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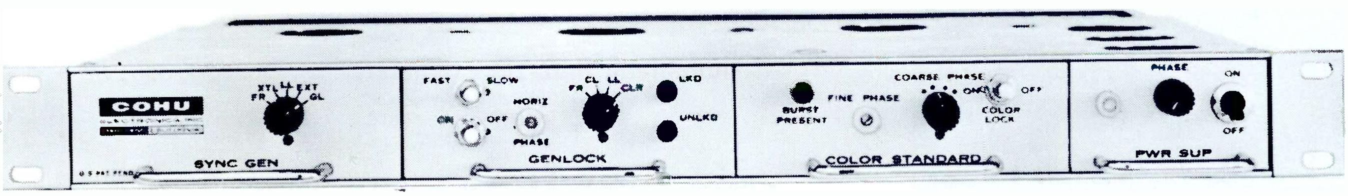

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the technical journal of the broadcast-communications industry

Broadcast Engineering

Volume 9, No. 7 July, 1967

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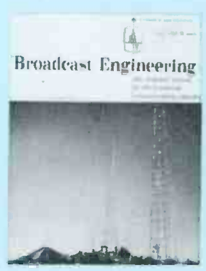
Features

Departments

Mt. Wilson, at Los Angeles, is indeed a "busy" place for broadcasters, as this month's cover photo shows. In the foreground are the tower and transmitter building of KCET, whose facilities are remote controlled from the Hollywood studio. Read about this interesting installation starting on page 26.



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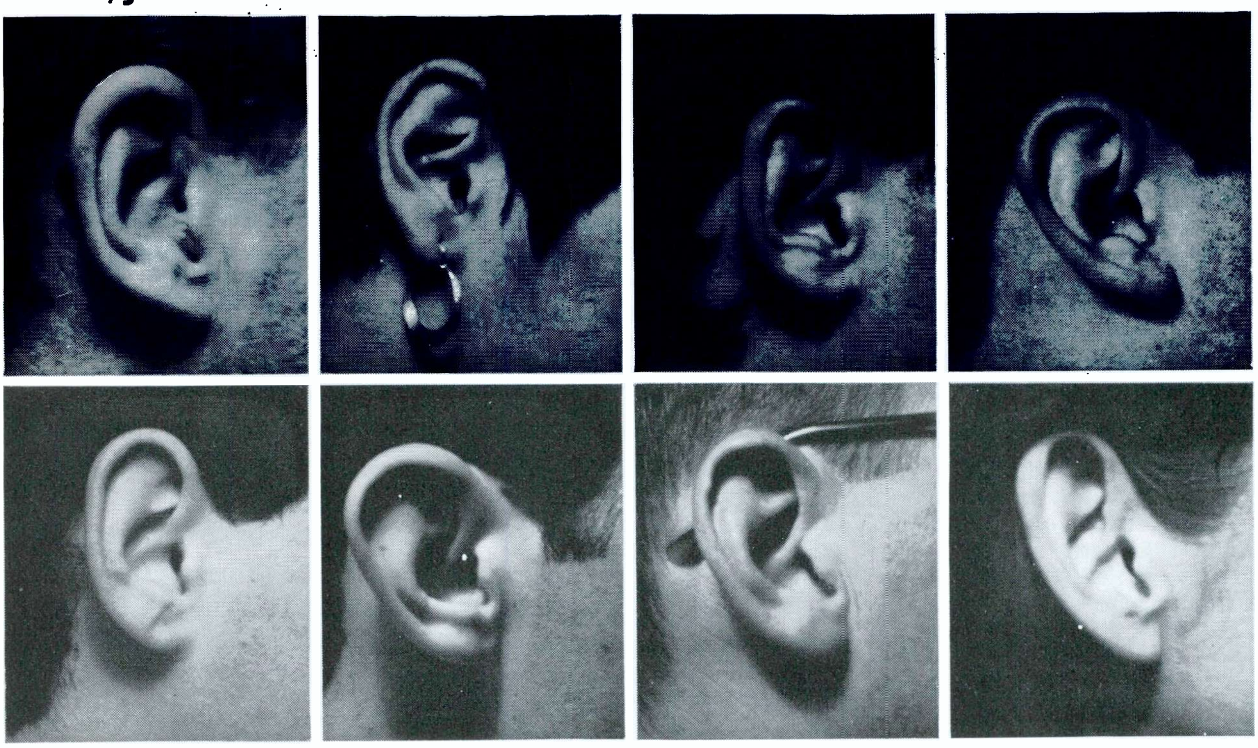

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Write to us for further information on CBS Laboratories' loudness indicator and automatic loudness control.

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BOOK REVIEW

Electronic Designer's Handbook: T. K. Hemingway; Business Publications Limited, London, 1966; 296 pages, 5½" x 8½", hard cover; $8.82 (63 shillings).

In this book, intended to introduce just-graduated engineers to the principles of practical semiconductor-circuit design, emphasis is given first to a complete examination of a few elementary circuits. This approach is intended to provide a thorough knowledge of the basic techniques which underlie the development of any other circuit.

Armed with this concept of fundamentals, the reader is then led to the synthesis of more complex circuitry. The designer is shown how to tie elementary ideas together in the solution of a problem, while allowing for limiting parameters such as temperature coefficients, operating voltages, and the effects of frequency. This results in the selection of specific semiconductors by type and operating characteristics, and the application of alternate subcircuitry.

The concluding portion of the work deals with the pitfalls encountered in practical design, particularly with respect to prototype testing, and the steps to be taken when failure or unsatisfactory results are obtained.

The appendixes are complete mathematical analyses of a number of the circuits described in the book. A short explanation of certain transistor data, with reference to parameter and rating symbology, is also given.

Since mathematics used in the main text does not go beyond advanced algebra, the volume should be useful to the advanced technician as well as the engineer. A good working knowledge of semiconductor phenomena is, however, essential, and some idea of the principles of circuit analysis would also be beneficial. ▲

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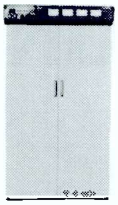

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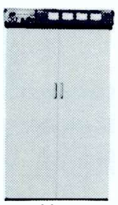

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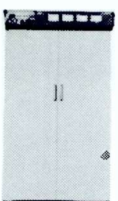

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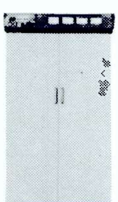
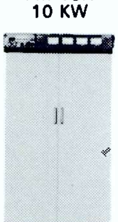


FM-10H
10 KW



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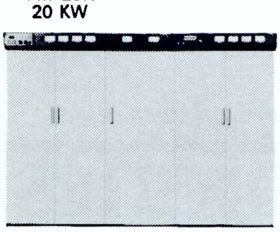
20 KW



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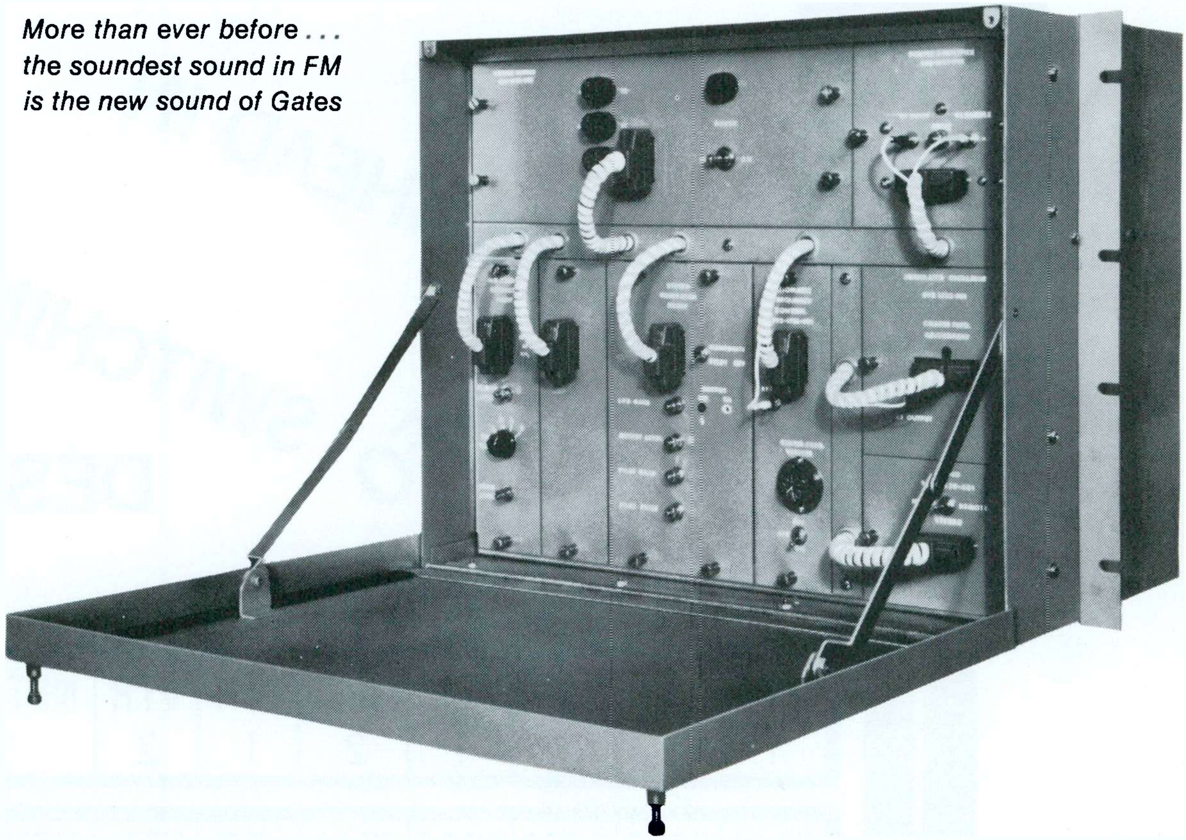

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DELAY LINE LOGIC FOR VIDEO SWITCHERS

by Roy H. Seim*

The use of delay lines to effect a smooth transition in video switching is given detailed treatment.

Smooth transistion between video sources is now possible through the use of solid-state switching and computer-type logic. Switching systems using special-effects generators, and faders using a single or double re-entry system, however, require delay-line switching. How this switching is accomplished without introducing a noticeable transient into the picture will be discussed in detail.

Vertical-Interval Switching

Vertical-interval switching is accomplished by gated flip-flops which are controlled by the external control equipment. Whenever a control switch is actuated, a control voltage is applied to the associated flip-flop, which changes state at the next clock pulse following the application of the control voltage.

Clock pulses are provided by a multivibrator which is triggered by vertical-drive pulses. Since the clock pulses are synchronized by the vertical-drive pulses, they are in synchronization with the complete video system. In order to attain video switching at the desired instant, however, the clock pulses are delayed an appropriate interval by the multivibrator before being applied to the flip-flops. The amount of delay is adjustable to allow precise time location with respect to the vertical blanking interval.

The schematic diagram of a vertical-interval control card is shown in Fig. 1. The control circuitry on each card consists of five identical flip-flop and relay circuits.

In the normal state (switch point controlled by this flip-flop is open), Q11 conducts and Q12 is off. The clock line connected to terminal 35 is normally at +10 volts and goes to approximately −5 volts shortly before the clock pulse is generated. When the external control equipment selects flip-flop Q11/Q12 to be switched, a −7-volt level is applied to terminal 34. (For direct control of a flip-flop by momentary contact closure, the control level, −7 volts, is routed through a low-value resistor prior to being switched to a control line before the next clock pulse occurs; the junction of C11 and R11 is allowed to go to approximately −5 volts.) When the clock pulse returns to its normal state, the junction of C11 and R11 returns to +10 volts and provides the positive pulse necessary to turn off Q11, thereby switching the flip-flop. The resulting +10 volts at the collector of Q12 provides the control signal, via pin 22, to turn on the associated video switch point in the switching matrix. When Q12 conducts, K11 energizes and provides (for tally purposes) contact closures associated with the video switch point.

The −7-volt control level from the external equipment is also routed by way of D13 and pin 33 to pin 33 (or equivalent) of all other flip-flops associated with the same video output. This enables the clock pulse to reset any flip-flop which had previously been switched. Diode D12 is used to clamp the Q11/Q12 reset-circuit clock input to −7 volts, thereby preventing a set pulse and a reset pulse from being applied simultaneously to the flip-flop being set.

Each control line also has associated with it a capacitor which returns to the −7-volt supply. These

* Project Engineer, Cohu Electronics, Inc.

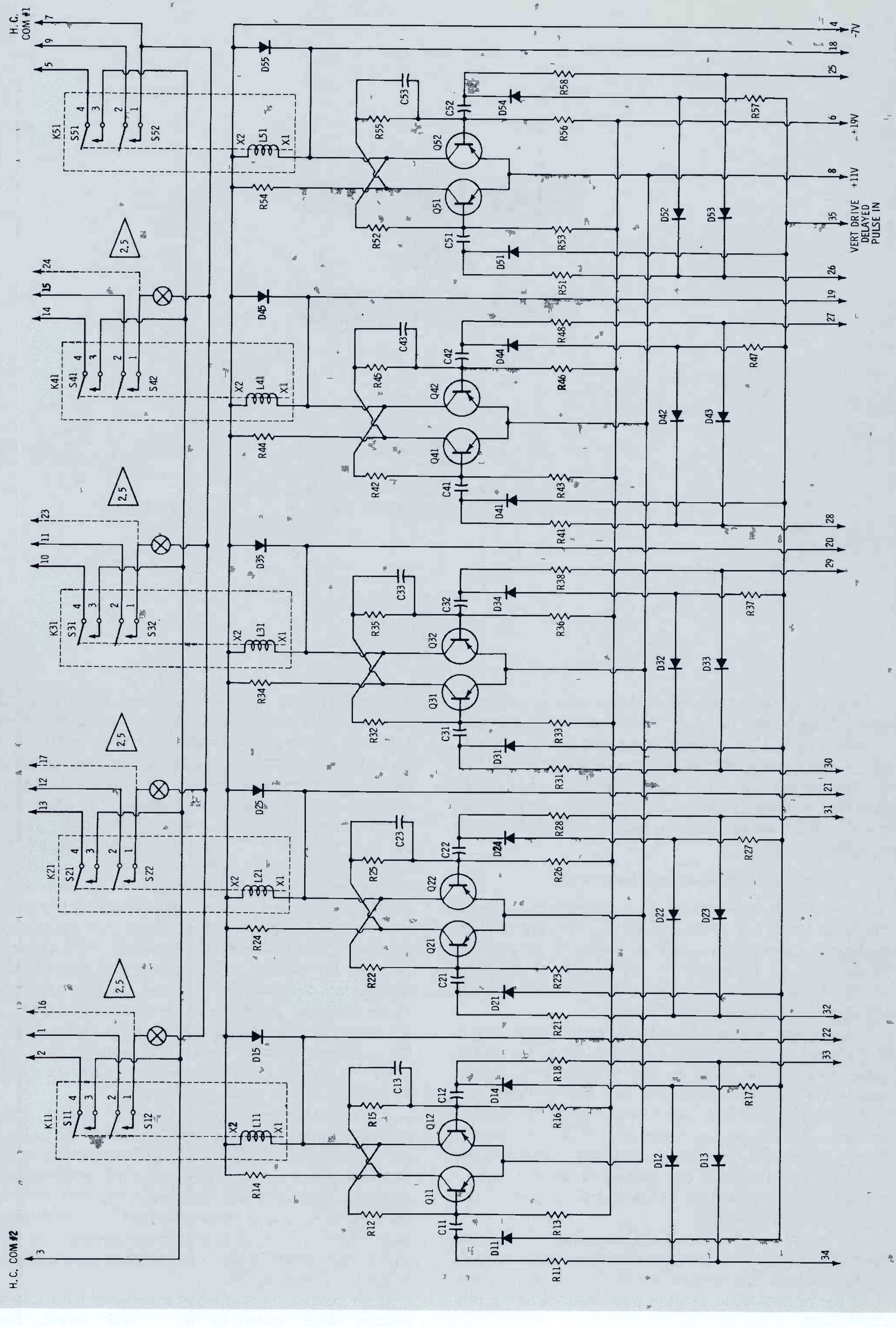

Fig. 1. Schematic diagram of one vertical-interval control card relates five identical flip-flop and relay circuits.

capacitors, in conjunction with the common low-value resistor, restrict the rise and fall times of the control level, thus preventing the voltage-level changes on the control line from setting or resetting a flip-flop.

When a flip-flop is controlled by an output from a logic card, the necessary time constant is provided on the logic card. In this case, the -7-volt supply is switched directly to the input of the logic card.

Delay in the Video Path

In a video switching system which includes equipment such as a fader unit and a special-effects unit, an additional delay occurs when the video is switched through the units. The delay depends on whether the video passes through both units, one unit only, or neither unit.

Since it is desirable that the delay times for all video signals be equal, equalizing delays (in some cases in the form of cables) are inserted in the video paths. This is accomplished so that the delay of each signal is equal to the maximum delay possible in the system: the summed delays of the fader unit, the special effects unit, and the appropriate sections of the switching matrix.

Delay lines are switched in and out of the horizontal video buses in the matrix by switching circuits. (The switching circuits are identical to those used for switching the video inputs on the horizontal buses.) The switching provides two parallel paths enabling the video to pass through the delay line or to bypass it.

When a push button on the control panel is pressed (to switch video on a horizontal bus), delay lines are switched in or out of the appropriate video path automatically in order to provide the proper delay. The function of determining which automatic switch points shall close for a given set of conditions is performed by the logic circuit.

The Logic Circuit

A switcher control unit may have one or two logic cards, depending on the number of re-entries. A schematic diagram of the logic-card circuit is shown in Fig. 2. In the following paragraphs are covered the schematic diagram in conjunction with a typical logic-circuit control diagram (Fig. 3), and then the logic equations as applied to a typical switching matrix (Fig. 4).

The logic circuit is comprised of diode gates, emitter followers Q1 through Q7, and inverters Q8 through Q11.

Each of the emitter-follower outputs, SA, SD, SH, SK, SG, SI, SE, and SR, and each of the outputs SC and SF controls a flip-flop. Each flip-flop controls a switch point in the video switching matrix; some of these flip-flops also provide logic-circuit inputs $\bar{F}$, $\bar{C}$, $\bar{G}$, $\bar{H}$, $\bar{I}$, and $\bar{K}$.

The flip-flops are on vertical-interval control cards and are identical to those discussed previously. All flip-flop outputs are taken from the bar-letter side; the other side is not used. When the bar-letter side of the flip-flop conducts, the associated switch point closes; this is the "set" state of the flip-flop.

Other inputs of the logic circuit come from control-panel push-button switches that control, via flip-flops, manual switch points in the video switching matrix. The inputs designated W_B and X_B come from a set of contacts, on each push-button switch, that is separate from the contacts used for controlling the manual switch points; each of these inputs is provided by any of the push-button switches used for switching the video on the same horizontal bus (Fig. 4). Each of the inputs Y_B, Z_B, C_B, and F_B comes from a separate push-button switch.

There is no output (open circuit) from the push-button switches to the logic circuit until a push button is pressed; then a control voltage of approximately -7 volts is applied to the gates. The output of a flip-flop to the logic circuit is at either of two voltage levels: approximately -6 volts when a flip-flop is in the reset state (associated switch point open), and approximately $+10$ volts when it is in the set state (associated switch point closed).

Input $\bar{C}$, in addition to being applied to gates, is applied to inverter Q10. The inverter output, C, is the complement of the input, and is also applied to gates which control emitter followers.

Input $\bar{F}$ is applied to gates and to inverter Q11.

Inputs $\bar{G}$ and $\bar{H}$ are applied to gate D45/D46/Q8. When $\bar{G}$ and $\bar{H}$ are negative, the output of Q8 (G or H) is approximately $+10$ volts. This voltage is fed to gates which control emitter followers. When $\bar{G}$ or $\bar{H}$ is positive, the Q8 output (G or H), which is the complement of the input, is approximately -6 volts. (Note that $\bar{G}$ and $\bar{H}$ cannot be positive simultaneously, since only one switch point on the same horizontal bus can be closed at any one time.)

Inputs $\bar{I}$ and $\bar{K}$ are applied to gate D47/D48/Q9, which functions in the same way as the gate discussed in the previous paragraph.

Each of the emitter followers is controlled by one of seven diode-gate outputs. In the quiescent state, the base of the emitter follower is positive, and the emitter follower output is approximately $+10$ volts. When the output of a gate to the base is negative, the emitter-follower output changes to approximately -6 volts. This permits the next clock pulse to set the associated flip-flop, which closes the switch point.

When a push button is pressed, a gate provides negative output unless it is inhibited by a positive input. For example, the gate controlling Q1 has four inputs: W_B and X_B from push buttons, and $\bar{C}$ and $\bar{F}$ from flip-flops. Pressing one of the W_B push buttons closes the two switch points controlled by Q1 only if the switch point associated with $\bar{F}$ is open; pressing one of the X_B push buttons closes the two switch points only if the $\bar{C}$ switch point is open.

When, in this example, a W_B push button is pressed and $\bar{F}$ is negative, the negative control voltage from the push-button switch passes through the gate. If $\bar{F}$ is positive, D3 conducts, clamping the D3/D1/R3 junction positive, and the control voltage is blocked. Similarly, the control voltage from an X_B push button passes through the gate if $\bar{C}$ is negative, or is blocked when $\bar{C}$ is positive and D4 conducts, clamping the D4/D2/R4 junction positive.

Some of the gate circuits controlling other emitter followers have more than four inputs, including inputs

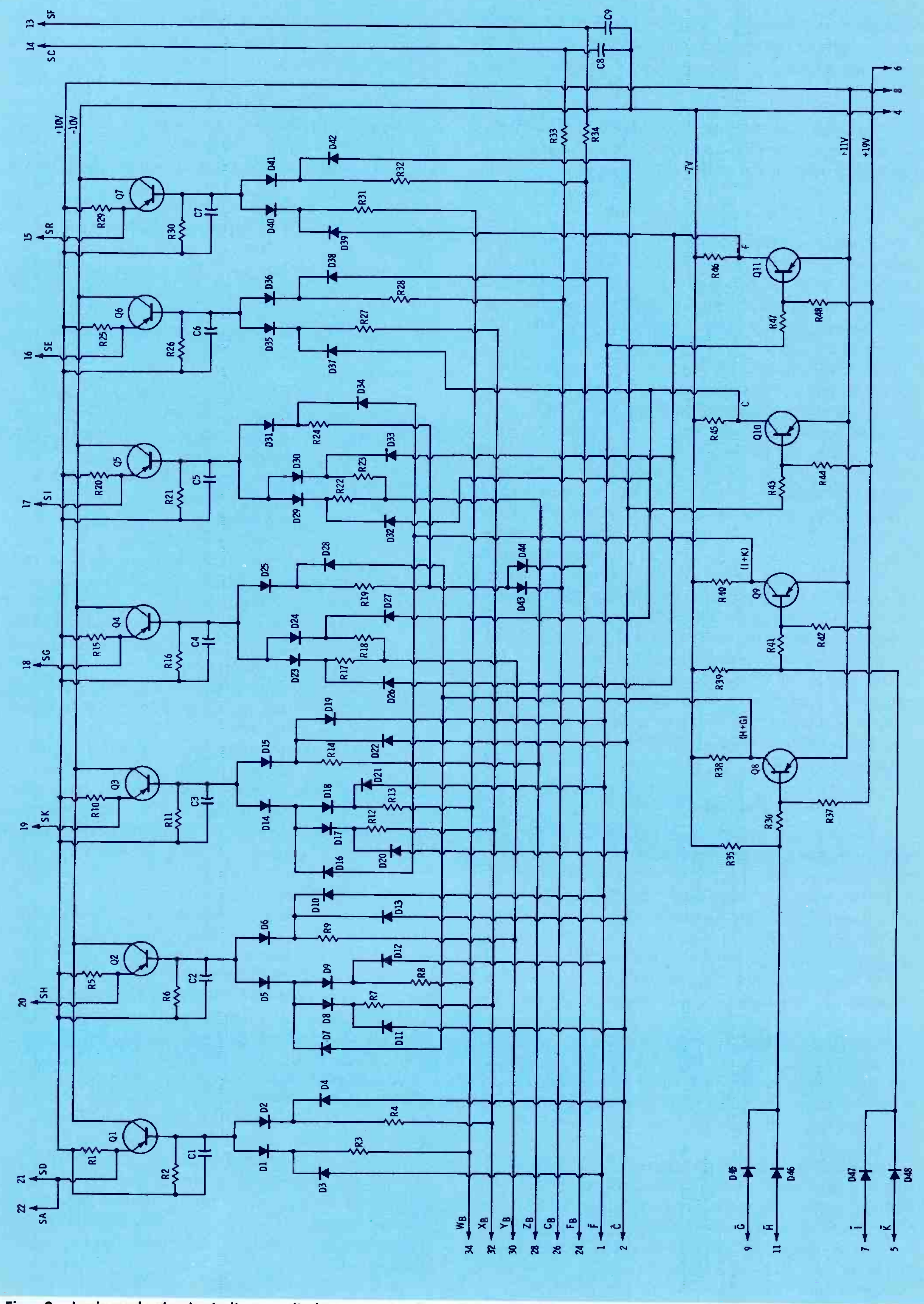

Fig. 2. Logic-card circuit indicates diode gates, emitter followers Q1 through Q7, and inverters Q8 through Q11.

from the inverters, but they all function on the same principle as the gate discussed in the example.

Video Switching System

To aid understanding how the logic circuit functions, a typical example of a video switching system, which includes a fader unit and a special-effects unit, is shown in Fig. 4. Only the video paths are shown. The reference designations of the switch points in the figure correspond to the inputs and outputs of the logic circuit in Fig. 3. (The outputs are prefixed S, meaning "set," in reference to the associated flip-flop).

A few points should be made with respect to Fig. 4. The reference designations with suffix 1 are associated with one logic card, and those with suffix 2 are associated with a second logic card. Logic-card inputs with suffix B originate at a push button. There is always one, but only one, switch point on a horizontal bus in the closed condition at any one time; when a switch point closes, any other closed switch point on the same horizontal bus opens. Thus, when a switch point closes, the video on the horizontal bus is replaced by the video coming through that point. The delay of each of delay lines, 1, 2, and 7, is equal to the summed delay of the special effects unit and one section of the switching matrix. The delay of each of delay lines 3, 4, and 8 is equal to the summed delay of the fader unit and one section of the switching matrix. The delay of each of delay line 5 and 6 is equal to the summed delay of the fader unit, the special-effects unit, and two sections of the switching matrix. Reference designations in parentheses are shown adjacent to the controlled switch point(s).

The logic circuit functions so that, as the video inputs are routed to the desired outputs, delay lines are automatically switched in and out of the video paths to delay-equalize the video signals. When the same video passes through the fader unit and the special-effects unit, no delay lines are inserted in the video path because this is the longest path, and therefore, provides the maximum delay between any input and output channels. The delay of every other video path is increased, by the insertion of a delay line, to equal the delay of the longest path. When a video signal passes through only one of the units, a delay line, equal to the summed delay of the other unit and the section of the matrix through which the video does not pass, is inserted in the path of the signal.

Designations of the automatic switch points and the C and F manual switch points are prefixed S at the left side of the logic equations. The S means that the flip-flop associated with a switch point "sets," and therefore the switch point closes, whenever any of the conditions indicated on the right side of the equation exists. These conditions are the only ones that cause the switch point to close. On the right side of an equation, a bar-letter designation indicates that the referenced switch point must be open to cause the switch point indicated on the left side of the equation to close when the referenced push button is pressed. Conversely, the unbarred designations indicate that the referenced switch point must be closed. In the following discussion, the logic equations using the switch-point designations suffixed 1 as examples also apply to the switch points having designations suffixed 2.

Equation A. $SC = C_B$ and $SF = F_B$. These two equations mean that when the push button is pressed, the switch point closes, switching video from the fader unit to the special effects unit or vice versa. For example, pressing push-button C_{B1} causes switch point C_1 to close, switching video from the special effects unit to the fader unit. Video from the fader unit is switched to the special effects unit when, for example, F_{B2} is pressed, causing F_2 to close.

Equation B. $(SA)(SD) = W_B\bar{F} + X_B\bar{C}$. This equation means that when condition $W_B\bar{F}$ or $X_B\bar{C}$ exists, switch points A and D close. (A and D function as a pair; both open or close simultaneously.) These conditions prevent delayed video from entering the special effects unit (or the fader unit) unless the opposite input is selected for fader (or special effects) re-entry. Under these conditions a video input does not require delay at this point, because it is not mixed (in the fader or special effects unit) with delayed video. For example, if F_1 is not closed, when one of the push buttons is pressed to switch video on the W_{B1} bus, A_1 closes. Thus, the video from W_{B1} bus is switched by A_1 to the fader unit, and therefore bypasses delay line 1. Similarly, if C_1 is not closed, video from the X_{B1} bus is switched by D_1 to the fader unit, bypassing delay line 2.

Equation C. $SB = W_BF + F_B\bar{C}$. When condition W_BF or $F_B\bar{C}$ exists, switch point B closes. Under these conditions, video from a W_B bus is delayed because it is mixed in one unit with video that has been delayed by the other unit. For example, if F_1 is closed, when one of the W_B push buttons is pressed, video from bus W_{B1} passes through delay line 1 to the fader unit so that its delay is equal to that of the video coming from the special effects unit. The other condition for closing B_1, for example, is that C_1 must be open when push button F_{B1} closes F_1.

Equation D. $SE = X_BC + C_B\bar{F}$. When condition X_BC or $C_B\bar{F}$ exists, switch point E closes. These conditions are similar to those in equation C. However, whereas equation C indicates the conditions for switching video from the W_B buses through delay lines 1 or 3, equation D indicates the conditions for switching video from the X_B buses through delay lines 2 or 4.

Equation E. $SH = (W_B\bar{F} + X_B\bar{C})(G + H) + Y_B\bar{C}\bar{F}$. When conditions $W_B\bar{F}G$, $W_B\bar{F}H$, $X_B\bar{C}G$, $X_B\bar{C}H$, or $Y_B\bar{C}\bar{F}$ exists, switchpoint H closes. These conditions permit a video input to pass through the fader unit or the special effects unit to output 1. Under these conditions, video from the fader unit passes through delay line 7, or video from the special effects unit passes through delay line 8. Since it passes through only one of the units, the video must also pass through delay line 7 or 8 to achieve delay equalization. In the first four conditions, $W_B\bar{F}$ and $X_B\bar{C}$ cause switch points A and D to close (refer to equation B). The additional condition here is that G or H may be closed. For example, if G_1 is closed when video is switched on the W_{B1} bus, and F_1 is open, H_1 closes causing G_1 to open, and the video from the fader unit passes through delay line 7 and switch point H_1 to output 1. The conditions that include

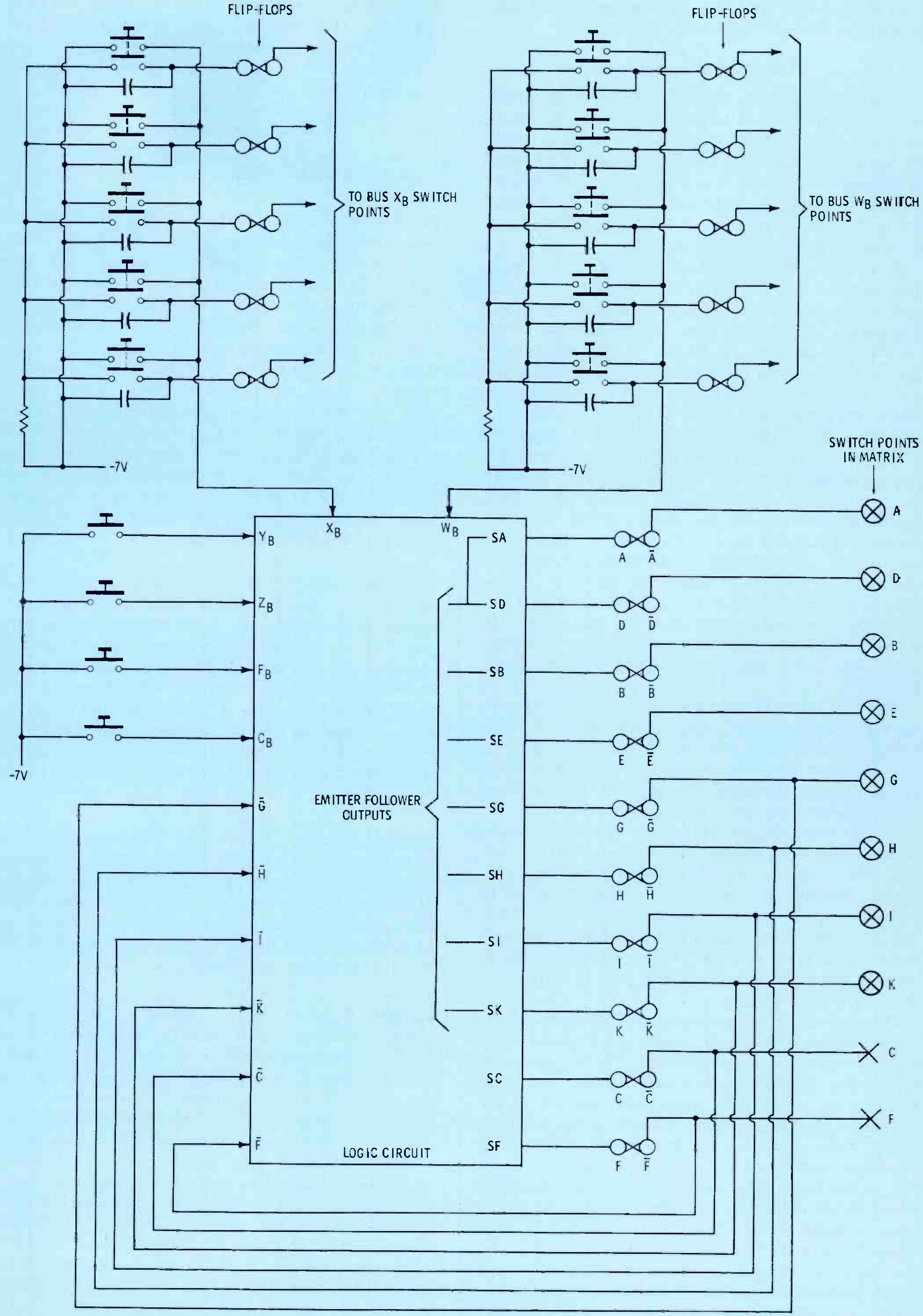

Fig. 3. Logic-circuit control diagram shows how flip-flops are connected to the switching matrix through logic card.

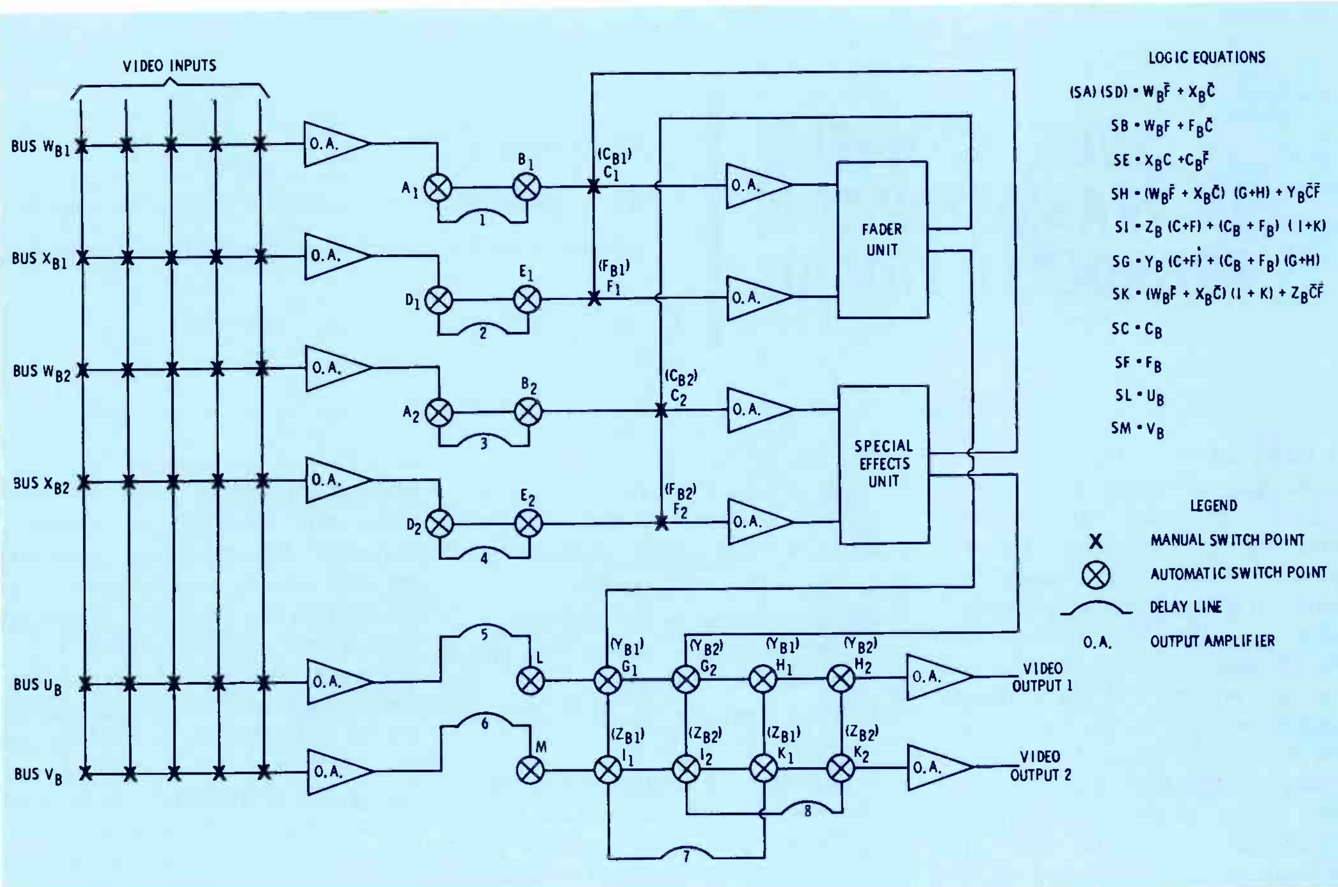

Fig. 4. Typical switching matrix for system including fader and special-effects units with useful logic equations.

switch point H indicate the conditions where H_1, for example, is already closed when video is switched on, say, bus X_{B1} and C_1 is open. The remaining condition, $Y_B\bar{C}\bar{F}$, means, for example, that if C_1 and F_1 are open (that is, video from the special effects unit is not passing through the fader unit) when push button Y_{B1} is pressed, H_1 closes and switches the video from the fader unit through delay line 7 to output 1.

Equation F. $SK = (W_B\bar{F} + X_B\bar{C})(I + K) + Z_B\bar{C}\bar{F}$. When condition $W_B\bar{F}I$, $W_B\bar{F}K$, $X_B\bar{C}I$, $X_B\bar{C}K$, or $Z_B\bar{C}\bar{F}$ exists, switch point K closes. These conditions are similar to those in equation E because they permit a video input to pass through the fader unit or the special effects unit and through delay line 7 or 8. However, where equation E indicates the conditions for switching the video to output 1, equation F indicates the conditions for switching the video to output 2.

Equation G. $SI = Z_B(C + F) + (C_B + F_B)(I + K)$. When condition Z_BC, Z_BF, C_BI, C_BK, F_BI, or F_BK exists, switch point I closes. These conditions permit a video input to pass through the fader unit and the special effects unit to output 2. Since, under these conditions, the video passes through both units (maximum delay), it does not require further delay. For example, provided C_1 or F_1 is closed, pressing push button Z_{B1} closes I_1, thereby switching the video from the fader unit, not via delay line 7, but directly to output 2. Other conditions indicate, for example, that if K_1 is closed when C_{B1} closes C_1, or F_{B1} closes F_1, switch point I_1 closes. The conditions that include switch point I indicate the conditions where I_1, for example, is already closed when C_{B1} closes C_1, or F_{B1} closes F_1.

Equation H. $SG = Y_B(C + F) + (C_B + F_B)(G + H)$. When condition Y_BC, Y_BF, C_BG, C_BH, F_BG, or F_BH exists, switch point G closes. These conditions are similar to those in equation G since they permit a video input to pass through the fader unit and the special effects unit. However, where equation G indicates the conditions for switching the video to output 2, equation H indicates the conditions for switching the video to output 1.

Equation I. $SL = U_B$. This equation means that when one of the push buttons controlling the video on bus U_B is pressed, switch point L closes. This condition permits a video input that does not pass through the fader unit and the special effects unit to be switched through delay line 5 to output 1. (Switch point L is caused to close by an additional set of contacts on each of the U_B push button switches.)

Equation J. $SM = V_B$. This equation is similar to equation I because it indicates the condition that permits a video input to bypass the fader and special effects units. However, where equation I indicates the condition for switching the video to output 1, equation J indicates the condition for closing switch point M, which switches the video through delay line 6 to output 2.

Conclusion

With all of the possible video paths equalized to the longest path, a smooth program change can be made without any noticeable horizontal shift in picture or color change. One of the techniques for accomplishing this equalization has been described. ▲

SOME PROBLEMS IN TRANSISTORIZING BROADCAST STUDIOS

*by A. Molchanovsky** — Some of the circuits used in transistorizing broadcast audio equipment are discussed.

Any attempt to transistorize broadcast equipment gives rise to a host of problems, most of which have excellent solutions. The first question is why transistorize? Actually, this was a problem some 5 years ago, when the transistor and the techniques of using it were still evolving rapidly, and circuit designs became obsolete before they reached the production stage. The wise decision of that time was to wait a little longer, let the art stabilize, and meanwhile experiment with pilot projects. In this way experience was gained in this new electronic art, and contributions were made to its technological growth.

The transistor has now "grown up," and its circuitry has become more and more standardized. In addition, the transistor has opened new avenues to the designer, unknown or unused during the "tube" period, and it is with these new techniques that this article will deal.

*Development Engineer,
Israel Broadcasting Authority

Let us review briefly the main advantages of replacing vacuum tubes with transistors. These include:

1. The transistor is smaller.
2. The transistor is less delicate.
3. The transistor consumes less power (no heater).
4. The transistor is less microphonic.

These are, of course, very important qualities, but the question asked by the designer is whether the use of transistors gives better results in the areas of noise, distortion, transient response, and consistency of manufacture.

The answer with respect to each factor is "yes." All this can be achieved quite easily in transistor circuits by using direct coupling between stages and large amounts of DC and AC negative feedback. DC feedback is needed to fix the operating points of the transistors and to make circuits insensitive to changes in transistor parameters and ambient temperature. AC feedback takes care of frequency response, harmonic distortion, and gain. Using this technique, it is possible to design building blocks of 20-30 dB gain which have less than 0.2% harmonic distortion and a flat frequency response in the range of 30 Hz-20 kHz. Silicon transistors are preferred, but with careful design, germanium transistors can be used without degrading the performance. Low-noise transistors should be used where necessary.

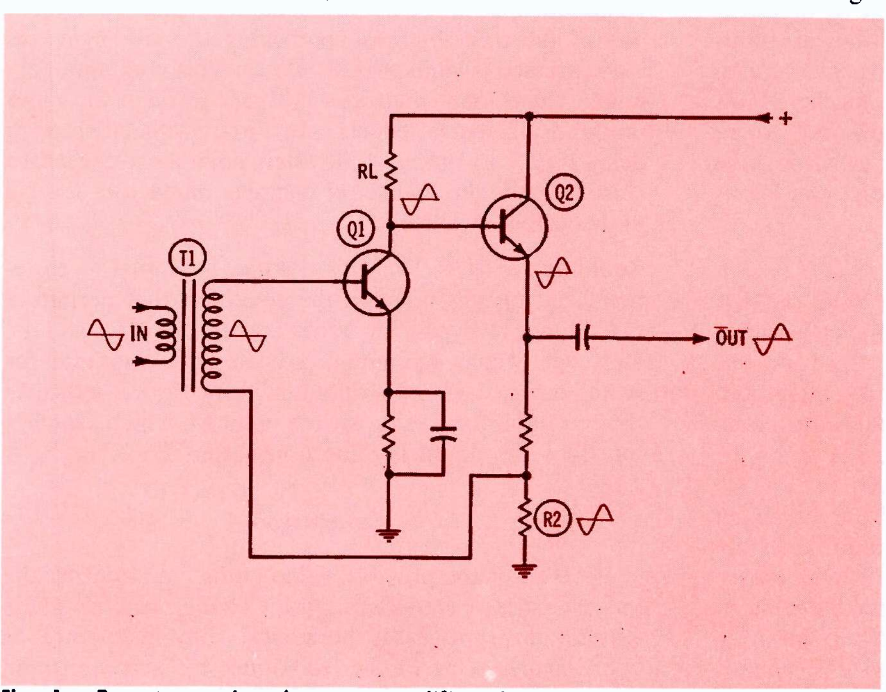

Fig. 1. Two-stage microphone preamplifier obtains negative feedback from R2.

Microphone Preamplifiers

As a first example of the employment of this technique, consider the microphone preamplifier, usually the first building block in a studio audio chain. There are several possible circuits, two of which are given in Figs. 1 and 2.

The circuit of Fig. 1 consists of a common-emitter stage directly coupled to a common-collector stage. This direct coupling fixes the operating point of the transistors to a value almost independent of transistor parameters or ambient temperature. The mechanism is as follows: Suppose the collector current of Q2 starts rising due to a change in ambient temperature or any other reason. A rise in this current results in a greater voltage drop across R2 and consequently results in more base voltage for Q1. This raises the collector current of Q1, and its collector voltage falls. Since the base of Q2 is connected directly to the collector of Q1, there is less voltage on the base of Q2, thus counteracting the rise in Q2 collector current which started the whole process. If the DC gain of the transistors is high, excellent stablization of the operating point is achieved.

Regarding the AC signal, the first

stage reverses the polarity and the second does not, so the signal appearing on R2 opposes the input signal. Thus the gain is stablized, the frequency response is extended, and the input impedance of Q1 is increased. This last point is very important. Consider input transformer T1. The input impedance of Q1 (R_i) is seen by the microphone as R_i/n^2, where n is the turns ratio of the input transformer. (As used here, "turns ratio" means the ratio of the larger number of turns to the smaller, in this case secondary to primary.—Ed.) This impedance must be at least 10 times higher than the impedance of the microphone so as not to load it and thereby distort its frequency response. From this it is obvious that high input impedance makes it possible to use a higher-ratio input transformer, and so a better signal-to-noise ratio is obtained. A primary/secondary ratio of 1:5 can be used for 50-ohm microphones, and a ratio of 1:3 for 200-ohm ones.

The next point of interest in this circuit is the problem of noise versus dynamic range. By keeping the collector current and voltage low, it is possible to obtain a very low noise figure. However, low collector current means that the input signal must be limited to rather small values so that the transistors are not overloaded. This is not a very serious problem when dynamic microphones are used, because their output is normally about −60 dBm and does not rise higher than about −35 dBm.

The story is quite different, however, when the amplifier has to accommodate certain condenser microphones as well. The output of some high-level condenser microphones can reach −20 dBm and even higher.

The solution in this case is to switch a 15-dB pad into the input of the amplifier and thereby reduce the input signal to a safe level. This, of course, does not reduce the noise at the output of the amplifier, and so the better signal-to-noise ratio which can be obtained with high-level microphones is lost. This, therefore, is not a very satisfactory solution.

Now consider Fig. 2. This circuit has more internal gain than the previous one, and so the stabilization is exceptionally good. The DC and AC negative feedback is obtained by feeding the emitter of the first transistor a bias voltage obtained from the voltage drop across R1. An interesting point concerning this circuit is that the amount of AC negative feedback can be changed by changing R2 (which bypasses the emitter of Q1 to ground). This does not disturb the DC conditions because the DC negative feedback remains unaffected.

This results in a better solution to the problem of switching from dynamic to high-output condenser microphones. By the insertion of a higher value of R2, the AC negative feedback is increased, and thus the signal between the base and the emitter of Q1 is decreased. At the same time, the noise at the output is reduced by the same amount as the gain, and a better signal-to-noise ratio is obtained when a condenser microphone is employed.

Other points of interest in preamplifier circuits are some ingenious design "tricks," the purpose of which is to "squeeze" all the available signal current from the circuit.

Again refer to Fig. 1. Consider the signal component of the collector current flowing out of the collector of Q1. There are two paths for this current to choose: collector load resistor R_L and the input resistance of Q2, which, in a common-collector circuit, is quite high. Obviously, some of the signal current will pass through R_L and will be lost to further amplification.

This loss can be prevented by the slight circuit change shown in Fig.

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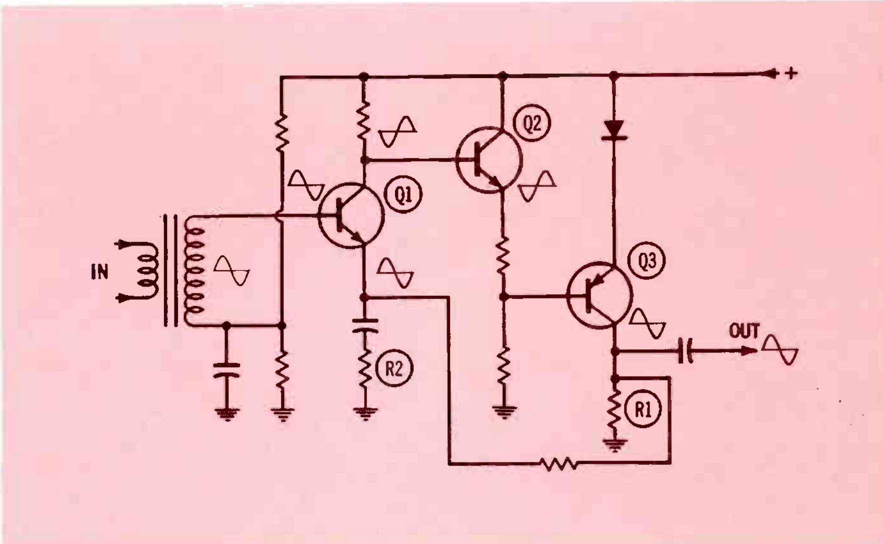


Fig. 2. Feedback voltage is applied to first-stage emitter in this circuit.

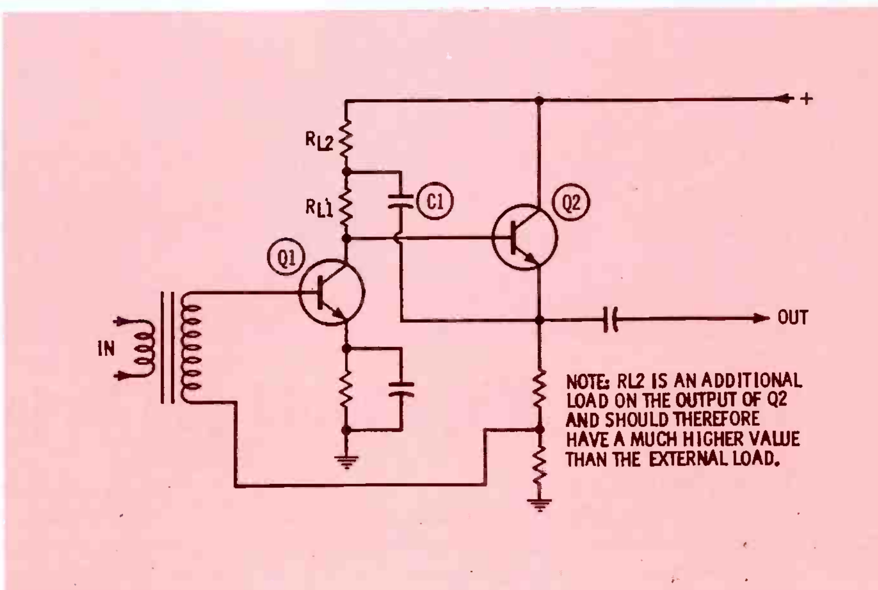
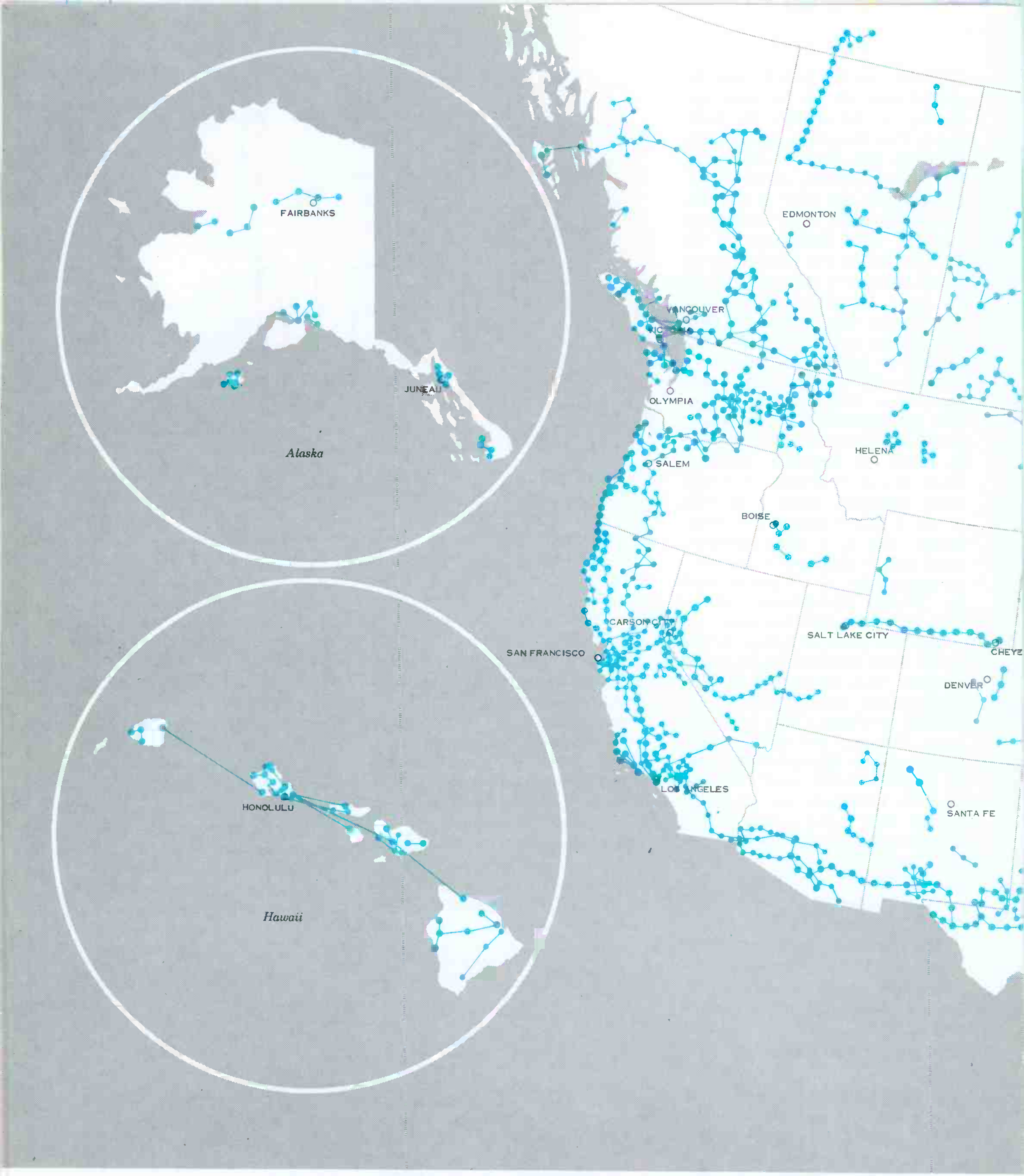


Fig. 3. "Bootstrapping" arrangement prevents partial loss of signal current.



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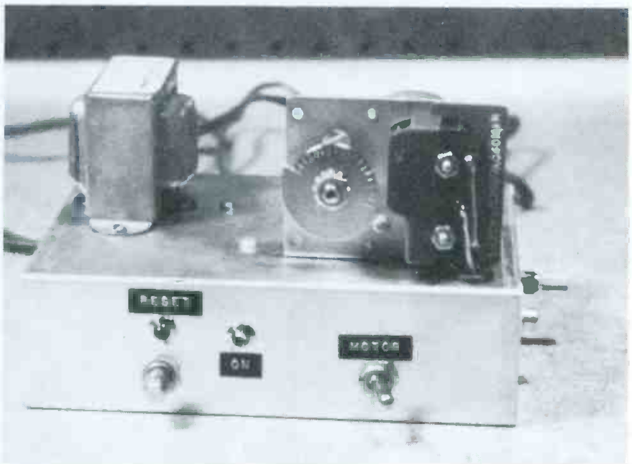
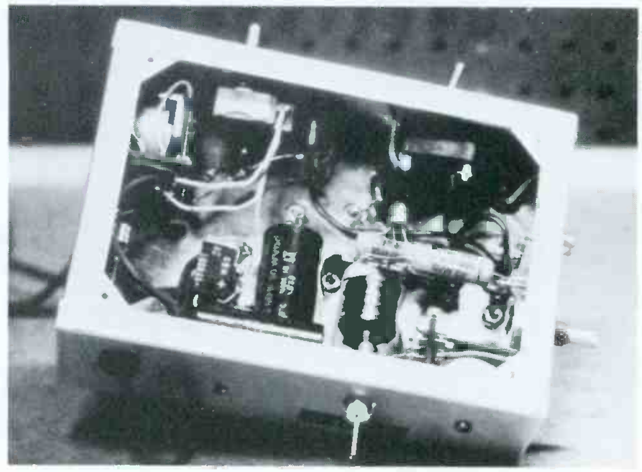
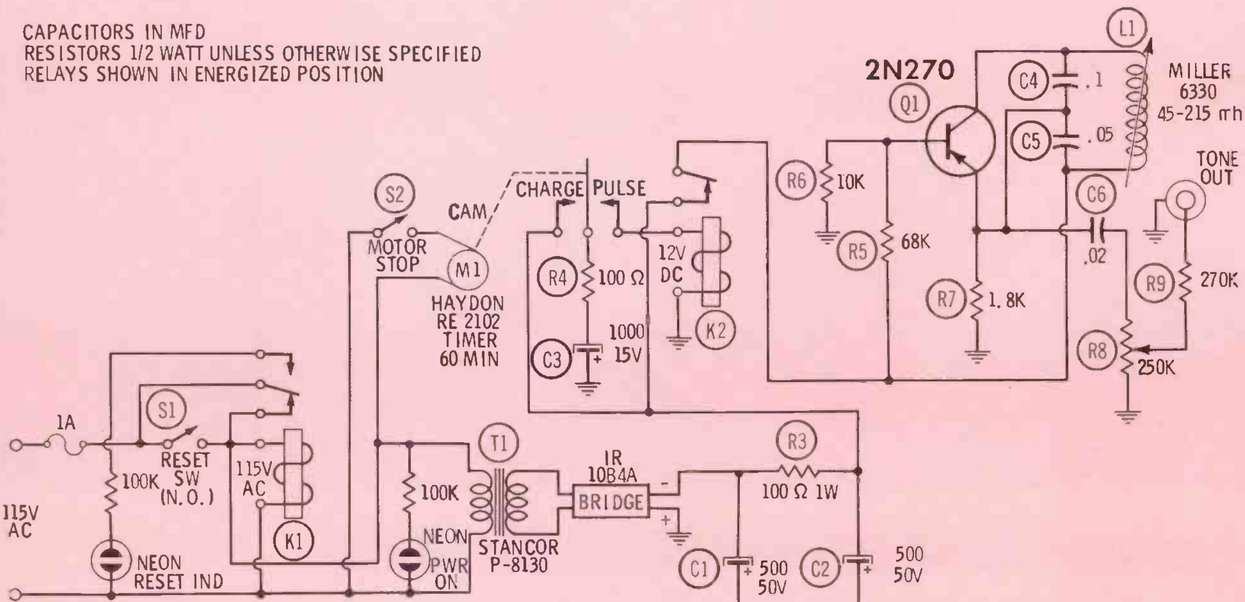




AUTOMATIC TIME-TONE GENERATOR

by Joseph Kish, Jr.*

This unit provides variable pitch and duration, and it has a built-in failsafe circuit.



When the need for an automatic hourly time signal arose at our station, the circuit described here was designed and built. It has been functioning reliably for a number of years, and several added benefits have resulted. The generator provides an excellent method to synchronize clocks and watches at remote broadcasts to studio time, and, much to our surprise, many listeners raised a real fuss when the unit was removed from service temporarily for addition of the failsafe circuit. These people said they had come to rely on the tone to check their timepieces, both at home and on the road.

The circuit is shown in Fig. 1. The components specified give values of pulse duration and tone frequency best suited for our needs, 1 second at 2500 Hz; these values can be varied over considerable limits to correspond to other needs or personal preferences. Pulse duration is fixed by R4 and C3. The frequency-determining elements are L1, C4, and C5. The frequency range with the values shown is from 3800 Hz with the slug fully extracted to 1900 Hz with the slug at maximum coil depth. Changes in C4 and C5 give a range of frequencies (Table 1). Although frequency stability is probably not of great importance in this application, paper capacitors were found to give better stability than ceramic units.

* Radio Station WTIG, Massillon, Ohio

The failsafe circuit was added after the unit had been in operation for some time. Momentary power failures added to the overall timing error, and during the hours when the station was off the air for the night, long, undetected failures led to tones at peculiar times. We decided that no tone at all was preferable to an erroneous time signal, so the failsafe circuit was built to stop the action dead, even on momentary power losses.

The alternate failsafe circuit shown in Fig. 2 will hold the unit in the "on" mode for short periods of time. Resistor Rx, capacitor Cx, and the resistance of relay coil Kx (same function as K1) determine the length of power outage, and therefore the extra timing error, to be tolerated. This error will be added to the normal error in the timing motor, which has been about ±2 seconds over a period of a week at our station.

We connected the unit into a high-impedance point in the main control board. This was a point beyond all announcer-operated switches and pots. Output level of the device is set with R9. We adjust it for a modulation level of 80%; this setting allows program material to override the tone slightly.

Adjusting the unit to WWV is somewhat tedious. We have found this procedure to be the quickest way: Start the unit by pushing the reset button and advancing the motor cam by hand to a point just before it switches from charge to pulse. Then let the motor carry the cam into the pulse mode, and cut the motor switch at that instant. The moment the WWV tone returns on the hour, place the motor switch "on." If you are careful and quick, you can obtain a tone signal very close to WWV time this way. Corrections to the cam can be made at the half hour, by listening for the cam to snap (no tone will be produced) and making any minor corrections required. This method can be expedited by placing both cam plates supplied with the motor parallel to each other, or by removing one plate altogether. This gives a half hour of charge time and a half hour of discharge time and allows you to hear the charge-mode click take place on the half hour.

A little experimentation with the values in the failsafe-hold, pulse-length, and frequency circuits should give you just the combination for which you are looking. ▲

Table 1.

C4	C5	FREQUENCY (Hz)
.2 mfd	.1mfd	1300-2600
.1 mfd	.05mfd	1900-3800
.05mfd	.02mfd	2800-5600

Fig. 1. Circuit of generator with a fast-acting failsafe provision.

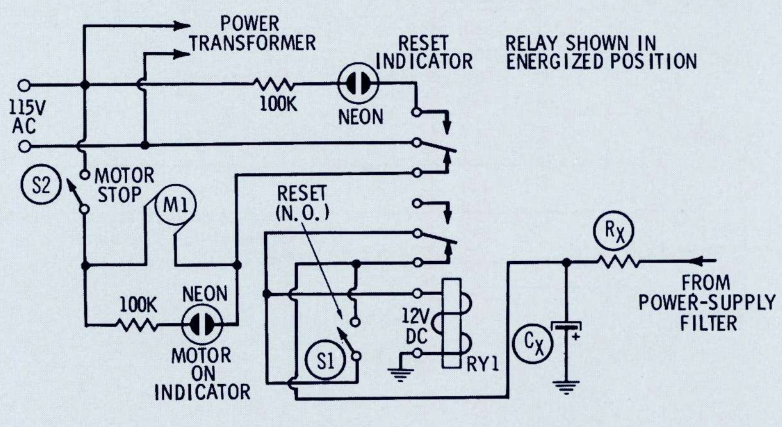


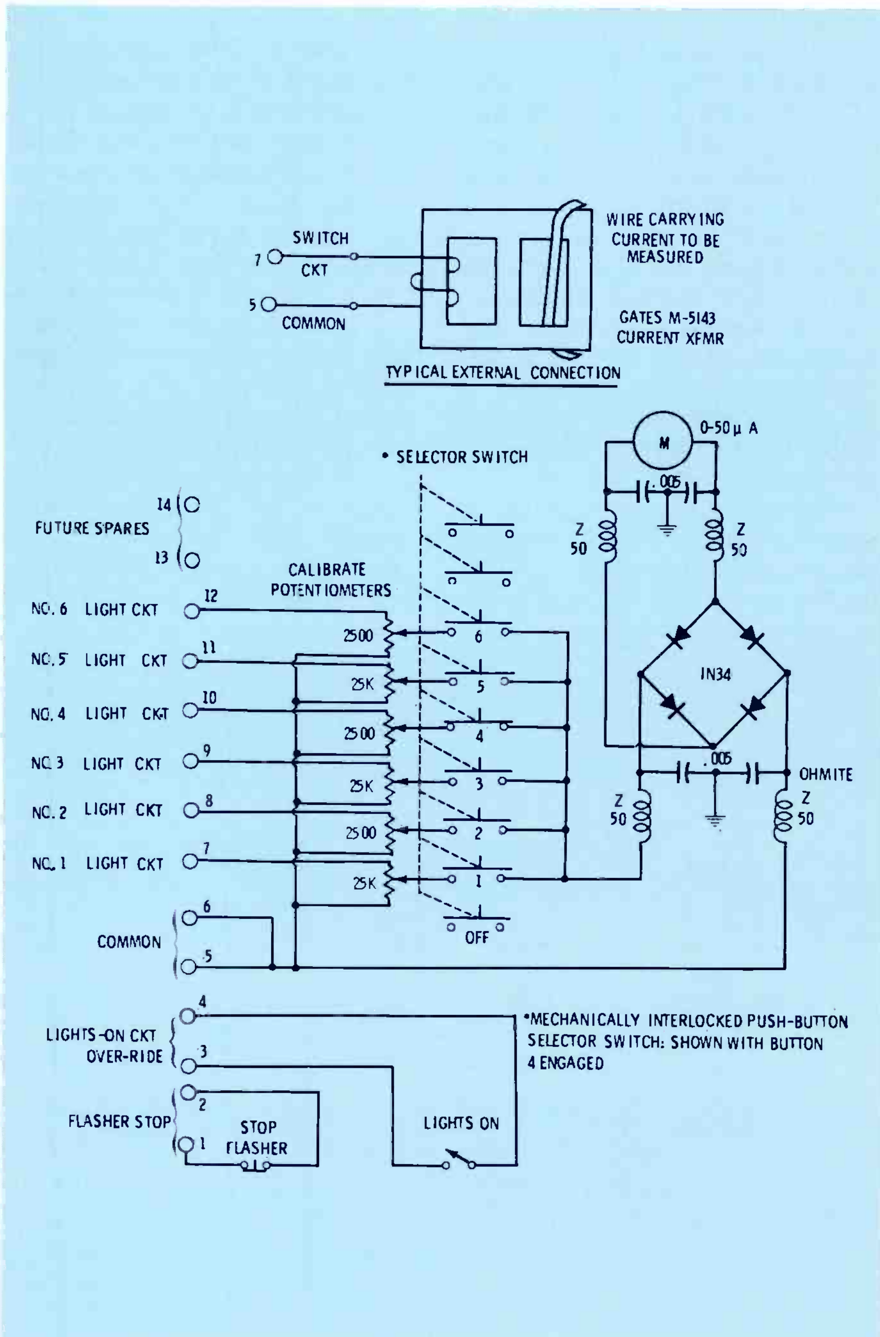
Fig. 2. Alternate failsafe circuit is insensitive to short outages.

A CHECKING SYSTEM FOR TOWER LIGHTS

by *William Vandermay**

A system for indoor monitoring of sparately fed tower lights.

*Fisher Broadcasting Co., KATU, Portland, Oregon.



Checking and monitoring tower lights in accordance with Parts 17 and 73 of the FCC Rules and Regulations can be a problem, especially on high towers on foggy or rainy nights. In these cases, some inside method of checking is a necessity. Often this merely consists of a simple pilot light connected across the tower-lighting circuit to indicate that the main lighting-power feed to the tower is energized. However, such a simple arrangement does not provide any checks of individual lights, nor does it give any assurance that all tower lights are operating in compliance with the Rules.

A simple and effective method of checking all lamps at all levels is described in this article. Normally, tower-lighting wiring is split into individual feeds to various levels or fixtures to provide a low voltage drop on the long runs required and to provide overcurrent protection for each circuit. The system em-

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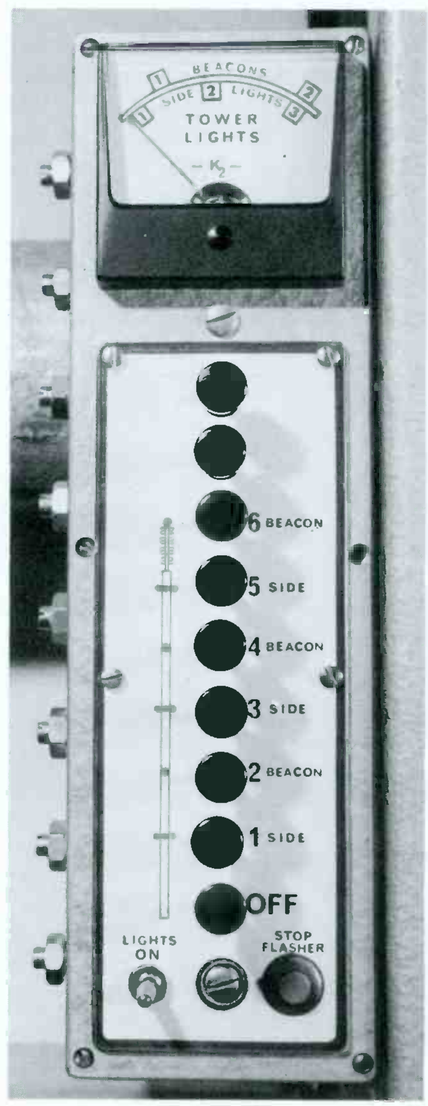

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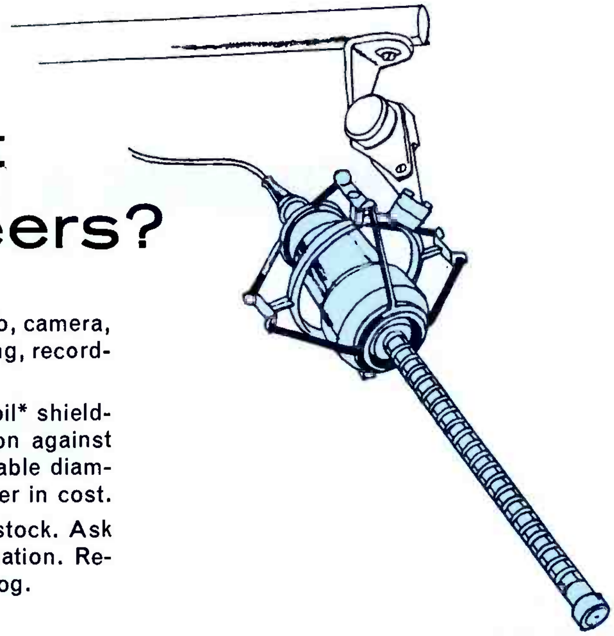

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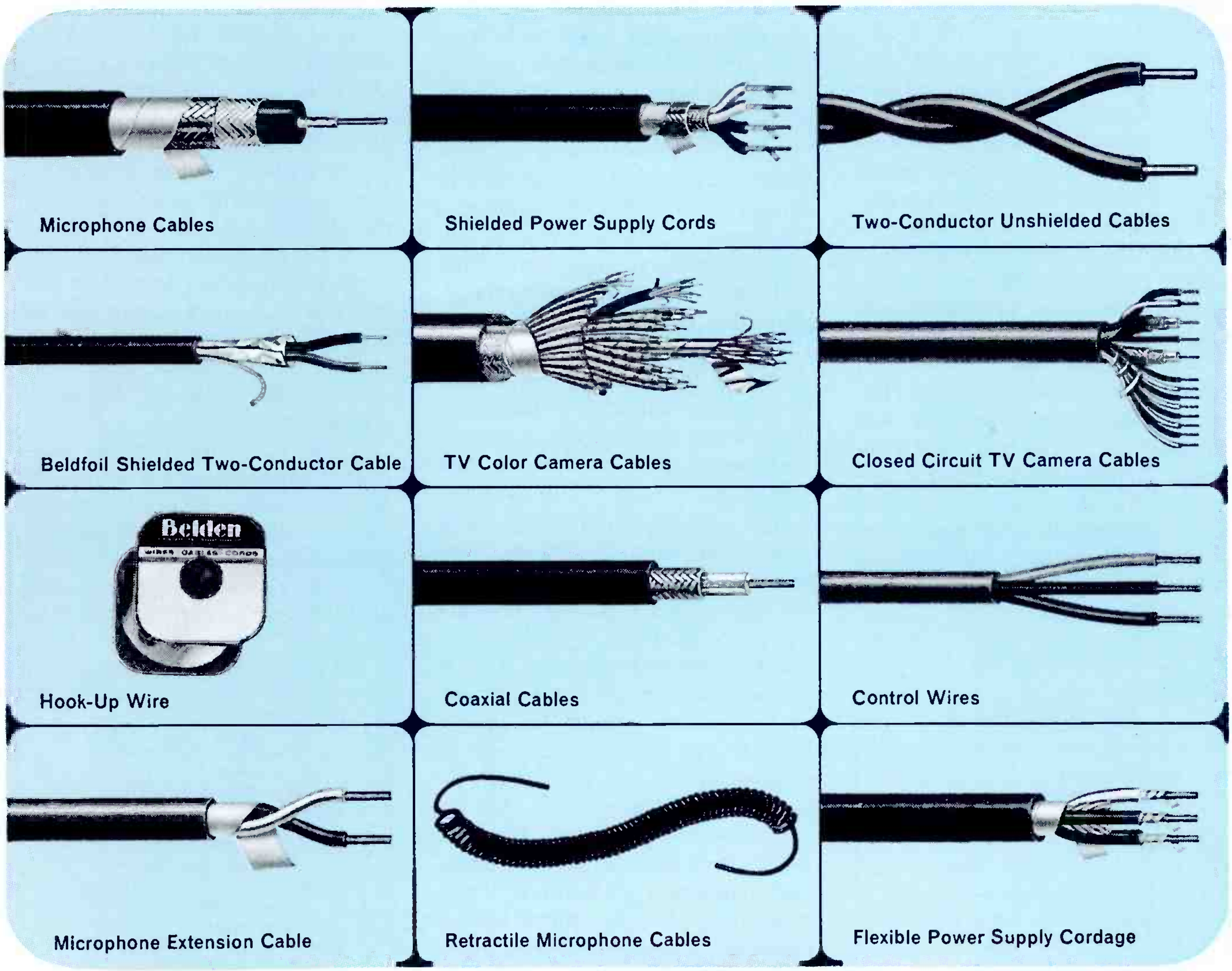

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ENGINEERING A TV REMOTE CONTROL

*by Evert A. F. Anderson**

Consideration of many factors is necessary for the conversion of a complex broadcast system to remote control.

The KCET transmitter is located on Mt. Wilson, nearly 6,000 feet above Los Angeles and a road distance of 26 miles from the Hollywood studios on Vine Street near Sunset Boulevard. At times, because of the altitude, heavy snowfall or rock and mud slides close the relatively narrow and sharply winding road, making it difficult for personnel to reach, or leave, the transmitter site. Consequently, a decision to remote control the educational television transmitter installation was made in the summer of 1965.

The decision was the result of careful consideration of two important questions. The first was whether the transmitter was sufficiently reliable for unattended operation, and the second was whether transmitter-quality video monitoring at the studio control point could be obtained.

* Senior Engineer in charge of maintenance, KCET, Los Angeles, California.

Table 1.
Control Requirements

1. Rack AC ON/OFF
2. Driver Main ON/OFF
3. Power Amplifier Main ON/OFF
4. Driver Filament ON/OFF
5. Power Amplifier Filament ON/OFF
6. Driver High Voltage ON/OFF
7. Power Amplifier High Voltage ON/OFF
8. Aural Driver OFF (for EBS)
9. Sync Level Lower/Raise
10. Aural Power Lower/Raise
11. Visual Power Lower/Raise
12. Stabilizer Select
13. Microwave Select
14. Centrifugal Pump Water Valves Open/Close
15. Air Intake/Exhaust Open/Close
16. Heat Exchanger Fan ON/OFF

The answer to the first question was supplied by the maintenance log. After 12 months of operation, most weak points could be isolated and corrected. Single failures were examined, and where failure involved heat, voltage, or current, overated components were installed. Tuning (cavity) of the transmitter proved to be stable. An additional factor was the primary voltage regulator used to stabilize transmitter and rack-equipment performance. Also, the transmitter building is air conditioned and has electrostatic air filters at the building air intake. This is of great value in reliability, because the dust content and temperature of the environment are controlled.

The second question, video monitoring, was important because remote control was not practical if the control-point picture was not equal to that obtained at the transmitter. Since linearity and stability problems in a modified receiver can be severe, the normal transmitter monitor was taken to the studio (a diode chopper was substituted for it at the transmitter) so that an evaluation could be made. The unit, a GE transmitter-demodulator monitor, requires a 25-millivolt input; it was fed a one-volt signal from a high-gain Blonder-Tongue preamplifier. Adequate performance was obtained, and no differential-gain problems were encountered.

With the primary conditions for remote-control operation satisfied, it was possible to begin an evaluation of our requirements.

Equipment to be Remote Controlled

The KCET transmitter is a 25-kw General Electric Model TT-57-A, which consists of a Model TT-55-A 100-watt UHF air-cooled exciting transmitter and a Model TF-20-A1 30-kw water-cooled klystron amplifier. ERP is 1.2 megawatts to the service area. The power output of the klystron amplifiers is controlled by a power divider which controls excitation to the klystron input cavity. The transmitter system was not originally designed for remote operation, but it did not appear that such control would be difficult to accomplish.

It was necessary to retain local-control capability at the transmitter because special encoded transmissions are used periodically for post-graduate medical programs.

Other system components were dual microwave receivers containing

Table 2.
Monitoring Requirements

1. Rack equipment AC voltage
2. Transmitter-Driver control voltage
3. Transmitter-Final control voltage
4. Visual Frequency
5. Aural Frequency
6. Visual-Final beam current
7. Aural-Final beam current
8. Total-Body current through both klystrons
9. Transmitter-Final high voltage (common supply)
10. Visual-power output
11. Aural-power output
12. Visual-Driver plate current (cathode modulated)
13. Aural Power output (EBS air alert)
14. Air Vents open
15. Three-phase AC
16. Building temperature
17. Air Vents closed
18. Klystron water temperature (visual)
19. Visual SWR
20. Aural SWR
21. Building Security

remote selection and AFC, distribution amplifiers, and two stabilizing amplifiers used with remote sync-level control. All tube-type equipment up to the transmitter is duplicated, but the reliability of solid-state equipment had been such that it was considered unnecessary to provide duplicates of these units. In Fig. 1 can be seen the video flow as it evolved for remote operation.

Other control and monitoring functions which the system would be required to perform included climatic controls and building security surveillance.

Function Requirements

At this point it was appropriate to list those things which required remote-control management, and to determine how that management could be achieved. This included all the manual functions normally performed by the transmitter technician. This comprised not only those things directly associated with the transmitter power control, but peripheral operations, such as water valves, air dampers, fans, and switches, as well.

A list of our requirements is shown in Table 1. Since it was possible to automate items 14, 15, and 16 by sequencing their operation into other steps, it was possible to reduce our remote-control unit function requirements. The remaining functions are such that they can all be controlled by relays.

Monitoring Requirements

A review of those things which would require monitoring included not only those items specifically required by the FCC, but also those which are necessary for effective transmitter and building control. The list of items to be monitored (Table 2) reveals that a number of items serve as warnings of an emergency situation.

Selection of Remote-Control Equipment

When the number of circuits to be controlled, the number of items to be monitored, and operating parameters were known, it was possible to set down our requirements for a remote-control unit. Our ex-

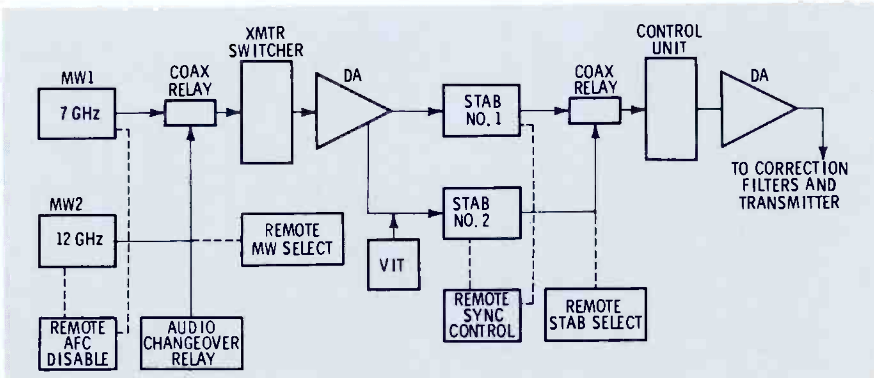


Fig. 1. Video flow as it evolved for the KCET remote-control installation.

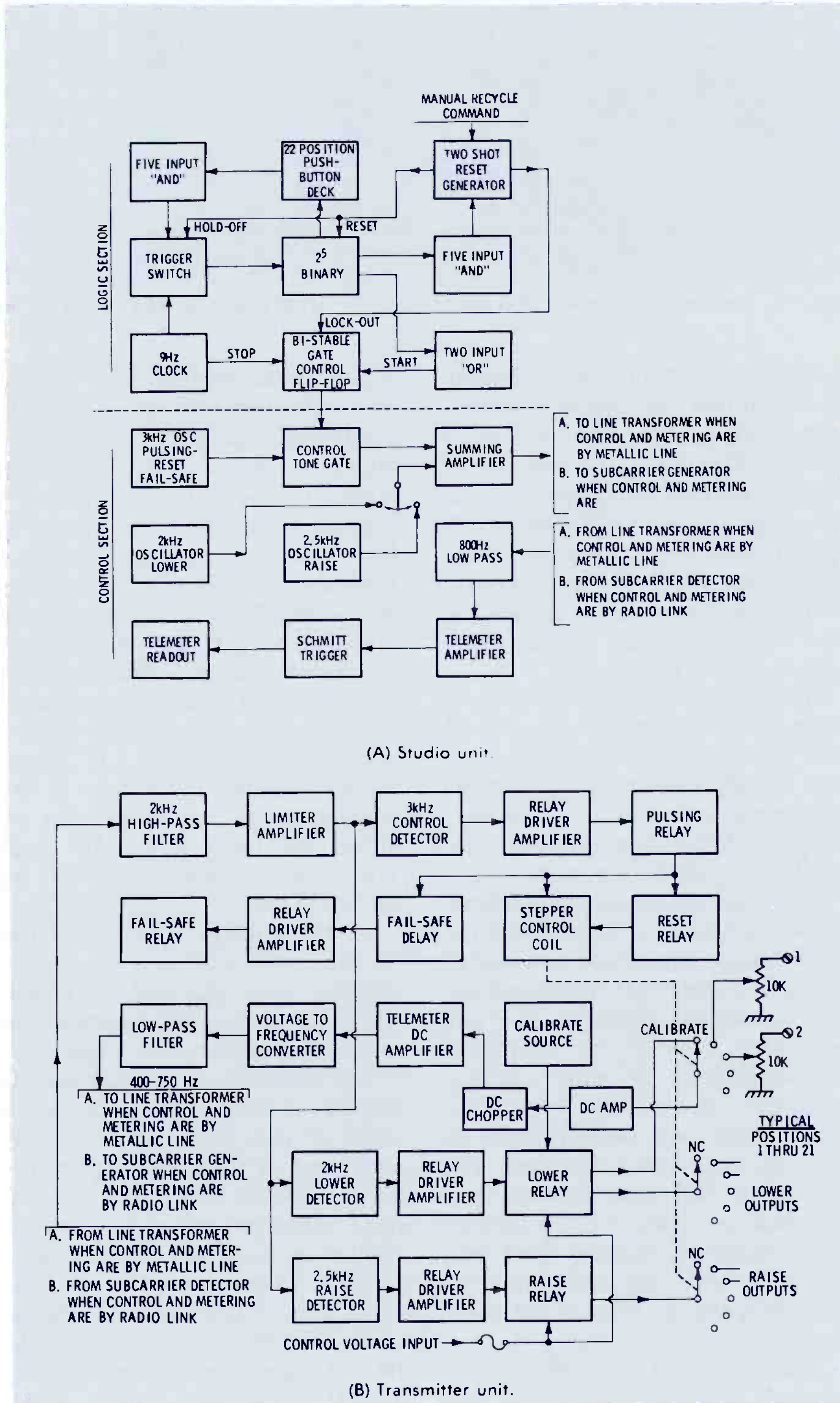


Fig. 2. Block diagram of the Moseley PBR-21 remote-control unit with changes.

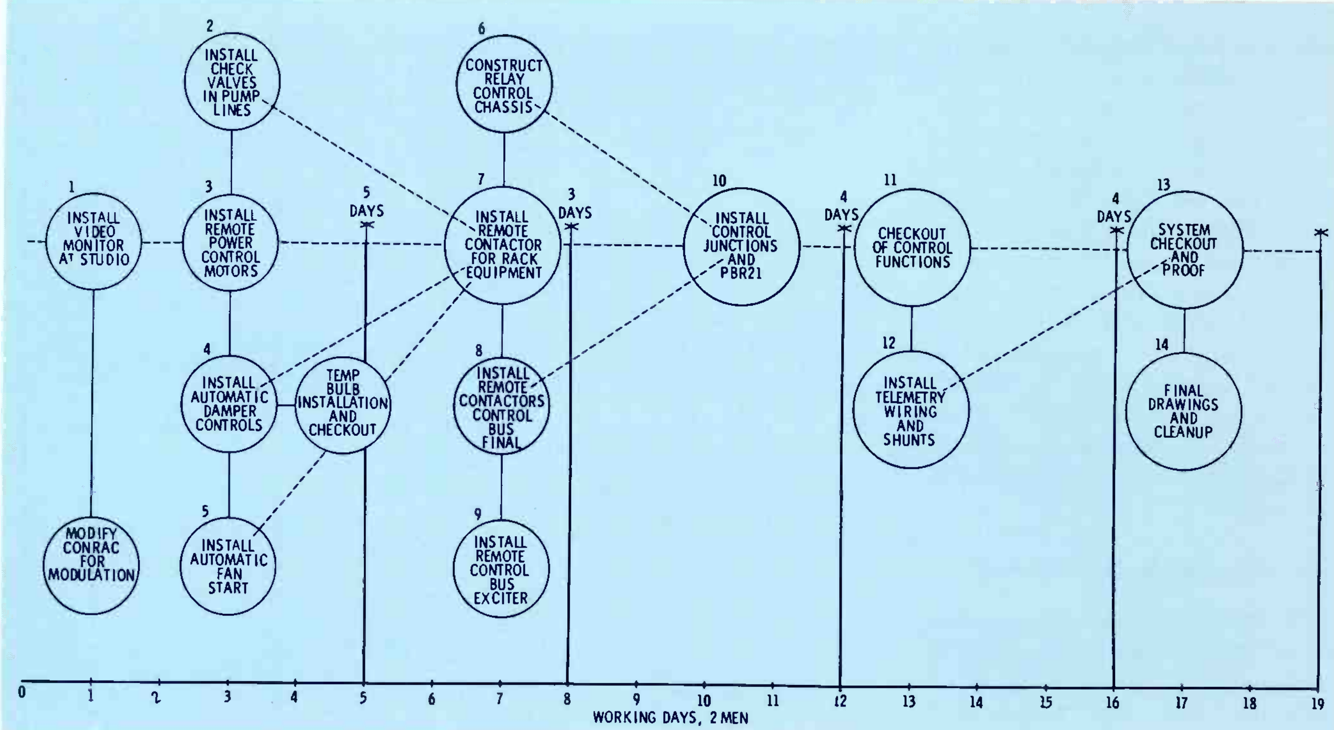


Fig. 4. Periodic Evaluation Review Technique (PERT) shows how work is accomplished in job versus time sequence.

perience with solid-state reliability indicated that this type of construction would probably be most satisfactory. If possible, the unit should operate on one telephone line and be adaptable to radio control. A qualification was that a DC telephone line should not be necessary. From a review of Table 2, we felt that no less than 20 telemetry circuits would be acceptable.

Table 1 showed a demand for at least 16 control functions in each of two positions. In addition, we could not reliably predict our future requirements and wanted, if possible, to have additional control positions available for future expansion.

With our minimum requirements known, a review of commercial remote-control equipment was undertaken. We found that the equipment then generally available did not adequately provide for peripheral operations such as water cooling, frequency monitoring, transmitter video levels, and various areas of klystron operation. Since our requirements had been carefully established, we knew what modifications would be required, and felt that they could be made, without great difficulty, to some of the units available.

The Moseley Type PBR-21 was selected. A block diagram of the unit is shown in Fig. 2 (A) and (B). While some modifications to this unit were necessary, they were accomplished easily. Specifically, the voltage-controlled oscillator (VCO) required four volts to drive the Schmitt trigger and the meters to full scale; our frequency-monitor readout had millivolt parameters. Also, the VCO would respond only to plus voltages, and the klystron circuitry in the transmitter required both plus and minus voltage readings. The Moseley unit was modified with a DC amplifier and a DC chopper so that inputs could be in the millivolt range and either plus or minus DC inputs could be used. The circuit modifications will be described later.

A review of the operation of the Moseley unit will help in understanding how the overall system works and why certain modifications to other equipment were made.

The telemetry monitoring system employs a VCO which requires an input of plus four volts for full-scale readout. The advantage of using a VCO is that it can use the same telephone line as the control circuits, or it can use a radio link.

Three tones are used in the control circuits. These are 2000 Hz for raise, 2450 Hz for lower, and 3000 Hz for fail-safe and stepping control. If the fail-safe tone is interrupted for longer than 25 seconds, a relay opens the interlocks to the final amplifier, thus removing the transmitter from the air.

There are 21 control functions on the stepper switch, with raise and lower positions for each control function. This gives a total of 42 control switches available. The stepping switch has one bank with gold-plated contacts. This is used to switch the telemetry signals to the VCO.

The VCO operates in the 400- to 750-Hz range, with frequency proportional to voltage input. This drives a Schmitt trigger at the studio for stable conversion back to a DC level. No commutation problems were encountered at the input, even though 50 millivolts is switched through the stepper switch. The original unit used 10K calibration potentiometers, but some were changed to one megohm because of loading on the monitored circuit. (In order to achieve the proper resolution necessary for accurate calibration, the high-impedance calibration potentiometers were of the 22-turn type.) Therefore, with a system which employs a high-gain amplifier requiring low input voltages and high input impedance, it is possible to look at most transmitter circuits without placing a loading effect on the monitored circuit.

Logic Control Circuits

In order to increase reliability, and to have the stepper-switch contacts and raise and lower relays see a standard load, it was decided to use auxiliary relays for all control circuits. This simplified the overall design from the standpoint of isolating controlled circuits from the common switching circuits of the stepper switch.

The mass of relays at Fig. 3 (A) (see foldout opposite page 36) constitutes the control logic circuit and is the means by which the PBR-21 actually controls the transmitter. This it does by presenting voltages to the relay coils, whose associated contacts in turn serve as switches to operate the various devices in the system.

An overview of the entire remote installation may also be seen in Fig. 3. Shown are the telemeter inputs and the means by which warning information is controlled by the logic circuit.

Work Schedule

Our object was to prepare the transmitter and other equipment for remote-control operation in such a way that as much work as possible could be accomplished during on-air operation. We also knew that some equipment would not be shipped immediately and wished to proceed with the work as much as possible before it arrived. Some modifications required that changes to other equipment be made first. For these reasons, a work-flow chart was created and followed in our remote-control program.

The chart (Fig. 4) follows the Periodic Evaluation Review Technique (PERT), with all tasks established in numerical sequence versus a time sequence. All jobs are identified by number so that time and material can be organized. Those jobs which can be performed during air time and those that can be accomplished only during off-air time can be identified. On the chart were listed all of the equipment to be modified, included, or installed in the overall project. Note that item 1 was the installation of the transmitter monitor in the studio.

The remainder of this article generally will follow the PERT schedule in the presentation of the steps taken to remote control the KCET transmitter. This technique not only will show how the work was accomplished in our installation, but also will give a picture of what has been done and what remains to be completed at any point.

Automating the Transmitter

As shown in the PERT schedule (Fig. 4), the first steps taken to prepare the transmitter installation for remote control were related to those transmitter operations which could be automated. Each step was unique, and required modification to the original equipment before it could be incorporated into automatic sequence.

Installation of Check Valves in Pump Lines

It was necessary to incorporate check valves into the pump lines because the centrifugal pumps would bypass water pressure developed during off-air-time circulation by a small pump used to keep the water temperature above freezing. Normal manual water valves had been used and were closed after transmitter shut-down. By inserting check valves, the pump lines are closed when the pumps are shut down. This allows the small pump to develop the four pounds per square inch of pressure needed to circulate warm water through the cooling system.

Remote Power-Control Motors

Prior to remote control of KCET, the power dividers at the input to the final klystrons were controlled by a flexible cable brought to a front-panel control knob. With remote control, however, it was necessary to make power changes with small electric motors.

Selecting motor size required knowledge of the torque required to drive each unit. The simple principle shown in Fig. 5 was employed to determine our torque requirement. With a lever arm of known length and a spring scale, the torque requirement may be determined by:

1. Attaching the lever arm to the shaft of the object to be turned.
2. Attaching the outer end of the lever to one end of the spring scale with a piece of string.

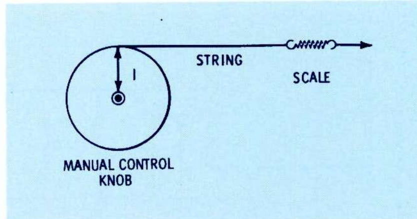


Fig. 5. Simple principle employed to determine motor torque requirement.

3. Pulling on the free end of the scale.
4. Observing the spring scale reading.
5. Multiplying the length of the lever arm (in inches) by the scale reading (in ounces).

The result is the torque requirement for the motor in inch-ounces, by which most small motors are rated.

Another factor in motor selection is speed of rotation. One RPM is usually satisfactory for remote-controlled operations, but a faster speed might be required where several rotations are involved. Generally, a greater accuracy accompanies slower speeds, but at a sacrifice in operation time.

In our case, a 50 percent range of power control was considered to be adequate. Miniature switches were installed to limit motor rotation to about 300°. (See Figs. 3 B and 6.) Small screws on the control shaft were used to actuate the switches, which shut off the motors.

Automatic Damper Controls

Air-vent control was automated into our installation. The vents, consisting of the air intake, air exhaust, and air bypass, are controlled by several parameters. The air intake is opened when the transmitter is turned on, and a commercial motorized unit controls all three vents to maintain water temperature at 100° F. At the point when the 18,000-volt transmitter supply is energized, the cooling fan is activat-

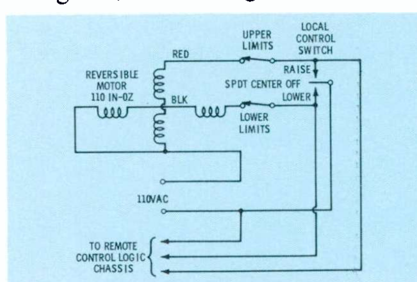


Fig. 6. Miniature switches limit motor rotation to 300° for power control.

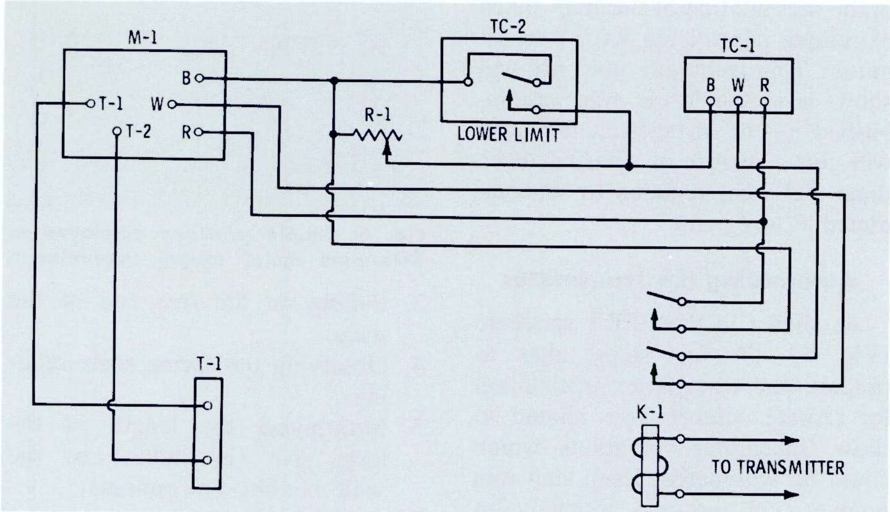


Fig. 7. Water and air temperature for air vent control is sensed by bulb TC-1.

ed, and the vents adjust to positions necessary to maintain a temperature of about 110° F at the klystron water output. When the transmitter is turned off, HIGH-VOLTAGE-OFF shuts down the cooling fan, FILAMENTS OFF bypass the temperature control, the intake and exhaust vents close, the bypass vent opens, and warm water circulates through the water system.

Water and air temperature is sensed by a bulb (TC-1 in Fig. 7), which was placed approximately four inches from the cooling-water coils in the heat exchanger. R-1 is a limit control to prevent the temperature bulb from completely closing the air intakes.

The three air vents are linked together with control rods, and are mechanically coupled to the motor of the commercial control unit. The design of the air-vent linkage required that a detailed drawing of the building be made, because two vents are on the first floor and one is on the second. Potential obstructions to the linkage were noted and measurements were then made. Since the bypass must open when the intake and exhaust close, it was necessary to accomodate the linkage to that requirement. The control arms on each vent were provided with sliding adjustments so that the required movement for each vent could be provided.

The relay shown in Fig. 7 serves two purposes: to activate the warm-water circulating pump for the cooling system plumbing during off-air time, and to close the vents when the transmitter is shut down.

Automatic Fan-Start Installation

The automatic fan start occurs with the application of high voltage. This was considered necessary to prevent the water temperature from falling too low during periods of standby. (During manual operation, the fan came on with the filaments. With very cold outside air, the water temperature soon fell to a very low temperature.) The modification was made by routing the fan-contactor control voltage through the high-voltage auxiliary relay. The modification was simplified by the availability of a spare set of contacts which operated normally open. With the modification, water temperature stability was improved, which resulted in better performance of the water-cooled field coils and better body-current characteristics.

The goal of the preliminary operations was to get the transmitter manual functions automated to the extent that the only transmitter functions not automated were those that could be controlled by relays. With the installation of the automatic fan start, the transmitter was ready for remote control.

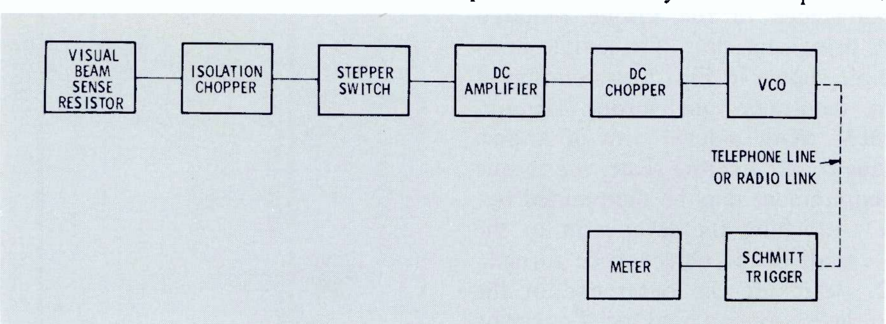


Fig. 8. Typical metering circuit which employs DC chopper and DC amplifier.

Remote-Control Unit Monitoring

A review of Table 2 shows that some of the items to be monitored were discrete and posed no requirement for modification. These were: air vents open, three phase AC, air vents closed, and building security. For them, a nominal voltage was fed through appropriate switches to give an indication of their condition.

Other readouts, however, did not comply with the PBR parameters, and it was necessary to modify the unit as supplied. As previously stated, the VCO will respond only to input voltages from zero to plus four volts, and, similarly, other input requirements were not satisfied by our situation. This included plus and minus voltages, high- and low-impedance circuits, and circuits above ground and with one side grounded. Specifically, the frequency monitor gave an indicated voltage of 70 millivolts at center frequency, the driver cathode was −300 volts below ground, and the beam shunts could not be grounded because they would then bypass the body protective relay.

In order to effect the necessary changes, the stepping-switch arm to the VCO was opened, and a DC amplifier and DC chopper were inserted into the circuit. (See Fig. 8.) The lead from the stepping switch was routed to a DC amplifier which has a gain of more than 40 dB. The amplifier (manufactured by Sanborn) employs a differential input of high impedance, has a high common-mode rejection of noise, and provides an output sufficient to drive the DC chopper.

The DC Chopper

A schematic diagram of the DC chopper used to convert negative

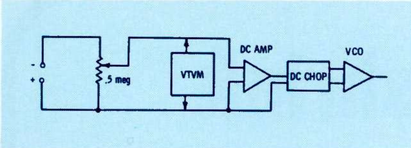


Fig. 9. Test setup for calibrating remote-control linearity after changes.

voltages to the positive polarity required by the VCO is shown in Fig. 3 (C). The same design is used in other places to provide isolation. With this circuit, certain limitations must be observed: The proportionality of the output to DC input holds only for a limited range. As the input approaches the value of the AC voltage across the line, the output will not follow the DC input.

The output of the isolation chopper becomes nonlinear as the DC voltage increases, and it acts as a limiter to prevent excessive voltage from reaching the VCO. After a chopper is constructed, the input-versus-output curves can be plotted with a battery used for the input parameters. Once the linear ranges are established, the design of the shunts becomes straightforward.

One other point must be observed: the input impedance of the chopper is quite low. If the circuit to be isolated and monitored has a low-current, high-impedance source, the operating point of the circuit may shift. Fortunately, in most cases the sensing resistors are of very low value, and this does not become a problem.

PBR Calibration

This system is quite flexible with the modifications accomplished; it will read out voltages as low as 15 millivolts full scale, the input impedance is determined by the calibration potentiometers, and the input is unbalanced. It must, however, be calibrated in order to assure that the system linearity is adequate.

With the test setup shown in Fig. 9, the curves shown in Fig. 10 were obtained. The input voltage was read with a HP 410C high-impedance vacuum-tube voltmeter. The frequency monitor established the lowest voltages to be read. All other voltages were brought to this level for the telemetering sensing circuits.

Frequency Monitor

Since only one telephone line was to be employed, it was necessary to devise a means for feeding the output of the frequency monitor into the telemetry. This was accomplished by installing calibrating potentiometers in the frequency-sensing circuits, and using them to adjust the DC-amplifier gain to give mid-scale readings on the remote-control unit.

The sensing circuits were fed from the output of the bridge rectifiers in the frequency monitor, a Hewlett Packard 335E. (See Fig. 11.) The value of the potentiometers was determined by making voltage measurements at the takeoff points, D3 for the aural frequency and D6 for the visual frequency. The voltages read from zero to 175 millivolts over a 6-kHz range. When a decade-resistance box was placed across the circuit to ground, it was found that above one megohm, readings at the local meters were not affected. Therefore, the calibration potentiometers were made one megohm.

The calibration control on the frequency monitor was varied over the frequency range from minus one kHz to plus one kHz, and the linear relationship over the total scale was established.

The leads from the frequency monitor are run in shielded audio cable with separate leads for the aural- and visual-frequency circuits.

Body, Beam, and High-Voltage Sensing

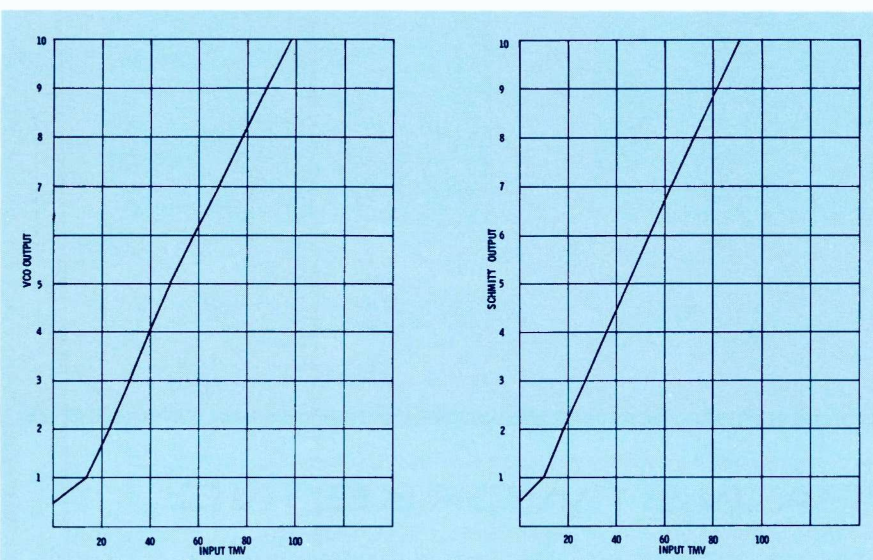
The klystron beam and body current-sensing circuit is illustrated in Fig. 12. Also illustrated is a type of problem encountered in the installation of telemetry sensing circuits.

Body Current—The body current represents the total beam scatter which travels through the ground and body-overcurrent relay back to the power supply. The beam scatter, or body current, is a useful measurement because it indicates the condition of the magnetic focus coils and the related field currents of the aural and visual klystrons. It is the total beam scatter of both klystrons. It is important that the telemetry sensing circuit not bypass the body-overcurrent relay. Excessive body current trips the transmitter off because the condition causes deterioration within the klystron.

The best place to sense body current appeared to be on the ground side of the body-overcurrent protection relay. Measurement of the relay revealed a resistance of 43.5 ohms ± 10%, and a one-ohm resistor would have negligible effect on the circuit. With body current of sixty milliamperes, sixty millivolts was available for the telemetry. A calibration potentiometer of 10,000 ohms was inserted in the sensing circuit; it did not affect the transmitter meter readings.

Beam Current—It is also necessary to avoid bypassing the body current to ground when sensing beam current. This was accomplished in our case by providing a DC chopper which isolates the voltage developed by the sensing circuit.

Visual beam current is sensed by two 160-watt, 10-ohm resistors in



(A) Input. (B) Output.

Fig. 10. Curves show PBR linearity after the modifications had been completed

parallel. The resistors are wire-wound and have a sliding-tap adjustment. One of the taps is adjusted to provide approximately two volts into the telemetry-calibration potentiometer. No interference to the beam or body circuits was encountered after a DC chopper was installed.

The very large resistors were employed to maintain the resistor temperature as close to ambient cubicle temperature as possible. This reduced the amount of thermal drift caused by internal heating of the resistors.

A similar circuit is used to sense aural beam current, except that only one resistor is necessary. This is because of the considerable difference between the currents in the circuits —4.9 amperes in the visual circuit and 0.96 amperes in the aural.

Driver Cathode Current

In order that the remote-monitoring operator can see the DC-insertion current at black-level (sync)-only modulation, the driver cathode current is also monitored. This shows that the DC insertion is correct and also that the microwave receivers are under control. The latter is required because of the rather crowded microwave spectrum on Mt. Wilson; when the microwave transmitter is shut down, the receiver AFC will lock on another channel in use. Monitoring the cathode current of the modulated stage enables the operator to test video control by fading white to black before the final amplifier is put on the air.

The driver-modulator sensing circuit is shown in Fig. 13. Notice that the cathode is biased at −300 volts. The problem was to isolate this circuit without upsetting its voltage or capacitance. The 125-ohm cathode resistor was bridged with two 3500-ohm resistors to a DC-chopper isolation unit. The output was then fed to a telemetry input.

Calibration of this unit was made at the normal 150-milliampere black-level current of the modulated stage. Only slight adjustment of the normal frequency compensation had to be made after installation of the telemetry sensing circuit.

Power Reflectometers

The power reflectometers pre-

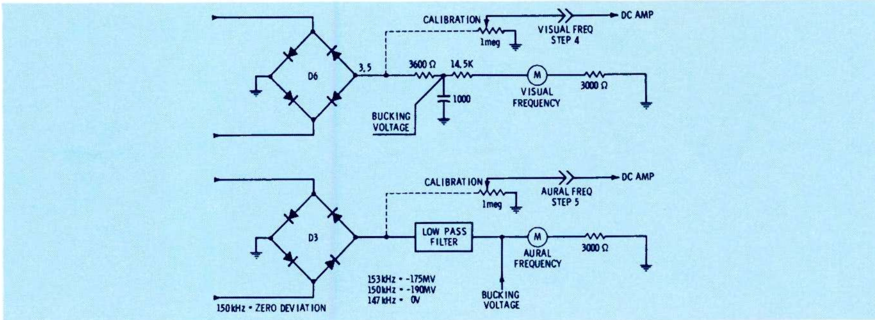


Fig. 11. Sensing circuits employed to measure aural and visual frequencies.

sented a problem because power is sensed in a diode, and a transistorized emitter-follower is used as an isolation for the high-SWR trigger circuit or the normal power reading. The base of the forward and reverse transistors has very high impedance. Only a millivolt of input is required for the DC amplifier, and the PBR-21 calibration potentiometer was changed to one megohm. This was placed in series with an 8.2-megohm resistor for forward power. A 4.7-megohm resistor is used for SWR sensing. (See Fig. 3D). Thus, the high-impedance circuit can be bridged across the base without upsetting the normal power reading.

After these circuits were installed, the transmitter power meters were recalibrated. There was less than a two-percent change with the telemetry resistors added.

Three-Phase Voltage

It seemed desirable to sense the three-phase voltage that goes to the centrifugal water pumps and the large cooling fans. To do this, 240-volt AC relays were connected across each phase at the three-phase distribution box. (See Fig. 3E.) The contacts are in series and fed with a small DC voltage that is in turn fed into a normal telemetry channel. This becomes a discrete function, and a voltage reading on the meter indicates the presence of all three phases. Failure of one phase causes a relay to drop out and provides a warning to the operator that the motors are not getting proper voltages.

Temperature Sensing

Problems with the pumps, fan, or air vents are indicated at the monitor point by means of the air- and water-temperature sensing circuits. (See Fig. 14.) The air-temperature readout also indicates off-air temperature during freezing weather.

A thermistor in a series circuit is used to sense temperature. A bridge was not utilized because both the DC power supply and the input circuit are grounded on one side. Use of a bridge would have required that an isolation unit be installed.

The series circuit was designed to prevent the danger of thermistor internal heating from the millivolt values of input voltage which are possible. This is an important consideration because current flow in a thermistor can give a false temperature-rise indication. A small, regulated voltage, therefore, is fed into a high-resistance thermistor; in our case a GA51J1 with 100,000 ohms of resistance at 25° C (77° F).

Rather than attempt full-scale linear response, the design aim was for a linear response between 100° and 150° F for the water tempera-

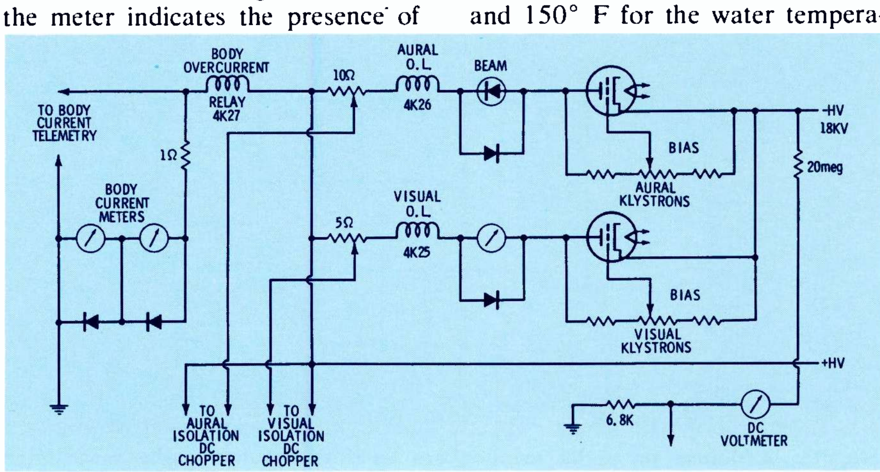


Fig. 12. One-ohm resistor senses klystron and body current in this circuit.

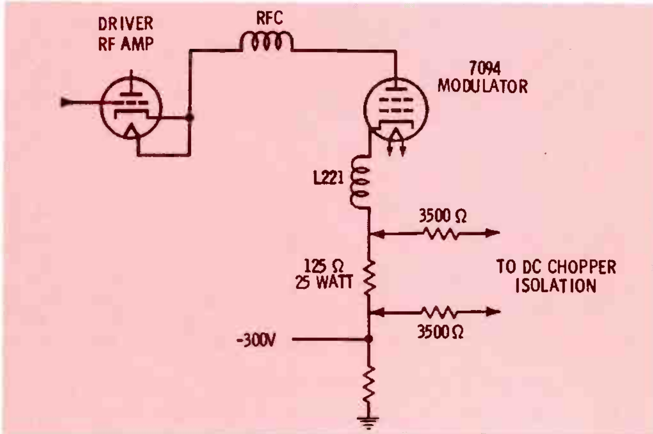


Fig. 13. Driver-modulator sensing circuit uses chopper.

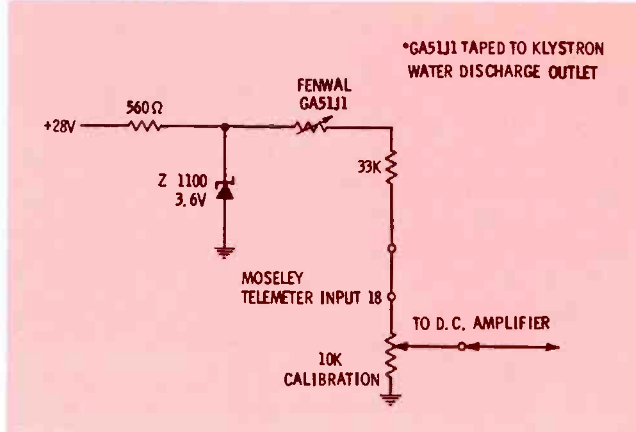


Fig. 14. Temperature problems detected with this circuit.

ture. Since a thermistor is a negative temperature coefficient device, the resistance goes down as the temperature goes up. The design-data curve shows 52,000 ohms at 100° F and 23,100 ohms at 150° F. Since a positive-coefficient reading was required and the thermistor reads inversely, a 33,000-ohm resistor was inserted in series with the thermistor so that as the thermistor resistance goes down, the proportional voltage across the 33,000-ohm resistor goes up, thereby giving a positive-coefficient input to the telemetry.

The normal calibration control in the remote-control unit is used for fine adjustment of the temperature reading. In this reading, a factor of two is used at the studio to determine the actual water-temperature reading. A two-degree temperature change will give one unit of change on the meter; a meter reading of 70 means that the temperature is actually 140°. Air-temperature values read directly, i. e., a reading of 70 is 70°.

Mounting the water-temperature-sensing thermistor was difficult because it is essentially a very small glass bead. We discovered that, due to its relatively high water flow (35 GPM), the water-outlet-pipe temperature is close to that of the internal water. The pipe was thoroughly cleaned, and the thermistor was taped to it. Voltage was taken from the DC relay supply, and a Z1100 zener was used for regulation.

Modulation

It was not possible to use telemetry for modulation transmission because the telemetry-circuit response was too slow for the very rapid changes which take place. Therefore, the audio section of a Conrac AV12E monitor was modified to provide for normal modulation monitoring at the studio.

A carrier meter was inserted in the circuit of the last audio IF stage so that the operator could peak the receiver on the aural carrier. The output of the ratio detector, prior to de-emphasis, is used to feed the overmodulation-peak indicator and the modulation indicator. The circuit additions are shown in Fig. 15. In order to preserve the proper time constants, a circuit similar to the one used in the transmitter modulation monitor is utilized.

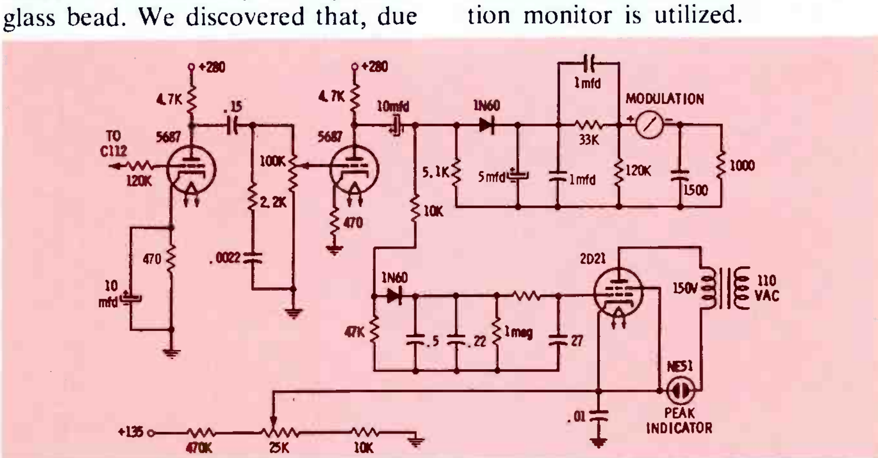


Fig. 15. Additions to studio monitor are used to monitor audio modulation.

While it was a tight fit, it was possible to add the components under the chassis of the Conrac monitor on an additional terminal board. The modulation meter and peak indicator were both mounted remote from the tuner chassis.

With the modified unit installed, a frequency run was made with the transmitter modulation meter as the standard reference. A response of ± 0.5 dB, from 20 to 18,000 Hz, was obtained at modulation levels of 30, 50, 80, and 100 percent. This assured that the meters were tracking satisfactorily. No particular problems were encountered except the mechanical squeeze that resulted when the additional circuits were added.

Tower Lighting

Tower lighting is not a requirement at Mt. Wilson because of close proximity to the astronomical observatory. Critical light measurements by astronomers would be affected by tower lighting, and no outside tower lights are used on the mountain.

Control Circuits

In the transmitter control installation there are two control channels available. These are the "raise" and "lower" control functions. Coupled with the 21-position stepper switch, the combination resulted in 42 control positions overall. All of the positions are not used, so spares are available for future requirements. How these control positions were finally utilized can be seen in Table 3 and Fig. 3.

Driver Control Voltages

The method used to apply control

JULY, 1967

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- ☐ Owner, Manager, Officer
- ☐ Engineer, Technician
- ☐ Other ____

Please indicate number of items you have circled — ☐

1	2	3	4	5	6	7	8	9	10	11	12			
13	14	15	16	17	18	19	20	21	22	23	24			
25	26	27	28	29	30	31	32	33	34	35	36			
37	38	39	40	41	42	43	44	45	46	47	48			
49	50	51	52	53	54	55	56	57	58	59	60			
61	62	63	64	65	66	67	68	69	70	71	72			
73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
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103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
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133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
148	149	150	151	152	153	154	155	156	157	158	159	160	161	162

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Table 3. Remote-Control Telemetering and Control Designations

	LOWER	RAISE	TELEMETRY
1.	Microwave AFC Reset	Rack AC Voltage On	Rack AC
2.	. . ....	Driver Main Breaker On	Driver Control
3.	... .. .	P. A. Main Breaker On	P. A. Control
4.	....	Driver Filament On	Visual Frequency
5.	..	P. A. Filament On	Aural Frequency
6.	. . ....	P. A. High Voltage On	Visual Beam
7.	... .	Driver High Voltage On	Aural Beam
8.	Microwave #1 Select	Microwave #2 Select	Body Current
9.	Stabilizer #1 Select	Stabilizer #2 Select	P. A. High Voltage
10.	Visual Power Lower	Visual Power Raise	Visual Power Out
11.	Aural Power Lower	Aural Power Raise	Aural Power Out
12.	Sync Level Lower	Sync Level Raise	Visual Drive Plate
13.	Aural Driver Off (EBS)	... .	Aural Power Out (EBS)
14.	Driver High Voltage Off	. ...	Air Vent Open
15.	P. A. High Voltage Off	. ...	Three-Phase AC
16.	Driver Filament Off	... .	Building Temperature
17.	P. A. Filament Off	....	Air Vent Closed
18.	Driver Main Off	....	Water Temperature
19.	P. A. Main Off	. ...	Visual SWR
20.	Rack AC Off	... .	Aural SWR
21.	....	Reset Building Security	Building Security

voltages to the driver is shown at Fig. 3 (F). With this circuit, it is possible to remove voltage from the primary bus to the driver section. The remote breakers were installed in parallel with the manual breakers in order that, in case of failure, the manual transmitter breakers could be used. The auxiliary breakers utilize a thermal overload with automatic reset. However, sustained overload will kick the transmitter off and it will remain shut down.

The auxiliary power breakers use their own locking control. This locking circuit is routed through the off auxiliary relay.

Momentary contact of the control relays (RAISE or LOWER) now controls the circuit. A similar method is used in the final control circuit. The on-off function of the control circuits is maintained as a recommendation of the manufacturer so that voltage is not left on the fault relays.

Filament and Power Application

The filament and power application relays are latching types, and only momentary impulse voltages are required for their operation. The auxiliary logic relay contacts are paralleled with the normal start-stop buttons.

Power Control

The power-control circuits used to operate the reversible AC motors which drive the power dividers are shown in Fig. 3 (B). An impulse circuit is used here also, and requires the operator to hold the raise or lower function until the desired power level is read on the associated step of the telemetry. These circuits are straightforward with the auxiliary relays slaving the remote-control unit.

The switching-stabilizing amplifiers and microwave receivers presented a different problem and required the use of a lockup circuit.

Audio and Video Inputs

DC relays were used to switch both the audio and video inputs, that for video being a coaxial type. The relay lockup uses two auxiliary relays so that the raise or lower function will release one relay and lock up the other. Selection of either raise or lower will retain that position until changed by the operator. The contact arrangement is shown in Fig. 3 (A) at relays K15 and K16. The output of the microwave units is switched to feed both stabilizing amplifiers, which in turn are routed through the coaxial relay to feed the transmitter D. A.

Sync-Level Control

The final control problem was the selection of a method to control sync level at the transmitter. This was necessary to maintain the signal within FCC specifications. The normal control circuit at the transmitter was routed through a local/remote-control switch. In the remote position, the sync-level controls are motor driven from the remote-control unit. (See Fig. 3G). The motors are driven simultaneously so that the sync-level controls of the stabilizing amplifiers are driven together. Then, if the amplifiers are switched on the air, the video-sync ratios are still maintained. Note that a manual level control is in series with each motor-driven control in order that differences in amplifier characteristics can be compensated.

Relay Logic Unit Construction

Octal-base, sealed relays with double-pole, double-throw contacts and 110-volt coils are employed in the relay logic unit. The relays are mounted in four pans, eight relays per pan. This gives a total availability of 32 relays, and Fig. 3 (A) shows that only 28 of these were used, leaving four for future modifications and additions. All pans are wired identically with leads brought out to terminal blocks. The wiring diagram for a typical pan is shown in Fig. 16.

Having leads at the terminal block permits making control-logic changes easily during testing. Changes were made to this wiring in some instances where locking circuits, DC control, and thermistors were installed and tested.

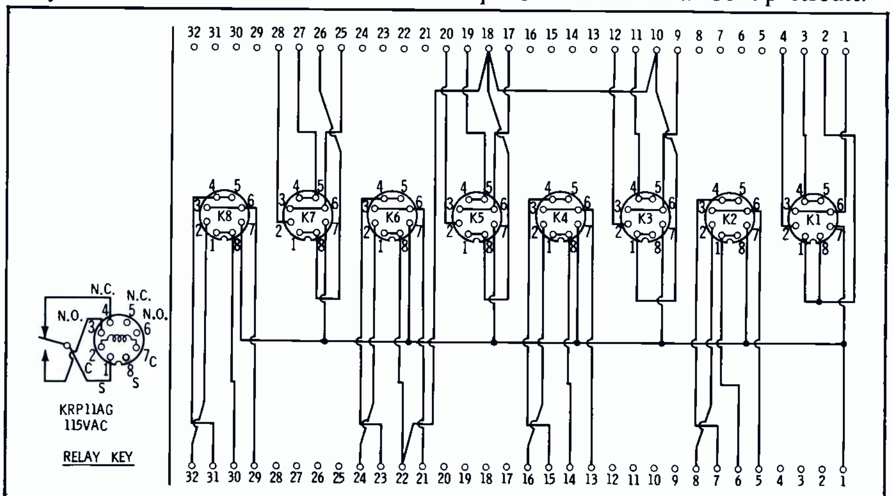

Fig. 16. Wiring diagram for typical basic unit of relay logic control unit.

• *Next page folds out.*
Text continues on page 43.

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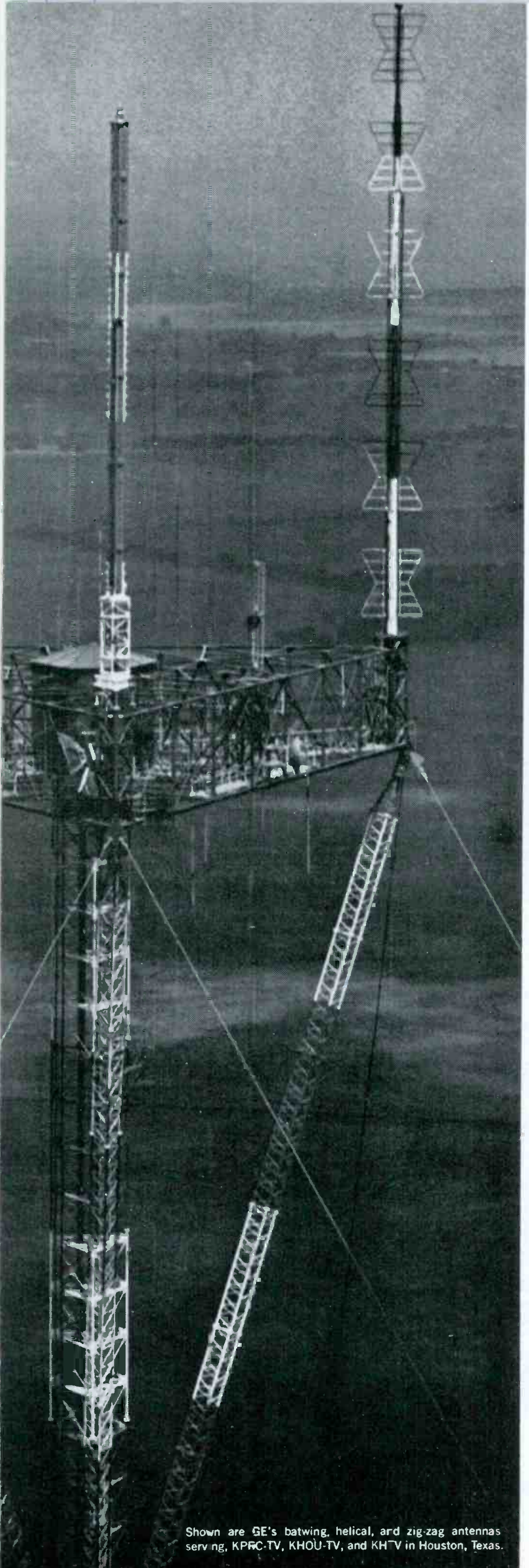

Shown are GE's batwing, helical, and zig-zag antennas serving, KPRC-TV, KHOU-TV, and KHTV in Houston, Texas.

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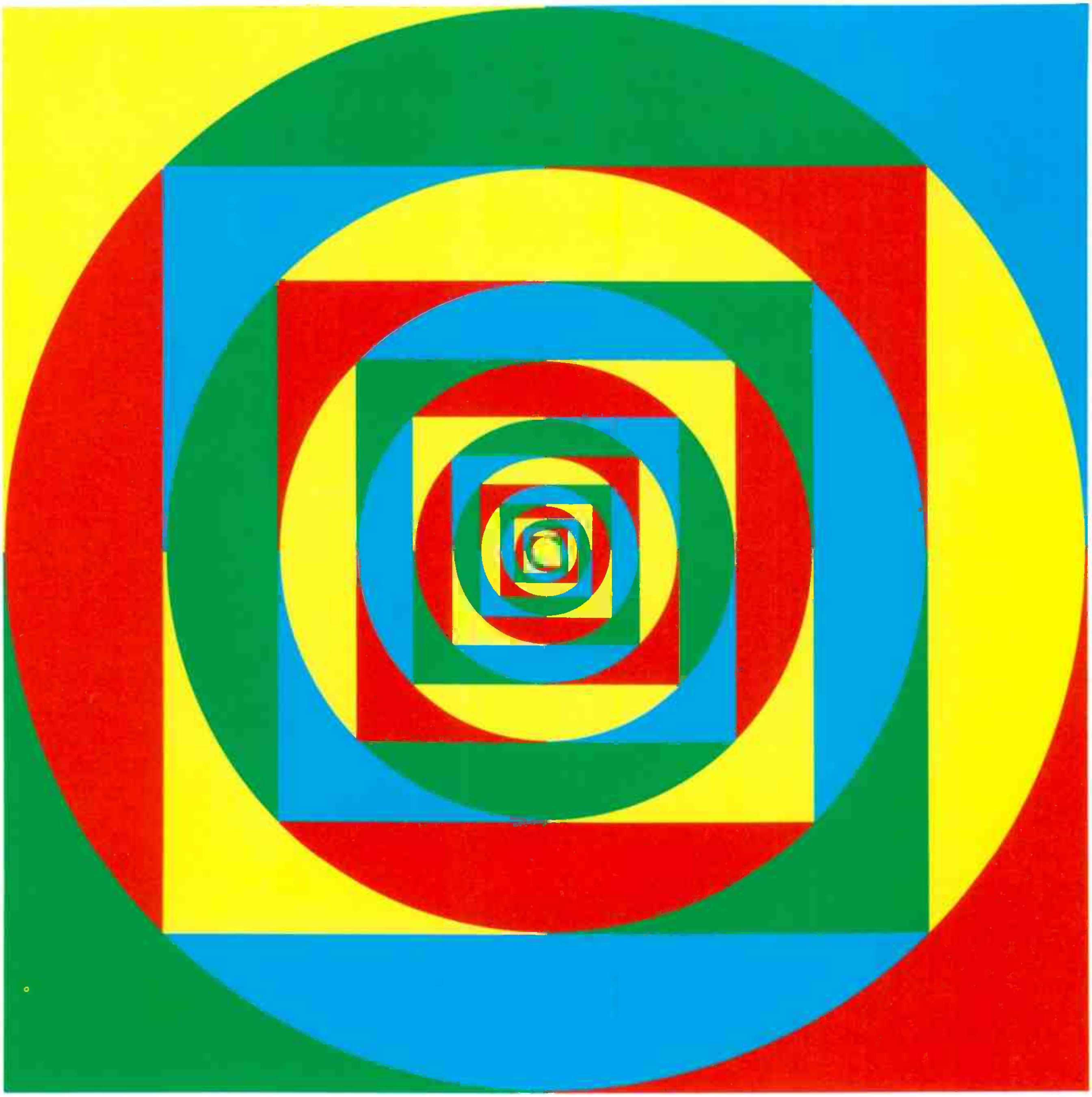

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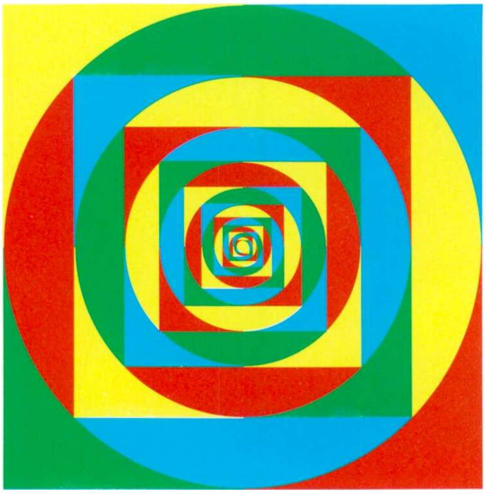

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System Operation and Checkout

A review of Table 3 shows that initating "raise" steps 1 through 7 puts the transmitter on the air. A normal warmup delay must be observed by the operator before turning the high voltages on. The turn-off sequence is "lower" steps 14 through 20, with a normal cool-down delay after the filaments have been turned to the OFF position. Normally, this is a three-minute delay, and the "air-vents closed" signal informs the operator that the transmitter has cycled down.

Once the transmitter auxiliary relays have been installed, wiring to the control unit is straightforward. Switching control functions can be altered by changing terminal board connections. Thus, the operation can be modified to suit the particular transmitter and operator. Note that the "on" functions require different steps, plus "raise," to start and the "off" functions require higher-numbered steps plus "lower." For the operator to initiate a wrong command requires a double error, i. e., a wrong number must be selected and a wrong initiate command executed. At the time of this writing, no problems have been encountered with accidental cycling of the transmitter, except when the operator failed to allow sufficient time for the stepper switch to arrive at its selected step. By pushing up step one and immediately holding "lower," all functions were shut down. Fortunately, this occurred during the warmup, instructional phase, and no interference to operations was committed.

Experience

The drift rate in this installation has been very low, and with the addition of a precise calibration circuit, no particular drift problems have been experienced.

At present, calibration is compared against the transmitter readings which are taken once a week. This permits compliance with the transmitter maintenance schedule.

Training

The training of remote operators is best accomplished by selecting

• *Please turn to page 48*

What's new

at KABC-TV, KATV, KEMO-TV, KEPR-TV, KFMB-TV, KGGM-TV, KHET-TV, KHFI-TV, KHTV, KIMA-TV, KIRO-TV, KMED-TV, KMVT, KNBC-TV, KOAP-TV, KOLO-TV, KPIC, KPRL-TV, KQED-TV, KTCA-TV, KTCI-TV, KTVB, KTVH-TV, KVIE-TV, KVOS-TV, KWGN-TV, KWTX-TV, WABC-TV, WBMD-TV, WCNY-TV, WDIQ-TV, WEDH-TV, WEIQ-TV, WERO-TV, WGEM-TV, WHDH-TV, WHDO-TV, WITA-TV, WJCT, WLOS-TV, WNBC-TV, WOR-TV, WPRO-TV, WPTZ-TV, WRAL-TV, WROW-TV, WSCO-TV, WTIC-TV, WTWO-TV, WVTV, WWTV, WCBS-TV, KGGM-TV, ABC Network, CBS Network, NBC Network **and** BELO HORIZONTE TV (Belo Horizonte, Brazil), CBC (Montreal, Can.), CFRN (Edmonton, Can.), CBC Newfoundland, BOGOTA TV (Bogota, Col.), CHSJ (St. Johns, N.B., Can.), CKLW-TV (Windsor, Ont., Can.), NRK (Norway), Radio Bandirantes (Sao Paulo, Brazil), RTB/BRT (Belgium), Staatsbedrijf Der Posterijn (Holland), Telefis Eireann (Eire), TV-2 (Panama City, Pan.), XEIP (Mexico City, Mex.), XET-TV (Monterey, Mex.), XEW-TV (Mexico City, Mex.), YNSA-TV (Managua, Nic.).

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Circle Item 17 on Tech Data Card

July 1967

We interrupt this magazine to bring you...

Late Bulletin from Washington

by Howard T. Head

Court Decisions on CATV: Giveth . . . and Taketh Away

Two recent court decisions are expected to have a profound influence on the future development of CATV. The Ninth Circuit Court of Appeals (Southern California), in a case involving carriage of Los Angeles television stations by CATV systems in the San Diego area, ruled that the FCC had no authority to order these CATV systems to refrain from expansion pending the outcome of a Commission hearing (see September 1966 and October 1966 Bulletins). But the decision did not stop with this holding; it went on to conclude that the Communications Act empowers the Commission to regulate only Commission licensees, and, since CATV systems are not so licensed, the FCC has no authority to regulate CATV systems generally. Although some lawyers have argued that the Court's opinion applies only narrowly to the San Diego case, the opinion can also be construed as a ban against any regulation of CATV by the FCC.

Shortly after the California case was decided, the Second Circuit Court of Appeals (Southern New York) upheld an earlier District Court opinion (see July 1966 Bulletin) which ruled that CATV systems are fully liable for copyright payments. Although the original decision applied only to two systems in West Virginia, the ruling has the effect of establishing the liability of any CATV system for payments for any copyrighted material carried on the system.

The only appeal from either of these two decisions is to the United States Supreme Court. The Department of Justice has authorized an appeal of the California decision, and Justice Brennan has granted a stay of the lower court's mandate pending the appeal.

Most observers expect that the Supreme Court will uphold the Court of Appeals' decision regarding CATV copyright liability. This would mean that any relief would have to come from revision of the 1909 Copyright Act now being considered by Congress (see November 1966 Bulletin). The House of Representatives deleted any provision for CATV in new legislation now under consideration, but the Senate version may include relief for CATV. It appears unlikely that a new Copyright Law will be enacted in this session of Congress.

New Call-Sign Rules Proposed

The Commission has begun action to codify its Regulations governing the assignment and use of AM, FM, and television call signs. The present call-sign rules are mainly procedural, and do not spell out established policies and precedents generally followed by the Commission.

The proposed new rules would recognize the established policy of assigning "W" call signs east of the Mississippi River and "K" call signs west of the river, and they would specify the practice of assigning only four-letter calls (except those ending in FM and TV). Stations would be assured of their right to use call signs of their own choice if they are in good taste and are distinguishable phonetically and rhythmically from other calls already in use in the same area. The use of the same basic call by AM, FM, and TV outlets in the same or adjoining communities would be defined.

A first-come, first-served principle would be established under which a requested call would be made available to the first eligible applicant. "Trafficking" in call signs would not be permitted.

FM Channel-Assignment Policies Tightened

The Commission has recognized the growing shortage of FM broadcast channel assignments by requiring special showings in connection with requests for new FM allocations. Justification must be furnished in support of a request for the assignment of a second FM channel to a city having a population less than 10,000, and for any additional assignment in a larger market. The mere resolution of a conflict between pending applications will not in itself be considered justification for the assignment of an additional channel.

Applicants proposing Class-B or Class-C channel assignments for smaller communities, especially in cases where Class-A channels are already assigned or could be made available, will be expected to include a showing that operation with the wider coverage would provide FM service to "white" or "gray" areas not now receiving adequate FM service.

Short Circuits

The Commission continues to levy substantial fines for violations of the Technical Rules -- one of the most common infractions is operation with an improperly licensed operator. . .Commissioner Johnson has dissented to the recent grant of an application for a new FM broadcast station where the applicant proposed commercial time running as high as 33 minutes per hour. . .An early hearing will be held by the Commission in New York City on proposals to move all television transmitters from the Empire State Building to a new 110-story World Trade Center Building in lower Manhattan -- studies showed that the new building would cause substantial ghosting if the stations stayed on the Empire State Building, and the best solution appears to be the proposed move. . .The National Association of Broadcasters (NAB) and the Association of Federal Communications Consulting Engineers (AFCCE) have supported the Commission's proposal to calculate FM and television coverage contours using radiation in the pertinent vertical direction rather than in the horizontal plane as now required (see January 1967 Bulletin).

Howard T. Head. . .in Washington

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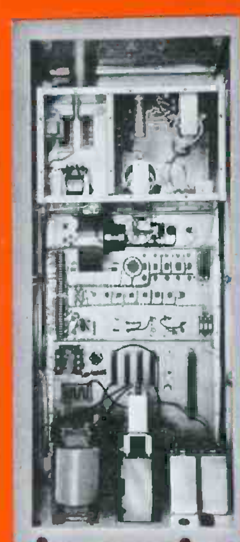

REAR VIEW
1 KW AM

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Circle Item 18 on Tech Data Card

TV Remote Control

(Continued from page 43)

personnel with previous knowledge of the transmitter, or by scheduling other employees to work transmitter shifts so that they may become acquainted with the particular transmitter operation. If the operator has knowledge only of the push-button functions and telemetry readings, he could fail to recognize problems as they arise. Also, adjustment of sync levels and power, and their interaction, should be given some thought.

Some operators will adopt a negative attitude toward the remote control, but this is usually resolved by successful, consistent experience in remote operation.

The Future

Modifications under development include the installation of smoke detectors in critical areas within the building. Also, a building-security operator alarm is being devised. The smoke alarm will employ the same circuit. Another improvement could be the installation of photocells on the transmitter trouble lights to warn the operator of a problem area.

Conclusion

From the preceding it is evident that, with the present state of the art, the remote control of television transmitters is practical. The advent of high-quality, solid-state DC amplifiers has made low-level telemetry readouts entirely practical, even in high-noise environments.

Only one method for developing a television-transmitter remote-control program has been presented, and it has been a prototype operation. Future improvements should increase reliability and decrease the costs of such installations. Digital-analog convertors will simplify remote-meter readings. Waiting for improvements can be expensive, however, and present methods give satisfactory results.

This article has been an attempt to show that an organized method of solving the remote-control problem is available. It is hoped that the information presented will assist others in the solution of their particular remote-control problems. ▲

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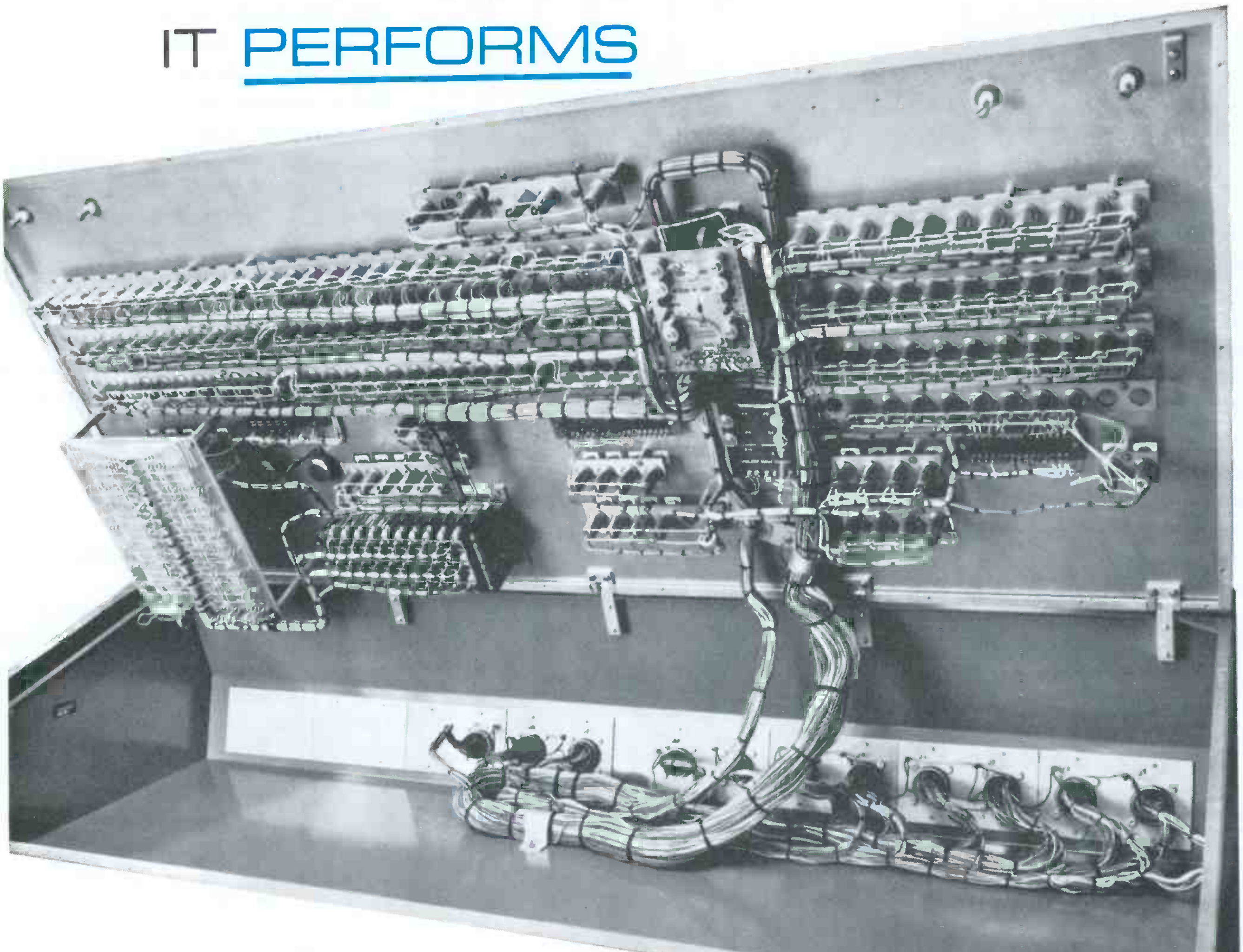

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Circle Item 20 on Tech Data Card

Problems in Transistorizing *(Continued from page 19)*

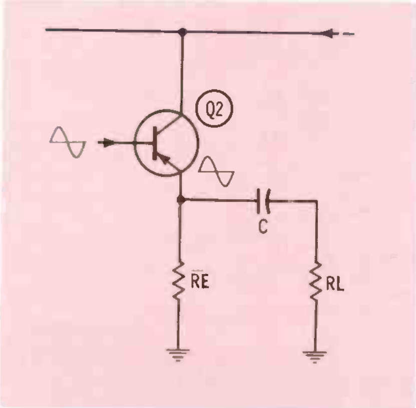


Fig. 4. Part of output signal current is diverted through emitter resistor.

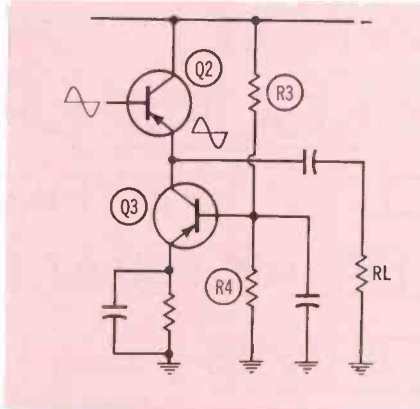


Fig. 5. Second transistor acts as an emitter-circuit "electronic choke."

3. The collector resistor (from Fig. 1) is divided into two parts, R_{L1} and R_{L2}. A capacitor (C1) connects the junction of these resistors to the emitter of Q2. The action of this connection results in what is known as "bootstrapping."

The signal voltage appearing at the emitter of Q2 is in phase with and almost equal to the signal voltage on the collector of Q1 (Q2 being an emitter follower). Therefore, the voltage transferred through C1 to the junction of R_{L1} and R_{L2} causes this point to undergo voltage changes in step with those on the collector side of R_{L1}. This means that the voltage drop across R_{L1} remains constant. This is equivalent to saying that there is no alternating current through R_{L1}. This means that all the signal component of the collector current of Q1 flows into the base of Q2 and consequently there is no loss.

Another trick is to use a transistor as an "electronic choke." Consider the emitter-follower circuit in Fig. 4. All of the transistor direct current passes through R_E because the path through R_L is blocked by coupling capacitor C. This path, however, is not blocked for the signal component of the emitter current, which therefore divides between R_E and R_L. In this way some of the signal current is diverted from R_L and is lost as far as the load is concerned.

This loss cannot be minimized by increasing R_E because this decreases the DC current of the transistor and limits its output dynamic-range capability. It is necessary to have a low value of R_E for DC and a high value of R_E for AC. This can be achieved by using a choke in place of (or in series with) R_E. However, chokes are not popular components because they are bulky and are prone to hum pickup. A transistor can be used for this purpose. This is shown in Fig. 5, where Q3 is substituted for R_E. The DC resistance of Q3 (between emitter and collector) can be adjusted to any desired value by voltage divider R3-R4, which fixes the base voltage of Q3 and consequently its DC current. However, looking from the emitter of Q2 to ground, the output signal sees the impedance of Q3 as the output impedance of a common emitter circuit, which is of the order 20,000 to 30,000 ohms. Thus, very little signal current is lost.

Intermediate Amplifiers

Next, attention will be turned to the intermediate amplifier which raises the signal from the microphone preamplifier to a mixing level. Here, again, DC-coupled pairs are

Fig. 7. High value of load R cannot be used to divert Q1 output signal.

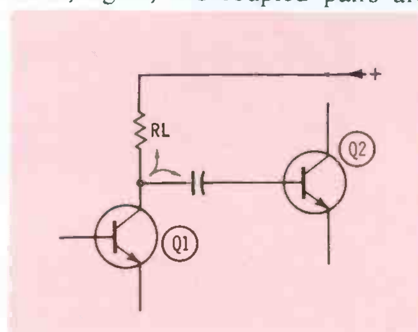
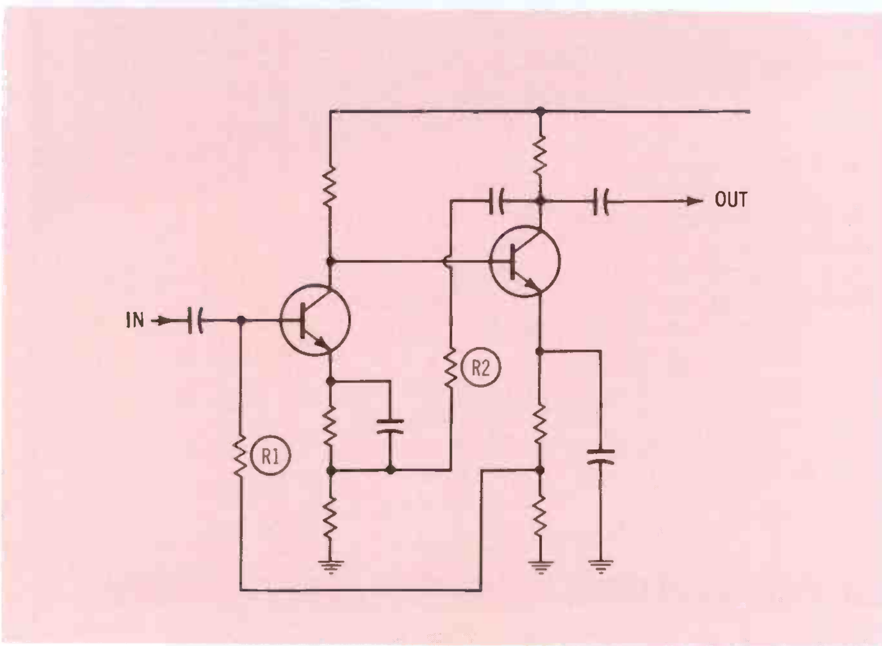


Fig. 6. Intermediate-level amplifier; R1 is for DC feedback, R2 is for AC.



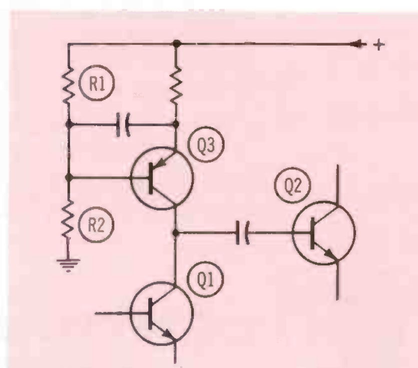
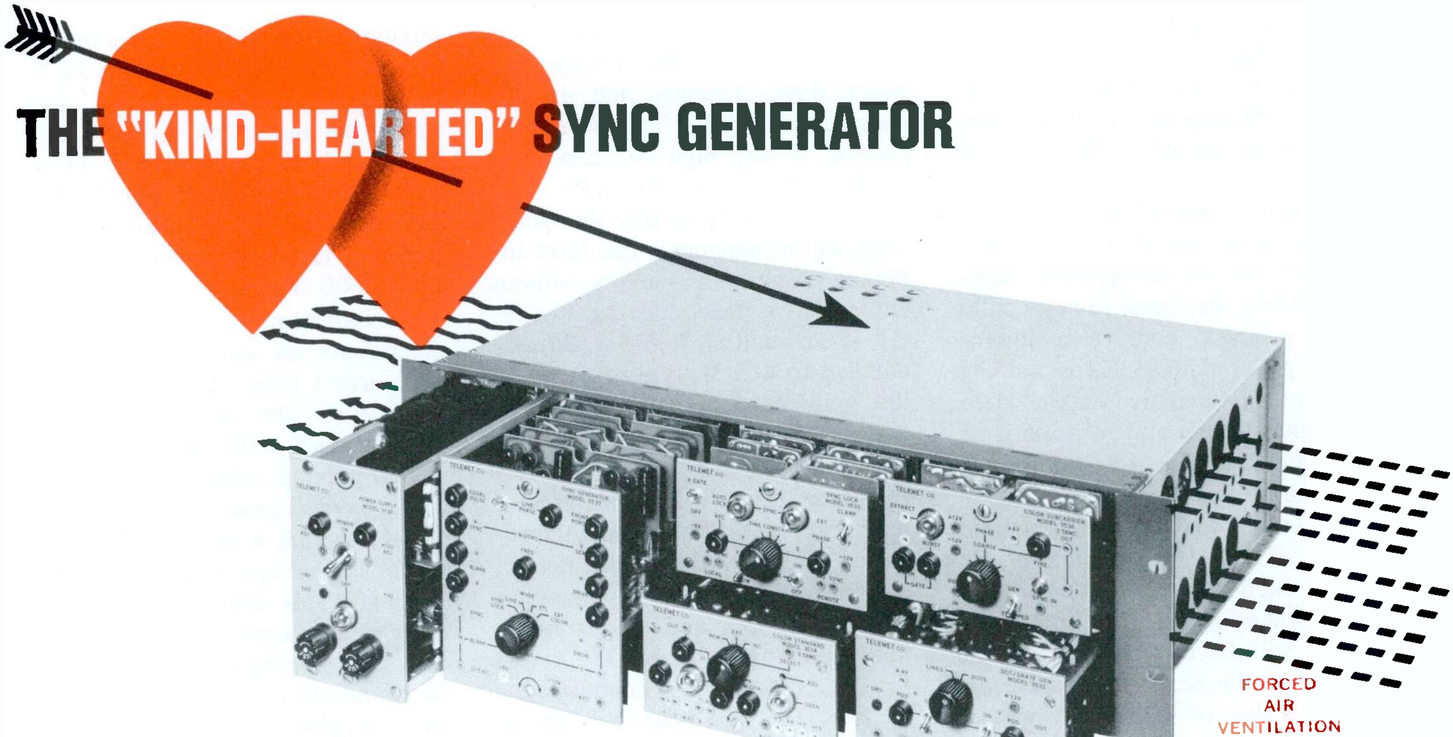


Fig. 8. Electronic choke replaces R_L.

THE "KIND-HEARTED" SYNC GENERATOR



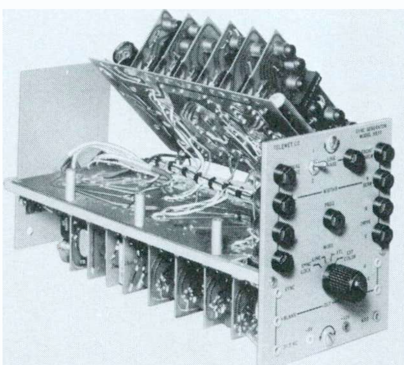
Color Sync Generator Package, Model 4230-A1

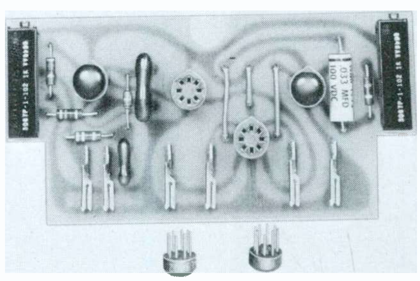
Most of today's sync generators use soldered-in microcircuits squeezed into a space that only a microbe could get in to repair. For very low priced generators, this is ideal—but MURDER for the broadcast engineers who have to maintain them. Here's why Telemet's new Model 4230-A1 is so "kind-hearted":

♥ PLUG-IN UNITS WITH PLUG-IN SUBASSEMBLIES. ♥ PLUG-IN INTEGRATED CIRCUITS. ♥ ADEQUATE FRONT PANEL TEST POINTS (COLOR CODED). ♥ BLUE RIBBON CONNECTORS. ♥ "STRAIGHT THRU" FORCED AIR VENTILATION. ♥ MINIMUM NUMBER OF INTEGRATED CIRCUIT TYPES. ♥ EXTREMELY RUGGED CONSTRUCTION. ♥ INCORPORATES THE BEST FEATURES OF ALL TELEMET SYNC GENERATORS.

The basic equipment (frame, power supply and sync generator) is $1,800. Plug-in accessories include: Model 3533-A1 Automatic Sync Lock Module; Model 3536-A1 Automatic Sub-Carrier Regenerator Module; Model 3534-A1 Color Standard Module with Proportional Oven; Model 3532-A1 Dot Grating Module.

Most of the engineers at this year's NAB Show who looked inside this sync generator—bought it . . . confirming that our heart *was* in the right place.





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Circle Item 26 on Tech Data Card

very popular, and AC and DC negative feedback is used.

A possible circuit is shown in Fig. 6; the stabilizing effect of the feedbacks is in principle the same as in Fig. 1.

There is, however, a basic difference between the microphone preamplifier and the intermediate amplifier. While the signal-to-noise ratio is the principal concern in microphone preamplifiers, this is not the case in intermediate stages. Here the signal is high and so noise is of little concern. The main interest is in a large signal-handling capability in order to keep the dynamic range as large as possible. This means high DC collector currents and voltages. In Fig. 7, a high value for R_L will divert most of the signal current to the next stage. However, a high value of R_L will lower the collector voltage (since the DC current is large), and thus the signal-handling capability of the stage will be lowered. Again, a transistorized choke will serve as a solution. In Fig. 8, Q3 replaces collector resistor R_L. Its DC resistance depends on the DC voltage between the emitter and base, and so can be adjusted to the desired value. Thus, any desired value of collector voltage for Q1 can be achieved. Now, from the AC point of view, Q3 has its base shorted to its emitter, so there can be no AC voltage between these elements, and no AC current will flow. Therefore, Q3 presents a very high AC resistance to the collector current of Q1.

It is interesting to note that some coupling arrangements can have inherent temperature stability without DC negative feedback. In Fig. 9, Q1 is an emitter follower directly coupled to Q2. If, due to a rise in the ambient temperature, the DC currents of both transistors start rising, the current of Q1 will rise very little because its large emitter resistor causes local negative feedback. However, the slight rise of current in Q1 lowers the voltage on the base of Q2, and this (through the amplifying action of Q2) lowers its DC current, thus counteracting the rise. The idea here is to use an NPN transistor followed by a PNP type.

Mixing Amplifiers

To conclude this brief review of some special circuits appearing in professional studio equipment, the problem of mixing several audio channels into a common output amplifier will be considered. A typical method appears in Fig. 10.

In tube circuits, it is desired to have as high a signal voltage on the mixing bar as possible, because the input of the amplifier connected to this bar is voltage controlled. This means the mixing bar should have a high impedance to ground. However, cross-talk and hum-pickup considerations fix the mixer-bar impedance at an optimum value of about 600 ohms.

In transistorized mixers the considerations are quite different. Signal current rather than signal voltage drives the mixing amplifier. This means that the input impedance of the mixing amplifier should be made very small (about 20-50 ohms) so that it will absorb all the signal current appearing on the mixing bar. This also makes the impedance of the mixing bar to ground very low (the input of the amplifier is connected to it); thus the mixer becomes practically immune to electrostatic hum pickup and cross talk. One method of achieving this is shown in Fig. 11. Here the input impedance of the mixing amplifier is reduced to about 30 ohms by a liberal amount of negative feedback through R1 to the input base.

Attention has been given to some of the transistor circuits likely to be found in broadcast equipment. It is hoped the comments in this article will be helpful to the broadcaster when he encounters such circuits. ▲

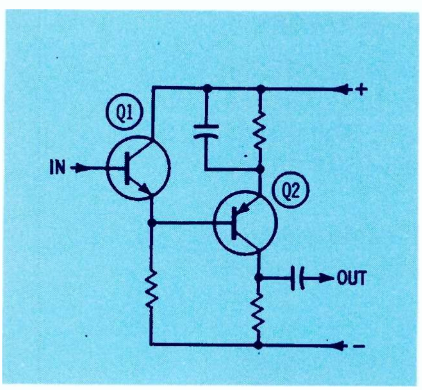


Fig. 9. Use of complementary transistors improves temperature stability.

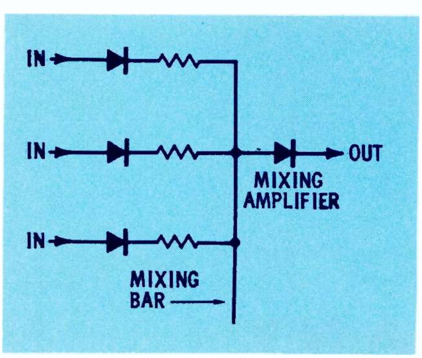


Fig. 10. Typical audio mixing method.

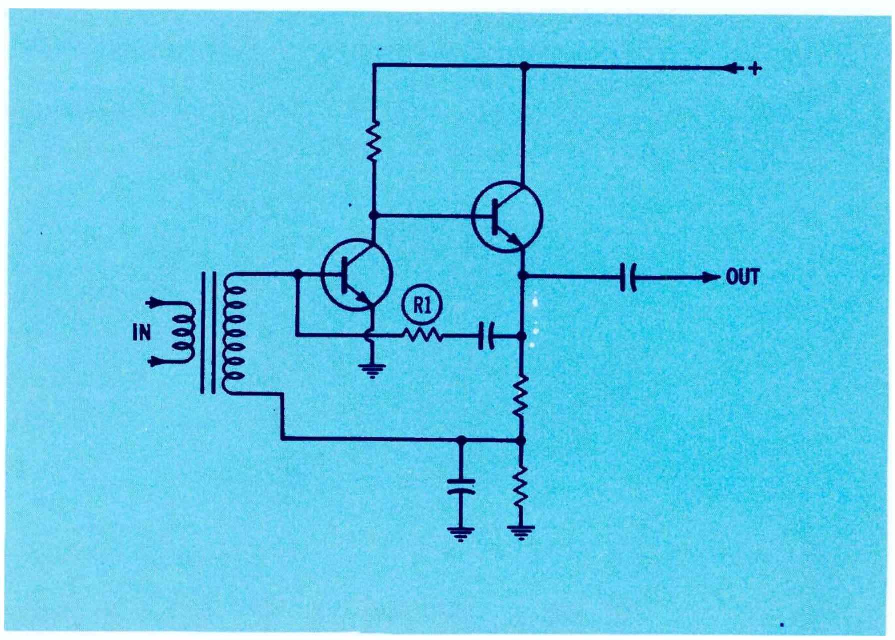


Fig 11. Negative feedback reduces the input impedance of mixing amplifier.

Tower Lights

(Continued from page 24)

ployed on the KATU tower provides for positive monitoring and observation of all fixtures, and the status of all lamps can be determined in a few seconds.

A diagram of the system is shown in Fig. 1. Current transformers of the type used for remote-control metering are placed on each circuit leg to be measured. The transformer outputs are fed through a push-button selector-switch arrangement, and individual potentiometers are used to calibrate accurately for different loads. The small sample of AC current from the transformer is fed through a full-wave bridge rectifier to a meter which has been provided with a special read-out scale for visual indication of lamp status. (An experimental breadboard arrangement with simulated loads should be made prior to final assembly to determine final circuitry and determine meter-scale calibrations.) The face of the 0–50 μa meter was modified to conform to our individual requirements by repainting the original dial face and applying india ink and "instant lettering" to provide new scales.

On the 883-foot tower at KATU, there are six levels of lighting: three sets of three 116-watt obstruction side-lights each, and three flashing beacons having two 620-watt lamps each. The selector-switch positions have been arranged to correspond to each lighting level from bottom to top of the tower. When a switch button an any given level is pressed, the meter shows whether one, two, or three side lamps are lighted, or whether one or two beacon lamps are operative. If a lamp is burned out, a correspondingly reduced reading is indicated on the meter.

The beacons are on a flasher circuit, and it is difficult to take a reading during the brief "on" time. For this reason, a "stop-flasher" momentary push-button switch has been included; it provides an override on the flasher mechanism by means of an auxiliary relay to freeze the beacon flash cycle so that a reading can be made. In addition, an override switch for testing purposes was provided to turn the lights on manually during daytime hours when the photocell automatic system is not actuated.

This unit also can be used to check other circuits than those for tower lighting. At KATU, one switch position has been wired for checking the antenna deicers. Spare switch positions have been provided for checking future additional circuits. Different load values can be sampled by using appropriate potentiometers or resistance networks.

While the unit used at KATU is built into an external box assembly, it is entirely feasible to design the system to be integrated into an aperating console, rack panel, or other spot suitably located for operator convenience. Various design configurations could be made, depending on the ingenuity of the constructor. The current-transformer outputs can be cabled and fed any reasonable distance with no problems. While individual installations will vary, it may be advisable to include filtering by RF chokes and bypass capacitors to eliminate RF problems when in the proximity of high-power transmitters. Transmitter output frequency should be taken into consideration when designing such filter networks; the values shown are for channel 2. ▲

NEWS OF THE INDUSTRY

Equipment For Katmandu

A contract to supply the Government of Nepal with a multi-studio sound broadcasting complex has been awarded to **Pye TVT Ltd.** The system has been developed in consulation with British Government advisers to the project. Special facilities will enable the new station to broadcast a variety of sound programs.

CAB President Named

S. Campbell Ritchie, president of **CKLW TV-AM-FM,** has been elected president of the **Canadian Association of Broadcasters.** He succeeds Mr. Jean Pouliot of **CFCM-TV,** Quebec city.

Mr. Ritchie, who is better known as Cam throughout the Canadian and U.S. broadcasting industry, has been associated with the CKLW stations since 1936, when he started as an announcer-singer. He later became program manager for CKLW Radio and then operations director in 1946, adding the same duties for CKLW Television in 1954. In 1961, Mr. Ritchie was named president of the CKLW Stations.

Mr. Ritchie came to CKLW from CHML, Hamilton, Ontario, where he had served as staff announcer. During World War II, he served with the Canadian Army, attaining the rank of Major, and was responsible for the establishment and operation of the Canadian Forces Radio Service.

He has served on the CAB Board of Directors and is a past president of the **Central Canada Broadcasters Association.**

Satellite Activity

The firm of **Holmes & Narver, Inc.** has been selected by **Communications Satellite Corp.** to provide architectural and engineering services for three new earth stations for commercial satellite communications. The new high-capacity stations will be located near Cayey, Puerto Rico; Green valley near Rowlesburg, West Virginia: and at a site to be designated in California. Two contracts are involved: one totals about $361,600 covering work on the West Virginia and California facilities; a separate contract for Puerto Rico will cost approximately $194,200.

In another announcement, Comsat urged speedy action on their request for authority to establish a pilot U.S. domestic satellite program, with channels available without charge for demonstrations by educational broadcasters. Comsat said it was prepared to finance and start construction of such an initial multi-service satellite and earth-station complex now, providing service starting by late 1969.

Receipt of a contract for a satellite communications earth station in the Philippines has been announced by **General Telephone & Electronics Corp.** The station will serve as a ground terminal for voice, television, and data communications to and from an Intelsat II satellite

in synchronous orbit 22,300 miles over the Pacific Ocean. The station will be at Pinugay, about 25 miles east of Manila.

Call For Improved TV Sound Quality

Hazard Reeves, chairman of **Reeves Broadcasting Corp.**, has charged that poor sound is being served to the public by the motion picture and broadcasting industries. In a speech before the **Society of Motion Picture & Television Engineers** at the New York Hilton Hotel, Mr. Reeves claimed low quality of motion picture sound reproduction is the result of an industry practice of sticking with frequency standards established in the 1930's. "Many motion picture theaters have sound systems that are not equal to the quality of a good hi-fi set," he said. "The photographic sound tracks used in a motion-picture theater generally have a cutoff frequency of about 7000 cycles."

In the case of television, Mr. Reeves pointed out the generally accepted standard for a telephone broadcast line of 5000 Hz is too frequently used, yet the telephone company makes a high-quality 15000-Hz line available. These lines, he added, are not used very often.

New Headquarters Building

Construction of a new headquarters building for **Fairchild Semiconductor,** a division of **Fairchild Camera and Instrument Corp.** has begun. The new building will incorporate 342,000 square feet in two levels of office space and a full basement. A two-level parking garage, which is to be located at the rear of the main building, will incorporate an additional 100,000 square feet. Both are scheduled for completion early in 1968.

New Type of Magnetic Recording Tape

A development program for a new type of magnetic recording tape is being conducted by the **Du Pont Co.** The tape employs chromium dioxide rather than conventional iron oxide. The patented compound was developed in the course of a Du Pont research program in the general field of magnetism.

Among the stated advantages of the new tape are greater magnetic strength and fidelity in high-frequency instrumentation and video recording, and increased reliability and information-storage capacity in computer use.

Du Pont is planning to produce development quantities of the tape in a manufacturing facility recently completed at the company's Newport, Del., site.

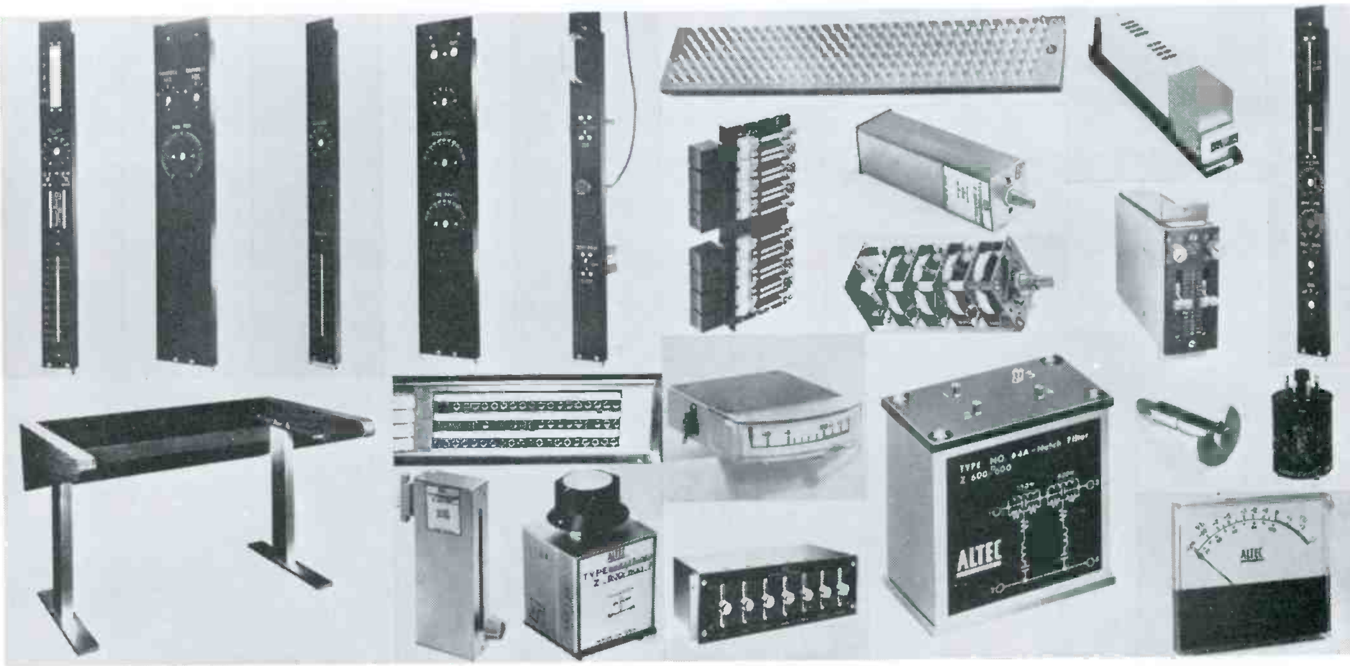
New CATV System

Cable TV service is now available to 800 of the estimated 5000 homes in the Bedford, Ind. area. A 200-ft head-end tower is used by the system, which carries ten stations and a weather channel. The system was engineered and equipped by **Blonder-Tongue Laboratories, Inc.** for **Bedford TV Cable, Inc.**

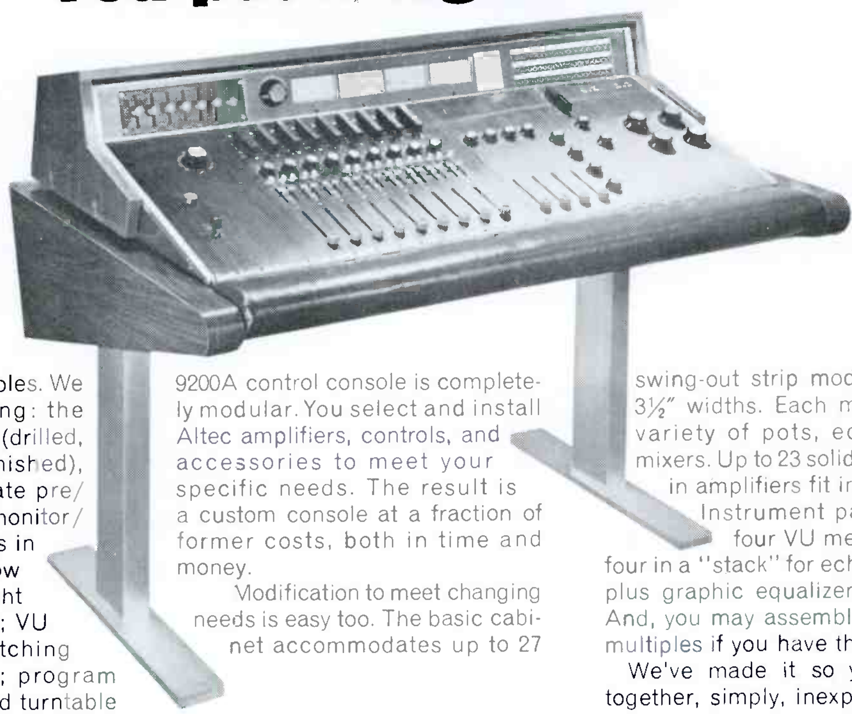
PERSONALITIES

Chris G. Chaggaris has been appointed to the post of advertising and public relations manager for **Visual Electronics Corp.** His responsibilities include all advertising, promotion, and public relations planning and administration for the Company's domestic and foreign subsidiaries.

We've got it made.



You put it together.



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

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

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

We've made it so you could put it together, simply, inexpensively and just as you like it. And that's always a good idea. You'll get more ideas by calling your Altec Distributor, or for a very complete technical kit on the console, write Dept. BE-7

ALTEC LANSING

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

Circle Item 24 on Tech Data Card

The appointment of **Antoine Roederer** to the position of chief engineer has been announced by **Jampro Antenna Co.** Prior to joining Jampro, Mr. Roederer was engaged in research design of log-periodic antennas and slot arrays for **Electronic Research Laboratories** in Berkeley, California.

William H. Butler has been appointed to the newly created position of product manager, closed-circuit television tapes, in the **Memorex** organization.

Two appointments have been announced by **Radio Corporation of America.** One is the assignment of **A. W. Power** to be manager, Eastern professional television and systems sales, Broadcast and Communications Products Division; the other is the appointment of **E. Noel Luddy** to the new position of manager, broadcast and communications consultant relations, in the same Division.

PROPERTY TRANSACTIONS

The **Superior Broadcasting Corp.** and **Kaiser Broadcasting Corp.** have announced plans for a new television station to operate on channel 61 in Cleveland. Superior holds a construction permit for channel 61. Kaiser and Superior plan to form a jointly owned corporation to seek authority from the FCC to build and operate the station.

Officials of **Cox Broadcasting Corp.** have announced that agreement has been reached on the principal terms whereby Cox will become sole owner of cable television operating systems in San Diego and Bakersfield, California. The two West Coast properties are currently operated by **Trans-Video Corp.** Cox already owns a 16% interest in Trans-Video Corp. and a 50% interest in **Bakersfield Cable TV, Inc.**

Comtel Engineering Inc., west coast communication-system engineering and servicing company, has been acquired by **Paul S. Byrne.** Mr. Byrne has been associated with American Hospital Supply Corp., Tracerlab, Inc., (a division of Laboratory for Electronics) and Ampex Corp. Comtel originated the "Sportrainer" videotape recording system used in teaching sports, and it installed the first 2500-MHz ITV System in California. ▲

IS YOUR VIDEO ON THE LEVEL?

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

Ultra Stable Circuitry
through complete and accurate temperature compensation

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

CLAMPING
Sync tip clamps remove hum, tilt and other low frequency disturbances. Where excessive negative spikes or transient-noise are present, additional noise immunity is available with an external pulse regenerator at $300.00

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

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

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

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

CHROMA CONTROL
Chroma response continuously adjustable ±4db. from unity.
For Automatic chroma feature to assure constant burst level, add $200.00.

WHITE STRETCH
Stretch adjustments provide a high degree of flexibility to compensate linearity characteristics of transmitters of all ages.

NON-COMPOSITE COLOR OUTPUT
Mono or **Color** non composite output board in lieu of white stretch for additional $100.00.

APPLICATION
At the input to all transmitters (VHF, UHF. 2500 MHz) and remote inputs to your station. You may use the non composite output (color or mono) and bring it into your switcher for mixing with local signals. You may use it at the input and output of VTR's including helical scan recorders. At the line output of your switcher, at the input and output of microwave equipment and for air pick-ups.

Price for the VI-500 still $1,750.00 Remote controls $150.00 . . . One out of 3 stations in the country already enjoys the benefits of this stabilizing amp.

GOOD ENGINEERING IS VITAL

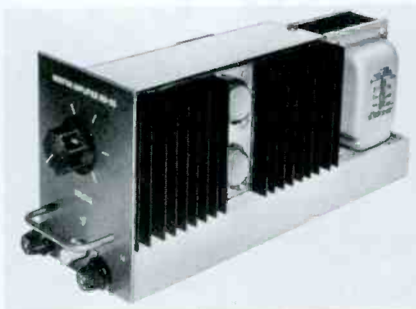
Write for complete information and specifications.

VITAL INDUSTRIES 3614 SOUTHWEST ARCHER ROAD GAINESVILLE, FLORIDA—PHONE 378-1581

Circle Item 29 on Tech Data Card

NEW PRODUCTS

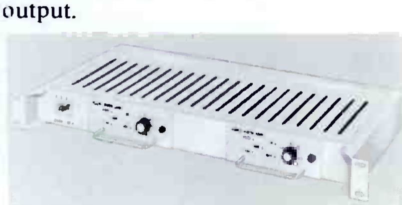
For further information about any item, circle the associated number on the Tech Data Card.



Solid-State Monitor Amplifier
(50)

A completely solid-state amplifier with a self-contained power supply has been designed specifically for use in commercial broadcast and recording studios for monitor and audition applications by **Aerovox Corp.** The Model 120-SS amplifier has been designed to provide sufficient undistorted power output to drive high-quality, low-efficiency speakers. The output transformer has been eliminated in the design for the purpose of obtaining low driving impedance and, consequently, a high damping factor.

Specifications of the amplifier are as follows: Input impedance bridging 20,000 ohms, balanced or unbalanced. Source impedance—may be connected for 50, 250, or 600 ohms. Load impedances—4, 8, and 16 ohms. Maximum input level—0 dBm matching and +30 dBm bridging. Average continuous power output—20 watts (+43 dBm) with an 8-ohm load. Maximum gain—79 dB matching and 45 dB bridging. Frequency response — ± 1 dB from 20 to 20,000 Hz. Harmonic distortion—less than 0.5% at 20 watts output across an 8-ohm load. Noise level at the output with maximum gain—61 dB below 1 watt output.



Video/Pulse Distribution Amplifiers
(51)

A new line of video and pulse distribution amplifiers is offered by **Ball Brothers Research Corp.** The Mark IX-A amplifiers are produced specifically for use in broadcast television studios. The fully transistorized equipment is designed for 20-MHz broadband amplification, low differential gain and phase distortion, quality derated components, and individual self-contained electronically regulated power supplies.

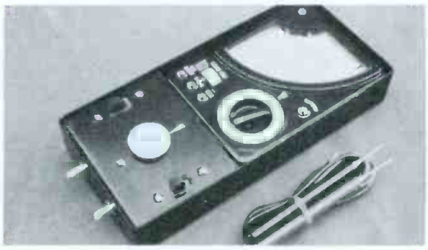
Modular construction of the plug-in units permits incorporation of two individual amplifiers in one electronic housing, providing a total of eight isolated outputs at one central distribution point. Each video amplifier has optional provisions for adding either sync or blanking to the output video. Prices start at $255.

High-Voltage Adjustable Delay Line
(52)

An adjustable lumped-constant delay line, featuring a dielectric strength of 2500 volts DC, has been developed by **Kappa Networks, Inc.** Specifications include: nominal delay, 3.5 μsec at an impedance of 1500 ohms; rise time, 0.2 μsec; adjustment range,

±0.1 μsec (screwdriver adjustment) with a resolution of less than 1 nsec.

Enclosed in an epoxy-filled glass-fiber package of ½″ x 2⅝″ x 6″, the Model 20E402 has been designed for printed circuit board mounting.



Pocket Meter
(53)

The Mini-Meter, a field-strength meter combined with an ohmmeter and voltmeter in one case, has been introduced by **Jacobsen Electronics.** The unit is enclosed in a steel case

The $73,000 Bargain

. . . or why the Norelco PC-70 3 Plumbicon* tube color camera is a better buy than any 4-tube color camera.

To begin with, it's a bargain in the keep-the-sponsors-happy department. With the PC-70, performers do not turn green or magenta, even when moving against a dark background. Nor do white doves, white knights or high-flying washing machines. *The PC-70 has virtually eliminated the dangers of lag.* But 4-tube cameras invite lag. For one thing, they must use a 4-way light split which "robs" light from RGB channels to "feed" the luminance (4th) channel. For another, their optical systems are too complex (more complex optics mean still more light loss).

The picture speaks for itself.

The use of three tubes instead of four motivated the only original color camera design in the industry: the first practical application of the "contours-out-of-green" principle to provide sharper edges in the vertical as well as horizontal direction.

Instead of a space-consuming fourth tube and its complex associated circuitry, the PC-70 improves sharpness *electronically*—to almost any degree you desire. Because of the low frequency characteristic of the vertical aperture correction, you produce a sharper image on the *home receiver* (not just on the studio monitor), in color and monochrome. You profit from greater long-term economy . . . far less optical, circuit and operational complexity.

There are more reasons why it's the "$73,000 bargain."

Your video-men and cameramen will find the PC-70 to be as simple to operate as an 8mm movie camera. (Well, almost.) This is a result of the 3-tube concept. Another reason: the PC-70's unique 3-way beam split prism. Because of it, there are no shading controls to fuss with. (Some 4-tube cameras require as many as 16!) There are no set-up controls required at the camera head. All are at the Camera Control Unit where they can be adjusted in the quiet control room—instead of the hectic and noisy studio!

For your maintenance-men, the PC-70 means adjusting and maintaining one less of everything that may need their attention: optical channels, deflection yokes, focus coils, deflection and processing amplifiers. The PC-70 saves time. And time still means money.

For color or monochrome, in bright lights or shadows, in the studio or on remote, the PC-70 picture stays sharp, natural, rich in detail and easily matched from one camera to another.

The Norelco PC-70.

A bargain any way you look at it.

Write today for a detailed brochure. Contact us—or our representative, Visual Electronics. To help you verify everything we've said, we'll include our references: a list of stations that now use Norelco Color Cameras. Two of the three major networks do.

Don Ferguson, Chief Engineer, KXTV, Sacramento, California

"A viewer commented recently that KXTV has the 'cleanest' picture in town. This layman summed up in a word the superior sharpness of our picture, the realistic color saturation and better signal-to-noise ratio we get with the Norelco 3 Plumbicon tube color camera. In the final analysis, it's the viewer we have to please. The Norelco camera does that, so we're pleased too: we're buying more PC-70s."

Norelco | **PHILIPS BROADCAST EQUIPMENT CORP.**

NORTH AMERICAN PHILIPS COMPANY, INC.
299 Route 17, Paramus, New Jersey 07652

Circle Item 34 on Tech Data Card

*Trademark of N. V. Philips' Gloeilampenfabrieken of the Netherlands for television tubes.

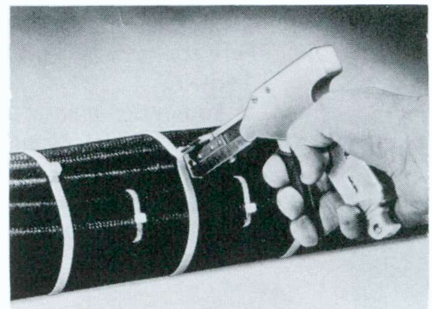
and was designed primarily for use by CATV house-drop installers for selecting the correct tap insert on the pole. The meter operates on TV channels 2 through 13, and the FM band. The unit is powered by 9-volt transistor radio batteries and is priced at $75.

Telephone-Type Relay
(54)

This new 5-ampere, telephone-type, multipole relay has a switching capacity ranging from 4-pole through 8-pole and an operating power of 1.2 to 1.5 watts. The AMCOR BKS-5 relay is available from the **American Monarch Div.** of **Minneapolis Scientific Controls Corp.**

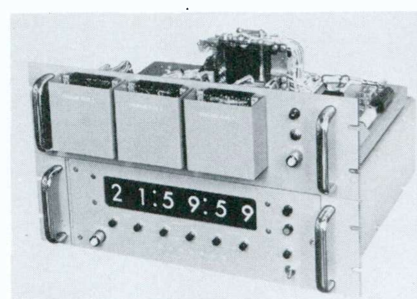
It is designed for continuous or intermittent duty in such applications as controls, computers, radio communications, etc.

Construction features and specifications include: high contact pressures (30 gram minimum NC, 35 gram NO); maximum contact resistance of 15 milliohms; low contact capacitance for RF applications; small molded nylon package (0.9" x 1.6" x 1.3"); molded reinforced alkyd contact stacks; coil-voltage options from 6 to 110 volts DC; large-diameter gold-treated contacts handling 5 amperes at 115 volts AC or 3 amperes non-inductive; and a variety of optional contacts including silver gold, gold alloy, silver cadmium, and palladium.



Tension-Controlled Harnessing Tool
(55)

A new heavy-duty harnessing tool from **Panduit Corp.** handles the ten largest sizes of Pan-Rap cable ties. The tool incorporates a two-position knob which can be adjusted to suit the tension requirements of a specific cable-tying job. The GS4H harnessing tool accommodates all of the Pan-Rap cable-tie sizes from the standard to the extra-long heavy-duty ties, and the tool also can be used for Panduit identification markers and clamps. Operation of the tool is simple; insert the Pan-Rap cable tie and squeeze the trigger. The tool cuts the nylon Pan-Rap flush at preset tension.



Digital Time Programmer
(56)

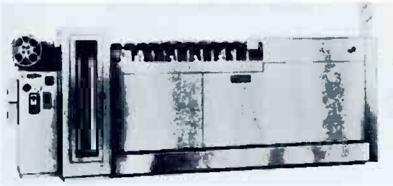
Parabam, Inc. is marketing a series of TP digital time programmers for program control by radio and television stations. Used in conjunction with a standard digital clock, the programmer permits the accomplishment of contact closures at preset time points. These contact closures may be used for controlling broadcast functions or special-effects sequences.

Specifications and features include:

program time resolution as small as one-tenth second regardless of program cycle; program cycle can vary from 10 seconds to a year depending on clock range and number of decades programmed; presetting of programs may be accomplished by means of program plugs or thumbwheel coding switches. Options such as time and program display, logic output, or override controls also are available.

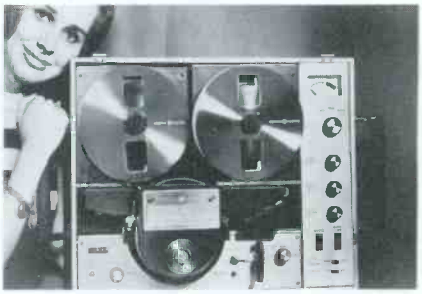
Solid-State Power Amplifier
(57)

The model SA 30-30 is a new solid-state stereo amplifier by **Crown International.** The unit is available for rack mounting or can be supplied with a black cover. Measuring 19" x 1¾" x 8", the amplifier delivers 20 watts per channel into 8 ohms, and over 30 watts into a 4-ohm load.



Color Film Processor
(58)

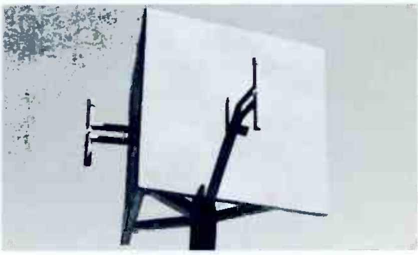
A continuous processor for 16-mm *Ektachrome* film has been announced by the **Filmline Corp.** Designated the F.E. 50., this unit is a scaled-down version of the large processors built for film laboratories, and is intended for use in TV stations and industrial installations. Features include: processes color emulsions at 50 fpm; stainless-steel construction; friction drive with built-in over-drive; variable speed control and drive; control switches for each machine function; feed-in elevator for continuous processing; stainless-steel air squeegee of the Micro-Ventur type; impingement drybox for safe, even drying; torque motor take-up unit; heavy-duty recirculation pumps for eight chemical solutions; and temperatures controlled by thermistor controllers. Basic price $22,500.



One-Inch, Professional VTR
(59)

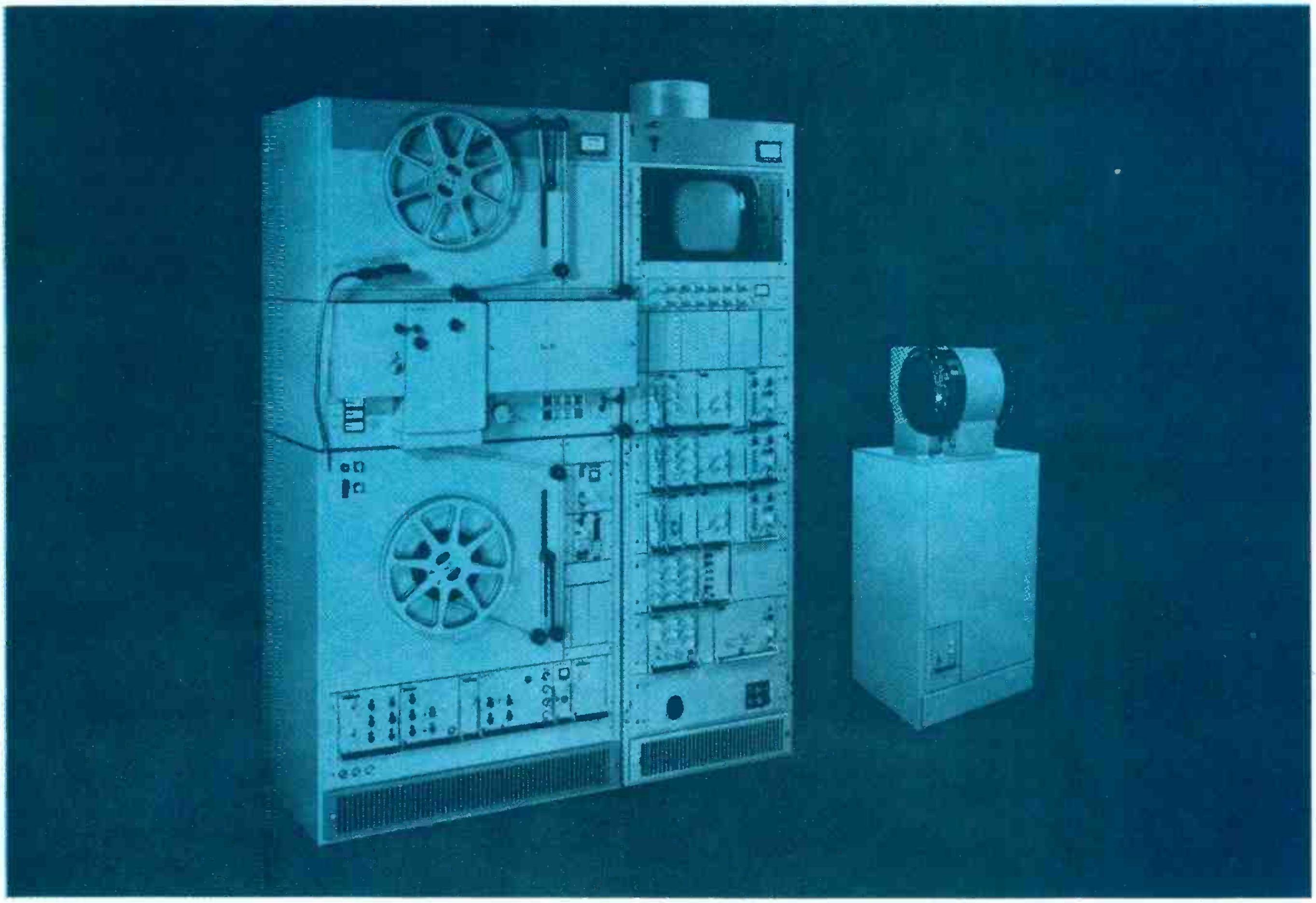
The **General Electric Co.** has introduced a one-inch, helical-scan, professional video tape recorder specifically designed for the educational and business training markets. Designated model 2-30, this VTR has a suggested list price of $3495.

The model 2-30 features slow motion and stop action, tape interchangeability, and two separate audio channels to allow delayed sound dubbing. It is also designed to operate in a horizontal or vertical position.



Emergency/Standby TV Transmitting Antenna
(60)

A new line of quarter-wave stub dipoles is manufactured by the **Jampro Antenna Co.** for standby and/or emergency use. Available from channel 7 through all UHF frequencies, the units can take inputs up to 25 kw, and may be stacked or directed to meet a variety of pattern or gain requirements. ▲



16mm Color Film Scanner — Control Console Unit — 2" x 2" Slide Scanner

ENGINEERS' TECH DATA

ANTENNAS, TOWERS, & TRANSMISSION LINES

70. CCA—Tech data sheet provides information for the CCA-FMA-6710R FM circularly polarized antenna.
71. FORT WORTH TOWER—Literature describes microwave towers, reflectors, and equipment buildings.
72. HUGHEY & PHILLIPS—"Tall Tower Lighting Specification Guide" SG-2 is offered.

AUDIO EQUIPMENT

73. ATLAS SOUND—Catalog 566-67 lists public-address loudspeakers and microphone stands and accessories.
74. DUOTONE—Tape Care Kit [including cleaners, brush, static-free cloth, and swabs] and E-Z splice, precut splicing strips for 1/4-in. magnetic tape are subjects of offer.
75. METROTECH—Six page brochure covers Series 500 professional tape recorders.
76. TELEX—Viking Model 230 and Magnecord Model 1021 tape recorders are illustrated, and technical data are given in publications.

CATV EQUIPMENT

77. AEL—Technical data bulletins have been prepared to describe the Models ER-412, ER-500, and ER-750 entrance receptacles for connecting sheathed cable to line-amplifier housings, and the Model CVT-MB bracket for mounting Colorvue line amplifiers to poles.
78. TELSTA—A newly revised, illustrated 16-page catalog of tools and accessories for aerial-cable placement is offered.

COMPONENTS & MATERIALS

79. BOSTON INSULATED WIRE & CABLE—Material concerns cables, connectors, and assemblies for all standard monochrome and color broadcast cameras now available.

80. CHERRY ELECTRICAL PRODUCTS—4-page leaflet presents information regarding the C10 series of crossbar-type selector switches.
81. SPRAGUE—Short form catalog CN-200A, about Econoline plastic molded NPN silicon transistors, gives operating parameters and other specifications.
82. SWITCHCRAFT—New Product Bulletin 69 deals with the Series BX "Box Switch," a miniature, momentary switch with capabilities up to 2-C and 2-A; the units also include "Adjusto-Clips" for snap-in mounting.
83. TROMPETER—Catalog M-4 gives information on line of coax, twinax, and triax matrix and multipole, multithrow switches.

LIGHTING EQUIPMENT

84. KLIEGL BROS.—Booklet titled "Television Lighting for Quartz," Catalog TV-6, and condensed catalog refer to lighting products.

MISCELLANEOUS

85. DENSON—Catalog 966-S1 lists new, used and surplus electronic equipment.
86. TEXAS ELECTRONICS—New wind direction and velocity indicator and standard line of meteorological indicating instruments are described in literature.

POWER DEVICES

87. TOPAZ—Available is a new short-form catalog on line of inverters and converters designed for operation of VTR's and other frequency-sensitive equipment in mobile or emergency environments.

REFERENCE MATERIAL & SCHOOLS

88. CLEVELAND INSTITUTE OF ELECTRONICS—Pocket-size plastic "Electronics Data Guide" includes formulas and tables for: frequency vs. wavelength, dB, length of antennas, and color code.
89. HAYDEN BOOKS—Latest brochure of "Key Books" for the electrical/electronics engineer is subject of offer.
90. HOWARD W. SAMS—Literature describes popular and informative technical publications; new 1967 catalog of technical books is included.

TELEVISION EQUIPMENT

91. ALMA ENGINEERING—Off-the-shelf and custom switchers, and a quad-view video scanner are covered by data sheets.
92. BALL BROS—Tech data sheet gives specifications and other information on the Mark 21 video waveform monitor.
93. CANON USA—Available are pamphlets about broadcast and ITV single-focal-length and zoom lenses and scoopic 16 electric eye 16-mm cine camera with built-in motor drive and zoom lens.
94. CLEVELAND ELECTRONICS—A 52-page quick-reference step-down die-cut catalog gives complete information on vidicon, **Plumbicon,** and image-orthicon deflection components.
96. COHU—The 3200 Series **Plumbicon** cameras and a chroma detector are discussed in literature.
97. COLORADO VIDEO—Listing of specialized video devices is contained in short-form catalog.
98. DYNAIR—Four-page brochure contains information about the solid-state "Equa-Dyn" equipment for transmission of video up to 10,000 feet.
99. INT'L NUCLEAR—Subjects of Catalog 7A are video amplifiers, video switchers, and other video products.
100. KAPPA NETWORKS—Included with electromagnetic delay-line catalog DL1 is a 4-page brochure which contains specifications and other information.
101. MARCONI—A technical description of the Mk VI photoconductive, monochrome camera for live and telecine applications is offered.
102. TELEMATION—Spec sheet describes the TMC-214 portable broadcast camera chain.
103. VITAL—Information tells about VI-500 color-stabilizing amplifier for correction of transmission irregularities and transmitter linearity, and VI-1000 processing amplifier [with built-in sync generator] for correction of monochrome and chroma signal disturbances.

TEST & MEASURING EQUIPMENT

104. POMONA ELECTRONICS—General Catalog 12-67 features the complete line of molded electronic test accessories and includes more than 380 items, 36 of which are new.
105. RUSTRAK—Miniature chart recorders and accessories comprise products treated in 16-page catalog.
106. TRIPLETT—Spec sheet is about the new Model 600 transistorized volt-ohmmeter featuring 11-megohm input, FET circuitry, and extra-low voltage ranges.

TRANSMITTERS & ASSOCIATED EQUIPMENT

107. COLLINS—Printed matter relates to the 820D-1 1-KW AM transmitter, the new 831C-1 1-kw and 831D-1 2-KW FM transmitters, the 54Z-1 frequency monitor, the new 900 Series of FM modulation monitors, the 54N-1 FM frequency monitor, and the 212T Series of audio control systems.
108. GATES—Brochures describe and illustrate the new FM "H" series transmitters with outputs of 1000, 3000, 5000, 7500, 10,000, and 20,000 watts.
109. MOSELEY ASSOCIATES—An automatic digital transmitter logger which records up to ten transmitter parameters and prints the information in log format is the subject of Bulletin 221.

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8673	electronic conducting glass	RCA Bi-Alkali	Close-spaced target-mesh, long-life tube for studio use
8673/S	electronic conducting glass	RCA Bi-Alkali	Same as 8673, except 8673/S designates one of a matched trio of tubes for use in color cameras
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8674/S	electronic conducting glass	RCA Bi-Alkali	Same as 8674, except 8674/S designates one of a matched trio of tubes for use in color cameras

TUBE TYPE NO.	TARGET MATERIAL	PHOTO CATHODE TYPE	REMARKS
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