IRE TRANSACTIONS

ON BROADCAST TRANSMISSION SYSTEMS

PGBTS-9 DECEMBER, 1957

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PUBLISHED BY THE

PROFESSIONAL GROUP ON BROADCAST TRANSMISSION SYSTEMS

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IRE TRANSACTIONS®

on Broadcast Transmission Systems

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A TRANSISTORIZED INTERCOM SYSTEM

Emil P. Vincent
Chief Audio Facilities Engineer
American Broadcasting Co.
New York, New York

Although this paper relates primarily to the application of transistorized amplifiers in intercom systems, it will also describe a complete typical system as designed and built for a three studio television plant. The installation includes a combination of two basic systems, telephone and amplified. Both are needed to accommodate the requirements of the operating staff. These requirements can be outlined generally as follows: Engineering communication between Technical Director, Cameraman, Video Control Operators, technical personnel on stage, Telecine, other studio and remote TD's; and production communication between Program Director, Stage Manager, Announcer, Turntable Operator, other studio and remote PD's. More detailed requirements will be discussed as the description progresses. (See Fig. 1).

The telephone or two way portion of the system will be described first. Most studio installations include a commercial telephone system for communication between various studios and operating locations. That system is ordinarily separately installed. It was decided in this case to include inter-location communication as part of the basic intercom system. The advantage lies in the fact that only one instrument need be used by a TD. Because there were only a limited number of telephone stations required, a seven position telephone key switch turret was designed for use by the TD, and on it appeared the other studios, maintenance, remote location and control center. The instrument used was a standard WE 52 AW head telephone set. (See Figs. 2 & 3). Its battery was supplied locally, with a standard RCA interphone outlet used as a plug-in point. The output of that instrument was fed to and through the turret to spare outlets in the studio and to the Video Control location, where it would be connected to the camera intercom circuits.

With the same instrument he can call any of the seven locations indicated on the turret by operating the proper switch. At the called location a lamp will light or a buzzer will operate, the called party will answer. Each of the incoming lines to a turret is bridged with a 30,000 ohm pad, the outputs of which are tied together to feed an auxiliary amplifier-loudspeaker combination. This system is connected so that a calling party will be heard on the loudspeaker at any time. The loudspeaker will be muted when the key, coinciding with the calling location as indicated by a light, is operated. (See Fig. 3). Provision is also made so that the output of the amplifier is switched to the local headset receiver. This system therefore provides a call system between many locations, with the facility for private isolated conversation. One position on the turret is marked "Remote", which when patched in Control Center will be connected to an order wire going to the remote location. A ring button is provided in the turret which will insert ring current on the line to be called. A telephone ringer is connected at the turret end of that remote line which will ring when called by the remote location. Each switch on the turret is a two way lever key with the center as "off". One direction provides a separate circuit to the called party lifting all other local circuits. The other direction provides a conference possibility wherein the called party is simply added to the existing circuits.

At this point it is desirable to mention that all camera control units are located in the Control Center, therefore, the Video Operators have control of the intercom circuits for all cameras. By use of keys they can designate routing of camera intercom circuits to the proper TD. It is also possible to isolate any one of a group of cameras for separate intercom between the VO and camera, without disturbing the circuits of other cameras. Once the camera intercom is set up, the TD now is able to talk to the cameras, to the Video Operator and to any one using the spare outlets in the studios. (See Fig. 4).

A second seven position turret is located at the Program Director's position. This turret includes circuits to transcription room and announce booth, used for cueing announcers and turntable operators, and to the PD's in other studios. A remote position is included on the PD's turret for the same purpose as that of the remote position on the TD's turret.

In the control room, therefore, both the TD and PD use the standard WE 52 AW head telephone instruments for all two way communications. A PD-TD tie switch is provided so that the PD can talk to cameramen when necessary.

Identical turrets are located in Maintenance, Announce Booth, Turntable Room (See Fig. 5) and Control Center. All turrets are wired to a centrally located rack, at which point all cross-connects are made as is done in telephone company practice. The remote positions are brought up to a jack panel where the remote order wire lines appear. A single switch and light appears at the audio operator location which when used in conjunction with a handset enables the audio operator to call Control Center and vice versa when necessary.

The lines between turret locations do not carry D.C., the battery being supplied locally in every case. All lines are balanced reducing the amount of cross-talk between pairs. A simplified single line schematic is shown in Figure 6.

The amplified portion of the intercom is normally used to feed the headset monitoring busses, studio announce and Telecine. In all prior installations, tube amplifiers had been used. It has been felt for quite some time that transistorized amplifiers should be put to more general use in broadcast installations, the main deterrent being the unavailability of packaged amplifiers for such use. It was discovered that a set of small plug-in amplifiers were being manufactured by the Collins Radio Company for application in aircraft intercommunication systems. The requirements and specifications for these amplifiers parallel many of those that applied to the Television Studio intercom system. Samples were obtained and tested and found to be quite satisfactory. There are two different units, a 40 db gain, 150 mw amplifier and a 15 db gain, 2 watt amplifier.

The former is a Collins Radio Type 356C-1 amplifier module, a two stage transistorized 40db gain audio amplifier employing PNP transistors. The input stage is a 2N45 and the output stage a 2N68, both operated as Class A. The two stages are transformer coupled. The input is 150 ohms unbalanced, the output 500 ohms unbalanced with 150 milliwatts power output capability. The frequency response is $\pm$ 3 db from 100 to 5000 cps with about 3% total harmonic distortion measured at 150 milliwatts output. The current drain was measured to be 80 milliamperes using a 24 volt source. (See Fig. 7 & 8).

While this unit is designed as a 40 db gain amplifier, there is up to 50 db of gain available with a modification of the input circuit. A voltage divider normally included in the unit can be replaced by a terminating resistor, increasing the overall gain and increasing the signal to noise ratio of the system. (See Fig. 9).

The second unit is the Collins Type 356D-1 amplifier module, a two watt 15 db gain, grounded emitter, class B amplifier, using two 2N 68 transistors. The output impedance is 30 ohms unbalanced with a 500 ohms unbalanced input.

The frequency response measured the same as for the 356C-1, the 5% distortion point occurred at 2.7 watts output. The current drain was 90 milliamperes at full output and 10 ma with no signal. (See Figs. 10 & 11).

The amplifier used in conjunction with the telephone system was built by General Communications Company, to our specifications. It is a 3 watt, 90 db gain, class A operated amplifier. Its frequency response and harmonic distortion was the same as measured on the 356D-1. This unit was designed as a plug-in unit and so that it could be mounted under the operating table with two level controls easily accessible, one for overall level and the other for headset level. (See Fig. 12).

As mentioned earlier, one purpose of the amplified portion of the intercom system is to feed various headset busses, where approximately one volt is required. Inasmuch as standard dynamic microphones are used in the control room by the TD, PD and Audio Operator, more than 40 db gain is required. Therefore, two of the 356C-1 amplifiers are cascaded, providing a maximum of 80 db of gain.

A desirable feature of an intercom system is the incorporation of automatic volume control. These amplifiers did not include this feature, so that a speech volume limiter using a thermistor, resistance lamps and transformers was used. All talking circuits are equipped with a volume limiter.

There are 4 headset busses available, namely, TD, PD, AO, and program. The output levels of these busses are adjustable by means of an output attenuator and the amount of limiting is controlled by a gain setting control located between the two cascaded amplifiers. (See Fig. 13 & 14).

In normal operation, the Studio personnel selects the proper outlet located in the studio. The Boom operator uses a split headset connected so that in one ear he can hear the TD, and in the other ear, the program. The Audio Operator can call the Boom Operator by using the AO-BM key that allows the AO buss to cut into the program feed. Both the TD and PD have access to the Studio Announce system by using the proper keys. The necessary amplifiers, volume limiters, controls, and relays are mounted on a chassis that fits on a 8-3/4" rack panel and shelf assembly. All connections are made through disconnecting plugs. The amplifiers are mounted using printed circuit plugs and are removable at the front of the rack. (See Figs. 15, 16, 17).

A five ampere, 24 volt regulated power supply mounted in the rack, is used to supply power for all the amplifiers as well as for the telephone instruments in the control room and on the studio floor.

The TD must also be able to contact a projectionist to give roll cues and film chain information. This is accomplished by using a foot switch operated microphone. The TD will be heard in Telecine on a loudspeaker, located over the film chain to be used. A general call system to Telecine is also provided for emergency purposes and is operated by the TD using a lever key.

Located at the TD's position is a small cue speaker on which he can receive calls from the projectionist. (See Fig. 3). This speaker is fed from a two way call box located over each film chain in Telecine. Once the proper studio is selected by a switch on the call box, all calls from the studio TD are heard on loudspeakers over the film chain. An answer is given by use of an attached microphone, an Electrovoice #600 TR dynamic type with a one stage transistor amplifier. Operating the switch on the microphone reverses the call box line amplifier to feed the aforementioned TD's cue speaker. It is in the Telecine

call box that the Collins 356D-1 2 watt amplifier is used to drive the Electrovoice #T10A treble speaker unit. A 356C-1 is used as the reversible line amplifier. (See Figs. 18, 19, 20).
The Telecine Video Operator in Control Center is connected to the Telecine intercom system in the same manner as are the TD's. He can also monitor all calls to and from studio TD's and projectionists. Available for maintenance purposes is a telephone bridge between any chain and the Telecine Video Operator location.

While the steps taken in this particular installation to completely transistorize the intercom system has proven to be entirely satisfactory and no failures have been reported to date, it is felt that further improvements are in order. There is no reason why a single standard amplifier cannot be designed by broadcast manufacturers to incorporate all of the requirements which, simply stated, are adequate gain with automatic volume control, and sufficient power output to drive a small speaker from a typical dynamic microphone.

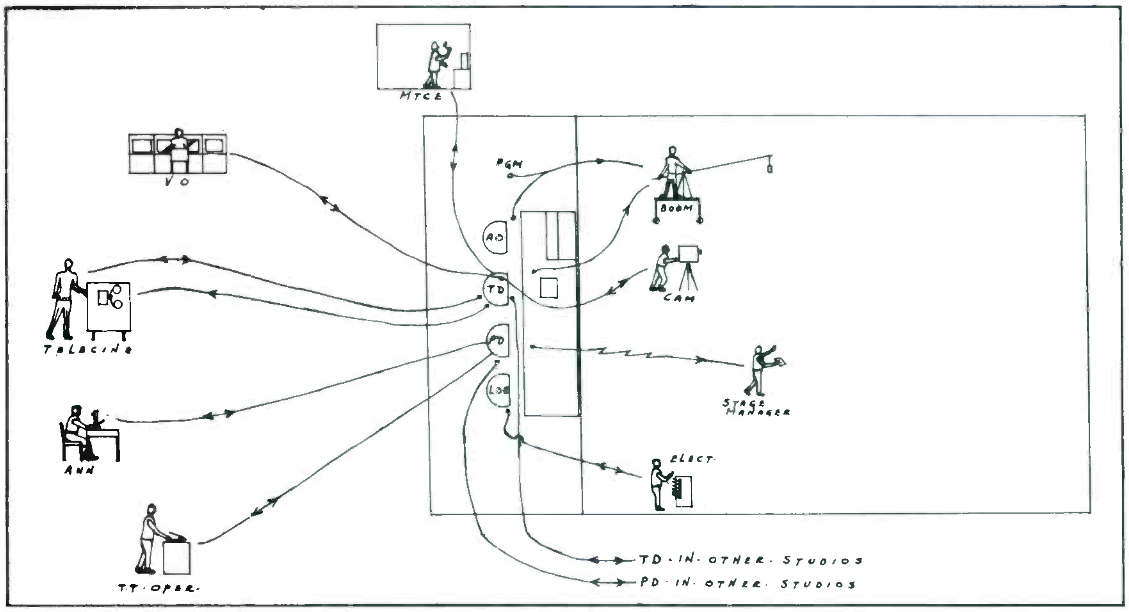
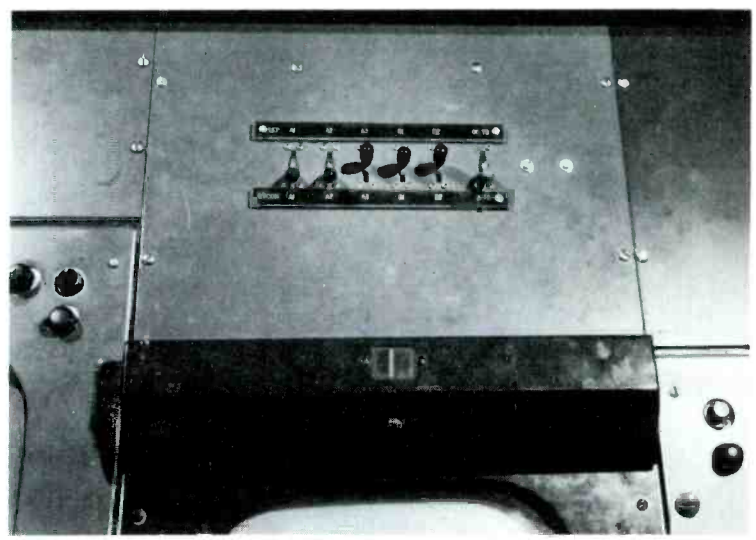


Fig. 1 - Sketch showing typical intercom requirements.

Fig. 2 - Photograph showing seven position key switch turret.

Fig. 3 - Photograph showing location of turret relative to the video switching panel at the TD position.

Fig. 4 - Photograph showing camera intercom selector keys at the VO position.



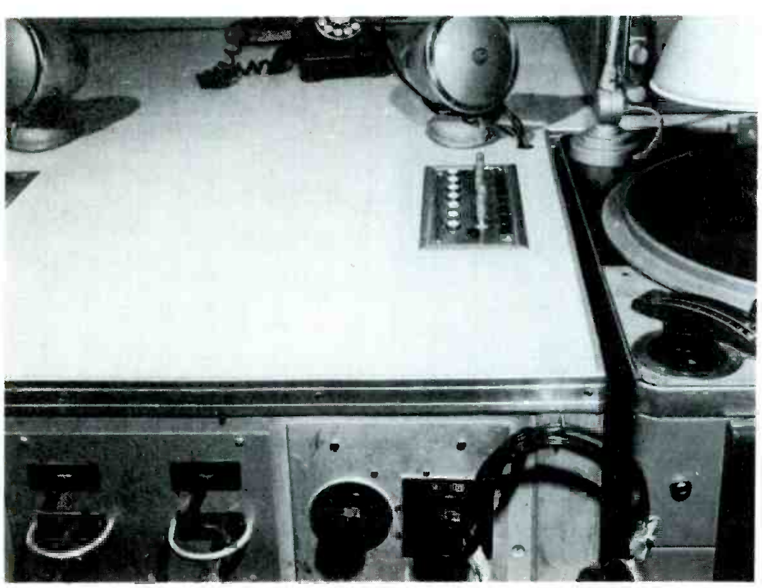


Fig. 5 - Photograph showing turntable operator's turret.

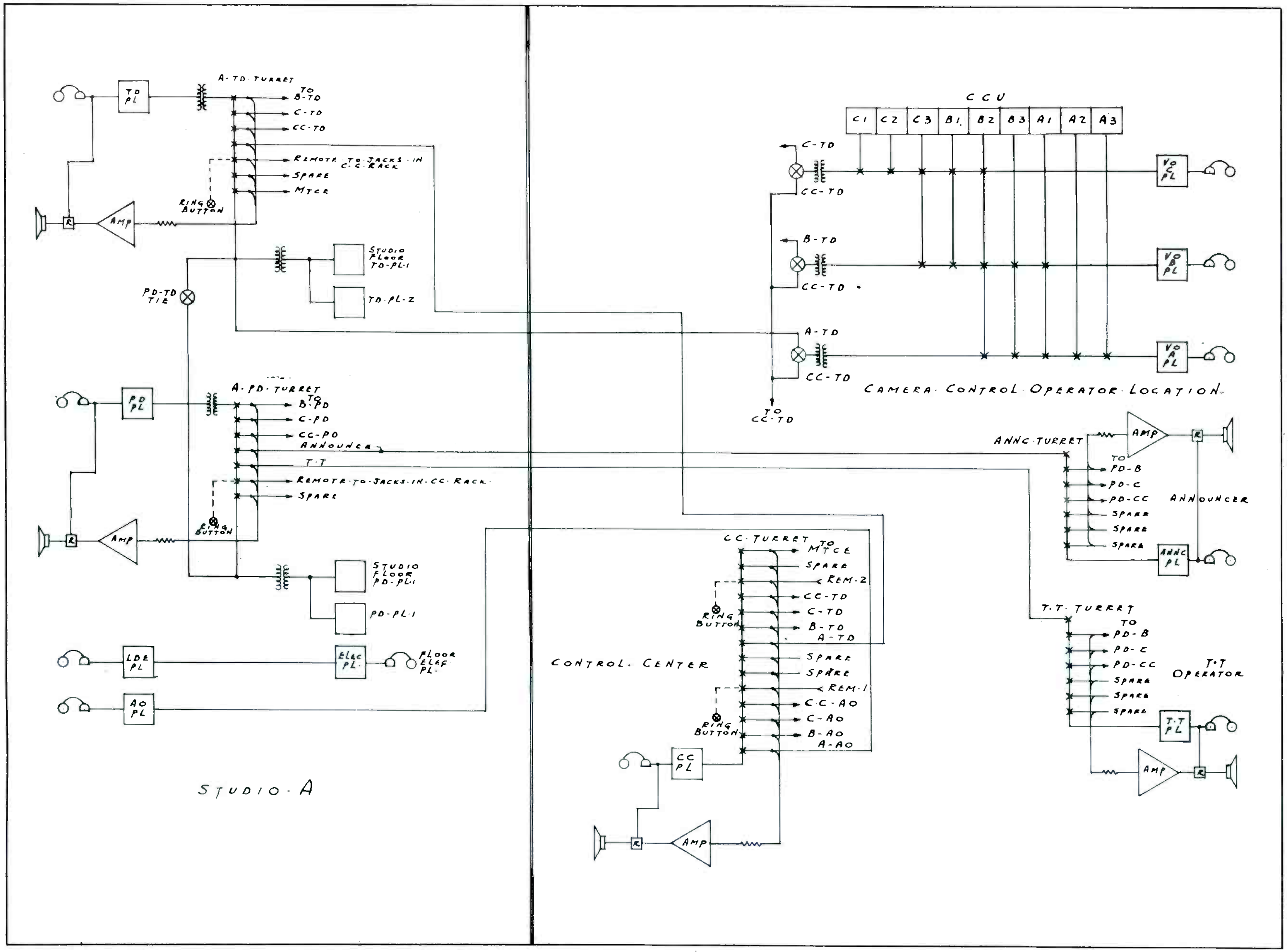


Fig. 6 - Simplified schematic of telephone portion of the intercom system.

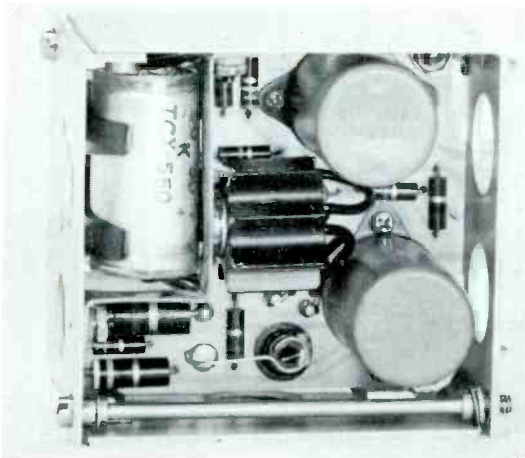


Fig. 7 - Top view of the Collins 356C-1.

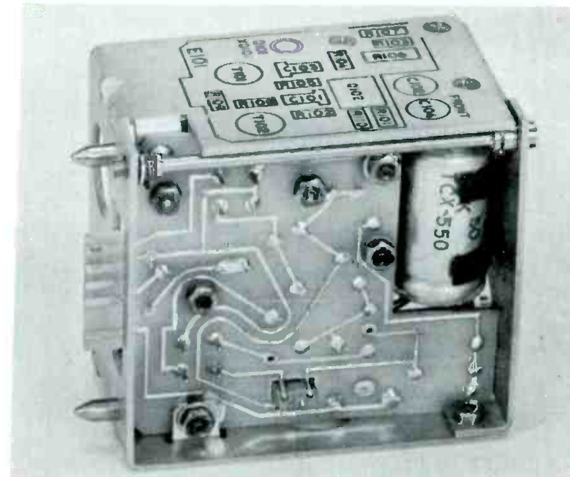


Fig. 8 - Underside view of the Collins 356C-1.

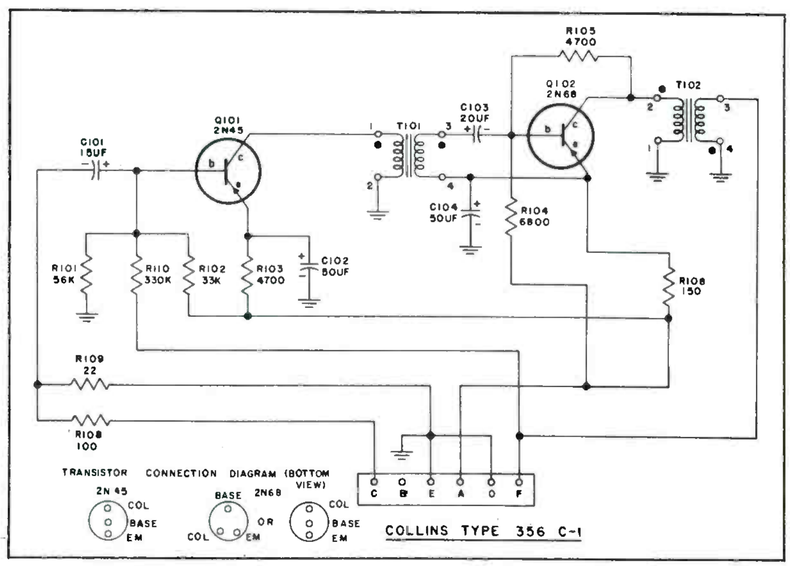


Fig. 9 - Schematic of the Collins 356C-1.

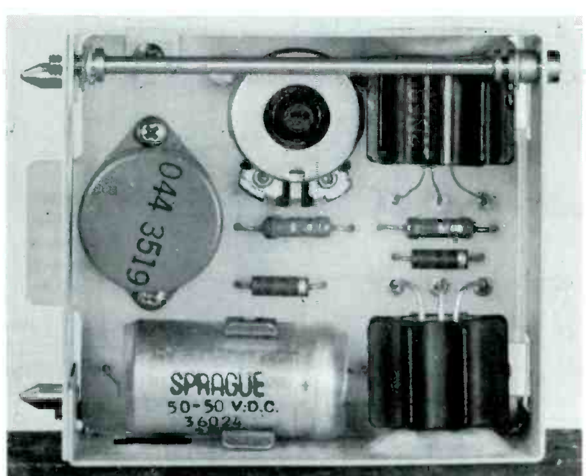


Fig. 10 - Top view of Collins 356D-1.

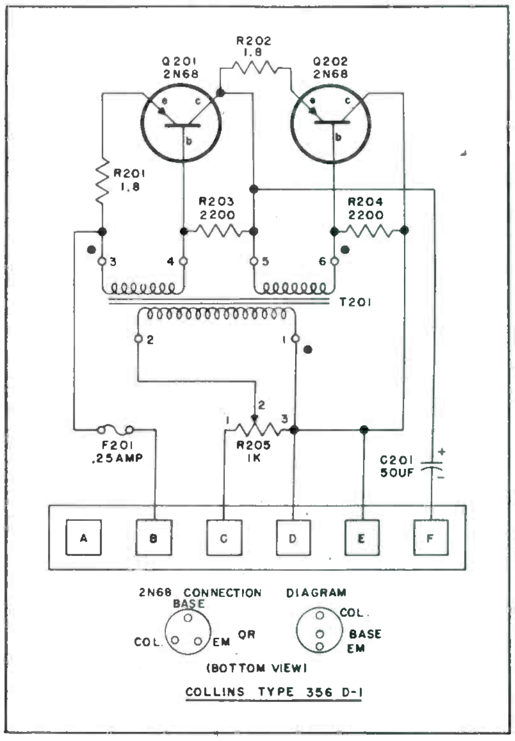


Fig. 11 - Schematic of Collins 356D-1.

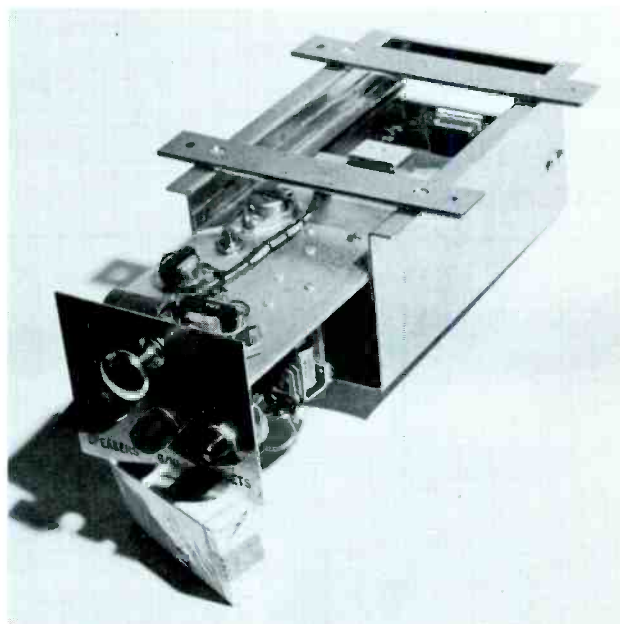


Fig. 12 - Photograph of the General Communications intercom amplifier.

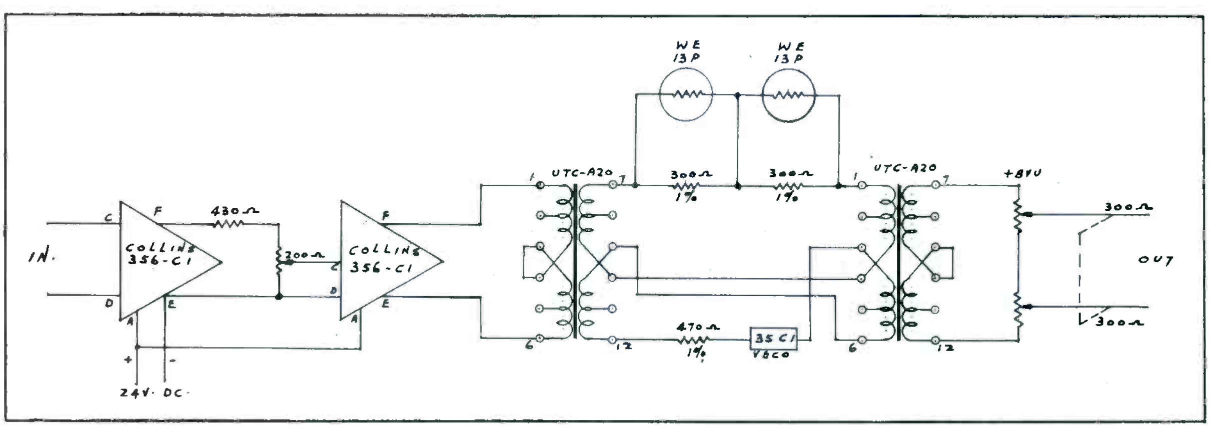


Fig. 13 - Schematic of single channel with AVC section.

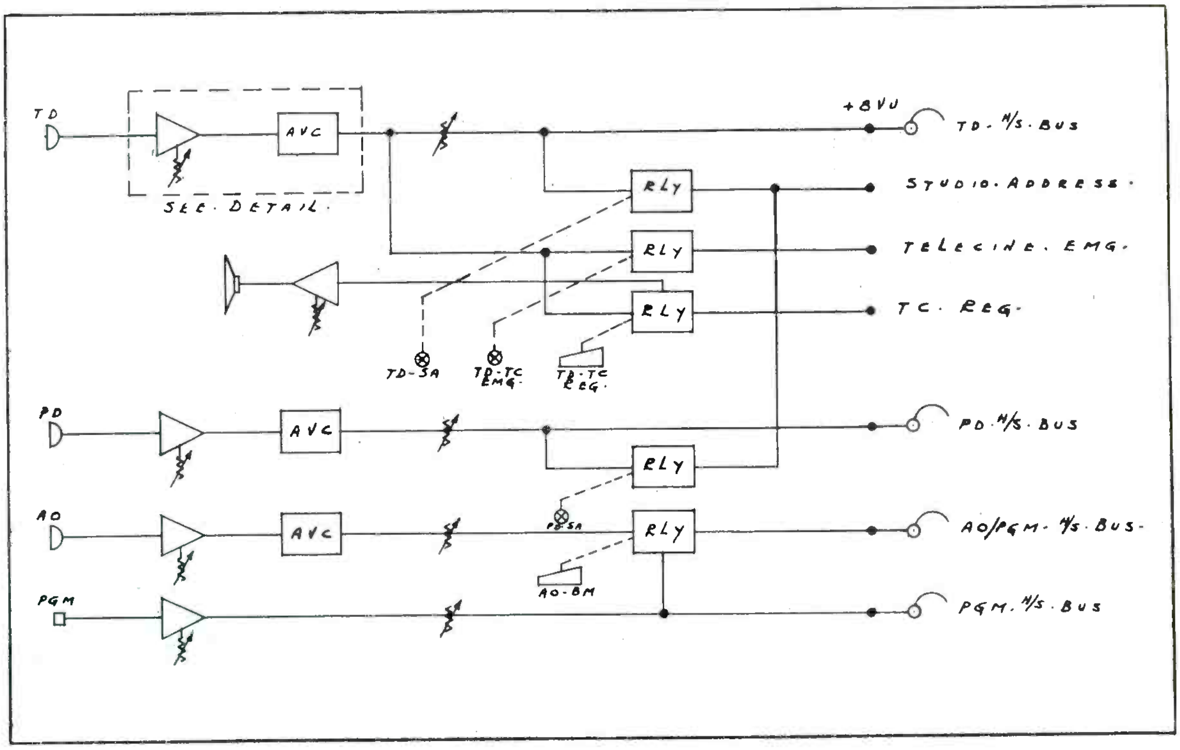


Fig. 14 - Simplified schematic of amplified portion of intercom system.

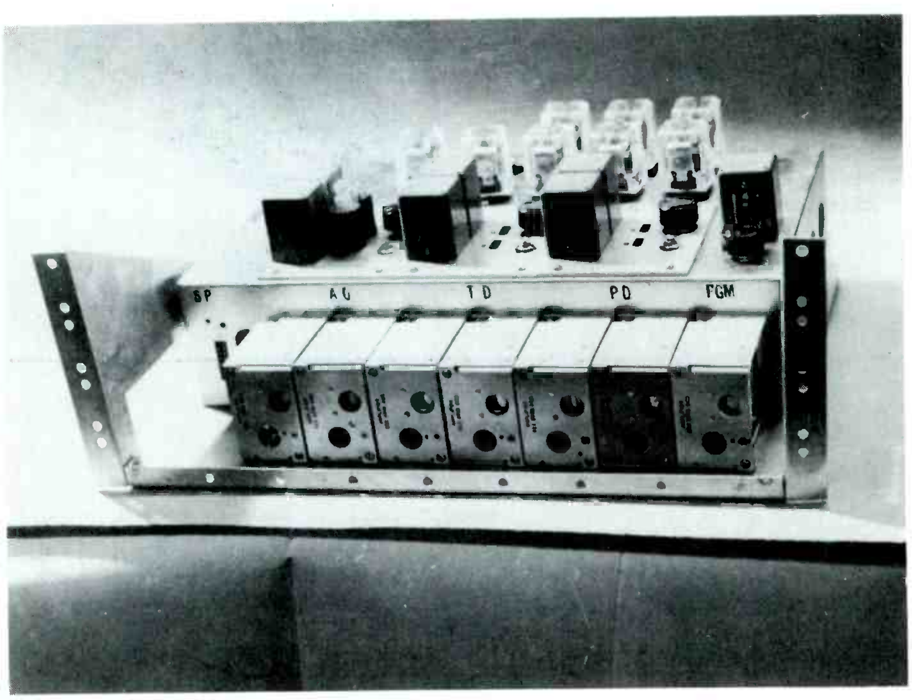


Fig. 15 - Front view of intercom chassis with amplifiers in place.

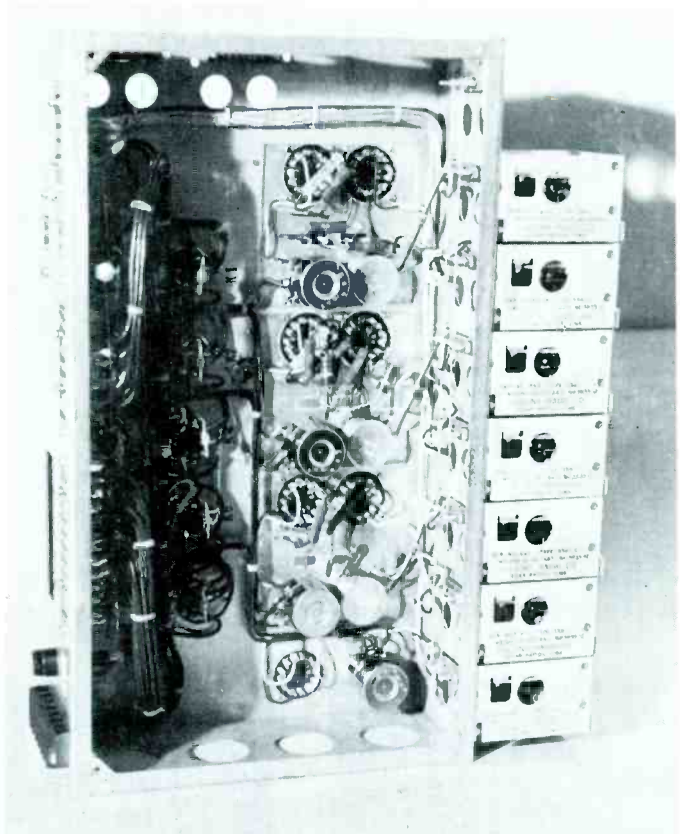


Fig. 16 - Bottom view of intercom chassis.

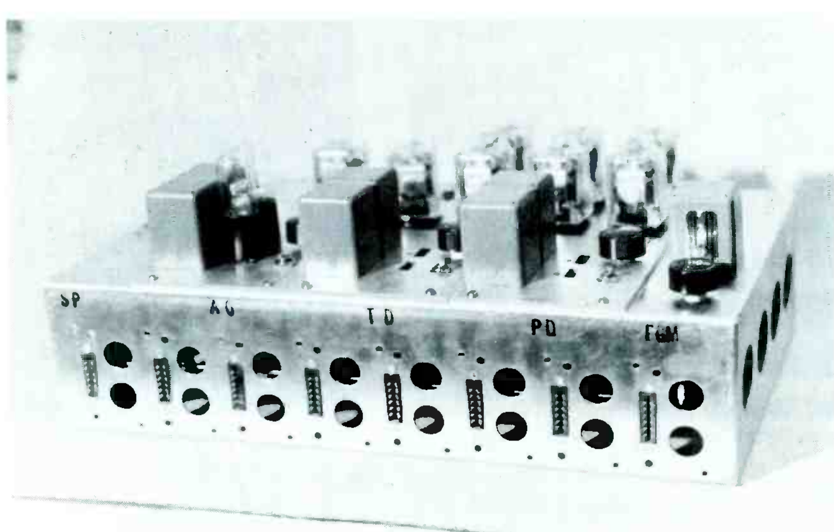


Fig. 17 - Top view of intercom chassis showing AVC sections.

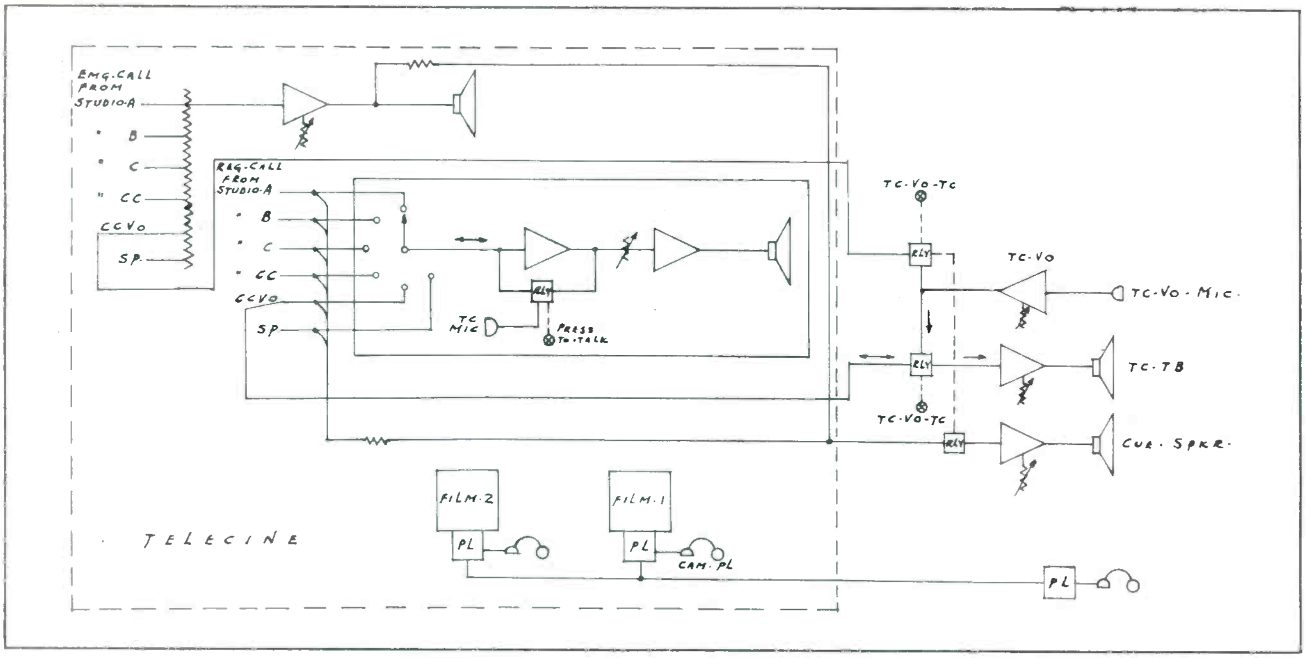


Fig. 18 - Simplified schematic of Telecine talkback system.

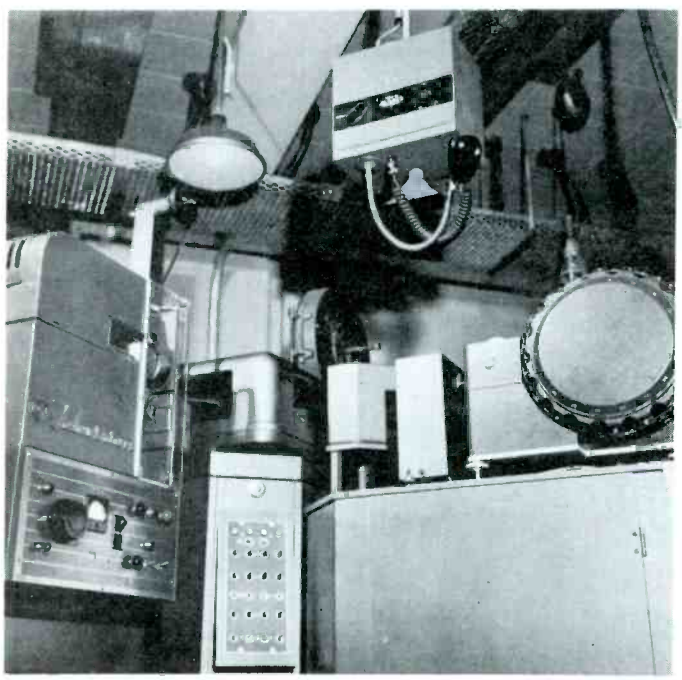


Fig. 19 - Photograph showing position of Telecine Call box with relation to projectors.

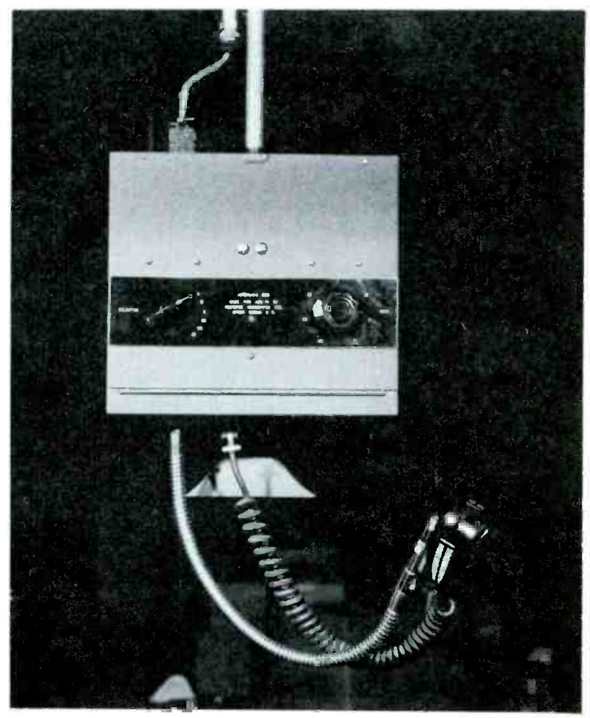


Fig. 20 - Close-up view of Telecine call box.

AUTOMATION APPLIED TO TELEVISION MASTER CONTROL AND FILM ROOM

J. L. "Lee" Berryhill, Chief Engineer
KRON-TV San Francisco, California

The majority of the switching performed in the television control and projection rooms is confined to a relatively short period of time encompassing the "station break" period and that portion of programming immediately preceding and following the station break. During this period technical personnel are required to accurately select numerous switches and accuate them in a precisely timed sequence. Under these circumstances, even those individuals possessing a high degree of coordinating skill will sometimes make errors which are costly and embarrassing to the station. Many television stations have resorted to dividing these switching functions among several individuals. This requires a high degree of coordination between technical personnel, the lack of which sometimes causes serious mistakes.

Considerable time exists during the program periods between these station break periods when technical personnel have relatively few duties. It would seem desirable to accomplish the many operational duties required by technical personnel within the station break period. During this time within the program period, personnel have adequate time to make switching selections without the pressure of immediate subsequent switching.

Described will be equipment designed to pre-select the video, audio, equipment switching and time selection within each sequence without the use of pre-punched tape or cards. Operational variations afforded by the system will also be outlined.

THE NEED

Our purpose here is to explain one approach to the application of automation to the control room and film room of a television station. The reader may ask "Why bother, since the methods now employed accomplish the desired results?" But do they? The coordinated efforts of one or more individuals is now required to do the necessary switching to air the television product.

The major portion of this switching occurs during and around the station break period. This can be referred to as the "frantic period." It is in this area where most of the station revenue is earned and where most of the switching errors occur. Even the best technician has his "off day." "Morning after, off day - oops! technician pushes wrong button" and the station has lost revenue, acquired an unhappy sponsor and irritated its viewer.

What can the station operator do to reduce the number of errors committed during the "frantic period"? He can fire the offending technician and should, if he makes excessive errors. But to fire each technician who makes a mistake creates new problems, and since we are dealing with people, and people will make a mistake, and since the television industry has designed an occupational environment where a technician has to work 30 seconds and rest for 29 minutes and 30 seconds, let us try to spread the work required by the technician during the preceding program period. Let's take the "panic" out of the "frantic period"!

THE LOGIC OF DESIGN

Every television engineer recognizes that the program day is a carefully scheduled series of sequential events. Within the "greater program schedule sequence" is the station "break sequence" within which most of the switching occurs in a television station. The equipment described herein is designed to do the switching within this station "break Sequence" or other period of complex switching, such as a complicated film or slide opening or closing of a program.

Sorting out the various types of switching operations required by the technician, we find the following classifications: Video Channel Switching, Audio Channel Switching and Equipment Function Switching. Equipment Function Switching contains many variables and must be broken down further for maximum flexibility. These are Equipment On, Equipment Off, Show (optical multiplexer positioning and Audio Change Over from one projector to another) and Slide Advance. These columns include the minimum of duplication.

Each of the functions that require switching by television technicians can each be assigned to one of the afore-mentioned classifications as follows:

Video	Audio
1 Network	1 Network
2 Studio	2 Studio
3 Remote	3 Remote
4 Film Chain 1	4 Film
5 Film Chain 2 and any other video sources	5 Announce Booth and any other audio sources

Equipment On	Equipment Off
1 Film Chain A Proj 1	1 Film Chain A Proj 1
2 Film Chain A Proj 2	2 Film Chain A Proj 2
3 Slide Chain A Proj 1	3 Slide Chain A Proj 1
4 Slide Chain A Proj 2	4 Slide Chain A Proj 2
5 Tape Recorder	5 Tape Recorder
6 Turntable and any other equipment	6 Turntable and any other equipment

Show	Advance
1 Film Chain A Proj 1	1 Slide Chain A Proj 1
2 Film Chain A Proj 2	2 Slide Chain A Proj 2
3 Slide Chain A Proj 1	3 Slide Chain B Proj 1
4 Slide Chain A Proj 2 and any other show positions	4 Slide Chain B Proj 2

Transfer these column headings to six selector switches horizontally arranged on a panel. Each selector switch will be identified by one of the above classification headings appropriate to the general function. Each position on each selector switch will represent one of the circuits that we wish to activate. Simple symbols are used as shown in Figure #1.

We have now, most of the essentials for routing control energy to all relay circuits that might need activation to operate a station control and film room and the associated equipment at any one instant of time. This we call a "Function Selector Level." We need one function selector level for each instant of time that we desire switching. Several instants of time are required for any one "Station Break Period." We, therefore, provide several function selector levels as shown in Figure #2.

Having supplied a means for storage of the desired switching information we need now provide a means to determine at what time this is to be effectively used. With the addition of two decade switches (see Figure #3) for time selection and a "time" or "not timed" switch, we can now pre-select each complex switching operation and the instant within the sequence each group switching operation is desired to occur. Thus we have provided the technician with a means of doing the precise work required of him before the station break period by pre-switching! We need only furnish him one button to depress to initiate the entire pre-selected sequence.

PHYSICAL DESCRIPTION

Figure #4 shows the appearance of the Mechron Model 107B Automatic Sequential Program Switcher. It consists of three chassis in a module type housing. The two upper units are identical. We refer to them as Function Selectors. Two function selectors, each capable of five moments of switching, are included in the Basic Model 107B. The bottom chassis includes the individual circuit over-current protection fuses, the time and sequence control unit and the terminal distribution. If more that ten moments of switching are considered necessary, additional function selectors may be operated in tandem with no additional wiring necessary since each is provided with connectors and may be pyramided indefinitely by the use of pre-wired cables.

Starting from the left - time selection is made in the first two vertical columns, "Time" or "Don't time" is selected by a simple two position switch located next, and the proper switching functions are selected on the appropriate

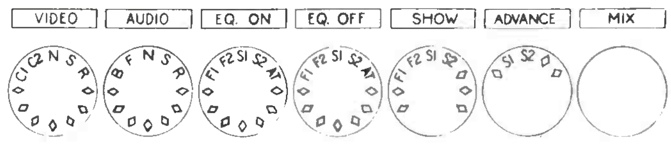


Fig. 1 - Basic single level function selector.

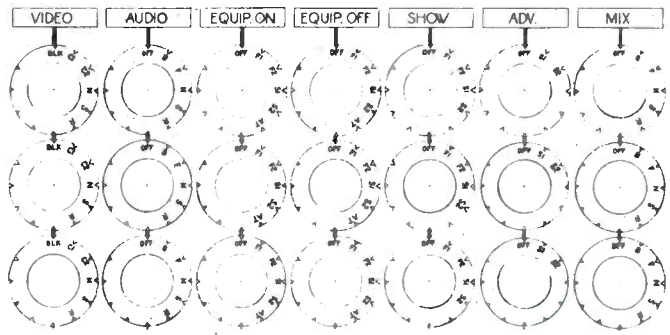


Fig. 2 - Basic three level function selector.

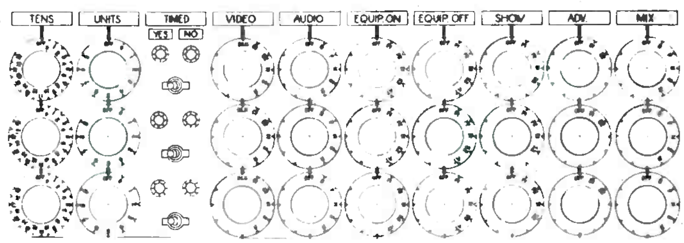


Fig. 3 - Three level function selector with time selectors added.

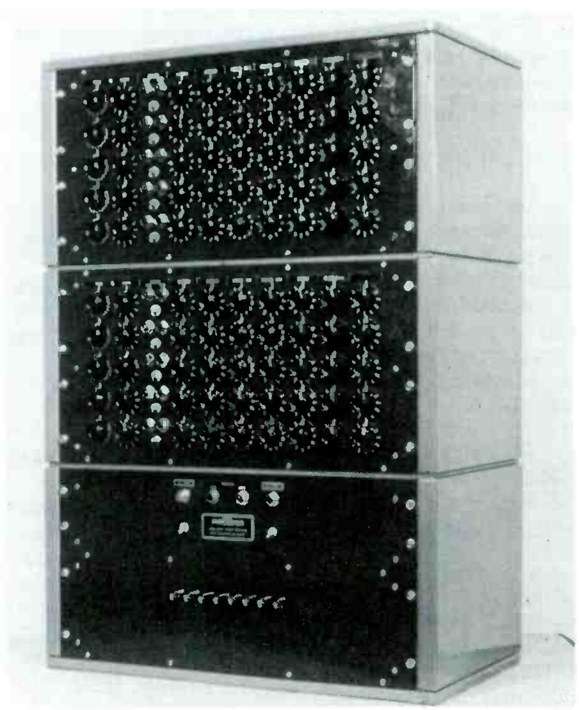


Fig. 4 - Mechron Model 107 B. Automatic sequential program switcher (front view).

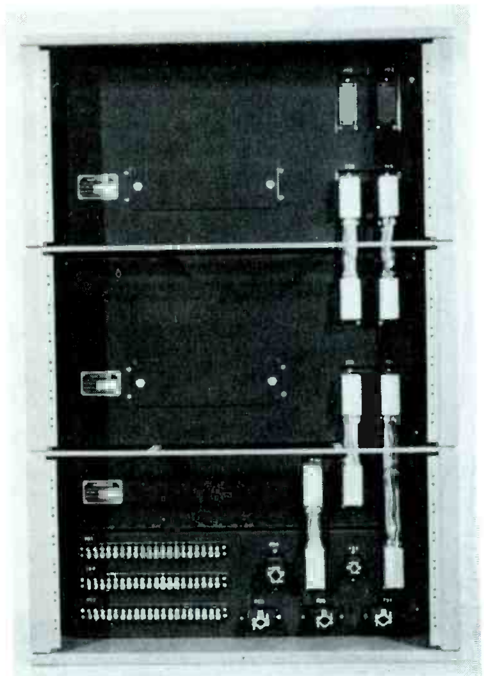


Fig. 5 - Mechron Model 107 B. Automatic sequential program switcher (rear view).

selector switches remaining. Not shown in this photograph is the Remote Control Head including start and stop switches and two indicating lamps which should be located conveniently to the operator's usual post.

Figure #5 is a rear view showing how all inter-chassis wiring is carried up through multi-conductor plugs, cable and receptacles. External circuitry is all connected to the rear of the bottom chassis.

SIMPLIFIED CIRCUIT DESCRIPTION

Figure #6 shows in a simplified circuit diagram, how the function selectors provide a routing for some typical required control voltages. The selector switches previously mentioned are represented as follows: Video selector switch with a position for each of the desired functions such as Network, Studio, Remote, Film Chain, etc., Audio selector switch with a position for each of its like functions; the Equipment On selector switch with a contact for each projector and other equipment, and a comparable Equipment Off selector.

Time scanning is represented by the column on the left. The proper selection of time is set in the time selector switches. Shown here are three pre-selected moments of time out of a possible four. If a stepping switch is made to scan the four pre-set times registered here, nothing will occur at moment #1. At moment #2, registered in the Time 1 row, a circuit path is completed from the scanner arm to each of the equipment function selectors and to the proper relay associated with each of the desired Video, Audio or Equipments. Shortly after the Time Scanner makes contact, a pulse of the proper polarity is applied to the arm of the Time Stepper and thence through the selectors to the proper relays. At moment #3, those circuits selected by the associated selectors of the row marked Time 2 will be actuated and at moment #4, those circuits shown as Time 3 will be actuated. Additional banks or Selector Levels can be added as desired to provide additional switching times, and more selectors can be added to each level to accommodate a variety of unduplicated switching functions.

One serious problem that might not be apparent, and is not shown by this diagram, is the "sneak." Assume that some portion of a switching sequence has been duplicated several levels below Time 1. Take this selector switch and position it to its number 3 position. You can readily see that a pulse occurring at Time 1 will pass through the arm of this selector switch to this contact, and thence to the arm of its counterpart in the Time 3 level, back through this bus and actuate all equipment selected for later operation on the Time 3 bus. One cure for this is to insert a blocking diode in each arm of each Equipment Function selector switch so that current will flow only from the Time bus toward the equipment bus and never in the reverse direction.

Figure #7 explains how we integrate time into our system. The pulse source is a 60 cycle synchronous motor employing gear reduction to revolve a shaft at the rate of 1 cycle per second. On the shaft are cams which actuate switches producing the pulses to be described later.

Pulses in increments of one second are applied to the stepping switch shown as X 1. Each 10th step of this stepping switch supplies one pulse to the motor of stepping switch "X10". The "once each 10 seconds pulse" is generated by a cam and a pair of contacts on the arm of the "one second stepper".

The choice of desired time for each function selector level is made by rotating the time selectors to the proper position. Seconds on the right hand selector and tens of seconds on the left hand selector. This timer shows only 99 seconds maximum time available, but an excess of three minutes is available on the timer currently in use by using a 20 position selector switch and stepper in the X10 position. I think it is also apparent that when the steppers and the selector switches are coincident, a path is provided for a pulse to travel from the pulse source through the stepper arms, out the selector arms and on to the equipment selectors previously shown.

The various pulses generated by the timer and their time relationship to each other are shown in Figure #8. One series of such pulses occurs each second. The keying pulse energizes the one second stepper. The inverted keying pulse and the auxiliary pulse are for internal use in positioning sequencing circuitry and to interlock the instantaneous start feature of the equipment.

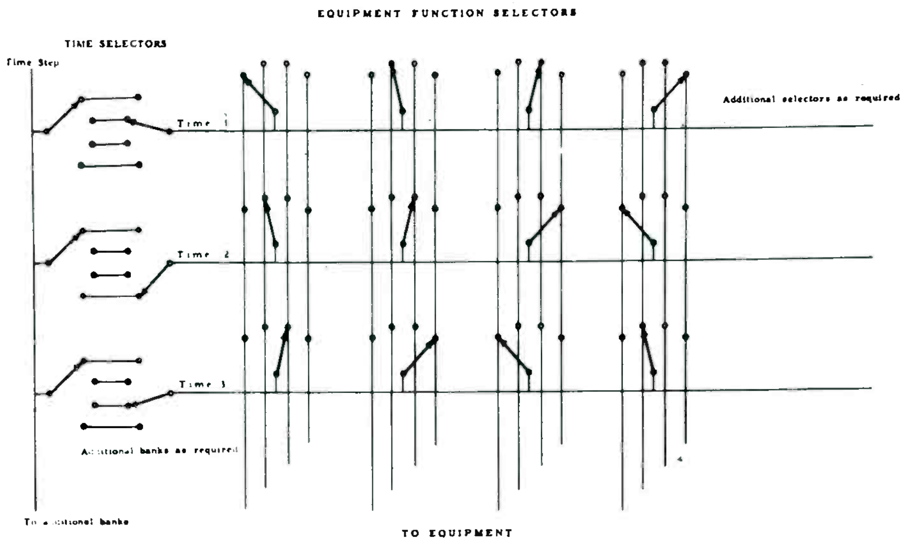


Fig. 6 - Simplified function selector circuit design.

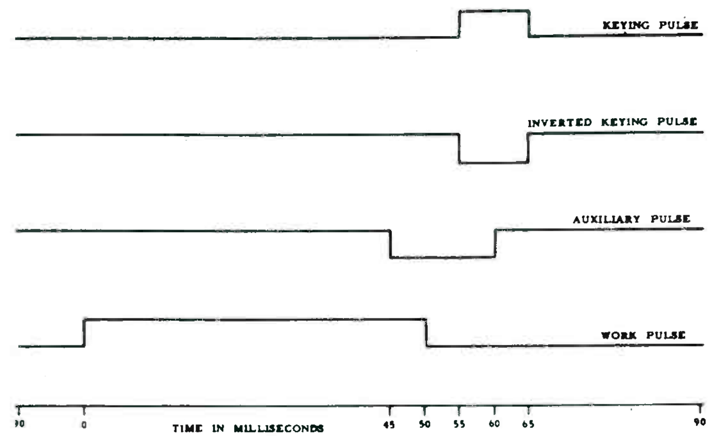


Fig. 8 - Pulse relationship in the Mechron Model 107 B ASPS.

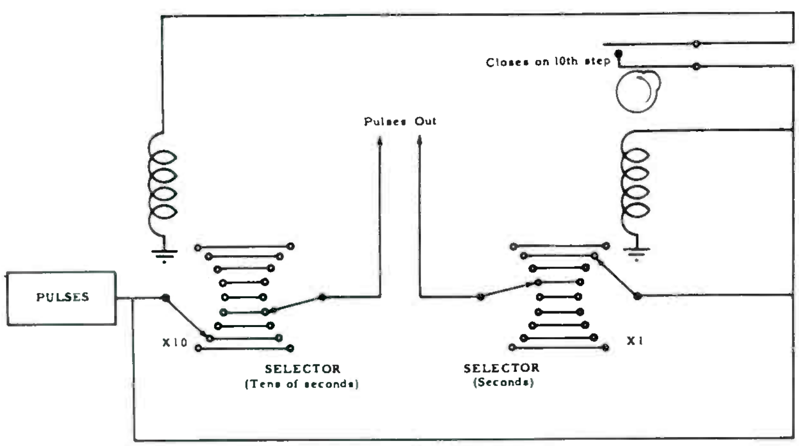


Fig. 7 - Simplified timer circuit diagram.

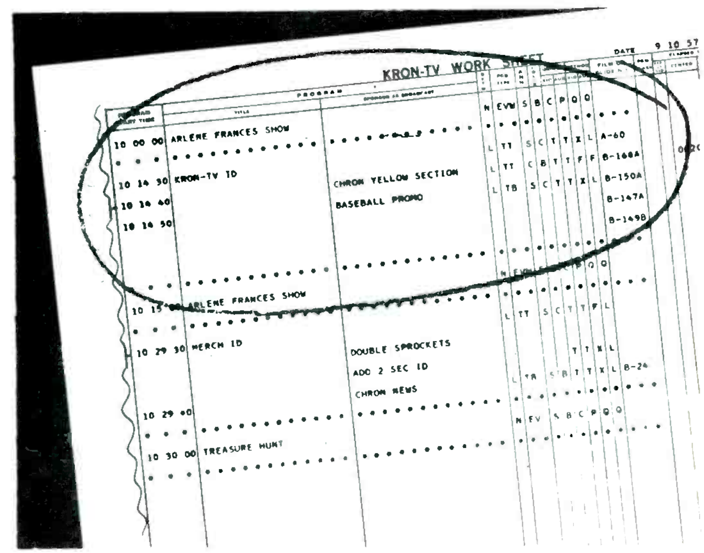


Fig. 9 - A typical KRON-TV program schedule.

The work pulse appears at the input of the switching matrix in Figure #6, where it is routed to the individual relay controlling the circuitry to be turned on or off.

ADAPTION TO OPERATION

Figure #9 shows a typical KRON-TV work sheet and high-lighted is a somewhat typical station break between two network programs. Visualize this station break in your own operation, if you will. Regardless of how many operators you may employ for this operation, the following operations must be done to accomplish this 30 second station break, which includes a single 10 second slide with promotional audio from the station announcer, followed by a 10 second sound on film, which is then followed by a 10 second promotional announcement of three slides with audio again from the station announcer:

1. Turn on or show chain #1 slide projector.
2. Take slide projector
3. Kill network audio
4. Kill network video
5. Take announcer audio
6. Roll film projector
7. Assuming an optical multiplexer is used, show chain #2.
8. Stop preceding film projector
9. Take chain #2 film
10. Take film audio
11. Kill announcer audio
12. Advance chain #1 slide projector
13. Take chain #1
14. Take announcer audio
15. Kill film audio
16. Change chain #1 slide
17. Stop film projector
18. Change chain #1 slide
19. Take net video
20. Take net audio
21. Kill announcer audio
22. Turn off chain #1 slide projector

These total 22 manual operations which must be carefully coordinated by one or more technical people all within a 30 second period for a comparatively simple operation. In order to present a clean appearing operation to viewers, each of these operations must be accomplished at a precise time. One manual switch thrown a second or so early or late becomes tantamount to an engineering error. When the human element is called upon to consistently perform with such precision, it inevitably falters somewhere. And as your own experience will undoubtedly show - mistakes of this nature always happen where they can be least afforded.

The following chart of events is arranged to show the relationship of each switching operation and the time, in seconds, it will occur after the start of the sequence. Note that 0 seconds is the start time. The left hand column notes the duration of each event, the middle column describes the occurrence and the right hand column indicates the time in seconds from the start of the sequence.

TYPICAL SEQUENCE OF OPERATIONS REQUIRED
TO AIR SAMPLE BREAK MANUALLY
(NET SHOW IN PROGRESS)

DURATION	OCCURRENCE	TIME FROM START
(Prior to break)	SHOW CH #1 SLIDE PROJ	
10 sec	TAKE CH #1 SLIDE KILL NET AUDIO KILL NET VIDEO TAKE ANNC AUDIO	0 sec
	START FILM PROJ EARLY	7 sec
10 sec	SHOW CH #2 FILM PROJ TAKE CH #2 FILM PROJ TAKE FILM AUDIO KILL ANNC AUDIO	10 sec
(Prior to next oper.)	ADVANCE CH #1 SLIDE PROJ	10 to 20 sec
3 sec	TAKE CH #1 SLIDE PROJ TAKE ANNC AUDIO KILL FILM AUDIO	20 sec
3 sec	CHANGE CH #1 SLIDE STOP FILM PROJ	23 sec
4 sec	CHANGE CH #1 SLIDE	26 sec
15 min minimum	TAKE NET VIDEO TAKE NET AUDIO KILL ANNC AUDIO	30 sec

Please notice that within the break period of 30 seconds, there are several occasions where simultaneous switching functions must be performed.' Obviously, the heat is on the operationg personnel at this moment. Knowledge of his responsibility may increase the operator's tension to where he is adversely affected and this, too, may disrupt his sense of timing or leave him open to inadvertently pressing the wrong button.

Here is how the Mechron ASPS panel would be set up to accomplish this same station break. This represents a check sheet that might be used to facilitate setup.

SETTINGS OF ASPS SELECTOR
PANEL TO EFFECT A 30 SECOND
TYPICAL STATION BREAK THAT
WOULD REQUIRE TWENTY DISTINCT
OPERATIONS OF AN OPERATOR

X10	X1	TIMED YES-NO	VIDEO	AUDIO	EQ. ON	EQ. OFF	SHOW	ADV.
0	0	YES	C1	BM	S1	-	S1	-
1	0	YES	C2	F	-	-	F2	S1
0	7	YES	C1	BM	F2	-	-	-
2	0	YES	C1	BM	S1	-	S1	-
2	3	YES	C1	BM	-	F2	-	S1
2	6	YES	C1	BM	-	-	-	S1
3	0	NO	N	N	-	S1	-	S1

Note there are seven time intervals which require switching action. The simultaneous switching functions that may have been performed by several individuals are selected on the panel of the ASPS long prior to their occurrence. Also note that there are five occasions when two or more switching operations occurred at the same time. Technical personnel can leisurely pre-set the station break or short interval and, by checking for possible errors, eliminate switching mistakes before they occur.

When the time of the break or short interval arrives, the operator initiates the sequence by pressing the start button. The entire break, regardless of complexity, is timed and switched with the reliability and accuracy of a machine. And, only <u>one</u> switching operation had to be performed by <u>one</u> person to air this station break with precision.

There are two push-buttons and two indicating lamps intended to be conveniently located in the operator's area. One button is used to start a timed sequence. The second button is the well known "Panic" switch and will, when pressed, restore the control system to an "all manual" condition while, at the same time, terminating further automatic sequencing. This button will be used in case of film breakage or equipment failure, and its use will enable the operator to salvage as much of the break as is feasible under the conditions. One lamp will show machine timing is in progress while the second lamp will indicate that a pre-selected sequence is in progress, but is not being machine timed and the operator must re-press the start button to effect the next operation. Several push buttons starting the automatic action may be connected in parallel, but located so that operators at different locations may assume control.

If your network sometimes does not return in exactly 30 seconds, the operator would pre-set the timed switch in the "No" position and could hold on the last slide until he saw the program on his network monitor, depress his same start button and audio and video switching to the net would be done for him. It is important to note that either timed or untimed switching can be accomplished by any selector level, and that switching can occur as frequently as one second intervals. Live camera switching may, for example, be on an untimed basis. Here again, a multiplicity of circuits may be transferred by an operator pressing one button.

ADAPTION TO EXISTING FACILITIES

Figure #10 shows a system block diagram of the Automatic Sequential Program Switcher, the associated equipment needed for modification to existing switching systems along with the appropriate switching system in the television station. The timer and the system distribution is shown with the two or more function selectors. The control switching can be located at any convenient location. Pulses are routed, at the prescribed time, to the proper equipment through, when necessary, auxiliary equipment that provides the necessary conversion to existing station equipment. This block drawing illustrates the various options from which may be chosen the scheme that permits retaining of a station's existing switching consoles or equipment, without in any way curtailing operational features that may prevail before the inclusion of automatic switching.

Referring to Figure #6, it can be readily seen that once relay action is initiated by a pulse, the initiating circuitry can be disconnected without disrupting the required operation in progress. Mechanical or electrical latching relays must be used. The start-stop control characteristic of two coil mechanical latching relays is desirable for controlling equipment. Where speed of switching is a vital factor, electrically latched relays are generally superior. This type of equipment requires that video, audio and equipment circuits shall all be controlled by a relay of the latching type, however some existing stations are not now so equipped. Many stations use mechanical-switch or key-controlled audio and video switchers, and

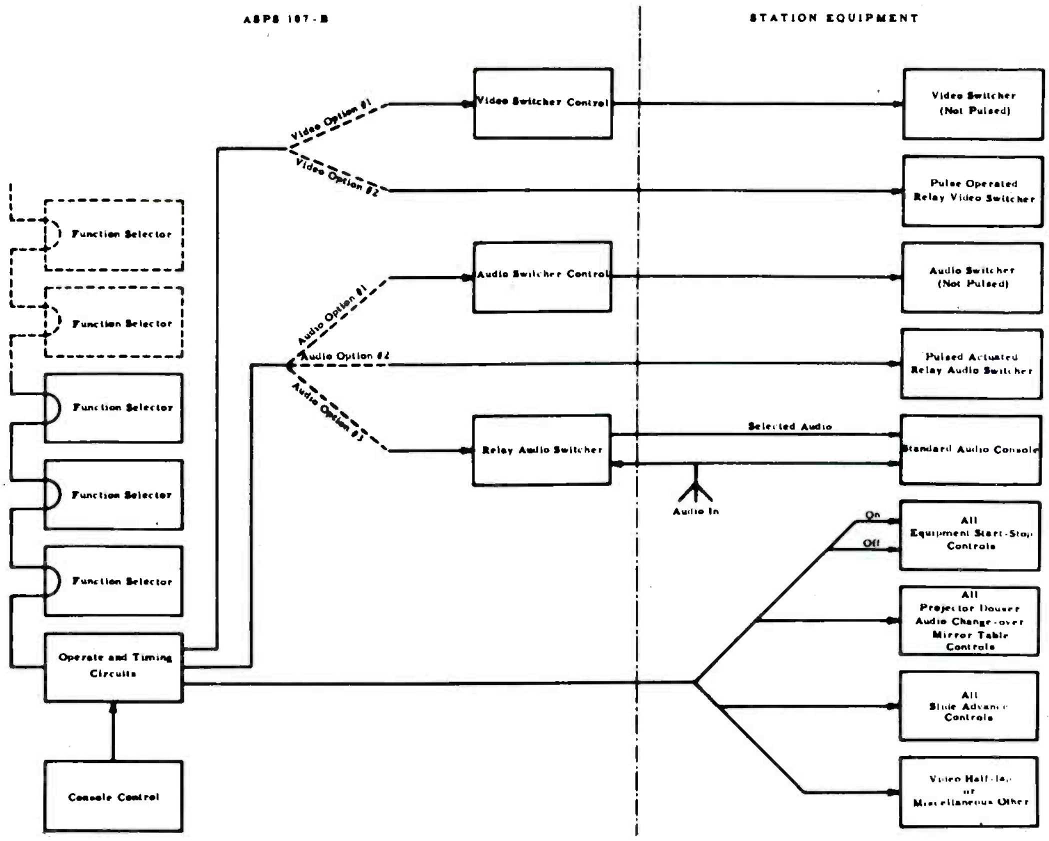


Fig. 10 - System block diagram of the Model 107 B ASPS and associated equipment needed for modification to existing switching systems.

much equipment controlling is accomplished with an ordinary on or off switch.

We cannot describe all of the many different individual modifications that might be necessary for the variety of station layouts that exist, or the infinite variety of modification methods that might suggest themselves. One method each for solving the video, audio and equipment modifications usually confronting the station engineer is described below. Many other methods will suggest themselves to each station engineer for solving his particular problems. The only requirement that the devices to be controlled must meet is that they be pulse operated.

Figure #11 shows a simple and effective adaption of the ASPS to an existing manual switcher by this video control layout. Feeding the output of the existing manual switcher into an automatically controlled vacuum tube switcher permits special effects to be manually set up and previewed in advance of airing. Manual takeaway is in no way hampered by this arrangement. Manual control can be selected automatically by the ASPS as part of a sequence or by ending the sequence with the "End Sequence" button.

A readily available vacuum tube switcher is the Adler VS-3. This device uses cathode followers as the video switches, and because the video inputs can be looped through the VS-3 and returned to a separate manual switcher, it provides a convenient method for intercepting the video inputs. Applying plate voltage to a stage causes that tube to conduct allowing the signal present on the control grid to appear on an output bus.

Mechron has a relay control unit intended to control this type of video switcher. This unit is effectively a video relay switcher, but by employing "softening" R-C delay networks, and by the way these nets are standard in the Adler tube switcher, relay timing is prevented from being a critical factor. As a result, this relay switcher may be of low cost.

Figure #12 illustrates in block form single bank control by the ASPS and dual bank control by the existing manual switcher.

Manual control of both banks is at the option of the automatic system. When in auto-operation, the manual buttons have no effect on switching of the shared bank, but the fader arms still operate and the alternate bank is exclusively under manual button control. Should a manual insertion be required, such as a half lap of a portion of an automatic sequence, the fader arm may be partially or wholly positioned in the "exclusively manual" position. Both banks are under manual control when either of the following conditions occur: Take manual is selected by

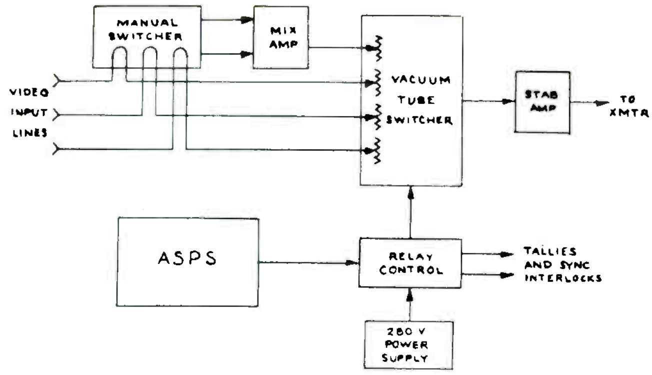


Fig. 11 - A simple adaption of the ASPS to an existing manual video switcher. Existing manual switcher feeds into the automatically controlled switcher.

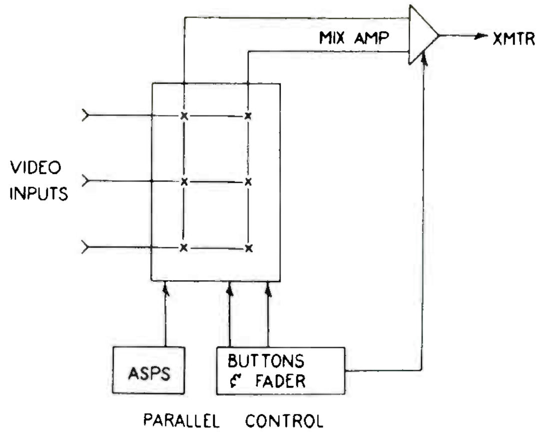


Fig. 12 - Block diagram showing single bank control by the ASPS and dual bank control by the manual switcher.

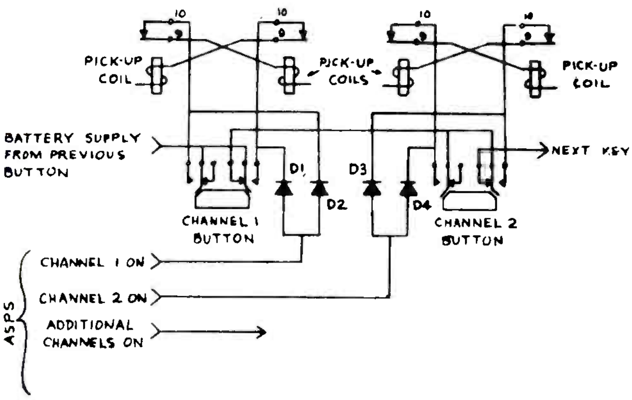


Fig. 13 - Method of adapting RCA TS20-A relay video switcher for ASPS operation.

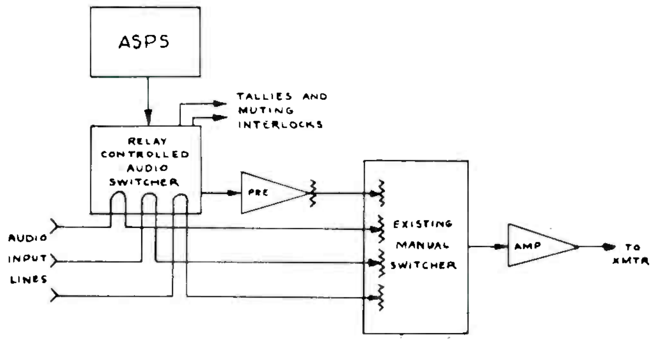


Fig. 14 - Block diagram of an audio relay switching system adapted to an audio console.

the ASPS as part of a pre-selected sequence; the end sequence button controlling the ASPS is depressed.

Adaption of the RCA-TS-20A (or equivalent) relay switcher is arranged so that simultaneous parallel control of one switching bus is allowed, and the switcher control relay unit is not required. The electrical tie-in of the ASPS to the RCA-TS-20A is illustrated in Figure #13. Note the use of diodes to permit pulses to be applied to both of the existing relay coils as is accomplished by the channel button, but prohibiting the chance connection of the channel relay coils in a series configuration.

This block diagram in Figure #14, shows a simple adaption of a typical audio switching system. In order to permit the ASPS to switch audio circuits automatically, where relay switching is not provided, each input to an existing audio console is routed through a relay switcher. Each relay is wired so that the circuit it switches is normalled when not energized. When normalled, the audio circuit feeds its usual position on the audio console. When any one circuit is desired to be switched by the ASPS, the actuated relay transfers the desired audio to any particular input of the manual audio console chosen as the ASPS input. With a designed 10 inputs, the loss in this switcher is 16 DB and additional gain must be provided if automatic mixing is desired. Where it is not desired to mix audio in this switcher, it can be used as a substitution switcher with 10 inputs. Under these conditions, no amplification is necessary, since the circuit is without losses. When operating in the automatic state, audio may be mixed by using the console pads.

A typical control circuit for a slide projector is shown in the upper portion of Figure #15. Lamp voltage is controlled by the double pole switch in series with the lamp source supply. Slide advance is controlled by a single pole switch in series with the 24 volt supply. B y ading a two solenoid mechanical latching relay as shown in the altered circuitry, the slide projector is made pulse controlled and does permit a parallel tie-in of the ASPS unit.

THINGS TO COME

The preceding section of this paper concerned itself with a short term, manually pre-set automatic switcher. The device we have been dis-

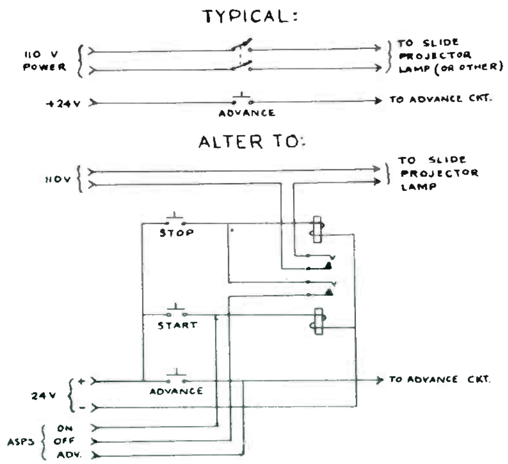


Fig. 15 - Slide or film projector start or stop circuitry conversion to pulse control.

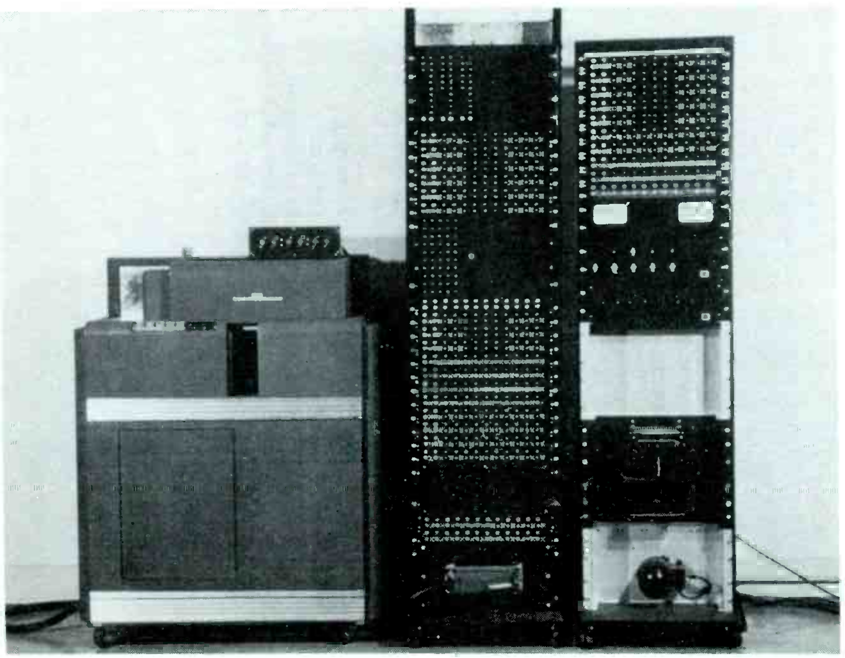


Fig. 16 - Mechron Model 101-B. Automatic broadcast programming system including IBM tabulating card reader.

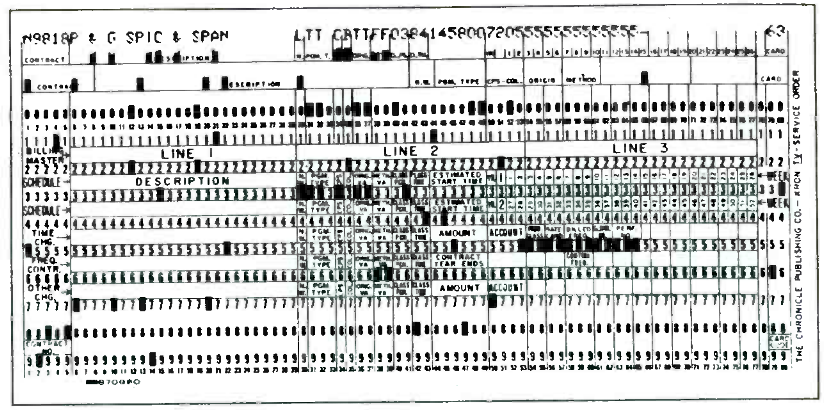


Fig. 17 - Typical tabulating card used in the ASPS.

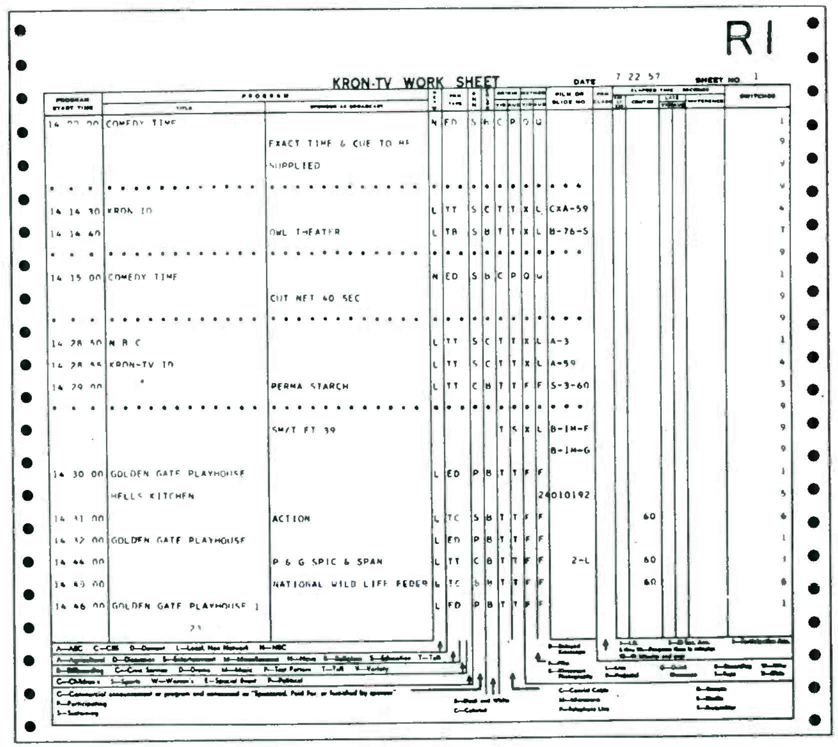


Fig. 18 - KRON-TV work sheet or program schedule prepared on tabulating equipment.

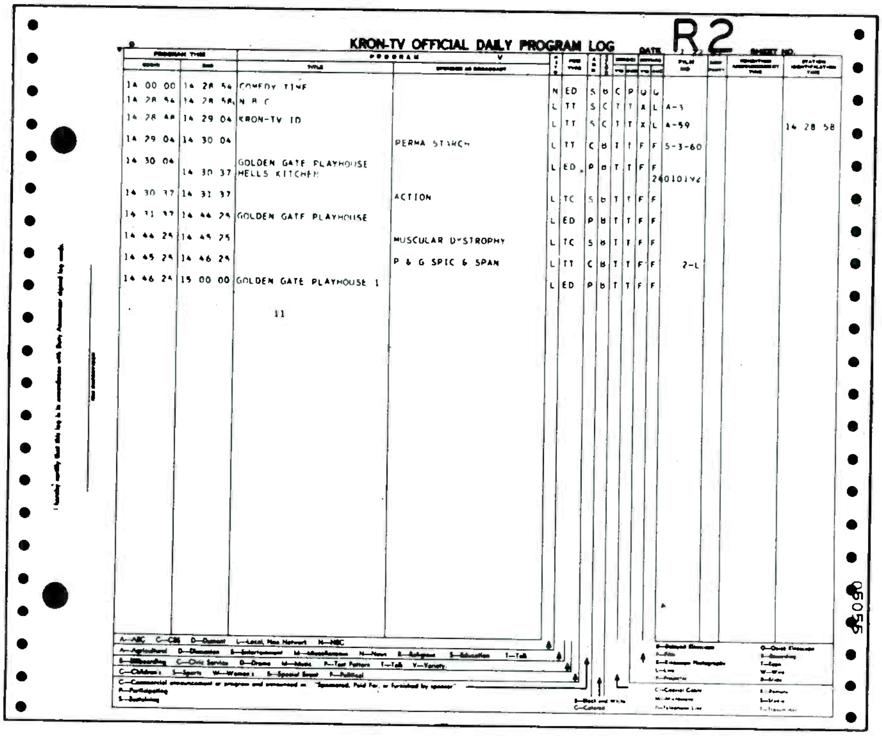


Fig. 19 - KRON-TV daily program log printed by tabulating cards.

cussing is presently in operation at KRON-TV in San Francisco, California, and an earlier prototype has been in use at KBAK-TV in Bakersfield, California, since last October. We believe it is a practical step in introducing automation to program switching.

I would like to describe briefly our progress in broadcast automation which may be of interest to broadcasters in the future.

The machine, shown in Figure #16, is a prototype designed to control all signal circuits and equipments used by television broadcasters. The machine works in conjunction with an IBM Reader, Model 523. In this instance, we take the same tabulating cards that are used for accounting and billing, and govern program switching in its entirety. The IBM machine reads out cards informing the automatic switcher what to do.

Tabulating cards, Figure #17, perform the extra duty of program switching, form part of a system of accounting services, work sheet, Figure # 18, and log printing, Figure #19, and the additional task of billing clients. KRON-TV is currently using the tabulating card-accounting system. This is another story to be told at a later date.

When the automatic switcher finishes a program, it clears itself and cycles the card reader obtaining new information.

Timing is, for the most part, based on the true time of the day and appropriate time is punched in the tabulating cards. However, there are occasions when the exact time that a program segment should be aired is unknown. In this case the machine will time the segment for the indicated duration of the program element. A remotely generated signal causes this machine to air the segment for the presecribed duration. An indefinite number of segments, all operating without known start time, may each turn on the next segment. When this segment or series of segments have run their course, the machine can automatically revert to switching on the true time basis. It is not yet in control of station switching although it has been used extensively with a simple display board. We feel further development is in order to improve the reliability of this device. How much longer this will be, I cannot say.

RECENT DEVELOPMENTS IN TV CAMERA TUBES

F. S. Veith
Electron Tube Division
Radio Corporation of America
Lancaster, Pennsylvania

SUMMARY

Image orthicons and vidicons have been improved substantially to fulfill requirements for better TV broadcasting. The advantages of "micromesh" and "super-dynodes" are explained and the performance characteristics of a new image orthicon with very high photocathode sensitivity described. Recommendations concerning studio practices to obtain best black-and-white and color pictures are presented.

Vidicon characteristics are analyzed with respect to best performance of existing commercial types. Electron optical problems in vidicon chains are considered and operational information for optimum performance recommended. Characteristics of a new developmental vidicon with increased "effective sensitivity" is described.

INTRODUCTION

During the last ten years, television broadcast cameras have undergone a rapid development cycle from primitive beginnings to rather sophisticated designs. While a number of different basic camera tube types were available, operations in the United States have become concerned with image orthicon and vidicon tubes exclusively. Although the earlier iconoscope film cameras have been improved, new installations call for vidicon chains. Other high-velocity scan tubes, such as image iconoscope types, have not found acceptance in this country, mainly because of their considerably lower sensitivities and shorter life. The advent of color operations has had a marked influence on camera tube development, particularly in establishing more stringent performance and quality requirements than previously available. The expanding market for camera tubes has also invited competition among manufacturers, thus giving the station operator a chance to satisfy his preference.

IMAGE ORTHICON DEVELOPMENTS

General

Because light requirements are of outstanding importance in live-broadcast operations, the image orthicon has become the accepted camera tube for such service in the United States. Although TV studios in England and the continent had for some time insisted that better pictures could be obtained with image iconoscope or orthicon types, even at considerable expense in light requirements, this trend is now reversed with the availability of image orthicons in these countries. Image orthicons are therefore of great importance for live-broadcast studio and outdoor applications.

Let us consider the more recent improvements in image orthicons and what they mean to the TV station operators who have to pay good money for every hour of broadcasting.

Micromesh

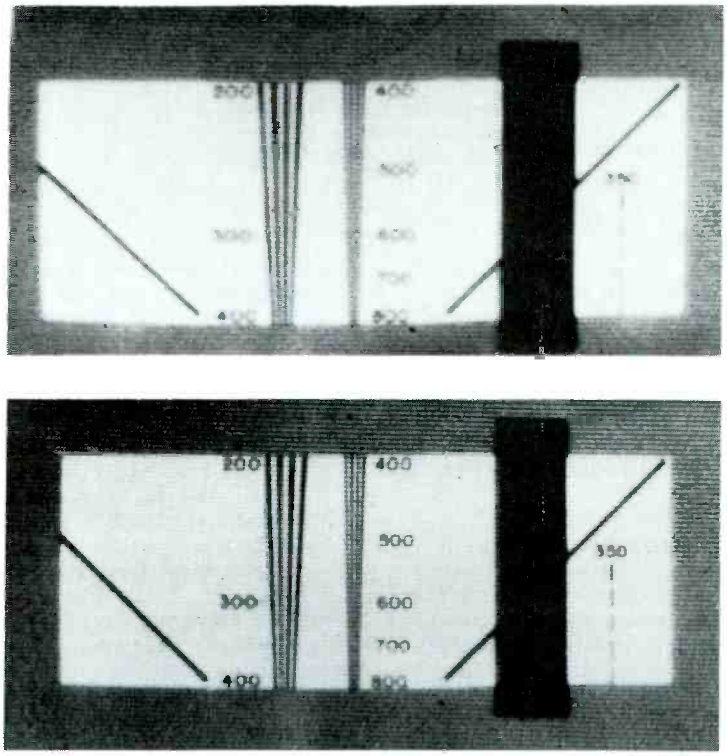
A little over a year ago RCA culminated many years of development in perfecting a ruling engine which allowed manufacture of specially fine mesh, a vital part in camera tubes. This delicate mesh structure having 750 openings per linear inch, called "micromesh", permits improved picture detail contrast when used with aperture-correction circuitry. Thus, 100 per cent aperture response can be obtained for 350-line information, whereas only 60 per cent was obtainable for the same information with the previous 500 mesh. If the full correction now possible is attempted with 500-mesh tubes, moiré and beat pattern problems become very pronounced (Figures 1 and 2).

Super-dynode

A second new feature was introduced earlier this year - also as a result of a long search. It was known for some time that changes in the secondary emission ratio of the material on the first dynode in image orthicons caused an objectionable phenomenon called "dynode burn" which contributed to excessive "dark shading". For color operations, particularly, tubes had to be retired for this "dynode-burn". A new material which eliminates dynode burn as a problem is now used. Tubes having the new "super-dynodes", as they are called, require a minimum of dark-shading-adjustment time, give a more uniform picture-background at all times with a minimum of undesirable background texture and shading in low-light areas, and, for color operation, give cleaner colors in the dark areas because of minimum color shift (Figure 3). In addition, and of great importance, is the fact that the decelerator-grid (grid No. 5) voltage can be set at the best value for highlight uniformity throughout the useful life of the tube, thus eliminating the interdependence of dark-shading and highlight uniformity.

Multi-alkali Image Orthicon[1]

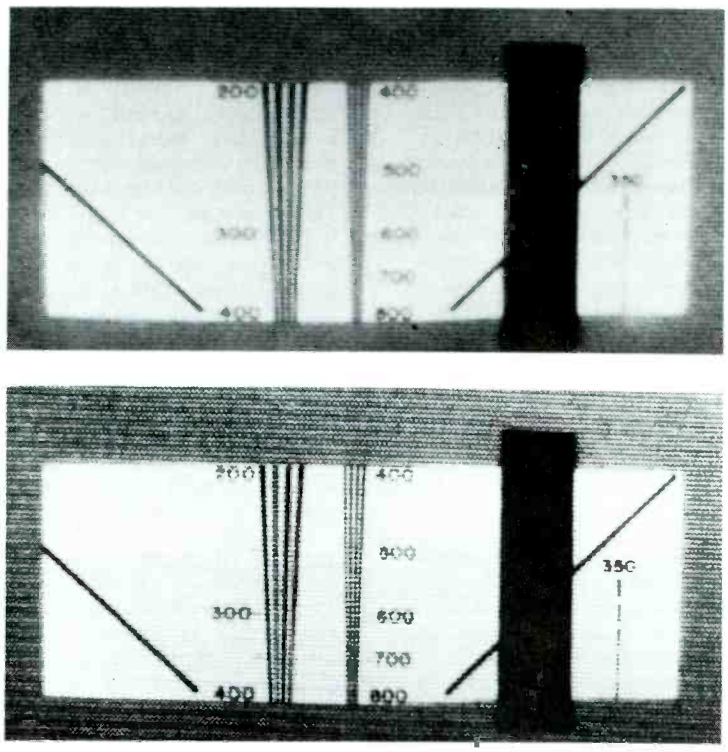
The most recent addition to the image orthicon family is the RCA 7037, designed primarily for improved color studio operation. This tube has an entirely new high-sensitivity photocathode, consisting of a combination of the antimonides of the alkali metals - sodium, potassium and cesium - as developed originally by Dr. A. H. Sommer of the RCA Laboratories Division.[2] The presence of these new materials and the necessary processing schedules resulted also in a stabilization of the



(a)

(b)

Fig. 1 - Photograph illustrating the absence of moire effects in image orthicons using "micromesh" (a) without and (b) with aperture compensation.



(a)

(b)

Fig. 2 - Photograph illustrating the presence of moire effects in image orthicons using "500-mesh" (a) without and (b) with aperture compensation.

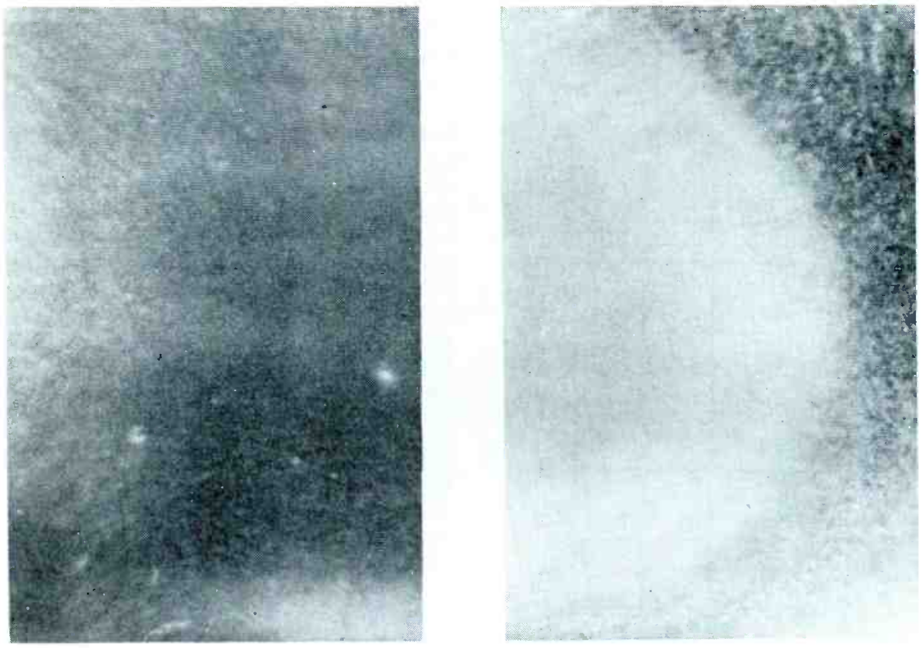


Fig. 3 - Photograph illustrating uniform background in low-light areas compared to nonuniform background of image orthicon not using new "super-dynode" structure.

target properties in addition to the introduction of the new photocathode characteristics. The design goal for this new tube was primarily aimed to reduce operating costs for color studio operations and to allow more freedom of motion by permitting greater depth of focus.

Figure 4 shows a comparison of light levels and lens stops for black-and-white and color. Note that at present typical color studios are using 300 to 500 foot-candles of incident light at a lens stop of f 5.6. The higher light levels are now required toward the end of the image orthicon life. A considerable reduction in light levels would result in two-fold savings: first, lower lighting power installation and operating costs, and, second, reduced air conditioning installation and operating costs. Figure 5 shows the accomplishments of the new tube compared to the original goals. As an overall evaluation the improvement can best be expressed by the fact that the effective sensitivity has been increased 2 to

	TYPICAL STUDIO LIGHTING LEVEL (FT-C)	LENS STOP (APPROX.)	RESPONSE			COLOR TEMP. OF INCIDENT LIGHT (° K)
			RED	BLUE	GREEN	
BLACK-AND WHITE	50-120	f:8	satis-factory	satis-factory	satis-factory	Not Critical
COLOR	300-500	f:5.6	satis-factory	limited	satis-factory	3000
DESIGN GOALS	200-300	f:8 or smaller	main-tain	Increase 2 to 3 X	main-tain	3000

Fig. 4 - Performance considerations for present image orthicons compared with design goals for the new tube.

PERFORMANCE CONSIDERATIONS	DESIGN GOALS	ACCOMPLISHMENTS
Typical Studio Lighting Level (FT-C)	200-300	250-350
Lens Stop (Approx.)	f:8 or smaller	f:8
Response:		
Red	Maintain	Increased
Blue	Increase 2 to 3 X	Increased 3 to 4 X
Green	Maintain	Increased
Color Temperature of Incident Light (° K)	3000	3000
Effective Sensitivity	Increase	Increased 2 to 3 X
Life	Increase	Greatly Increased
Stability	Improve	Improved

Fig. 5 - Comparison of goals and accomplishments in the development of the new image orthicon having a multialkali photocathode.

3 times over that of the present tube. In addition, life and stability are greatly superior, as will be shown later.

The spectral response of an image orthicon having the multi-alkali photosurface is shown in curve A in Figure 6. Curve B is for the RCA-5820 and RCA-6474 image orthicon. Curve A straddles curve B and extends further into the blue and into the red regions. Also, the absolute values of photocathode sensitivity are considerably higher. It is well to realize, however, that the amount of light needed to reach a specific operating point, such as the knee of the transfer characteristic of the image orthicon, depends not only on the photo-

CURVE	TYPE NO.	PHOTOCATHODE MATERIAL	PHOTOCATHODE MAXIMUM SENSITIVITY (μA/LUMEN)
A —·—·—	DEVELOPMENTAL MULTI-ALKALI IMAGE ORTHICON	Sb-K-Na-Cs	200
B ———	5820, 6474	Bi-Ag-O-Cs	90
C - - - -	931-A	Sb-Cs-(O)	90

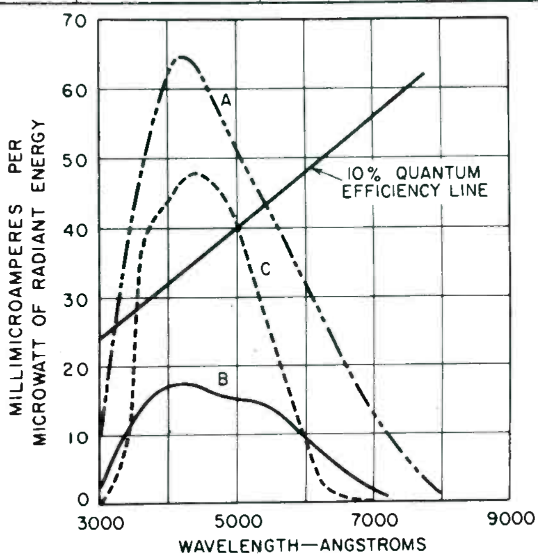


Fig. 6 - Spectral sensitivities of photocathodes used in image orthicons, and of the Sb-Cs-(O) surface which was noted for its high quantum efficiency until the multialkali surface was developed.

cathode but also on the secondary emission ratio of the target. The term "effective sensitivity"* takes into account this secondary emission ratio, which is somewhat lower initially in multi-alkali tubes than in the 5820 or 6474. Figure 7 shows an interesting comparison between the 6474 and the 7037. The blocks for the three color channels correspond to the RCA color-camera optics and are referred to 2870°K incandescent light. For new tubes a typical comparison ratio is 2.6 for red, 2.0 for green and 3.2 for blue. However, after 100 hours or more of operation, these ratios increase by about 30 to 40% to 3.4, 2.8 and 4.7 respectively. The reason for the increased ratios with life becomes apparent from Figure 8. The effective sensitivity of the 6474 drops appreciably during early life due to a drop in the secondary emission ratio of the target. The drop in effective sensitivity for the multi-alkali tube is much less pronounced, because of its stabilized target. Both the 6474 and the 7037 can be operated without any change in the camera optics so long as the light balance between the color channels is maintained with neutral filters.

*($I_{eff} = I_{pc} \times (S-1)\,T$, where I_{eff} is the effective sensitivity, charging the target in microamperes per lumen, I_{pc} is the photocathode sensitivity, also in microamperes per lumen, S is the secondary-emission ratio of the target glass and T is the transmission of the mesh in front of the target.

Finally, a most gratifying characteristic of the stabilized target in the new tube is shown in Figure 9. As is well known, image retention or "sticking" is a real problem in image orthicon operations and determines the end of useful life in the majority of cases. The "sticking" value for the 6474 expressed by the ordinate, increases from practically zero to a limit of usability within a relatively short time of actual tube operation. On the other hand, the new tube might start out with a "sticking" value equivalent to about 50 to 100 hours of operation for the 6474, but the sticking remains practically unchanged for a long time. Consequently, the life of the RCA 7037 is considerably greater than that of the 6474. It is obvious that the advantages of lower light requirements, reduced air conditioning needs and greatly extended tube life will result in substantially reduced operating costs per hour.

Black-and-White Camera Operation

Often the question arises as to means of improving the black-and-white TV picture we have become accustomed to in this country. If good photographic reproduction is a standard of comparison, much can be done to approximate this goal. Obviously, increased attention must be given to video control and, in particular, lighting practices need some measure of discipline. With wide-spaced image orthicons like the 5820, a certain light range can be covered by "squashing" whites and allowing all the effects of electron redistribution, such as halo and white edges, to become very pronounced. Usually, little effort is exerted by the operator in careful adjustment of the video levels and in specifying and maintaining a given light range. On the other hand, the use of "close-spaced" image orthicons such as the 6474 or the new 7037 for black-and-white studio operations will produce pictures superior to those obtained by adhering to current practices with 5820's. The higher target capacitance of the 6474 and the 7037 results in a longer linear portion of the light transfer characteristic as shown in Figure 10, thus allowing operation with the highlights only one lens stop above the knee of this curve, and at the same time producing a larger output signal. This larger signal, in turn, results in a higher signal-to-noise ratio and a longer dynamic range or gray scale. Combined with gamma correction in the low lights (black stretch) and aperture compensation for increased picture detail, operation of the 6474 image orthicons have resulted in pictures of outstanding quality of the highest standards. Two years of performance in many European TV stations have clearly demonstrated such superiority.

The new 7037 promises to be a very attractive tube in studio operation for pictures of high quality in black-and-white as well as color. In black-and-white service, light control by means of neutral density filters in the camera will probably be required.

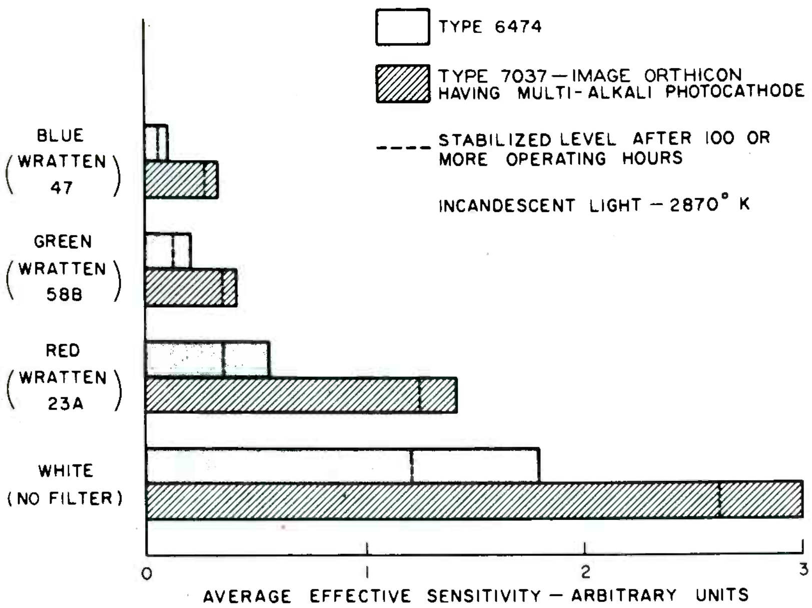


Fig. 7 - Average effective sensitivity of the new 7037 image orthicon compared with that of the 6474.

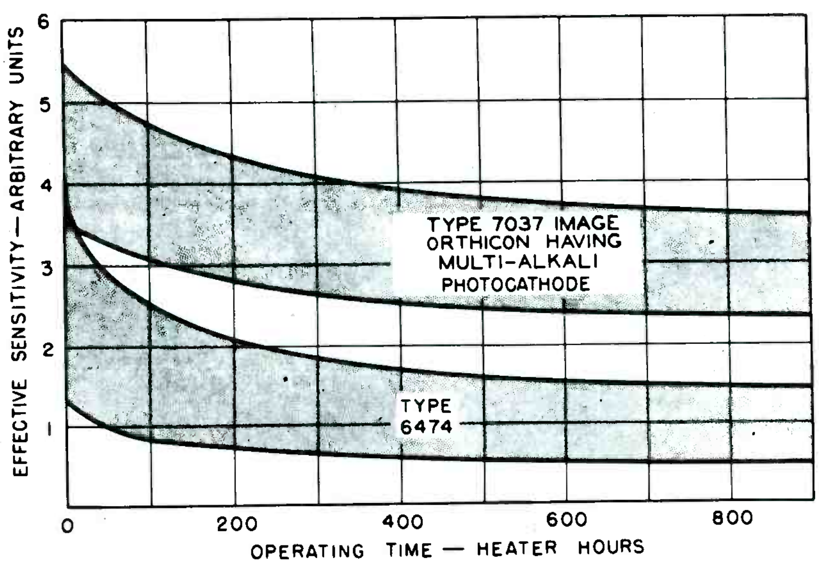


Fig. 8 - Effective sensitivity vs. life of the new 7037 image orthicon and of the 6474.

VIDICON DEVELOPMENTS

Beam Landing Errors and Signal Output Uniformity(3)

The first vidicon tube suitable for broadcast use was the RCA-6326. It has found wide use in film cameras for black-and-white and for color operations. So successful was film reproduction by vidicon chains that today vidicon film chains are widely accepted in preference to flying-spot systems. The simplicity of vidicon camera operation and the high signal-to-noise ratio, coupled with long tube life, proved to be of great advantage. Even the concern about registration of color images has disappeared with improvements in circuit stability. Such a broad accomplishment could not have become reality were it not for a very intimate relationship between the camera design and the vidicon characteristics. It is therefore important to realize that the 6326 is the best tube for use in existing black-and-white and color film chains.

Let us consider first how the beam in a vidicon behaves when the deflecting yoke is of a design used in existing film chains. In the ideal case the beam would land perpendicularly to the photoconductor at all points of the scanned area and drive the surface of the photoconductor exactly to cathode potential. In a special tube having

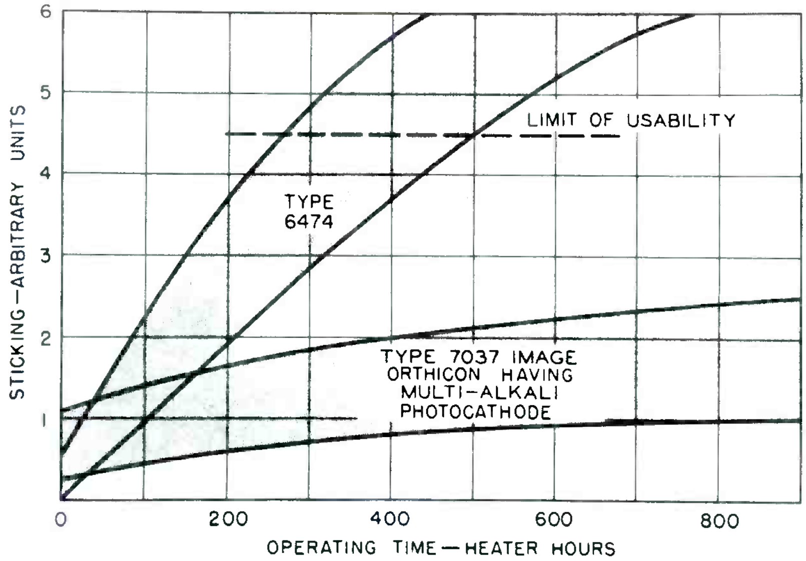


Fig. 9 - Sticking vs. life characteristic of the new 7037 image orthicon and of the 6474.

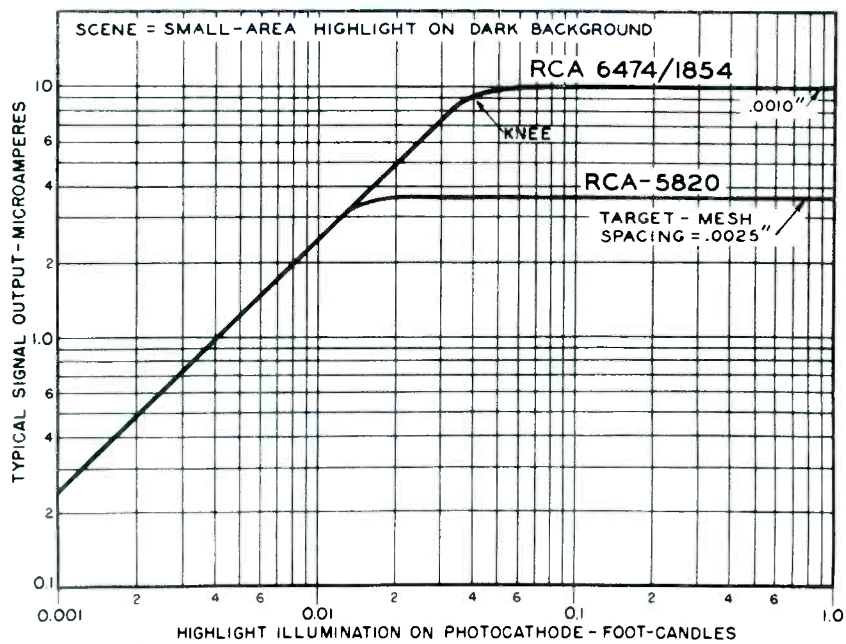


Fig. 10 - Light transfer characteristic of "close spaced" image orthicon, type 6474, compared with characteristic of "wide spaced" tube type 5820. The new image orthicon is a "close spaced" type.

only a signal plate and no photoconductor, beam landing characteristics were studied and the results are shown in Figure 11. For a signal electrode voltage of 1.5 volts, only the electrons having the highest velocities land at the center of the tube. The curve for 2.5 volts is significant in that it represents the voltage at which all of the beam lands in the center or undeflected portion of the scanned area. Finally, the curve for 7.0 volts illustrates the condition when all of the beam lands over the entire scanned raster. The voltage difference between the last two curves illustrates the magnitude of the maximum beam landing error. In this case, the error is 4.5 volts.

For operation at high light levels (200 to 300 foot candles on the face of the tube), as is the case for film pickup, it can be shown that the beam landing error for a typical case can result in a variation of signal output from center to edge of as much as 40 per cent for a perfectly uniform

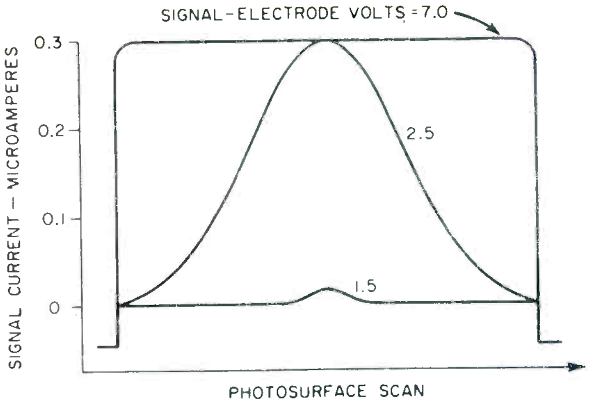


Fig. 11 - Signal output as a function of signal electrode voltage measured in a special vidicon having no photoconductor.

photoconductor. However, the signal output uniformity of the 6326 is in general better than would appear from these considerations. The reason for this better signal output uniformity is the rather delicate balance maintained between photoconductor non-uniformity and beam landing errors. In the 6326 the photosurface is thinner at the edges than at the center and, therefore, has a higher voltage gradient across the edge portions than across the center portions. As a result the edges have a higher sensitivity than the center and consequently the effects of the lower voltage that is applied across the photoconductor in the edge regions, due to beam landing errors, are offset. Figure 12 illustrates the non-uniformity of the photosurface of type 6326, which gives best results for film cameras of existing design, in comparison with the more uniform photosurfaces of type 6326-A. The 6326-A, because of its uniform photosurface, does not provide the balance between photoconductor non-uniformity and the beam landing errors. For this type, signal-output uniformity can be obtained by a circuit change or addition. This change involves supplying a modulating voltage of suitable wave form to the cathode of the vidicon so that the potential of the scanned area will be essentially constant. Figure 13 shows such a typical arrangement. The amplitude of the modulating waveform should be the same as the beam landing error, or approximately 4.5 volts. This method of correction contributes also to improved center-to-edge focus as an additional bonus.

Live Broadcast Operations with Vidicon Cameras

In cases where presently available vidicons are used for pickup of live scenes, the major requirement is maximum sensitivity. To achieve highest effective sensitivity the signal-electrode voltage is usually increased almost to the point where the dark current flare becomes intolerable.

The dark current, which was negligible for film cameras, now becomes appreciable and is very much affected by beam landing errors and by photoconductor non-uniformities. For type 6326 the condition for dark current flare, as illustrated by Figures 14,is soon reached. A better answer for live-scene operation is the use of type 6326-A, which has the more uniform photosurface. Also, it can be shown that the beam landing errors, which are responsible for considerable variation in signal output and in dark current, can be reduced substantially by an increase in the photoconductor thickness so that a higher signal-electrode voltage, in the 80 to 90 volt range, is required when the tube is operated to produce maximum sensitivity. In summary, then, the RCA 6326-A is best suited for live scenes and the RCA 6326 is best for existing film cameras without modification.

New Developmental Vidicon(4)

An improved developmental one inch vidicon, is being evaluated for use in live and film cameras (Figure 15). This vidicon has an electron gun structure and photosurface similar to that utilized in present commercial RCA types, but differs from present vidicons in that it is a

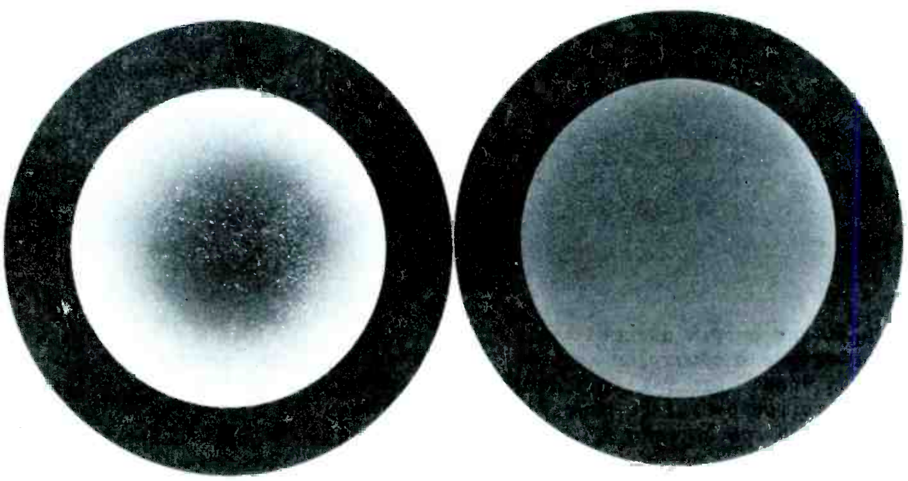


Fig. 12 - Photograph of vidicon faceplates comparing uniform photosurface of type 6326-A with that of type 6326.

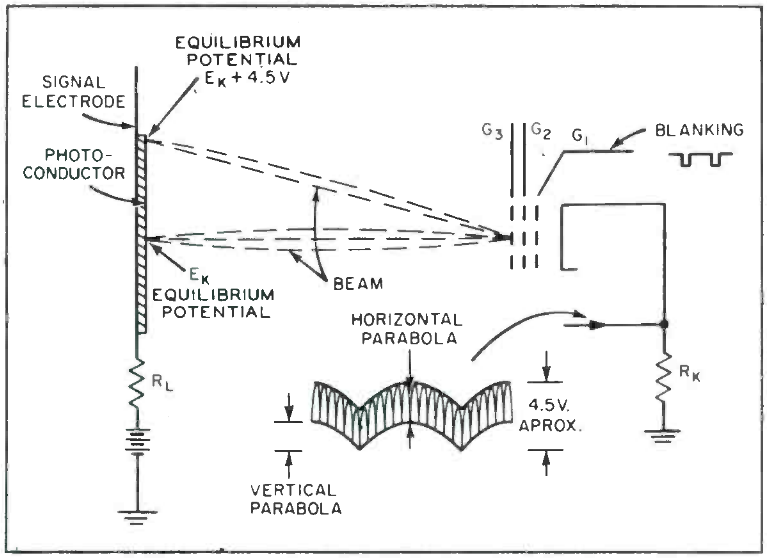


Fig. 13 - Cathode modulation circuit and waveforms necessary for correction of beam landing error.

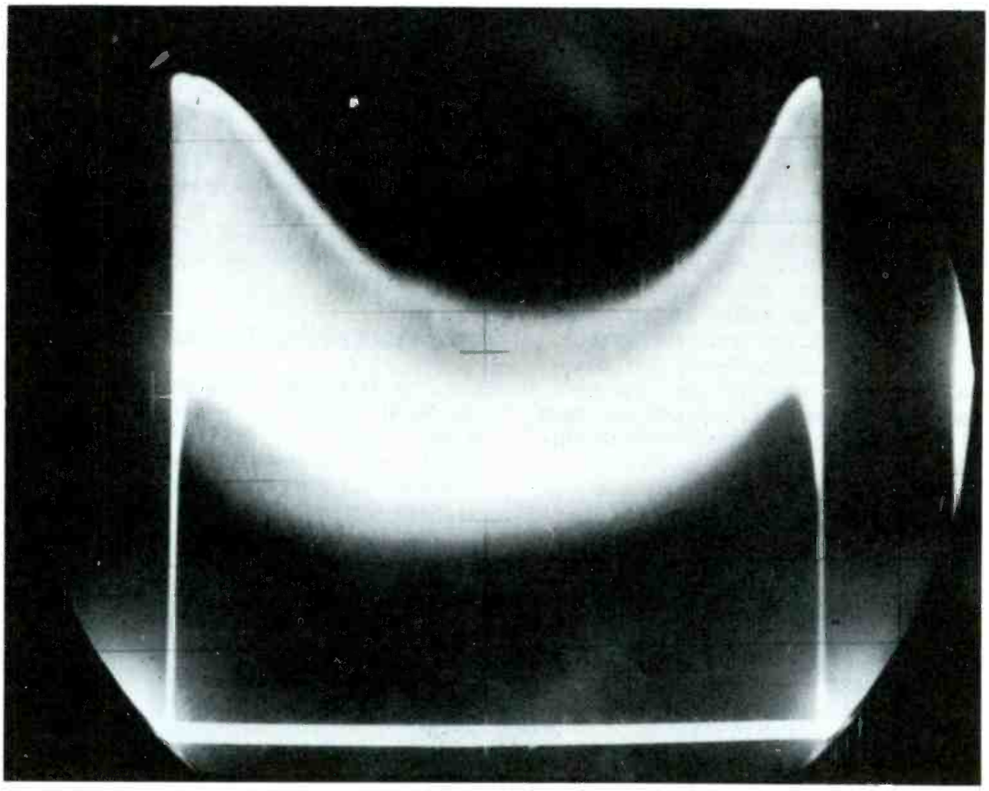


Fig. 14 a - Oscillograph trace of signal output of type 6326 illustrating flare under conditions of high dark current.

precision design featuring higher effective sensitivity, more uniform signal output, an extremely flat faceplate free from optical distortions, and non-magnetic parts. These features are the result of the development of a photoconductive surface of extremely uniform thickness and the development of new tube processing and fabrication techniques.

For film cameras, both black-and-white and color, the new tube contributes a new degree of improvement in quality. The flat faceplate reduces optical distortions in the light path, and the absence of magnetic parts near the faceplate minimizes distortion of the electron optics. The photoconductor is extremely uniform and variations of photoconductor thickness from tube to

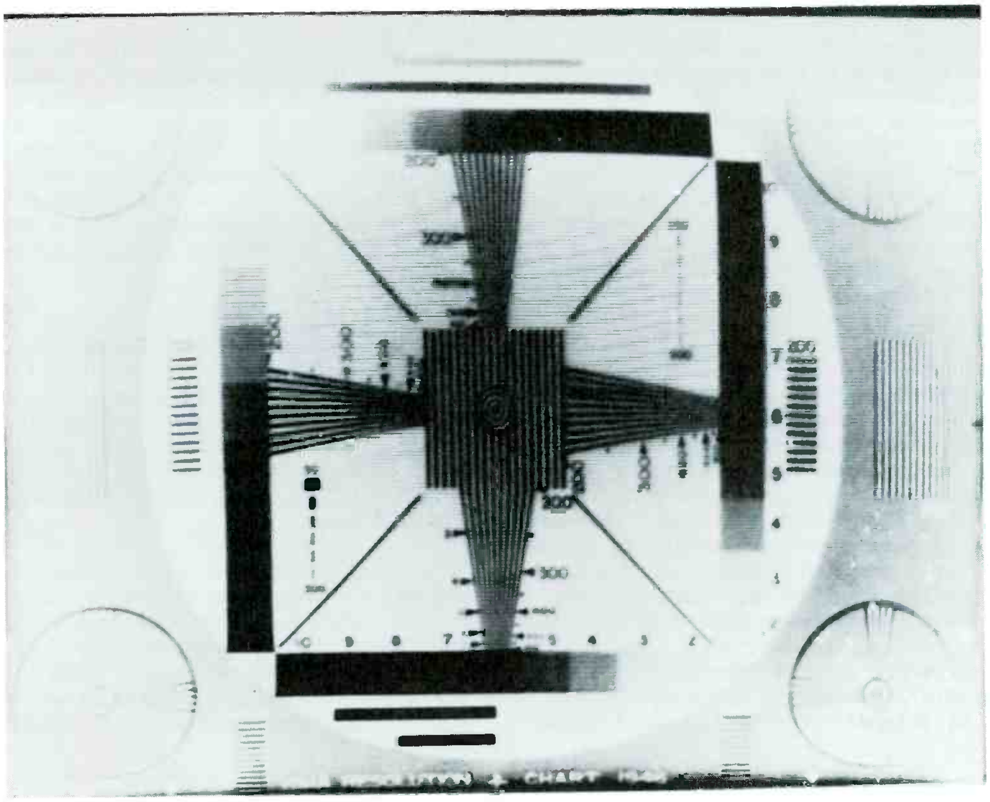


Fig. 14 b - Test pattern showing effect of flare under conditions of high dark current.

Fig. 15 - Photograph of improved developmental vidicon.

tube are small. As was explained before, operation of a tube with good photosurface uniformity requires correction for beam landing errors. With such correction, this developmental vidicon shows excellent potentialities for black-and-white film cameras and is particularly promising for color film cameras. Its precision design makes registration a simple operation. Its envelope is without a side-tip, similar to the 6326-A, therefore making it possible to take advantage of deflecting and focusing components producing the most uniform fields.

For live scenes the new vidicon with its extremely uniform photosurface provides an entirely new mode of operation. The signal-electrode voltage, which is limited to a given value by dark current flare, can be pushed up very significantly in this new tube to approximately twice the limiting value for present vidicons. Increasing the signal-electrode-voltage results in greater signal output for a constant light level and thus in greater effective sensitivity. With a higher signal-electrode voltage a very high dark current is now present, as shown in Figure 16. The important fact, however, is that this dark current is now "manageable", due to its uniformity, and it can easily be clipped off. It is well to note that the amplifier must be able to pass the full amplitude of signal plus dark current. The value of dark current for maximum sensitivity operation is increased from 0.02 microampere, which is normal for the older tubes, to approximately 0.2 microampere. The signal output should be held to the normal 0.2 to 0.3 microampere (peak-to-peak) value which corresponds to a light level at the face of the tube of approximately one foot-candle.

Comparing operation of the new tube at the higher signal-electrode voltage with conventional operation of present vidicons, the light level requirements are now reduced by a factor of 5 or 6, thus producing a corresponding gain in effective sensitivity of this order. The gamma characteristic of the tube (Figure 17) remains approximately 0.65, allowing coverage of a fairly wide contrast range.

The lag or image-decay characteristics of the new vidicon is an important consideration. It was always known that lag would become greater with lower light levels, or expressed in another way, lag would become greater with higher signal-electrode voltage for a given tube. The left side of the curve in Figure 18 illustrates this

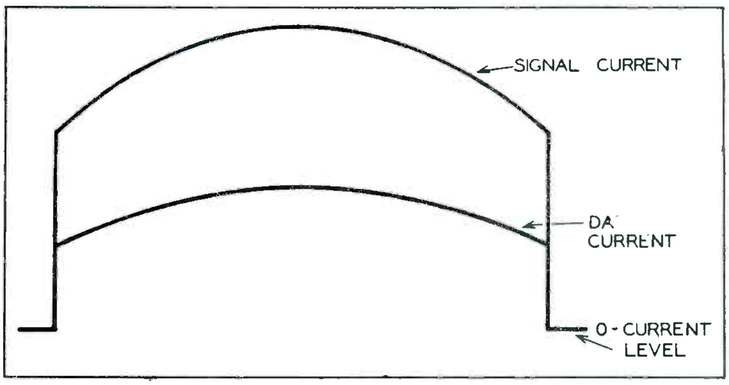


Fig. 16 - Output signal waveform of improved developmental vidicon operated under high dark current condition.

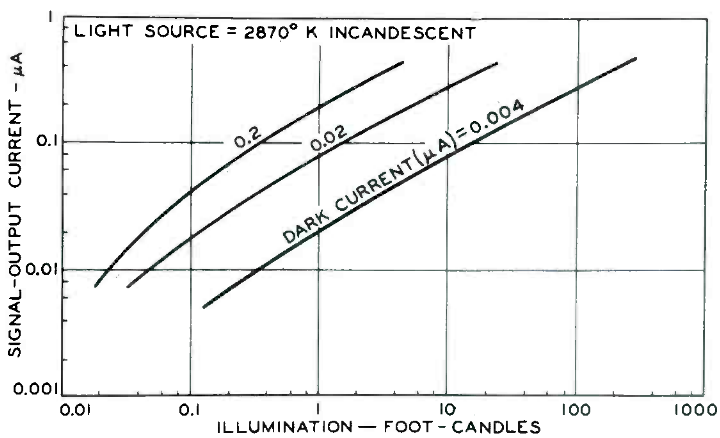


Fig. 17 - Light transfer characteristics of developmental vidicon.

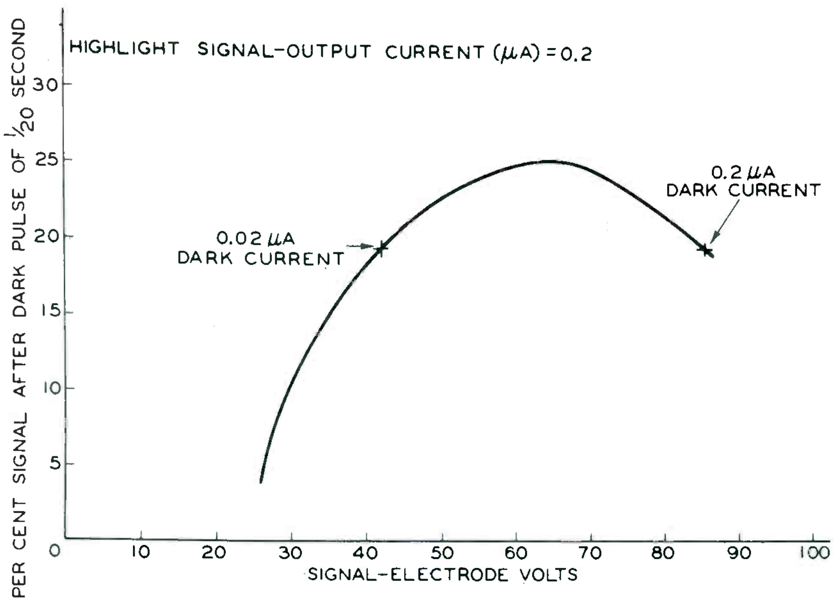


Fig. 18 - Lag characteristic of developmental vidicon.

relationship. What is of interest, however, is the fact that when the signal electrode voltage is increased sufficiently, for example, to double its normal value, the lag remains the same, because the lag curve passes through a maximum and then decreases. This curve shows that the photoconductor has an acceptable lag characteristic at dark current values of both 0.02 and 0.2 microampere, a fact which makes the new tube practical.

Another consideration is the effect of temperature variations. Since the dark current is temperature-sensitive and is a substantial factor, means must be provided in the camera design to cope with this relationship. Further evaluation is necessary to determine the details of possible temperature-stabilization or temperature-compensation techniques.

The new developmental vidicon has the basic performance characteristics which are desirable in studio cameras for live pickup of black-and-white as well as color operations. With cathode modulation the tube is also attractive for film cameras. Its outstanding features are its higher sensitivity and uniform signal output resulting from precision design and the use of a photoconductive surface of extremely uniform thickness.

1. P. W. Kaseman, "A New Developmental Image Orthicon Employing a Multi-Alkali Photocathode for Color Cameras". Presented at the National Electronics Conference, Chicago, Illinois, October 9, 1957.

2. A. H. Sommer, "Multi-Alkali Photocathodes", Trans. IRE-PGNS, Vol. NS-3, p. 8-12, November 1956.

3. R. G. Neuhauser and L. D. Miller, "Beam Landing Errors and Signal Output Uniformity of Vidicon Tubes". Presented at the National Electronics Conference, Chicago, Illinois, October 9, 1957.

4. L. D. Miller, B. H. Vine, "An Improved Developmental One Inch Vidicon For Television Cameras". Presented at the SMPTE Convention, Philadelphia, Pa., October 9, 1957.

A TRANSISTOR REGULATED POWER SUPPLY FOR VIDEO CIRCUITS

Robert H. Packard and Marvin G. Schorr
Technical Operations, Incorporated*
Burlington, Massachusetts

Summary

A high-efficiency all-transistor regulated power supply for 280 volts and 1.5 amperes is compared with conventional supplies using vacuum tubes. Test results show good characteristics for video use with size and weight reduced by a factor of two.

Introduction

The operation of a modern TV studio involves the use of many video amplifiers incorporating hundreds of vacuum tubes. In order to supply plate voltage for these amplifiers well regulated sources of d-c are required which are capable of delivering a total of several amperes at voltages between 250 and 300 v d-c. These supplies must have low ripple and low output impedance at frequencies well over 100 kc.

A typical power supply unit is one which will supply d-c for a complete black and white camera chain requiring 280 volts at 1.5 amperes d-c. A color chain would require two such supplies, or a total of 3 amperes.

If such a supply were made using conventional vacuum tubes the losses would be in excess of 500 watts for each 1.5 ampere unit, or a total heat generation in the control room of several kilowatts. Due to the high equipment density in a typical TV installation air conditioning must be used to keep ambient temperature within reasonable limits.

In the face of expanding facilities, partly due to the advent of color TV, it is obvious that any reduction in heat as well as equipment size will be welcomed. The completely transistorized regulated power supply now makes this possible.

In Table I are shown the comparative losses and efficiencies of three types of supplies using (Case I) all vacuum tubes, (Case II) germanium rectifier with vacuum tube regulator and (Case III) germanium rectifier with transistor regulator. The total losses for the transistorized model are seen to be less than one third those of the all-vacuum-tube model, while those of Case II are intermediate.

In addition to having no filament losses, the transistor has the added feature of nearly zero minimum voltage drop even at full load, whereas the typical vacuum tube has a limiting voltage in the order of 60 volts which at 1.5 amperes wastes an extra 90 watts.

Design Considerations

The design objectives for the Transistor Regulated Power Supply are shown in the first column of Table II. In order to preserve high efficiency in the face of widely differing nominal line voltages the primary of the power transformer was provided with several taps, leaving the regulator to take care of the ±5% or so fluctuations remaining.

A germanium bridge rectifier is a natural choice for this power supply not only because of its high efficiency but also because the ambient operating temperature of 50 deg C is well within its capabilities.

A choke input filtering system is also indicated both for optimum transformer design and to give good load regulation ahead of the transistors.

*This supply was developed by Technical Operations, Inc., for Power Sources, Incorporated, Burlington, Massachusetts.

TABLE I COMPARISON OF LOSSES IN TYPICAL REGULATED POWER SUPPLIES

	Case I	Case II	Case III
	Vac. Tube Rectifier Vac. Tube Regulator	Germanium Rectifier Vac. Tube Regulator	Germanium Rectifier Transistor Regulator
Rectifier Filament	60 watts	--	--
Rectifier Plate	100 "	10 watts	10 watts
Regulator Filament	90 watts	90 watts	--
Regulator Plate	150 "	150 "	60 watts
Other Losses	170 watts	170 watts	110 watts
Total Losses	570 watts	420 watts	180 watts
Output	420 watts	420 watts	420 watts
Efficiency	$\frac{420}{990} = 43\%$	$\frac{420}{840} = 50\%$	$\frac{420}{600} = 70\%$

TABLE II SPECIFICATIONS FOR TRANSISTOR REGULATED POWER SUPPLY
MODEL PS-4000

	Design Objectives	Test Results	
Input Voltage Range	105 - 125	100 - 125	volts a-c
Output Voltage Range	260 - 300	260 - 300	volts d-c
Load Current Range	0.3 - 1.5	0.25 - 1.6	amps d-c
Regulation (0.5 - 1.5 amp)	$<$ 0.2	0.08	volt change
Stabilization (10v line variation).	$<$ 0.2	0.04	" "
Ripple and Noise	$<$ 10	5	mv pk-pk
Output Impedance (d-c to over 100 kc)	$<$ 0.2	0.08	ohm
Efficiency (at full load)	70 %	70 %	nominal
Centering Voltage 0.6 to 1.2 a load	-6 to -4	-6 to -4	volts
Max ripple	$<$ 200	100	mv pk-pk
Ambient Temperature (max)	50	50	deg C
Accidental Short on Output	No damage; blows fuse only		
Accidental No Load on Output	No damage; stops regulating.		
Dimensions	5-1/4" high, 19" wide, 12" deep		
Weight		40	lbs
Time delay before application of output voltage to external load			5-60 sec

Series Element

The regulator section would logically be the transistor analog of the conventional series regulator as shown in Figure 1 where the power tube would be replaced by a power transistor, the VR tube reference by a silicon Zener diode, and the d-c amplifier by one utilizing transistors in place of tubes.

Referring to Table III it is seen that the series element must withstand at least 64 volts total at high line voltage (10% step) and minimum load, and must dissipate at least 45 watts at high line voltage (10% step) and full load. The 2N174 germanium power transistor with a collector voltage rating of 80 volts and current rating of 12 amperes appeared a good choice, especially so because of its availability and reasonable cost. Subsequent experiments showed that at 50 deg C ambient temperature even with the transistor on a finned aluminum heat sink in an air stream, it would be desirable to derate the transistor by holding the collector dissipation down to 30 watts and requiring it to hold off no more than 30 volts continuously. Accordingly, it was decided to use three 2N174's in series, thus allowing the whole series element to handle 90 volts and to dissipate 90 watts maximum. This also results in a comfortable margin of safety for handling wider line voltage swings and higher than normal ambient temperatures.

Just as the current must be equally divided between vacuum tubes which are in parallel, so also the voltage must be equally divided between transistors in series. To accomplish this the bases are coupled with a resistance network as shown in Figure 2. The diode CR1 is used to provide reverse bias to counteract the effect of I_{co} in the series transistor at low currents.

Feedback Amplifier

It will be noted (Figure 2) that the whole series transistor assembly is placed in the negative side of the power supply. This is done in order to allow readily available 30-volt transistors to be used in the driving amplifier, also to enable the use of 6-volt silicon diodes as the reference element. If NPN equivalents of the 2N174 were available, the circuit could be placed in the more conventional positive side. The error signal for the feedback circuit is derived from a voltage divider tapped at about 19 volts and three type 1N429 Zener diodes in series provide a reference of about 18 volts. A silicon NPN type transistor is used as the first amplifier in the feedback circuit because of its good temperature stability and low I_{co}. The design of the intervening d-c amplifier shown in the triangular box is straightforward and could be accomplished in many ways.

To provide a "Centering" current for use in camera chains it has been customary to insert a bypassed resistor in the negative B return circuit of the supply. In the present unit this location has been occupied by the transistor regulator, consequently a separate source of "Centering" current has been provided using a low voltage germanium rectifier and a R-C filter.

Performance

The performance of this supply is best shown in a series of graphs. Figure 3 shows the voltage regulation as a function of load current. It is seen that the output voltage change is well under 0.2 volt from minimum load to full load. In Figure 4 are shown the effects of varying line voltage over a 10-volt range. Again the output voltages stay well under the

TABLE III DESIGN CONSIDERATIONS FOR SERIES ELEMENT

Impedance of supply ahead of regulator		28 ohms
1.2 amp load change through 28 ohms.		34 volts
10 % line step changes d-c output		30 volts
Min total voltage across series element		64 volts
10 % line step with full load: dissipation	30 v x 1.5a. . .	45 watts
Three 2N174 transistors in series can handle		90 volts
" " " " " " "		90 watts

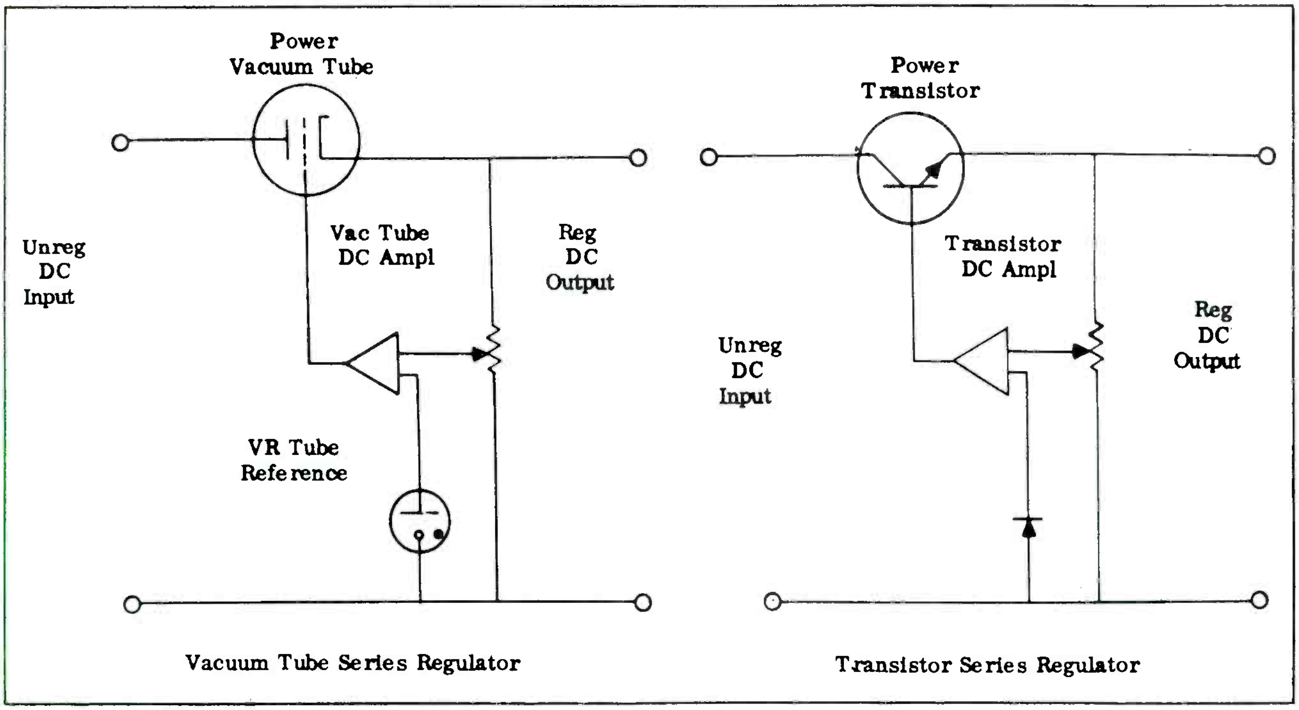


Fig. 1 - Comparison of basic regulator circuits.

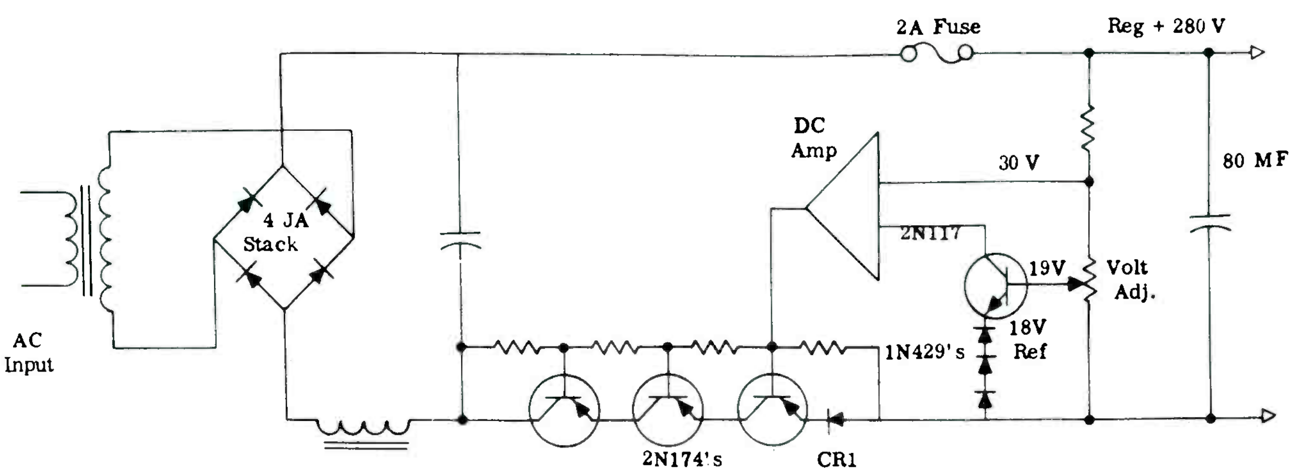


Fig. 2 - Simplified circuit diagram, transistor regulated power supply.

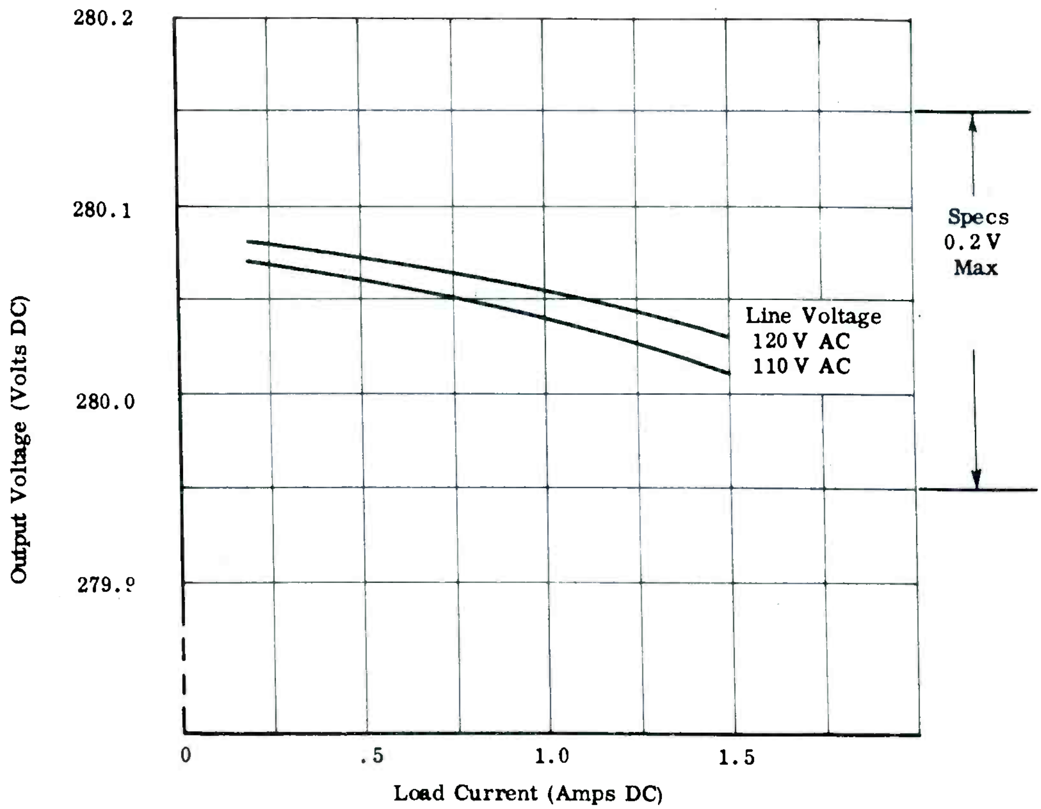


Fig. 3 - Typical output voltage regulation curves.

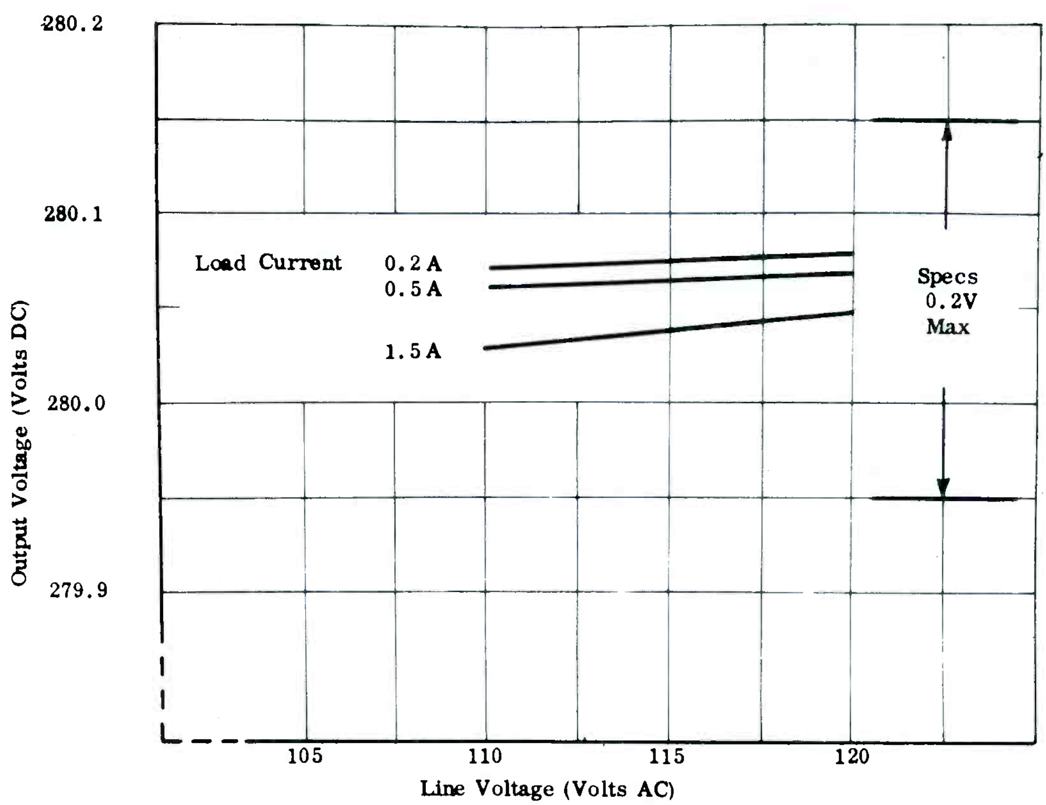
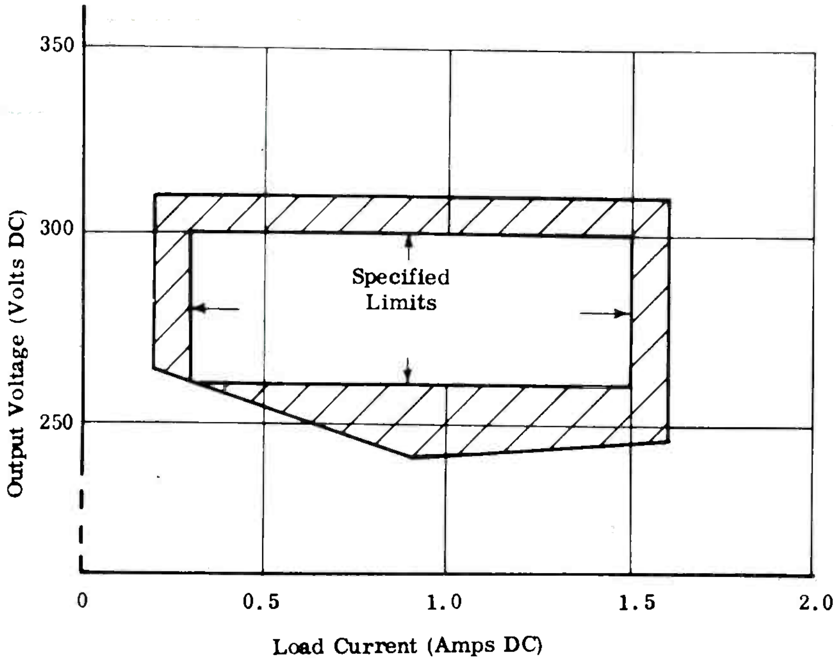


Fig. 4 - Output voltage stabilization curves.



Shaded Area Represents Wider Limits Possible Under Special Conditions

Fig. 5 - Operating limits of transistor regulated power supply.

specified 0.2 volt limit. The line tap switch allows operation over a total line voltage span of more than 105 to 125 volts.

Figure 5 shows the specified operating limits of the supply for any line voltage between 105 and 125 volts as a function of load current. The output is adjustable by means of a screwdriver potentiometer to any value between 260 and 300 volts. The shaded area shows that with certain combinations of load and line even wider ranges of output voltage can be obtained. The output impedance as a function of frequency is depicted in Figure 6. At d-c and low audio frequencies the impedance is well under the 0.2 ohm specified for the supply. Beyond 20 kilocycles the impedance drops to even lower values as the reactance of the 80 μf capacitor dominate the impedance of the supply.

When the supply is carrying its full load of 1.5 amperes at 280 volts the output power is 420 watts. Under normal line conditions the input power is then 600 watts, giving a nominal efficiency of 70%. Figure 7 shows how the efficiency varies as a function of load current. It is seen that it stays around 70% down to currents of about 0.5 amperes.

In the second column of Table II the test results are given for a typical power supply. The output ripple and noise combined are usually in the order of 5 mv peak-to-peak at maximum load and less for lower load currents. (The equivalent rms value would be under 2 mv).

Operation of the power supply with no load is not recommended but for short periods no damage will result. An accidental short circuit across the +280 -volt output does not damage transistors or other components but merely blows the 2-ampere 600-volt d-c fuse.

Physical Features

The complete power supply shown in Figure 8 occupies only 5-1/4" vertical height and 12" depth in a standard rack panel, 19" wide. Movable side brackets convert the unit to bathtub type mounting when desired, thus recessing the unit about 5" back from the front of the rack. The chassis construction is that of an open frame with perforated metal covering which allows vertical convection currents to circulate not only in the supply itself but through units which may be installed above and below the supply. At the same time accidental contact with high voltage points is prevented.

When installing a supply or when setting it up under new load conditions the line tap for most efficient operation is chosen by means of a rotary switch accessible through a door on the front panel. It is merely necessary to turn the switch until the small meter on the front panel reads between two red lines. Thus no separate a-c meter is needed and the adjustment is quickly made while the supply is operating. There is another switch on the panel by means of which the meter may be made to indicate output voltage or output current.

A time-delay is incorporated, not because the supply needs a warm-up period but in order to prevent applying voltage to external vacuum tube equipment until their filaments have reached operating temperature.

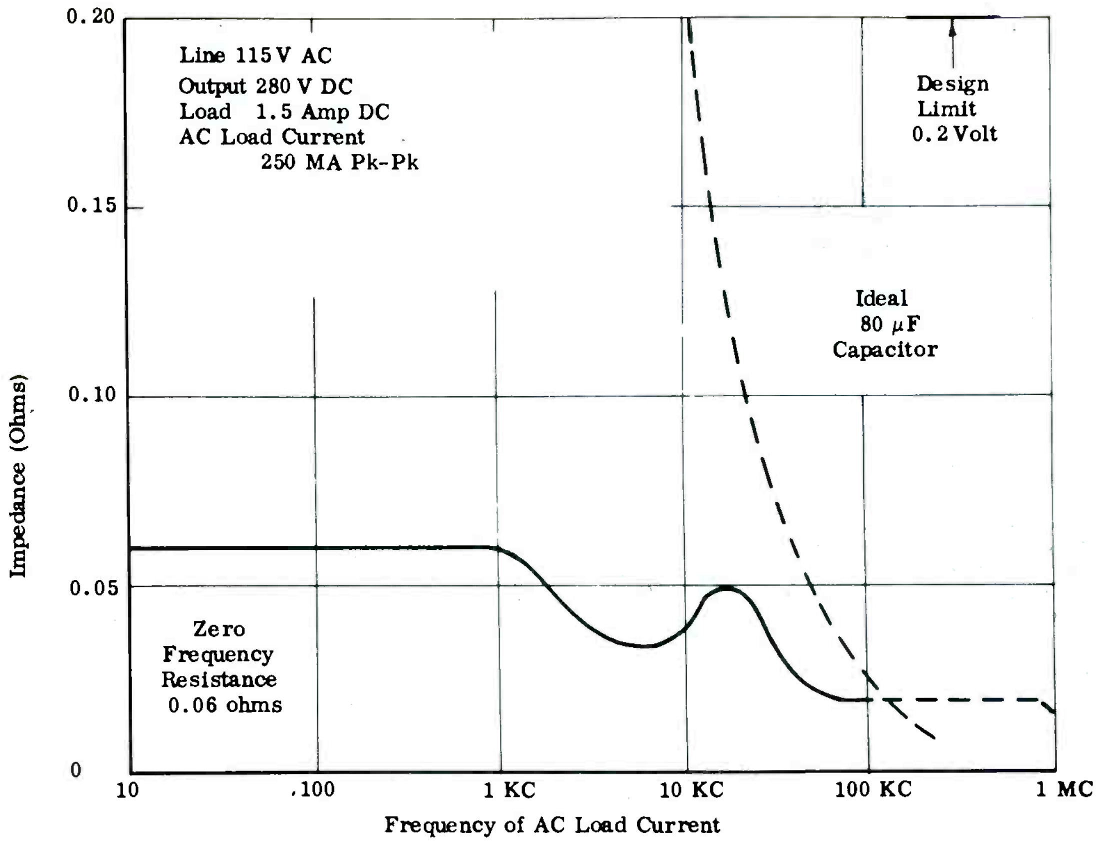


Fig. 6 - Typical output impedance vs. frequency.

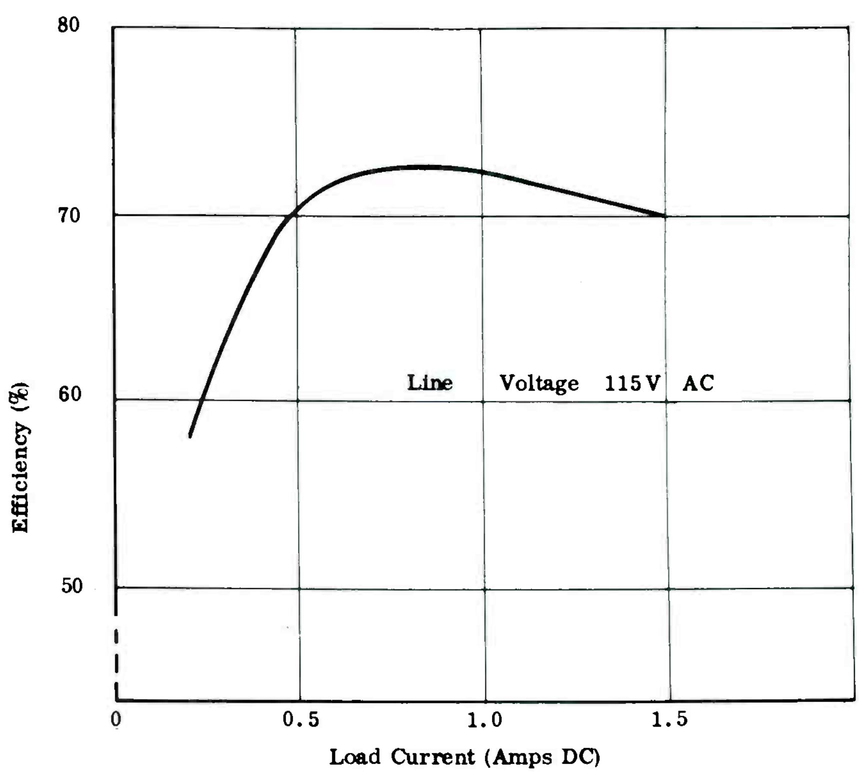


Fig. 7 - Efficiency vs. load current.

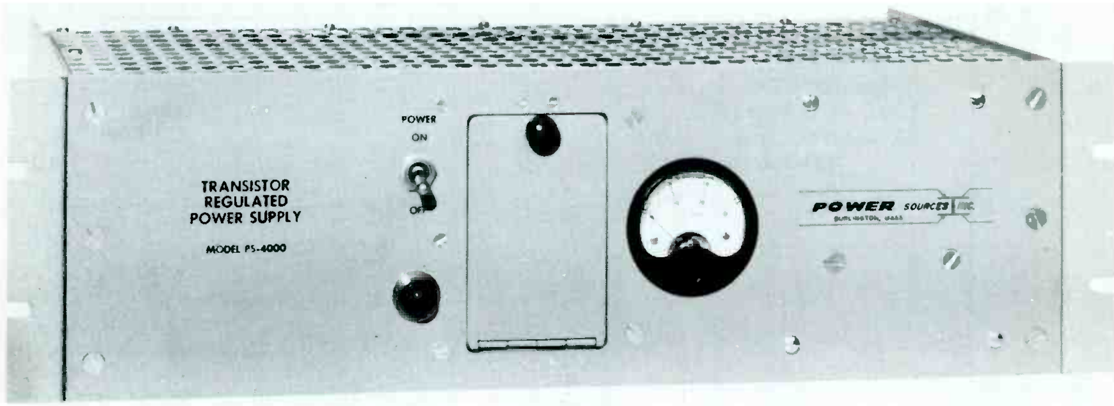


Fig. 8 - Photograph of transistor regulated power supply.

While the present supply has been designed around the specific application calling for 280 volts at 1.5 amperes, there is no reason why the general design cannot be extended to handle both higher voltages and currents, not to mention lower ones. For example, a 3-ampere supply at the same voltage could easily be designed which would occupy no more space than two of the 1.5 ampere units. It would be merely necessary to add another string of 2N174's in parallel with the first three and to change the other components in the system accordingly. Similarly, a 400-volt supply could be designed using four 2N174's instead of three. Thus the supply has promise of fulfilling the requirements of many different fields of application because of the inherent flexibility of the design.

MAINTENANCE OF DIRECTIONAL ANTENNAS

J. G. Rountree
Consulting Radio Engineers
Dallas, Texas

Except for the development of precise frequency control, it is probable that no other technical development has contributed so much to the efficient utilization of the standard broadcast band as the directional antenna. As of September 1, 1957, there were authorized in the United States some 3300 standard broadcast stations. Of these, about 1000 or roughly 30% use directional antennas either daytime or nighttime or both. Because some stations use more than one pattern, a total of over 1200 different directional antenna patterns are involved.

Before authorization is granted for construction of a directional antenna in the United States, the Federal Communications Commission requires that a complete engineering showing be made. Before a license is granted for the regular operation of a directional antenna, a complete and thorough proof-of-performance must be made and submitted by the permittee and approved by the FCC.

We may thus assume that each directional antenna is operating properly at the time that it commences regular operation. But what of the problems of maintenance of the antenna in day-to-day operation of the system? Let us examine the factors affecting the maintenance of directional antenna systems.

To begin with, the design of the antenna system will affect the maintenance problems. In his design, the engineer must determine whether the array will operate with reasonable stability and efficiency. Generally speaking, the design must be such as to avoid low values of base operating resistance,either negative or positive. Such a condition could lead to excessive losses in the system and possibly to a "flip-flop" operating condition where a small change in tuning results in a drastic change in operating parameters.

Insofar as the design engineer can do so, he must avoid deep minima in the pattern, since this results in a condition where a relatively small change in phase or current can result in a relatively large change in field intensity radiated in the directions of the minima.

Further factors affecting the stability of a directional antenna and the problem of its maintenance arise in the design of the phasing and coupling equipment. A design which incorporates a minimum of resonant circuits will, in general, exhibit greater stability than one which has a number of such circuits.

In the physical location of phasing and coupling equipment, one method frequently used is to have the power division and phasing equipment distributed through the system and placed in tuning houses at the antenna bases. While this has the advantage of requiring a minimum length of transmission line and furnishes some protection against unauthorized tinkering by operating personnel, it has the disadvantage of making the initial tune-up and any necessary subsequent readjustment more difficult and lengthy than would be the case with a more convenient arrangement. The alternative, and I believe, better arrangement is to concentrate the phasing and power-dividing equipment in the transmitter building. Here the effect of adjustments may be observed at once with the monitoring system, and the tuning of the array can be completed more easily and quickly. Under this concentrated arrangement, the equipment is usually better housed, thus making for better and easier maintenance.

Still more factors affecting maintenance of the directional antenna system arise in the course of construction of the system. The choice of transmission and sampling lines, for instance, is important. Open-wire lines are unsuited for use with directional antenna systems. The characteristics of such lines change with the accumulation of water, ice or snow on the wires and insulators, and this alters the operating parameters of the array.

The solid-dielectric transmission lines having an outer conductor of copper braid, such as RG17U and RG19U, are also unsuitable for a directional antenna system unless special precautions are taken. The somewhat lower efficiency of these lines must be taken into account in the design of the system. Because the outer conductor of such lines "leaks" r.f. energy and because of the difficulty of adequately grounding the lines along each run, the most satisfactory way in which to handle this type of line is to install it in well-grounded metal conduit. The expense of doing this, however, increases the cost of the installation so greatly as to nullify the advantage of the lower first cost of the line itself.

No more satisfactory transmission line or sampling line can be found than air-dielectric line having an outer conductor of copper tubing and grounded adequately along each run. When properly installed and maintained, such lines provide many, many years of satisfactory service. The June, 1957, issue of Broadcast News contains an excellent article by one of our Professional Group members, Joseph Novik, on "Installing Antenna Systems for AM Operations".

In any installation of pressurized lines, particular attention must be given to the arrangement for pressurizing the lines. Maintenance of pressure in the lines is an important part of the overall maintenance of the system, therefore, the arrangement for pressurizing must be convenient and readily accessible.

It goes without saying that the tuning equipment must be adequately housed, that all ground connections must be well made and that good workmanship must be used in all details of the installation if maintenance problems are to be kept to a minimum.

One of the most important aids in maintaining a directional antenna system, if not the most important, is an adequate sampling system and a reliable current and phase monitor. A sampling loop mounted on the tower is to be preferred to a resonant pickup circuit coupled to the antenna lead. If the resonant circuit is used, it will be found that the relative phase and current indications of the phase monitor will change as the circuit drifts or is jarred out of resonance. If such a sampling pickup is used, the maintenance procedure at the station should provide for frequent checking of resonance of each such circuit.

The phase monitor at the station should be maintained according to the directions of the manufacturer.

Mention was made earlier of the desirability of avoiding deep minima in the design of the directional antenna pattern. It follows that in the adjustment of the antenna, the field radiated in the direction of each minimum must not be reduced substantially below the theoretical value since if carried too far, such a reduction will result in a low value of field intensity difficult to maintain in regular operation.

After the proper adjustment of an array has been obtained in the initial operation, useful and valuable information can and should be obtained by measuring the reactance of the component branches of all tuning networks. Then, if it should be necessary to replace a defective component at a later date, the value of reactance originally established may be quickly achieved. Also, the data obtained from such measurements may be used in later checking the condition of a suspected component.

After a directional antenna has been properly adjusted, a record should be made of all dial settings of variable tuning elements and the position of any clips on tapped inductors should be marked. Such marking may be done quickly and effectively by painting a strip of fingernail polish across the clip and the turn of the coil on which it is located. Where a coil has two or more clips, a different color should be used for each clip. Then, if a clip should accidentally be dislodged, it is a simple matter to replace it in the proper location.

In maintaining a directional antenna system, as in the maintenance of other equipment, one rule is important: Keep it clean! Components should be wiped and blown clean each week. The tuning houses should be kept rodent -, reptile - and insect-proof. It adds nothing to the operation of the system to have a scorched mouse, a dead snake or a large dirt-dauber's nest scattered among the tuning components.

Vegetation should be kept down in the vicinity of each tower base. Cut vegetation should be raked away from the tower base and burned under supervision to minimize re-seeding and to prevent a fire hazard. Chemicals may be used to inhibit growth of vegetation.

Pressure in the transmission and sampling lines should be maintained at 10 to 15 pounds, using dry air or dry gas, to prevent the entry of moisture. If a leak develops, it should be located and repaired promptly. Periodic checks should be made of the pressure gauges so as to be certain that no gauge has become stuck and is giving false indications.

It is helpful to apply a very light coating of silicone compound to exposed insulators and end seals to prevent formation of a moisture film during wet weather. It goes without saying that all insulators should be kept free of paint.

An important part of the maintenance procedure is to make a weekly visual inspection of all elements of the antenna system. Broken insulators or other damaged elements should be replaced at once. Where necessary, lightning gaps should be re-spaced, using a piece of flat insulation of the proper thickness as a feeler gauge.

The tightness of all connections in the antenna tuning equipment should be checked at quarterly intervals. At yearly intervals and also after every violent windstorm, a transit should be used to determine whether each tower remains plumb. It is advisable at the same time to check all tower bolts and nuts for tightness and to check for bent members. During these checks, a visual inspection should be made of the guy wires and insulators for any signs of damage or deterioration. If a tower is found to be out of plumb or other difficulties are found, a competent tower erector should be employed to correct the situation.

Meter readings having to do with the antenna system should be made carefully and logged accurately so that if difficulty arises, a complete and accurate record of what has transpired is available for reference. If an electrical storm occurs in the vicinity of the antenna, that fact should be entered in the log. Readings of the antenna base meters and the sampling loop meters should be made under conditions of no modulation. Usually, the cooperation of studio operating personnel can be obtained and a pause of five seconds or so allowed between announcements or musical selections so that each reading may be obtained accurately. When reading antenna base meters, the operator should carry with him a monitor permitting him to discern when no modulation is present. A crystal diode rectifier wired across a phone jack and equipped with a probe or pickup coil may be used with a pair of headphones to provide such a monitor.

A device which has proved useful in antenna work is shown in Figure 1. With the switch open, this device is a useful monitor. Adequate pickup is obtained by holding the sleeve of the plug in one's hand while touching the tip to a metal panel, messenger cable or the like. With the switch closed, the device becomes an effective noise limiter for use with a receiver in r.f. bridge work.

Usually, the station license requires that field intensity measurements be made periodically at each of the monitoring points. In the event that the license does not require such measurements, it is a good practice to make them at monthly intervals. Such measurements should, of course, be made carefully and an accurate record maintained, indicating the date and time of each measurement and the field intensity observed at each monitoring point. If any unusual conditions are encountered, a record should be made of them. If a monitoring point becomes unusable, an informal application should be made to the FCC to change to a new monitoring point along that radial.

In dealing with tuning equipment for directional antennas, we must deal with the component parts which are commercially available - not the idealized components on which theoretical considerations are based. It will be found that as the components of the system age and undergo variations in temperature and vibration, their values will usually drift. Also, tower base impedances will frequently change, and the effective conductivity of the soil will vary with moisture content and temperature. In time, these changes may result in change of the operating parameters of the array to the extent that the field intensities at the monitoring points are no longer within the allowable values and it becomes necessary to readjust the array.

Any readjustment should be attempted only by personnel familiar with directional antenna theory. Unfortunately, recent years have seen a move of qualified personnel away from the field of standard broadcasting. This has happened for a number of reasons, mostly having to do with money. Since any adjustments of the tuning elements probably will alter the common-point impedance, it follows that the person making the adjustments must have an r.f. bridge and associated equipment and must be familiar with their operation.

In correcting for any drift in adjustment of the array, the initial goal should be to re-establish the operating conditions obtained in the original adjustment, as indicated by phase monitor, loop current and base current readings. However, due to what has been politely termed the perversity of the inanimate objects, it will on occasion be found that re-establishing the original current ratios and phase indications does not result in producing the desired field intensities at the monitoring points. Assuming that the monitoring system is in good working order, it then becomes necessary to readjust the array.

In undertaking readjustment of the array, certain aids may be found useful in guiding the adjustments to be made. For a two-element directional antenna system, it is helpful to have a copy of the theoretical pattern on which the directions of the minima are indicated, as well as the direction of each monitoring point. Figure 2 illustrates such a pattern. It is also helpful to indicate on this pattern the direction in which the minima will move for an increase in phase difference between the towers. It will be recognized, of course, that the depth of the minima will depend upon the current ratio. Theoretically the minima will become complete nulls if the fields radiated by the two towers are equal. This overlooks the effects of re-radiation from nearby objects, but this concept does provide a point of departure for adjustment of the array.

A similar device may be found useful in readjusting an array with four towers arranged in

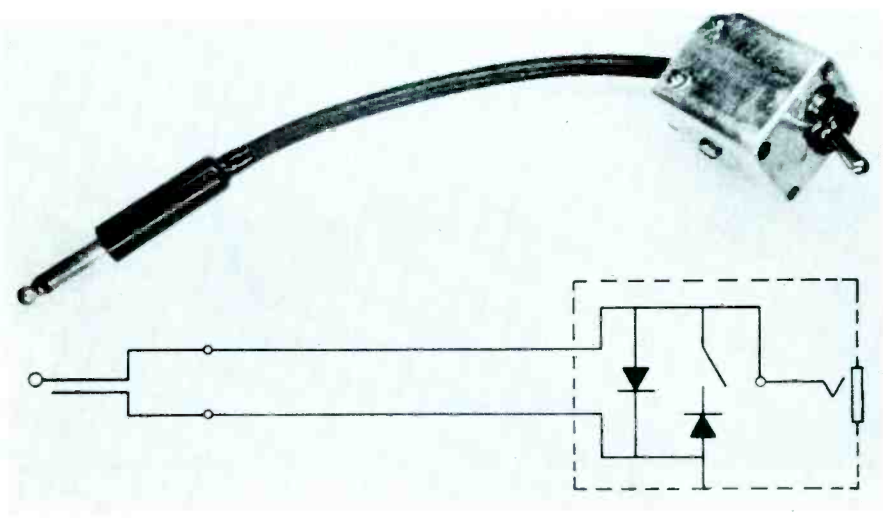


Fig. 1 - Detector/noise limiter for use in antenna work.

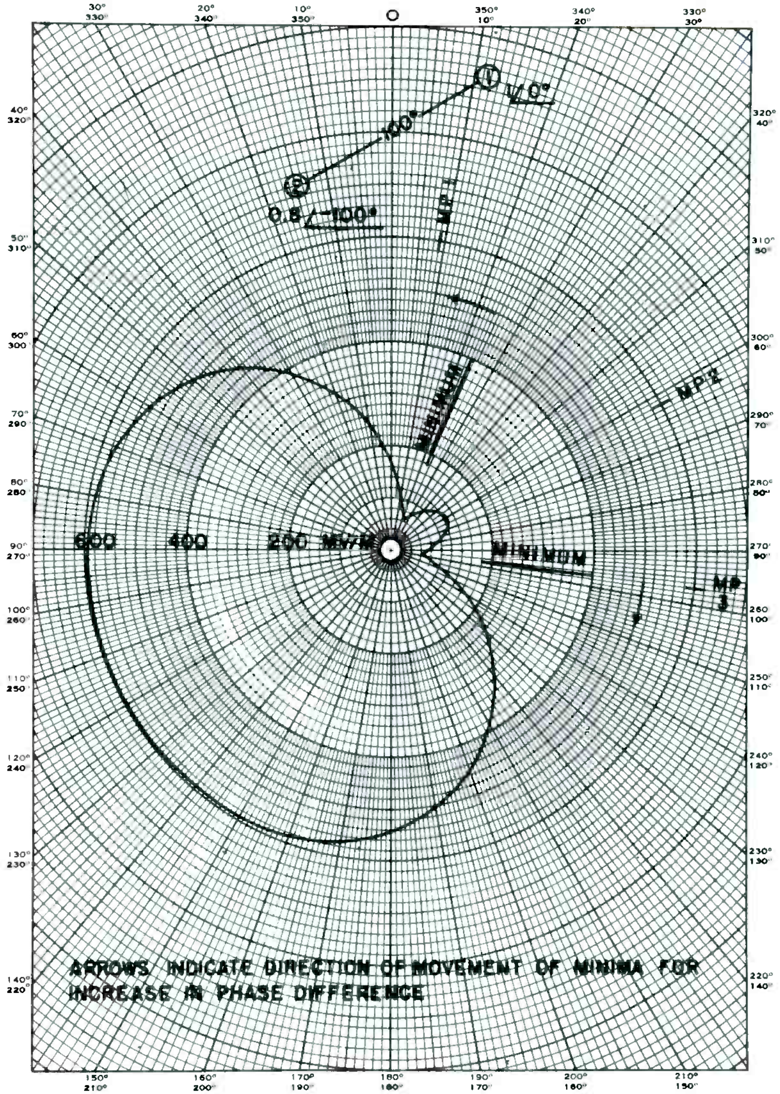


Fig. 2 - Two-element directional antenna pattern on which have been indicated directions of minima and directions of movement of minima for increase in phase difference.

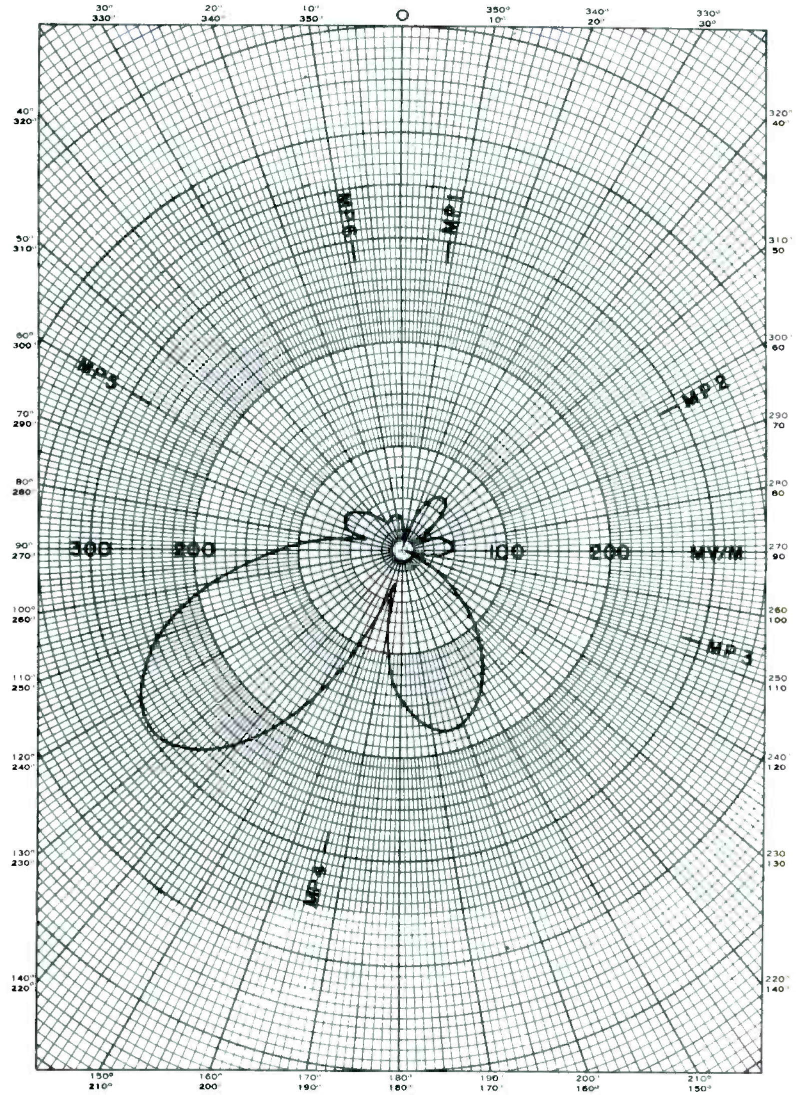


Fig. 3 - Pattern produced by a directional antenna consisting of four elements arranged in a parallelogram.

the shape of a parallelogram. In this case, it is desirable to portray the basic patterns which go to make up the final pattern, preferably in contrasting colors. Figure 3 shows a pattern produced by such a four-tower array. In Figure 4, one of the basic patterns is shown as a solid line and the other as a dashed line. Here, too, arrows have been placed on the basic patterns to indicate the direction of movement of each minimum for an increase in phase difference between the sets of towers making up each basic pattern. The direction to each monitoring point is also given. Since the final pattern is the result of multiplying together the values of the basic patterns in any given direction, the effect of a change of parameters of a basic pattern on the final pattern may be readily visualized.

Of possible use for a two-tower system is a calculator in the form of a circular slide rule, based on an article appearing in the December, 1944, issue of "PROCEEDINGS OF THE I R E". Figure 5 illustrates such a calculator, which was quickly constructed from two sheets of graph paper and a piece of cardboard. In the operation of this calculator, the towers are numbered 1 and 2, and the phase of Tower 2, read on the scale on the periphery of the rotary element, is set to the arrow designated "α". The outer fixed scale on the base represents the bearing from the line of towers, measured from the Tower 2 end. A separate outer scale is needed for each tower spacing. The group of figures on the runner represents field ratios. The resultant vector field is read from the inner scale opposite the figure for the field

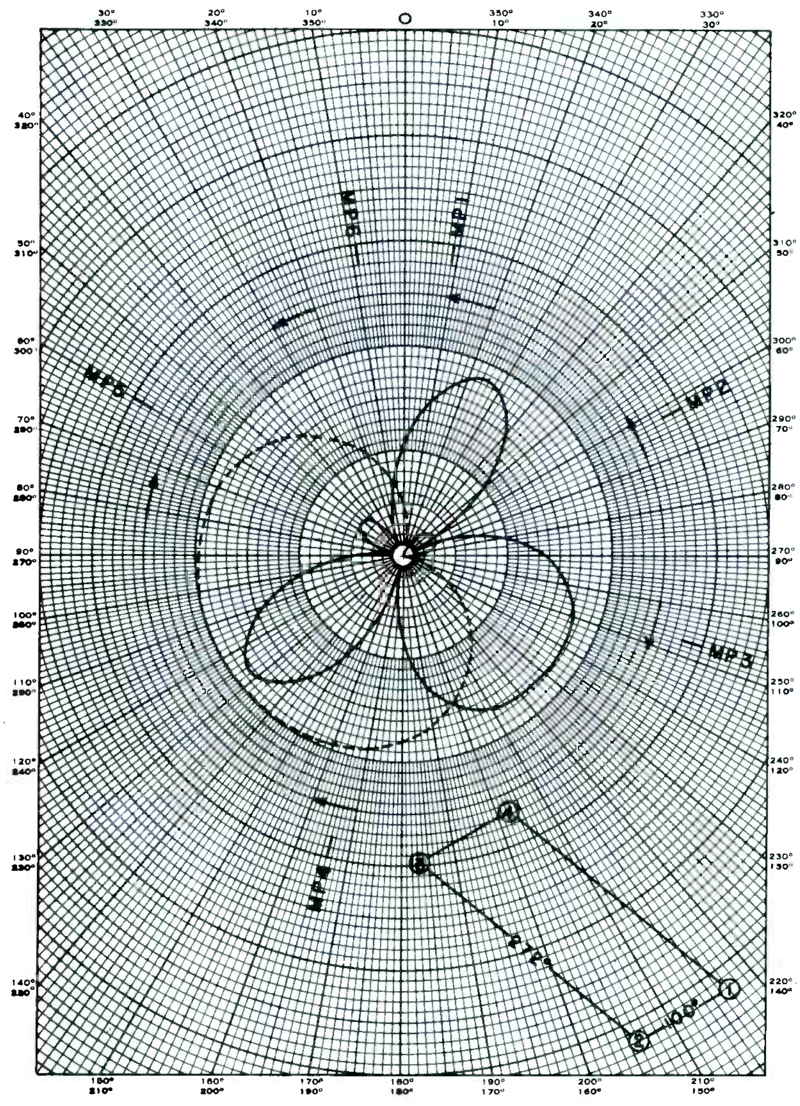


Fig. 4 - Basic vector patterns which make up the pattern of Fig. 3. Arrows indicate the directions of movements of minima for increases in phase between pairs of elements.

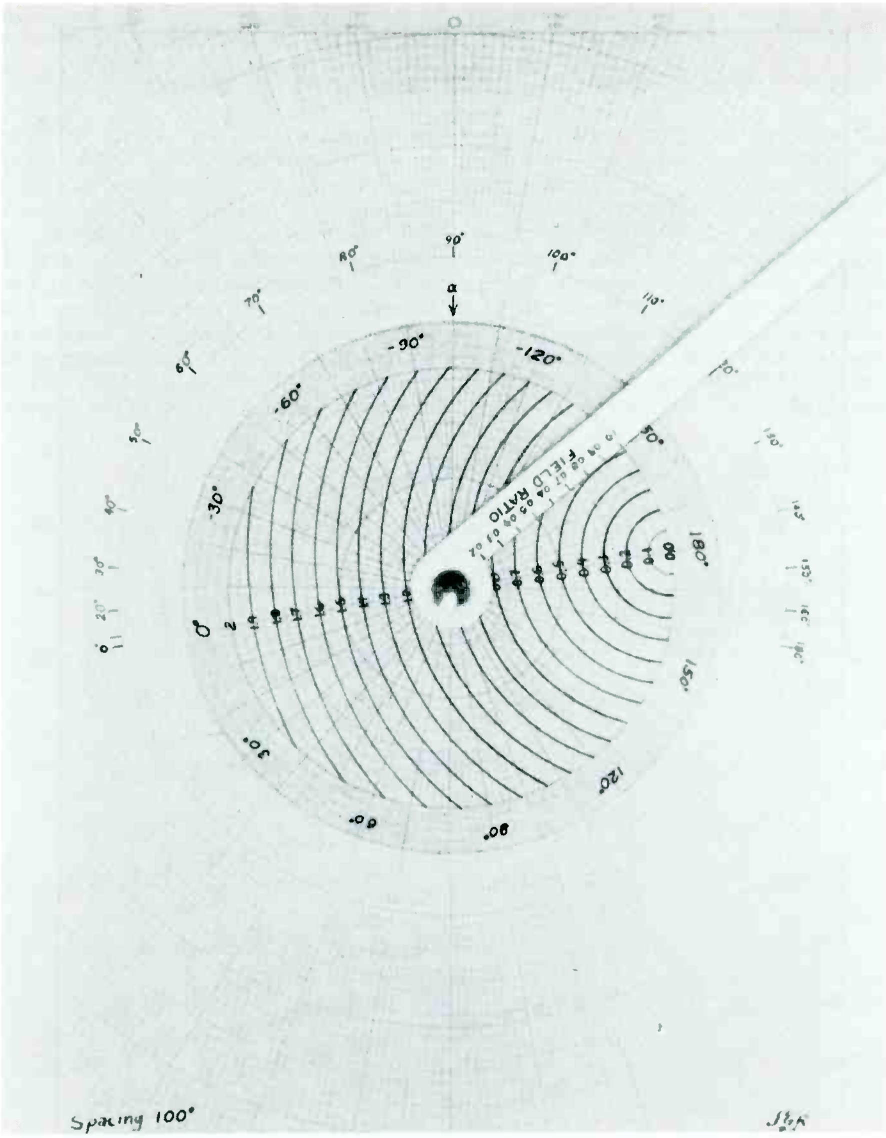


Fig. 5 - Calculator for two-element directional antenna having spacing of 100 degrees between elements.

ratio. It can be seen that the effect of a change in phase or field ratio on the field radiated in any given direction can be quickly determined.

A modified form of the calculator can be used with a three-element in-line array. The vector representation of the resultant field of such an array in a given direction is as shown in Figure 6 where Vector 2 represents the field from the center tower and Vectors 1 and 3 represent the fields from the end towers. Considering the position of Vector 2 as fixed, Vectors 1 and 3 revolve in opposite directions as one's vantage point is moved around the array.

When re-drawn the vector relationship is as shown in the lower half of the illustration. Here "R" is the resultant vector, drawn from the origin of Vector 1 to the terminal point of Vector 3. If we construct a mechanical device having scales depicting the position of Vectors 1 and 3 for various bearings from the line of towers, we may then determine the effect of changes in operating parameters on the resultant field in any desired direction.

Such a device is illustrated in Figure 7. Here the distance between pivot points for the rotary elements has been scaled to represent the magnitude of Vector 2. The radius of each of the rotary elements has been chosen to represent the magnitude of Vectors 1 and 3. If desired, a scale could be marked on each of the rotary elements along the line from the center to the "0°" mark on the periphery.

In using this device, a pencil mark or a small tab of drafting tape is placed on the periph-

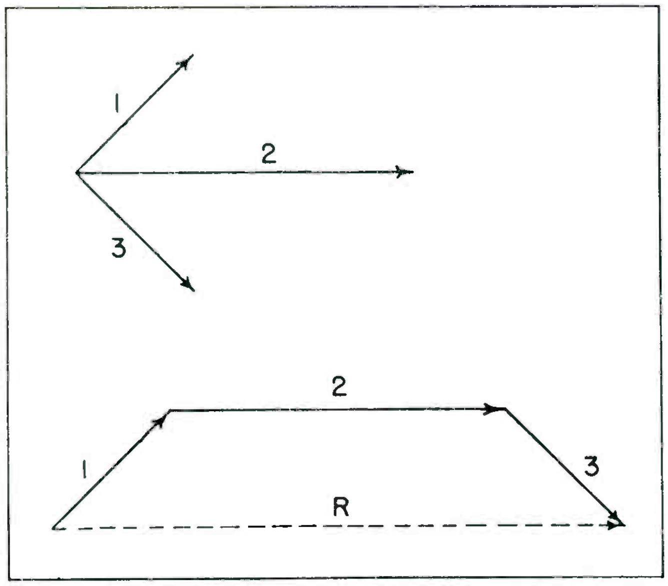


Fig. 6 - Typical relationship of field vectors for three-element directional antenna system.

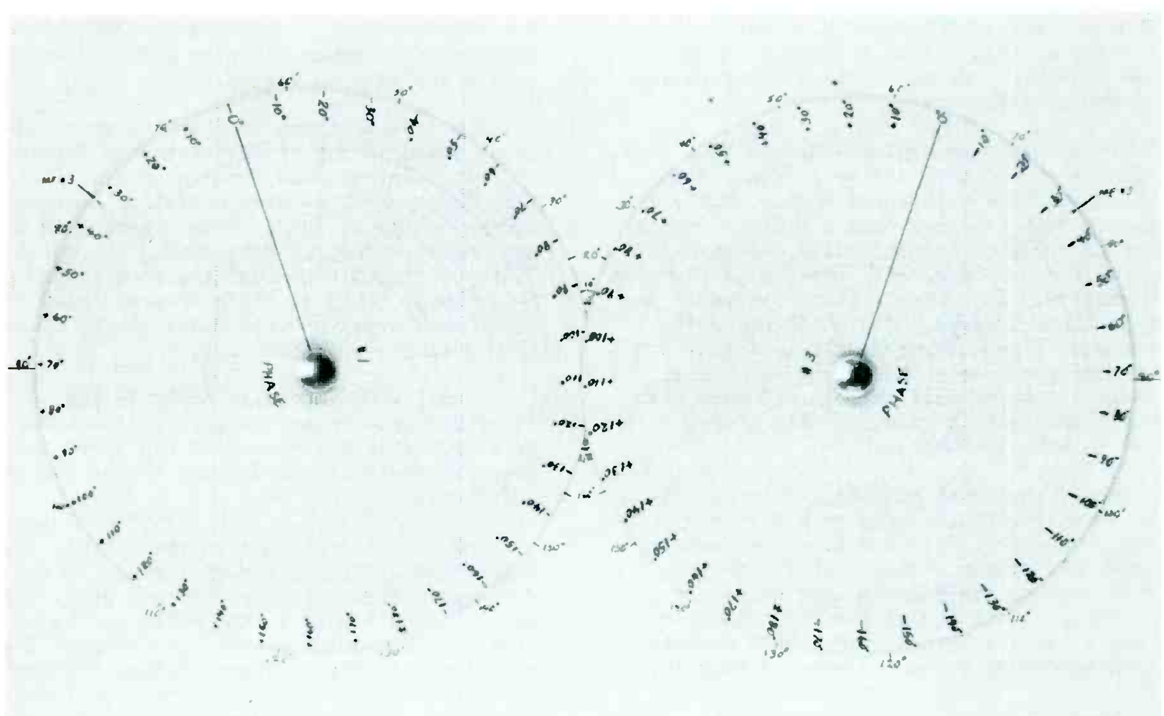


Fig. 7 - Calculator for three-element in-line directional antenna.

ery of each rotary element at a point corresponding to the phase of the tower there represented.

To determine the relative field radiated in a given direction, the rotary elements are rotated so that the tab or mark lies at the desired bearing shown on each fixed scale. The distance between the "0°" marks on the periphery of the rotary elements then corresponds to the resultant vector field. The effect of a change in phase of any of the towers or a change in field ratios can be readily visualized.

Unfortunately, these relatively simple procedures cannot be so easily applied to arrays with more elements; however, if the basic patterns that go to make up the overall pattern are known, these procedures can be applied to the basic patterns.

A SIMPLIFIED 5 MEGAWATT ANTENNA FOR THE UHF BROADCASTER

R.E. Fisk
General Electric Company
Syracuse, New York

Summary

A stacked arrangement of two UHF five-bay helical antennas is used to provide an antenna system with a power capacity of 120 KW and a power gain of 50. A power gain of 100 is achieved in the maximum direction with horizontal directivity.

The contoured pattern approach and available performance data is discussed.

The FCC ruling that permits UHF-TV broadcast stations to increase their radiated power to five million watts has roused great interest in methods of achieving high power levels. Transmitter output powers of up to 120 KW are currently planned. To achieve the five million watt level, therefore, antenna gains of approximately 50 are required, assuming average transmission-line efficiency. With horizontal directivity, a still higher antenna gain may be realized to achieve more effective coverage with lower power transmitters.

The problems of employing antennas that have gain figures of 20 to 25 are well known, since most UHF stations use antennas having this gain figure. The FCC requires that a minimum signal level of 80 dbu, or ten millivolts, be maintained for the principal city area being serviced by the station. In general, it is desirable to keep this minimum level 15 to 20 db higher to assure a good signal in difficult locations where inside receiver antennas may be in use. A moderate amount of null fill-in and beam tilt is usually all that is required with these antennas in most locations.

An omni-directional antenna with a power gain of 50 achieves this high gain figure by compressing the vertical beam to approximately one degree half-power width. Careful control of the contour of the beam is thus necessary to maintain a strong signal the first 10 miles or so for a typical installation whose antenna height is 1000 feet above the average terrain.

The General Electric five-bay helical antenna with a nominal power gain of 25 and a 60 KW power capacity is readily contoured to provide vertical beam tilt and null fill-in. The phase angle of a particular bay is adjusted by mechanical rotation of that bay by means of swivel inter-bay flanges. The amplitude of the current in any bay may also be adjusted by the coupling of the feed probe. Figure 1 is a typical five-bay antenna feed system. Over fifty of this type of General Electric UHF helical antennas have been in service at UHF stations throughout the United States, providing reliable service for the past several years with power inputs of up to 60 KW.

Using a structural adapter, two of these helical antennas may be stacked one above the other as in Figure 2, to form a 10-bay array having a nominal gain of 50. Besides tying the two antennas together mechanically, the structural adapter also provides space for the input feed adapter for the upper five-bay antenna and a point for the attachment of guys. By guying the antenna at the center point it is stabilized to an extent greater than possible than by the use of a cylindrical mast of the same length and having over twice the diameter.

Still greater pattern control is possible with this 10-bay array. The individual 5-bay patterns may be controlled; in addition, the phase relation between the upper and lower 5-bay sections may be varied by the length of the trombone section used in the combining network. The power division between the two halves may also be varied.

The resultant pattern for the upper and lower antennas may be calculated by considering that the two antennas form an array with a vertical spacing between radiation centers of approximately 27.5λ. A vector plot is a convenient method of determining the resultant field taking into account the individual 5-bay array vectors. With a vector plot of each 5-bay array the resultant may be calculated from a simple 2 vector plot.

A null would normally occur in the resultant pattern at vertical angles where the relative array phase between the upper and lower antennas is 180 degrees if the two are identical.

The signal amplitude in the null is thus determined by the vector difference in the two five-bay patterns at the vertical array null angles. The signal in the nulls can be kept from dropping below a specified minimum level by using slightly different values of beam tilt and pattern shapes for the upper and lower antennas. When, for example, the relative phase difference between the antennas is 180 degrees at some vertical angle, the upper antenna may have the peak of a minor lobe fall at that particular angle, while the lower unit has a relatively deep null.

Each five-bay antenna employs a simple end-feed system and there is a slight variation of beam tilt over the channel of $57.3 \frac{\Delta f}{f}$ degrees. At 500 megacycles between the visual and aural carrier, the beam tilt thus varies ± 0.25 degree. While not serious for 25-gain antennas having

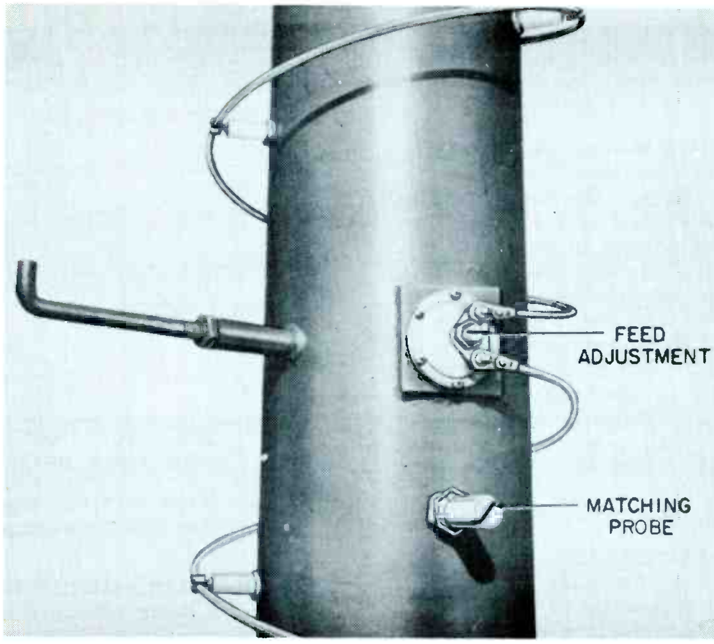


Fig. 1 - UHF antenna feed system.

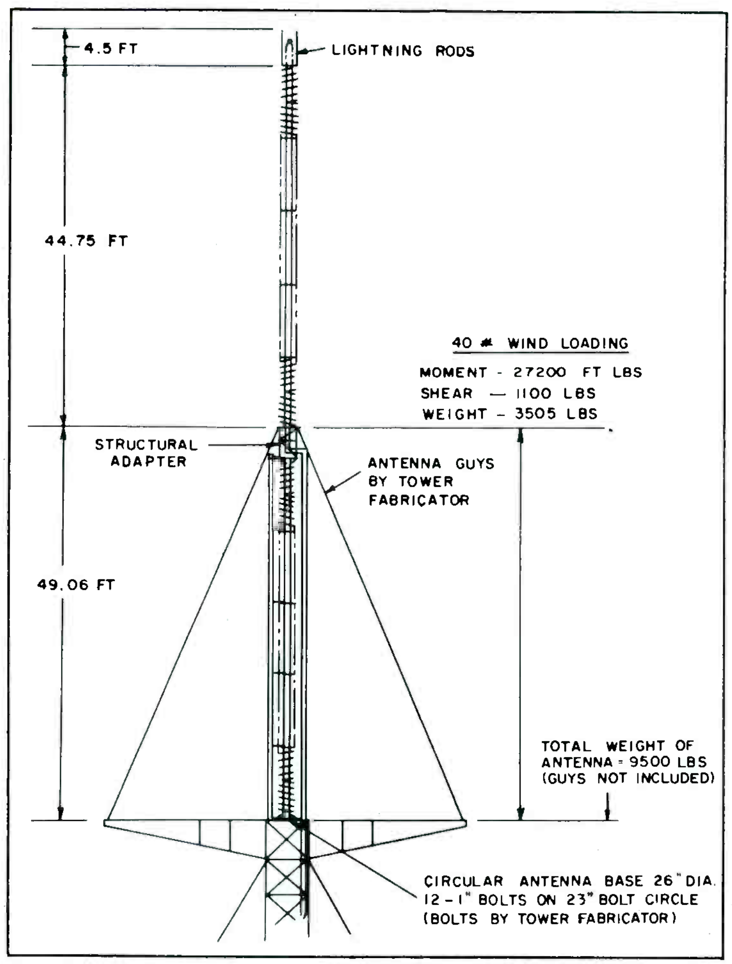


Fig. 2 - Tower arrangement 10 bay 50 gain dual UHF antenna.

a 2-degree beam, this amount of tilt would be excessive with the 1-degree beam width of the 50 gain antenna.

Variation of the phase between the upper and lower antennas causes the resultant beam as shown in Figure 3 to vary. The power gain of the resultant beam will change only a small amount because of such a change in phase as shown in Figure 4. Since the end-feed system causes the beam tilt to increase at a lower frequency, and because of the small effect on power gain, it is feasible to introduce a phasing slope corrector in the form of additional transmission line length in the trombone which serves to "lag" the phase of the lower antenna with increasing frequency in order to offset the change in tilt arising from the end-feed system as in Figure 5.

The 6 1/8 inch transmission line used to feed the upper antenna runs parallel to the axis of the lower antenna at a spacing of approximately $3/4\lambda$. The pattern distortion of the lower antenna due to the presence of this line is, as shown in Figure 6, slight.

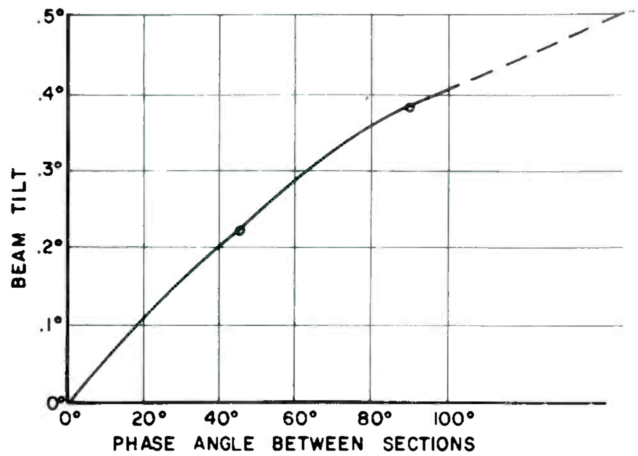


Fig. 3 - Beam tilt vs. phase angle between upper and lower antennas.

The transmission line feeding both the upper and lower antennas may be brought down to the transmitter building to provide an extremely flexible arrangement of antenna facilities. In one installation, that at WDAU,

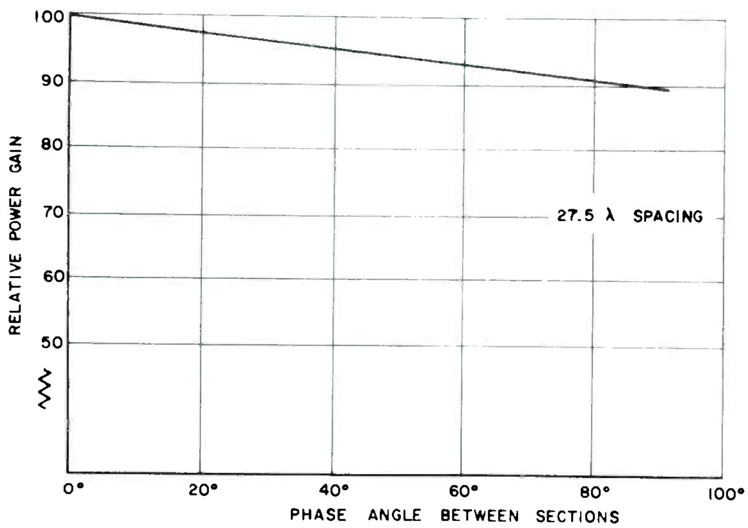


Fig. 4 - Maximum power gain vs. phase angle between upper and lower antennas.

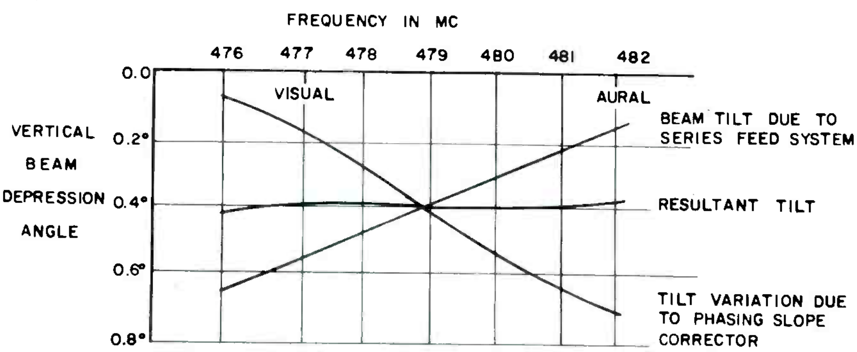


Fig. 5 - 33λ phasing slope corrector operation characteristics. Channel 15 desired beam tilt 0.4°.

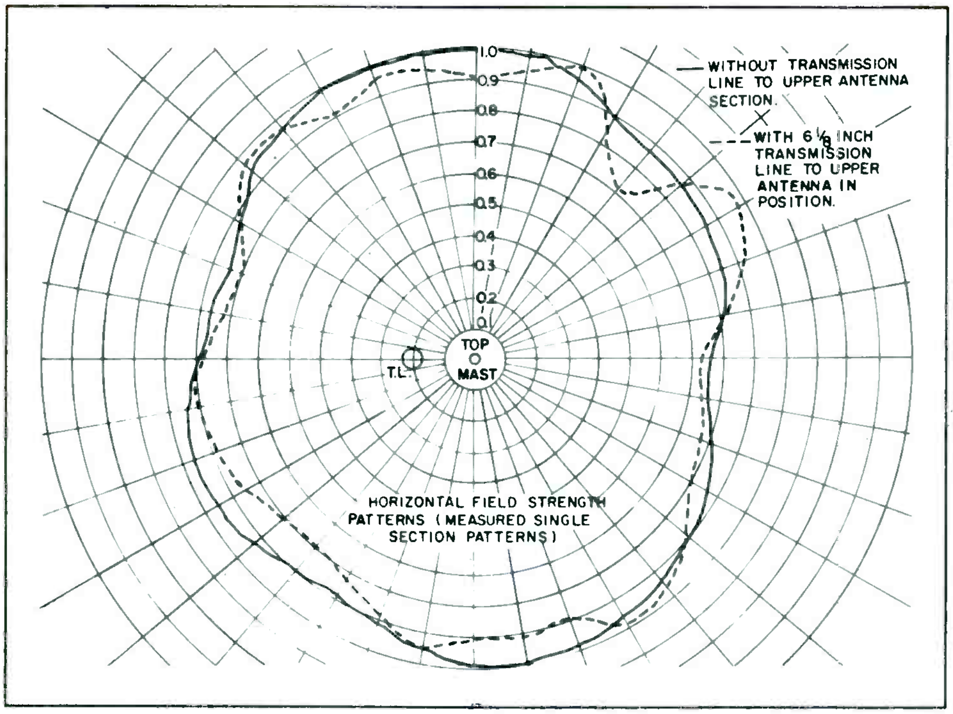


Fig. 6 - Horizontal field strength with and without transmission line to upper antenna.

Channel 22 in Scranton, Pa., either one of two 23.5 KW amplifiers or their combined 45 KW output may be fed to the upper antenna, to the lower antenna, or to both antennas by push-button control of a hydraulically-operated waveguide switcher. Nine possible combinations of antennas and amplifiers are thus available. In addition, the power division ratio between the two antenna feed lines is adjustable at the waveguide switching unit. This permits adjustment of the null fill-in from the transmitter room.

The first antenna system to use stacked directional UHF 5-bay antennas was put into operation in June of 1956 at station WIN-T now WANE-TV, Channel 15 in Waterloo, Indiana. Located 21 miles from downtown Fort Wayne, WIN-T wanted to direct as much signal as possible toward Fort Wayne with their 12 KW transmitter and still serve their market in other directions with at least as much signal as they were formerly transmitting; the station had been on the air with a General Electric 5-bay UHF antenna since the summer of 1954.

The helical UHF antenna is readily directionalized by the attachment of short radial stubs approximately 0.1 λ long to the radiating helix. The azimuthal location of the stubs is used to control the directivity of the horizontal pattern.

A directional five-bay antenna was built and tested for WIN-T to become the lower half of a 10-bay array (Figure 7). This was shipped to serve as a substitute to avoid losing air time. The antenna originally used was returned to our Syracuse plant and was modified to become the top half of a 10-bay directional array. The measured horizontal gain of this array is over 100 as shown in Figures 8 and 9.

After solving problems that involved getting both antennas plumb and adjusting the phase between upper and lower sections, a measured signal improvement of an average of 4.8 db was measured in the Fort Wayne metropolitan area.

Mr. C.E. Wallace, formerly Chief Engineer of WIN-T and now Chief Engineer of WANE-TV, has submitted measurements made at WIN-T together with notes and copies of the data to serve as the basis of a more detailed discussion of the 5-megawatt antenna performance for the UHF broadcaster.

WIN-T is one of the fortunate UHF stations having their own UHF field intensity measuring equipment and associated recorder. As a result the station coverage with their old antenna was very well known, particularly along the south radial toward the city of Fort Wayne, Indiana.

Shown in Figure 10 is the signal improvement measured with the directionalized 10-bay array. The plot shows the median field as determined by a continuous recording averaged over 1 mile intervals. The directional antenna increased the maximum erp toward Fort Wayne to 960 KW as compared to 240 KW with the old antenna. Yet erp levels in other directions were not decreased below 240 KW. Both antenna

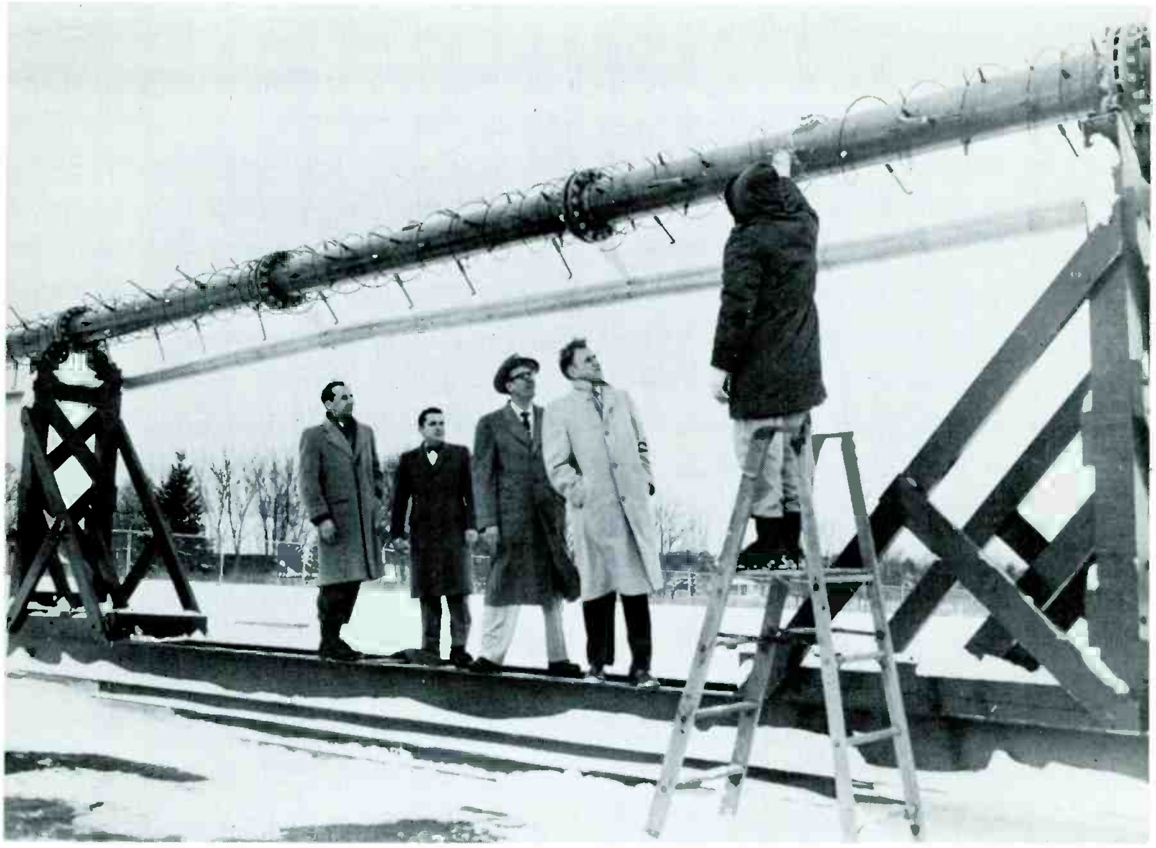


Fig. 7 - Photo of WIN-T antenna in test.

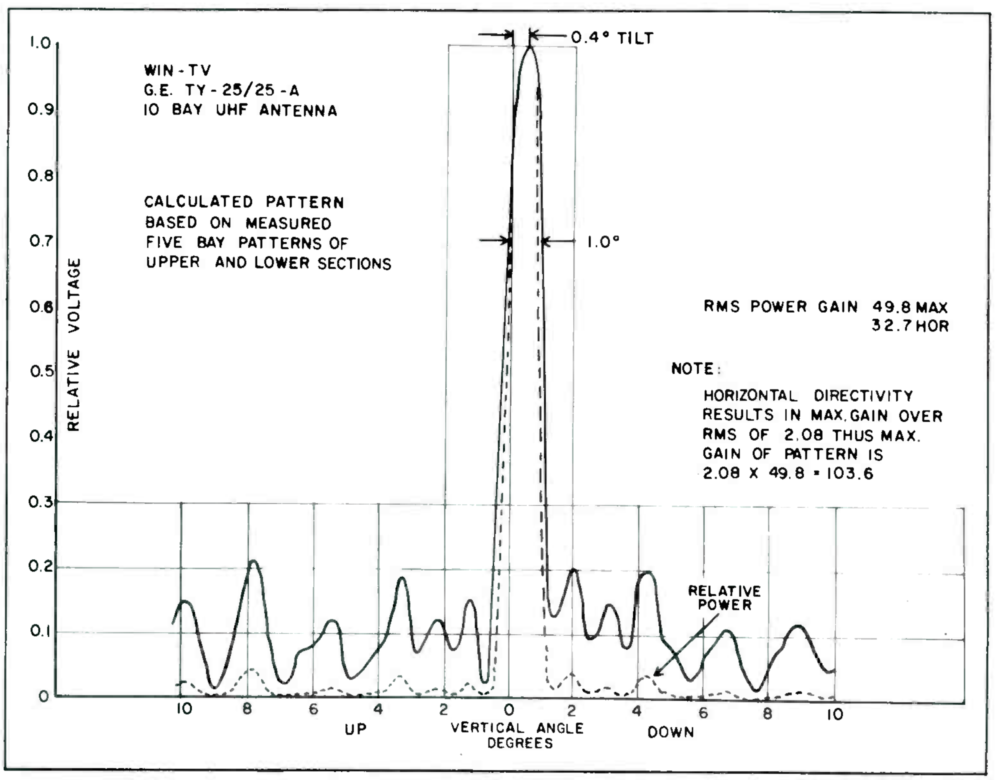


Fig. 8 - Vertical pattern of WIN-T.

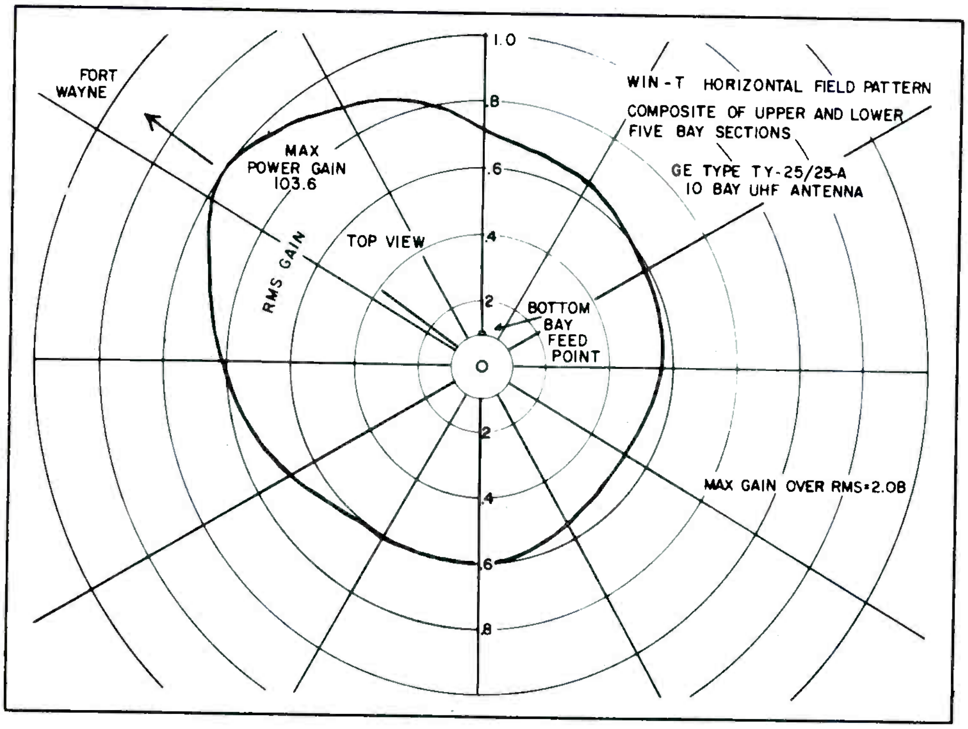


Fig. 9 - Horizontal directional pattern.

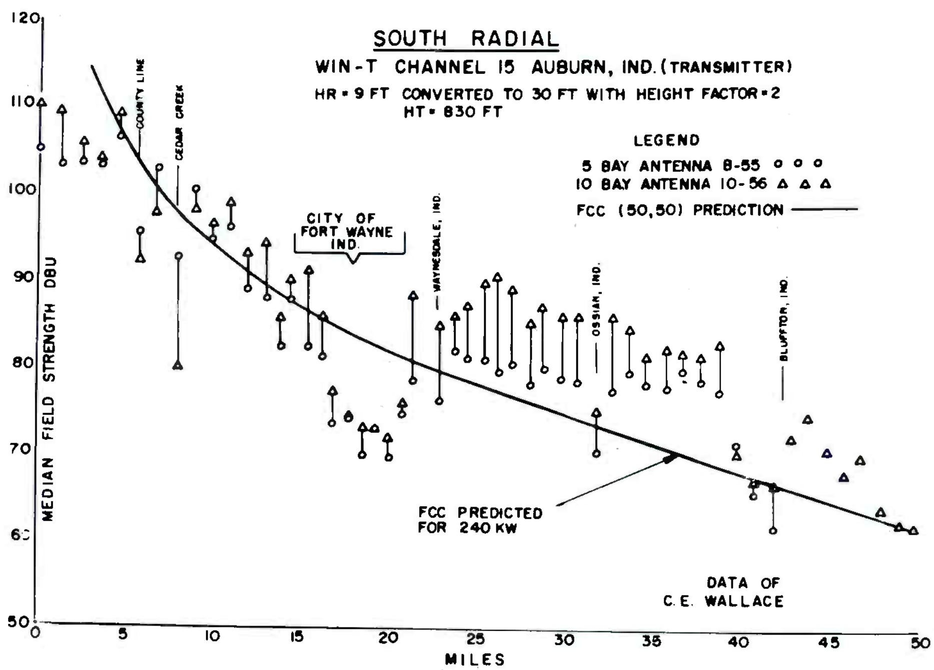


Fig. 10 - WIN-T field intensity measurements.

systems were used with their 12 KW GE UHF transmitter.

Note the congestion factor when making measurements at 9 feet in the business district of Fort Wayne drops the signal level about 10 db. There is a sharp rise in signal improvement when the residential district is approached. This probably results because the same factor of 2 was used to correct for the height change from 9 to 30 feet for both the open country and city runs.

In summary antenna gains up to 100 are practical for many market areas. The use of the stacked antenna arrangement provides a simplified method of achieving high gain and high power capacity.

REDUCTION OF IMAGE RETENTION IN IMAGE ORTHICON CAMERAS

S. L. Bendell and K. Sadashige
Radio Corporation of America
Industrial Electronic Products
Camden, New Jersey

Summary

In television cameras employing image orthicon tubes, the problem of picture sticking or image retentivity often limits the effective life of these tubes. Methods are discussed which minimize this problem by slowly rotating the image on the tube in a small circular orbit by either optical or electronic means for color or monochrome cameras.

Introduction

Nearly all color and monochrome television cameras in live broadcast pick-up service throughout the United States use the image orthicon tube. Since this is inherently a complicated and expensive device requiring precision assembly and great care in processing, the cost per hour of camera operation becomes a significant portion of station operating costs. Any method which can extend useful tube life will result in important cost savings both in monochrome and in color programming.

Image Retention or Burn

Broadcast experience with image orthicon tubes has shown that in most cases a tube is retired because it develops a tendency to "burn-in" or "stick." That is, if a camera is held stationary on a high contrast scene for 10 to 30 seconds or more, that scene in the form of a well-defined negative image will persist after the camera is "panned" away. The magnitude of this effect increases with the number of hours of actual tube operation. All image orthicons will exhibit some sticking if held on a static scene long enough, even when new. However, the problem becomes annoying and objectionable when the exposure-time required to cause the burn becomes short enough to equal the duration of an average stationary scene encountered in normal programming. The negative image is not permanent, but disappears after an interval ranging from a few seconds to many minutes, depending on the age of the tube and the severity of the burn. It is well-known that a sticking image can be removed more quickly by flooding the photocathode with light, but this is an awkward procedure for broadcast program operation.

Procedures for balancing and registering color cameras require that they be held on test patterns for considerable periods. Sticking under these conditions can become very troublesome. In the case of monochrome the difficulty with sticking on fixed scenes such as weather maps, charts, news commentators, etc., is familiar to all critical viewers of television.

As was noted previously, even a new tube will exhibit sticking if held long enough on a static scene. The effect resides in the thin glass target, but the exact mechanism of its formation is not completely understood. Continuous high-velocity bombardment of electrons emitted from the photocathode together with the scanning of the target by the electron beam causes a net flow of charge through the target glass. As a result, certain physico-chemical and electrolytic changes take place in the glass target material. These gradually increase the susceptibility of the tube to target burn.

The photocathode of the image orthicon under all normal operating conditions has, in itself, no tendency for image retention. Ever since the commercial introduction of the image orthicon, much effort has gone into developing improved target materials and into studying the mechanism of target burn, without complete success in finding an ideal material.

It is important to point out that the tendency to stick is aggravated by operating the image orthicon over the "knee" which is common procedure in monochrome, but which is avoided in color cameras. "Over the knee" refers to overexposure (excess light on the photocathode) which produces no further change in the net charge on the target but rather causes redistribution of electrons in the target in areas surrounding those portions of the picture that are overexposed.

Possible Approaches to Minimizing the Burn Problem

A rather obvious possibility that suggests itself is that of arranging conditions so that no scene can stay in one place on the target long enough to produce a burn. This may be done in one of three ways:

1. Scene motion.
2. Camera motion.
3. Image motion (without moving either the scene or the camera).

A special case of this last method is orbiting, a technique which is the principal subject of this discussion.

In aligning and registering color cameras it has long been common practice to mount the various test charts on a motor-driven eccentric, which produces a slowly and continuously moving image on the photocathode and also on the target, thereby minimizing burn. Obviously, this idea cannot be used except for specialized applications. Neither is constant motion of the camera itself very practical.

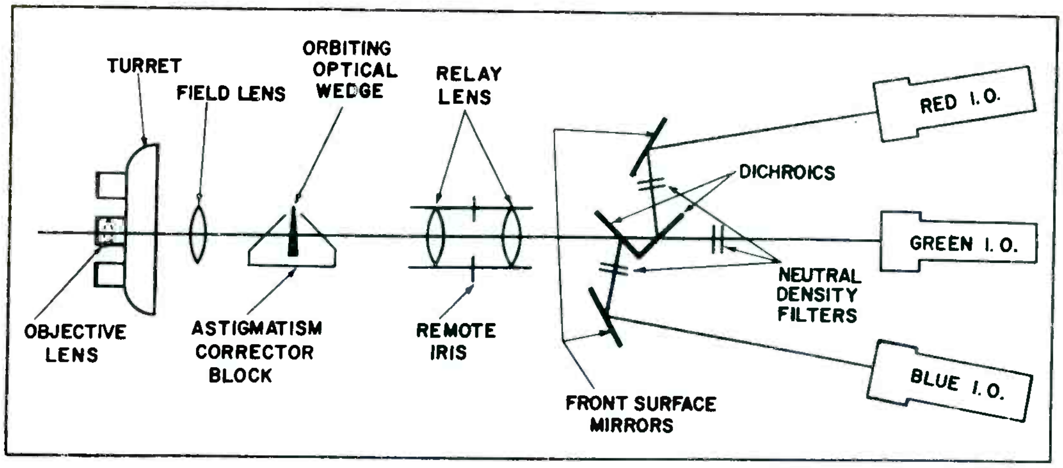


Fig. 1 - Color camera optical system schematic showing location of orbiting optical wedge.

Optical Orbiting Concepts

Rotation or movement of the optical image falling on the photocathode is practical and can be accomplished in a variety of ways. In the RCA color camera a single slowly rotating rim-driven glass wedge, located in a portion of the optical system common to all color channels is used to make the optical images on the photocathodes of the three image orthicons move in a circular orbit. Thus, since the individual images on the red, green, and blue tubes move together, there is no resultant misregistration. Other mechanical methods of moving the lens turret such as described and developed by J. Wilner, Chief Engineer of WBAL-TV, may be used to produce motion of the optical image on the photocathode. In monochrome cameras, the small working space in the back of the lens makes it difficult to apply the optical orbiter technique without resorting to complicated mechanisms that must of necessity be external to the camera.

Details of RCA Optical Orbiter

The optical orbiter used in the RCA color camera fits neatly into the existing optical system of that unit as shown in Figure 1. The rotating optical wedge has a taper of 0.5° and gives a circular movement to the image on the photocathode. The deviation, exaggerated, is shown in Figure 2. The image moves in a circle whose diameter is approximately 3% of picture height. The period of one orbiting cycle is approximately one minute. A small DC motor acting through a suitable gear train rotates the optical wedge mounted in the ring gear shown in Figure 3. The small optical taper required for orbiting produces no adverse effects on optical image quality. The complete optical orbiting unit shown in Figure 4 is very easy to install in existing equipment, requiring only direct substitution for an existing assembly.

Such an optical orbiting device for the RCA color camera was built by L. T. Sachtleben of the Optics Laboratory, and H. C. Shepard, consulting engineer, Advanced Development; was tested in our laboratory studio and was widely shown and demonstrated at the NARTB Convention in Chicago in April, 1957. The optical deviation orbiter concept is attributed to John H. Roe.

Electromagnetic Orbiting

A suitable deflection yoke placed over the image section of the image orthicon tube, and excited by appropriate currents makes possible a non-mechanical method of orbiting the charge image on the target in its translation from the photocathode to the target. No scanning deflection takes place in the image section. This

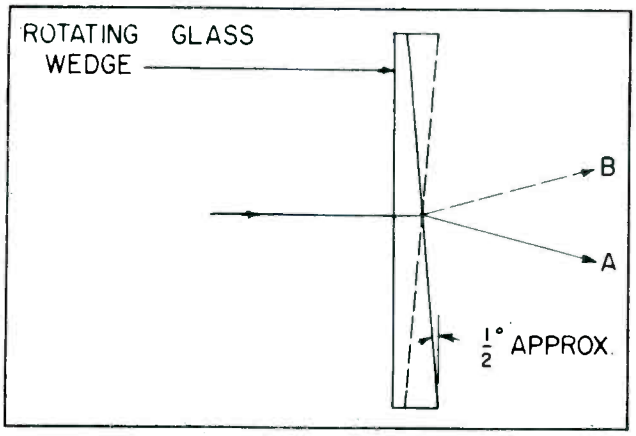


Fig. 2 - Schematic showing deviation by rotating wedge.

Fig. 3 - Photograph of prism and ring gear.

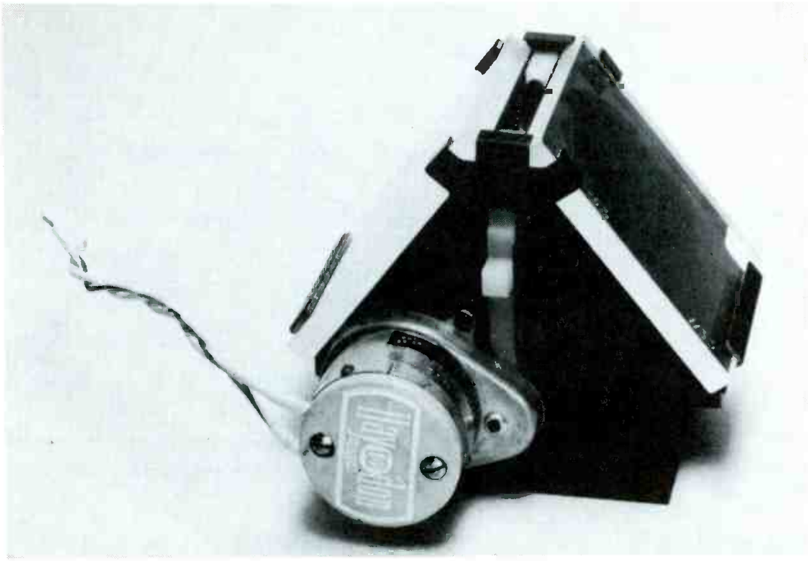


Fig. 4 - Photo of complete subassembly -- optical orbiter.

method, while not practical for color cameras because of the registration problems introduced, is ideal for monochrome cameras. It is interesting to mention that the broad concept of electromagnetic orbiting with image orthicons is covered in Patent 2,632,864 issued to D. O. Hunter of RCA Laboratories in 1953.

Electromagnetic Orbiter Details

The non-mechanical electromagnetic orbiter used in monochrome is composed of two essential parts: a deflection yoke for the image section and a signal generator for supplying the exciting currents.

In the latest monochrome cameras the yoke may be placed over the focus coil while in some earlier models it must go in the space between the tube envelope and the focus coil. These possibilities are shown in Figure 5. Either location requires that the yoke be very thin to fit into the available space. A toroidal construction has been used to make the yoke as thin as possible. The core is a thin section of either mu-metal laminations or iron wire. The mu-metal core in the case of the external yoke preserves the continuity of the mu-metal shielding over the focus coil. The iron wire core for the internal yoke presents a high-reluctance path for the focus field and hence does not disturb the normal magnetic focus fields within the image section of the tube. Each yoke has two quadrature windings as illustrated in Figure 6. These are supplied with appropriate quadrature sinusoidal currents, causing the electron image to rotate or orbit in a circular fashion. Figures 7 and 8 show the orbiting coil separately and installed on the focus coil assembly.

Orbiting Signal Generator

The design of a signal generator for this yoke becomes complicated by the fact that it must put out quadrature currents having the extremely low frequency of about one cycle per minute. Electronic circuits to generate such low frequency currents can, of course, be made but they become somewhat complicated and cumbersome. A novel method using a small resolver driven by a 1 RPM motor has proved to be very simple and reliable. The armature of the resolver is excited with 60 cycle AC. The three stator windings are located 120 degrees apart physically as shown in Figure 9. The amplitude of the 60 cycle voltage appearing on each stator winding is a function of the shaft angle of the armature. If the shaft is turned at a constant speed, such as 1 RPM, the three stator windings will put out three amplitude modulated 60 cycle signals; the phase angle of the 1 cycle per minute modulating components will be 120° between windings. In a sense the 60 cycle currents may be thought of as carriers modulated at 1 cycle per minute. Only two of the stator output signals are required--these are appropriately rectified and filtered. The waveforms are shown in Figure 10. The outputs of the rectifiers are 1 cycle per minute currents whose amplitudes are sufficient to drive the quadrature yoke winding directly. The two 1 cycle per minute signals are 120° apart instead of the 90° required for purely circular orbiting. This produces a slightly elliptical path which, however, is completely satisfactory. A developmental orbiting generator is shown in Figure 11.

The amount of orbiting (peak-to-peak) is approximately 5% of picture height compared to 3% in the case of the optical orbiter used in color. It is believed that since monochrome cameras are generally operated over the "knee," where the tendency toward burn is greater, the orbiting should be greater than for color. The orbiting signal generator may be located remotely from the camera and the currents fed to the camera on the audio intercom lines as shown in Figure 12. Phantom operation of these lines

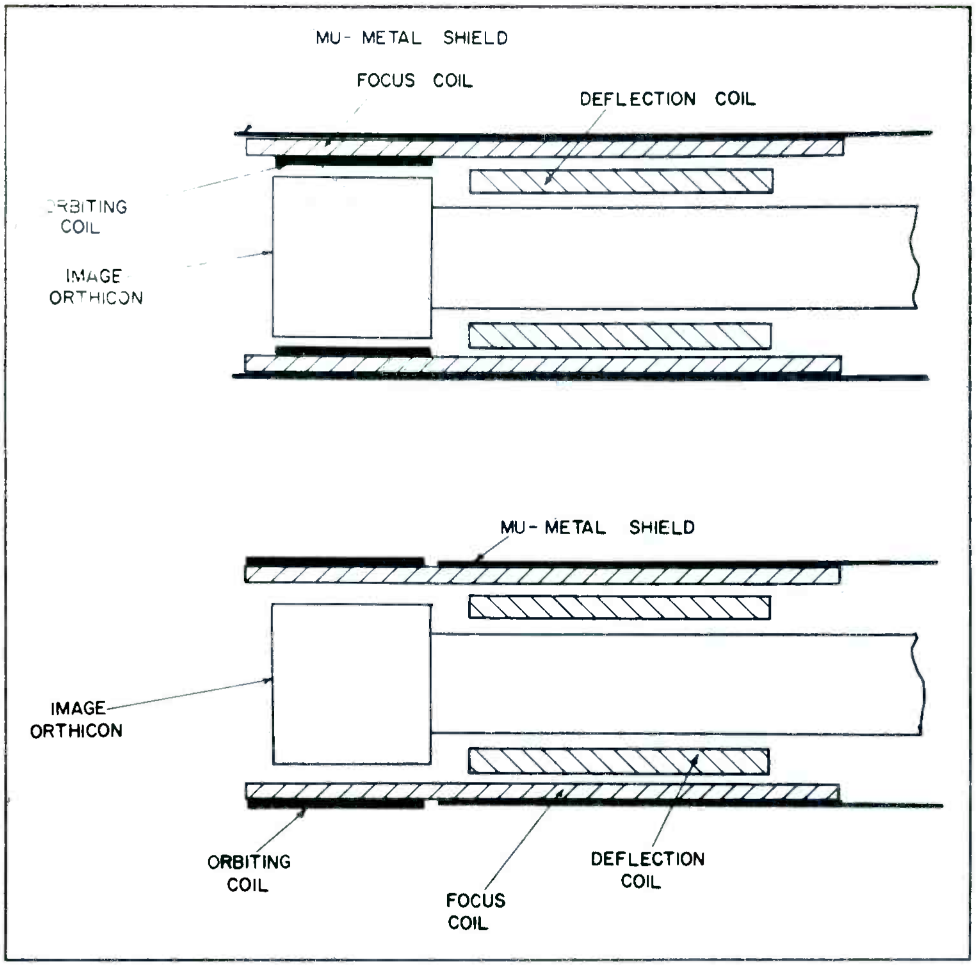


Fig. 5 - Schematic of image orthicon focus assembly showing location of internal and external orbiting coils.

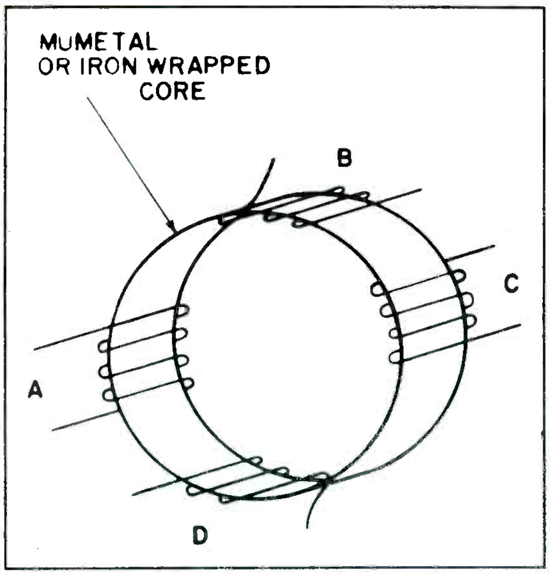


Fig. 6 - Schematic of orbiting coil showing core and torroidal quadrature windings.

Fig. 7 - Photo of orbiting coil toroid.

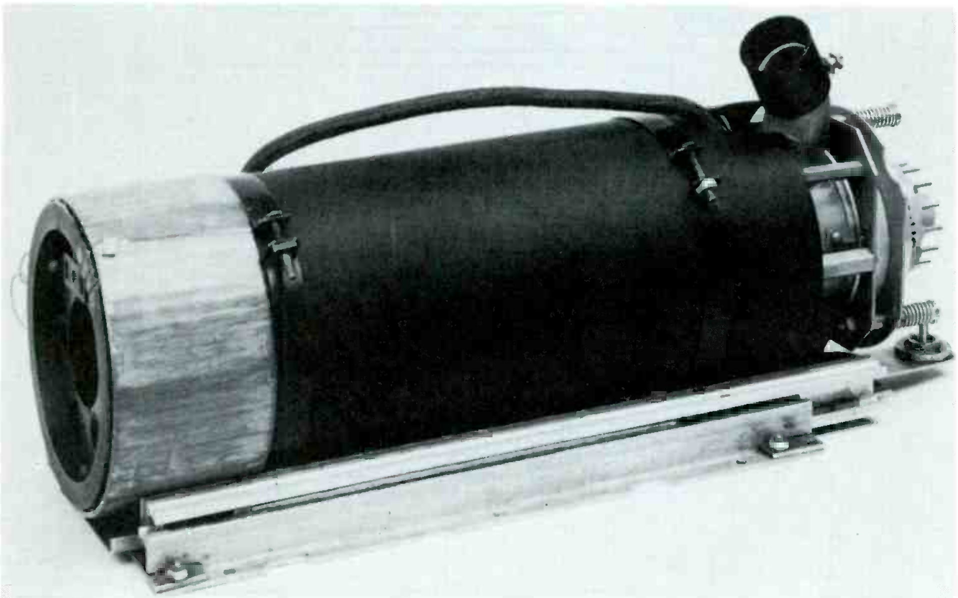


Fig. 8 - Photo of orbiting coil installed on image orthicon focus coil assembly.

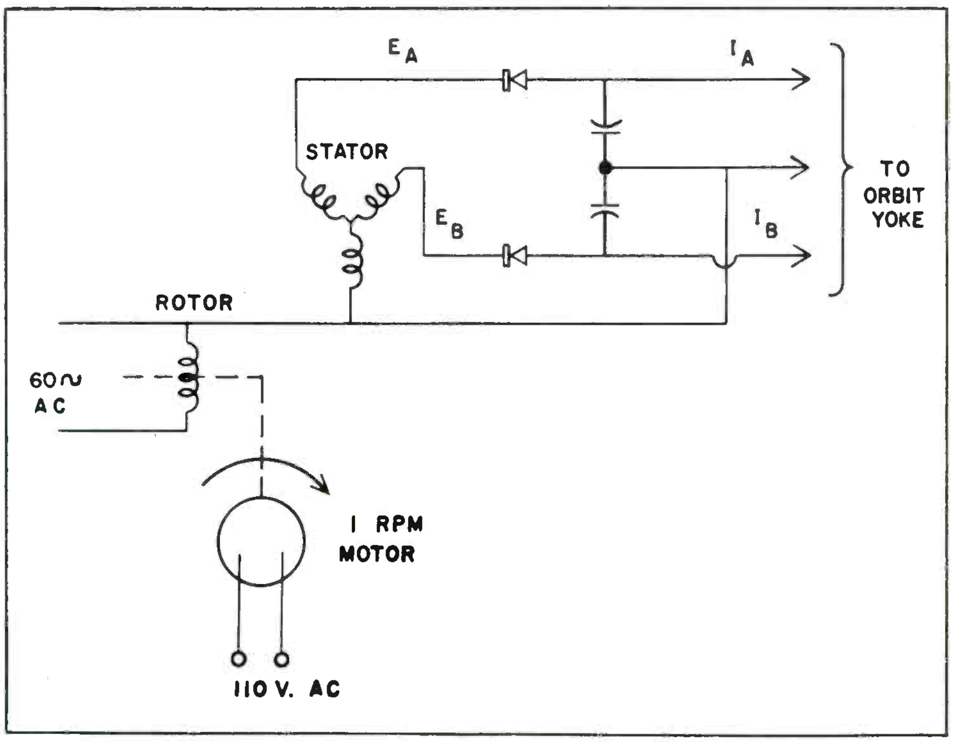


Fig. 9 - Schematic of orbiter generator.

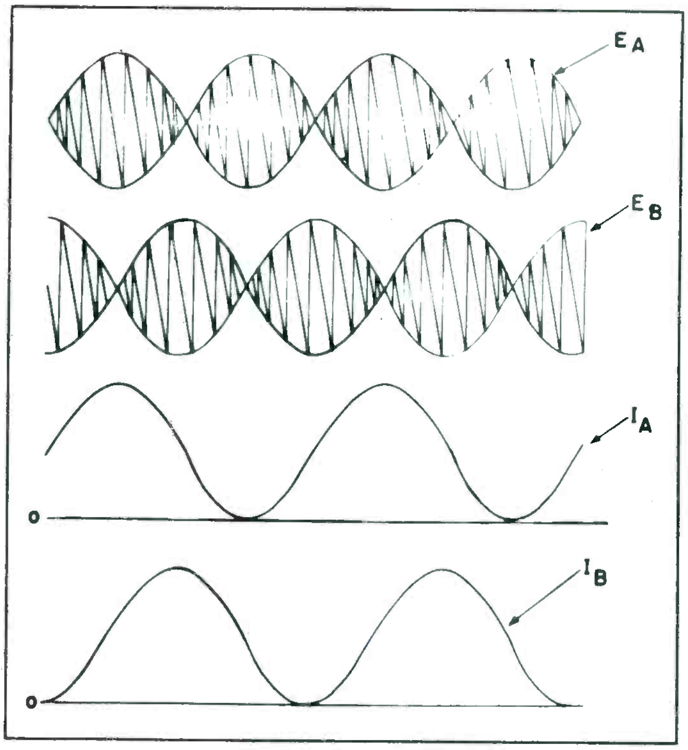


Fig. 10 - Waveforms in orbiter.

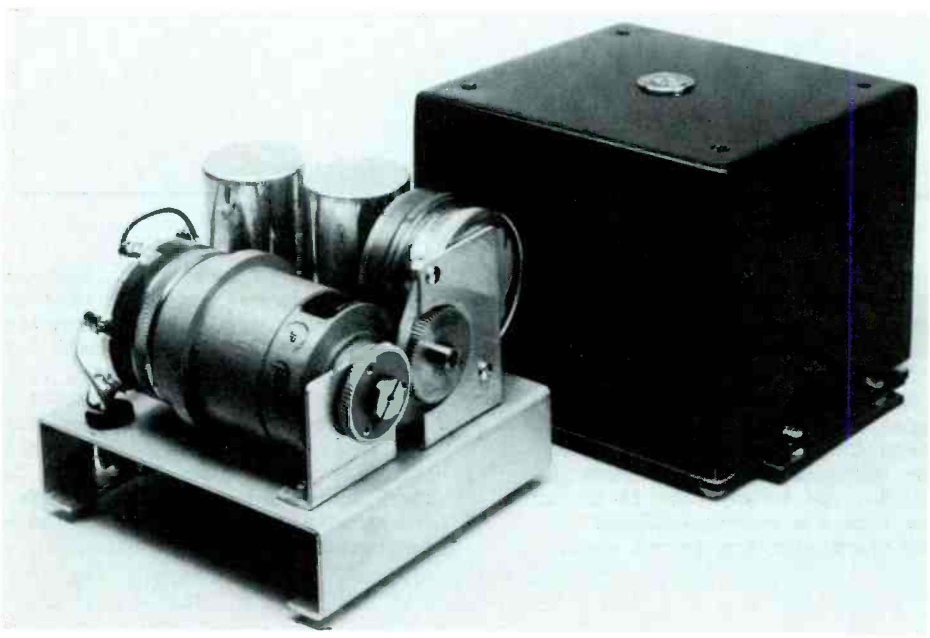


Fig. 11 - Photo developmental orbiting generator (covers on and off).

for currents of this type is relatively easy to obtain.

The small amount of orbiting and the slow rate used make the effect not readily apparent to the viewer. By introducing simultaneous centering current changes in the main camera deflection yoke, the image in the final picture can be made to appear motionless or immobilized. Other methods of immobilization which are somewhat simpler are available. Tests indicate, however, that the very slight amount of picture rotation does not at present appear to justify the extra complexity in equipment. In fact, immobilization may cause a burned border to appear around the edges of the picture. This will cause trouble if that tube is put into another camera with a slight change in angular rotation. In

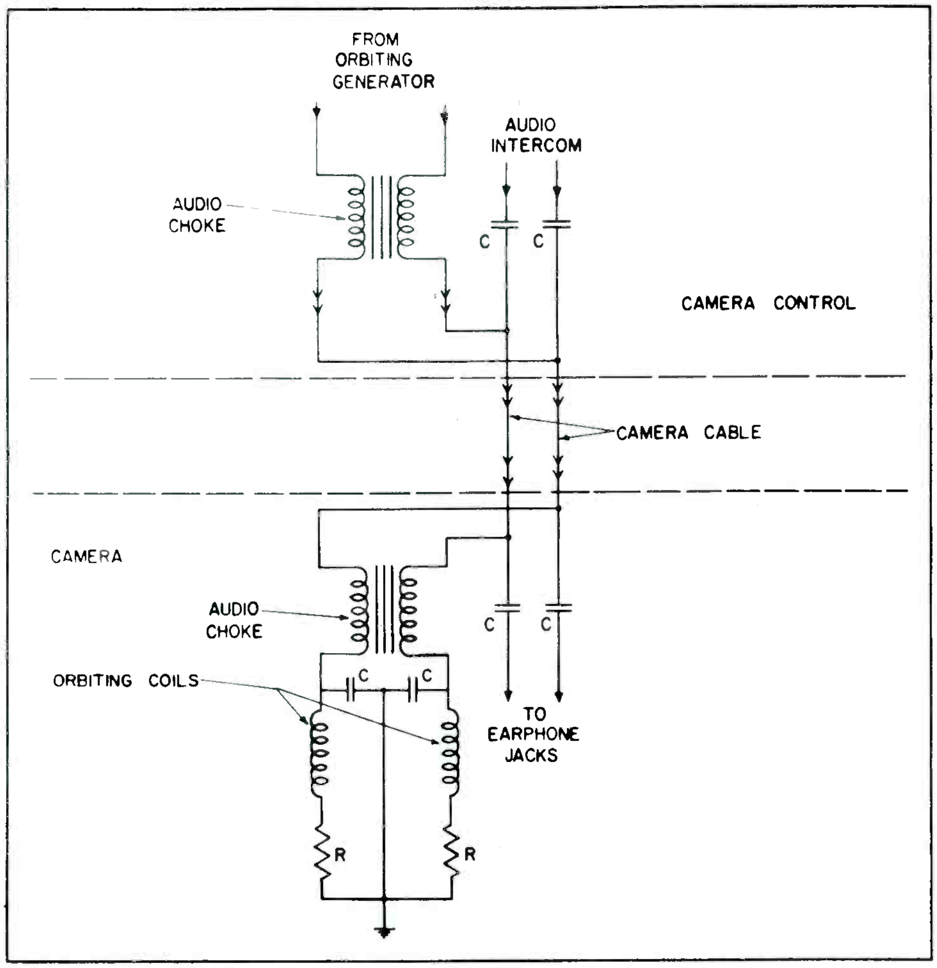


Fig. 12 - Phantom cable circuit schematic.

the case where a camera is used for inserts or other special effects the orbiter can be turned off for the duration of the on-air shot.

The manner in which orbiting aids reduction of image burn is that the retained image, while still present, appears as a blur instead of a sharply-defined negative. In pictures of normal scene content this residual blur is, in most cases, not noticeable, and in any case it is far less objectionable than the sharply-defined image which exists where orbiting is not used.

Orbiters of both types, optical and electromagnetic, have been on field test in several broadcast plants. While no accurate estimate can be made as to how much these devices will effectively lengthen tube life, it is encouraging to note that in many instances tubes which had been previously taken out of service for burn have been found to be acceptable when used with an orbiter. More meaningful data on the actual increase in useful tube life will have to come after a much longer period of field experience.

APPLICATION OF AUTOMATIC GAIN CONTROL DEVICES TO BROADCAST AUDIO CONTROL

A. A. McGee
General Electric Company
Syracuse, New York

Summary

Present day broadcast program practices have brought about more complex operational requirements with the result that less effort can be devoted by the operator to maintaining a desirable constant audio level.

Recent developments in the audio equipment field have provided new automatic gain controlled amplifiers which can relieve the operator of many level control problems - and in many cases, can result in better over-all level control than was possible by manual means.

The field of automatic audio level control is not new. For years, you have been using limiting amplifiers to feed your transmitters. There were many other applications where the limiting amplifier could have been applied, but size and cost made such applications undesirable.

Now, with the advent of Uni-Level Program and Uni-Level Pre-Amplifiers, there is an AGC audio amplifier for every application in a studio audio system.

The basic purpose of this paper is to discuss how these amplifiers can work for you. Therefore, the design of these amplifiers will not be covered. But I shall try to cover some practical applications of these amplifiers as they could be applied in your broadcasting station.

Let's consider the application of an automatic gain control microphone pre-amplifier.

Experience has shown that the use of boom microphones presents many operating problems - the least of which is insufficient level.

These pick up problems have become more acute since the advent of television. As you know, it seems to be a cardinal sin to allow the microphone to be seen in the picture in many types of shows; mainly those situations where its presence would detract from the realism of the program. In most boom pick ups, the talent is constantly moving in and out of the optimum microphone pick up point. A boom microphone pick-up is another version of the eternal triangle - three people are involved - the talent, the boom operator and the audio operator. Being human - and therefore not synchronized via a selsyn system, it's quite a task to coordinate the effort of all three to produce the best pick-up. In addition, the boom is swinging around the studio first directed at one actor and then another. Many times it is necessary to operate the audio console with the mixer and master gain control in the maximum position. This then means that there is no margin of gain left to provide proper mixing or balance of the show. Often times, it becomes necessary to operate microphone amplifiers in cascade in order to provide sufficient gain. I think you will agree that an amplifier must provide at least two additional features in order to overcome these problems. It must have more amplification in order to overcome the problems that arise when the talent is not at the optimum distance from the boom microphone. The second important feature is that it must be able to automatically compensate for the continuously changing conditions that occur when the talent is moving in and out of the optimum microphone range.

There is now available a new microphone pre-amplifier having these two features: 1st - it has 20 db more gain than a conventional pre-amplifier. It has as a 2nd feature, and I believe a contribution to the industry, the ability to provide automatic gain control over a 30 db range.

Fig. 1 shows the automatic gain characteristics of the Uni-Level Pre-amplifier. Plotted along the base line are pre-amplifier input reference levels expressed in dbm. The levels indicated cover the range of output signals generally associated with the many types of microphones used today. Plotted along the vertical axis is the Uni-Level Pre-amplifier output level again expressed in dbm. As you can see, pointed out on the slide, the threshold of gain reduction occurs at an input level of -70 dbm. Let me define for you the threshold of gain reduction. It is the point where the amplifier changes from a linear to a non-linear device. With an input signal level to the amplifier of -70 dbm, the output of the Uni-Level Pre-amplifier is -10 dbm. This of course represents a gain of 60 db, which is 20 db more gain than conventional pre-amplifiers. Be-

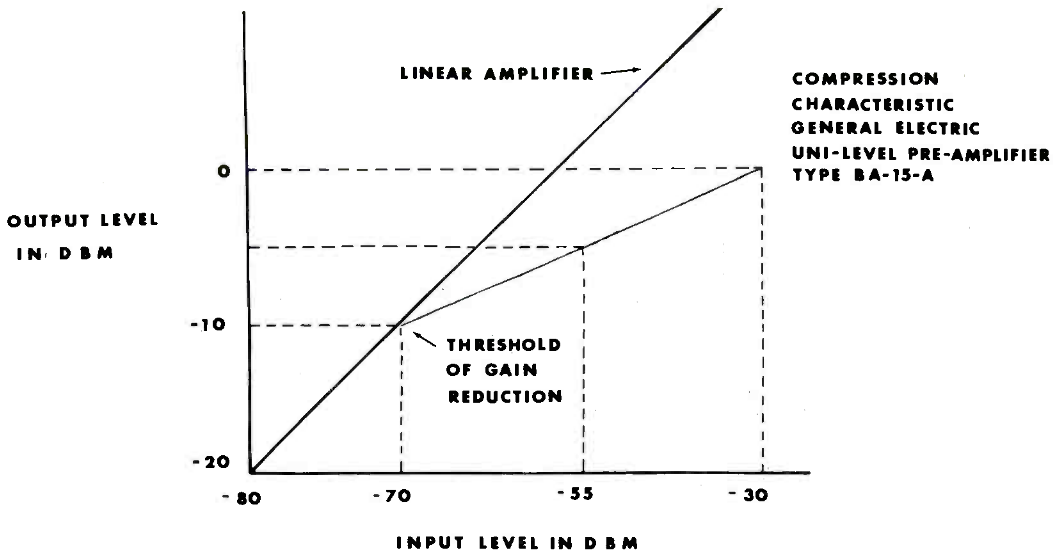


Fig. 1 - Gain reduction characteristic of BA-15-A amplifier.

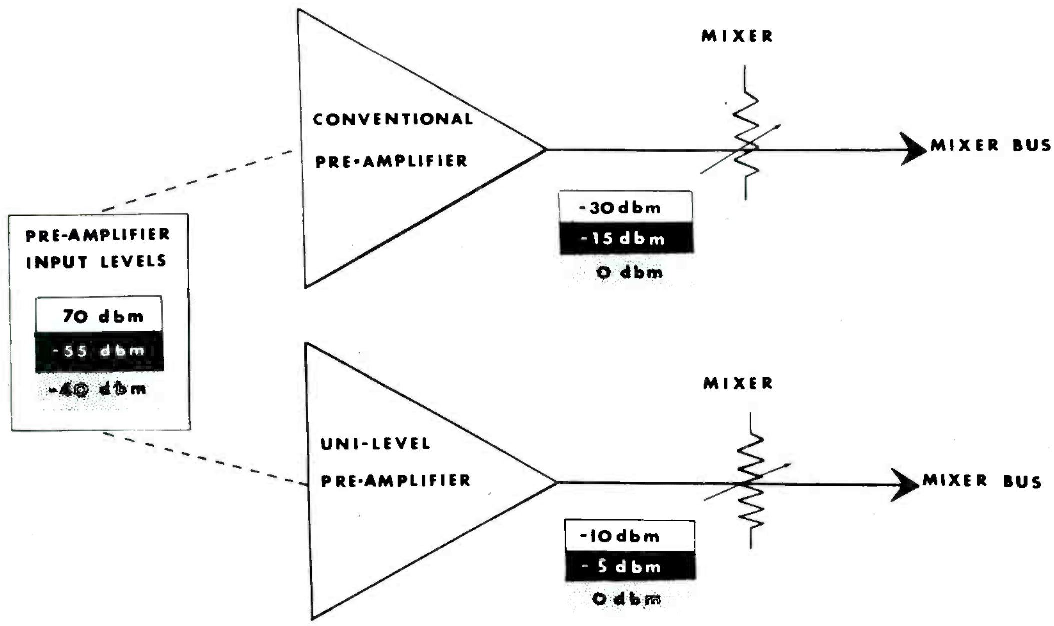


Fig. 2 - Comparison of output levels of a standard and a Uni-Level Pre-amplifier with different input levels.

yond this point, as the signal from a microphone increases, it will be reduced by this amplifier at a 3 to 1 compression ratio. That is, for every 3 db change in the input signal level, the output will only change 1 db. Compression ratio is a measure of how much the dynamic range of the program is reduced. It is usually expressed in how many db change at the input is required to change the output level 1 db when the signal level is above the threshold point. Chances are you have already used automatic gain control amplifiers with this 3 to 1 compression ratio.

Let's set up a typical example of how the automatic gain control microphone pre-amplifier could be working for you. Fig. 2 shows a comparison between a typical pre-amplifier having 40 db gain with linear characteristic and the Uni-Level Pre-amplifier. Let's assume that the input levels to the pre-amplifiers are the same. A -70 dbm signal fed into the standard pre-amplifier will give an output of -30 dbm and a -10 dbm out of the Uni-Level Pre-amplifier. With a -55 dbm signal fed into the pre-amps the output of the conventional pre-amplifier is -15 dbm and a -5 dbm from the Uni-Level

Pre-amplifier. Should the input rise to -40 dbm, the pre-amp with linear characteristics and the Uni-Level Pre-amplifier will be 0 dbm. As you can see, the variation at the standard pre-amplifier output is 30 db and the Uni-Level Pre-amplifier is 10 db. If the optimum signal from a boom microphone supplies a signal to the Uni-Level Pre-amplifier equivalent to -55 dbm, variations in sound level of ±15 db can be controlled with but 5 db change in program level.

This high gain AGC Pre-amplifier is particularly useful in an Announce Booth, or any studio microphone input where it is desired to maintain a regulated level.

The Uni-Level Pre-amplifier will be an aid in relieving your studio personnel of many exacting level adjustments, as it will control levels with a minimum of attention to individual controls.

Many of you are already deriving the benefits of an AGC device as a program or line amplifier in your audio system. Since the introduction of the first of these units more than three and a half years ago at the NARTB in Chicago, they have become what you might describe - a household commodity.

Having covered the Uni-Level Pre-amplifier, let's see what a Uni-Level Program Amplifier can do for your operation. First of all, it can increase your average signal supplied to the transmitter. This is certainly important to you because the higher the average signal level the greater will be your coverage. This is probably more important to you A.M. broadcasters. The important point for you television broadcasters is that the audio portion of the signal is smoother and less apt to be too high at one minute and down in the mud the next.

The Uni-Level Program Amplifier functions a little differently from the Uni-Level Pre-amplifier in that it takes its signal from a mixer bus - which is a composite from many different sources, such as microphones, turntables, projectors, tape recorder, or remote sources.

I believe that an automatic level control amplifier will eventually be as indispensable as a VU meter in every studio. With that thought in mind, a metering circuit was developed for the Uni-Level Program Amplifier which uses a standard VU meter as an indicator of gain reduction. A decal is supplied with the Uni-Level Program Amplifier and may be applied to the VU meter scale without changing its original usefulness. The scale is calibrated on a 3 to 1 compression ratio. Installation of a DPDT switch - either toggle, lever or turn key will allow instant connection of the VU meter for either VU or Gain Reduction indication. The gain reduction scale does not indicate actual compression but rather how much the input signal supplied to the Uni-Level Program Amplifier is above the threshold point. Thus, with the recommended compression ratio of 3 to 1, the output will rise 1 db for each 3 db rise in input signal above the threshold point.

The maximum effectiveness of the Uni-Level Amplifier can be had by incorporating it in the audio console as the program or line amplifier. It then operates as a combination compressor-expander. As an example, the input signal to the Uni-Level Amplifier should be adjusted so that what is considered an average signal will cause about 15 db of gain reduction to be indicated on the Gain Reduction Meter. It is now possible to have an additional increase of 15 db in the input signal with a resultant increase in output level of 5 db. When the input signal level decreases from the average indication on the meter by as much as 15 db, the output signal level will decrease 5 db. With this type of operation, the operator no longer has to ride gain with his eyes glued to the VU meter to maintain the correct output level.

You are all familiar with the sudden changes in level when switching between different program sources. A good example is the different audio levels encountered in TV film operations, this presents quite a gain control problem for your operators. Here, the difference in exposure and development between different variable area and variable density sound tracks spliced one after the other will cause vast and abrupt changes in the input level to the console. Because of this, it has become the practice of some operators to set their levels low. Result? - Low output accompanied by rapid and objectionable changes of level in the home receiver. These undesireable variations can be reduced to a range of + or - 3 db when the Uni-Level Program Amplifier is properly applied.

To those of you who use a combination disc jockey and engineer, an automatic level control amplifier will be a third hand. It makes an inexperienced operator sound like a first class engineer.

Another type of operation is to set up the Uni-Level Amplifier as an automatic fader control as shown in Fig. 3. Let's assume there are two sources of signal, one being a turntable and the

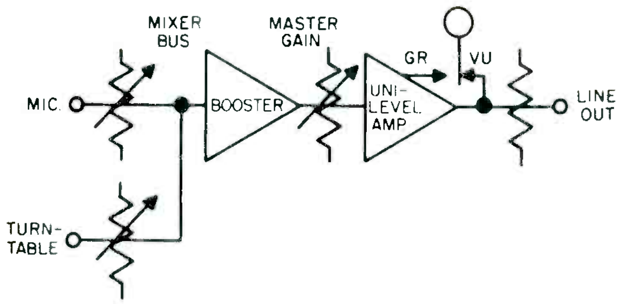


Fig. 3 - Uni-Level Amplifier, BA-9-A, used to provide automatic fader operation.

other a microphone. Adjust the turntable signal level so that it causes 2 to 3 db of reduction to be indicated on the Gain Reduction meter. The level of the microphone channel at the mixer bus should be set so that it is 20 db higher than the turntable at the same point. Now our "automatic fader" is set so that it is only necessary to speak into the microphone and the music will fade down and is separated from the microphone by 20 db. The difference will be the amount of the separation of the microphone and turntable signals at the mixer bus. The resultant change in level fed to the limiting amplifier is only 6 to 7 db, a level change which is well within the range of the limiting amplifier.

Automatic level control amplifiers can be used in many places to overcome the need for constant gain riding. An example might be a remote pick-up of a dance band or a church service. These types of installations are more or less on a permanent basis and once the level is adjusted, it should remain quite constant over a relatively wide signal range.

Since the Uni-Level amplifier is a relatively slow acting device, both in attack and recovery times and utilizes relatively small compression ratios, it is not recommended that it be used as a transmitter limiting amplifier.

The new General Electric Audiomatic Limiting Amplifier, Type BA-7-A, is ideally suited and is designed for this application.

The BA-7-A is a peak limiting amplifier designed to permit a substantial increase in the average program level without danger of any audio peaks exceeding a pre-determined level. The design incorporates an improved thump reduction circuit, extended limiting range, high output level, and a unique program controlled recovery circuit.

The ideal peak limiting amplifier is one in which the input signals above threshold will instantaneously cause a reduction in gain equal to the signal above threshold, thus holding the output constant.

Most limiting amplifiers previously available, have departed from the ideal by allowing an appreciable increase in output signal with inputs above threshold, and by not having a gain reduction action rapid enough to catch fast peaks.

Fig. 4 shows the gain reduction characteristic of the Audiomatic Limiting Amplifier. Up to the threshold point, it is a linear amplifier. From the threshold point and for a range of 20 db, there is essentially no change in the output level. The variation of the output level is less than 1 db over this range - thus it has a compression ratio of better than 20:1.

Although a high compression ratio is essential, it is also necessary that the compression characteristic be effective for rapidly changing wave forms as well as those changing slowly. If the limiting amplifier is to catch fast program peaks, voltages rising in microseconds must be controlled in accordance with the curve, otherwise instantaneous over-modulation could occur. Thus, a good limiting amplifier must be very fast-acting; that is, it must have a short attack time. The Audiomatic Limiting Amplifier has an attack time of approximately 70 microseconds.

Here I would like to depart for the moment from the application of this device and explain the "why and wherefore" of its recovery circuits.

Most of you are familiar with the action and application of previously available limiting amplifiers. Because of a unique recovery circuit in the Audiomatic Limiting Amplifier - Type BA-7-A, you may further increase your average modulation level.

So, you will recall that when large amounts of gain reduction are employed with a limiting amplifier using conventional R-C time constant recovery circuits, a certain type of program distortion is introduced which in broadcasting is called pumping. This is a periodic rise of background noise or low level material at a rate determined by these R-C time constants. In an AGC amplifier, such as the Uni-Level Amplifiers, this type of action is minimized because of the relatively long recovery time constants. In peak limiting amplifiers, it is important that this recovery time be made short in order to maintain high average program level. In conventional R-C circuits, the time constant usually

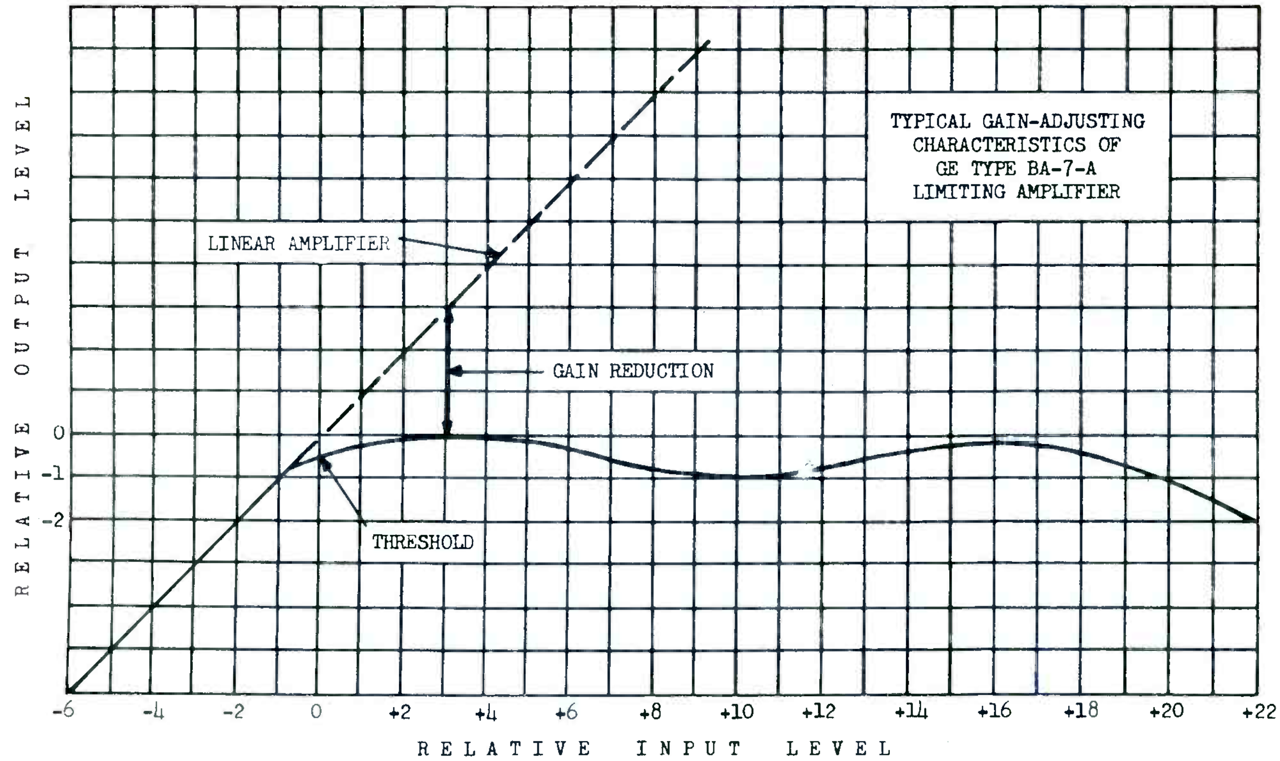


Fig. 4 - Gain reduction characteristic of the BA-7-A Limiting Amplifier.

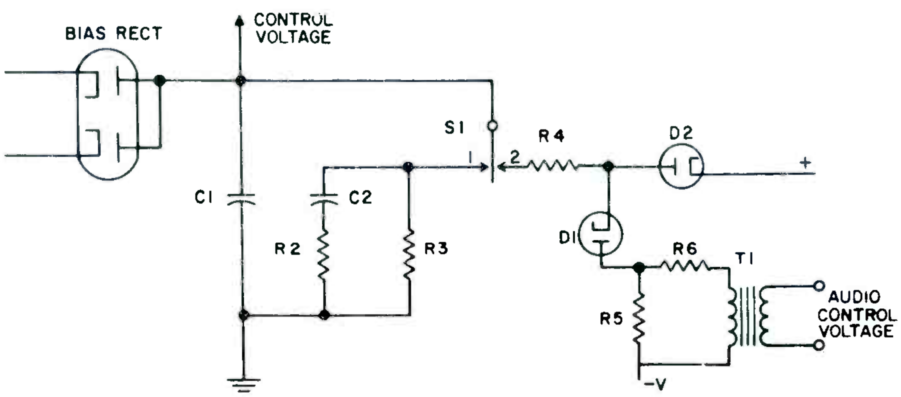


Fig. 5 - BA-7-A Limiting Amplifier gain recovery circuit.

is limited to about 0.5 second. This is generally determined by listening tests.

The Audiomatic Limiting Amplifier incorporates 2 different types of recovery circuits. By a switch position selection, you may choose between the conventional dual R-C time constant, which incorporates one R-C circuit for single short peaks and a shunting series R-C circuit for sustained level changes or a new type of recovery circuit which is dependent upon the nature and intensity of the program material. We call this a Program Controlled Recovery Circuit.

Fig. 5 shows the bias generator of the Audiomatic Limiting Amplifier. The switch in position 1 connects the standard R-C circuit, R3 being the resistor in the recovery circuit. With the switch in position 2, diode D1 is substituted for R3 in the R-C recovery time constant. A negative voltage is applied to the plate of D1, of sufficient magnitude to bias the diode to cutoff for any value of control bias voltage. Program audio voltage is applied to the plate of D1, from transformer T1 at a level to cause D1 to conduct at a fixed point on the gain reduction curve, normally about 3 db above the threshold point. Thus, the discharge rate of C1 is determined by two factors: the type of program material and the value of R4. Diode D2 is shunted across D1 and biased to prevent the intensity of the program level from causing too rapid a discharge rate of Cl.

Note, and this is particularly important, that when there is an absence of program material, the Audiomatic Limiting Amplifier can not recover and will remain at the previous peak of gain reduction until the next program peak causes the diode to conduct - you will recall that this program peak need be only about 3 db above the threshold point. In addition t to minimizing pumping this type of recovery circuit prevents the limiting amplifier from returning to full gain. This prevents background noise from being emphasized during the absence of Program. If for instance, there should be a fairly long pause at the end of a disk and the start of a following spot announcement.

When the Uni-Level Program Amplifier is working in conjunction with the Audiomatic Limiting Amplifier, it would be best to operate them in the following manner:

Set up the Audiomatic Limiting Amplifier so that when the Uni-Level Amplifier is indicating about 30 db of gain reduction, the amount of gain reduction being applied, by the limiting amplifier is about 10 db.

This then gives a safety margin of about 10 db which the Audiomatic Limiting Amplifier can use to catch those very fast peaks missed by the Uni-Level Amplifier because of its slower attack time.

Today, there are available new automatic level control amplifiers and improved types of limiting amplifiers offering performance characteristics which were thought impossible a few years ago. When properly applied to your operation, these units can improve your operating efficiency by eliminating unnecessary level changes, and by increasing your average audio power output. Increased program efficiency and increased power can result in increased profits for you.

I would like to express my thanks to A. C. Angus and R. N. Blair of the General Electric Company for their assistance in the preparation of this paper.

PROGRESS REPORT ON VERTICAL INTERVAL TELEVISION TEST SIGNALS

Robert M. Morris and John Serafin
American Broadcasting Company
New York, New York

At the IRE annual convention this year and again at the NARTB Engineering conference April, Panel meetings were held to discuss the subject of vertical interval signals and their application to television broadcasting. At these meetings representatives of manufacturers and the networks outlined methods by which signals of various types could be keyed and added to the standard television signals, they also discussed types of signals believed to have merit and plans for initial testing of such signals. More recently cognizance has been taken by Electronic Industries Association (formerly RETMA) of the signal specification problem presented by this contemplated technique and by the FCC proposed rulemaking Docket #11986. A subcommittee has been established under the Broadcast Television Systems Committee to make recommendations on the subject.

This committee, known as BTS-5, has been instructed to:-

"(1) Examine all proposals in the light of their intended purpose and try to consolidate these into as few proposals as practicable. The effects of all signal proposals on television receivers now in the field are to be carefully examined.

(2) Determine if the proposals can be made mutually compatible.

(3) Make one of the following recommendations to BTS:

- (a) No action be taken at the present time.
- (b) One or more signals specified by BTS-5 be given a further period of trial. Several signals may be recommended on a permissive basis (by permissive is meant that the transmission of the special signals is not obligatory).
- (c) Any other action as BTS-5 may deem desirable be taken.

(4) Act as the sponsor or observer of field tests of the recommended signals.

(5) Make an initial report to BTS by August 15, 1957.

A meeting of this subcommittee has been held at which the network proposals were reviewed and at which other recommendations not previously made were considered. It has for example, been suggested by the telephone company that a specific space in the vertical interval should be reserved for telco use in such manner as not to interfere with other signals simultaneously applied in this interval.

A representative of the FCC indicated that they too are interested in the use of vertical interval test signals and hope that it will be feasible to apply them in such manner that monitoring of the technical characteristics of the television transmitting system will be facilitated.

Representatives of the three networks outlined plans for the procurement and installation of vertical interval test equipment and plans for initial field testing. It was indicated that at least a month would be required before all three networks would have the necessary equipment ready for use and that another three months minimum should be available for field tests. This made necessary a recommendation to the FCC that the filing date for comments in connection with the test signal docket #11986 be advanced from September 1st to some time after the end of December, if the results of these tests and the deliberations of Committee BTS-5 were to be available for consideration. Accordingly, the proposal was made that such a request for the advancement of the comment filing date be made by EIA for January 15th, 1958. This request has been forwarded to FCC, and action by the FCC has been taken, adopting this revised date. The committee has requested that simultaneous consideration be given by R4 receiver committee of EIA in the matter of collecting data regarding retrace time of past and current production television receivers. This information will be of great value in correlating with field test observations resulting from the transmission of these signals. It is expected that the results of the network field tests will be available to this subcommittee which plans to meet again later this fall.

The characteristics of the test signals proposed by the three networks differ in several respects. The proposal of ABC involves two or three separate signal functions, each allocated its own specific place in full integral numbers of lines. The waveform diagram of this proposal is shown in figure #1. In this diagram three functions are included, (1) control or cue signals; (2) technical test signals; and (3) amplitude reference signals, and each of the functions is assigned two full lines. The control signals occupy lines 13 and 14, technical test signals occupying lines 15 and 16 and the amplitude reference signals occupying lines 17 and 18. Line 19 of the vertical interval and any which occur in excess of 19 lines remain as a guard interval. In this signal it is intended that the amplitude reference signal shown in detail in Fig. 2, be such as to be visible on a standard waveform monitor without benefit of any keying out technique to enhance its visibility. The technical test signals and the interval for control or cue signals, however, are intended to be keyed out and viewed, or used separately from the rest of the signal. It may be possible that

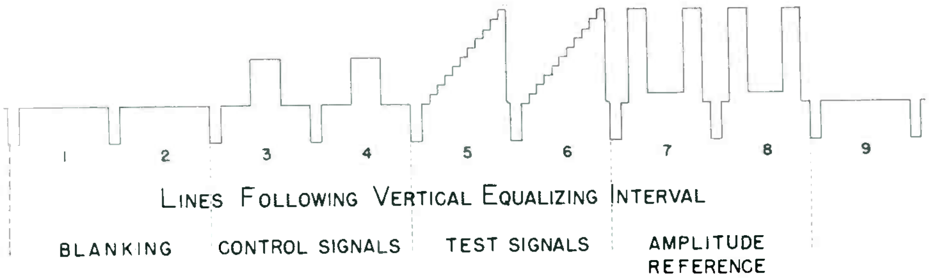


Fig. 1 - ABC initial vertical interval test signal proposals.

these two functions can each be reduced to a single line.

The advantage of this type of signal is believed to be the visibility of the amplitude reference signal on normal operating monitors under varying picture signal conditions and the ability to use conventional full period test signals such as stair-step, multi-burst, etc. in the interval provided for this purpose. It is intended to use these test signals on a sequential basis at a time interval (perhaps five minutes each) which will facilitate their use.

The Columbia Broadcasting System has proposed a test signal occupying three lines in the vertical interval as shown in Figure #3. This signal, which provides for at least two functions, i.e., reference signals and technical test signals, does so by time division within each line as shown in the expanded detail. This signal has the advantage of providing a maximum number of lines for both the white portion of the amplitude reference signal and the technical test signals. It does, however, require a modified technical test signal to fit into approximately 80% of the space between horizontal sync and blanking pulses. Black reference may also depend upon the technical test signals being transmitted.

The National Broadcasting Company proposal, shown in Figure #4, is also planned to occupy three full lines in the vertical interval. It is proposed that lines 18, 19 and 20 be occupied by the test signal with line 21 as a guard line.

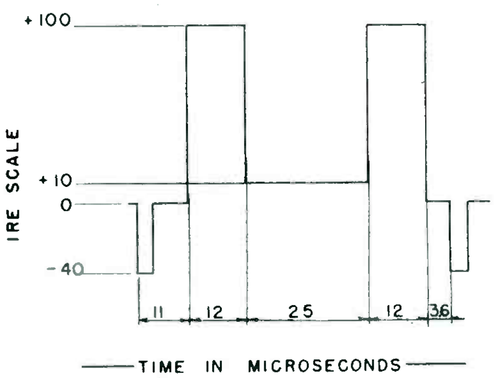


Fig. 2 - ABC vertical interval amplitude reference signal shown in detail.

It is also proposed that the vertical interval should be set at its maximum limit of 21 lines.

This brings up one matter which will have to be considered by the EIA Committee, namely, whether the present specification of vertical interval, which permits a minimum of 19 and a maximum of 21 lines, should be changed. The NBC signal proposal has several unique features. It is a signal in which it is intended that there be no time sequential changing of test signals as can be done in the other two network signals. Rather, it is proposed that the signal, as transmitted, simultaneously serve the purpose of an amplitude reference signal, a check of video frequency response, and a check of differential gain and phase. These technical test functions would not be accomplished as completely as would be permitted by the conventional multi-burst or stair-step signal. It is believed by its proponents, however, to be capable of providing operationally useful data in these three respects. The signal does not, in its proposed form, transmit a black reference. It does, however, include a 50 IRE unit reference which is believed by NBC to have merit.

The technique of generating and applying a vertical interval test signal to television circuits, involves the creation of a keying pulse, of the desired width, synchronous with the signal to which it is to be applied, and correctly located in time in the vertical interval. This keying pulse is then applied together with the desired test signal to the terminals of a product detector or other modulator which passes the test signal for precisely the desired interval. This keyed signal is then added in a mixing amplifier to the program circuit to which it is to be applied. Suitable controls for adjusting level and for disabling the test signal without interference to the program circuit, are, of course, included. In the normal television broadcast system it appears desirable that the amplitude reference signal be added to the circuit as early in the system as possible. Having it included in each camera chain would it is believed, be highly desirable since it would then serve as an operational guide in setting levels of each camera. In view of the large number of cameras involved in a complex network system, however, this approach is considered impractical for a field test of the technique. Instead, it has generally been found expedient to apply the reference signal to the output of each studio or program originat-

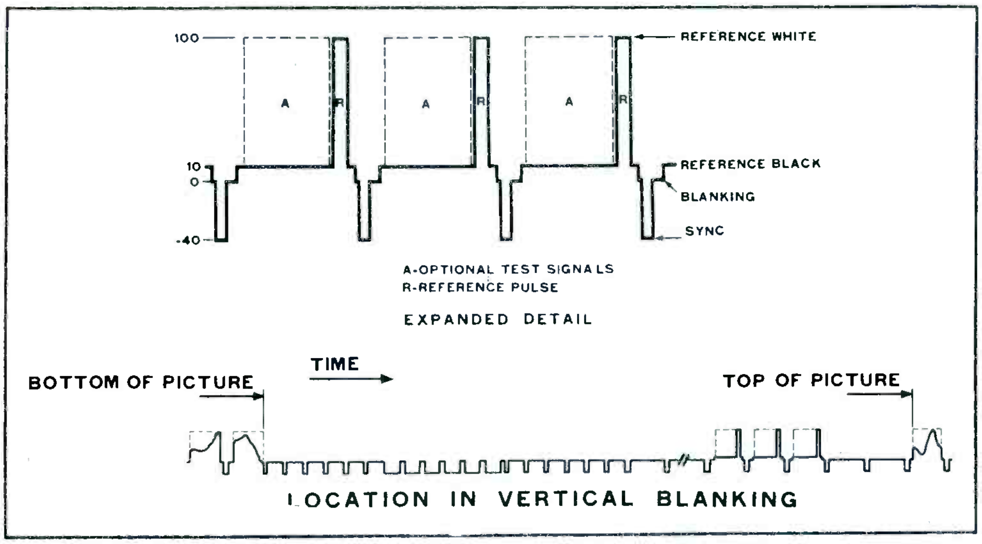


Fig. 3 - CBS TV reference pulse proposal.

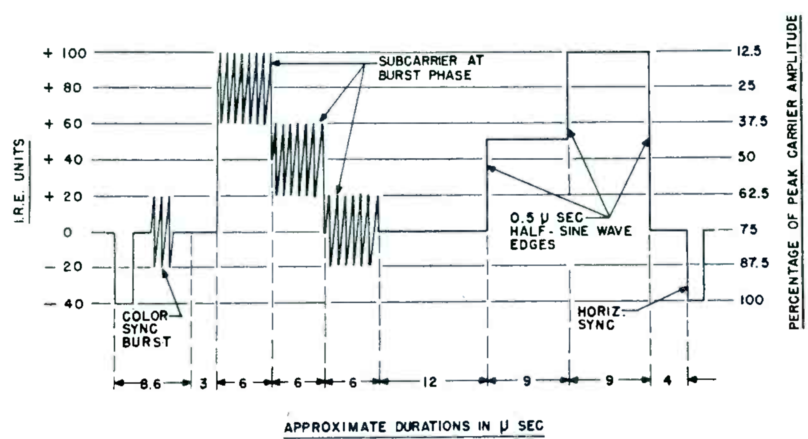


Fig. 4 - NBC vertical interval test signal shown in detail.

ing point, on the transmissions of which the reference signal is desired.

A block diagram of the equipment installed thus far by ABC for the addition of reference signals to the outgoing program lines is shown in Figure #5. A Telechrome 1008A Keyer is connected to horizontal and vertical drive from the synchronizing generator and is adjusted to provide a keying signal of the desired number of lines and position within the vertical blanking interval. Suitable controls permit keying of from 1 to 4 lines in the Vertical Interval from the 13th through the 20th line from the start of vertical blanking.

The keyer output is fed to a panel, in which the Amplitude Reference Signal is generated and keyed. Addition of the Amplitude Reference Signal to the program circuits is accomplished by means of the DA sections shown, bridging their respective studio feeds to the Master Switcher. If a studio transfers to an outside program source or "nemo", the reference signal must, of course, be removed from the studio feed to avoid interference between the non-synchronous signals. Interlock features are incorporated to remove the Amplitude Reference Signal from a studio feed, whenever the sync disabling relay is operated in that studio.

In signals of the type proposed by ABC and CBS where the technical test signal is separate from the reference signal, the test signal can be generated by another keyer and adder system and applied to outgoing trunks at the master control. If this concept is followed through in a network system in which program originating points change from time to time it can be seen that complexities could arise unless the policy is adopted of applying the test and reference signals at the point of program origination.

It has been suggested that a device like a genlock can be used to recover synchronizing pulses from an incoming program and thus lock and control the operation of the test signal keyer to any incoming program. If in network practice this were to be used it would become necessary also to have a device for scanning the vertical interval to determine whether any test signals had been previously applied before permitting the keyer and adder to function. Otherwise, double test signals could be created which would cause abnormal levels to exist. In one instance where this was tried it was found that the reference signals on line 18 were being superimposed on one line of program material due to an abnormal vertical interval coming from the program originating point. This, of course, was quickly corrected; however, it suggests both the dangers of this method and the necessity of more rigorous adherence to technical standards than appears to have been true in the past.

Experience to date has been very encouraging especially with respect to the benefits derived from the amplitude reference signal. In the past it has been true that the only fixed reference points being transmitted were the ZERO IRE scale blanking and the -40 reference for the peak of sync. This region is, unfortunately, subject to the greatest discrepancies due to non-linearity. There is also a tendency on the part of operating technicians to fail to appreciate the limitations of levels in this region with the result that incorrect gain adjustments are frequently made based on incorrect levels in synchronizing regions. In one instance, when a reference signal was first applied to a circuit feeding the local telephone company test board, the report came back that the reference signal was running low -- only about 85 IRE units. Upon checking it was found that the amplitude reference level was in fact, correct; the discrepancy lay in adjusting the circuit for the correct synchronizing level which was, in fact, high. The adjustment of this level resulted in correct adjustment of the circuit and proper video levels. In another case, using the ABC amplitude reference signal, the black level reference was observed at the local transmitter to be at 5 IRE units on the waveform monitor rather than at 10 units. An investigation of this proved that the transmitter stabilizing amplifier had been incorrectly set causing 3 or 4 units of setup to be lost by a very critical adjustment of this amplifier. It was found that use of black level reference provided an excellent and highly sensitive indication for the adjustment of this parameter.

One rather unexpected dividend from the use of the reference signal is reported by CBS. It has been observed that differential gain variations can be detected as a result of varying duty cycle with change of picture content. The amplitude of the reference white signal has been observed on some circuits to change 5 to 10 percent with changes of average picture level. A similar phenomena has been observed at ABC using a test signal composed of a "window" signal together with an amplitude reference signal. Setting the two signals initially for 100 IRE units, they will on equipment having a poor differential gain characteristic show a difference in amplitude on the output of 5 percent or more.

One of the principal benefits of the amplitude reference signal has been the increased consciousness on the part of studio technicians of the importance of video level. The impact of having a level reference "riding along" with the program has tended to make everyone level conscious. Video operators have asked that the signal be included in each camera chain. At present only the outgoing line master monitor has the reference signal present in its display.

A report has been recently submitted to members of BTS-5 by the chairman of Committee R4 on TV receivers. This report is a survey of vertical retrace time of a cross section of receivers manufactured since 1952. It indicates that a very appreciable number of receivers take essentially the entire vertical interval of 19

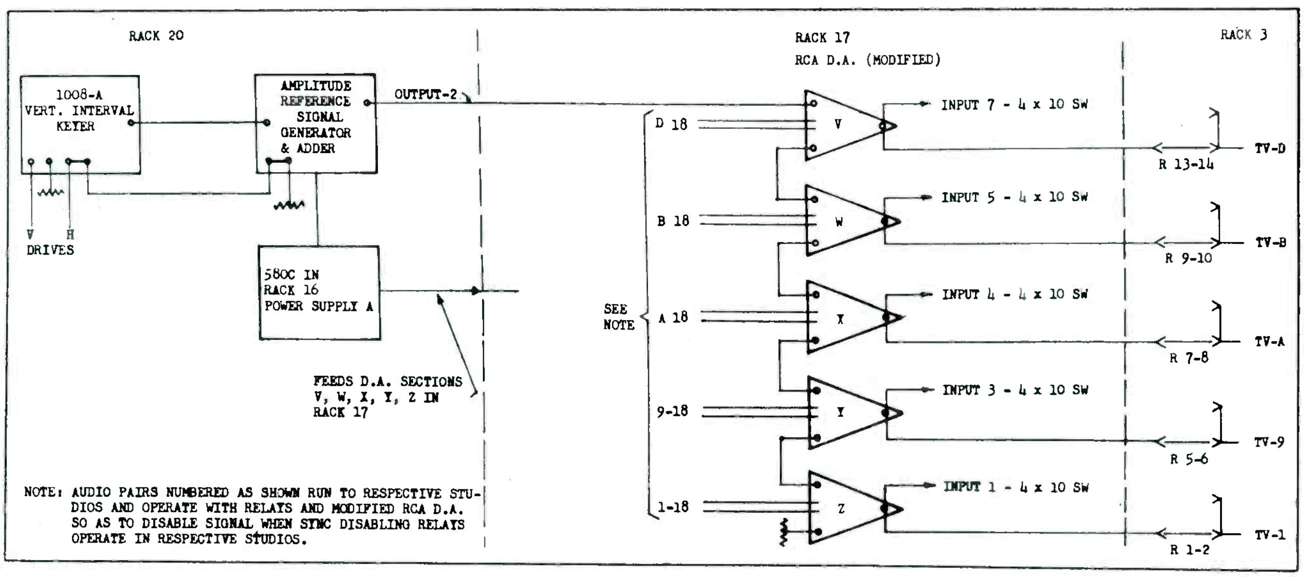


Fig. 5 - Block diagram of system for addition of amplitude reference signal to ABC TV programs in New York.

lines for retrace and that less than one fourth of current output complete their retrace in 13 lines. This would be a very gloomy contribution to this project were it not for the fact that initial field tests of vertical interval signals have indicated no objectionable problem in this respect. It is probable that a revised definition of retrace time will be needed to obtain information which applies directly to this problem.

Field tests of vertical interval signals are now being conducted by all three television networks. Columbia Broadcasting System has announced a schedule of transmissions during the daytime, seven days a week, beginning August 13. These transmissions are with amplitude reference signal only, and are the same as previously announced and discussed by CBS with the exception that the signal occupies two lines of each field instead of three. National Broadcasting Co. has announced that beginning August 30, all network programs originating at or transmitted through New York will include their composite vertical interval test signal. American Broadcasting Co. on September 17, resumed the transmission of the amplitude reference signal on a majority of network and local programs originating in New York. Both CBS and ABC expect to add technical test signals to their transmissions in the near future.

Each of the three network proposals is subject to several modifications and it is believed that desirable changes or variations will become evident after initial tests have been conducted. It is significant that all three networks agree on the operational importance of the amplitude reference signal and that a healthy spirit of cooperation in comparing these different ideas exists in the planning and conducting of these tests. The objective is the utilization of this new technique to the maximum advantage of the television broadcast service.

THE TELEVISION ALLOCATIONS STUDY ORGANIZATION -- ITS OBJECTIVES AND PROGRESS

George R. Town
Television Allocations Study Organization
Washington, D. C.

SUMMARY

The Television Allocations Study Organization was established, at the request of the Federal Communications Commission, by five of the major associations in the television industry. The objective of TASO is to make a thorough study of the engineering factors affecting the allocation of channels for television broadcasting. To carry out this task, six engineering panels have been formed. Each is working on a specific phase of the overall problem -- (1) transmitting equipment, (2) receiving equipment, (3) field tests, (4) wave propagation, (5) analysis and theory, and (6) levels of television picture quality. A total of 174 engineers from 92 organizations from all branches of the television industry are serving on TASO panels. The work of the panels is progressing rapidly and it is expected that significant results in the form of reports for the use of the FCC and the television industry will be forthcoming by the middle of next year.

It is not necessary in a group such as this to review either the crowded condition of the electromagnetic spectrum or the history of frequency allocations. It is sufficient to note that the demand for television channels and the reluctance on the part of prospective broadcasters to accept available channels in the UHF region have resulted in creating a most difficult allocation problem for the Federal Communications Commission. This paper is concerned with steps which the television industry has taken through its Television Allocations Study Organization (or TASO) to aid the FCC in the solution of this problem.

In its Report No. 2875 of June 26, 1956, the FCC discussed various ramifications of the allocations problem and suggested the possibility of ultimately shifting all television broadcasting to the UHF region. It was pointed out, however, that before anything of this nature could be done (if indeed, it should become practicable), many technical problems would need to be solved and the FCC suggested that the television industry make a concentrated attack on these engineering problems.

On August 31, 1956, the FCC issued its Public Notice 35638 in which it noted that the Commission had called a meeting of representatives of the television broadcasting and manufacturing industries to be held on September 20, 1956, for the purpose of establishing an organization to conduct an investigation into the engineering factors affecting the allocation of frequencies to television broadcasting. The organizations invited to the meeting were the Association of Maximum Service Telecasters, the Committee for Competitive Television, the Joint Council on Educational Television, the National Association of Radio and Television Broadcasters, and the Radio-Electronics-Television Manufacturers Association (since renamed the Electronic Industries Association). The scope of the investigation requested by the FCC was considerably broader than that visualized in its Report of June 26, as the studies were to include not only an inquiry into UHF problems, but also a general consideration of "the technical principles which should be applied in television channel allocation".

The television industry responded to the FCC's request by establishing the Television Allocations Study Organization (TASO). The organizational meetings of this group were under the chairmanship of Dr. W.R.G. Baker, President of RETMA, and former President of IRE. In the three months following the initial meeting on September 20, a Statement of Policies and Operations (or "charter") was drawn up and approved, a plan of organization was adopted and an Executive Director was employed. The planned activities of the organization commenced on January 1, 1957, when the Executive Director assumed office with headquarters in Washington, D. C.

The objectives of TASO are well expressed in the following quotation from the "charter":

> "The objectives of the organization shall be to develop full, detailed and reliable technical information, and engineering principles based thereon, concerning . . . . UHF and VHF television service. These principles, plus full supporting technical data shall be made available by TASO to the Federal Communications Commission so that the Commission may be able to determine the soundest approach to television channel allocations. TASO's functions shall be limited solely to technical study, fact finding and investigation, and interpretation of technical data."

To carry out the objectives of TASO, the organization shown in Figure 1 has been established. The policy making group is the Board of Directors which consists of two representatives of each of the five sponsoring organizations. The engineering studies are carried on by six panels of engineers and by appropriate committees and subcommittees of these panels. The work of the various panels is unified through actions of the Panel Coordinating Committee which consists of the chairmen and vice-chairmen of the panels, and the Executive Director. The latter is responsible for the administration of the activities of TASO. Members of the staff of the Federal Communications Commission serve as observers on all panels and also preside at meetings of the Board of Directors

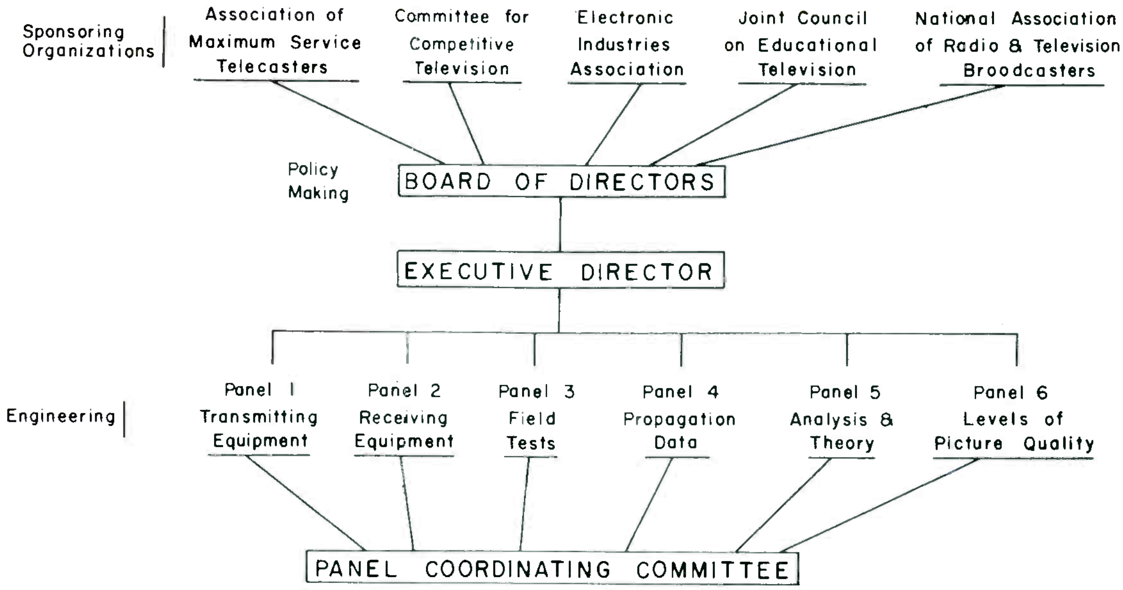


Fig. 1 - Television allocations study organization.

and of the panels and committees in order to comply with the suggestions of the Department of Justice with respect to the operation of industry groups advisory to governmental agencies.

The administrative expenses of TASO are borne through financial contributions from the five sponsoring organizations. The much larger expense involved in the operation of the panels is borne directly by the companies by whom the panel members are employed.

A few of the highlights of the work of the six panels will now be considered. The organization of Panel 1 - Transmitting Equipment - is shown at the top of Figure 2. This panel is charged with the responsibility of making detailed studies of the performance characteristics of television broadcast and repeater transmitters and of transmitting antennas and transmission lines. It has prepared and has circulated questionnaires to all television broadcasters to collect information on the performance of standard transmitters. A similar questionnaire is being formulated to collect information on repeater transmitters. Definitions relating to repeater transmitters have been drawn up and tests of a UHF booster operation in the Waterbury, Conn., area are in progress. Tests are also being conducted of the alternate channel operation of UHF boosters. The results of a number of tests of the operation of television stations with a reduced ratio of sound-to-picture power are being studied carefully. Panel 1 is aiding other panels in setting the requirements for proper operation of transmitters used in the propagation tests and field tests. Among the items still to be studied by the panel are those relating to transmitting antennas and transmission lines.

Panel 2 - Receiving Equipment - has responsibilities analogous to those of Panel 1, but in the area of television reception. The organization of the panel is indicated in the lower part of Figure 2. This panel is making a comprehensive survey of the performance characteristics of all types of television receivers -- VHF only, combined UHF and VHF receivers and UHF converters -- as well as of receiving antennas and transmission lines. It also has established a committee to report on the problems of community television distribution systems as they are related to television allocations. This panel also is considering the problems involved in lowering the sound-to-picture power ratio.

It may be noted that no mention has been made of studies of the probable performance of future transmitting or receiving equipment. Information on this matter is of vital concern to any group studying allocations problems. TASO must, however, proceed cautiously in such matters to avoid the possibility of involving the participating companies in antitrust difficulties. One procedure would appear to be to have the FCC request information directly from individual manufacturers and then for the Commission to give average figures to TASO. This problem is being studied further.

The task of collecting and analyzing data on wave propagation is assigned to Panel 4. This panel is making an exhaustive analysis of existing data on the strength of service fields and of interfering signal fields and is also conducting extensive measurements of the propagation of signals from representative UHF and VHF television stations in various sections of the country. The organization of this panel is shown at the bottom of Figure 3. One of the first tasks of Panel 4 was to establish standard methods for taking field strength data. Standards have been set for measurements taken primarily for analytical purposes and are being developed for measurements taken primarily to determine station coverage. In cooperation with the Association of Maximum Service

Telecasters (one of the TASO sponsors), comprehensive measurements of UHF and VHF propagation in the Wilkes-Barre, Pa., area have been completed and similar programs are now in progress at Baton Rouge, La., and Madison, Wisc. A tremendous amount of data on tropospheric propagation collected by the Central Radio Propagation Laboratory of the National Bureau of Standards over a period of several years is being studied and analyzed. The panel is also studying the possible merits of vertical, cross, and circular polarization and the relative coverage of single high power versus multiple low power transmitters.

Panel 3 - Field Tests - is concerned with the performance of television receiving equipment in the home and with the correlation of this performance with field strength as measured by Panel 4. Two avenues of approach to this problem are being employed. The first is a comprehensive survey of television reception conditions through the use of a questionnaire which has been circulated to some 5000 television servicemen through the cooperation of the National Alliance of Television and Electronics Service Associations. The second is the use of teams of technically trained observers from Panel 3 and from local television stations who, in cooperation with Panel 4, make observations of television reception in the homes in the areas in which Panel 4 makes propagation measurements. These observers, who incidentally, do not themselves touch the householders' receivers, also record the comments of the householders. Preliminary field surveys have been made in New Orleans, La., and Fresno, Calif., to develop techniques. A full-scale field survey will start next week in Baton Rouge, La., and another will start the following week in Madison, Wisc. These will be followed by tests in California and elsewhere. Arrangements have been made to facilitate the analysis of the data collected by Panel 3 through the use of electronic data processing equipment. The organization of Panel 3 to accomplish these tasks is indicated at the upper portion of Figure 3.

One of the basic problems in television allocations is that of specifying what constitutes a satisfactory picture in the presence of various types and degrees of interference. Such information must be known before anything can be determined regarding the spacing of television transmitters. The study of this problem is the province of Panel 6 whose organization is shown at the bottom of Figure 4. This panel was established only recently upon the recommendation of other panels and it will hold its first meeting next week. The first task of the panel will be to delimit the sphere of its activity to a consideration of those factors -- such as, for example, co-channel and adjacent channel interference, multipath interference and interference from multiple sources -- which have a bearing on the allocations problem. The panel will then have the task of setting up tests whereby groups of typical television viewers will judge the quality of laboratory-produced pictures when the different kinds of interference are introduced in order to determine the maximum amount of interference which can be tolerated in a "satisfactory" picture. It may be desirable to conduct such tests with two different classes of observers -- one accustomed to viewing excellent television pictures in areas near broadcasting stations and one accustomed to viewing in more remote areas.

Finally, Panel 5 - Analysis and Theory - has the task of fitting the information obtained by the other panels into a coordinated picture of the

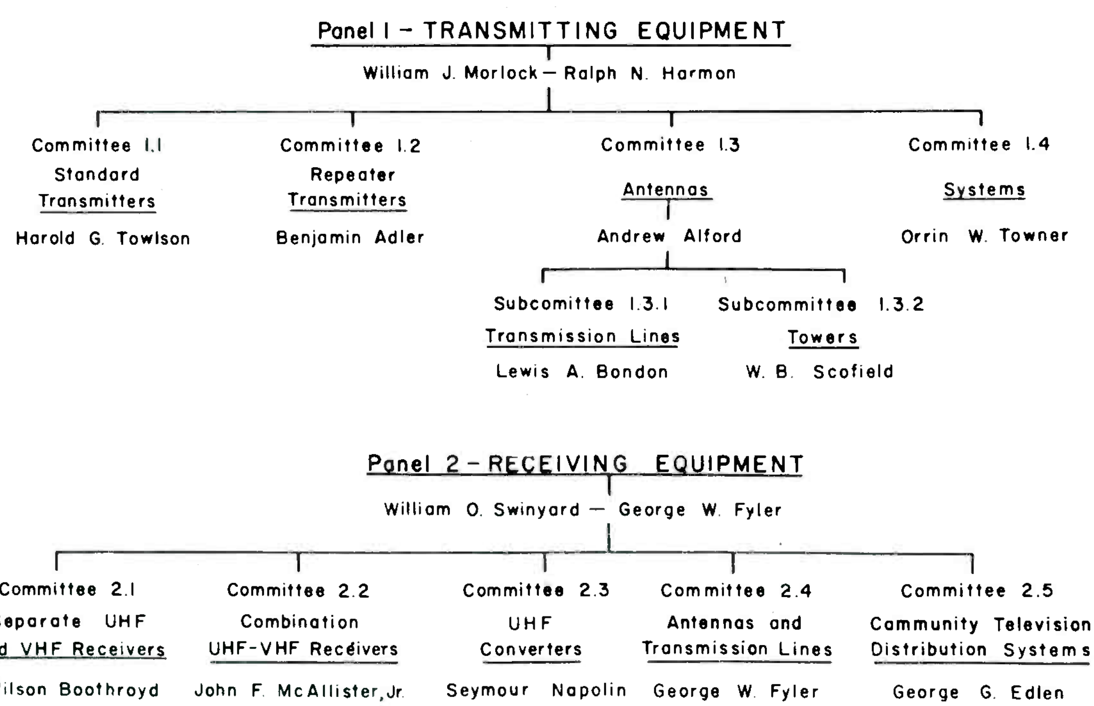


Fig. 2

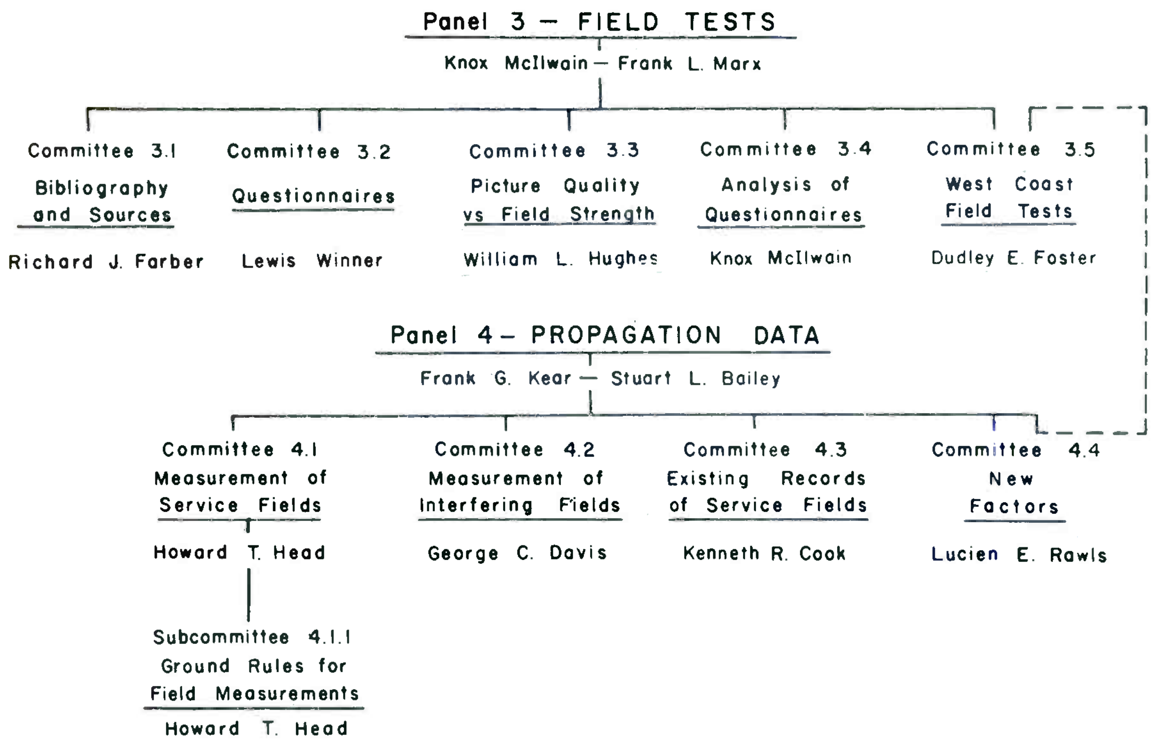


Fig. 3

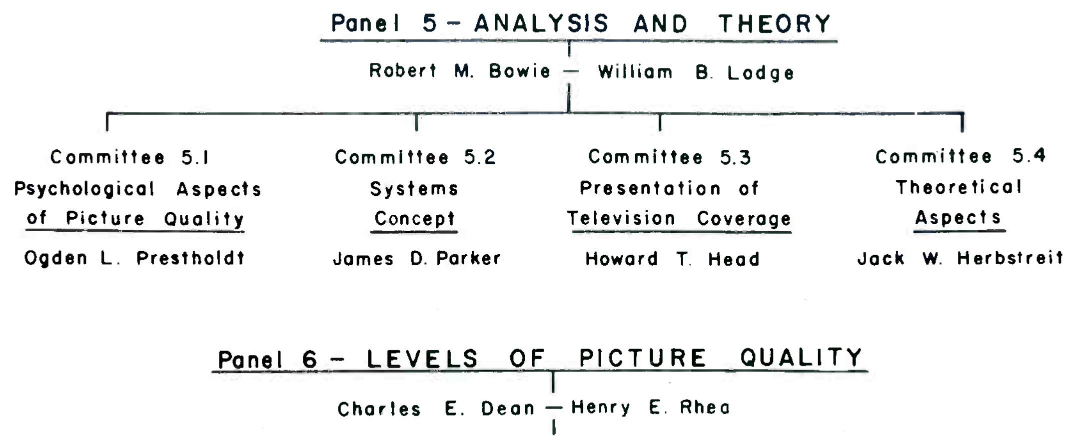


Fig. 4

entire television system and of presenting the conclusions of TASO in such form as to be most useful for allocations purposes. The top part of Figure 4 shows the organization of Panel 5. Although some of the work of Panel 5 cannot be done until after considerable progress has been made by the other panels, this panel is now actively engaged in a variety of tasks. One problem is that of determining how television coverage data may be presented to best advantage. The panel is also currently studying the theoretical aspects of a variety of activities of the other panels to be certain that there are no basic weaknesses in their approaches to their tasks. Panel 6 was established as a result of preliminary studies of the psychological aspects of picture quality made by Panel 5.

One of the major tasks of Panel 5 is that of studying the entire television allocations problem from the systems point of view. This has led to their development of the system concept chart of Figure 5. This chart shows the interrelationship of the many factors which enter into the study of television allocations and it serves to point out the existence of factors which must be studied before the work of TASO can be finished. Starting with the left hand column, it is noted that quantitative data are needed regarding the permissible ratio of wanted signal to interference and other necessary characteristics of a satisfactory television picture. Working to the right, or from the output to the input of the receiver, pertinent characteristics of television receivers must be de-

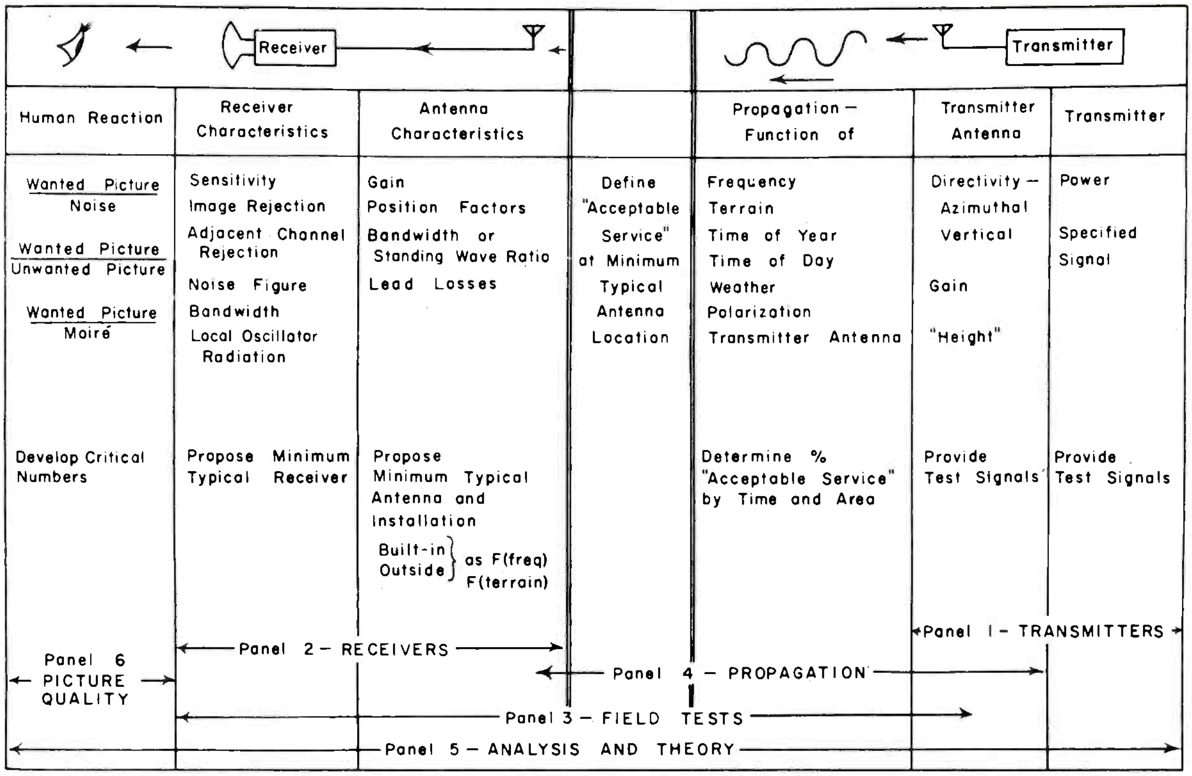


Fig. 5 - System concept chart.

termined and combined with the required picture characteristics in order to specify the necessary signal input to the receiver. Going one step further to the right, if the characteristics of typical receiving antennas and transmission lines are determined, it is then possible to specify the necessary strength of the desired signal field and the maximum permissible strength of interfering fields at the position of the receiving antenna. Now, starting at the right hand column and assuming the existence of a satisfactory picture at the television studio, if information is at hand regarding the available power output of television transmitters and, moving to the left, the characteristics of transmitting antennas and transmission lines, it is possible to determine the effective radiated power. The next, and most difficult task, is to analyze the propagation path. Once its characteristics are known, the service area of the transmitter can be determined since both the radiated power and the required field strengths at the receiver location have been determined and specified. All the factors mentioned are, of course, functions of frequency, terrain, etc. The system concept chart thus provides a framework or outline which can be, and which is being, expanded to specify in detail the characteristics of all parts of the television system which must be determined before the FCC can "determine the soundest approach to television channel allocations".

This outline of the work being undertaken by the six TASO panels is necessarily brief and incomplete. But it may serve to indicate the scope of the work now in progress.

Looking toward the future, a large amount of work remains to be done. Wave propagation measurements still must be made in many areas and the Panel 3 field tests are actually only well under way. The work of Panel 6 has only recently been commenced. In addition to these broad areas of study, a considerable number of investigations of a more restricted scope need to be completed within the purview of the various panels. These include studies of such diverse topics as the determination of the true power radiated in a given direction from an installed transmitting antenna; the possible effectiveness of cross polarization and of circular polarization; the effectiveness of various types of receiving antennas; the deterioration of receiving antennas and transmission lines with age; the relationship between receiving antenna height and the developed signal voltage; the description and specification of characteristics of the terrain which affect wave propagation; the description and specification of the ambient conditions at the receiving antenna site which affect the received signal; the relative values of noise and of multi-path effects at UHF and VHF; the relative reception of color television at UHF and VHF; the extent to which repeater transmitters are useful or are required under various conditions; the methods by which the effects of interfering signals from two or more sources should be combined; and the method for the best presentation of data on television station coverage. Finally, there will be the essential task of preparing the final reports in which all pertinent information is summarized and conclusions are drawn.

The success of any venture such as TASO depends primarily upon the engineers who serve on the technical panels. TASO has been particularly fortunate in securing outstanding engineers as officers and members of its panels, committees and sub-committees. These have been drawn from all branches of the television industry in all parts of the country. A total of 174 engineers from 92 organizations are serving as panel members, alternates and observers and still others are serving on committees. These men work for manufacturers of television transmitters and receivers, for broadcasting networks, for independent high and low power, UHF and VHF television stations, for engineering consulting organizations, for educational institutions, for technical publishing houses and for governmental agencies. It is believed that the TASO membership represents an unusually able and, at the same time, inclusive cross section of the entire television engineering profession. Almost every engineer participating in TASO is a member of IRE and many are members of the Professional Group on Broadcast Transmission Systems.

In summary, it can be said that significant progress has been made to date, that there is a large amount of activity on many engineering fronts and that a great deal remains to be accomplished. There appears to be a well-founded expectation that as a result of these activities, TASO will make a significant contribution to the television allocations problem.

A MANAGEMENT VIEW OF TV TRANSMITTER OPERATIONAL PRACTICES

Ralph N. Harmon
Westinghouse Broadcasting Company, Inc.
New York City, New York

One of the men in a company associated with us has a five-year old son named Dick.

Dick and his mother got on a bus near home, and as they walked down the aisle of the bus they passed a woman Dick's mother had never seen before. The stranger said hello to Dick, and Dick said, "Hello, Mrs. Shelton." When they got to their seats, Dick's mother, puzzled as to how her five-year old could know someone in the neighborhood she didn't, asked: "How did you know that was Mrs. Shelton?" Dick replied, "I knew by her face."

At one of the sessions of "The Boston Conference," Franklin A. Tooke, Station Manager of WBZ-TV, threw some slides on the screen which showed, in succession, the front covers of LIFE, SATURDAY EVENING POST, WALL STREET JOURNAL, BUSINESS WEEK, and some others.

Then he said, "When you look at each of those covers you know what you will find inside the particular book or paper. Each of those publications has a face that you recognize. That face is an identity that you recognize which has been created consciously and deliberately by years of effort."

There are a great many fine department stores in America, and one of the smartest of them is in Dallas, Texas. Why should Neiman-Marcus, away out in Texas be able to distinguish itself in a field which is so full of agressive, imaginative, daring outfits? Because Neiman-Marcus has deliberately set out to do startling, original things and because, as someone has said, it regards itself as a "state of mind."

As Chief Engineers of television broadcasting stations, it may not have occurred to you that your "state of mind" as it applies to your job could have an important affect on the face of your station.

The management of the Westinghouse Broadcasting Company believes that the "state of mind" of all its personnel makes the "face of the station"

With respect to the Chief Engineers and their personnel this state of mind is most important as it relates to the picture and sound of their station's face. If they and their personnel exhibit a critical attitude, a continual seeking for improvement, a dissatisfaction with the limitations of their equipment and themselves as a "state of mind," then the face of their station is going to be clear, clean, sharp and sweet.

If, however, their state of mind is the opposite of critical, if they are complacent and satisfied with themselves and their equipment, then it is a certainty that their station's face will be dull, smeary, unsteady and in bad voice.

The basic ingredients which determine the face of your station are: People, Time and Money. All stations have some of each of these ingredients; some have more people or more money, but all have the same amount of time.

The successful station has competent, effective people who make the maximum use of time and money in creating the station's face. Some of us, and perhaps you too, may feel that there is a minimum of competent people and money available to do your job, so the maximum applies only to the number of hours you and your staff work.

However, a successful station with competent people also means dedicated people, and the challenge of the better face far outweighs the 28-hour days worked.

The unsuccessful station may have plenty of people and, in some television markets, plenty of money, but they are not competent, dedicated people nor do they effectively use their time and money in creating the better face for their station.

The Westinghouse Broadcasting Company believes that competent, dedicated people are the most important of the three ingredients (People, Time and Money). They go to great lengths to get these people and to see that they are capable and do an effective job in creating a better face for the station.

Successful management must use all known methods to obtain, create and train effective and dedicated people. They must delegate to these people the maximum authority and responsibility each can carry, because the strength of the station and its better face is the sum of the effectiveness of the individuals.

The Hallmark of the station with the better face is the sum of the effectiveness of its individuals.

Effective organization of the management team of a station, between the manager and departments, can often be the difference between the better face and the ordinary or dull, smeary one.

The preferred organization of the management team of the Engineering Department of Westinghouse Broadcasting stations is: A Chief Engineer, reporting to the Station Manager, a Studio Operations Supervisor, a Transmitter Operations Supervisor, and a Technical Facilities Engineering Supervisor, each reporting to the Chief Engineer.

The titles of this management team indicate their general areas of responsibility and authority. However, because of our strong belief in spelling out lines of authority and responsibility for all management and non-management personnel, several of these responsibilities are outlined below:

Basically the responsibility of the Chief Engineer to the station management is to provide the most efficient and economical high quality technical operation possible consistent with good engineering practices and general policies and procedures established by Headquarters. In accomplishing this objective the Chief Engineer's responsibilities include:

1. Serving as a member of the station Management Committee for the establishment of local station policies, procedures and the solving of local problems.

2. Preparation of Engineering Annual Facilities Program and Yearly Operating Budget.

3. Initiation and initial approval of expenditures within the limits of the approved budget.

4. Initiating for approval "E" Order requests to accomplish the approved Annual Facilities Program.

5. Liasion with the Program Manager and the Sales Manager in the interest of scheduling man power and facilities as economically as possible consistent with the Program and Sales Departments' needs.

6. The development of more efficient operating techniques.

7. Engineering representation at labor negotiations for technicians and building service employees.

8. The interpretation and application of the provisions of Union Contracts.

9. Making special studies and reports as required by the General Manager.

10. Keeping abreast of technical advancement in industry for possible application to the improvement of the station's operation.

11. Solution of labor problems.

12. Direction of the Supervisors in achieving the basic responsibilities of the Engineering Department.

13. Direction of the Supervisors in the design, selection, procurement, installation, operation, and maintenance of all technical facilities.

14. Preparing engineering reports as directed by Headquarters, and required by the F.C.C. with respect to license renewals and applications.

15. Selection of operating personnel and the direction of their training through the Supervisors.

16. The technical quality of all programs and facilities.

17. The establishment of operating maintenance procedures.

Through the Chief Engineer, Supervisors are directly responsible for the following:

1. Operation and maintenance of all technical facilities under their jurisdiction.

2. Scheduling of personnel under their jurisdiction.

3. Training of personnel under their jurisdiction.

4. The establishment of maintenance and testing procedures and the execution of these procedures.

5. Compliance with F.C.C. regulations relative to the operation of transmitters and equipment under their jurisdiction.

6. Technical quality of broadcasts through their facilities.

7. The development of operating techniques to improve station efficiency.

8. Recommendations for engineering changes of their facilities to meet Program and Sales Departments' needs.

9. Assistance to Chief Engineer in planning facilities changes.

10. Direct contact where applicable with clients and agency personnel in connection with operating problems.

11. Accepting and executing special requests from the Program Department necessitating changes to meet their needs.

12. Performing emergency repairs and maintenance as required.

13. Furnish data for inclusion with Monthly Report to Headquarters.

14. Inventory of spare tubes and parts and initiate requests for replacement items as needed.

Technicians are responsible to the Supervisor for the following:

<u>Crew Chiefs:</u>

In addition to the items listed under "Technicians", the Crew Chiefs shall be responsible for the direction and instruction of personnel in their respective crews.

Technicians:

1. Perform operating duties in accordance with the methods in which they have been trained.

2. Perform routine maintenance duties according to established maintenance schedules and perform emergency maintenance when required.

3. Report troubles and outages as well as maintenance jobs performed on report forms provided.

4. Report serious trouble immediately regardless of when it occurs.

5. Make suggestions for changes and improvements on existing equipment and systems.

6. Advise supervisors at the first indication that equipment is not meeting Standards of Good Engineering practice.

7. Install and test new equipment and make necessary changes in existing equipment as directed.

8. Provide a high quality operating service for the Program and Sales Departments.

9. Keep operating areas and appearance of equipment neat at all times.

10. All technicians, whether assigned to Film Control, Studio or Maintenance shall acquire a thorough knowledge of the routing of all video and audio signals in order that they can patch around defective equipment to keep outage time to a minimum during emergencies. Transmitter personnel shall acquire the same knowledge with respect to their facilities.

Individual responsibilities and authorities as detail as these leave no room for doubt as to who has authority for what functions and who is responsible for their performance.

Having a complete organization chart and the responsibilities and authorities spelled out in detail for each member of this chart leads to the next step -- How to get effective people for each position.

The ability to pick effective people at all levels in the organization is one of the most difficult of management's jobs. Knowing what kind of a job you want filled goes a long way toward determining what kind of man you are looking for. With proper understanding of these, a careful screening and testing of applicants will usually turn up a satisfactory candidate. Having enrolled the new member on the team, the next important step of orienting and training must be immediately started; not the least important part of this is to turn him into a truly dedicated member of the team always trying for the better face of the station. ("Westinghouse-ize")

If it can be assumed that suitable engineering personnel are available, the second ingredient, effective use of their time, must be solved.

Again, the solution is simply stated: What is to be done and why, where, when and by whom?

In the Westinghouse Broadcasting stations the answers to the most basic of these questions are found in various operating and policy manuals available to all departments. Perusal of the proper manual will usually give the company's policy position and operational procedure preferred regardless of whether it is an accounting, sales, program, engineering or what-not problem. It should not be assumed that this results in an operation by rote.

Far from it. Having deliberately picked personnel who are trying for the better face, we find they are more apt to find reasons for short-circuiting the manual than practicing it by rote. However, the manuals are an invaluable aid in spelling out what the problems are and suggesting methods for solving them. Naturally some parts of the operating manuals of the Engineering Department must be adhered to in all respects, others are only suggestive and may be optioned.

For example, the Engineering Department Operation Manual spells out in considerable detail all operating procedures necessary to assure compliance with F.C.C. rules and also Westinghouse good engineering practices and standards, which are generally more strigent and broader in scope than the requirements of the F.C.C.

The purpose of the Manual is to make most effective use of the time of the Engineering personnel in creating the better face for the station. In other words, to specify what to do, when, where and why, and by whom. Since the television transmitter plant from a viewpoint of spectrum bandwidth is apt to be the limiting factor in determining the face of the station, it is felt that there is no part of the television plant where it is not mandatory to actually know -- not just think or hope we know -- the actual condition and performance of every component in the plant; not just now and then, but all the time.

Most of you know the better television transmitting plant doesn't just happen to get that way, anymore than your wife happens to keep your house clean, tidy and comfortable to live in. In other words, your house doesn't just happen to get to be a home. You and your wife and family plan it and make it home.

The same is true of the better transmitter supervisor. He plans it, so it is that way. He lays his work out in detail on an hour-by-hour, day-by-day, week-by-week, and month-by-month basis. Yes, even on a seasonal basis. He knows what is to be done ahead of time, does it at the time to do so, and keeps records of what is done so he can do better the next time. Also, he can assure the Chief Engineer that everything possible has been done, and he can help in the making of future plans. This is the way the better transmitter plant gets that way.

The difference between the critically-minded transmitter staff, looking for the better face, and the complacent staff, which is satisfied to get by with a dull face and a tolerable amount of outage, amounts to the same difference as the care a racing car mechanic gives a racing car and the care you give the car you drive to work every day. Maybe you are satisfied as long as it gets you to work, but it is not the competitive performance level necessary for a racing car, nor that necessary for the better face of the competitive television station.

Time will not permit, nor is it necessary to go into the details of each of the procedures followed to assure that all parts of the television plant are performing at top capability. It is sufficient to say that numerous detailed systems measurements are made, regularly and frequently; all for the purpose of getting and knowing that the performance is the best possible.

Apparatus used is in most cases commercially available and probably similar to that used by other broadcasters. Except for the monthly report made by the Chief Engineer of each station to the Vice President for Engineering in New York, records and engineering reports to station management are probably similar to those used by most of your stations.

The monthly report to New York usually contains ten to twenty pages, most of which are completed standard, printed forms, tables, curve sheets and photographs. In any large organization everyone complains about too many reports. In our organization we actually have a committee to do away with reports.

The monthly engineering report from the stations is considered one of the most useful of our engineering reports. It starts out with a short discussion of what happened at the station during the month that was unusual, how operations were (normal, abnormal), changes in personnel, facilities, work in progress, suggestions or discussions on engineering problems. Generally this part covers not over two to four pages. The bulk of the report is data contained on standardized forms, curve sheets, etc. on performance tests, measurements, tube hours, inventory changes, and so on. Enough information can be obtained from these measurements to have a good feel for how the plant was doing for that period. Actually, this information is what we call "FYI information of a POP nature," that is, "For Your Information here is our Proof of Performance for the past month." Most of the time that is actually what it is used for. Infrequently it is used for detailed policing when there may be some areas of dissatisfaction on some performance.

The third and last ingredient -- "the root of all evil" -- is the necessary common commodity everyone will accept for services and goods rendered -- namely, MONEY.

How to make the best use of money is a problem every organization spends much time and effort on; if for no other reason than the false reason, to make money.

Actually, we all know all business must render a service to someone to whom the service is considered sufficiently useful to cause them to pay the server more money than it cost the server to perform the service. Thus, the interest in obtaining the maximum service for the minimum money.

At Westinghouse Broadcasting stations money comes under two basic budgets. The first is the operating budget on which the day-to-day, month-by-month business is conducted. It is prepared annually and revised quarterly. The second budget, also prepared annually but rarely modified during its active budget year, is what is usually called the "Annual Facilities Budget."

The first budget, the operating budget, covers all departments. From this budget the station manager can determine what his total operating costs will be on a month-by-month period and when related to sales can determine his break-even point and profit or loss for various levels of sales. The operating budget must be detailed and accurate if money is to be used wisely, and it must be so used if services rendered are to be sold for more money than the money it costs to produce the services sold.

In the case of the Engineering Department, their operations budget is almost entirely an expense budget because in the main they are a service department to the other departments in the station. Their budget is seldom broken down to cover separate costs for studio or transmitter, operating costs; although, in some cases, a separate operating budget is used for studio and administrative offices and buildings.

The Engineering operating budget usually has about forty different individual expense accounts. This is set up starting with "technical salaries" as 01 and ends with 39 as "other" expenses.

Items of interest to a transmitter supervisor after the 01 salary account are: power, tubes, depreciation of equipment, maintenance of equipment, telephone lines, etc. Each item is carefully estimated and controlled. History on each account and comparison of similar accounts among the various stations indicates trouble areas and where improvements should be sought.

The second budget, the Annual Facilities Budget, insofar as it is of interest to the Engineering Department, is a budget which is used almost entirely for providing money to modify, improve, change, repair or build new technical facilities and plants.

Engineering facilities money is provided to reduce operating costs, improve and expand product and to replace worn out or obsolete equipment. Items for this budget are first recommended by the stations to Headquarters, where they are reviewed and finally approved for each station and for all stations in the broadcasting company to the parent company after conference between Headquarters and the stations and by the several levels of management above the departmental level.

A competent Chief Engineer and his supervisors know what their plant needs are and why. Headquarters people, through monthly reports, trips to the stations and other contacts with manufacturers and others, are familiar with the state of the art and what equipment is available now or later. This results, again, in competent and knowledgeable recommendations for use of money to maintain and improve technical plants. Repeating again, as in the case of use of personnel and their time, the two budgets are for the purpose of using money most effectively -- where, when, for what, how and why.

In summary, the station with the better face doesn't just happen. It is planned that way through the use of competent, dedicated people who are given the maximum responsibility with its related authority and with well defined and spelled out methods and procedures for using their time and the station's money effectively and efficiently so the station's better face can render a service for which the station receives more money than it costs to produce the service.

A SURVEY OF AUTOMATION AND THE APPLICATIONS OF TAPE RECORDING IN BROADCASTING AND TELECASTING

R. A. Isberg
Consulting Engineer
Palo Alto, California

Summary

The responses to a mail survey of 2735 broadcast and television stations were analyzed to determine the extent to which tape recording is presently used in routine broadcasting.

The average broadcaster has three or more tape recorders. The majority of the stations use tape extensively for delaying remote, local and network programs as well as for spot announcements, auditions, telephone calls, master recording, echo effects and sound effects.

Approximately 40 per cent or the stations evidenced interest in automatic program systems, and approximately 5 per cent of the stations reported that they are presently using automation. Reactions to the future use of automation in individual stations varied from enthusiastic to very negative, but the favorable comments prevailed. Comments from users of automation were all enthusiastic and indicated that automation permitted expansion of program service with the same size staff, better working conditions, and increased profits.

Six types of automation equipment are described, as well as an automatic one hour delay program system for network time zone application.

Introduction

Automation has been described as a word that is a synonym for Yankee ingenuity. The RETMA Automation Committee has defined it: "Automation is the technique of improving human production in the processing of materials, energy, and information by utilizing, in various degrees, elements of self control and product flexibility."

Many of the redundant operations in broadcasting can be performed by automatic control systems, and during the past two years, a number of radio and television stations in the U.S.A. have installed and are using automation equipment. The extent to which automation is used, the potential interest in automation, the comments both pro and con regarding it, and an analysis of the uses for tape recording in broadcasting was recently studied by a mail survey of all the operating radio and TV stations in this country. More than 30 per cent of the stations returned the post card questionnaires, such as the one shown in Fig. 1. This is an unusually large response for a mail survey and is, in itself, an indication of the interest in the subject, as well as an indication that the survey's accuracy is high. This study was sponsored by the Ampex Corporation.

Tape Recorder Utilization

The average station has three or more tape recorders, the majority being semi-professional and professional types, but many stations also reported home type inexpensive recorders. Twenty-four makes were reported, and the oldest recorder was over 11 years old. The average age of all the recorders was approximately three years.

The extent to which tape recording is utilized in broadcasting is shown by Fig. 2 in bar graph form. Sixty-five per cent of the stations use tape for recording remote programs, and the majority of these stations record from 1 to 3 hours of remote programs per week.

No. of tape recorders in use 4, Makes Ampex & Magnecorder
Ages 5 & 2, Hours/week tape is used for remotes ______, delayed local 2, delayed net ______, spot announcements 12
automatic announcer 4, automatic program 4, or other uses ______
Do you operate Yes, ~~plan to install~~ ______ an automatic program system? What type: tape Ampex, tape and records ______, automatic records only ______, Make ______?
Are you using IBM for logging? No Are you interested in sequential switching systems for television? Yes
How will Automatic Programming increase your profits? By Reducing Operating Cost.
NAME C. L. Carter Call Letters WJAP-TV
ADDRESS 4058 Phillips Highway, Jacksonville, Fla.

Fig. 1 - Data for this survey was obtained from post cards returned by radio and TV stations.

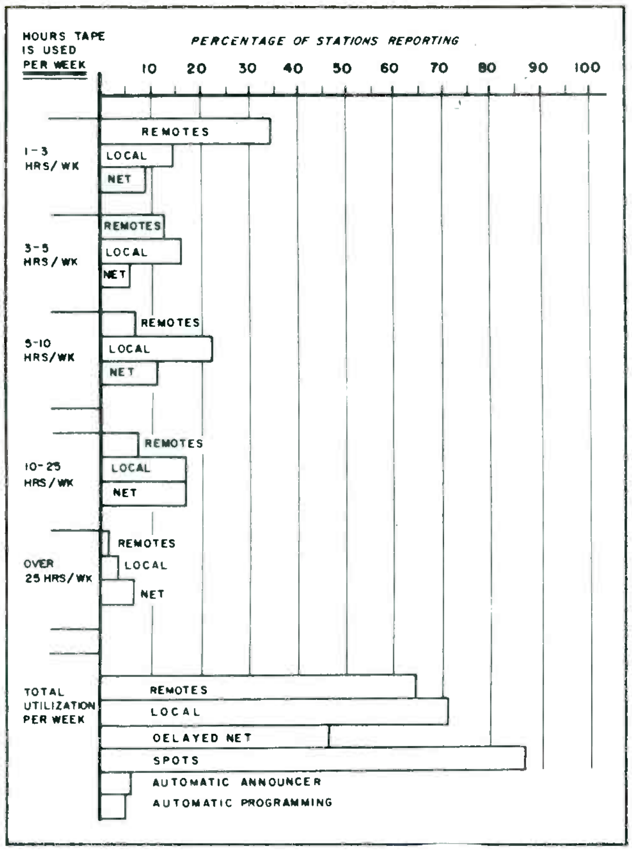


Fig. 2 - Data from 700 of the postcard replies was used to prepare the above charts which illustrate the extent to which tape recording is used in broadcasting.

Seventy-one per cent of the stations delay their local programs by tape recording, the majority utilizing tape recording from 1 to 10 hours per week for this purpose. Forty-seven per cent of the stations use tape delay for network programs, and the extent of this use varied considerably with time zones. Eighty-eight per cent of the stations use tape extensively for spot announcements, some stations indicating that more than 200 spots per week were on tape, others stating that 40 per cent of all spots were taped.

A relatively large number of stations first tape record their spots, then they re-record the spots on acetate discs. This is evidently done for operating convenience at stations which do not have tape reproducers located within arms reach of the operating console. On the other hand, a large number of stations have installed their tape transports within reach of their combination announcer and operator and thereby have made it easy to integrate taped spots with their programs.

An example of this type of operation is KMAK in Fresno, California, which has established a policy that all spots are recorded on tape, even if they are furnished to the station on records. The spots are individually wound on small reels, and are numbered and titled for easy identification, and are filed in a set of rotatable shelves located adjacent to the tape transports. The operator merely loads the spots on the tape transports and intersperses them between the records in accordance with the schedule. He does no announcing, since all announcements are on tape. The advantages to this station are that each spot can be perfect before it is aired, maximum utilization can be made of the best announcers on the staff, and the man on duty need not be a qualified announcer. Ampex, type 350-R recorders with remote controls are used in the control room. The remote control feature greatly simplifies the operator's duties. Tight cuing (1/10 second) is possible since the tape transports' capstans run all of the time and are engaged by a solenoid from the operator's remote control panel. A further improvement in this installation to simplify the operators functions, might be to add an automatic stop feature to stop the tape transport after the spot has ended.

Automatic Program Systems

Of 790 stations responding to the questionnaire, 38 were using automatic programming and 45 were utilizing automatic announcing facilities. The majority of these stations use automatic programming from 28 to 50 hours per week.

Over 39 per cent of the stations responding to the survey are either operating or contemplate operating automatic program systems. The remainder of the stations are either undecided or believe that automation will not fit in with their program formats or operations.

One of the systems used by a number of stations is the Ampex S-3380 with an automatic record player such as is shown in Fig. 3. This system utilized one tape reproducer at 7 1/2 ips for announcements and either an automatic record player (AMI or Seeburg) or another 3 3/4 ips tape reproducer for program material. The system is controlled by timers so that it will make station identification announcements on the hour or half hour, automatically fading the program during the announcement. This system can be programmed for up to 18 hours of operation, but most of the stations presently utilize it for night operation, or from midnight until the next work day begins. Sub-audible 25 cps tones are recorded during or at the end of announcements to start the program player, whether it be a record or a tape reproducer. Tight cuing and overlapping of the music with announcements is thus possible, since the announce reproducer continues to operate to the end of the 25 cps tone, but the program reproducer starts to operate at the beginning of the tone. A 25 cps filter is supplied to attenuate the control tone so that the public is unaware of the automatic operation.

Semi-Automatic Announcing Systems

A great deal of interest has developed in a simpler automatic control system for tape recorders. Such systems have been used principally to stop tape recorders at the end of an announcement in semi-automatic announcing systems or at

Fig. 3 - The Ampex S-3380 Automatic Program System and Seeberg record changer. The rack mounted equipment includes a 7 1/2 ips announce tape reproducer, the automatic control unit, an optional panel for controlling an automatic record changer, and a 3 3/4 ips program tape reproducer. This system includes a master timer for automatically reproducing the station identification on the hour and half hour as well as an electronic fade system which fades the music when announcements and music overlap.

Record changers such as the Seeberg Model 200 IU-1, shown at the left are adaptable to the automatic program system. It will play 200 sides of 45 rpm records in succession (100 records) or in sequence as determined by individual preset levers at the front of the unit.

The tape recorder is used to record the taped programs and announcements, and the recording console at the right provides a 3 channel mixer, program timer, 25 cps tone generator, and remote controls for the tape recorder.

the end of a musical selection in semi-automatic tape program systems. Fig. 4 shows a semi-automatic announcing system such as is in operation at KCRA-TV in Sacramento, California.

Most of the voice announcements during network and film programs at KCRA-TV are reproduced by the Ampex Model 350 recorder associated with a 25-cycle tone sensing unit in such a way that the machine automatically stops after each announcement.

The equipment is rack mounted in the control room and can be operated from three remote control positions. A custom built announcer's control panel and two operator's control panels provide complete control of the tape transport; fast forward, rewind, stop, play, and record, as well as a tone button which activates a 25 cps oscillator. The operator's control panels have remote control switches for two phonograph turntables and an announcer signal button which flashes a light in the announce booth.

The announcer's control panel also includes a clock, a program timer, a headphone monitor selector, intercom, push button for a control room buzzer, announce key, and tally lights.

While recording the announcements, the announcer pushes the tone button after each announcement. The 25 cps signal stops the tape transport after each announcement is played, relieving the technician of an additional switching operation and eliminating the danger of the next announcement being played out of order. A big advantage of this method of operation is that the technician does not have to follow a script. Since the announcer has remote controls for the recorder, he can edit his announcements, and erase portions which he may wish to correct. The program timer can be manually operated to time programs on the air, or to automatically time the duration of recordings. KCRA-TV operates 18 hours a day, hence recorded announcements have solved many problems involved in scheduling announcers to cover more than two shifts and have relieved the announcers from menial and confining announce booth duties. The result is more interesting work for the announcers and more available manhours for live commercial and public service programming. It is used for more than 70% of the broadcast day.

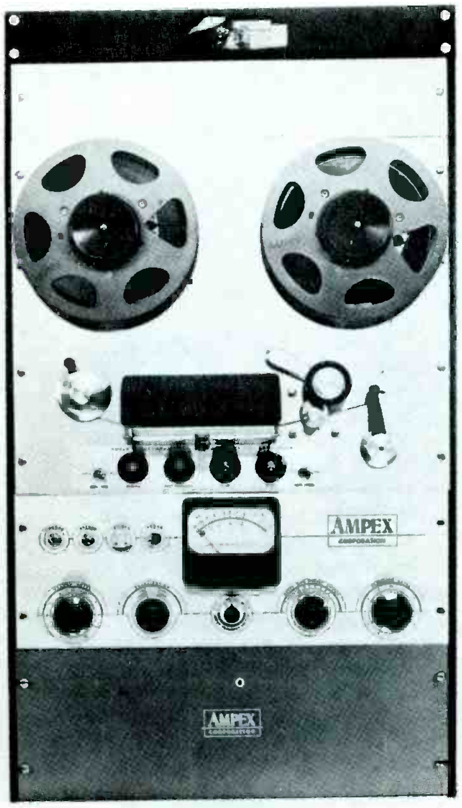


Fig. 4 - A semi-automatic Program Control System consisting of a Model 350 tape recorder and a Model 355 Automatic Program Control Unit. This system provides automatic stopping after each announcement of musical selection recorded on tape. If desired, another Model 350 or 352 tape reproducer or an automatic record changer can be added to this system for automatic operation. No modification is required of either the control unit or the recorder to add the second program machine.

Semi-Automatic Broadcast Operation

To reduce the stresses of combination operation, improve the quality of reproduction and to reduce operating costs, some broadcasters have installed semi-automatic systems for their tape recorded music libraries. These systems are similar to the one described above and shown in Fig. 4. Twenty-five cycle tones are recorded after each musical selection to automatically stop the tape reproducer which is then properly cued for the next selection. The operator simply makes the next announcement, plays a recorded commercial or inserts a disc recording. When he desires the next tape selection, he merely has to press the start button on his remote control panel. Should the operator not desire to play the tape recorded selections in the order in which they are recorded, he simply runs the machine at fast forward or rewind and counts the beeps caused by the 25-cycle tones at high speed. This feature overcomes a major objection to the cuing of tape recorded musical selections or announcements.

One station has a library of 5,000 discs dubbed onto 300 10 1/2 inch reels of tape, approximately 24 popular records to each reel. Two men worked full time for three months to complete the dubbing operation. Twenty-five cycle cue notes are recorded between each selection. Wear and breakage of records has been practically eliminated, a very important consideration, since many of the discs are collectors' items. In addition, an important by-product of the dubbing process is the fact that objectionable choruses can be eliminated from show tunes.

Each tape has an initial identifying voice announcement, giving its library number, and 10 seconds of 25-cycle tone for a reference level to insure that the playback gain is properly adjusted for reliable operation of the sensing circuit.

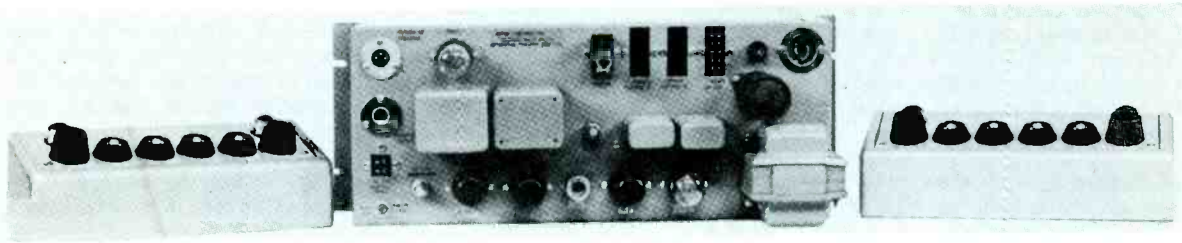
The station varies its programs by playing one recent record for each three selections from tape, and two tape machines are used for playback permitting further variation and flexibility in programming.

Simplified Automatic Program Systems

The basic features required for the semi-automatic automatic program systems are combined with the essential relays and terminations necessary for complete automatic operation in the Ampex Model 355 Automatic Program Control. This unit is the nucleus of a "building block" type of system which may be utilized with solenoid controlled tape recorders and automatic record changers. It is shown in block diagram form in Fig. 8.

A single 7 inch x 19 inch chassis (Fig.5) for rack mounting provides all the features necessary for recording 25 cps tones, detecting them on playback, and controlling the sequence of operation of two tape reproducers, or a tape reproducer and an automatic record changer. It does not have a master timer and automatic fading circuit which is provided in the Ampex S-3380 system. There are no controls on the front panel, but a switch is provided on the chassis for deactivating the automatic control system. A complete system is shown in Fig. 6.

Two remote control panels may be used in an announce booth and the control room. These panels provide buttons for controlling rewind, fast forward, stop, play and record functions of a Model 350 as well as the recording of a 25-cps tone. Thus, while recording, the announcer can remotely control a recorder that is recording announcements and 25-cps tones. If a mistake is made, he can rewind, cue and erase the defect from either remote position, and re-do the an-



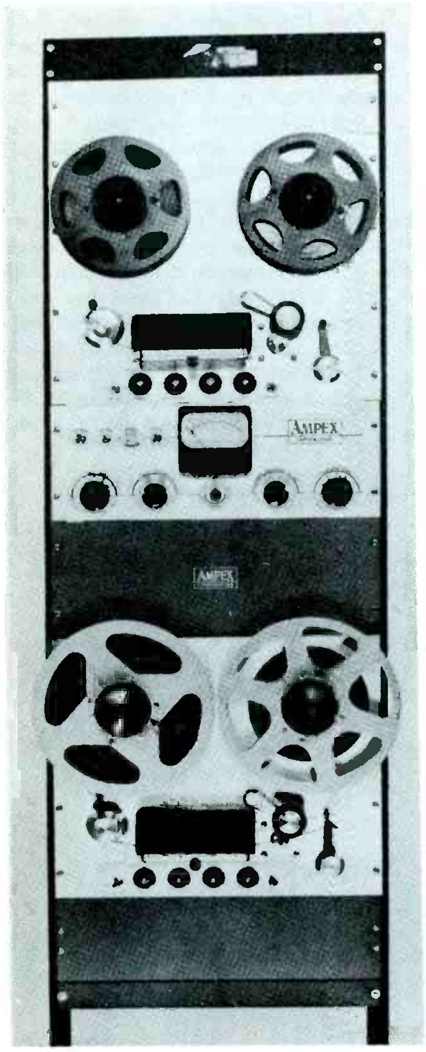


Fig. 5 (above) - The new Ampex Model 355 simplified automatic program control chassis is shown with above two of the new recorder remote control panels. The chassis contains a 25 cps tone generator, an amplifier for mixing the 25 cps with the program being recorded, a 25 cps tone sensing unit for stopping the tape reproducer and for starting another tape reproducer or an automatic record changer. The remote control panel provides a push button for controllong the 25 cps oscillator as well as controls for operating the Model 350 tape recorder.

Fig. 6 (left) - A complete Simplified Automatic Program System consisting of an Ampex Model 350 announce recorder and reproducer, the Model 355 control panel, an Ampex Model 352 reproducer, and an Ampex 7630-102 25 cps sensing strip. If desired, another panel can be added to permit alternate use of the 352 program machine with a record changer. This system utilizes the stations existing audio control equipment.

nouncement without help from another person. Transient noise at the beginning of the recording has been minimized by a circuit modification in the recorder and this is included in late production Model 350's. It can be quickly made in older machines. Hence, the recorded announcements sound live on the air.

The system is controlled by the 25 cps tones so that the next machine required to operate is started at the beginning of the 25 cps tone, and the machine that has been operating is stopped at the end of the tone. This feature permits instantaneous cuing. Overlapping of the announcements with music is possible simply by holding the tone button down while the announcement is being recorded. However, since there is no automatic fade system, such overlapping should be done only with selected music.

The switching time from announce tape reproducer to program tape reproducer is instantaneous; and from the start of the 25 cps tone from an announce tape reproducer to the beginning of a record selection from a record player, the minimum time will be approximately 1.5 seconds assuming normal length lead in grooves. The switching time at the end of the record will depend upon the length of the silent grooves ahead of the spiral, usually from 2 to 4 seconds. Since this may vary with records, some stations have utilized silence sensing units on the output of their record players to control the start of their announce machine.

The record change time with a single automatic changer is approximately six seconds (longer if records are not in adjacent slots) but with two automatic changers, the operating time is reduced to approximately 1.5 seconds, since one machine cues itself while the other machine is playing. The AMI automatic record changer mechanism is shown in Fig. 7.

Generally speaking, automatic record changers should be installed in locations where

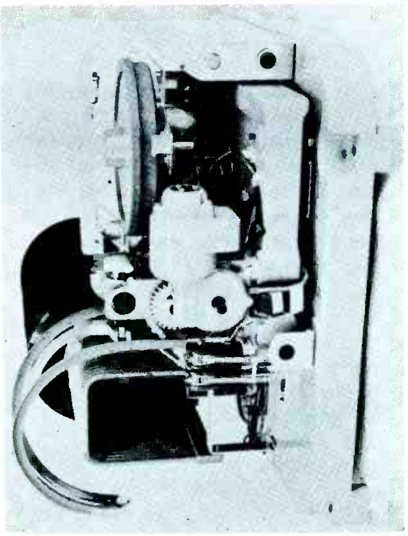


Fig. 7 - The AMI automatic record changer is also compatible with automatic programming systems when it is modified by adding several micro-switches to control cueing and to start the announce tape machine. This record changer will play up to 120 sides of 45 rpm records in sequence (60 discs). The records can be played in sequence, or if a pushbutton control system is utilized, the records can be selected in any order. Operating time is comparable with that of the Seeburg. If close cueing or short announcements are to be used, two machines should be installed.

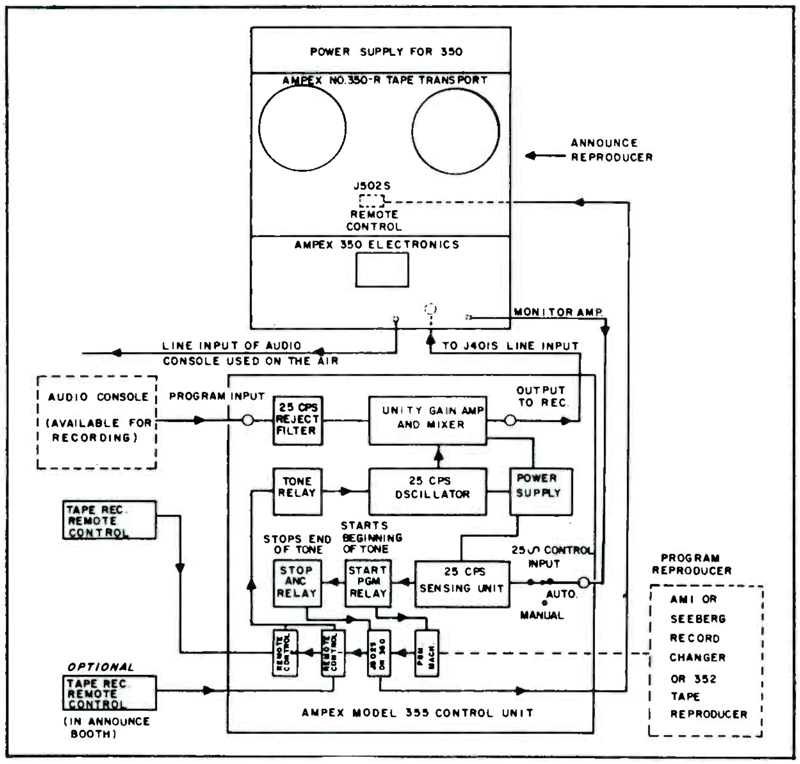


Fig. 8 - Block diagram of the Ampex Model 355 simplified automatic program system. This system is suitable for either semi-automatic or automatic program systems.

they can be attended in the event of improper tracking or imperfect spirals. Records used on automatic changers should be first checked to be certain that they will perform satisfactorily.

On the other hand, automatic tape systems can be depended upon to operate in unattended locations with little chance of failure.

Automatic Network Time Delay Systems

Greatest interest among broadcast networks in automatic programming seems to be in equipment for automatically delaying network programs one or more hours to compensate for time zone scheduling problems.

The American Broadcasting Company in New York is currently using an Ampex one hour delay system which is completely automatic in operation. This equipment consists of two recorder/reproducers and automatic control systems for keeping the system in synchronism with network time. This system is shown in Fig. 9.

In operation, one machine is running at a time for approximately one half hour. The sequence of the magnetic heads of each of the machines has been altered so the playback head is first, then the erase head, next the record head, and finally a monitor head. While a machine is running, it plays back material which has been recorded an hour earlier. Simultaneously, this earlier programming is erased and current "live" material is recorded. The machine which has completed its half hour cycle automatically rewinds and cues itself to begin operation again at the beginning of the next half hour period. Photo conductive cells mounted in the head assemblies are utilized to control the stopping and cuing of tape reproducers. Time delays longer than one hour can be obtained by using 10 1/2 inch reels of tape rather than the eight inch reels used for one hour delay, and by interchanging timers.

Automatic Business Machines For Logging

A number of radio and television stations have adopted punched cards and automatic business

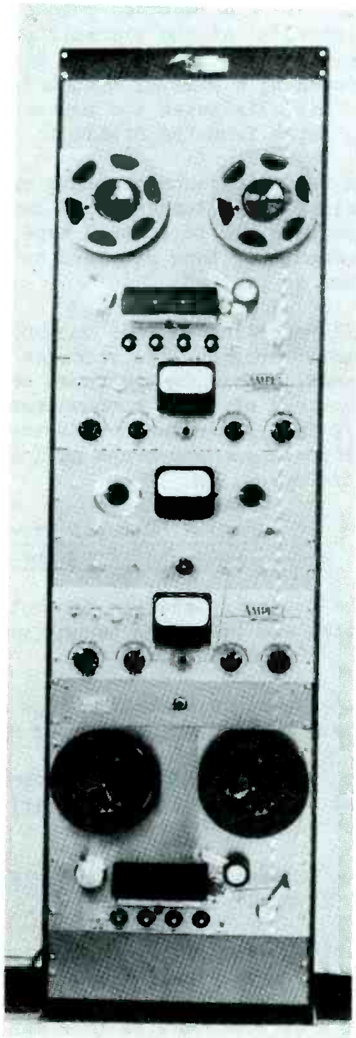


Fig. 9 - The above automatic program system delays New York Network programs one hour to compensate for time zone and daylight saving time. Each recorder operates for approximately one half hour, and is controlled by the master clock system. At the end of the half hour program period, control is shifted from the operating machine to the waiting machine which is started approximately one second before the next program period begins. Shortly thereafter, the unused machine is automatically rewound and automatically cued by a photo electric cell to the start of the program which is immediately preceded by a transparent section of tape. A silence sensing alarm is also provided to warn master control if there is a loss of program.

machines for reducing their traffic, typing, and accounting load. The advantages of this system to a station which depends upon spot business are great since it saves time, reduces errors, and provides a file which can afford a voluminous amount of research data with very little labor.

KSON, a 250 watt station in San Diego, has found that their IBM system simplifies their accounting and traffic procedures and eliminates the necessity for typing their log. The savings in secretarial and clerical staff permits expanded news coverage with radio equipped mobile reporters, and this is a big feature at this music and news station.

Comments From Users of Automation

KSON utilizes two composite automatic programming systems, one for AM and one for FM. Live announcements are aired only from 6 A.M. to 4 P.M. each day. Automatic operation is used from 4 P.M. to 6 P.M. with spots from tape and the records from a record changer, but live time signals and record title announcements are injected by a combination operator on duty. From 6 P.M. to midnight, the programs are all from automatic systems.

The station enjoys a very large audience, and to quote their operations manager, "Without automation we couldn't provide this service. We presently have a staff of 20 persons. It would require 30 or more to provide as much programming and news coverage without automation and this would not be economically feasible."

WJET in Erie, Pennsylvania, has operated an automatic programming system since December of 1955. The following quotation is from Mr. Myron Jones, General Manager of the Jet Broadcasting Company.

"We have, as you know, the complete Ampex system operating in conjunction with a Seeburg record changer. We were able to install all of this equipment within a very few days after receiving it and since its initial installation which was late in 1955, it has operated for us on a virtually trouble-free basis. The Ampex programming starts at 6:30 P.M. and on most weekday evenings, continues until 2:00 A.M. with only the attention of an operator. On Sunday evenings, the entire programming is broadcast through this system.

"Some of the advantages that we have encountered with the system are namely, a more efficient use of our experienced personnel and also we are able to take advantage of part-time personnel who are not available at the time the program is broadcast.

"Needless to say, we are, of course, pleased with the entire system and we know that it increased the flexibility of our independent operation. Incidentally, the recent pulse survey proves that our system meets the need of the majority of our audience, as we now rank first in audience with nearly a third of the share in this four station market."

A 50 KW major market station is using the Ampex Automatic S-3380 Programming System from 1:00 A.M. to 6:30 A.M. on weekdays and from 1:00 A.M. to 9:00 A.M. on Sundays. Music for programs from 1:00 A.M. to 4:00 A.M. is provided by 45 rpm records played on a modified AMI Model 800 record changer with voice announcements automatically interspersed from a Model 450 tape machine operating in conjunction with the control unit of the Automatic Programming System. After 4:00 A.M., both the program and the announcements are from tape. Since the automatic program control equipment is at the transmitter, no studio staff is required for the all night operation.

During the period when the record changer is used for music and tape player for announcements, 25 cycle tones recorded after each announcement start the record changer and microswitches installed in the turntable mechanism start the tape unit.

Announcements for the entire automatic programming period and programs for the period after 4:00 A.M. are all recorded remotely, the recorders being installed at the transmitter approximately 10 miles from the studio. The recorder is started and stopped by a simplex system over the telephone line. This eliminates the necessity for transporting tapes from the studio to the transmitter.

In recording announcements and programs, the announcer used an Ampex record console, Fig. 3, which permits him to control tape motion, time the announcements or tape programs and insert 25 cycle cue tones as desired.

All recording is done on Ampex Model 350 equipment. Programs are recorded at 3 3/4 inches per second, providing two hours capacity on a 10 1/2 inch reel of tape; announcements are recorded at 7 1/2 ips, giving an hour's time on a reel -- ample for all announcements during period of automatic operation.

Adverse Comments Regarding Automatic Programming

The following adverse comments regarding automation are reactions taken from the mail survey:

1. "We could probably throw a couple of announcers out of work, but over my dead body."

2. "How can automatic programming be achieved on a station that is very heavily local, not just playing 45's?"

3. "Starve many a poor employee who now makes a living."

4. "We're already at the irreducible minimum - 1 man only."

5. "It's too new to know any advantages."

6. "Can see no real advantage with net."

7. "If used, only advantage will be to eliminate errors. Present union contract not compatible with automation."

8. "Does not fit into our type of operation."

9. "We rely upon personality and automation is not conducive to this."

Favorable Comments Regarding Automatic Programming

The comments on the cards listed the following advantages of automatic programming:

1. "More efficient utilization of man power."

2. "More variety in voices heard on the air."

3. "Better working hours for personnel, elimination of dog watches."

4. "Reduction of human error."

5. "Relieve tight schedules" -- reduce overtime."

6. "Reduce overhead."

7. "Make it possible to combine AM and TV staff."

8. "Protect records and create smoother operation."

9. "No reduction in staff. Announcers will also sell."

10. "Relieve program staff for better planning."

11. "Estimated 10 per cent saving in operating cost."

12. "Estimate savings of $200 per month."

13. "Better management control over free lance announcers."

14. "Keeps us in front of the listener 24 hours per day."

15. "It will make it possible to continue operating without a loss."

16. "A must for any reasonable profit in the future."

Conclusion

Broadcasting, like most other successful industrial activities, is undergoing a gradual evolution which is resulting in greater productivity per man hour as well as improved working hours for program personnel. In most stations which are using automation, the program service has been expanded without reducing the number of personnel employed. Some stations have found that their increased program service has created additional employment, particularly in sales and public service activities.

Imagination and ingenuity are required to adapt automation to an existing broadcast operation. Some stations may have to revise their program structure in order to utilize it effectively; for example, it is not easily adaptable to a disc jockey program involving telephone calls from the audience. However, given a little thought, most disc jockey programs can be just as well done on an automatic basis (announcements only are recorded) or as a delayed tape recorded program.

Automation is a challenge to the broadcast engineer since it offers him an opportunity to improve his station's facilities and at the same time to simplify the scheduling of personnel. If a system has been well planned and installed, the public will not be aware of its existence. Obviously, no system should be placed in regular operation until the staff is familiar with its use and it is known that the system conforms with broadcast standards of performance.

The end result will be a better service to the station's audience and an increased dollar profit to the station.

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