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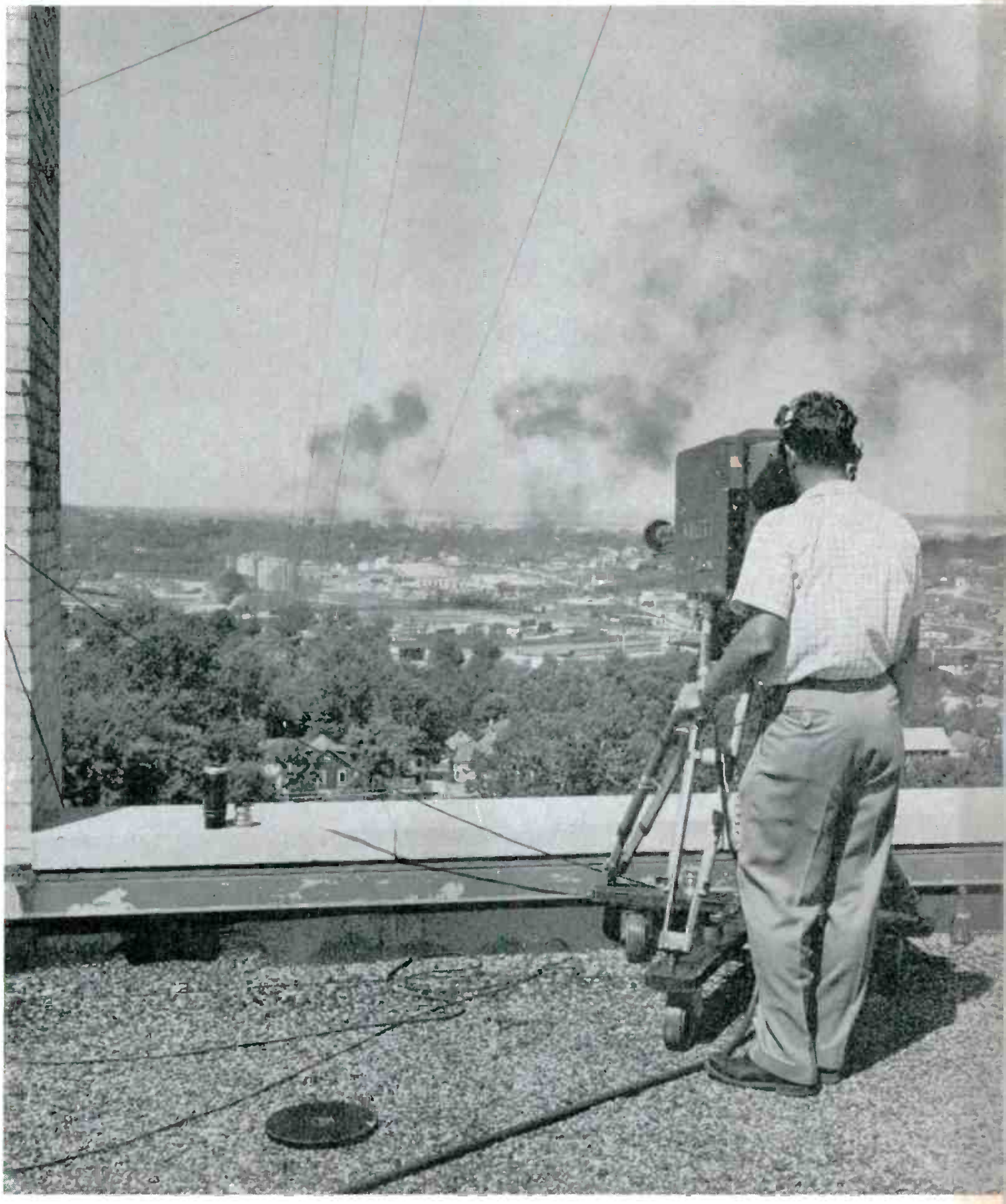
BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY



BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

VOLUME 1 **SEPTEMBER, 1959** **NUMBER 5**

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Cover

A disastrous fire which broke out three blocks from the studios of WDAF-TV in Kansas City was covered by cameras mounted on the studio roof and taped for local repeats and network feeds. The story begins on page 20.

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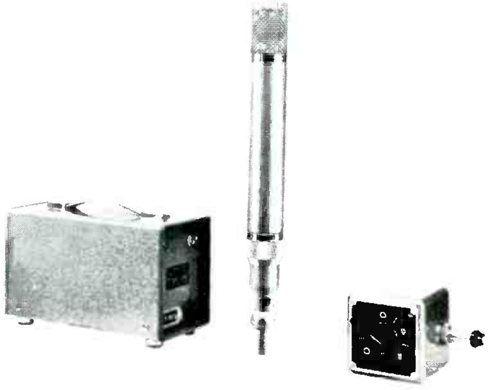

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Sensitivity (for 200 ohms): 1 mV/μbar ±1.5 db.

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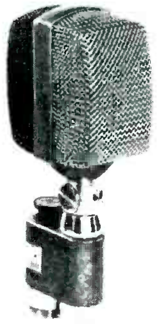

D 30 B
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A universal microphone for recording studios, this microphone virtually replaces three different types with different response characteristics:

1. In normal position as an omni-directional;
2. A ribbon microphone with figure 8;
3. A cardioid microphone.

Simple pattern switching. A built-in bass cut permits the reduction of low frequency response in steps of 7 and 12 db on close talk.

TECHNICAL DATA

Frequency range: 30 - 15000 cps.

Frequency response: ± 2.5 db with reference to standard curve.

Sensitivity: 0.12 mV/μbar.

Impedance: 150 ohms (75 ohms in cardioid position).

Directional characteristics: Cardioid and omni-directional.

B 15
DYNAMIC DIRECTIONAL MICROPHONE

Close talking hand microphones with cardioid characteristic. Can also be supplied with harness for reporters. Especially suitable for radio and television reporting on portable tape recording equipment under conditions where the background noise ratio is high.

TECHNICAL DATA

Frequency range: 50 - 15000 cps.

Frequency response: ± 3.5 db with reference to standard curve.

Sensitivity: 0.18 mV/μbar.

Impedance: 200 ohms.

Directional characteristic: Cardioid.

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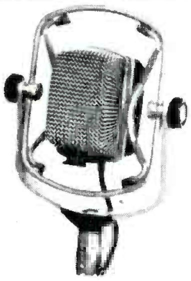

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DYNAMIC DIRECTIONAL MICROPHONE SHOCK MOUNTED

With Remote Control of Directional Characteristics.

This studio microphone provides a choice of eight patterns, any of which can be selected by a remote control unit, as follows:

2 cardioids with opposite directions of max. response
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1 figure 8
4 intermediates, 2 of which are hypercardioids.

All patterns may be brought into operation during program pick-up without clicking or other disturbances. In addition, a bass switch allows the response curve to be dropped by 7 or 12 db at 50 cps, to increase shock resistance of the microphone and prevent over-emphasis of the bass at very short range.

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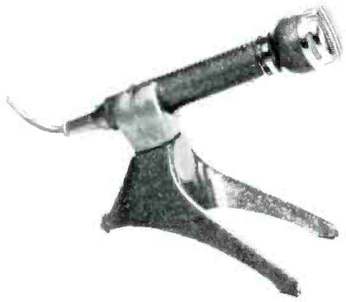
TECHNICAL DATA

Frequency range: 30 - 15000 cps.
Frequency response: ± 2.5 db with reference to standard curve.
Sensitivity: 0.12 mV/μbar at 1000 cps.
Impedance: 150 ohms at all patterns except cardioid positions, which are 75 ohms.
Directional characteristics: Omni-directional, figure 8, and cardioid.



D 19 B
DYNAMIC DIRECTIONAL MICROPHONE FOR TAPE RECORDERS

With cardioid characteristic and bass cut switch, this microphone covers the entire frequency range from 40 - 16000 cps. Rising characteristic. The pronounced directional characteristic, especially in the lower frequencies means freedom from background noises.

TECHNICAL DATA

Frequency range: 40 - 16000 cps.
Frequency response: ± 3 db. with reference to standard curve.
Sensitivity: 0.18 mV/μbar (2.5 mV/μbar at high impedance).
Impedance: 200 ohms (high impedance 50K ohms).
Directional characteristic: Cardioid.

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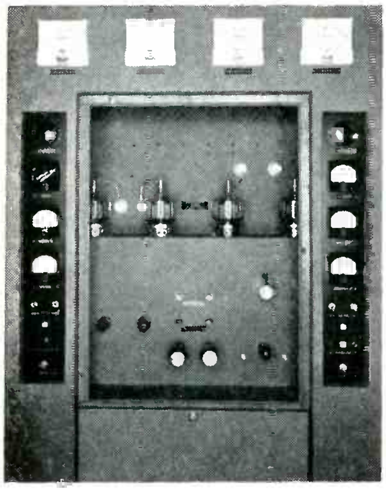
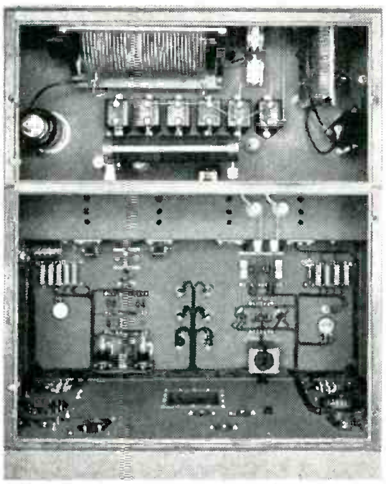
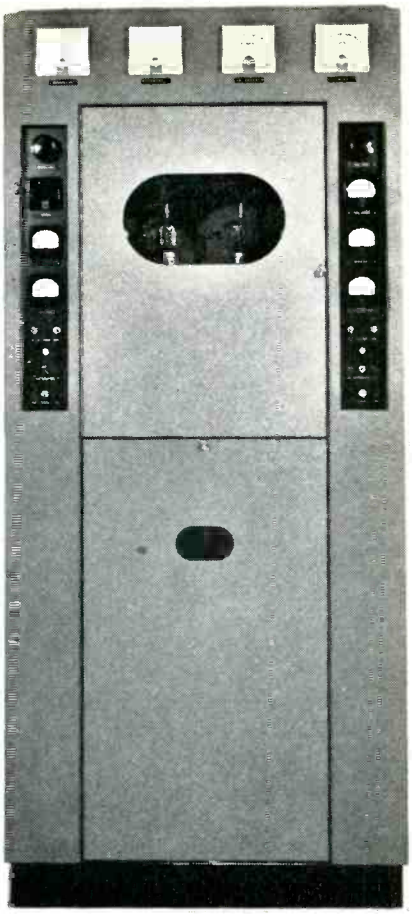


All audio and R.F. tubes are removable from upper door. Each critical circuit is separately metered.



Vacuum variable tank condenser, output circuitry, and accessibility of components are shown.



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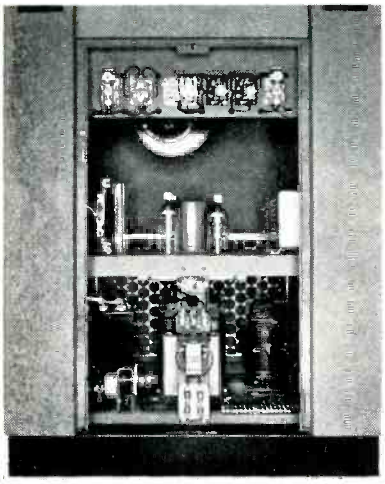
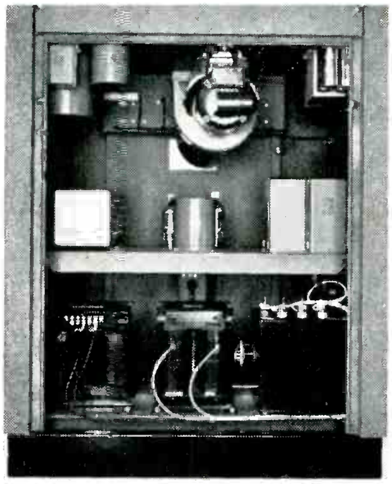


Relays are in a dust-free location. All components and circuit terminals are in convenient locations.



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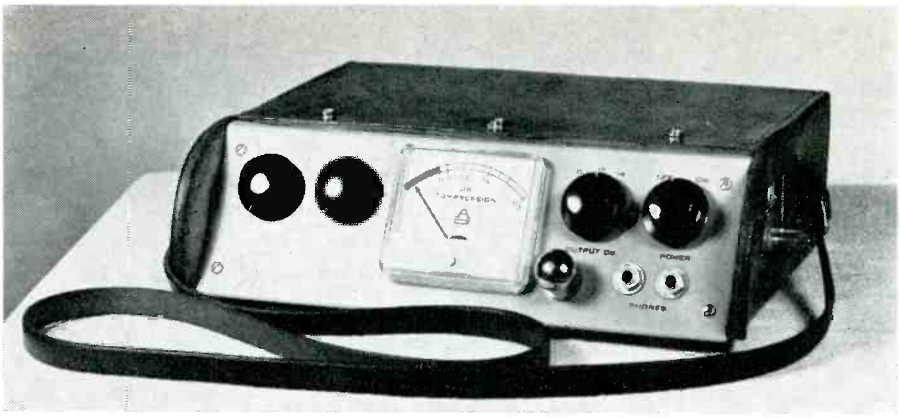


AN AUTOMATIC FADER

By ED MILLER*

Design considerations for a broadcast remote amplifier incorporating an automatic gain circuit

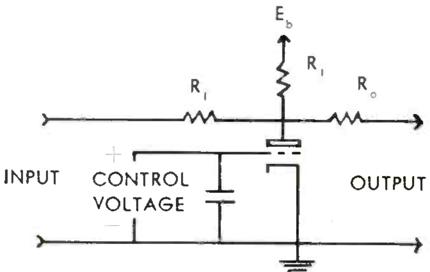


Figure 1

Basic electronic pad.

*KWEI, Box 791, Weiser, Idaho.

In a "T" pad which has equal input and output impedances, and where the minimum insertion loss is in excess of 25 db., the input and output legs can be fixed at approximately the value necessary for a 30 db. loss, and the attenuation controlled entirely by varying the value of the center leg resistance. With such an arrangement, the insertion loss may be adjusted from 25 db. to infinity, without causing more than 10 per cent change in either input or output impedance.

If the variable element in such a pad is replaced by the plate impedance of a vacuum tube, attenuation can be controlled by varying the grid voltage, thereby varying the plate impedance. In an application of this type, it is not the DC plate to cathode resistance that is the center leg impedance, but rather the plate impedance, Rp, of the tube used, which is determined in the usual manner,

$$Rp = \frac{\Delta Ep}{\Delta Ip}$$

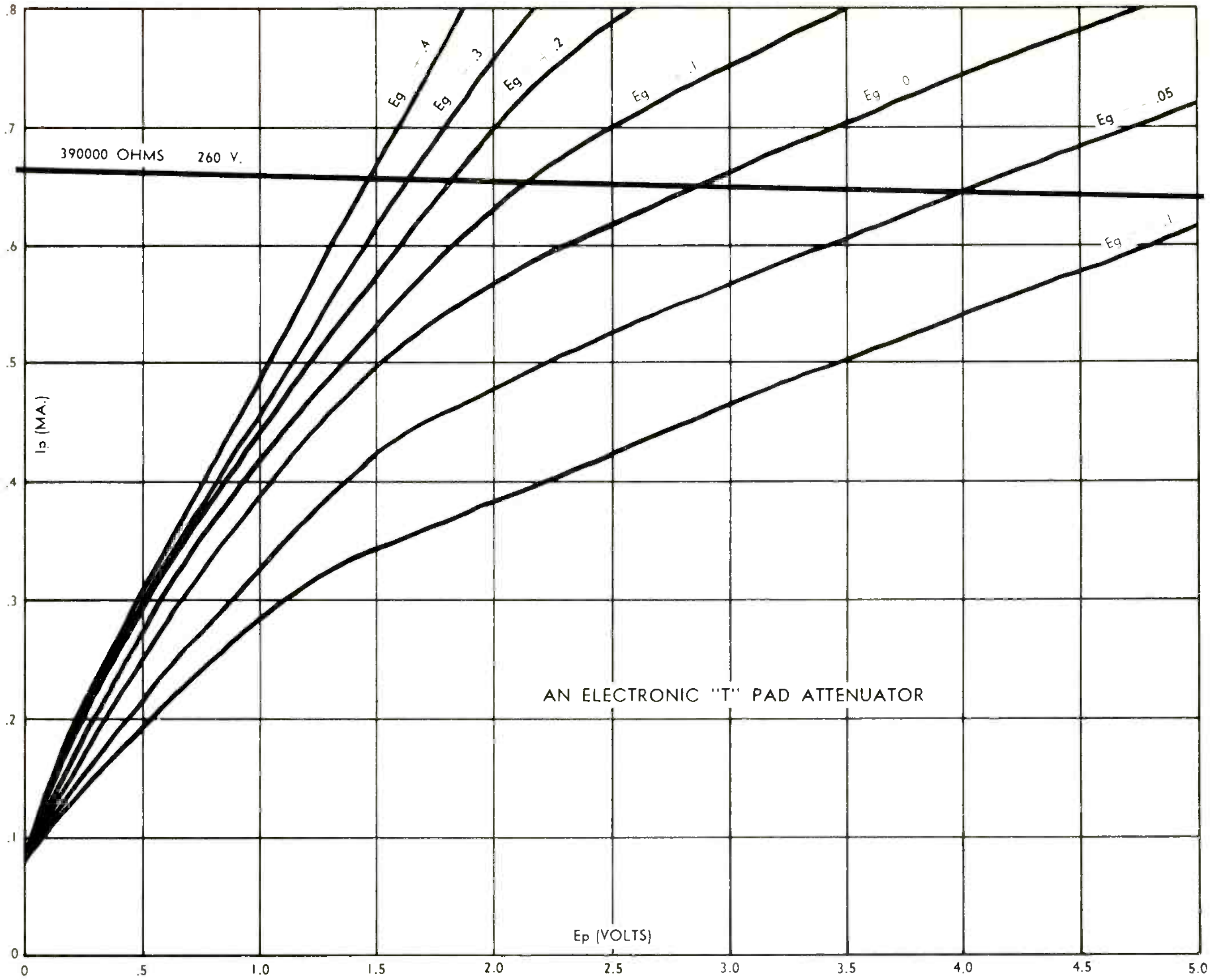


Figure 2
Plate characteristics of one section of a 12AU7 tube.

Figure 2 shows a family of curves for one section of a 12AU7, with a load line for a 390,000 ohm plate load from a supply of 260 volts. This graph shows a change in excess of 15 db. in plate impedance, between the grid voltages of minus .05 volts and positive .4 volts. Note that the plate impedance remains relatively constant over most of the negative grid operating range. Therefore, maximum control will be obtained with positive grid operation. This has a distinct advantage, in that the voltage present at the plate of the tube will be limited in its range to only a volt or so over a range of several db. change in plate impedance. This reduces the amplitude of the control transient in the output, which permits operation at lower frequencies; that is, frequencies more nearly approaching the control transient frequency, without the need for push-pull operation and transformer termination to balance out the transient. Thus the lower frequency limit of single-ended operation is controlled by the desired attack time (this being generally much shorter than the release time), and by the amplitude of the transient in relation to the signal at the output of the "T"-pad. The upper frequency limit is dependent upon the plate-to-grid and plate-to-cathode capacity of the tube used, and the value of the input leg of the "T"-pad. With most standard receiving triodes, essentially flat operation can be had from less than 100 cycles to more than 100 kc.

As Figure 2 shows, over a range in excess of 15 db., the change in plate impedance is very nearly inversely proportional to the change in grid voltage. This characteristic adapts this method of attenuation to forward acting self-control, for use in an amplifier of automatic gain. That is, the signal input is rectified and applied to the grid, to control the attenuation, and, therefore, the output level. This is contrary to the usual method of volume compression, where a portion of the output voltage is rectified and used as the control voltage. In the usual, or backward-acting, circuit, there is a low frequency feedback path, from the output, through the control system, to some portion of the circuit preceding the output.

For this reason, single-ended operation is limited to use where the control transient is very slow. It cannot be practically used where rapid control is desired, except in push-pull arrangement. Also, because the level at the output determines the degree of compression, the output must increase, however minutely, with increased input.

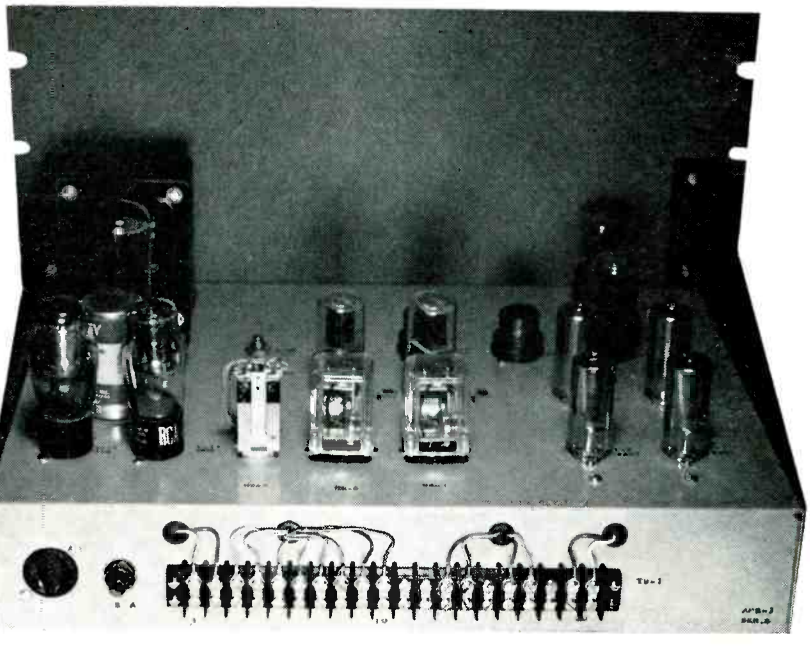
The forward-acting "T"-pad permits a design, if desired, wherein the output actually decreases with an increase in input. It also permits single-ended circuitry without fear of oscillation, because there is no feedback path. The lowest frequency is still limited, but not because of feedback. And this low frequency limitation applies to the usual form of compressor also, in any case where oscillation is not a determining factor.

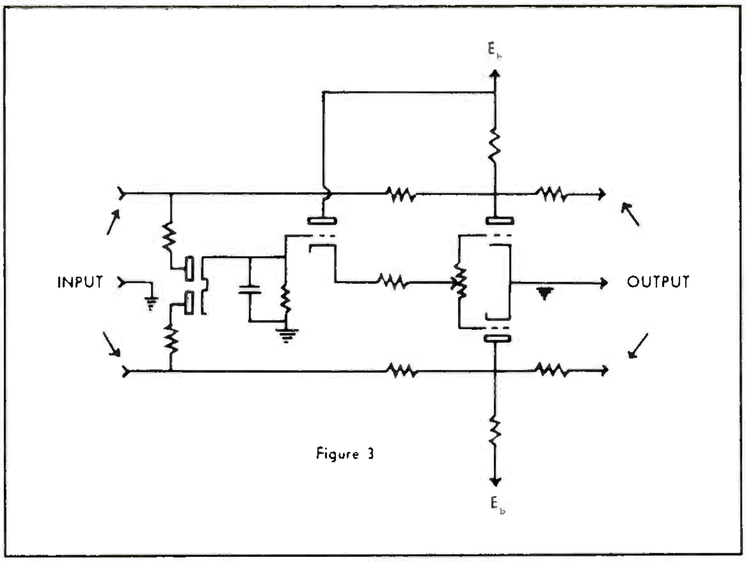
In separate control attenuators, because the grid control power required is small, control voltage can be controlled by manual, electromechanical, or electronic means. In either case, the attack and release times can be controlled by applying the control voltage through suitable RC networks. If self-control automatic gain is desired, it is generally necessary to isolate the control voltage from the signal source, because positive grid voltage is used and therefore, grid current flows. This can be most simply done by using a cathode follower to supply the control voltage to the grid of the control tube. In applications where relatively slow attack times are required, the cathode follower can also act as the rectifier of the applied signal, with a high value of capacitance from its cathode to ground. When such a circuit is used, the attack and release times are nearly equal. Whether rectification is accomplished preceding, or in, the cathode follower, the value of its cathode resistance can be used to adjust the grid voltage of the control tube for the plate impedance desired of the center leg at zero signal.

Considerations in the design of this electronic "T"-pad include input and output impedances, plate supply voltage and minimum grid operating voltage.

From the tube characteristic curves, a point is selected on the zero grid voltage line where the plate impedance is less than 10 per cent of the input or output impedance, whichever is smaller. A load line is then drawn from the plate supply voltage through this point to zero plate volts. The plate impedance is then determined graphically at various grid voltages, in its positive range, and then the attenuation calculated at the various grid voltages. If the attenuation rate is not the optimum for the particular application, another load line should be drawn from the same supply voltage through another point on the zero grid voltage line, slightly removed from the previous point. This procedure can be repeated until the desired rate of attenuation is arrived at, then the plate load resistor can be calculated from the load line. Naturally, the plate resistor can be determined by experiment if it is so desired.

This method of self-control or volume compression adapts itself to compact, light-weight applications. Compact, because push-pull circui-





Electronic balanced "H" pad used in Broadcast Remote equipment.

try can be used with a twin triode in the control portion; and lightweight, because no transformers are necessary for the control operation.

A practical application of this automatic gain circuit is in broadcast remote equipment. There has been a long-felt need for some form of automatic gain-rider incorporated within remote broadcast equipment, especially when it is used for play-by-play description of athletic events. Its use permits one man to sportscast from a remote location without being burdened with control of the program level. It also prevents excited exclamations by the sportscaster that, because of their spontaneous nature, are too rapid to allow adequate human control, from overdriving the output stage of the remote amplifier, the telephone line in use, or the equipment at the station studio or transmitter.

Besides providing all that a conventional two-channel remote amplifier does, an automatic gain remote permits one man operation without detriment to program quality. Because of its wide frequency response and low distortion, it can even be used in unattended operation, such as broadcasting a church service; or, by using one channel for a turntable pickup, it can be easily used for remote disc jockey shows (from a store, etc.).

The photograph shows how compact such automatic gain control equipment can be, yet the unit pictured has two microphone inputs, self-contained power supply, an output of 18 db. into a 500 ohm line, two monitoring jacks, and metered compression over a 20 db. range.

Typical operating characteristics are:

Frequency response: ±1.0 db. from 50-15,000 cps.

Distortion: 1% or less from 50-15,000 cps at 20 db. compression.

Attack time: 16 milliseconds.

Release time: .9 seconds.

The complete circuit uses conventional triode cascade pre-amplifiers, followed by a single triode phase inverter, the output of which passes through the electronic attenuator into two push-pull triode stages. Figure 3 is a schematic of the automatic gain portion of the amplifier, showing full-wave diode rectification of the applied signal, with the resultant pulsating DC voltage filtered in a manner to provide reasonably rapid attack and slow release. This filtered POSITIVE DC voltage is then applied to the grid of a cathode follower, whose cathode resistor is adjusted to provide the desired compression ratio. All of the cathode current of this tube flows through the grids of the compression control tubes. A variable resistor is used to equalize the zero signal voltages at each of these grids, so that each tube will operate over the same range of plate impedances, thus reducing any distortion that would present itself in succeeding push-pull amplifiers not precisely balanced. In the remote amplifier shown, the output stage uses a balancing resistor in its cathodes, to more fully realize the low distortion inherent in this type of automatic gain circuit.

The push-pull arrangement changes the electronic pad from a "T" to a balanced "H", but except for the balancing of the tube impedances, the design is the same. Push-pull circuitry would not be mandatory for remote equipment, but its use permits a rapid attack time and wide frequency range.

A question may arise in your mind concerning the tube life to be expected in a circuit such as this, where sometimes the grid current approaches the plate current in value. Several life tests have been performed with all indications pointing to no reduction in tube life when used in this circuit. One piece of remote equipment using this electronic attenuator was put in service in early 1953 and has been used on almost all remote broadcasts at KWEI, Weiser, Idaho, since that time. The compression control tube and the cathode follower have not been changed during that period, and the characteristics of the amplifier and control were unchanged when measured in January, 1959. Apparently normal tube life can be expected.

Earlier, the two primary methods of using automatic electronic gain circuits were discussed. An application of one, the self-control circuit, is exemplified in the automatic gain broadcast remote equipment. An application of the other, separate-control circuit, in a practical, working installation, is as voltage controlled faders for control of audio signals in broadcast program automation.

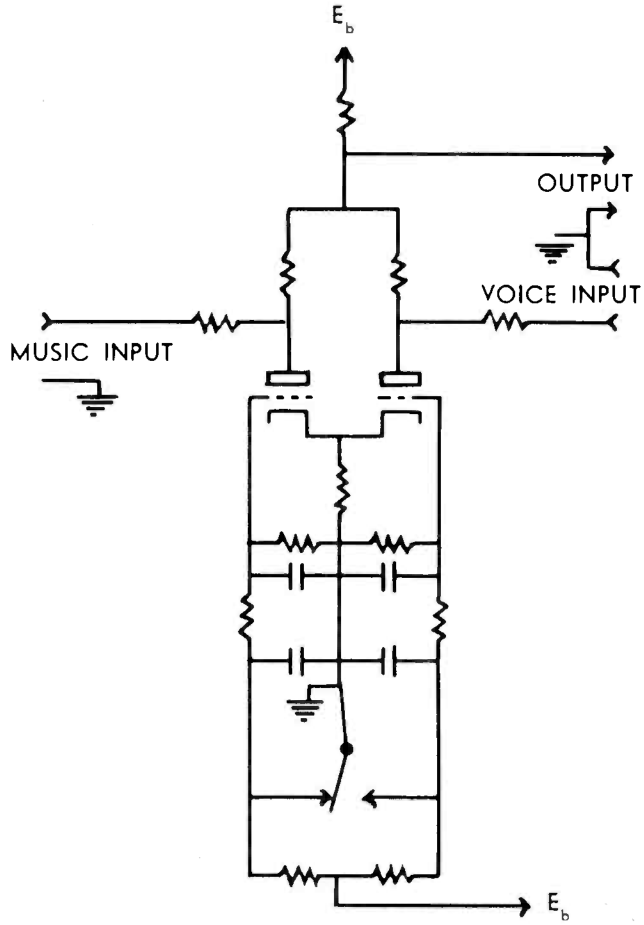


Figure 4

Relay controlled duplexfader as used in automatic program installation.

Figure 4 shows the faders as used in a program automation system installed at KAYT, Rupert, Idaho. Its use in this particular service is of a specific nature, and I think it best to briefly outline what was desired of it.

Audio from a music system and audio from a magnetic tape playback amplifier were mixed and fed to a single input of the master control console. Any extraneous noise on the tape, after the control signal had ended, should be faded as much as possible. Likewise, any noises from the music system during its record-changing cycle should also be reduced or eliminated. From a programming standpoint it was desirable to have the music at a predetermined audible level under the voice introduction of the tape. Experiments indicated that a level 20 db. below 100 per cent was the most pleasing to listen to, while providing a musical cushion for the voice introduction. As a relay was used to do the actual switching of the tape transport, one set of its contacts was also used to control the voltage to the grids of the faders. By using a common cathode resistor for both faders, as they are switched on and off, alternately, the amount of fading can be pre-set to any amount from zero to 40 db. The actual amount is determined by the positive voltage applied to the fader grids, or, in practice, the value of the series resistor in each fader grid; and by the value of the common cathode resistor.

Mixing of the music and voice is done in the output legs of the respective attenuators. For this type of service, comparatively slow and similar attack and release times are desired; therefore, no cathode followers are used to provide the voltage to the grids of the control tubes, and electrolytic condensers are used in conjunction with the grid dropping resistors to provide the desired time constants.

The measured frequency response of the complete amplifier used for the KAYT automation installation, faded or unfaded, is 50-15,000 cps, with a measured harmonic distortion over this frequency range of less than 1.0 per cent.

Let me summarize.

This type of automatic gain circuit can be used in self-control, separate control, or combined self and separate control applications. It can be used in single-ended or push-pull configuration, and can use almost any tube that can be triode connected, as its control tube. This last feature is especially important in the building of compact equipment where multi-section tubes are used to conserve space, where the rest of the circuit functions can be performed with specific tube sections, leaving, perhaps, a triode section available for this type of service. It is then possible to design the attenuator around the tube type available. It should be possible to fit this automatic electronic attenuator to almost any application where electronic or electrical control of attenuation is desired.

And, as a final note, as can be seen from Figure 2, a circuit can be designed for automatic gain, using a standard tube, with a plate supply voltage as low as ten volts. This permits its use in transistorized circuitry with its plate voltage obtained from the same supply as the transistors.

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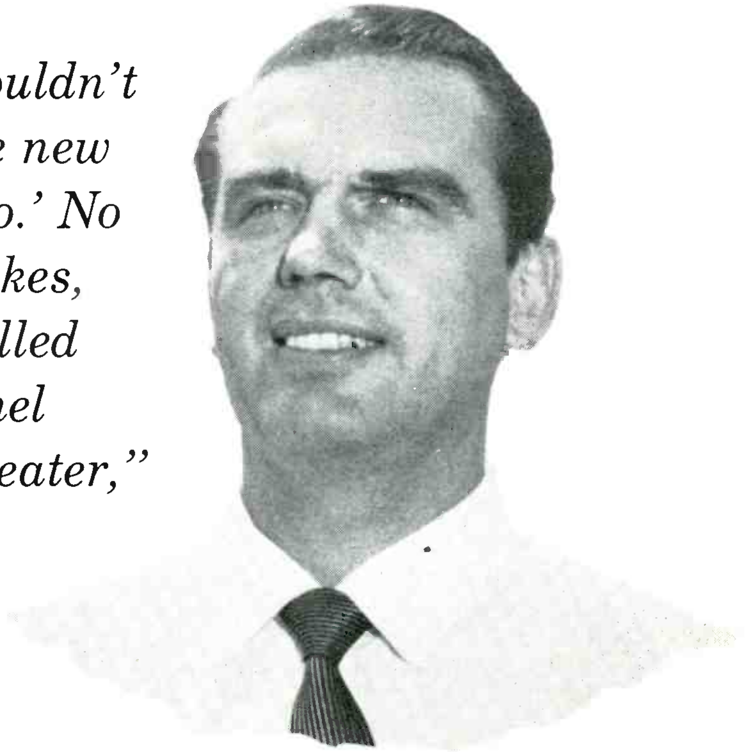

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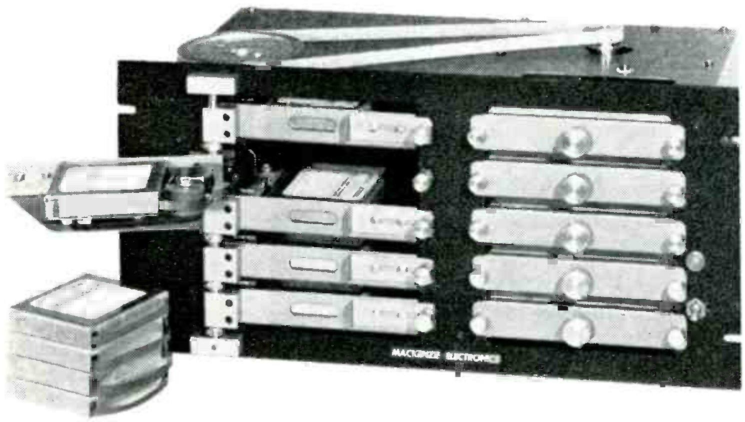

Write, wire or phone collect, for further information, specifications and delivery. The Model 5CPB shown here features five channels, each with individual plug-in transistorized preamplifiers and separate gain controls.

Delivered as illustrated, mounted on a standard relay rack panel (8¾" high), complete with self contained power supply. Included with each machine are five magazines and accessories. Price $1,250 F.O.B. Los Angeles. Leasing available. Demonstration upon request.

MACKENZIE ELECTRONICS, INC.

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MULTIPLEX INTERFERENCE IN FM RECEIVERS

The causes and cures of interference to FM reception in receivers tuned to FM stations transmitting multiplexed subcarriers

By DWIGHT "RED" HARKINS*

When an FM station starts multiplexing, the station receives reports from listeners of interference in the main channel signal. This usually creates a situation of doubt in the station engineer's mind as to whether or not the transmitter is operating correctly. Since the fault lies entirely in the function of the receiver, this article will explain the various causes and their remedies.

The interference is usually heard in the form of an unwanted program in the background or as a distant station on top of the desired station. No fault lies at the transmitter station, since this phenomenon is created entirely as a malfunction of the receiving process.

We shall first review briefly the nature of the signal that is created through the process of frequency modulation.

When the carrier is deviated in frequency above and below its unmodulated position, that transmitted energy is distributed into various additional carriers above and below the unmodulated center. These are known as sidebands. Although the total transmitted power remains the same as before modulation took place, the signal now occupies a "spectrum" that is as much as 75 Kc. above and below the unmodulated carrier. Under certain conditions literally hundreds of additional carriers are instantaneously created.

Those seriously interested will find readily available much information that mathematically correlates the generated sidebands directly to the modulation frequency and the amount of deviation to the carrier by that particular tone.

For the sake of this discussion, consider the case where a 5000 cycle tone is transmitted. As shown in Figure 1, this causes the creation of definite sidebands both above and below the center carrier. The side carriers will be spaced 5 Kc. apart and with a selective communication type receiver can be easily tuned in and identified. With the selective communication receiver each of these sidebands will tune in just as if it were a separate signal. Each sideband will have a slightly different amplitude, some of them being stronger than the main carrier. In fact, at times easily predicted mathematically, the center carrier itself will completely disappear and only the sidebands can be tuned in.

With a correctly designed FM set, the whole bundle is allowed to pass through. All of the tuned circuits must be "broad" enough to allow the passage of the complete set of carriers.

Now, let us skip to a condition where the station is transmitting a multiplex subcarrier of 65 Kc. The 65,000 cycle per second signal arrives over the system just as if it were an audio tone except that it is inaudible, being above the range of the human ear. In Figure 2, we show the generation of sidebands, or side carriers, that are above and below the center carrier by the spacing of the modulation tone, or 65 Kc. The second pair of side carriers is shown to be insignificant. Although of no use, they do exist and are shown to help illustrate the relation between this example and that of the 5000 cycle tone shown in Figure 1. If the 65 Kc. tone were to modulate the transmitter at a level higher than the 15 per cent usually used, the additional side carriers would begin appearing as in the 5000 cps case.

We now have existing both above and below the center carrier, additional signals spaced above and below by 65 Kc. Unlike the example of the 5000-cycle tone, however, these new side carriers are also frequency modulated by the music or announcements sent out by the station for the subsidiary service. We then have an upper and a lower sideband which is also making its own little group of sidebands since it also is an FM signal. In fact, if we were to filter out the center carrier and the lower sideband and tune in the upper side carrier all by itself we would be able to pick it up and detect it just as if it were an FM station all of its own. This also applies to the lower side carrier if tuned in by itself.

*Harkins Radio Co., 4444 E. Washington St., Phoenix, Arizona.

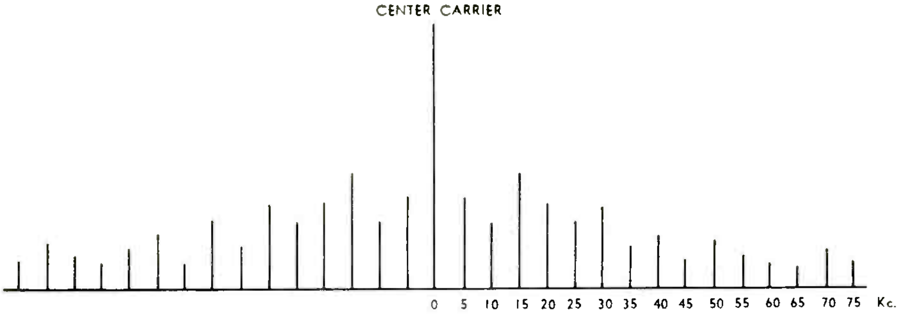


Figure 1—With 5000 cps modulation on the FM transmitter, sidebands are generated at intervals of 5 Kc. above and below the carrier. Audio tones of other frequencies will produce sidebands spaced in accordance with the frequency of the tone. The amplitude of the applied tone determines the extent of the deviation and the amplitudes of the individual side carriers.

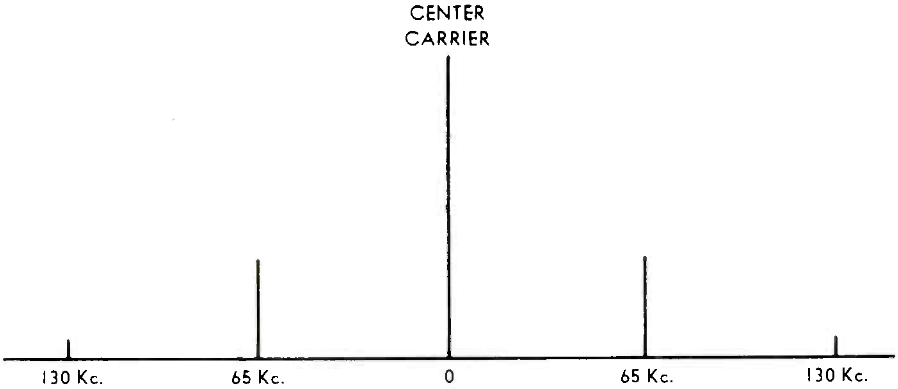


Figure 2—With 15 per cent modulation of a 65 Kc. supersonic tone (used for a subcarrier), the sidebands are positioned as above. The outer pair are very weak and insignificant.

in Figure 3. The properly tuned circuit will be centered upon the carrier and the linear portion of the curve, both above and below, will be sufficient to take in all of the major sidebands created by the signal during modulation.

In Figure 4, the correctly tuned detector curve is shown with the appearance of the two Kc. side carriers drawn in above and below center. In this case, the 65 Kc. will be detected but the modulation appearing on the 65 Kc. will not be heard. The upper and lower 65 Kc. sidebands are actually FM signals of their own and as they move up and down the slope, are being demodulated but under these conditions of perfect alignment the components demodulated on the upper half will be in exact out of phase condition with those of the lower half; hence, complete cancellation of the audio on the subcarrier takes place. To put it another way, it will be noted that when the upper side carrier moves up, the lower one also is moving up and since they are on opposite sides of the center, the upward movement generates a voltage change that is opposite in polarity, in comparing the two, and complete cancellation takes place. The audio components from the 65 Kc. subcarrier are 180 degrees out of phase.

Now consider what takes place when the receiver is tuned to one side of the signal causing the center carrier to be off to one end of the detector slope as shown in Figure 5. Here, one of the sideband carriers is in the linear portion of the curve while its mate is out in left field. This condition allows the audio to be recovered from the subcarrier as its mate is missing to provide the cancelling voltage. If no modulation were applied to the regular carrier, good reception of the subcarrier is possible.

This is not the normal method of recovering the subcarrier since it is impractical to design a receiver that

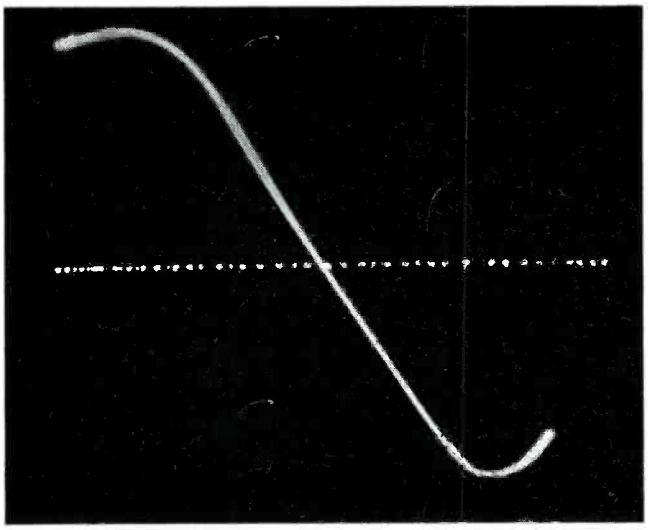


Fig. 3—Correctly adusted discriminator or ratio detector produces this type of "S" curve. With a variable marker oscillator the length of the linear slope can be measured. It should be at least 200 Kc. for low distortion as well as for minimum demodulation of the subcarrier audio.

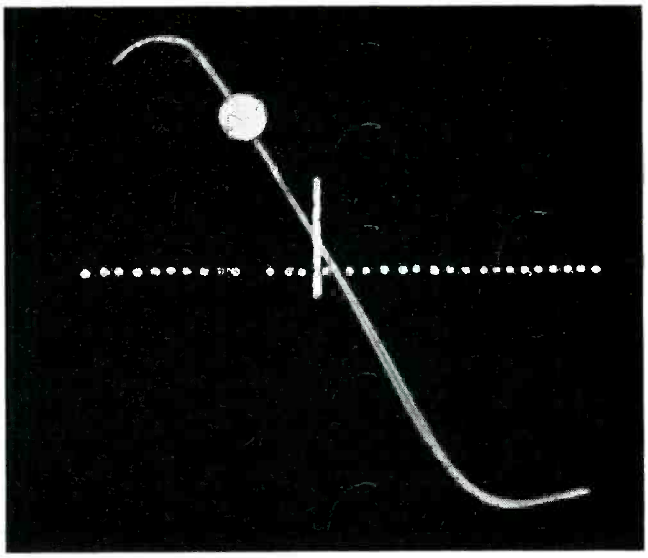


Fig. 5—The large white dot is placed to show the position of the main carrier when the receiver is tuned to one side. Only one of the 65 Kc. sidebands appears on the linear slope. The other one is lost. In this case, the sideband which appears on the slope will be detected as it deviates with modulation. The shorter the linear portion of the slope is, the more exaggerated will be the condition.

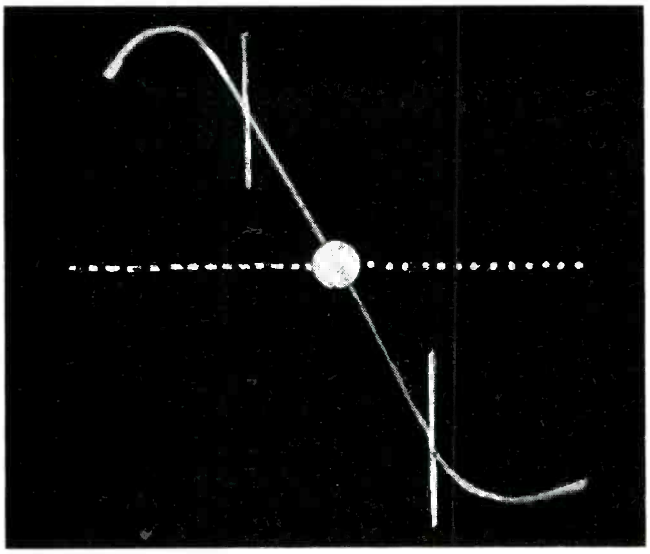


Fig. 4—In the case of a correctly adjusted receiver, the large white dot in the center of the linear portion of the "S" curve represents the position of the carrier. The two vertical lines are drawn in to show the relative positions of the upper and lower 65 Kc. sidebands when the subcarrier is being transmitted.

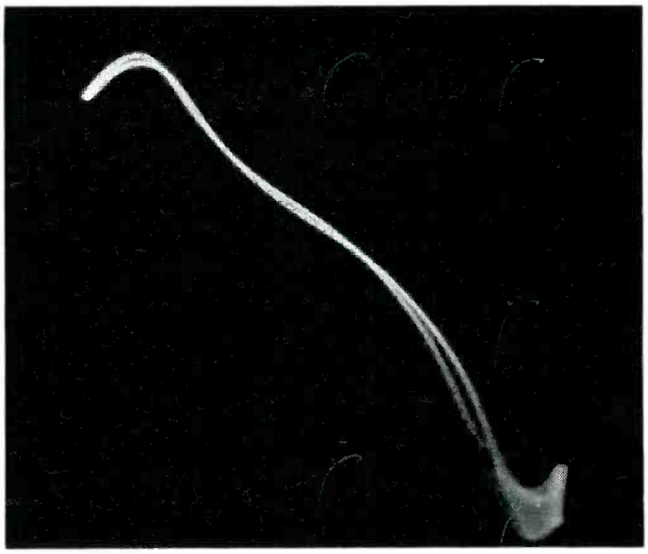


Fig. 6—With a typical misaligned discriminator such as this, there is no way of tuning in a station so that the subcarrier sidebands will balance each other. As a result, unwanted demodulation of the subcarrier will be heard along with the regular main channel program.

would receive this single sideband without getting interference from all the other sidebands that exist when normal modulation is also on the carrier. However, this is exactly what happens when the subcarrier appears as interference to the main channel program. It is actually being detected in the receiver as if it were an independent FM signal. Something in the receiver is causing attenuation of part of the sidebands.

Going back to the generation of the sidebands, an additional fact is now brought out. The sidebands created above the carrier always have a definite phase relationship with their mates which appear below the center carrier. The sideband carriers are always 90 degrees out of phase with their mates on the other side of the carrier.

The FM Demodulator

In order to convert the FM signal into audio, the receiver must use some sort of "detector" that converts excursions of frequency into changes in amplitude. The most commonly used devices are the Foster-Seeley Discriminator and the balanced ratio detector.

It is common practice to align an FM detector by "sweeping" it out with a device known as a sweep generator which allows a graphic picture to be seen on an oscilloscope. This represents the function of the circuit to change the frequency excursions into amplitude changes. A properly adjusted detector of the types we are discussing will produce on the scope an "S" curve as shown

Working with FM receivers has revealed many types of curves to be obtained from their detectors. Some have relatively narrow distance between the peaks and others are quite wide. The shorter the length of the linear portion of the detector slope, the easier it is to recover subcarrier audio, since slight mistuning will get the one sideband out of the center range.

If the detector slope is broad enough that both sidebands created by the subcarrier remain on the linear portion until the set is side tuned so much that the I.F. selectivity kills the signal, the signal disappears before the unbalanced condition can arise that permits the audio recovery to be heard.

Even the correctly tuned FM receiver that has a narrow "peak to peak" separation on the detector slope will permit identification of subcarriers when the set is side tuned slightly.

If the receiver in question cannot be tuned so that the detector "curve" is linear, some demodulation of the subcarrier will always appear and usually changes in strength as the receiver is carefully tuned, which in essence, is moving the sidebands up and down a portion of the detector slope, some positions being more linear than others.

The majority of the cases of unwanted subcarrier detection have been traced to misalignment of the detector, inherent non-linearity of the detector or side tuning of the receiver. Those sets with AFC are less liable to this unwanted detection since the properly working AFC circuit keeps the signal in the linear portion of the slope.

The I.F. Amplifier

A badly tuned I.F. strip can also cause an unbalance between the sidebands which makes detection of either one occur. If the incoming signal passes through the I.F. transformer tuned to one side, then the energy reaching the detector is not properly balanced on either side of center carrier; a regenerative I.F. will cause the same condition.

The various existing makes of I.F. transformers can also exaggerate interference of unwanted subcarrier. The same thing applies here at the discriminator itself. If the coils are tuned correctly, the sidebands are allowed to pass through without disturbing their original phase relationship as transmitted.

Regeneration in the I.F. strip will cause the transformers to produce an effect of selectivity that is unbalanced. This will cause a serious disturbance of the phase relationship. This condition is not as common as the mistuned discriminator.

There is a wide difference in makes of I.F. transformers. Some are relatively broad and others are quite sharp. Some have steep skirts on the selectivity curve. The narrow pass band together with the steep skirts of the selectivity curve attempt to exaggerate the reception of the unwanted subcarrier.

The Receiving Antenna

There are several things that can occur in the antenna circuit which will also enable the reception of the subcarrier.

First of all, an improper orientation of the antenna will cause a portion of the signal to be out of phase with other portions. This creates somewhat the same condition as a mistuned detector coil.

The same condition in a receiving antenna system that would cause ghosts in a television receiver will create distortion in the FM signal. Where the received signal is suffering from severe multipath distortion, there will be instances when the unwanted subcarrier will be heard intermittently. This condition has been observed in the districts of large cities where many high buildings are causing unwanted signal reflections.

Correct alignment according to the standard techniques should be used to remedy the faults outlined herein. Sometimes a replacement of the discriminator or ratio detector transformer of known broad band will be required.

Observation of the interference varies widely with different types of receivers. The amount of interference heard usually is not related to the cost of the set. Some of the most expensive have been the worst offenders. This is hard to explain to the proud set owner. On the other hand, some of the inexpensive AC-DC FM tuners will not produce interferences from the multiplex signals.

Once the serviceman is alerted to the causes of the condition, however, he can take steps to produce a cure at relatively low cost.

As the radio serviceman becomes alerted to the nature of this problem, the number of calls received by the station that is multiplexing will diminish. If the station will supply information to the serviceman and then recommend that serviceman to the listener you will have a successful solution to the problem.

F. C. C. EXPERIENCES WITH TRANSMITTER REMOTE CONTROL

By HAROLD L. KASSENS*

A paper presented at the 13th Annual NAB Engineering Conference

As a result of the filing of a petition for rule making by the NAB, the Commission in January of 1953 issued a Report and Order amending its rules to permit stations using non-directional antennas and power of ten kilowatts or less to be operated by remote control.

At present over 1,200 stations have obtained authority to operate in this manner. The emergence of remote control has been an important factor in the expansion of the AM and FM broadcast services during the past six years. It has provided an economically feasible operation in a great number of small communities which would otherwise be without a local broadcast facility.

In September of 1957, and again as a result of the filing of a petition for rule making by the NAB, the Commission further amended its rules to permit all AM and FM stations to operate by remote control—without limitation as to power or type of antenna.

Since that time a total of 48 stations have taken advantage of the new rules and filed applications for remote control—44 for operation with directional antennas and four for non-directional operation with 50 kilowatts. Twenty-three of the directional applications have been granted and we have confident hope that processing of the remaining 21 applications will be completed within the next two months. Of the 50 kilowatt applications, the three have been granted and approval of the fourth is anticipated in the near future.

Two difficulties have arisen which appear to be delaying implementation of remote control at many stations. The first is the requirement that stations with directional antennas and those with power in excess of ten kilowatts be equipped so that they may be operated on a CONELRAD frequency with power of five kilowatts or not less than 50 per cent of the maximum licensed power. The power may be less however upon certification by the CONELRAD Field Supervisor that a lesser power will provide satisfactory service under CONELRAD. The rule does not require that a CONELRAD authorization be obtained, but does require that provision be made at the remote control point to permit the station to be operated on either 640 or 1240 kilocycles with the proper power. Further, installation of the equipment is not required until the commencement of operation under the remote control authorization.

The second difficulty of stations seeking remote control authorizations appears to be the requirement of submitting weekly readings of field intensity at each monitoring point for the preceding one-year period. This may appear to be unduly burdensome, but let me quote from the Commission's Report and Order in this matter:

In response to the request contained in the Notice of Proposed Rule-Making, many parties submitted comments concerning the information to be supplied with the application for remote control of directional antenna stations as well as to what data should be supplied after remote control was authorized. We have carefully reviewed the comments filed and have concluded that applications for remote control will be considered upon a case-by-case basis and granted upon a satisfactory showing that the directional antenna system is stable and is in proper adjustment.

I'd like to reemphasize those last few words: "that the directional antenna system is stable and is in proper adjustment." This, then, is the *basic* information we are seeking. For many years the Commission has used as its criteria: (1) the maintenance of base currents or appropriate samples thereof within 5 per cent; (2) maintenance of phase essentially at the values specified in the license; and (3) maintenance of monitoring point field intensities within the maximum values specified. Perhaps there are other criteria which may be substituted for these. But we feel that it is entirely reasonable to require new stations to submit monitoring point readings for a one-year period as a means of demonstrating, in part, the stability of the directional antenna system.

Many older stations complain that they are not required to measure the field intensity at each monitoring point. What they fail to recognize is that the license specifies

*Chief, Aural Existing Facilities Branch, Broadcast Bureau Federal Communications Commission.

the maximum field at each monitoring point, and there is no way they can tell whether this maximum is being exceeded unless measurements are taken at regular intervals.

Licensees are not precluded from filing applications for remote control and requesting a waiver of the one-year period of measurements, but they should be able to substantiate requests for waiver by the submission of other information to permit a determination "that the directional antenna is stable and is in proper adjustment." Of the twenty-three applications for directional operation already granted, eight applications contained less than fifty-two consecutive weeks of monitoring point readings. One contained readings each month for only ten months; another twenty-six weekly readings plus twenty-four months of quarterly readings; a third contained thirty-four weekly readings. In each case, however, consideration was given to other information available, such as technical logs from renewal applications, skeleton proofs-of-performance, and inspection reports. I'm sure you'll agree that if the inspector departed without leaving a violation notice the array was being operated properly!

Let us look now at the nature of some of the violation notices issued in connection with remote control.

The existence of a remote control authority does not in itself change the operator requirements. Stations with directional antennas and those with power over ten kilowatts are required to have on duty at the transmitter or at the remote control point an operator with a first-class license. Stations with non-directional antennas and power of ten kilowatts or less may use restricted permittees, but must have one first-class operator in full-time employ. And speaking of employment, it should be borne in mind that each operator, regardless of class of ticket held, must be an employee of the station. While this may sound fundamental, it has resulted in some difficulty for stations which use automatic programming and would like to have the remote control point at some all-night business establishment.

Section 3.39 of the Rules relates to the accuracy of the plate voltage and antenna current meters. It contains such specific details as: length of scale, total number of divisions, and accuracy figures. Meters at the remote control point to indicate these parameters are also expected to comply with the requirements of this rule. Meters having arbitrary scale divisions may be used provided that a calibration curve, showing the relationship between the arbitrary scale and actual meter reading is maintained at the remote control point. Further, the meter or meters at the remote control point must be calibrated once a week against the regular meters and the results entered in the operating log. If arbitrary scale readings are indicated in the station operating log, a copy of the calibration curve should be submitted to the Commission with each renewal application to enable the staff to properly correlate the readings given.

Section 3.67 of the Rules reads, in part, as follows: "A malfunction of any part of the remote control equipment and associated line circuits resulting in improper control or inaccurate meter readings shall be cause for the immediate cessation of operation by remote control." In simple terms, it means—if anything goes wrong, fix it in a hurry!

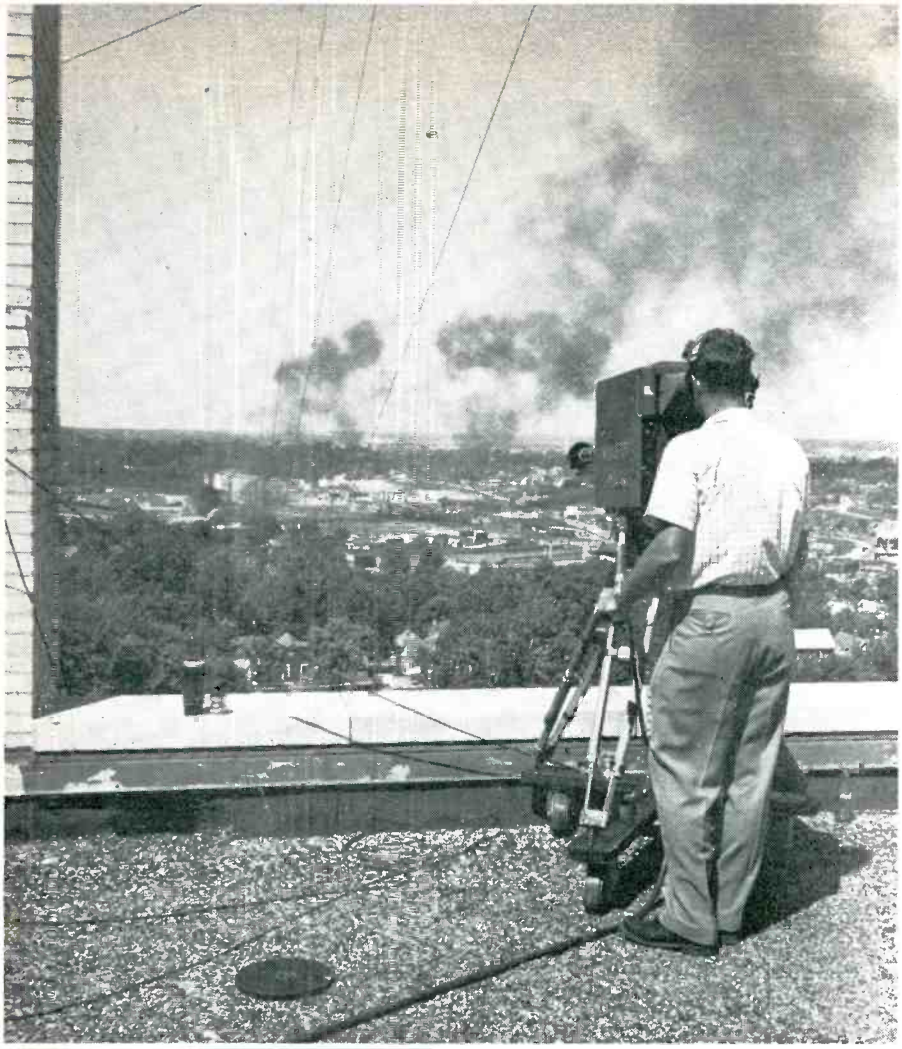
A point to be remembered is that prior approval must be obtained whenever the location of the remote control point is to be changed. Remote control is permissible only from the location specified in the station license.

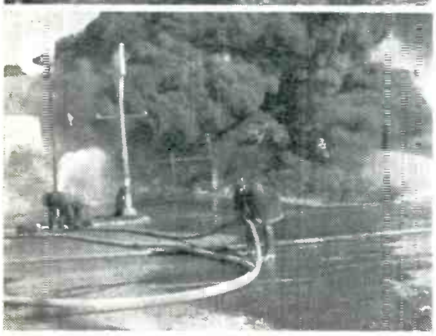
When operating by remote control, there are certain requirements concerning the logging of directional antenna parameters. Each half hour during directional operation, the Rules require the logging of common point current and remote readings of antenna base current. In addition, within two hours after the beginning of operation with each directional pattern, an operator with a restricted permit or first-class ticket must read and log, at the transmitter location, the common point current, base currents, phase monitor sample currents and phase indications. The purpose of this latter requirement is two-fold. First, it provides a means of determining that the phase readings are within the values specified, thus eliminating the difficult problem of providing a means for remote readings of phase. Secondly, it permits a physical inspection of the transmitting equipment to insure proper operation and to anticipate breakdowns.

One further requirement not to be overlooked is that of a skeleton proof-of-performance of the directional antenna system once each year during remote control operation. This is not a difficult requirement for it requires only three or four measurements on each radial used in the original proof. The points may be accurately spotted on a map in advance and the readings checked once each year. A comparison of these readings with those made previously should give an indication as to whether or not the directional array is in proper adjustment.

One advantage which accrues automatically to those who obtain authority to operate a directional antenna system by remote control, and one which should not be overlooked, is the Commission's practice of modifying the station license to require the taking of monitoring point readings on a monthly rather than a weekly basis. The theory supporting this practice is that once stability has been demonstrated, monthly readings are sufficient to indicate proper maintenance of the array. This relaxation is also available to those of you who, for one reason or another, do not desire to operate by remote control. It may be obtained by submitting an informal application supported by fifty-two weeks of monitoring point measurements and readings for thirty days of the directional antenna parameters. This information is the same as that required by paragraphs 3 and 4 of the remote control form.

An advantage which has accrued to FM operators who use remote control is the possibility of utilizing radio rather than wire lines for telemetering purposes. The control information is multiplexed on the studio-transmitter link and the meter readings are relayed back as multiplex modulation on the main carrier. Unfortunately no one has yet devised an acceptable means for relaying meter readings from an AM transmitter to the remote control point by radio. Perhaps investigation in this area will make remote control of AM transmitters even more attractive.





FAST COVERAGE OF COORDINATED USE

A DISASTROUS fire, which claimed six lives and hospitalized approximately one hundred firemen recently, provided a challenge to the staff of WDAF, of Kansas City, resulting in a spectacular TV pickup and outstanding radio coverage. Portions of the TV pickup were carried numerous times over NBC. The quick coverage was made possible by the use of an extensive mobile radio system, Zoomar lens, Videotape recorders and a crew which was ready to go.

At 8:25 A.M., August 18, a black cloud of smoke and red, searing flame mushroomed skyward three blocks west of the WDAF-TV studios. The fire was at a gasoline bulk supply depot and filling station just off one of Kansas City's busiest trafficways. Staff members of WDAF, seeing the fire, immediately alerted the mobile radio crew, which was on the scene and on the air describing the tragedy by 8:30 A.M.

Because of the station's location overlooking the disaster scene, WDAF set up a camera equipped with Zoomar lens on the roof of the studio building and was televising

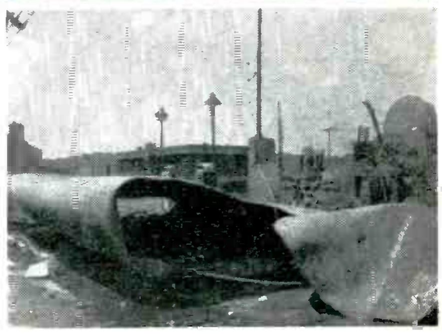
DISASTERS RESULTS FROM OF FACILITIES

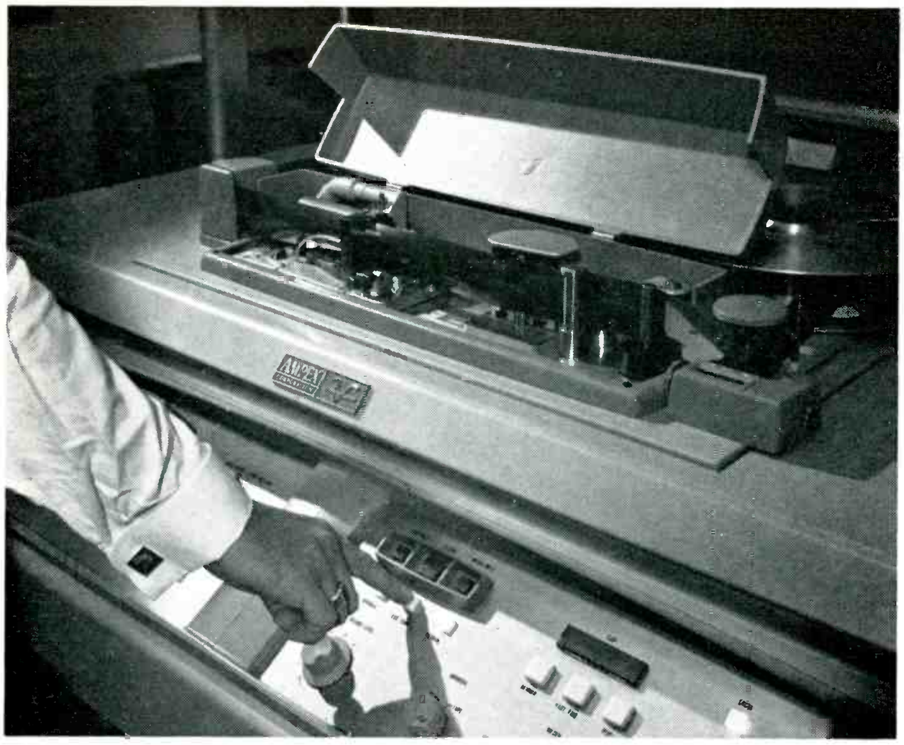
the disaster scene at 8:50 A.M. Closeups of the fire were obtained from the camera location, while on-the-spot descriptions were made by the mobile crews strategically placed around the fire.

The entire telecast, which lasted for two and one-half hours, was recorded on the station's video recorder which made it possible to repeat highlights of the fire during the day. At one point, a large boiling ball of flame from an exploding gasoline storage tank shot out in all directions, engulfing firemen. This dramatic segment, caught by the zoom lens, was carried on NBC three times by videotape.

The significance of the coverage from a technical aspect is the tremendous capability of modern stations to cover news events almost immediately by the coordinated use of present day equipment.

The five-unit mobile system, versatile zoom lens and videotape equipment made it possible for WDAF to handle this coverage while under different circumstances, other equipment could also be brought into use.





Front view of VTR console, showing tape transport system and push button controls.

HOW TO OPERATE A

One of the questions frequently asked is: "How difficult is it to operate a television recorder?"

From this, we may assume that many members of television station staffs around the country, as well as the general public, have the false impression that operating a VTR is a terribly complicated process.

Nothing could be farther from the truth. Anyone reading this magazine, even though he had never laid eyes on the machine before, could learn to operate it quite proficiently in 15 minutes.

In fact, there is little difference between operating a Videotape television recorder and an audio tape recorder.

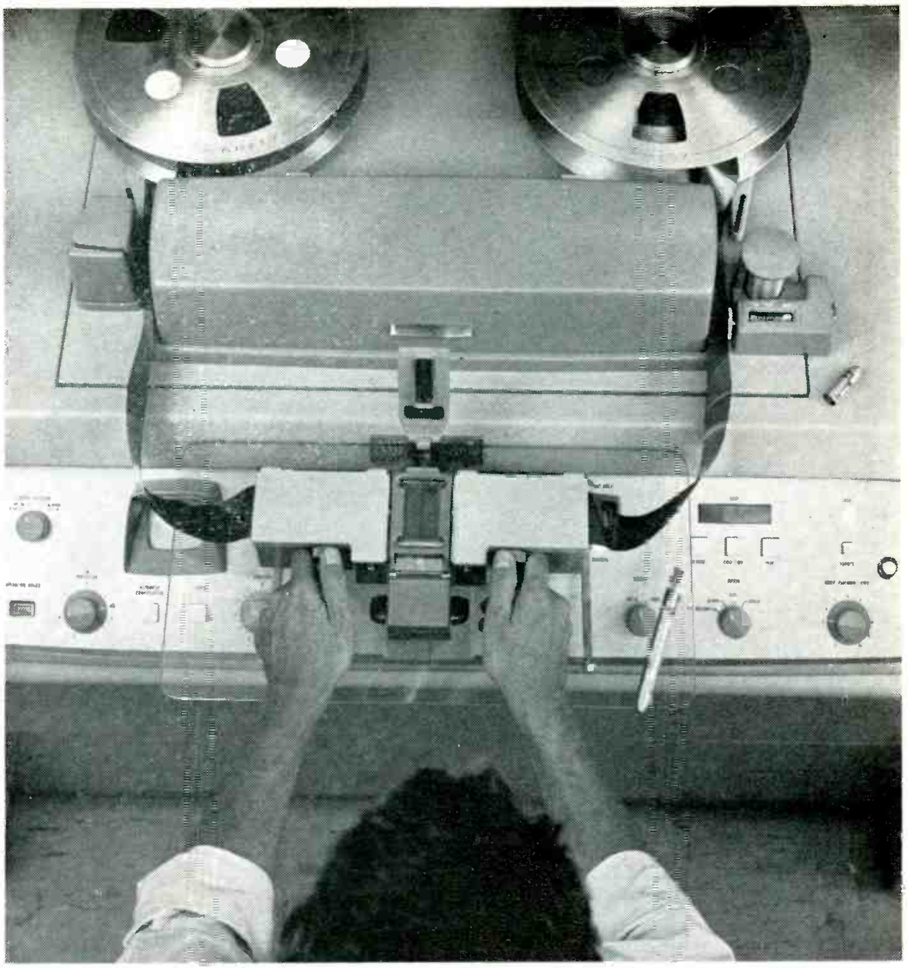
The tape is on a reel. The tape transport system is horizontal at table top height. The tape runs from supply reel (at operator's left) to take-up reel (at right). Threading the tape across full-width erase head, video head, audio and cue track heads is simple.

It then is necessary only to punch the record button. When recording is completed, the stop button is punched. Then rewind button, stop button and play buttons are pressed in that order, to obtain playback of the recorded tape. As you can see, these are exactly the same steps you employ with an audio tape recorder. The only difference is that you are recording and playing back both the picture and the sound of a live television broadcast.

There are just these five buttons to push: Record, Stop, Rewind, Fast Forward and Play. Again you can see the similarity to an audio recorder.

In program cueing, the VTR operator has several aids to quick, positive action. Features providing this assistance include the tape timer, cue track, two-second fast start, as well as the push-button controls.

Even a 10-second commercial can be cued with assurance. The de-



Operator splices TV tape with videotape splicer mounted on front of Ampex videotape television recorder, directly above console's control panel.

TELEVISION RECORDER

By ELLIS WALKER, Ampex Corp.

sired spot can be located on the reel either by the accurate tape timer or by counting "beeps" previously recorded on the cue track when spinning the tape fast forward. By alternately touching the fast forward and rewind buttons, the reel is coasted back to the beginning of the spot. The tape timer can be set to "zero" and then backed up two seconds, three seconds, five seconds or seven seconds, depending on the station's standard cueing procedures.

The cue track provided by the Ampex machine is a speech quality extra sound track. A touch of a tone button on the control panel puts an intermittent or continuous 325 cycle tone on the tape. In addition, an audio input permits voice recording on the same cue track for instructing recorder operator or cast, or for editing notes.

An automatic brake release makes it easy for the operator to pull tape free for threading, editing and splicing.

With the VTR, complete remote control can be provided for start, stop, fast forward, rewind, record (total record, audio only, cue only) and cue tone functions. The remote control facility also allows independent setting of video level, sync level and pedestal or blanking level, permitting control of picture quality as well as tape transport functions from a remote position.

The full width erase feature guarantees the VTR operator a signal-free tape to the recording heads. It operates automatically when the recorder is in the record mode. This feature also is useful when only portions of a tape need to be erased and re-recorded. Completely shielded, it eliminates RF interference to an adjacent recorder or other equipment.

Switching from black and white to full color recording is an instantaneous process. Just a flip of the switch does it.

Closeup view of videotape splicer mounted on front of VTR console directly above control panel.

The Videotape Splicer, developed by Ampex, is a precision engineered accessory for fast, perfect splices. It incorporates the same principle of splicing as that used with audio tape. Anyone can learn to operate it in a few minutes' time, turning out excellent results.

When recording on the VTR, the operator has a constant check of the video and audio signals coming to the recorder. By means of the complete, accurate monitoring system, he knows whether they meet quality standards. The monitoring system also assures the operator that the recorder itself is performing properly. And it assures him that the video and audio signals leaving the recorder meet given quality standards.

Provided with the Ampex machine is a Conrac CM17 video monitor. It provides resolution beyond 600 lines and rigid control over geometric linearity. This permits precise inspection of the gray scale, signal to noise performance and the geometric accuracy of the picture both in and out of the VTR. The monitor also has a switch allowing the operator to select full-sized or reduced scale picture sizes.

A Tektronix 525 waveform monitor provides the operator with an exact inspection of the video signals. Continuously in the picture circuit, it is instantly switchable to compare input and output waveforms.

The Ampex Model 9901 audio monitor provides for a 40 to 10,000 cycle response (plus or minus 2 db) to continually monitor not only the audio signal but also the very low or high frequency sounds heard through quality speaker systems in the home.

Every mode of the Ampex VR-1000B operation is indicated by lights. They provide instant visual check, even from a distance.

Lighted buttons indicate whether the recorder is in record (all functions or audio only, cue only), play, fast forward, rewind or stop.

An "on air" tally light indicates when the recorder is in studio or on-air use.

A red light indicates when the video erase head is in operation.

A separate red light shows when RF/RF dubbing is in process.

Lighted buttons indicate the channel selected on the push-button monitor selector panel.

Four differently colored lights indicate the sync source selected for the servo system.

A lighted button shows that the automatic compensation feature is in operation.

An EE switch on the control panel of the VTR permits the operator to check the video signal after it passes through the entire record and electronic playback system. Comparison of this signal with playback of a test recording, plus a comparison with the incoming signal, provides complete assurance that the recorder is functioning properly.

During recording, an oscilloscope located on the left hand control panel can be used to show over-all system stability. It displays a lissajous loop that combines readings continuously showing the stability of head drum servo, capstan servo, 240 cycle time reference signal and 60 cycle sync source. In addition, each of these functions is metered to indicate individual performance.

Also during recording, the oscilloscope on the left control panel shows the field pulse signal superimposed on the lissajous loop. This signal is metered from the control track head, as it is put on the tape. A proper indication also assures exact referencing to the video signal.

A large meter on the rear console panel indicates the level of the control track signal in record or playback modes (in addition to being shown on the oscilloscope). Complete assurance that the control track signal is going on the tape during record is provided by measuring the signal from within the control track head itself.

Another large meter on the rear control panel of the VTR provides monitoring of the signal just prior to being laid on tape. It indicates and assures proper current to all four heads. This monitoring point gives maximum assurance that optimum signals are being recorded on tape.

A separate meter on the rear control panel provides continuous readings of recording or playback audio level. In addition, erase current, bias current, tone cue and audio cue levels may be selected for individual readings.

A meter on the rear control panel of the console gives a continuous reading of the level of the vacuum-assurance that the concave tape guide is properly holding the tape at the video record heads.

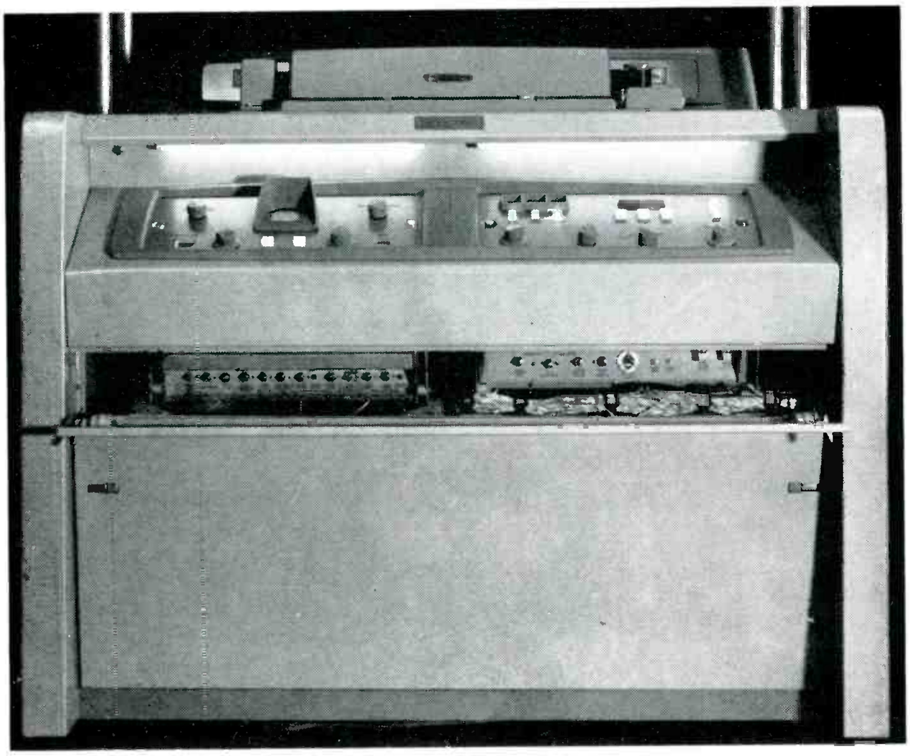
When the operator goes through a checkout procedure, the design of the VR-1000B makes it easy to pinpoint the circuit, locate the assembly and check its functions. A complete operating manual is provided with each recorder to facilitate this. It is so thorough that a TV engineer can check out the recorder by exactly following the procedures outlined.

To facilitate routine maintenance and check-outs, all functions of the VR-1000B have been made readily accessible. For example, controls used by the operator in routine maintenance adjustments are easily reached through the front panels of the console itself.

Each electronics chassis is equipped with its own protective circuit. A light snaps on in the chassis when it requires the operator's attention.

Swing-out harnesses give rear access to racked components without interruption of service. The console also is mounted on wheels so that it can be rolled into any position for quick accessibility to the circuits.

So the next time you hear the question, "How difficult is it to operate a television recorder?"—you'll already know the answer. It's easy.



Front panels of VTR console dropped down, revealing easy accessibility of controls used by the operator in routine maintenance adustments.

A. J. La Frano, vice-president and program director of KHJ, Los Angeles, is shown with the Five Channel Automatic Audio Repeaters recently installed at KHJ.

AN AUTOMATIC AUDIO SYSTEM

New program repeaters permit greater versatility in handling short program segments

A NEWLY developed program repeater has been introduced by MacKenzie Electronics, Inglewood, Calif., to answer the requirements for playing the many short segment recordings used in today's radio formats. The five channel unit is a complete programming machine which plays continuous endless-loop tapes. These are used for DJ introductions, news introductions, news bulletin sound effects, station ID's, spot announcements and other introductions and background effects used by a station.

The machine holds five tape magazines on hinged trays. Each tray incorporates the necessary pressure roller and magazine driving assembly so that it can be engaged by high-speed solenoid action with a rotating capstan which is common for all five channels. Five separate playback heads are connected to individual transistorized preamplifiers, each with low-impedance output terminals. The machine is complete with power supply and individual solenoid connections brought out to terminals for remote actuation of any one channel or combinations of any of the five channels.

An important feature of this machine is its instantaneous stop-start operation which is achieved by engaging the tape loop with a continuously rotating capstan upon actuation by a high-speed solenoid. This system permits the instantaneous starting and stopping of individual tape loops. Tests show that a tape loop recorded with a steady tone can be started and stopped so

The push button control console built at KHJ which enables the engineers at KHJ to have instant cueing and split second control of all program material.

USING ENDLESS LOOP TAPES

rapidly that the human ear will not detect a transient.

Each of the five channels is equipped with small photoelectric cells which operate in conjunction with transistorized pulse amplifiers that control the individual solenoids. A cue mark consisting of a narrow stripe of silver paint is painted on the tape at the precise beginning of the program material. When the cue mark passes the photocell, the resulting light pulse triggers the solenoid, disengages the tape transport from the capstan, and the tape stops immediately. The tape is then ready to start again precisely "on cue" upon the push of a button. This feature allows the insertion of lip-synchronized audio effects into live productions without elaborate and time-consuming preparation, with the attendant danger of missed cues. Gun shots, music bridges, laugh tracks and any other special effects can be "cued" and played either individually or in any combinations. If cue marks are not put on the tape, continuous background effects such as crowd noises, thunder and lightning, footsteps, traffic noises, birds, etc., are readily available.

A system using six of the five channel units was recently installed by KHJ Los Angeles who adopted a new program format requiring tight, fast playing of short program segments. The equipment is built into a special console designed and built by KHJ. The equipment is also being used by NBC, CBS and other stations.

ADVANTAGES OF UHF TRANSLATORS OVER VHF BOOSTERS

Basic advantages claimed are lower costs at both the retransmitting and receiving sites, higher quality service, and less interference to other services

The following article is from a statement by Mr. Benjamin Adler* before the Subcommittee on Communications of the Senate Committee on Interstate and Foreign Commerce

STATEMENTS have been made before this Committee during the past few days claiming that "UHF cannot do the job" and that ". . . it is clearly evident from the number of VHF repeater stations now operating that the VHF booster is doing the job." This testimony was given with special reference to the capabilities of VHF vs. UHF in the Rocky Mountain area. Let us take a good look at how communities blocked from direct reception are getting their TV in this area. Actual FCC records checked within the past two weeks show the existence of fifty-three (53) UHF TV translator stations serving 282,000 people in the four Rocky Mountain states of Colorado, Wyoming, Utah and New Mexico. The other states in the area are equally well served by UHF TV translator stations.

In the State of Colorado alone twelve (12) UHF TV translators, serving fourteen (14) mountain communities within the state, provide excellent multichannel TV broadcast service to a population of 93,500, none of whom receive any direct TV broadcast service. The latest population figures and the reported TV homes within the state show that UHF TV translators are actually bringing fine service to approximately one-third of the homes in Colorado not served directly by the TV stations.

Based on these figures taken from FCC records and TASO reports, a statement to the effect that "UHF cannot do the job" would bear further investigation before it is used as a guide to determine whether or not VHF repeater stations should be authorized.

To complete the statistical data supporting the fact that UHF TV repeaters are definitely doing the job, I should like to point out that at the present time there are more than 200 UHF TV translators in operation throughout the United States serving more than one million people who receive no direct service from TV stations. Here again, the figures are taken from FCC records and from our own company records of shipments of translator equipment.

Testimony has been presented to this Committee during the current hearings and on previous occasions to the effect that VHF repeaters cost considerably less than UHF repeaters. In making such statements the specifications of the two equipments being compared, obviously, have been far from the same. The equipment used at the several hundred unauthorized VHF repeaters now in operation throughout the Far West does not even begin to comply with specifications that would be required if suitable safeguards and good engineering practices were enforced by the FCC. Cost comparisons have been made between jerry-built VHF repeater stations using composite equipment, and complying with no accepted engineering practices on the one hand, and factory-built, well engineered, UHF translators fully complying with FCC rules and regulations, on the other. It is understandable that fallacious results would be obtained through such comparisons.

In order to arrive at a true cost comparison between VHF and UHF TV repeater equipment, we at Adler Electronics made a careful cost analysis of a one-watt VHF trans-

*Adler Electronics, Inc. One Lefevre Lane, New Rochelle, New York.

lator which was developed in our laboratories at the same time that we developed the 10-watt UHF translator. The VHF one-watter was a working laboratory model. This model was developed to comply with our engineers' estimates of technical specifications that would be required to meet the safeguards of operation on VHF TV channels. These were no more stringent than those now being used in the approved UHF 10-watt translator. The cost estimates were based on production quantities in the same order of magnitude as those now being used for our UHF production. Many of the parts and pieces used in the VHF one-watter are currently being used in our VHF 150-watt translator, a number of which are in operation in various countries outside of the United States. The same distribution and service warranty costs that are normally part of the price structure of any commercial equipment were included for the VHF one-watter.

The result of these cost analyses was a selling price of $2,420 per one-watt VHF translator unit, including all of the equipment within one enclosure necessary to accept a VHF off-air pickup signal and deliver one watt peak visual along with one-half watt average aural to a VHF retransmitting antenna.

A further cost analysis was made to determine the selling price of an equivalent VHF 10-watt translator and the results were almost exactly equal to the 10-watt UHF translator now being sold for TV repeater purposes.

Assuming (without substantiation) that the one-watt VHF translator could do as good a coverage job as the 10-watt UHF translator, it should be noted that the cost of the one-watt VHF unit will be approximately 20 per cent less than the cost of the 10-watt UHF equipment. This does not indicate by any means that the over-all cost of a VHF translator station will be that much less than the over-all cost of a UHF translator station. In both cases the costs of the off-air pickup equipment, retransmitting equipment, power, access road, housing for the installation, the cost of acquiring land, and the cost of test and maintenance equipment will be identical for both installations. Since these auxiliary items account for more than half the cost of a typical 10-watt UHF translator station, the saving that may be realized on a VHF translator station is approximately $500. While the 10-watt power output of the UHF translator may be increased to 100 watts under present FCC regulations, the VHF one-watter could not be increased in power because of interference problems.

The Television Repeater Study Committee, consisting of a group of highly qualified consulting engineers and CATV operators, has presented testimony to the Committee concerning the relative costs of UHF and VHF translator equipment and home receiver installations. I want to state here that I fully concur with the statements of the Television Repeater Study Committee concerning not only the cost considerations but also its statement on basic allocation problems which favors the use of UHF for TV broadcast repeater service.

I should like to particularly emphasize and support with my own basic knowledge and information the figures supplied for VHF and UHF public reception costs. In several areas, carefully studied by our field engineering organizations, where unauthorized VHF booster stations were replaced by licensed UHF translator stations, the cost of adding a UHF converter plus a UHF receiving antenna averaged about half of the original cost of the VHF receiving antenna alone. A good UHF converter lists for $39.95. A corner reflector UHF receiving antenna and 50 feet of UHF twin lead list for less than $10.00. Since the average height of installation for best reception of UHF is 10 to 15 feet above the ground, the installation cost is extremely low and in most instances is accomplished on a do-it-yourself basis. This $50.00 average cost for UHF conversion, including antenna, is contrasted with a $100 to $200 cost for a suitable VHF receiving antenna and tower capable of picking up the average VHF booster signal beyond two or three miles. These figures conclusively prove that the cost of an average UHF receiver installation for repeater reception is considerably less than the present VHF receiver installations.

Based upon discussions with a number of large TV receiver manufacturers, I would like to add one further comment on the relative cost of UHF TV receivers as against VHF TV receivers. This is, that there is no reason why a UHF-only TV receiver should cost any more than a VHF-only TV receiver. The difficulty has been that in order to receive UHF it has been necessary to retain the VHF capabilities and add the UHF channels. It is the opinion of many of the TV receiver manufacturers that a continued buildup of requirement for UHF-only in a TV receiver through the expanded use of UHF translators would definitely result in better UHF receivers at costs that are no higher than the present VHF-only receivers.

There is attached as Exhibit A a report on Alternate Channel UHF TV Broadcast Tests conducted at our company's laboratories at New Rochelle, New York, during May, 1959. This report shows conclusively that UHF TV broadcast assignments may be made on alternate channels—with UHF receivers in their present state of development—by taking certain simple precautions. When the quality of all UHF TV receivers becomes as good as the best which were tested, alternate channel UHF assignments may be made without special precautions. These findings indicate that the allocation taboos applicable to UHF can now be considered for elimination. This would render the UHF TV channels as suitable as the VHF channels from an allocations viewpoint.

In previous comparisons between UHF and VHF for television broadcasting purposes, there has been a tremendous amount of prejudice against UHF. This same prejudice has filtered through to the choice of a suitable part of the spectrum for TV repeater service. It is my contention that the UHF part of the spectrum offers many advantages over VHF because of the requirements of a repeater service. In repeating a TV broadcast signal the aim is to add audience not directly covered by the originating station and at the same time not interfere with that part of the audience already receiving direct service. In order to do this the repeater service must of necessity confine its retransmissions to the unserved area. Any spill-over beyond this white area will understandably detract from the originating station's direct service.

UHF, because of its inability to travel as far as VHF, since its propagation is poorer, has the desirable quality of having an extremely high useful range to nuisance range ratio. What I mean by this is that at the UHF frequencies now used for TV translator purposes the signal travels little beyond the range over which it is usable. Beyond this range it dies out so rapidly that it causes little or no interference to other signals on the same frequency. At VHF, extremely low power signals provide usable service over a considerable range. At the end of this range of usefulness, however, the signal which is too weak to provide anything but snowy and unrecognizable pictures is still strong enough to interfere with the direct reception of TV signals on the same channel. Because of VHF's good propagation characteristics this nuisance or interfering signal will travel many miles beyond the useful range.

In addition, because of the shorter wave lengths at UHF, directional antenna configurations are much smaller and are capable of being designed and manufactured within acceptable costs. These directional characteristics enable the UHF antenna to more readily fill in the shape of a particular white area. At VHF, an antenna to do the same fill-in job would cost very much more because of the larger size needed to achieve the same horizontal beam width.

A third inherent advantage of UHF over VHF for TV repeater service is its invulnerability to man-made noise interference and to ghosting. Contrary to most beliefs, UHF reflected off of steep mountain walls or buildings can provide completely usable signals free of ghosts, whereas this is almost impossible with VHF. This characteristic renders UHF that much more desirable over VHF for repeater service in rugged, mountainous areas, such as Colorado.

Because of the advantages of UHF over VHF for TV repeater service, it is possible to duplicate clusters of multichannel repeaters using the same channels with separations as close as 20 to 50 miles, depending upon the intervening terrain and the use of highly directional antennas. Such repetitive uses of the same channels on UHF are now in operation in many areas throughout the country.

Testimony has been provided to show that the existing UHF TV repeater service now authorized by the FCC in the form of translators is doing an outstanding job at costs that are no higher than a properly designed VHF repeater service would be.

I submit that the FCC is fully aware of the advantages of an all UHF TV repeater service to fill white areas. As a result of the studies it has made, it is fully cognizant of the problems that would be involved in enforcing a change in the existing unauthorized VHF boosters stations to comply with rules and regulations based on standards of good engineering practice, and protection of TV stations and other services using the VHF spectrum.

The FCC has on several occasions in the past ruled the VHF boosters off the air, instructing them to change over to the authorized UHF TV repeater service. It has more recently indicated that it would be willing to authorize VHF repeaters under certain limited conditions. My contention is that such authorization will definitely result in a continuation of unauthorized operation as it has in the past. If, however, the FCC would adhere to its original findings—based on engineering fact—that UHF TV translators, perhaps with certain additional relaxations, can provide the only adequate service, all repeaters would eventually change over to UHF.

It would, in my opinion, be a disservice to the public and a tremendous setback to the TV broadcast industry to authorize a VHF TV repeater service, even under limited conditions.

1. Purpose of Tests

Part 3 of FCC rules covering standard TV broadcast stations require six channel separations between two UHF-TV stations operating in the same general geographical area. The same rules permit alternate channel spacing of two VHF-TV broadcast stations under the same conditions. UHF channel spacing requirements are not applicable to TV translator service as covered in Part 4 of the rules. However when translator service first started a self-imposed restriction of three-channel spacing was adopted by applicants as a precautionary measure without having definite data as to the possibility of interference. Later, as TV translator channels (numbers 70 through 83) became more crowded, applicants began to request alternate channel spacing and these were granted by the FCC based on subjective observations made by Adler Electronics at New Rochelle, New York, using two 10-watt transmitters operating with a blank channel between and reported verbally to FCC staff. Since that time, a number of clusters of UHF translator stations have gone into operation with alternate channel spacing. These have operated satisfactorily with no record of interference complaints or of inability of the receiver operators to select any desired station in the cluster without objectionable interference from the other stations.

It was recently suggested by members of TASO's Panel No. 1 and staff members of the FCC that more definitive tests be made using three UHF stations on alternate channels with interference observations made in fairly strong signal areas using several different makes of receivers. Adler Electronics has conducted such tests at its plant in New Rochelle, in collaboration with four TV receiver manufacturers who supplied a total of six UHF-TV receivers.

2. Facilities Used

Three UHF-TV Translater Transmitters (Adler 100-watt peak visual plus 50-watt average aural) were set up to transmit channels 74, 76 and 78, converting and repeating programs from channels 5, 4 and 2, respectively, in New York City, 20 miles distant. Each was connected to a separate transmitting antenna having 9 db gain.

Three commercial, all channel UHF corner reflector receiving antennas were placed approximately 500 feet away from the translator transmitting antennas to deliver about 35 millivolts of visual signal

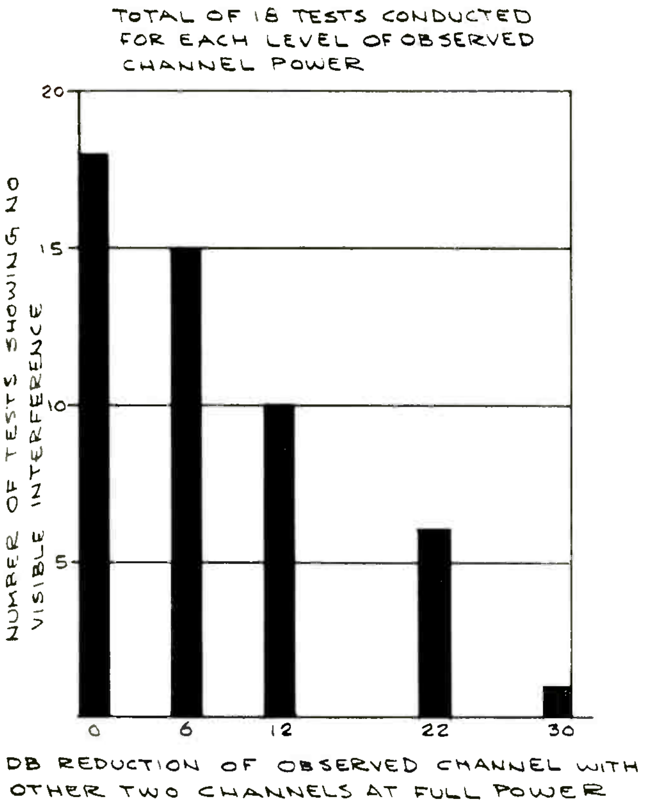


FIG. 1
ALTERNATE CHANNEL UHF TV BROADCAST TESTS

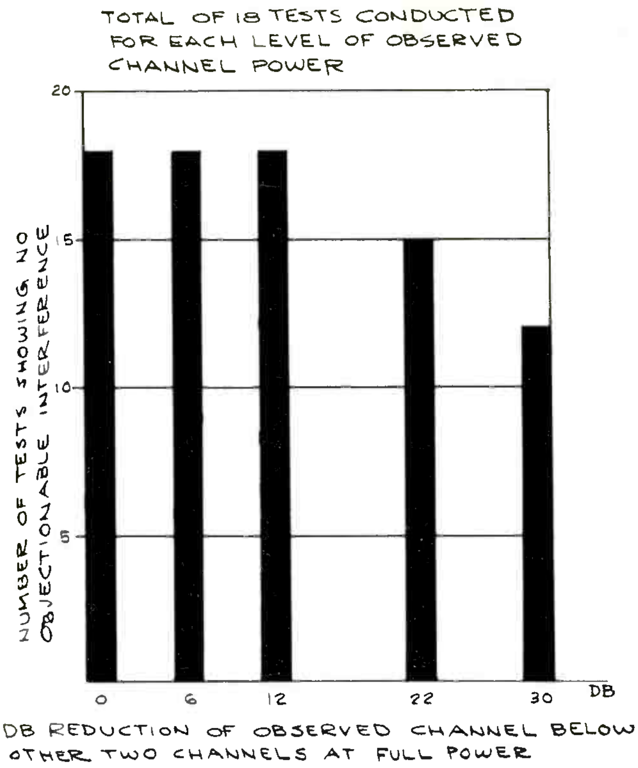


FIG. 2
ALTERNATE CHANNEL UHF TV BROADCAST TESTS

to each of the three TV receiver antenna terminals for 70 watts peak visual output from each of the transmitters. Approximately equal signal strengths were available from each of the transmitters at the terminals of all three antennas.

3. Tests Conducted

Each of the six different UHF-TV receivers was tested separately. Two other receivers were used as monitors on the undesired channels. The receiver under test was tuned to a desired channel and interference was observed with all three transmitters delivering 70 watts of peak visual power and 35 watts of average aural power to each of their respective transmitting antennas. Under these conditions each of the three stations delivered 35 mv to the antenna terminals of the receiver under test. Similar observations were made successively selecting the other two channels as desired ones. In each case, the desired channel was reduced in power 6, 12, 22 and 30 db with observations made for "just visible" interference and for "objectionable" interference. All tests were repeated for each of the six receivers. The tests were made by trained observers with agreement reached by at least three observers in each case before recording results.

It was originally planned, in addition to having observations made by engineers accustomed to observing television pictures, to have a series of subjective tests by untrained observers who would attempt to tune the sets for a satisfactory picture with all three signals present. However, it was found that it was as easy to tune for a satisfactory picture when all three signals were on and nearly equal as it was when only the desired signal was being transmitted. Therefore, the untrained observer tests were not conducted.

4. Results Obtained

Separate histogram plots were made of the tests for "no visible" interference (Fig. 1) and for "no objectionable" interference (Fig. 2).

The "just visible" interference in 17 out of 18 tests and the "objectionable" interference in 6 out of 18 tests both with the desired signal reduced 30 db can be attributed partially to varying quality of receivers among those tested. Because of poor RF and IF selectivity in some of the receivers, spurious products such as those resulting from the beat between two strong undesired signals interfere with the desired center channel where a weak signal exists.

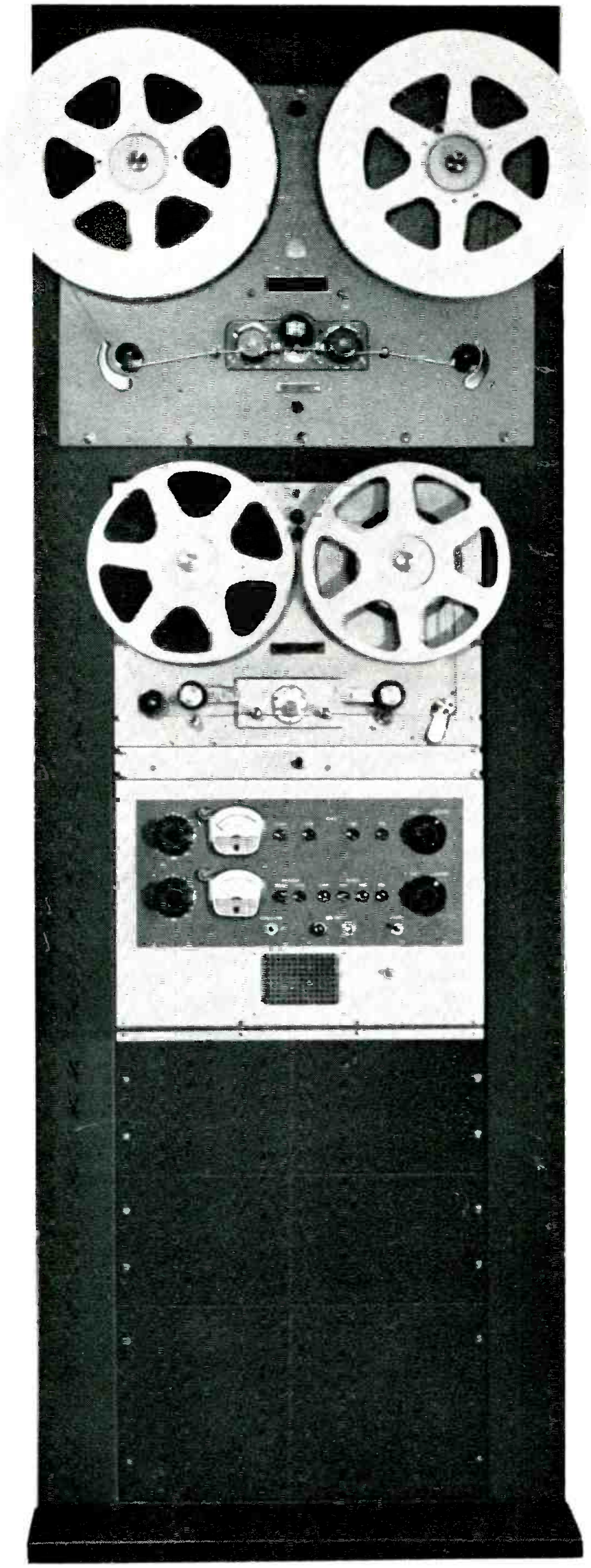
Equalizing all signals to a ±10 db range and reducing the average level to just above that required for snow free pictures, virtually eliminated objectionable interference.

5. Conclusions

It is evident from the tests conducted that alternate channel assignments may be used for UHF-TV broadcasting with no objectionable interference in current production receivers if

(1) stations are sited in clusters to equalize field patterns,
(2) receiver antennas are properly probed for approximately equalized signals (± db),
(3) pads are used at receiver inputs in strong signal areas to reduce overload signals.

When the quality of all makes of UHF receivers becomes comparable to the best of those tested, alternate channel assignments may be used with practically no precautions.



AN

With the growth of special program services offered by broadcasters the need for automatic programming equipment is increasing. A system offered by Programatic Broadcasting Service in conjunction with a program service provides eight hours of operation per machine and by using three machines it is possible to program continuously for twenty-four hours. Announcements, which are recorded separately, are automatically injected into the program.

The system consists of a program tape transport unit, announce tape transport unit, control unit, and separate announce and program amplifiers. The system is controlled by 25 cycle signals of varying time duration which starts, transfers, reverses, stops, or will switch to another program source. The announce transport unit uses single track tape to facilitate splicing and the program transport uses dual track tape.

Control signals at 25 cycles per second and of varying duration are

AUTOMATIC PROGRAM SYSTEM

A system which plays pre-recorded programs and injects announcements

recorded onto the two tapes along with the music and announcements. The signals are amplified by the music and announce channel amplifiers and fed to the control unit and to the output audio line.

The control unit provides the means for separately metering and adjusting the output signal levels of both amplifiers and monitoring the playback from either tape.

The control unit, through the use of the 25 cps control signals, causes the playback system to switch back and forth automatically between the two tape transports. It interprets the control signals according to their time durations and performs the functions of starting, transferring, reversing and stopping both transports as well as transferring to other units.

In the normal operation of the system, the music-tape transport is started at the beginning of each quarter hour group by a program timer contained within the control unit. At the end of four hours of operation the music tape reaches the end of its run in the forward direction. A reversing signal on the music tape causes relays to be energized which reverses the direction of movement of the tape.

At the end of eight hours, when the transport completes its run in the reverse direction, a control signal on the tape starts another system if one is connected. Similarly, when the announce tape is nearing the end of the reel, a control signal on the tape turns on another tape transport before it throws itself into rewind.

Announce tapes are recorded at tape speeds of either 3¾ or 7½ inches per second on either 10½-inch or 7-inch reels. The music tapes furnished provide a total of 13 minutes of music for each 15-minute time period so two minutes of local announcements can be recorded for each quarter-hour time period. The local announce recordings can consume as much time as desired without interfering with the synchronous operation of the music tape. During synchronous operation of the system, the music tape transport will start automatically at the correct time to maintain synchronism even though the local announcements may not have been completed. The music, however, will not go on the output audio line if the local announcement is not completed since the announce channel always takes precedence. The music will fade in at the end of the announcement.

The system is kept in synchronization and controlled by signals that are recorded on the music and announce tapes or by timers. They vary in time duration to accomplish their intended purposes. For example, a four second signal is used to start the announce transport and stop the music transport while a sixteen second signal starts the announce tape and disconnects the music tape from the output line. At the end of the sixteen second signal, the music tape transport is reversed and ready for operation in the reverse direction. Similarly, all other required switching and functions are determined by other control signals.

ANOTHER SENSORY PERCEPTION NOW POSSIBLE

By PROFESSOR OSCAR VON DER SNIKRAH

If your problems seem tough, read what the professor has tackled and solved this month

PROBABLY the most challenging engineering development of the age has been completed. The transmission of odors is now made possible by this exclusive new approach that utilizes the spectrum made available only to FM broadcast stations.

Since neither radio nor television offers complete satisfaction to the sensory perceptions, the additional appeal to realism made possible by being able to "smell" the program has added the missing link to the whole concept of communication by radio waves.

Recent advances in the field of stereophonic reproduction have supplied the listener with a feeling of presence that satisfies the auditory senses. Now with the reception of synchronized odors, the only thing left is the transmission of "touch feeling."

In the development of our "smellophonic" system several problems were immediately discovered that led to the posting of specific performance goals. The overall system requirements were as follows:

Compatability — The transmission of multiplex odor control signals must in no way interfere with the main channel transmission. Those listeners not equipped with a "smellophonic" adapter shall have no degradation of reception.

Crosstalk — Crosstalk between odors shall be down at least 40 Db. as measured by the F.C.C. approved "Scentometer." No standards are required regarding crosstalk of odors into other multiplex functions such as background music.

Distortion — Harmonic distortion above 7.3 per cent causes a failure of odor identification and will not be tolerated. (Distortion as high as 14.6 per cent is tolerable on the stronger more offensive odors; however, any broadcaster that respects his audience will not use them anyway.)

Noise — With no odors being transmitted, the residual shall be 39.5 Db. below the threshold of smell using "Channel No. 5" as the reference.

Modulation — A limiting amplifier shall be used to prevent peaks from exceeding 100 per cent deviation of the subchannel. This prevents overloading of the "interserser" part of the receivers.

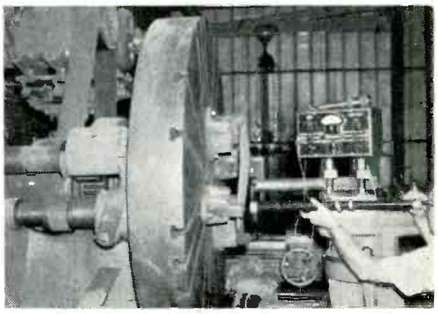
The over-all system that permits performance to meet these standards starts at the transmitting end where every precaution has been taken to insure absolute linearity of function. Pulse position modulation of subsonic tones is used on the supersonic subcarrier which in turn is phase modulated and predistorted and pre-emphasized to conform with the 75 microsecond curve. Seven channels are available to enable the transmission of six different scents along with an "all clear" signal. The latter is used to clear the air enabling a quick transition from one odor to another which is especially necessary when applied to television.

At the receiver, a simple one-tube reflex circuit is used to amplify the subsonic tones carried on the supersonic multiplex. These, in turn, pass through respective filters to key the individual odor release valves. A cartridge containing the six basic odors is easily replaced to replenish the concentrated odors. If necessary for future expansion of programming, additional cartridges can be supplied the listener and special instructions given at the beginning of the program as to which group of odors should be used.

In all cases the seventh coded pulse group operates an electrostatic air precipitation device that clears the air between odors.

Since the odor cartridges will be sold to the public only through broadcasters licensed to use the system, a steady source of income will be realized from this source. (It may well replace the income from advertising.)

While awaiting rule making procedures of the Commission, a group of industry experts are deciding the basic odors that the system will use so that all parts of the country can use the same programming.



The professor is shown in his hideaway workshop electronically making final measurements on the mechanical portion of the scent discriminator used as the heart of the transmission system. The lathe was originally purchased to turn out large color wheels for the CBS color TV system. Except for an occasional custom order for precision manhole covers (king size) the investment has not paid off. It can now be put to good use manufacturing smellophonic components.

F.C.C. REGULATIONS

SUBPART A—STANDARD BROADCAST STATIONS

§ 3.40 *Transmitter; design, construction, and safety of life requirements.*

(a) *Design.* The general design of standard broadcast transmitting equipment [main studio microphone (including telephone lines, if used, as to performance only) to antenna output] shall be in accordance with the following specifications. (In cases where telephone lines are not available to give the performance as required in these specifications a relay transmitter may be authorized to supersede the lines.) For the points not specifically covered below, the principles set out shall be followed: The equipment shall be so designed that:

(1) The maximum rated carrier power (determined by § 3.42) is in accordance with the requirements of § 3.41.

(2) The equipment is capable of satisfactory operation at the authorized operating power or the proposed operating power with modulation of at least 85 to 95 per cent with no more distortion than given in (3) below.

(3) The total audio frequency distortion from microphone terminals, including microphone amplifier, to antenna output does not exceed 5 per cent harmonics (voltage measurements of arithmetical sum or r. s. s.) when modulated from 0 to 84 per cent, and not over 7.5 per cent harmonics (voltage measurements of arithmetical sum or r. s. s.) when modulating 85 per cent to 95 per cent (distortion shall be measured with modulating frequencies of 50, 100, 400, 1000, 5000 and 7500 cycles up to tenth harmonic or 16000 cycles, or any intermediate frequency that readings on these frequencies indicate is desirable).

(4) The audio frequency transmitting characteristics of the equipment from the microphone terminals (including microphone amplifier unless microphone frequency correction is included in which event proper allowance shall be made accordingly) to the antenna output does not depart more than 2 decibels from that at 1000 cycles between 100 and 5000 cycles.

(5) The carrier shift (current) at any percentage of modulation does not exceed 5 per cent.

(6) The carrier hum and extraneous noise (exclusive of microphone and studio noises) level (unweighted r. s. s.) is at least 50 decibels below 100 per cent modulation for the frequency band of 150 to 5000 cycles and at least 40 decibels down outside this range.

(7) The transmitter shall be equipped with suitable indicating instruments in accordance with the requirements of § 3.58 and any other instruments necessary for the proper adjustment and operation of the equipment.

(8) Adequate provision is made for varying the transmitter power output between sufficient limits to compensate for excessive variations in line voltage, or other factors which may affect the power output.

(9) The transmitter is equipped with automatic frequency control equipment capable of maintaining the operating frequency within the limit specified by § 3.59.

(i) The maximum temperature variation at the crystal from the normal operating temperature shall not be greater than,

Plus or minus 0.1° C. when an *X* or *Y* cut crystal is employed, or

Plus or minus 1.0° C. when low temperature coefficient crystal is employed.

(ii) Unless otherwise authorized, a thermometer shall be installed in such manner that the temperature at the crystal can be accurately measured within 0.05° C. for *X* or *Y* cut crystal or 0.5° C. for low temperature coefficient crystal.

(iii) It is preferable that the tank circuit of the oscillator tube be installed in the temperature controlled chamber.

Note: Explanations of excessive frequency deviations will not be accepted when temperature variations are in excess of the values specified.

(10) Means are provided for connection and continuous operation of approved modulation monitor and approved frequency monitor.

(i) The radio frequency energy for operation of the approved frequency monitor shall be obtained from a radio-frequency stage prior to the modulated stage unless the monitor is of such design as to permit satisfactory operation when otherwise connected and the monitor circuits shall be such that the carrier is not heterodyned thereby.

(11) Adequate margin is provided in all component parts to avoid overheating at the maximum rated power output.

(b) *Construction.* In general, the transmitter shall be constructed either on racks and panels or in totally enclosed frames protected as required by article 810 of the National Electrical Code and as set forth in this paragraph and paragraph (c) of this section.

Note 1. The final stages of high power transmitters may be assembled in open frames provided the equipment is enclosed by a protective fence.

Note 2. The pertinent sections of article 810 of the National Electrical Code read as follows:

"8191. *General*—Transmitters shall comply with the following:

"a. *Enclosing*—The transmitter shall be enclosed in a metal frame or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.

"b. *Grounding of controls*—All external metallic handles and controls accessible to the operating personnel shall be effectually grounded. No circuit in excess of 150 volts shall have any parts exposed to direct contact. A complete dead-front type of switchboard is preferred.

"c. *Interlocks on doors*—All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts when any access door is opened."

(1) Means shall be provided for making all tuning adjustments, requiring voltages in excess of 350 volts to be applied to the circuit, from the front of the panels with all access doors closed.

(2) Proper bleeder resistors or other automatic means shall be installed across all the condenser banks to remove any charge which may remain after the high voltage circuit is opened (in certain instances the plate circuit of the tubes may provide such protection; however, individual approval of such shall be obtained by the manufacturer in case of standard equipment, and the licensee in case of composite equipment).

(3) All plate supply and other high voltage equipment, including transformers, filters, rectifiers and motor generators, shall be protected so as to prevent injury to operating personnel.

(i) Commutator guards shall be provided on all high voltage rotating machinery (coupling guards on motor generators, although desirable, are not required).

(ii) Power equipment and control panels of the transmitter shall meet the above requirements (exposed 220-volt AC switching equipment on the front of the power control panels is not recommended; however, is not prohibited).

(iii) Power equipment located at a broadcast station but not directly associated with the transmitter (not purchased as part of same), such as power distribution panels, control equipment on indoor or outdoor stations and the substations associated therewith, are not under the jurisdiction of the Commission; therefore, § 3.46 does not apply.

(iv) It is not necessary to protect the equipment in the antenna tuning house and the base of the antenna with screens and interlocks, provided the doors to the tuning house and antenna base are fenced and locked at all times, with the keys in the possession of the operator on duty at the transmitter. Ungrounded fencing or wires should be effectively grounded, either directly or through proper static leaks. Lightning protection for the antenna system is not specifically required but should be installed.

(v) The antenna, antenna lead-in, counterpoise (if used), etc., shall be installed so as not to present a hazard. The antenna may be located close by or at a distance from the transmitter building. A properly designed and terminated transmission line should be used between the transmitter and the antenna when located at a distance.

(4) Metering equipment. (In addition to the following requirements, instruments shall meet the requirements of § 3.39 and § 3.58.)

(i) All instruments having more than 1,000 volts potential to ground on the movement shall be protected by a cage or cover in addition to the regular case. (Some instruments are designed by the manufacturer to operate safely with voltages in excess of 1,000 volts on the movement. If it can be shown by the manufacturer's rating that the instrument will operate safely at the applied potential, additional protection is not necessary.)

(ii) In case the plate voltmeter is located on the low potential side of the multiplier resistor with one terminal of the instrument at or less than 1,000 volts above ground, no protective case is required. However, it is good practice to protect voltmeters subject to more than 5,000 volts with suitable overvoltage protective devices across the instrument terminals in case the winding opens.

(iii) The antenna ammeters (both regular and remote and any other radio frequency instrument which it is necessary for the operator to read) shall be so installed as to be easily and accurately read without the operator having to risk contact with circuits carrying high potential radio frequency enegry.

(c) *Wiring and shielding.* (1) The transmitter panels or units shall be wired in accordance with standard switchboard practice, either with insulated leads properly cabled and supported or with rigid bus bar properly insulated and protected.

(2) Wiring between units of the transmitter, with the exception of circuits carrying radio frequency energy, shall be installed in conduits or approved fiber or metal raceways to protect it from mechanical injury.

(3) Circuits carrying low level radio frequency energy between units shall be either concentric tube, two wire balanced lines, or properly shielded to prevent the pickup of modulated radio frequency energy from the output circuits.

(4) Each stage (including the oscillator) preceding the modulated stage shall be properly shielded and filtered to prevent unintentional feedback from any circuit following the modulated stage (an exception to this requirement may be made in the case

of high level modulated transmitters of approved manufacture which have been properly engineered to prevent reaction).

(5) The crystal chamber, together with the conductor or conductors to the oscillator circuit shall be totally shielded.

(6) The monitors and the radio frequency lines to the transmitter shall be thoroughly shielded.

(d) *Installation.* (1) The installation shall be made in suitable quarters.

(2) Since an operator must be on duty at the transmitter control point during operation, suitable facilities for his welfare and comfort shall be provided at the control point.

(e) *Spare tubes.* A spare tube of every type employed in the transmitter and frequency and modulation monitors shall be kept on hand. When more than one tube of any type are employed, the following table determines the number of spares of that type required:

Number of each type employed:	Spares required
1 or 2	1
3 to 5	2
6 to 8	3
9 or more	4

(f) *Studio equipment.* (1) The studio equipment shall be subject to all the above requirements where applicable except as follows:

(i) If it is properly covered by an underwriter's certificate, it will be considered as satisfying the safety requirements.

(ii) Section 8191 of article 810 of the National Electrical Code shall apply for voltages only when in excess of 500 volts.

(2) No specific requirements are made relative to the design and acoustical treatment. However, the studios and particularly the main studio should be in accordance with the standard practice for the class of station concerned, keeping the noise level as low as reasonably possible.

§ 3.41 *Maximum rated carrier power; tolerances.* The maximum rated carrier power of a transmitter shall be an even power step as recognized by the Commission's plan of allocation (100 watts, 250 watts, 500 watts, 1 kw., 5 kw., 10 kw., 25 kw., 50 kw.) and shall not be less than the authorized power nor shall it be greater than the value specified in the following table:

Class of station	Maximum power authorized to station	Maximum rated carrier power permitted to be installed
Class IV	100 watts	250
Class IV	250, 500 or 1,000 watts	1,000
Class III	500 or 1,000 watts	1,000
	5,000 watts	5,000
Class II	250, 500 or 1,000 watts	1,000
	5,000 or 10,000 watts	10,000
	25,000 or 50,000 watts	50,000
Class I	10,000 watts	10,000
	25,000 or 50,000 watts	50,000

§ 3.42. *Maximum rated carrier power; how determined.* The maximum rated carrier power of a standard broadcast transmitter shall be determined as the sum of the applicable power ratings of the vacuum tubes employed in the last radio stage.

§ 3.43 *Changes in equipment; authority for.* No licensee or permittee shall change, in the last radio stage, the number of vacuum tubes, nor change to vacuum tubes of different power rating or class of operation, nor shall it change the system of modulation, without authority of the Commission.

§ 3.44 *Other changes in equipment.* Other changes except as provided for in this subpart which do not affect the maximum power rating or operating power of the transmitter or the operation or precision of the frequency control equipment may be made at any time without authority of the Commission, but in the next succeeding application for renewal of license such changes which affect the information already on file shall be shown in full.

§ 3.45 *Radiating system.* (a) All applicants for new, additional, or different broadcast facilities and all licensees requesting authority to change the transmitter site of an existing station shall specify a radiating system the efficiency of which complies with the requirements of good engineering practice for the class and power of the station. (See §§ 3.186 and 3.189.)

(b) No broadcast station licensee or permittee shall change the physical height of the transmitting antenna, or supporting structures, or make any changes in the radiating system which will measurably alter the radiation patterns, except upon application to and authority from the Commission.

(c) Should any changes occur which would alter the resistance of the antenna system, the licensee shall immediately make a new determination of the antenna resistance (see § 3.54) and shall submit application for authority to determine power by the direct method on the basis of the new measurements.

(d) The antenna and/or supporting structure shall be painted and illuminated in accordance with the specifications supplied by the Commission pursuant to section 303 (q) of the Communications Act of 1934 as amended. (See Part 17 of this chapter; Rules Concerning the Construction Marking and Lighting of Antenna Structures.)

(e) The simultaneous use of a common antenna or antenna structure by more than one standard broadcast station, or by one or more standard broadcast stations and one or more stations of any other class or service may be authorized provided:

(1) Complete verified engineering data are submitted showing that satisfactory operation of each station will be obtained without adversely affecting the operation of the other station.

(2) The minimum antenna height or field intensity for each standard broadcast station concerned complies with paragraph (a) of this section.

(3) Complete responsibility for maintaining the installation and for painting and illuminating the structure in accordance with the pertinent provisions of Part 17 of this chapter is assumed by one of the licensees.

§ 3.46 *Transmitter.* (a) The transmitter proper and associated transmitting equipment of each broadcast station shall be designed, constructed, and operated in accordance with good engineering practice in all phases not otherwise specifically included in the regulations in this subpart.

(b) The transmitter shall be wired and shielded in accordance with good engineering practice and shall be provided with safety features in accordance with the specifications of article 810 of the current National Electrical Code as approved by the American Standards Association.

(c) The station equipment shall be so operated, tuned, and adjusted that emissions are not radiated outside the authorized band which cause or are capable of causing interference to the communications of other stations. Spurious emissions, including radio frequency harmonics, and audio frequency harmonics, shall be maintained at as low a level as practicable at all times in accordance with good engineering practice. In the event interference is caused to other stations by modulating frequencies in excess of 7500 cycles or spurious emissions, including radio frequency harmonics and audio frequency harmonics outside the band plus or minus 7500 cycles of the authorized carrier frequency, the licensee or permittee shall install equipment or make adjustments which limit the emissions to within this band or to such an extent above 7500 cycles as to reduce the interference to where it is no longer objectionable.

(d) The audio distortion, audio frequency response, carrier hum, noise level, and other essential phases of the operation which control the external effects shall at all times conform to the requirements of good engineering practice.

§ 3.47 *Equipment performance measurements.* (a) The licensee of each standard broadcast station shall make the following equipment performance measurements at yearly intervals. One such set shall be made during the four-month period preceding the date of filing application for renewal of station license:

(1) Data and curves showing over-all audio frequency response from 30 to 7500 CPS for approximately 25, 50, 85, and 100 (if obtainable) per cent modulation. Family of curves should be plotted (one for each percentage above) with DB above and below a reference frequency of 1000 CPS as ordinate and audio frequency as abscissa.

(2) Data and curves showing audio frequency harmonic content for 25, 50, 85, and 100 per cent modulation for fundamental frequencies of 50, 100, 400, 1000, 5000, and 7500 CPS (either arithmetical or root sum square values up to the tenth harmonic or 16000 CPS). Plot family of curves (one for each percentage above) with per cent distortion as ordinate and audio frequency as abscissa.

(3) Data showing percentage carrier shift for 25, 50, 85, and 100 per cent modulation with 400 CPS tone.

(4) Carrier hum and extraneous noise generated within the equipment and measured as the level below 100 per cent modulation throughout the audio spectrum or by bands.

(5) Measurements or evidence showing that spurious radiations including radio frequency harmonics are suppressed or are not present to a degree capable of causing objectionable interference to other radio services. Field intensity measurements are preferred but observations made with a communications type receiver may be accepted. However, in particular cases involving interference or controversy, the Commission may require actual measurements. Measurements shall be made with the equipment adjusted for normal program operation and shall include all circuits between main studio amplifier input and antenna output including equalizer or correction circuits normally employed, but without compression if such amplifier is employed.

(b) The data required by paragraph (a) of this section together with a description of instruments and procedure, signed by the engineer making the measurements, shall be kept on file at the transmitter and retained for a period of two years and on request shall be made available during that time to any duly authorized representative of the Federal Communications Commission.

§ 3.48 *Acceptability of broadcast transmitters for licensing.* (a) In order to facilitate the filing of, and action on applications for station authorizations, transmitters will be accepted for licensing by the Commission under one of the following conditions:

(1) A transmitter may be Type-Accepted upon the request of any manufacturer of transmitters built in quantity by following the type acceptance procedure set forth in Part 2 of this chapter, provided that the data and information submitted indicates that the transmitter meets the requirements of § 3.40. If accepted, such transmitter will be included on the Commission's "Radio Equipment List, Part B, Aural Broadcast Equipment." Applicants specifying transmitters included on such a list need not submit detailed descriptions and diagrams where the correct type number is specified, provided that the equipment proposed is identical with that accepted. Copies of this list

are available for inspection at the Commission's office in Washington, D. C., and at each of its field offices.

(2) An application specifying a transmitter not included on the Radio Equipment List, Part B, may be accepted upon the request of a prospective licensee submitting with the applictaion for construction permit a complete description of the transmitter, including the circuit diagram, listing of all tubes used, function of each, multiplication in each stage, plate current and voltage applied to each tube, a description of the oscillator circuit together with any devices installed for the purpose of frequency stabilization and the means of varying output power to compensate for power supply voltage variations. However, if this data has been filed with the Commission by a manufacturer in connection with a request for type acceptance, it need not be submitted with the application for construction permit but may be referred to as "on file." Measurement data for type acceptance made in accordance with subparagraph (1) of this paragraph shall be submitted with the license application.

(3) A transmitter shown on an instrument of authorization by manufacturer and type number, or as a composite, and which was in use prior to June 30, 1955, may continue to be used by the licensee, his successors or assignees, provided such transmitter continues to comply with the rules and regulations.

(b) Additional rules with respect to withdrawal of type-acceptance, modification of type-accepted equipment and limitations on the findings upon which type acceptance is based are set forth in Part 2 of this chapter.

§ 3.49. *Requirements for approval of frequency monitors*—(a) *General requirements and approval.* (1) There are several ways or means by which it can be determined whether the frequency of the emitted carrier wave is within the required limits of the assigned frequency. However, one of the commonest ways is by means of a local piezo oscillator of known frequency producing a beat with the emitted wave used in conjunction with an instrument to indicate the resultant beat frequency. The visual indicator is the only method now in common use by which it is considered that the frequency of the beat may be determined with the required degree of accuracy. Approval of a frequency monitor will be given based upon data taken by the Laboratory Division of the F.C.C. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details. If the specifications appear to meet the requirements, the Commission will authorize the Laboratory Division to issue shipping instructions. The shipping charges to and from the Laboratory Division at Laurel, Md., shall be paid by the manufacturer.

(2) In approving a frequency monitor, based upon the tests by the Laboratory, the Commission merely recognizes that the type of monitor has the inherent capability of functioning in compliance with § 3.60, if properly constructed, maintained, and operated. The Commission accepts no responsibility beyond this and further realizes that these monitors may have a limited range over which the visual indicator will determine deviations. Accordingly, it is necessary that adjunct equipment be used to determine major deviations.

NOTE: In addition to the visual indicator, the range of which is necessarily limited in order to obtain the required accuracy, an aural indicator should also be employed to indicate frequency deviations beyond the range of the visual indicator, particularly where the visual indicator is so designed that the indication becomes zero when the deviations become considerably greater than the range of the instrument. When it is desired to make any change, either mechanical or electrical, the details shall be submitted to the Commission for its consideration.

(3) No change whatsoever will be permitted in the monitors sold under approval number issued by the Commission except when the licensee or the manufacturer is specifically authorized to make such changes.

(4) When it is desired to make any change, either mechanical or electrical, the details shall be submitted to the Commission for its consideration.

(5) Approval is given subject to withdrawal if the unit proves defective in service and cannot be relied upon under usual conditions of maintenance and operation encountered in the average standard broadcast station. Withdrawal of approval means thta no further units may be installed by standard broadcast stations for the purpose of complying with § 3.60, but will not affect units already sold, unless it is found that there has been an unauthorized change in design or construction, or the material or workmanship is defective.

(b) *General specifications.* The general specifications that frequency monitors shall meet before they will be approved by the Commission are as follows:

(1) The unit shall have an accuracy of at least five parts per million under ordinary conditions (temperature, humidity, power supply, and other conditions which may affect its accuracy) encountered in standard broadcast stations throughout the United States.

(2) The range of the indicating device shall be at least from 20 cycles below to 20 cycles above the assigned frequency.

(3) The scale of the indicating device shall be so calibrated as to be accurately read within at least 1 cycle.

(4) The unit shall be equipped with an automatic temperature control chamber (preferably enclosing the tank circuits of the oscillator) such that the maximum temperature variation at the crystal from the normal operating temperature shall not be greater than.

Plus or minus 0.05° C. when X or Y cut crystal is employed, or

Plus or minus 0.5° C. when low temperature coefficient crystal is employed.

(5) Unless otherwise specifically authorized, the instrument shall be equipped with a thermometer such that the temperature can be accurately measured within 0.025° C. for X or Y cut crystal or 0.25° C. for low temperature coefficient crystal.

(6) The monitor circuit shall be such that it may be continuously operated and the emitted carrier of the station is not heterodyned thereby.

(7) Means shall be provided for adjustment of the temperature or other means for correction of the indications of the monitor to agree with the external standard.

(c) *Tests to be made by the Laboratory Division of the F.C.C.* The tests to be made at the Laboratory will include the determination of the following:

(1) *Accuracy.* (i) Oscillator frequency, as received.

(ii) Constancy of oscillator frequency, as measured several times in 1 month.

(iii) Accuracy of readings of frequency-difference instrument.

(iv) Functioning of frequency adjustment device.

(v) Effects on frequency of changing tubes and of voltage variations.

(2) *Temperature control stability.* Effect on frequency of variation of room temperature through a range not to exceed 10° to 35° C.

(3) *Sensitivity.* Response of indicating instrument to small changes of frequency.

(4) *General construction.* (i) Inspection to determine ability to stand shipment and service.

(ii) Special tests to determine quality of construction, such as effect of tilting or tipping on frequency.

(5) *Miscellaneous performance.* Various, depending on character of apparatus (e.g., changes after stopping and starting, effect of varying coupling with transmitter, etc.).

(d) The equipment will be operated in a test in the same way and the same conditions under which it will be used in service as specified by the manufacturer. The manufacturer shall supply to the Laboratory Division all instructions or services which will be supplied to the purchaser of the equipment. The equipment, as submitted, shall be adjusted for operation in connection with broadcast stations operating on 1600 kilocycles.

§ 3.50 *Requirements for approval of modulation monitors.* (a) Approval will be given based on the test data taken at the Laboratory Division of the F.C.C. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details and if the specifications appear to meet the requirements, the Commission will authorize the Laboratory Division to issue shipping instructions. The shipping charges to and from Laurel, Md., shall be paid by the manufacturer.

(b) The specifications that the modulation monitor shall meet before it will be approved by the Commission are as follows:

(1) A DC meter for setting the average rectified carrier at a specific value and to indicate changes in carrier intensity during modulation.

(2) A peak indicating light or similar device that can be set at any predetermined value from 50 to 120 per cent modulation to indicate on positive peaks, and/or from 50 to 100 per cent negative modulation.

(3) A semi-peak indicator with a meter having the characteristics given below shall be used with a circuit such that peaks of modulation of duration between 40 and 90 milliseconds are indicated to 90 per cent of full value and the discharge rate adjusted so that the pointer returns from full reading to 10 per cent of zero within 500 to 800 milliseconds. A switch shall be provided so that this meter will read either positive or negative modulation and, if desired, in the center position it may read both in a full-wave circuit. The characteristics of the indicating meter are as follows:

(i) The time for one complete oscillation of the pointer shall be 290 to 350 milliseconds. The damping factor shall be between 16 and 200. The useful scale length shall be at least 2.3 inches. The meter shall be calibrated for modulation from 0 to 110 per cent and in decibels below 100 per cent with 100 per cent being 0 DB.

(ii) The accuracy of the reading on percentage of modulation shall be ±2 per cent for 100 per cent modulation, and ±4 per cent of full scale reading at any other percentage of modulation.

(4) The frequency characteristics curve shall not depart from a straight line more than ±½ DB from 30 to 10,000 cycles. The amplitude distortion or generation of audio harmonics shall be kept to a minimum.

(5) The modulation meter shall be equipped with appropriate terminals so that an external peak counter can be readily connected.

(6) Modulation will be tested at 115 volts ±5 per cent and 60 cycles, and the above accuracies shall be applicable under these conditions.

(7) All specifications not already covered above, and the general design, construction, and operation of these units must be in accordance with good engineering practice.

INDUSTRY NEWS

Shure Names New Manager Of Microphone Development

ROBERT W. CARR

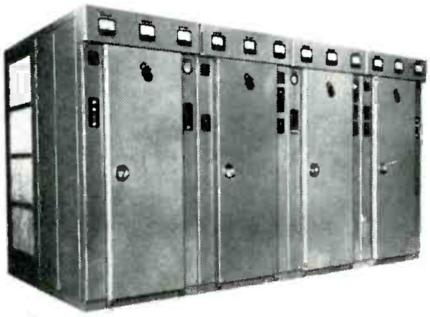
Robert W. Carr has been named manager of the microphone development department of Shure Brothers, Inc., Evanston, Ill. The appointment was announced by Harold J. Adler, vice-president in charge of operations.

Carr joined Shure in 1948 and has been a senior engineer in microphone development. He is a member of the Institute of Radio Engineers; the Acoustical Society of America; and the Chicago Acoustical and Audio Group.

James R. Day Named Director of R. E. L.

James R. Day, the inventor of the Serrasoid FM Modulator circuit which was described in the July issue of Broadcast Engineering, has recently been named a director of Radio Engineering Laboratories, Inc. Mr. Day began working on FM problems with the late Major Edwin H. Armstrong at Columbia University laboratories from 1937 to 1942. He joined Radio Engineering Laboratories in 1945 and announced the development of Serrasoid modulation in 1949. He has been vice-president of engineering and research since that year. Serrasoid is a registered trademark of Radio Engineering Laboratories.

Radio Pioneers Order Continental Transmitters



Los Angeles radio station KFI, NBC affiliate, and pioneer Earle C. Anthony, Inc., broadcasting outlet, have released the order for complete modernization of their transmitting plant, according to Thomas B. Moseley, sales director of Continental Electronics Mfg. Co., Dallas, manufacturer of the KFI transmitting package now being installed.

The "package" includes Continental's new Type 317B 50 kilowatt transmitter which offers introduced, patented design innovations plus company, lightweight styling. Also included in the order is Continental's Type 316 B 10 KW transmitter provided for standby and Conelrad purposes. The complete transmitting plant will be operated on an unattended basis using the Dallas firm's newest Type TRC transmitter remote control, plus their recently announced "Magniphase" antenna protection system.

Conrac Will Rebuild After Fire

Plans for rebuilding Conrac, Inc.'s Plant No. 2, entirely destroyed by fire the night of August 11, have been announced by W. J. Moreland, the company's president. Moreland states that rebuilding will be completed and production resumed within 120 days.

The destroyed plant housed the assembly lines for Conrac's industrial and broadcast monitors and Fleetwood home television receivers, as well as the finished stock inventory. Most of Conrac's manufacturing facilities, their large machinery and the office and extensive engineering department were unaffected by the fire as they are housed in another plant.

Manager of Government Sales Appointed at CBS Electronics

KENNETH A. WALDRON

Kenneth A. Waldron has been named manager of government sales for CBS Electronics, the manufacturing division of Columbia Broadcasting System, Inc., in an announcement by Reed Vail Bontecou, vice-president of marketing. Mr. Waldron was manager of marketing projects for General Electric Co., Owensboro, Ky.

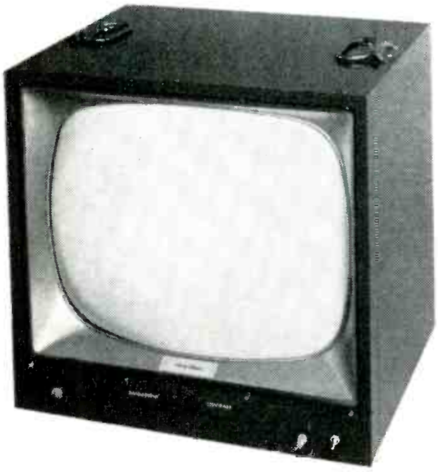
Hewlett-Packard Co. Acquires Boonton Radio Corp.

The Hewlett-Packard Co., Palo Alto, Calif., manufacturer of precision electronic measuring instruments, has acquired all outstanding stock of Boonton Radio Corp., Boonton, N. J.

Arrangements call for the transfer of Hewlett-Packard Co. stock for all outstanding shares of the radio company's stock, with Boonton Radio Corp. becoming a wholly owned subsidiary, the announcement said. Boonton Radio Corp., founded in 1935, designs and manufactures signal generators and similar instruments.

Earlier this year Hewlett-Packard, by an exchange of stock, acquired the Palo Alto Engineering Co., manufacturer of components and quality transformers. More recently, the shareholders approved a Hewlett-Packard merger with Dymec Inc., manufacturer of electronic measuring systems and special equipment.

PRODUCT NEWS



NEW FOTO-VIDEO MONITORS FOR CLOSED CIRCUIT AND BROADCAST TV

Foto-Video Lab., Inc.
36 Commerce Road
Cedar Grove, N. J.

As part of a mobile television unit at the WESCON Convention, Foto-Video Laboratories, Inc., is showing a new line of video monitors. The monitors include both cabinet and rack types in 14-inch (V-36), 17-inch (V-96), 21-inch (V-98), and 24-inch (V-92), picture tube sizes.

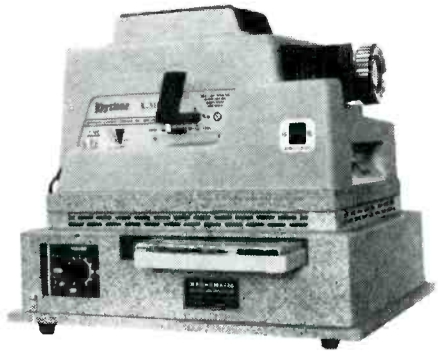
Among the utility line features are plug-in modules, 600-line resolution, 2 per cent maximum non-linearity, silicon rectifier power supply, 8-mc frequency response, and aluminized picture tube with non-glare face plate.

The professional series in addition feature electro-magnetic focus, regulated by a constant-current supply. Both the main B-plus voltage and the picture tube high voltage are electronically regulated. Plug-in modules are replaceable within seconds, minimizing maintenance and service. Foto-Video monitors have been operating successfully for some time at an AEC installation and at television stations in the United States and abroad.

AMATEUR TELEVISION EQUIPMENT

Industrial Television
7940 Fareholm Dr.
Los Angeles 46, Calif.

The Electron Corp.'s Lingmitter Ham TV station equipment is now available from Industrial Television of Los Angeles. Amateur television is permitted by the F.C.C. in the 420-450 MC band. A multiplex aural transmitter for both the video and audio portions is available.



MAGNEMATIC AUTOMATIC SOUND/SLIDE PROJECTOR

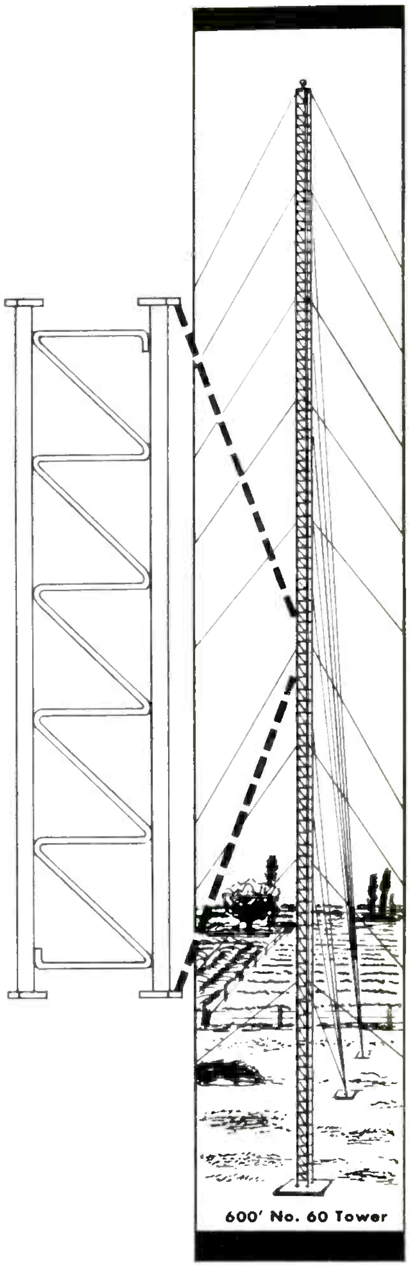
Amplifier Corp. of America
398 Broadway
New York 13, N. Y.

A fully automatic sound synchronized slide projector features a one-piece integrated construction of an automatic tape cartridge record-play mechanism and a 500-watt projector. Models are available with monophonic or stereophonic record-play facilities utilizing two, three, or four tracks on ¼-inch magnetic tape. Depending on tape speed, record-play time of various models ranges from 30 minutes to eight hours. A separate built-in recorder permits programs to be produced with the projector and subsequently played back on the same or other playback projectors. During recording the slide change is manually controlled. Each slide change automatically puts a 20 cycle control tone on the same or adjacent track. During playback the control tone automatically changes the slide in precise synchronism with the original timing.

BOOM MIKE HEADSET

Telex, Inc.
St. Paul, Minn.

The Telex Boom-Mike headset includes a noise cancelling dynamic microphone. The receivers have a rising response curve at voice range for maximum intelligibility and a uniform frequency response from 50 to 5000 cycles. The set weighs 3½ ounces.



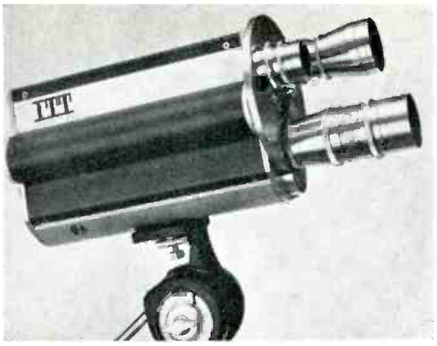
600' No. 60 Tower

ROHN No. 60 EXTRA HEAVY-DUTY COMMUNICATION TOWER

Rohn Mfg. Co.
116 Limestone, Bellevue
Peoria, Ill.

This Rohn tower utilizes the No. 9 section of the Rohn "Self-Supporting" tower and can provide outstanding rigidity and strength in heights up to 630 ft. when properly guyed. Its rugged strength lends the No. 60 Tower to a wide range of communication uses including the mounting of antennas for micro-wave, radio communications, radio telephone, military needs, TV reception and amateur uses. It is particularly desirable where extreme windloading and height requirements must be met.

All tower sections are completely hot-dipped galvanized *after fabrication* to permanently protect all points of welding and construction against corrosion. Ease of shipping and installation are facilitated by the uniform 10-foot length. Each section is a 26¼-inch equilateral triangle in size with ⅝-inch solid steel rod zig-zag cross-bracing attached to 2-inch 11-gauge tubing for legs.

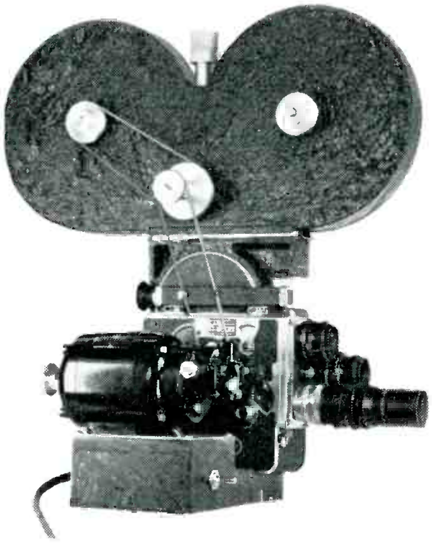


NEW CLOSED CIRCUIT CAMERA

New industrial closed-circuit television camera developed by International Telephone & Telegraph Corp. which received a 1959 WESCON award for outstanding design. The camera was one of 18 winners of 140 entries of industrial equipment and was the only camera chosen for an award. A compact 7-lb. unit with a self-contained automatic light compensator, the camera assures high-contrast, low-noise pictures by automatically adjusting its operation to compensate for light variations of 10,000 to 1. The camera was developed by the ITT Industrial Products Division, San Fernando, California.

CONTINENTAL 400 MODEL EL 3536
High Fidelity Products Div.
North American Philips Co., Inc.
230 Duffy Ave.
Hicksville, Long Island, N. Y.

The new stereo recorder for record and playback features four tracks and three speeds. It will record stereo or monaural and play back stereo or monaural tapes through the unit or through an external system. An output jack for monitoring with stereo headphones is incorporated. The unit consists of the tape drive mechanism, two preamplifiers with controls, two four watt power amplifiers, and a wide range speaker. A dual element stereo microphone is also included.



BOLEX 400 FOOT MAGAZINES AND ACCESSORIES
S. O. S. Cinema Supply Corp.
602 W. 52nd St.
New York City 19, N. Y.

The S.O.S. Cinema Supply Corp. has taken over the manufacture and distribution of the TCE line of Bolex 400-ft. magazines and accessories. The TCE 400-ft. magazine unit uses a saddle block permanently mounted to the Bolex Camera with a light-tight cap when the magazine is not in use. S.O.S. will continue the manufacture of the TCE line as all the patterns, tools, dies, jigs and fixtures have been moved to New York.

VARIABLE 3-SPEED TURNTABLE TYPE B
Ercona Corp.
16 West 46th St.
New York 36, N. Y.

The Connoisseur Variable 3-Speed Turntable manufactured by the A. R. Sugden Co., Brighouse Yorks, England, employs a hysteresis motor and maintains constant speed with line voltage variations of 25 per cent. The motor platform is constructed of a heavy zinc alloy diecasting finished in silver hammer. The dimensions are 15¼ x 13½ with 3¾ inches clearance below the motorboard.

Index To Advertisers

MERCURY RECTIFIER TESTER
Teletronix Engineering Co.
4688 Eagle Rock Blvd.
Los Angeles 41, Calif.

A single commercial instrument which will test all types of mercury vapor rectifiers. Self-contained and complete with indicating meter the tester reads ionization voltage for determination of tube condition and life. Tubes are tested without removal from their sockets. Auxiliary jacks are provided for optional connection of an oscilloscope if visual observation of the ionization level and waveform is desired.

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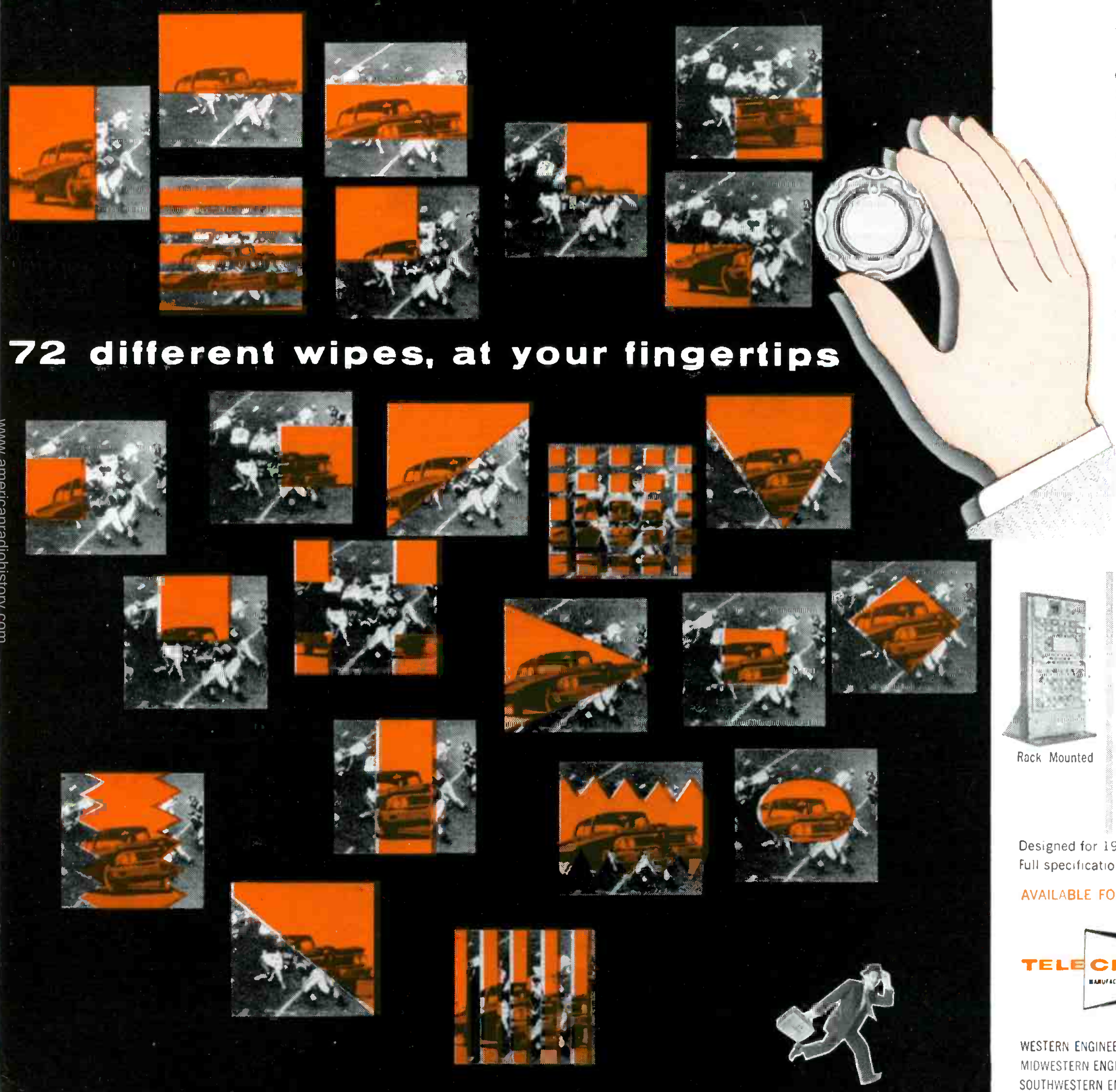
"The Technical Journal of the Broadcast Industry"



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- Its versatility permits use in live, video-tape or film programming.

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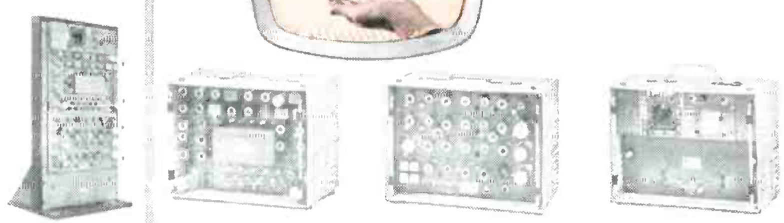
SPECIAL EFFECTS GENERATOR
FOR WIPES & MATTING, MODEL 490A

Insert Keying with Super Stability



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