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Broadcast Engineering

the technical journal of the broadcast-communications industry

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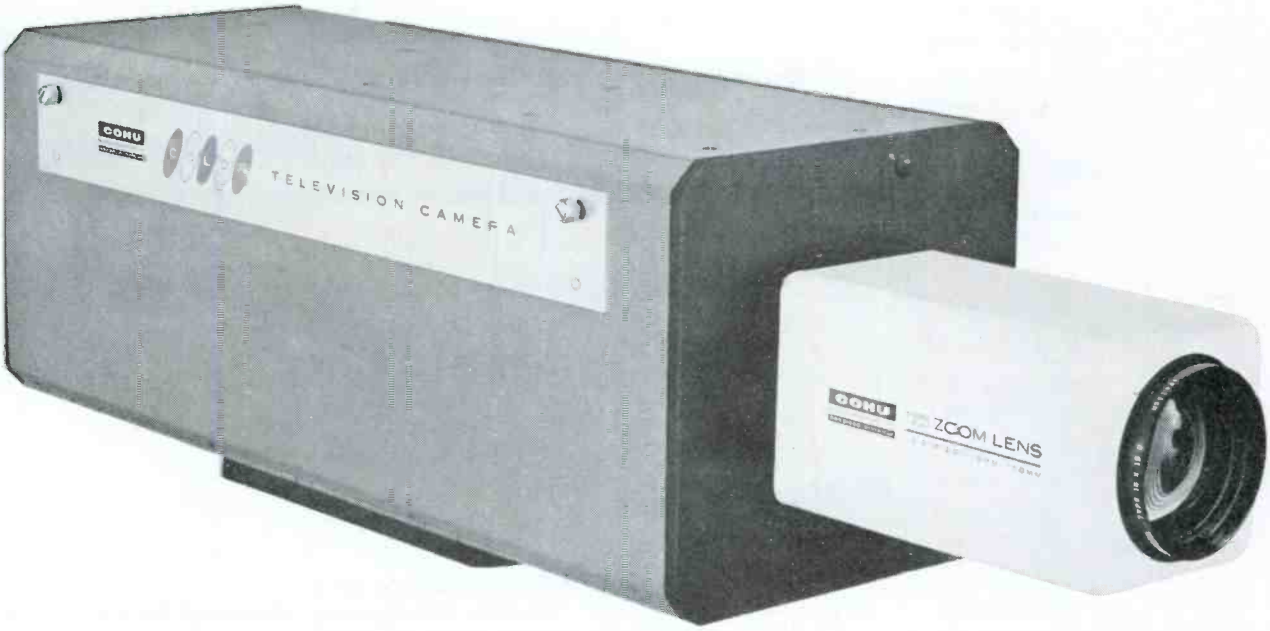

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the technical journal of the broadcast-communications industry

Broadcast Engineering

Volume 9, No. 11 November, 1967

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Features

Departments

This tower has been a Midwestern landmark for more than 30 years. For more details, see page 38.

ENGINEERS' EXCHANGE

Monitor Calibration Problem

We have encountered a problem with the Hewlett-Packard 335B Frequency-Modulation Monitor. When the transmitter is on, and the operator switches from the USE position to the CALIBRATE position, the monitor frequency-deviation meter goes negative, and the modulation meter does not come up to 100%.

Many engineers believed the cause of the problem was a bad or dirty mode-position switch, and consequently they tried correcting it with a contact cleaner. However, it has been found that by replacing the 6AC7 (V1, the local crystal oscillator tube) the problem may be solved.

—Sherman Clapman

Remote Tower-Light Indicator

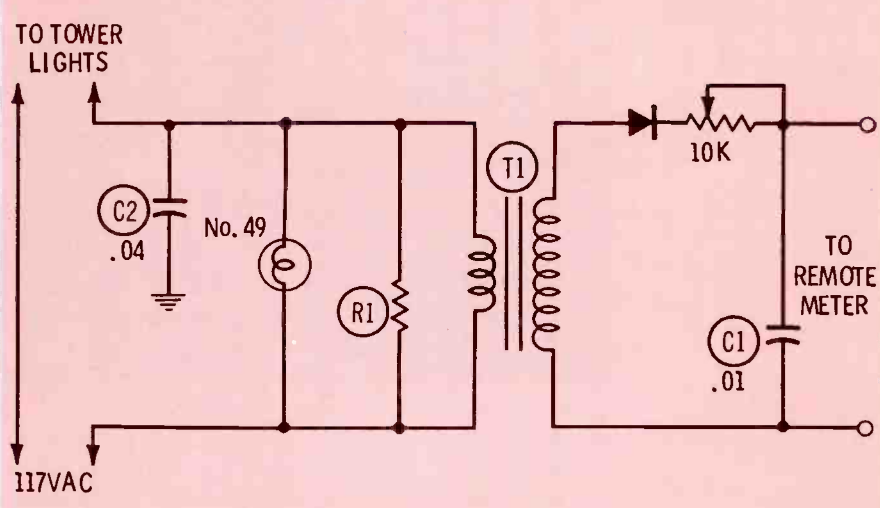
When it became necessary to install a device to indicate the operation of the tower lights through our remote-control unit, it occurred to us that a small piece of electric clothes-drier heating element could be used to provide a suitable voltage drop for measurement.

With a 3½-inch piece of the element, shown as R1, the accompanying circuit was developed. T1 is a door-bell transformer, but a filament transformer should serve equally well. The lamp is not vital to the circuit but can be used inside the transmitter building as a quick indicator of tower-light operation. C2 serves to reduce RF interference.

The unit is inserted in series with the tower-light circuit. With all the lights on (four obstruction lights and two 600-watt beacons in our case), the voltage drop across R1 is about 1.5 volts. Any variation in the voltage as read on the remote meter indicates failure of one or more of the individual bulbs.

The unit, built on a 7″ × 5″ × 2″ aluminum chassis, would have cost about $10 if it had been necessary to purchase the parts. It has been installed for nearly a year and has given us no problem.

—Robert Brigham



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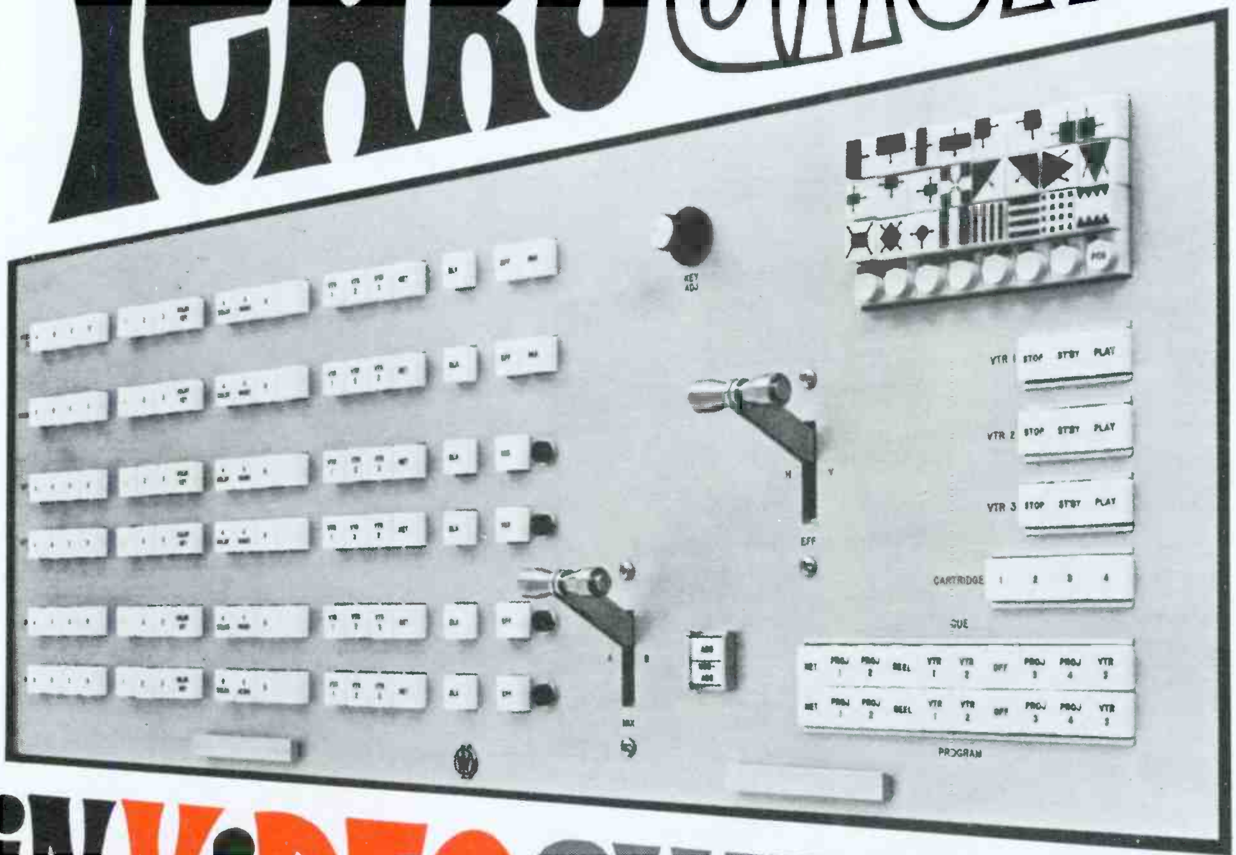

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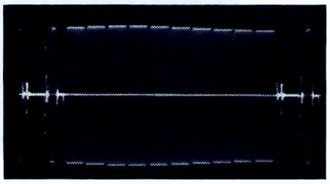

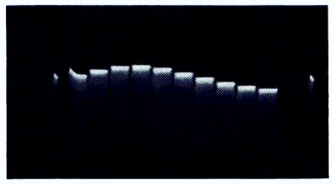

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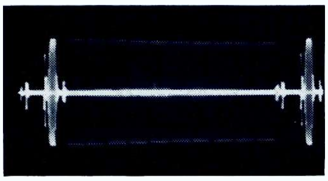

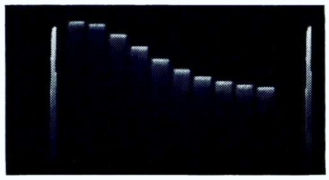

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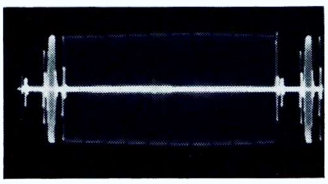

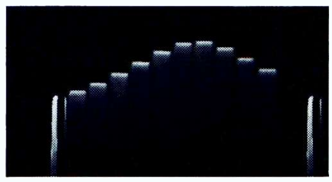

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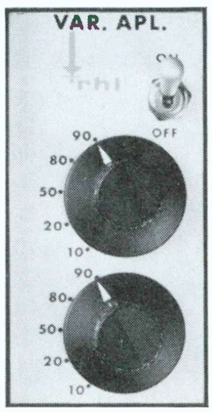

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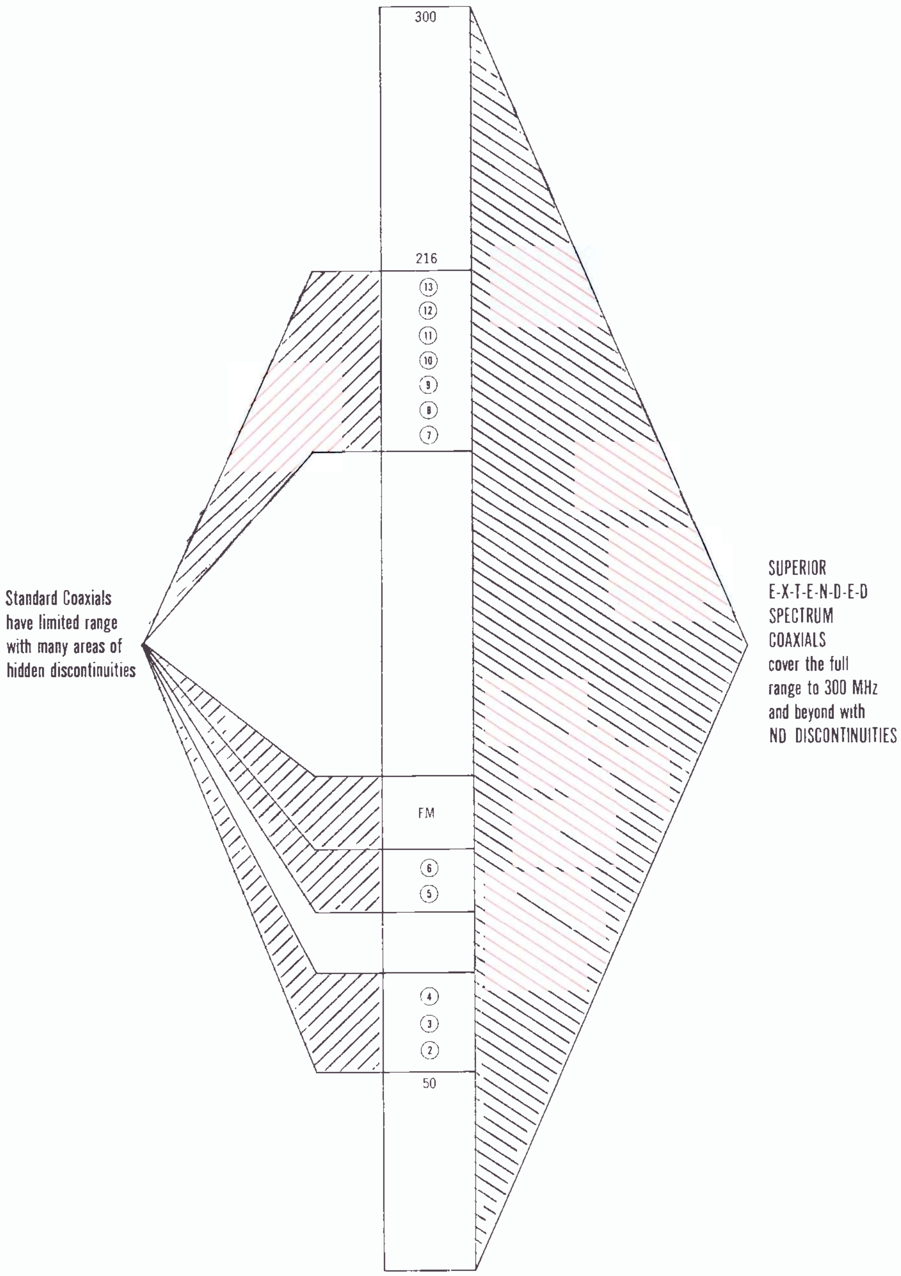

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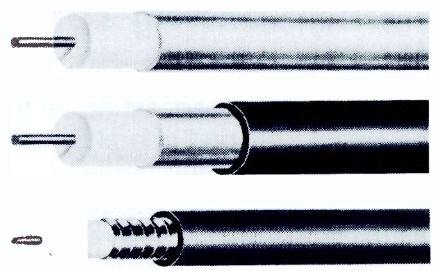

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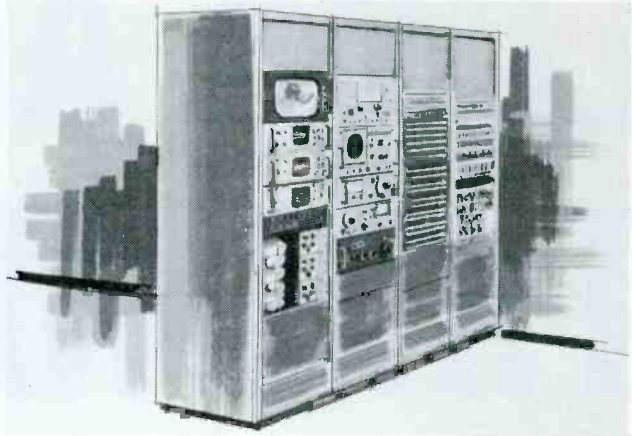

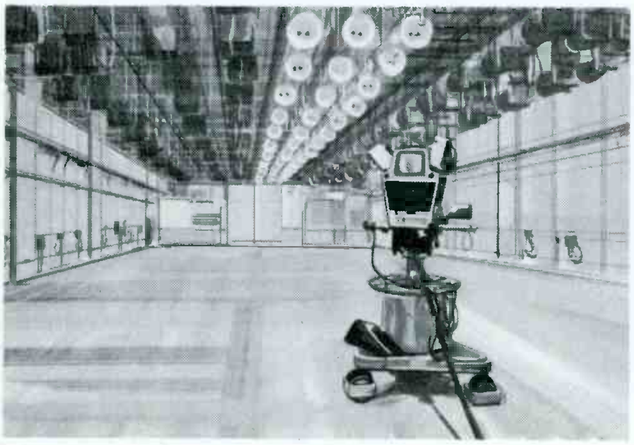

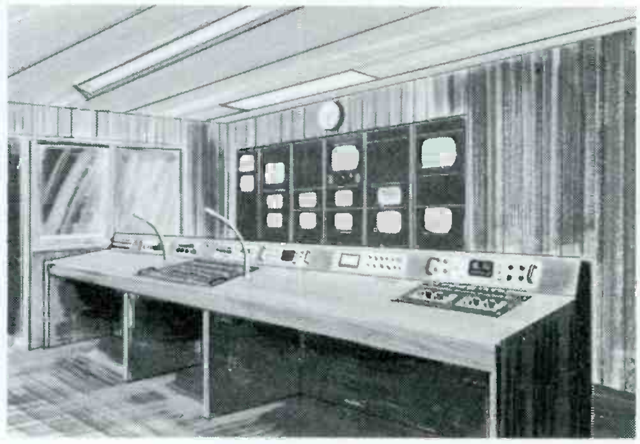

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DESIGN CONSIDERATIONS FOR A LAVALIER MICROPHONE

by Reinhard Plantz
—Scientific research forms the basis for a design that achieves the desired results.

Lavalier microphones designed for high-quality reproduction must reproduce the human voice without modifying the sound and without introducing troublesome noises due to motion of the unit against clothing, etc. In short, the sound reproduction of such a microphone must be indistinguishable from that of a quality microphone used on a stand. Because of the frequency-dependent directional characteristic of the mouth, which radiates sound predominantly in a straight line, and the presence of noise-absorbing material (clothing) near the transducer, many problems must be overcome. Futhermore, the lavalier microphone must operate in the sound field found in the region of the chest, which is an excellent radiator. Thus, the lavalier environment is quite different from that of a microphone placed on a stand in front of a speaker or performer.

Optimum Transducer Frequency Response

In order to arrive at a realistic picture of what "optimum response" means in the lavalier environment, it is necessary to measure the relative frequency dependence, over the entire voice range, of the sound-pressure level at the sound port of the lavalier microphone. To this end, the research of Olson, Preston, and Bleazey (1) and the extensive measurements of Yamamoto and Nishimura (2) are useful. Especially notable in the latter work is the fact that a life-sized, fully clothed dummy was employed. The head of the dummy contained an artificial "mouth" (radiating transducer), which was excited with sine-wave signals for the frequency tests.

Other significant experiments were conducted by the German Television Research Institute, which measured the sound-pressure levels in the region of the breastbone. The measurement was accomplished using the test setup shown in Fig. 1. Subject P is placed approximately 1 meter from microphone M1 (the reference microphone). The signal from M1 is fed to channel 1 of a dual-channel tape recorder. A second microphone, M2, identical to M1, is placed in the vicinity of the subject's breastbone. The signal from M2 is fed to the second channel of the tape recorder. This procedure readily facilitates comparison of the sounds received at the two locations.

The taped signals are played back and fed through a 1/3-octave filter for camparison with each other. Of course, this procedure can also be followed with two single-track machines which have the same frequency response. However, the tapes must be made at the same time, since it is extremely difficult to duplicate emphasis, loudness, etc., in a second reading. The only important consideration is that the sounds picked up by the two microphones be available for simultaneous comparison.

The analysis was facilitated through the use of a 1/3-octave analyzer, connected to a level recorder having a maximum stylus displacement of 2 mm/sec and a paper velocity of 0.3 mm/sec. This precise, time-consuming technique

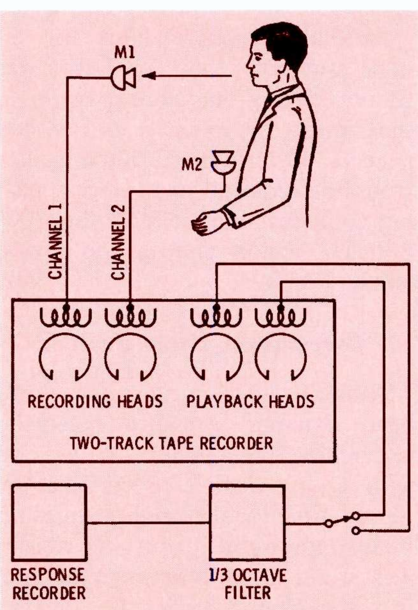


Fig. 1. Microphone comparison setup.

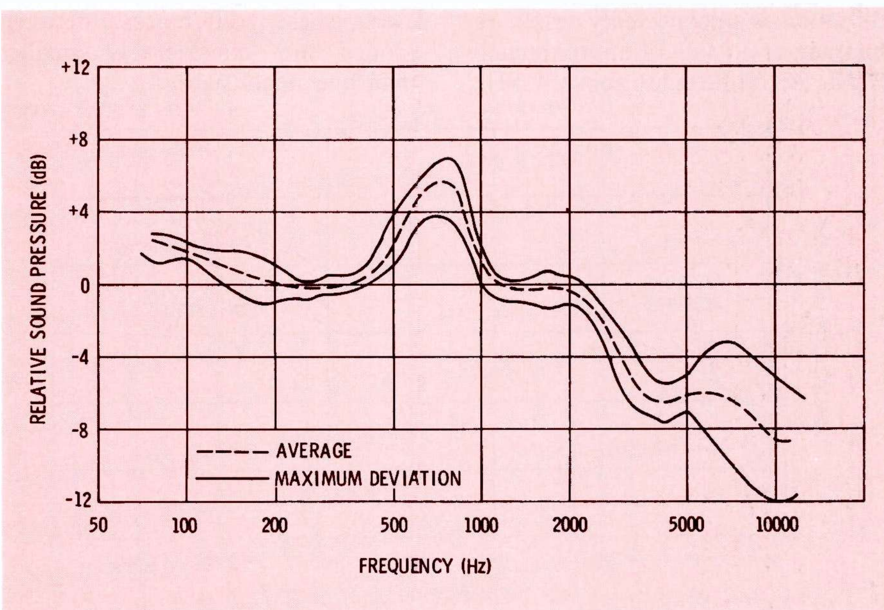


Fig. 2. Microphone response in region of the breastbone (for male subjects).

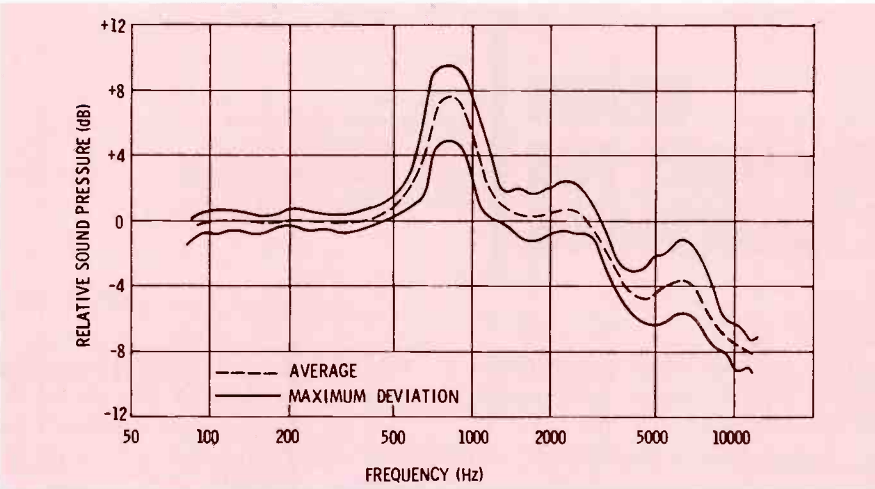


Fig. 3. Microphone response in region of the breastbone (for female subjects).

is necessary for adequate analysis of human speech, which consists primarily of impulse-like waveforms. In order to increase the accuracy of measurement, six separate tape loops were analyzed with the filter-recorder combination.

By comparing the pressure level at M2 versus that at M1, one can explore the relative frequency dependence of the sound level appearing at the aperture of the lavalier microphone. The median. distance of M2 to the subject's mouth was 27 cm, which adequately approximates the average demands placed on the lavalier microphone in its normal environment. Fig. 2 illustrates the average, maximum, and minimum values of sound pressure in the region of the breastbone, as measured with six male subjects of various sizes. In the region from 80 Hz to 4 kHz, the deviation is unexpectedly small, remaining at a value of approximately 2 dB. At frequencies above 4 kHz, greater deviations in sound pressure levels occur, extending to 7 dB in the six subjects tested.

The pressure dropoff at higher frequencies results primarily from the highly directional characteristic of the mouth as a radiator, and follows closely the results of Olson, Preston, and Bleazey, and Yamamoto and Nishimura. Surprising is the rise in sound pressure level encountered in the range of 700 to 800 Hz.

The same measurment procedure was duplicated with six female subjects. The results are shown in Fig. 3. The individual differences above 1 kHz are generally greater than with the male subjects. A slight increase is also observable in the midfrequency area, approximately 100 Hz higher than for the male subjects and generally more pronounced (though narrower). However, these differences between groups are considerably smaller than one might at first expect.

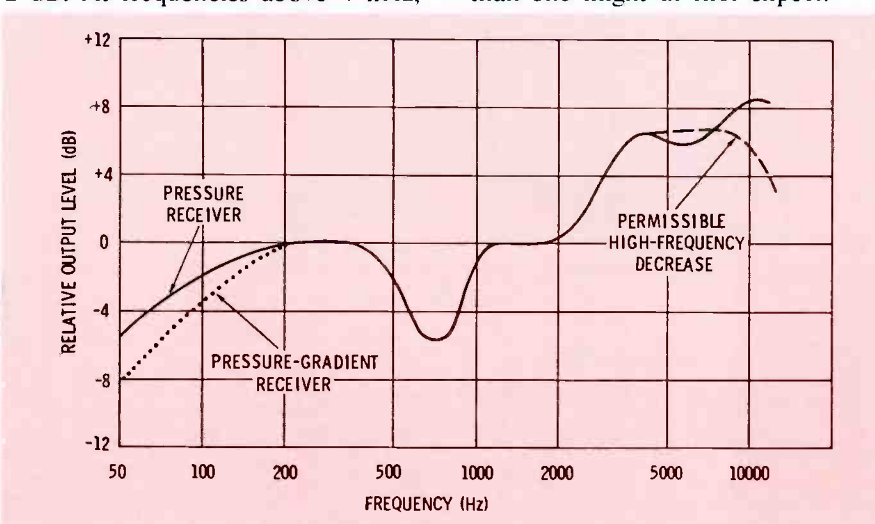


Fig. 4. Response curves for pressure receiver vs pressure-gradient receiver.

The desired microphone response curve, based upon the results already discussed, is shown in Fig. 4. This curve is valid for pressure receivers (omnidirectional characteristic) when used to pick up the male voice. A gradual roll-off, beginning at 8 kHz, is permissible, down 3 dB at 10 kHz and 5 dB at 12 kHz from the theoretical curve. The attenuation produced by this roll-off is not considered harmful to the accurate reproduction of speech or singing. The dotted line illustrates the response obtained with a lavalier microphone operating on the pressure-gradient (cardioid) principle. When these measurements are made with an identical microphone utilizing pressure-receiver principles, the results coincide, except below 200 Hz. In that region, the proximity effect causes the descrepancy.

Practical tests have been conducted with a lavalier microphone designed with the "ideal" response shown in Fig. 4. The results indicated that trained listeners could detect no subjective differences between its reproduction and that of a comparable flat-response studio microphone placed on a stand in "normal" position. However, when the increased sound pressure encountered in the region around 700 Hz is not compensated for, a typical "lavalier" sound is readily observed. Another result of comparison tests indicated that separate correction is unnecessary for male and female speakers. Any improvement which a special corrective filter for female subjects may produce was found entirely out of proportion to the design complexity that would need to be introduced. Such a filter would be required to provide separate compensation both in the 700-800 Hz region and in the region above 1 kHz.

Directional Characteristic

Most lavalier microphones have been dynamic pressure receivers, responding to higher frequencies with a spherical characteristic. A highly directional response, to eliminate undesirable disturbing noises, was found to be unnecessary except in rare cases. Since the lavalier working distance is relatively small, averaging about 25 to 27 cm, the microphone operates under extremely favorable conditions for suppression of reverberation and similar problems. Even in a small, reverberant room, the microphone is well within the rigion where the direct sound is far stronger than the reflected sound.

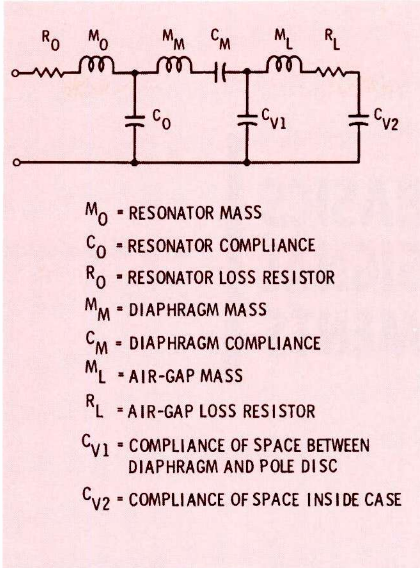
One application where special characteristics would seem most advantageous is in large halls, where a public-address system is used to amplify sound from the microphone. In such applications, a lavalier microphone with a cardioid characteristic will result in a 5-dB suppression of ambient noise. However, because of proximity to the body and other effects, the directional pattern of the microphone will vary from the optimum as its nearness to the body changes.

In actual tests conducted by the Norddeutsche Rundfunk, it was shown that a cardioid dynamic microphone increased the level at which feedback occurred by 3 or 4 dB. However, this advantage appears relatively useless in the light of the greater sensitivity to vibration of the cardioid mircophone, as shown by Dr. Griese (3). Even an ordinary dynamic microphone exhibits considerable vibration pickup, and special means must be devised for reducing microphone vibration sensitivity.

Precautions to Counteract Noise Pickup

While the lavalier microphone possesses the advantage of being at a constant distance from the mouth of the speaker, it also presents, for the same reason, the inherent problem of being mounted, in effect, on the speaker. It is, therefore, prone to noise pickup due to the sounds of the case rubbing against clothing, or of the cable moving along the floor. These noises are carried to the microphone by a combination of mechanical vibration and airborne sound.

Special attention must be given to maximum noise suppression. One of the most obvious means, of course, is to make the microphone case smooth and without sharp edges. In addition, the means of



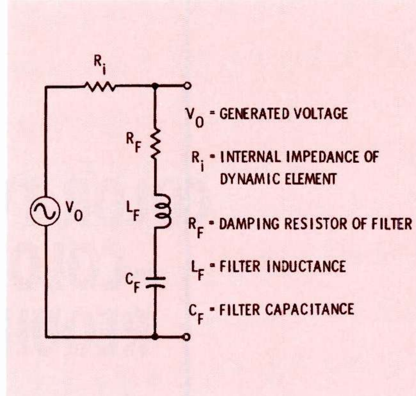


Fig. 6. Electrical equivalent circuit.

Fig. 5. Equivalent acoustic circuit.

attachment should provide for the microphone to rest as rigidly against the body as possible.

Of equal concern is the problem of sound pickup when the microphone cable rubs against some object. Practical experience has shown that additional vibrational insulation must be provided. An effective means is to suspend the transducing element elastically from both housing and strain relief.

A Practical Design

According to Fig. 4, the ideal frequency response of a lavalier microphone should coincide with the solid line up to 5 kHz, and above 5 kHz it can follow the dash line. The necessary attenuation in the region of 700 Hz is easily achieved in an ominidirectional dynamic microphone. The equivalent acoustic circuit is shown in Fig. 5. The air mass in the air gap, M_L, is larger than usual in dynamic microphones, which results in a flat frequency response to 2 kHz; above this frequency, a slight rise can be noted, with maximum at 5 kHz of 6.5 dB. The necessary dip in the frequency response is achieved by means of a filter in parallel with the voice coil, as shown in Fig. 6. In the actual resign represented by the figure, C_F has a capacitance of 0.58 mfd, and L_F has an inductance of 90 mh. Resistor R_F is 150 ohms, the sum of the voice-coil resistance and that of L_F. The action of such a circuit can be seen in Fig. 7. The response obtained without the filter is shown with a dash line, while the result with the filter closely approximates that outlined previously.

A mechanical design chosen to achieve vibration insulation is shown in Fig. 8; the design is based on a double-housing construction. The inner housing is an aluminum

• *Please turn to page 62*

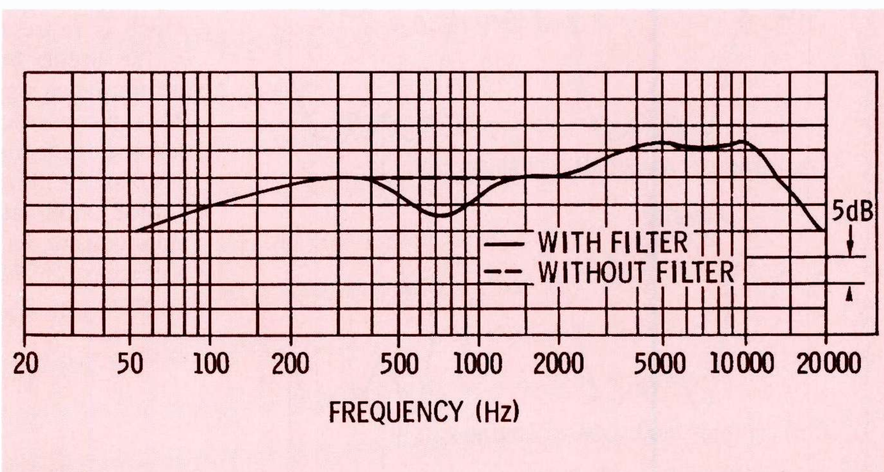


Fig. 7. Response curve shows result of circuit arrangement shown in Fig. 6.

COLOR-TV BASICS —COLOR-SIGNAL REQUIREMENTS

Part 2 of the color series examines the requirements the color signal must meet.

Last month the principles of colorimetry and the nature of human vision were examined. In this second part of the color-basics series, the requirements of the color signal are described.

The composite color signal not only must carry color information, but it must also be compatible with the long-established system of monochrome television. In other words, the signal must be such that it can be received on a monochrome receiver in black and white without any modification of the receiver. In addition, the part of the signal which conveys color must be transmitted in such a manner that it does not appreciably affect the quality or type of picture reproduced by the monochrome receiver.

The signal must represent the scene according to its color, and the colors must be transmitted in terms of the three chosen primaries—red, green, and blue. By some means, the three physical aspects of brightness, hue, and saturation must be conveyed by the signal for each color in the scene, because the eye sees color in terms of these aspects.

In order to make the color system compatible, the specifications of the standard monochrome signal had to be retained. This meant that such things as the channel width of 6 MHz; the aspect ratio of 4 to 3; the number of scanning lines per frame of 525; the horizontal-scanning and vertical-scanning rates of 15,750 and 60 Hz, respectively; and the video bandwidth of 4.25 MHz had to remain the same within narrow tolerances. To these basic specifications, provisions had to be added to convey the color elements by means of a signal which will hereafter be known as the chrominance signal.

Even if the same specifications were retained, the color system would not be compatible if the composite color signal did not contain a signal which would convey brightness. To satisfy this requirement, a signal which is representative of the brightness of the colors in the scene must be transmitted together with the chrominance signal. This brightness signal is very much the same as the video signal used in standard monochrome transmission, and it will be referred to hereafter as the luminance signal. It is transmitted by amplitude modulation of the picture carrier in such a manner that an increase in brightness corresponds to a decrease in the amplitude of the carrier envelope.

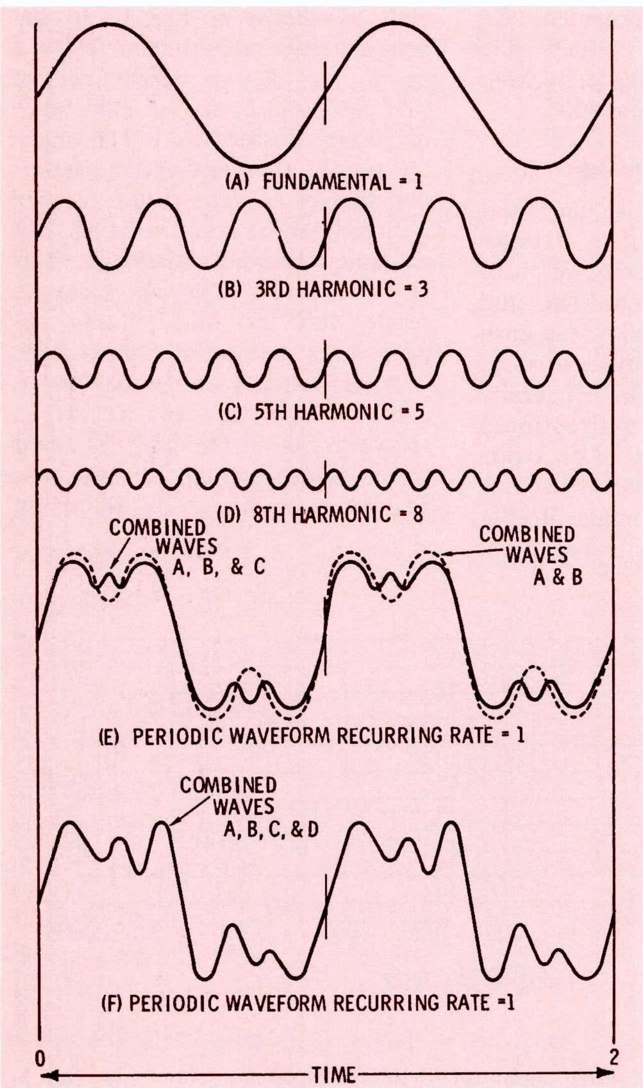


Fig. 1. Sine-wave components make up periodic waveform.

Color could be transmitted by three separate signals, each representing a primary color, but a channel width of at least 12.75 MHz would then be required. Since this would not satisfy the requirement for compatibility, color had to be represented in some other manner in order to utilize the standard 6-MHz channel width.

The chrominance and luminance signals are included within the normal 4.25-MHz video bandwidth by an interleaving process. This process is possible because the energy of the luminance signal concentrates at specific intervals in the frequency spectrum. The spaces between these intervals are relatively devoid of energy, and the energy of the chrominance signal can be caused to concentrate in these spaces. A detailed discussion of the interleaving process is presented later in this article.

The chrominance signal is conveyed by means of a subcarrier, the frequency of which was chosen to accomplish the desired interleaving. Three signals—for red, green, and blue—are obtained from the camera. Portions of these three signals are used to form the luminance signal. This leaves three signals which are referred to as color-difference signals. Two of these are proportionately mixed together to form two other signals that are used to modulate the chrominance subcarrier.

A method of modulation known as divided-carrier modulation may be employed in order to place two different signals upon the same carrier. The subcarrier is effectively split into two parts, and each part is modulated separately. Then the two portions are combined to form the resultant chrominance signal. The amplitude and phase of this signal vary in accordance with variations in the modulating signals. A change in amplitude of the chrominance signal represents a change in color saturation, and a change in phase represents a change in hue.

A reference signal of the same frequency as the subcarrier is transmitted in the composite color signal. This reference signal, called the color burst, has a fixed phase angle and is employed by the color receiver in order to detect properly the colors represented by the chrominance signal.

In the foregoing discussion, it has been shown that the composite color signal contains a luminance signal and a chrominance signal. A color-burst signal is also transmitted along with the conventional blanking and sweep-synchronizing signals. Next, the methods employed in making up the composite color signal will be examined in greater detail.

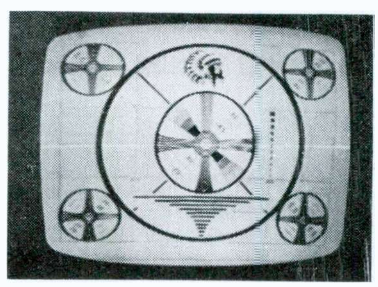
The Interleaving Process

The interleaving process, as mentioned previously, makes it possible to transmit the composite color signal within a channel no wider than that used for monochrome transmission. The process stems from a principle discovered by Mertz and Gray.[1] Their studies concerning the scanning process used in telephotography and television revealed that the energy produced by scanning an image concentrates at specific intervals in the frequency spectrum. It was further shown that these points of energy concentration occur at frequencies computed as whole multiples of the scanning rate. The actual proof of this phenomenon involves a series of complicated mathematical formulas not practical to reproduce here, but a more or less general idea of the reasons for such energy concentration is presented in order to help the reader to understand the interleaving process.

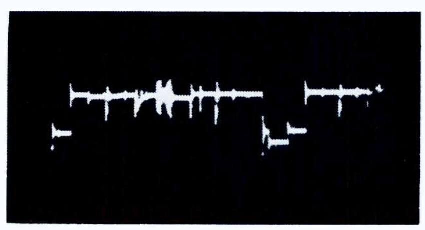
A mathematical solution would show that any video signal produced by scanning an image contains an infinite number of pure sine waves. As an example, waveform E in Fig. 1 can be matched by combining waveforms A, B, and C. If the eighth harmonic of waveform A is added to waveform E, waveform F will result. Note that the frequency of each of the pure sine waves is either the fundamental or a harmonic of the recurring rate of waveforms E and F. Although more complex than waveform E or F, every video waveform is composed of harmonically related sine-wave components.

The monochrome video waveform shown in Fig. 2 contains an infinite number of sine waves which have frequencies that are multiples of the fundamental frequency of the entire waveform. Because this fundamental frequency is determined by the rate of scanning, a video waveform produced by scanning an image at a constant rate will contain an infinite number of sine waves which have frequencies that are harmonics of the line-scanning frequency. If the waveform shown in this figure were followed through several successive scanning lines, there would be very little change in its

[1] Mertz, Pierre and Frank Gray, "A Theory of Scanning and Its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television," *The Bell System Technical Journal*, Vol. XIII, No. 3, July 1934.



(A) Test pattern



(B) Waveform for 1½ bright lines in (A)

Fig. 2. Video waveform from horizontal picture scanning.

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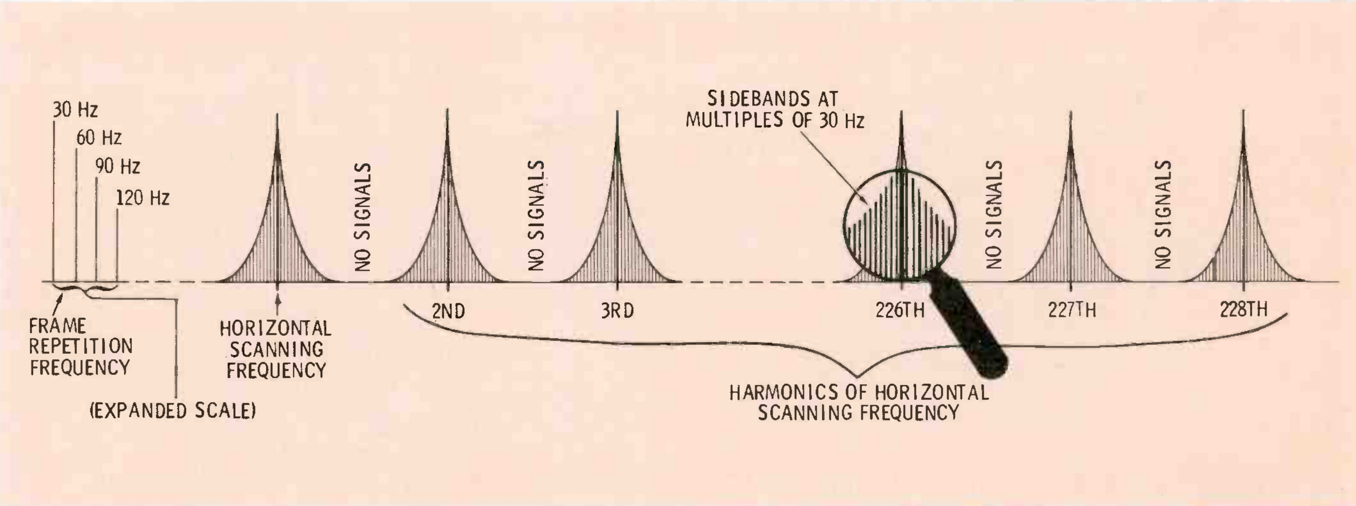


Fig. 3. Representation of the distribution of energy in the frequency spectrum of a standard monochrome video signal.

composition. Thus, the waveform recurs at the line-scanning frequency.

It follows that for an image which is not moving rapidly, the waveform of a particular line will be repeated during the scanning of each successive frame; therefore, the waveform also recurs at the frame rate. As a result of repeated scanning, a number of recurring waveforms at the frame frequency and at the line-scanning frequency are produced.

Since the transmitted signal is comprised of recurring waveforms at the frame and line frequencies, and since these waveforms contain an infinite number of waves which have frequencies that are harmonics of the frame and line frequencies, concentrations of energy occur in the video spectrum at whole multiples of the frame and line frequencies. More energy concentrates at multiples of the line-scanning rate than at multiples of the frame rate because of the greater number of successive waveforms at the line frequency.

Present-day monochrome transmission follows this principle of energy distribution. The drawing presented in Fig. 3 shows the frequencies at which the concentrations of energy occur. It may be noted that nearly half the video spectrum is unused.

Since the scanning rates for the chrominance signal and for the luminance signal are the same, the concentrations of energy produced by both are spaced at the same intervals. It is feasible, therefore, that the bands of concentrated energy of the chrominance signal could be spaced between the bands of the luminance signal. As seen in Fig. 4, the spaces in the frequency spectrum occur at odd multiples of one-half the line frequency. If a subcarrier frequency equal to an odd multiple of one-half the line-scanning frequency is chosen, the chrominance and luminance signals will be interleaved.

Development of the Subcarrier Frequency

A carrier may be described as a signal in which some feature—such as amplitude, frequency, or phase—may be made to vary in accordance with the characteristics of a modulating signal. In radio and in monochrome television, the modulation can be recovered by a detection process. In color television, however, a portion of the modulation on the video carrier performs by itself the functions of a carrier. This modulating frequency is called a subcarrier. After being detected and separated from the video carrier, the subcarrier must undergo further demodulation before the characteristics of the modulating signal which is conveyed by the subcarrier can be obtained.

The frequency of the chrominance subcarrier is governed by several factors. The subcarrier frequency must be high enough above the video carrier to keep interference at a minimum in either monochrome or color receivers. Also, if a frequency near the upper

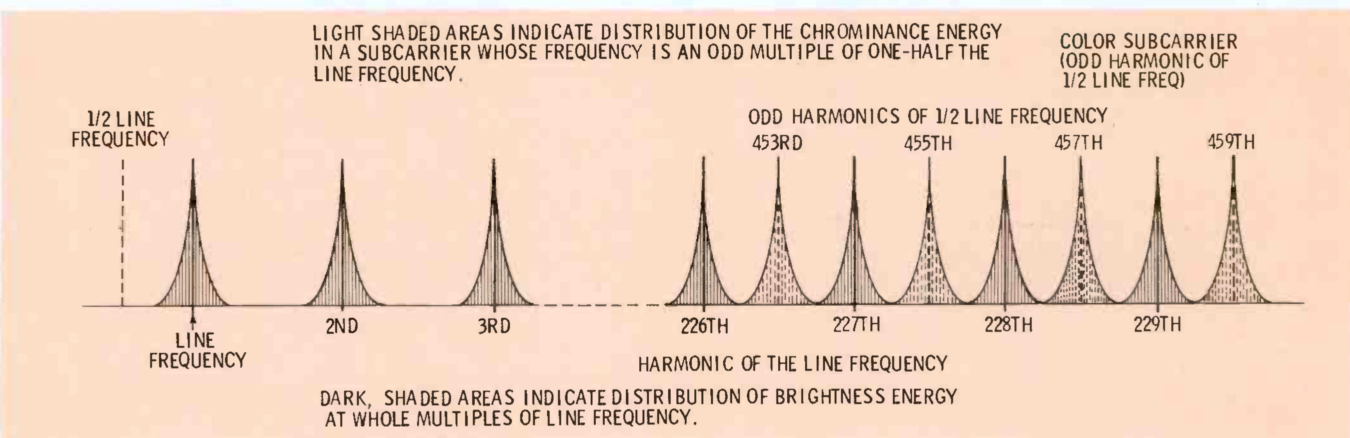
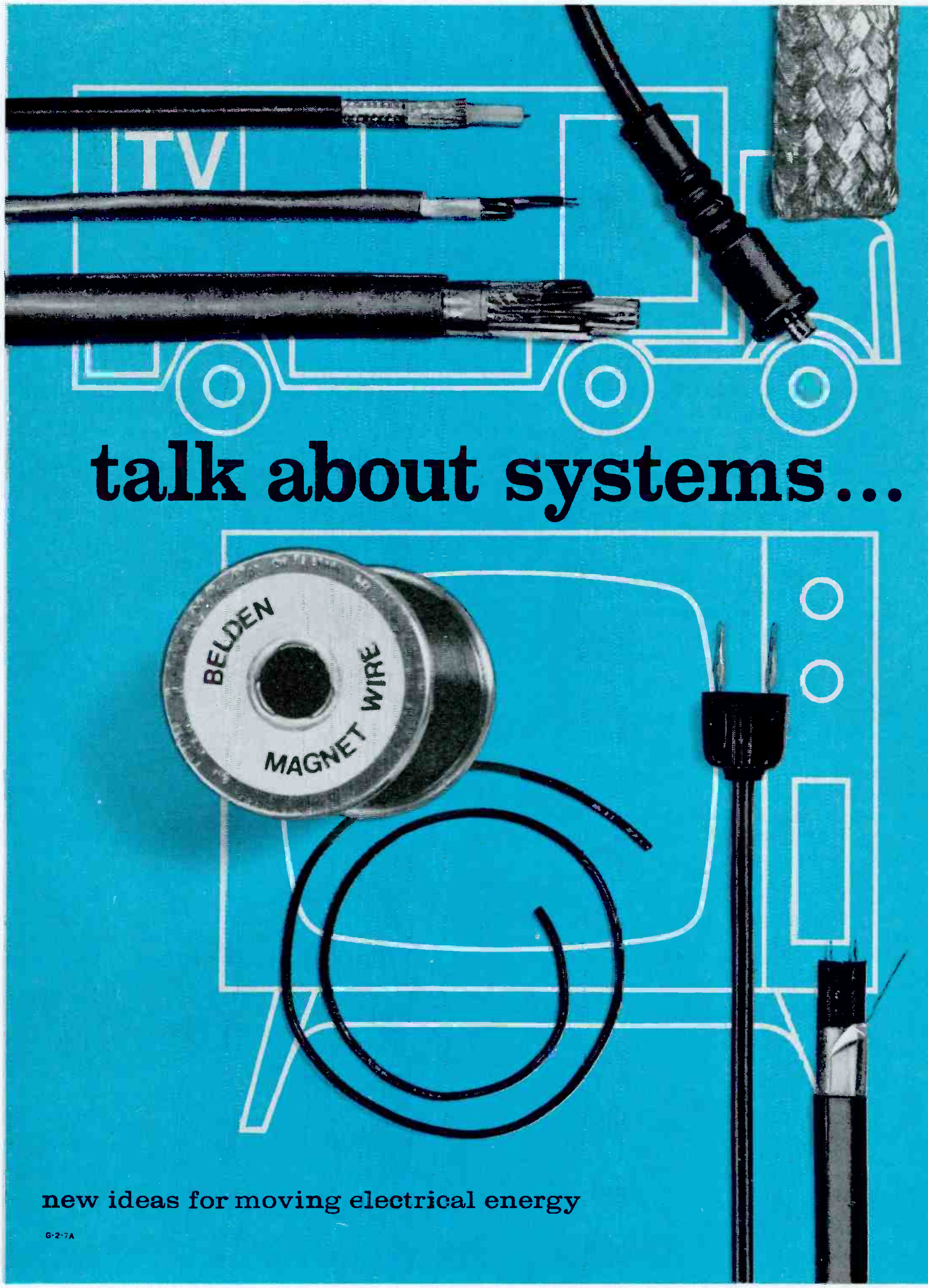


Fig. 4. Representation of interleaving of brightness and color signals within the spectrum of a color video signal.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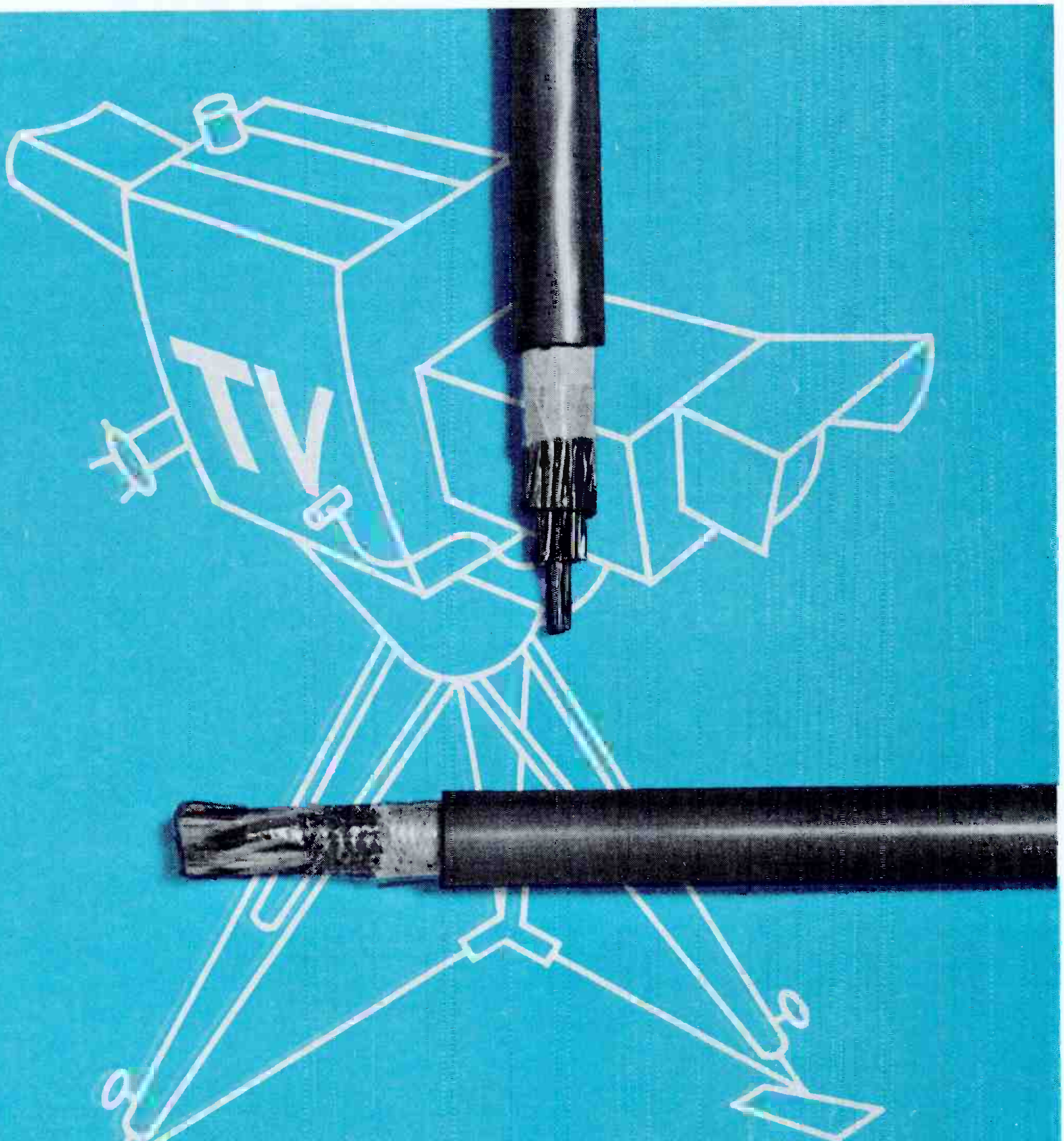

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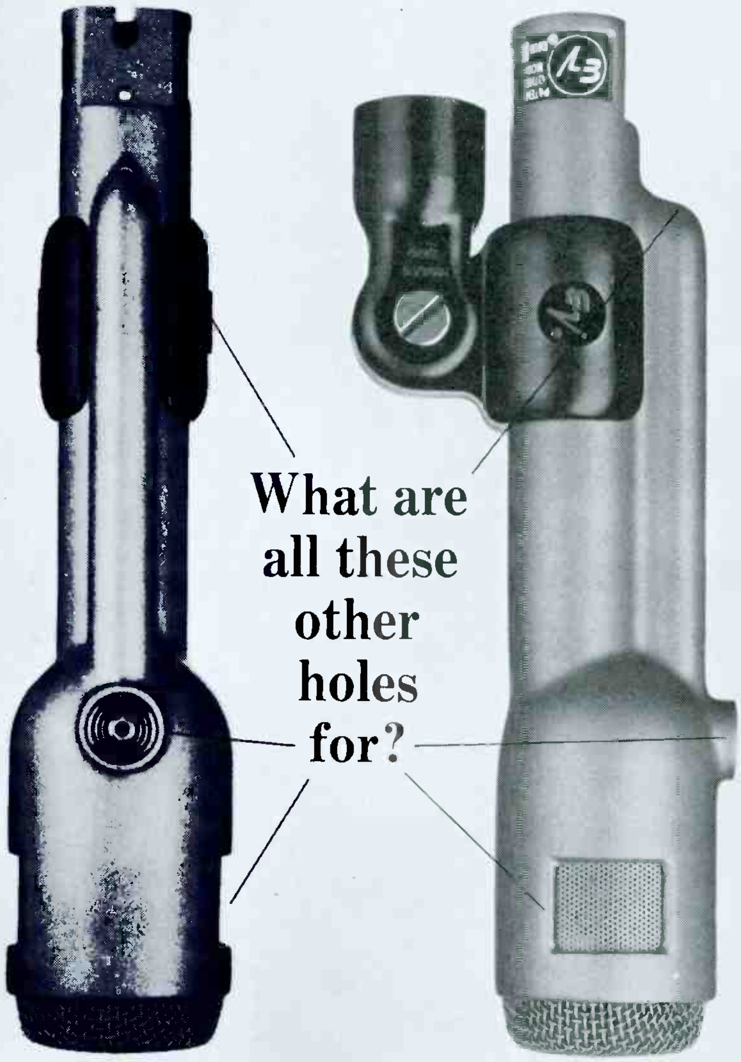

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limit of the video range is used, it will undergo attenuation in the relatively narrow-bandpass circuits of a monochrome receiver; and moreover, if this signal does reach the picture tube, the dot structure it produces will be very fine and not too objectionable.

On the other hand, the subcarrier frequency must be low enough so that its upper sidebands will fall within the established range of the video frequencies. Specifications for the color signal indicate that the upper limit of the subcarrier sidebands should be 0.6 MHz above the frequency of the subcarrier. It follows that the subcarrier frequency can be as high as 3.6 MHz, if the practical video bandwidth for color transmitters and receivers is considered to be approximately 4.2 MHz.

It has been shown that the signal energy produced by scanning an image will concentrate around the harmonics of the scanning frequencies. Nearly half the space in the video spectrum is therefore left unused. The location of the unused space is another determining factor for the subcarrier frequency because the harmonics of the subcarrier must concentrate in this space. A frequency which is an odd multiple of one-half the line frequency must be used for the chrominance signal so that the interleaving process will take place. A tentative subcarrier frequency, f_s, can be computed as:

$$f_s = \frac{15{,}750 \times 10^{-6} \times 455}{2} = 3.583125 \text{ MHz}$$

The multiple 455 is chosen to keep the frequency close to 3.6 MHz above the video carrier.

This 3.583125-MHz frequency was not adopted for the color-transmission standards because of an objectionable feature which may be described as follows. Monochrome receivers which employ an intercarrier sound system develop a 4.5-MHz signal at the output of the video detector. When this 4.5-MHz signal beats with the color subcarrier, a difference frequency of approximately 900 kHz is produced. Experiments were conducted, and it was found that when the 3.583125-MHz frequency was used for the color subcarrier, the beat frequency created a distracting pattern on the screen of a monochrome picture tube. Further experimentation indicated the beat frequency would be less objectional if it were an odd multiple of one-half the line frequency.

Naturally, it would have been impractical to change the 4.5-MHz intercarrier frequency which is accepted as standard in so many existing receivers. This made it necessary to select a slightly lower frequency for the color subcarrier than the tentative value given; consequently, slightly lower line and field frequencies had to be used in order to retain their frequency relationship to the subcarrier frequency.

The difference frequencies between the subcarrier and both the video and audio carriers must be taken into consideration when the new line and field frequencies are being determined. For the best results, it is desirable that each of these two difference frequencies should be some odd multiple of one-half the line rate. Since the addition of two odd harmonics of one-half the line rate will yield an even multiple of the line rate, the separation between the video carrier and the sound carrier must be defined as an even multiple of the new line frequency. Using the 15,750-Hz line rate as a basis for determining this multiple, it was found that the 286th harmonic would be at a frequency of 4.504500 MHz.

The desired new line frequency, f_L, can be computed as follows:

$$f_L = \frac{4.5 \times 10^6}{286} = 15{,}734.264 \text{ Hz}$$

Thus, the 286th harmonic of the new line frequency is equal to the 4.5-MHz picture-to-sound separation.

Since each frame must consist of 525 lines, it follows that the new field frequency, f_F, can be computed as follows:

$$f_F = \frac{f_L}{525} \times 2 = 59.94 \text{ Hz}$$

Now the subcarrier frequency, f_s, becomes:

$$f_s = \frac{455}{2} \times f_L = 3.579545 \text{ MHz.}$$

Note that the new scanning frequencies used for color transmission are slightly below the nominal values used in monochrome receivers; however, the changes amount to less than the one-per-cent tolerance allowed, and the new frequencies will fulfill the requirements for compatibility in monochrome reception. For purposes of maintaining close synchronization of color receivers, the tolerance for the subcarrier frequency is set at ± 10 Hz, and the rate of change cannot be more than 1/10 Hz per second.

Divided-Carrier Modulation

It has been pointed out that for purposes of color transmission, a chrominance signal is required; moreover, the chrominance signal must represent two color signals separable from each other. One subcarrier at a frequency of 3.579545 MHz above the picture carrier is available to convey both color signals. Consequently, some method of modulating one carrier with two signals must be utilized at the transmitter.

The fundamental block diagram in Fig. 5 illustrates the manner in which the foregoing requirement is met. A subcarrier generator produces a sine wave of constant frequency and amplitude. This subcarrier is then applied to two doubly balanced modulator circuits represented by blocks A and B. The subcarrier coupled to the modulator in block B has been subjected to a 90-degree phase shift. One of the two modulating signals is applied to modulator A, and the other is applied to modulator B.

In order to show what occurs in each of the balanced modulator circuits, a simple schematic diagram representing the modulator in block A is presented in Fig.6. The modulating signal is passed through a phase-splitter circuit to produce two signals of opposite polarity. This causes the signal at the grid of V2 to be 180 degrees out of phase with the signal at the grid of V3. The subcarrier also undergoes a phase-splitting process

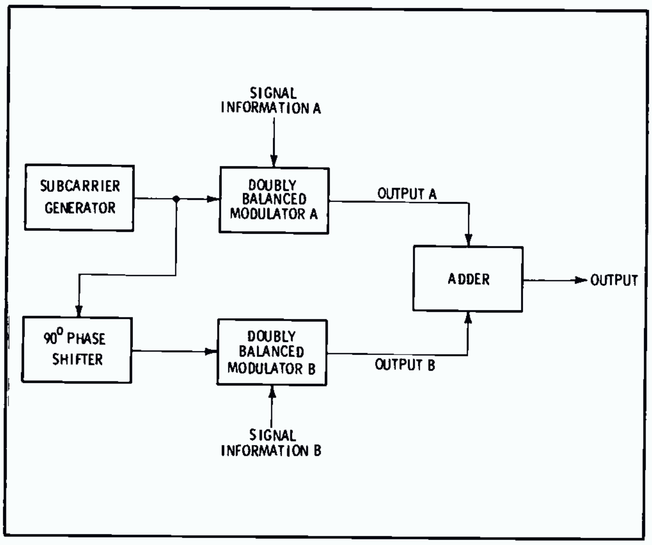

Fig. 5. Block diagram shows divided-carrier modulation.

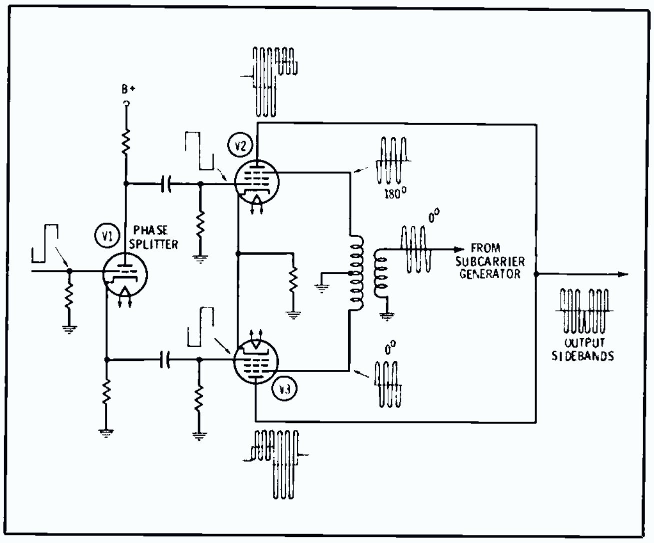

Fig. 6. Schematic diagram of a doubly balanced modulator.

in passing through the transformer, and the suppressor grids are fed with signals of equal amplitude but opposite polarity.

When the modulating signal at the grid of V2 is in the positive portion of its cycle, a subcarrier signal of increased amplitude is produced. As the signal at the grid goes through the negative portion of its cycle, a subcarrier signal of lower amplitude appears at the output. The waveform of the resulting subcarrier signal is shown in the figure at the plate of V2. A similar action takes place in V3, except the modulating signal goes through its negative excursion first. The resultant waveform from V3 is shown in the figure.

The operation of the entire circuit is dependent upon the fact that the plate circuits of V2 and V3 are tied together. The waveforms shown at the plates do not exist separately but are actually combined because of the common plate circuit. It can be seen in the illustration that the two plate-signal components are 180 degrees out of phase. The amplitude of the total output becomes the difference in the amplitudes of the two signals. In addition, the phase of the output sidebands agrees with the phase of the signal having the greatest amplitude.

It can be seen that if the signal applied to the grid of the phase splitter is increased in amplitude, then the amplitude of the output signal will also increase. The phase of the output sidebands will change 180 degrees when the polarity of the modulating signal is reversed; consequently, the output signal represents the modulating signal in terms of the phase and amplitude of the subcarrier frequency. If no signal is applied to the grids of V2 and V3, no signal will appear in the output because both tubes will conduct equally and complete cancellation will result.

In Fig. 5, there are two blocks representing doubly balanced modulators. The modulator in block B operates in the same manner as that described for the one in block A, with the exception that the subcarrier input is delayed 90 degrees. This delay causes the output of modulator B to be displaced 90 degrees in phase with reference to the output of modulator A. In this respect, it should be remembered that the output of modulator B can either lead or lag that of modulator A by 90 degrees, depending upon the polarity of the modulating signal introduced into each balanced modulator circuit.

Consider a particular case in which the output of modulator A is equal in amplitude to the output of modulator B but leads the latter output by 90 degrees. See Fig. 7. Since the values of both of these signals are continuously changing and since the signals are displaced in phase, it is easier to analyze their relationship through the use of vectors.[2] Thus, both signals may

[2] See "Review of Vector Computation," February 1965 BROADCAST ENGINEERING, page 22.

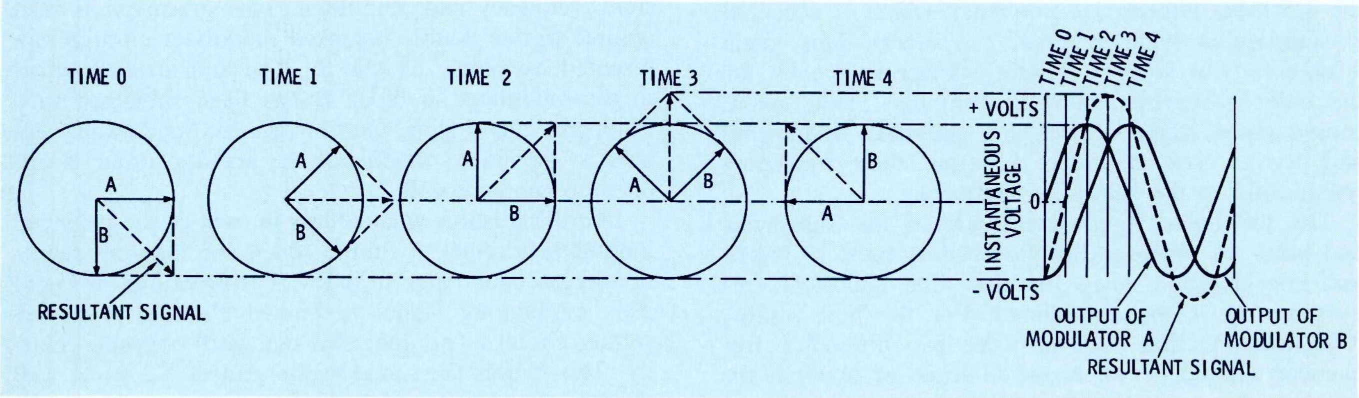

Fig. 7. Diagram shows vector representations of instantaneous voltages, and relates vectors to sine curves at right.

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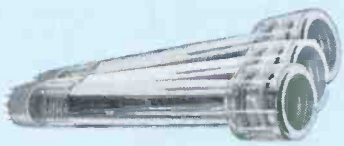

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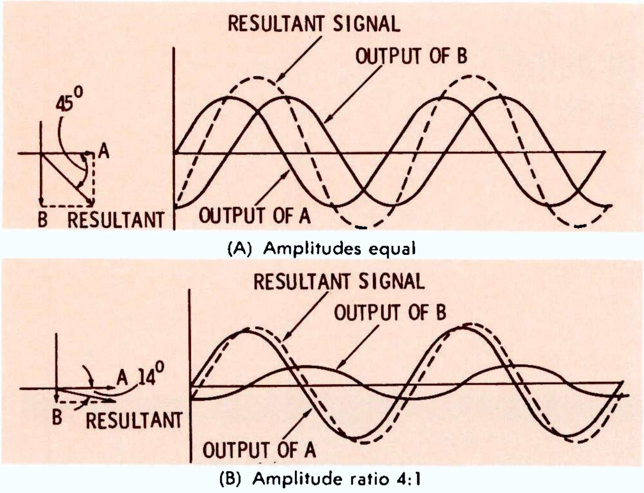

Fig. 8. Results of adding two signals separated by 90°.

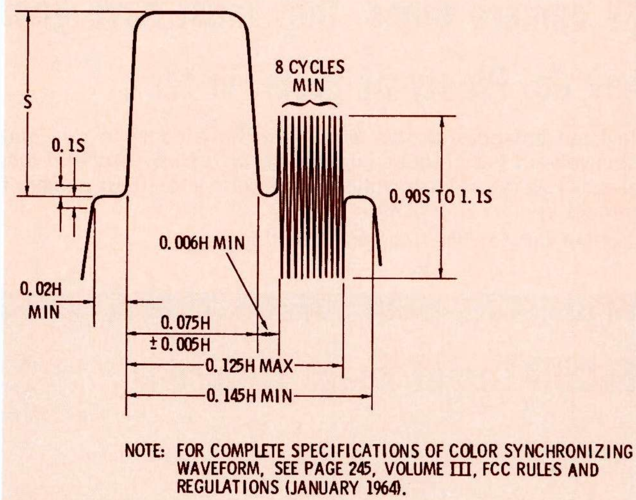

Fig. 9. The color burst follows the horizontal sync pulse.

be considered as vectors rotating at the same speed but with one leading the other by 90 degrees.

The first pair of vectors in Fig. 7 is shown at zero time. The vector representing the instantaneous value of A leads that representing the instantaneous value of B by 90 degrees because the motion of vectors is considered to be counterclockwise. At zero time, the voltage of A is zero and the voltage of B is at a maximum negative value. The resultant signal at zero time is equal in magnitude to the value of B.

If the vectors rotate another 45 degrees, they will appear as shown in the vector diagram for time 1. Vector *A* has reached an amplitude of 70.7 per cent of the positive peak, and vector *B* is 70.7 per cent of the negative peak. The resultant signal has an amplitude of zero. In the sine-wave diagram, these values are shown at time 1. The positions of the vectors at times 2, 3, and 4 indicate that the instantaneous voltages in the vector diagrams are equal to those on the sine-wave diagram at their respective times.

If the rotating vectors in Fig. 7 were analyzed at every degree throughout their complete cycle, the waveforms which are represented by these vectors could be traced as they have been in the sine-wave diagram. The length of each vector equals the peak amplitude of the signal it represents.

In the foregoing discussion, the outputs of modulators A and B were considered to be of equal amplitude, and they produced a resultant signal shown by the dash line in Fig. 8A. The associated vector diagram is drawn for the vector positions at zero time. In actual practice, the output from each of the doubly balanced modulators will vary in amplitude and undergo a 180-degree phase shift from time to time. As an illustration of this condition, Fig. 8B shows the resultant signal produced when the output of B is one fourth the output of A. Notice that the resultant signal has a smaller amplitude than in Fig. 8A and it has shifted in phase so that it lags the output of A by 14 degrees instead of 45 degrees.

The voltages from the outputs of the two modulators are combined in the adder stage (Fig. 5). The output of this stage is a single waveform which varies in amplitude and phase in accordance with the amplitude and phase of each of the two signals introduced to modulators A and B. Thus, two modulating signals are impressed upon a single subcarrier, and these two signals can be recovered by reversing the modulation process at the receiver.

Color Synchronization

The phase difference between the chrominance signal and the output of the subcarrier generator identifies the particular hue being transmitted at a given instant. When the chrominance signal reaches the receiver, some means must be provided for comparing the phase of the signal with a fixed reference phase corresponding to that of the subcarrier generator at the transmitter. This reference phase is provided by a local oscillator which is synchronized with the subcarrier generator by means of a color-burst signal transmitted during the horizontal-blanking period. The color burst consists of a minimum of eight cycles at the frequency of 3.579545 MHz.

As shown in Fig. 9, the color burst is placed on the back porch of the horizontal-blanking pedestal. When located at this point, the burst will not affect the operation of the horizontal-oscillator circuits because the horizontal systems used in existing receivers are designed to be immune to any noise or pulse for a short time after they have been triggered. Since the average voltage of the color burst is the same as the voltage of the blanking level, the burst signal will not produce spurious light on the picture tube during the retrace period.

A color receiver is designed to extract the color burst from the transmitted signal. This reference signal is used to synchronize the color section of the receiver

• *Please turn to page 45*

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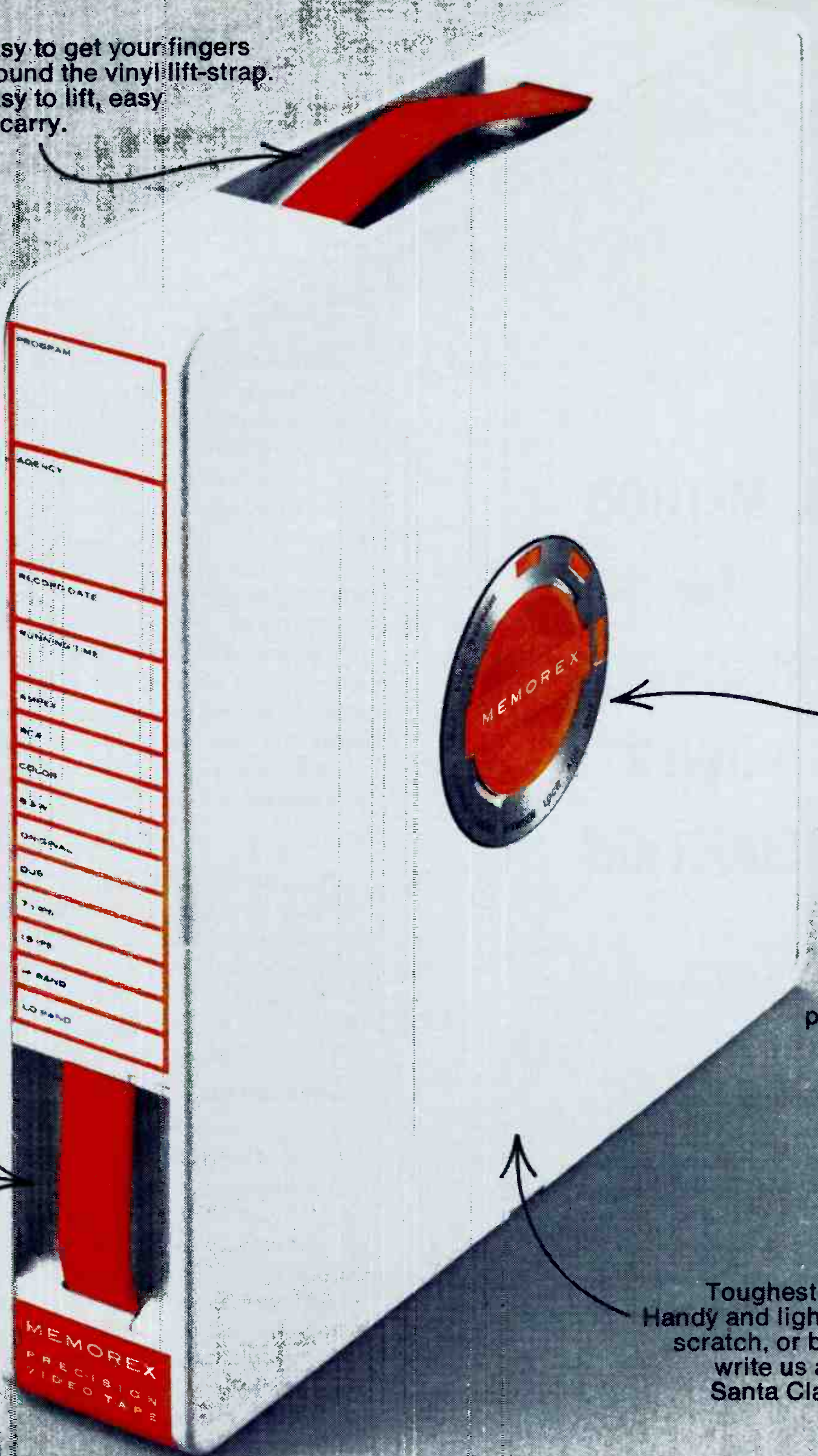

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A METHOD for PRESUNRISE POWER REDUCTION

by John H. Mullaney*

New FCC Rules regarding AM operation prior to sunrise have brought about some new technical requirements for many stations. This article presents one method for achieving the large power reductions imposed in some cases. A derivation of the design formulas follows the main text.

Many AM broadcasters are faced with the problem of reducing their transmitter output power by a substantial amount in order to comply with the requirements of Section 73.99 of the Commission Rules. When, for example, the power of a 1-kw station must be reduced to approximately 100 watts, it usually is not practical to use the existing transmitter. The broadcaster would ordinarily have to purchase an additional transmitter (type approved) capable of operating at the lower power. From an economic standpoint, this is not practical since, at most, a broadcaster could only gain approximately two hours per day of operating time in the winter months. Therefore, the need for a simpler method is indicated. The following is one way of achieving power reduction for presunrise operation at a minimum cost.

Technical Approach

It is proposed to use the regular transmitter operating at its normal output power into a simple power-divider network, as shown in Fig. 1. This circuit principle was developed in the early 1940's by Earl Travis. In December 1943, Dr. George H. Brown of RCA introduced the technique[1] for power dividing in a two-tower directional system.

Principle of Circuit

Fig. 1 can be redrawn as shown in Fig. 2. For the sake of discussion, capacitive reactance is shown in the dummy-load branch. The circuit is basically a simple power divider. There are two equal (50- or 70-ohm) loads; R_D is a dummy load, and R_O is the transmission-line resistance or common-point resistance. Reactances X_C and X_L are of opposite sign, and their values are uniquely determined by the power-division ratio and input impedance desired. In this case, the input impedance is selected to match the output of the transmitter (50 or 70 ohms). The power division is determined by FCC limits on power delivered to the antenna. The power division can be expressed in terms of a factor, M', as follows:

$$M' = \sqrt{\frac{P(hi)}{P(low)}}$$

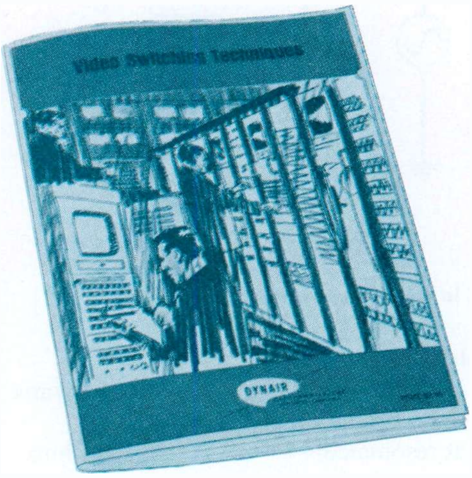
where,

P (hi) = power dissipated in dummy load, and
P (low) = power fed to transmission line or common point.

The value of reactance for the high-power leg (dummy load) is:

*President, Multronics, Inc.

[1] Brown, George H. and John M. Baldwin, "Adjusting Unequal Tower Broadcast Arrays," *Electronics*, December 1943.



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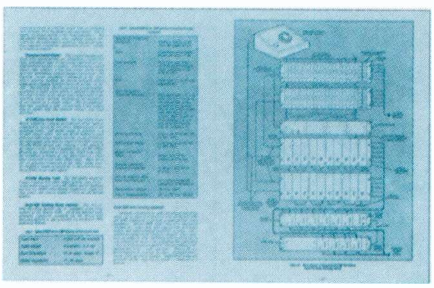

The photographs shown are sample pages reproduced directly from "Video Switching Techniques" and are typical of the material presented. Pictorial diagrams, supported by easy-to-understand text, charts and tables, make system design simple.

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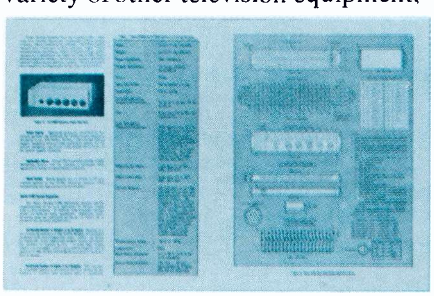

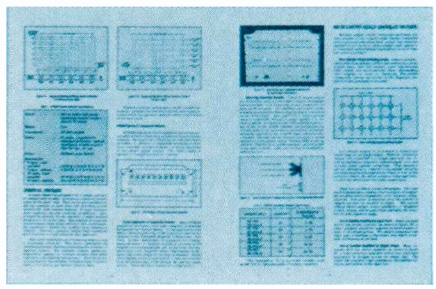

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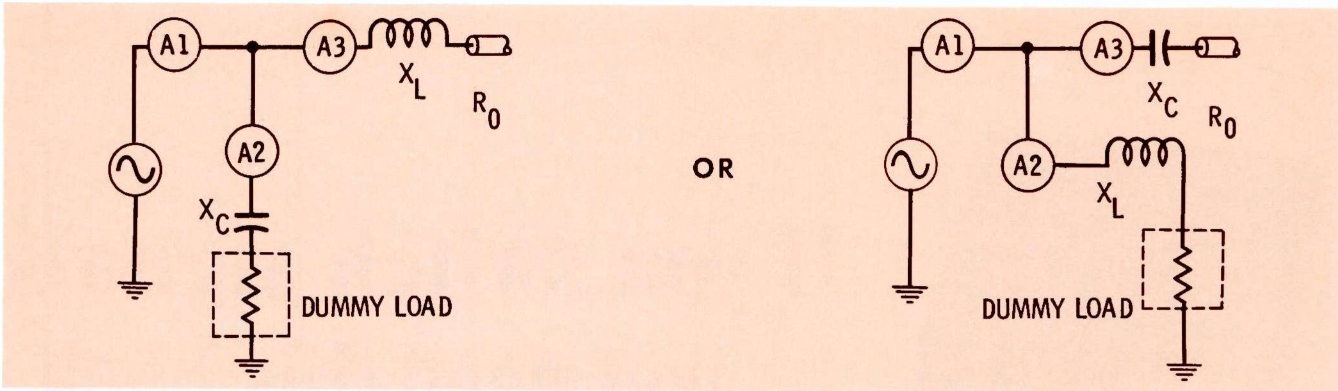


Fig. 1. "Power-dump" network may have either L or C in high-power branch.

$$X = \pm \frac{R_D}{M'}$$

where,

- X = value of positive or negative reactance in ohms,
- R_D = dummy-load resistance in ohms, and
- M' = power-division factor defined above.

The value of the reactance for the low-power side (antenna or common point) is:

$$X = \pm M'R_o$$

where,

- X = value of positive or negative reactance in ohms,
- M = power-division factor, and
- R_o = transmission-line or common-point resistance in ohms (must be equal to dummy-load resistance).

It will be demonstrated later that the input impedance will always be equal to the dummy-load and transmission-line impedance, provided certain design requirements are met. This is the same as saying that, under the required conditions, the feedpoint resistance will always remain equal to the load resistance, regardless of the power division between the two branches.

Practical Application

Assume a station is required to reduce its presunrise power to 100 watts from 1kw. The known parameters are:

(1) Frequency (assumed) = 1300 kHz
(2) Transmitter output = 1000 watts
(3) Allowable power to nondirectional tower or common point = 100 watts
(4) Transmitter output impedance ($Z = R$ at resonance) = 50 ohms

The following quantities may now be computed:

(5) Transmitter output current for 1 kw

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{1000}{50}} = 4.48 \text{ amperes}$$

(6) Allowable line current to antenna or common point for 100 watts

$$I = \sqrt{\frac{100}{50}} = 1.41 \text{ amperes}$$

(7) Current in dummy load for 900 watts which must be dissipated

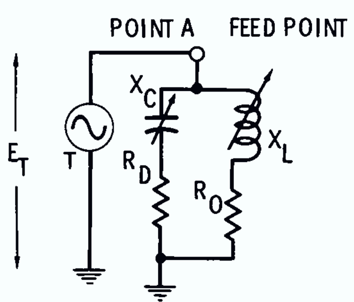
$$I = \sqrt{\frac{900}{50}} = 4.25 \text{ amperes}$$

(8) Power division factor

$$M' = \sqrt{\frac{P(hi)}{P(low)}} = \sqrt{\frac{900}{100}} = 3$$

(9) An inductor is selected arbitrarily for the high-power branch. The reactance is:

$$X_L = + \frac{R_D}{M'} = \frac{50}{3} = 16.7 \text{ ohms.}$$



- T = Transmitter (50- or 70-ohm unbalanced output)
- X_C = Variable capacitor in series with dummy-load resistor (50 or 70 ohms)
- R_D = Dummy-load resistor (50 or 70 ohms) having proper power rating (Note: Station loads should be able to handle 1300 watts for a 1-kw station.)
- X_L = Variable inductor in series with transmission line to non-directional tower, or common point of directional antenna system
- R_o = Resistance of transmission line (50 or 70 ohms)
- E_T = Voltage across transmitter output

Fig. 2. Power-division circuit may be redrawn for more convenient analysis; explanation of terms used is included.

(10) Inasmuch as an inductor was selected for the high-power branch, a capacitor must be used in the low-power side. Its reactance is:

$$X_C = -M'R_0 = -3 \times 50 = -150 \text{ ohms.}$$

(11) The magnitude of X_L and X_C have now been determined. The inductance and capacitance now can be found readily. The inductance is:

$$L = \frac{159X_L}{f}$$

where,

L = inductance in microhenries,

$159 = \frac{1}{2\pi} \times$ conversion factor for units,

X_L = inductive reactance in ohms, and

f = frequency in kHz.

Then:

$$L = \frac{159 \times 16.7}{1300} = 2.04\ \mu h.$$

(12) The capacitance is determined by:

$$C = \frac{1.59 \times 10^8}{fX_C}$$

where,

C = capacitance in pf,

$1.59 \times 10^8 = \frac{1}{2\pi} \times$ conversion factor for units,

X_C = capacitive reactance in ohms, and

f = frequency in kHz.

Then:

$$C = \frac{1.59 \times 10^8}{1300 \times 150} = 816 \text{ pf.}$$

A variable capacitor is required, or a coil and capacitor in series may be used.

The circuit can now be redrawn as shown in Fig. 3.

Circuit Variations

It is obvious that different combinations of X_L and X_C can be selected to accomplish other desired power reductions, and the exact values of components will be governed by the amount of reduction required and the power levels involved. In many cases, it will be more practical to use variable capacitors and inductors to obtain the exact power ratio; in others, a fixed capacitor can be made equivalent to a variable unit by using a variable or tapped coil in series with the capacitor.

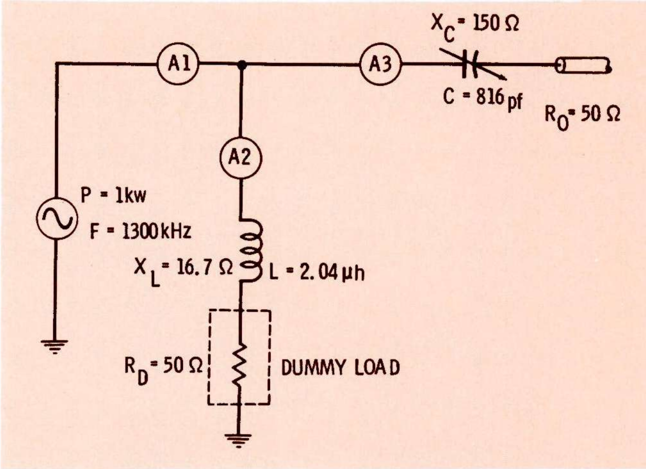


Fig. 3. Calculated values for power-divider components.

Switching, particularly where directional arrays are involved, can become tricky; however, the primary advantages of using such a "power-dump" circuit to dissipate power are:

(1) The transmitter operates at its normal output power regardless of how much the antenna power must be reduced.

(2) Most stations already have a 50- or 70-ohm dummy load that can be used for the system.

(3) No adjustments of the transmitter controls are needed.

(4) The cost for a well-engineered system is materially less than the purchase price of a new lower-power transmitter.

Fig. 4 illustrates a typical power reduction setup, assuming a nondirectional operation.

In practice, the station dummy-load and transmission-line or common-point resistance may not be exactly the same (several ohms difference). Hence, the adjustment of the circuit will have to be altered by changing the ratio of reactances, and a slightly different common-point resistance will result. Because the entire network will have to be measured to determine true powers, the proper common point can be determined by bridge measurements for the Commission.

The FCC

The circuitry described has been used in licensed stations to reduce the E_{rms} of a directional array when tall towers are used for vertical suppression, but the high E_{rms} of a tall-tower array cannot be tolerated. It should be acceptable to the Commission for reduction of power for presunrise operation. The Commission may accept logging of the dummy-load meter in lieu of a new antenna-base meter. It might also require an additional line meter on the output side of L to demonstrate

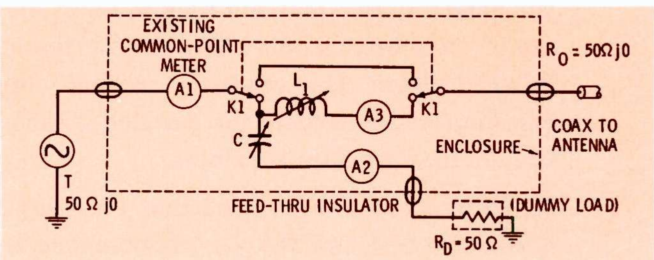
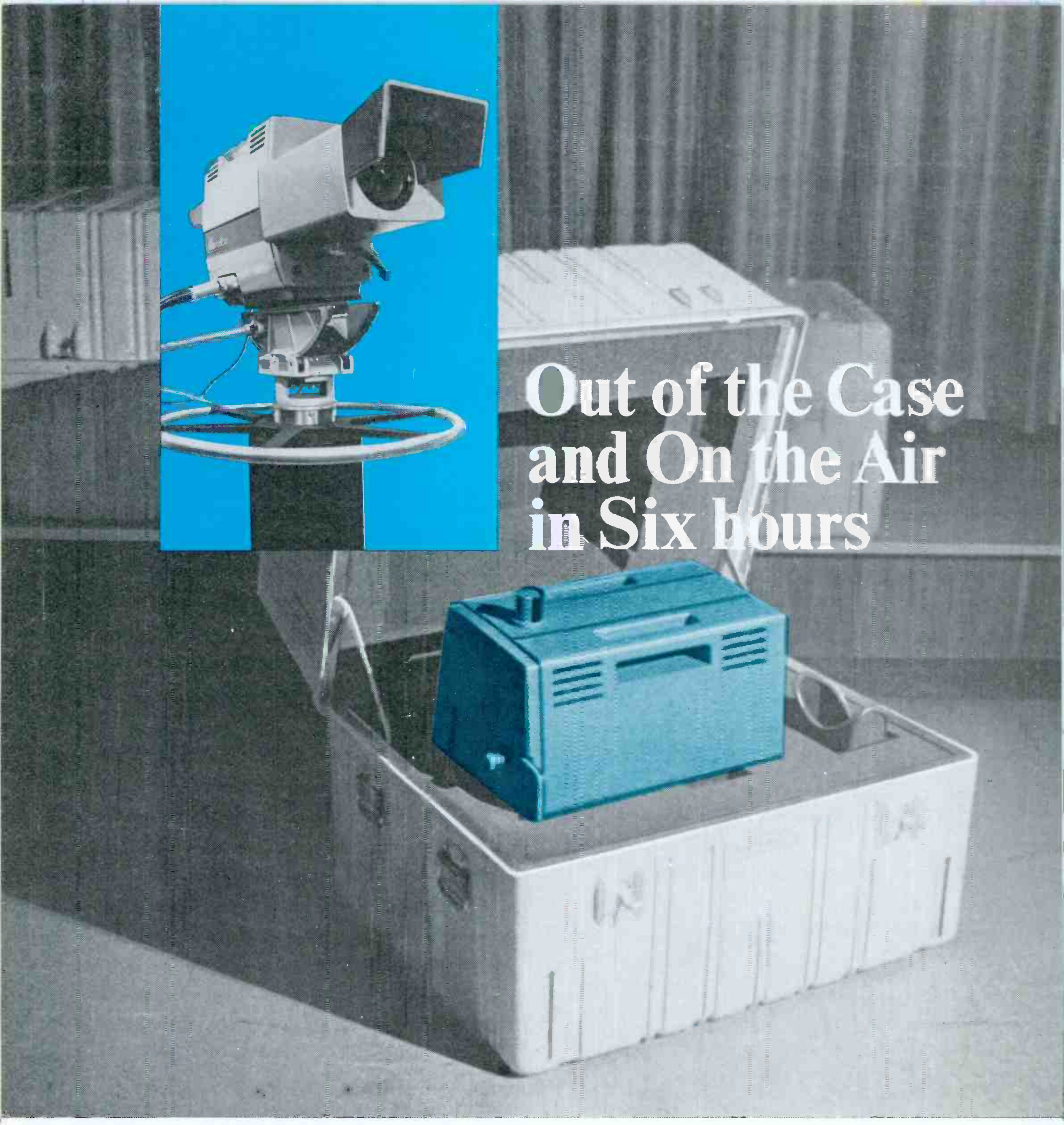


Fig. 4. Switching system for presunrise power reduction.



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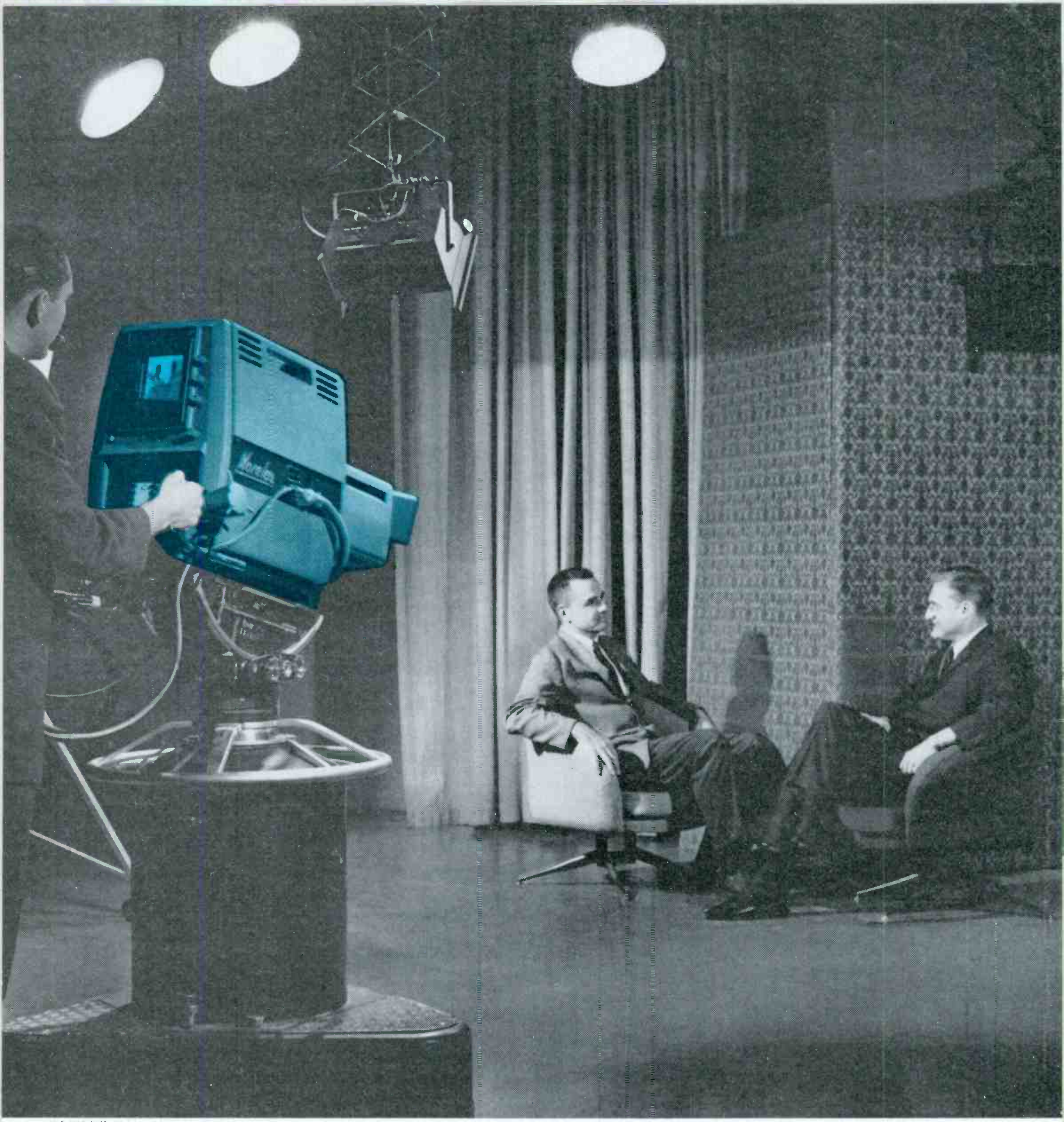

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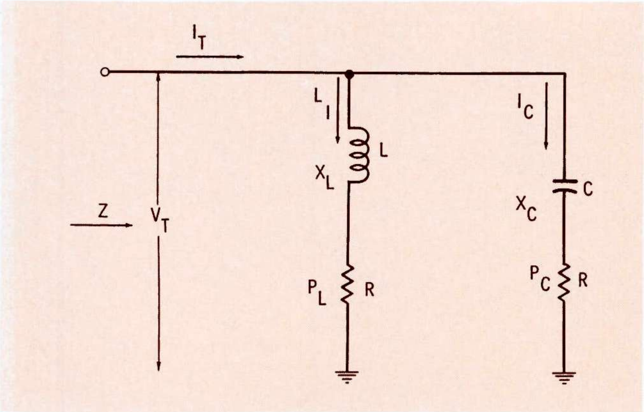


Fig. 5. Diagram shows nomenclature used in derivation.

the lower line current. However, the station attorneys and consulting engineers will have to explore this matter and obtain appropriate waivers if possible.

Conclusion

A simple power-divider technique has been explained which allows a broadcaster to meet presunrise power-reduction requirements without the purchase of a new transmitter. The principle is electronically straightforward, and it should provide a practical, economical method of power control for broadcasters who need to reduce their power by a ratio greater than about 2:1.

The author wishes to thank George P. Howard and J. K. Raines of the Multronics engineering staff for their suggestions and derivations.

Derivation

The following derivation shows the validity of the power-division method that is the subject of this article.

The corresponding admittances are

$$Y_1 = \frac{1}{R + j\omega L}$$

and

$$Y_2 = \frac{1}{R - j\frac{1}{\omega C}},$$

and the admittance of the network is therefore

$$Y = \frac{1}{R + j\omega L} + \frac{1}{R - j\frac{1}{\omega C}}$$

$$= \frac{R - j\frac{1}{\omega C} + R + j\omega L}{(R + j\omega L)(R - j\frac{1}{\omega C})}$$

$$= \frac{2R + j(\omega L - \frac{1}{\omega C})}{(R^2 + \frac{L}{C}) + j(\omega L - \frac{1}{\omega C})}.$$

The impedance of the network is

$$Z = \frac{1}{Y} = \frac{(R^2 + \frac{L}{C}) + j(\omega L - \frac{1}{\omega C})}{2R + j(\omega L - \frac{1}{\omega C})}.$$

Rationalizing and collecting terms results in

$$Z = \frac{(R^2 + \frac{L}{C}) + j(\omega L - \frac{1}{\omega C})}{2R + j(\omega L - \frac{1}{\omega C})} \cdot \frac{2R - j(\omega L - \frac{1}{\omega C})}{2R - j(\omega L - \frac{1}{\omega C})}$$

$$= \frac{2R(R^2 + \frac{L}{C}) + R(\omega L - \frac{1}{\omega C})^2 + j(R^2 - \frac{L}{C})(\omega L - \frac{1}{\omega C})}{4R^2 + (\omega L - \frac{1}{\omega C})^2}$$

The nomenclature used in the derivation is shown in Fig. 5.

First it must be established that the input impedance, Z, of the network is equal to R. The expression for Z can be developed as follows.

The impedance of the left branch is

$$Z_1 = R + j\omega L,$$

and the impedance of the right branch is

$$Z_2 = R - j\frac{1}{\omega C}.$$

For the purpose of this article, it is required that Z be purely resistive and equal in magnitude to R. The reactive component of Z must therefore be equal to zero. This component is

$$j\frac{(R^2 - \frac{L}{C})(\omega L - \frac{1}{\omega C})}{4R^2 + (\omega L - \frac{1}{\omega C})^2}.$$

Setting this quantity equal to zero yields

$$(R^2 - \frac{L}{C})(\omega L - \frac{1}{\omega C}) = 0.$$

Either of the solutions

$$\omega L = \frac{1}{\omega C}$$

and

$$R^2 = \frac{L}{C}$$

satisfies this equation.

It is also necessary that the resistive part of Z be equal to R:

$$\frac{2R\left(R^2 + \frac{L}{C}\right) + R\left(\omega L - \frac{1}{\omega C}\right)^2}{4R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \stackrel{?}{=} R$$

$$2R\left(R^2 + \frac{L}{C}\right) \stackrel{?}{=} 4R^3$$

$$2R^3 + 2R\frac{L}{C} \stackrel{?}{=} 4R^3.$$

It has already been determined that if $\frac{L}{C} = R^2$, Z is purely resistive. Under this condition

$$2R^3 + 2R(R^2) = 4R^3,$$

$$4R^3 = 4R^3,$$

and the network impedance is therefore equal to R (when R has the same magnitude in both branches), as desired.

The relationship of X_C, X_L, and R can now be established. It is known that

$$R^2 = \frac{L}{C},$$

$$L = \frac{X_L}{\omega},$$

and

$$C = -\frac{1}{\omega X_C}.$$

From these relationships, it follows that

$$R^2 = \frac{X_L}{\omega}\left(-\frac{\omega X_C}{1}\right)$$

$$= -X_L X_C.$$

It is still necessary to determine the relative magnitudes of X_L and X_C required for a given power division. The ratio of power in the two branches may be written

$$\frac{P_C}{P_L} = \frac{|I_C|^2 R}{|I_L|^2 R} = \frac{|I_C|^2}{|I_L|^2}.$$

It can be seen that

$$|I_C| = \frac{V_T}{\sqrt{R^2 + X_C^2}}$$

and

$$|I_L| = \frac{V_T}{\sqrt{R^2 + X_L^2}}.$$

For convenience, let M be defined as

$$M = \frac{P_C}{P_L}.$$

Then

$$M = \frac{\dfrac{V_T^2}{(\sqrt{R^2 + X_C^2})^2}}{\dfrac{V_T^2}{(\sqrt{R^2 + X_L^2})^2}} = \frac{R^2 + X_L^2}{R^2 + X_C^2}.$$

Since it has already been established that $R^2 = -X_C X_L$, it can be seen that

$$X_L = -\frac{R^2}{X_C}.$$

Substituting this expression in the previous equation gives

$$M = \frac{R^2 + \left(-\frac{R^2}{X_C}\right)^2}{R^2 + X_C^2}.$$

Clearing of fractions and rearranging terms gives

$$MX_C^4 + (M - 1)R^2X_C^2 - R^4 = 0.$$

Factoring gives

$$(MX_C^2 - R^2)(X_C^2 + R^2) = 0.$$

The solutions relating M, R, and X_C are obtained as follows:

$$MX_C^2 - R^2 = 0$$

$$X_C^2 = \frac{R^2}{M}$$

$$X_C = \pm\sqrt{\frac{R^2}{M}} = \pm\frac{1}{\sqrt{M}}R$$

(Only the negative solution has physical significance.) It is known that

$$X_L = -\frac{R^2}{X_C}.$$

Substituting the expression for X_C gives

$$X_L = -\frac{R^2}{-\frac{1}{\sqrt{M}}R} = \sqrt{M}\,R.$$

The values of X_L and X_C have now been defined in terms of R and the power-division ratio. With the reactances known, the values of L and C can be determined easily:

$$X_L = \sqrt{M}\,R,$$

$$\omega L = \sqrt{M}\,R,$$

and

$$L = \sqrt{M}\frac{R}{2\pi f}.$$

Also,

$$X_C = -\frac{R}{\sqrt{M}}$$

$$-\frac{1}{\omega C} = -\frac{R}{\sqrt{M}},$$

and

$$C = \frac{\sqrt{M}}{2\pi f R}.$$

When f is in kHz and R is in ohms, the inductance in microhenries is

$$L = 159\frac{\sqrt{M}\,R}{f},$$

and the capacitance in picofarads is

$$C = 1.59 \times 10^8 \frac{\sqrt{M}}{fR}.$$

Expressions for the network current magnitudes may now be derived. By inspection, the total (input) current can be seen to be

$$|I_T| = \sqrt{\frac{P_T}{R}}.$$

Similarly,

$$|I_L| = \sqrt{\frac{P_L}{R}},$$

and

$$|I_C| = \sqrt{\frac{P_C}{R}}.$$

It is possible to express P_C and P_L in terms of P_T and M, as follows:

$$P_T = P_L + P_C,$$

and

$$\frac{P_C}{P_L} = M.$$

Rearranging gives

$$P_L = P_T - P_C$$

and

$$P_C = P_L M.$$

Substituting the latter into the former results in

$$P_L = P_T - P_L M.$$

Solving for P_L gives

$$P_L = \frac{P_T}{1 + M},$$

and substituting this result into the expression for I_L results in

$$|I_L| = \sqrt{\frac{P_T}{(1 + M)R}} = \frac{1}{\sqrt{1 + M}}\sqrt{\frac{P_T}{R}}.$$

Similar manipulations can be used to arrive at an expression for I_C:

$$P_C = P_T - P_L,\ P_L = \frac{P_C}{M}$$

$$P_C = P_T - \frac{P_C}{M}$$

$$P_C = \frac{M}{1 + M}\,P_T$$

$$|I_C| = \sqrt{\frac{\frac{M}{1 + M}\,P_T}{R}}$$

$$= \sqrt{\frac{M}{1 + M}}\sqrt{\frac{P_T}{R}}.$$

For convenience, the formulas derived above are tabulated here.

$$M = \frac{P_C}{P_L}$$

$$X_C = -\frac{R}{\sqrt{M}}$$

$$X_L = \sqrt{M}\,R$$

$$C = \frac{\sqrt{M}}{2\pi fR} = 1.59 \times 10^8 \frac{\sqrt{M}}{fR}$$

$$L = \sqrt{M}\frac{R}{2\pi f} = 159\,\frac{\sqrt{M}\,R}{f}$$

where,

C is in picofarads,
L is in microhenries,
f is in kilohertz, and
R is in ohms.

$$|I_T| = \sqrt{\frac{P_T}{R}}$$

$$|I_L| = \frac{1}{\sqrt{1+M}}\sqrt{\frac{P_T}{R}}$$

$$|I_C| = \sqrt{\frac{M}{1+M}}\sqrt{\frac{P_T}{R}}$$

Note that in the foregoing derivation, there was no requirement that M be greater than 1. This means that either circuit branch may receive the greater power; if P_C is the larger power, M is a whole number, and if P_L is the larger power, M is a fraction. In either case, the proper results can be obtained.

In the main part of the text, factor M' was defined as

$\sqrt{\frac{P(hi)}{P(low)}}$. If $P_C > P_L$, $M' = \sqrt{\frac{P_C}{P_L}} = \sqrt{M}$.

The formula given in the text for X in the high-power branch is $X = -\frac{R_D}{M'}$ (negative in this case because the branch is capacitive). The reactance in the low-power branch is given as $X = M'R_O$. Since $M' = \sqrt{M}$, and $R_O = R_D = R$, the text equations reduce to $X = -\frac{R}{\sqrt{M}}$ for the capacitive (high-power) branch and $X = \sqrt{M}\,R$ for the inductive (low-power) branch.

By the same reasoning, if it is desired to make the high-power branch inductive, $M' = \sqrt{\frac{P_L}{P_C}} = \frac{1}{\sqrt{M}}$. The text equations become $X = +\frac{R}{1/\sqrt{M}} = \sqrt{M}\,R$ for the inductive (high-power) branch, and

$$X = -\frac{1}{\sqrt{M}}R = -\frac{R}{\sqrt{M}}$$

for the capacitive (low-power) branch. Thus the two sets of reactance formulas are equivalent as far as the results obtained are concerned.

Sample Calculations

The following two examples illustrate the use of the above formulas for determining power division and component values. In the first example, the capacitive branch carries the high power. In the second, the inductive branch carries the high power.

Example 1

(a) Frequency—1300 kHz
(b) Transmitter power—1000 watts, 50 ohms match
(c) Power reduction—10:1
(d) Use a capacitor in series with dummy load for dissipating 900 watts of power.

Then:

$$M = \frac{900}{1000 - 900} = \frac{900}{100} = 9$$

$$|I_T| = \sqrt{\frac{1000}{50}} = 4.47 \text{ amperes}$$

$$|I_L| = \frac{1}{\sqrt{1+9}}\sqrt{\frac{1000}{50}} = 1.41 \text{ amperes}$$

$$|I_C| = \sqrt{\frac{9}{1+9}}\sqrt{\frac{1000}{50}} = 4.24 \text{ amperes}$$

$$X_L = 50\sqrt{9} = 150 \text{ ohms}$$

$$X_C = -\frac{50}{\sqrt{9}} = -16.7 \text{ ohms}$$

$$L = \frac{159 \times 50 \times \sqrt{9}}{1300} = 18.4\ \mu h$$

$$C = \frac{1.59 \times 10^8 \times \sqrt{9}}{50 \times 1300} = 7350 \text{ pf}$$

Example 2

(a) Frequency —1300 kHz
(b) Transmitter power—1000 watts, 50 ohms match
(c) Power reduction—10:1
(d) Use an inductor in series with dummy load to dissipate 900 watts.

Then:

$$M = \frac{1000 - 900}{900} = \frac{100}{900} = \frac{1}{9}$$

$$|I_T| = \sqrt{\frac{1000}{50}} = 4.47 \text{ amperes}$$

$$|I_L| = \frac{1}{\sqrt{1+1/9}}\sqrt{\frac{1000}{50}} = 4.24 \text{ amperes}$$

$$|I_C| = \sqrt{\frac{1/9}{1+1/9}}\sqrt{\frac{1000}{50}} = 1.41 \text{ amperes}$$

$$X_L = 50\sqrt{\frac{1}{9}} = 16.7 \text{ ohms}$$

$$X_C = -\frac{50}{\sqrt{1/9}} = -150 \text{ ohms}$$

$$L = \frac{159 \times 50 \times \sqrt{1/9}}{1300} = 2.04\ \mu h$$

$$C = \frac{1.59 \times 10^8 \times \sqrt{1/9}}{50 \times 1300} = 816 \text{ pf}$$

▲

WLW "the Nation's Station"

by William E. Burke

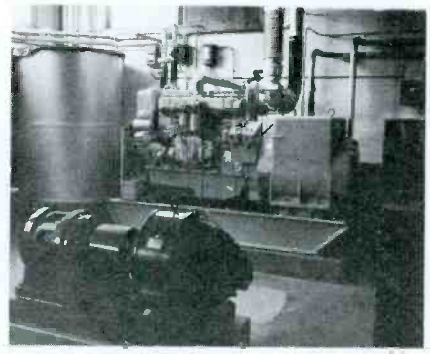
A visit to one of the nation's historic radio transmitting facilities.

Radio Station WLW presents a history as colorful and as varied as that of any station in the United States. It is unique in that it is the only station ever granted authority to broadcast with 500 kw, in the so-called super-power range.

The station actually began with 20 watts of power as a hobby of Powel Crosley, Jr. The first license for station WLW was granted by the Department of Commerce in 1922. Mr. Crosley was authorized to broadcast on a wavelength of 360 meters with a power of 50 watts on three evenings a week.

Growth of the station was continuous. It operated on various wavelengths and power levels until, in 1927, it stabilized at 700 kHz and, in 1928, on 50 kw. The super-power era began in May, 1934 and ended in March, 1939, when the FCC ended WLW's full-time broadcasting with 500 kw.

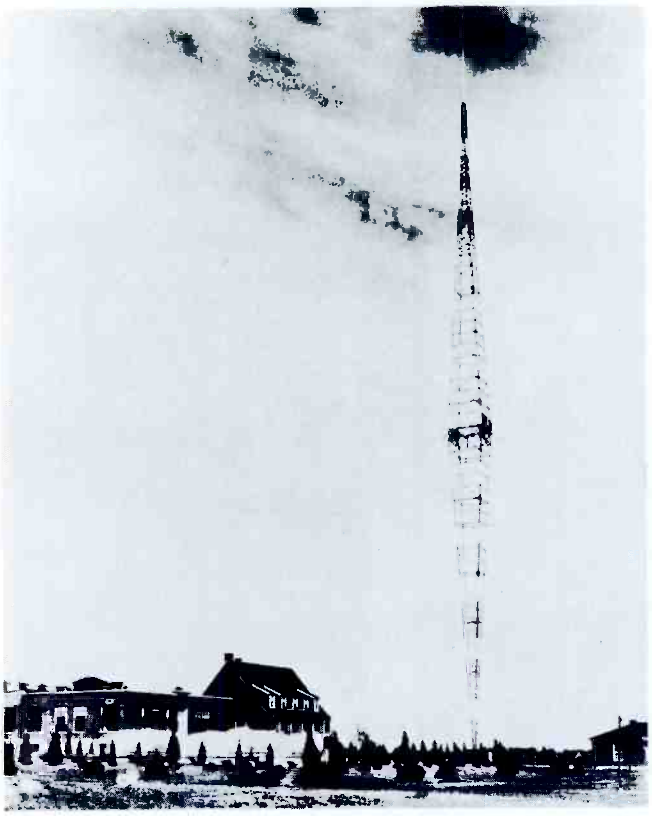
A distilled-water tank (200 gals) and an emergency-power generator appear in the background. The motor-generator in the foreground was used to generate 125 volts DC for control circuits in the 500-kw transmitter.



The WLW antenna reaches a height of 708 feet today since the flagpole was removed. The antenna rests on a single ceramic insulator which supports the combined force of 135 tons of steel and 400 tons exerted by the guys. The tower is guyed with eight 1⅞-inch cables anchored 375 feet from the antenna base.

At one time, this antenna was augmented by a directional antenna to protect CFRB, Toronto, when WLW was using 500 kw at night. This directional system was unique in that it was the first designed to achieve both horizontal directivity and vertical-angle suppression.

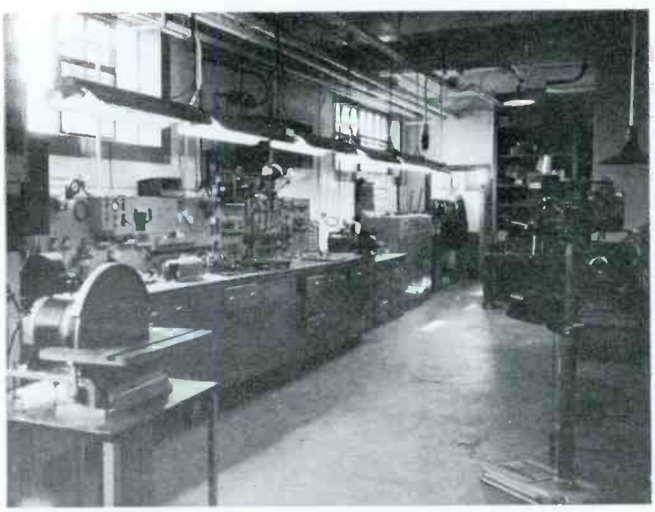
Audio and monitoring equipment now in use with the 50-kw transmitter is contained in these racks.



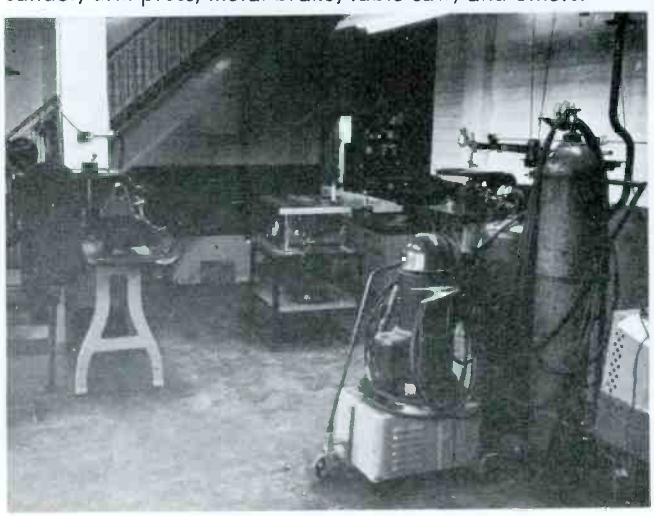
This is the WLW station as it appeared in 1934. With the flagpole on top, the tower extends 831 feet. The spray pond in the foreground is cooling water at the rate of 512 gallons per minute. Through a heat exchanger, this water then cooled 200 gallons of distilled water in a closed system. To the right out of the picture is the station's own power substation. While operating on 500 kw, the transmitter consumed 15,450,000 kwh per year.

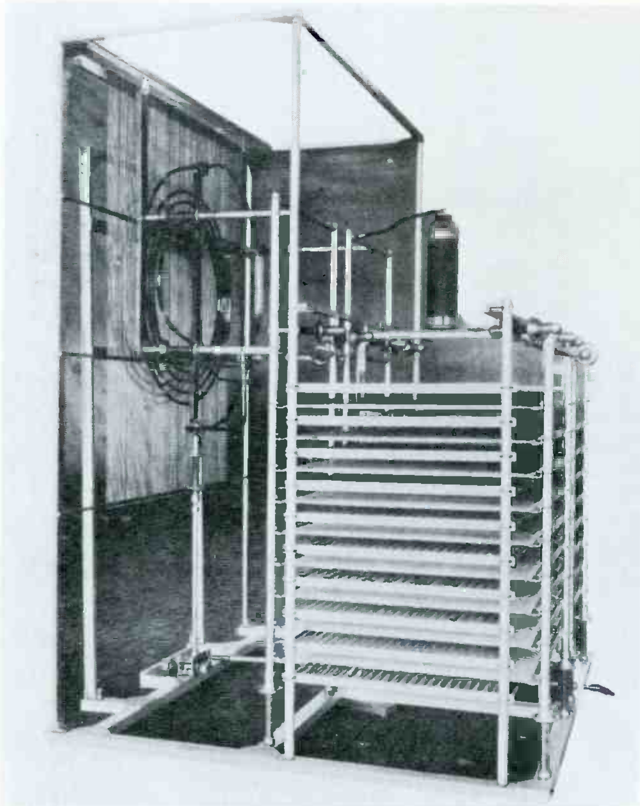
This scene shows the WLW complex at Mason, Ohio as it appears today. In the foreground is the spray cooling pond which is now operated at a bare trickle to cool the 50-kw transmitter in use. Immediately behind the pond is the transmitter building. The second building was originally constructed in 1925 to house the facilities of WSAI and for staff living quarters. The square tower behind the transmitter building was erected during World War II as a guard tower for use while WLW was conducting Government work.

One side of the well-equipped machine shop is seen here. Station personnel construct the majority of the equipment needed at the station, and they have more than adequate facilities to do so.

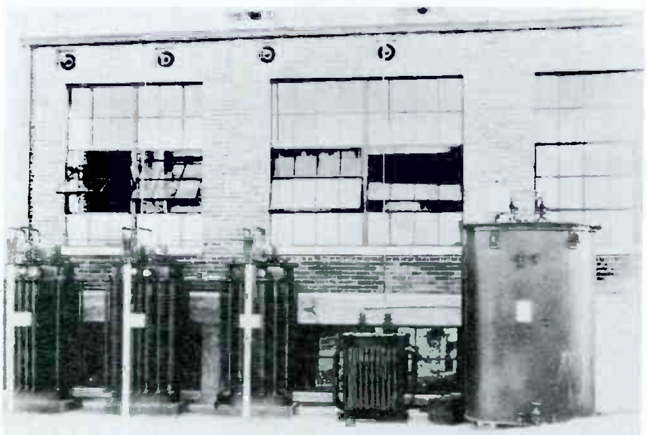


This photo shows another side of the machine shop. Equipment in the shop includes gas, arc, and spot welders; metal lathe; milling machine; engraving machine; sander; drill press; metal brake; table saw; and others.

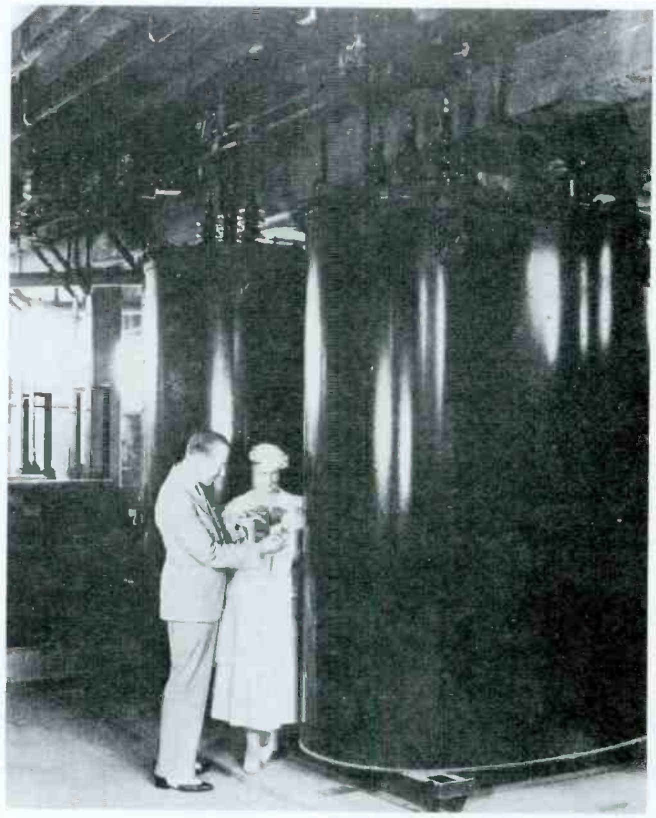




This view shows a power-amplifier tank circuit partly assembled. It is one of three identical units. Circa 1934.



This view shows the WLW transmitter building as seen from the front entrance. The 50-kw exciter appears at the left, the 500-kw amplifier-modulator is in the background, and the audio control room is at the right. Circa 1934.

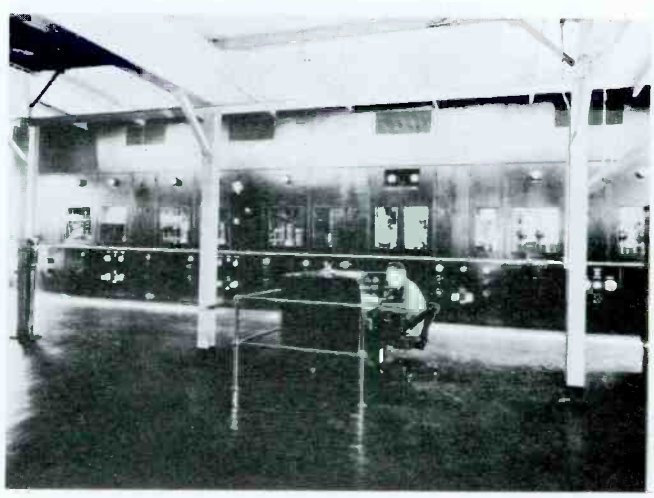


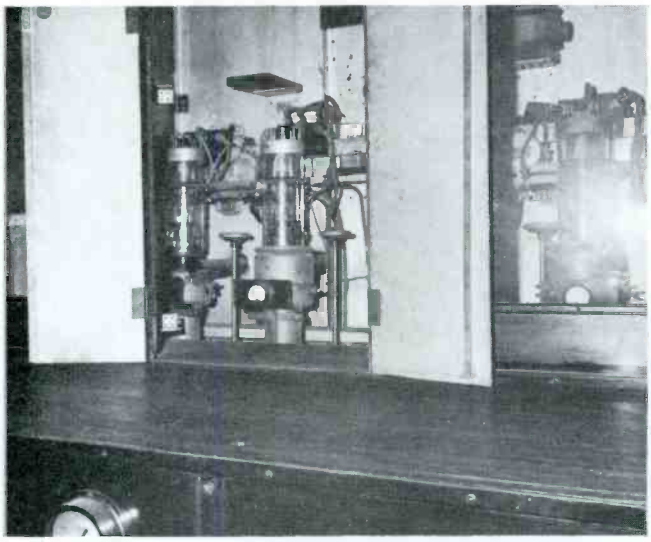
Modulation transformers weighing 37,000 pounds each were installed in the basement of the transmitter building. Circa 1934.

Three plate transformers (left), a rectifier filter reactor, and a modulation reactor were installed outside the transmitter building. The protective fence had not been installed when this photograph was taken. Circa 1934.

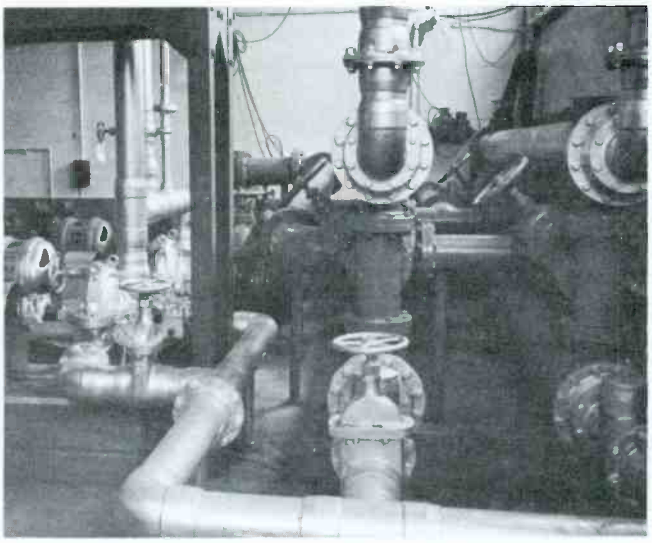
WLW's 500-kw transmitter and control console looked like this in 1934. The contract for construction of the transmitter was awarded to RCA in February, 1933. Tests began on January 15, 1934, and full-time operation began May 2, 1934. The cost of the transmitter and associated equipment was approximately $400,000.

Operation on 500 kw continued until March 1, 1939 except for a short period when a directional antenna was being installed.

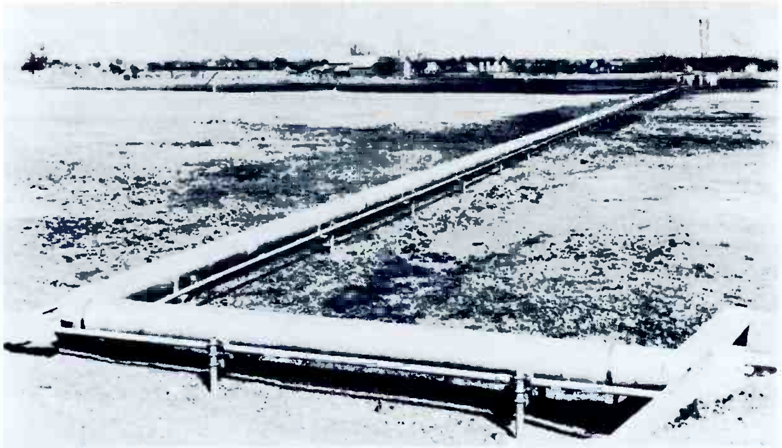




The view above shows water-cooled UV-862 tubes in one of the two modulators of the 500-kw transmitter.



The water-circulating and heat-exchanger installation is in the basement. All water pumps are installed in duplicate for utmost reliability and safety.



The RF transmission line to the antenna is 775 feet long and has a surge impedance of 100 ohms. The outer tube has an inside diameter of 9.78 inches, and the inner tube has a diameter of 1⅞ inches.

These shelves show a portion of the wire and cable kept in stock at the transmitter. With a similar stock of other components, station personnel have adequate means to construct any item of equipment.

There are two 50-kw transmitters at WLW. In the foreground is the transmitter designed by Ronald J. Rockwell and built by station personnel. This is WLW's main transmitter and features an audio response from 20 Hz to 20 kHz. Just beyond this transmitter is a completely rebuilt Western Electric unit.

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Stereo Statesman Console – features 5 stereo mixing channels from 11 inputs. Full audio switching. New illuminated program keys.

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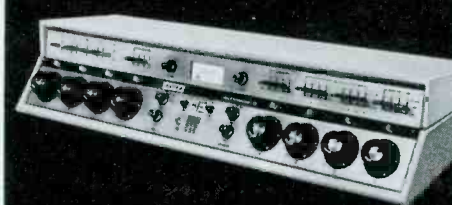
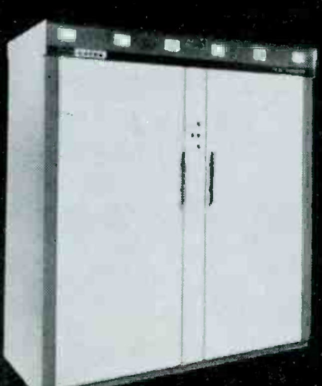


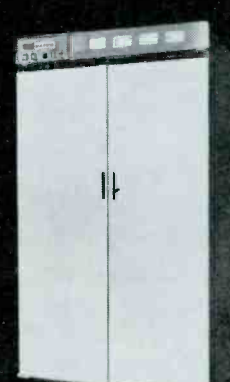
Gatesway II Console – 8 monaural mixing channels from 18 inputs. Provides for remote announcer operation of studio mike channel.

10,000-Watt AM Transmitter BC-10H – only 5 tubes! Lowest tube cost of any 10,000-watt AM transmitter. New overall design.



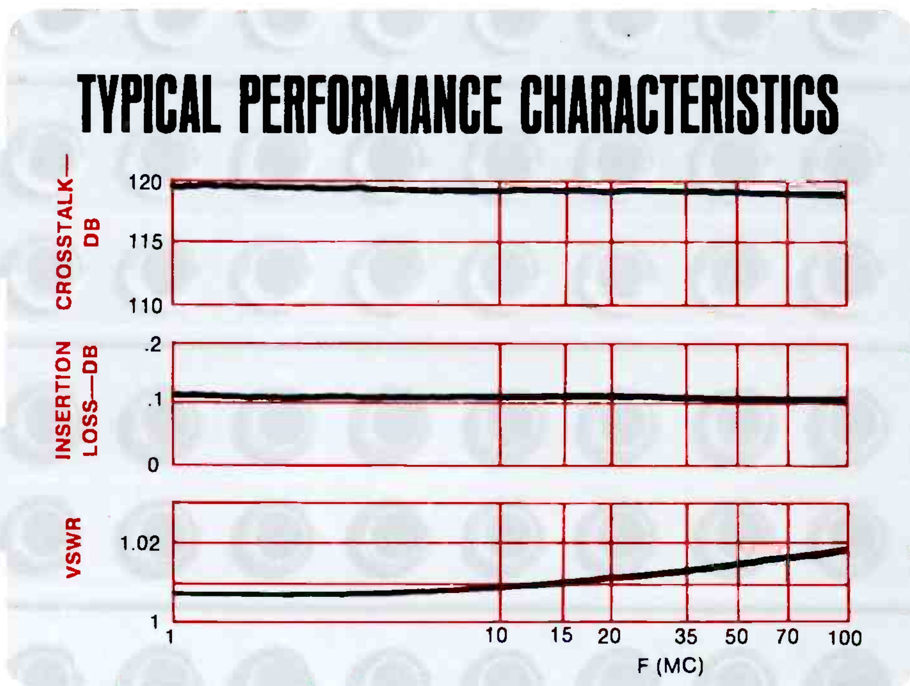
Remote Amplifiers – choice of 1, 2, 3 or 4 channels. All Solid Statesman models rugged, compact . . . with modern flightline styling.

5,000-Watt FM Transmitter FM-5H – only two tubes! 100% solid-state 10-watt exciter employs Direct Carrier Frequency Modulation.



Circle Item 17 on Tech Data Card

a new concept & performance in coaxial switching



ONLY FROM COOKE Coterm 22T a normal-through coaxial* switching and terminating jack.

* Patented

Complete compatibility and Cooke quality combine to make this coaxial switching equipment first choice for TV, radar, communication patching, data handling, etc. Advanced in concept, engineered for the utmost in reliability, it will provide years of dependable, economical service.

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735 N. SAINT ASAPH STREET
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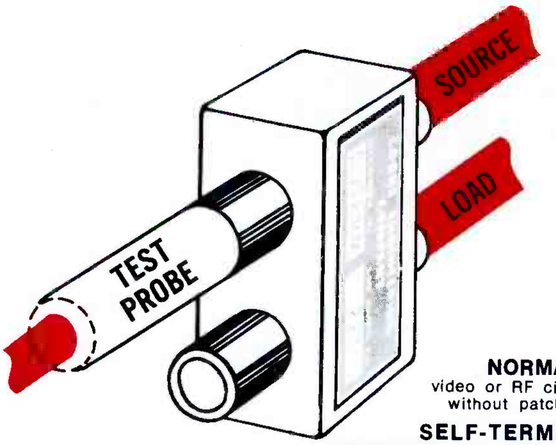
Test probe permits sampling or testing of normal-through circuit without interruption of signal

The Coterm 22T accepts either standard BNC connectors or Cooke-built quick-disconnect connectors.

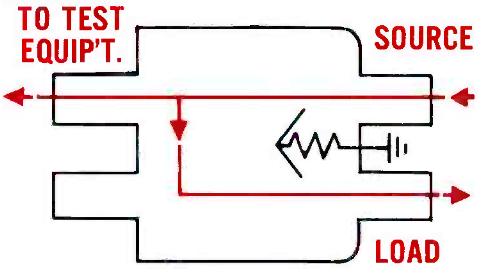


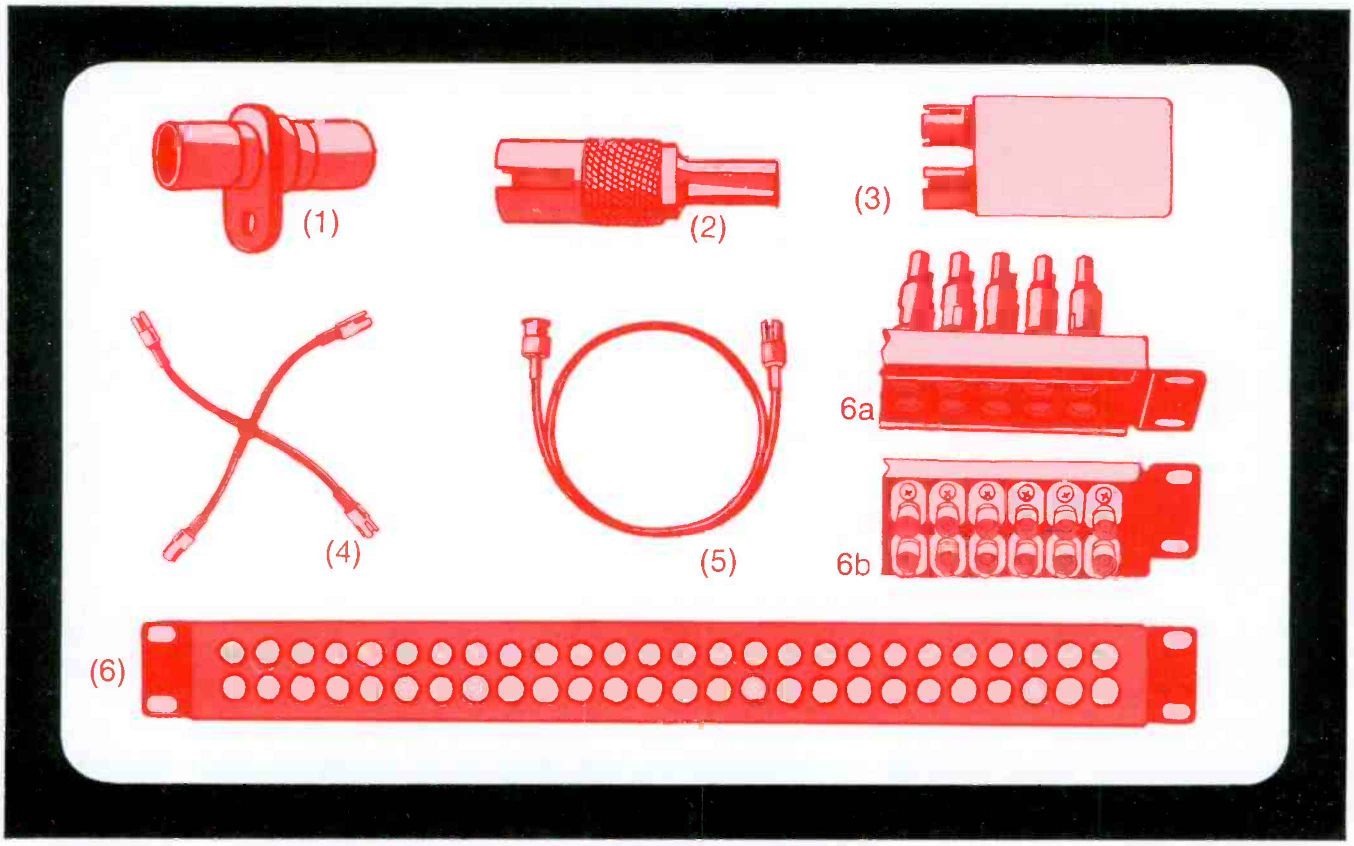
NORMAL-THROUGH video or RF circuit is provided without patch cords or plugs.

SELF-TERMINATION OF SOURCE without extra terminating plug when load side is patched. Patched in circuit feeds load.

TOTALLY FLEXIBLE PATCH FACILITY of extremely high density possible when patch cords are inserted on both sides.

COJAX* Model 22B. This normal-through coaxial switching jack is built to the same dimensions and standards as the Coterm Model 22T. It performs all functions except self-termination. It accepts the same equipment as the Coterm so can provide a mixed patch field.





Other Cooke Coaxial Switching Equipment Available

(1) Coaxial Patching Jacks. (2) Quick-Disconnect Snap-Lock Connectors*. (3) Quick-Disconnect Normaling Plugs. (4) Bridging Networks, four and five way (four way shown). (5) Test and Patch Cords. (6) Panels . . . 6a showing permanent cabling, 6b showing Coaxial Patching Jacks, (1) above installed.

* Patented

For further information write . . .

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Color Basics

(Continued from page 26)

in much the same manner as the horizontal and vertical pulses are used to synchronize the sweep sections.

Chrominance-Cancellation Effect

From the standpoint of compatibility, how does color transmission affect monochrome reception? The frequency of the color subcarrier was established at 3.579545 MHz. The sidebands extend 0.6 MHz above and 1.5 MHz below this frequency (Fig. 10). Note that the chrominance signal falls within the bandpass limits of existing monochrome receivers, which ordinarily have good frequency response to approximately 3.5 MHz.

Because the chrominance signal falls within these limits, a dot pattern will be reproduced on the screen of a monochrome receiver which is tuned to a composite color signal. The dot structure of this pattern is very fine because the frequency of the chrominance signal is relatively high in the video spectrum. In addition, the color subcarrier was set at a frequency which is an add harmonic of one-half the line-scanning rate, and the brightness variations produced on the screen by such a frequency go through a cancellation effect. The explanation of this phenomenon is given in the following discussion.

It has been shown that video signals can be broken down by analysis into many sine waves; thus, the brightness variations produced along any given scanning line by each of these waves is of a sinusoidal nature. Since it has been established that all of the sine-wave components of the luminance signal are harmonics of the line and frame frequencies, the brightness variations produced by these components go through a whole number of cycles during the scanning af any given line or frame. This means that either in the next line or in the next frame, the variations recur in phase. A reinforcing effect is produced and is like that illustrated in Fig. 11A.

In the case of the chrominance signal, however, the opposite condition exists. The frequency of the chrominance signal is an odd harmonic of one-half the line frequency. During the scanning time of any one line on the picture tube of a monochrome receiver, the chrominance signal goes through a certain number of cycles plus a half cycle. During the scanning of the succeeding line in the same field, the chrominance signal recurs out of phase by 180 degrees. It also recurs out of phase during the scanning of the same line in the succeeding frame. This can be more clearly understood by studying Fig. 11B. A cancellation effect occurs as a result of this out-of-phase condition, and the brightness variations produced on the screen of a monochrome receiver by the chrominance signal cannot be perceived by the human eye. Thus, satisfactory monochrome reproduction can be achieved when a composite color signal is being transmitted.

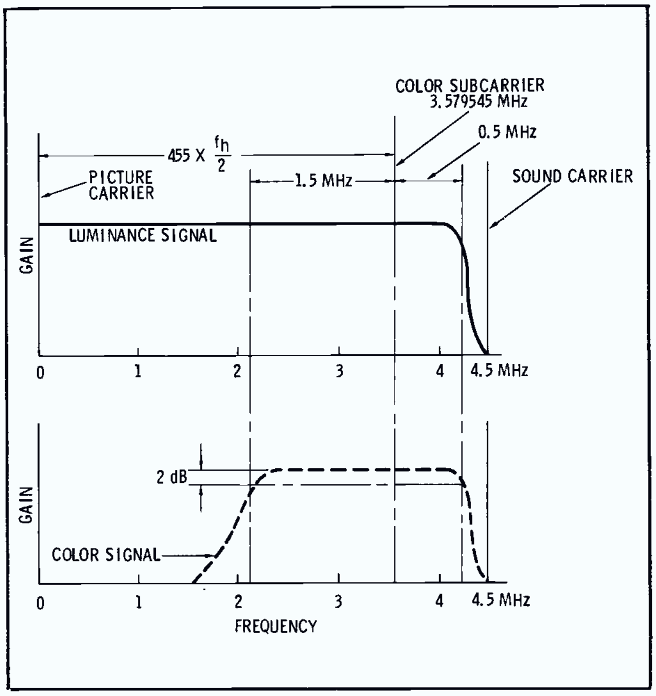


Fig. 10. Video spectrum of standard color transmission.

Summary

The composite color signal contains a luminance, chrominance, burst, horizontal-sync, and vertical-sync signal. The luminance signal represents the brightness elements of a scene, the chrominance signal represents the colors of a scene, and the burst signal is used as a phase reference.

The use of a specific frequency for the chrominance subcarrier results in an interleaving of the luminance and chrominance signals. This interleaving of signals makes it possible to transmit both the luminance and chrominance signals within the same channel width used for the transmission of a monochrome signal.

Next month, the makeup of the color picture signal will be examined. ▲

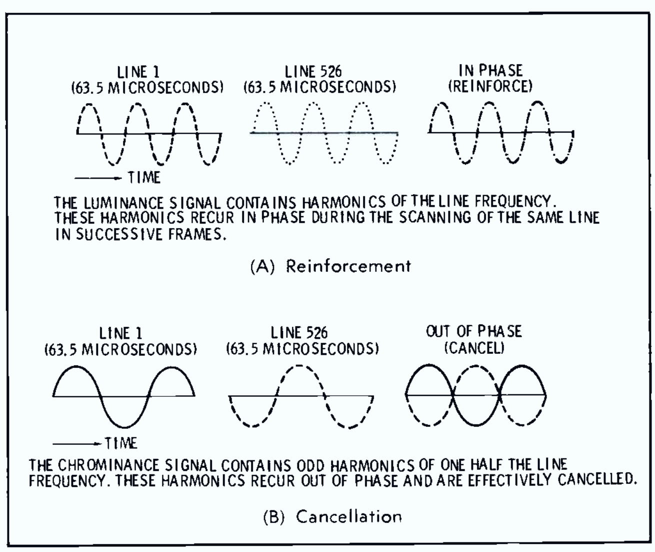


Fig. 11. Brightness variations depend on signal phases.

870-foot self-supporting catenary installation of 5-inch HELIAX air dielectric coaxial cable (Type HJ9-50) at mountain top site of Station KBYU-TV, Provo, Utah.

November 1967

We interrupt this magazine to bring you. . .

Late Bulletin from Washington

by Howard T. Head

Commission Moves to Ease Operator Licensing

Responding to complaints that candidates for operator licenses frequently must travel substantial distances for examination (May 1967 Bulletin), the Commission has proposed to establish a procedure to facilitate obtaining a third-class license with broadcast endorsement. Under the new procedure, a candidate in a remote area may apply for and receive by mail a provisional license good for one year; this license will permit transmitter operation by the holder until a regular license is obtained. During the one-year period, the applicant is expected to take and pass the required examination for the regular license. Under ordinary circumstances, however, this would permit awaiting the scheduling of examinations closer to home.

The Commission action arose from studies instituted by the NAB Small Markets Committee.

Digital Meters Now Permitted

The Commission has amended its Rules to permit the use of digital meters, printers, and other numerical readout devices. Previously, only the use of conventional dial-type indicating instruments was permitted. It is anticipated that digital meters will be used chiefly for automatic logging, although they may be used also for direct indication.

The new Rules permit the digital-meter indications to be read and entered on the transmitter operating log, but require that either another digital meter or a conventional dial-type meter be available for standby use. Under these Rules, the digital devices must provide a readout of at least three digits to an accuracy of at least 2%. Decimal points may be omitted.

Limitation Proposed on Microwave Frequency Diversity

Noting the increased drain on frequencies available in the microwave spectrum, the Commission has proposed to limit the use of frequency diversity in microwave relay systems. Under the proposed new Rules, a special showing would be necessary to justify the need for frequency diversity, including a need for the higher reliability intended to be accomplished.

Although the new Rules will affect principally the common carriers, the Commission inquiry foreshadows similar limitations on the employment of frequency diversity by broadcast licensees for studio-transmitter links and other microwave circuits.

Action Expected Soon on Low-Frequency Telemetering

After extensive study and analysis, the Commission staff has concluded that the use of low-frequency audio tones on broadcast-station carriers for telemetering purposes would not interfere with the operation of the broadcast station either in normal day-to-day operation, or under emergency conditions. Earlier, some concern had been expressed, particularly with respect to AM stations which are part of the BRECOM network. The BRECOM system employs frequency-shift keying of the carrier at subaudible frequencies (July 1964 Bulletin).

A formal proposal to permit low-frequency telemetering is expected from the Commission shortly. The adoption of the proposal will permit the elimination of the telephone pair now required for meter indications during remote-control operation.

Short Circuits

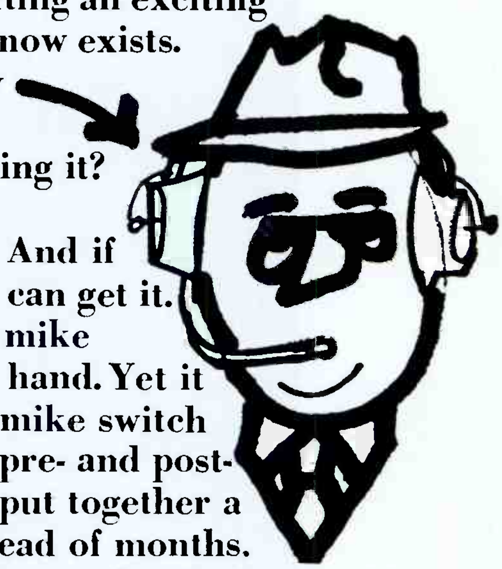
The Commission has proposed the authorization of "wireless microphones" in the 942-952 MHz band. . .A Florida UHF television translator has been authorized to test local commercial orgination. . .Eighteen UHF television channels (eight educational) have been assigned to Hawaii, the first UHF assignments in the State. . .The Commission is proposing to require call signs and the names of licensees to be displayed on STL and intercity relay antennas. . .The FCC is moving its Washington Offices to 1919 M Street, N.W.; new telephone number: (202)632-6300.

Reminder: All former presunrise authority for AM stations expired with the end of Daylight Saving Time on October 28. Only stations which have received presunrise service authority (PSA) may now operate with daytime facilities prior to sunrise.

Howard T. Head . . . in Washington

Harvey's is selling stuff you may not know exists.

There's an information gap in the broadcast and recording fields today. Sometimes we find ourselves distributing an exciting new product that many professionals don't even know exists.



For example, did you know that there's a new boom headset with built-in microphone that's so light you can actually forget you're wearing it? It can pick up two different signals at once. It's interchangeable with any standard boom headset. And if you want one now, Harvey's is the only place you can get it.

Also, there's now a complete console mike channel so small, you can hold it in your hand. Yet it includes a fader, program equalizer, line-mike switch with input pad, reverb-send channel and pre- and post-echo switch. With a few of them you can put together a complete console in a couple of days instead of months. It's revolutionary—yet, just about the only people who know of it are Harvey customers. Because just about the only place you can get it is Harvey's.

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Circle Item 19 on Tech Data Card

NEWS OF THE INDUSTRY

Merger Involves CATV Firm

In a joint announcement, it has been revealed that the respective boards of directors of **General Instrument Corp.** and the **Jerrold Corp.** have agreed to the merger of the two companies. General Instrument will issue seven-tenths of a share of its common stock for each of the 2,381,570 shares of Jerrold common presently outstanding. It is contemplated that Robert H. Beisswenger, president, and Paul A. Garrison, vice-president—operations, of Jerrold will become directors of General Instrument.

General Instrument's sales in the fiscal year ended February 28, 1967, when combined with those of Universal Controls, Inc., which it is acquiring, totaled $205,000,000. General Instrument will have outstanding approximately 3,816,000 shares of common stock and 520,000 shares of preferred stock after completion of the Universal Controls acquisition. Jerrold's sales for the same fiscal year were $50,000,000.

The transaction is subject to receipt of a favorable tax ruling as to the tax-free nature of the transaction to the Jerrold stockholders, and to approvals of stockholders of both companies.

Antenna Manufacturer Merges

The merger of **Jampro Antenna Co.** with **Computer Equipment Corp.** has been announced. Jampro will operate as a division of CEC, and no personnel changes are contemplated.

Jampro, founded in 1958, occupies a 14,000-square-foot plant and an antenna test range. It has 30 employees.

CEC's activities now include Vega Electronics Corp., the Bendix Marine Division, and seven other electronics companies.

New Name

A new corporate name and a number of organizational changes have gone into effect at **Superior Cable Corp.** Effective September 1, Superior became **Superior Continental Corp.,** heading a group of manufacturing and sales divisions including some newly created units.

Under the new structure, Superior Continental Corp. will have the following presently established divisions: Superior Cable Div., responsible for all wire and cable operations; Systems Equipment Div., responsible for production of communications hardware, accessories, and cable pressurization equipment; and the Electronics Div., responsible for production of electronic communications equipment. New divisions include Superior Sales and Service Div., responsible for sales and marketing of all Superior Continental products; Communications Apparatus Co., responsible for production of telephone and communications equipment and accessories; and Continental Telephone Laboratory.

J. H. Bowman, Superior Continental's vice-president, marketing, also will serve as general manager of the new Superior Sales and Service Div. R. F. Apple will be division manager of Communications Apparatus Co. Warren Bender will be director of Continental Telephone Laboratory.

The new name recognizes Superior's assignment as the manufacturing and supply arm of the Continental Telephone Corp.

Sales Representative Named

ELSCO, Electronic Sales Corp., has been appointed to represent **TeleMation** CATV products in the Intermountain West. ELSCO has engineered and installed TV systems for schools, universities, broadcast stations, industry, and the military. Regional sales managers are located in Denver; Scottsdale, Arizona; Albuquerque; and the Salt Lake City home office.

Wood Tower Razed

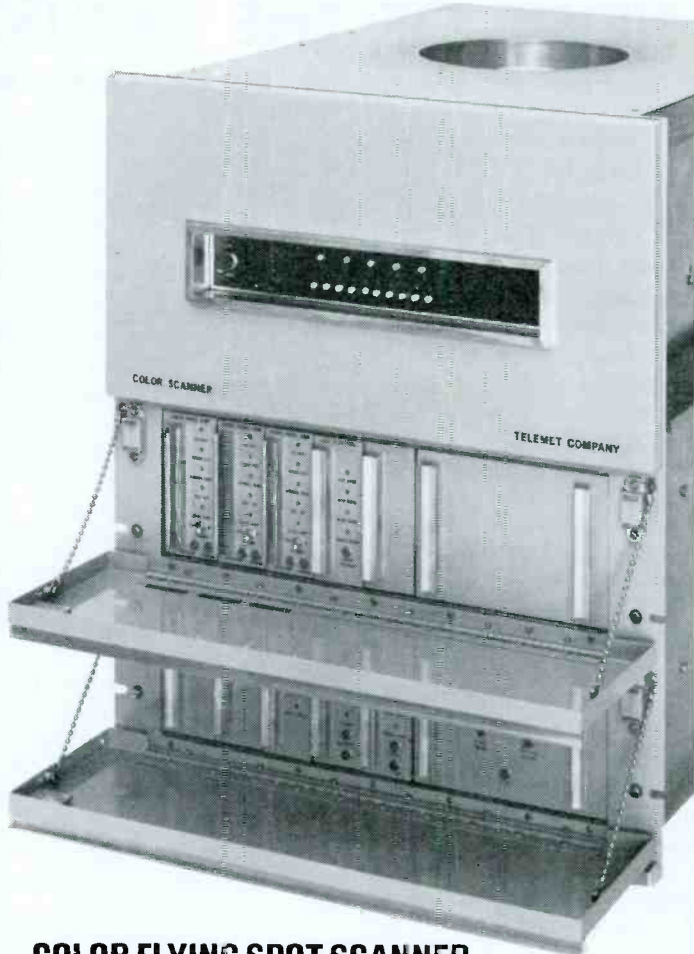
One of the country's last remaining wooden radio broadcast towers is being replaced at the **University of North Dakota's KFJM.** The 165-foot structure has been serving the campus broadcasting facility for 31 years.

The tower, which supports an antenna wire, is being replaced by a steel tower located northwest of the campus to avoid problems with blanketing interference.

The construction of the old wood tower corresponds with the beginning of regular educational programming by KFJM. Until the 1930's the radio

HOW TO SAVE ABOUT $40,000 ON A SUPERB SLIDE CHAIN

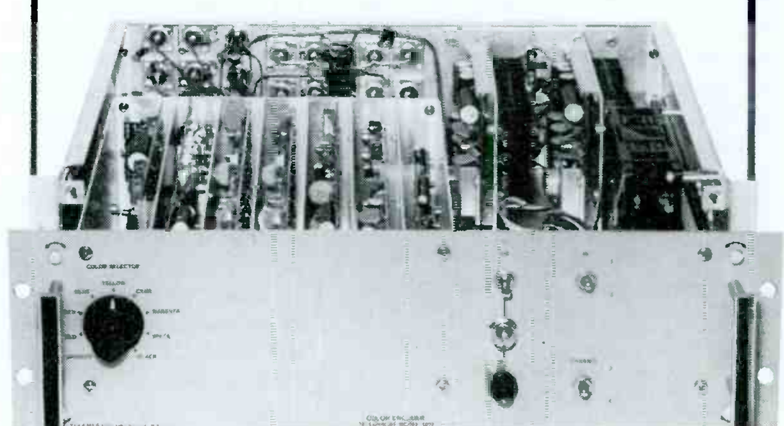
Telemet's Color Flying Spot Scanner costs $15,000 and our Color Encoder costs $2,800. That's a total of $17,800 for an excellent Slide Chain —and **$40,000 less** than you'd normally pay! It's ideal both for studio use and remote truck installation.



COLOR FLYING SPOT SCANNER, MODEL 3420-A1

▪ 50 slide magazine* ▪ Random selection ▪ Remote control (optional) ▪ Built-in power supply ▪ Built-in gamma correction ▪ Rack mount 19" x 26½" ▪ Solid state circuitry ▪ 600 line resolution

*Double drum slide changer quoted on request.



COLOR ENCODER, MODEL 3251-B1

▪ All solid state ▪ R-G-B-Y inputs ▪ Modular construction ▪ Fully self-contained ▪ Rack mounting 7½" high

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Circle Item 21 on Tech Data Card

Circle Item 22 on Tech Data Card

station operated on a more commercial basis, broadcasting music contests and sports events in addition to a daily noon program. The first formal KFJM broadcast took place Oct. 22, 1923, but the station's history goes back to 1911. In 1913, it was broadcasting standard time signals and official forecasts from the University's weather station.

WWVH Radiation Pattern Modified

In order to improve reception in the Pacific and Far East of signals from standard-frequency station **WWVH** at Maui, Hawaii, the radiation patterns at 5, 10, and 15 MHz have been modified by installing parasitic reflectors on the existing antennas. (No change has been made in the 2.5-MHz radiation pattern which remains omnidirectional.) WWVH is operated by the **National Bureau of Standards (U.S. Department of Commerce).**

The design and locations of the reflectors are such that maximum radiation is transmitted in the direction of Manila with an effective gain of approximately 3 dB, without degradation of the radiation intensities in the directions of Alaska and New Zealand. However, there has been a decrease of about 6 dB in the direction of the main continental portion of the United States.

Transfer Approved

The FCC has announced approval of the transfer of the construction permit for Cleveland channel 61 from the **Superior Broadcasting Corp.** to **WKBF Inc.,** a partnership of **Kaiser Broadcasting Corp.** and Superior, a Cleveland company. WKBF-TV, which will be Cleveland's first independent television station, will be operational in from three to five months. Three million dollars have been allocated for facilities and programming.

ORGANIZATIONS

IEEE

Papers to be presented at the IEEE Western Conference on Broadcasting will cover such topics as special antennas, color TV, satellite broadcasting, laser communications, CATV, and the use of time-sharing computers in designing equipment.

Dr. A. R. Hibbs, senior staff scientist at Jet Propulsion Laboratories, Pasadena, will present a Thursday afternoon luncheon talk on, "Television Photography in Space." He will show photographs of the moon and Mars which have been made by television techniques and transmitted to earth by both television and radio means.

Dr. Owen De Lange, Bell Telephone Laboratories, will be the featured luncheon speaker on Friday. His subject is "New Laser Applications." The symposium is scheduled for November 9 and 10 at the Ambassador Hotel, Los Angeles.

NAB

Members of the NAB Small Market Radio Committee met recently with three members of the Federal Communications Commission to discuss problems of the smaller radio stations. The committee, headed by Raymond A. Plank, owner of WKLA, Ludington, Mich., met with Chairman Rosel Hyde, Commissioner Robert T. Bartley and Commissioner Robert E. Lee.

Among the points presented to the commissioners were these: Julian F. Haas, president and manager of KAGH, Crossett, Ark., told of the difficulty in testing applicants for third-class engineering licenses and asked for relief for stations in markets distant from testing sites. John W. Jacobs, Jr., president and general manager of WDUN, Gainesville Ga., asked for assistance in eliminating excessive paperwork. Ted A. Smith, vice-president and general manager of KUMA, Pendelton, Ore., said the requirement that broadcasters advertise their applications for renewals and changes of facilities in newspapers is unfair to stations and to the public since many people do not read newspaper legal notices. Frank Balch, general manager of WJOY, Burlington, Vt., urged standardization of inspection techniques to serve both the Commission and the broadcaster.

SMPTE

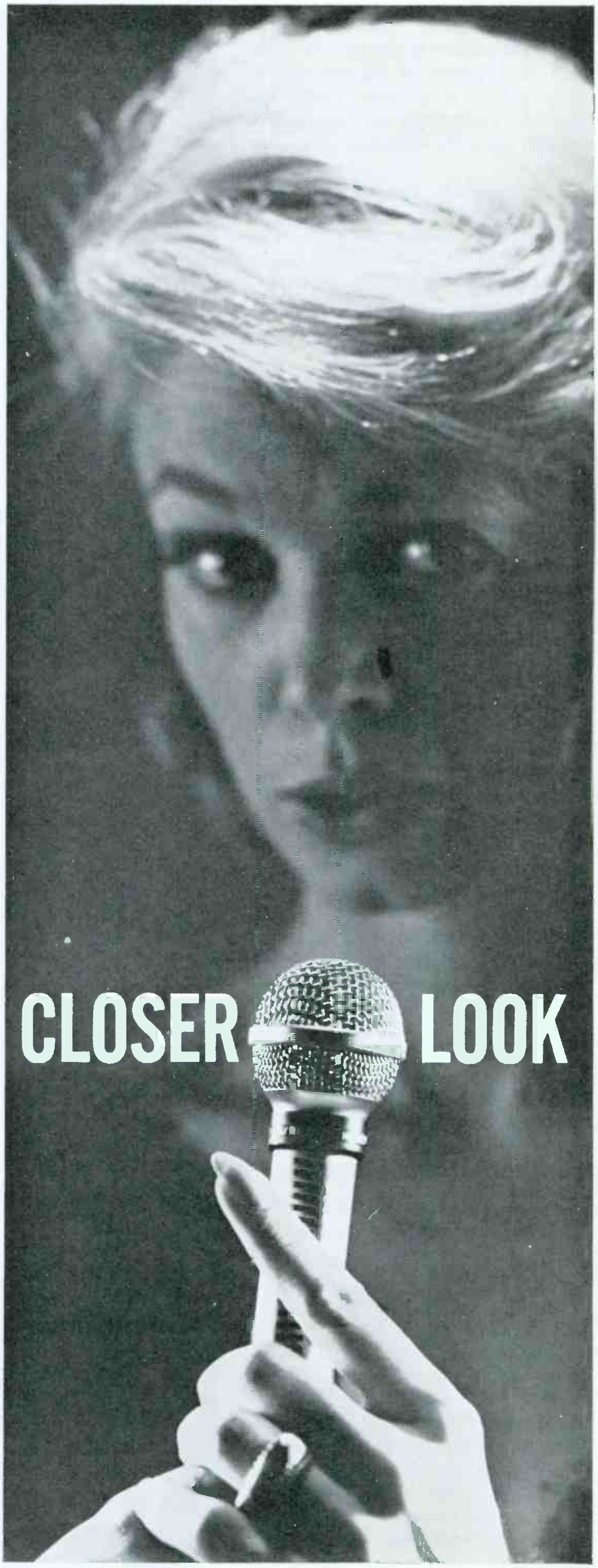
Additional winners of awards have been named by the Society of Motion Picture and Television Engineers. Mr. Alda V. Bedford, a fellow of the David Sarnoff Research Center, Princeton, New Jersey, is the recipient of the 1967 David Sarnoff Gold Medal Award. The award is in recognition of outstanding contributions in the development of new techniques or equipment which have contributed to the improvement of the engineering phases of television. Mr. Bedford retired last June after completing

Circle Item 24 on Tech Data Card

Take a real close look. We are proud of this original microphone used by so many top recording artists. Now, like any successful product, *it is being copied in appearance.* However, there are any number of top performance characteristics, *which we doubt can be duplicated,* which will continue to make the **D-24E** first choice of foremost entertainers as well as recording and broadcast engineers.

The **D-24E** boasts a wide and smooth frequency response (an individually plotted frequency curve is supplied with each unit); no popping nor harshness, plus above average cardioid characteristics to guard against feedback.

Write for details or see your local dealer today. He will show you many more advantages.



COME ON, TAKE A CLOSER LOOK

One step removed, the **D-119ES** provides similar characteristics such as good cardioid and freedom from popping. It may be connected directly to any amplifier — *high or low impedance.* With on-off switch.

1-66

AKG

MICROPHONES • HEADPHONES

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Circle Item 25 on Tech Data Card

General Electric adds 15 KW to their VHF transmitter line. That's important even if you need 30 KW output.

The new GE 15 KW VHF transmitter, TT-515, takes up only 24 square feet of floor space. The TT-515 combines economical operating characteristics with no-fight maintenance, and quality performance.

Need 30 KW output? Install two TT-515 transmitters in parallel operation. It's the ideal solution for power cutback flexibility, lower operating costs, and minimum floor space.

The TT-515 has remote control capability via required external landline and/or microwave terminal equipment.

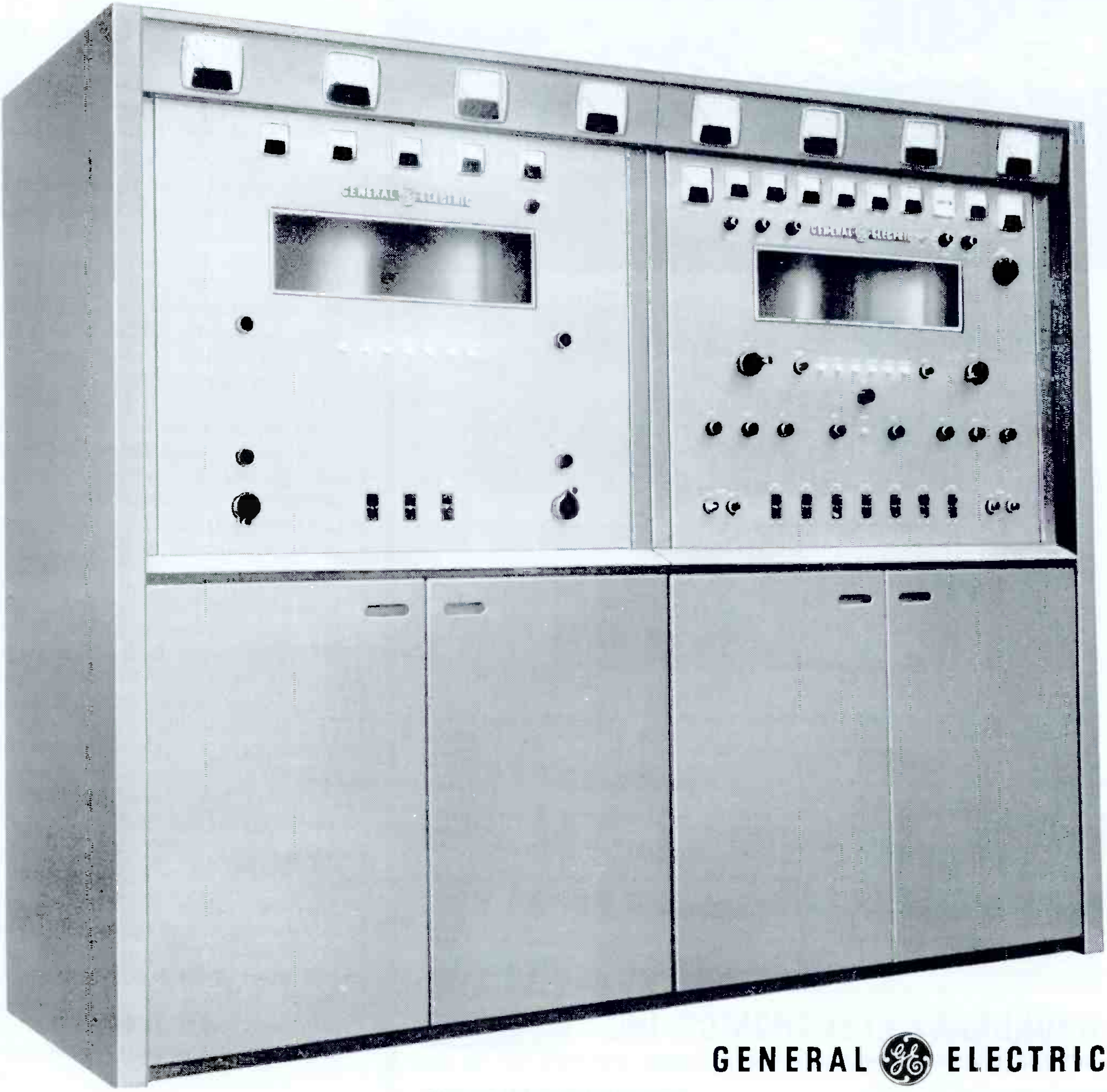
Motorized controls are provided within the transmitter for aural and visual power output.

GE VHF Transmitters: 1 KW TT-49-A/B; 5 KW TT-50-A/B; 10 KW TT-510-A/B; 15 KW TT-515-A/B; 30 KW TT-530-A/B; A/B = Low Channel/High Channel

Write General Electric Co., Visual Communication Products Department, Electronics Park, Syracuse, New York 13201 GE-52

TT-515 A/B (5-1) 15 KW

Frequency Range	—A Channels 2-6 (54-88 MC) —B Channels 7-13 (174-216 MC)
Visual Output	15 KW Sync Peak
Aural Output	3.3 KW Nominal
Output Impedance	50 Ohms
Power Consumption	208/230 Volts, 3 phase 50 or 60 cycles, at approximately 35.5 KW Average picture (0.9PF) 42.0 KW Black picture (0.9PF)
Convenience Outlets, and Cubicle Lights	117 Volts, single phase, 50 or 60 cycles, at approximately 500 watts.
Compliance	Complies with applicable FCC and EIA Specifications.
Dimensions	96" wide x 37" deep x 83" high



GENERAL ELECTRIC

Circle Item 26 on Tech Data Card

nearly forty-two years with RCA and its predecessor companies. He is best known for his contributions to the principle of mixed highs, a keystone in the development of color television. He is responsible for the concept of the four-tube color camera.

Mr. Stefan Kudelski, a Swiss precision machinist and transistor electronics engineer has been selected as the recipient of the Society's 1967 Samuel L. Warner Memorial Gold Medal Award. It is the purpose of this award to do honor to the individual by recognizing outstanding contributions in the design and development of new and improved methods and/or apparatus for sound-on-film motion pictures. The citation reads in part: "for the engineering and development of a portable synchronous ¼" tape recording system of unique design resulting in exceptional speed stability under widely varying conditions."

PERSONALITIES

Mario Alves has been appointed president and chief executive officer of **Riker Video Industries, Inc.** Mr. Alves was formerly president of American LaFrance. **H. Charles Riker,** a founder and current president of the corporation, has relinquished his administrative duties in order to devote more time to long-range policy planning as a member of the board of directors.

William M. Gaskins is the new national sales manager, Supplies Division, **Memorex Corp.** Mr. Gaskins has been associated with Memorex for the past three years, since March 1966 as western regional sales manager. Previously he held positions of responsibility at both IBM and North American Aviation.

Barton Kreuzer has been appointed division vice-president and general manager of the **RCA** Broadcast and Communications Products Division. Mr. Kreuzer has been division vice-president and general manager, RCA Astro-Electronics Division. He succeeds **Charles H. Colledge,** who is retiring after a 34-year career with RCA.

In an earlier announcement, **Max Ellison** was named manager, merchandising, for the Division's facility at Burbank, California, succeeding **John Salani** who has transferred to the Division sales organization.

The retirement of **Len Spencer** as technical director of Radio Station **CKAC,** Montreal, has been announced. Mr. Spencer joined the staff of CKAC in 1922 and had been with the station continuously since that time. Among the technical activities during his tenure were experimental television transmissions begun in 1931.

Mr. Spencer has written numerous books and magazine articles on broadcasting, and he will continue this activity. He is one of the original Consulting Authors for BROADCAST ENGINEERING.

Allen T. Powley has been named regional sales manager for **Ward Electronic Industries.** Mr. Powley began his career in broadcasting in 1926 as an engineer for WOR, New York. Subsequently he worked for Fox Movietone News and NBC in Washington. He joined the WMAL stations as assistant supervisor in 1947, and has been the stations' chief engineer for the last 13 years.

OBITUARY

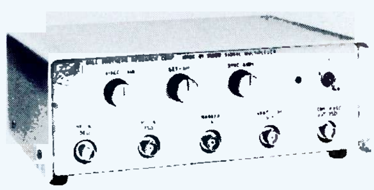
George A. Pyle, 48, chief engineer for Midwest Television Stations WMBD AM-FM-TV, Peoria, Illinois, died of a heart attack while at work on Friday, September 8, Mr. Pyle had been employed by WMBD for 28 years and had been chief engineer for the station since 1955. ▲

NEW PRODUCTS

For further information about any item, circle the associated number on the Tech Data Card.

Automation Cueing System
(50)

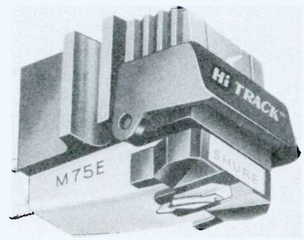
The Autocue solid-state 25-Hz cueing system for automation is offered by **Broadcast Products Co.** The device consists of a sensing amplifier, program-line filter, and tone generator. It is intended to permit use of existing tape equipment to provide an automation or background-music system. Features include self-contained 25-Hz cue-tone generator and timing circuitry, silicon solid-state design, program-line filter to eliminate the 25-Hz tone on playback, high selectivity to avoid actuation on program material, and the ability to record music tapes or use prerecorded tapes. The unit requires 3-½ inches of rack space; its net price is $300.



Video Signal Multiplexer
(51)

A video signal multiplexer, for use with general-purpose video sweep generators, has been developed by **Ball Brothers Research Corp.** Designated the Mark 81, this unit adds EIA television synchronization pulses to the output of video sweeping oscillators. The composite video output is a test signal in television format for measuring frequency response of video amplifiers. Through the use of composite video test signals in a measuring operation, clamp circuits found in many pieces of television equipment do not have to be disabled. The Mark 81 also provides an output to synchronize a sweep oscillator with a TV vertical sync pulse for stable oscilloscope display.

Absorption markers are provided at the multiplexer output to avoid overloading equipment under test. Price of the Mark 81 is $390.



Phono Cartridges
(52)

A new series of Hi-Track phono cartridges is available from **Shure Brothers, Inc.** The M75E features a biradial elliptical stylus, while the M75-6 has a conical stylus with .0006-inch radius. The M75E is designed to track at from ¾ to 1-½ grams, with optimum trackability obtained at a tracking force of 1 gram. The M75-6 has a tracking force range of from 1-½ to 3 grams. Trackability characteristics of this cartridge are identical to the M75E, when tracking force is set at 2 grams. In all other respects the two cartridges are identical. Both feature retractile stylus (to prevent record damage) and built-in stylus guard.

Also available within the M75 Series is a special conical stylus, the N75-3, with a radius of .0025 inch, which can be used with either the M75E or M75-6 for playing 78-RPM recordings.

List price of the M75E is $39.50; the M75-6 lists at $24.50. The N75-3 stylus is listed at $9.00.

Tungsten Halogen Projector Lamp
(53)

A tungsten halogen projector lamp with an internal reflector is manufactured by **Sylvania Electric Products Inc.** The new BCK lamp uses a Tru-Focus base and socket and is interchangeable with existing CZA incandescent projector lamps.

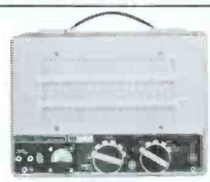
The lamp has an all-tungsten internal structure, including the reflector. The support structure required for the

MORE THAN JUST THE BEST PRODUCTION RECORDER!

KUDELSKI NAGRA III ACCESSORIES

ADD VERSATILITY—CONVENIENCE—QUALITY—ECONOMY

BMT 3-dial auxiliary mixer through normal input, makes available 3 microphones and a line input.



DH self-contained loudspeaker-amplifier provides remote quality monitoring during recording or reproduction. Ideal stage loudspeaker when shooting to Nagra synchronous tape playback.

SLO synchronizer, used for self-resolving when transferring from tape to sprocket film. Also used for synchronous playback of pre-scored music and supplies synchronizing signal when camera is driven by 60 or 50 cycle power.

SV speed varier broadens Nagra compensation capabilities when transferring synchronous ¼-inch tape to sprocket-driven magnetic film if camera ran at improper speed during shooting.

NAGRA III ¼" Tape Sync Recorder

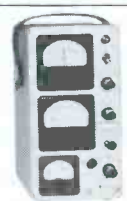
- Lightweight—Portable
- Fully transistorized—Self-contained
- Neopilot synchronizing system
- Three speeds—15, 7.5, 3¾ ips
- Fast forward—Fast rewind controls
- Self-contained speaker
- Closed loop servo motor drive
- Lineup and bloop oscillators
- Microphone and line inputs

HTN leather carrying case facilitates shoulder-slung operation. Three other models, HTF with foam rubber lining, HTP with pockets for 5" reels and HTQ with pocket for SQS generator.

SQS time-sync generator makes Nagra completely portable. Retains synchronous capability without cable connections with camera driven separately from an SQS time control or a power line.

BS preamplifier converts the line input to a second microphone input for two-microphone mixing.

PAR Automatic Attachment, used with the ATN to charge 2.5 A.H. nickle-cadmium batteries.



WFM, a precision instrument used by service technicians to measure the wow and flutter of tape recorders and similar equipment.

ATN power unit provides external power to the Nagra. Also serves as a synchronizing transformer when camera is driven by 60 or 50 cycle power.

DISTRIBUTION—SERVICE—SALES

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565 Fifth Avenue • New York, New York 10017 • Tel.: (212) 661-8066

SOUTHERN CALIFORNIA SERVICE
RYDER MAGNETIC SALES CORP.
1147 No. Vine Street • Hollywood, California 90038 • Tel.: (213) 469-6391

Circle Item 29 on Tech Data Card

Lavalier

(Continued from page 15)

cylinder. Since this tube serves only as a shield against airborne noise, and as a support for the transducer, it can be very thin. All that is necessary is that it be opaque for sound pressure. Naturally, touching it would result in a large amount of noise pick-up; however, this is prevented by the outer case, which is a relatively thick casing.

The inner case is suspended by a spiral spring. Since the transducer is primarily sensitive to axial motion, it is unnecessary to insulate it against lateral movement. Close to the transducer is a soft plastic ring with a round cross-section, through which the inner tube can roll and slide along its axis, aided by means of a lubricant. Besides permitting freedom of axial movement for the inner case, the ring and lubricant also act as an acoustic barrier, separating the environment in front of the diaphragm from the space between the outer case and the inner tube. To allow the inner case to move as freely as possible, outlets in the form of small openings allow the displaced air to escape, while acting as acoustic baffles. The overall effect of this design is to reduce microphone sensitivity to noise pickup by 17 dB as compared to a similar unit with a one-piece case.

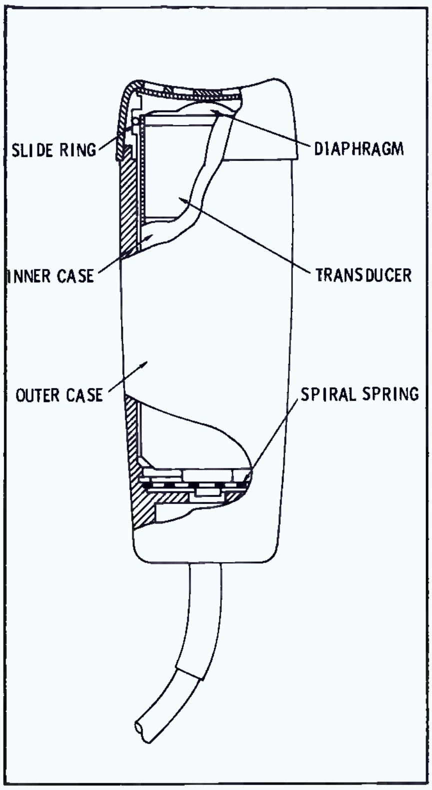

Fig. 8. A partial cutaway view shows mechanical construction of microphone.

Conclusion

The foregoing discussion has presented some of the considerations involved in the design of a lavalier microphone. Careful design is necessary for response tailored to produce quality equivalent to that of a flat-response microphone placed in front of a subject, This response must be combined with precautions to reduce sensitivity to vibrational sound pickup, thus enabling the speaker to move about.▲

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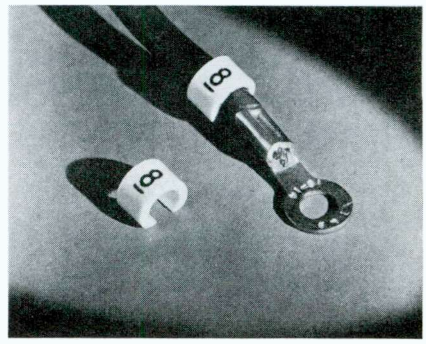
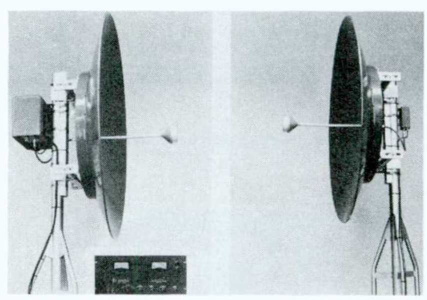
2. Yamamoto, T. and R. Nishimura. "Transmission Characteristics of Voice Around the Head," *Technical Journal of Japan Broadcasting Corporation,* January 1964.
3. Griese, H. J. "Eigenschaften von Modernen Mikrophonen," *Radio Mentor,* Vol. 29 (1963), 414-418.

C13D filament and internal reflector also are made of tungsten. The 500-watt BCK lamp has an average rated life of 50 hours.



Clip-On Wire Markers
(54)

The C-Type Markers made by the **Components Div.** of **Electrovert Inc.** are a clip-on type, specifically designed for application after the connection has been made. They may be removed at any time for recording without breaking the terminal connection. Molded of rigid Polyvinyl-chloride (PVC), the markers are resistant to abrasion, grease, oils, and chemicals; they are designed to last the life of the wire and cable. Each is an individual marker with any numeral, letter, or electrical symbol. A number of markers can be used to form any code combination required. The markers are available in fourteen different sizes to fit a range of wire and cable diameters from .080 inch to .570 inch. They are packaged with 50 of the same size and marking (in standard white with black markings) to a pack. An assortment of colors also is available.



TV Monitoring Relay
(55)

Systems for remote video and audio monitoring of distant operations or events have been introduced by the **Micro-Link Systems** unit of **Varian Associates.** The systems, known as the TVL Series, consist of compact microwave transmitter and receiver units and parabolic antennas. With the basic Micro-Link TVL relay unit, the camera can be located up to four miles from the observation monitor. How-

Our VG 2100 special effects unit

gives you 32 wipes with 12 rewipes....plus outstanding design and performance

If station operators got together and designed their own special effects unit, it would probably look and perform like the VG 2100—with operator-oriented design features like these: color matting with single joystick control of color hue and saturation throughout the full NTSC spectrum; positioner unit designed to allow smooth motion in any direction, with audio oscillator to modulate any wipe pattern; exceptional frequency response and differential phase and gain specifications.

The VG 2100 easily integrates into any existing switching system. And the price is so low for a unit of this quality that it simply cannot be met by any other manufacturer. For complete technical information, write:

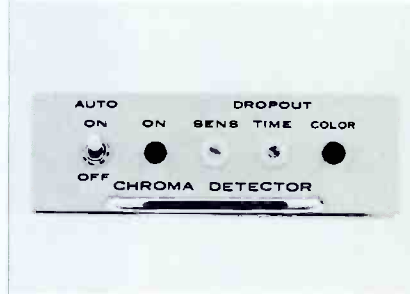
CENTRAL DYNAMICS CORPORATION

HEAD OFFICE: 903 Main St., Cambridge, Mass. 02139

Circle Item 30 on Tech Data Card

ever, repeater units and amplifiers can extend this range. TVL systems are color capable and can provide multichannel transmission.

The complete transmitting and receiving equipment comprising the basic TVL system costs $4060, excluding masts or towers.



Chroma Detector
(56)

The 2610/2620 Series chroma detector is now being manufactured by **Cohu Electronics** as an accessory for operation with Cohu 9800 Series color video encoders.

When a transitation from color to monochrome broadcasting occurs at the encoder input, the chroma detector automatically deletes the burst and chrominance signals from the encoder output, reducing chrominance noise during monochrome transmissions.

The chroma detector, and regulated power supply, are designed as plug-in modules for insertion into a mounting frame. The solid-state etched circuit boards plug into the frame, mating with connectors on an interconnection board. The unit occupies 1-¾ vertical inches in a standard 19-inch rack.

Sensitivity and dropout delay are controlled by a screw-driver-slotted adjustment. Indication and disabling of the chroma-deletion function may be remotely controlled through a rear-panel connector.

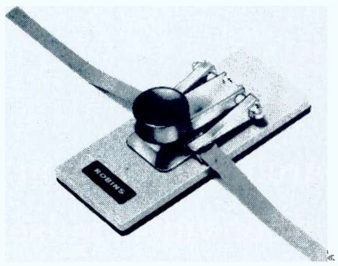
Price of the unit is $750.

Phase-Control Unit
(57)

A new phase-control unit for use in sweep testing CATV systems is a product of the **CATV Systems Div.** of **Jerrold Electronics Corp.** The unit, designated PCU-60, is designed for use in tests where the distance between a sweep generator and a monitoring oscilloscope make it impractical or impossible to use the 60-Hz horizontal output of the generator as reference. Necessary variable-voltage 60-Hz reference voltage is provided by the unit.

The dual input permits acquisition of the signal from a CATV system's 30-volt power or from a standard 115-volt source. A switch on the unit permits selection of either input.

The PCU-60 has a controllable phase range of 0 to 330 degrees, and it can be connected to the horizontal input terminal of an oscilloscope by means of a coaxial jumper provided with the unit.



Video Tape Splicers

(58)

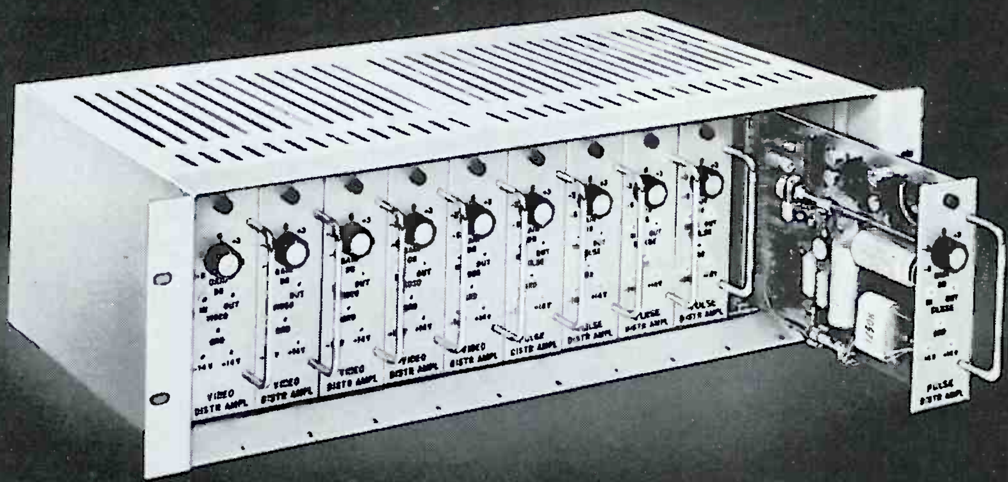
New from **Robins Industries Corp.** are a pair of video-tape splicers which list for under $20. Model TSV-50 handles ½-inch video tape, and Model TSV-100 is for 1-inch tape. Both models use pressure-sensitive patches to make the splices.

The TSV-50 and 100, which have replaceable blades and cutting pads, come on a base with a "no-mar" bottom. Extra patches are available, also. TT-247-½" patches for TSV-50 list for $1.65 per package of 60. TT-248-1" patches for TSV-100 list for $1.65 per package of 48.

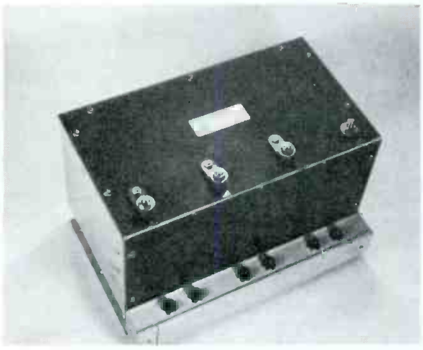
16-mm TV Projector

(59)

The Model STV-TB projector has been introduced by the **Kalart Co., Inc.** for use in television distribution systems which show films in the educational, broadcasting, industrial, and military markets. The projector features, as standard equipment, solid-state circuitry, lamp-brightness controls, optical sound pick-up with provisions for adding magnetic sound, a 600-ohm audio output, a built-in



monitor speaker with volume control, and a 2000-foot reel capacity. Optional features, such as remote control, the magnetic sound playback, and different lenses are available. The basic model lists at $1250.



Lightning Protector
(60)

A lightning and transient protector, Model 1420-01, for 120/208-volt three-phase power equipment is being marketed by **Joslyn Electronic Systems.** The protector was developed especially to safeguard solid-state networks operating from commerical power.

Transient rating is 10,000 volts, 1 x 40 μsec wave, and 10,000 amps, 10 x 20 μsec wave. Output is clamped to less than 1000 volts peak at rating, and less on lower transients. A companion Model 1414-06 clamps to less than 1000 volts on 277/480-volt systems. Rated lifetime of the models is more than 2000 operations per phase. The hermetically sealed spark element is designed to contain all discharge and emit no gases. Size is 14-¼" x 9-⅝" x 10".

Price is $1200 for each of the models. ▲

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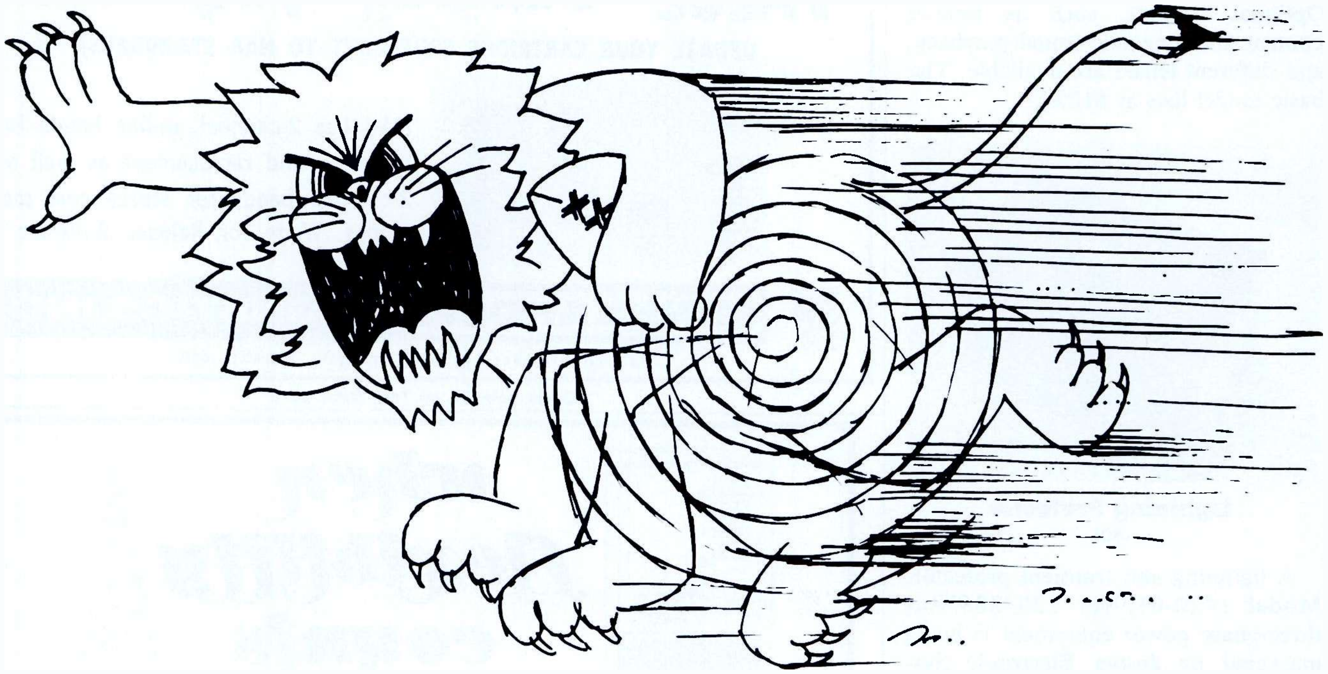


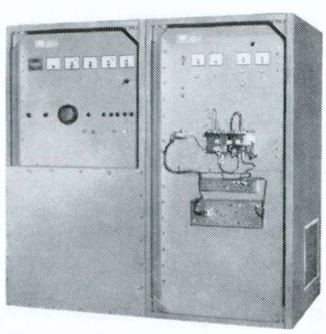
No. 1 Ground-Gainer

With the EMCEE 1 KW Translator you can now get 10 KW E.R.P. in a non-directional pattern — to cover an entire metro area

The 1 KW Translator dramatically increases the broadcaster's span of TV coverage. This solid-state, completely self-contained UHF unit has all the necessary control circuitry for automatic, unattended operation. It functions by receiving an off-the-air television signal, converting it to a UHF-TV channel and re-transmitting it at 1000 watts peak visual power, 100 watts average aural.

With the EMCEE 1 KW Translator you now have new territories to explore. Its 10 KW Effective Radiated Power is strong enough to reach otherwise inaccessible terrain; economical enough to be the means of providing TV reception to areas that cannot support a television station.

Want to learn how you can improve the color performance in your outlying areas? Ask for the free EMCEE Translator Information Kit that proves how an alert broadcaster can increase his coverage . . . discover new revenues . . . and become a No. 1 ground-gainer with EMCEE Translators.



Yes, EMCEE! I want to roar like a lion in *my* television coverage area. Send your free EMCEE Translator Information Kit.

Name ____________________

Company ____________________

Address ____________________

City ________ *State* ______ *Zip* ______

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NOT SATISFIED with your present income? The most practical thing you can do about it is add to your Electronics know-how, pass the FCC exam and get your Government License.

The demand for licensed men is enormous. Today there are over a million licensed broadcast installations and mobile transmitters on the air, and the number is growing constantly. And according to Federal Law, no one is permitted to operate or service such equipment without a Government FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Opportunities in Plants

And there are other exciting opportunities in the aerospace industry, electronics manufacturing, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal Government's FCC exam and getting your License is widely accepted proof that you know the fundamentals of Electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The Government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. That's to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE graduates who take the exam pass it. That's why we can afford to back our courses with the iron-clad Warranty shown above: you get your FCC License or your money back.

Mail Coupon for Two Free Books

Want to know more? Send the coupon below for free copies of our school catalog, "How To Succeed In Electronics," describing opportunities in Electronics, together with our special booklet, "How To Get A Commercial FCC License." If coupon has been removed, just send your name and address to us.

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All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box in coupon for G.I. Bill information.

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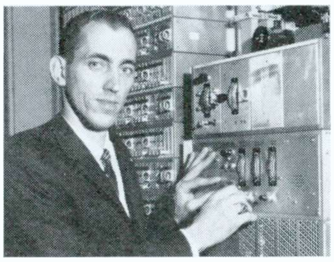

Thomas E. Miller, Jr., Engineer, Indiana Bell Telephone Company: "I completed my CIE course and passed my FCC exam while in the Navy. On my discharge, I was swamped with job offers from all over the country. My only problem was to pick the best one, and I did—engineer with Indiana Bell Telephone. CIE made the difference between just a job and a management position."

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1. Your 40-page book "How To Succeed In Electronics" describing the job opportunities in Electronics today and how your courses can prepare me for them.
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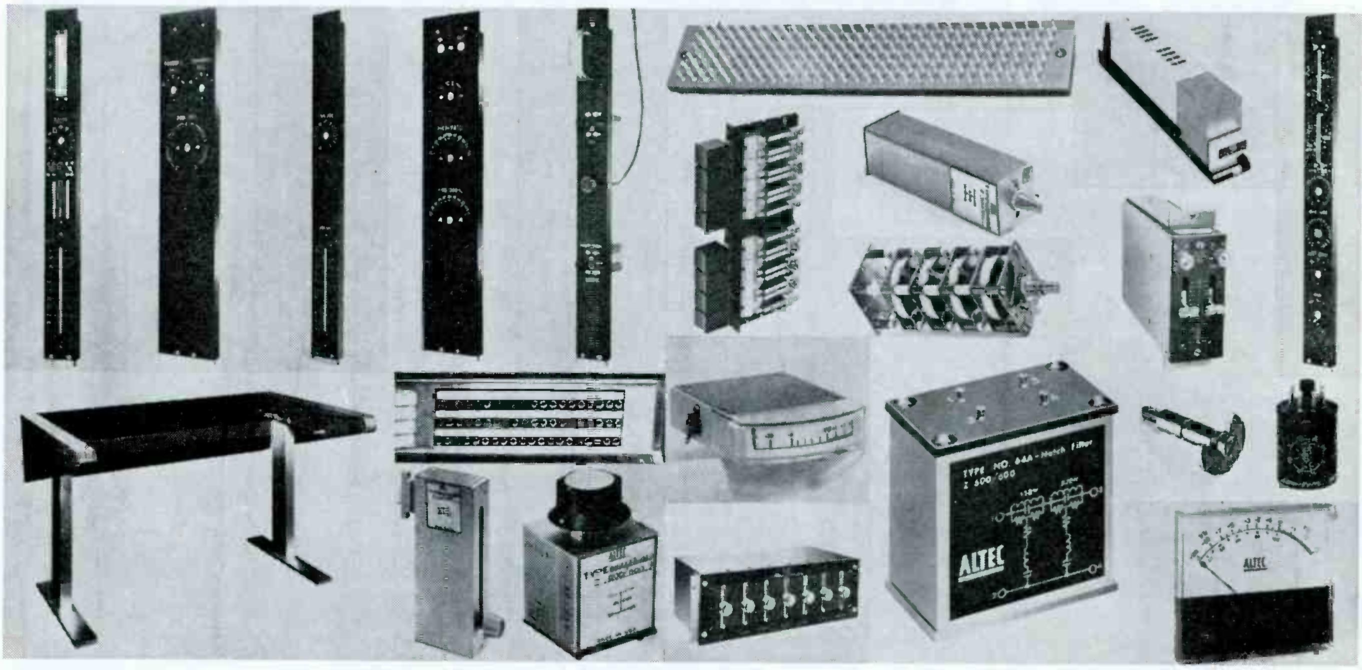
Accredited Member National Home Study Council
A Leader in Electronics Training...Since 1934
BE-41

Circle Item 37 on Tech Data Card

We've got it made.



You put it together.

It's a new idea in custom consoles. We furnish just about everything: the basic cabinet and hardware (drilled, punched, and beautifully finished), plus your choice of solid-state pre/line/booster/program and monitor/cueing amplifiers; attenuators in any configuration; high and low pass filters; rotary or straight line controls; mixer networks; VU meter range extenders; matching networks; stereo pan pots; program equalizers; motion picture and turntable faders; slating and talkback keys; jack fields for any function; matching transformers; and any keys and switches you may need.

The big idea is this: This new Altec 9200A control console is completely modular. You select and install Altec amplifiers, controls, and accessories to meet your specific needs. The result is a custom console at a fraction of former costs, both in time and money.

Modification to meet changing needs is easy too. The basic cabinet accommodates up to 27 swing-out strip modules of 1¾" and 3½" widths. Each module accepts a variety of pots, equalizers, keys, mixers. Up to 23 solid-state Altec plug-in amplifiers fit inside the cabinet. Instrument panel holds up to four VU meters for program, four in a "stack" for echo send channels, plus graphic equalizer and jack panel. And, you may assemble the consoles in multiples if you have the need.

We've made it so you could put it together, simply, inexpensively and just as you like it. And that's always a good idea. You'll get more ideas by calling your Altec Distributor, or for a very complete technical kit on the console, write Dept. BE-11

ALTEC LANSING

A Division of LTV Ling Altec, Inc., Anaheim, Calif.

Circle Item 39 on Tech Data Card

ENGINEERS' TECH DATA

ANTENNAS, TOWERS & TRANSMISSION LINES

70. CCA—Data sheet provides information about the CCA-FMA-6710R FM circularly polarized antenna.
71. DELHI—Twelve-page catalog concerns towers and masts for Citizens-band and similar applications.
72. FINNEY—Information about **Finco** 75-ohm master-system antennas is contained in brochure.

AUDIO EQUIPMENT

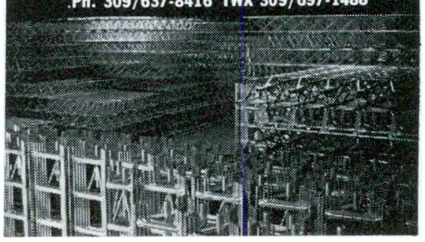
73. ALTEC LANSING—Literature consists of folder of information sheets explaining Model 9200 user-assembled modular audio console.
74. ATLAS SOUND—Catalog 566-67 contains illustrations and specifications of public-address speakers, microphone stands, and accessories.
75. BELL P/A PRODUCTS—Commercial sound equipment catalog covers amplifiers, tuners, tape players, PA systems and accessories.
76. FAIRCHILD RECORDING—Four-page leaflet describes Integra II 692 Series remote-controllable audio components designed on plug-in printed circuit boards.
77. QUAM-NICHOLS — Catalog 67 gives information about speakers for public-address, background-music, general-replacement, and other applications.
78. SHURE—Professional products brochure is about microphones, circuitry, cartridges, tone arms, and microphone accessories.
79. SUPERSCOPE—31-page catalog "All the Best From Sony" features Sony/Superscope tape recorders, magnetic tape, microphones, and accessories. Additional catalog has technical specifications of consumer and professional microphones.
80. SWITCHCRAFT — Bulletin 172 describes battery-operated studio mixer, "Studio MixMASTER" Model 307TR.
81. UNIVERSITY—Three catalogs are offered; commercial sound Catalog '67-B lists 24 pages of PA speakers and accessories; dynamic-microphone catalog has four pages of cardioid and omnidirectional microphones and accessories; high-fidelity Catalog '67 lists 16 pages of high-fidelity speakers and systems.
82. VEGA—Information sheet presents wireless microphones and accessories.

CATV EQUIPMENT

83. TELEMATION—Four-page brochure tells about the **Cablecaster** video control center for CATV.

COMPONENTS & MATERIALS

84. AMECO CABLE—16-page brochure, "Ameco Cable Capabilities," includes listing of product line.
85. AUTOMATED MEASUREMENTS—Information sheet has as its subject remotely programmable coaxial switches.
86. BENDIX—Application note on DC voltage-regulator modules is available.
87. DIALIGHT—Catalog Sheet L-206 depicts indicator lights accommodating incandescent T-2 bulbs with telephone slide base (PSB type).



88. TROMPETER—Catalogs M-4 and T-6, listing coax, twinax, and triax patching and switching products, are offered.
89. UNIMAX SWITCH—Unimax LBP Series 9 illuminated push-button controls are subject of 12-page catalog.
90. ZERO—Eight-page Catalog P67 contains information about **Aluma-Trak** aluminum chassis slides.

FILM EQUIPMENT

91. GEN'L ANILINE & FILM—Films, papers, chemicals, processors and supplies, printing and processing aids, and photofinishing supplies are presented in 44-page catalog "Professional Photographic Products."

LIGHTING EQUIPMENT

92. PHOTO RESEARCH—**Spectra** line of incident-light exposure meters, footcandle meters, and color-temperature meters is described in product bulletins and data sheets.

MICROWAVE & STL EQUIPMENT

93. MICROLINK/VARIAN—Descriptive specification sheet is about TVL Series TV-relay equipment.
94. MICROWAVE ASSOC.—Applications Bulletins 3 and 4 relate uses of microwave TV relay in commercial and military applications; revised specifications of MA-2A and MA-7A relays are offered; and CCIR International Catalog SF-9501 is available.
95. WEINSCHEL—Short-form Catalog 4 contains data on product line of microwave components, instruments, and systems for attenuation, phase, impedance, and power measurements.

MISCELLANEOUS

96. AIR SPACE DEVICES—Booklet tells about **Saf-T-Climb** device for preventing falls when structures are climbed.
97. GIBBS—Catalog sheets for Model 411A static converter, crystal oscillators, and Model 438 frequency standard clock are offered.

MOBILE RADIO & COMMUNICATIONS

98. E. F. JOHNSON—16-page booklet defines and shows equipment for Business/Industrial two-way radio.

RECORDING & PLAYBACK EQUIPMENT

99. AMPEX—Brochure V67-1 deals with VR-7500 closed-circuit VTR; Brochure V67-2 covers VR-7500C closed-circuit color VTR, AC-924 color corrector, and TRC-921 monitor/receiver; additional brochure discusses Ampex Video Institute.
100. CROWN INT'L—Four-page brochure is on Crown Pro 800 recorders with computer-logic transport control.
101. ELECTRONIC ENG'G OF CALIF.—Eight-page booklet provides information concerning **On Time** editing and control equipment for TV tape recorders.
102. JOA—Prices and data are given for new tape cartridges and for cartridge-reconditioning service.
103. MEMOREX—Brochure describes helical-scan video tape in a series produced for each type of recorder.
104. NAGRA—Synchronous ¼-inch tape recorders and accessories are subjects of leaflet.
105. SCULLY—Brochure on 1968 Model 280 recorder/reproducer is offered.
106. STANCIL-HOFFMAN—Literature contains information about magnetic recorder for mono or stereo on four separate tracks.
107. TELEX—Descriptions of Viking Studio 96 and Magnecord Models 1021 and 1022 tape recording and reproducing equipment are given in literature.

REFERENCE MATERIALS & SCHOOLS

108. CLEVELAND INSTITUTE OF ELECTRONICS — Pocket-size plastic "Electronics Data Guide" includes formulas and tables for: frequency vs wavelength, dB, length of antennas, and color code.

109. GATES—A 9½" x 12½" electronic-terminology chart has been prepared.

TELEVISION EQUIPMENT

110. BALL BROS. RESEARCH—Specifications and other information concern Mark 81 video signal multiplexer for adding EIA sync pulses to the output of video sweep oscillators.
111. CLEVELAND ELECTRONICS — A 52-page quick-reference step-down die-cut catalog gives information on vidicon, **Plumbicon,** and image-orthicon deflection components.
112. COHU—The 2610/2620 Series chroma detector, black burst generator, drive generator, color lock, dot-bar-crosshatch generator, color-bar generator, and color-bar encoder are shown in data sheets.
113. COLORADO VIDEO—Literature describing 201-A and 220-A "Slow-Scan" TV converters is available.
114. DYNAIR—Four-page, illustrated Bulletin 81C provides information on VS-121B solid-state video switcher-fader; separate sheet for remote-controlled version is included.
115. KALART—Kalart/Victor 16-mm TV projector, **Tele-Beam** large-screen TV projector, projection TV in schools, and 16-mm sound motion-picture projectors are subjects of material.
116. PHILIPS B'CAST EQUIP'T—36-page booklet is titled **"Norelco** PC-70 **Plumbicon** Camera . . . the Television Camera That Sees Eye to Eye With the Viewer."
117. TV ZOOMAR—Literature covers TV Colorgard meter to balance color TV monitors, H.T.S. studio equipment, and Newsbreaker 400 color film processor.
118. VISUAL—Literature package includes publications on TV color film and slide scanner system, zoom image-orthicon camera, video switching systems, Visual/Allen high-band color video tape recorders, and Visual/Videograph display control unit.
119. VITAL—VI-500 color video stabilizing amplifier with AGC, video and pulse distribution amplifiers VI-10A and VI-20A, and VIX-60 solid-state switching systems are subjects of literature offer.
120. ZOOMAR, INC.—Material concerns TV Macro Kilar lenses and Mark IV-B lens for closed-circuit applications.

TEST & MEASURING EQUIPMENT

121. BENRUS TECH. PRODS.—Catalog No. 704, "Benrus Electronic Instruments," features CRT display devices and other instruments.
122. DELTA—Information sheet has as its subject the Model RG-1 receiver/generator for use with impedance bridges in antenna-system measurements.
123. SECO—Operating manual for the Model 107C tube tester is available.
124. SENCORE—Eight-page catalog and a four-page supplement catalog are offered.
125. SIMPSON—Bulletin No. 2076 lists VOM's, VTVM's, oscilloscopes, other instruments, and accessories.
126. TRIPLETT—Catalog 51-T contains data on line of VOM's, VTVM's, tube and transistor analyzers, and accessories.
127. WATERS MFG.—Leaflet shows RF instrumentation equipment available from this company.

Advertisers' Index

Professional Services

VIR JAMES
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Applications and Field Engineering
345 Colorado Blvd.
Phone: (Area Code 303) 333-5562
DENVER, COLORADO 80206
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Consulting Engineer
National Press Bldg.
Washington 4, D. C.
Telephone District 7-1205
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PRECISION FREQUENCY
MEASURING SERVICE
SPECIALISTS FOR AM-FM-TV
445 Concord Ave. Phone 876-2810
Cambridge, Mass. 02138

AMPEX HEAD ASSEMBLY RECONDITIONING SERVICE for all Ampex professional model recorders. This professional service features precision relapping of all heads for maximum head life. Your assembly is thoroughly cleaned and guides are replaced as required. Price includes optical and electrical inspection and complete testing on Ampex equipment in our plant. Full track or half track assemblies . . . $35.00. One to two day service. "Loaner" assemblies available if necessary. LIPPS, INC., 1630 Euclid Street, Santa Monica, California 90404. (213) EX 3-0449. tf

CRYSTAL AND MONITOR SERVICE — Frequency change and repair service for AM monitors including G.R., RCA, Gates, W.E., and Doolittle; also H-P 335B FM. AM monitors bought and sold. What have you, what do you need? New or regrinding of AM crystals for RCA, Gates, Bliley, W.E., and J-K oven holders, repairs, etc. Fastest service, reasonable prices. Over 25 years in this business. Eidson Electronic Co., Box 96, Temple, Texas 76501, Phone 817 773-3901. 2-67-tf

ROSNER TELEVISION SYSTEMS

ENGINEERS	CONTRACTORS
120 E. 56 St.	230 Newtown Rd.
New York	Plainview
N. Y. 10022	N. Y. 11803

VIDEO TAPE RECORDER AUDIO HEAD ASSEMBLY SERVICE
Precision relapping of all heads and supporting posts, including cleaning and testing. Ampex head assembly with "cue" tracks, $75.00 complete. RCA units also relapped. One to two day service. LIPPS, INC., 1630 Euclid St., Santa Monica, Calif. 90404. (213) EX 3-0449. tf

Kits serviced, shipped. Professional, reasonable. Also small broadcast rack and table units, carts, tuners, limiters. Write: 109 Pinetree, Woodbridge, Va. 4-67-tf

JOHN H. MULLANEY and ASSOCIATES
Suite 71,
1150 Connecticut Ave., N.W.
Washington, D. C. 20036
Phone 202-223-1180
Member AFCCE

Swift, professional service on your tape cartridge rebuilding needs. All work fully guaranteed — virtually no audio dropout with our splicing technique! Write Broadcast Equipment Rebuilders, Route 2, Box 723, Connellys Springs, N. Carolina 28612. 10-67-tf

Classified

Advertising rates in the Classified Section are fifteen cents per word. Minimum charge is $2.00. Blind box number is 50 cents extra.

Equipment for Sale

SPOTMASTER cartridge equipment and accessories, Crow tape recorders, QRK, Rek-O-Kut, Russco (turntables and preamplifiers) Gray and Euphonics tonearms, Metron modulation monitors, Universal Audio Products, Pultec, Norelco-AKG microphones, Fidelipac and Audiopak cartridges. Write for special money saving offers. Audiovox, Box 7067-55, Miami, Florida 33155. 11-67-tf

CO-AXIAL CABLE Heliax, Styroflex, Spiroline, etc. Also rigid and RG types in stock. New material. Write for list. Sierra-Western Electric Co., Willow and 24th Streets, Oakland, Calif. Phone 415 832-3527 5-66-tf

Television / Radio / communications gear of any type available. From a tower to a tube. Microwave, transmitters, cameras, studio equipment, mikes, etc. Advise your needs—offers. Electrofind Co., 440 Columbus Ave., NYC. 212-EN-25680. 8-64 tf

CARTRIDGE TAPE EQUIPMENT
Completely reconditioned and guaranteed. Spotmaster Model 500 Record/Playbacks, $350.00. Model 505 Playbacks $250.00. 30-day money-back guarantee on all equipment.
BROADCAST PRODUCTS COMPANY
18804 Woodway Drive, Derwood, Maryland, 20855
(301) 926-4600 3-67-12t

"AUDIO EQUIPMENT — Whatever your needs, check us first. New and used. Ampex, Altec, AKG, EV, Fairchild, Neumann, Langevin, Rek-O-Kut, Uher, Viking. Send for equipment list." Audio Distributors, Inc., 2342 S. Division Ave., Grand Rapids, Michigan 49507. 6-66-tf

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

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

FOR SALE: RCA TK60A camera only. First reasonable offer takes it. Write Dept. 184, Broadcast Engineering. 11-67-1t

2 RCA TK60 camera chains including camera CCU cable cam head lenses.. Available approx. 60 days. For further info call Charles Robison WOOD-TV, Grand Rapids 616-459-4125. 11-67-1t

Mono 600 Conax. Only a few hours use. $350.00. Boyd Recording, 2924 Lemmon Ave. East, Dallas, Tex. 11-67-1t

Ampex VR-7000 VTR with 1" tape. Portable case. Used 400 hours. New price $3400. Selling for $2800. Martin Shalek, 87 Fairmont St., Malden, Mass. (617) 324-2411. 11-67-1t

For Sale: Excellent, reconditioned and recalibrated General Radio AM frequency monitor, to your frequency, inquire. Eidson Electronic Co., Box 96, Temple, Texas 76501. 11-67-1t

BROADCAST EQUIPMENT REBUILDERS... your headquarters for tape cartridge reconditioning, all work fully guaranteed! Write Quin Morrison about your used equipment needs. New Address: Box 276, Hickory, N.C. 28601. 11-67-tf

Coils, Contactors, Switches, Complete ATU systems. Top Quality, Lowest Prices, Fast Delivery, No Duty. Write for catalogue: Geleco Electronics Ltd., 2 Thorncliffe Pk. Dr., Toronto 17, Ont. 416-421-5631. 11-67-12t

4 RCA TR-22 TV tape recorders with monochrome ATC, color ATC, and non-phase color. Three also include line lock and modified head cover. One (with all modifications) available now. Others this fall.
1 RCA TK-41C color studio camera chain. George C. Wetmore, Director of Project Engineering, WTOP-TV, Washington, D.C. 20016. 11-67-1t

Equipment Wanted

We need used 250, 500, 5K & 10K Watts AM Transmitters. No Junk. Guarantee Radio Supply Corp., 1314 Iturbide St., Laredo, Texas 78040. 3-66-tf

SPOTMASTERS WANTED—Model 500 Record/Playbacks and Model 505 Playbacks. Send full details to: BROADCAST PRODUCTS COMPANY, 18804 Woodway Drive, Derwood, Maryland 20855 (301) 926-4600. 10-67-6t

Wanted: Lampkin frequency meter type 105-B in good condition. Must be complete with books. Pete Russo, 359 E. 69th, Long Beach, Calif. 90805. 11-67-1t

Monaural Audio Console in good condition, record/playback cartridge machine and playback only cartridge machine. Contact Willis, WOMT, Manitowoc, Wisconsin 414-682-8247. 11-67-1t

Used 250, 1 KW AM Xmitter. No Junk. KRSP—Radio, 1130 West 5200 South, Salt Lake City, Utah 84107. 11-67-2t

Used 1 KW remote controllable AM transmitter, all types considered. Would prefer Gates BC-1G or 250, 500 watter which can convert to 1 KW and remote control. Contact Wally Dowhan, Chief Engineer, CKWW Radio, 1150 Ouellette Ave., Windsor, Ontario. 11-67-1t

Employment

IMMEDIATE OPENINGS—Qualify for any of the following positions: Technicians for RCA Closed Circuit Television equipment, Cameramen, Maintenance men, Video Tape men, Video Engineers, Sales Engineers. RCA Rep. 143-08 94th Ave., Jamaica, New York, or (212) 297-7344. 7-67-tf

Electrical Engineers needed immediately for TV/Radio stations, manufacturers, and CATV for all positions. Send well prepared resume to Nationwide Broadcast Personnel Consultants, 645 North Michigan Avenue, Chicago, Illinois, 60611. We have openings for all qualified applicants and the employer pays our fee. 10-67-tf

Immediate opening for Broadcast Engineer. All color station, second class license or better required. Send resume to WNYS-TV Channel 9, Syracuse, Inc. P.O. Box 9, Syracuse, N.Y. 13214. 10-67-tf

Job Headquarters for all Radio and Television Engineers. Immediate openings exist in 9 western states and elsewhere for qualified engineer and technical personnel. All categories from trainees to experienced transmitter maintenance, chief, assistant chief, live color video maintenance and technical operations. Send us your complete resume now. The AMPS Agency, 3924 Wilshire Blvd., Los Angeles, California 90005. Telephone DU 8-3116.
By Broadcasters—For Broadcasters 11-66-tf

Wanted: Engineer for college ITV facility. Operation, maintenance, installation work. Contact Dr. Swank, Central Missouri State, Warrensburg, Missouri. Tel. (816) 747-3418. 11-67-1t

Electrical engineers are urgently needed nationwide for television and radio stations, broadcast equipment manufacturers and CATV systems. Send resume to Nationwide Broadcast Personnel Consultants, 645 North Michigan Avenue, Chicago, Illinois 60611. No fee and confidential. 11-67-1t.

1st Class FCC License Engineers. Prefer experienced men, strong on MCR operations, switching, VTR, and projection. Good salary and benefits. Reply Kaiser Broadcasting Corp., WKBD-TV, Box 359, Southfield (Detroit) Michigan 48075. Attention Al Martin, Chief Engineer. Equal Opportunity Employer. 11-67-1t

Position available for experienced studio maintenance engineer with broad background in tape-disc-console maintenance. Also accepting applications for mixers and recordists. Send complete resume to Chief Engineer, United Recording Corp. 6050 Sunset Blvd., Hollywood California. 90028. 11-67-1t

TELEVISION ENGINEER — Expanding instructional television system requires engineer with broadcast or ETV experience. Equipment includes three studio cameras, film chain, four VR660's programming to two channels on campus cable system. New remote truck equipped with vidicon cameras. Applicant will aid and assist in design, installation, and maintenance of the system, part time assistance with studio and remote operations as needed. Salary in the $700/mo/range. Send resume, address, and phone number to Dr. Ralph Smith, Director of Radio and Television, Illinois State University, Normal, Illinois 61761. 11-67-1t

"SOMEWHERE there is a young, ambitious engineer with several years experience in video engineering, and he is a sharp technician. This man is ready to move up to the chief engineer position of a small TV station that is growing fast. He would start at about $750.00 per month. He probably has a wife and children, mature, and would like to live in the Rocky Mountain area. He also has good leadership potential, and would someday like to make much more than wages. This is a great opportunity for somebody." Box 186. 11-67-1t

Training

To advance in electronics, knowledge and ability are required. Grantham offers correspondence and resident instruction, in depth, leading to the degree of Associate in Science in Electronics Engineering. G.I. Bill approved. Credit for previous training and experience allowed. Free Catalog. Write: Dept. E-2, Grantham School of Electronics, 1505 N. Western Ave., Hollywood, California 90027. 6-67-tf

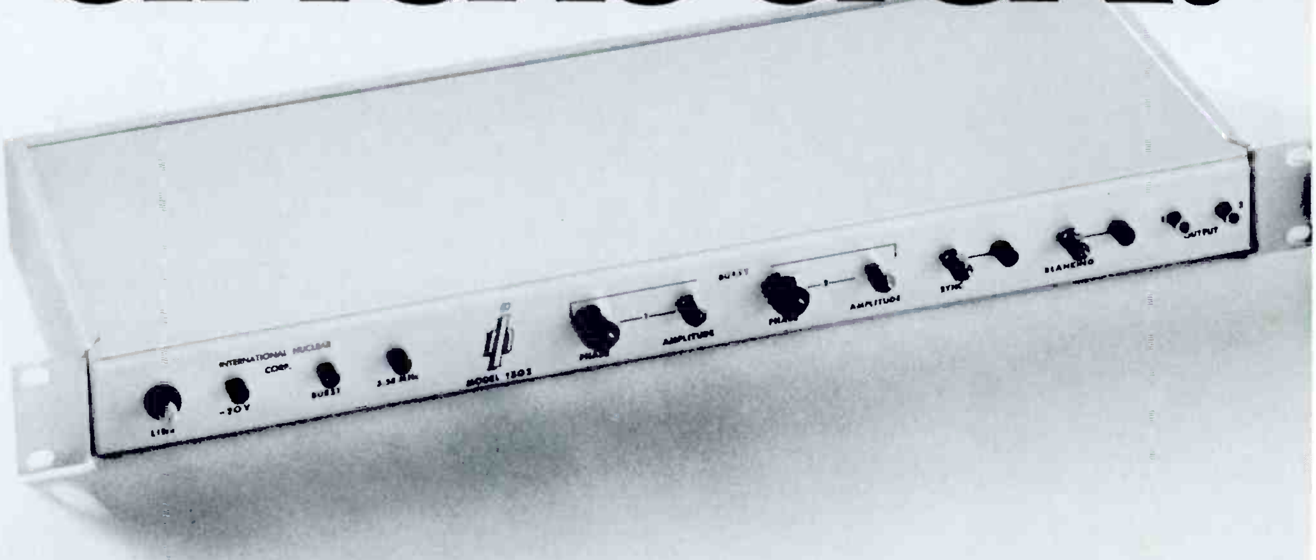
Miscellaneous

RADIO AND TELEVISION STATIONS for sale in all parts of United States. Qualified buyers may receive further details by writing to Inter-Media Communications Corporation, 246 Fifth Avenue, New York, New York 10001. 1-67-12t

BROADCAST EQUIPMENT SERVICE MANAGER

A major manufacturer of broadcast equipment requires a Service Manager with the ability to develop and maintain a field service organization to support rapidly expanding product lines. This is an opportunity to accept management responsibility with a growing electronics firm. Technical broadcast field service and supervisory experience required. Headquartered in midwestern city. Limited travel. Compensation commensurate with background and capabilities. Full company benefits. Send resume to Box 185. 11-67-1t

To Black and back.



International Nuclear's brand new TBG2 Black Burst Generator allows you to go to black and back with perfection.

The TBG2 has two outputs available for added versatility, and each have burst phase and burst amplitude adjustments so the two feeds can be matched under any condition.

The TBG2 has the industry's only continuously rotatable phase control, and it's accurate to within one degree. All the controls are on the front panel, and can be locked.

The TBG2 Black Burst Generator is small, compact and lightweight. So is the price, $475.00.

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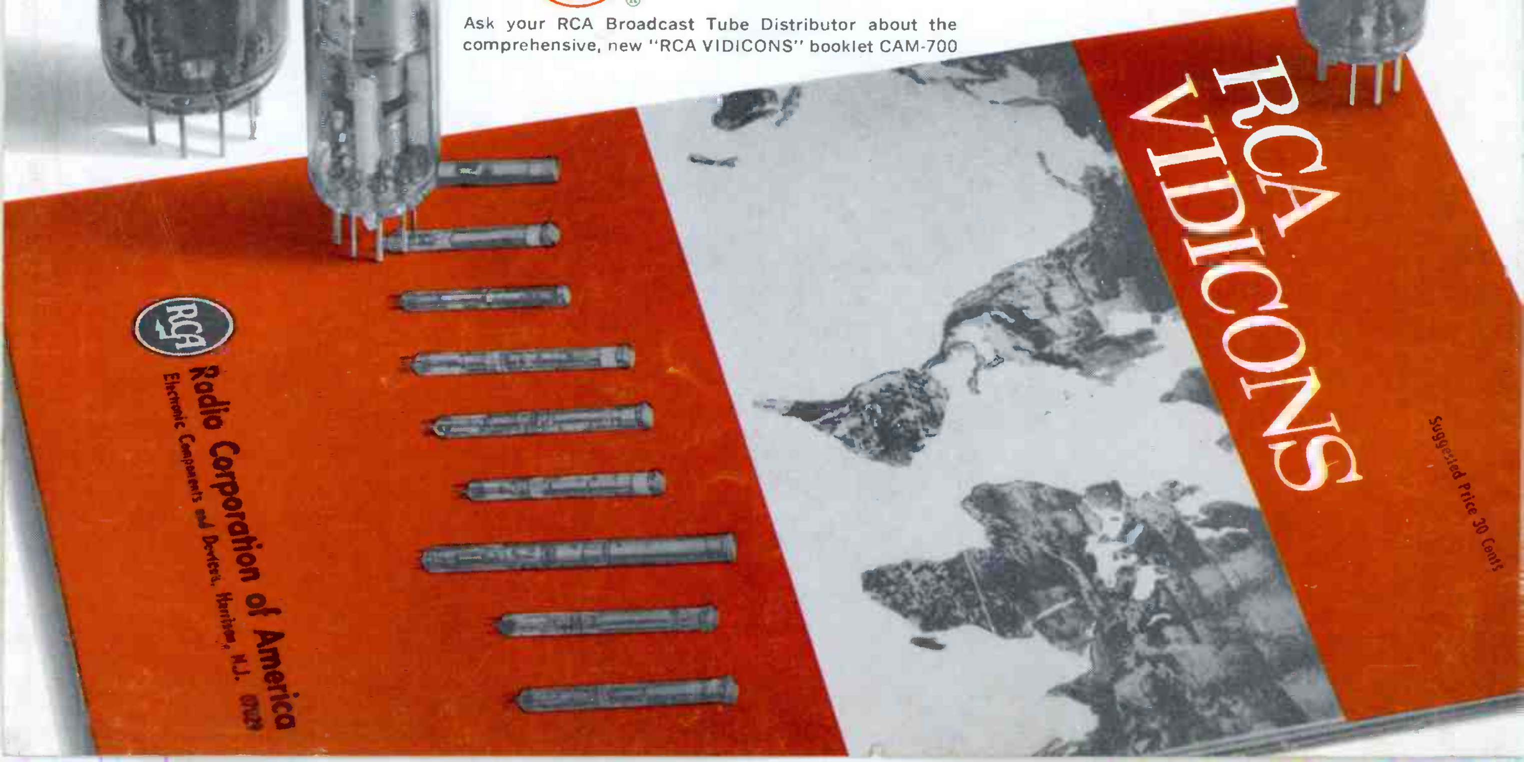
INTERNATIONAL NUCLEAR CORPORATION
608 Norris Avenue
Nashville, Tennessee
(615) 254-3365
"Transistorizing the Television Industry"

INTERNATIONAL NUCLEAR CORP.



RCA VIDICONS
Radio Corporation of America
Electronic Components and Devices, Harrison, N.J.
Suggested Price 30 Cents