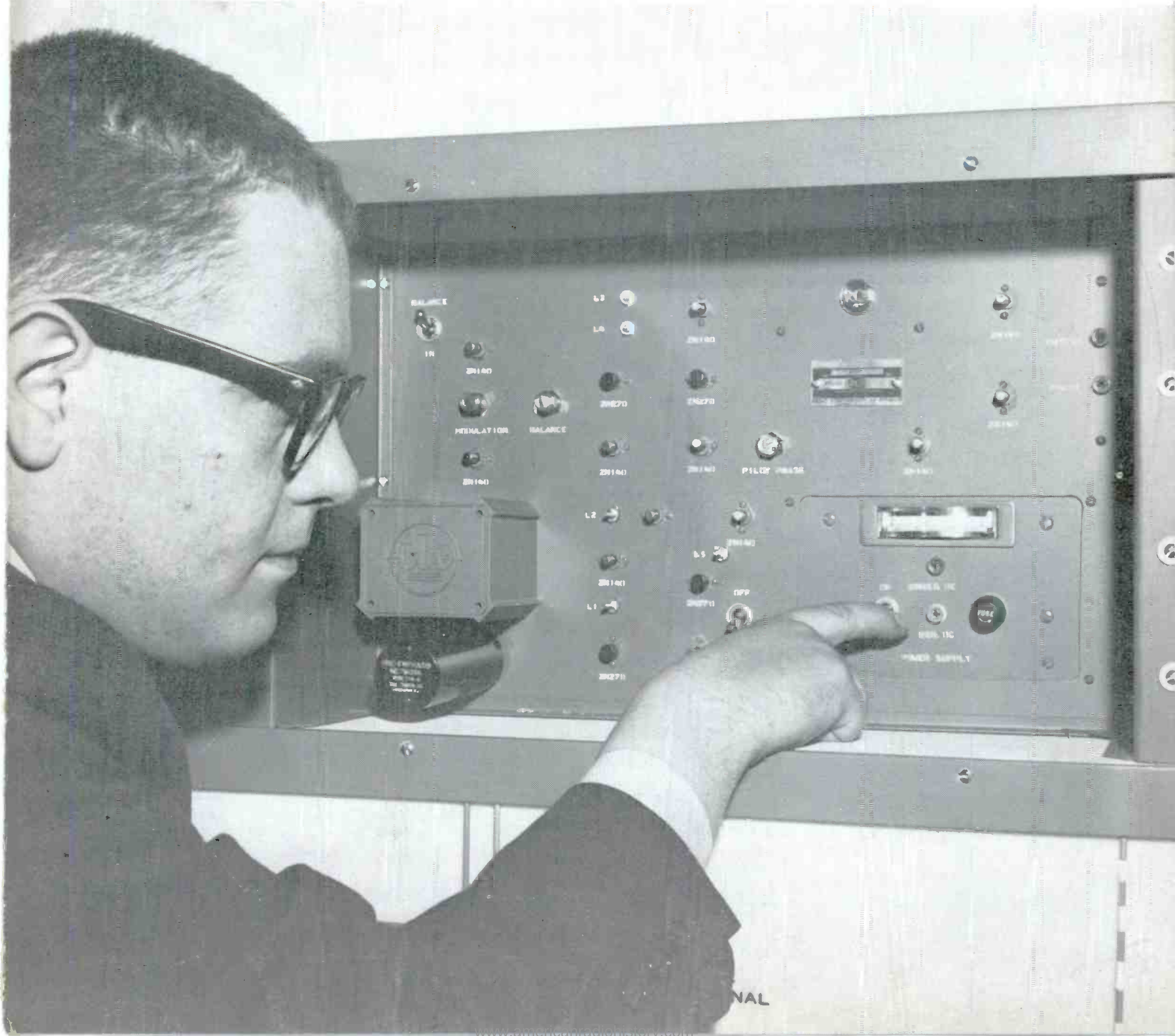
JUNE, 1961

BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

STEREO, NEW ERA FOR FM



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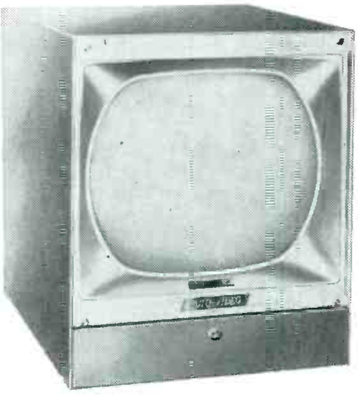
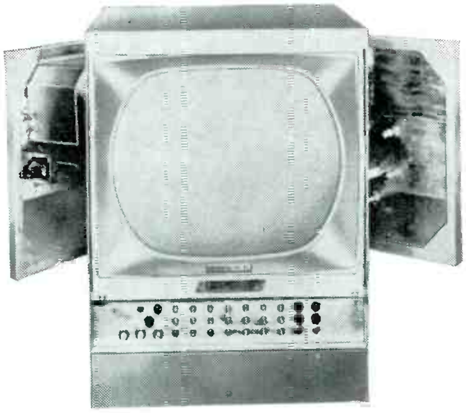
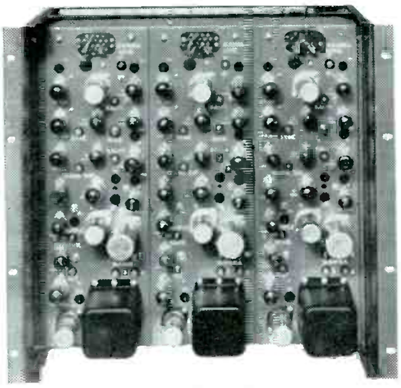


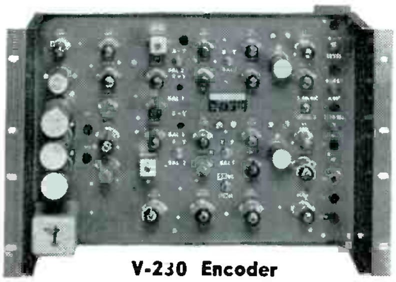
V-298
21" Color TV
Monitor
All Modular
Construction



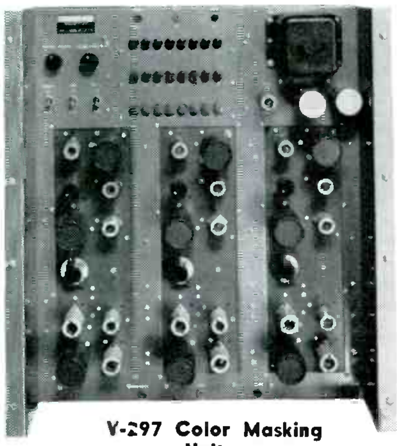


V-225 Color Gamma Correctors

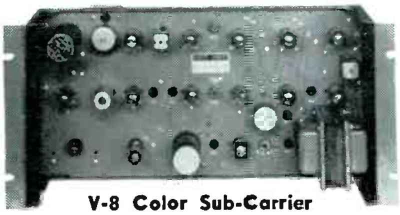
V-229 Color Matrix Delay



V-230 Encoder



V-297 Color Masking Unit



V-8 Color Sub-Carrier Generator

V-516 Automatic Level Control

V-139 Color Sync Change Over

V-17 Color Burst Keying Unit

V-29 Color Bar Generator

ALSO V-525—3-V Color Film Camera Chain • F-602 Color Film Slide Multiplexer • V-184—12—4 Color TV Diode Switcher • V-243 Color Stabilizing Amplifier • V-292 Color Special Effects Generator and Amplifier • F-107—1 Light Box and Test Chart Kit for Color • V-700 Transistorized Sync Generator • V-128 Transistorized Sync Slave

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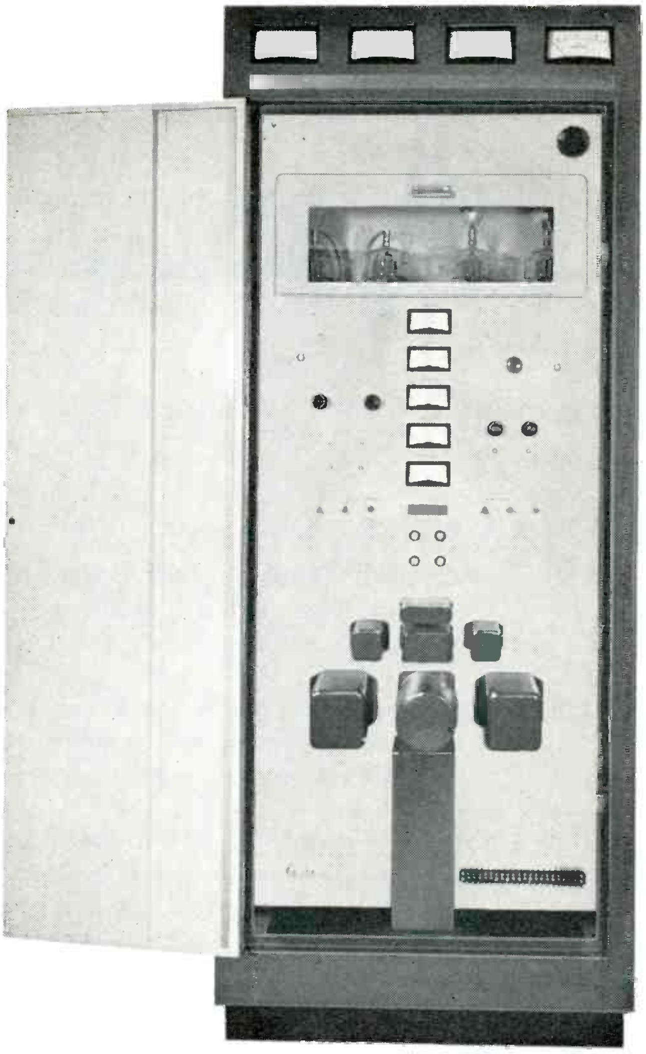
1000/250 WATT AM TRANSMITTER



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BUILT-IN DUMMY ANTENNA–Furnished as standard equipment. A Bauer feature for many years!

THE ECONOMICAL APPROACH

The Bauer Model 707 is also available as a kit . . . at a substantial savings.

DON'T BUY A 1 KW TRANSMITTER UNTIL YOU HAVE THE BAUER STORY.
WRITE TODAY!

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BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY ®

VOLUME 3 JUNE, 1961 NUMBER 6

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GENERAL ELECTRIC 50 KW AM TRANSMITTER FROM CANADA TO MEXICO...

Here is a partial listing of stations from Canada to Mexico that are using or installing the General Electric Type BT-50-A 50 KW AM Transmitter:

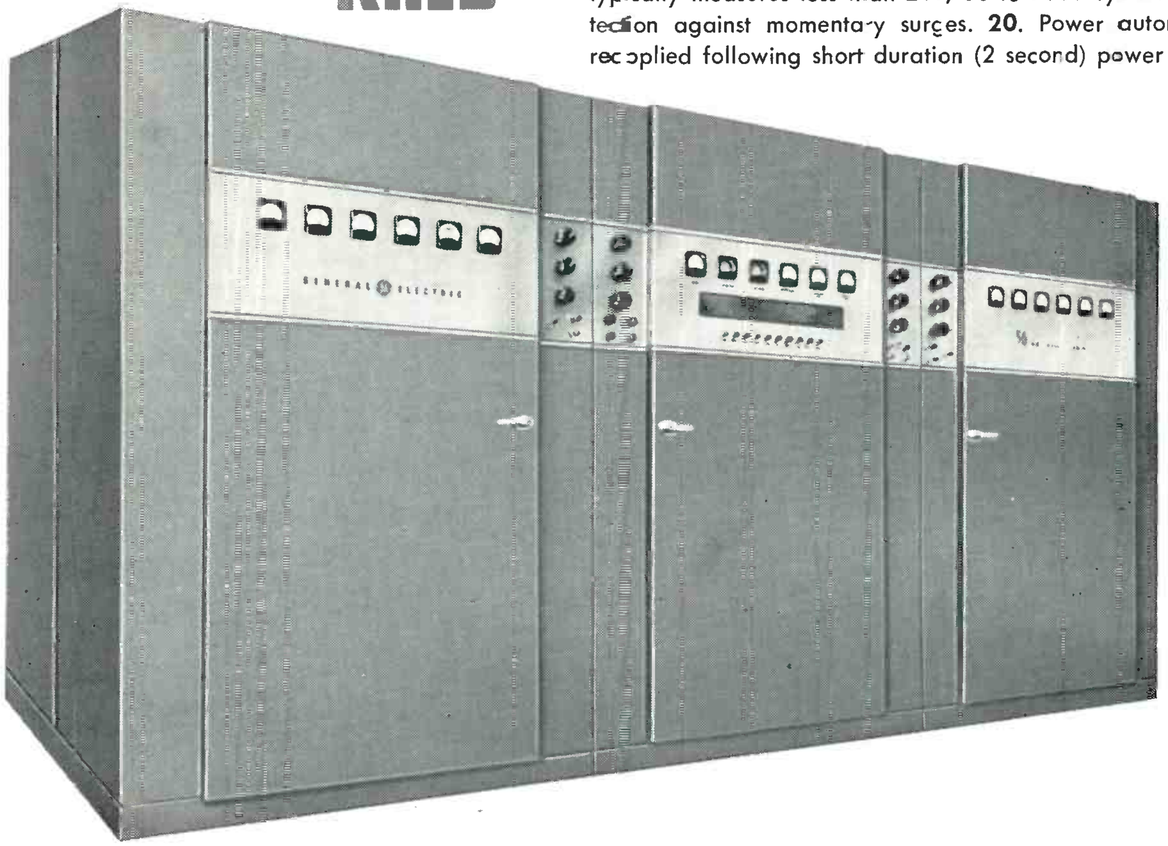
WCBS New York **KRAK** Sacramento
KRLD Dallas

WABC New York **KNX** Los Angeles **WLS** Chicago
KOA Denver **WSM** Nashville **KXL** Portland

LOW INSTALLATION COST—**1.** Small size—13½ ft. x 4½ ft. **2.** Lightweight tubes. **3.** No under floor ducts. **4.** External blower. **5.** Ambient temperature is 0° to 120°F. **6.** Accommodates RF load impedances from 50 to 230 ohms.

LOW OPERATING COST — **7.** Efficient tube complement uses only 16 tubes of 6 types. **8.** Low-cost, long-life tubes. **9.** Low power consumption.

DEPENDABLE OPERATION, LOW MAINTENANCE — **10.** Germanium rectifiers for long life. **11.** No destructive voltage surges caused by arc starvation in mercury vapor tubes. **12.** Extreme simplicity in RF circuits. **13.** Class B audio modulation with Class C RF stage. **14.** Only four Class C amplifier stages produce 53 kw output at terminals. **15.** Easily tuned. Front-mounted meters easily read. No special equipment required. **16.** Final RF and audio tubes only 20 lbs. each. **17.** Full length doors front and back for easy access. **18.** Low distortion — typically measures less than 2%, 50 to 7500 cycles. **19.** Protection against momentary surges. **20.** Power automatically reapplied following short duration (2 second) power outages.



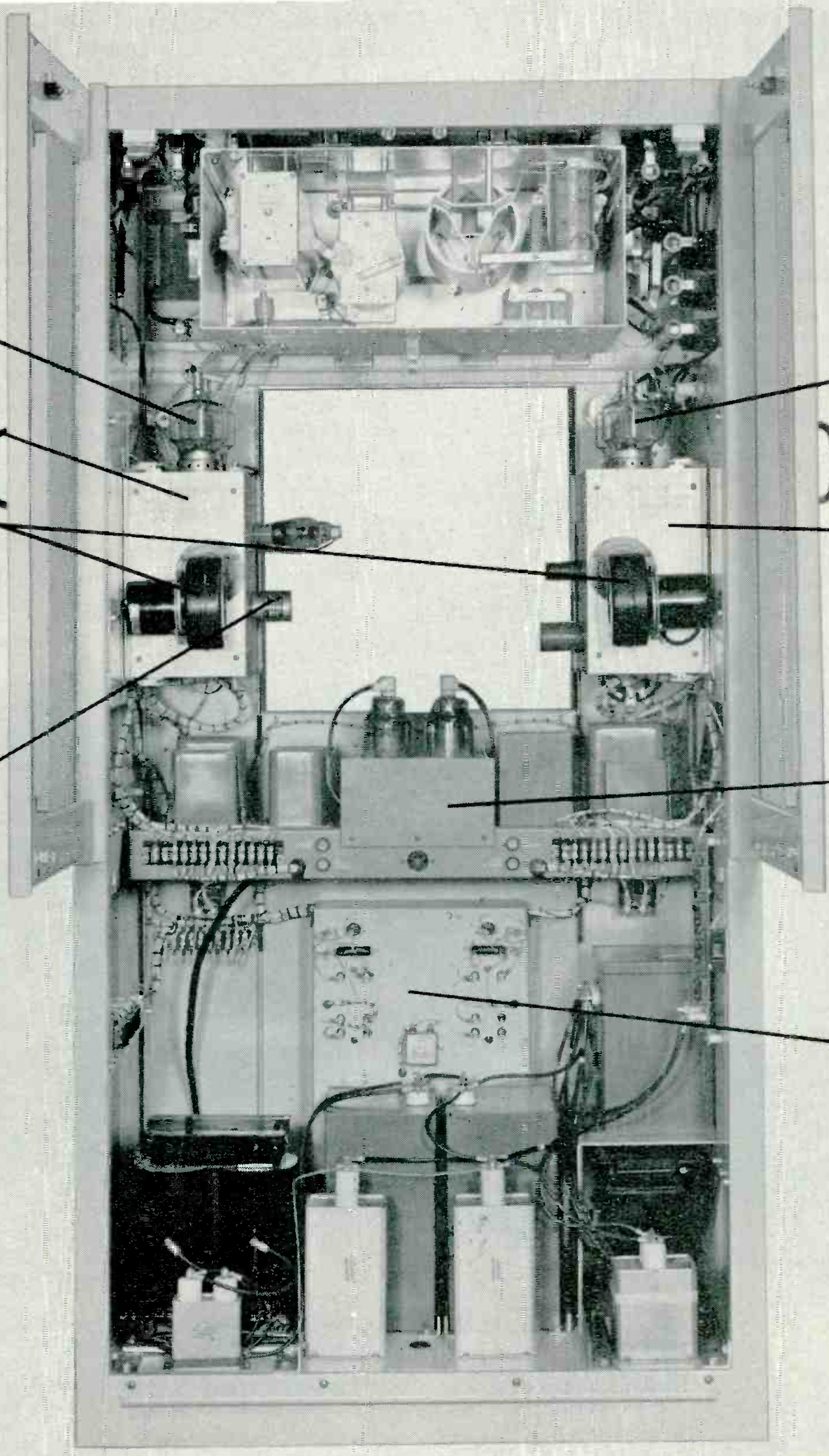
KPOL Los Angeles
CKAC Montreal **CKY** Winnipeg
CFRN Edmonton **XEAK** Tijuana

For complete technical information, write to Broadcast Equipment, Section 4961, General Electric Company, Lynchburg, Virginia. In Canada: Canadian General Electric, 830 Lansdowne Ave., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N. Y. 17, N. Y.

GENERAL ELECTRIC

COLLINS CLOSE-UP

no. **4** *in a series*

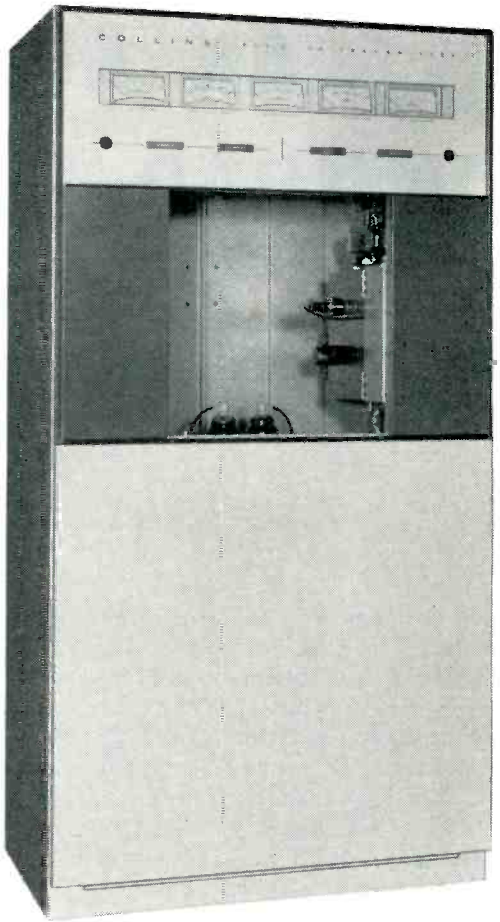


COLLINS 20V-3 1000/500/250-WATT AM TRANSMITTER

HIGH STYLING AND EASY ACCESSIBILITY

THIS NEW COLLINS AM TRANSMITTER MERITS LOOKING INTO . . .

(and looking into the 20V-3 is very easy)



The clean-cut, smooth, simple lines of the new Collins 20V-3 transmitter reflect a refreshing change in transmitter styling. But the boldness of the 20V-3 is right in keeping with its modern circuitry design. Streamlined, brushed aluminum trim adds to the attractive appearance of the cabinet, which is finished in gray, blue-gray and off-white baked enamel.

The RF and audio chassis swing out and the power supply tilts up so that all components are exposed to provide the unparalleled accessibility that enhances operation, maintenance and inspection (and, of course, these are all money-savers).

More about the 20V-3's easy accessibility

All operating controls, mounted behind two front panel doors, feature flexibility and convenience. Pushbutton control of filament and plate power is provided and may be extended to a remote position. Automatic sequencing of the power control circuits is incorporated. The filament voltage control is easily accessible for adjustment while the transmitter is in operation.

Exceptional frequency stability

Frequency stability is better than ±5 cps with typical stability of ±2 cps. This stability is attained by using a highly perfected oscillator design in conjunction with very stable, low temperature coefficient crystals — a concept pioneered by Collins to eliminate the troublesome crystal oven.

Down-time is kept to a minimum

Thermal time delay circuitry in the Collins 20V-3 selects the optimum time interval before the transmitter can be returned to the air after a power line failure. After an instantaneous power interruption, the carrier can be returned to the air immediately, cutting off-the-air time to a minimum.

Another concept pioneered at Collins

The Collins 20V-3 uses four, Type 4-400A tetrodes in the modulator and final amplifier. The use of the 4-400A tetrodes is another concept pioneered by Collins and widely accepted as the best in transmitter design. The entire tube complement reflects conservative operation. Only seven different tube types are used.

Mounted on the RF and audio chassis are quiet, high capacity blowers which force air directly on the tubes. This forced air cooling gives an extra assurance of long tube life.

Take a look at the new Collins 20V-3. It's easy to look at, and it's easy to look into, too. The new 20V-3 was not only designed at Collins but is built at Collins to maintain the Collins reputation for quality.

COLLINS

COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • NEWPORT BEACH, CALIF.

AN AUTOMATIC CONELRAD TEST PROCEDURE

Tape cartridge machine controls and programs complete civil defense message.

By HOMER HAINES, Chief Engineer, WNAE-WRRN (FM), Warren, Pa.

AUTOMATION can remove the problems of sending Conelrad Test Alerts on any AM-FM radio broadcast station using remote control. At WNAE, WRRN (FM) in Warren, Pa., automatic tape control has eliminated the difficulties of timing, tone frequency and scheduling. Any station announcer may send a perfect Test Alert with no assistance.

Prior to installation of the present automatic Conelrad system, it was necessary to dial the FM plate circuit to turn off the FM transmitter and then dial the AM plate circuit to turn off the AM transmitter. Then, after the five-second interval, it was required to repeat the process in reverse to return both transmitters to the air again for the next five-second interval. By the second time around, the announcer becomes sufficiently confused with dial numbers, on and off switches and the second-hand reading of the control room clock, he might be dialing off the filaments instead of the plate circuits and removing one or both transmitters from the air. This could result in an embarrassing off-the-air time of several minutes before the transmitters could be returned to normal operation and there still would have been no Test Alert transmitted.

The services of at least two announcers were required—one to read the Conelrad copy and operate the turntable with a tone record and the other to operate the remote control unit. Tone records, having notoriously narrow bands between cuts, proved to be unreliable with 500 cps or perhaps 5000 cps being transmitted instead of the required 1000 cps.

Transmitting the Alert Test was becoming a major irritant for both the engineering and program departments. It was necessary at WNAE to develop a simple device anyone could operate successfully and which would provide the proper timing as well as the correct frequency tone. The simplest method we could devise was to program the entire Conelrad Alert, including transmitter on and off operation, from tape. Using the "Collins" automatic cartridge type tape recorders, we were able to record on the cue side of the tape, two five-second tones spaced five seconds apart for controlling the FM and AM transmitters, and on the program side of the tape, the Conelrad message and the 1000-cycle tone.

To broadcast a Conelrad Alert today, all that is necessary is to insert the Conelrad tape cartridge in the tape machine and hold the start button in during the entire tape travel. Both transmitters are keyed at the proper time and a true 1000-cycle tone is transmitted.

This automatic Conelrad unit centers around a tape recorder which uses one side of the tape for cueing on and off tape control operations. The switching unit used for transmitter control is designed using a tone decoder unit. A commercial decoder unit, model 9303, was purchased from Motorola Co. for $55.00. Figure 1 gives the schematic diagram of the unit. The only change made in the decoder is the removal of R8-15k ohm resistor from relay K1 and a 1000-ohm resistor is inserted from this contact to the tie point of the black cable wire. As long as a signal is present at the grid of V2B, enough current flows in the cathode to close K1, but with no signal present, the relay drops out. Without this 1000-ohm resistor, enough current flows in the cathode circuit to hold K1 in once it is energized.

This change is an important requirement as relay K1 will hold in until reset and will not release the moment the tone stops. These decoder units come in ranges from 600 cycles to 3200 cycles. The unit used has a frequency of 1950 cycles. This frequency was used because it was far enough removed from the cue

EDITOR'S NOTE: This is a second article on automation of Conelrad Test systems. See Broadcast Engineering, February, 1961, issue for a different approach to this requirement.

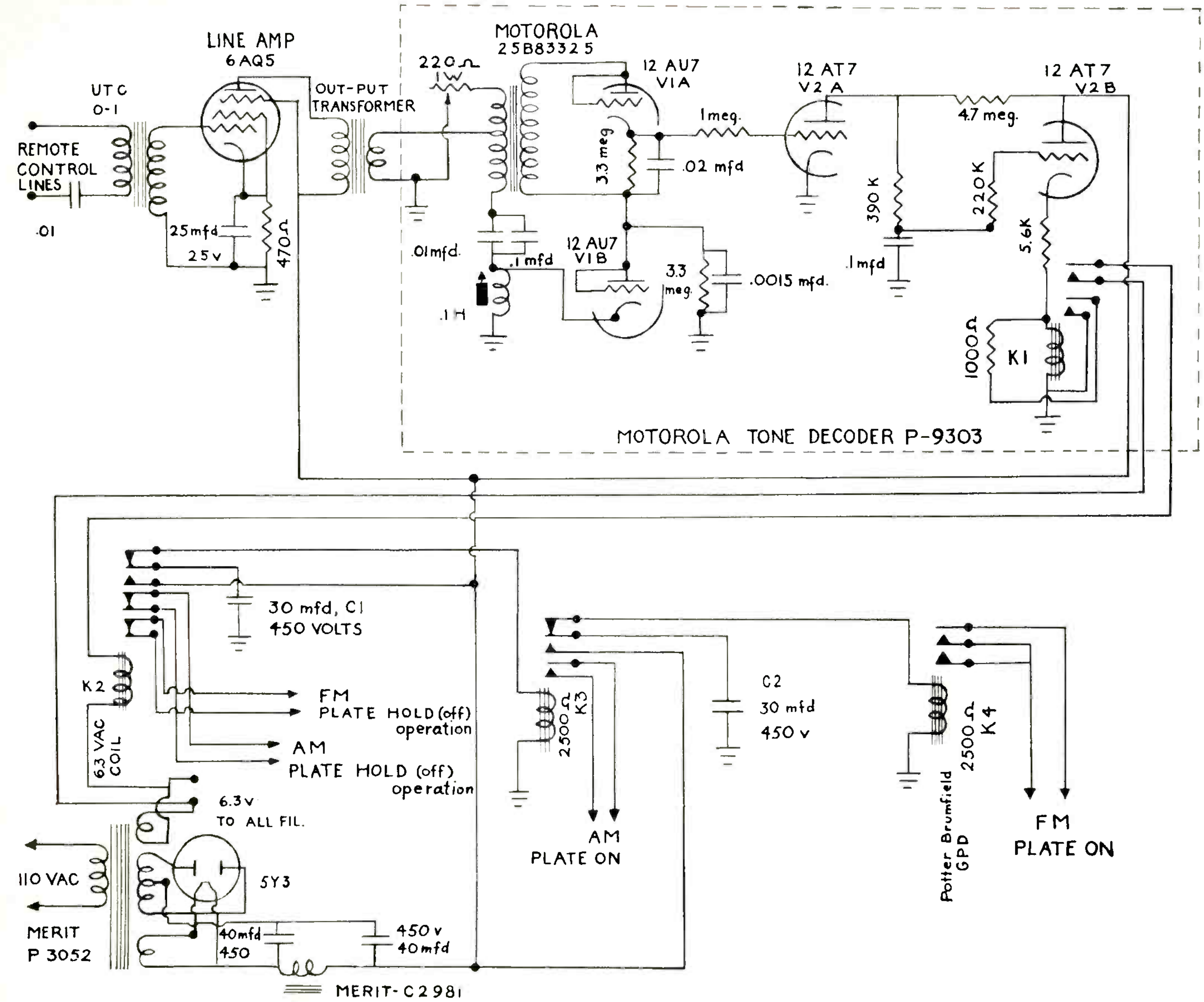
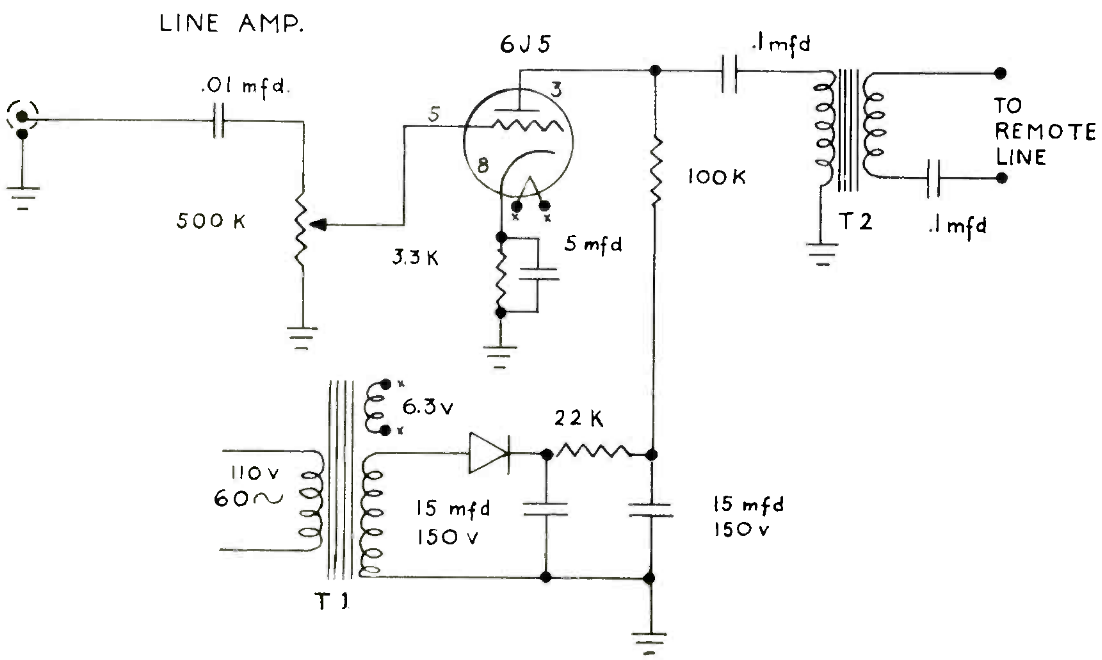


Figure 1

This connects to plate pin No. 1 of V302A cue section of Collins automatic tape model P-190 and P-150 or any machine equipped with cue tone facilities.

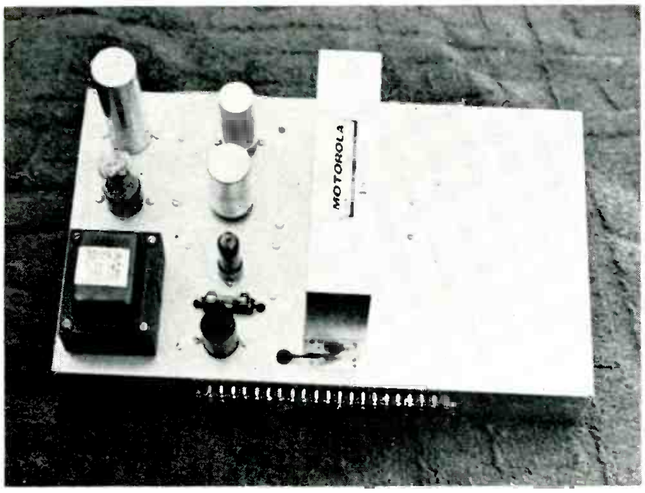


T1—Power transformer 6.3V & 150V

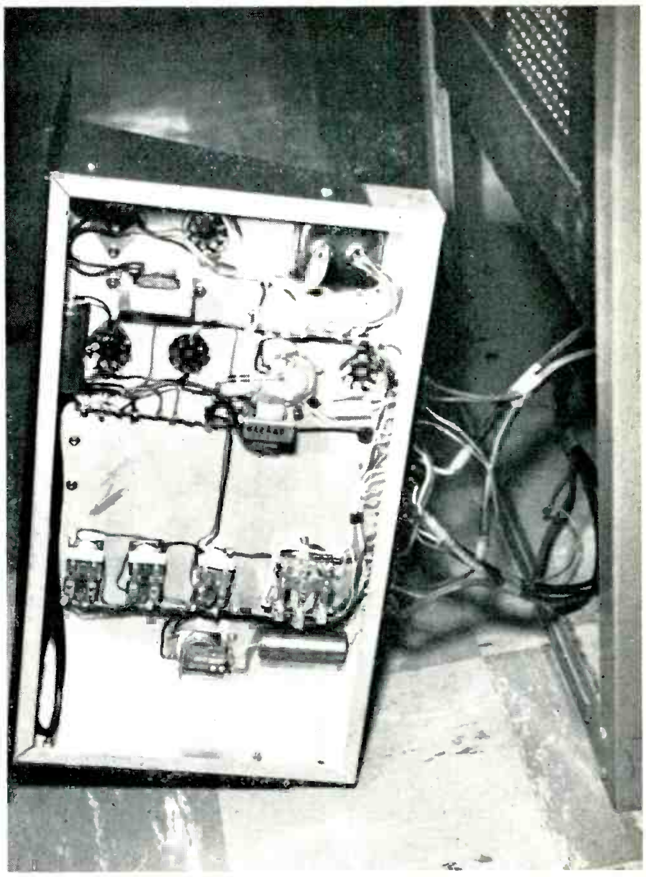
All resistors 1/2 watts

T2—UTC Type 0-9 any type plate to line will do

Figure 2



Photograph shows the top side of the decoder. The Motorola tuned tone detector is mounted in the center.



The under chassis reveals the control relays of the decoder. This unit is rack mounted near the AM-FM transmitters.

frequency not to effect the tripping of the tape cue circuit. It was found that the cue circuit in the "Collins" tape unit was sufficiently broad in response. The normal cueing frequency for the unit is around 900 cycles per second.

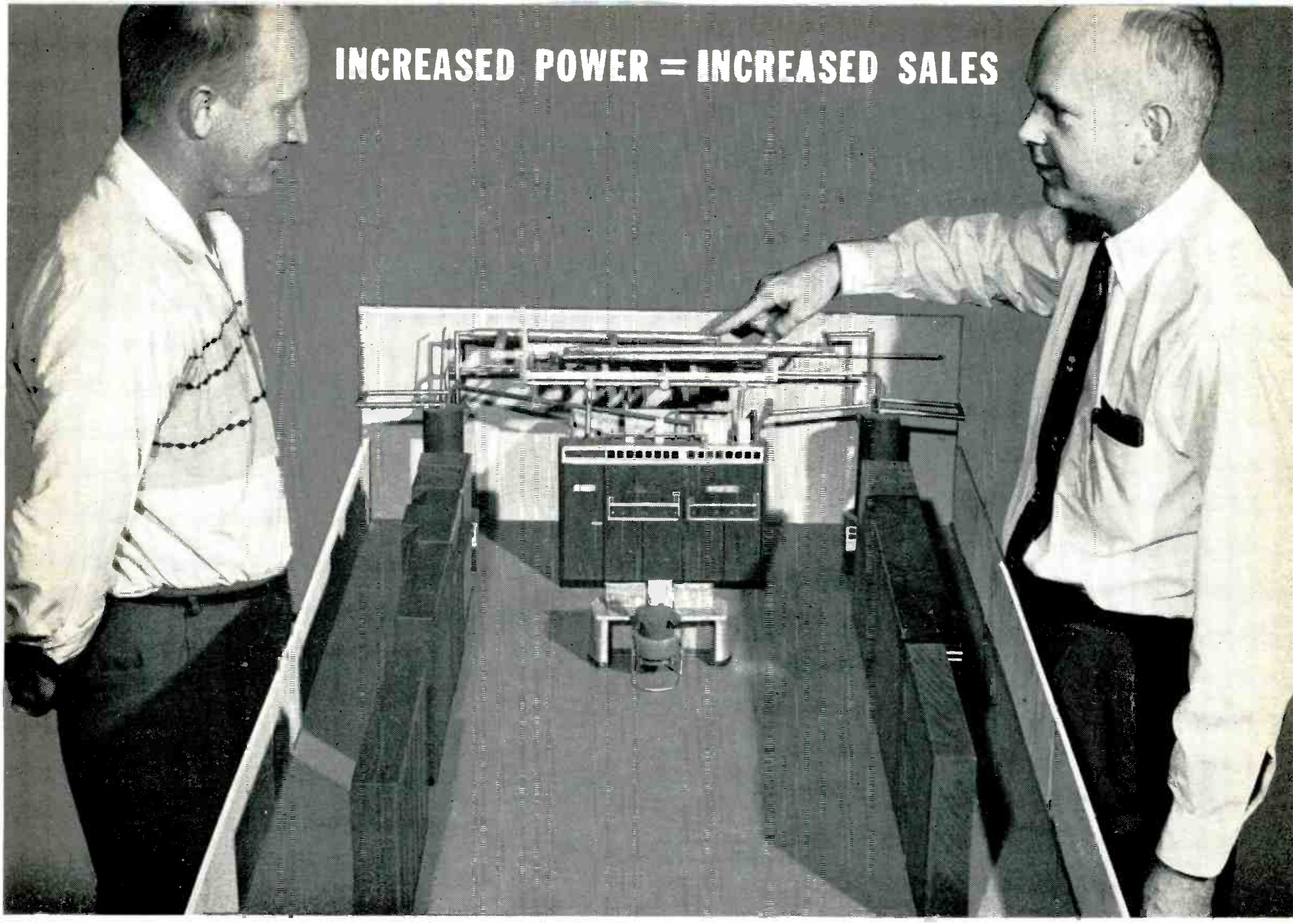
The 1950-cycle tone recorded on the cue side of the tape will stop the tape recorder so it is necessary to hold the start button in for the time the cue tones are being transmitted to the decoder unit. When the Conelrad tape cartridge is inserted at the studio and the start button is held on, the Conelrad message begins. At the end of the message the 1950-cycle tone on the cue side of the tape is fed into one of the remote control lines of the station's remote control system and is received at the transmitter location. This 1950-cycle tone is for five seconds duration followed by five seconds of silence, and again five seconds of 1950-cycle tone. The decoder at the transmitter site is connected across the remote control circuits at all times and is isolated by a by-pass capacitor to prevent any interference with the dc remote control circuits but allowing passage of the 1950-cycle tone to the decoder unit. When the decoder unit receives the 1950- cycle tone, relay K1 closes relay K2, which opens the plate circuit hold relay for both transmitters, AM and FM. The third set of contacts on relay K2 receives a positive charge to capacitor C1. As soon as the tone stops, K1 and K2 return to their normal position and the charge which C1 received is connected to K3 and is enough to close K3 for a fraction of a second and turn the AM transmitter on.

While K3 is turning the AM transmitter on, one side of the relay contacts is building a charge on capacitor C2. This charged voltage is applied to K4 as soon as K3 returns to normal condition. The holding time is determined by the size of C1 and C2 capacitors. When K4 is closed, the FM transmitter is switched on. The slight time delay between the two transmitters prevents any heavy line surge which would blow the main power fuses if the plate circuits of both the 5kw AM and the 1kw FM transmitters were turned on at the same time. This arrangement makes the FM transmitter re-start about a half-second after our AM transmitter. Figure 1 shows the switching unit which is located at the transmitter building. Figure 2 is the schematic of the booster amplifier used between the "Collins" automatic tape control and the telephone remote control lines. The output of this amplifier is connected across the remote lines at all times without any interference to transmitter control.

Recording the 1950-cycle tone on the cue side of the tape was accomplished by feeding an audio oscillator directly into the cue head of the recorder.

The band width of the decoder unit is narrow in frequency response. Therefore, a frequency difference of only 75 cycles from the decoder frequency will not operate the decoder. The cues from the normal operation of the tape cartridge machine will not trip the transmitter, nor will impulse voltage from the dialing circuits affect the decoder.

It is felt this system could be associated with any type of automatic tape machine. This unit has been in operation for many months and is felt to be well worth the $150 spent for its construction.



KPHO-TV and KPHO radio director of engineering, George McClanathan (right), points to a section of the "model" used to construct KPHO-TV's new transmitter building as Engineering Supervisor, Glenn Thompson, looks on

RCA High-Power Transmitter-Antenna Combination— Extends Coverage—Improves Picture Quality

...says George McClanathan, Director of Engineering, KPHO-TV

"We've completely modernized our transmitter plant and stepped up KPHO-TV's sales power with a new high-power RCA transmitter. The improved facilities started paying for themselves at once—by increasing sales. And even though operating at maximum power, we are obtaining very low operating costs, because of the way we did it."

The new power amplifier is capable of 25,000 watts output. However, the new RCA six-bay superturnstile antenna needs less than 20,000 watts of this power to get full 100 kilowatts of ERP. This puts a very light load on the transmitter, which results in low operating costs, long life, and very reliable performance.

All reports on extended coverage show that KPHO-TV's signal is extremely good. KPHO-TV's programs originating in Phoenix, Arizona, are now being enjoyed as far west as Blythe, California; as far north as Page, Arizona; as far south as Nogales, Arizona; and as far east as Silver City, New Mexico. And 90 per cent or more of the reports show far superior picture quality.

Learn how an RCA modernization program can increase your station's sales while providing reduced maintenance and increased reliability. Your RCA Broadcast Representative will be glad to give you additional information about new transmitters and antennas that can bring your station up to date. There's a complete RCA line to choose from. Get the facts before you buy. RCA Broadcast and Television Equipment, Dept. W-367, Building 15-5, Camden, N. J.

Television station modernization starts at the Transmitter Plant

The Most Trusted Name in Television

RADIO CORPORATION OF AMERICA

A SIMPLE APPROACH TO THE PARAMETRIC AMPLIFIER

The history, fundamental principles, gain relationships, and system considerations are presented.

By JOHN L. DuBOIS
Electrical Engineering Dept.
Northwestern University,
Evanston, Ill.

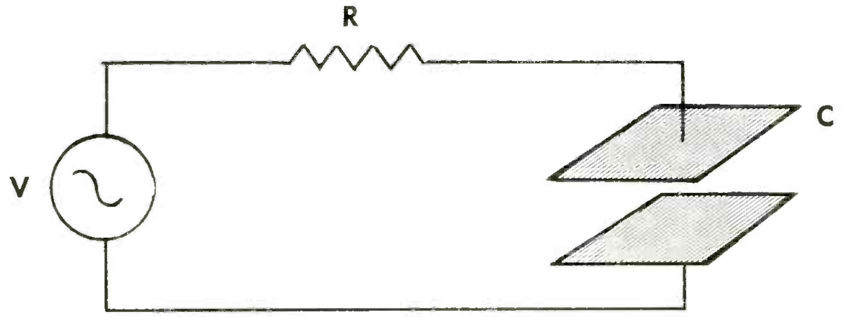
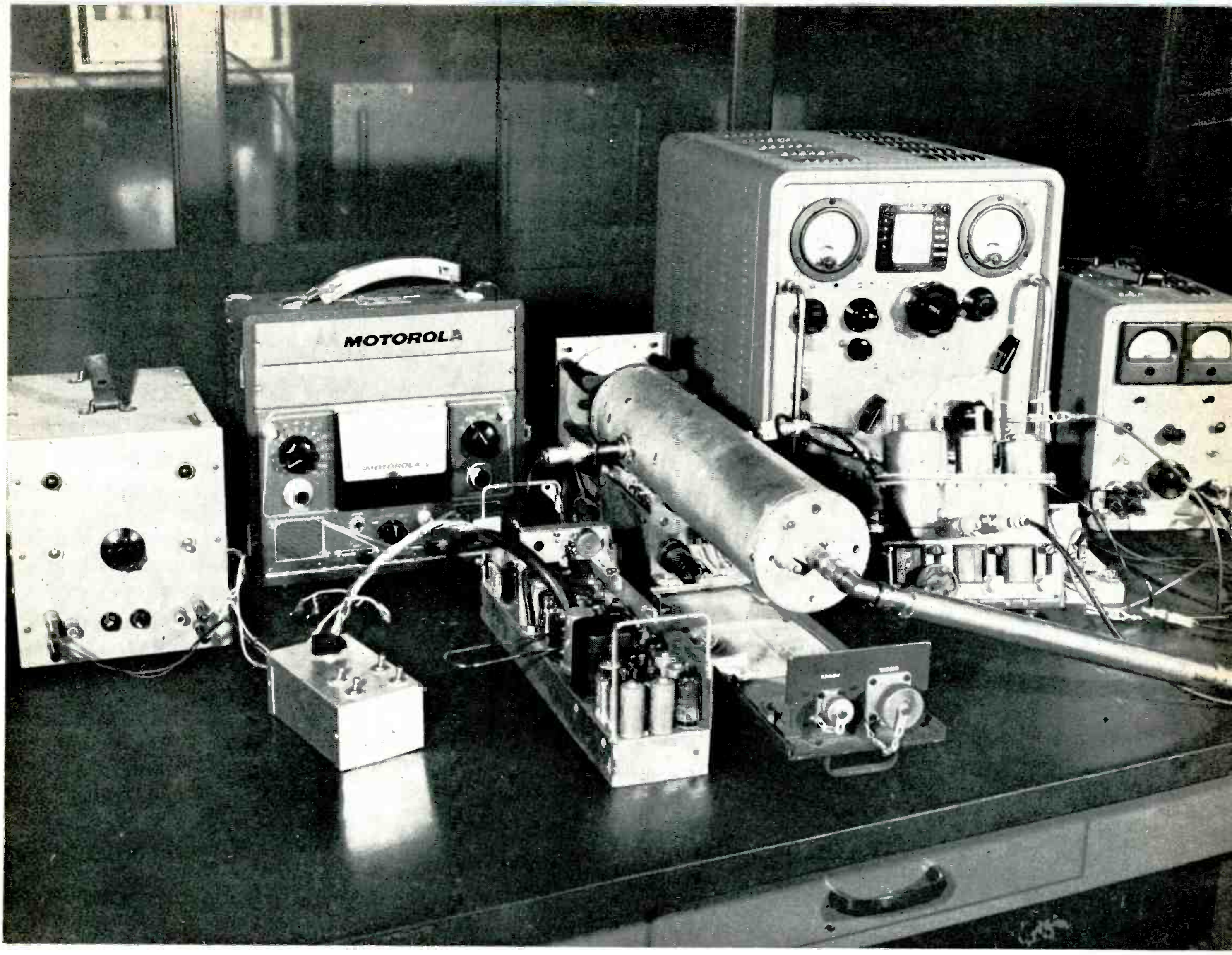


Figure 1

RADIO frequency energy has been used for decades to convey intelligence over large distances. These distances and the amount of intelligence conveyed are increasing at an amazing rate. Man-made signals have been received from a satellite several million miles away from the earth and interstellar RF energy (noise) is received by large radio telescopes from sources many light-years into space.

Reception and interpretation of energy originating at such great distances as well as energy propagated under adverse conditions for shorter distances is limited primarily by the fact that power losses operate to decrease this energy to lower and lower levels. For a given transmitted power, the maximum distance at which radio-frequency energy may be received and converted to intelligence depends on its relationship to noise — random and uncorrelated sources of energy present at the receiver.

At frequencies below 100 Mc, a great deal of noise is produced by atmospheric phenomena such as lightning and precipitation static. The noise, which is external to any receiving apparatus, can be considerable and even interfere with transmissions originated at very high power levels. Above 100 Mc, on the other hand, noise of this sort does not exist and the RF noise levels drop sharply to a lower limit dictated by Johnson, or thermal noise. This noise originates in the random, thermal motion of atoms everywhere in the universe. For a given RF bandwidth, this energy, or noise power is given by:



Experimental parametric amplifier using varactor diode built by author for 150 mc communications service. Amplifier is in the tubular cavity in center of the photograph.

Where:
$P_n = KT_nb$
P_n = noise power
K = Boltzman's constant
T_n = temperature of noise source in °K
B = bandwidth over which noise is measured

The noise temperature of the source then is seen to be a deciding factor in establishing whether or not a desired signal will be above the surrounding background noise when it reaches the receiver. Since in most high frequency radio systems using essentially a uni-directional antenna a line drawn outward from the axis of the antenna would extend into space, the antenna is "looking" into outer space and a corresponding noise temperature of only a few degrees Kelvin.

Once a signal has arrived at the receiving antenna above the background noise, however, it is not possible to amplify and use it without adding at least some undesirable noise in the process. Since the voltage developed across the antenna terminals is on the order of less than $1 \text{ x } 10^{-8}$ volts for a weak signal, it must be amplified before it can be of use in the receiver.

Amplification of these small currents adds noise to the signal, noise that is produced in the resistances through which they pass in the amplifier. This source of noise, as one would expect, is quite similar to external "background" noise as it is produced by thermal motion of electrons in the resistances. The mean squared value of this noise voltage is given by:

$$\frac{2}{e} = 4KTBR$$

Where:
K = Boltzman's constant
T = temperature of noise source in degrees Kelvin
B = bandwidth over which noise is measured
R = noise resistance

For a given B, to reduce this source of noise, we must reduce either the noise resistance or the noise temperature of the amplifier. In practice, once the signal voltages are raised to a level considerably higher than that of the thermal noise, it is unnecessary to have a low noise amplifier because it is then a simple matter to separate noise and signal. So we see at this point that recovery and use of low levels of RF energy occurring at a receiver is primarily a problem of first separating it from the external background noise, and then adding as little noise as possible to it in the first stages of amplification.

The latter factor, amplifier noise, is at the present state of the art a much larger factor than background noise, as the noise developed in practical amplifiers is still greater in most cases than the background noise present at the input to the amplifier. To evaluate the noise produced in an amplifier, a figure of merit, noise figure or noise factor is used. Noise figure is defined by:

$$F = \frac{\frac{Si}{Ni}}{\frac{So}{No}}$$

Where:

$\frac{Si}{Ni}$ = signal to noise power ratio available at input to device.

$\frac{So}{No}$ = signal power to noise power ratio available at output of device.

Ideally, a device would add no noise to an incoming signal and F would be one, but unfortunately this is not the case with practical amplifiers. Several types have been developed, however, which are extremely good in this respect, possessing very low noise figures. One of these types is the parametric amplifier.

The principles on which the parametric amplifier is based were observed as early as 1831 by Faraday, and later more complete mathematical foundation was provided by Lord Rayleigh in 1887. In one experiment typical of this class of phenomena, Lord Rayleigh observed a string maintained in motion by attaching it to an end of one prong of a large vibrating tuning fork would assume transverse oscillations whose period was double that of the fork. A more commonly observed example of parametric amplification and even an analog of electronic amplifiers of this class is that of a child swinging in an ordinary suspended swing. He raises his body and center of gravity at the high point of his swing. Then he lowers it at the lowest point, adding potential energy at this highest point, to increase the amplitude of the swing. He is "pumping" at twice the frequency of the swing oscillation.

Similarly, the electrical parametric amplifier in its simplest form may be illustrated in Fig. 1. Consider a series circuit consisting of an ac generator, a large two-plate capacitor and a resistive load. If at a time when the voltage across the capacitor is at or near a maximum, the capacitor plates are mechanically pulled apart, work will be done against the electrostatic forces tending to pull the plates together. This energy will reappear as additional power dissipated in the resistance R. If then at a time when the voltage across the capacitor is at or very close to zero, the plates are mechanically returned to their original position, the energy in the circuit does not change since the charge on the capacitor is zero and no forces are present. Thus, by varying the capacitance in series with the load, at a rate roughly twice that of the alternating current, amplification is achieved; the additional energy being supplied by some mechanical device which is varying the capacitor plate spacing.

It can be seen at this point that there are other electrical parameters such as inductance which could be varied to achieve the same result. Such amplifiers have actually been constructed, but the most successful parametric amplifiers to date have used a variable capacitance.

Since these amplifiers commonly operate above 100 Mc, the capacitance involved must vary at frequencies of this order and higher. Obviously mechanical devices are not suitable for operation at this high a rate and some kind of electronically variable capacitance must be used. Specially manufactured semiconductor diodes provide the necessary characteristics for this purpose. A semiconductor diode with a voltage applied across it of such polarity that conduction does not occur exhibits a small resistance in series with a voltage-variable capacitance. This capacitance varies approximately inversely with the cube root of the applied reverse voltage (Fig. 2). If an ac voltage is applied across the diode then this capacitance will vary about a mean value determined by any fixed reverse bias applied to the diode.

Although the principles of parametric amplification are essentially as described, in practice there are two basic types to be considered: the up-converter and the down-converter. The more common type of parametric amplifier, the negative resistance amplifier, is a special type of down-converter. A generalized circuit for the parametric amplifier would appear as seen in Fig. 3.

The signal voltage is sinusoidial at frequency fs. The pump frequency fp is an integral multiple of fs. Due to the nonlinear reactance of the variable capacitor, beat products between fs and fp appear at fo = fp ± fs. It is to this sum fp + fs or difference fp-fs frequency that the resonant load circuit must be tuned. In the case of fp + fs the device becomes an up-converter, for fp-fs it is termed a down-converter. Hence, the useful output of the amplifier will appear at fp ± fs, or in the case of the regenerative amplifier, at fs. In the case of the up or down-converter it can be shown that the power amplification is given by:

$$\text{amplification} = \frac{fo}{fs}$$

For the up-converter, we see the useful output occurs at fp + fs and the amplification becomes greater as the ratio of fo to fs is increased. In the case of the down-converter where the useful signal is taken out at fp-fs, however, the gain is still $\frac{fo}{fs}$ but this is less than one or an attenuation. Neither of these devices amplifies a signal at its own frequency; still there are a number of applications where gain and frequency conversion are simultaneously desirable, such as superheterodyne receivers. A slight modification of the down-converter makes it possible to amplify an incoming signal

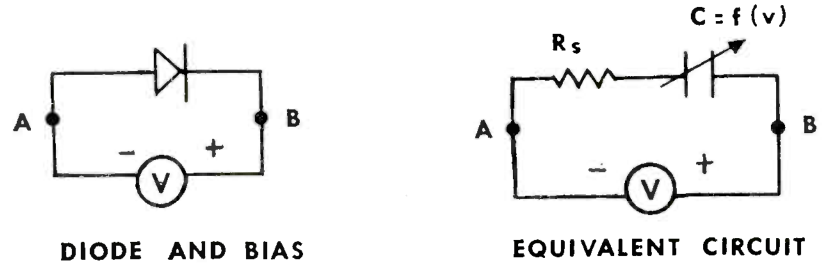


Figure 2

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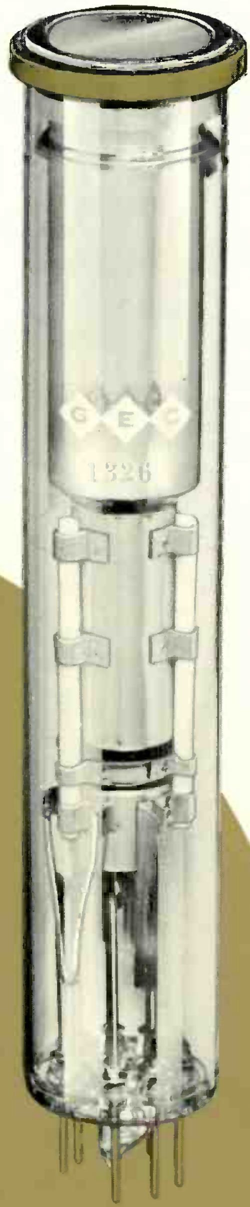

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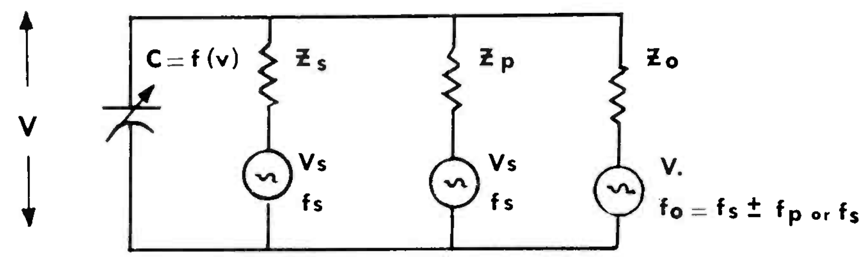


Zs, Zp, and Zo are Ø at fs, fp, and f. respectively and very large for all other f.

Figure 3

and take it out at the same frequency. This is the regenerative, or negative conductance parametric amplifier.

In this down converter configuration, the difference frequency appears and must be terminated in a passive load for proper operation of the amplifier. This passive load and the difference frequency tank is called the idler circuit. The idler or difference frequency is denoted by fi. The power relationships which demonstrate the use of the down-converter as a regenerative amplifier are shown by:

$$\frac{Pp}{fp} = -\frac{Pi}{fi} = -\frac{Ps}{fs}$$

where Pp is the power flowing out of the pump, Ps is the power flow through the signal circuit, and Pi is the power flow through the idler circuit.

The negative signs indicate that power may be taken from both the idler and the signal frequency circuits. This net outward power flow is equivalent to a negative conductance existing across the terminals of the amplifier at the signal frequency. The signal is coupled into and out of the resonant circuit that is tuned to the signal frequency. The negative conductance cancels the losses that would otherwise occur in the resonant circuits and the signal is amplified. The operation of this form of the amplifier may be described qualitatively by the same mechanism as mentioned before. The pump oscillator reduced the capacity of the diode near the maximum value of signal voltage and energy is added to the circuit. The capacity is increased again near the zero value of signal voltage and the energy in the circuit is not changed. The resulting amplification is illustrated in Fig. 4.

The power gain of the regenerative amplifer is given by:

$$A = \frac{fi}{fs}$$

Where:
fi = idler frequency
fs = signal frequency

This equation shows that as the ratio of idler to signal frequency is increased, the power gain is raised. Therefore for high gain, it is desirable to place the idler at as high a frequency as possible and since fp = fi + fs the pump must also be quite high in frequency. Typical power gains for this type of amplifier are on the order of 10 to 15 db. The primary reason for a high pump frequency, however, lies in the noise figure of the amplifier.

It can be shown that the noise figure of the regenerative amplifier is given by:

$$F = 1 + \frac{Ra}{Ri} \quad \frac{Ra}{R} \quad \frac{fs}{fi}$$

Where:
Ra = generator impedance
Ri = losses in signal circuit
R = negative resistance appearing across signal circuit

We can see from this equation that lower noise figures will result as the ratio $\frac{fs}{fi}$ becomes smaller. To achieve a good noise figure in practice, this ratio is placed at approximately 0.1 with the pump frequency correspondingly higher than the idler. For signal frequencies between 100 and 500 Mc noise figures on the order of 1 db are possible. By comparison, similar vacuum tube amplifiers would exhibit noise figures about 5 db greater. Although a more complicated non-vacuum tube amplifier, the MASER, is capable of surpassing the noise figure of parametric amplifiers, their greatly increased complexity has led researchers to concentrate a good deal of effort on improving the simpler parametric amplifier which has already contributed much to low-level microwave techniques.

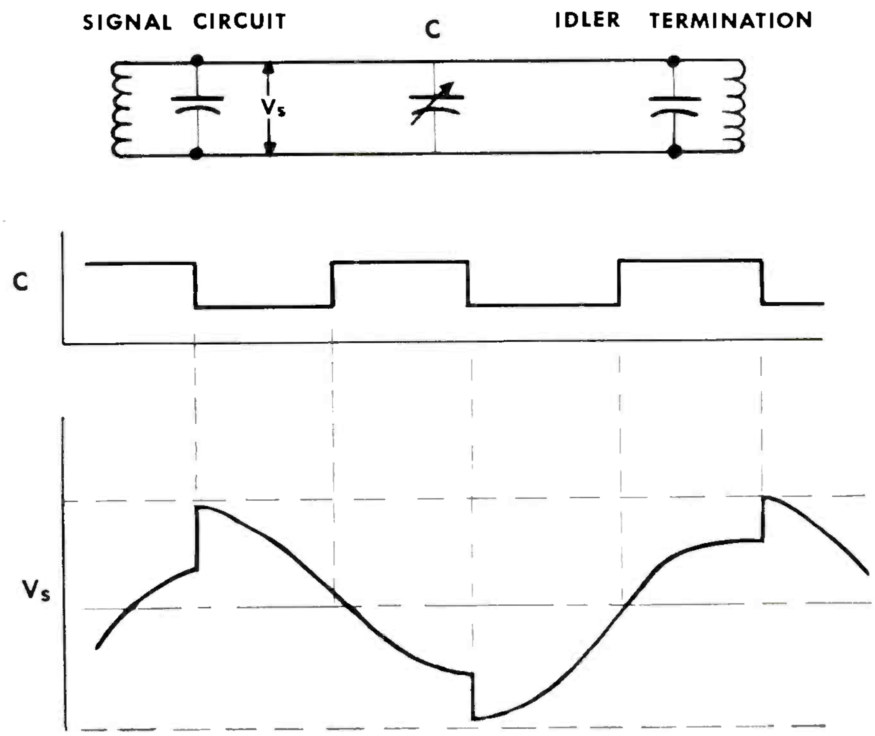
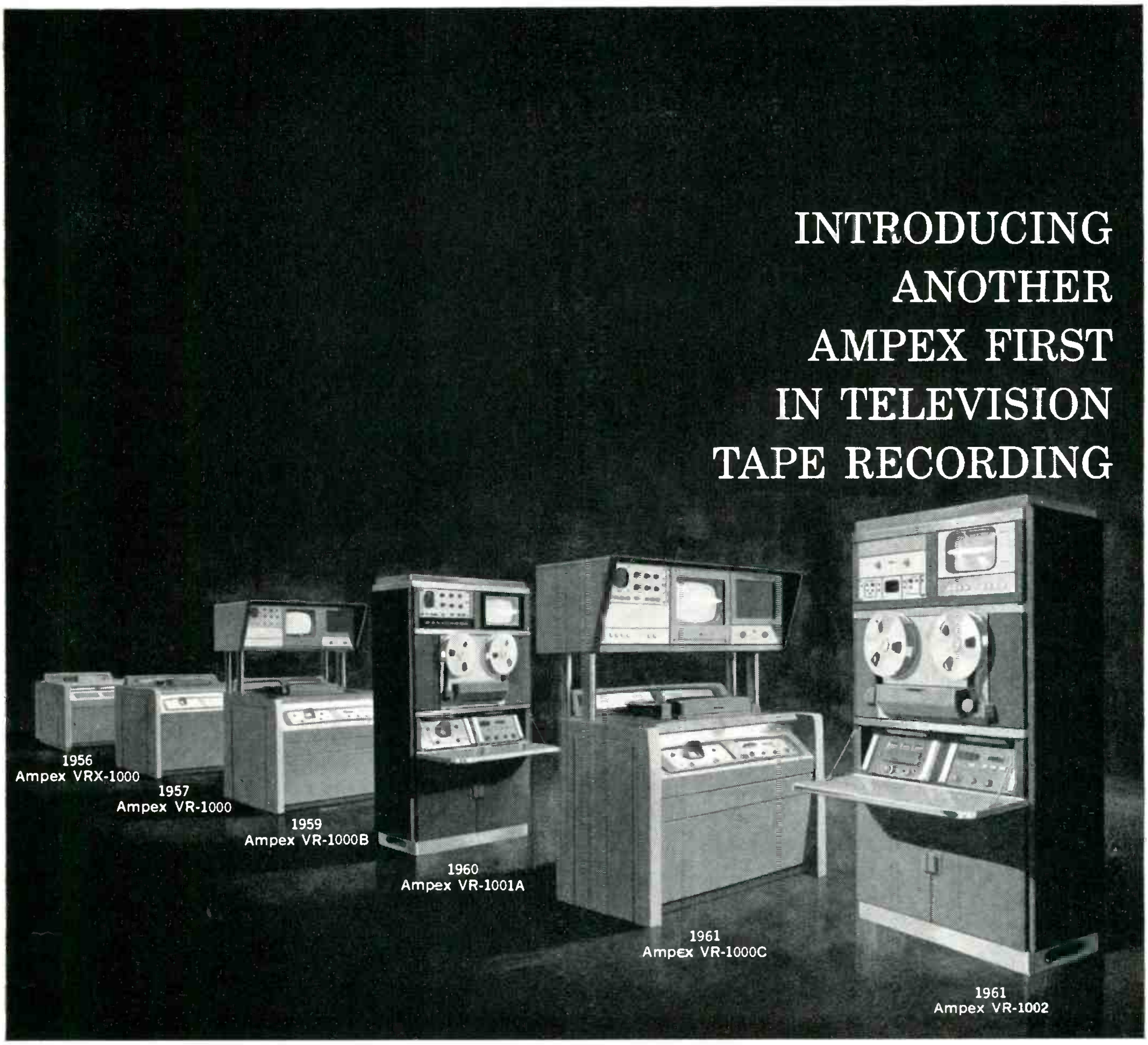


Figure 4



The new Ampex VR-1002 upright model represents the latest and most practical advance in **Videotape*** Recording, taking its place beside the VR-1000C console. It gives today's broadcasters the quality features they want most . . . in a new compact design that stresses simplified operation with major innovations and refinements in controls and circuitry. The objective of an exhaustive Ampex study of broadcast practices, the exclusive new VR-1002 offers owners unprecedented initial and operating cost savings, at the same time advances the standard of VTR performance.

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International Videotape System Standards

A discussion of the problems and methods of converting a television signal from one standard to another.

By J. R. POPKIN-CLURMAN*

THE AMAZING growth in the use of video tape as a powerful tool in the broadcasting of television has resulted in the use of over 700 video tape recorders after their practical birth of only four years ago. Naturally, the great operating economies and convenience of video tape over other more conventional means of recording television information, such as by kinescope film recording, have spurred the use of Ampex and RCA video tape recorders overseas. This is true not only in 525 line standards countries, but also in those world countries which use the 405, 625 and 819 line standards.

Ampex has developed their Interswitch in which, by the addition of suitable black boxes, 405, 525, 625 lines (and later 819 lines) may be video-tape recorded by throwing a series of switches to change the operation of the video tape recorder. 405 lines are used in Great Britain and Hong Kong. The video band width is 3 MC, the picture rate is 25 pictures/sec. The conversion of an Ampex video tape recorder to British operation is very easy and, because the band width is actually narrower than the American system, the conversion produces very good pictures on 405 line standards. The 625 line CCIR standards are used in most European countries and Australia. The video band width is 5 MC. It also is a 50 cycle system. This band width is a little more difficult to accomplish with present video tape recorders. However, with 4½-inch I. O. and super iconoscope cameras as sources of video, quite acceptable pictures are produced. The 625 line O. I. R. standards are used in all iron-curtain countries and Red China. The bandwidth is over 6 MC. It is more difficult to get good video tape pictures than with the 625 CCIR standards.

Nevertheless, it appears that a good grey scale and contrast ratio are obtained quite readily. The subjective results are still very good, even though the resolution is impaired. The 819 line system which is used in France, Luxembourg, Monaco and Algeria has 11 MC band width. In practice, however, this 11 MC band width is not actually used in French mass produced TV receivers, these receivers seldom exceed 7 MC in band width. It is therefore possible to use VTR on the 819 line system with somewhat reduced resolution. 819 lines are also used in Belgium, but there the video is also limited to about 7 MC and the VTR pictures have the same quality as is obtained in France.

With so many tape recorders operating overseas, there have been increasing requirements for the use of video tape recordings as a medium of program exchange, especially between different international standards. Let us consider possible conversion systems for 50 cycle systems. For example, when going from 625 to 405 lines or 819 to 625 lines, it is quite apparent that going from a higher resolution to a lower resolution system will generally still result in quite acceptable pictures. Even proceeding from 405 lines to 625 lines or to 819 lines, no special problem is presented, except that the translated picture is not as good, because the original TV system was not as good. There are additional special problems to be considered when an interchange is tried between a 50 cycle TV system and a 60 cycle system, such as from 625 lines to 525 lines. It is not possible to go from one standard to another without some kind of storage to take into account the time differences of the various TV systems and a longer storage time is required for 50-60 cycle conversion. Of course, there is no problem when a tape on one standard is played into a film kine recorder, then re-recorded off the

TABLE I

Characteristics of Television Systems

System	I	II	III	IV	V	VI	VII	VIII
Name of System	British	United States		Gerber	U.S.S.R.	French	Belgian 625	Belgian 819
Number of Lines	405	525	625	625	625	819	625	819
Video Bandwidth Mc	3	4	4	5	6	10.4	5	5
Channel Width Mc	5	6	6	7	8	14	7	7
Sound Carrier Relative to Picture Carrier Mc	-3.5	+4.5	+4.5	+5.5	+6.5	±11.15	+5.5	+5.5
Line Frequency cps	10,125	15,750	15,625	15,625	15,625	20,475	15,625	20,475
Field Frequency cps	50	60	50	50	50	50	50	50
Picture Frequency cps	25	30	25	25	25	25	25	25
Picture Modulation	AM	AM	AM	AM	AM	AM	AM	AM
Sense of Picture Modulation	+	-	-	-	-	+	+	+
Sound Modulation	AM	FM ±25 kc	FM ±25 kc	FM ±50 kc	FM ±50 kc	AM	AM	AM

*President, Telechrome Mfg. Corp., Amityville, N. Y.

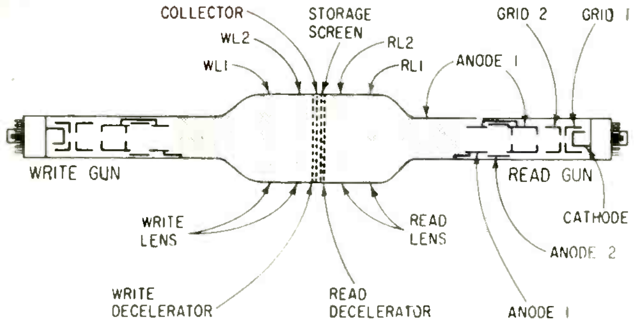


Figure 1. Raytheon two-gun storage tube or scan converter type QK 787. Highest direct potential is 3500 volts.

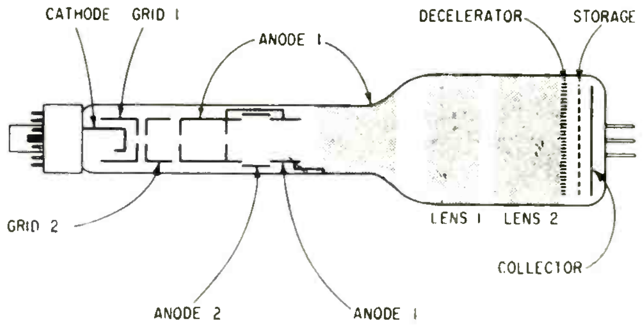


Figure 2. Single-gun recording storage tube is $14\frac{1}{2}$ inches long. Type shown is Raytheon QK 685.

film through a video film chain on to a new tape at a different standard.

Naturally, this method is quite costly, since the film is used only as the storage medium. The main reason for VTR's justification was its ability to usually eliminate a film intermediate. Of course, a new cheaper method might be found by using thermo plastic film recording instead of conventional emulsion film. The most practical method today is the electrical-optical-electrical standards converter.

The first standards converters were developed by Television Diffusion Francaise around 1947. These standards converters were built by Companie Francaise Thompson Houston and La Radio Industrie. The main purpose of the standard converters at that time was to convert from 819 lines, which had been newly adopted, to 441 lines, using the electrical-optical-electrical system with a special phosphor kinescope running on 819 lines and the super iconoscope camera pick-up tube running on 441 lines. The purpose of this converter was to take care of programs for the 441 line prewar television receivers (about 5000 in all) that were in operation in the Paris region. In 1953 the Dutch Philips Company built a standards converter to change the British 405 line picture to 625 lines in order to be able to broadcast the British coronation ceremonies to the Dutch people. Since 1953 a United Europe TV broadcasting system known as Eurovision has been operating. For this system, the Bundespost in Germany started in 1954 to use Riesel—iconoscopes and picture tubes for converting the French 819 line system to 625 lines and also for converting 405 lines to 625 lines. Some excellent work in Standards conversion have been done by CBS with their Chromacoder system which used a field sequential one gun color camera.

The output of the single gun color camera was fed to three kinescopes (one for each color) and then three EMI cathode potential stabilized

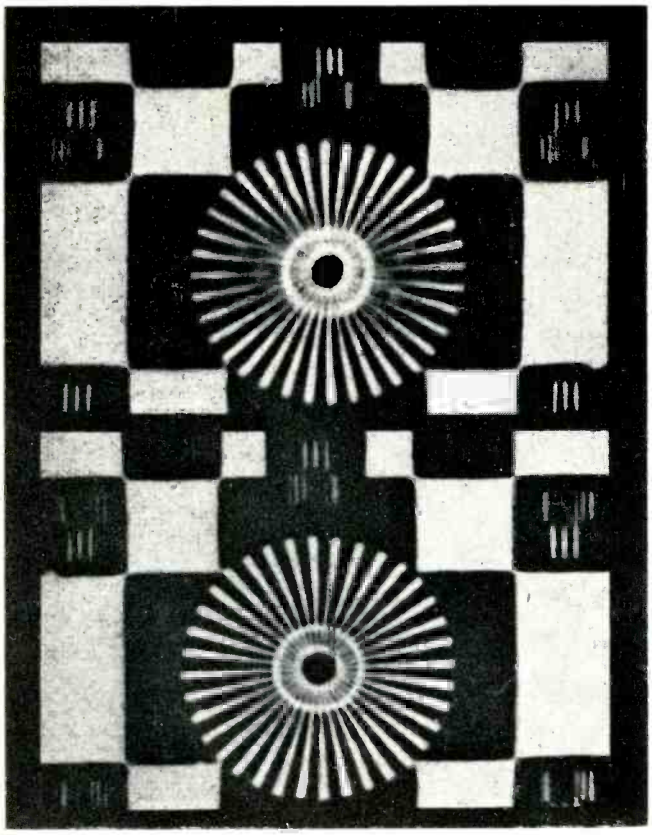
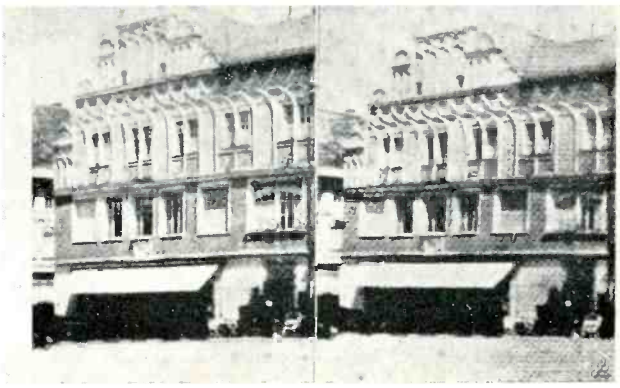


Figure 3. Loss of definition in the vertical direction in a converted 625 line picture. Above is a spot wobbled 819 line picture, below is the picture without spot-wobble.

Figure 4. Comparison of contrast in received 819 line picture at left and outgoing line picture at right.



(CPS) Emitrons were used as camera pick-ups. These converted the field sequential color to NTSC simultaneous color standards. However, in the original CBS Chromacoder, the sequential color camera used a 60 cycle/sec. system, instead of the 48 cycle system advocated by CBS for their own field sequential system. In the light of present day work, it is also now possible to go directly from 48 cycle CBS field sequential standards to the NTSC 60 cycle simultaneous system (with some lag). In 1956, Fernseh GmbH. in Darmstadt, Germany, developed a new standards converter, using a vidicon. Its kinescope was equipped with a special Willemite phosphor screen, having very high brightness and enabling the lag normally present in a vidicon to be satisfactorily overcome. Also, in order to avoid the effects caused by the presence of line structure with its possible beat patterns, the use of spot wobble was incorporated in the equipment. This equipment has been ordered by CBS. It is capable of working on 405, 525 or 625 lines. Thus, it is possible to standards convert a tape by feeding its video output into the very bright kinescope running on the first standard TV system and then photographing it with the vidicon running on the second standard TV system. Re-recording may be then done on new videotape or it may be used for program work directly. Some new work by General Precision Laboratories for the U. S. Navy using new high resolution kinescopes and vidicons makes it possible not to lose as much resolution in standards conversion as had heretofore been expected. The BBC is using a 4½-inch close spaced image orthicon supplied by EMI.

Granada Television, one of the ITA Network affiliates in England, is using a CPS Emitron in conjunction with a new high brightness kinescope recorder. Up to now, standards conversion of videotapes for use in the United States have been mostly done in Europe. With the new CBS equipment, it is quite possible that standards conversion will be done in the United States as well. In connection with standards conversion, it is interesting to note that the BBC Image Converter even converts 50-cycle programs coming from the Continent on Eurovision to a *new* 50-cycle program standard for England. This is because the BBC and the ITA run all British programs locked to the 50 cycle lines. Since the continental 50 cycles can considerably differ from the 50-cycle power used in England, it is necessary to image convert, even though the program could have been supplied at 405 lines for the British. The BBC and ITA programs that are supplied to northern Ireland are not locked to Irish power, so it is necessary to supply the power plant at Belfast with a poorly filtered television set. By watching that television set, the power generators are adjusted until the generator engineer gets a good picture on his television set.

There are very many problems associated with the optical scan conversions which use a kinescope and optical TV camera. Some of these problems concern optical focus, losses in the lenses, reflections due to light diffraction, loss in resolution from scattering through the face plate of the kinescope, scattering in the phosphor, scattering in the optical system at the vidicon or image orthicon pickup area. In addition, there are the geometric distortions added by the nonplanar surfaces, etc. There is also the grain size of the kinescope phosphor, the variation in resolution as a function of brightness of the kinescope, the noise in the black areas of the kinescope, the shading and flatness of field in the pick up tubes, the landing errors in the pick up camera tubes, the necessity for changing the transfer characteristics to compensate for highlight compression in the phosphor.

All these things mitigate in favor of some other than an electrical-optical system for scan conversion. In this connection, there have been a number of interesting all-electronic storage devices proposed. Tubes which are being tried presently as TV image scan converters were originally designed for radar applications. However, they show some promise with respect to their scan conversion use in television. Typical of these are the double ended Intec TMA-403X and the Raytheon QK-787. Both of these tubes have resolution in excess of 1000 television

(Continued on page 36)

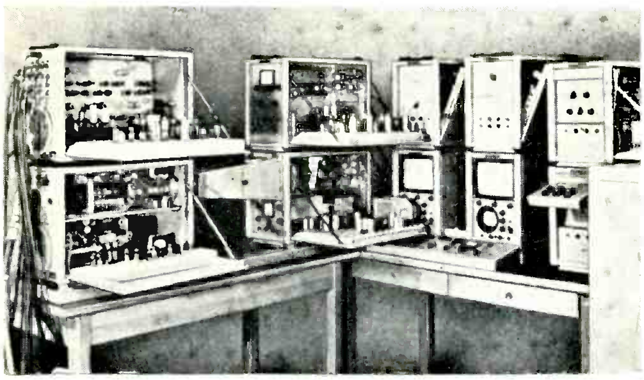


Figure 5. The standards converter at the Merkur near Baden-Baden.

Figure 6. Picture from Strasburg television station converted by means of the Image-Orthicon. The 819 line picture was not spot wobbled.

This paper was given at the American Institute of Electrical Engineers meeting of June 1960.

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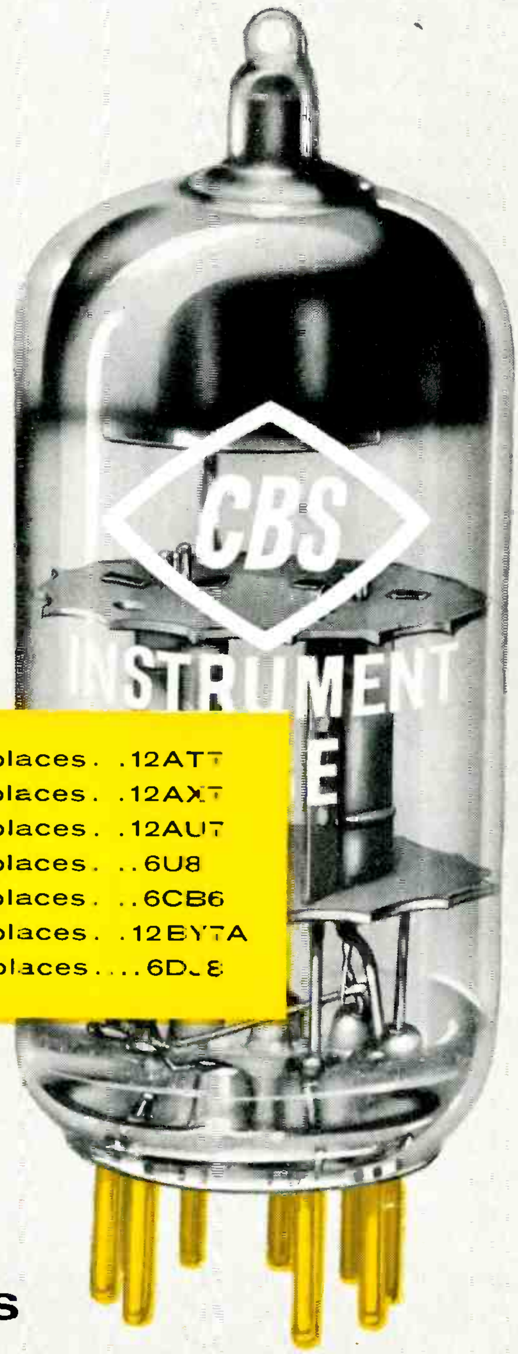

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TELEVISION SYSTEM MAINTENANCE

III. Amplitude Calibration And Level Interpretation

Correct terminology and standards of video levels are vital for consistent television transmissions.

By HAROLD E. ENNES
Maintenance Supervisor,
Television City, Inc. (WTAE)
Pittsburgh, Pa.

EDITOR'S NOTE:
This is the third in a series of comprehensive reports on Telecast Systems Maintenance

AFTER some fifteen years of television broadcasting, the standards of video level measurement are still in a semi-fluid status. The situation is somewhat analogous to that which existed in aural broadcasting before the standardization of the VU meter. Video level measurement is more complex than the audio portion since the ratio of several different signal levels is involved requiring waveform presentation on an oscilloscope.

Required Sync-to-Video Ratio

Fig. 1 represents the transmitter carrier wave modulated with a standard window signal. Sync tips are 100% of carrier, blanking level 75%, and peak white represents 12.5% of maximum carrier. This "white setup" is fixed by FCC standards at 10% to 15% of carrier (12.5% nominal) to avoid carrier cutoff which results in audio buzz in intercarrier type receivers due to loss of the carrier frequency reference.

It is evident that the signal amplitude from the studio line is represented on the modulated carrier as that portion between 12.5% and 100% of maximum carrier values. Since "full modulation" of the transmitter occurs at 87.5% of carrier, the necessary sync-to-video ratio of the input signal to result in 25% sync is 25/87.5 = 0.286 or 28.6% of the total composite signal. Thus disregarding special circuits such as sync stretching stages of transmitters or stabilizing amplifiers, the input signal must be 71.4% video and 28.6% sync to a linear transmitter to obtain the FCC requirement of 25% sync in the radiated signal.

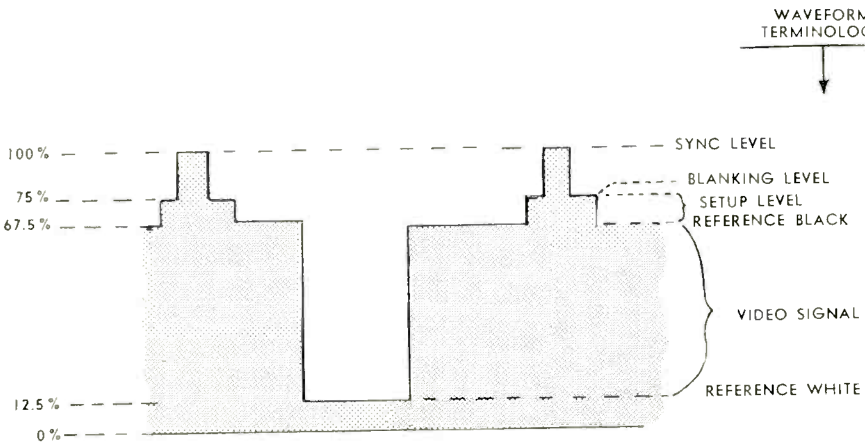


Fig. 1—Transmitter carrier representation when modulated with standard window signal.

Terminology and Standards of Video Levels

The original standards for studio line output (transmitter input) set in 1946 established a 2 volt composite signal level comprised of 0.5 volt sync and 1.5 volt video, or 25% sync to 75% video. All early transmitters employed sync stretching circuits to properly adjust the respective amplitudes and to compensate for the inherent sync compression.

Largely because of difficulty of obtaining good amplitude linearity in existing equipment over the 2-volt range (particularly in a large number of cascaded amplifiers as in network transmission), this standard was changed in 1950 to a composite level of 1.4 volts; 1 volt video to 0.4 volt sync. This standard not only established better amplitude linearity characteristics, but also provided a compatible 28.6% sync to 71.4% video ratio. Some transmitter manufacturers deleted the usual sync stretching circuits from transmitters, and obtained proper sync/video ratios in external stabilizing amplifiers if required due to any sync compression under modulation.

Since the advent of color television, many stations (even those operating monochrome only) have established a 1.0 volt composite signal as standard line output level. Because of the overshoot of the color subcarrier on color-bar transmissions, amplitude linearity problems again manifested themselves for the 1.4 volt standard. Numerous tests indicated the desirability of reducing the transmission level to 1.0 volt composite, and this is now standard practice for AT&T television operating centers and the majority of commercial broadcast stations.

The new 1.0 volt standard maintains the same sync/video ratio as the older 1.4 volt standard. The voltage ratios of the old and new standards as correlated with the IRE scale (adopted for use as an industry-wide standard) is shown by Fig. 2. Although the 1.0 volt signal is normally spoken of as "0.7 volt video to 0.3 volt sync," the actual voltage values are 0.714 video to 0.286 sync. By calling all values in IRE units, a standard is established which eliminates any confusion.

It is becoming increasingly important that all TV transmission engineers "talk the same language." Fig. 3 illustrates definitions of most often used terms. This terminology, as well as that included under Glossary of Terms Concerning TV Waveform Levels at the end of this article is approved by the AT&T and local telephone companies. Terminology used in describing specific troubles is to be presented where appropriate in future articles.

It is common practice to call out levels from blanking toward white and blanking toward sync as "100 over 40," "85 over 30," etc., which refers to IRE units in each direction. When calling out keyed sine wave burst levels to the telephone company for frequency response checks, adjust the level from blanking to peak reference white for 100 IRE units on the scope, and read each burst frequency in IRE units occupied by the individual burst. Reference white is established by a pulse immediately following blanking for use in this adjustment.

The "setup" level (units between blanking and maximum picture black) should be called out only when picture content includes a reference black rather than intermediate shades of gray only. This level should be a minimum of 5 and a maximum of 10 IRE units under this condition. It is standard operating practice at a few stations to run zero setup on all camera controls and to insert a fixed 5% setup at the line output stabilizing amplifier.

All level checks not involving frequency response (such as keyed burst signals) should be made with the scope response on IRE position. When the scope is on wide band response as is necessary to properly measure the keyed burst signals, the small-energy overshoots of the higher frequency components are quite apparent on the monitoring CRO. If these overshoots are held below 100 IRE units and the scene suddenly changes to one of much lower frequency content, the operator adjusts his gain to bring the overall level up. Since the luminance content is largely in the middle and lower frequency range, the operation results in a needless shift of apparent contrast in the home receiver. To avoid this result, the

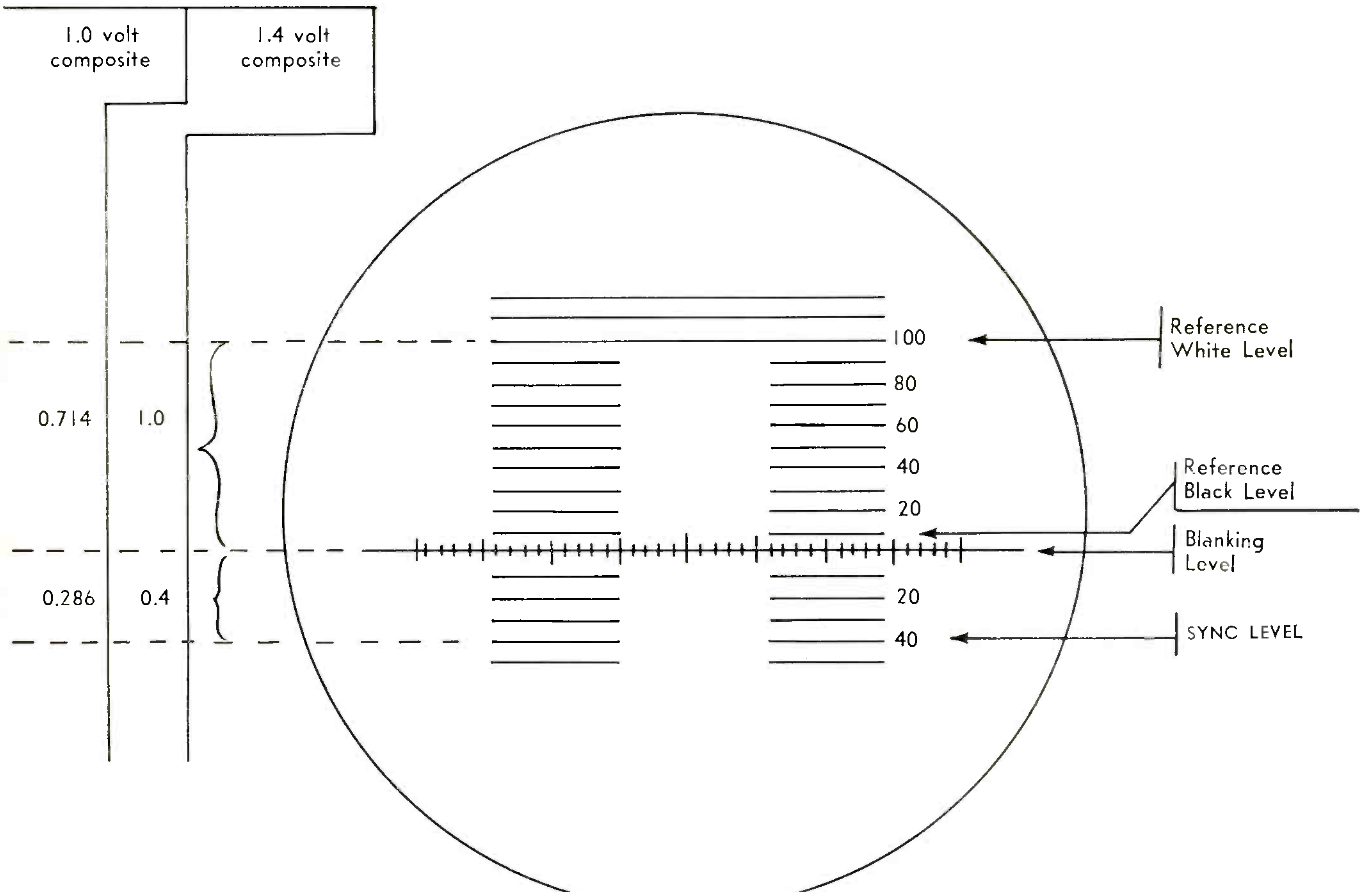


Fig. 2—Standard IRE Scale showing correlation of 1.0 volt and 1.4 volt signal.
For 1.4 volt signal: volts per unit = 1.4/140 = 0.01v/unit
For 1.0 volt signal: volts/unit = 1.0/140 = 0.00714/unit

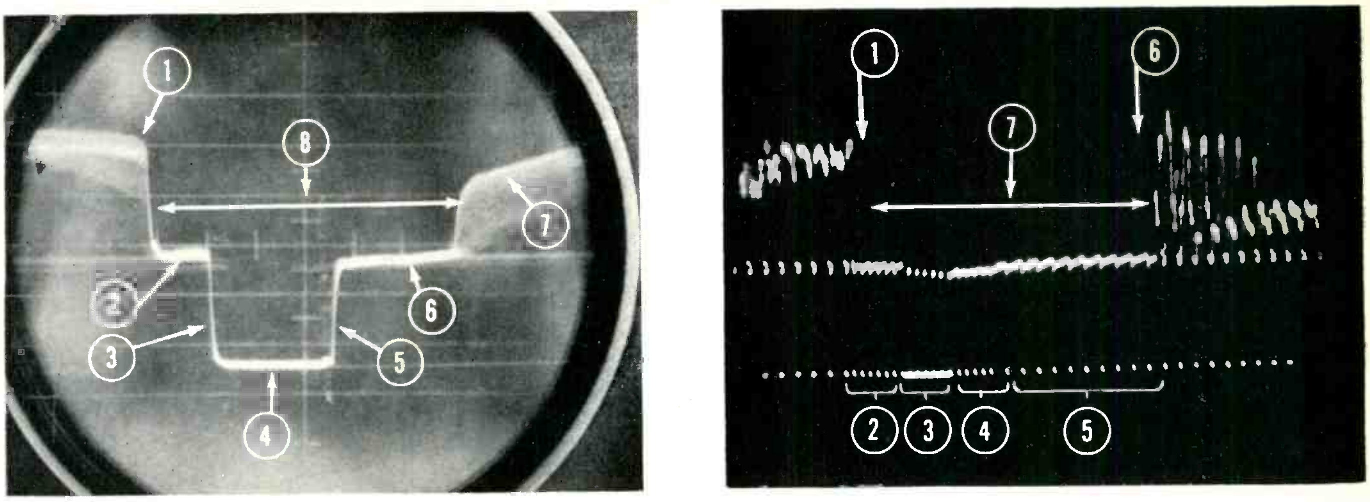
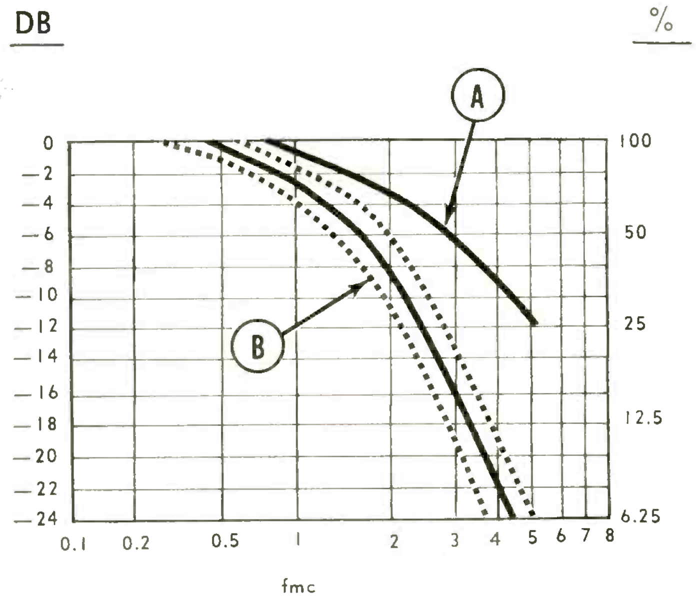


Fig. 3

(a). Definition of terms, expanded horizontal.
1. Pix voltage at right side of image
2. Front porch
3. Leading edge of sync
4. Tip of sync
5. Trailing edge of sync
6. Back porch
7. Pix voltage at left side of image
8. Horizontal blanking interval

(b). Definition of terms, expanded vertical.
1. Picture voltage at bottom of image
2. Leading group of 6 equalizing pulses
3. Serrated vertical sync pulse
4. Trailing group of 6 equalizing pulses
5. Horizontal sync pulses during vertical blanking
6. Picture voltage at top of image
7. Vertical blanking interval



(A) IRE Roll-off Standard 2 3 5-1—1950 (Old)
Rise time = 0.175 u/s

(B) IRE Roll-off STD 2 3 5-1—1958 (New)
Rise time = 0.3 u/s The dotted lines adjacent to (B indicates the upper & lower limits of the new response curve.

Fig. 4—(A) Old IRE response curve (1950)
(B) New IRE response curve (1958)

IRE response curve was standardized for the purpose of video "gain riding" and for checking levels of normal signals between studio and transmitter, or studio and AT&T. Fig. (A) of 4 is the CRO amplifier response when using the "old" IRE curve, and (B) is the response of the "new" IRE curve.*

Factors Affecting Level Variations

Level variations are classified into two major groups: short-term and long-term variations. The short-term grouping may include anything from the rapid "bounce" observed on scenic content changes between radical differences in duty-cycle (or unclamped points of observation, or unregulated power supplies) to variations occurring in a single program from laxity in "gain riding" or variations in distribution amplifiers operating at fixed gain (usually unity). Long-term variations (usually considered as a week or more) are not troublesome provided the maintenance department is aware of the required frequency in level checks for the particular installation.

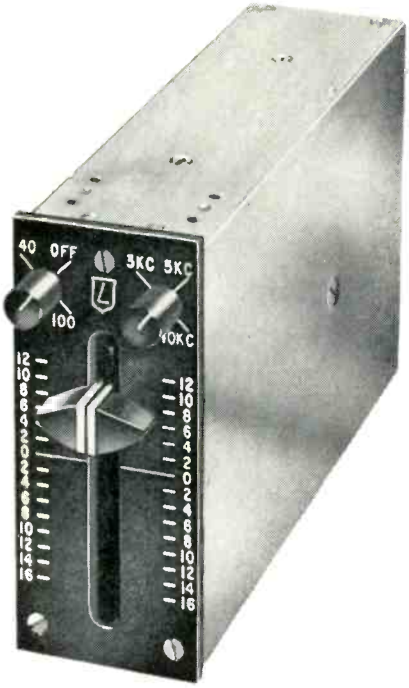
Rapid variations in level which

*IRE Standard 23S-1. 1958. Discussed in first article of this series, "Standards for Picture Signal Analysis."

Langevin

Equalizing for Spectral Character

MODEL EQ-251-A PROGRAM EQUALIZER



FEATURES

New Concept Gives Variable Equalization at 6 Important Points.

Only 1½ Inches Wide — 10 units require panel space of 3½ inches high by 15 inches wide.

Flexible — 2 rotating cam switches for high and low peak settings.

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Low Insertion loss of only 14 db.

Uses etched circuits of military quality for super-compactness.

Toroid coils — no hum.

The Model EQ-251A Equalizer is Langevin's miniaturization of an instrument that has long been standard for corrective equalization in recording and reproduction of sound. The diminutive size of this precision instrument permits mounting adjacent to mixer controls, thereby making possible multiple installations of several units in close proximity.

The Model EQ-251-A Equalizer's improved design features two sliding levers for equalization and attenuation. The perpendicular sliding action is more functional than rotary action, and facilitates reading of knob positions. Adjustable in 2 db steps at specified frequencies, with a range of 12 db maximum equalization to 16 db maximum attenuation, this instrument is an ideal tool for dubbing and frequency response corrections.

This assembly is a passive, L/C/R, bridged T network, and does not require power supply, tubes or additional connections. It can be inserted directly into a transmission line with only input and output connections.

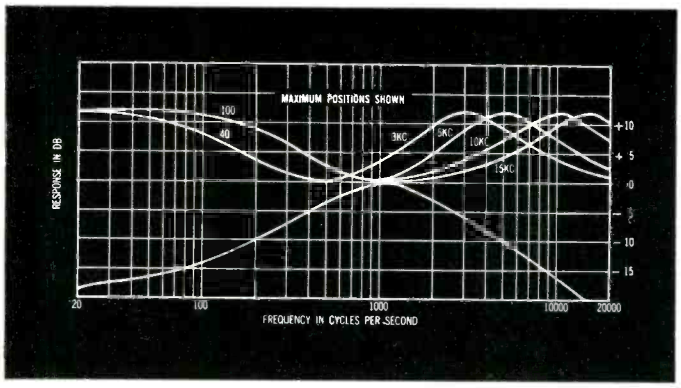
Two rotating cam switches are provided on the face panel. The switch at the right gives high frequency equalization peaks at 3 kc, 5 kc, 10 kc or 15 kc. The left switch provides low frequency equalization peak settings of 40 cps or 100 cps.

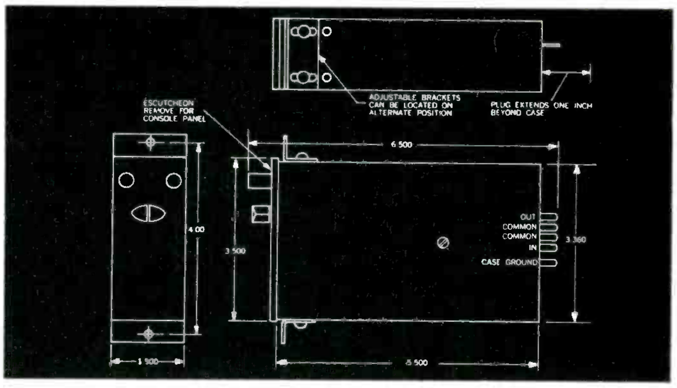
TECHNICAL SPECIFICATIONS

Circuit, Bridge T; **Impedance,** 600/600 ohms; **Insertion Loss,** 14 db; **Input Level,** minimum: −70 dbm, maximum: +20 dbm; **Phase Shift,** negligible; **Power Requirements,** none; **Terminals,** plug-in; **Finish,** black non-halation, satin finish, anodized aluminum with engraved markings. Chassis parts are nickel plate on brass. **Dimensions,** panel: 1½ inches wide by 3½ inches high; 5½ inch depth behind mounting panel.

ORDERING INFORMATION

MODEL EQ-251-A PROGRAM EQUALIZER, complete with female plug receptacle, mounting hardware and instructions; Weight, Net, 1¾ lbs., shipping 3 lbs. **Price, Net, $260.00**





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TEST No. 2

SERIES TUBE CURRENTS (ma)		OPERATING DATA
V1A	168	
V1B	160	Total = 1014 ma
V2A	180	Average/Section = 169 ma
V2B	182	Lowest Desirable = 152.1 ma
V3A	164	Highest Desirable = 185.9 ma
V3B	160	

Fig. 5—Tabulated data of Test No. 2.

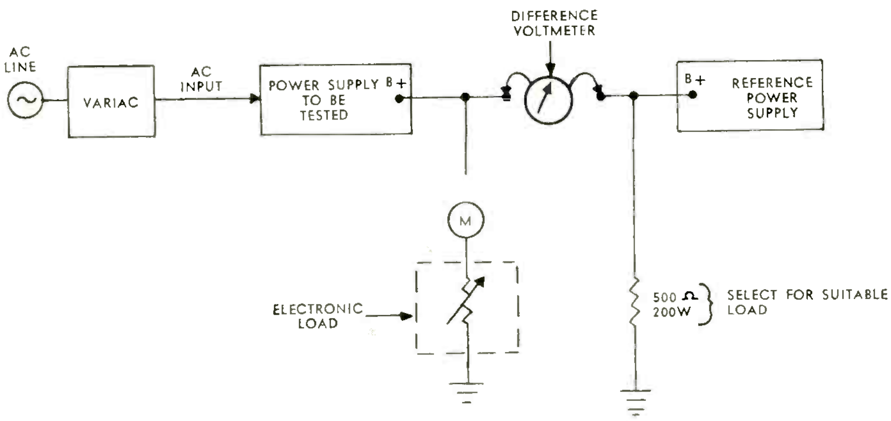

Fig. 6—Test setup for checking power supply regulation.

occur when switching between sources are often due to hitting the input coupling capacitor of a distribution amplifier with dc, as would occur with a leaky output capacitor from the source being switched. This effect is most pronounced with amplifiers employing heavy dc negative feedback circuits to obtain low line driving impedances over a wide bandwidth.

Most video amplifiers using several negative feedback loops in cascade, or overall feedback, will give no indication of a drop in gain when weak tubes are present. Low emission tubes, or tubes with high resistance internal element shorts can, however, aggravate very short term level changes. It is desirable to establish routine tube checks at 60 to 90 day intervals on such equipment, or to run video sweep checks which normally is a more sensitive indication of tube condition than tube testers can reveal.

When video AGC amplifiers are used, a check for proper operation should be made at least on monthly intervals. A satisfactory procedure can be outlined as follows:

1. Check any gas voltage regulator tubes for regulation on a reliable tube tester including this type of test. If outside regulation limits, replace with a new tube that checks within limits. Gas regulators are usually used to supply screen voltage regulation for variable gain stages where AGC action occurs.

2. Check all setup controls per the manufacturer's instructions for the amplifier used. When any gain controls need to be increased to obtain proper operation, check tubes. For transconductance checks, the "Good-Bad" scale is sufficient as this allows the normal manufacturers tolerance for the particular tube being tested. In addition, check for shorts and gas.

3. AGC amplifiers usually operate with either a 3, 6 or 12 DB control range. Assuming a 6 DB control range, check as follows:

(a). Reduce the input 6 DB (50% on voltage scale). The output should remain constant within 0.5 DB,† and fall off as the input is further reduced.

(b). Increase the input 6 DB over normal. The output should again remain constant within 0.5 DB.†

(c). Try rapid variations of level within this range. No more than plus or minus 0.5 DB† variation should occur. Most critical to proper operation are any adjustments affecting bridge-type balancing networks, reserve gain for AGC control, and the conduction threshold centering of the AGC rectifier.

Note that for step 3(a), a 3 DB control range AGC would require the input to be reduced to 70% of the voltage scale; the 12 DB range

(Continued on page 36)

†Average. Check according to manufacturers' specifications for particular equipment used.

TEST No. 3

LINE VOLTS	VO	ACTUAL VOLTS VARIATION
117(ref.)	280.5	0(ref.)
100	280.94	+ 0.44
105	280.75	+ 0.25
110	280.62	+ 0.12
115	280.5	0
120	280.42	− 0.08
125	280.37	− 0.13
130	280.31	− 0.19

Fig. 7—Tabulated data for Test No. 3.

TEST No. 4

LOAD CURRENT (Ma.)	VO	ACTUAL VOLTS VARIATION
1000(ref.)	280.54	0(ref.)
400	280.52	− 0.02
600	280.5	− 0.04
800	280.52	− 0.02
1200	280.54	0
1400	280.56	+ 0.02
1500	280.51	− 0.03

Fig. 8—Tabulated data for Test No. 4.

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- lower operating cost

The new Amperex Type 7459, forced-air cooled triode, was designed for use in many popular TV, FM and Broadcast transmitters operating in the 5, 10 and 25 KW ranges. By virtue of its exceptional ruggedness, reliability and cooler operation, this new 4 KW dissipation tube is becoming a preferred replacement for the conventional 2½ to 3 KW types.

The 7459 incorporates the exclusive Amperex "K" (carbide coated) grid which results in extremely low primary and secondary emission. The "K" grid has been operated at temperatures far above 1000°C with excellent life, thereby assuring reliable operation in *both* communications *and* industrial applications. Where short tube life is your problem in the 2½ to 3 KW dissipation range—the Amperex 7459 is your solution. Application engineering assistance is available.

RF POWER AMPLIFIER & OSCILLATOR, CLASS C

Typical Operation, Grounded Grid Circuit (Two Tubes)

Frequency (MC)	75	110	110	220*	
DC Plate Voltage	6000	5000	4000	4000	volts
DC Grid Voltage	400	300	200	200	volts
Peak RF Grid Voltage	740	640	500	450	volts
DC Plate Current	3	3	2.75	2.5	amps
DC Grid Current (approx.)	0.62	0.66	0.70	0.40	amps
Driving Power	2240	1840	1350	760	watts
Power Output (approx.)	15,600	12,100	8600	5600	watts

**For operation above 110 mc. in TV applications, please consult our Application Engineering Department.*

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Quantitative Phasing System Specifications

By R. S. BUSH
Phasing Design Engineer
Gates Radio Company

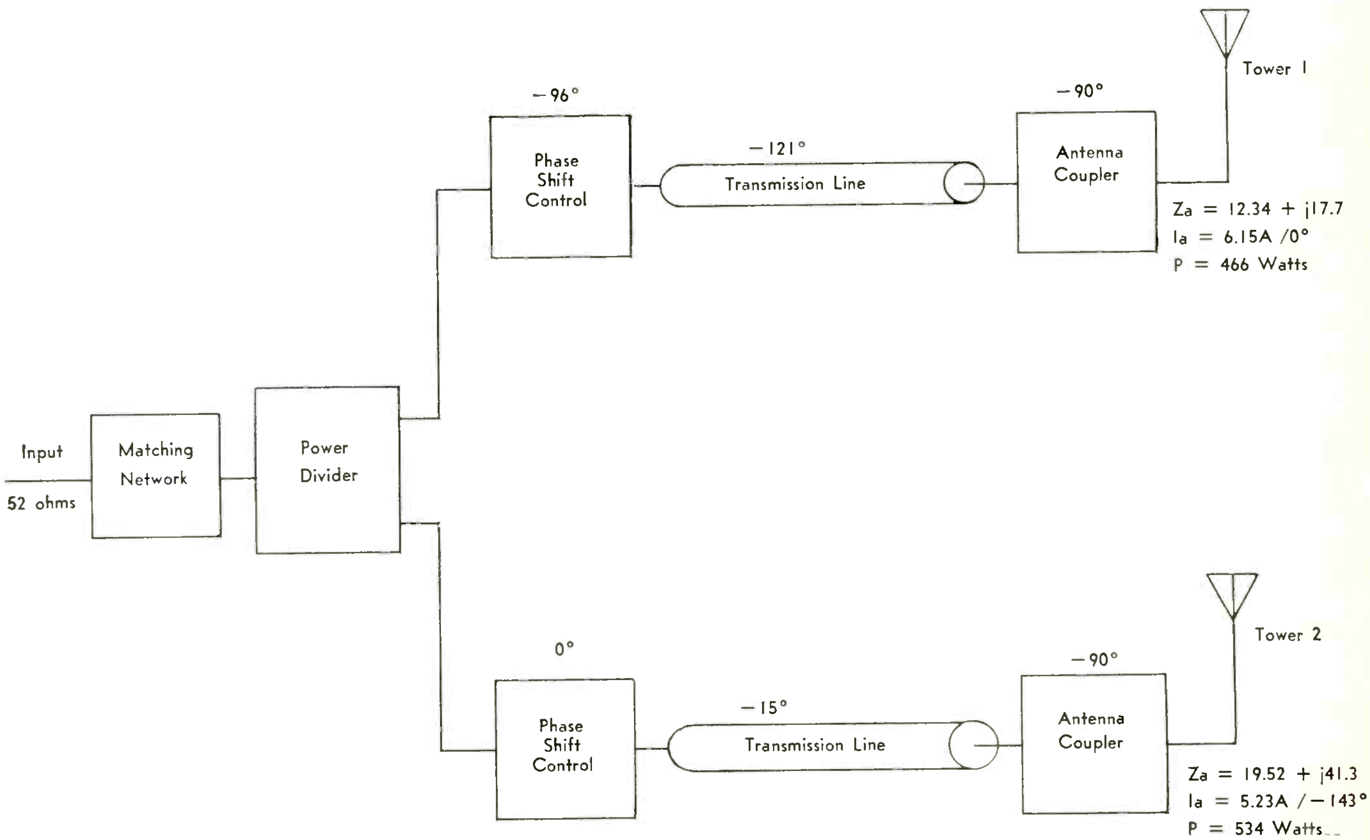
A vital requirement of directional antenna planning is the establishment of requirements and the precise definition of the capability of the system

For most electronic equipment certain exact specifications can be written. Phasing systems for directional antennas are unique in this respect in that they are designed to be adjusted in the field. Until this adjustment is made, actual performance characteristics of the system cannot be known.

Customarily, phasing system designs have been made using single valued transfer functions. Components are then selected slightly larger than required on the premise that the added size will allow sufficient variation of the networks to account for expected differences between design assumptions and actual field conditions. Such methods of design never define exactly what may be expected in the way of actual ranges of adjustment possible. It does not specifically spell out what the manufacturer is supplying either to the adjusting engineer or to the purchaser of the equipment. All too often such designing methods have resulted in either an over design, which is needlessly expensive, or an insufficient design, which seriously interferes with the proper adjustment and operation of the system.

Differences of opinion exist among

Figure 1. Block drawing of proposed phasing problem



engineers as to methods of design, desirable networks, and requirements which a phasing system should meet. Varied experience sometimes leads to good, practical reasons why some requirements are particularly desirable, but often there are opinions expressed which are the result of inaccurate information or of insufficient information. This latter condition leads to system designs which are inefficient, unnecessarily complicated with too many components, and, of course, expensive.

It is the purpose of this article to establish a set of specifications, applicable to any phasing system, which will, in each instance, precisely define what the system is at least capable of, in performance and adjustment. Further, it is a purpose to clarify and define specific functions of a phasing system, leading to more pertinent requirements written for particular systems. Looking to these ends, every effort is made to consider all factors arising in any practical adjustment of the equipment.

Antenna Driving Point Impedances

A familiarity with the relative values of the antenna driving point impedances is a pre-requisite to the adjustment of any antenna system. For this reason, a knowledge of the factors used in their computation is needed by the adjusting engineer.

The first specification is, then:

The antenna self base impedances and the values of mutual impedances used for the computation of the antenna driving point impedances shall be clearly stated.

Antenna Coupling Networks

The antenna coupling network always has three functions to perform in any phasing system.

1. Matching the antennas to the transmission line.

2. Provide a portion of the phase difference between the currents fed to the various towers.

3. To provide a conjugate reactance to the reactance portion of the antenna driving impedance. This latter function is in reality a part of the first requirement. However, since it must be considered separately in the design of the coupling units, it is included here as a separate function.

Antenna base impedances are always complex and effected by their surroundings, ground systems, etc. Base impedances may differ over quite wide limits between identical physical structures located in different surroundings. Consequently, a very generous allowance is required by the coupling networks to assure that they will perform their functions under actual field conditions. This allowance must consider the resistance and the reactance portion of the driving impedance as two independent variables.

The second requirement of antenna coupling networks, providing a portion of the phase difference between the currents fed to the various towers, is automatically fulfilled whenever a network of any kind is inserted in the system. However, in the case of the antenna coupling network, it is desired that the phase shift be controlled so that the balance of the system can be adjusted to include this phase shift. The phase transfer function of the coupling network thereby becomes a particular function of the network.

With the previous considerations in mind, the second specification is written:

Antenna coupling networks shall provide a specific phase shift and at the same time be capable of matching the transmission line to antenna base resistances at the computed base reactance of from 50% to 200% of the computed base resistance; and, shall also be capable of matching the transmission line at the computed base resistance but with a base reactance of from 50% to 200% of the computed value. The exact computed ranges of the networks shall be specified with each design.

Figure 2 illustrates this specification very clearly.

Phase Shift Network Ranges

These networks are the controlling elements for determining the phase relations between currents fed to the various towers.

They are usually considered as equal input and output impedance networks, their phase transfer functions being the prime consideration. Computation over a range of phase shifts is required to assure components of a sufficient range and to assure that the components used will be capable of handling currents and voltages throughout the range considered. The voltage and current encountered can vary quite rapidly as the transfer function of these networks is changed.

The third specification:

Figure 2. Sample phasing system design specifications

ANTENNA DRIVING POINT IMPEDANCE CALCULATIONS:
Z11 = 27 + j20 = Z22
Z12 = 19.8 to / −29°

ANTENNA COUPLING UNIT RANGES AT INDICATED PHASE SHIFTS:
Tower No. 1:
5.2 to 26 + j17.7
Tower No. 2:
10.4 to 41.6 + j41.3
or
Tower No. 1:
12.338 — j30.7 to + j49.8
Tower No. 2:
19.523 — j 7.4 to + j73.1

PHASE SHIFT NETWORK RANGES:
Line 1:
—80° to —110°
Line 2:
—15° to +15°

OVERALL TRANSMISSION LINE EFFICIENCY:
95.1%

POWER DIVIDER DRIVING POINT IMPEDANCE RANGE:
11.154 to 22.308 ± j22.46 ohms

MATCHING NETWORK RANGE:
Matching 52 ohms
to 11.154 — j34.38 to + j46.12
to 22.308 — j30.01 to + j50.44

COMPONENT RATINGS THROUGHOUT ABOVE RANGES:
CURRENT:
Greater than 1.414 × max. RMS
VOLTAGE:
Greater than 4.0 × max. RMS

Phase shift networks shall be capable of phase adjustment of 15° above and below the design center phase shift required.

Overall Transmission Line Efficiency

This is not a specification of the phasing system since the length or type of transmission line used is determined by considerations other than the parameters of the antenna system. However, line efficiency is of utmost importance to the adjusting engineer and to the station operator. Power supplied to a directional antenna system can only be determined, accurately, at the input to the system. Power lost in the transmission lines is, therefore, a measure of the possible overall efficiency of the system, because it usually accounts for the greatest loss.

Overall transmission line efficiency can only be computed after the antenna driving point impedances and the power division between towers is estimated. The fourth specification is added as a convenience factor, easily determined by the phasing system design engineer as he makes his system design.

The overall transmission line efficiency shall be computed and supplied with the phasing system design.

Power Divider Driving Point Impedance Range

The design of power dividing circuits is of the utmost importance in the design of any phasing system, for in general, larger and more expensive components are required than are needed for any other portion of the system.

Power divider design, unfortunately, has not received much attention in literature. Many methods of design and adjustment are in current use, some of which are good and others which are inefficient, expensive, and difficult to adjust properly.

Regardless of how the design is made or the actual circuit configuration used, the desired end result is the same — the input or driving point impedance.

By replacing the power divider circuit with a Thevenin equivalent circuit, it can be shown that the real or resistance part of the power divider driving point impedance uniquely determines all current and voltage requirements of the network components comprising the power divider. This is true since this resistance portion of the impedance represents the real load to the transmitter at this point in the system. Because of this, the real part, therefore, determines the efficiency of this circuit, its cost, the band-width of the system, and the requirements of the required matching network between this point and the transmitter.

The determination of the driving point impedance is made by consideration of the following factors:

1. The power division required between the several transmission lines.

2. The input impedance to each transmission line.

3. The method to be used to divide the power.

4. An assumed practical adjustment of the power divider.

The first of these is, of course, fixed by the antenna system. The second has, for the most part, been assumed equal to the characteristic impedance of the transmission lines used. This assumption, however, is seldom if ever valid, for in the process of adjusting the antenna system full attention must be paid to securing the desired results at the towers themselves, and because of this, transmission lines within a phasing system are almost always mismatched to a greater or less degree. Good design of the power divider, therefore, dictates the necessity of considering the input impedance of the transmission lines over a range of possible values. A VSWR of 2 to 1 restricts the range to a practical limit and is suggested in connection with the specification for the power divider circuit.

The method selected for dividing the power should be determined from a consideration of the number of towers, the total power, its division, and the type of adjustment desired. It should be kept in mind, however, since the efficiency of the circuit is directly proportional to the real part of the driving point impedance, that a method should be chosen that will result in a real part that is as high as possible.

A practical power divider adjustment selection, for the purpose of design, is one requiring experience in power divider design, preferably a

(Continued on page 34)

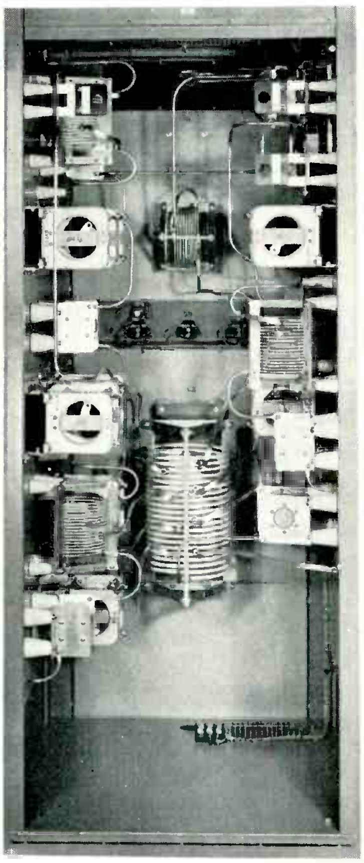


Photo A. Rear inside view of typical phasor. Note the ample space layout of components.

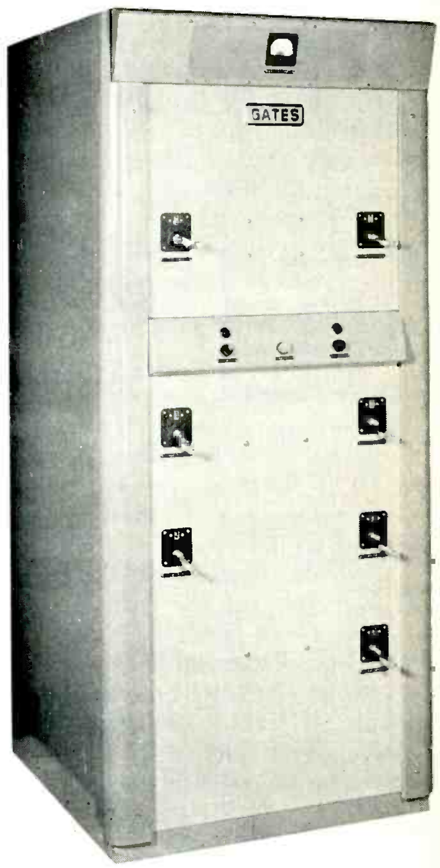
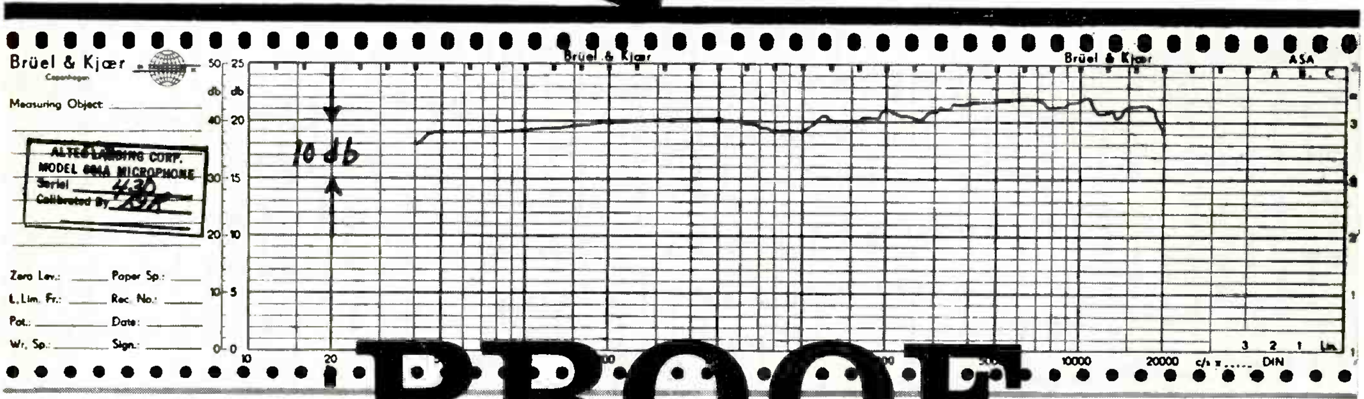


Photo B. Front view of phasing control cubical designed for station WJBO, Baton Rouge, La.

Frequency Response: 35 to 20,000 cycles
Output Impedance: 30/50, 150/250 and 20,000 ohms (selection by connections in microphone cable plug)
Output Level: –55 dbm/10 dynes/cm²
Hum: –120 db (Ref.: 10–³ Gauss)
Dimensions: 1⅛" diameter at top (1½" largest diameter) 7½" long not including plug
Weight: 8 oz. (not including cable & plug)
Finish: Two-tone baked enamel, black and dark green
Mounting: Separate "Slip-On" adapter No. 13338 furnished. Adapter has standard ⅝" –27 thread.



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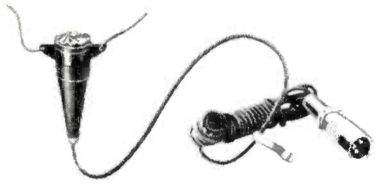
ALTEC 681A—$36.00 net—Inexpensive general purpose omnidirectional microphone with smooth, uniform frequency response from 50 to 18,000 cycles. Includes the new ALTEC "Golden Diaphragm" of indestructible Mylar®. Available with 150/250 or 20,000 ohms output impedance.

ALTEC 682A—$49.50 net—Featuring uniform frequency response from 45 to 20,000 cycles, the 682A Omnidirectional Microphone incorporates the new ALTEC "Golden Diaphragm" and exclusive sintered bronze filter. Output impedances of 30/50, 150/250, and 20,000 ohms easily selected in microphone plug.

683A DYNAMIC CARDIOID—$66.00 net—Uniform response from 45 to 15,000 cycles with average front-to-back discrimination of 20 db. Design incorporates the new ALTEC "Golden Diaphragm" and exclusive sintered bronze filter. Output impedance of 30/50, 150/250, and 20,000 ohms selectable at cable plug.

ALTEC 685A STUDIO CARDIOID—$96.00 net—This dynamic microphone offers flat frontal response from 40 to 16,000 cycles with average front-to-back discrimination of 20 db. Design incorporates the new ALTEC "Golden Diaphragm" and exclusive sintered bronze filter. Output impedances of 30/50, 150/250, and 20,000 ohms selectable at cable plug. Individual certified calibration curve is supplied with this model.



ALTEC 686A LAVALIER – $54.00 net – Unobtrusive 3-ounce Omnidirectional Lavalier Microphone. Incorporates the new ALTEC "Golden Diaphragm" and exclusive sintered bronze filter for an exceptionally smooth frequency response from 70 to 20,000 cycles, equalized for chest position. Selectable 30/50 and 150/250 ohm impedances.

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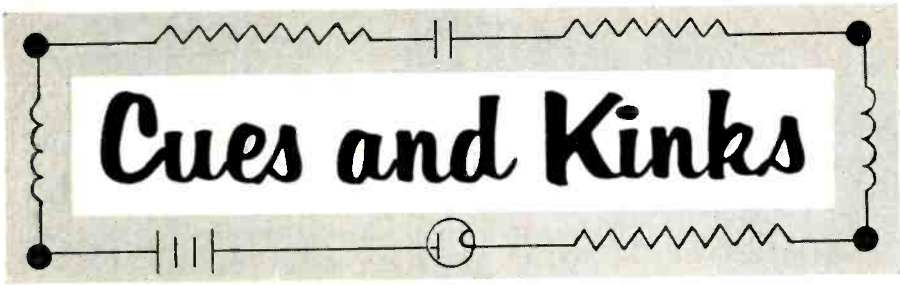


A 600-Ohm Impedance Matching Unit

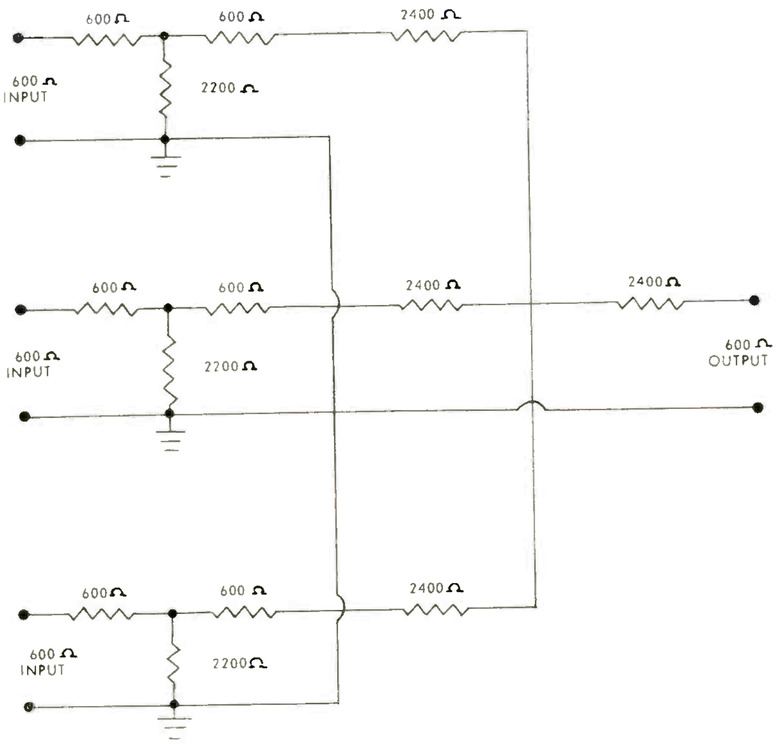
By DONALD E. LEFEBVRE
Chief Engineer, WTSL,
Hanover, N. H.

The purpose of this unit is to enable the engineer to produce his remote broadcasts with a maximum of audio quality and a minimum of distortion when using two or three remote amplifiers.

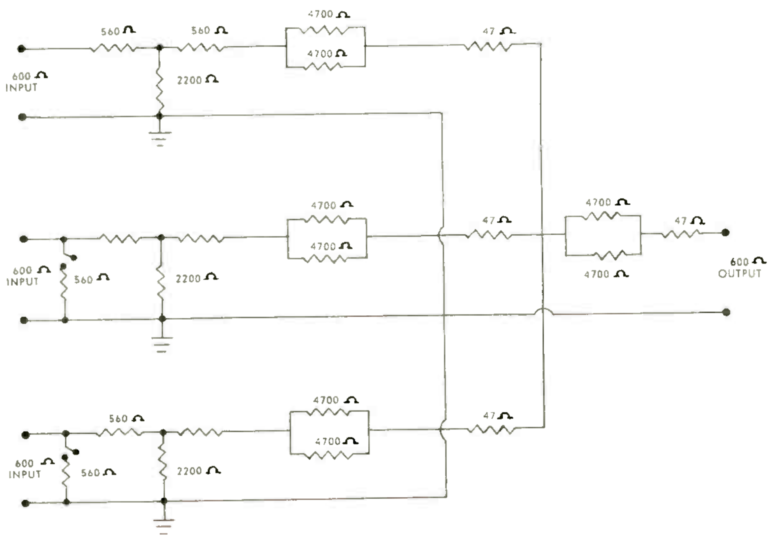
It is the problem of many of the smaller broadcast stations with a limited budget to need more microphones on a remote broadcast than their remote amplifier will allow. Paralleling two such amplifiers with the same output impedance usually results in low volume output, and in many cases, a high degree of hum. Three amplifiers in parallel greatly increase the distortion and hum.

This unit will allow up to three 600-ohm remote amplifiers to be connected to it with a resulting output impedance of 600 ohms, therefore maintaining good output volume with a minimum of distortion and hum.

Schematic diagram number one is the basic diagram using the minimum amount of parts and labor. Schematic diagram number two is the one the author used in constructing his unit because of its versatility and also because more of the component parts were locally available. However, both diagrams are basically the same with the exception that diagram number two has a 600-ohm "dummy load" across inputs two and three. This enables the unit to be used as an isolation unit by using only input number one and placing the "dummy loads"



Schematic Diagram Number One: Original diagram devised by the author.



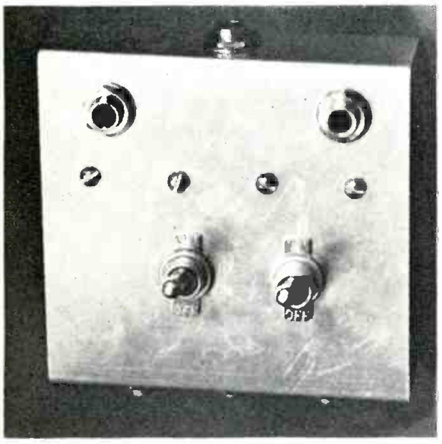
Schematic Diagram Number Two: This is the modified diagram using locally available parts. This is the diagram the author used in constructing his unit.

Parts List (Schematic Diagram Number 2)

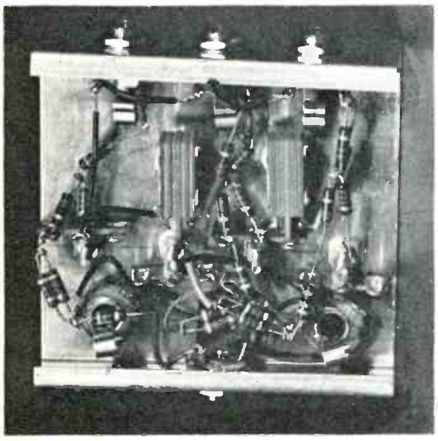
1—Aluminum chassis 4x4x1
2—SPST toggle switches
6—Standard phone jacks
4—Standard phone plugs
8—560 ohm 1 watt resistors
3—2200 ohm 1 watt resistors
8—4700 ohm 1 watt resistors
4—47 ohm 1 watt resistors
4—Three point tie points, center one grounded
4—¾ inch metal screws
4—⅛ inch nuts

across inputs two and three. If the engineer wishes to use the unit with only two remote amplifiers, the proper switch should be thrown putting a "dummy load" across input number three. If three remote amplifiers are to be used, all switches should be in the off position. The "dummy loads" are put into the circuit by throwing their respective switches, which are located on the top of the unit. Two standard phone jacks were paralled across the output in order for the engineer to monitor all of the amplifiers at once with a high impedance head set.

The unit was constructed in an aluminum chassis and took approximately two hours to build. It has been in operation for over three months and has proved to be very satisfactory. It can be easily modified to handle as many amplifiers as the broadcast engineer may desire.



Picture number one is the outside of the unit showing the three input jacks which are located on one end, the output jack on the other end, and on the top the two monitoring jacks and the two "dummy load" switches.



Picture number two shows the wiring on the inside of the unit.

STEREO . . .
New Era for FM

Dimensional programming is legal but problems still exist.

It will be remembered in the history of broadcasting—June 1, 1961, the beginning of a new era—stereocasting—for Frequency-Modulation.

But all is not well in the camp of the FM broadcaster. There are many questions yet unanswered. How long will it be until adequate transmitting equipment is available to the broadcaster at reasonable prices? How soon will the general public have sufficient quantity of multiplex receivers or adapters? How many FM stations will expand fully into this new service? What about SCA multiplex; is it as simple as the headlines in the business magazines proclaim? These questions were asked during the recent FM Day of the NAB Annual Convention in Washington, D. C. These are the same questions that still go unanswered today.

Harold L. Kassens, chief of the aural exisiting facilities branch of the FCC, told the broadcasters that the multiplex system which has been authorized by the FCC as the standard for all such multiple usage was selected only after a long process of comparative testing against other systems. He told the delegates at the FM-NAB meeting that various problems will arise with FM stereocasting. He said the newly approved multiplex system meets a most important requirement—that it function without significant impairment of present FM broadcasting standards.

FCC's H. L. Kassens informing the FM broadcasters about new stereo standards at NAB Convention.

"Main channel listeners must not suffer a loss of reception quality because of the addition of other programs on the FM frequency," he said. "In the case of multiplex stereo, there may be some slight loss, but it would be so slight that most listeners could not detect it."

Kassens warned broadcasters to guard against poor stereophonic programs. He stated the public will demand top quality sound from stereo-broadcasters, and will compare the stereocast against present stereo LP recordings. Another point made was the possible need of outdoor FM receiving antennas for fringe or semi-fringe areas for best reception from stereo FM broadcast stations.

"Also expect receiving problems under co-channel or adjacent channel interference coverage areas," stated Kassens. (The original Uniontown, Pa., measurements were made under ideal conditions with the service area *not* subject to this type of interference.)

It is understood the FCC is working on new standards and specifications for an FM frequency and modulation monitor. Accurate measurement of main channel, stereophonic channel, and the SCA multiplex perimeter is necessary to maintain the new requirements. The monitoring specifications may be released in the "near future," meaning this fall or the end of the year.

Kassens said, "In fact, the FCC will give birth to a complete new set of rules and regulations pertaining to FM broadcasting in the coming future. This, however, will take time to develop."

In order to broadcast stereo, the Commission requires a simple written application from the proposed FM station, giving the following information:

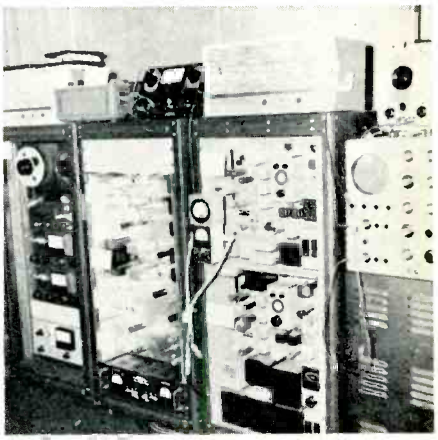
1. Notification of type approved stereo exciter transmitting equipment.

2. Notification of the hours of proposed stereophonic broadcast programming.

Any additional changes in hours of stereocasting should be reported to the FCC. This data should be filed with the District FCC Engineer and/or the FCC in Washington, D. C.

Harold Kassens warned future FM stereo broadcasters of the close specifications issued recently by the Commission. (See page 39, May issue of BROADCAST ENGINEERING.) A proof of performance will be required on the stereo channel as well as crosstalk and distortion measurements between channels. This again discloses the need for reliable test and monitoring equipment at the station.

The FCC spokesman pointed out to the SCA operator the new requirement of the reduction of the SCA injection on the main carrier to ten per cent while broadcasting stereophonic programs. Some multiplex receivers in the field may require at least one additional filter

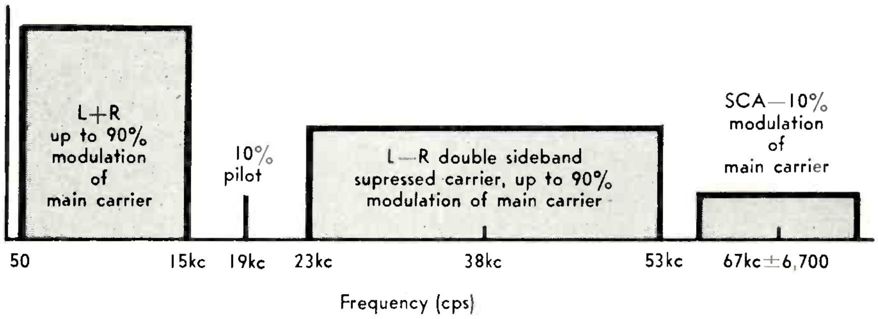


Zenith Radio Corp. and General Electric Co. demonstrated closed circuit stereo multiplex programs to FM delegates in Washington. Picture shows the Zenith equipment used in the show.

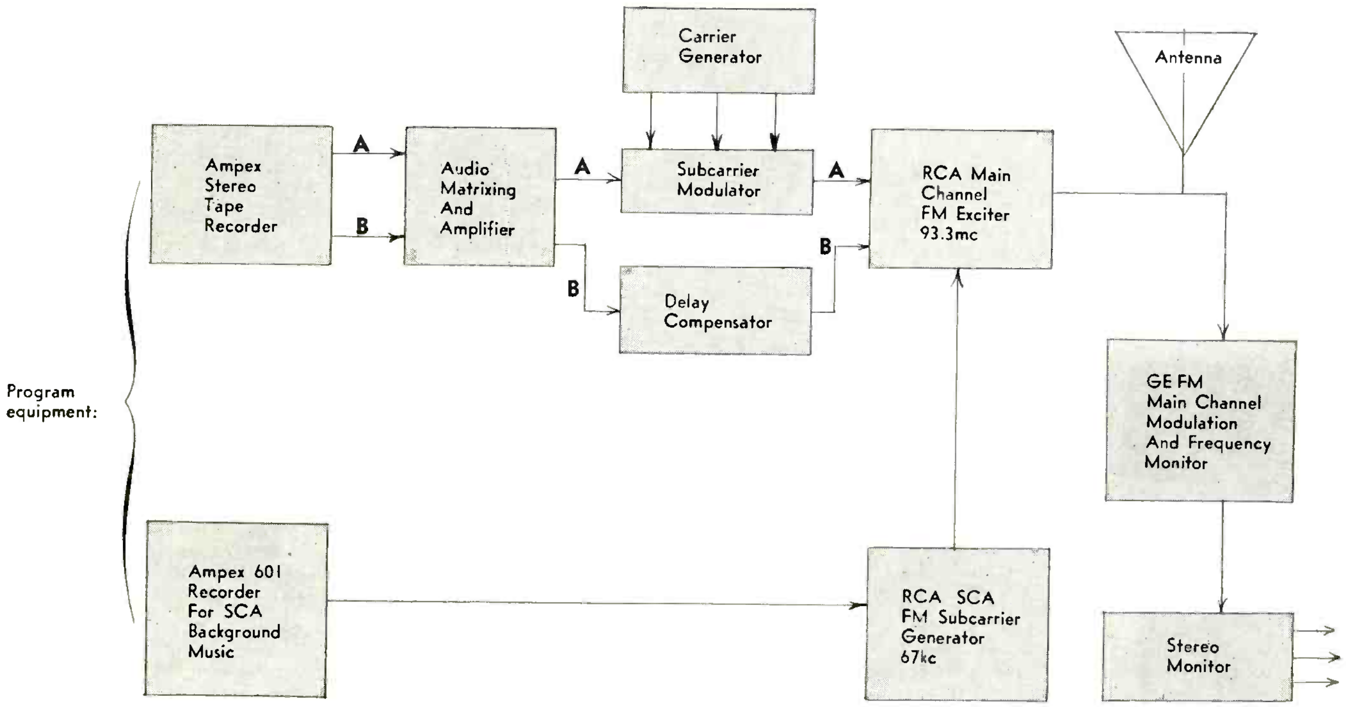
trap to reduce stereo crosstalk leaking into the SCA subchannel. There are no specifications or standards, to date, in the rules of the FCC pertaining to the degree of crosstalk of the stereo channel into the SCA channel!

Three FM broadcast stations across the nation raced to be the first to stereocast at the stroke of midnight, June 1st. Questions unanswered today will soon have answers tomorrow.

SPECTRUM OF SIGNALS APPEARING FROM AN FM STATION BROADCASTING STEREO AND SCA SERVICE

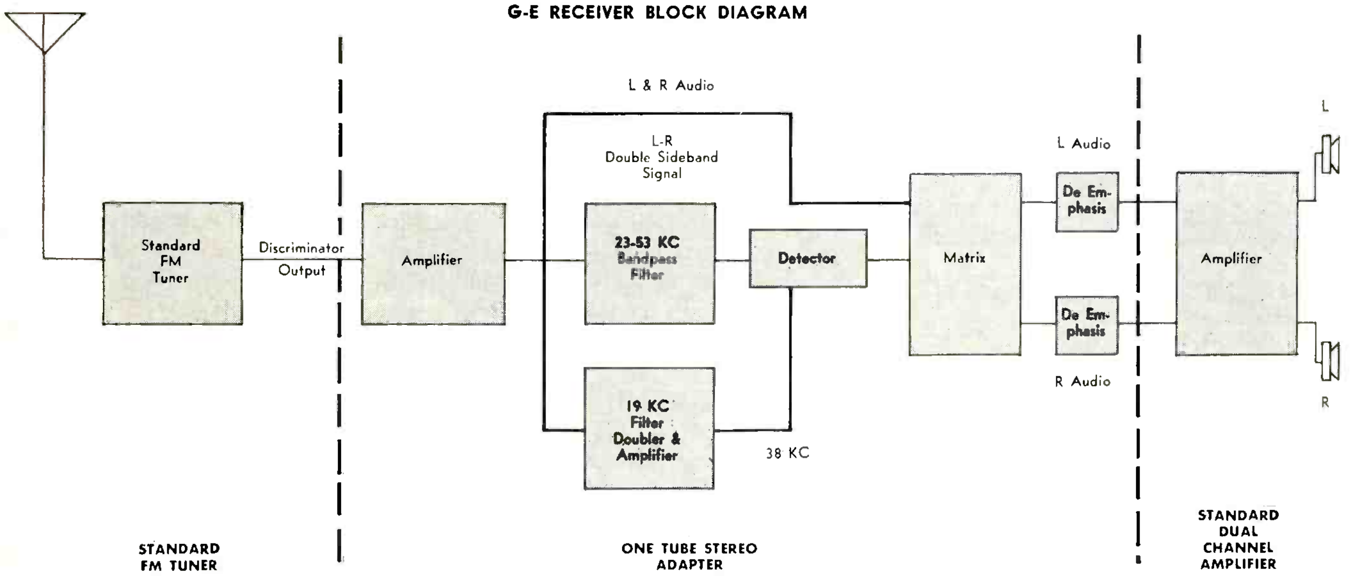


STEREO TRANSMITTING EQUIPMENT



A block diagram of the stereo exciter and SCA equipment used in the Zenith Radio demonstration.

G-E RECEIVER BLOCK DIAGRAM



Breakdown block diagram of the proposed General Electric form of FM stereo recovery.

Quantitative Phasing

(Continued from page 28)

knowledge of the adjusting engineer's techniques, and a knowledge of practical components available. Whatever the choice, no design can be considered complete unless all of the above discussed factors are carefully weighed and included within the actual computations. This results in a range of impedance values that should be clearly stated as a part of the phasing system specifications and completely defines the requirements of the subsequent matching network.

The fifth specification follows:

The power divider driving point impedance shall be computed over a range that will include a possible standing wave ratio at the input to each transmission line of 2 to 1. In no event shall the real part of this impedance be considered over a range less than maximum to ½ maximum. The actual range of this impedance shall be clearly stated with every system design.

Matching Network Range

The driving point impedance of any power dividing network is the impedance that appears at that point in the circuit where the full power of the transmitter is immediately distributed between the various lines feeding the antennas. All circuits preceding this point, or between this point and the transmitter output, serve only one purpose, to match the transmitter to the power divider.

This singularity of purpose for this network suggests, at once, that it be as simple as possible. The more components used to accomplish this purpose, the greater the expense, and each additional component added, in turn, adds to the system losses.

The matching network range, of course, must equal or exceed the power divider driving range. However, knowledge of the full range of the matching network is of interest to the adjusting engineer in order that he know the actual maximum limits he can tolerate in the adjustment of the power divider.

The sixth specification:

The matching network preceding the power divider shall be designed to match the input resistance of the system to greater than the stipulated range of resistance and reactance of the power divider driving point impedance. The computed range of this network shall be included with the design.

Component Ratings and Selection

In any circuit handling large amounts of radio frequency power, the ultimate design limits are the practical current and voltage ratings of available components. Consequently, if the foregoing specifications hold, every component selected must be capable of withstanding the maximum current or voltage it will encounter throughout the complete range it is expected to operate.

It goes without saying that a safety factor must be applied as a matter of good engineering practice. A factor of 1.414 is chosen as an economical value, since, to overcome this factor, the power would have to double or the impedance of the circuit would go to ½ its estimated value.

A voltage factor of $2 \times 1.414 \times 1.414 = 4$ is used to convert RMS voltages to peak voltages.

So with these factors the seventh and last specification is written:

All components shall be selected such that their current ratings shall be greater than 1.414 times the maximum RMS current occurring in the circuit at any point within the above specified range.

All components shall also have a voltage rating at least 4.0 times the maximum RMS voltage occurring across the component throughout the above range.

Conclusion

A complete set of quantitative specifications for all directional antenna phasing systems has long been needed to provide a clear cut guide for design and consideration. Antenna systems are becoming increasingly complicated and exacting in their requirements.

Smaller stations are required to install more elaborate and more costly antennas as the frequency spectrum becomes more crowded. Phasing systems must, therefore, be better designed, easier to adjust, more stable and reliable, and as economical as possible.

The phasing specifications as outlined here and as exemplified in Figure 2 are believed to assure this type of system. Certainly, they provide a very effective means of evaluating any system design and should, at least materially, assist in providing the best possible directional antenna phasing system at the lowest possible cost.

Photo courtesy American Broadcasting Co.

"Thanks, Al Powley"

Your telegram tells more effectively than any advertisement, the performance you can expect — and get — from the GL-7629 General Electric image orthicon. The results are all the more gratifying because this was the first time the President's press conference was taped for release through the three major networks (by WMAL-TV, ABC, Washington, D. C.). Meeting the quality requirements of critical video tape recording under these conditions was a real challenge to your staff and your equipment.

The GL-7629 is especially designed for both black-and-white and color telecasting where normal lighting is either unavailable or undesirable. It requires less than one-tenth the light of standard camera tubes. A thin-film magnesium oxide target improves depth of focus, eliminates "stickiness" and burn-in. Use the GL-7629 to broaden the scope of your color and monochrome camera work — in the studio and for remotes. General Electric Company, Distributor Sales, Owensboro, Kentucky.

INDUSTRIAL TUBES • SEMICONDUCTORS • PANEL METERS • RESISTORS

Progress Is Our Most Important Product

GENERAL ELECTRIC

Videotape Standards

(Continued from page 18)

lines. They have only two problems at the present time which are not yet solved. The first is a poor grey scale and the second is the lag between record and erase time. They appear to show much promise in that they will be simpler and cheaper than electrical-optical-electrical systems. Both of these types are double ended tubes. Other types which also show some promise are the GEC 1300.32 and the RCA 7539. Typical of some interesting possible tubes are the single ended gun types. Double guns with single ended targets have been developed by NHK (Japanese) and the RCA type 7448.

Other storage devices possible are by video delay lines or magnetic drums or discs. A magnetic disc storage unit has been developed by Philips. Its present application is for storing X-Ray pictures taken with a vidicon television camera. The problem of standards conversion for color is even more difficult than that for monochrome. However, a very interesting development, using the Henri deFrance system (de Francaise de Television), of compatible sequential color TV has been applied by NHK Development Laboratory to rigid requirements of phase and time stability of a color VTR. The Henri de France system is characterized by line sequential transmission of chrominance information and simultaneously transmitting only two pieces of information instead of NTSC's three. There is only one modulation of the color subcarrier. It is necessary to store the chrominance information line by line.

By converting the NTSC color system to the deFrance system, it becomes much easier to record the color on VTR and much easier to change the information from one system to another.

Several new devices using mercury storage delay lines and quartz lines running at radio frequencies also show promise in aiding scan conversion for VTR's.

Television System Maintenance . . .

Continued from page 24

would require a reduction to 25% of normal on the voltage scale.

Checking Regulated Power Supplies

The maintenance of regulated power supplies is extremely important to overall video level stability. The following four tests enable the maintenance engineer to keep a running check on the condition of his regulated supplies.

Test 1. Voltage output range at fixed load. Use a fixed load that will draw at least two-thirds of the maximum rated load current. Rotate Voltage Adjust control to extremes of adjustment and record the minimum and maximum voltages. For example, the normal available range of a 280-volt regulated supply might be from 270 to 300 volts, at a given load current. Failure to reach the "normal" maximum voltage is usually the result of a weak dc amplifier tube or voltage adjust tube.

Test 2. Check of series regulator tube currents for balance. Most regulated supplies incorporate a meter selector switch on the panel for measuring individual regulator tube currents. Fig. 5 shows the application of such readings. Note that the total load in this example is 1014 milliamperes, therefore the ideal average for each of the six tube sections is 1014/6 = 169 ma. Since maximum tube life and stability can be expected when these currents are balanced within 10% plus or minus (20% total variation), a record is kept of individual currents as shown and compared to the minimum and maximum values which should occur for the given load. This will indicate the need for a tube change before trouble occurs, barring any sudden failure.

Test 3. Input voltage regulation (voltage output with fixed load and varying input ac line voltage). The setup for this and the following test is shown by Fig. 6. Adjust the power supply to be tested to 0.5 volt above the reference supply, and connect a voltmeter between the two outputs to measure this voltage difference. By means of the variac, take measurements at the reference line voltage (usually 117 volts), then record the measurements over a specified range such as 100 to 130 volts ac input. Fig. 7 is the data recorded at WTAE for an RCA WP-15B supply, showing the excellent input voltage regulation of this supply with a fixed load.

Test 4. Output voltage regulation under variable loads (fixed ac line voltage with varying load current). In this test the variac is fixed for an ac input of 117 volts, and the electronic load on the supply under test is varied over a specified range. Fig. 8 is the corresponding data for the WP-15B, again indicating extremely good regulation under varying loads, and very low internal power supply resistance.

The condition of power supply filters should be checked at least several times yearly by observing the ripple content of the output voltage on an oscilloscope. An increase in ripple content will indicate the need for filter replacement before reaching troublesome amplitudes.

Glossary of Terms Concerning TV Waveform Levels

The following terms are currently used in operation and maintenance, and are approved by the Long Lines Division of the American Telephone & Telegraph Co. for use in television customer relations. Only those terms concerned with normal or abnormal levels are defined herewith. Terminology of specific types of troubles in waveforms will be covered where applicable in future articles of this series.

Black Peak: The point of maximum excursion of the picture signal in the black direction at the time of observation.

Blacker-Than-Black: The amplitude region of the composite video signal below reference black level in the direction of the synchronizing pulses.

Blanking Level: The level of the front and back porches of the composite video signal. (See Fig. 3a.)

Bounce: Sudden variation of level (hence brightness) of the picture signal.

Breathing: Amplitude variations similar to bounce but at a slow regular rate.

Clipping: Sharp cutoff of the video signal peaks. May affect either the white (positive) peaks or the black (negative) peaks. The sync amplitude may be affected on a composite signal.

Compression: An undesired decrease in amplitude of a portion of the composite signal relative to that of another portion. This term defines a less than proportional change in output of a circuit for a change in input level. For example, sync pulse compression means a decrease in the percentage of sync relative to that at the sending end.

Displacement of Porches: Any difference between the level of the front porch and the level of the back porch.

Overshoot: Excessive response to a unidirectional signal change. Sharp overshoots are sometimes referred to as "spikes."

Peak-to-Peak: The amplitude (voltage) difference between the most positive and the most negative peak excursions of the signal.

Pedestal Level: See "blanking level" which is now the preferred term.

Polarity of Picture Signal: Does not refer to the picture as it appears on the monitor in terms of a "positive" or "negative" image. This term refers only to the polarity of the BLACK portion of the waveform as it appears on the CRO with respect to the white portion of the signal. It is standard that outputs of camera chains, distribution amplifiers and terminal equipment be black negative, which is the standard polarity for the transmitter input to produce a positive image to the viewer.

Reference Black Level: The level corresponding to the specified maximum excursion of the signal in the black direction.

Reference White Level: The level corresponding to the maximum excursion of the luminance signal in the white direction.

Setup: The separation in level between blanking and reference black levels.

Sync Level: The level of the tips of the sync pulses.

Video-in-Black: Condition where the black peaks extend through reference black level as observed on the CRO. More often termed "loss of setup."

White Peak: The maximum excursion of the picture signal in the white direction at the time of observation.

Industry News

Robinson Appointed Director of Engineering

Communications Industries Corp. of New York City has announced the promotion of Ralph J. Robinson to a newly created post of director of engineering for the chain which includes WACE, Springfield-Holyoke, Mass.; WEOK, Poughkeepsie, New York; WKST, Newcastle, Pa.; and WKST-TV, Youngstown, Ohio.

Robinson has been general manager of WACE for the past 14 years, and was vice-president of the Regional Broadcasting Co. He joined the WACE organization at its inception as chief engineer handling the original installation of both AM and mountain-top FM facilities.

Eimac Elects R. T. Orth To Board of Directors

Eitel-McCullough, Inc., San Carlos, Calif., has announced the election of R. T. Orth as a director of the company. Orth is vice-president, operations, of the firm.

Gould Hunter, vice-president, administration, was elected secretary, replacing E. E. McClaran, former vice-president of finance and secretary, who recently resigned.

Gates Names Robert Tilton Broadcast Sales Engineer

Gates Radio Co., Quincy, Ill., a subsidiary of the Harris-Intertype Corp., announces the appointment of Robert Tilton as broadcast sales engineer covering the territory of Pennsylvania and eastern Ohio.

Tilton was formerly director of engineering for the Todd Storz stations.

NEW–
SOLID STATE–
VERTICAL INTERVAL SWITCHER

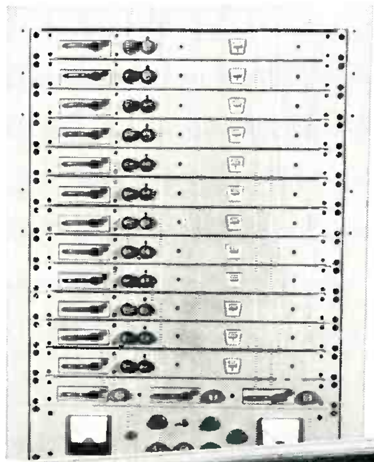
This is the new Sarkes Tarzian switcher that "stole the show" at the recent NAB Convention.

Here's why:

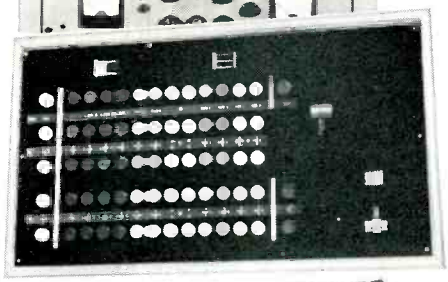
MAJOR PERFORMANCE SPECIFICATIONS

1. SWITCHING TRANSIENT
   —10 db below equalizing pulse amplitude
2. Phase Delay
   .02 microseconds @ 3.58 (Ref. to 200 kc)
3. SWITCHING TIME
   Less than .8 microseconds
4. Differential Gain
   .2% max
5. DIFFERENTIAL PHASE
   .5° max @ 3.58 mc
6. Isolation (between any 2 channels)
   60 db @ 3.58

This performance is engineered into a compact package less than half as big as other switchers, and it's priced lower.



Solid State Vertical Interval Switcher



Typical Control Panel

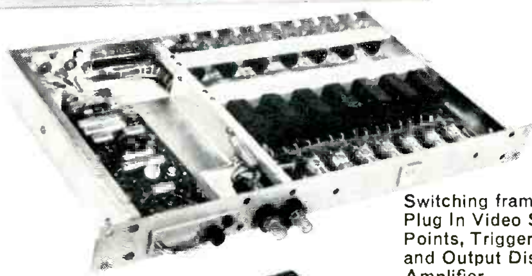
AVAILABLE NOW—NO WAITING

Yes, you can get immediate delivery on this equipment—NOW. Modular construction permits custom tailoring to your specific requirements—at NO premium in cost to YOU. And, you can economically expand the system as future growth demands. Of course, we furnish full technical instruction, schematics and any engineering assistance required.

This outstanding switcher is another in a long line of Sarkes Tarzian products to gain immediate acceptance in the broadcast and electronics industry. Its HIGH QUALITY . . . RELIABILITY . . . . AND FINE PERFORMANCE are the same that engineers, broadcasters and technical personnel have come to expect from Tarzian.

Along with the extensive manufacturing facilities (semiconductors, variable capacitors, magnetic tape, TV tuners, radios and Hi Fi), SARKES TARZIAN, INC. owns and operates WTTV (TV) . . . WPTA (TV) . . . WTTS (AM) WFAM (TV) . . . WTTV (FM) . . . and WPTH (FM). All of which gives us a better understanding and down-to-earth approach to the Broadcaster's problems.

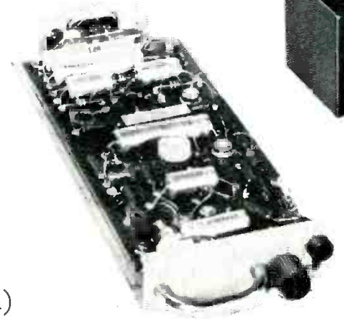
We will engineer your switching system requirements at no cost or obligation to you.



Switching frame showing Plug In Video Switch Points, Trigger Modules and Output Distribution Amplifier

Trigger Module

Diode Matrix Video Switch Module



Solid State Video Distribution Amplifier

SARKES TARZIAN INC
Broadcast Equipment Division
Bloomington, Indiana

F.C.C. Regulations

CONELRAD and Emergency Broadcast System

The Commission having under consideration the desirability of making certain editorial changes in Part 3 of its rules and regulations; and

It appearing that the amendments adopted herein are editorial in nature, and, therefore, prior publication of notice of proposed rule making under the provisons of section 4 of the Administrative Procedure Act is unnecessary.

It further appearing that the amendments adopted herein are issued pursuant to authority contained in sections 4 (i), 5 (d) (1) and 303 (r) of the Communications Act of 1934, as amended, and section 0.341 (a) of the Commission's Statement of Organization, Delegations of Authority and Other Information:

It is ordered, This 19th day of May 1961, that, effective June 5, 1961, Part 3 Radio Broadcast Services, is amended as set forth below.

(Sec. 4, 48 Stat. 1066, as amended; 47 U. S. C. 154. Interprets or applies sec. 303, 48 Stat. 1082, as amended; 47 U. S. C. 303).

Released: May 22, 1961.

FEDERAL COMMUNICATIONS COMMISSION

[SEAL] BEN F. WAPLE, *Acting Secretary*.

1. Section 3.902 is amended to read as follows:

§ 3.902 Object of plan.

The aim of this plan is to minimize the navigational aid that may be obtained from the continued operation of broadcast stations and to fulfill other national security requirements while at the same time providing for transmission of vital information to the public. During a CONELRAD Radio Alert condition, when not broadcasting vital information, stations operating in the Emergency Broadcast System may, on their own responsibility, broadcast such other programs as they may desire.

2. Section 3.913 is amended to read as follows:

§ 3.913 Emergency Broadcast System (EBS).

The Emergency Broadcast System consists of broadcast stations and interconnecting facilities which have been authorized by the Commission to operate in a controlled manner during a war, threat of war, state of public peril or disaster or other national emergency.

3. Section 3.930 (f) is amended to read as follows:

§ 3.930 Notification of a CONELRAD Radio Alert.

* * * * *

(f) During the experimental period many broadcast stations may be off the air. All broadcast stations will be supplied with a list of 24-hour broadcast stations at least one of which must be monitored during any period of operation when the regularly used station is not on the air.

4. Section 3.932 (a) is amended to read as follows:

§ 3.932 Operation during a CONELRAD Radio Alert.

(a) Those stations which are authorized to participate in the Emergency Broadcast System will immediately begin operations on assigned frequencies in accordance with the terms of their National Defense Emergency Authorizations and current operating instructions. Except as provided in paragraph (b) of this section, all other broadcast stations will observe radio silence until the CONELRAD Radio All Clear is issued by appropriate military authority.

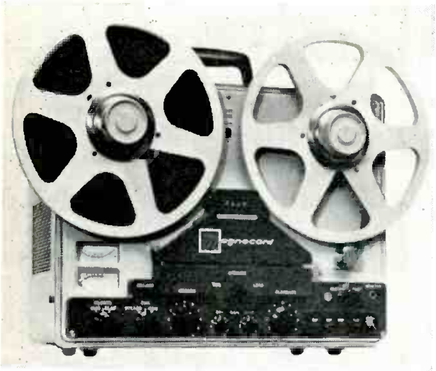
5. Section 3.940 is amended to read as follows:

§ 3.940 Notification of a CONELRAD Radio All Clear.

The CONELRAD Radio All Clear notification will be transmitted through the same channels as the CONELRAD Radio Alert. Stations operating in the Emergency Broadcast System will transmit the CONELRAD Radio All Clear Message on an Emergency Broadcast System frequency. All standard, commercial, FM, and TV stations, upon resuming regular authorized operation will follow the prescribed procedure and immediately broadcast the CONELRAD Radio All Clear Message.

(F. R. Doc. 61-4935; Filed, May 25, 1961; 8:51 a.m.)

Product News



NEW MAGNECORD 748 SERIES TAPE RECORDER/REPRODUCER

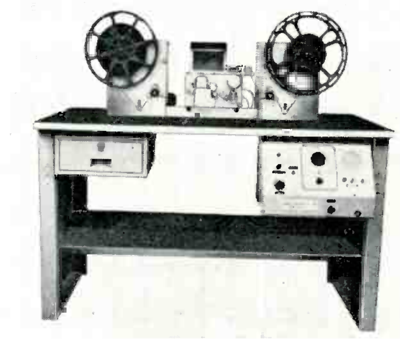
The new Magnecord 748 series tape recorder/reproducer has been announced by Midwestern Instruments, Inc., P. O. Box 7186, Tulsa, Okla. The unit has 3¾ ips and 7½ ips tape speed, and is built to meet professional performance standards.

The 748 is said to be capable of stereophonic, monophonic and sound-on-sound recording, accommodates up to 10½-inch reels and can be ordered with ½-track or ¼-track play heads. It is available for custom cabinet or rack mounting, or with a portable case for carry-around use.

A direct-drive hysteresis synchronous motor is designed to provide timing accuracy of plus or minus three seconds in 30 minutes of playing. At 7½ ips, frequency response is 40 to 15,000 cps, plus or minus 2db, and flutter and wow is held to 0.15 per cent.

Simplified operation is provided by the push button controls, and tapes are handled gently even at 24 ft. per second rewind or high forward speed, the manufacturer reports. The tape is lifted from the heads under these conditions.

Pre-amp output is 2 volts, and inputs are through two high impedance microphones and two high impedance bridges. Low impedance (professional) inputs and outputs are optionally available through the use of input and output transformers. By using individual record and reproduce amplifiers, input and output can be monitored orally or visually through two illuminated VU meters—one for each channel. Speaker/amplifiers for the 748 are available as optional equipment.



CECO HIGH-SPEED EDITING TABLE

A new high-speed editing table and viewer for rapid film scanning has been introduced by Camera Equipment Co., Inc., 315 W. 43rd St., New York.

The new unit is available in both 16mm and 35mm models, and is said to be ideal for television stations and film libraries where rapid inspection of prints, insert spots and commercials is required before release. The editing table features high-speed, scratch-free operation from 0 to 250 ft. per minute in both forward and reverse, and also has the ability to stop the film action on a single frame instantaneously without damage to the film, the manufacturer states. Built to government specifications, the easy-to-thread professional viewer has a large 4 x 6-inch brightly illuminated screen, and comes equipped with a footage counter and optical sound head.

FLUTTER BOOKLET FOR ENGINEERS

Amplifier Corp. of America, 396 Broadway, New York 13, N. Y., announces the publication of a new technical booklet, "Flutter, Its Nature, Cause and Avoidance," written by N. M. Haynes. This report gives a comprehensive analysis of mechanical problems, the effect of flutter, and the proper means of measurement.

Any engineer who maintains tape machines, sound projectors, or transcription units should request this free booklet for reference reading.

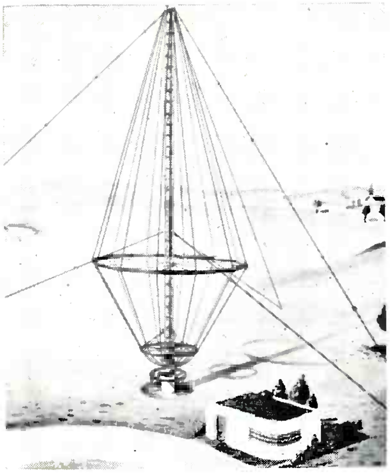
CORRECTION

A typographical error appeared in the April issue concerning the appointment of Jan Bleeksma to Ampex. The corrected title should be: "Bleeksma Named Vice-President at Amperex."

UHF TV Antenna to be Built Atop Empire State Bldg.

Melpar, Inc., will develop a special UHF television antenna which will transmit from atop New York City's Empire State Bldg. as a part of a system to assess the merits of ultra high frequency in comparison with lower frequency transmissions in metropolitan areas, it was announced by Melpar president, Edward M. Bostick. Completion of the antenna, to be built and installed under a $248,000 contract from the Federal Communications Commission, is scheduled for early November. The project is under the direction of Dr. Robert Wayne Masters, manager of Melpar's antenna laboratory.

The antenna will be designed to function in Channel 31 (572-578 mc) at a nominal wavelength of .523



meters. The pattern of the antenna will be substantially circular in azimuth, in order to provide equal signal in all directions, and specially shaped to approximate a cosecant function in the vertical plane in order to utilize the limited amount of radio frequency power most advantageously.

The last session of Congress appropriated funds for the government-controlled experimental operation.

Advertisers' Index

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

EQUIPMENT FOR SALE

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

EQUIPMENT for SALE—Sell for $200 off new price—Ampex 601 full track portable tape recorder and Ampex 620 Amplifier-Speaker, like new. Used less than 15 hours. New Price $784. RODDICK, 5105 East Sunset Drive, Yakima, Washington. 6-61 1t

BUY, SELL OR TRADE

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

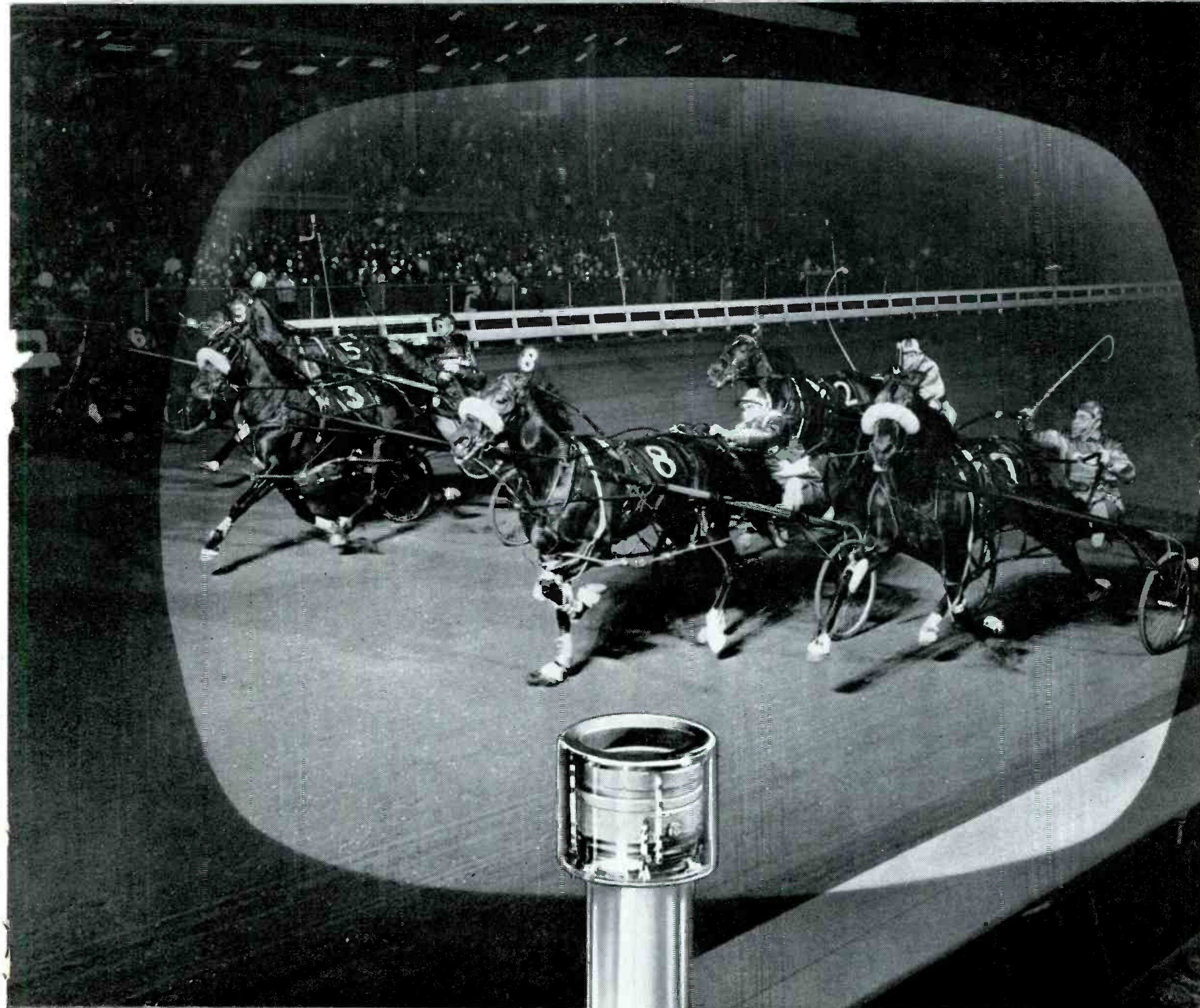
INSTRUCTION

1st Phone Exam prep course. Train now in New York City. This is the successful course formerly taught for years at other leading NYC broadcast schools. Proven Methods. Proven Results. Day and evening sessions. Announcer Training Studios, 25 West 43rd St., N.Y.C. Oxford 5-9245. 4-61 3t

POSITION WANTED

TELEVISION MAINTENANCE ENGINEER 5½ years major network. Color, Black and White, Ampex, RCA Videotape. 20 years theatre sound and projection. Desire closed circuit or good foreign contact. Broadcast Engineering, Dept. 179, Kansas City 5, Mo. 6-61 1t

Professional Services



THE LIGHTS WENT OUT... BUT NOT THE PICTURE

Thanks to the super-sensitivity of the RCA-4401-V1 Image Orthicon

One night last season at New York's Yonkers Raceway, halfway through a race, an entire bank of lights went out near the finish line. Yet with only a quick camera adjustment, TV pick-up of the rest of the race came in sharp and clear with the RCA-4401-V1 image orthicon.

So sensitive is the 4401-V1 that it produces an excellent picture of a difficult low-key subject (horses against a dark track) with an incident light level of no more than 20 footcandles on the track itself. And it could easily operate at half that amount of light!

The 4401-V1—expressly designed for remote B&W pickup at very low light levels—is but one of the broad RCA family of specialized image orthicons. Others include:

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

RCA-7513: Featuring special precision construction and new RCA field-mesh design for high quality color or B&W TV.

RCA-7293-A: A field mesh image orthicon having an image section designed to prevent highlight ghosts. Field mesh design to improve corner focus and prevent porthole effects. For B&W studio and outdoor pickup.

RCA-7295-A: A 4½ inch diameter field-mesh image orthicon with high resolution and very high signal-to-noise ratio, designed for tape and B&W studio broadcast use.

RCA-7389-A: A superior-quality field-mesh design 4½ inch image orthicon, with extremely high signal-to-noise ratio, for tape and exceptionally high-quality B&W studio pickup.

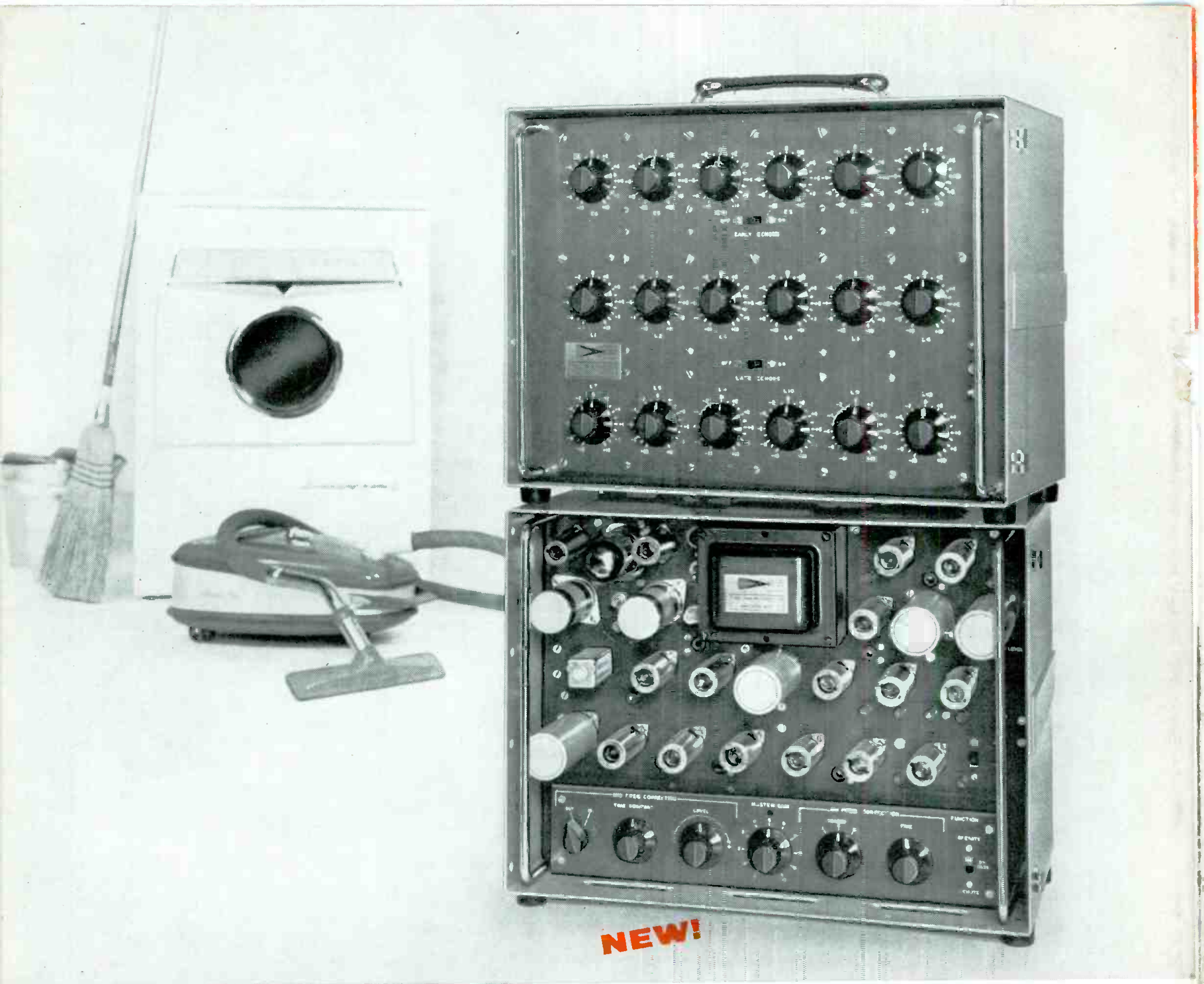
RCA-5820-A: For studio and outdoor pickup in B&W. The "standard" of broadcasting.

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

RCA®

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

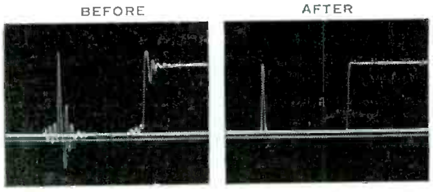


...but only the *"Twenty/Twenty"* cleans up video transmission distortion

BEFORE AFTER

Photos, taken a few seconds apart, show how the Model 20/20 cleans up smears, overshoots, ringing and other waveform defects.

BEFORE AFTER



Waveform correction is illustrated by before-and-after photos of an expanded portion of Sine^2-test signal. The Model 20/20 can be used with any desired test signal for pre-broadcast, or on-the-air correction.

The Model 20/20 Time Domain Equalizer is Telechrome's ingenious application of the proven "paired echo" principle to the problems of video transmission and video tape recording. Result: for the first time a practical, commercially-priced instrument that eliminates overshoots, ringing, smears and other waveform defects from monochrome, color, composite and non-composite signals.

Portable or rack-mounted, the Model 20/20 can be used anywhere in a television system. At the terminal end it eliminates difficulties regardless of where they originate. It is equally effective for pre-broadcast or on-the-air correction. And Telechrome's engineers have made it simple enough for easy use by anyone after only a brief demonstration. See for yourself how the Model 20/20 dramatically cleans up transmission quality, assures continuous broadcast fidelity for maximum viewer and advertiser appeal.

For a demonstration, contact H. C. Riker, Vice-President, Marketing.

TELECHROME

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