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Volume 7, No. 3 **March, 1965**

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SUBSCRIPTION PRICE: U.S. $6.00, one year; $10.00, two years; $13.00, three years. Outside U.S.A. add $1.00 per year for postage. Single copies, 75 cents, Back issues, $1.00.
BROADCAST ENGINEERING is published monthly by Technical Publications, Inc., an affiliate of Howard W. Sams & Company, Inc. Editorial, Circulation, and Advertising headquarters: 4300 West 62nd Street, Indianapolis 6, Ind.

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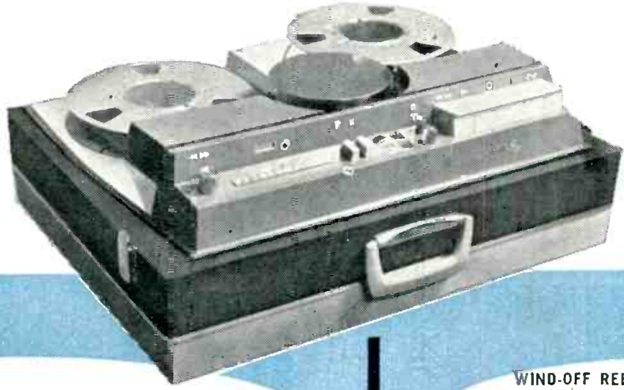

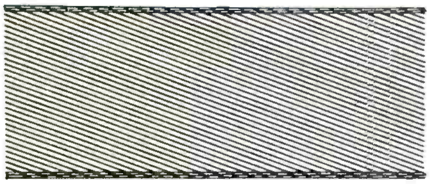

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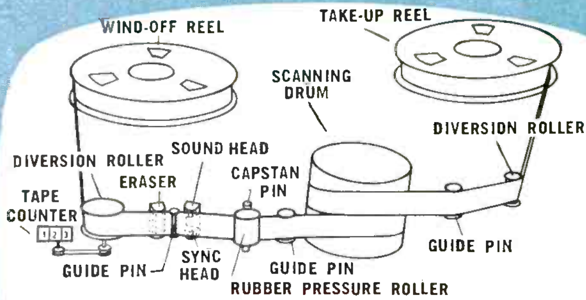

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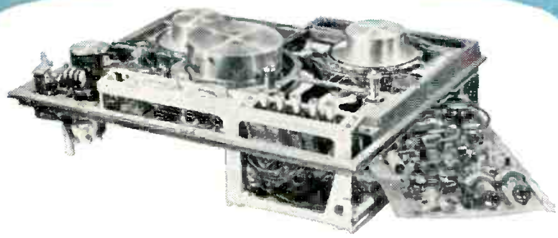

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LETTERS
to the editor

DEAR EDITOR:

I read with great interest the article entitled "Video Microwave Specifications for System Design," by Donald Kirk, in the October 1964 issue of BROADCAST ENGINEERING. I found the article very useful in a field somewhat diverse from its intended application. However, I have some questions regarding the equation for FM S/N ratio given on page 32.

1. I would appreciate some information relating to the derivation of the equation and a discussion of any assumptions that were made.
2. I am somewhat puzzled by the constant 206. If it is, as I suspect, supposed to be (kT) expressed in dbw, I believe it should be —204.
3. While the special case (large f_2 compared to f_1) equation appears reasonable enough, I believe that the general-case equation contains an error. The term written

$$-10 \log \frac{(f_2)^2}{(f_1)}$$

will not withstand dimensional analysis; the db unit is properly applied only to a unitless ratio.

Thank you for your consideration of these questions. Congratulations are due Mr. Kirk for a very fine article and a most readable treatment of the subject.

ROBERT W. MORRISON
State College, Pennsylvania

Author Kirk's comments on the above questions and his derivation of the equation follow.—Ed.

I wish to thank Robert Morrison for catching the error in the equation shown on page 32 in the October issue. Both f_1 and f_2 should have been shown to the third power.

Mr. Morrison is also correct in assuming that the constant 206 in the equation has its origin in (kT). However, in deriving the equation, a factor of two-thirds shows up as part of the constant, and it is this which changes the value from 204 db to 206 db.

My version of the derivation is as follows:

Let the FM signal be represented by a carrier of P_O watts and two sideband signals of Ps watts. If the deviation is small, P_C is constant, and P_S is proportional to $(J_1\ \Delta\theta)^2$, where J_1 is the Bessel function of the first kind and first order of the argument $\Delta\theta$, and $\Delta\theta$ is the modulation index. The modulation index is related to the modulating frequency by:

$$\Delta\theta = \frac{f_D}{f_m}$$

where,
f_D is the peak deviation, and
f_m is the modulating frequency.

For small values of the argument, x, the Bessel function is given by:

$$J_1(x) = .5x$$

Then if carrier power is set at unity, the sideband power is given by:

$$P_S = \left(\frac{f_D}{2f_m}\right)^2$$

The discriminator which converts this FM input to baseband output has a law, k, given by:

$$P_{BB} = 4kP_S$$

where,
P_{BB} is baseband power, and
4 is a factor introduced because the sidebands are coherent. (This would be 2 if the sideband signals had been two noise bands.)

$$P_{BB} = 4k\left(\frac{f_D}{2f_m}\right)^2 = k\left(\frac{f_D}{f_m}\right)^2$$

This expression is normalized by equating baseband power to carrier power (requires only the right IF and video gain). Then:

$$k = \left(\frac{f_m}{f_D}\right)^2$$

The discriminator constant, k, can now be used to derive baseband noise output. The noise power density in the receiver, at a point where the carrier power is P_O, is:

$$P_{ND} = 4 \times 10^{-21} F$$

where,
P_{ND} is the noise power density in watts per cycle, and
F is the noise factor of the receiver.

The baseband noise power output due to the input noise in a frequency slot df is:

$$dP_{BB} = 2kP_s = 2kP_{ND}\,df$$
$$= 2\left(\frac{f_m}{f_D}\right)^2 4 \times 10^{-21} F\, df_m$$

The factor 2 accounts for one noise slot on each side of the carrier.

The total baseband noise is given by:

$$P_{BB} = \int_{f_1}^{f_2} \frac{8 \times 10^{-21} F}{f_D^2} f_m^2\, df_m$$

for a band extending from f_1 to f_2.

$$P_{BB} = \frac{8 \times 10^{-21} F}{f_D^2} \frac{1}{3} \left[f_m^3\right]_{f_1}^{f_2}$$
$$= \frac{8 \times 10^{-21} F}{3f_D^2} (f_2^3 - f_1^3)$$

The signal-to-noise ratio may be derived by recalling that baseband signal power was normalized to be equal to P_O (carrier power) in defining k.

$$S/N = \frac{P_O}{\frac{8 \times 10^{-21} F}{3f_D^2} (f_2^3 - f_1^3)}$$

In decibels this is:

$$S/N = 10 \log P_O + 206 - F' + 20 \log f_D$$
$$-30 \log f_1 - 10 \log \left[\left(\frac{f_2}{f_1}\right)^3 - 1\right]$$

where,
P_O = receiver input carrier in watts,
F' = receiver noise figure in db,
f_D = peak deviation in cps,
f_1 = low end of baseband in cps, and
f_2 = high end of baseband in cps.

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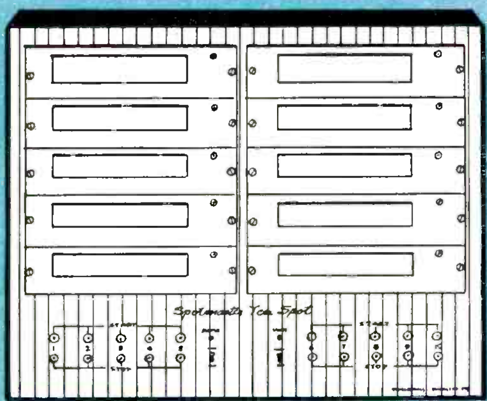

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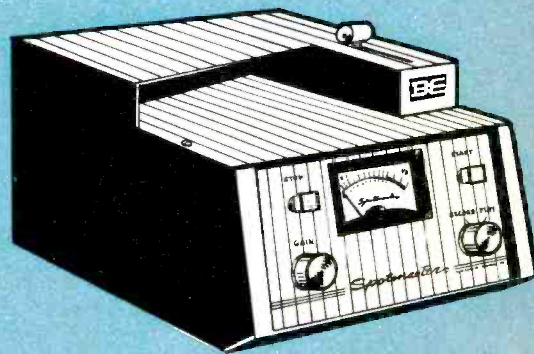

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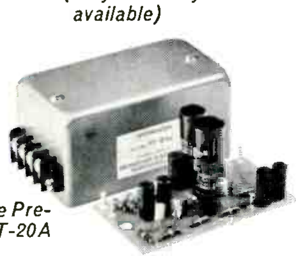

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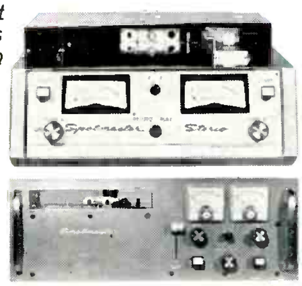

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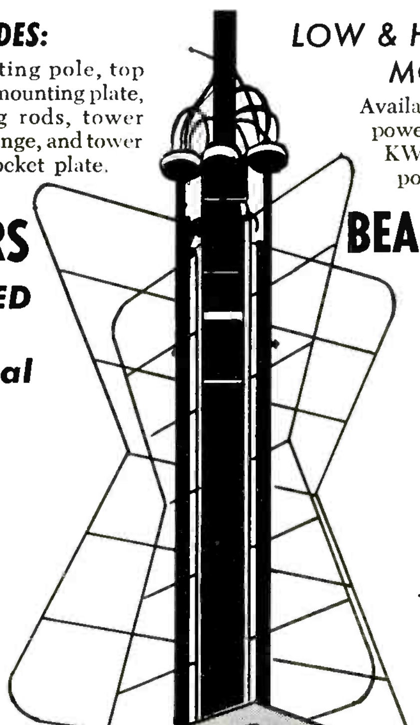

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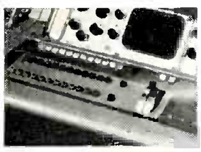

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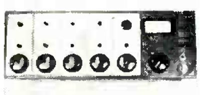

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PLANNING THE LOW-BUDGET UHF-TV STATION

by George Sitts, B-E Consulting Author, Staff Engineer WHEN-TV, Cortland, N.Y. — Part 2. Conclusion of a compendium of ideas and suggestions derived from interviews with engineers who learned the hard way, by experience.

Last month we discussed the selection of a transmitter site and practical building layout. This month's conclusion covers equipment needs and costs, staff, and studio requirements.

Q: What type of weather protection, heating, and air conditioning does the building need?

A: Small UHF stations are seldom prosperous enough to have elaborate air conditioning systems. Heating systems we saw were notable because the carefully planned ones had duct systems arranged to utilize the transmitter heat in cool weather and shunt it outside in warm weather.

Q: What about studio, lights, cameras, and props?

A: Many station engineers* we visited felt that unless there are special circumstances, low-budget stations should attempt to operate without a live studio until after they show a profit. The only exception to this rule might be live news reports. This type of show seems occasionally to show an early profit. A news show can be done in almost any room of office size. Basic equipment includes a desk, chair, picturesque or blank wall, four or five spot and flood lights, and a single camera mounted on a tripod.

Engineers' opinions are that news-program problems are with personnel cost, not equipment cost. As one engineer put it, "As long as you can stick to one or two short news shows built on newswire and local newspaper stories, you can sell it for a profit. If you gather your own news, or spend more than four man-hours a day on news, you will find it hard to make any money from it." Another said, "If you can afford news, do it; but remember that a good syndicated film in that spot will cost you less to put on, give you a larger audience, and be easier to sell at a profit." All the engineers polled suggested that vidicon-type cameras be used for any such shows. They cited low initial cost, low upkeep cost, and ease of operation as their main advantages.

Q: You have mentioned cameras, projectors, and monitors. What other equipment is necessary to operate a small station?

A: Minimum needs would appear to be a transmitter, an antenna, some connecting transmission line, a tower or antenna support, and a network signal. To operate within FCC rules, however, you also need monitoring equipment. This can be obtained in package form, including monitoring of visual and aural frequencies and aural modulation. An oscilloscope and picture monitor are also needed.

All U. S. television stations must give a visual and aural identification each hour. This requires some local video and audio facilities. To be practical, these include a minimum of one film camera and associated control unit and power supply, one slide projector and an identifying slide, one synchronizing signal generator and power supply,

*Chief Engineers interviewed were: Mr. T. A. Greene, Chief Engineer of WSYE-TV, Elmira, New York, a UHF satellite of a Syracuse VHF station; Mr. Gino Ricciardelli, Chief Engineer of WINR-TV, Binghamton, New York, an AM - radio/UHF - TV combination with separate TV studios and transmitter; and Mr. Louis Stantz, Chief Engineer of WBJA-TV, Binghamton, New York, a low-budget UHF station with combined studio, offices, and transmitter. Photos by Peter L. Tarolli.

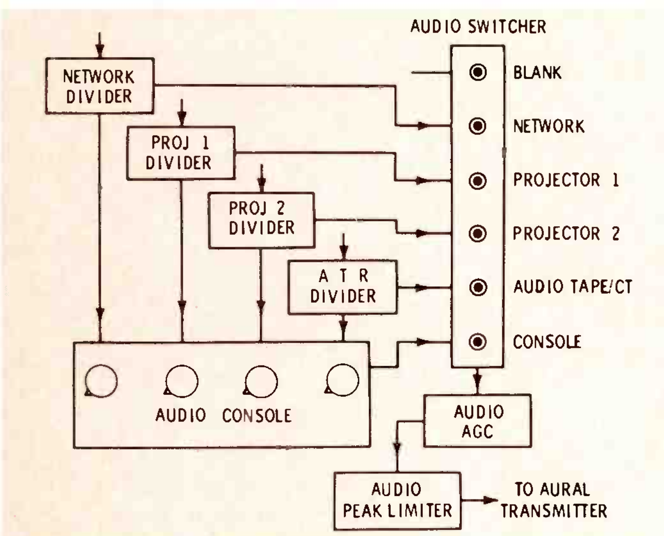

Fig. 1. A typical audio system for use in a low-budget TV station.

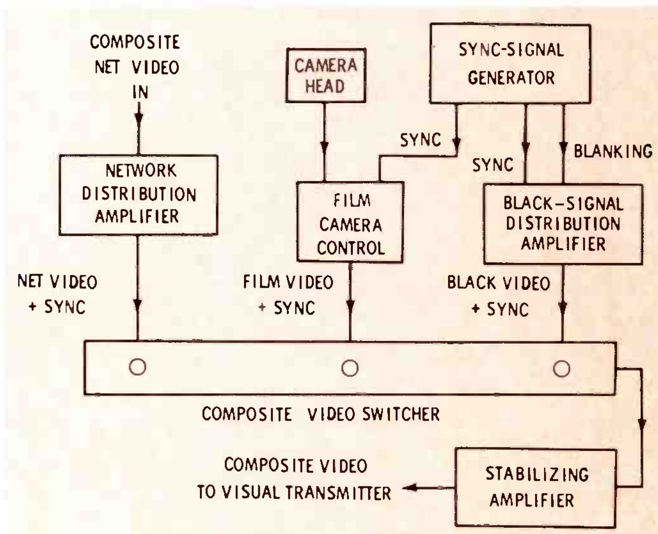

Fig. 2. Video system for network and local film program sources.

a small audio console, a microphone, and some means of switching from network to local.

Networks do not at present operate continuously from sign-on to sign-off, so additional equipment is needed unless a test pattern is to be run for extended periods. As mentioned last month, equipment should include at least one 16-mm projector, a slide projector, and an optical multiplexer; another film projector will add versatility of local film programs and commercials. Audio equipment should include a minimum of one microphone, one turntable, and one tape machine.

To free the single operator for such duties as putting up films and taking transmitter readings, most small stations utilize an audio AGC and limiter as well as a stabilizing amplifier for video. The best of these latter units incorporates facilities to clean up the video signal, completely shape the synchronizing signal, and automatically regulate the video gain. Thus, they can take in a rather poor video signal and put out a clean, regulated picture. The "stab" amp and audio AGC equipments are customarily connected at the transmitter input.

Other operator conveniences include a video monitor for the incoming network signal and another for the local film signal. Also convenient is a means of checking the waveform of each of these two signals.

Some stations put non-network and non-film audio on reel-type ATR's, taping the whole day's station breaks on a single reel, in order. The operator simply cues and plays these breaks at the proper time. Other stations use tape cartridges for all the station breaks and audio. The most versatile systems use both methods.

Q: Have you an example of a typical station break with such equipment?

A: Assume the station is in a network show. At the end of this show the network gives a network identification which is the cue to go local. The operator then switches video and audio to local, perhaps switches on a slide promoting a local show, runs a 20-second cartridge tape over it, switches off the slide, rolls a 20-second film commercial, switches on the projector, and takes its audio. During the film he may advance the slides to an identification slide. At the end of the film, he switches off the projector, turns on the slide identification, and operates the reel ATR for an audio station identification and a time check. At this point, he either switches audio and video back to network, or starts rolling a film show on his other projector, switches it on, and brings up that film audio.

Q: How are the projectors switched on and off?

A: The on, off, roll, and change controls for the projectors are remotely controlled from the operator's console. The most common optical multiplexer for low-budget stations does not discriminate between projectors but will transmit any light that enters. It is necessary either to keep the lamps off on projectors not in use or to use a device called a douser plate, which is simply a solenoid-operated shutter that interrupts the light beams of unwanted projectors. A douser mechanism is relatively inexpensive, can be homemade, and eliminates the need to turn the projector lamp on and off frequently—a major contributor to lamp failure. The douser also has the advantage of letting the operator see that the lamp is all right before he uses the projector.

Q: How do the switching systems work?

A: To explain the switching systems fully, it is necessary to examine a typical audio and video distribution system.

Network audio comes in at about +8 dbm (Fig. 1). The projectors have built-in audio preamps that put out a similar level, as do the tape machines. Input amplifier demands of the aural transmitter are also in that range. Each of the audio signals is split two ways by a passive divider network. One side is fed to an input on the audio console; the other feeds directly through a switcher to the audio AGC input.

When the console is switched to the AGC amplifier, the operator can fade in and out of his audio programs. When a source is switched directly through to the AGC input, the console is out of the circuit and can be used for auditions or previews. Besides console bypass switching, most stations allow for patching around the AGC and limiter in case either fails.

The video system (Fig. 2) is much like the audio system. Just as +8 dbm is the common audio level, 1.4 volts peak to peak is the common composite video level. This includes .4 volts of sync riding atop 1 volt

• Please turn to page 82

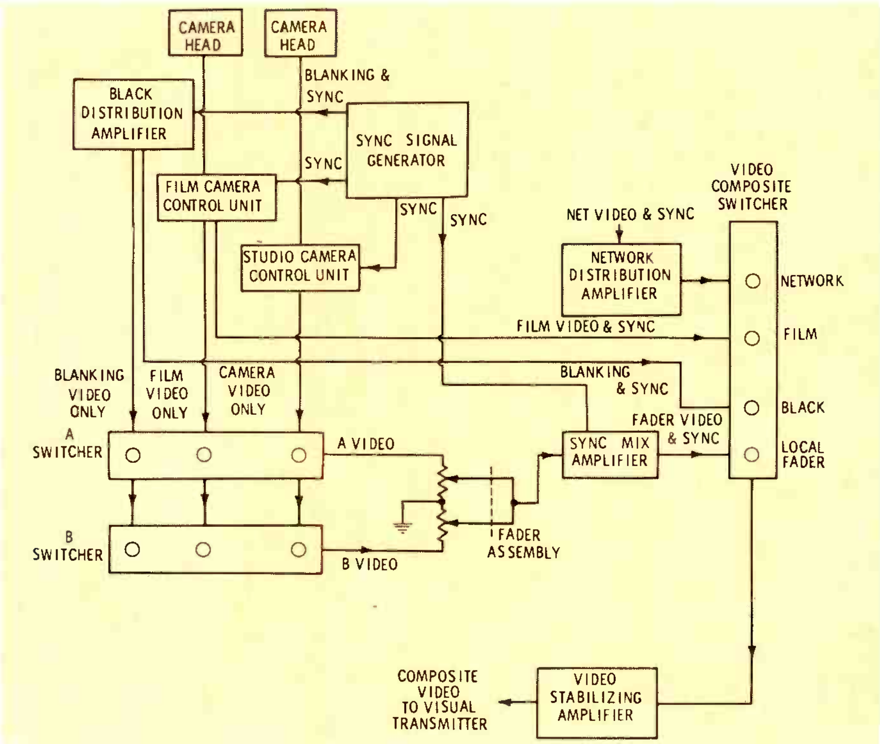

Fig. 3. A more complex video switching system makes provision for fading locally originated program material; sync is not faded.

INSTALLING A 10-WATT FM STATION

by Lawrence L. Prado, Jr.,
Installing and Maintenance Engineer, WPEA, Exeter, New Hampshire—
An example of installing the equipment and setting up the operating procedures for a low-power educational station.

Until two years ago, students at the Phillips Exeter Academy, Exeter, New Hampshire, were not permitted to have radios in their rooms. Yet, through the combined efforts of many, including students, radio broadcasting has come to this staid old New England institution of learning in the form of 10-watt FM station WPEA.

Planning

To be sure, installing a low-power educational FM radio station isn't as complicated as installing a four-tower directional array, but it can present problems. In the early stages of planning of WPEA, some errors were made and some difficulty was encountered. As a result, the services of a qualified consultant were obtained for planning the station, and an experienced broadcast engineer was engaged to do the actual installation work under the general supervision of the consultant. Discussions and site inspections were held, suitable equipment was ordered, and proper contracts for installation and maintenance were signed. This is the phase of building a radio station where care is perhaps most essential. Errors, omissions, or incomplete proposals cause confusion and delay.

Antenna and Transmitter

Inspection of the site disclosed that the transmitter was to be located in the basement of Amen Hall (Fig. 1). The construction permit indicated that the antenna was to be located atop the building, 74′ above ground level. Careful consideration of the low power (10 watts) and the length of transmission line required to reach the antenna prompted a modification of the transmitter location. It was felt that, by placing the transmitter as close to the antenna as physically possible, the cost of the transmission line could be reduced to a minimum and the effective radiated power could be kept as high as possible. Nearly 250′ of transmission line would have been required if the basement transmitter location had been used.

Inspection also revealed the desirability of a change in the method of mounting the antenna. The roof of Amen Hall was found to be steeply pitched and constructed of slate; the only reasonable means of access was through an 18″-diameter window in a rooftop cupola. Suitable support for the antenna could not be found on the roof or the lightweight copper ridge cap. Furthermore, the vertical bearing surface of the cupola was not suitable for side mounting the antenna, and there was no suitable support for a transmission-line run across the roof. The building housed members of the faculty and their families, including small children. A completely substantial mounting area was thus mandatory from a safety standpoint. Since the authorized antenna height could be obtained by mounting the antenna inside the cupola, this approach was chosen.


Fig. 1. Amen Hall, the location of WPEA.

There was ample room inside the cupola for mounting the one-section ring antenna on a 10′ vertical mast (Fig. 2). Placing the transmitter in an unused fifth-floor attic directly below the cupola (Fig. 3) made it possible to use only 20′ of transmission line between the antenna and transmitter. The platform-type table which supported the transmitter was placed in position directly under the cupola to provide a vertical feed to the antenna. No special problem was encountered in installing the antenna on a 2″-diameter mast in the upper portion of the cupola; a standard floor flange and several supporting brackets were used. An existing heavy-duty lightning-rod ground in this section of the cupola was utilized as station ground. A 2″-wide copper strap connected to the antenna mast and transmitter was silver-soldered to the lightning-rod ground.

The transmission line used is a ⅜″-diameter, semi-flexible aluminum-sheathed type with a tape helix insulator between the inner and outer conductors. Although this type of coaxial cable may be pressurized, this was not deemed necessary in the WPEA installation. This line was chosen because it has lower losses and is lighter in weight than solid-dielectric cable. Installation was merely a matter of securing the proper length of cable and the appropriate fittings and installing them according to factory instructions. No soldering is required to install fittings, and no special tools are required, although a small tubing cutter and two adjustable wrenches are necessary.

A brief word of caution in using this type of cable and fittings is in order for those not experienced in their use. Careful bending is possible, provided the aluminum outer jacket is not nicked or dented. Bending more than two or three times under such conditions will produce a break in the outer jacket. The means of support used should not create undue pressure on the outer aluminum jacket. Swaging of the outer jacket to retain the cable in a metal clip with a pass-through hole is not advisable.

A basic remote-control unit was constructed to permit turning the transmitter on and off from the basement control room. A control switch, located in a small aluminum utility box near the operating position, was linked by a low-voltage control line to a small DPST relay mounted inside the transmitter cabinet. The relay directly controls the incoming AC power to the transmitter. A separate bypass circuit, ahead of the control relay, was necessary to provide constant power for the crystal oven. All wiring conforms to the applicable codes and is properly secured to prevent injury.

Control Room

In the control room, a main ground bus was run under the console desk top and out to each island containing the turntables and associated preamplifiers. This bus, a 2″ copper strap, was extended to an existing ground bus for the building wiring. Where necessary, a suitable bond was accomplished by means of silver soldering. Half-inch wide shield-braid ground leads from both turntables were silver soldered to the copper ground bus. Standard solder lugs or self-lugs were used on the equipment end of the braid for mounting under a bolt or to a terminal board. (Providing a self-lug in shield braid is an extremely simple procedure: Apply plenty of heat with a soldering gun or iron and heavily tin an inch or so of the braid. When the solder cools, the desired hole may be drilled through the braid, and the end of the braid can then be shaped by cutting with sharp shears.)

Similar ground provisions were made for the audio console by extending the ground bus to the rear-apron terminal board on the console. A single heavy (No. 10) copper lead was run parallel to the terminals and secured at each end. The copper ground strap was silver soldered to the middle of the ground wire. All shield or drain wires in the audio cable were soldered to this heavy ground wire.

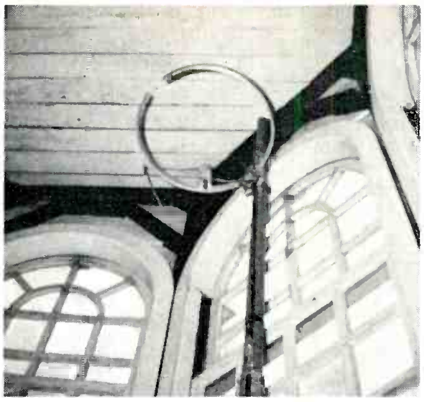

Fig. 2. FM antenna mounted inside cupola.

AC power for the audio console, turntables, preamplifiers, and associated equipment is fed from a separate service box (fused) so that all power, including that for the remote-control unit, may be controlled from one point. Suitable convenience outlets were installed in surface-mounted electrical utility boxes in each turntable island and under the console desk. A complete in-line run of ½″ electrical tubing extends from the service box to the outlets. No. 12 wire was run through the tubing for the AC circuits.

Extensive use of electrical utility boxes was made for microphone outlets in the control room and studio. Properly fitting outlet plates for microphones made neat-appearing surface-mounted boxes. Lengths of flexible tubing (similar to the metal covering on BX cable) with approved fittings were run from the microphone-outlet boxes to a similar junction box located directly under the console microphone-input terminals. This tubing is available in a variety of diameters, and since it is flexible, it requires no bending tools. All audio wiring is completely enclosed in flexible tubing and terminates in utility boxes for complete protection and separation from other circuits. Future wiring modifications or additions can be made easily by opening the appropriate boxes and snaking in the new lines.

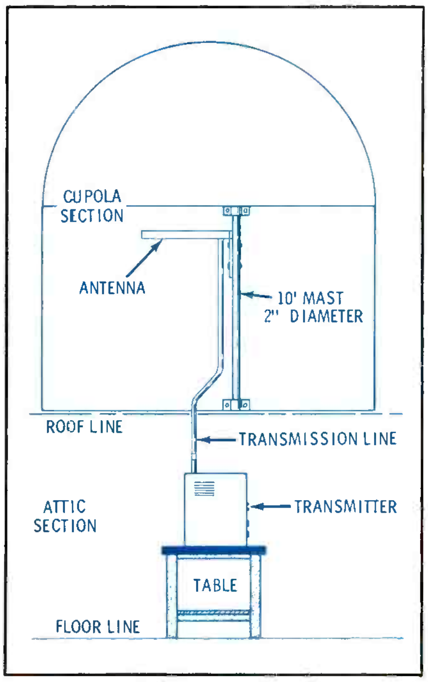

Fig. 3. Drawing of transmitter-antenna installation, part of engineering report.

The WPEA control room in the basement of Amen Hall is shown in Fig. 4. The remote control unit (not visible), is below the warning light on the right side of the studio window. The service boxes shown on the wall are not a special service for the station, but are part of the building wiring. The service box for the station is installed below the warning light, mounted on the side of the console desk. Desk panels in each turntable island are held in place by wood screws and may be removed easily to facilitate servicing. Typical use of flexible tubing is shown in the wiring to the warning light. Observe that the console is not mounted flush with the rear of the desk. This console has all input terminals on the rear apron, and it is necessary to allow enough room to use a short screwdriver to secure connections. (Final finish had not been applied to the desk sides when the photograph was taken.)

Frequency Check

After the installation of the entire station had been completed and due notice given the FCC, initial testing and adjusting of the transmitter was commenced. While a frequency monitor is not required for stations with this operating power, the regulations do require that the frequency be measured initially. For this purpose, some sort of reference signal source that can be calibrated against WWV is needed. The particular unit available in this case had a 5-mc crystal-controlled master oscillator. Switch-selected output frequencies of 10

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AERONAUTICAL FIELD INTENSITY MEASUREMENTS

by ***Robert A. Jones,*** Consulting Author, Consulting Radio Engineer, La Grange, Ill. — A description of a technique for measuring field intensities in a vertical plane.

Why bother to use an airplane to take field-intensity measurements, particularly when the FCC has never required such data? This idea was quickly dispelled during the installation of a nighttime antenna at WBBY. Attached to the Construction Permit was a special condition requiring that vertical-plane field-intensity measurements be taken to prove that the radiation at angles above the horizontal was equal to or less than the predicted values. It should be noted that the three towers employed at WBBY are each provided with a small amount of top loading. It is well known that top loading normally increases the electrical height of a tower, but engineers never seem to agree how much. In the past, the Commission has usually requested in such cases that current-distribution measurements be taken along the tower to establish its electrical height, but this time field-strength measurements above the ground were requested.

Analyzing the Problem

Many thoughts came to mind in trying to cope with this new requirement; they ranged from using a balloon or helicopter to hoist the field-intensity meter to suggesting (politely) that maybe the FCC had made a mistake on the CP. The physical problems involved were somewhat alarming. For example, one paragraph of the Rules says that no field-intensity measurements should be taken closer to the antenna than ten times the element spacing in the directional array. For safety, this is assumed to mean ten times the maximum tower spacing. In the case of WBBY, this is ten times 824′, or about 8240′—a distance of nearly 1.6 miles. Assume that it is necessary to measure angles up to 45° above the horizontal. The legs of a right triangle having 45° acute angles are equal. Thus the altitude for a reading at this elevation angle would have to be at least 1.6 miles, or 8240′. Converted to feet above mean sea level (the figures indicated on an aircraft altimeter), the required altitude would be 8710′ in the vicinity of WBBY. To be able to take readings at an elevation angle of 60° would require measuring at an altitude of 15,000′. At these heights and distances it becomes difficult to determine the precise measuring point.

In studying the problem realistically, it was obvious that the FCC was not asking for vertical measurements in all directions. Logic indicated that such measurements were required only in the directions of nearby cochannel stations, where possible skywave interference might result. For WBBY, only station WOW is nearby, so we therefore determined to make vertical-plane measurements along two bearings toward that station. In addition, it was concluded that vertical measurements along the line of the towers in the major lobe and the back lobe would clearly establish the vertical pattern.

After the decision was made to measure these four bearings, which also corresponded to four ground radials, the next problem was how to get up in the air to read the field-intensity meter. The use of a helicopter was considered first, but this proved to be impossible for two reasons. First, the only one available in the area could not climb high enough, and second, the cost per day was prohibitive. (The craft was not available for rent by the hour.) The only vehicle left was a conventional airplane.

Identifying the Points

For ground-level readings, only bearing and distance are of concern. Both can easily be determined by using large-scale Geological Survey maps. In taking field-intensity readings in the vertical plane, however, one must keep in mind that he is

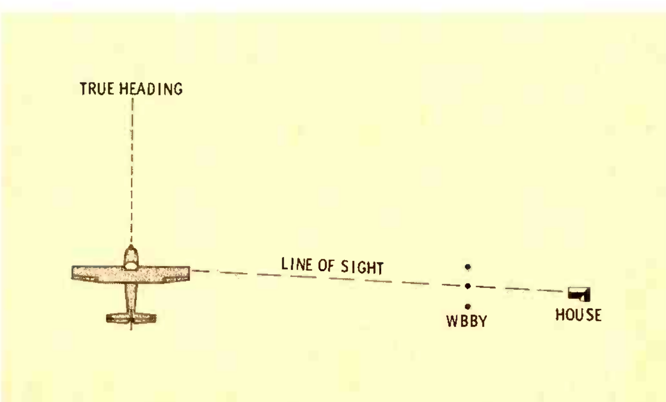

Fig. 1. Method of determining position of airplane over radial.

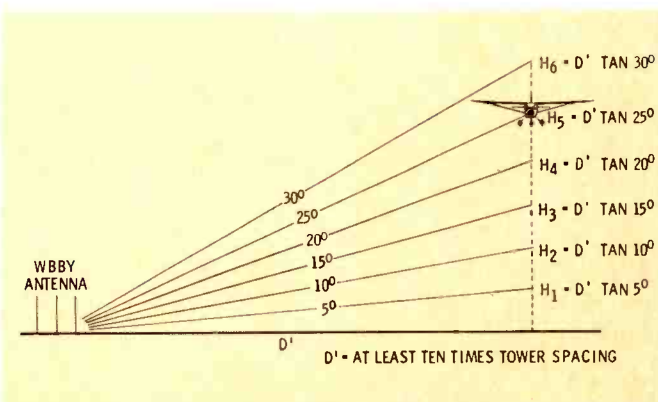

Fig. 2. Relationship of distance, height, and elevation angle.

working in **three** dimensions: bearing, distance, and elevation angle.

Bearing

On the basis of the experience gained at WBBY, the bearing from the station is the easiest of the three parameters to determine. The two bearings determined by the line of the towers (roughly north and south in the case of WBBY) present no problem; along either of these bearings, the towers are in alignment as viewed from the airplane. The two bearings toward WOW (296 and 309°) were only a little more difficult to identify. It was done this way: A low-altitude pass was made over one of the ground measuring points. When the airplane was directly over this point, the center tower was "lined up" visually with some identifiable landmark, such as a house, a mile or so east of the antenna site (Fig. 1). Thereafter, no matter what the altitude of the airplane, whenever this house was "in line" with the center tower, the bearing was correct.

Distance and Elevation

The determination of distance and elevation angle are really tied together. The starting dimension is the horizontal distance, D′ (Fig. 2), which should be at least ten times the tower spacing. Preferably it should be the distance to some easily seen landmark along the bearing in question. Keep in mind that the closer this point is to the station, the lower in altitude will be the vertical "check points."

At WBBY, readings were taken at 5° intervals, since patterns must be computed at this interval in applications for nighttime facilities. Based on the experience gained in this case, it appears that 10° would have been satisfactory. As shown in Fig. 3, the altitude for each 5° point is equal to D′ times the tangent of the elevation angle. For example, at 30° the altitude is 8240′ x .577, or 4750′. To this number must also be added the ground-level elevation above sea level. In the case of WBBY this was 470′. Thus, at an elevation angle of 30° and a ground distance (D′) of 8240′, the aircraft altimeter must indicate 5220′. Thus the correct bearing can be determined by observation, and the correct elevation can be determined by the altimeter reading. If it can be determined when the airplane is directly above the ground-distance landmark, all three dimensions are correct.

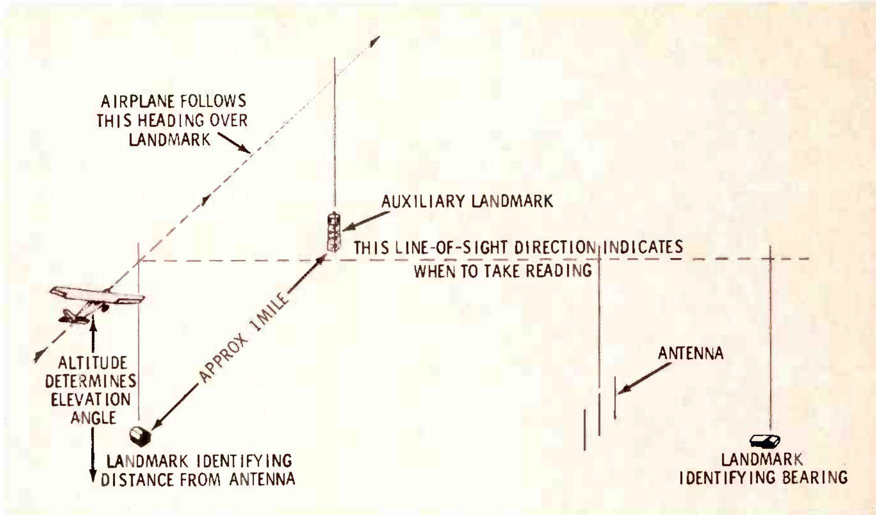

Fig. 3. Pictorial representation of method for aligning airplane over point on ground.

Most airplanes don't allow you to see straight down, so it is necessary to resort to some simple navigation to determine when the landmark is directly below. First a low-altitude pass was made directly over the landmark (at low altitude the course of the airplane can be directed over the target with reasonable certainty). As the airplane passed over the landmark, a second landmark, straight ahead but about a mile away, was observed. At higher altitudes, the pilot approached the landmark on a compass heading that placed this landmark in line with the auxiliary landmark chosen during the low-altitude pass (Fig. 3). The pilot maintained this heading while the engineer watched out the window for the center tower to line up with its reference landmark. When this occurred, the reading was taken. It is believed that by these methods a positional accuracy within 100′ was attained.

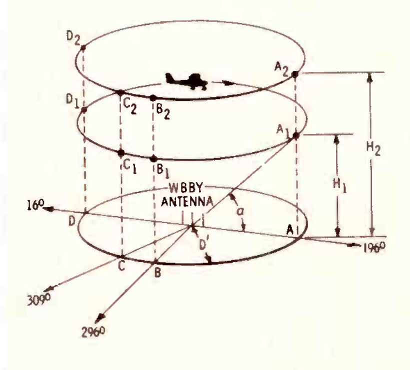

Fig. 4. Diagram of measurement method.

Fig. 4 shows how the pattern was determined. Points A, B, C, and D are landmarks along the four radials to be measured. Points A1, B1, C1, and D1 are the vertical points directly above these for an elevation angle of α and a ground distance of D′. Points A2, B2, C2, and D2 are for a different value of α. If D′ is the same for each radial, the airplane can follow a circular path at each altitude.

Equipment Considerations

Fig. 5 shows the field-intensity meter in place against the right rear window of the aircraft. The meter was locked in a fixed position for all readings. Fig. 6 shows why this was done; the metal structure of the airplane caused distortion of the receiving antenna pattern. Because of this, the plane was flown in a clockwise pattern around the station, and all readings were taken with the right wing pointing toward the towers. This eliminated any variations due to noncircular reception characteristics.

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Fig. 5. Field-intensity meter in position.

THE 4-400A IN AM TRANSMITTERS

by Thomas R. Haskett, Consulting Author, Broadcast Consultant, Cincinnati, Ohio — A review of the circuits in which this tube is used and some useful troubleshooting hints.

At least six major manufacturers of 1-kw AM transmitters in use today employ 4-400A's as both modulators and power amplifiers. In these two stages, the circuits used in the Bauer 707, the CCA AM-1000DK, the Collins 20V-3, the ITA AM-1000A*, the RCA BTA-1R or 1R1, and the new Visual 1-kw AM are very similar. Due to the similarity in circuitry, some faults are common to all, and these faults require similar common troubleshooting procedures. Once you understand the basic configuration, you can work with any of these rigs more easily.

Tube Characteristics

The 4-400A is a beam-power tetrode employing a directly-heated, thoriated-tungsten filament. Nominally 5 volts, filament voltage should not exceed limits of 4.75 to 5.25 volts. Required current is 14.5 amperes. The tube must be operated in a vertical position with the base downward. This base is a metal-shell giant with 5 pins, and the shell must be grounded by means of spring fingers. The plate connection is brought out to a metal cap atop the glass envelope, and a heat-dissipating (finned type) plate connector must be used here. The 4-400A runs extremely hot—the base at 200°C (393°F), the plate cap at 225°C (437°F)—and forced-air cooling must be used. The manufacturer recommends that air flow be applied simultaneously with filament power and that the column of air be directed upward through the base toward the bulb. All transmitters using 4-400A's are therefore interlocked so that filament power is removed whenever the blower stops.

As a class-AB1 modulator (as used here), maximum ratings are: plate voltage, 4000; plate current, 350 ma; plate dissipation, 400 watts; screen voltage, 800. Maximum power output is approximately 1000 watts. As a class-C plate modulated RF power amplifier (also used here), maximum ratings are: plate voltage, 3200; plate current, 275 ma; plate dissipation, 270 watts; screen voltage, 600. Maximum power output is about 800 watts.

*ITA is no longer a transmitter manufacturer, but many ITA transmitters are in use, and parts are still available (see "Letters to the Editor" in the February 1965 issue).

Modulator Circuit

Fig. 1 is a simplified diagram illustrating modulator features common to most transmitters. Audio is applied to the primary of input transformer T1, in the range of +4 to +10 VU. T1 has a split secondary to feed the grids of V1-V2, the drivers, in push-pull. A portion of the driver bias is provided by voltage drop across cathode resistors R3, R4, and R5. As R3 and R4 are separate and unbypassed, they provide current feedback which tends to equalize tube differences and balance the stage. Note that the grids of this stage no **not** return to ground at the "cold" end of T1. More on this later.

The drivers are coupled to the modulators by means of capacitors C1 and C2. The modulators are 4-400A's, operated class AB1 in push-pull. Grid bias is obtained through the two bias-set pots, R12 and R13 (Bauer uses a single control here). The purpose of R14 and R15 is to minimize any tendency toward parasitic oscillations. Filament current is taken from transformers T2 and T3; the respective center taps are brought out through R17 and R18, thence together

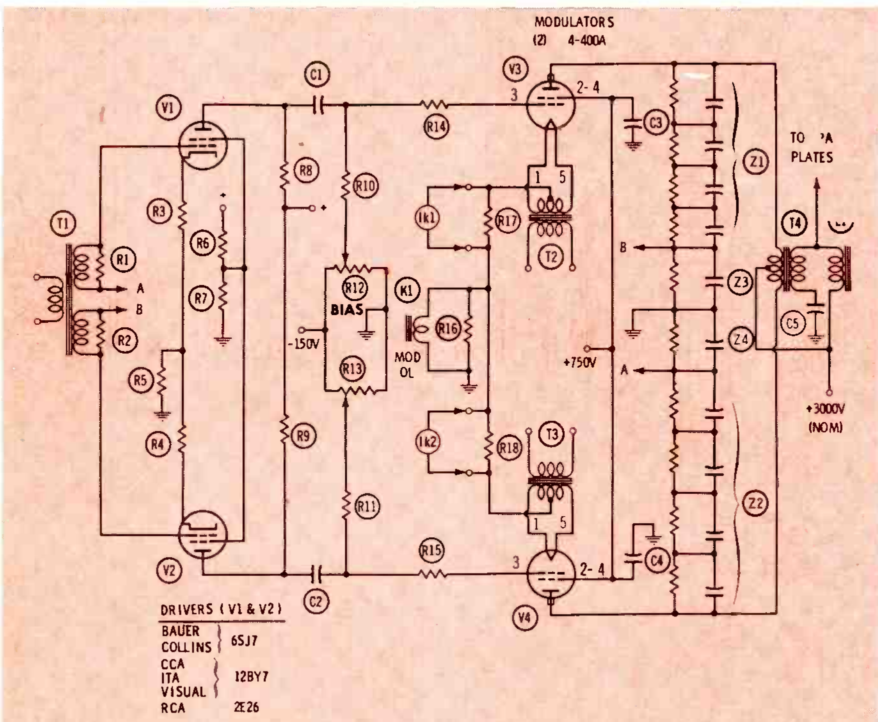

Fig. 1. This simplified schematic shows some typical features of modulators using 4-400A.

through R16 to ground. Modulator cathode current is monitored by switching a meter across resistors R17 and R18. Shunting R16 is K1, the modulator overload relay; if modulator cathode current exceeds a preset value, K1 trips and removes high voltage. Fig. 2 shows the slightly different cathode systems used by Bauer and Collins.

Feedback ladders Z1-Z3 and Z2-Z4 couple 8 to 10 db of negative feedback from modulator plates to driver grids. The junction of Z3 and Z4 is grounded, forming the ground return for the driver grids. Bauer uses a simplified version (Fig. 3) of this ladder, with no capacitors. CCA and ITA use a resistor and a coil in parallel, as parasitic suppressors in series with each modulator plate. Beyond the feedback ladders, the modulator plates are connected to T4, the modulation transformer. One end of the T4 secondary is grounded (through a capacitor), while the other end is connected to one end of modulation choke L1 and thence to the PA plates.

Modulator Troubleshooting

When one side of a push-pull circuit goes bad, the trouble generally reveals itself as DC unbalance. When the modulators are thus unbalanced, audio distortion results. The most obvious emergency remedies are to try new tubes, reset grid bias, and rebalance the driver stage. If the trouble is severe, the modulator overload relay may kick the rig off the air.

In some cases, however, the trouble persists. Here are some steps to follow in that event (use Fig. 1 as reference):

1. Check cathode resistors R17-R18. Although normally low in value (2 or 3 ohms), they should be equal. (Does not apply to Bauer or Collins.)
2. Check modulator filament voltages with servicing voltmeter; they should be equal when measured at tube socket—not less than 4.75 nor more than 5.25 volts AC.
3. Measure modulator screen voltage. Measuring at socket, you should find equal voltages —about 750 volts DC above ground or chassis.
4. Check DC grid bias on modulators. Depending on setting of the bias pot(s), bias value should be anywhere from 90 to 150 volts negative with respect to chassis. Bauer should show equal bias at each grid; others should be capable of being adjusted to equal values. Bias should not shift when audio driver is applied; if it does, modulator is drawing grid current (see Step 5).
5. Check audio voltages at grids of modulators with AC-VTVM (not VOM). Check for possible grid current; stage operates class AB1 and should not draw current. Grids should remain balanced under drive, same as they were in Step 4 without drive. Grid current here suggests leaky coupling capacitor C1 or C2, wiring or socket partially shorted, or tube defect (probably gassy).
6. Check coupling capacitors C1 and C2 by disconnecting grid end and connecting VTVM between loose lead and ground. With plate voltage on V1-V2, you should read no more than 1 volt DC from the loose end to ground. If either is doubtful, replace with 1000-volt Mylar Difilm type.
7. Check for unwanted continuity from grid pins of modulator sockets (topside of socket) through wiring to plate pins of driver sockets. If doubtful, lift slider connection of bias pots R12 - R13 and measure DC resistance between grids and ground; should be many megohms.
8. Check Driver balance by replacing tubes and measuring DC voltage drop across cathode resistors R3-R4; adjust pot(s) until drops are equal. (Bauer has a cathode balance pot for this purpose.) If doubtful, recheck cathode resistor values, as in Step 1.
9. Defeat the two feedback ladders, Z1-Z3 and Z2-Z4, by strapping a 20-mfd capacitor from point B to ground and another from point A to ground. This shorts the feedback networks for AC, although not for DC; the latter is needed for proper driver bias. Any resulting unbalance suggests trouble in one of the feedback ladders. You can also check the ladders during operation by measuring from point A to ground and point B to ground with an AC and a DC voltmeter, with the primary of T1 shorted. (You don't need the 20-mfd capacitors for this test.) DC voltages from each point to ground should balance within 2%; if they don't, there's a bad resistor in one of the ladders. AC voltages should also balance within 2%; if they don't, there's probably a bad capacitor in one of the ladders. The actual values of the lad-

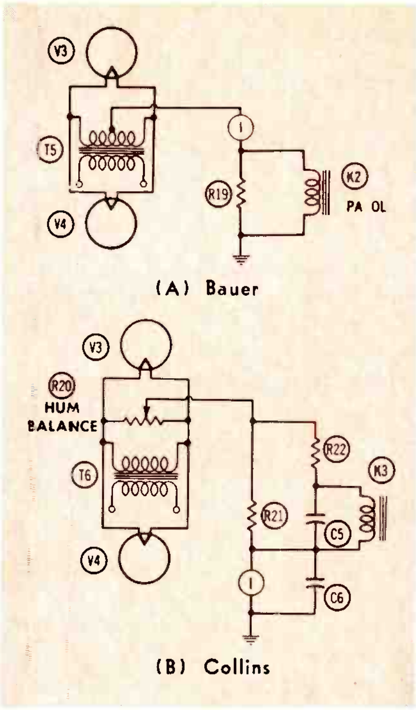

Fig. 2. Two alternate filament schematics.

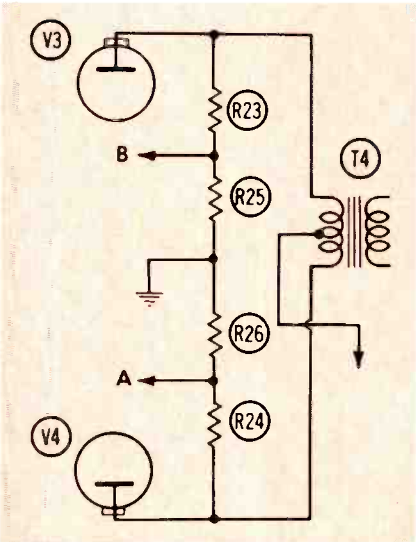

Fig. 3. Feedback in the Bauer transmitter.

der components aren't too important, so long as they are equal overall.

10. Check modulation transformer by reversing plate leads to see if unbalance shifts to other tube. Also try disconnecting T4 completely, putting 117 volts AC on entire **secondary,** and measuring AC voltage from either end of primary to center tap. You should get about 70 volts AC on each side, and values should be within 2% of each other.
11. If RF is suspected of getting into audio stages, use dummy load on modulation transformer to isolate audio section. Completely disconnect secondary of T4. Across entire secondary, connect 4000-ohm, 200-watt resistor in series with 500-ohm, 10-watt resistor, as shown in Fig. 4. Then connect vertical input of scope across 500-ohm resistor. Turn on transmitter and drive a 1000-cps sine wave through modulators. Scope should exhibit clean sine wave if modulators are in balance. If it does, you probably have RF trouble; if it doesn't, you probably have audio difficulties.
12. To completely isolate modulator stage, use dummy load on T4 as in Step 11. Disconnect plate ends of coupling capacitors C1-C2 and connect them to ground. As a final assurance, disconnect the feedback ladders from the modulator plates. These steps will usually eliminate parasitics or undesirable feedback, proving modulator stage itself okay. **Note:** You must disconnect platecap straps from the modulators and connect each plate directly to modulation transformer. **Caution: Be very careful;** with feedback ladders gone, there is no bleeder on HV supply. **Discharge HV filter capacitors carefully** after this test.

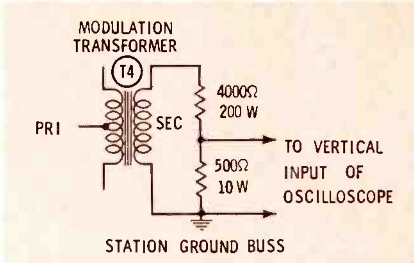

Fig. 4. Dummy load for modulator tests.

After any unbalance has been corrected, run audio proof on transmitter as final qualitative check.

Power Amplifier

Fig. 5 is the simplified diagram of a PA circuit which is more or less common to all six transmitters —two 4-400A's in parallel as class-C modulated amplifiers, with high-level plate modulation. With new tubes, plate efficiency is 70%. RF drive from the IPA stage is applied through coupling capacitor C51 and parasitic suppressors R53-R54 to the PA grids. Grid rectification, and resulting grid current, produces grid bias. L51 and C52 decouple RF, but permit DC grid current to flow through R51-K51 for protection and R52 for metering. K51 contacts are normally open; grid current holds them closed, permitting the application of screen voltage to both PA's and modulators. If grid current disappears, as when there is no RF drive, K51 opens and removes screen voltage. Grid-drive monitoring is accomplished at this point by metering across R52.

Filament power for the PA's is obtained via T51-T52. C53-C54-C55-C56 are RF bypasses at the tube sockets. Filament transformer centertaps are brought out through metering resistors R55 and R56, thence through K52 and its shunt, R57. If PA cathode current exceeds a preset value, overload relay K52 trips and removes high voltage. Note that Collins and Bauer again use but a single filament transformer, as shown in Fig. 6. Bauer has a single PA cathode-current meter; Collins has none. However, Collins has a PA filament voltmeter.

PA screens are decoupled with C57-R58 and C58-R59, and screen-current metering is across R62. Normally, plain plate (and screen) modulation is used, but there is some variation in circuit design among brands. CCA, ITA, and Visual use AF chokes in series with the PA screen supply to cause self-modulation of the screen. RCA's modulation transformer has a tap which feeds modulation to the IPA plate.

Returning to Fig. 5, in the plate circuit, you'll note two parasitic suppressors are used—L52-R60 and L53-R61. (Collins doesn't use these.) RF power is coupled to plate and coupling tank Z51 via C59 and thence to the antenna. The tank consists of several coils and capacitors arranged in either a T or a pi network, along with a harmonic suppressor; the exact arrangement varies from brand to brand. L54 and C60 decouple RF from the modulator and power-supply sec-

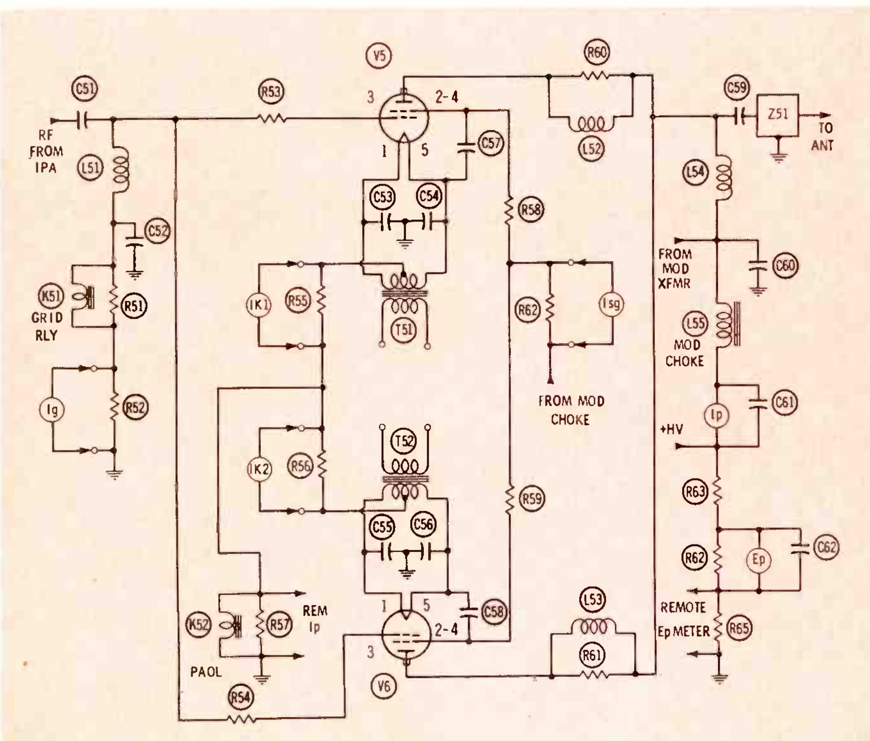

Fig. 5. Simplified diagram of typical final RF amplifier in an AM transmitter using 4-400A.

Some plain talk from Kodak about tape:

Sensitivity and frequency response

Controlling every electrical factor involved in the making and using of sound tape is a bit like trying to watch a three-ring circus . . . it can be done, but you need fast eyeballs. Let's discuss two critically important parameters: sensitivity and frequency response.

Sensitivity means the degree of output for a given input.

We put in a 400-cycle signal and measure the output. The result: low-frequency sensitivity. We choose 400 cycles for a number of good reasons. A 400-cycle note recorded at 15 inches-per-second gives us a wave length that the tape "sees" of roughly .0375 inches, and by a happy coincidence this wave length penetrates the entire depth of the oxide coating, but not the support material. Everything else being equal, low-frequency response is a function of the thickness of the coating. The thicker the coating, the better the bass response. We test at a frequency that penetrates the entire coating. We choose 400 cycles instead of, let's say, 20 cycles because the 400-cycle note tells us just as much—and has an added advantage. An engineer can *hear* 400 cycles, so we have audio monitoring as well as instrumented observation on a scope face.

Just as the low-frequency sensitivity test gives us an idea about oxide thickness, the high-frequency test gives us a fairly accurate picture as to just how smooth the surface of the tape is. Good high-frequency response is impossible on a tape having a rough surface. Here's why: The low points will represent gaps in the oxide and cause a loss of H.F. response. We test our high-frequency sensitivity at 15,000 cycles. (Inches-per-second divided by cycles-per-second gives us recorded wave length.) So at 15 ips the arithmetic looks like this:

$$\frac{\frac{\text{inches}}{\text{second}}}{\frac{\text{cycles}}{\text{second}}} = \frac{\text{inches}}{\text{second}} \times \frac{\text{second}}{\text{cycles}} = \frac{\text{inches}}{\text{cycles}} \text{ which is wave length } (\lambda)$$

THUS:

$$\frac{\frac{15 \text{ inches}}{\text{second}}}{\frac{15{,}000 \text{ cycles}}{\text{second}}} = \frac{15 \text{ inches}}{\text{second}} \times \frac{\text{second}}{15{,}000 \text{ cycles}} = \frac{1 \text{ inch}}{1000 \text{ cycles}} = 1 \text{ mil wave length}$$

At this high frequency (short wave length) we are recording only on the surface of the tape. If any roughness is present, big troubles result. If you have a surface condition where the amplitude of the roughness is just .0001 inches and your recorded signal has a 1-mil wave length, you will lose 5.5 db in high-frequency response! Let's rephrase the catastrophe. It takes a surface variation of just one tenth the wave length to knock down response by about 6 db. And this can happen at any frequency!

We are working toward making a point: KODAK Sound Recording Tape has a surface that is unsurpassed in smoothness, a surface that varies no more than 25-50 millionths of an inch from a theoretically perfect plane.

Frequency response is merely the arithmetic subtraction of high-frequency sensitivity from low-frequency sensitivity. Ideally the response is zero. It's quite an easy matter to juggle the characteristics of an oxide around so that frequency response is nice and flat. For instance, if your oxide has poor high-frequency sensitivity, you can reduce the thickness of the oxide layer. This will degrade L.F. sensitivity, and thus effect a flat response. But is the resulting L.F. loss worth it? We don't think so. That's why we designed our coating to give us superior low- and high-frequency sensitivities, as well as a nice flat response.

Next time we'll chat about a few other basic considerations.

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Circle Item 10 on Tech Data Card

tions, while L55 acts as load for the modulator audio. Modulation is decoupled from the power supply by the supply's own output filter capacitor. A plate ammeter is used in series with the plate supply, and a plate voltmeter and its multipliers R63-R65 are used across this supply. Note that remote plate voltage can be read across R65, and remote plate current across R57.

PA Troubleshooting

Whenever the PA operates improperly, the following steps may be followed:

1. Determine presence of grid drive by noting grid current (Ig) across R52. If absent, check for RF output from IPA—you may have to trace all the way back to the oscillator. If the IPA is working properly, suspect an open or leaky coupling capacitor C51 (make DC leakage test as outlined in Step 6 earlier), a shorted C52 bypass, an open or shorted L51, or a change in value of R51 or R52. Make ohmmeter checks of these. If the Ig panel meter is suspect, substitute another.
2. Check tube balance by switching PA's or trying new tubes. Check filament voltages with tubes in sockets. Measure Ik1 and Ik2, try substitute meters, and check resistance of R55 and R56 metering shunts. Check value of R57.
3. Measure PA screen voltages at sockets—they should be equal and not above 600 volts. Suspect leaky or shorted screen bypasses C57-C58, or change in value of dropping resistors R58-R59, if voltages are low. If screen current exceeds normal value (check your transmitter manual), there is probably leakage or a short to ground (C57 or C58), or one of the tubes is defective.
4. If the plate voltage is abnormally high or low, shut down the rig and measure the plate voltmeter multiplier, R63. If doubtful, substitute another voltmeter. With care, even a VOM may be used, if it has a 5-kv range. Make connections carefully **with power off** and make sure the test leads are dressed well away from ground. Suspect a leaky or shorted C60 bypass or a partial short in metering circuits.
5. If audio-RF interaction is suspected, isolate RF section by disconnecting secondary of modulation transformer and using dummy load, as described earlier. With proper grid drive, PA should produce pure RF output. If trouble persists, it probably has nothing to do with audio.
6. When checking continuity of protective relays in interlock circuits with ohmmeter, you must always disconnect the relay coil from its shunt. Otherwise, either the coil or the shunt could be open, and the other would still show continuity.
7. Try RF dummy load (nonreactive) in place of antenna, to eliminate possibility of change in antenna resistance. If directional antenna system is used, put the dummy **before** the phasor. ▲

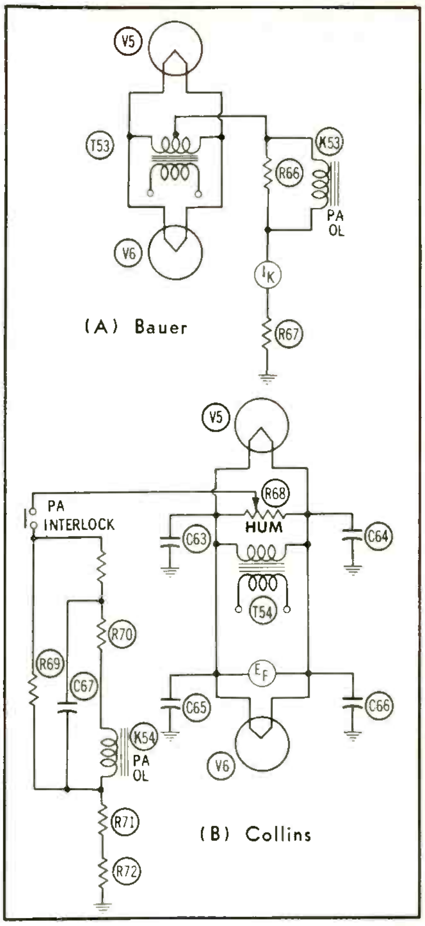

Fig. 6. Alternate PA filament circuits.

March 1965

We interrupt this magazine to bring you ...

Late Bulletin from Washington

by Howard T. Head

Federal Regulation of CATV

As Community Antenna Television (CATV) systems become more numerous, an increasing number of proposals advocating Federal regulation of CATV are being made. At present, the Commission regulates only those CATV systems which employ microwave relays, by conditions imposed on the microwave licenses. Such systems, however, constitute fewer than one-fourth of the total number of CATV installations.

Although the proposals differ in scope and detail, the principal areas in which Commission control is urged are: protection of local broadcast stations from the bringing in of outside programs which duplicate those broadcast locally; requiring CATV systems to carry the programs of local stations; prohibiting "leapfrogging," the bringing in of programs from very distant stations; prohibiting the origination of programs by the CATV system; and the establishment of technical regulations to govern the quality of signals distributed by CATV systems.

The Commission staff is generally in accord with the recommendations, although there is some sentiment in favor of permitting, or even encouraging, CATV systems in smaller communities to provide a degree of local program service. However, the Commission's final action is likely to be closely tied to its belief in the need for a nationwide, locally-operated, competitive television service based on full utilization of the UHF channels.

Sharing TV Channels with Other Users

The Joint Technical Advisory Committee (JTAC) of IEEE and the EIA has under study a recommendation that the Commission permit the shared use of present television channels by the Land Mobile Radio Services (fire, police, taxicab, business, etc.) (June 1964 Bulletin). Television channels would be made available to these other services in cities where the channels cannot be assigned for television-broadcast use because of the Commission's engineering requirements. Land mobile operation would be confined to a band approximately 1 mc wide near the center of a television channel adjacent to an occupied channel. Engineering studies submitted to JTAC indicate that a minimum of interference would be caused to television reception.

Under study by a joint industry-government advisory committee are proposals which would provide for the multiplexing of land mobile base-station transmissions on FM broadcast carriers. The technique would be essentially the same as that employed for regular FM multiplexing, except that by employing narrow audio bandwidths a number of multiplex channels would be provided. Studies indicate that under favorable conditions up to eight 3-kc voice channels could be provided in the portion of each FM channel presently available for multiplex operation.

Stereo Sound for Television

In replies to the Commission inquiry concerning stereo sound for television (January 1965 Bulletin), some receiver manufacturers express the view that the small size of the television screen would render stereophonic sound ineffective. The relatively poor audio quality and lack of stereo material for television use are also cited as reasons in opposition to the proposal. On the other hand, some manufacturers have given their wholehearted endorsement and have offered detailed technical proposals for accomplishing the desired stereo effect. Several parties have asked for additional time to comment, and a final decision from the Commission is likely to be many months away.

Early Release of New UHF Table

Prospects are that the Commission will release at least portions of the anticipated new table of UHF channel allocations (September 1964 Bulletin) in the near future. The revised table, which has been checked by a computer, will probably be released in portions, beginning with the allocations for the congested northeastern portion of the United States. The revised table is expected to make a substantial number of new UHF channel assignments available for both commercial and noncommercial-educational television operation.

Antenna Farms and New TV Propagation Curves

The Commission is preparing Notices of Proposed Rule Making in connection with the matter of antenna farms for tall towers (November 1964 and February 1965 Bulletins) and the adoption of new field-strength-vs-distance curves for both the VHF and UHF television bands (September 1964 Bulletin). These topics have been linked in this context for two reasons. First, the new field-strength curves will influence the selection of television transmitter locations meeting the Commission's Technical Standards. Second, the proposed antenna-farm Rules contemplate "equivalent protection" of existing television stations when operation is proposed at a farm area which would result in a short mileage separation from other cochannel stations.

Under the new proposal, an applicant for permission to erect a tall FM or television tower would be required to specify operation in a designated farm area unless prior FAA approval has been obtained for a different location.

Howard T. Head ...in Washington

MICROELECTRONIC MODULES, 1965

by Allen B. Smith, — An up-to-date report on the state of the search for higher circuit density and reliability.

There is, within the broad field of electronics, an explosive revolution that may soon significantly alter the design and construction techniques now familiar to us all. The microelectronic module, or integrated circuit, has been developed with almost unprecedented speed and with surprisingly little fanfare. Announced at the 1959 IRE Show, the new concept was greeted with much enthusiasm but little hope for immediate practical applications; after all, each module cost nearly $2000. And yet, today, less than six years later, several integrated circuits employing silicon planar epitaxial elements can be purchased "off the shelf" for less than $3. The way in which this solid-state technique has grown so rapidly is another example of a vigorous electronic technology working to fill a need of the industry.

When the first practical semiconductor devices appeared in 1948, engineers wasted little time designing them into a wide range of circuitry. Within a very few years, the transistor became the most challenging and effective device in the quest for greater reliability, smaller size, and adaptability to printed-circuit techniques. It saw widespread use in missile and space-age equipment, in computers, and in home entertainment instruments. However, the transistor as a discrete component is proving to be only a relatively short-lived intermediate step in the development of totally integrated circuit packages. As engineers became more at ease with transistorized circuitry, they began to think more directly of using their expanding knowledge of the atomic, crystalline, and electrical characteristics of metals and semimetals to further increase the reliability and component density of low-power circuits. A variety of techniques has been developed to provide a practical integrated-circuit technology.

Three Major Concepts

Early attempts to unitize component assemblies, developed primarily from transistor-PC-board circuits, used individual miniaturized components mounted on small wafers or cards which, in turn, were stacked and mounted in hermetically sealed cans or were encapsulated. Later, a second concept evolved. Deposited-carbon resistors and semiconductor elements were combined on various substrate chips (glass, ceramic, or fiber) for mounting on transistor-type (TO-5, for example) headers; a more recent, and perhaps the most promising, technique employs deposited metal films for resistive, capacitive, and inductive circuit elements. The third concept is that of the pure solid circuit using metal and semimetal diffusion processes.

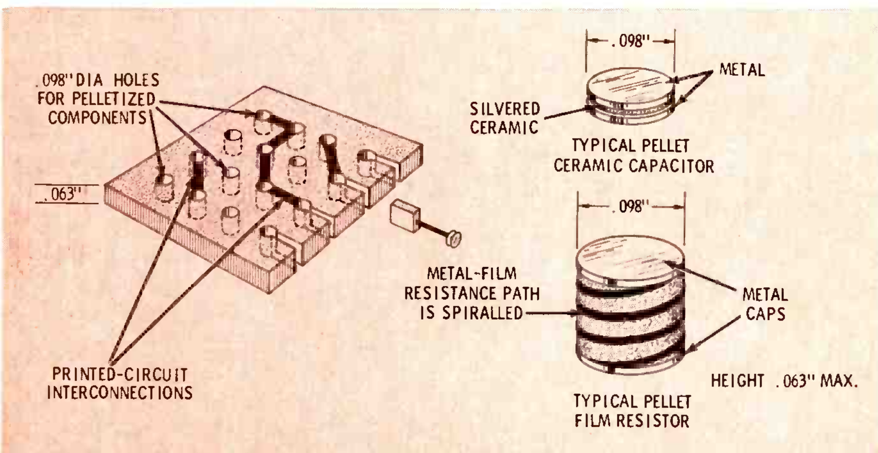

Fig. 1. A graphic representation of the pelletized high density approach to circuit design.

High-Density Packages

In many circuits, primarily those used in computer devices where memory sections occasionally may have to be replaced, the stacked or cordwood high-density approach has been widely used. The stacks usually have multifinger contacts for plug-in replaceability and lend themselves well to low-cost design flexibility because they use more-or-less standard components. When it is considered that the cost increase over standard printed-circuit designs is only nominal, integrated circuits of this type offer reliability of a rather high order.

Several companies (Mallory, Micram, Raytheon, Sprague, and Westinghouse, among others) have pursued various high-density concepts from stacking conventional components to "pellet" components of uniform size recessed into cavities in an insulated base and interconnected by printed-circuit wiring (Fig. 1). Pelletized components enable one defense contractor (Arma Div. of Bosch Arma) to build a 20-lb guidance computer for solving space-navigation problems that occupies only .40 cubic foot and draws less power than a small (50-watt) incandescent bulb. A design survey conducted by a prominent space-age contractor (General Dynamics/Astronautics) shows that approximately 80% to 95% of all GD electronics circuits could be pelletized directly or with very


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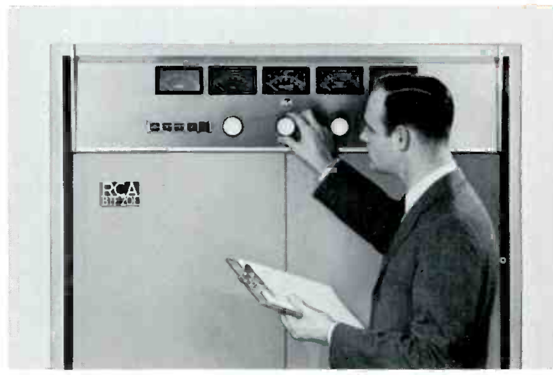

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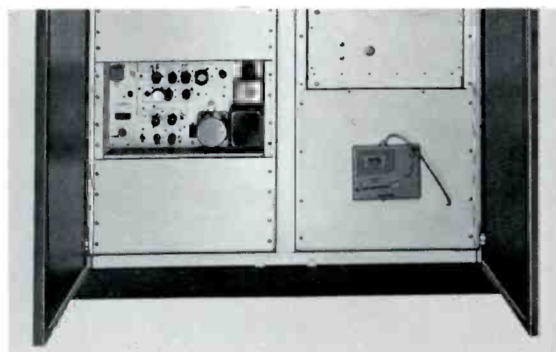

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Wind and Boom noise from fast boom swings.	Two-stage mechanical isolation—two-stage permanent windscreen assembly. Element and isolation completely surrounded by outer wind shell, minimizing wind and mechanical noise in any indoor or outdoor application.
Pickup of electrical hum	No transformers or inductors. May be used in extreme hum fields.
Maneuverability	Perfectly balanced, lightweight — excellent stability, minimum overswing.
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50-15,000 CPS
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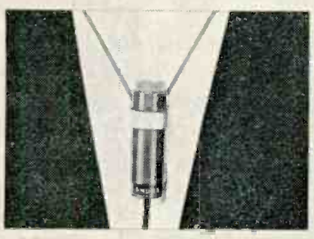

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Uniquely uniform and symmetrical cardioid pattern solves many difficult studio and remote problems. Provides broad useful front coverage.

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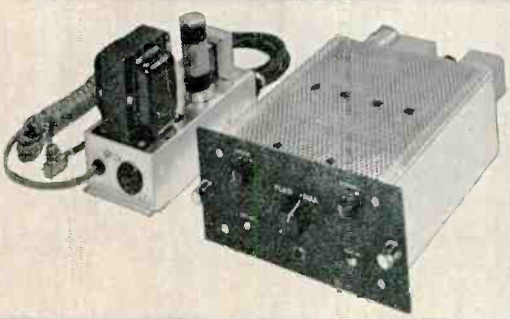
Extremely rugged. Exceptionally attractive and compact. Ideal for music (stereo or mono) and general applications on stand or boom. Super cardioid, flat wide-range response.

CIRCUITRY

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



SE-1 STEREO TRANSCRIPTION PREAMPLIFIER
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Passive equalizer compensates recorded frequency to three playback characteristics: RIAA, flat, roll-off. Provides precise equalization from magnetic pickup at microphone input level.

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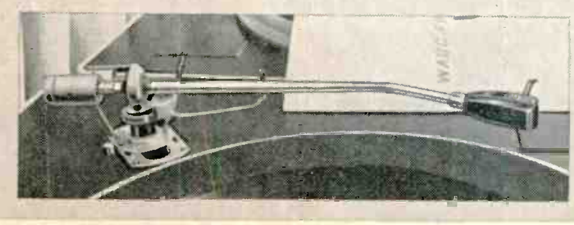
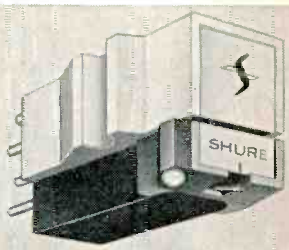
World standard for quality sound.



SHURE SME "THE BEST PICK-UP ARM IN THE WORLD"
Utterly beyond comparison. Supremely accurate, proved reliable in quality music stations.



STEREO DYNETIC Phono Cartridges
First choice on every count—standard in the quality music stations.

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

slight (about 5%) circuit redesign. Automated fabrication processes for this concept are being studied.

Other manufacturers and governmental agencies are performing additional research on high-density packaging of microminiature and standard components. Because of its relatively high power capabilities, the pelletized approach is being used in the design of several communication devices. One communications unit, developed recently by Motorola's Semiconductor Division, uses multiple-wafer construction and offers voltage gains adjustable from about 10 to 40, with an output of 1 watt from an input of .5 volt rms. The device, housed in a TO-5 can, draws approximately 1.5 ma standby current and couples directly to the output load. Its circuit configuration is shown in Fig. 2.

Semiconductor and Thin-Film Integrated Circuits

Even though component-type microelectronic circuitry has shown great promise in many applications, thin-film and semiconductor integrated circuits are gaining significant support from military and civil research groups, particularly in the design of digital data-processing equipment and computers. The need for compact, low-level, and highly reliable logic circuits has produced many different items. As recently as a year ago, most of these devices carried minimum prices of almost \$50; one company, however, (Fairchild) now offers many logic circuits at under \$5, several under \$3. Improved etching, deposition, and diffusion techniques promise further reductions in price, while circuits operating at power levels in the 120 to 800 microwatt region will allow even greater reductions in size than are now possible.

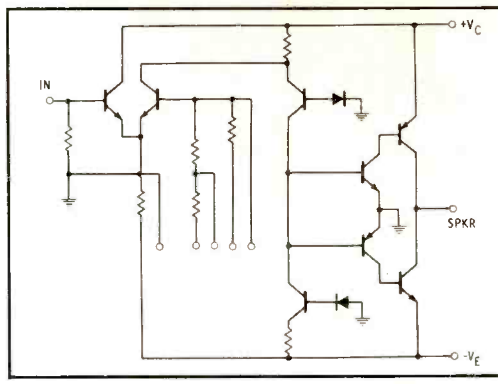


Fig. 2. Schematic of multiple-wafer amp.

In spite of improved manufacturing techniques, production yields of integrated circuits are still fairly low for the more complex functions. Reliability, however, has been improved greatly from a failure rate reported by one company (Texas Instruments) of .13% per 1000 hrs at 85°C in 1962 to less than .006% in 1964. The Bureau of Naval Weapons reports that semiconductor integrated-circuit reliability is higher in many applications than that of standard discrete components.

Several missile-guidance and control systems in the newest generation of ballistic weapons employ semiconductor networks: Minuteman ICBM, EGO and POGO satellite digital signal systems, the Apollo guidance computer, and other computer-navigational systems rely heavily on integrated circuits. Semiconductor limitations in tolerance (20%, nominally) and maximum available values of resistance and capacitance (about 50K and .001 mfd respectively), however, preclude their use in many applications. Thin-film circuits, on the other hand, provide resistance in the megohm region and, with tantalum films, can achieve capacitance values in excess of 1 mfd.

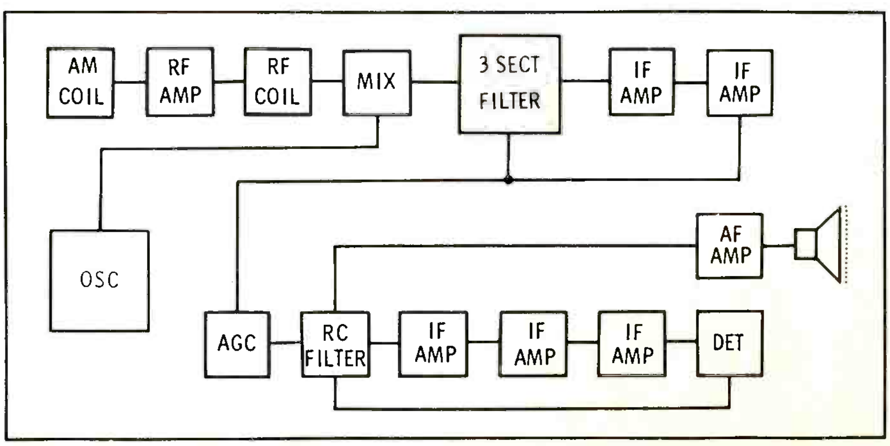


Fig. 3. Block diagram showing a complete 120-mc transceiver using only microcircuits.

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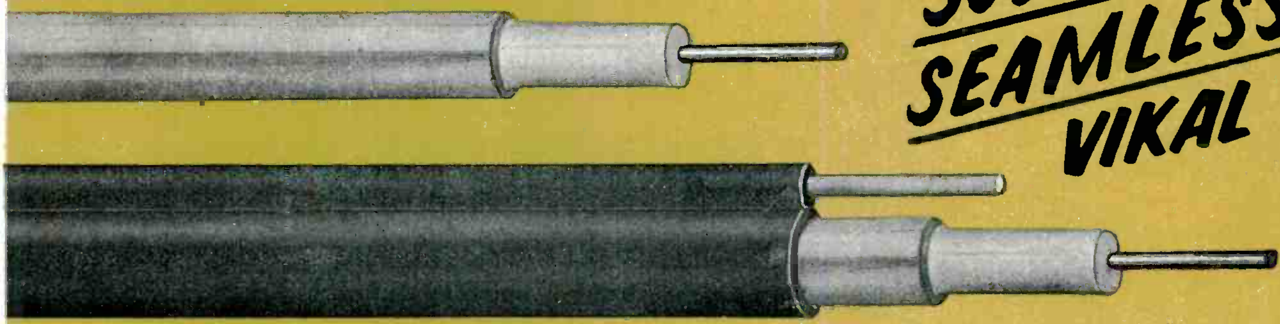

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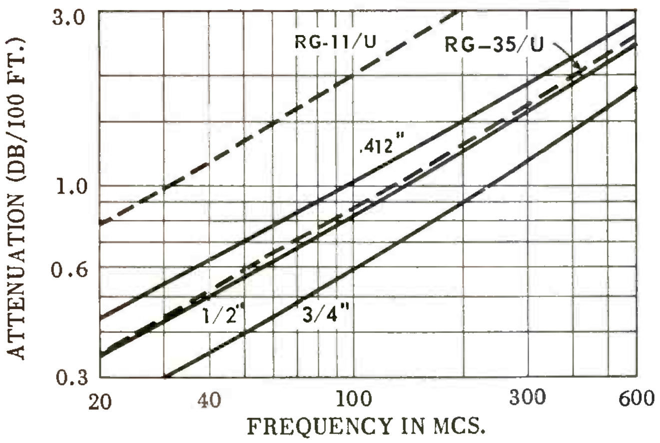

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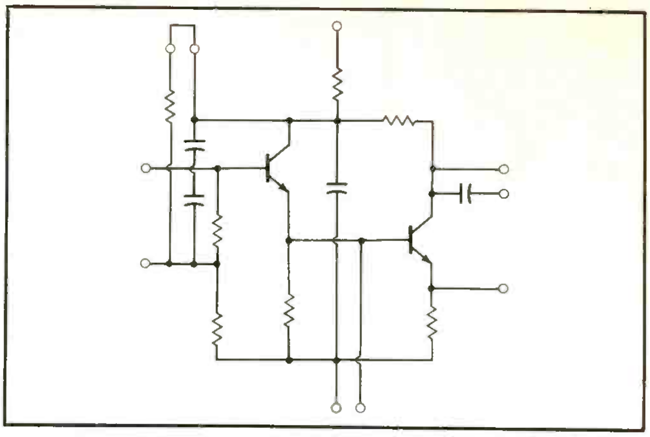

Fig. 4. Schematic diagram of a typical micro IF amplifier.

Using a combination of semiconductor and thin-film techniques, Motorola has developed a 120-mc transceiver giving 60 mw output from an 11-volt supply with a maximum current drain of less than 40 ma. A block diagram of the unit is shown in Fig. 3. Each complete, monolithic (using silicon substrate wafers with diffused semimetals and deposited films) IF stage of the handheld unit is mounted in a TO-5 can and is tuned to 12 mc; gain per stage is 20 db. Five such IF stages are used in the small (5⅞" x 2⅝" x 1") unit. Fig. 4 shows the circuit of one stage.

Single-Block Circuits

In the abstract sense, the term "solid-" or "single-block" circuit denotes the philosophical height of electronic sophistication, because it implies utilization of the basic crystalline and atomic structure of a single material to obtain a desired electronic function. The material is modified by machining, diffusion techniques, etching, and plating so that a known signal input will produce the desired output function or waveform. The term also implies an extremely high level of precision in the manufacture of the devices.

In a practical view, because of their limited power-handling abilities and higher cost, solid-block devices are being used primarily for computer logic functions at this stage of their development. Their level of complexity is generally lower than for semiconductor or thin-film integrated circuits, but recent developments in thin-film transistors promise a wider range of circuits using TFT active devices for linear functions. The application of "pure" electronic circuits will continue to attract the efforts of the creative engineer interested in smaller, more efficient equipment.

Summary

While high-density packaging concepts and the solid-block circuit approach both promise a great deal, it seems that the immediate future will see increased use of integrated circuits using a combination of semiconductor, solid-state, and thin-film techniques.

It is difficult, even dangerous, to make firm predictions that will define the course microelectronic circuits will take within the next few years. It's fairly safe, however, to suggest that the very rapid development of these interesting devices over the past few years has just begun to provide the industry with higher reliability, reduced size, and lower cost. Concerning microcircuits, you haven't seen anything, yet. ▲

A SOLID-STATE AUDIO SWITCHING SYSTEM

by ***Larry J. Gardner,*** Chief Engineer, WCKY, Cincinnati, Ohio—A useful piece of equipment designed around some unusual components.

Have you ever wished for the equivalent of a latching push-button switch bank which can be remotely actuated? Have you ever needed an audio switching device which produced a fade-in or fade-out instead of an abrupt switch? Have you ever lost a commercial or a program because of dirty switch or relay contacts? Chances are you have encountered these problems at one time or another. Here is a system that has solved these problems and many more for us at WCKY.

The system is based on two new electronic components, the optical-electronic relay and the silicon controlled rectifier. We used these devices to build a solid-state audio switcher to feed the outputs of three cartridge playback units into a single console input, with a rapid cross-fade between the inputs.

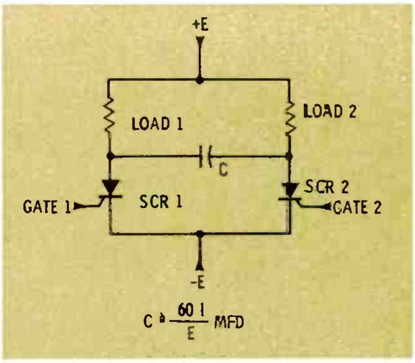

Fig. 1. Basic circuit of SCR static switch.

Fig. 1 shows a basic circuit for an SCR static switch. Being anxious to experiment, we ordered a few small SCR's and wired up some breadboard circuits. To our delight, we found that five or six stages of this kind of static switch worked very well so long as the series capacitance between the anodes of any two SCR's was greater than the value given in Fig. 1. We thus had a solid-state push-button latching switch. The next step was to put it to practical use.

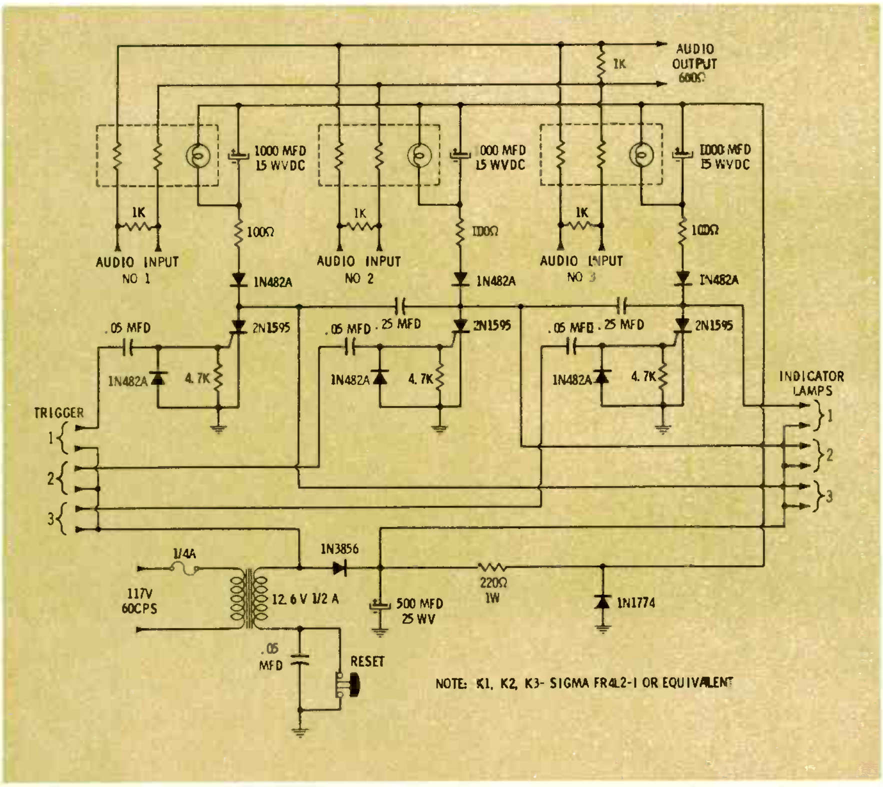

Fig. 2. Complete schematic diagram of the all-solid-state audio switching unit.

In our air studio, three cartridge machines fed three console faders; this sometimes caused operators to wonder which was which. We needed a good way to feed these machines to a single fader. Relay-type switchers had been tried, but they were found to be unsatisfactory because their abrupt switching didn't harmonize with good, tight production.

Then the optical-electronic relay came to mind. This little device contains a small lamp adjacent to one or two cadmium-sulphide photocells. The entire assembly is sealed in a light-tight box about the size of a sugar cube. When voltage is applied to the lamp, the resistance of the photocells drops from over ten megohms to less than 500 ohms. But, unlike in ordinary relays, the "contact" resistance of this unit can be adjusted to any value between the extremes simply by adjusting the lamp voltage. Thus, by using suitable RC networks the designer can produce almost any desired fade-in or fade-out characteristic.

Fig. 2 shows the final result of our work, a three-stage static switch in which the lamps in the optical-electronic relays are the loads. The audio passes through both photocells in each relay to maintain a balanced audio-circuit configuration. A few well chosen capacitors and resistors provide a fade-in time of about one-tenth second and a one-second fade-out time. A few isolating diodes and a good power supply complete the design.

The operation of the unit is as follows: First, referring again to Fig. 1, when power is first applied, neither SCR is conducting, and ca-

Just What Does a TV Computer Programmer Do?

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pacitor C assumes no charge. When a small positive-going pulse is applied to the gate of SCR1, the SCR conducts, and full supply voltage is applied to load 1. Capacitor C then charges through load 2 to full supply voltage. Then, when a trigger pulse is applied to the gate of SCR2, C is in effect placed across SCR1. This causes the current through SCR1 to fall below the holding value, and this SCR is turned off. The same kind of switching action occurs in the three-stage unit in Fig. 2.

The fade-in time is determined by the 100-ohm resistors and the 1000-mfd capacitors. The fade-out time depends on the same capacitors and the 1000-ohm resistance of the lamps in the relays. The 1N482A diodes in series with the SCR's prevent the timing capacitors from discharging through the 24-volt indicator lamps. Other diodes in the gate circuits provide the correct triggering signal. The unit is operated by connecting the trigger terminals to the auxiliary-start terminals on the cartridge machines or to extra contacts on the machine start switches. The indicator lamps used were part of the illuminated remote-start pushbuttons.

Two power-supply outputs are provided: an 18-volt output for the indicator lamps and an 11-volt regulated output for the 12-volt relay lamps (to insure long life). A reset button is provided to turn off all SCR's, and the audio inputs and outputs are terminated to maintain proper impedance matching. The unit has an "on" insertion loss of about 10 db.

Three of these units have been constructed and are going strong, and we are constantly dreaming up new applications for the basic circuit. So far, however, we haven't been able to use it to switch our directional antenna system. Anybody know where to get a 50-kilowatt photocell? ▲

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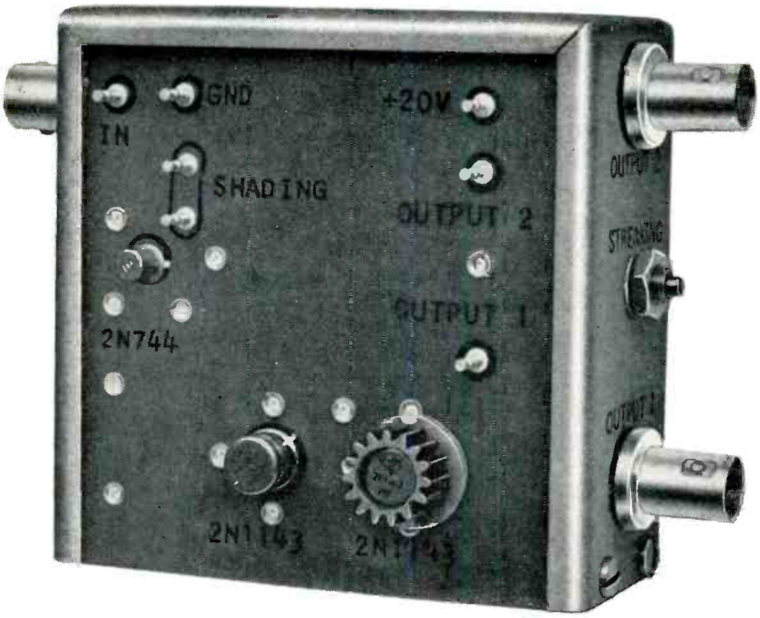
Not far from the head end of our CATV system are located fence chargers that cause a constant pulse streak on channel 4, which we receive from about 100 miles away. Are there any effective ways to go about eliminating this type of interference? We constantly check the fence lines for arcing, and we cut any weeds that might cause arcing, but we still have the problem.

I can't offer a guaranteed solution to your problem, but here are some suggestions that should prove helpful. First, try a small amount of resistive suppression in the HT side of the fence chargers that are causing the interference. A pulse-train type of "signal," almost identical to the spark pulse of auto ignition systems, is being generated, and using suppressor resistors often helps. If you can find any of the old "inductive suppressors" of the spark-plug type, they seem to work a bit better than the resistors. While this does reduce the peak voltage and duration of the pulse somewhat, it doesn't seem to interfere with the effectiveness of the charger. If the resistive type suppressor is used, not over 10,000 ohms resistance should be used.

One other method has helped in some cases: the use of LC filtering across the input AC line (in AC-powered chargers) to keep the pulses from feeding into the AC supply lines and being radiated from there. Wind a couple of air-core RF chokes (about 15-20 turns of No. 14 wire), and connect a pair of .05-mfd capacitors across the input and a pair of .005 mfd capacitors across the output, with all of the free ends tied together to a common ground. This assembly can usually be placed inside the fence-charger cabinet. Ground the cabinet well.

I am the Chief Engineer of an AM Broadcast station having a directional antenna. The station license requires that we read the base currents once daily. A chemical plant immediately adjacent to our transmitter site emits acrid fumes which under certain weather conditions settle near the ground and make it impossible to venture to the tower bases to take readings. Will the Commission allow us to skip readings of the base currents under these conditions?

There is no provision of the Commission's Rules which would permit deviation from the terms of the station license under these conditions. One possible solution to your problem is to ask the manufacturer to cooperate by not producing these fumes for a particular period of the day so that you can make the required readings. From an engineering standpoint, you must record these readings even if it is necessary to don a gas mask, and, therefore, cooperation by the manufacturer would seem to be the most satisfactory solution. ▲



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TECHNIQUES FOR AUDIO TAPE MASTERING

by ***John D. Harmer,*** President and Chief Engineer, Capital City Sound Recording Co., Columbus, Ohio—Some pointers to help the sound recording engineer produce a better product.

In the recording of original tape masters for phonograph records and tape duplicating, there are some techniques that are better than others for producing a quality product. The methods to be described have been developed over a number of years in the professional recording business.

Mastering

Better high-frequency response, ease of editing, and wider dynamic range are obtained when the master recording is made full track at a tape speed of 15 ips. Master tapes should be made only with first-line professional mastering tape. This may sound extravagant at first, since almost any tape will accept a signal, but experience shows the advisability of using such tape. Absolute perfection from both a technical and artistic point of view is difficult to attain. Conscientious artists and artist and repertory (A & R) men, when listening to playback monitor speakers—usually under high-level conditions—can often sense even the most minute tape-motion flaws and other disturbances possibly not even connected with the recording equipment. Thus the engineer must do everything possible to insure highest recorded quality, and the use of unspliced professional-grade mastering tape is essential to maintaining that quality.

To provide a "protection tape," a second tape recorder may be bridged across the program buss. This machine runs at 7.5 ips and provides a full-track "copy." This second tape is recorded at the same time as the master and can be thought of, therefore, not as a copy at all, but rather as a slow-speed, low-noise original. This method has proved to be a valuable time saver in case the client wants such a "copy" of the master material for audition purposes.

Splicing

When a splice must be made, perhaps the most important single factor is maintaining the two tape ends parallel. The tape splicer should be one having superb tape holding and aligning qualities, even if it is not as fast to use as others or requires some handling of the tape for trimming. However, the best rule to apply when making original or second- or third-generation recordings is to avoid splices if at all possible. Few things short of a tape break will ruin a good recording more quickly. Even carefully trimmed, well-made splices can cause a momentary "bump" or "flutter" when going over stabilizer flywheel drums or across heads and thereby perhaps ruin an otherwise "perfect" performance.

Equipment Considerations

Each recording session may (and often does) require a different equipment arrangement; however, the following general approach can usually be applied:

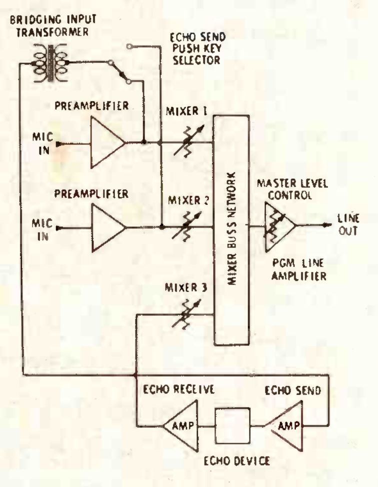

Fig. 1. A versatile arrangement for adding echo effects to the audio program.

(A) Musical instruments and vocal artists should be separated whenever possible. This may require the use of portable sound-absorbing folding screens to increase the apparent distance of separation.

(B) A different microphone should be used for each group or individual so separated.

The purpose behind this separation is to gain more flexible and individual mixer control over the various portions of the entire recording group. This allows, for example, the A & R man to call for (and the engineer to supply) increased volume level for the vocalist without a corresponding increase in the level for the orchestra.

Microphone Equalization

The use of individual microphone equalizer controls is well established in many of the major recording companies because it is an extremely versatile tool. This may cause some raised eyebrows among readers accustomed to working with broadcast transmission systems having essentially flat frequency response. Broadcast systems are designed, by and large, to transmit, unaltered, signals they receive from microphones, lines, and reproducers. On the other hand, the purpose of a recording studio is to record a performance and to alter, if necessary, the characteristics of that performance to produce a more pleasing recorded sound. In addition to adjusting the relative levels, this might mean increasing the high-frequency response of one microphone to obtain a crystal-sharp piano "ring," reducing the low-frequency response of the voice track to retain clean, understandable dialogue, or introducing vari-

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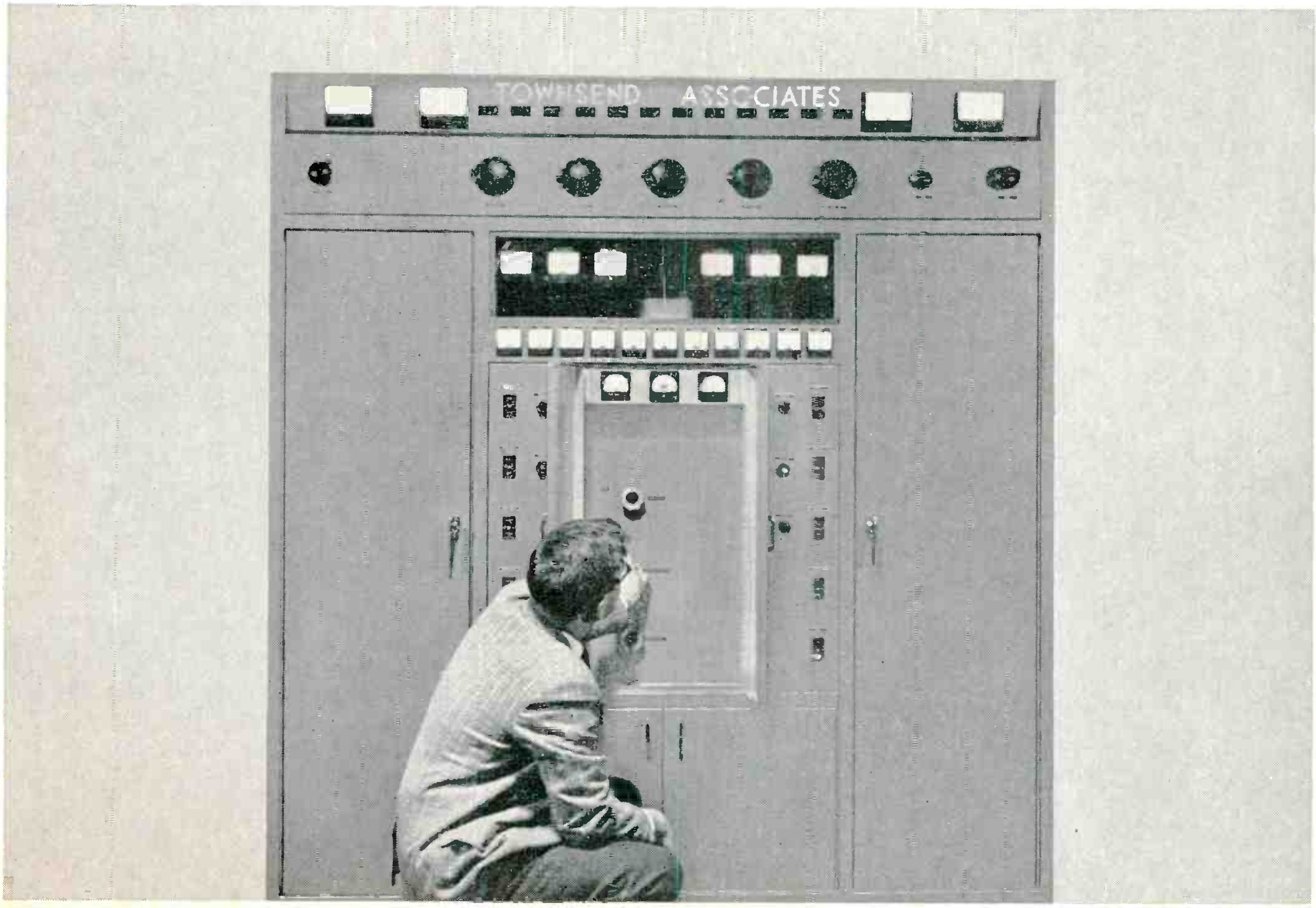

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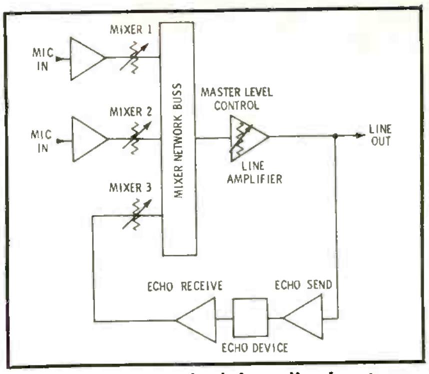

Fig. 2. Usual method has disadvantages.

ous degrees of echo into some of the microphone channels. All this results in a coloration of the original sound to produce a product in accordance with the wishes and desires of the producers, the A & R men, and the performers themselves.

Echo Devices

Most recordings made today have some amount of artificial reverberation added. Artists and A & R men demand echo effects, and the engineer must supply them.

One method of producing echo effects that has been found to work well is the following: The recording console equipment is modified so that echo send signals are derived from the channel selector keys through a transformer bridging network (Fig. 1). The output of the echo receive amplifier is brought to a mixer control on the console. This arrangement allows the recording engineer to add any amount of echo at will. In general, reverberation devices are so connected that the input of the device is isolated from its own output to prevent feedback.

A one-shot "slap echo" can be obtained by the arrangement in Fig. 1 if the echo device is a tape machine (usually running at the 7½ ips speed) set up for tape monitoring. This effect is differentiated from the normal tape reverberation in that it is a one-time echo and does not decay as the echo produced by a re-entrant system does.

The conventional method of introducing reverberation (Fig. 2) has some inherent drawbacks. In this arrangement, the program amplifier and the echo section form a closed loop. Instability due to feedback appears before a substantial echo level can be obtained. A further disadvantage is that reverberation is applied to all signals after mixing, and selective echoing of indi-

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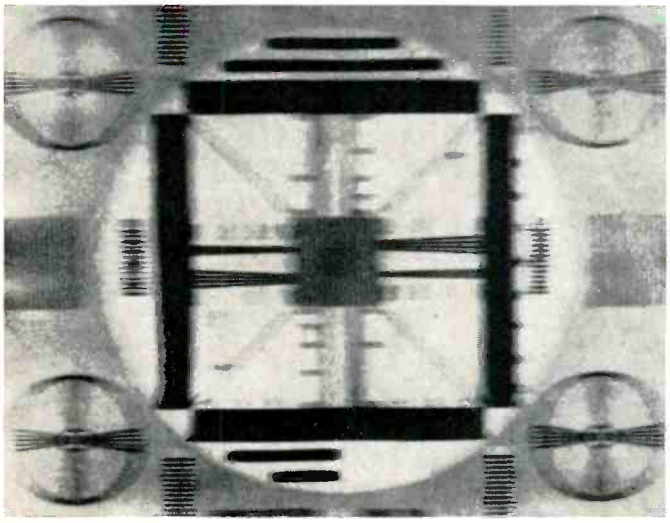
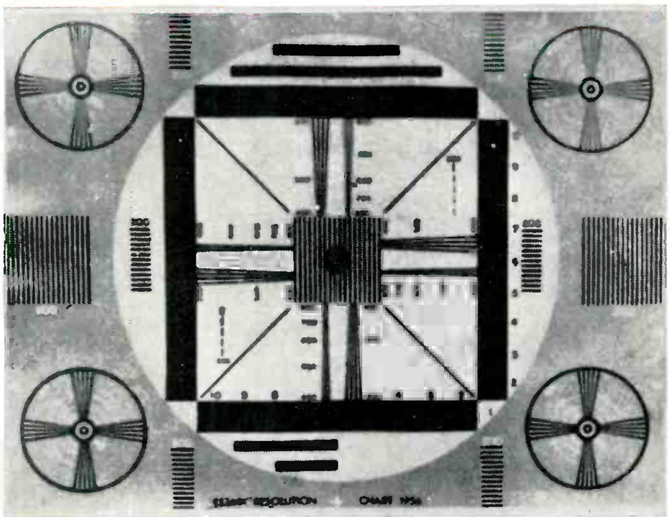


Without Dynalens—Test pattern photographed from a monitor with I.O. camera vibrating horizontally at 25° per second.



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vidual sources is thus impossible.

Pickups

A somewhat unique, though by no means original, method of picking up electrically-operated musical instruments is shown in Fig. 3. Instruments in this class include electric guitars, bass guitars (often accompanied by huge amplifier-speaker systems), electric organs, electric pianos, and electric bass pianos. In the arrangement of Fig. 3, a connection is bridged across the voice coil of the instrument speaker. This type of pickup has been used frequently with good success.

Use of this method has generated some interesting byproducts, however, not the least of which is a general increase in background noise level. Most of the noise energy is power-frequency hum and buzz; frequently, there may be as many as four instrument amplifiers operating at the same time in the studio, and each contributes noise.

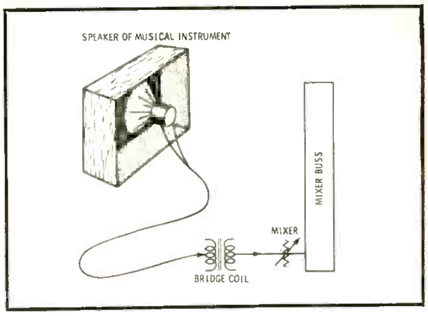

Fig. 3. A method for instrument pickup.

Unusual conditions sometimes arise. In one such instance that occurred with an electrically amplified guitar, there was an all-too-familiar ground-loop buzz, but no amount of power-cord reversing or experimentation with separate ground wires seemed to reduce the buzz. The noise persisted when the instrument was held or strapped about the musician, but it stopped when he laid the instrument down. When the engineer accidentally touched the musician while grounded, the noise was reduced. Several combinations of ground wires were then tried without totally satisfactory results. Finally, in desperation, the engineer tried having the musician stand on a large grounded sheet of metal. This reduced the noise enough to permit continuing the session.

Another form of noise is low-frequency disturbances caused by the musicians' fingers and hands on guitars or other instruments hung about the neck or otherwise in close proximity to the body. However, these are small technical difficulties that once explained and demonstrated to the A & R man can usually be cleared up with tactful instructions to the artists involved.

A further matter to consider is the relative studio sound levels from vocalists and instruments. Electrically operated and amplified instruments usually deliver better-quality sound when run below normal output, and this definitely should be encouraged by engineers and A & R men, since the direct-tap pickup allows the volume level to be restored by the mixer control. Moreover, lower instrument volume permits greater flexibility, since the sound issuing from instrument speakers in the studio is not so likely to be picked up on adjacent microphones.

The subject of piano pickup has

been discussed at length elsewhere, so it will be considered only briefly here. A satisfactory and pleasingly clean pickup from a vertical grand can be obtained by using the familiar ribbon-type microphone. With individual equalization in the piano-pickup microphone channel, the character of the pickup can be changed from bright stage-front pickup to a more mellowed background sound.

Experimentation with several pickup positions has shown that two such positions give best overall results in our studio environment. In one position, the microphone is placed 2′ to 3′ in front of the instrument at a point in line with C above high C on the keyboard. The microphone faces the sounding board, and the instrument front cover is removed. In the other position, the microphone is placed 2′ to 3′ directly above the piano at a point in line with highest C. The top lid of the piano is removed, and the microphone faces directly into the instrument.

Client Relations

Some of the toughest jobs for a recording studio occur when musical talent having no previous recording experience is encountered. These people may test the microphones by blowing into them, or they may insist on playing instruments with volume levels approaching the threshold of pain. It is a good idea to try to release the studio space to the client ½ hour in advance of the scheduled session to allow time for the client to become accustomed to the premises and facilities and to permit instrument set-up time. If the engineer is on duty during this advance period, he can make the musical-instrument pickup taps, if any, determine a general microphone placement, and give what advice may be helpful.

Conclusion

The techniques for making professional tape masters depend somewhat on the individual circumstances. It is hoped, however, that the general comments given here will be helpful to those who may be called upon to assume the technical responsibility for making such recordings. ▲

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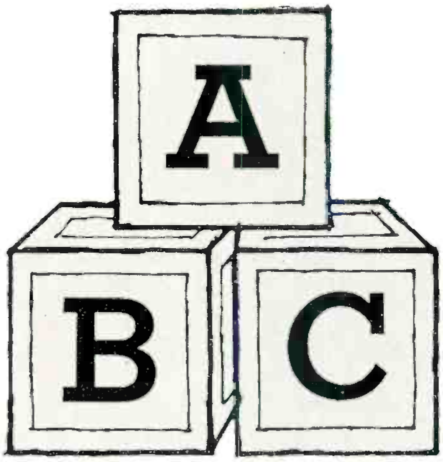

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LOOK TO VISUAL FOR NEW CONCEPTS IN BROADCAST EQUIPMENT

A COUNTERWEIGHTED TRANSMISSION LINE

by Len Spencer, **Consulting Author, Montreal, Quebec, Canada****—A basically simple, but effective, solution to the problem of sagging conductors in an open-wire transmission line.**

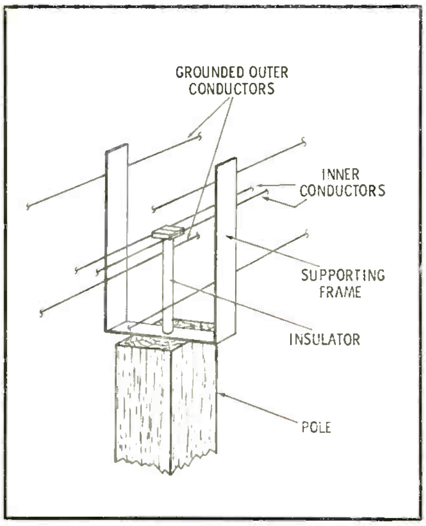


Fig. 1. Basic design of open-wire line.

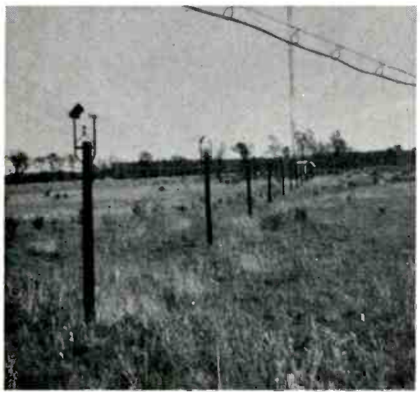


Fig. 2. One of two lines in use at CKAC.

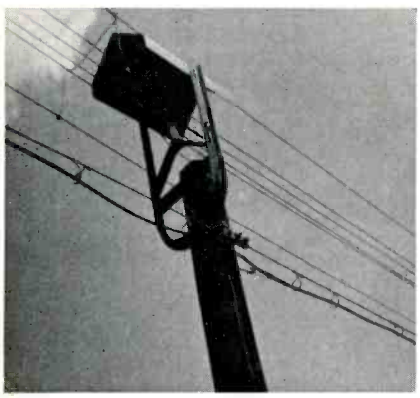


Fig. 3. View of frame atop one pole shows metal shield to keep ice off insulator.

Because of their low cost and simple maintenance requirements, unbalanced open-wire RF transmission lines for the lower broadcast frequencies were quite popular before the perfection of gas-dielectric coaxial cables. A typical open-wire unbalanced line consists of two closely spaced center conductors inside four grounded, equally spaced wires (Fig. 1). The dual center conductor is insulated from the supporting frames, each of which is mounted on a wooden pole.

At CKAC, the two-tower array is fed by two transmission lines, each about 525′ long. One of these lines is shown in Fig. 2. The supporting poles are approximately 50′ apart. Although the lines were taut when first installed, extreme seasonal changes in temperature (–32

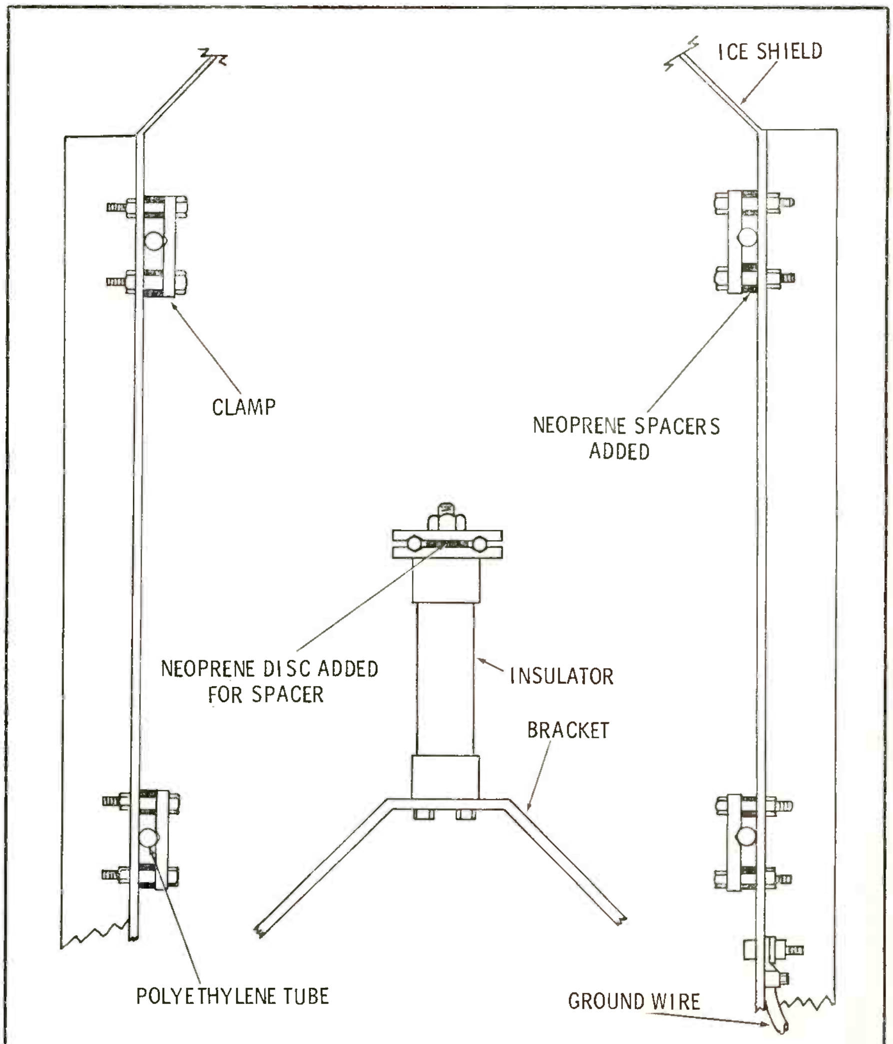


Fig. 4. Detail of support-frame changes for the counterweighted transmission line.

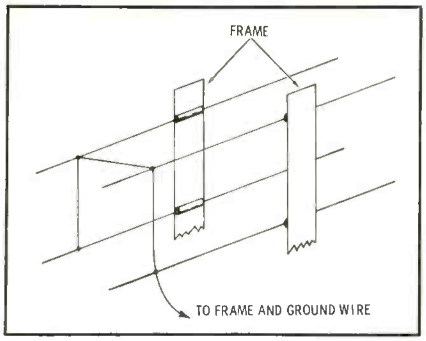


Fig. 5. Method of grounding outer wires.

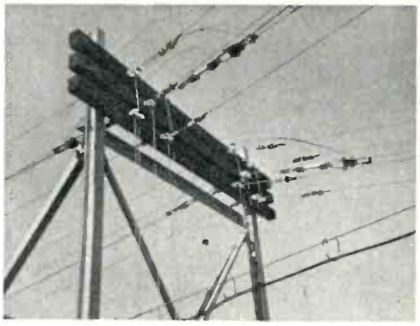


Fig. 6. Steel frame and wooden crossarms.

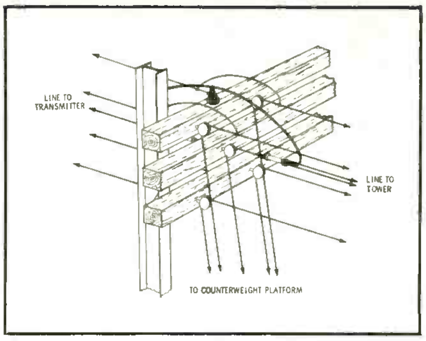


Fig. 7. Arrangement of pulleys and method of carrying "hot" wire across arms.

to 109°F) eventually resulted in considerable sag between the supporting poles. The outer wires, each firmly attached to the U-shaped metal supports (Fig. 3), expanded unevenly and would swing away from the "hot" center line whenever there was a high wind. This, of course, caused variation in the characteristic impedance of the line, which in turn caused the output power of the transmitter to vary.

It was decided to try freeing all the outside grounded wires from their individual supports and allowing them to expand and contract with their tension controlled by a suitable weight. When this proved successful, we attached the center line to the counterweight also.

To accomplish the modification, the "deadman," or pole closest to the tower, had to be extra heavily guyed. Each "U" was provided with polyethelene tubes (Fig. 4) through which the wires were passed after being securely attached by insulators to the "deadman." Near each supporting bracket a wire was soldered to the outside wires, at a distance away from the tubes (to allow for lateral movement), and ground wire on the pole as shown in Fig. 5.

At the building end of the line, cross bars are mounted on two upright steel "I" beams (Fig. 6), and the outside wires pass through pulleys attached to the top and bottom crossarms (Fig. 7). The center line, protected by a suitable insulator, has tension applied through a pulley on the center crossarm. The hinged counterweight platform (Figs. 8 and 9) keeps all the lines in tension. (The heavy cables supported by messenger cables are the phase-sampling, telephone, and power lines to the tuning huts at the bases of the towers.) The 25-lb concrete blocks in the figures were used to adjust the lines to tautness at 68°F and with the platform horizontal.

Note in Figs. 6 and 7 how the "hot" center line was carried over the top of the "H" frame but still kept under tension by the pulleys and counterweights.

The arrangement described is basically simple, but it has resulted in a more stable feed to the array and closer phasing tolerances winter and summer. ▲

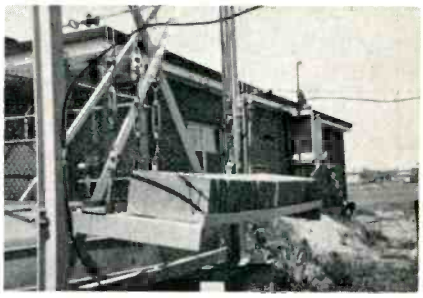


Fig. 8. Blocks on platform act as weights.

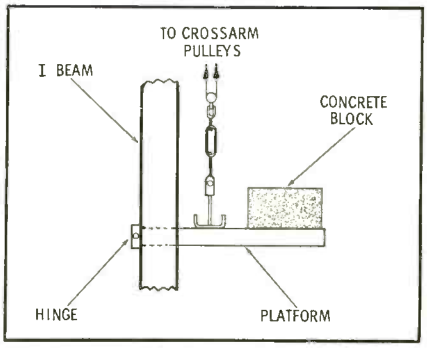
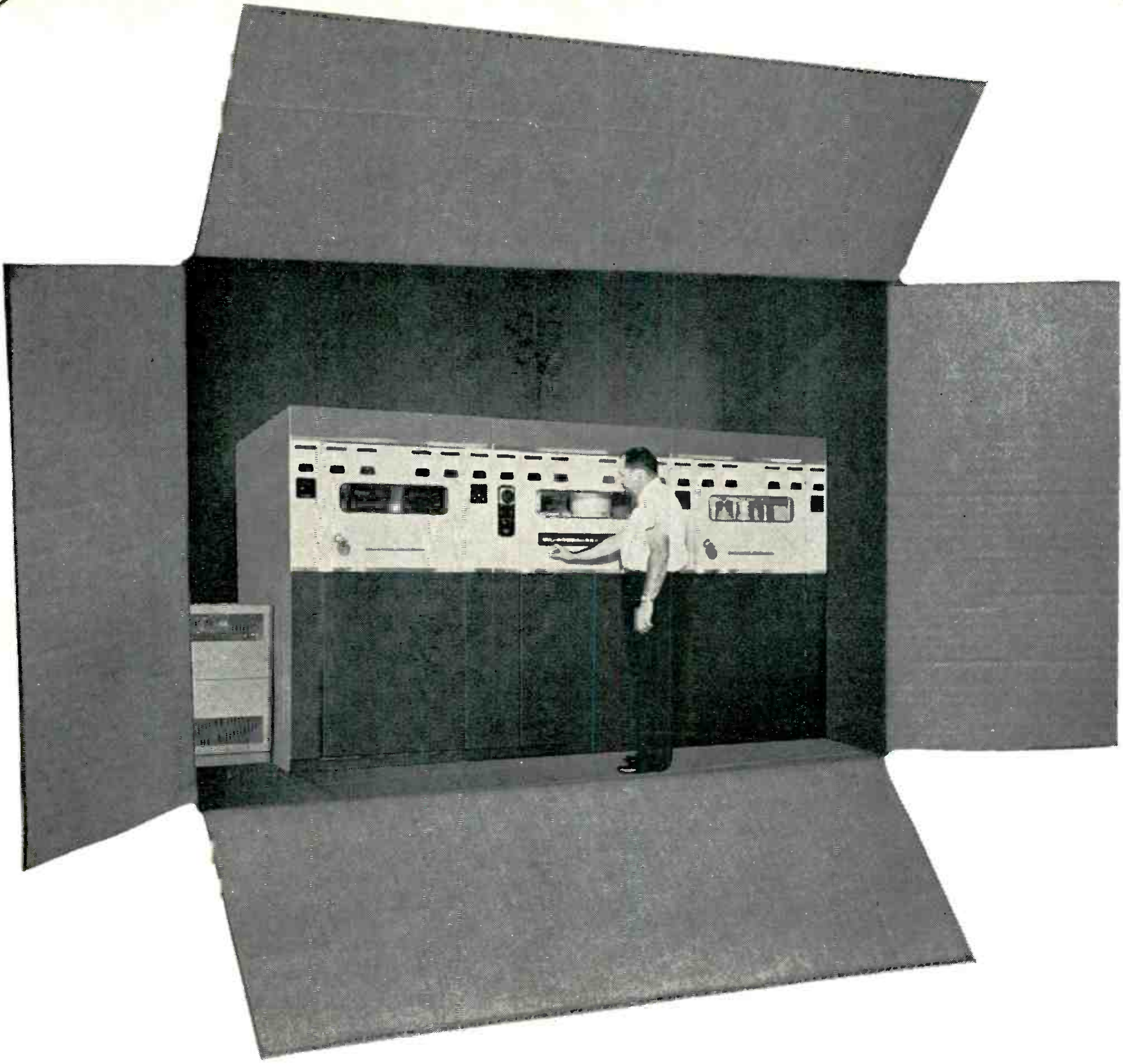


Fig. 9. Diagram shows platform fulcrum.



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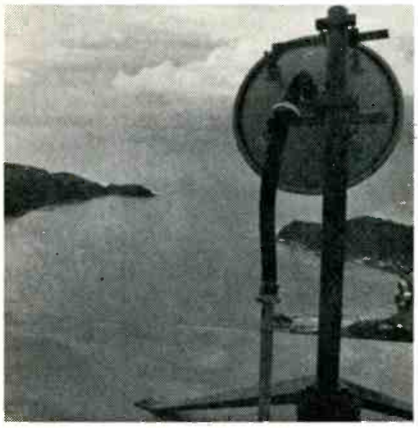

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- A Look at Maintenance Logs
- Building a Transistorized Synchronizing Generator

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- What to Do in Tower Emergencies
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ENGINEERS' EXCHANGE

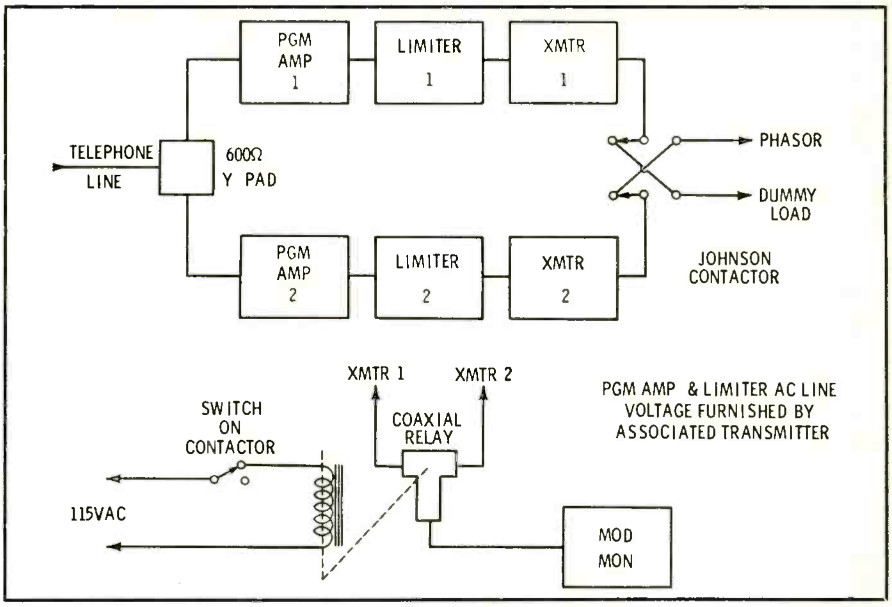


Fig. 1. Block diagram shows alternate use of the main, auxiliary transmitters at WIL.

An Automatic Transmitter Control

by Melvon G. Hart, Technical Director, WIL, St. Louis, Mo.

As more stations convert to remote-control operation of their transmitter facilities, a large number of older transmitters will be pressed into service as auxiliary transmitters to be used in the event of failure of the main transmitter. These older transmitters, while still capable of good performance, were not designed to be operated by remote control and are, in some instances, rather complicated to get on the

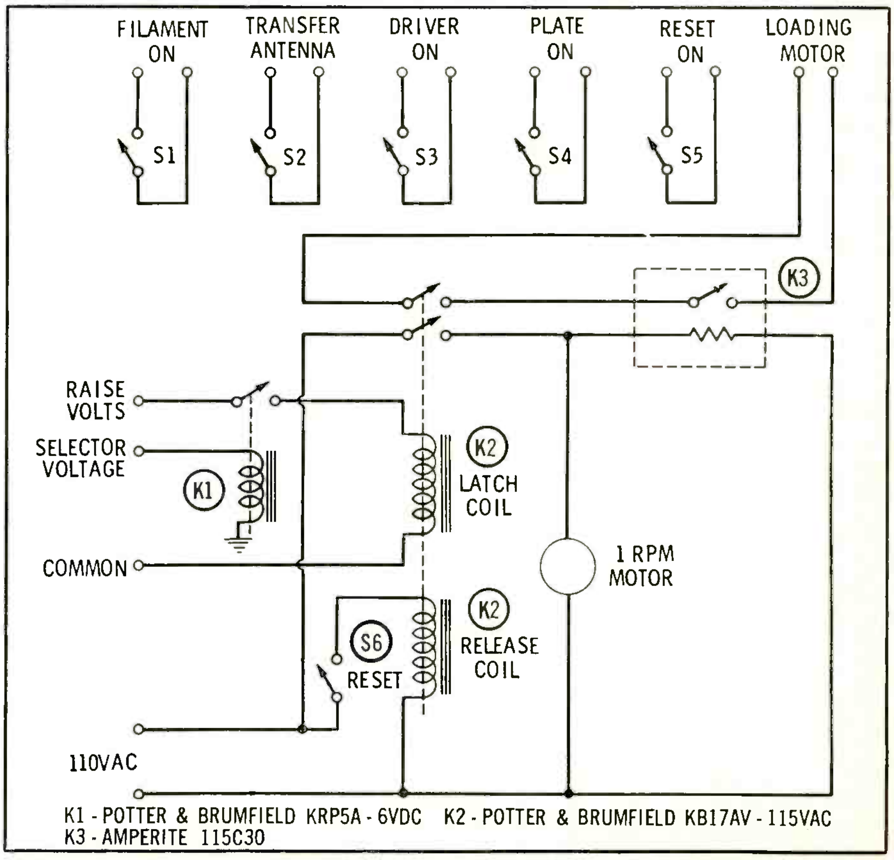
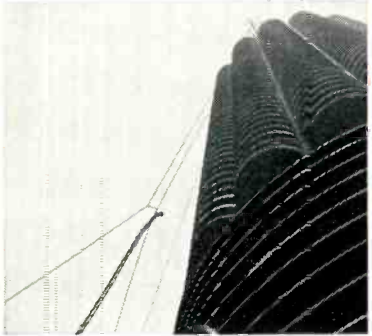
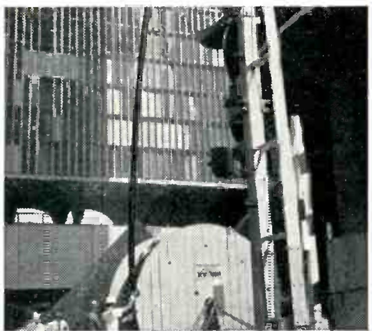


Fig. 2. Schematic diagram showing how the motor-switch arrangement functions.

...Factory attached fittings



...Long lengths

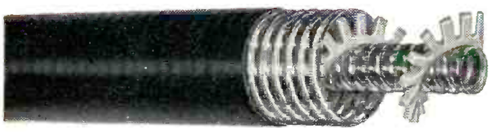


...No splices

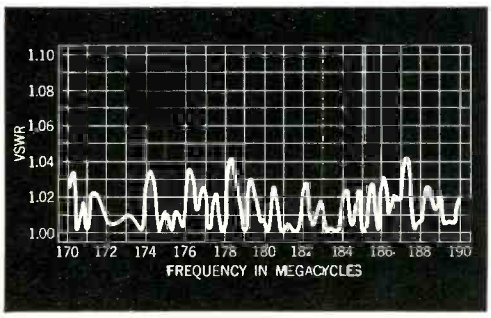
HELIAX 5" air dielectric coaxial cable hoisted from street to Marina Tower rooftop in one continuous length for ABC-TV, Chicago

HELIAX® FLEXIBLE COAXIAL CABLE

guaranteed reliability for high power RF transmission



Actual measured VSWR for installed 742 foot length of 5" HELIAX



Long continuous lengths, and flexibility of Andrew HELIAX cable made this critical transmission line system possible. Installation required less than six hours. Cost was dramatically reduced.

Type H9-50 HELIAX cable insures long term reliability in high power RF transmission*. Corrugated copper inner and outer conductors absorb stress and cable retains superior electrical qualities after repeated flexing. Andrew end connectors firmly anchor inner to outer conductor and eliminate any RF noise from vibration or temperature changes.

Contact your Andrew sales engineer, or write for information on this superior transmission line.

*Handles average power of 250 kw @ 10 Mc or over 50 kw @ 200 Mc

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4-65

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air. At WIL, the standby transmitter is a Gates BC5A which was built in 1948. Putting this transmitter on the air requires that the following operations be performed in exactly the right sequence: (1) Filaments on, (2) Antenna transfer, (3) Drive plate on, (4) Final plate on, and (5) Automatic reset on. If any of these functions is forgotten or not done in proper sequence, the transmitter will not operate or, worse yet, may be operating fully modulated into the dummy load.

After several outages during which the operator on duty at the studio failed to start the standby transmitter, it was decided that a simple, automatic means of placing the auxiliary unit on the air was needed. Provision had been made for automatic switching of the audio chain and the frequency and modulation monitors in the original installation (see Fig. 1); when the new remote-controlled transmitter was installed, a new program amplifier, limiter, frequency monitor, and modulation monitor were also installed. The old units were retained as standby units. Thus each transmitter has its own set of associated audio equipment that is automatically turned on when the transmitter filaments are started. In the event of any failure a completely different set of audio and RF equipment is switched on the air.

The heart of the new system is an aluminum chassis on which are installed a one-rpm motor and cam and six lever-actuated snap-action switches. The circuit is shown in Fig. 2. To initiate the changeover, it is necessary only to dial one position on the remote-control unit and press the on or raise key. This action starts the motor, which then actuates, in proper sequence, the switches controlling the filaments, the antenna transfer, the driver, the plate voltage, and the automatic transmitter reset. At the conclusion of the sequence the motor unit resets itself. As soon as the motor starts turning, time-delay relay K3 closes the circuit to the plate-loading motor, which decreases the plate loading for 30 seconds. This allows the transmitter to start with a light load. After the transmitter is on the air, the operator adjusts the loading for the correct common-point reading. ▲

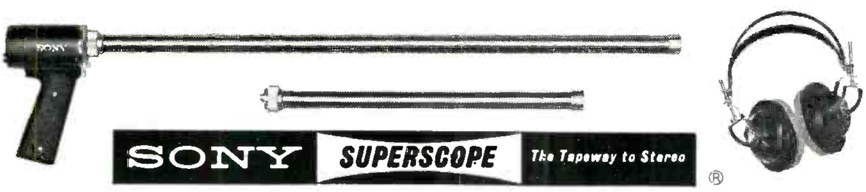
Telemike Exclusive: Built-in Monitor Facility*

Now, with *three* readily interchangeable sound tele-probes, similar in principle to changeable telephoto lenses, you can 'zoom' in from varying distances for the precise sound you're after. The 18-inch probe may be used for 'close-ups,' as far back as 75 feet from the sound source; the 34-inch probe from 150 feet. A 7-foot probe is optional for distances beyond 150 feet.

*The most unique feature, a Sony exclusive, is the built-in, battery powered, solid state monitoring amplifier in the pistol grip handle, which assures the operator that he is transmitting the source with pin-point accuracy.

OTHER FEATURES, OTHER USES: The new Sony F-75 Dynamic Tele-Microphone is highly directional at the point of probe, with exceptional rejection of side and back noises (35 to 40 db sensitivity differential). Recessed switching allows quick selection of impedances (150, 250 and 10K). The uniform frequency response, controlled polar pattern, and unprecedented rejection of background noise eliminates feedback interference in P. A. systems.

The complete Sony F-75 Tele-Microphone includes two sound probes, 18 and 34 inch lengths, monitoring pistol grip handle and the Sony dynamic headset, all in a velvet-lined compartmentalized carrying case, for *less than* **$395.** For specifications and a catalog of the complete line of Sony microphones, visit your nearest Sony/Superscope franchised dealer, or write: Superscope, Inc. Dept. 52, Sun Valley, Calif. *The best sound is Sony.*



SONY SUPERSCOPE *The Tapeway to Stereo* ®

Superscope, Inc., Sun Valley, California

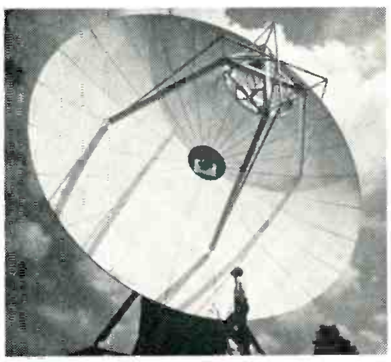
Circle Item 38 on Tech Data Card

About the Cover

Truly international, transoceanic television is a reality, and in a few years it will be commonplace. The efforts of countless scientists and engineers have made this achievement possible. Symbolic of this research and development work is the antenna system shown on this month's cover.

The 30' parabolic reflector is part of a transportable space-communications terminal developed by ITT Federal Laboratories, a Division of International Telephone and Telegraph Corporation, Nutley, New Jersey. The antenna can be disassembled for transportation; semi-trailer vans contain the transmitting and receiving equipment. A servo system is provided to permit automatic tracking of the satellite with the antenna.

The system was designed for switchover from one satellite system to another with relative ease. A dual transmitter system with



separate feed horns makes possible rapid shifts in frequency.

Stations of this type have been operated from a number of locations, including California, New Jersey, Brazil, and Germany.

Experiments have been conducted using both the Relay and Telstar satellites.

The particular antenna shown here probably will not feed overseas programs to local TV stations, but it is one of the electronic stepping stones that will ultimately lead to this development. When that happens, significant changes in broadcasting may very well take place.

UHF-TV Station

(Continued from page 13)

of video. Standard video-cable impedance is 75 ohms. Incoming network video, which may be only 1 volt peak to peak, is fed to a distribution amplifier which brings it up to the station level and usually offers two or more outputs at that level. The camera control unit for the film island also has two or more outputs of standard composite video information. A third source of video is a mixing amplifier that furnishes .4 volts of sync, plus the station's "black" signal, about .07 volts below blanking level. Each of these video sources is fed to a three-position switcher which in turn is fed into the stabilizing amp, AGC, and then into the transmitter. Thus, the operator can select video and audio from network, from the film camera, or from black.

Q: What about some means to fade the video as the audio is faded?

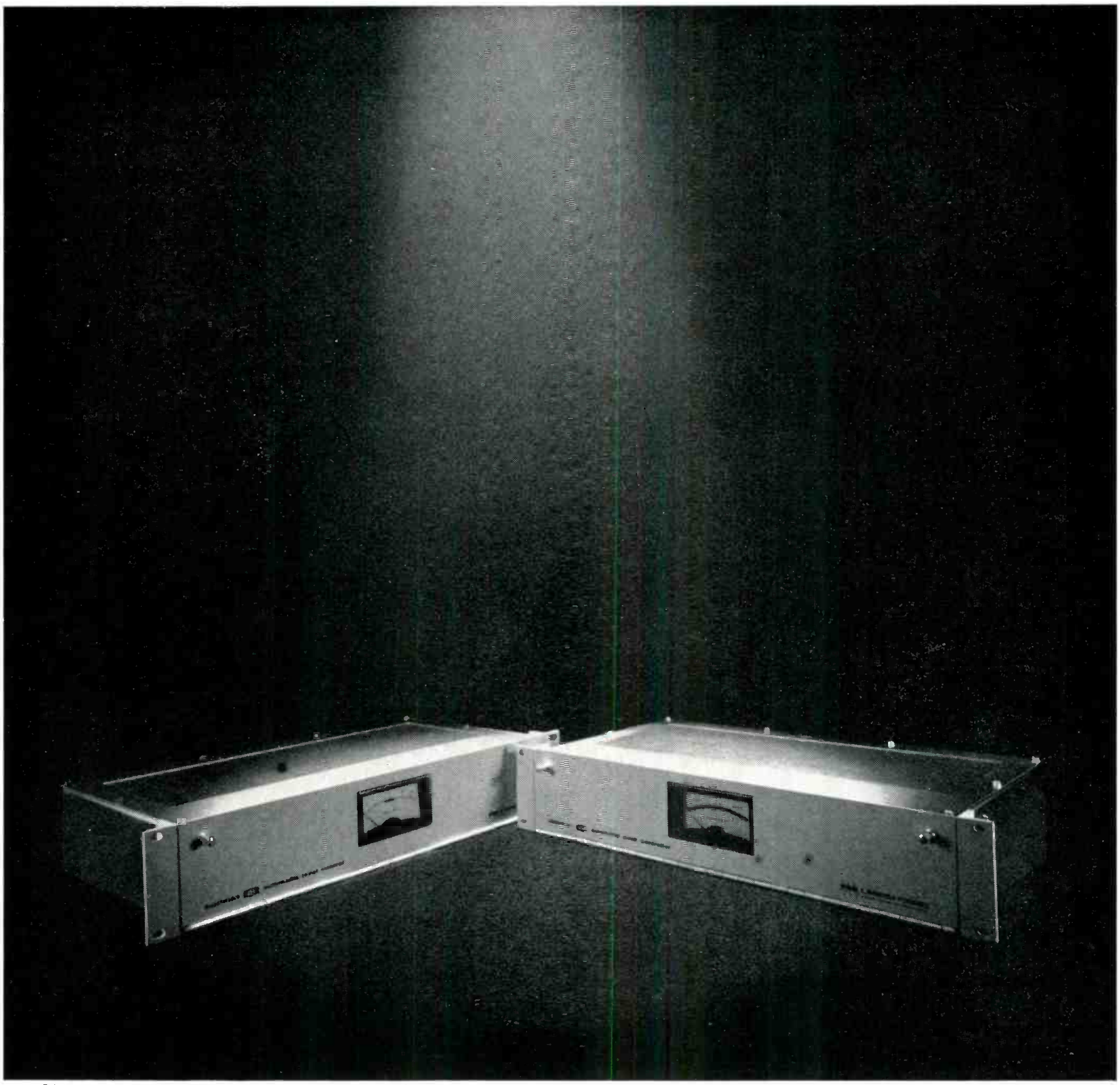
A: Fading of network video is almost never done in the smaller stations. A local video fader unit is not usually bought until local cameras are added to the facilities. Then the system works like this:

Each local camera's plain video signal (without sync added) is fed to two parallel switchers—see Fig. 3. The output of each switcher goes through a fader-pot with both pots connected through gears to a common lever which can be moved to fade out one switcher while fading in the other.

The video output of the switcher-fader unit is fed to a video-sync mixing amplifier where the sync is added. The sync is added after the fader unit to prevent loss of sync when the video is faded out. The output of the fader unit is commonly fed to a fourth position on the switcher preceding the stab-amp input.

Q: What equipment is needed for film handling?

A: Equipment for 16-mm film should include an ordinary projector, which can be a home-type unit, to preview the films and find cue lines for inserting commercials. One also needs a film rewinder, either hand-crank or motor-powered type, and a film timer. A film timer actually measures the length of the film as it is wound or rewound, but it is calibrated in hours, minutes,



See the Max Brothers increase your program power up to 8-fold!

(That's the new solid state Audimax on the left . . . and the Volumax on the right)

Hear this unique combo perform free in your studio for 30 days! Now CBS Laboratories *gives* you the famous Max Brothers (Audimax and Volumax) both solid state for the first time. They'll perform *free* in your studio for 30 days. Then, If you're not convinced that solid state Audimax can "ride" gain to increase program power up to 4-1, and solid state Volumax can control modulation peaks for as much as an additional 2-1 increase, you can cancel the Max Brothers, with no obligation.

If you decide to keep them, they cost only $665 each.

See why the Max Brothers are broadcasting's new money-making stars! Audimax is an automatic level controller that outmodes the ordinary AGC. A brilliant studio technician without human shortcomings. By automatically controlling audio levels, it frees engineers, cuts costs and boosts your signal.

Volumax has a few specialities of its own. It outmodes conventional peak limiters by controlling peaks automatically without side effects. By expanding effective range and improving reception in fringe areas, it brings in extra advertising revenues.

Call or write CBS Laboratories for a bulletin with complete details on the exclusive talents of Audimax and Volumax.

REMEMBER! Together, the Max Brothers can increase your program power up to 8-fold. Decrease operating costs. Bring in more advertising. For just $665 each. Can you afford *not* to ask for a FREE 30-day trial? Special Convention engagement. See the Max Brothers perform in Booth 242 at the NAB.

CBS LABORATORIES
Stamford, Connecticut. A Division of Columbia Broadcasting System, Inc.

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and seconds rather than in feet. A film splicer is also needed.

There is some disagreement as to what slide-making equipment is basically necessary. The traditional system uses 35-mm film, some sort of tripod, and an easel (either horizontal or vertical) where artwork, pictures, or plastic letters can be arranged to form the desired slide image. Many stations are turning from 35-mm film to Polaroid positive transparencies. Proponents of Polaroids contend they are faster and simpler, with results visible immediately. Opponents say Polaroid slides cost about three times as much as 35-mm slides.

Q: How large a staff is needed?

A: The nontechnical staff is essentially as large as a medium-size radio staff. Typically, there is a station manager who is responsible for general station business and regional and national sales. There are one or two local time salesmen, as well as a program director who is responsible for program scheduling, commercial scheduling, and network relations. A traffic manager handles the contracts and sees that they are scheduled and run as agreed. Each day's log is made up by a traffic secretary. One or two bookkeepers and a receptionist-secretary, to answer the phone and type letters, round out the staff.

The technical staff includes a chief engineer who, aside from finding and scheduling staff engineers, usually bears the responsibility for all equipment maintenance. The number of staff engineers depends on the number of hours the station will operate.

The average low-budget station, with studio, control, and transmitter housed in one facility, has three to five staff engineers. They are often radio engineers selected for their production ability. Completing this staff is the film man. He is responsible for timing film, splicing commercials in, slide making, and generally being sure each day's films are ready to air.

Q: How much does television equipment cost?

A: We'll start by approximating the new cost of a basic station's technical equipment.

Medium-gain antenna	$20,000
Transmitter monitoring equipment	2,000
Master monitor	1,700
Simple switching system	1,500
Video monitors—dual, 8"	600
Sync generator	3,000
Film camera chain	10,000
Prism-type optical multiplexer	2,000
16-mm projectors (two)	13,000
Slide projector	500
Stab amp and AGC	4,500
Film equipment, rewinder, Polaroid, etc.	1,000
Audio equipment	5,000

Thus, using new equipment, the cost is about $100,000 plus the cost of the transmitter and tower. A 1-kw transmitter will cost around $45,000, while a 12.5-kw UHF transmitter sells for near $175,000. Tower costs depend on height.

Q: Is there any way to cut this cost?

A: Most of the equipment—except the transmitter, antenna, and transmitter monitor—is common to both VHF and UHF television. The audio gear is the same as used by AM and FM radio. Thus, there is a fair availability in used equipment. The cost of used equipment varies, but as a rule seldom exceeds 50% of that of similar new equipment.

We heard several hints for buying used equipment. First, don't buy out-of-date equipment. The piece itself need not be recent, but it should either still be in production or not be out of production for more than four years. Second, stick with equipment made by a known manufacturer. It is easier to obtain parts for, and is probably more compatible. Third, talk to other engineers before buying; once they've been in the UHF field a few years, they have an idea which equipment is good.

Along with these hints, the engineers we talked to generally agreed that it is presently a buyer's market in used equipment, because many VHF stations are converting to all-transistorized equipment.

Conclusion

As we have tried to show, planning a successful low-budget UHF operation requires careful selection of location and equipment and a constant eye on costs. This article is only a check list of considerations. There was universal agreement on one fact: The actual UHF television station installation should be designed and directed by a professional consulting engineer. ▲

10-Watt FM Station

(Continued from page 15)

mc (from a doubler), 10 kc, 100 kc, and 1 mc (all from multivibrator frequency dividers) are available. The instrument provides calibration frequencies at 100-kc intervals into the FM broadcast band.

The first step in the measurement procedure is to calibrate the reference unit. This was done by setting the selector switch for 1-mc output and comparing the fifth harmonic of this output with the 5-mc transmission of WWV. A communications receiver was used to determine when the two signals were in zero beat; the 5-mc oscillator was set within an accuracy of ±1 cps by this means.

Next the calibration unit was switched to the 100-kc output, and the difference between one of the harmonics of 100 kc and the carrier frequency was determined by comparing the difference frequency with the output of a laboratory-type audio oscillator. By this means, the carrier deviation of the transmitter as received from the factory was found to be +400 cps. The transmitter crystal control was then adjusted until the transmitter frequency was within 25 cps of the reference frequency. (The carrier-frequency tolerance for this class of station is ±3000 cps.)

This method of frequency measurement is not as accurate as some others, but it is sufficiently accurate for the purpose. Ample warmup time should be allowed for the equipment to stabilize, and care must be exercised to be **sure** the transmitter signal is being compared with the proper harmonic of 100 kc. (A calibrated receiver is usually adequate for this purpose.)

Engineering Report

It was decided that merely filing an FCC form 341 in the usual manner, while entirely proper, would not suffice completely. Therefore, a complete engineering report book was made. This book contained an affidavit of the installing engineer's qualifications, a copy of the maintenance contract, and a comprehensive engineering report describing the methods and procedures used in the installation. Also included in the report were drawings of the remote control unit, a sketch of the elevation of the transmitter-antenna installation, and a detailed description of the antenna system. The measuring techniques and equipment used to measure the frequency of the new station were described. Four photographs (showing Amen Hall, the transmitter location, the antenna installation in the cupola, and the control room) and one additional FCC form 341 (in addition to the other three engineering sections filed) completed the book. Photocopies (the original book was sent to the FCC) were made to provide the permittee and the installing engineer with a permanent record of the installation. Nine days after filing the complete FCC form 341 and the engineering report book, authority was granted for WPEA to conduct program tests.

Compliance With the Rules

Suitable program and operating logs were printed by the academy printing shop. A large notebook was purchased and marked for use as a maintenance log. WPEA maintenance is conducted according to FCC Rules and Regulations on a bimonthly basis, per the yearly contract. It will be remembered that a copy of the maintenance contract was included with the request for program-test authority. A copy of the same contract was filed with the FCC district office in Boston, as required by the Rules and Regulations. The maintenance log book provides a continuous record of the bimonthly inspections and all maintenance over a period of several years.

To ensure compliance with subpart G (the portion of the Rules dealing with the Emergency Broad-

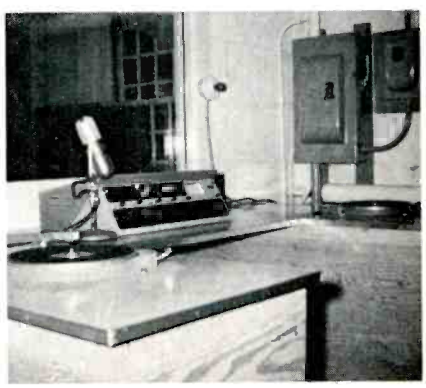
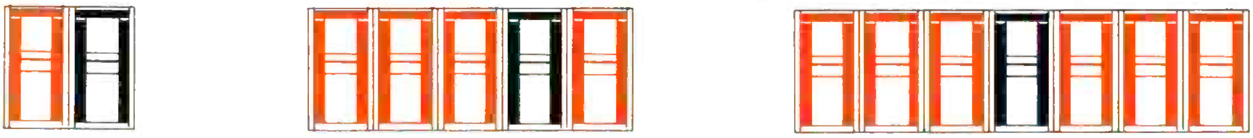


Fig. 4. View of basement control room.

PICK ANY VHF-UHF* POWER COMBINATION



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* UHF Now Available in AIR COOLED High Power Combinations.

Now, thanks to SE's advanced transistorized design, you can build almost any power level and aural/visual power ratio that you need to meet the new FCC ruling and your pocketbook.

COMBINE THEM ANY WAY YOU WISH . . . The only "building blocks" you need are a transistorized driver and one or more SE amplifiers. These highly compatible units can be grouped in countless combinations to give you aural/visual power combinations varying from 10% to 50%; at any power output level.

SE AMPLIFIERS COMPLETELY SELF-CONTAINED . . . All SE amplifiers are identical regardless of their output power . . . and each is completely *self-contained* in a newly designed unit that includes power supply, cavity, blower, control circuits, metering, etc.

SIMPLY ADD AMPLIFIERS TO BOOST POWER . . . Thus, whenever you wish to add to your present transmitter, regardless of make, or change your aural/visual power ratio, you simply add to or change your *amplifier* combination.

SAVINGS UP TO 50% . . . Best news of all . . . SE amplifiers are compatible with *any* driver/transmitter. Savings to you can be as much as 50% in equipment costs!
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cast System), an official interpretation was obtained. According to this interpretation, WPEA is required to monitor an EBS station while on the air, just as other stations must do. However, due to the low operating power and limited operating schedule, WPEA is not required to conduct weekly test alerts. It must, of course, air the standard alerting procedure in the event of a real alert and discontinue operation. WPEA is not required to broadcast the full requirements of Section 73.921 (b), unless it voluntarily desires to do so. To provide complete compliance, a suitable receiver is used to monitor a key station while WPEA is broadcasting.

Complete step-by-step operating instructions, scope of authority of operators with third-class licenses, prohibited procedures, a copy of the maintenance contract, and all licenses are posted on a control-room bulletin board. Additional pages were inserted, where necessary, in all instruction manuals to indicate equipment modifications. A master line drawing of all external wiring connections not covered by factory manuals and drawings of special equipment constructed especially for use at WPEA were prepared. Students were given instruction in operating the console and turntables and were made aware of the normal practices and procedures used in commercial radio stations. Those operators in actual charge of the transmitter are required to have valid third-class licenses, and all students connected with the station were advised to obtain a license to provide a flexible operation.

Conclusion

By stressing proper installation and constant attention to proper operating practices, WPEA was able to attain a smooth and efficient operation. The act of incorporation of The Phillips Exeter Academy, which was signed by the Governor of New Hampshire on April 3, 1781, begins: "Whereas the education of youth has ever been considered by the wise and good as an object of the highest consequence to the safety and happiness of a people . . ." It is hoped that WPEA will, in the years to come, continue to enlarge this belief of John Phillips of nearly two centuries ago. ▲

Aeronautical Field

(Continued from page 17)

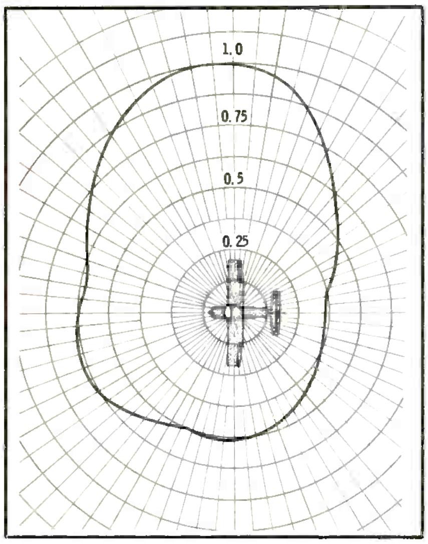


Fig. 6. Pattern of field-intensity meter antenna, distorted by metal in airplane.

It was found that the readings inside the metal airplane were strongest next to a window. With the airplane on the ground, the reading inside (with the right side of the plane toward the station) was about 1/10 the outside reading. More than one set of readings should be taken to correctly determine the correction factor.

Results

Fig. 7 shows the type of results obtained at WBBY. It is of interest to note that in the vertical plane there is still the same wide scattering of points in nulls that is observed when measuring nulls on the ground.

In the course of making these measurements, a fact became apparent that may be of help to other engineers in connection with their directional arrays. Directional patterns are determined from measurements made at a relatively few bearings, not all the way around. Thus minor variations—extra nulls or minor lobes—could exist between measured radials and never be known. But with an airplane flying at low altitude in a circular path around the array, you can for the first time see the directional pattern traced out graphically on the field-intensity meter. Nulls and minor lobes stand out precisely and can be checked quickly against landmarks to see if they fall at the

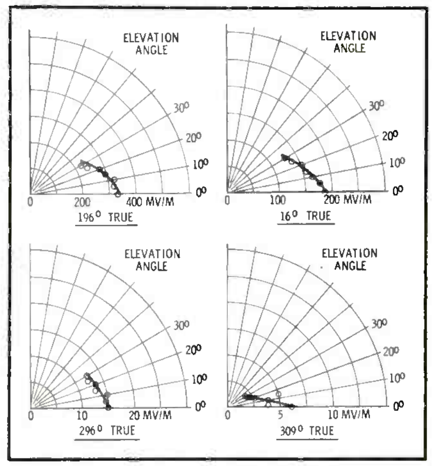


Fig. 7. Vertical-plane field intensities.

correct bearings. Also, pattern distortion can be discovered and its position in terms of bearings determined for further ground-level investigation.

Conclusion

There are some engineering problems in connection with directional antennas that can be solved only by making airborne field-intensity measurements. In many other cases, useful information can be gained by making such measurements. ▲

NEWS OF THE INDUSTRY

NATIONAL

NAB Opposes Frequency-Sharing Plan

Opposition to the FCC proposal that television broadcasters share with the Apollo space program two frequencies assigned to auxiliary TV services has been expressed by the National Association of Broadcasters. In its comments, NAB said the proposed operation would create interference that would "greatly restrict" the broadcasters' use of the frequencies to provide public service. NAB added that ample spectrum space is available among frequencies assigned exclusively to the government to accommodate the Apollo communications channels without encroaching upon the auxiliary TV frequencies. The FCC has proposed that broadcasters share the 2106.4 and 2101.8 mc frequencies to provide earth-to-space communications for the man-on-the-moon project from four earth research stations—Goldstone, Calif.; Cape Kennedy, Fla.; Corpus Christi, Tex.; and Kauai, Hawaii. The two frequencies now are used for remote TV pickups, studio-to-transmitter links, and intercity relays. NAB also noted that while the FCC proposal is "limited to the life of the Apollo project, it is noted in the proceeding that the project life expectancy is measured in terms of a decade." Therefore, they said, it is "conceivable that this project could go on indefinitely . . ." NAB requested that if the Commission decides to go ahead and require broadcasters to share the frequencies, "a specific time limitation should be imposed on the use of these frequencies" by the Apollo project.

Antennas for Mexico

Three high-power TV antennas have been ordered for installation in Mexico. Each has an input power rating of 100 kw. These are believed to be the most powerful VHF-TV antennas in the world. The antennas, to be supplied by **Jampro Antenna Company,** are for transmitters to be located on a 4000′ mountain top about 75 miles northwest of Vera Cruz. The channel 6 antenna, ordered by **Television Regional Veracruzana, S.A.,** is for a six-bay batwing antenna. The channel 8 antenna, for **Tele-Lajas, S.A.,** has a power gain of 19.2 with an omnidirectional pattern. The channel 10 unit, for **Television de Veracruz, S.A.,** is intended to provide an ERP of 1.4 megawatts with a 100-kw input.

New TV Technique

Fifty-year-old photographs and drawings are being given "life" on the CBS News series, "World War I," by means of "still-motion" photography. In this technique the camera "eye" pans across a still picture to give an illusion of motion. These effects are produced using a "human-engineered" single-stick control for all movements and speeds. The control device, developed by **Measurement Systems, Inc.,** permits the cameraman to control speed and direction of pan by varying pressures on a single "joystick." The joystick control converts forces in any direction into electrical signals that control camera movements. In doing so, the stick does not move more than 1/16″ in any direction. This design was indicated by recent research in Human Engineering, which aims at making the most of human capabilities by designing mechanical equipment to fit the operation of the human nervous and muscular systems.

INTERNATIONAL

Firm Sold

Benco Television Associates, Ltd., Toronto, has been sold to **Neighbourhood Television Ltd.,** of Guelph, Ontario. Neighbourhood Television is acquiring a 100% interest in Benco. **Blonder-Tongue Laboratories, Inc.** held a controlling interest in Benco since the fall of 1961. Benco manufacturers translator and community antenna television products, and Neighbourhood Television owns and operates CATV systems in Canada.

A Radio Pioneer Passes

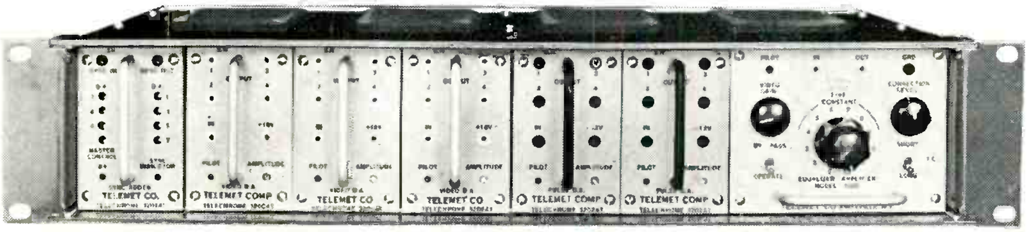
Charles Samuel Franklin, one of the early radio pioneers, died recently in London. Mr. Franklin joined the **Marconi Company** in 1899 and almost immediately left for South Africa and the Boer War to help introduce wireless to the battlefield. His first close contact with Marconi himself came in 1902 when they sailed across the Atlantic, successfully receiving transmission from Poldhu in Cornwall at ranges of up to 1550 miles.

In 1916 Franklin and Marconi started their first experiments with short-wave communications, Franklin designing a special spark transmitter that operated in compressed air. Some highly promising results were obtained from these initial experiments, and they eventually led to the first beamed short-wave system in the world. Some of Franklin's designs are still in use in HF communications.

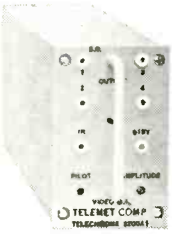
Franklin continued to work on the development of his short-wave beam system and by 1933 had even reached a stage where he was experimenting with radar. He was closely connected with broadcasting and helped in the design and installation of 2LO, London's first broadcasting station. He also designed the antenna system for the original BBC television station at Alexandra Palace. Sixty-five patents stand to Franklin's credit. These include the variable capacitor, the ganged capacitor, the reaction circuit, and the concentric feeder. ▲

SATISFY ALL DISTRIBUTION REQUIREMENTS

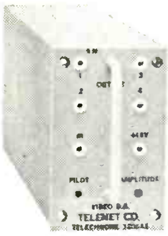
with these transistorized and completely self-contained modules



MODEL 4000 Rack Mounting Frame provides common mounting facility for any combination of modules.

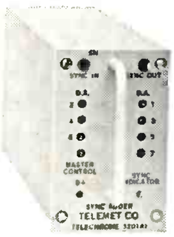


MODEL 3200

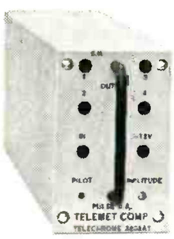


MODEL 3206

MODELS 3200 and 3206 Video Distribution Amplifiers feature high impedance bridging inputs and 4 identical isolated outputs, source terminated in 75 ohms.



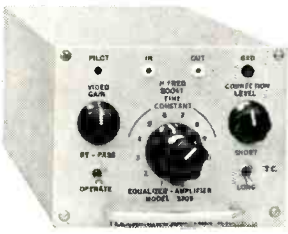
MODEL 3201



MODEL 3202

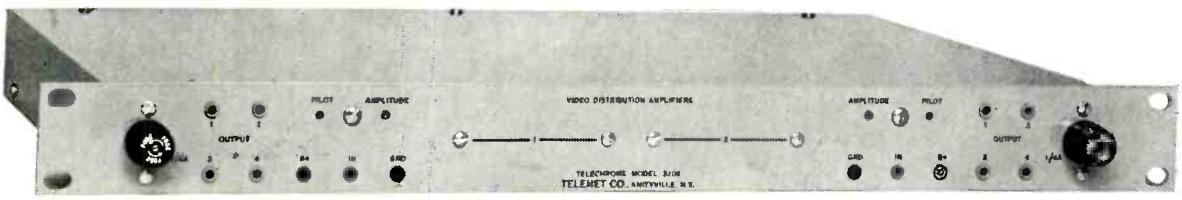
MODEL 3201 Sync Adder provides a means of mixing sync into any or all video amplifiers in the frame.

MODEL 3202 Pulse Distribution Amplifier regenerates sync, blanking or drive pulses, providing 4 identical isolated outputs.



MODEL 3205

MODEL 3205 Equalizer Amplifier now contains frequency boost circuits providing up to 10 db at 4.5 Mc. Slope adjustable to match cable. Also provides adjustable time constant correction. Ideal for Frequency Phone Correction of long coaxial lines.



NEW MODEL 3208 Dual Video Distribution Amplifier actually contains 2 separate and completely independent amplifiers and power supplies of the Model 3206 type in a space-saving configuration.

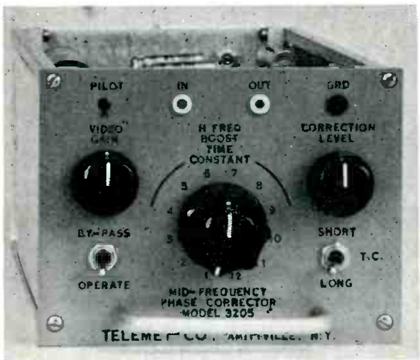
See these new items at the NAB Show

Model 3203—Clamper Amplifier with remote gain control
Model 3209—Color Stabilizing Amplifier
Model 3518—Color Bar Generator
Model 3806—Electronic Pointer
...and many others

TELEMET COMPANY
a division of
GIANNINI SCIENTIFIC CORPORATION
185 DIXON AVENUE, AMITYVILLE, N.Y. • PHONE (516) 541-3600

Circle Item 24 on Tech Data Card

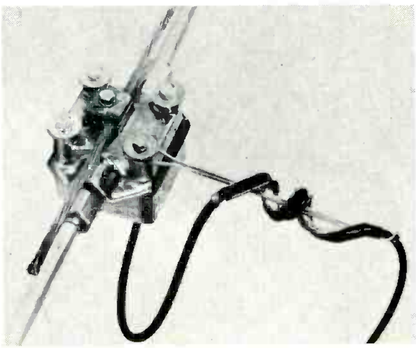
NEW PRODUCTS



Equalizer-Amplifier

Time-constant correction to reduce streaking, overshoots, and undershoots in color and monochrome TV signals is provided by the Model 3205B2 equalizer-amplifier. This **Telemet** amplifier also provides frequency boost of up to 10 db with adjustable slope. The amplifier is designed to operate with a 1-volt peak-to-peak composite or noncomposite video signal. It can be used for equalization of runs of 75-ohm coaxial cable up to 2000′ in length. Any one of a series of correction curves can be selected with a front-panel control that connects an appropriate internal capacitor in the high-frequency boost-amplifier circuit. A concentric knob is used for selecting the phase correction. A continuously variable gain control is provided. A by-pass feature permits routing the video signals around the unit if no correction is required. The unit is fully transistorized and fits the company's Model 4001-A1 rack mounting frame.

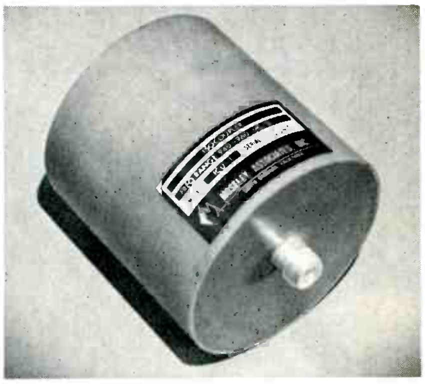
Circle Item 111 on Tech Data Card



Tapoff for CATV

The new "Multee" tapoff is engineered to accommodate four housedrop taps and still maintain excellent VSWR and low insertion loss. The fully weatherproof **Entron** unit (MT Series) has a strand-mounting clamp for easy installation. It features throughline match and backmatch for all-band color, extremely low insertion loss (.3 db average), seven attenuation values, and high isolation between tapoffs. The unit is supplied with UHF or complete aluminum flare fittings for the throughline and with threaded tapoff fittings.

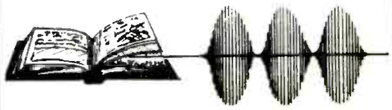
Circle Item 112 on Tech Data Card



Coupler For STL Lines

When the Model ICU-1 Isocoupler is used, an STL antenna and transmission line can be mounted directly to an ungrounded standard-broadcast tower with negligible effect on the base impedance and without employing an insulated quarter-wave matching section. The coupler has less than .3 db insertion loss to signals in the 890 to 960 mc band and presents less than 10 pf of capacitance between the input and output connectors. Rated at 5000 volts peak, this coupling unit is completely sealed in a moisture-proof epoxy resin and is designed to be strapped to the base of an AM tower. Weighing less

BOOK REVIEW



Basic Electronics: Bureau of Naval Personnel; Dower Publications, Inc., New York, New York; 459 pages, 6½ x 9¼, paperback, $2.75. This republication of Navy Training Course NavPers 10087-A has not been changed from the Navy version except for the omission of a list of training films. Nineteen chapters include fundamentals of electron tubes and transistors, tuned circuits, amplifiers, oscillators, transmission lines, transmitters, receivers, and an introduction to radar. The last two chapters serve as an introduction to computers. An appendix lists electronic color codes and symbols. An 8½-page index is also included.

The reader must already have an understanding of basic electricity if he is to comprehend this text. A knowledge of basic algebra and trigonometry is needed to thoroughly understand some sections. Line drawings, schematics, charts, graphs, and waveform drawings are used throughout to supplement the text.

The introduction urges the reader to study the book with pencil and paper and to refrain from skimming the text. This is excellent advice if the aspiring technician is to get the most from the volume.

than two pounds, the unit is 5" in overall length and 4" in diameter. Type N RF connectors are used. The price of this **Moseley Associates** product is $150.

Circle Item 113 on Tech Data Card

Compact Console

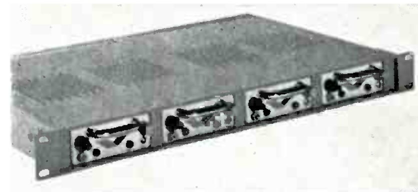
Up to eight separate audio sources can be selected through the four mixing channels of the **Sparta** A-10B console. Four plug-in preamplifiers and/or four plug-in input transformers can be supplied so that the console can handle as many as eight low-level inputs. Also included are cue facilities for all inputs, a headphone jack with gain control, and a public-address-system output. The unit has speaker muting and a self-contained monitor speaker. All preamplifiers, the program amplifier, and the monitor amplifier are of solid-state design and modular plug-in construction for ruggedness. The new console can be operated from an 18 to 22½ VDC or a 115 VAC, 50-60 cps source. It weighs 10 lbs.

Circle Item 114 on Tech Data Card

Bulk Tape Eraser

The Model 150-A Magneraser Junior, manufacturered by **Amplifier Corp. of America** and sold by **Artronics Company, Inc.,** is designed to remove from a reel of tape, in a matter of seconds, all recorded signals and to reduce background noise below that of new tape. The unit can also be used for demagnetizing record-playback and erase heads. This reduces tape distortion and background noise which is added to program material by magnetized heads. The Model 150-A can also be used to demagnetize tape guide posts, bearings, pulleys, flywheels, capstans, tools, watches, and magnetized metal. Designed for easy, hand-held operation and housed in a molded plastic case, the eraser is furnished with operating instructions and an eight-foot gray vinyl-covered line cord. List price is $18.95.

Circle Item 115 on Tech Data Card



Solid-State Amplifier

This solid-state video distribution amplifier, by **Vital Industries,** combines compact construction and many desirable features; self-contained regulated power supply, low differential gain and phase, high signal-to-noise ratio, and high-gain stability. The Model VI-10A provides four identical 75-ohm outputs from a 50K-ohm loop-through input, and gain is adjustable from −6 to +6 db, with frequency response within ¼ db to 20 mc.

Circle Item 116 on Tech Data Card

STOP You lose two turns for going too far. Turn back to page 86 for Instantaneous Selection Remote Control by Bionic Instruments.

Check Item 53 on Tech Data Card

ENGINEERS' TECH DATA

AUDIO & RECORDING EQUIPMENT

59. ALTEC—Folder on line of recording and broadcast equipment.
60. AMPROBE—Full-line catalog on recorders, including information on REE-16.
61. ATC—Specification sheet on the ATC-55 solid-state multiple-cartridge unit.
62. BROADCAST ELECTRONICS—Packet contains specifications and prices for "Spotmaster" tape-cartridge systems.
63. CINE SONIC—Data sheet describes rental service which supplies background music prerecorded on 7", 10½", and 14" reels of tape or in cartridges.
64. DUOTONE—Booklet No. EL-1 describing new "Elipticon" stylus.
65. LANGEVIN—Descriptive literature covering complete line of professional sound equipment.
66. MAGNASYNC—Information on motion-picture magnetic-film sound-recording equipment and accessories.
67. McMARTIN—Data sheets covering complete line of solid-state and tube-type SCA multiplex monitors.
68. MILES REPRODUCER—Literature describes automatic logging recorder.
69. QUAM-NICHOLS—New catalog lists coaxial, extended-range, and hi-fi speakers and tweeters.
70. SCULLY—Bulletin SP-14 describing Model 280 solid-state recorder with 14" reel-size capacity.
71. SENNHEISER—Bulletin and technical information on Model MD 421 dynamic cardioid studio microphone with built-in bass control.
72. SPARTA—New product brochure describes and illustrates "Sparta-Matic" tape-cartridge systems, audio consoles, and other related studio equipment.
73. SWITCHCRAFT—New product bulletin No. 149 describes the latest molded headphone coiled cord.
74. TURNER—New four-color, 16-page microphone catalog.
75. VIKING OF MINNEAPOLIS—Specification bulletins describe Model 96 tape transport, RP120 record-playback amplifier and Model 38 cartridge handler.

COMPONENTS & MATERIALS

76. BRADY—Self-bonding signature plates for studio property identification and control.
77. TIMES WIRE—Product sheets with technical data on various flexible and semiflexible coaxial cables.

MICROWAVE DEVICES

78. LECTRONIC—Bulletin No. 83 contains a comprehensive presentation of microwave equipment, waveguide components, regulated power supplies, test equipment, and electronic components.
79. MICRO-LINK—Brochures on portable microwave link and fixed-station relay link; also planning guide for 2500-mc instructional TV systems.
80. MICROWAVE ASSOCIATES—Information on newly introduced MA-8531, a companion unit to the MA-2 microwave TV relay system.
81. SURFACE CONDUCTION—Bulletin on microwave-by-wire (G-line) for long-distance, broadband transmission.

MOBILE RADIO & COMMUNICATIONS

82. MOSELEY—New technical bulletin describes remote pickup transmitter and receiver featuring low distortion, extended frequency response, and automatic leveling and peak-limiting circuits.
83. MOSLEY—Literature describes Citizens band antennas.

POWER DEVICES

84. HEVI-DUTY—Bulletin No. 7-12 describes line-voltage regulator that uses saturable-core reactor.
85. TERADO—Brochures on line of mobile power inverters that supply instant AC power.

REFERENCE MATERIAL & SCHOOLS

86. CLEVELAND INSTITUTE OF ELECTRONICS—Brochure describes electronics slide rule with four-lesson instruction course and grading service.
87. HOWARD W. SAMS—Literature describing popular and informative technical publications; includes latest catalog of technical books.
88. JERROLD—Eight-page technical brochure describes a new bridge method of sweep-frequency impedance measurement.
89. RIKER—Brochure on how to assemble a custom video-processing amplifier with all-transistor video modules.

STUDIO & CAMERA EQUIPMENT

90. CBS LABS—Literature on Audimax III automatic level control, Volumax 400 automatic peak control.
91. CLEVELAND ELECTRONICS—Data concerns deflection yoke and alignment coil for 3" image orthicons.
92. ZOOMAR—Bulletins contain descriptions of zoom lenses and remote-control systems for television cameras.

TELEVISION EQUIPMENT

93. STANDARD ELECTRONICS—Technical data on new solid-state TV driver-amplifier combinations; detailed specs on low-cost visual/aural combinations.
94. TELEMET—Literature describing clamper amplifier, color-bar generator, and color-stabilizing amplifier.
95. VITAL INDUSTRIES—Data sheets describing video-distribution amplifier Model VI-10A, pulse-distribution amplifier VI-20, and video clamper-stabilizer VI-500.

TEST EQUIPMENT & INSTRUMENTS

96. BALLANTINE—Information on new Model 355 DC-AC digital voltmeter.
97. HICKOK—Brochure on Model 580 solid-state tube tester and general test-equipment catalog.
98. LECTROTECH—Separate bulletins detail color generator and vectorscope Model V7, color generator V6, and regulated modular power supplies.
99. SPRAGUE—Technical data and specifications on Model 500 interference locator and accessories.
100. TELONIC—Four-page brochure describes line of sweep generators, RF attenuators, RF detectors, and coaxial switches.
101. TRIPLETT—New catalog No. 46-T concerning complete line of VOM's, VTVM's, signal generators, and tube and transistor analyzers.

TOOLS

102. ENTERPRISE DEVELOPMENT—Bulletin features new desoldering-resoldering iron for use on printed circuit boards.

TRANSMITTER & ANTENNA DEVICES

103. BAUER—Data sheet concerning Model 607 FM broadcast transmitter, 1000-watt unit housed in a one-piece custom cabinet.
104. CCA—Information available on complete line of AM and FM broadcast transmitters and accessories.
105. CONTINENTAL—Brochure describes Model 317C 50-kw AM broadcast transmitter.
106. CORNELL-DUBILIER—Replacement component selector, TV-FM reception booklet, and 4-page rotor brochure.
107. GATES—Latest information concerning 5-kw AM transmitter Model BC-5P-2.
108. RUST—Data sheet on Autolog AL-100R, remote-operation version of continuous line synchronous system.
109. SCALA—Catalog sheets describe antennas for monitoring FM and TV signals.
110. WARD ELECTRONICS—Information on CDL video signal processing amplifiers and CO.-EL. UHF slot antennas.

Professional Services

Classified

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

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

EQUIPMENT FOR SALE

EQUIPMENT WANTED

Personnel

Advertisers' Index

SEE YOU AT NAB BOOTH 215

McMartin

No other FM MONITORS can do so much!

McMartin TBM-4000

FM/SCA MULTIPLEX MONITOR FCC TYPE APPROVED #3-116

This is the most versatile instrument available for monitoring all main channel modulation and SCA Multiplex operating characteristics. Compatible with FM stereo.

Direct meter readings of:

- Total Modulation
- SCA Modulation
- SCA Frequencies
- Crosstalk
- SCA Injection

McMartin TBM-3000

McMartin TBM-3500

FREQUENCY & MODULATION MONITORS FCC TYPE APPROVED #3-113, #3-119

- The TBM-3000 is a completely self-contained frequency monitor and the TBM-3500 is a self-contained modulation monitor.
- The 3000 used in conjunction with either the 3500 or 4000 fulfills the FCC requirement for a station monitor.
- The TBM-3500 is completely compatible with FM stereo.

McMartin TBM-2500

RF AMPLIFIER FOR REMOTE MONITOR OPERATION

The TBM-2500 will drive any combination of two monitors including other brands.

- Isolated high and low level outputs.
- Excellent stability and long tube life.
- 2 watt output with 1000 μv input.
- Complete with yagi antenna and coaxial cable.

McMartin

Originality by

McMartin Industries, Inc.

605 North 13th Street
Omaha, Nebraska

Code 402 — 342-2753

In Canada Sold By: Canadian Marconi Company, Montreal 16, P. Q.

Circle Item 58 on Tech Data Card

ONLY RCA's BROAD LINE OF IMAGE ORTHICONS OFFERS A CHOICE OF ALL THESE FEATURES

Now you can bring out the best in your TV pick-up equipment—even in the most critical applications—because you can select the proper RCA image orthicon specifically designed to cope with the *practical problems* of everyday broadcasting. Ask your RCA Broadcast Tube Distributor to explain this in terms of a specific, practical, everyday problem you face or might be faced with shortly. Or, write for current information: Camera Tube Booklet CAM-600.

SEE YOU AT NAB RCA BOOTH 100

IMAGE ORTHICON SELECTOR

Type	Color	Color at B/W Light Levels	Black & White	Field Mesh	Precision construction	4½″ diameter	Studio Taping	Matched sets	Long Life Targets
4401V1			X(1)						
4415-4416	X	X		X	X			X	
5820A			X						
5820A/L			X						X
7293A			X	X					
7293A/L			X	X					X
7295B			X	X		X			
7389B			X	X		X	X		
7513	X			X	X		X(2)		
7513/L	X			X	X		X(2)		X
7629A			X(3)						
8092A	X		X(3)	X	X				
8093A			X	X			X		
8093A/L			X	X			X		X

(1) For exceptionally low studio light levels. (2) 7513/V1 or 7513/L/V1.
(3) Thin film semiconducting target.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

The Most Trusted Name in Electronics