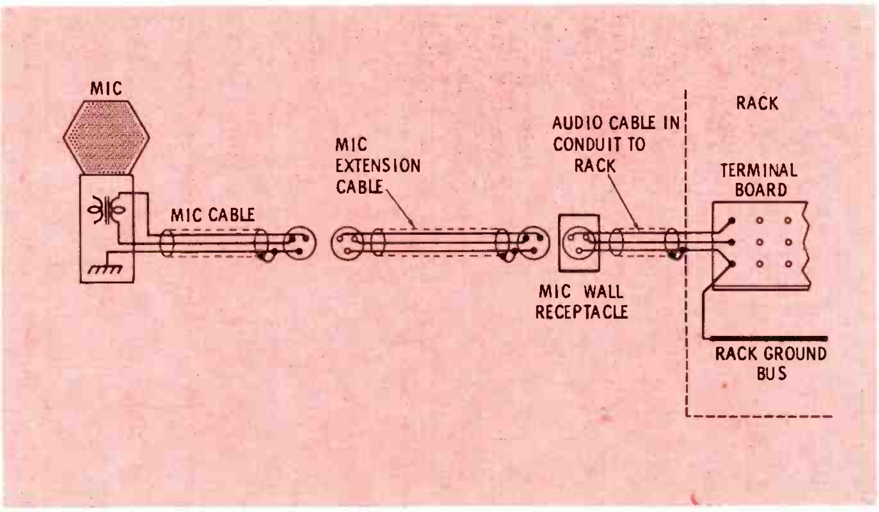


Fig. 6. In wiring microphones, the shield of each cable is grounded at one end only.

ence. Furthermore, microphone circuits, being portable, are often brought near fluorescent lights, AC cables carrying large lighting loads, cue-transmitter antennas, and other possible sources of audio interference.

The standard microphone circuit in broadcasting uses balanced-to-ground, low-impedance lines. Such lines pick up less interference than if they were of high impedance; furthermore, the low-impedance permits using long extension cables without undue attenuation of the higher audio frequencies due to cable shunt capacitance. Obviously, microphone cables, though of low impedance, must be shielded to avoid as much interference pickup as possible. It is often thought that two insulated conductors are required to carry the balanced-to-ground signal from the transformer in the microphone case, and the shield provides the ground to the metal case. Such wiring philosophy leads to hum and interference pickup, for a cardinal rule of microphone wiring is that the shield must not carry current of any kind. Microphones should be wired with cable that contains three insulated conductors within a flexible braid. In addition, the cable should have an insulated covering to prevent chance grounds of the shield to conduit, trough, or other cables.

Fig. 6 illustrates microphone wiring practice. No matter how many wiring extensions there may be between plugs and receptacles, between microphone proper and the terminal board at the rack, two wires must carry the signal, and the third must carry the ground between the microphone case and the station ground system. The shield of each section of cable is always grounded to the insulated ground wire at the end of the cable nearest the station grounding system. Since the shield is not connected at both ends, no current can flow through it, and there can be no IR drop. This preserves the integrity of the ground system. Don't forget that the shield must be insulated at the end of the cable nearest the microphone, to prevent chance grounding and resultant ground loops.

There is sometimes confusion as to how to connect one system (control room, studio, etc.,) to another. Connection *must* be made through repeat coils, isolation transformers, etc., which remove DC coupling, or else one system must outrank the other and supply the ground. It is recommended that transformers be used and the shield of the interconnecting line be tied to a unit ground bus at one end only. For medium-level signals (-30 dbm or above), it does not matter which end of the cable, sending or receiving, is grounded.

Some variable attenuators, filters, and equalizers are constructed with one side grounded, making them unbalanced-to-ground. (Balanced models are available, but they're more expensive.) To use such units in a balanced system with a minimum of hum and interference pickup, multiple grounds must be avoided. The common side of each filter or attenuator must be grounded, and it's important to make the connection from the common terminal through a separate insulated wire to the unit or rack ground bus. The ground should never be made to an amplifier, for this restricts it to unbalanced use only. If an amplifier with an unbalanced input or output must be used within the system, it should have a 1:1 isolation transformer added to preserve the integrity of the balanced system. This makes it possible to patch amplifiers interchangeably to balanced or unbalanced circuits.

It cannot be overemphasized that, in general, ground and distribution busses should be made of solid copper wire with an insulated covering. Chance grounds must be avoided, for ground loops result. Bare wires and busses may be used where the particular conductor is rigid and supported in midair within an amplifier chassis, or within a rack or console, and where many subwires connect to the bus. Connections made between a subwire of smaller diameter than a bus should be made by wrapping the subwire around the bus, then soldering by heating the *bus* until applied solder flows smoothly throughout the coiled joint. A large-wattage iron or gun, or even a gas torch, should be used. The best possible solder connections must be made to avoid contact or interface resistance. If either the subwire or the bus appears greasy, dirty, coated, or old, it must be burnished or scraped down to bare, shiny metal. Metal files, nail files, sandpaper — even manicurist's emery boards—may be used. The DC resistance of a ground bus should never exceed 0.1 ohm.

While each component of an audio system may have a good signal-to-noise ratio, when connected together, the total system may be degraded if certain precautions aren't taken. Lines in particular are subject to noise pickup from extraneous electric and magnetic fields and from the potential drop created by ground currents flowing through the line conductors.

The unbalanced line is seldom used in broadcasting, but when it is, it should be grounded at one point only. Fig. 7 shows why. In Fig. 7A, there is a *ground loop*. The section of the line between points A and B, like all conductors, has some resistance. There is bound to be some AC-operated equipment in the immediate vicinity, and by electromagnetic or electrostatic induction, some 60-cps hum will be coupled into the section of the line between points A and B. An induced current I_g will flow, and in so flowing will cause an IR drop between A and B. This potential is applied across the section of the line in series with the signal voltage and hence will add an extraneous noise to the signal. Obviously, this effect can be eliminated by removing one of the ground connections.

If the transformers at each end of a balanced line have center taps, both center taps may be grounded,

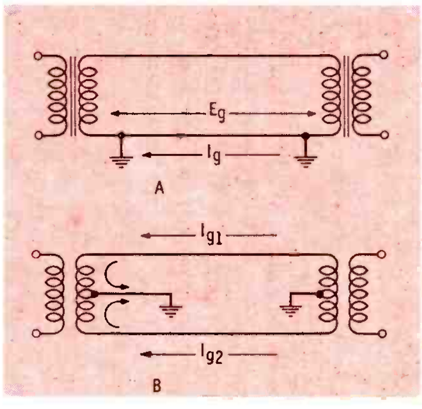


Fig. 7. Balanced vs. unbalanced lines.

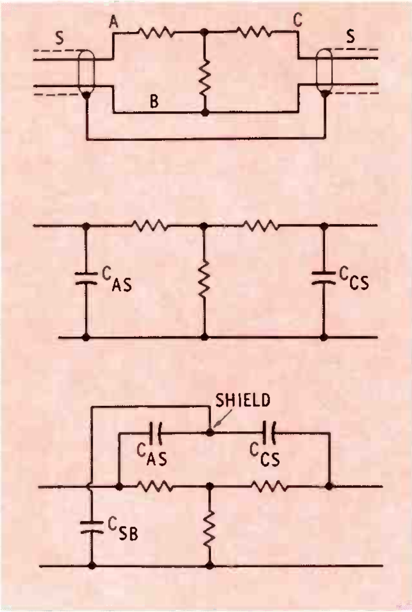


Fig. 8. Frequency distortion is reduced.

as illustrated in Fig. 7B. Now there are two induced currents, I_{g1} and I_{g2}, both flowing in the same direction, since the magnetic or static lines of force intercept the conductors at almost exactly the same point and at the same angle. The two currents flow up to the transformer winding and to its center tap, and thence to ground. In so doing, they cancel each other. Hence a balanced line connected to a transformer with a grounded center tap is practically immune to noise interference.

A line must be grounded at a minimum of one point if it is connected to unbalanced circuits such as attenuators, equalizers, and filters; otherwise frequency distortion may be introduced. This is illustrated in Fig. 8A, which shows lines connected to the input and output terminals of an unbalanced attenuator. The two sections of shield S are, of course, at ground potential and hence are effectively connected to each other, as shown. Figs. 8B and 8C show the equivalent circuits of this arrangement, wherein C_{as} is the capacitance between conductor A and shield S, etc. In Fig. 8B, the common conductor is not connected to ground (nor to the shield), and the elements of the attenuator are effectively paralleled and bypassed by the capacitances as shown. Reduced attenuation with increasing frequency results. The effect is fairly pronounced when the lines are long, with resulting high capacitances, and when the loss of the attenuator is high. Connecting conductor B to ground short-circuits capacitance C_{sb}, and the equivalent circuit of Fig. 8C results, with consequent elimination of the difficulty.

In telephone parlance, the term *repeat coil* is frequently used to designate any type of audio transformer. In the broadcast field, however, the term is usually restricted to 1:1 ratio transformers that are sometimes interposed between the end of a line and the terminating apparatus. One purpose of such coils is to eliminate ground loops. Frequently the terminating apparatus at each end of the line is grounded, and if the line were connected directly, a ground loop would be formed. By breaking the direct continuity through the line, by means of a transformer at either end, the loop is eliminated.

Such repeat coils sometimes have electrostatically shielded windings to eliminate passage of high-frequency noise voltages through the interwinding capacitance. The electrostatic shield consists of a conducting cover which completely encloses one or both of the windings (although insulated from them) and is connected to ground. The capacitance between windings is thus reduced to zero. This type of transformer is of considerable aid in reducing the effect of RF voltages picked up by the antenna-like action of a line. Frequently the input transformers of low-level amplifiers are electrostatically shielded and usually are enclosed in high-permeability cases to provide magnetic shielding.

Video-Frequency Grounding

Video circuits are never found without accompanying audio circuits in close proximity, whether these circuits be program-signal channels or intercommunication lines. In addition, there are always power-supply circuits, DC relay or signalling channels, and possibly even RF radiations. Since video circuits encompass frequencies from DC to at least 4, and often 8, mc, it's obvious that we are interested in avoiding interference and noise within the range of power-line frequencies, audio frequencies, and radio frequencies. Furthermore, while the ear will tolerate a small amount of noise or interference, the same amount of noise will cause a highly objectionable beat or interference pattern on the TV screen. This makes the avoidance of interference through proper grounding all the more important in video circuits.

The ability to control all circuit grounds completely in a TV audio-video installation is an invaluable asset when crosstalk and hum pickup problems arise. The use of audio and video cables with shields covered by insulating jackets, combined with careful installation of these cables to avoid accidental and unknown grounds, goes a long way toward avoiding crosstalk and hum pickup. The finding of a chance ground that is responsible for poor system performance can be a most tedious and onerous undertaking. Therefore, every effort should be made to avoid trouble from the beginning.

Video circuits, unfortunately, are always unbalanced, since the use of coaxial cable is standard within the industry. Such unbalanced operation does not provide the opportunity to control video-circuit grounds as precisely as in the audio circuits described earlier. Multiple grounds on video-cable shields are largely unavoidable, since connections must be made to both ends of the coaxial shield used to interconnect equipment units. The shield represents one side of the video circuit, and there must be DC continuity.

The main precaution in video grounding is the avoidance of high-resistance ground busses and of ground leads in which high-amplitude currents may flow. Unless this is done, the voltage drop across the ground lead may introduce unnecessary interference into the video signal. One technique which has been found reliable in television plants is the use of a main audio and video grounding point separate from both the AC grounding point and the transmitter RF grounding point. Many TV stations have the transmitter located at the same place as the studios; if everything is tied to a single grounding point, there may be much crosstalk, since all interference flows through this point. If the station has radio studios and perhaps an FM transmitter at the same location, more crosstalk is the result if a common ground is used for both studio and transmitters.

There is no direct equivalent in a video sense to the audio microphone. The microphone proper is carried around by itself, and hence is susceptible to much interference pickup, while the vidicon or image-orthicon pickup tube is always moved only while securely mounted within the camera head. This means that there is a much tighter control of wiring practices for a camera than for a microphone circuit. If you follow the manufacturer's instructions for installing a television camera, the chances are that the equipment will be properly grounded and won't pick up much video interference.

To understand properly optimum techniques of video grounding, it is necessary to understand RF grounding, for video can be considered to include RF, and the considerations applied to RF apply equally to video. One further point must be added: Most RF circuits have a relatively narrow bandwidth compared to the 4- to 8-mc bandwidth of a video circuit. It is well known that signal-to-noise ratio is inversely proportional to the bandwidth of the system. It is therefore much easier to achieve a good s/n ratio in AM, where the bandwidth is only 10 kc, or in FM, where it is 150 kc. A television circuit with a bandwidth of 4 mc is wide open to noise. This point emphasizes the need for observing good RF grounding procedures in video circuits. Since these circuits are always unbalanced, they are even more susceptible to pickup of extraneous noise.

Radio-Frequency Grounding

RF grounding presents special problems because of the impedance of conductors at radio frequencies. This impedance is the algebraic sum of the resistance and reactance; the total effect is that a given grounding conductor shows a potential drop that is very low for DC, somewhat higher for 60-cps current, even higher for a 1-mc current, and quite high for 100-mc current.

At high frequencies, the current carried by a conductor tends to be concentrated near the surface. This action, termed *skin effect,* is a result of magnetic flux lines that circle part but not all of the conductor. Those parts of the cross section which are circled by the largest number of flux lines have higher inductance than other parts of the conductor, and hence a greater reactance. The result is a redistribution of current so that those parts of the conductor having the highest reactance, i.e., those parts nearest the center, carry the least current. In a round wire, the current density is maximum at the surface and least at the center. In a square bar, the greatest concentration of current is at the corners, with the flat sides coming next, and the center carrying the least current. In a flat strip, the current density is greatest at the edges, considerable at the flat surfaces, and least in the center.

The result of this phenomenon is that a larger wire, while it will carry more DC with negligible drop, will have an increasingly appreciable drop for RF currents. Table 3 lists several wire and strap sizes together with their cross-sectional areas and AC/DC resistance ratios. Note that it requires extremely heavy wire (No. 000) to equal the area of 2″ strap, whereas 4″ strap exceeds even the heaviest available wire in surface area. Since strap weighs less than No. 000 wire, it costs less. Notice also that the ratio of AC to DC increases with the size of the wire, but is extremely low for strap. In effect, strap offers a maximum surface area per pound of weight (hence per dollar of cost) and is therefore ideal for RF- grounding purposes.

The redistribution of alternating current is always of such a character as to make the flux linkages, and hence the inductance, less than would exist with a uniform current distribution. The magnitude of these effects on inductance and AC resistance increases with frequency, conductivity, magnetic permeability, and conductor size: At higher frequencies, the differences in reactance resulting from the different inductances of various current paths, is greater. Higher conductivity makes the same difference in reactance more effective in modifying current distribution, and a greater magnetic permeability increases the flux.

In the case of isolated tubular conductors, the ratio between AC resistance and DC resistance is always closer to unity than for a solid conductor of the same outside diameter. This is because the center of a solid wire does not do its full share in the carrying of current; thus if the center is removed to form a tube, the resistance ratio is improved. However, the DC resistance of the tube is higher, and the actual value of AC resistance is greater than for the corresponding solid wire.

A flat rectangular ribbon or strap has a resistance ratio lower than for a solid round wire of the same cross-section but higher than for a tube of the same cross-sectional area and wall thickness. This is because the current in a ribbon tends to concentrate more at the edges than at the sides. For practical ease in construction and wiring, however, strap is much more convenient than tubing. Copper strap commonly used in broadcast work measures 0.032″ thick and 2″ or 4″ wide.

At frequencies so great that the resistance ratio is large, substantially all of the current carried by a conductor is concentrated very close to the surface. Under these conditions, the AC resistance offered by the conductor is approximately the same as

Table 3. Surface Areas and Resistance Ratios

Conductor	Surface Area	Ratio R_{AC}/R_{DC}
No. 18 Wire	0.253″	4.1
No. 10 Wire	0.641″	10.0
No. 4 Wire	1.285″	19.5
No. 0 Wire	2.045″	32.0
No. 000 Wire	4.140″	41.0
2″ x 0.032″ Strap	4.064″	Approx. 1.8
4″ x 0.032″ Strap	8.064″	Approx. 1.3

the DC resistance of a hollow conductor having the same external shape as the actual conductor, but having a thickness equal to the calculated skin depth.

RF Amplifier Grounding

In high-gain RF and IF amplifiers, the flow of ground currents from different stages through a common chassis path can introduce sufficient feedback to cause oscillation. Consequently, all of the ground returns which carry signal currents for a particular stage should be returned to a common ground point. Fig. 9 illustrates this technique. The heater circuit, which is not part of the signal circuit, should be grounded separately to prevent the signal circuits of other tube electrodes from inducing voltages into the filament circuit through a common ground impedance. The electrostatic coupling within the tube between the cathode and heater will induce small currents into the heater circuit. Amplifier instability caused by feedback through the tube-heater circuit is minimized by the use of decoupling inductances between the heater connections of the various stages. Series decoupling is used almost exclusively in filament circuits.

A multistage amplifier should be constructed in a straight line to achieve maximum isolation between the ground currents of the successive stages. Any resonant-circuit inductances in the strip should be oriented to minimize inductive coupling between the windings and the chassis ground currents.

The outer conductor of a coaxial cable which might introduce a signal into an amplifier should be grounded on the outside of the chassis. The effects of any undesired currents induced in the outer conductor should then be eliminated. Conductors carrying DC into a chassis or compartment should be bypassed by coaxial capacitors soldered in a chassis or compartment hole just large enough to admit the capacitor. This insures that the conductor will enter the chassis surrounded by a bypass capacitor. Sometimes this is the only way to decouple a line for VHF and above.

Receivers should never be grounded to the electrical conduit used to supply AC in a building, for the conduit has both a high DC resistance and a high RF impedance. Even if a separate wire is carried within the conduit for AC grounding purposes, it must not be used for receiver grounding, because it will often induce an undesirable hum modulation of the signal. The only proper ground for a receiver intended for low-noise reception of weak signals is a direct physical connection to the earth itself, in the form of ground rods, wires, or plates. This procedure has already been covered in the section under audio grounding, and a further expansion will be given below under transmitter and antenna grounding systems. These principles apply equally well to receivers.

Modulation hum in a receiver can often be caused by capacitive coupling between primary and secondary windings of the power transformer. This effect can be avoided by using a transformer that has an electrostatic shield between windings, the shield being grounded. If this is not possible, a grounded LC filter must be used in the power line.

It is interesting to note that both receivers and transmitters sometimes use grounded-grid triodes as RF amplifiers, especially at VHF. Some of these triodes have the grid connected to two base pins. Since these pin leads have *some* reactance at VHF and above, both pins should be connected as directly as possible to the stage ground point, to take advantage of the reduction in series inductance offered by the parallel connection.

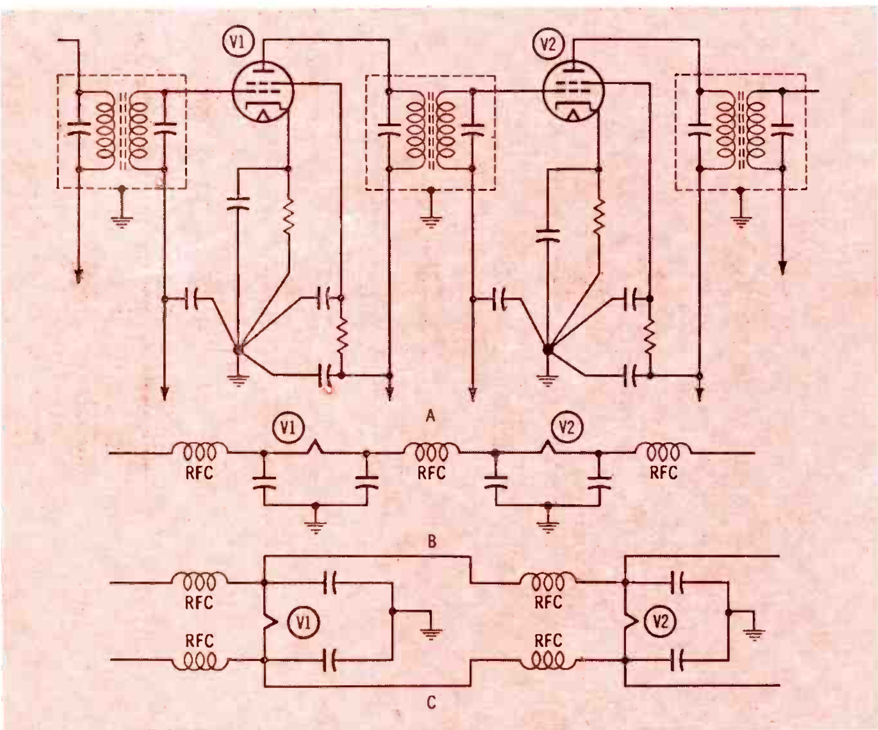


Fig. 9. Special grounding techniques must be applied in RF and IF amplifier circuits.

Antenna and Transmitter Grounding

The typical AM broadcast station uses a radiating system consisting of a vertical radiator (or radiators) about one-quarter to one-half wavelength in height. If the lower end of such an antenna is grounded or connected through the transmitter output circuit (or other matching or phasing networks) to ground, it need be only a quarter-wave high to resonate at the same frequency as an ungrounded half-wave antenna. The operation can be understood when it is remembered that the ground acts as an electrical mirror, and the missing half of the antenna is supplied by the mirror image.

The grounded antenna may be much shorter than a quarter wavelength and still be made resonant by loading it with inductance at the base. By adjusting the inductance of the loading coil, even very short wires or towers can be tuned to resonance. Such short antennas are not very efficient, however, and can seldom meet the FCC requirements for radiation efficiency. Hence, they are rarely used in broadcasting.

The current along a grounded quarter-wave vertical radiator varies practically sinusoidally, as is the case with a half-wave antenna, and is highest at the ground connection. The RF voltage, however, is highest at the open end and minimum at the ground.

If the antenna height is greater than a quarter wavelength, the antenna shows inductive reactance at its terminals and can be tuned to resonance by means of a capacitance of the proper value in series with the antenna and ground. As it is somewhat inconvenient to do this, usual broadcast practice is to insert in series with the antenna several fixed capacitors which total more than the required capacitance. Then a tapped coil is added in series with both antenna and capacitors. The position of the tap is varied until the antenna matches the line and is resonant.

The radiation resistance of a grounded vertical antenna, as measured between the base of the antenna and ground, varies as a function of the antenna height. (The word "height" as used in this connection has the same meaning as "length" applied to a horizontal antenna.) Below 60° (1/6 wavelength), the radiation resistance is less than 15 ohms, which is undesirable due to high current losses in the radiating system. The value for 90° (1/4 wavelength) is around 35 ohms, which is a usable value. At 120°, (1/3 wavelength), R is approximately 100 ohms, which is also usable.

No standard-broadcast radiating system is complete without both an antenna tower and a ground system. To feed power into such a system, it is common practice to couple the output of the transmitter across the tower base insulator (Fig. 10). The tower base forms one terminal, and the ground system forms the other. (This assumes the use of a series-fed, or insulated, antenna. Some stations use a shunt-fed, or grounded antenna. The transmission line is attached to the tower a short distance up from the base. The exact point is found experimentally, depending on the resistance desired to match the line. At any rate, although a shunt tower is grounded for DC, at the feed point there is an RF impedance, and the same principles apply. Another point: The tuning house will be located some 20 or 30' away from the base of a shunt-fed tower and the feed line brought up to the tower at an angle. Even though this feed line might be only No. 10 wire, it is not correct to assume that you can use the same conductor to tie the tuning house to the base/ground system. Use strap.) Simple antenna theory assumes the ground plane to be a perfect conductor which acts like a mirror plane to the radio waves. In practice, it is not a perfect conductor and may introduce a series-ground-loss resistance of from a fraction of an ohm to several ohms.

Ground losses constitute the largest power loss in a broadcast antenna system. Such losses arise from the fact that the current charging the capacitance between the antenna and ground flows through the earth to the grounding point at the transmitter. The object is to return these currents to the transmitter with a minimum of loss. One way of accomplishing this is to bury enough wires near the surface of the earth so that there is a low-resistance path through the ground back to the transmitter. In order to be effective, these buried wires must be so arranged that the charging currents entering the earth travel a minimum distance through the earth to reach a wire.

The behavior of the earth depends considerably on the transmitted frequency. At low frequencies — through the standard broadcast band —most types of soil do act very much like a good conductor. At these frequencies, the waves can penetrate for quite a distance and thus find a large cross section in which to cause current flow along their paths. The resistance of even a moderately good conductor is low if its cross section is large enough. The soil acts as a fairly good conductor even at frequencies as high as the 3.5-mc amateur band. Hams have sometimes buried insulated wire in soil and found good reception on both the broadcast and 80-meter bands.

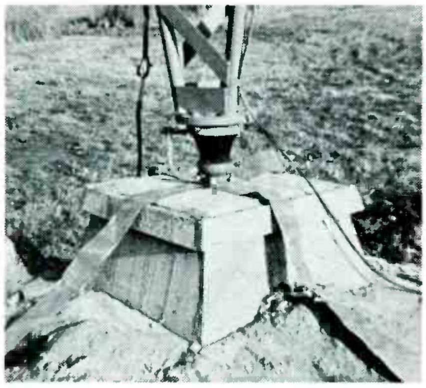


Fig. 10. Power is fed across insulator.

The ground system for a standard-broadcast antenna system usually consists of at least 120 buried copper wires, equally spaced, extending radially outward from the tower base to a minimum distance of one-quarter wavelength (Fig. 11). The ground-loss resistance can be decreased by reducing the E loss due to the electric field and the H loss due to the magnetic field.

When a tower is approximately a half wavelength in height, there is a voltage maximum at the base and a resulting strong electric field. Because of the displacement current which passes from the antenna through the earth to the radial wires, high E losses are encountered unless some means is employed to reduce them. An effective solution is to place expanded copper screen around the antenna base. As an alternative, the number of radial conductors can be increased and the wires placed just below the surface or under a layer of asphalt having low loss for the electric displacement current.

The H loss due to the magnetic field extends out a considerable dis-

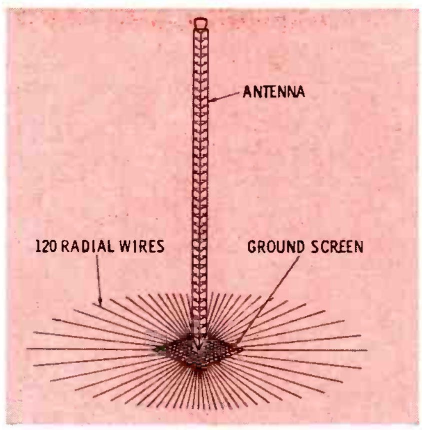


Fig. 11. Radials form ground system.

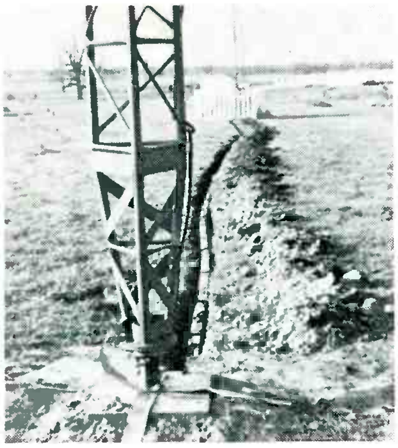


Fig. 12. Strap is buried between towers.

tance. This loss is due to the radial current which divides between the ground conductors and the earth. It can be decreased by using more and longer conductors. This causes a larger portion of the current to be in the copper radials, where the resistance is very low.

It is important that at least 120 radials be used, for the resistance of the antenna-ground system increases rapidly when the number of radials is reduced. For instance, with only 15 radials, the resistance is such that the antenna efficiency is reduced to about 50% at a tower height of one-quarter wavelength. This is due to a power loss in the ground, which depends on current concentration near the base of the antenna; this in turn is a function of tower height. Typical values for small ground systems (15 radials or less) have been measured to be from about 5 to 30 ohms for antennas less than a quarter wavelength in height. It has also been found that as the number of radials is reduced, the length required for optimum results with a particular number of radials also decreases; in other words, you cannot use a small number of radials and extend them out to a half wavelength. In general, a large number of radials, even though some or all of them have to be short, are preferable to a few long radials.

It is common practice to use a wire plow to lay the ground system. This machine consists of a thin vertical steel blade to cut a slit in the ground; at the rear edge of the blade is a small tube through which the copper wire passes from a reel into the ground. The depth to which the wire is buried can be controlled by the adjustment of the vertical blade with respect to horizontal sled runners or wheels which support the plow mechanism. Soft- or medium-hard-drawn copper wire is easier to handle in the field than hard-drawn copper wire. It can also stand more mechanical stretching before breakage occurs.

The radial wires are usually plowed in starting from the tower and driving a tractor pulling the plow toward stakes at the edge of the ground system. It is convenient to provide a ring or square of strap around the tower base pier to which each radial wire can be fastened mechanically while the radial is being installed. The radial wires must then be soldered or brazed to this ring to provide a good electrical connection. Additional strap is then bonded to the ring and run to the ground-system terminal of the antenna. Copper-clad stakes are commonly used to hold the copper ring in place and act as a lightning ground. These stakes are driven down level with the ring, and the two are brazed together to form a good electrical connection. All connections made in an AM ground system between radials, screens, straps, rings, etc., should be made with silver solder and a gas torch. Conductors must be bright and clean when soldered. Ordinary solder will corrode from weather effects, producing interface resistance; it should be avoided.

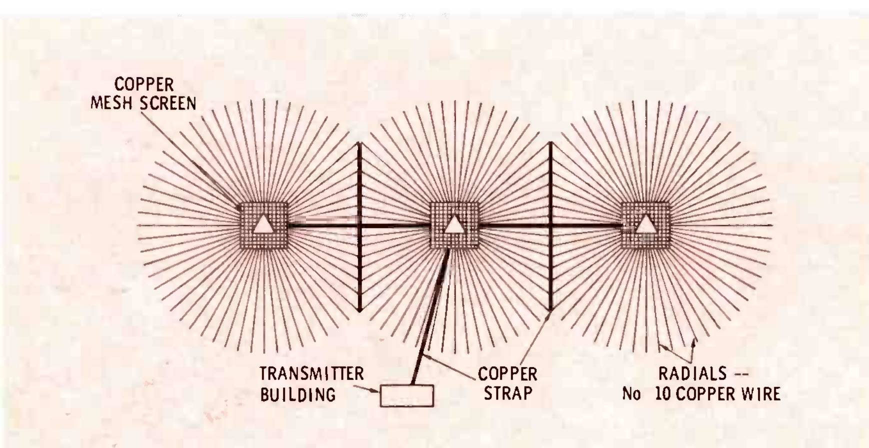


Fig. 13. Strap joins radials, tower bases, and building at a directional installation.

As has been mentioned, expanded copper mesh or screen is often used inside the copper tie ring or square. Primary purpose of the screen is to terminate the E field. Its secondary job is to carry the radial ground-system current. However, if the amount of copper in the mesh is inadequate, then radial copper straps can be added in this area and bonded to the mesh.

At low-power installations, the base screen or mesh is often omitted, and in its place 90 or 120 extra radials, 20′ or so in length, are used at the tower base. This practice is often done for economy and with a short tower (near 90°) can be tolerated, although it's better to use a screen. The short radials are no substitute for a screen, and if the tower is electrically tall, a screen is a must.

The precise nature of the RF coupling from the antenna-ground system into space is not well understood. Ground currents are conduction currents returning directly to the antenna base; the total earth current flowing through a cylinder of radius X concentric with the antenna (known as the *zone-current*) is a function of tower height. Ground-system losses dissipate a portion of the input power and reduce the field radiated from the antenna. This has been proven at a number of sites where a poor ground system was improved. Ground losses are equivalent to the power dissipated by a resistor in series with the antenna. A value of 2 ohms gives predicted results in good agreement with actual measured effective field strengths.

The transmitter site, to a certain extent, determines the type of ground system used. For a sea-water site (conductivity approximately 4.6 mhos/meter), the salt water provides an adequate ground system; a submerged copper ground screen is often employed to make contact with the salt water. At a land site of high local conductivity, a less elaborate ground system than that previously described may be employed. However, adequate local-conductivity data are rarely available, unless field measurements are made of a test transmitter or another local station.[2]

When the soil is very poor or rocky, it may be desirable to employ an artificial ground consisting of a network of wires placed a small distance above the earth (two to five feet) and insulated from it. Such an arrangement, termed a *counterpoise,* effectively replaces the earth by a conducting screen, provided the spacing between the wires of the counterpoise is not greater than the height of the counterpoise above the ground. (Years ago, a number of broadcast transmitters were installed on hotel and office-building rooftops in urban areas. Such an antenna required a counterpoise on the roof as a ground system. For various reasons, such installations are not made today.) To be fully effective, the counterpoise should extend from the antenna a distance at least equal to the height of the antenna above ground, and preferably twice as great, so that it will intercept most of the electrostatic field in the vicinity of the antenna. A combination of the counterpoise and buried-wire grounds is also possible. In such arrangements, the counterpoise is connected to the transmitting antenna coil; the electrical relationship of the counterpoise to the ground will bring about a particular division of current in each case that causes the total ground losses to be a minimum.

[2]See "How To Conduct a Site Test," by Robert A. Jones and Howard L. Enstrom, Nov. 1965 BE, page 16.

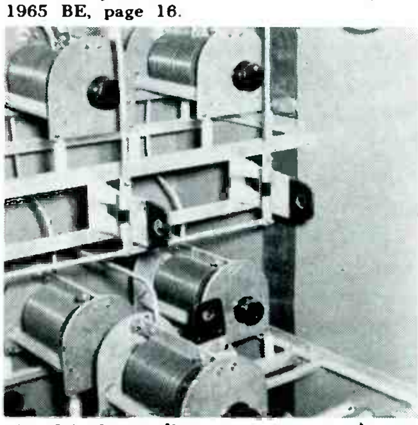


Fig. 14. Grounding strap enters phasor.

An individual ground system is required for each tower element in a multielement array. There should be strap between all towers (Fig. 12), and a main run of strap from the center of the array to the transmitter building (Fig. 13). When the individual systems would overlap if extended, the adjoining systems are usually terminated in a common bus of strap, as Fig. 13 illustrates. A complete system may be installed around each tower when high ground currents are expected. The width of the strap used depends on the station power and the distance the strap must run. For low powers and short runs, 2″ strap may be used, although 4″ strap is preferable for the majority of installations. If excessive distance is involved and station power is 10 kw or more, 6″ or even 8″ strap may be needed to keep ground losses at a minimum. It is *never* sufficient to rely on anything but strap for connecting the transmitter to the radiating system. As Fig. 14 shows, this conductor must be carried up into the phasor, so that all circuit elements which return to ground can terminate in the strap rather than to the phasor cabinet. Of course, the strap should be bolted to the cabinet, but the point here is that the strap, not the cabinet, is the prime ground return. The conductor should continue on into the transmitter cabinet, as well as any auxiliary equipment cabinets.

There can be no current flow in any electric circuit unless there are two conductors, one of which must provide a return for the other. Thus the transmitter output must have two conductors—one hot and the other grounded. The shield of the transmission line should be tied to the transmitter (or phasor) frame and to the copper ring or strap at the base of the tower, but it should *not* be used to couple the transmitter and other facilities in the building to the antenna and ground system. Neither should one or two ground radials which may happen to extend close to the building be used for this purpose. Of course, it is also useless to sink ground rods at the building and hope for a good ground—interface resistance between the rods and ground, and between the ground radials and ground, will produce an appreciable resistance which will introduce losses in the radiating system. The station ground at an AM transmitter site is established around the tower (or towers), and this is the reference point for the entire plant. This station ground *must* be carried back to the building by strap, regardless of what other paths exist along coax, sampling lines, etc.

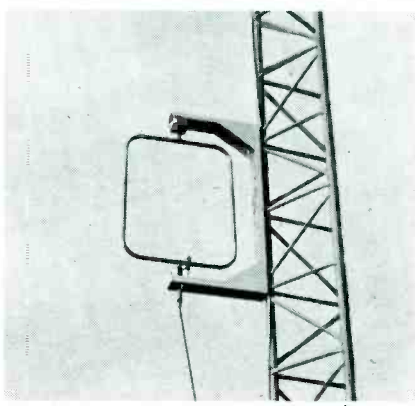


Fig. 15. Loop requires special technique.

Fig. 15 illustrates a sampling loop attached to one tower of a directional antenna. If an insulated loop is used, the sampling line is kept insulated from the tower all the way down, and no special precautions must be taken. Sometimes, however, an unbalanced loop is used, and one side of the sampling cable is connected to the tower. To avoid grounding the radiator for RF, the cable is coiled at the base to present a high impedance at the operating frequency.

FM and TV transmitters and antennas do not require the extensive physical grounding systems used in AM. The usual AM station uses an unbalanced quarter-wave Marconi antenna, in which the active radiator is only half of the entire radiating system. The system takes advantage of ground-wave propagation, which is good at broadcast frequencies. The secondary sky wave may or may not be useful, depending on the particular channel and station power.

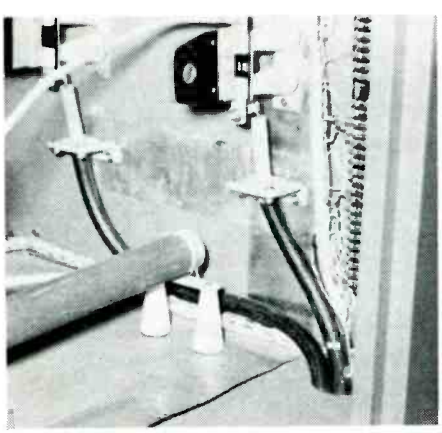
At VHF and UHF, the usual antenna consists of a modified balanced Hertz antenna, nominally a half wavelength. The antenna consists of two elements (per active bay) which are insulated from each other and from ground. Radiation is propagated via line-of-sight waves; there is no ground wave, and most transmitting antennas are designed to minimize sky waves, which are not considered useful at VHF and above. Since the ground does not form part of the radiating system for FM and TV, grounding procedures are much simpler.

Connection to the earth at an FM or TV transmitter site is sometimes simplified if an AM transmitter is also installed, for the station ground is already established, and the VHF transmitter can often simply be tied on to the existing ground system. However, if crosstalk between the services results, it may be necessary to set aside a plot of ground, outside the building and apart from the AM strap and radial system, where ground rods or a copper plate are buried for the purpose of grounding the FM or TV transmitter system. Because very high inductive reactance exists in conductors at UHF and VHF, it cannot be over-emphasized that the station ground should be as close as possible to the transmitter. It is also important that the antenna-supporting tower frame be strapped to the main station ground, both for lightning protection and to prevent undesirable radiation from the tower.

Equipment Grounding in RF Fields

Grounding procedures applicable to DC, power frequencies, audio and video frequencies, and RF have been discussed. However, DC control equipment, AC lines, audio and video amplifiers, and other devices are quite often found in the same building with a high-power transmitter, and in the presence of such an intense RF field, further RF grounding considerations are in order. It is not unusual to find a medium-sized installation that includes an AM and an FM transmitter, the latter with both stereo and SCA multiplex generators; a remote-broadcast transmitter or two; a couple of studios with consoles, turntables, preamps, and tape recorders; a rack or two of automation equipment for FM; teletype machines and beeper phones; fluorescent lights; tower-light flashing circuits; mercury-vapor rectifiers; and even audio intercom and talkback circuits. In short, the RF spectrum in such a plant contains a considerable amount of radiation at various frequencies and power levels. Heterodyning, intermixing, and intermodulation are widespread in various nonlinear circuits and detectors, remote-metering diode circuits, and audio-input grid circuits. If a TV station is also present, horizontal-sweep interference and RF from the transmitter stages is added to the interference spectrum. The result is that proper grounding becomes an absolute necessity if all of the various services and units are to coexist peaceably.

The first point about grounding in strong RF fields is that a ground bus is useless for anything but within-chassis use. The use of large-diameter copper bus for grounding within racks and equipment consoles was discussed previously in connection with audio and video grounding. However, where a high RF field exists, racks and other units must be tied in to the station ground with copper strap—2″ will do, but 4″ is better. Fig. 16 illustrates the procedure. Where the strap is bolted to chassis or frame, paint must be removed and the metal scraped or brushed until bright and clean. Nuts, bolts, and washers should be cadmium plated—never raw steel or iron, which rust and corrode. Soldering should always be done with silver solder and a torch. Where something movable such as a metal door or a floating turntable frame, must be grounded, use heavy braid of the type used for auto-battery cables.



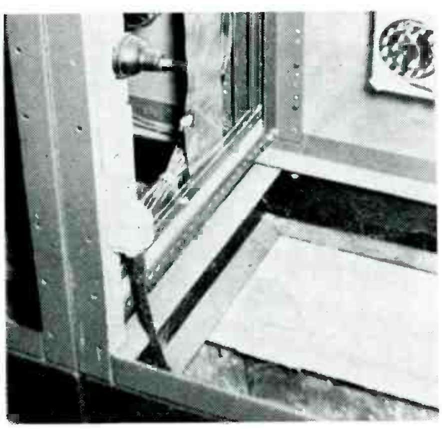


Fig. 16. Thorough grounding is necessary for equipment located in a strong RF field.

RF in audio and video equipment can show up as feedback, high noise, bars on a monitor screen, etc. Since even a small piece of unshielded wire makes a very efficient antenna for VHF or UHF, shielding must be done conscientiously and must be properly grounded.

It is sometimes found that a particular piece of highly sensitive apparatus, such as a harmonic-distortion and noise meter, will pick up RF when used in a high ambient field from several transmitters. Assuming that AC line bypassing is adequate, various methods and places of using strap and/or braid between the meter case and the station ground should be tried. If undesirable RF pickup and erratic meter readings persist, it may be necessary to spot-solder copper sheeting inside the meter cabinet. Panel-to-chassis and cabinet-to-chassis connections should be checked for tightness. Also try running several pieces of braid from the chassis to the cabinet and the front panel. The best possible contact must be made between the protective cabinet shield and the station ground system.

Nonbroadcast electrical equipment must be treated separately in the studio-transmitter plant. Such things as air conditioners, drinking fountains, ventilating fans, fluorescent lights, heater motors, and the like, should preferably be grounded to the separate AC ground system. If they still produce interference to the broadcast gear, perhaps the only thing left is to run strap from the offending appliance directly to the earth below it.

There is an old saying in electronics: "Ground is ground, the world around." Yes, the ground—meaning the earth—is the same no matter where you go. But the way you *tie* equipment to ground is *not* the same. ▲

You'll find our TSA1 Clamping/Equalizing Video Amplifier highly satisfactory in microwave video application. It's all solid state, designed to process signals from microwave, mobile gear, master control, or feed corrected signals to the input terminals of a television transmitter. It has a self-contained regulated power supply.

Controls are provided for sync stretching or compressing, white stretching and white clipping. The equalizer will equalize approximately 500 feet of cable. *You'll find the TSA1 Clamping/Equalizing Video Amplifier highly satisfactory in microwave application.* As in all International Nuclear solid state equipment, high stability is achieved with minimum maintenance.

The TSA1 Clamping Amplifier employs clamps to remove low frequency deficiencies. The clamping technique, however, is different. Tip clamping is employed which does not disturb burst and other chrominance information in or about blanking or back porch levels. This means *you'll also find the TSA1 particularly adaptable for color transmission.*

$850.00 each F.O.B. NASHVILLE, TENNESSEE

We invite your inquiry, write or phone collect today

INTERNATIONAL NUCLEAR CORPORATION

608 NORRIS AVENUE • NASHVILLE, TENN. • PHONE 615-254-3366

INTERNATIONAL NUCLEAR CORP.

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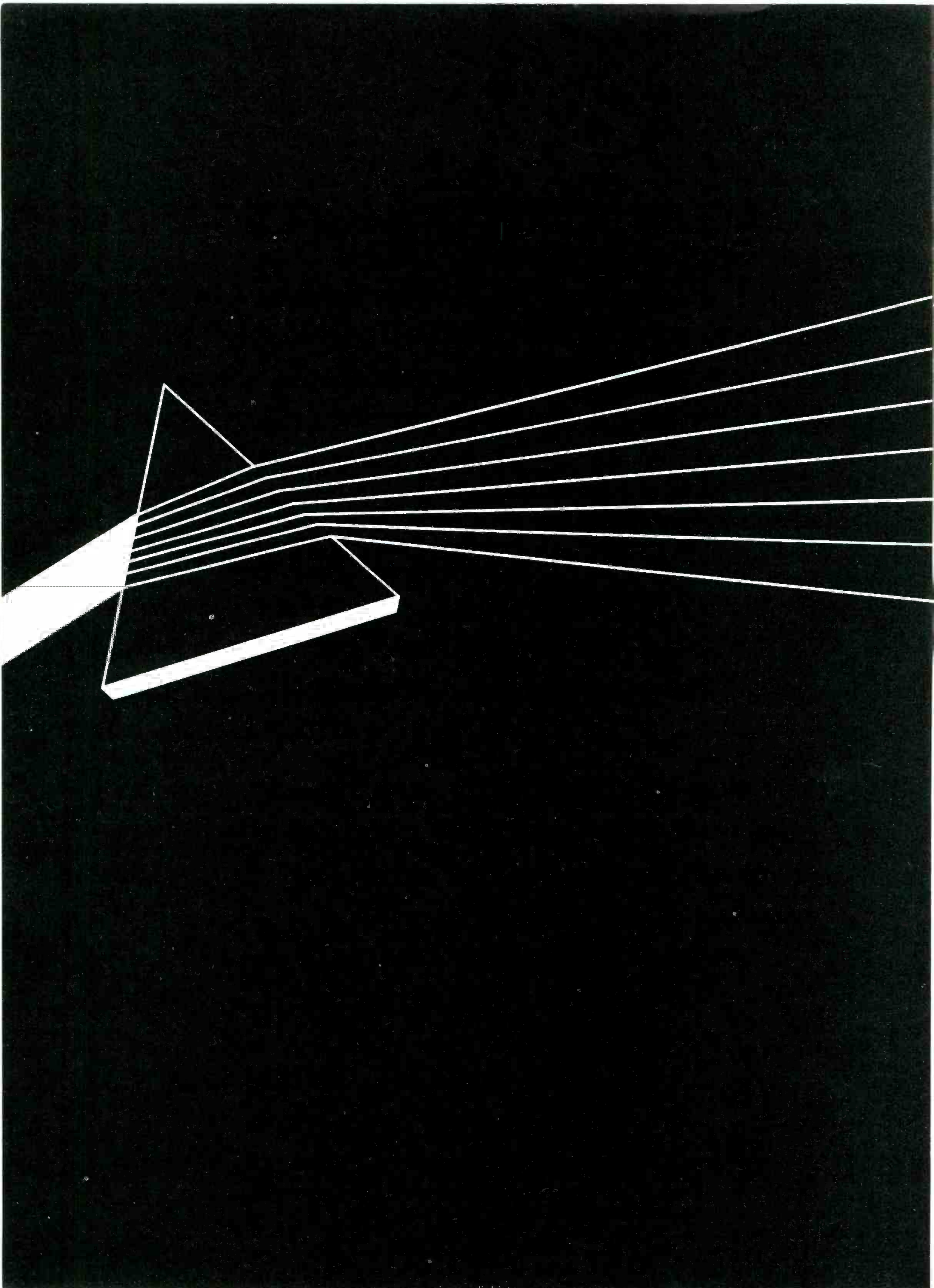


COLOR TV TAKES A GIANT LEAP FORWARD WITH THE REVOLUTIONARY NEW...

Polychrome Camera

Sarkes Tarzian, Inc. brought a fresh outlook to the problems of color television. We were free to explore all possibilities. We had no commitment—economical or philosophical—to an existing system, with its inherent faults.

We had no hesitation to innovate, where innovation was called for. Likewise, where we found a proven concept, we adopted it.

Results? The revolutionary, full-color Polychrome Camera system—the only color system offering a choice of tubes.

Here is color television previously unknown. Here is color performance to still the remaining skeptics. Here is rare purity of color . . . rigid stability . . . delicate detail.

And while our engineers were at it, they designed out heaviness and awkward appearance—giving the Polychrome Camera a trim, eye-pleasing silhouette in a unique magnesium housing. Like its monochrome predecessors, Tarzian's Polychrome Camera systems feature 100% transistorized circuitry.

The first Polychrome Camera systems are scheduled for June delivery.

Symbol of Excellence in Electronics

Circle Item 13 on Tech Data Card

BOOK REVIEW

North American Radio-TV Station Guide, 3rd Edition: Vane A. Jones; Howard W. Sams & Co., Inc., Indianapolis, Indiana, 1966; 128 pages, 5½" x 8½", paperback, $1.95.

This little book lists information on the facilities of more than 1000 television, 1500 FM, and 5000 standard broadcast stations in the United States and its possessions, Canada, Mexico, Cuba, Haiti, the Dominican Republic, and the islands of the West Indies. Listings are organized by location (country, state, province, etc.), frequency, and call letters.

The AM listings are the most comprehensive. In the listing by frequency are given call letters and location, day and night power, network affiliation, and such supplementary information as temporary or special operating conditions, stations broadcasting country and western music, and stations authorized but not on the air. In the listing by location are given city of license, frequency, daytime power, and symbols indicating different night power, daytime-only operation, and other information.

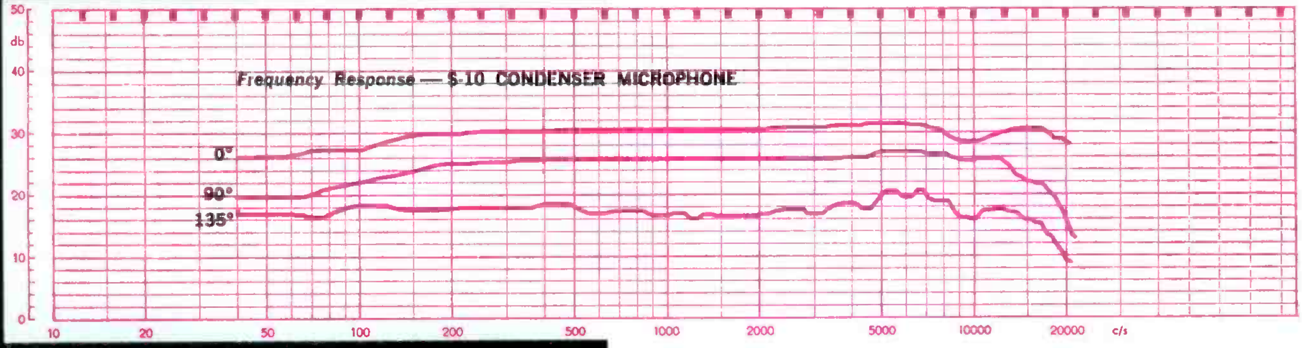
In the TV listing by location are given call letters, city of license, channel number, and network affiliation. ETV stations are identified, and for satellite stations, the station rebroadcast is listed. Stations not operating at the time of publication are indicated. All of this information is repeated in a listing organized by channel numbers.

FM stations in the United States and Canada are included in two lists, one by location, one by frequency. The FM listings include call letters, city of license, and frequency. Symbols indicate noncommercial educational stations, stations broadcasting stereo, stations featuring country and western music, and stations temporarily not on the air.

An integrated alphabetical call-letter list includes all three classes of stations.

The compact size and concise format of this book should make it a useful reference source for anyone who has need of the information it contains. ▲


Introducing
S-10
SYNCRØN
SOLID STATE / CONDENSER MICROPHONE
Cardioid Pattern / Self Contained with Lifetime Polarization



WHY CONDENSER . . . ?

Many dynamic microphones entering the market in recent years appear to have all the qualities of condensers. In some cases their frequency curves show linear responses from 30 to 18,000 Hz. They also claim performance comparable to condensers due to new diaphragm materials. Why is it then that professional recording studios are filled with condenser microphones? Why is it that the condenser microphone is used as a standard measuring tool against which all other types are compared? Why is there such a startling difference between the condenser and other types in A-B comparisons?

Much of the answer lies in the microphone's response to *transients* — the attack of a bow on a string, the strike of a drum, the nuances of a human voice.

A dynamic microphone diaphragm must be massive in order to achieve a low enough resonant frequency to reproduce the lower end of the audio range. This is true for all magnetically operated microphones, including ribbons. The ribbon type achieves its low resonant frequency by its great compliance which results in a fragility too great for many applications.

Condenser types, on the other hand, have resonant frequencies well above the audio spectrum, permitting the lowest possible diaphragm mass. The condenser's diaphragm is not required to move a voice coil as in the dynamic nor is it surrounded by a large magnetic structure as in the ribbon, *it is free to follow the sharpest audio transients.*

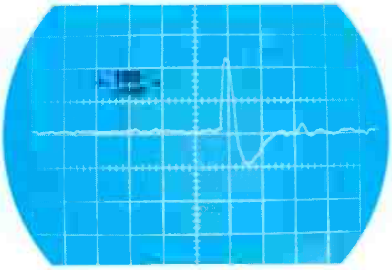


FIGURE 1

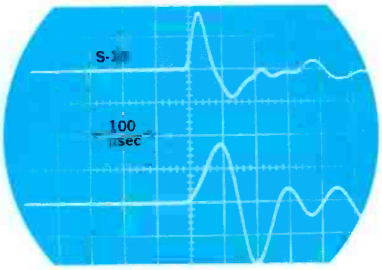


FIGURE 2

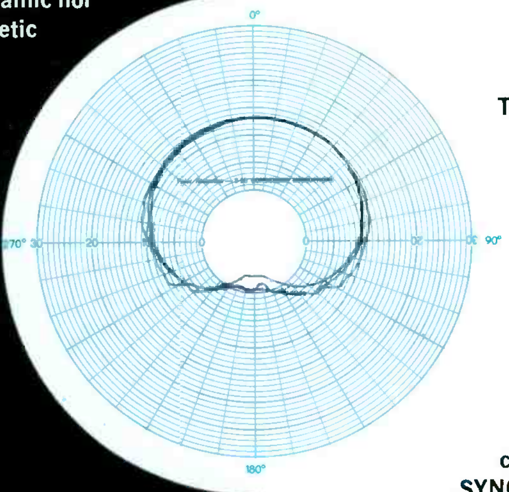
THE DIFFERENCE

In order to measure the transient response of a microphone, it is necessary to subject it to the severest of all acoustic transients — the shock wave, in this case produced by an electrical discharge. The acoustic transient produced has a risetime of less than one micro-second. By observing the output of a microphone subjected to such a shock wave, its transient response can be determined.

In order to portray this shock wave as accurately as possible a special pressure condenser microphone was built using an extremely small, light diaphragm with linear frequency response well beyond 200,000 Hz. Figure 1 shows the characteristics of the shock wave as measured by this special microphone in an anechoic chamber.

Figure 2 is a dual beam presentation of the response of two microphones to the same shock wave at the same instant. The upper trace shows the response of the new SYNCRØN S-10 condenser microphone. It shows a risetime of 15 micro-seconds and an insignificant amount of ringing and overshoot. The lower trace shows the response of a leading cardioid dynamic microphone at the same instant. The risetime is 40 micro-seconds and a significant amount of ringing and overshoot is evident.

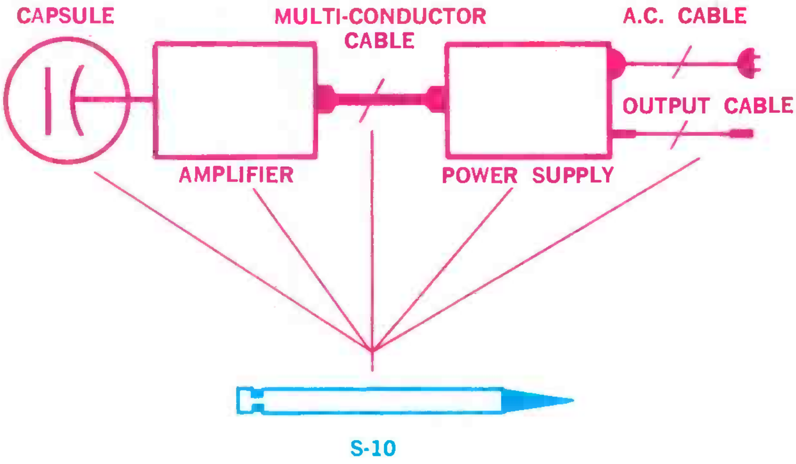
Comparisons of the S-10 with virtually all leading dynamic microphones have produced essentially the same results as shown here — graphic proof that frequency response curves do not tell the whole story . . .



UNIPOLAR RESPONSE

The S-10's on-axis frequency response shows all the smoothness and wide range expected of condenser microphones. Just as important, the frequency response for off-axis sounds is very linear. The polar pattern pictured here indicates a deviation of no more than 2 dB. from the on-axis response for frequencies of up to 10 kHz. These curves were produced by an actual S-10 microphone in an anechoic chamber and are not artists' conceptions. Each S-10 microphone produced is tested under identical conditions and an individual response curve is furnished with it. For a nominal charge, S-10 owners may return their microphones to SYNCRØN at any time for verification of this performance

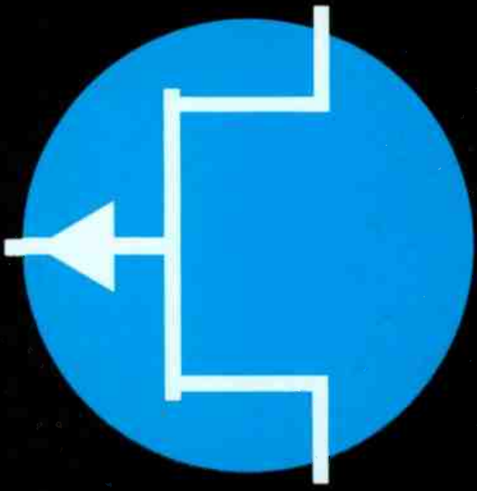
SELF-CONTAINED



SYNCRØN's employment of the latest semiconductor and battery technology obsoletes elaborate condenser microphone "systems". The external power supply is eliminated, enabling the S-10 to be used with the ease of a dynamic microphone. The condenser element is *permanently* polarized at a potential of 62 volts. Electronic circuitry is powered by a single inexpensive mercury battery encased in the microphone body. Battery life is 1,000 hours minimum with simple insert replacement. The S-10 can be used with assurance on critical "no second chance" pickups. There's no tube filament to suddenly burn out. The end of battery life is signaled by a slight increase in distortion, giving the user several hours advance warning at replacement time.

THE SOUND

The first and final analysis of microphone quality concerns *sound*. The clear superiority of condensers has been proven through the years with their universal use by recording centers, film studios, broadcast operations, orchestras, vocalists, and everyone sensitive to highest fidelity. The S-10 fulfills the really important requirements: superiority in the lab and superiority in the studio.



SOLID STATE

The S-10 Field Effect Transistor circuitry has noise performance superior to tubes — and the obvious solid state advantages of longevity small size, and low power consumption without the necessity of resorting to complicated RF circuits. Microphonics and heat generation are entirely eliminated. In addition, the inherent linearity of the FET makes possible a dynamic range unequalled by tubes or transistorized RF circuits, thus eliminating the need for costly overload protection devices. The S-10 is not encumbered by over-design or trick circuits. The emphasis is on simplicity, quality, and reliability.

CONVENIENCE

Battery replacement is accomplished easily in a matter of seconds without the use of tools. The single mercury battery — Mallory TR-126 or equivalent — is easily obtained locally. Substitution of a three-wire shielded cable adapts the S-10 for remote on-off switching, and the addition of an S-104 battery bypass enables operation via an external source of 8-9 volts when inaccessibility or continuous service are factors.

SYNCRØN

S-10 Microphone SPECIFICATIONS

Type:	Pressure gradient, condenser
Frequency Response:	40 — 20,000 Hz ± 3db
Capsule Capacitance:	60 pf
Diaphragm:	Mylar
Directional Characteristic:	Cardioid at all frequencies, 20 db front-to-back ratio
Overload Protection:	None needed
Total harmonic distortion:	Less than 0.5% to 124 db SPL at all frequencies
Output Level, 200 ohm load:	−53 dbm re 10 dyne/cm²
Noise:	Less than 27 phon, (DIN 45405) Less than 23 db SPL (DIN 5045)
Output Impedance:	200 ohms nominal, characteristics unaffected by any load from 30 ohms to ∞
Amplifier:	Field Effect Transistor
Microphone Connector:	4 pin XLR type (serves as on-off switch)
Cable:	2 wire shielded, stripped and tinned, 20 feet
Power Supply:	Single TR126 mercury battery, life — 1000 hours
Mount:	⅝" — 27 swivel stand mount
Finish:	Satin nickel
Dimensions:	⅞" diameter x 7⅜" long
Weight:	9 oz. with battery
Price:	$240.00 complete with battery, carrying case, swivel mount, and cable

ACCESSORIES

S-101 WINDSCREEN

Prevents wind noise and effectively reduces plosive speech sounds without affecting microphone characteristics. 100% nylon construction. Weight: ⅕ oz. Diameter: 2 inches.

Price: $14.95

S-102 DESK STAND

A heavy brass casting provides maximum stability on three padded legs. Unique swivel band permits finger-tip positioning — 360° horizontally, 150° vertically. Rich textured vinyl finish. 4¼" high, 10½" long, 7¼" wide. Weight: 1¾ lbs.

Price: $19.95.

S-103 SUSPENSION

Eliminates vibration and shock problems. Used on floor stands, booms, and desk stands. Construction: brass. 4" diameter. Equipped with swivel mount ⅝" — 27 thread. Weight: 8 oz.

Price: $29.95

SYNCRØN AND THE FIELD EFFECT TRANSISTOR

Syncrøn Corporation was formed by a group of young engineers from broadcasting, recording, and acoustical instrumentation fields with a common primary interest — quality condenser microphones. With all the fast-breaking developments of the space age, somewhere they felt, in the melange of power supplies, tubes, fuses, cables, expensive foreign connectors and high price tags, there must be a better way.
With the United States' active leadership in Field Effect Transistor technology it was only natural that an American company would be the first to use the Field Effect Transistor successfully in a condenser microphone. Upon the introduction of commercial FETs in early 1963, Syncrøn built the first condenser microphones to use such devices. The cost of the FETs that would meet Syncrøn's rigid requirements was extremely high, so the microphones remained in the laboratory where they were subjected to nearly a year of intensive field-testing. The inevitable price break came in 1964 whereupon Syncrøn introduced its FET condenser microphone — the first commercial product to employ a Field Effect Transistor in any form. Syncrøn engineers have continually worked to perfect the use of the Field Effect Transistor in condenser microphones. The Syncrøn S-10 is the result of this clear leadership in modern condenser microphone development.

SYNCRØN CORPORATION

WALLINGFORD, CONN., U. S. A.

February 1966

We interrupt this magazine to bring you...

Late Bulletin from Washington

by Howard T. Head

Late Renewal Applications to Draw Fines

The Commission has announced that beginning with those renewal applications due to be filed by March 1, 1966, it has instructed the Broadcast Bureau to note all instances in which such applications are not filed by the applicable deadline. Unless the Bureau finds the delay to be justified, the Commission intends to levy forfeitures (fines) for late filing.

Some 300 to 400 broadcast licenses must be renewed every two months. Late filings have been troublesome to the Commission in the past, and the levying of fines is intended to avoid this burden.

Increased Minimum Power Proposed

The Commission has invited comments on a proposal to raise the minimum power required for all new standard broadcast station applications to 250 watts. At present, applicants for new Class IV stations on the local channels may propose powers as low as 100 watts. Minimum power requirements are 250 watts for Class II stations on clear channels, and 500 watts for Class III stations on regional channels.

Existing Class IV stations operating with 100 watts power would be permitted to continue operation, although they would be encouraged to apply for power increases to the new 250-watt minimum. There's one catch, though -- the 250-watt operation would have to meet all of the interference standards.

Revised FM and TV Propagation Curves Due Shortly

The Commission's staff has completed revisions in the basic data underlying new FM and television propagation curves (November, 1965 Bulletin). At a recent meeting of a joint Industry-Government Working Group established to study these revisions, general agreement was reached on revision of the curves, and the new curves are expected to be proposed for adoption soon.

The new F(50, 50) curves for FM and VHF television broadcasting are expected to differ but little from those presently employed. At UHF, however, the new curves will show generally lower fields than those calculated using existing curves. The new curves will also take into account the effects of varying terrain roughness, which is of particular importance at UHF.

Program Requirements in Effect for Microwave-Fed CATV

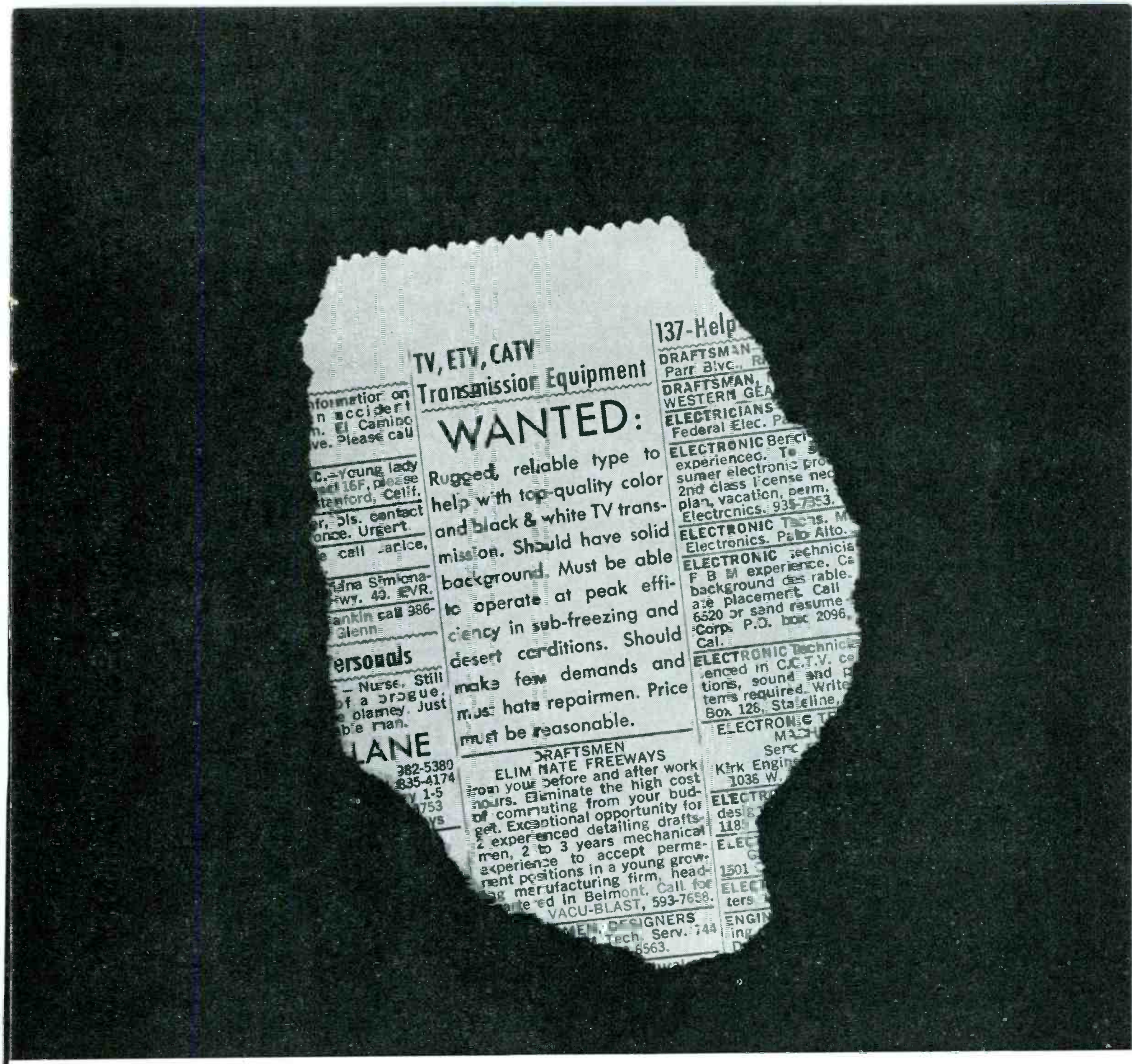
As a result of responses received to questionnaires sent by the Commission to all known CATV systems (August, 1965 Bulletin), the Commission has concluded that all but a small percentage of microwave-served CATV systems already comply with the requirements for the carriage of local television broadcast stations and nonduplication of local programs by distant stations also carried on the CATV system. An even smaller percentage of these remaining systems would encounter technical difficulties in complying with the carriage and nonduplication requirements. As a result of these responses, the Commission established February 1, 1966, as the date after which the carriage and nonduplication requirements will apply to all microwave-fed CATV systems.

In several recent cases, however, the Commission has given favorable consideration to individual requests for exemption from the requirements. In one instance, a CATV system was exempted from both local-carriage and nonduplication requirements because of the poor technical quality of the local broadcast signal (particularly in color), and because limited CATV cable capacity would have required dropping an outside channel to carry the local signal.

Short Circuits

The U. S. Armed Forces have inaugurated "Stratovision," television transmissions from high-flying airplanes, covering both North and South Vietnam; programs are intended both for U. S. troops and the Vietnamese...New guide lines governing suburban broadcast stations have been issued by the Commission in an attempt to distinguish between true suburban stations and those which actually attempt to serve instead the metropolitan center... The Commission has rejected a proposal by a UHF television broadcaster in Massachusetts that he be permitted to broadcast CATV pickups without the usual rebroadcast permission...The Commission, on a waiver basis, has authorized educational television translators to be used in Detroit in conjunction with ITFS transmissions (2500-2690 mc) rather than with a broadcast transmitter as normally required by the Rules...Over 30 Commission personnel, including Chief Engineer Ed Allen, retired from the Commission last December 30...The NAB Engineering Advisory Committee has approved plans for a complete revision of the NAB Engineering Handbook to replace the 5th Edition published in June, 1960.

Howard T. Head...in Washington



So far, there's only one applicant

It's Lenkurt's 76 TV microwave transmission system.

This is the system that's bringing top-quality color and black & white TV into areas where they used to think something was wrong with their picture if it didn't have snow most of the time.

For instance, take the 76 TV Studio Transmitter installation at station KOLO-TV in Reno, Nevada. Since the 76 is transistorized, the new system operates with practically no maintenance, quite a bonus to KOLO-TV because one of their microwave terminals is located on Freel Peak, where 20 foot snows and 100-200 mile winds are not uncommon.

Another outstanding feature of the 76 system is its versatility. At the University of Kansas Medical Center, a 76 ETV system makes it possible for students to participate in classes being presented at a sister campus, 45 miles away. This is one of the few two-way ETV systems in existence. This system is significant because of the high resolution it provides for remote observation of medical techniques.

And the Columbia Basin Microwave Company is using our microwave to transmit two off-the-air pickups through an extensive 76 network to serve several CATV companies and school districts.

So, whether you're planning a community TV setup, an Educational TV program, or want to join a network, *and* you want rugged, reliable equipment to help with top-quality color and black & white TV transmission, you'd be doing a smart thing to write us for the resume on our money-saving, solid-state 76 TV microwave system.

Lenkurt Electric Co., Inc., San Carlos, Calif. Other offices in Atlanta, Chicago, Dallas, and New York City.

LENKURT ELECTRIC

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

Circle Item 16 on Tech Data Card

Convention

(Continued from page 16)

nomical automated operation designed by himself and the technical staff of that station. The system is in operation during nighttime hours.

E. Mott, chief engineer of station CJAD, Montreal, gave a paper on research into the cure of intermittent shut-downs due to lightning strikes. This station has four 675′ towers, and its location is such that it is subject to excessive static and lightning discharges. A solid-state VSWR device with rapid control of the steep wavefronts was developed and is operating satisfactorily.

CFRB's switching facilities and installation problems were discussed in a paper given by Mr. R. Cambridge of the Northern Electric Co., installers of the equipment.

Electro-Voice microphones were shown and the design features explained in a paper given by Mr. Desjardins of that firm.

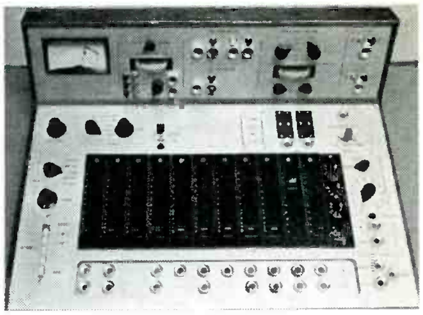
The Canadian Government was represented by Mr. J. T. Chrome of the Department of Transport, speaking on "Channel Allocation for FM Broadcasting Stations." RCA of Montreal was represented by Mr. Dashney's paper on "Fundamentals of Compatible Colour." This was illustrated by 60 color slides.

Station CFRA from Ottawa brought their mobile unit to illustrate Mr. G. Roach's contribution, "VHF Mobile Radio Links in a Broadcasting Station."

From Gates Radio came Mr. W. Holbrick with "Preventing FM Overmodulation" as his subject.

As has been the custom for many years, McCurdy Radio Industries provided the many "Coffee Breaks."

Station CJAD arranged a visit to



CFRB dual master control and switcher.

its transmitter site, a visit to the CFTV studios, and a trip to the top of Mount Royal for a look at the CBC's two-station TV set-up and the operation of dual TV transmitters by Canadian Marconi Co's. CFCF and CFTM.

The 15th annual meeting of the CBA Engineering Section was a complete success, and those who worked on its preparation are to be congratulated. ▲

In next month's PRE-NAB Issue:

Radio-Station Floor Plans

Just one of the informative features in this special issue.

FM Overmodulation

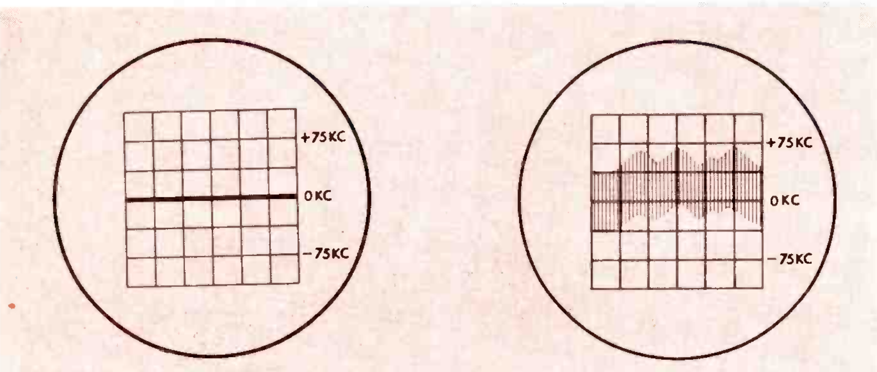
(Continued from page 15)

designated point No. 1 in Table 1.

Realizing now that as the audio modulating frequency level is increased, normally termed "increasing the percentage modulation," note that more and more side frequencies are produced. Obviously a point must be determined beyond which these side frequencies must be stopped. Otherwise, they will continue to spread until they interfere with an adjacent-channel station. This limiting point is by definition the 100% modulation point, or, in the example given, the 75,000-kc deviation point. To quote Section 73.268 of the Rules: "The percentage of modulation of FM broadcast stations shall be maintained as high as possible consistent with good quality of transmission and good broadcasting practice and in no case less than 85 percent *nor more than 100 percent* on peaks of frequent recurrence during any selection which normally is transmitted at the highest level of the program under consideration."

In order to measure the deviation of an FM transmitter, it is necessary only to know the modulation index. Table 1 shows some typical values of the index that result in zero carrier. By listening to the carrier frequency with a receiver having a BFO, one can easily hear each null as it is reached. By counting the nulls and observing the percent modulation as registered on the station monitor, the accuracy can be checked easily.

Special attention should be given to the percent modulation indicated on the station monitor in cases of SCA and/or stereo broadcasting. As shown above, the total modulation cannot exceed 700%. Thus we have to allow for these other services. Section 73.319 (c) indicates that the arithmetic sum of the modulation of the main carrier by SCA subcarriers shall not exceed 30%. However, if Stereo is also employed, the sum of the subcarriers cannot exceed 10%. With stereo, the percent modulation used for the pilot carrier has to be between the limits of 8% and 10%. If no SCA is used, about 90% re-



A
(A) No modulation

B
(B) With modulation

Fig. 4. The percentage modulation can be determined with a calibrated scope.

mains for the right and left signals. Neither right nor left signal, when applied individually, can exceed 45% modulation if 10% is reserved for SCA.

FCC Method of Determining Percent Modulation

Stations have often been cited for either overmodulation or undermodulation by an FCC monitoring unit when the station's own monitor may have indicated normal operation. As indicated above, this discrepancy can result from miscalibration of the station's monitor. Therefore, it is helpful to understand that the FCC employs its own method of determining percent modulation.

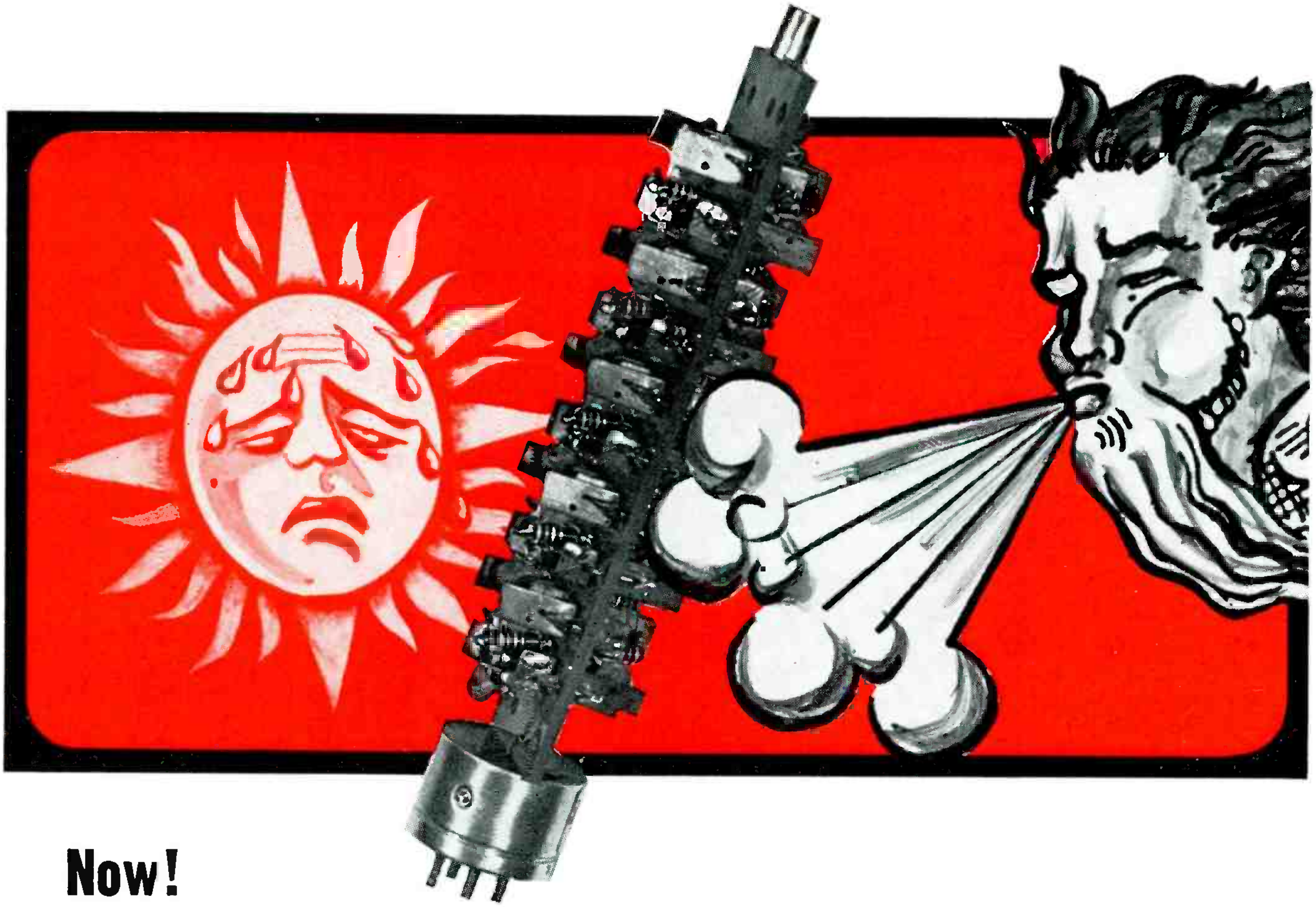
Basically, the FCC method consists of taking the FM signal off the air and displaying it on an oscilloscope. The oscilloscope is set up so that with zero modulation there is a straight line across the grid (Fig. 4). Then, as modulation is applied by the FM station, deflections occur both above and below this base line. The distance the scope trace deflects is directly related to the distance the modulation deviates from the carrier frequency of the FM station. For example, a deviation of 75kc equals 100% modulation. Thus if the scope grid were calibrated in kc, an observer could tell precisely whether the deviation was in excess of 75kc. The only problem remaining is to calibrate the oscilloscope grid in some way. This is done with a frequency meter. For each FM station and frequency, it is necessary to check the calibration before attempting to determine overmodulation. The vertical-gain control on the oscilloscope is used to correct for any minor calibration adjustments required.

In some ways this method is similar to the technique widely used in calibrating AM modulation monitors by viewing the deflection on an oscilloscope. Possibly a system similar to that used by the FCC monitoring unit could serve as an additional protection against overmodulation and as a tool in verifying the accuracy of the station's regular modulation monitor. The April 1964 issue of Broadcast Engineering contains a more detailed description of the FCC monitoring unit.

The above discussion should help to clarify what frequency modulation is and how it occurs. While the percent modulation may not be as easy to check as in an AM transmitter, nevertheless, it can be measured (and should be regularly) in order to prevent overmodulation. With stations engaged in SCA and/or stereo, this accuracy becomes even more important. The FCC has not yet established rules to cover modulation monitors for SCA and stereo, but will in the near future. Several monitors now available are capable of reading individually and collectively the various modulating components. Those stations engaged in SCA and stereo broadcasting would do well to use one of these. ▲

Table 1. Points of Zero Carrier

Point Number	Modulation Index
1	2.405
2	5.520
3	8.654
4	11.792
5	14.931
6	18.071
7	21.212
8	24.353
9	27.494
10	30.635



Now!

End "Off-Air" Panic and Eliminate Temperature Worries Forever, with... WILKINSON SILICON RECTIFIERS

No more finicky temperature sensitive mercury vapor rectifiers . . . Go on cold mornings! Forget heating and air conditioning! . . . Wilkinson Silicon Replacement Rectifiers produce no filament heat and function below −60° C.

No longer high priced! Wilkinson Silicon Rectifiers cost less than others and can be repaired in seconds with low-cost replacement diodes. No encapsulation used! No more guesswork or costly test time! You know at a glance the exact status of your complete power supply because a "GO, NO GO" indicator warns when the reverse leakage of any diode is in excess of 50 microamps. Wilkinson Rectifiers virtually last forever!

Now it's easy and economical to solid state the power supplies in high power equipment. With Wilkinson Rectifiers no rewiring is necessary. Just plug them into your present mercury vapor tube socket. Filament transformers as well as other components are left in place.

Modernize your equipment today! Consult the Tube Replacement Chart shown here and order now!

FEATURES: Light indicator on each diode warns of any difficulty or high voltage ON. • Easily replaceable low-cost diodes. • Reduces heat – power cost – hash. • Operates from −65° C to +70° C Free Convection. • Eliminates warm-up time.

TUBE REPLACEMENT CHART

WE TYPE	REPLACES TUBE TYPE			P.R.V.	AMPS	UNIT PRICE
SR-3-1	866A	816		3KV	1	10.95
SR-10-6	872	8008		10KV	6	50.00
SR-10-12	872	8008	575	10KV	12	60.00
SR-14-6	872	8008	575	14KV	6	72.00
SR-14-12	872	8008	575	14KV	12	84.00
SR-20-6	6894	6895	673	20KV	6	100.00
SR-20-12	6894	6895	673	20KV	12	120.00
SR-24-15	869B			24KV	15	225.00
SR-32-25	857B			32KV	25	475.00

FOR COMPLETE DETAILS WRITE:

WILKINSON ELECTRONICS, INC.
1937 MAC DADE BLVD. • WOODLYN, PA. 19094
TELEPHONE (AREA CODE 215) 874-5236 874-5237

Circle Item 24 on Tech Data Card

Station-Break

(Continued from page 13)

Switchers

The older direct-type audio and video switchers allow only simple automatic functions to be performed. A relay-type switcher, however, will permit many variations in automatic switching functions because the console push buttons supply only a DC voltage pulse to relays which do the actual switching operations. If one already has such switchers in use, preset switches can be used or a pin board wired up to provide the desired switch routings. When the air equipment is modified to send back ending pulses, a simple system can be built to handle the panic period without difficulty.

Present-day solid-state switchers generally use solid-state switchpoints rather than relays (Fig. 5). The actual video signal is passed through the special switchpoint and isolated from the control circuits. Switching action is accomplished by bias action on the switchpoint. The bias is derived from the station sync generator, or at least synchronized to the vertical drive pulse. This permits the switching to be accomplished during the vertical blanking interval. There are also in use other methods of developing the trigger pulses. This brief explanation is intended only to bring out the great difference between new and older-style switchers. While the end objective is the same with both types, the methods used are different.

Programmers

Sophisticated commercial systems which can operate during the panic period with ease are also capable of full or total automation. Simple panic-period use does not do justice to their full capabilities.

The simplest commercial system makes use of a pin-board programmer to set up the desired circuit routings and sequence of operation. A full day's programming may be set up in advance by the use of several of these boards, which can be inserted as the desired sequence arrives. The operation is quite simple. A timer supplies pulses through the preprogrammed pin board to the audio and video switchers and control circuits for the air machines. A readout shows the time, events, etc. This system is not a video or audio switcher, but works in conjunction with the station switchers. It will operate any of the solid-state switchers directly through appropriate cabling, as it will do with a relay or crossbar switcher. Any manual or direct-type switcher must be modified, and for this purpose the manufacturer will supply an optional relay package. There is also an optional package to modify the on-air equipment to accept starting and stopping pulses from this programmer.

One type of commercial system (Fig. 6) makes use of a 1″ punched paper tape to provide information to the computer to control programming for long periods of time or a full day's operation. A special typewriter and integrated tape punch are used to prepare the tape and the program log (if desired). The punched tape is then inserted into a tape reader which sends electronic signals (decoded from the tape) to the memory or storage unit. The

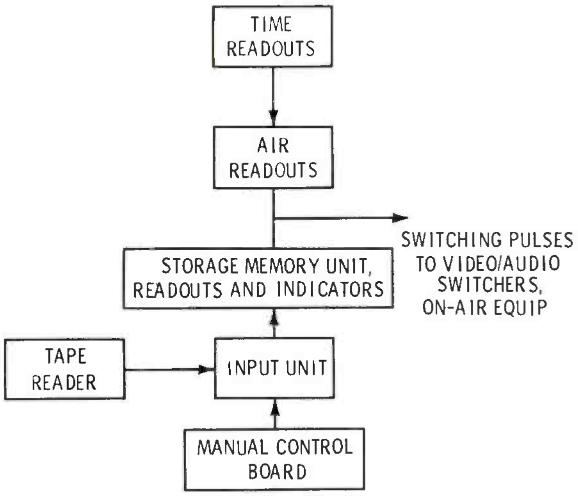


Fig. 6. Block diagram of tape-programmed automation unit.

memory unit is usually built up from magnetic memory-core units. The information stored in the memory unit causes appropriate signal pulses to activate the various readouts and switching paths as required through the control section, and complete control is assured by the automation unit.

Many of these systems have basic principles in common, although they use different methods. For example, one system which has a larger storage unit than another can control longer periods of time without the use of additional programming information. To make it control a full day's programs, punched cards and additional associated circuitry may be included with the package.

These systems can be programmed directly by the control operator to the capacity of the storage system. They provide a control panel by which he can control the system, make changes in the stored information at will, slow down or speed up the action, instantly take over manual control, etc. The punched-tape system also allows him to replace a section of tape when changes are to be made.

Such systems have a precision master clock system providing pulses to operate the readout countdowns and synchronize the switching actions. Such time countdowns permit the operator to know exactly where his air programming is and at what instant or stage the automatic action is progressing. He can make judgments when to take control if, for example, a film spot is running several seconds short of its schedule.

The punched-tape system has still another advantage. The prepunched tape may be fed back to the special typewriter, which will automatically print on the log form what is encoded in the punch holes of the tape.

As was pointed out earlier, these systems are intended ultimately for full or total station automation. A full system is expensive, but need not be purchased complete. To control the panic period, the basic system only may be used. Even basic systems are expensive, but for many stations, the greater ease of "on-air" programming and reduced errors afforded by the systems will justify their purchase and installation. ▲

IS YOUR VIDEO ON THE LEVEL?

Solid State Color STABilizing AMPlifier
with A.G.C. model VI-500

AUTOMATIC VIDEO LEVEL CONTROL
Maintains video peaks constant to a preset level, with reference to blanking.

CLAMPING
Sync tip clamps remove hum, tilt and other low frequency disturbances.

SYNC LEVEL
Sync level is maintained at a constant amplitude despite large variations in input.

EQUALIZATION
Accurately compensates for losses in up to 1000 feet of coaxial cable.

REMOTE CONTROLS
Automatic/Manual video gain
Sync Level
White Clip
Black Clip
By-pass switch

WHITE CLIP
Adjustable sharp white clip remains fixed with respect to blanking.

BLACK CLIP
Adjustable sharp black clip for monochrome operation.

WHITE STRETCH
Stretch adjustments provide a high degree of flexibility to compensate for transmitter characteristics.

NON-COMPOSITE COLOR OUTPUT
Mono. or **Color** non composite output board in lieu of white stretch is available at additional cost.

APPLICATION
Wherever there is video and you want to assure:

• Constant levels • Constant clean sync • Elimination of tilt, hum and low frequency disturbances.

Price for the VI-500 $1,750.00 Remote controls $150.00 . . . Have you placed your order yet?

GOOD ENGINEERING IS VITAL

Write for complete information and specifications.

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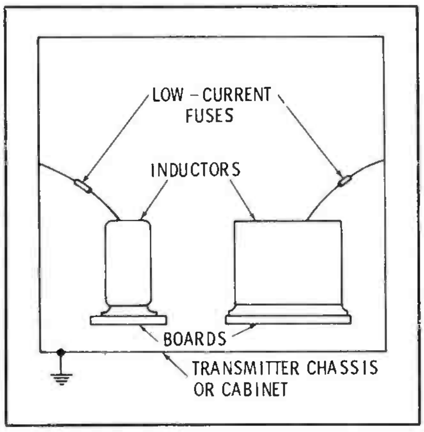
Circle Item 29 on Tech Data Card

Engineers' Exchange

(Continued from page 6)



is a rather expensive thing to replace them all, we had to find the exact one—and that would be a problem since the symptom was only a momentary thing that occurred at the most five times a day.

We finally decided to place all the transformers and chokes on insulated boards. We then connected a low-current fuse between each inductor and the chassis of the transmitter. After about three days of no transmitter trouble, we made a check of our fuses. Sure enough, we had a blown fuse going to the filament transformer of the 866 rectifier tubes. We replaced the transformer, and after about four months there still was no trouble.

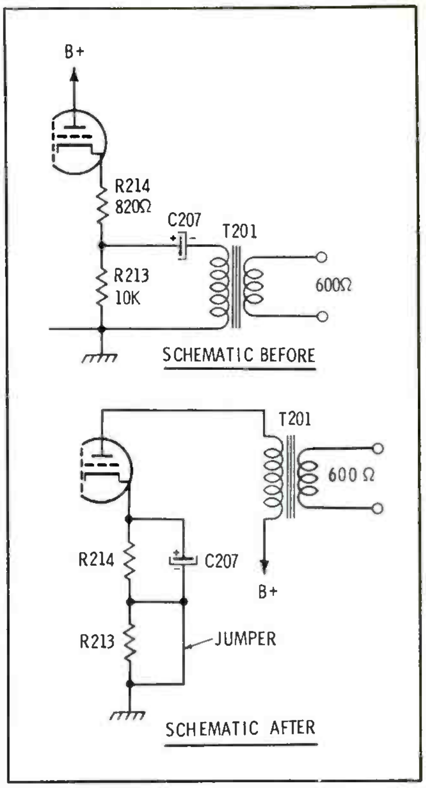
Some engineers make a practice of leaving inductors on boards and continuing to use them even after they have become permanently shorted to the case. It should be kept in mind that the inductance changes when these shorts occur, and the inductor no longer is operating as it was before the short occurred. In order to maintain top performance in a transmitter, shorted inductors should be replaced as soon as possible.

This item made Walt a repeat winner in our contest.

Modification to Cartridge Machine

by Robert R. Groome
Chief Engineer, WOOO
Deland, Florida

We purchased some ATC P-190 cartridge machines and ran them through separate pots to our Col-



line 212F-1 console. After an announcement had finished but the tape had not run out, the output cathode follower would hold our compressor amplifier to about 7 to 15 db of compression. Anything that went to a high-level input of the console would be very low in gain. To correct this, the following changes were made:

Jumper R213 (10K resistor).
Rearrange C207 to shunt R214.
Rearrange leads of T201 so primary is in series with V202 (12AT7 second section).
Readjust R209 for best output.
It may be necessary to change value of R214.
Finally, readjust R208 for best frequency response.

This arrangement has worked well during several weeks of use. ▲

HELP!

We're running short of items for Engineers' Exchange. We pay cash for every one used, and to the author of the item judged best each month, we also award a volume of his choice from the **Broadcast Engineering Notebooks** or **Modern Communications** Course series. Send in your entry today!

NEWS OF THE INDUSTRY

INTERNATIONAL

TV and FM in Spain

One of Europe's highest television transmitters, currently being installed in Spain, will double Madrid's TV broadcasting capability early in 1966. The 5-kilowatt VHF transmitter is being installed atop 7546′ Navacerrada Peak in the Guadarrama Mountains north of Madrid. The station will permit Spain's **Division of Radio and Television Communications** to schedule programs entirely independent of the existing national station. Supplying the transmitting equipment is the **IGE Export Division of General Electric.**

Lured by rising consumer purchasing power—per capita income has nearly doubled since 1960—and pressed by congestion of its airwaves, Spain is placing new emphasis on FM radio broadcasting. Sale of 16 FM transmitters to one of the country's largest networks, **S.E.R.**, has been announced by **Gates Radio Company**, subsidiary of Harris-Intertype Corp. The transmitters, each 1,000 watts in power, are enroute to S.E.R. for installation in 16 different Spanish cities throughout the Iberian Peninsula.

ETV System Expanded

Two microwave channels began broadcasting educational television (ETV) programs simultaneously with an existing UHF educational channel for the first time in January. The multichannel broadcast of ETV lessons, originating from the radio and television center of the Detroit Public Schools, was transmitted over UHF channel 56 and two 2500-mc channels. Combined broadcast programming is now beamed continuously over the three channels to 60 Detroit public schools A fourth broadcast source is the Midwest Program for Airborne Television Instruction (MPATI).

The 2500-mc system, manufactured and installed by **Electronics, Missiles & Communications, Inc. (EMCEE)**, provides multichannel black-and-white and color broadcast service. The cost was about $20,000 for the first channel and $15,000 for the second.

The first 2500-mc transmitter was installed in September, 1965; the second commenced broadcasting a month later. By the end of 1965, both microwave channels were totally operative, and proof-of-performance tests had been completed.

Advantages of adding microwave channels to the existing UHF channel include the ability to repeat programming throughout the day. The multichannel capability greatly reduces scheduling problems. Also, the individual school gains flexibility in selection of programs.

The system is capable of transmitting within an approximate 15-mile radius. Repeater stations can be installed at the perimeter of this area to extend the signal to additional communities.

NATIONAL

Color Television Test Film

The Society of Motion Picture and Television Engineers has announced the availability of a new Color Television Test Film for use by laboratories, telecasters, manufacturers, producers, and agencies as a "reference print" for subjectively evaluating color release prints and color television transmission systems and for performing quality control.

The film as produced in 16mm, 35mm, and 2x2" slide formats is intended to serve the film laboratory and telecaster as a "representative material" to evaluate subjectively the product for density and color balance, and as a final evaluation of the performance of color television transmission systems after the chain has been properly set up.

Objects to FCC Proposal

The National Association of Broadcasters has objected to the **Federal Communications Commission's** requirement for an automatic measuring device in its proposed rule authorizing remote control of VHF television transmitters.

The NAB, which requested that the FCC allow such remote control operation, asked the Commission to delete from its proposal the necessity of providing a device to detect and measure out-of-band radiation. NAB further objected to the requirement for manual scanning of the spectrum if an automatic device cannot be designed for practical application.

An *Allenized* VTR provides

High Band Color, Simple Troublefree Operation, Top Performance and Economy with the new LONG LIFE Allen High-Band Head

Available as a complete machine to add to your facilities. Available as system components to re-equip your existing VTR by Allen's factory rebuilding exchange — for the best in High Band Color Operation.

- High Band Color — at modest cost; ALL BAND operation at the turn of a switch
- Automatic RF Processor — superior color with "hands-off" operation
- Simpler Equipment — far fewer controls and adjustments
- Best Performance — routinely meets or exceeds all performance specifications of the latest, most expensive "deluxe" VTR equipment
- Stable "Sync-lock" Servo — positive lock both frame and line comparable to best sync generator "gen-lock" — with instantaneous lock-up after tape guide pulls in
- Stable Signal System — incorporates all U.S. deviation standards including both Low Band (SMPTE) and High Band operation
- Allen Factory-Rebuilt VR1000 Transport—self-contained flat tape console for tape handling convenience
- Plug-in Modules interchangeable with no readjustment

VISUAL ELECTRONICS CORPORATION
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LOOK TO VISUAL FOR NEW CONCEPTS IN BROADCAST EQUIPMENT

In a filing on Jan. 17 by Douglas Anello, NAB general counsel, NAB said it shares the Commission's concern over "potential interference to other services" but noted that adequate safeguards are "incorporated into present-day television equipment which minimizes the possibility of interference . . . by these transmitters."

NAB stated that the automatic measuring device is not now available and it is "problematical whether such a device could ever become a reality and effectively function in the area set forth in the Commission's proposal. It is inconceivable that this proceeding should be associated with a yet-to-be developed piece of equipment whose usefulness is a subject of considerable debate."

New FCC Examination Element

All field examination offices of the Federal Communications Commission will begin using a revised Commercial Examination Element Three effective January 31, 1966. This revised Element 3 corresponds to new study material issued initially during January 1965.

The revised examination contains 100 questions of the multiple-answer type in which the applicant is to choose the best of five choices. 75% is passing.

Enters CATV

Stromberg-Carlson Corporation, a subsidiary of **General Dynamics,** is entering the Community Antenna Television (CATV) field in association with **Entron, Inc.** Under terms of the association, Stromberg-Carlson, using some Entron-developed equipment, will finance, engineer, furnish, and install complete CATV systems for telephone operating companies. Entron equipment to be used by Stromberg-Carlson in the CATV systems includes high-power tubes and solid-state all-band amplifiers.

High-Speed News Transmission

High-speed transmission of news between London, Paris, and Washington via the GH205 telephone-speed data communications system was demonstrated in January by **Standard Telephones and Cables, Ltd.,** subsidiary of **International Telephone and Telegraph Corp.**

In a three-way link between the Washington Post, the Newspaper Society, London, and Agence France, Paris, copy was sent on regular voice channels at speeds up to 1200 words per minute.

After the copy is first punched onto paper tape, then converted into corresponding trains of electronic pulses by the GH205 system, the transmission is made over standard telephone connection via suitable conversion apparatus. At the receiving end, the copy is punched again onto paper tape and fed into reproducer sets to obtain printed copy for immediate use, or further local transmissions over normal teleprinter channels.

Three Grants for ETV

Approval of three grants totaling $929,071 to establish or expand educational television facilities have been announced by John W. Gardner, Secretary of Health, Education, and Welfare.

A grant of $725,190 to **WGBH Educational Foundation** will be used to activiate WGBX on Channel 44 as the second ETV outlet in Boston. The new station will broadcast six days a week in color to a population area of 5.3 million in Massachusetts, Rhode Island, New Hampshire, and Connecticut, including 1.4 million students in 3,000 schools.

A Federal grant of $178,881 to the **University of Hawaii** will be used to activate a noncommercial television station on Channel 11 in Honolulu as the first step in a statewide ETV network. The new station will serve 372,000 persons, including 129,000 students in 190 schools. Channel 11 plans a 40-hour week of daytime programs, with instruction in music, art, language, history of Hawaii, social studies, science and arithmetic for teachers and other professional persons, vocational education, and community-affairs programs. The state plans to distribute 700 television sets to elementary schools.

A grant of $25,000 to **Florida East Coast Educational Television** will be used to add a second production studio for Station WMFE, Channel 24, in Orlando. The new equipment will enable the station to broadcast eight hours daily instead of six, to serve 796,000 people, including 231,000 students in 596 schools.

FM Station Uses New Empire State Antenna

WQXR-FM, the first FM station to go on the air in New York City (in 1939), is the first station to transmit from the new master FM antenna atop the Empire State Building. The WQXR-FM transmitter, operating on 96.3mc (Channel 242), inaugurated its high-altitude signal officially on Wednesday, Dec. 15.

A new transmitter has been installed by WQXR on the 81st floor of the Empire State Building. This equipment will feed the station's signal to the master antenna 21 floors above through coaxial cables and will extend the hearing range of WQXR-FM to an average 73.9-mile radius from the 34th Street site. Located 1250′ above the ground, the master antenna is situated above and below the observation windows on the 102nd floor of the building. The antenna is omnidirectional, providing a circular pattern with horizontal and vertical polarization. The antenna can accommodate 17 stations.

Color TV in Puerto Rico

A new station in San Juan, Puerto Rico, has ordered the island's first color television studio equipment from the **Radio Corporation of America** and expects to begin color broadcasts in March. The equipment, including a complete color TV film system, will be delivered to **El Imparcial Broadcasting Company** for **WITA-TV,** its UHF station scheduled to broadcast on Channel 30.

PERSONALITIES

Three supervisory engineers each with 16 years experience at **WPIX,** New York have been promoted to assistant chief engineers. **Dominick Bruno** will be assistant chief engineer in charge of transmission, **Louis J. Climent** will be assistant chief engineer in charge of operations, and **John E. Neeck** will be assistant chief engineer in charge of facilities.

Bruno, a Demarest, New Jersey resident, has been with the station since May 1948 and an engineering supervisor since 1953. He was in charge of the new antenna system installed by WPIX on the Empire State Building tower to overcome the canyon handicaps of skyscraper New York City.

Climent, who joined the station in June 1948 as its maintenance supervisor, has had his responsibilities increase concurrently with the broadening horizons of television operations and WPIX-FM. In his new post, Climent, a Bayside, Queens, resident, will be directly responsible for both studio and remote engineering tied to the station's colorcasts of the New York Yankees' home baseball games.

Neeck, who joined WPIX in July, 1948, is now directly responsible for the color television and black-and-white camera, video-tape, and film-chain complexes the station has been installing in its program for color expansion which was initiated in 1964. He is a resident of Douglaston, Long Island.

Albert H. Chismark, director of engineering of Meredith-owned **WHEN-TV,** Syracuse, New York, has been named director of engineering of **Meredith Broadcasting Company,** a new executive post. He will be based at Syracuse to continue his present duties, and will report to the president of Meredith Broadcasting at Omaha, Nebraska.

Mr. Chismark joined WHEN-TV as station engineer in 1955, and in 1957 was appointed director of engineering. From 1946 to 1955 he was chief engineer and assistant manager of WTRY Radio and WTRI-FM, Troy, New York. In 1952 he was assigned the additional responsibility of chief engineer for WTRI-TV (now WAST) in Albany. In 1940 he designed and built WTRY Radio at Troy. In 1939 he was staff engineer with WSYR, Syracuse, and with WOKO-KABY, Albany, from 1936 to 1939. He is a resident of Fayetteville, N.Y.

Robert M. Johnson has been named to head a new Telecommunication Sales organization for General Electric's Communication Products Department. He will be responsible for sales, sales planning, and proposal activity—both headquarters and field—on long-distance point-to-point communication equipment, such as data transmission systems. With General Electric since 1951, Mr. Johnson joined the Communication Products Department in 1953 as supervisor of government service. In 1958, he was named manager of government sales and service with responsibility for contractual liaison with federal agencies throughout the country.

The appointments of **Gifford C. Campbell** as **WOR** Radio chief engineer and **Raymond J. Smith** as WOR-TV chief engineer have been announced. **Joseph S. Fioravanti** has been named supervisor of the Technical Facilities Division and Technical Construction of WOR Radio.

Mr. Campbell, who joined WOR in 1931 as a maintenance engineer, has served as supervisor of the technical facilities division at the station. Mr. Smith joins WOR-TV after serving as chief engineer for WGR AM-FM-TV in Buffalo, New York, since 1960. He also held engineering posts at WVET-TV in Rochester, New York, and WBEN-TV, Buffalo. Mr. Fioravanti, who joined WOR four years ago, served in an engineering capacity at CBS from 1949-61.

RCA NEW LOOK

A COMPLETELY NEW CONCEPT IN COLOR TV CAMERAS

the best of color

starts with black!

Like the black plate in four-color printing, this radically new camera uses a "black tube" to produce perfect color pictures

Ask any printer and he'll tell you that four-color printing needs a black plate to supply "snap" to the color picture. For the same reason, the TK-42 color camera has a separate luminance (black) tube added to the red, green and blue (color) tubes. Result: Finest detail and superior color pictures.

Everything about this great new camera contributes to the finest, most reliable color reproduction ever provided. Stabilized circuitry permits it to operate for long periods without adjustment. Completely transistorized, plug-in modules provide highest performance and reliability. Big 4½-inch image orthicon tube in luminance channel provides high quality monochrome pictures, as well as highest quality color pictures.

The separate luminance principle has been proved by more than 5 years of intensive engineering, product research and field testing. Several models have been demonstrated at three NAB Conventions. In 1962, broadcasters registered their choices regarding the separate luminance principle, as well as other features. The result is the TK-42...a new standard of color picture quality!

This 4½-inch image orthicon (black tube) is used in the separate luminance channel to sharpen the color picture and to assure a high-quality monochrome picture.

Transistorized modules afford easy servicing, are more reliable, and provide highest performance.

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

RCA®

The Most Trusted Name in Television

News of the NAB Convention

Engineering Conference Speakers Named

Two internationally known broadcast executives and an outstanding military leader will be featured speakers at the National Association of Broadcasters' Broadcast Engineering Conference to be held at the Conrad Hilton Hotel in Chicago, March 27-30.

George Hansen, director of the Technical Centre of the European Broadcasting Union (EBU), Brussels, Belgium, will address the opening day luncheon, Monday, March 28.

John Chancellor, director of the Voice of America, will be the Tuesday luncheon speaker; and General Maxwell D. Taylor, special consultant to President Johnson, will address the March 30 management luncheon.

Mr. Hansen, long active in Belgian and European broadcasting, assumed his present position in 1956. He joined the Belgian Broadcasting Corp. after his graduation, in 1932, from Brussels University. Four years later he became its head of research. After his World War II military service, Mr. Hansen returned to the Belgian Broadcasting Corp. and in 1946 was named chief engineer and deputy director-general. He is presently a member of engineering societies in the United Kingdom, France, and Belgium.

John Chancellor, the first working journalist to head the 23-year-old Voice of America, was named VOA director by President Johnson last July. When appointed, he was chief White House correspondent for NBC news—his final assignment in a 15-year career with the National Broadcasting Co. He had been an NBC correspondent in Vienna, London, Moscow, Brussels, and Berlin.

General Maxwell Taylor's long military career reached a pinnacle in 1962 when he was chosen to head the Joint Chiefs of Staff. He retained this post for two years until being appointed ambassador to South Viet Nam, serving in that position during a critical period of U.S. involvement. The four-star general retired from active duty in 1959, and held two civilian posts until 1962, when he was recalled to military service as military representative for President Kennedy.

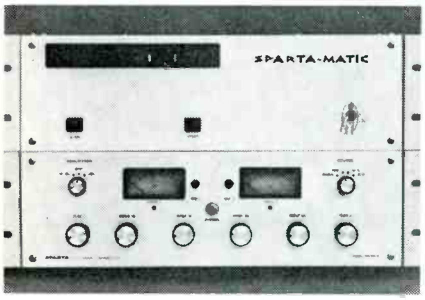
A 1922 West Point graduate, General Taylor was promoted to General in 1953. He has been assistant military attache in Peking, commander of the 8th Army in the Korean War, commander of the U.S. Army Forces in the Far East, and U.S. and U.N. Commander in the Far East. Following his European service during World War II, he became superintendent of the U.S. Military Academy in 1945, and in 1949 was named Chief of Staff for the American Forces in Europe.

Engineering Award Recipient Named

Carl J. Meyers, senior vice-president and director of engineering of WGN, Inc., Chicago, has been chosen by the NAB to receive its annual Engineering Achievement Award. The award will be presented March 30 at the final luncheon of the 1966 Broadcast Engineering Conference.

George W. Bartlett, NAB's vice-president for engineering, said Mr. Meyers was selected for his "pioneering and experimental efforts in color telecasting." WGN credits his efforts as being instrumental in the station's "most practical and inexpensive" conversion to color.

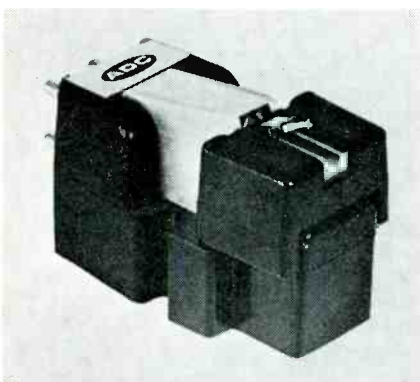
A broadcast veteran of more than 40 years, Mr. Meyers has experimented with numerous high-sensitivity pickup tubes to make possible the origination of color remotes under low lighting conditions. ▲



Stereo Tape-Cartridge System

The 600 Series stereo tape-cartridge record and playback system was developed as a result of increased requirements for short-length programing facilities in the stereo-FM industry. The record-playback unit of this **Sparta** system is designed for rack mounting as well as table-top installation. The accompanying playback unit is housed in a table-top cabinet so that it can be moved as desired. The record-playback unit features two separate inputs with a variety of plug-in options; it also utilizes the latest NAB 3-track tape-head configurations. The units are completely transistorized.

Circle Item 52 on Tech Data Card

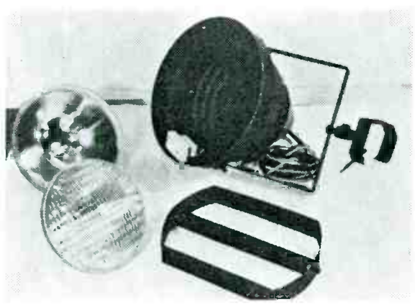


"Induced Magnet" Phono Cartridge

Like its predecessors in the Point Four series, the **ADC** 10/E cartridge uses the "induced magnet" principle and adheres to the standard 15° vertical tracking angle. With the "induced magnet" principle, magnetism is induced by a fixed permanent magnet into a tiny magnetic collar which, in turn, moves between the pole pieces. The manufacturer states that use of this design reduces the mass of the moving system to a minute value until the limiting factor becomes that of physically supporting the stylus in the groove. The mass of the actual generating system is minimal and no longer limits the performance of the unit.

Manufacturer's specifications are: sensitivity—4 mv at 5.5 cms/sec recorded velocity; Channel separation—30 db, 50 to 10,000 cps; frequency response—10 to 20,000 cps ±2db; stylus tip radius—elliptical stylus, contact radius: .0003", lateral radius: .0007"; vertical tracking angle—15°; tracking force range—½ to 1 gram; IM distortion—less than ½%, 400 & 4,000 cps at 14.3 cms/sec velocity; compliance—35 x 10^{-6} cms/dyne. Price is $59.50.

Circle Item 53 on Tech Data Card



Variable-Beam Backlight

Series 73-20 backlight—designed and manufactured by **Lighting & Electronics, Inc.**—is being offered for operation in variable beam spreads with 300W quartz or PAR 300W and 500W lamps. This unit is designed primarily for the TV broadcast industry. Features of the 73-20 include: adjustable yoke with steel pipe clamp; steel housings; and a removable louvre to reduce TV-camera lens flare and accommodate wide flood, medium flood, or narrow spot lamps.

Approximate cost for each series 73-20 backlighter is $20, and the unit works with both 110- and 220-volt AC systems.

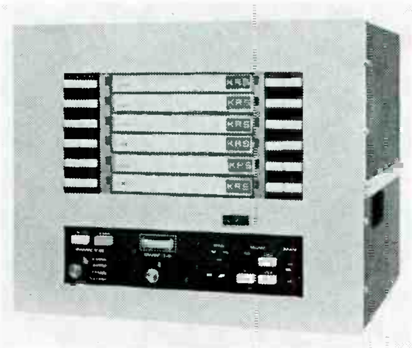
Circle Item 54 on Tech Data Card

CCTV Monitor

A 27" video monitor available from

Packard Bell for CCTV systems features a bonded face plate which is treated to reduce reflections to a minimum. The steel cabinet is finished in textured satin black with brushed aluminum trim. Front controls are concealed behind the flip-down name plate. This monitor's 12-mc bandwidth provides maximum horizontal resolution of 800 lines. Also, the set features a fully regulated power supply. List price for the video monitor is $480.

Circle Item 55 on Tech Data Card



Automatic Tape System

The SB6A Series STACT Broadcast tape recorders featuring reversible, continuous-loop STACTape cartridges with ¼" magnetic tape, six tape decks, automatic cuing and sequencing and remote control are available from **KRS Instruments.** Monaural units use one track for audio information and one track for cue tone which may be used for control of slide projectors, film projectors, etc. Corresponding models are available for stereo, with one track for cue-tone control and two tracks for audio.

Rear-panel connections for remote control include start, stop, sequence, all stop, record/erase, and cue tone. Cartridge sequencing may be performed manually or automatically programmed from a panel switch on a one-cycle, continuous recycle, or preset sequence. Other external automatic programming devices are available.

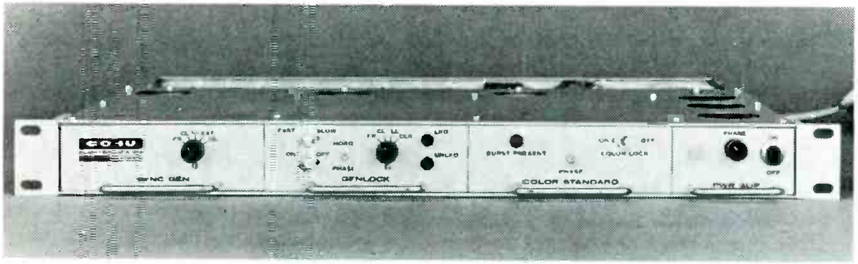
Manufacturer's specifications are as follows: Tape speed—3¾ or 7½ ips. Frequency response — 30-18,000 cps ± 2db at 7½ ips. Signal-to-noise ratio—At least 50 db from 3% THD point. Flutter and wow—Less than 0.18% rms on fully loaded cartridge; below 0.1% on short length stuffing cartridge. Record input—For bridging 600Ω line. Outputs—mixed and individual (600Ω, 0 dbm) available at rear connector. Playing time—From 10 seconds to 31 minutes per track at 7½ ips; over 2 hours maximum per cartridge for 4 tracks. Playing time doubled at 3¾ ips. Dimensions—14" x 17" x 14". Weight—70 lbs. Price — Model SB6AP—1/$1985.

Circle Item 56 on Tech Data Card

Cleaning Tape

This product for cleaning recording heads and guides of tape recorders consists of a cloth tape, impregnated with a cleaning and lubricating formulation, which "plays" through a tape recorder like regular recording tape. The ¼" tape is wound on a 3" reel for use with small recorders and on a 5" reel for use with larger recorders. Manufacturer is the **Robins Industries Corp.** The 3" reel lists at $1.65; the 5" reel lists at $2.50.

Circle Item 57 on Tech Data Card



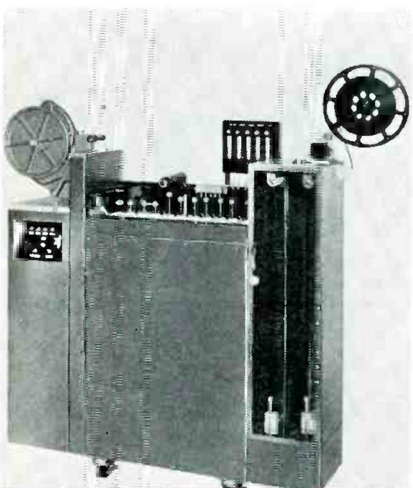
Solid-State Sync Generator

A transistorized sync generator and accessory system for basic broadcast TV studio operation in black and white or color—all contained in a 19″ rack unit 1¾″ high—is built by **Cohu Electronics, Inc.** The 2470 series plug-in circuit assemblies for the complete broadcast system include a 525-line sync generator, genlock, color standard with colorlock, and a power supply. Outputs are compatible with EIA and FCC standards.

Additional accessories include dot-bar generators and accessory changeover switches. Also, other sync generators are available for 729-line, 873-line and 945-line scan rates for closed-circuit TV use. Each sync generator enclosure has a plug-in power supply.

A basic system (Model 2471-100) including 525-line sync generator and power supply with rack-mount cabinet is $945. The complete broadcast system, including genlock and colorlock, is $2,240.

Circle Item 58 on Tech Data Card



The drying cabinet is internally illuminated, and has a clear plastic door to facilitate observation. Four 250-watt heaters provide drying heat for the 160 c.f.m. blower.

The arm for the 1200′ take-up reel has a reversible torque motor with center-off switch for optional A or B wind take-up.

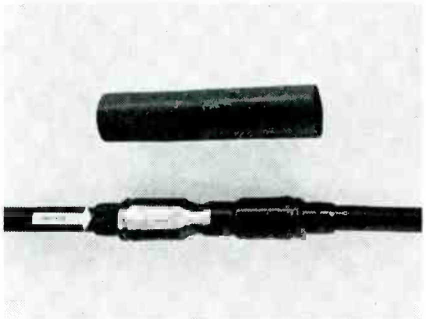
The entire processor is stainless-steel jacketed and mounted on locking casters.

Circle Item 59 on Tech Data Card

Condenser Microphone

"Condenser sound" in a compact package is offered by **Boynton Studio** in the 9¾″ Syncron AU-7a microphone. Manufacturer's ratings are: frequency response —±3db 40-20,000 cps; directional characteristics—cardioid with front-to-back ratio better than 20db; output level— —50db; distortion — less than 0.5%. Price is $169.50.

Circle Item 60 on Tech Data Card

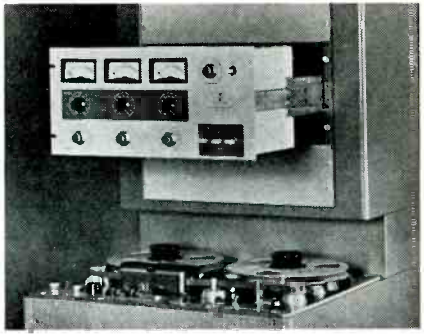


Cable Protection

A heat-shrinkable tubing for waterproofing, insulating, and protecting in-line coaxial-cable splice connectors as used by CATV aerial and underground systems is manufactured by **Sigma Industries, Inc.**

The tubing, a modified polyolefin material, has a factory-applied sealant which melts and flows at the cable enry points as the cover is shrunk over the connector. The splice cover is available in 3″, 6″, and 9″ lengths for application over all standard in-line connectors and cable entries to amplifiers and splitters. Three-minute installation time is accomplished by shrinking the cover at 250° F with a standard hot-air blower, heat gun, or torch.

Circle Item 61 on Tech Data Card



Tape System

A new head design (focused-gap field), heavier bias at 4mc, and the use of direct-coupled silicon-transistor circuitry are intended to offer low noise, low distortion, and high performance in multiple-generation tape recording.

The **Fairchild** Master Tape Improvement System is designed for compatibility with existing professional recording transports. Models are available for one-, two-, and three-track ¼″ tape, and three- and four-track ½″ tape. ▲

Circle Item 62 on Tech Data Card

Erratum

In the November 1965 "New Products" item describing the **Stancil Hoffman Corp.** Model R70 tape recorder (page 56), tape size is listed incorrectly. The correct tape width is ¼″.

ENGINEERS' TECH DATA

AUDIO & RECORDING EQUIPMENT

71. ATLAS SOUND—Catalog 565 illustrates and describes public-address loudspeakers, microphone stands, and accessories for commercial sound applications.
72. CBS LABS—Literature on the "Volumax" automatic peak controller and the "Audimax III" solid-state automatic level control.
73. INDUSTRIAL ELECTRIC REELS—Specification sheets provide photos, dimensions, and applications for line of motor-driven and hand-mounted microphone-cable reels.
74. KOSS/REK-O-KUT—New full-line catalog details audio products and accessories.
75. QUAM—General catalog No. 65 lists speakers for color-TV replacement, PA systems, high-fidelity, and general replacement.
76. SCHLUMBERGER—Instruction book lists operational data and specifications for turntables, tape recorders, and audio mixers.
77. SONY—Full-color catalog describes 1966 line of tape recorders and full recording accessories.
78. SPARTA—Catalog sheet details new tape-cartridge system; new-product brochure is also available.
79. UNIVERSITY SOUND—Cardioid, dynamic, and professional miniature microphones are listed in 1966 catalog.
80. VIKING OF MINNEAPOLIS—Pictorial folder shows plug-in components, mechanism, outside views, and specification chart for Model 230 tape transport and Models RP110 and RP120 amplifiers.

CATV EQUIPMENT

81. JERROLD—Eight-page brochure features "Starline" solid-state unitized CATV systems.

COMPONENTS & MATERIALS

82. AMPEREX—Condensed form of standard catalog lists available tube types useful in wide range of applications.
83. DENSON—Catalogs 965S-1 and 965S-1 SPECIAL feature new, used, and surplus radio and TV broadcasting equipment. The SPECIAL edition includes schematics and construction features.
84. MULLARD—Flier sheets provide cross-reference data and price list on tubes for special-purpose, industrial, and broadcast applications.
85. SIGMA INDUSTRIES—Data sheet supplies photos and specifications for self-sealing, re-entry enclosure designed for cable systems.
86. SWITCHCRAFT—New-product bulletin No. 156 describes "Lamp Jax" designed for use in circuits requiring ballast lamps.

MICROWAVE DEVICES

87. MICRO-LINK—Planning guide covers 2500-mc ITV systems. Brochures and specification sheets provide data on Model 420A portable link and Model 600 fixed link.
88. MICROWAVE ASSOCIATES—Sixteen-page brochure, bulletins, and technical report detail applications and specifications for TV-broadcast solid-state microwave-relay equipment.

MOBILE RADIO & COMMUNICATIONS

89. MOSLEY ELECTRONICS—Catalog lists complete line of 1966 Citizens-band equipment.
90. SPRAGUE—Circular M-853 describes SK-1, SK-10, SK-20, and SK-30 "Suppressikits" for vehicles with alternators or DC generators.

Next Month

32-Page Special

NAB CONVENTION SUPPLEMENT

- Show News
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POWER DEVICES

91. HEVI-DUTY—Bulletin 7-22 supplies data on line-voltage regulator using saturable-core reactor.
92. ONAN—Eight-page form No. 31d/On contains information on installation and selection of standby-power equipment.
93. SOLA—Catalog VR-200A includes applications, theory of operation, and specifications for line-voltage regulators.
94. TERADO—Catalog sheet features solid-state and vibrator DC-to-AC power inverters.

REFERENCE MATERIAL & SCHOOLS

95. CLEVELAND INSTITUTE OF ELECTRONICS—New pocket-sized, plastic "Electronics Data Guide" includes formulas and tables for: frequency vs. wavelength, db, length of antennas, and color code.
96. HOWARD W. SAMS—Literature describing popular and informative technical publications; includes latest catalog of technical books.

STUDIO & CAMERA EQUIPMENT

97. CLEVELAND ELECTRONICS—Data concerns modifications using new yoke assembly to update 3" image-orthicon camera.
98. COHU—Four-page data guide No. 6-323 for zoom lenses discusses focal lengths, horizontal-view angles, iris, and focus.
99. GENERAL ELECTRIC—New-product brochures are: GEA-7859A which includes specifications, single- and dual-channel makeup, and rack- and cabinet-mount details for solid-state 3" IO monochrome camera; GEA-8051 which describes solid-state CCTV caemras; and GEA-7858A which covers line of VHF transmitters from 1 to 60 kw with visual-aural power ratios from 5:1 to 10:1, all including provisions for remote control.
100. TV ZOOMAR—New literature features Autocam programed remote-control pan and tilt equipment; literature describes lenses for IO and vidicon use.

TELEVISION EQUIPMENT

101. BALL BROTHERS—Product brochures feature monochrome- and color-special-effects generators.
102. COLORADO VIDEO—Data sheet describes Model 201 video converter which provides audio-bandwidth signals from standard TV inputs.
103. VITAL—Data sheets give specifications of Model VI-500 stabilizing amplifier, Model VI-10A video distribution amplifier, and Model VI-20 pulse-distribution amplifer.

TEST EQUIPMENT & INSTRUMENTS

104. PRECISE—Specification sheets provide details on VTVM and regulated power supply.

TOOLS

105. ENTERPRISE DEVELOPMENT—Bulletins feature Models 300 and 100A desoldering-resoldering iron for PC-board use.

TRANSMITTER & ANTENNA DEVICES

106. BAUER—Tentative specification sheet supplies data on Model 605 7500-/5000-watt FM transmitter.
107. GATES—"FM for the AM Broadcaster . . . One Year Later" is a commentary on financial and technical aspects of FM broadcasting; accompanying folder "What $10,000 Will Buy" describes equipment packages selected for maximum tax benefits.
108. KRECO ANTENNAS—New catalog No. 68 lists vertically-polarized omnidirectional antennas for use from 25 to 470 mc.
109. MOSELEY ASSOCIATES—New three-page brochure describes solid-state Models WRC-1OT and PBR-21 remote-control systems.

Advertisers' Index

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

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

EQUIPMENT FOR SALE

Audio Equipment bought, sold, traded. Ampex, Fairchild, Crown, McIntosh, Viking. F. T. C. Brewer Company, 2400 West Hayes Street, Pensacola, Florida. 3-64 tf

Television/Radio/communications gear of any type available. From a tower to a tube. Microwave, transmitters, cameras, studio equipment, mikes, etc. Advise your needs—offers. Electrofind Co., 440 Columbus Ave., NYC. 212-EN-25680. 8-64 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 service on AM monitors and H-P 335B FM monitors. Nationwide unsolicited testimonials praise our products and fast service. Eidson Electronic Company, Box 96, Temple, Texas. 5-64 tf

AMPEX 350 SERIES reconditioned capstan drive motors (BODINE NCH-33 only) $85.00 exchange. Send us your old one, or order for $100.00 and get $15.00 back after sending old one in. Ours have new bearings and rewound stator. Package motor well. TABER MANUFACTURING & ENGINEERING CO., 2619 Lincoln Ave., Alameda California. 1-65 12t

Everything in used broadcast equipment. Write for complete listings. Broadcast Equipment and Supply Co., Box 3141, Bristol, Tennessee. 11-64 tf

New and Reconditioned Remote Pickup and 2-way radio equip., Fire and Police Receivers. All brands and models. Sales Manager, Box 238, Phone 817-594-5171, Weatherford, Texas. 5-65 12t

Parabolic Antennas, 6' aluminum solid surface complete with dipole and mounting bracket. Now tuned for 1750 MC for $125 set. Tuned to 950 MC for $175 set. Sierra Western Electric Cable Co., 24th and Willow Streets, Oakland, California. Phone 415 832-3527. 12-65 tf

Transmitting tube sale—All new, fully warranted 5736 @ $115.00 ea. —4CX-1000A @ $135.00 ea.—5894 @ $17.00 ea. —4CX250B @ $18.00 ea.—6146B/8298A @ $3.75 ea.—891R @ $210.00 ea. Send for complete list. Your one source for electronic tubes and semiconductors at realistic prices. Thor Electronics Corporation, 741 Livingston Street, Elizabeth, N.J. 07207. 2-66-2t

General Radio 916-AL RF bridge. Good condition. Two coax connectors included. $475.00 FOB. Rountree, Box 9044, Austin, Texas 78756. 2-66-1t

3 EIMAC 4KM3000LR TV Camera Tubes for sale. Unused. $1200 each. Rex Industrial Electronics, 84 Cortlandt St., New York, N.Y. Area code 212-COrtlandt 7-1616. 2-66-1t

EQUIPMENT WANTED

WANTED TO BUY . . . Used, 1 and 5 KW AM or FM Broadcast transmitters, regardless condition or age. Write or call Continental Electronic Wholesale Corp., 457 West 28th St., Hialeah, Florida 33010. Phone 305-888-3511. 1-66-2t

Employment

Want To Get into Color? We've been full color for 4½ years! We need one or two technicians who are interested in working at a modern, all color station. There are no state licenses, fee requirements or payments to be made to any third party in connection with this position. Contact Chief Engineer, KSTP-TV, 3415 University Avenue, St. Paul, Minnesota 55114 or call collect 612-645-2724. 2-66-1t

WANTED—Technicians for closed circuit systems planning—closed circuit — color television—video tape maintenance or supervision of installations of RCA equipment. 630 Fifth Avenue, Rockefeller Center. 757-0677 or 297-3336. G. Whiteford. 2-66-tf

Excellent openings exist on the West Coast for qualified Broadcast Engineers; live color video, transmitter, maintenance, studio, technical operations, etc. Send us your complete resume. The AMPS Agency, 130 South Robertson Boulevard, Beverly Hills, California 90211. By Broadcasters for Broadcasters. 2-66-2t

CATV PRODUCT MANAGER WANTED

Excellent opportunity for man with experience in the Community Antenna Television industry. Knowledge of CATV people, equipment, and system operation essential; sales and/or engineering background highly desirable. The man chosen for this position will be responsible for overall marketing programs for CATV products. He will participate in the establishment of sales objectives and will be expected to develop and coordinate product promotional plans. He will work with the staff team of the leading manufacturer of communications products in the southeast. Salary commensurate with experience; all fringe benefits including outstanding insurance program and profit-sharing plan. All replies will be held in strict confidence. Send letter or detailed resume to Dept. 147. 2-66-1t

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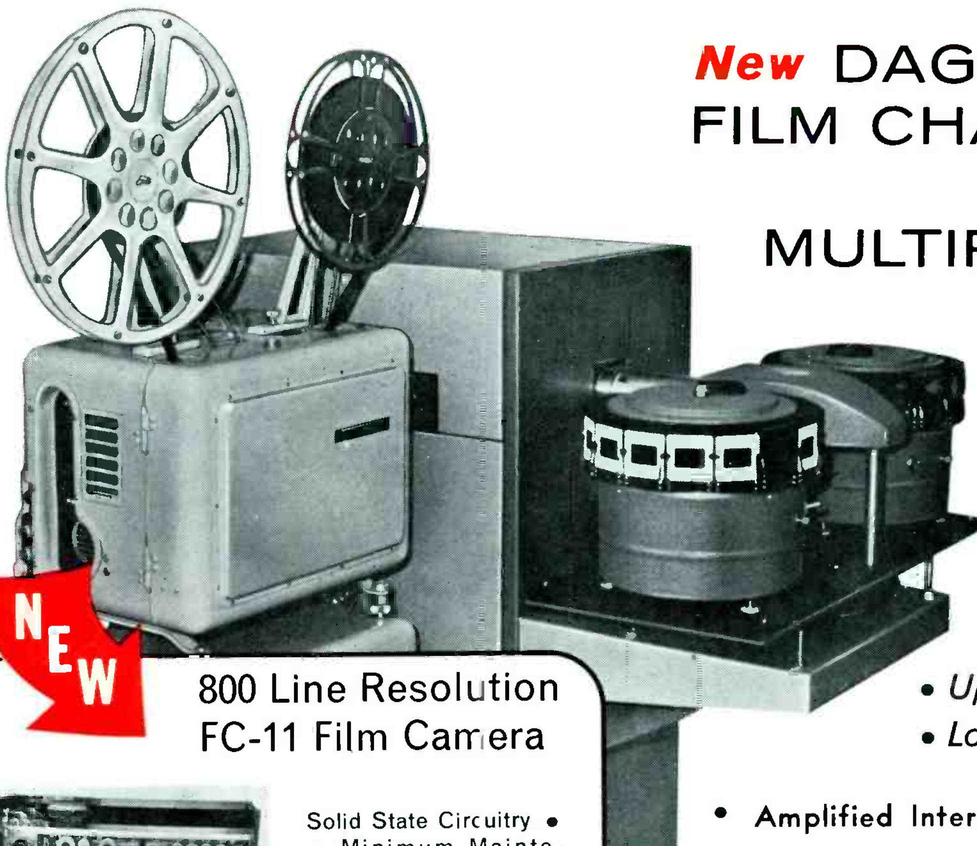

New DAGE FC-11 FILM CHAIN and PRISM MULTIPLEXER

NEW

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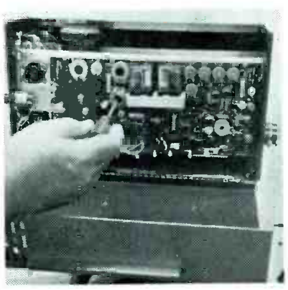

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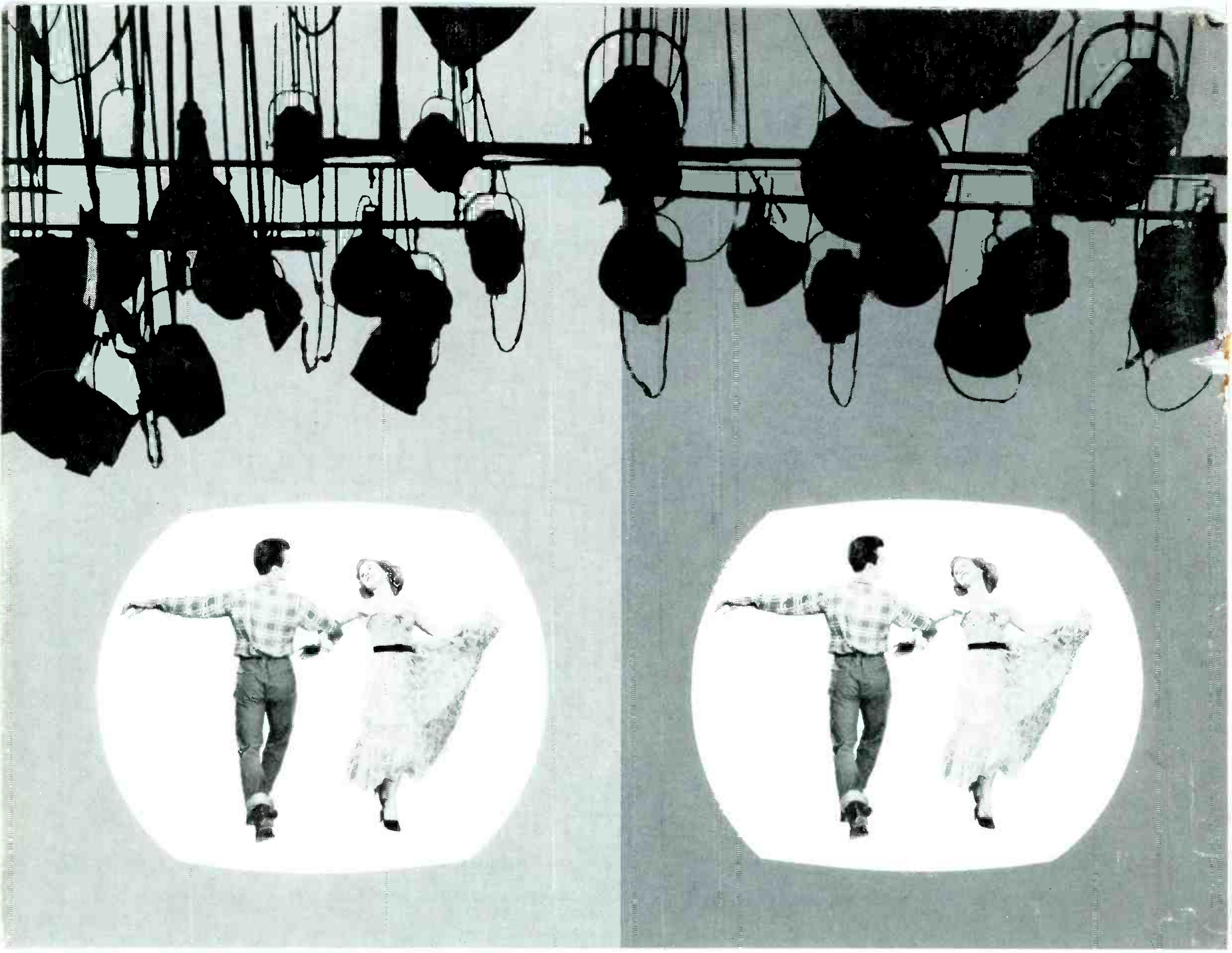
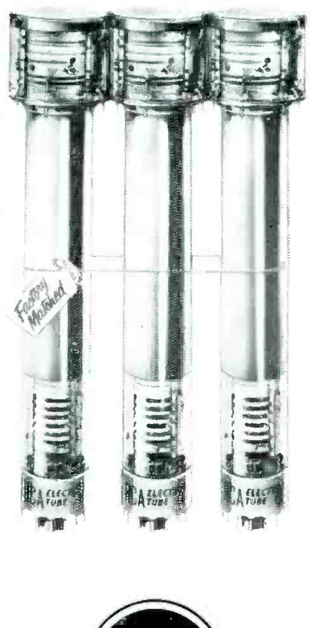


TURN DOWN THE LIGHTS WITH RCA-7513/S and 4513/S IMAGE ORTHICON MATCHED SETS FOR COLOR

We've always been proud of our RCA-7513 since it produces very clean looking colors with the least noise of any tube for three-Image Orthicon cameras... We're also particularly proud of the nice uniform grey scale and the slightly more rounded knee we've built into this tube. But, by the time a broadcast engineer gets the depth of focus he'd like to have, he's usually running 600 to 800 ft. candles of studio illumination, a bit too much for some actors' comfort!

We took another look at this problem, realizing that incandescent light, color filters, and optical systems being what they are, color cameras needed more sensitivity in the blue end of the spectrum. By devising a special photocathode and other innovations, we developed a tube with double the sensitivity in the blue channel.



This tube for the blue channel is called the RCA-4513/S. Now, when you buy a matched set (that's what the "S" stands for) of one 4513/S and two 7513/S tubes for the red and green channels, you'll find that you can turn out about half the lights. This helps in keeping the actors contented and the air conditioning from straining after a long day's session of broadcasting or taping. In addition, when you buy the matched set, you'll find they produce both good color pictures and good tracking over the entire dynamic range.

See your local RCA Broadcast Tube Distributor for further information on RCA Image Orthicons. He'll be glad to hear from you.

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