JULY, 1960

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AM FM TV BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

TV—Complete Automation at WKRC

AM—Diplexing Two AM Transmitters into One Tower

FM—Planning an FM Station

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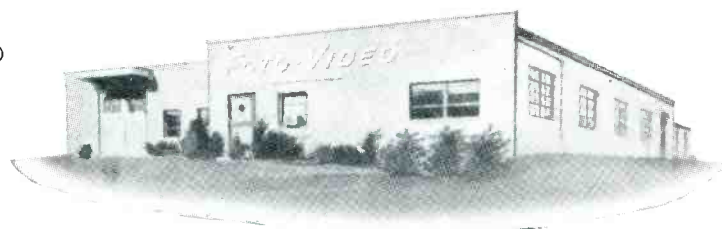

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BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

VOLUME 2 JULY, 1960 NUMBER 7

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Departments

Next Month

In the August issue BROADCAST ENGINEERING will publish the results of its equipment survey of radio and TV stations. The survey reveals the purchasing intentions of stations and the individual requirements for equipment features and new broadcast products. In this rapidly growing and changing industry we feel that this information will be of interest to all of our readers.

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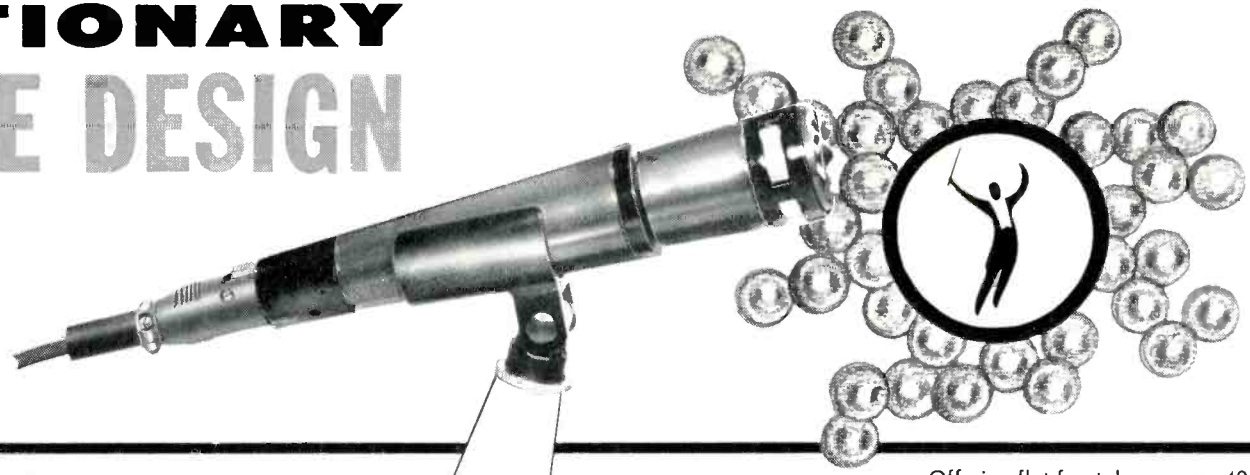

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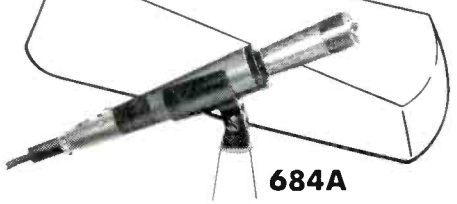

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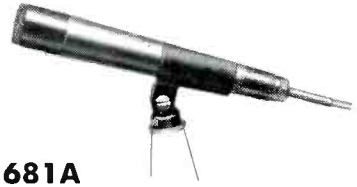

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AUTOMATION AT WKRC-TV

Full-time automation system cuts operating costs and reduces errors

By P. A. GREENMEYER* and W. H. HANSHER†

More than four years ago engineers of the Taft Broadcasting Co., under the direction of W. H. Hansher, vice-president, engineering, began planning a new plant for their Cincinnati station, WKRC-TV. Their burning desire was to make the new station, not only the finest and most advanced in the industry, but also the most efficient and reliable. To attain the latter, they planned the world's first full-scale, full-time automated TV station installation.

Preliminary studies leading up to the actual planning extended over several years. During this period engineers of Taft Broadcasting studied various possible ways of building a system which would fit WKRC's needs. They investigated methods of accomplishing the necessary control and switching operations, and they tested circuit components to be sure they had the best solutions. With this background to go on, they wrote specifications for an automation system which was far in advance of anything previously in existence. After preliminary negotiations, RCA was chosen to build the equipment and from this point on engineers of the RCA Systems group worked hand in hand with engineers of Taft Broadcasting to build and install an automation system which is undoubtedly one of the industry's true pioneering advances.

Since Jan. 4, 1960, when WKRC-TV first went on the air under automatic control, there has been a constant stream of visiting officials from other TV stations. The automatic programming tape, the remotely controlled cameras, and the operator-less film operation attract a great deal of attention. But of prime importance to station managers and owners is the increased efficiency of operation.

Engineers like the precision that this new approach makes possible. Its built-in accuracy affords a new solution to the age-old problem of human error. And the ability to prearrange switching operations avoids the tenseness of the station-break period.

Agencies and advertisers feel that this electronic control system relieves them of much of the headache of checking commercials. Smooth handling of clients' spots seems assured. Lost air time will become a thing of the past. In the words of one agency vice-president: "There are some things that machines do better than people."

Economics of Automation

There is no doubt that automation reduces expenses in the operating area. Fewer operators are required for such tasks as switching camera control, and running projectors. Furthermore, machines make fewer mistakes than people. Finally, automation relieves the tension and strain that lead to errors.

On the other hand, the automation system does not bring unmixed benefits. It is to be expected that the maintenance load, for example, would increase. This would offset some of the savings in manpower.

At WKRC, the introduction of automation resulted in reduction of technical staff from 23 to 10 men. It is conservatively estimated that no more than three of 13 will be replaced, because of requirements in other areas. The dollar savings add up to a six figure total.

Of more consequence, of course, is the improvement in operations. Since WKRC estimates that 95 per cent of all errors are human errors, the increase in operating accuracy is somewhat tremendous.

A Complete Automation System

There have been, before this, attempts to automate TV stations with varying degrees of success; however, most previous attempts have been confined to only a small fraction of the program day, namely, the station break periods. At WKRC, the automation schedule covers the entire program day. On the control tape are logged all programs and commercials from sign-on early in the morning to sign-off in the small hours of the following day!

Furthermore, previous attempts at automation were restricted to control of film and slide facilities, and for switching to and from the network. Local live shows were all handled manually. At WKRC, however, even live shows are switched by the electronic brain. Not only film and slide projectors but live cameras also are switched at the proper time according to the master clock and control tape signals.

In the audio area, the various sound sources are all controlled by the tape. These include: sound-on-film,

*Manager, RCA Broadcast and Television Advertising

†Vice-President Engineering, Taft Broadcast Co.

announce booth, studio microphones, and tape recorders. They are all switched together with the proper video source as called for by the control tape.

Thus, this is a system that covers all of the station's needs. It operates over the entire program day. And it handles switching of all facilities, be they local or network, live or film.

The Automation System Helps Freeze Schedule

The three elements of the automation system are: (1) the control tape, (2) the electronic brain, and (3) the master clock. Stated very simply, these three control the various equipments and switch the programs and commercials on air. It's all done at the proper second.

Here is how it is done. The control tape sends signals to the electronic brain by means of a special code. The electronic brain turns equipment on and off and switches program sources—by means of decoders and relays. The master clock supplies accurate time signals so that all commercials and programs are properly timed.

Automation offers a distinct advantage to stations in firming of advertiser's programs. Those local clients who have a habit of dropping in do not make as many changes as they once did. Not only so, but it has been found that automation helps the advertiser in preparing his schedule on time. So that he can check in advance, he prepares in advance.

Control Tape

In normal station procedure, a daily schedule is usually typed. This lists the programs and commercials, the scheduled time, and the video and audio sources. At WKRC-TV this schedule is typed on a machine called the Flexowriter.

As the operator is typing the schedule, the Flexowriter also actuates an RCA-designed device affectionately called "the magic box." This produces a narrow paper tape, punched according to a special code. This is the control tape. It is used for automatic control of the TV station.

The control tape contains lines of punched holes as shown in the accompanying illustration. Ten lines comprise one of the events on the schedule. Each line of holes has a meaning. Thus, the control tape contains information about: mode, time, video source and audio source.

The control tape contains in one small roll the data to guide all operations during the 18-hour day. This tape is placed on a "tape reader" in master control, prior to start of the day's programming.

The reader takes the information from ten lines (one event) at one time and passes it directly to the electronic brain. As each event is put on air, the reader "steps up" to the next event and puts it in the brain.

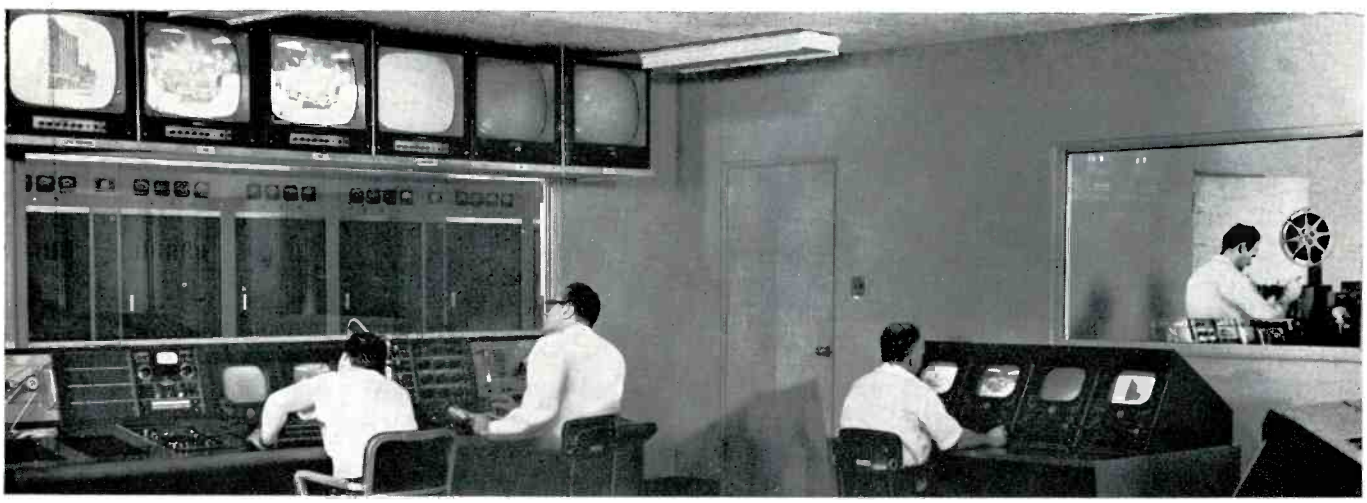
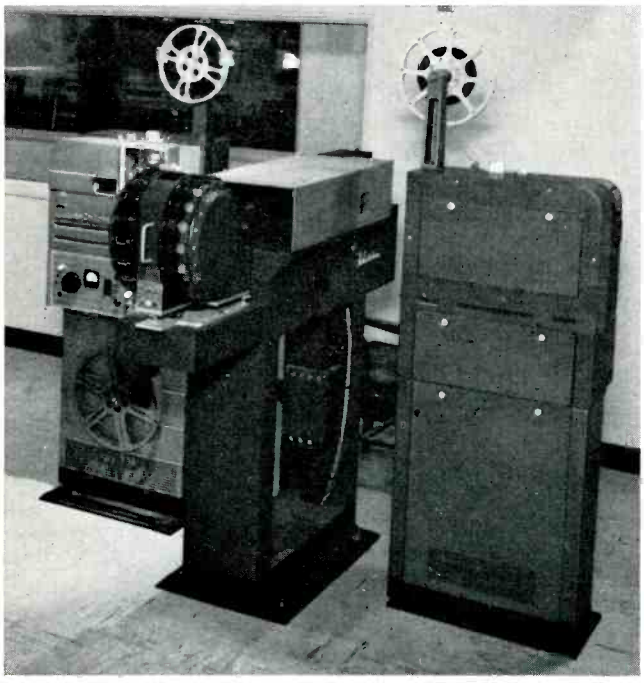


Figure 1. Above photograph shows the control room at WKRC before automation. Below is the operation after automation.

CONTROL TAPE PERFORMS THESE FUNCTIONS:

SWITCHES LIVE SHOWS



CONTROLS AUDIO AND VIDEO GAIN

SWITCHES TV TAPE, AUDIO TAPE AND ANNOUNCE

★

STARTS AND STOPS PROJECTORS

SWITCHES FILMS AND SLIDES

CUES PROJECTORS

RUNS SINGLE PRINTS AS MULTIPLE SPOTS

MAKES POSSIBLE UNATTENDED PROJECTION ROOM

A second reader is included in the installation. This makes possible the use of a correction tape, when required. It is placed in the second reader and takes over operation at the proper time to insert changes. After corrections have been made, control is returned to the primary tape reader.

Data received from the tape is stored in the electronic brain. Circuit paths are then set up to the specified video and audio sources. When the prescribed time is reached, the event is put on air.

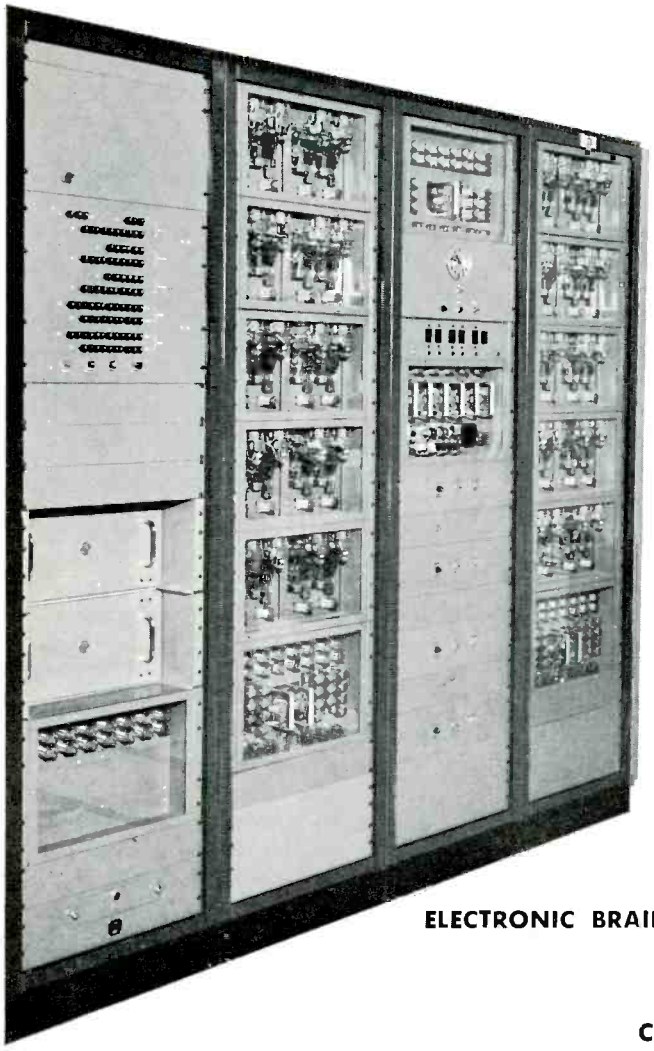
In the WKRC installation, relays are used for storage of data. Information from the reader passes directly to stepping switches. These perform several functions, including decoding.

In the decoding operation, there are source decoders and time decoders. The source decoders cause source selector relays to set up circuit paths for switching slides, film, TV tape, turntables, live cameras, announce booth, and audio tape recorders. The time decoders supply signals for comparison with a master electronic clock to determine when time coincidence occurs.

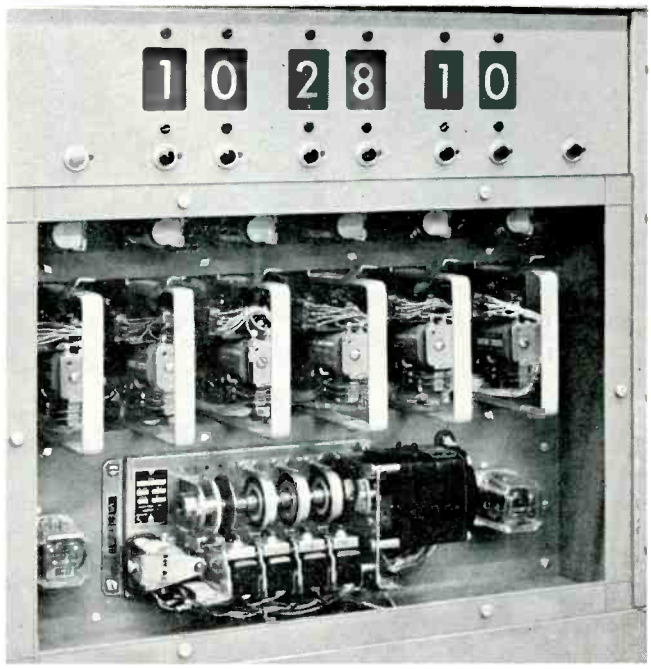
In each control area there is a wall mounted unit called the readout panel, which reads out (or displays) the information in the brain. It reveals two events: (1) the program on air and, (2) the upcoming event. Note in the accompanying illustration that the following information is given: mode, time, video source, and audio source. The top line relates to the program that is on the air, and on this line, the seconds tick away to show elasped time. The bottom line relates to the upcoming event, showing the time it is to go on air, and the sources for video and audio.

This information is useful to all operating personnel as well as program people. For this reason, readout panels are located in all control areas, announce booths, equipment and projector rooms, and on the floor of the studio. They tell operating personnel how much time until the next switch point. They tell program people how much time left until they go either on or off air.

As the event in the bottom (or preview) line reaches air time, the switch is made. Then the information on the top line disappears, and the information on the bottom line is transferred to the top line. At the same

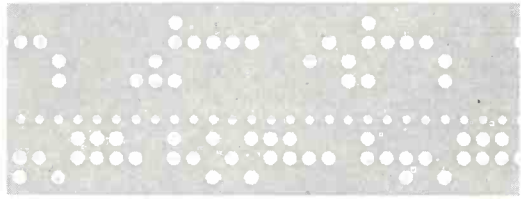


ELECTRONIC BRAIN



MASTER CLOCK

CONTROL TAPE



The above three elements control the various station equipment.

time, the control tape advances and the next event appears on the bottom line.

Master Clock Times Programs and Commercials Accurately

An electronic clock in the automation system is used to time the precise second that a switch is made to put a program or commercial on air. Events can be spaced as close as three seconds apart. The clock is very accurate, being timed by a tuning fork—in a temperature-controlled oven.

Signals from this clock also operate slave units which are mounted above the readout panels, to show the exact time. This time agrees with the time in the program line of the readout panel when in "C" (clock) mode. When in "A" (approximate) mode, the exact time and program time may not necessarily agree.

Signals from the master clock not only switch events according to the predetermined time, they also advance the control tape to the next event, so that the process is a continuing operation, as long as the system is in the "clock" or "approximate" mode of operation. Only a "manual" mode of operation can change this continuing procedure for automatic switching.

System Accommodates Industry Practices

The system was designed to accommodate conditions that exist in the industry. For example, some network breaks are scheduled at "approximately" such and such a time. Manifestly, it is impossible to program an "approximate" break completely automatically. Hence, there is provision made for "approximate time" method of operation.

At other times, it is desirable to take control manually. This may be necessary during certain live programs. It may also be useful when it is desired to lengthen or shorten a scheduled event. Hence, provision is also made for releasing the TV operation from automatic control and returning it to manual control —whenever desired. Furthermore, it is unusual for a client to request rescheduling of a commercial. Although the control tapes are usually prepared 72 hours in advance, correction tapes can be inserted at any time before an event goes on the air.

Moreover, on occasion, it may be necessary to delete a scheduled event completely. This is usually a commercial or other short time event. This can be done by merely pushing the "by-pass" button. Then the scheduled event is eliminated.

Figure 2. Traffic director types schedule and simultaneously punches control information on paper tape.

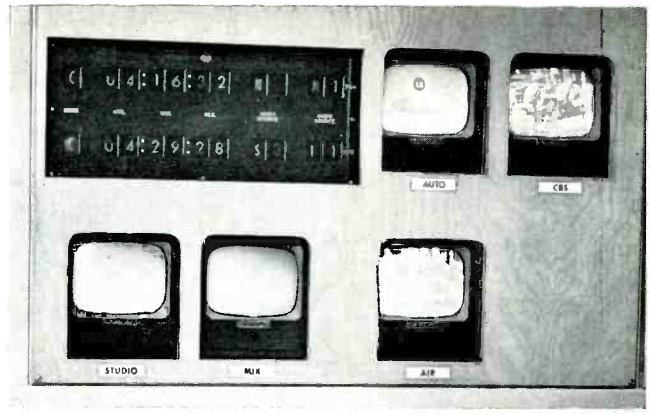


Figure 3. Readout panels indicate the mode, time, video source, and audio source for the program on the air and the upcoming event.

Visitors are greatly impressed at WKRC. Clients like the precision and accuracy with which their commercials are handled. Agency people predict a lot less supervision and checking of commercials. Automation helps them to freeze schedules. Also clients do not make so many changes. Although changes can be made, there is less tendency to do so.

The approximate mode of operation is designed for breaks in network shows, when the exact time for the break is not known. The events to occur during this break are known, and the duration of each event is known, so that they can be entered on the schedule, and punched on the control tape. However, since the starting time for the break is only an approximate time, such a series of events must be started manually, upon receipt of network cue. Once started, they can proceed automatically until the switch back to network occurs.

Again only one button need be pushed by the operator to initiate the commercials during this break at an approximate time. It is not necessary for the operator to perform the numerous switching operations that complicate the routine of station operation during a program break.

Operation of the system as a pre-set switcher is possible. This relieves the operator of the great burden but retains manual control of timing. Also special effects can be inserted by the operator, specially for large live shows.

When the tape reaches a manual control point, the operator must push a button to initiate the next event. A flashing red button on the control panel (together with a flashing red light on the preview line of the readout panel) tell the operator that he must do something before the next event can go on air. It is not necessary for the operator to perform all the manual switching normally associated with a manual method of operation. It is only necessary to push the "operate" button, since the system acts as a pre-set switcher. In this area of simplifying operations automation makes its most important contribution.

During the period of a station break appear the commercials that provide opportunity for the advertiser and revenue for the station. Yet it is in this period of time that activity is severely concentrated. The operating personnel spend much of their time preparing for this and can relax once it is over. But while it is on they are subject to a great deal of stress and strain. This is a condition not conducive to good judgment. It is this atmosphere that leads to operator errors.

In order to crowd in just two commercials during a break, together with station ID, some 19 functions must be performed by operators.

With automation, these 19 functions would all occur at precisely the predetermined time, and without any chance for error. Only one operator would be needed. His job would be mainly that of supervision. If the system were set up for approximate mode of operation he would need to push the "operate" button once upon receiving his cue. Then the 19 functions would all occur automatically.

With automation, advertisers have assurance that full time is given to their commercials. Station people are assured that programs and commercials go on as per schedule. The stress and strain of the human overload are relieved.

In preparation for the advent of electronic control of TV stations, RCA had been developing certain essential equipment devices. These would make film and slide projectors, turntables and recorders, all capable of automatic operation. These developments include: automatic light control, fast start, automatic cue, and continuous loop.

Automatic light control relieves the operator at the film camera, by providing self-compensation for areas in films and slides that are either too light or too dark.

Fast start enables the film projector to get up to operating speed within one second, in order to fit into the three second interval desired for automatic switching. Automatic cue makes it possible to make sure that when the projector stops, it will be in exact position to show the next event on the film.

Designed especially for WKRC-TV is a projector accessory capable of handling up to five minutes of 16mm film on a continuous loop. This is used for repeats of commercials, when only one print is supplied. It is a most convenient way of dealing with this vexing problem.

Local motion picture houses frequently supply a trailer, of which they have only one copy, to be run as much as ten times daily. Public services usually

only have a single print available for showing (because of budget restrictions). In many cases, local advertisers are in the same position. It is here that the CLP enables a TV station to serve its clients' needs at a minimum cost.

Robot Cameras and Robot Floorman

Weird is the sight in the studio as Skipper Rile puts on his show for the children. He is alone in the studio. Only silent stark pieces of equipment stare at him. Although unattended and without human hands to guide them, TV cameras follow every movement of the Skipper. At the same time an inanimate but extremely accurate readout panel blinks away the seconds, revealing to the Skipper exactly how much time is left until he is switched off air.

Thus, these robot cameras do everything that an attended camera can do. They pan right and left, or tilt up and down—as the action requires. A zoom lens is used to get dolly effects for close up, medium, and long shots. These effects are produced by the operator in the control room. He has a "joy stick" which he uses to control pan and tilt movements of the camera. Also a set of toggle switches to control the zoom lens.

A slave of the master clock is located in the studio to guide the talent timewise. It is mounted directly over a floor monitor. The clock has two rows of windows. The top row gives the exact time, ticking away in seconds. The bottom row gives the time that the next program is due on air. Thus, this unit acts as a robot floorman. The talent knows exactly when to begin, and also how much time is left to finish the show or commercial.

Automation's Worst Enemy

Because of the instant nature of news shows, it is impossible to schedule them into control tapes that are made 72 hours in advance of show time. Even the provision for a correction tape is not completely satisfactory to cope with this situation. Producers of the news show do not know the exact content until 30 minutes in advance of air time, which is not sufficient for cutting and inserting a control tape to handle so many events. However, the personnel at WKRC-TV have developed a special method for incorporating this show into the automation system.

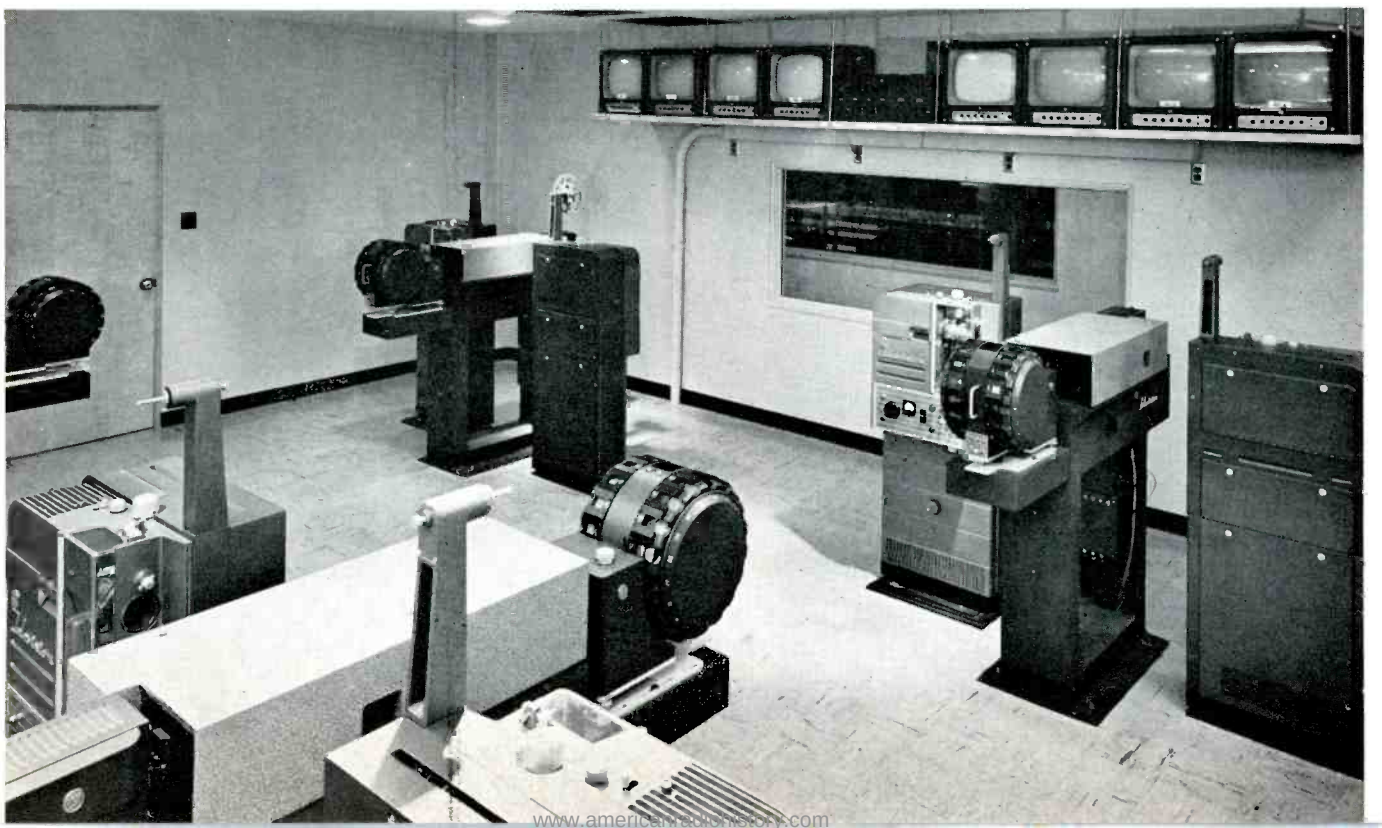
An electronic brain, when it is thoroughly understood, is capable of many unusual and diverse functions other than those for which it was originally designed. As traffic and operating people have become more and more familiar with the capabilities of their system, it became evident that they could use it to become their slave rather than become slave to it. WKRC's development of the "Possibilities Tape" is a case in point.

In preparing this tape for the news show, all known events are included in the schedule: (1) commercials on slides with audio from announce; (2) commercials on film with sound-on-film; and (3) live camera shots of newscaster—and all programmed on the control tape. Included also are six possible film sequences, cut into the tape at appropriate points, but giving no exact times.

These "possibilities" can then be used for film clips that the newscaster wishes to show. They are usually sandwiched between live camera shots of the newscaster. For example, two film possibilities are sandwiched between three live shots and this is then placed between two commercials. The process is repeated three times in the schedule. As a result, the newscaster then has considerable leeway in making up his show, since the system is capable of receiving as many as six film clips, in addition to slide and rear screen projections for still shots.

The news program begins on exact time in the clock mode of operation. These "possibilities" are logged on the control tape in the manual mode. Audio is ar-

Figure 4. Facilities at WKRC enable the station to handle films and slides for half of the normal 18-hour day's programming.



ranged for automatically following video. Projectors will roll in advance, then stop and cue up for next start—all automatically. However, in order to terminate an event and to begin the next, it is necessary for the operator to push the "operate" button. (This is pre-selected switching).

The operation is under control of the director-engineer. He can eliminate any of the "possibilities" by pushing the operate button twice—instead of once. Thus, this arrangement permits a degree of flexibility in the automation system to accommodate the last minute news items to be included.

Naturally, more than six possibilities could be scheduled. However, WKRC has found this number to be more than sufficient for its needs.

Automation Improves Efficiency

Using an automatic system for putting commercials on air makes it mandatory that control tapes be extremely accurate. This means more careful attention to preparation of the daily schedule. Thus, the traffic department receives more responsibility for assuring correct on-air times for commercials and programs.

In the film department, it is now not only necessary but vital to insure that slides and films are properly loaded. No longer is a projectionist around to correct mistakes. As a result everyone is more on their toes.

After some reflection, it appears that this is a good condition. It spreads the feeling for accuracy rather than concentrating it in one area. Net result is to make everyone more conscious of the need for exactness. Thus, it improves the over-all efficiency of the entire station staff. This is one of the side benefits of automation.

As a direct result of automation there has been created at WKRC a new position—that of engineer-director. He is one who previously was an engineer. Having aesthetic sense also, he now combines both talents for the special requirements of automation.

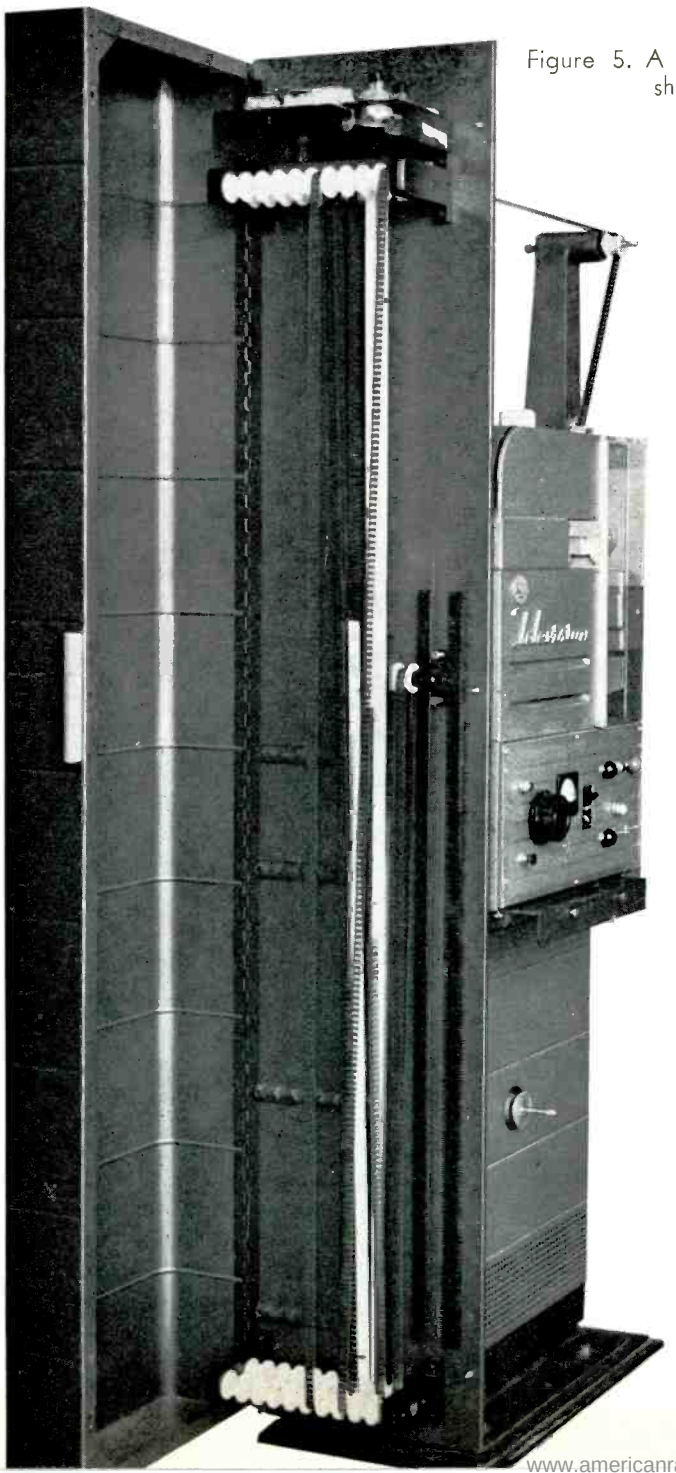


Figure 5. A continuous loop projector makes multiple showing of single prints possible.

Figure 6. Upper photo shows standard operation before automation. Below is the automated operation at WKRC. These robot cameras are used to present live shows that do not require a great deal of production. Where no more than two live cameras and two microphones are used, this can be done. News and weather shows are typical. Also interviews, panels, and personality shows. All these have been successfully handled at WKRC. In addition, all live commercials are produced this way, both for rehearsal and for on air.

Figure 7. The two studio cameras are remotely operated from master control.

Figure 8. A "Joy-Stick" is used for pan and tilt. Toggle switches are used for zooms and focus.

It has been found that the former two-man team of director and engineer is not required for many live presentations such as commercials, news, weather, and interview shows. These can be adequately, and sometimes better handled, by one who knows the equipment operation. Furthermore, this also provides a position for some of the technical personnel released by the advent of automatic control.

In WKRC the program department formerly had five directors, now it has two directors and three engineer-directors. Still a total of five.

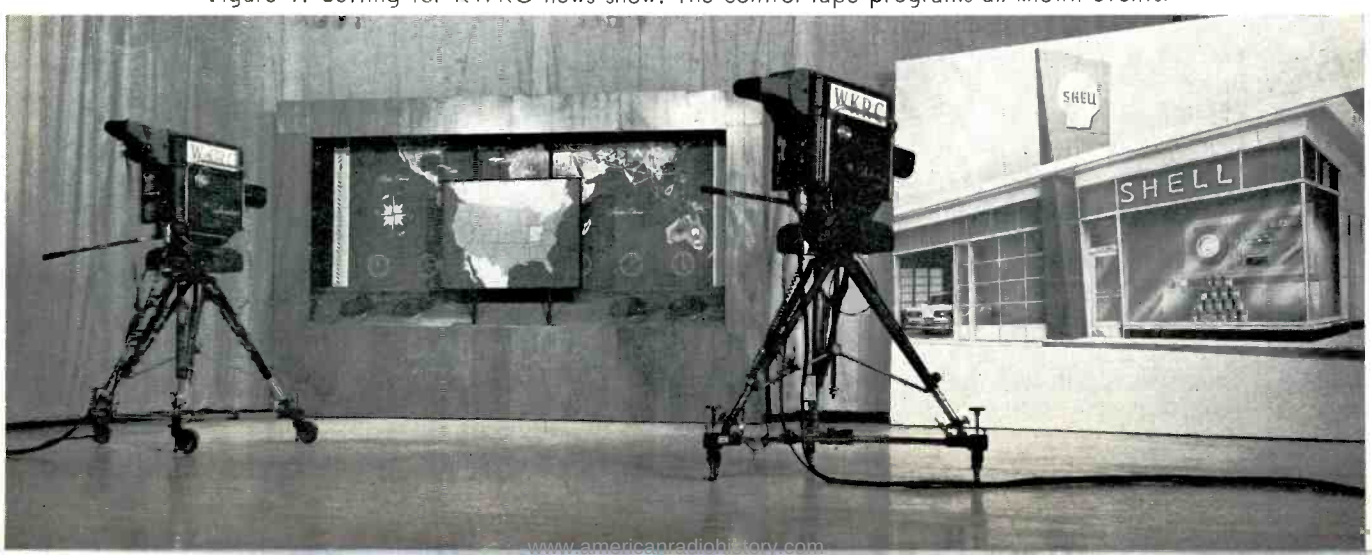
However, the engineer-director can do more than the ordinary director. Since he belongs to the union, he can move cameras, switch lights and otherwise handle equipment. An engineer is not required when he is handling a show. This makes the operation more efficient.

In order to provide for continuing growth and greater demand upon the technical facilities of the station, three separate but complete operating centers were included in the design of the system. This makes it possible for more than one program to be handled by the station at the same time. For example, while one program is being telecast, another could be fed to the network (or rehearsed), and a third could be put on TV tape. Thus, it is possible to handle three operations simultaneously.

This is made possible because of the three control positions built into the WKRC system. One is at master control, which is the main operating position. The second is located in the directors control room. The third is located in a special sub-control room—just off master control.

Each control position is provided with the new RCA transistorized switching and special effects system. There is also complete monitoring of video and audio. There is also provision at each control position for remote control of the robot cameras. Hence, any kind of film or live program or commercial can be handled from each of the three control centers.

Figure 9. Setting for KWRC news show. The control tape programs all known events.



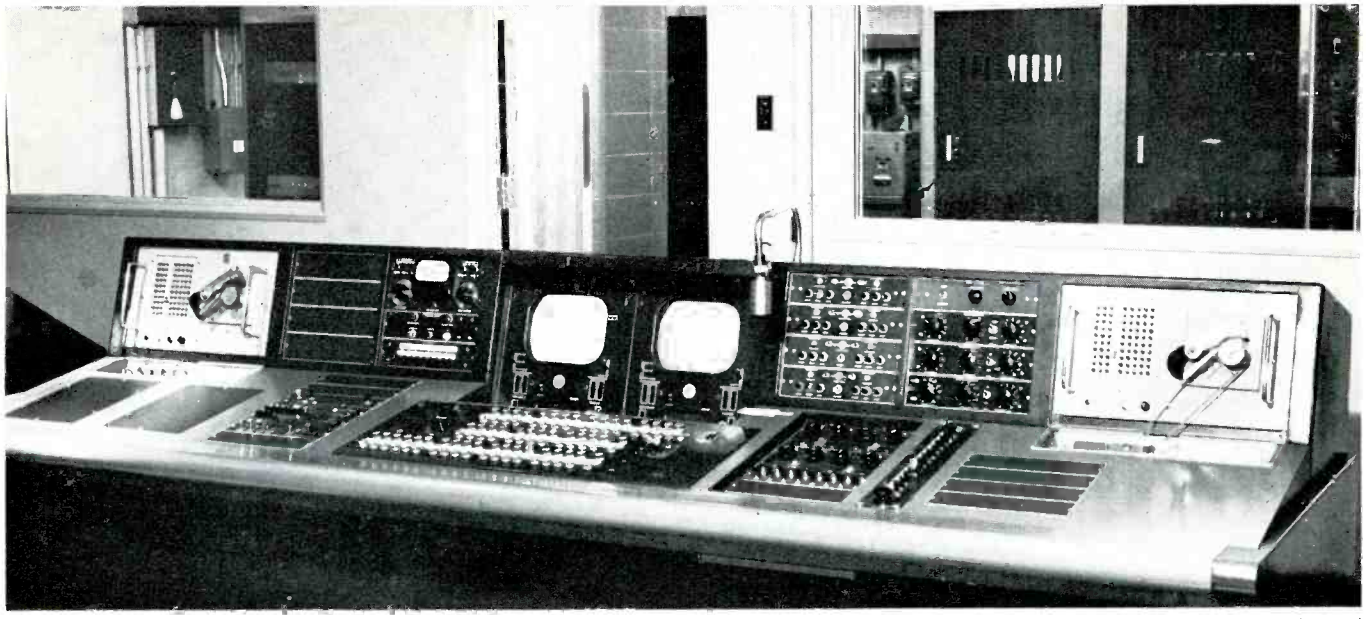


Figure 10. The master control console includes provisions for both primary control tape, shown on the left end, and the correction tape which is on the right end of the console.

Design for Automation

The WKRC system was designed according to operating requirements specified by the engineering staff of the Taft Broadcasting Co., owners of WKRC. Unlike previous systems, it operates over the entire program by day. Further, it can switch live shows and commercials as well as film and slides. Thus, the system at WKRC represents not only the most complete but also the most advanced in the world today.

Similar systems can be designed for other television stations. Since each station has its own particular requirements, it becomes a matter of custom design. Some future systems may wish to include provisions for automation of paperwork—such as billing—as well as program control. Others may simply desire to automate for that intensely critical period of activity during station breaks. But all stations seek to use these most modern methods to attack the twin problems of rising operating costs and ever present human error. It is in this area—where 95 per cent of all errors occur—that an automation system serves its chief purpose.

Since it assures accuracy in switching, the electronic brain eliminates those human errors that cut short a commercial or otherwise give rise to a rebate or make good. In any event, automatic machinery can do some things better than people. As a result this machinery usually pays for itself in terms of savings and improved product.

In the area of broadcasting, it is likewise true that automatic operation can reduce costs of operation as well as improve programming. Rebates are reduced. Times of tension are eased or eliminated.

Automation introduces television broadcasters to a new era. Through the magic of electronics much of the routine labor of man can be taken over by the machine. Hence, the broadcaster can have the time and facilities to concentrate on the more important things that only men can do.

Figure 11. The subcontrol room at WKRC includes complete switching and remote control facilities.

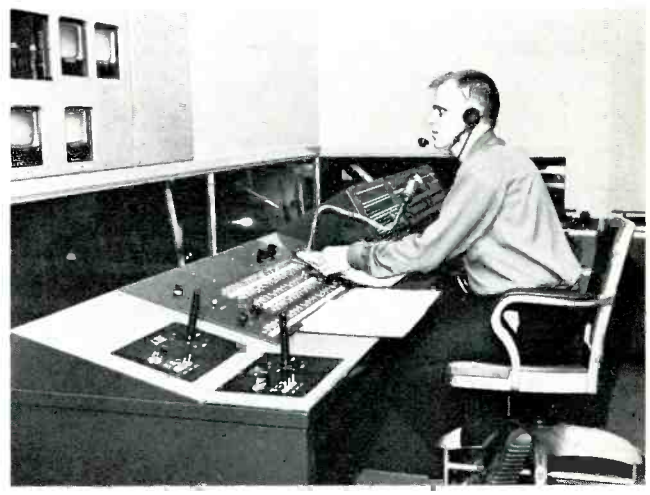
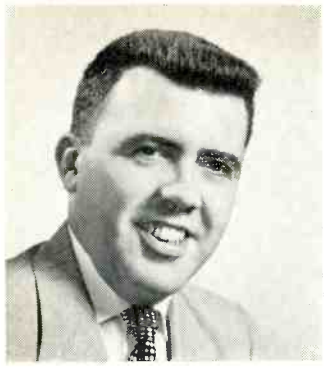


Figure 12. The director's control room contains a duplicate set of switching and remote camera control facilities.



STRAIGHT TALK to BROADCAST ENGINEERS

All Broadcast Equipment should meet these five qualifications

By ED GAGNON
Manager, Broadcast Sales Department
Collins Radio Company

"What should I consider most important in selecting broadcast equipment?" is a question every broadcast engineer and station manager must ask on occasion. Naturally, there are many qualifications an equipment must meet to gain your approval. I think the following questions should be among those which receive your foremost consideration when buying broadcast equipment:

- Is the design mechanically and electrically straightforward?
- Is it an advanced design or a new idea in broadcasting?
- Is it a proven design?
- Is the equipment completely tested before it leaves the factory?
- Is trade-in and financing of equipment possible and advantageous?

All broadcast equipment, if it can be considered a good purchase, should meet these five qualifications. Let me explain briefly how Collins measures up to this checklist.

All Collins broadcast equipment is designed so that components are easily accessible. Routine checks and adjustments are simplified through straightforward design of circuitry and components. For example, Collins transmitters, with straightforward design, have less off-the-air time than any other transmitter — a fact recently proved by an unbiased market research survey of 1,024 U.S. broadcasters.

Collins broadcast equipment is advanced equipment — often the first of its kind in the field. Collins Automatic Tape Control, for instance, is the undisputed leader in automatic programming. It is the most popular automatic tape machine in the world. It is also the most copied tape unit on the market today.

Collins broadcast transmitters have long used high efficiency, dependable tetrode tubes in the final amplifier. Only in the past few years have tetrode tubes been widely accepted and used in this application. Collins remote equipments have brought about more versatile broadcasting, too. Among new Collins developments in this area have been the M-60, a single unit, hand-size remote microphone and amplifier that eliminates as much as 45 pounds of conventional remote equipment; and the Collins Announcer, a portable console-amplifier with two turntables which is ideal for remote broadcasts.

Too, Collins equipment is built to last. Magazine advertisements of used equipment seldom list Collins. This is mainly because Collins designs are proven designs — proven in the field after they are proven in the Collins test department. For example, all components in Collins transmitters are individually tested and then the assembled transmitter is completely tested on the customer's frequency before it leaves the factory.

Collins stands ready to assist you in providing financing arrangements tailored to suit your requirements. Whether you need new or replacement equipment, you receive assistance with financing and a fair market value on trade-in equipment — regardless of make. Advantageous financing, trade-in and down payment are additional services you can expect from Collins.

These are only a few of the major considerations you must make before you recommend or buy broadcast equipment. Call your Collins representative and ask him about the features of the Collins complete line of quality broadcast equipment. Ask him for full details about Collins services, too.

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Diplexing AM Transmitters With Only Three Per Cent Frequency Separation

Since the early 1930's a number of broadcast stations have realized the economic advantages made possible through diplexing techniques. Many other stations have requested designs of systems combining two stations into a single antenna. It is believed many more would consider the possibility if it were not for the common belief that diplexing becomes impractical if the two frequencies are closer than 50 per cent. The discussion to follow is of particular interest to those radio stations who, through the use of a common antenna, may gain materially in savings in land, buildings, and tower facilities by combining their operations. Certainly, the article discloses the possibility of much closer frequency separation than the 50 per cent figure heretofore considered.

By R. S. BUSH*

A DIPLEXING network to combine the output of two transmitters operating on 2522 and 2598 kilocycles is described. Many of the practical limits and considerations pertinent to all diplexing systems are discussed in connection with the description. A slightly different approach to the design of critical systems is taken pointing out the practical limitations of prior designs. Conclusions drawn show the definite need for regular attention to the operation of diplexing systems in general. More specifically, the combination of the outputs of transmitters operating simultaneously on the above two frequencies is shown to be both practical and possible, provided the system receives regular attention.

The successful operation of two transmitters simultaneously into a single antenna with no more than 3 per cent frequency separation requires a very thorough understanding of the many factors involved. Field conditions, optimum network responses, component reliability and control all enter the problem in a very positive way. This article, then, has a twofold purpose. It is an attempt to point out some of the more important considerations with their practical limits. And, secondly, it is a description of a system, recently built and installed. In this way, it is hoped that the ever growing field of medium frequency diplexing will be given a clearer, practical understanding.

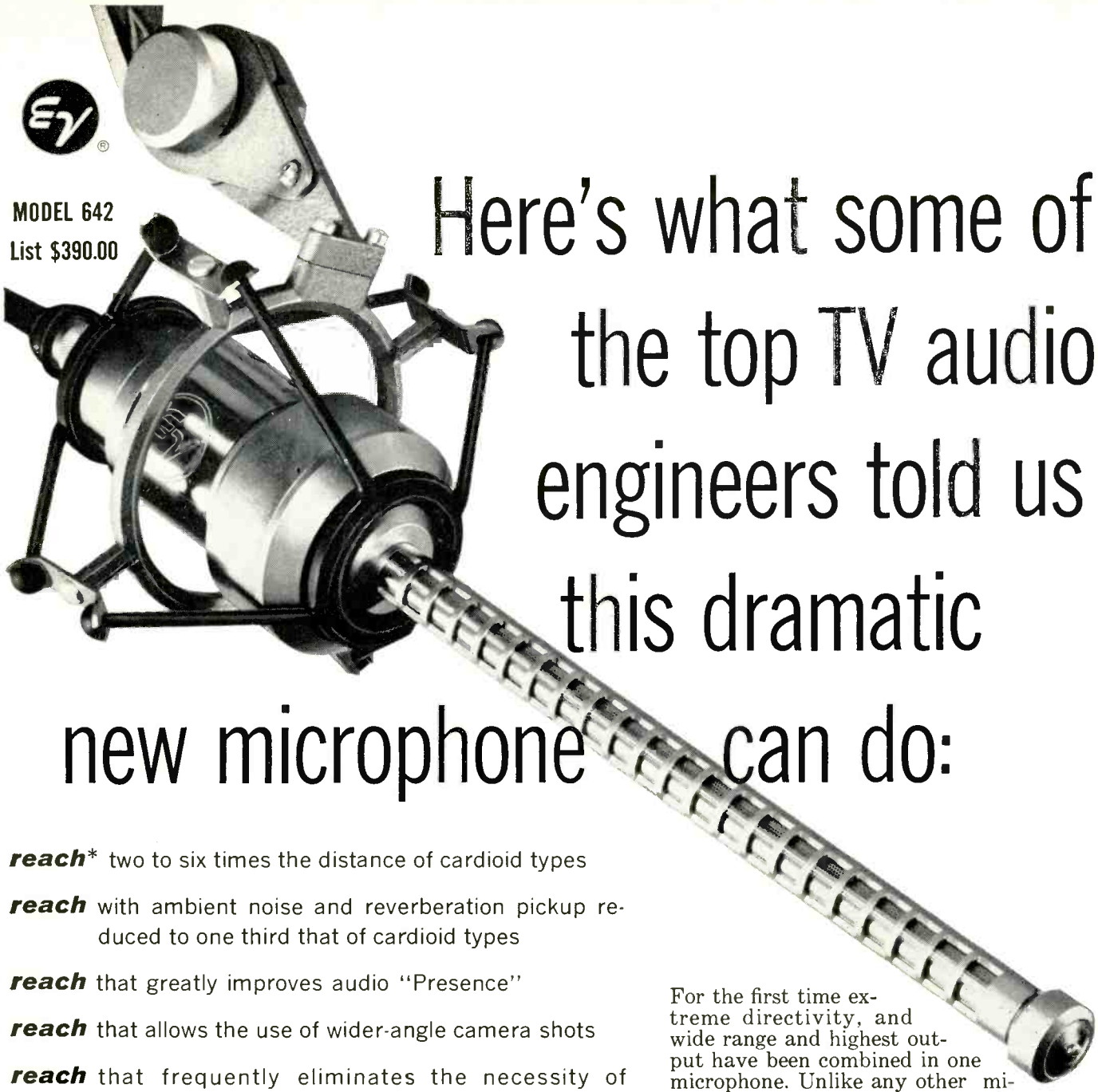
Operating data available on a diplexing system similar to the one described clearly point to at least three design areas that must be taken into account. First, component reliability is of paramount importance. Secondly, current and voltage ratings of practical components are more likely to provide design limits than are the usual network realizability conditions. This is true even at relatively low powers. Third, and at least as important, the system must be easily controlled. This will be discussed in greater detail, but for now it is well to remember that in any antenna system there is a continual change in field conditions. A network sufficiently complex to provide satisfactory operation of transmitters into a single antenna with only 3 per cent frequency separation must be capable of being adjusted from time to time to compensate for this change.

Design and Adjustment

The units described in this article were designed and built to meet the following specifications. Two one-kilowatt AM transmitters, operating on frequencies of 2522 and 2598 kilocycles, are to be fed to a single vertical radiator. A third transmitter simultaneously operating on 2566 kilocycles will be fed to a second radiator a short distance away. The required network for the first two transmitters shall provide suitable coupling to the antenna and sufficient attenuation that no combination of any of the three frequencies will be re-radiated at a higher level than 80 decibels below the desired field of the carrier frequencies. The networks shall have an insertion loss of less than 1.25 db at each operating frequency.

Because undesired radiation can originate from many sources other than through the coupling to the antenna, the specification for attenuation through the network was later revised. It was finally stated that each filter would have a one-way loss of at least 30 db for all undesired frequencies. This value is arrived at by assuming a conversion loss of 20 db. Thus, a signal traversing the filter from the antenna and combining in the transmitter to produce an undesired signal would experience an attenuation of 30 plus 20 plus 30 or 80 db before the undesired signal is radiated.

Figure 1 is a two terminal network configuration that provides the basis for most diplexing networks. When the two frequencies are fairly widely separated, L and C_1 are made series resonant at the operating frequency. C_2 is adjusted to make the whole circuit anti-resonant at the frequency of the second transmitter. Theoretically, it is an ideal circuit for this purpose. However, as the two oper-



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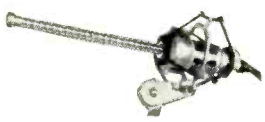

ating frequencies approach each other, the value of the inductance increases. Assuming most of the circuit losses occur in L, these, too, increase. This fact together with a rapid increase in circulating current in this circuit as the difference in operating frequencies approach 3 per cent, make the above adjustment of this network extremely impractical for the purposes of this design.

Despite these difficulties, however, the two terminal network of Figure 1 still seemed to offer the best solution provided its synthesis could be made to furnish the desired characteristics and at the same time keep losses and currents within reasonable values. For the 2522 kc filter, the solution was accomplished by setting the series resonant frequency of L and C_1 at .9 of the operating frequency. The circuit was then made anti-resonant at 2598 kc and its impedance level at 2522 kc was set equal to the magnitude of the antenna impedance. In this adjustment, assuming a coil Q of 400, the circuit loss at 2522 kc was .5 db with an attenuation of 62.2 db at 2598 kc. Circulating current was computed as 21 amperes.

Due to the existence of the 2566 kc frequency and in order to provide additional control, the final filter arrangement was made to consist of two of these two terminal networks in series together with a mid shunt capacitive leg. In this manner, at 2522 kc the completed filter then formed a "T" network with the shunt capacity leg serving primarily as an impedance level setting device. The actual match of the antenna to the transmission line is accomplished with a second, straightforward "T" matching network, removing any matching requirements from the adjustment of the filters.

The opposite filter for the 2598 kc transmitter is simply the reciprocal of the 2522 filter. In this case, the series resonant frequency becomes 1.111 times the operating frequency, making the completed "T" network a high pass circuit at 2598 kc. A simplified schematic of both units is shown in Figure 2 as they appear in the final installation.

Selection of components for the networks involved two somewhat contradictory considerations. It was desired that all components be of sufficient size and rating that under no possible condition would there be any heating or excessive losses. It was also desired that all components be kept as small as possible in physical size. It was imperative that if design conditions were to be met, extraneous capacities and lead inductances would have to be held to very low values.

Vacuum capacitors are used throughout the filters proper because of their inherent stability and extremely low temperature coefficient. The types used are rated at 20,000 to 25,000 peak volts. This is a safety factor of better than 5 over the calculated circuit voltages, but as determined from a study of prior diplexers, transient voltages of this magnitude are possible.

The coils are silver-plated, 3/8-inch copper tubing, and known to have Q's in excess of 500 at these frequencies. All inter-connections are made with 1/2-inch silver plated copper tubing to minimize losses and lead inductances. Ground connections are carried through the cabinets with 4-inch copper strap.

Figure 3 and Figure 4 show the interior arrangement of the 2522 and the 2598 kc filters, respectively. The compartments housing the individual sections of the filter are of such size that the coils at no point are closer than one diameter from their shields. Subsequent measurements of this construction revealed that the coil Q's remained very close to their free space value and well above the assumed 400 used in design calculations. The variable capacitors are tuned with a screwdriver fitting into the end of an insulated shaft. One-inch holes appear in the inner doors opposite each capacitor making possible the complete adjustment of the filter with the doors closed.

In Figure 5 can be seen the two units as they appear in their final

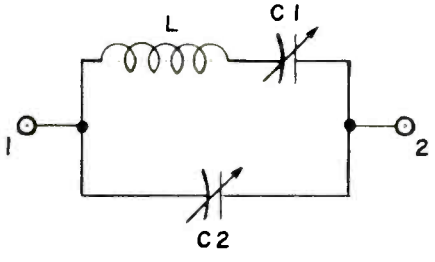

Figure 1.
Basic diplexing circuit.

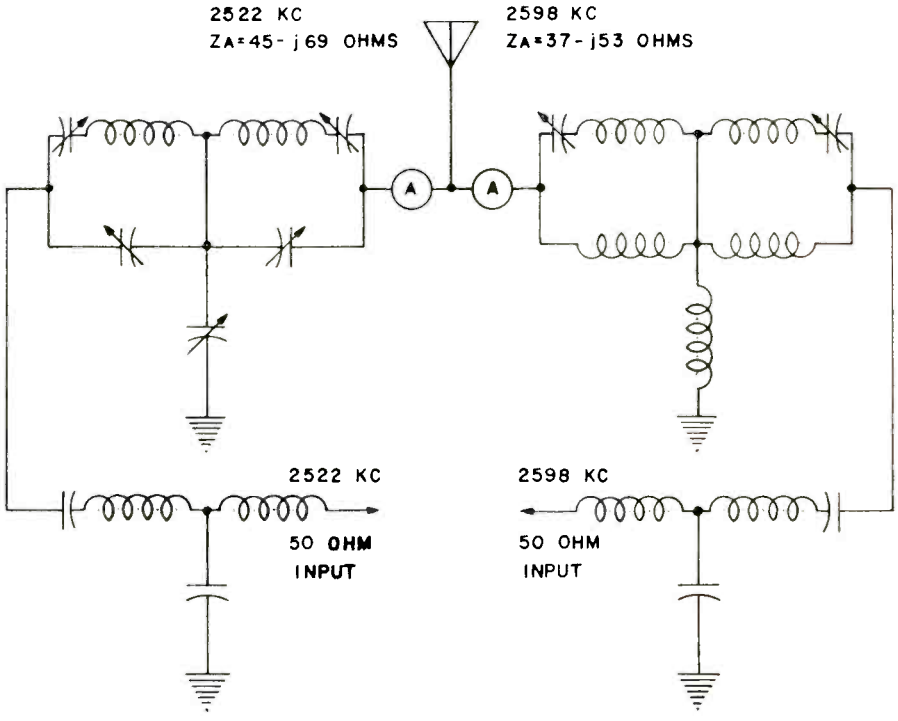

Figure 2.
Simplified schematic of complete diplexing networks.

*Network Design Engineer, Gates Radio Co., Quincy, Ill.

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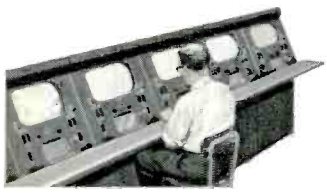

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4½ INCH IMAGE ORTHICON. This new camera uses a larger image orthicon picture tube—4½ inches in diameter. The 50 per cent greater tube size makes it possible to obtain far better picture detail than has been possible before.

FUNCTIONAL STYLING. A "new look" to identify this camera with the "new picture" has been given the TK-12, in the form of a distinguishing keystone shape. Functional in advantage, too, it provides space for an 8½ inch view finder instead of the usual 5 or 7 inch.

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ONE MINUTE WARM-UP. Camera set-up is the easiest ever! Turn it on and in one minute the picture is there. Quality pictures "snap in" each time you turn on camera.

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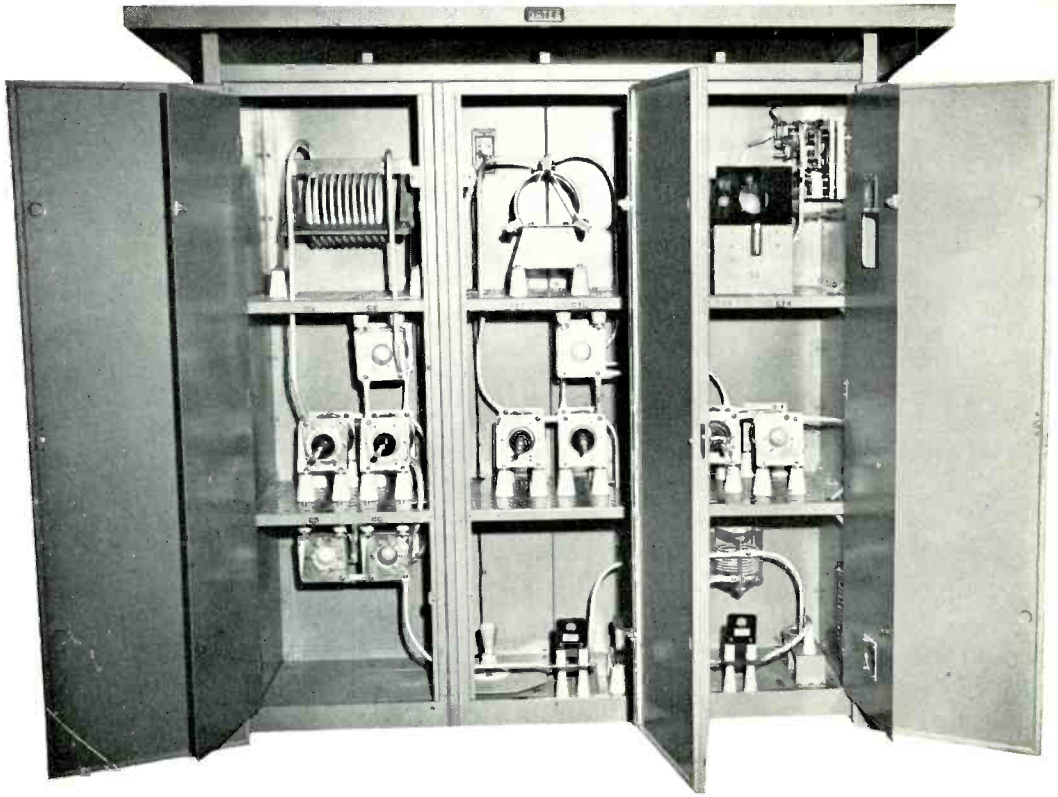


Figure 3. Interior 2522 kc filter unit.

installation. Each of the two cabinets measures 72 inches high, overall. At the base they are 63 inches wide and 23 inches deep. The roof has a 6-inch overhang all around. Each unit is made of an outer weatherproof cabinet and an inner cabinet separated by 1½ inches of spun glass insulation. The inner doors are interlocked with the transmitters and remain closed during operation. The outer doors may be locked and provide access to the controls and meters.

Ventilation for the units is provided by a free air space between the roof and the ceiling of the inner cabinet. The free flow of air through this space pulls air through three screened openings in the bottom of the unit and thus up through the cabinet and out three similar openings in the ceiling of the inner cabinet. This has long proven a very effective cooling method for antenna couplers.

Upon completion the units were tuned and adjusted at the factory under conditions as near similar to expected field conditions as possible. However, because of the many facets of field conditions, these factory adjustments can only be considered qualitatively and may or may not be indicative of actual results obtained in the field. It was extremely interesting to note the extent to which the actual units approached the calculated design performance. Attenuations of better than 60 db were measured at the opposite transmitter frequency in each filter while they exhibited less than 1 db of attenuation at their respective operating frequencies. With this adjustment, the final filters also each measured greater than 40 db of attenuation at 2566 kc.

Certainly by far the most interesting aspect arising from the factory adjustments was the degree of flexibility of control which the completed units exhibited. This was dramatically demonstrated in the manner in which the two series arms of each filter were adjusted.

Referring again to Figure 1, C_1 is the most critical of the three elements in the adjustment procedure. It was used to hold the anti-resonant frequency of the circuit at the main reject frequency of the filter. L and C_2 were then increased until the series resonant frequency of the circuit approached the design value. In so doing it was determined that over a relatively wide range, C_1 would vary the anti-resonant frequency but at the same time produce only a small change in the amount of attenuation at the operating frequency. Thus, once the units were in adjustment, actual control of the complete filters reduced to only two capacitors. Furthermore, each of the two series arms of either filter could be finally adjusted to produce maximum effect on two slightly different frequencies.

With this knowledge it was readily apparent that the two units were capable of wide latitude of adjustment depending upon particular field requirements at any one time.

Conclusions

In this diplexing system, as with others, the adjustment of each filter for maximum attenuation of the opposite transmitter frequency is not the same adjustment which allows each filter to see the antenna impedance at its operating frequency. In other words, the adjustment of the filters to produce maximum attenuation of the unwanted frequency results in a slight mismatch of impedance at the output of each filter. Also, as in this case, the fundamental frequency of the opposite transmitter may not be the cause of the most troublesome interfering signal appearing in the field. A harmonic of one of the transmitters may combine with the output of the other transmitter to cause more serious interference. Either of these conditions may be of concern at the time of the original adjustment, but at a later date with a change of transmitter

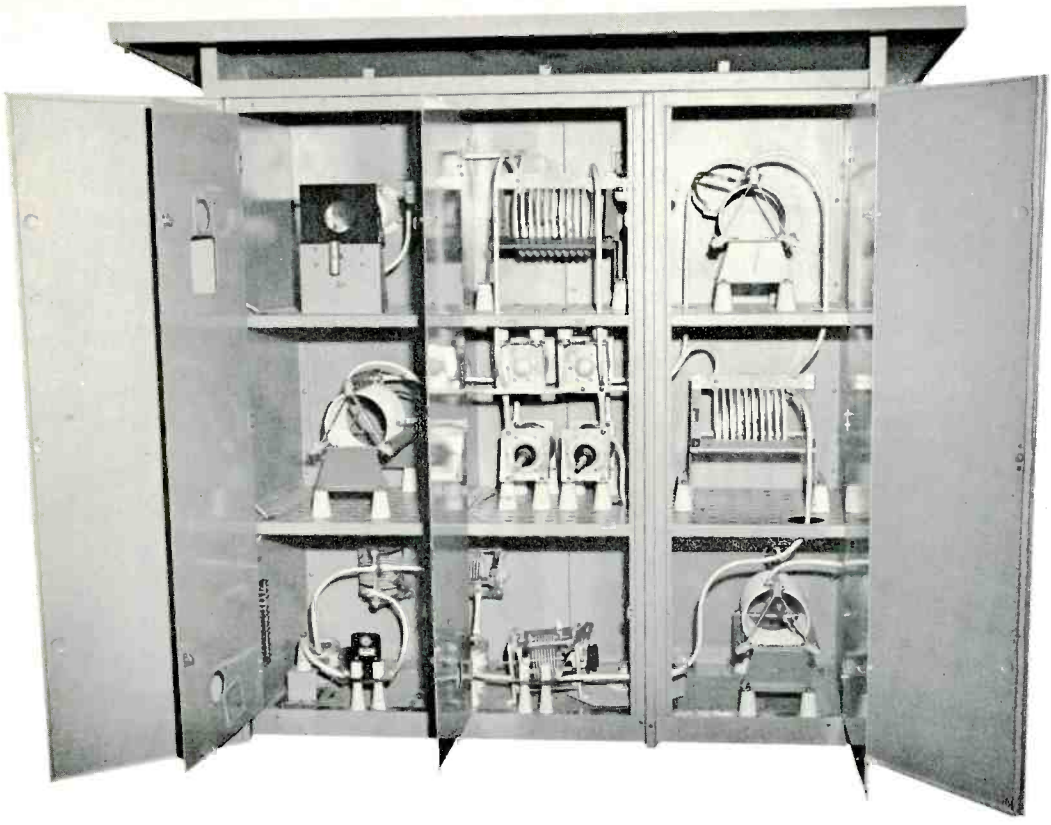


Figure 4.
Interior of 2598 kc filter unit.

tubes or a shifting of some field condition, some other set of conditions may be of more concern.

These conditions plus others peculiar to each individual installation preclude the possibility of considering diplexing networks as though they were single antenna couplers. They might more properly be considered as one would a directional antenna system which is kept under regular surveillance. Conversely, if a diplexing system is thoroughly understood, regularly monitored, and readjusted from time to time as is done with a well maintained directional antenna system, there appears no reason why satisfactory performance cannot be continually secured even though the system be highly complex.

The system described has demonstrated its ability to provide a high degree of attenuation at the specified frequencies with acceptable loss at the operating frequencies. It has demonstrated its flexibility of control so that it may be adjusted for satisfactory performance under a wide variety of possible field conditions. It is constructed of such components as to make it highly stable. If it is maintained over the years to come in the light of the points previously discussed, it should prove conclusively that two transmitters separated by only 3 per cent in frequency can be successfully combined into a single antenna.

Figure 5.
Completed diplexing filters as they will appear at tower base.

PLANNING AN FM STATION

An outline of the engineering and economic factors that must be considered in planning for the construction of an FM station.

By DWIGHT HARKINS*

DURING the past year, the manufacture and sale of FM receivers has made a strong showing to such an extent that the growth of this phase of broadcasting is beginning to "snowball." With over 800 stations now authorized by the F.C.C., new applications are literally "pouring" into the Commission with activity over 500 per cent ahead of last year.

In considering a future FM operation, many engineering phases must be closely coordinated with the economic factors of the individual location. It is a well known fact that many stations rushed into FM shortly after World War II only to find it economically a failure. Now that an audience is growing through the successful sale of auto and home FM radios, both existing AM stations and independent aspiring broadcasters are returning to FM.

Choice of Frequency

The Commission has divided the FM broadcast band into 100 channels numbering 201 through 300. From 88.1 Mc. to 107.9 Mc., each channel occupies 200 Kc. of the spectrum. Channels 201 through 220 are for educational non-commercial use. Twenty of the remaining channels are designated for Class A stations and the balance of 60 channels are for the use of Class B stations.

Class A stations are those with 1,000 watts radiated power or less. The Class B stations are designed to render service primarily to a metropolitan district and shall use a transmitter of 1 Kw or more power.

A Class B station operating in Area I shall not use more than 20 Kw. effective radiated power from an antenna height of 500 ft. Area I includes southern New Hampshire, Massachusetts, Rhode Island, Connecticut, southeastern New York, New Jersey, Delaware, the District of Columbia, portions of Maryland and eastern Pennsylvania.

The balance of the United States makes up Area II. In this area, the maximum radiated power is limited only to that which would not cause interference to existing stations or probable assignments insofar as can be determined at the time of the grant.

At one time, the FM channels were designated to specific cities and it was necessary to follow this allocation plan. In recent years, however, the channels have not followed any allocation plan. Stations will not normally be authorized to operate in the same city or coverage area with a frequency separation of less than 800 Kc. In the assignment of frequencies, the Commission has endeavored to provide the optimum use of the channels available in the band.

In certain areas, all channels are now assigned, while in other cities the choice of frequency depends upon which channels are still open for assignment. In the case of the FM band, no particular frequency is better than another.

Coverage

The proposed coverage area to a large extent determines the transmitter site and radiated power. The coverage expected can be predicted through the use of a chart shown in Fig. 1. This chart as supplied by the F.C.C. enables the distance to a particular contour to be determined.

The distances shown are based upon an effective radiated power of 1 Kw. To use the chart for other powers, the sliding scale associated with the chart should be trimmed and used as the ordinate scale. The sliding scale is placed on the chart with the appropriate graduation for power lined up with the lower line of the top edge of the chart. The right edge of the scale is placed in line with the appropriate antenna height graduations and the chart then becomes direct reading for the power and antenna height. Where the antenna height is not one of those for which a scale is provided, the signal strength of distance is determined by interpolation between curves connecting the equidistant points.

A field intensity of 5 mv/m should be provided over the densely populated areas to be served while as little as 50 microvolts per meter will give good service to the rural areas.

From the chart of Fig. 1 it is obvious that the transmitter site is very important in obtaining the height necessary to provide adequate coverage.

Antenna Gain

The effective transmitter power is multiplied by using multiple element antennas. Antennas with 16 elements are available to provide as much as 15.8 power gain. For example, a transmitter of 1 Kw. would effectively radiate 15.8 Kw. with the high gain antenna. Obtaining radiated power in this manner reduces the operating cost and initial investment in the transmitter. The high gain antennas operate on the principle of focusing the signal towards the horizon instead of allowing it to radiate upwards into the sky where it serves no practical purpose. The net result is the same as increasing transmitter power.

Programming

If the planned FM station is to operate in conjunction with an AM station, the programming can be duplicated, thus creating no additional program costs for the FM operation. In many cases, the FM is programmed separately during some hour of the day. If an FM-only station is planned, careful study should be made of program costs and possible income before proceeding. The majority of the new FM-only stations are having difficulties in be-

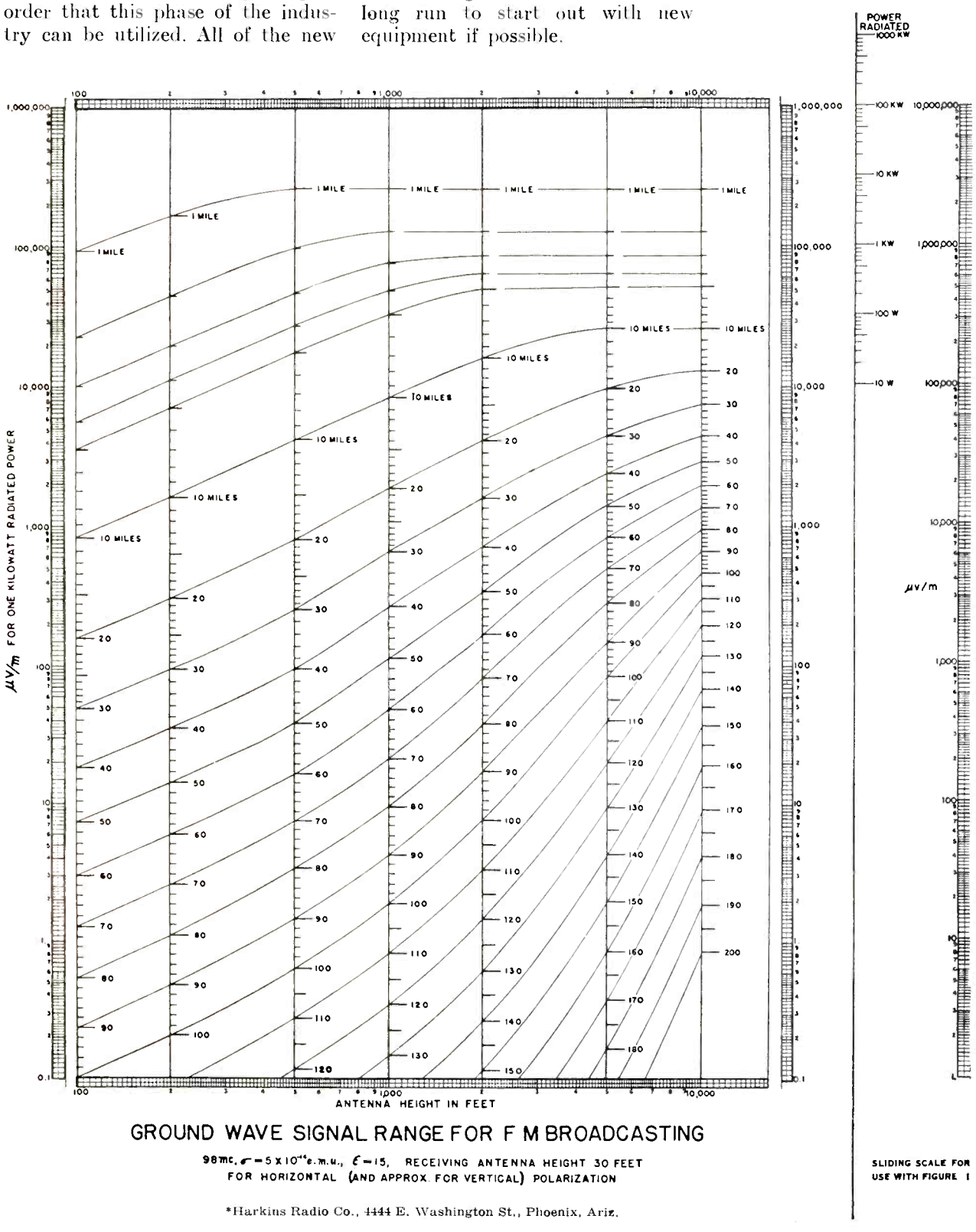
coming commercially successful although this situation is improving rapidly.

Multiplexing

As announced last month, the Commission has adopted new rules that permit many added uses of multiplex channels that will enhance the income of FM stations. In choosing equipment, plans should be made to permit multiplexing in order that this phase of the industry can be utilized. All of the new FM transmitters now offered are designed to permit multiplexing.

Equipment is available that will permit the modification of older transmitters to permit multiplexing and provide up-to-date quality transmission of the main channel. Most of the older transmitters, however, use expensive tubes that are becoming difficult to obtain, thus making it more desirable in the long run to start out with new equipment if possible.

Fortunately, the design of FM transmitters allows them to be built in sections so that a new station may start out with a 1 Kw. transmitter and at a future date add power amplifiers without losing any of the initial investment. By using this building block principle, a very economical start can be made and future growth can be paced with the demands.



GROUND WAVE SIGNAL RANGE FOR F M BROADCASTING

98mc, $\sigma = 5 \times 10^{-14}$ e.m.u., $\epsilon = 15$, RECEIVING ANTENNA HEIGHT 30 FEET
FOR HORIZONTAL (AND APPROX. FOR VERTICAL) POLARIZATION

SLIDING SCALE FOR USE WITH FIGURE 1

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

Thermoplastic Recording

By W. E. GLENN*

A recording system is described which combines the processing speed and versatility of magnetic recording and the storage capacity of photography. Information is written at extremely high density by means of an electron beam on a film consisting of a low melting thermoplastic material. This can be projected as a full color image, or can be converted to an electrical signal. The tape, which is processed by quick heating, can be readily erased and reused. The method was only recently developed and employs basically new principles. Much additional technical development must be done before it will appear in commercial products.

A WIDE band width recording technique will be described in this article in which an electron beam is used to cause deformations in the surface of a thermoplastic film. These deformations can be detected optically, and by using a special optical system described in a previous paper,[1] full color images can be projected from the film. The film requires no chemical processing and can be erased and reused. The resolution is comparable to that of photographic film and the bandwidth capability is well in excess of that required for video-recording.

Recording Technique

The recording principle is illustrated in Fig. 1. The film used consists of a high-melting base film coated with a transparent conducting coating with a thin film of a low-melting thermoplastic on its surface. An electron beam is used to lay down a charge pattern on the surface of the thermoplastic film in accordance with the information to be stored. The film is then heated to the melting point of the thermosplastic. Electrostatic forces between the charges on the film and the ground plane depress the surface where the

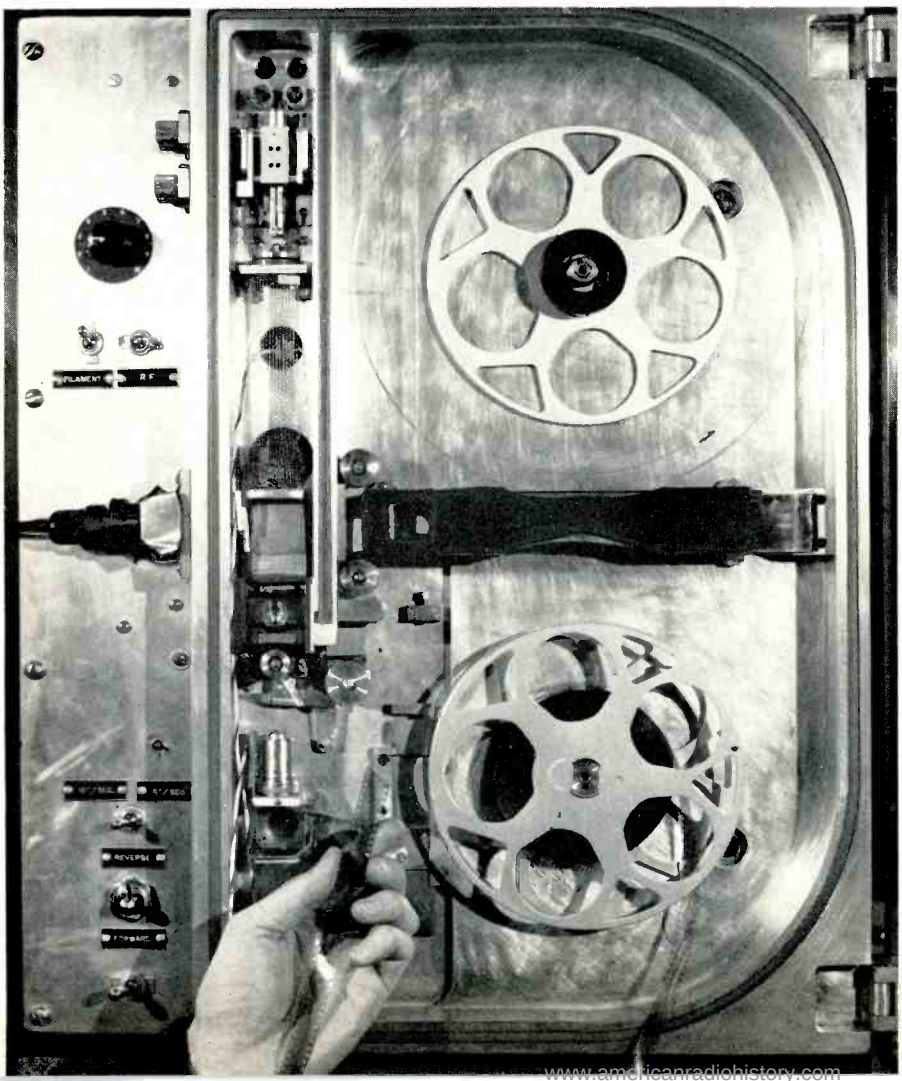


Figure 1.
The thermoplastic tape moves from the play-off reel (bottom), past an electron gun, a heating unit, and an optical monitor to the take-up reel (top).

Figure 3.
Each frame of the thermoplastic record is less than a quarter of an inch wide and fits easily inside a paper clip. The image is recorded in the form of microscopic indentations, but when ordinary light strikes the record at an angle, the image can be seen with the naked eye.

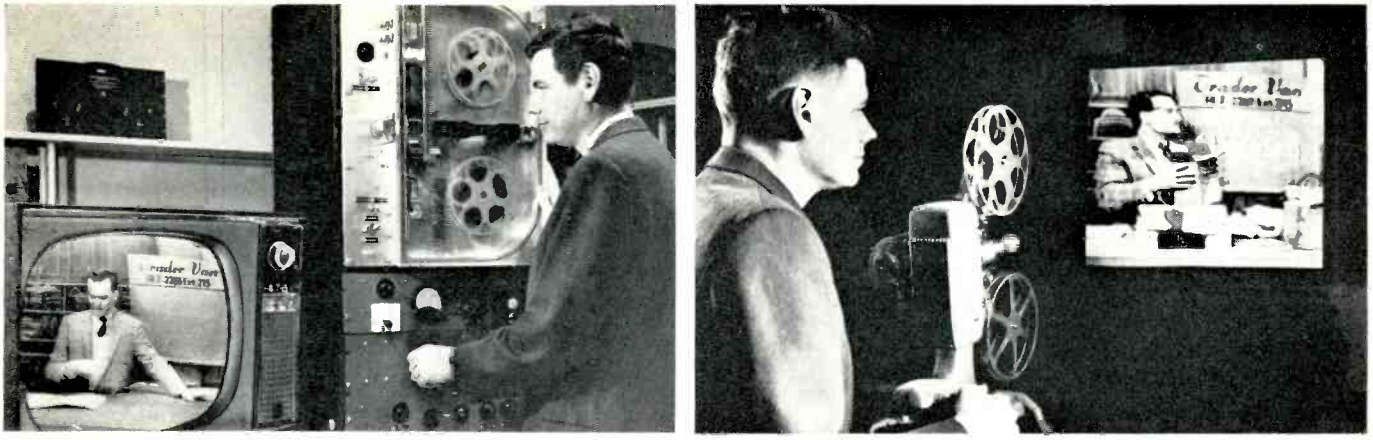


Figure 2. Dr. William E. Glenn, inventor of Thermoplastic Recording, demonstrates how the recorder transforms a television signal into a series of minute wrinkle patterns in a plastic coated, transparent tape and the resulting record is projected by means of a special optical system. The tape can also produce an electrical signal.

charges occur until these forces are in equilibrium with the surface tension restoring forces. The film can now be cooled below its melting point and the deformations will be "frozen" into the surface. With some materials the charge pattern will persist for days. It is usually not necessary to develop the deformations immediately after charging the film; however, this is usually done so that the recorded information can be monitored as it is being recorded.

The time required for the deformations to form depends on the viscosity of the film when it is melted but is usually of the order of a few milliseconds.

To erase the film the charge pattern must be discharged by heating the film well above its melting point so that its conductivity will increase. Surface tension will then smooth out the deformations and the film is ready for reuse. The film is usually heated for developing the deformations in a vacuum. It must also be cooled back below the melting point before it can be rolled up. A practical way to do this is to heat only the top surface of the film by inducing current in the transparent conducting coating for about 0.01 sec. This is ample time for the deformations to form. The heat will then diffuse into the film base and the surface will cool. By confining the rf fields, local erasure of areas a few mils square is possible if desired.

A recorder was constructed as illustrated in Fig. 2. The film plays off a reel, is driven at constant speed by a drive capstan and is charged by the electron beam. The electron beam is modulated by the signal to be recorded. The charge pattern is laid down in a television-type raster. The electron beam sweeps across the film, providing the horizontal sweep of the raster. Vertical sweep, along the film, is provided by the tape motion. As the film passes over the pair of rf electrodes, the surface is heated to the melting point of the thermoplastic, allowing the deformations to form. As the film moves on, the heat diffuses into the film base and the deformations are frozen into the surface. A small optical system, to be described later, is placed just after the rf electrodes (not shown in Fig. 2) so that the recorded information can be monitored. The entire device is in a continuously pumped vacuum chamber.

The charge pattern has been laid down success-

[1] W. E. Glenn, J. Opt. Soc. Am., 48, 841 (1958).

*General Electric Research Laboratory, Schenectady, New York

This article appeared in the December, 1959, issue of the Journal of Applied Physics.

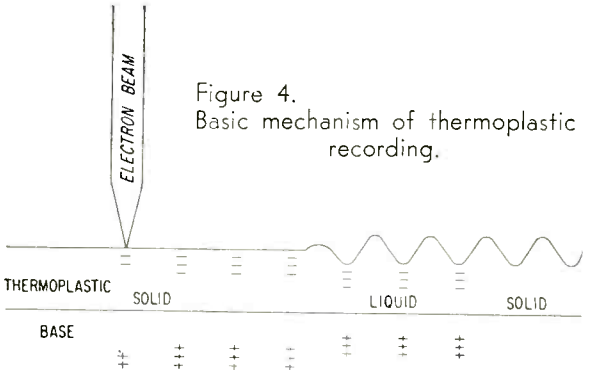


Figure 4.
Basic mechanism of thermoplastic recording.

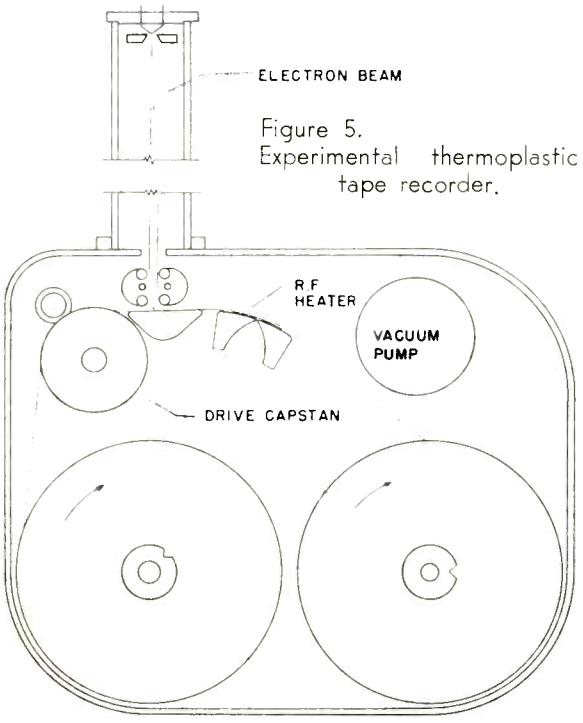


Figure 5.
Experimental thermoplastic tape recorder.

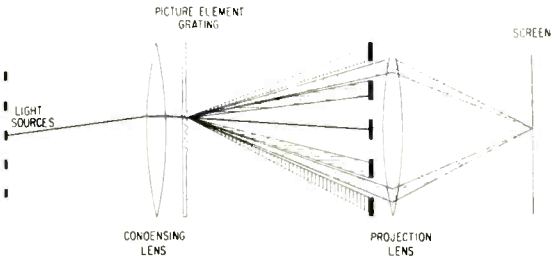


Figure 6.
Optical system for projection of color images from deformed transparent medium.

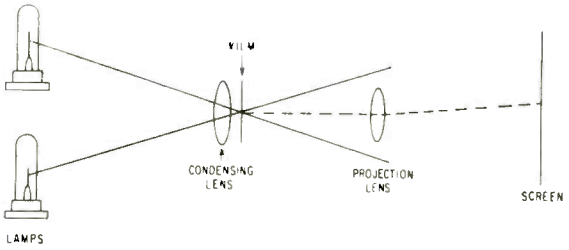


Figure 7.
Optical system for projection of color images from deformed transparent medium.

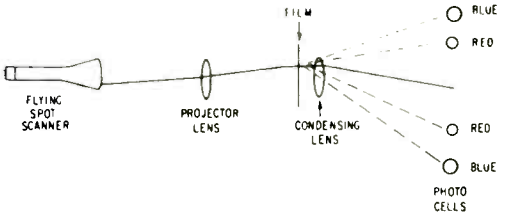


Figure 8.
Flying spot scanner optical system for converting recorded image to electrical signal.

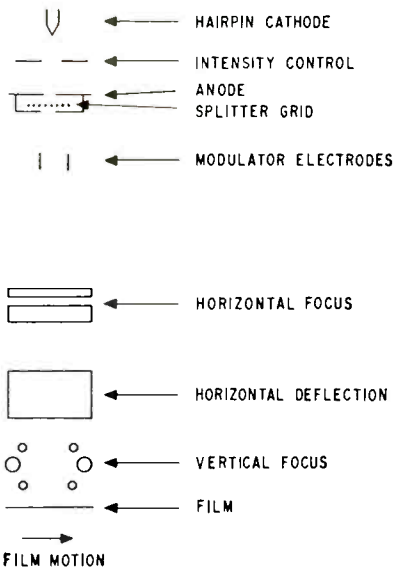


Figure 9.
Schematic drawing of electron beam splitting gun.

fully in air simply by dragging a fine wire, with the voltage to be recorded applied to it, across the surface of a thermoplastic film. However, recording in a vacuum seems to be much more practical since it permits higher writing density and speed, and is more reproducible.

Reading

Color Images—For color imaging the deformations are impressed on the thermoplastic surface in the form of phase diffraction gratings. The optical system described in a previous paper[1] permits projection of a color image from such a pattern of gratings. This system is illustrated in Fig. 3. In this projector a condensing lens near the film images an array of line light sources on a set of opaque bars in front of the projection lens. Where the film is smooth, these bars intercept the light and these areas appear black on the screen. In an area where the deformations form a diffraction grating, light will be diffracted through the slots and the projection lens will image this light at a position on the screen corresponding to the position of the grating. The slots are narrow enough to admit only one primary color of the spectrum that falls on the bar system. The spacing of the grating determines the color of the picture element. The amplitude of the grating determines the intensity of the diffracted light.

For color image reproduction more than one pri-

mary color is necessary. A color which is the sum of two or more primary colors can be formed by simply superimposing two or more gratings, each with a spacing corresponding to a primary color. A new primary system[1] using one fixed and one variable color is found to have many advantages over a system of three fixed color primaries.

A special electron gun, to be described later, is used to produce the gratings in each picture element with the appropriate spacing and amplitude.

Black and White Images—The optical system employed for projection of black-and-white pictures is a modified Schlieren system. The slots and light sources are made wide enough for the entire spectrum to be passed by the optical system. The electron beam simply scans a normal television line, depositing charge in accordance with the light intensity of each picture element. The amount of charge will govern the depth of the resulting deformation, and upon projection the light intensity of the picture element will depend upon this depth.

Resolution—The electron beam size can resolve wavelengths smaller than the wavelength of light. However, the resolution of the system is limited by optical considerations. For the black-and-white system each line can be resolved by the optical system. For color, narrower slots and light sources are used. Because of diffraction from these narrower slots, about four grating lines are required to produce a resolvable picture element in color. This means that a picture element recorded in color requires about four times the area of the corresponding element recorded in black and white.

As the grating spacing is narrowed, the diffraction angle of course increases. When the diffraction angle is large, the optical system of Fig. 3 simplifies to that shown in Fig. 4.

Electrical Signal Output—To read the film to produce an electrical output, a flying spot scanner or camera tube may be used with the optical system described above. A simple version of a flying spot scanner reading system is shown in Fig. 5. Here the film is scanned with light of a single color from the flying spot scanner. Photoelectric cells are placed at different angles to accept light diffracted by gratings of different spacing.

Analog or Digital Data—To record electrical signals in analog form, the electron beam is modulated by the signal to be recorded. For a single beam, the intensity can be modulated. When the split beam is used, both the grating spacing and the intensity can be modulated.

For binary digital data, a single split beam may be used. In this case, it is desirable to use only two colors, one for the 0's and another for the 1's. In this way all data bits appear as the presence of a single color. Since a dust speck scatters light randomly, it appears as white light. A coincidence in the zero and one detectors can thus be made to reject dust. Coordinate data can be recorded as the absence of a color. Since coordinates can be recorded in with the data, high mechanical tolerances are not required to realize the high resolution of the system.

Figure 10.
Photographic image of split beam on phosphor.

Electron Gun Design

A special electron gun was designed which lays down a charge pattern that will form a diffraction

(Continued on page 39)

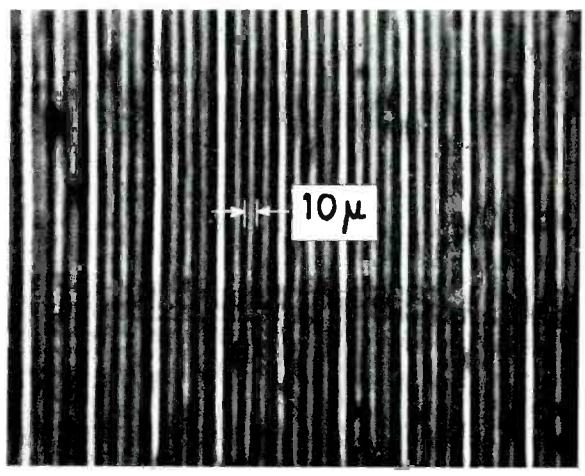


Figure 11.
Photograph of raster lines, recorded on thermoplastic tape, with split electron beam.

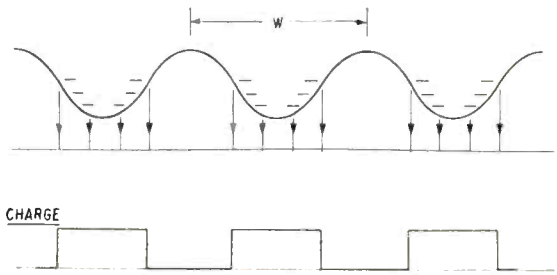


Figure 12.
Assumed deformation of thermoplastic surface (upper) and distribution of charge on surface (lower).

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AMENDMENTS AND PROPOSED CHANGES OF F.C.C. REGULATIONS

OPERATION OF CO-CHANNEL AMPLIFYING TRANSMITTERS IN CONJUNCTION WITH MAIN TRANSMITTER

1. The Commission has before it for consideration its Memorandum Opinion and Notice of Further Proposed Rule Making (FCC 57-700), issued in this proceeding on July 2, 1957, proposing the authorization of television broadcast booster stations for use in conjunction with UHF television broadcast stations.

2. This proceeding was instituted on March 31, 1955, by a Notice of Proposed Rule Making (FCC 55-404) designed to elicit information on the desirability and feasibility of licensing UHF television co-channel amplifying transmitters, generally referred to as TV boosters. The Notice contemplated that such devices would be used by the licensees of UHF television broadcast stations to receive, amplify and retransmit the signals of the TV broadcast station on the original channel in order to "boost" the signal in areas of sub-normal signal intensity. After reviewing the comments directed to this phase of the proceeding, the Commission, on June 27, 1957, adopted a Memorandum Opinion and Notice of Further Proposed Rule Making proposing specific rules to govern UHF television boosters.

3. There was no opposition to the general proposal. Some of the comments merely endorsed the proposal without commenting on the specific rules; others suggested certain modifications; and a few requested that provision be made for VHF boosters.

4. Governor McNichols of Colorado filed comments on behalf of the Governors of several western states urging that provision be made for licensing the numerous low-power television boosters and translators operating in the VHF television band without Commission authorization.

5. Two other parties filed comments supporting the subject proposal but requesting that it be expanded to include VHF boosters and translators. Television Montana, Inc. (KXLF-TV, Channel 4, Butte, Montana) proposed the licensing of VHF boosters with power up to 100 watts not only to the licensee of the primary TV station but to other "qualified applicants." The Washington State TV Reflector Association endorsed the subject proposal but requested that the proceeding be expanded to include provision for licensing devices such as those now being operated by its members.

6. The Commission by a Memorandum Opinion and Order of July 29, 1957, initiated a separate proceeding (Docket No. 12116) concerning low power TV repeater stations. In the judgment of the Commission, the considerations involved in that proceeding are not sufficiently related to the matters considered in the subject proceeding to be included herein. Since none of the parties commenting with respect to the above problem objected to the subject proposal for UHF, their comments need not be considered further in this UHF booster proceeding.

7. The following parties generally supported the proposal but did not comment with respect to specific rules: Basin TV Company (KBAS-TV, Channel 43, Ephrata, Washington), WATR, Inc. (WATR-TV, Channel 53, Waterbury, Connecticut), Prairie Television Company (WTVP, Channel 17, Decatur, Illinois), Great Lakes Television Company (WSEE, Channel 35, Erie, Pennsylvania), KCOR, Inc. (KCOR-TV, Channel 41, San Antonio, Texas), Sir Walter Television Company (WNAO-TV, Channel 28, Raleigh, North Carolina), WBRE-TV, Inc. (WBRE-TV, Channel 28, Wilkes-Barre, Pennsylvania), Committee for Competitive Television and American Broadcasting Company.

8. Six parties submitted comments which support the proposal generally but suggest certain modifications. These are discussed in the following paragraphs.

9. Adler Electronics, Inc., which is engaged in the production of UHF transmitting apparatus, has operated an experimental UHF booster in conjunction with WATR-TV (Channel 53, Waterbury, Connecticut) since July, 1955. Adler endorses the general proposal and subscribes to the comments of Electronics Industries Association (formerly RETMA). Adler suggests that the required suppression of emissions more than 3 mc above or below the assigned TV channel be reduced from 60 decibels to 40 decibels below the peak visual carrier power, with additional suppression added in individual cases if objectionable interference occurs. Adler contends that the proposed 60 decibels of suppression would add considerably

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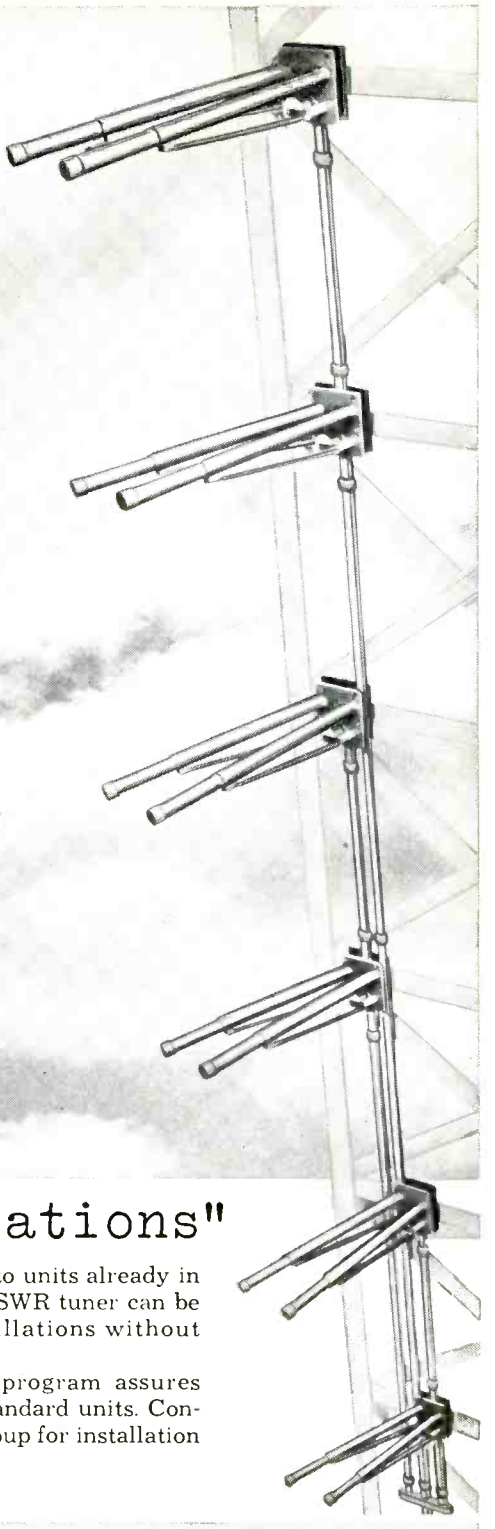

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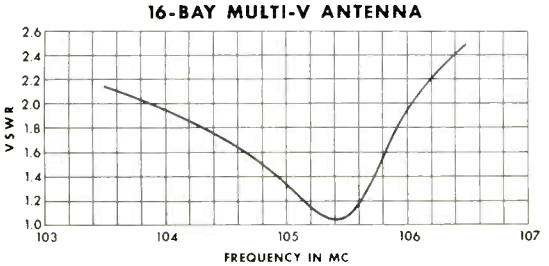

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to the cost of basic equipment and would be unnecessary at the majority of the actual installations.

10. Columbia Broadcasting System, Inc., supports the proposal generally but recommends the following modifications:

(a) CBS suggests that the rules expressly state that there is no numerical limit on the number of boosters used by a licensee to fill in shadows in its normal service area.

(b) CBS urges that the rules should clearly show that there is no fixed minimum separation required between boosters or between a booster and other TV broadcast stations since potential interference is controlled to a great extent by limitations on power and field intensity as well as the provision limiting boosters to the Grade A service area of the parent station.

(c) CBS submits that the provision in § 4.803 (a) suggesting adjustment of time differential as a corrective measure for interference is impractical and should be deleted.

(d) CBS urges that the reference to "principal community" in §§ 4.835 and 4.837 should be deleted since the principal community might be difficult to determine and the provisions could impose an artificial and unnecessary barrier to providing service to two adjacent communities from a single booster. CBS suggests that "center of the area of highest concentration of population" could be used instead.

(e) CBS believes that the proposed requirement of § 4.803 (c) that the booster licensee "assume full responsibility for resolving all valid complaints of interference" may be impossible to meet and recommends that the responsibility of the booster licensee be limited to "reducing the interference to a minimum."

(f) CBS suggests that the provision of § 4.883 (b), which states that the Commission may request the operator on duty at the TV broadcast station to interrupt the transmissions of the booster for short intervals to aid in identification of a particular booster, should be modified to limit such requests to times when the booster is not transmitting programs since such interruptions may prove annoying to viewers.

11. Radio-Electronics-Television Manufacturers Association (RETMA), now Electronics Industries Association (EIA), supports the proposal generally but comments specifically with respect to the following:

(a) EIA now supports the proposal to restrict the use of boosters to areas within the Grade A contour of the primary TV station.

(b) EIA agrees that a reduction in out-of-band emissions should be specified but recommends that the proposed requirement be reduced from 60 decibels to 40 decibels below the visual carrier power, with additional attentuation required in individual cases of interference.

(c) EIA opposes any maximum limit on power since such a restriction may raise problems when a booster operates close to the primary station. EIA is of the opinion that the amount of power which may be employed will be automatically limited by design considerations, which restrict the possible gain in the amplifier because of "feed-back" problems. The output power would thus be controlled by the strength of the signal available from the primary station and would decrease with distance from the primary station.

(d) EIA recommends against imposing a maximum field intensity over the area to be served since this will be governed by the automatic limit on power output. In this connection, EIA believes the political boundaries of a "principal community" would be difficult to define.

(e) EIA supports the proposal which would limit the field strength to not more than 5 millivolts per meter at 68 miles from the primary station.

(f) EIA suggests that the term "maximum overall gain" in § 4.850 (d) be changed to "maximum utilized gain" to embrace circumstances where the booster amplifier might be operated below its maximum capabilities.

12. Joint Council on Educational Television (JCET) supports the proposal generally but expresses concern that boosters operating in locations at less than the minimum separations required by regular TV broadcast stations may cause interference under certain conditions. JCET suggests that an applicant proposing a booster at less than the normally required separation from any TV broadcast station be required to submit a special showing with regard to potential interference.

13. Indiana Broadcasting Corporation supports the proposal generally but believes that the requirement of § 4.834 (a) (3), that a manned control point be established in the areas served by the booster, would add substantially to the cost of operation and might discourage the use of boosters. Indiana Broadcasting suggests that the rules also permit remote control of boosters from the primary station if automatic devices are incorporated which will transmit a warning signal to the control point by wire lines if the booster equipment malfunctions.

14. National Broadcasting Company, Inc., supports the proposal generally and stated that it was considering the use of boosters in conjunction with its UHF stations at Buffalo, New York, and New Britain, Connecticut. NBC suggests the following modifications:

(a) Delete the provision in § 4.832 (b) (1) that would require a showing that 50 per cent of the locations in the area proposed to be served by the booster receive signals of less than 5 millivolts per meter from the primary station. NBC contends that this requirement would be burdensome, that making such a determination with respect to the "principal community" would not necessarily indicate that the area adjacent to the "principal community" and served by the contemplated booster had less than 5 millivolts at more than 50 per cent of the locations, and that the purpose of the rule is obscure. NBC urges that delegation of this requirement would not lead to abuses since self-interest would deter broadcasters from placing boosters in areas where they are not actually needed.

(b) Delete the restriction on maximum power in § 4.835 (c) and let this be governed by the strength of the signal available from the primary station at the booster location. NBC contends that the provisions of § 4.803 (c) and (d) afford adequate protection to other services from interference by the booster and that limiting the 5 millivolt per meter field to within the Grade A contour of the primary station guards against extension of the service area of a TV station.

(c) NBC states that the reference in § 4.835 (a) to political boundary of the principal community may be difficult to determine and that elimination of the limit on maximum power and maximum field intensity would remove any need for such a reference point.

DISCUSSION

15. The Commission agrees with CBS that the sentence in § 4.803 (a) concerning adjustment of the time differential of the modulation envelope should be deleted.

16. On the basis of the comments of NBC with regard to § 4.832 (b) (1), we have reconsidered the proposed requirement that booster applicants indicate the quality and extent of direct reception in the area proposed to be served, and agree that the cost and complexity of the necessary field strength survey outweighs the importance of the data so obtained. This requirement has therefore been deleted.

17. We do not agree with the suggestion by CBS regarding § 4.803 (c)—that the licensee of a booster should assume responsibility for interference only to the extent of "reducing it to a minimum." On-channel amplifiers used for "boosting" and re-radiating TV signals inherently are a source of potential interference. The subject rules stress this fact and there will undoubtedly be places where boosters cannot be operated because of insoluble interference problems. Where a TV booster is authorized, the burden of resolving interference must, in our judgment, rest with the licensee. In the experimental UHF booster operations that have been conducted to date, it has been found that when a UHF booster is properly located, it is possible to eliminate interference through the use of readily available engineering procedures. If the circumstances are such that the booster cannot be properly located, the operation is not feasible. The Commission is placing the burden of eliminating interference on the licensee to prevent the use of boosters to provide service to one group of people at the expense of service to another group, even though such use might result in a net gain in audience.

18. We have carefully considered the comments of Indiana Broadcasting Corporation concerning the establishment of a monitoring point in the area served by the booster and conclude that the additional protection against interference caused by improper operation, which might be afforded by the establishment of a local monitoring point is not sufficient to warrant the cost of establishing such a monitoring point. The most important feature of the originally proposed local monitoring point was the provision for manual on and off control of the booster, particularly in the event of failure of the remote on and off control. This problem has been met by adding a requirement to the remote control provision which makes necessary the periodic transmission of a "cue" signal by the primary station. Failure of the primary station to transmit the cue signal or failure of the booster control circuit to receive the cue signal will automatically place the transmitter in an inoperative condition. The cue signal need not be transmitted more frequently than intervals of one hour.

19. CBS, NBC, and EIA commented extensively with respect to § 4.835. It is their consensus that using the political boundaries of a "principal community" as a reference point in connection with the maximum limit on field intensity radiated by a booster is impractical and might introduce artificial restrictions on the use of boosters. All of the parties subscribed to the provisions of paragraph (b) (4) of this section, which would prohibit the radiation of a field having an intensity in excess of 5 millivolts per meter beyond the theoretical Grade A contour (68 miles) of the primary station; and EIA and NBC submitted that the further restriction limiting the radiated field to 5 millivolts per meter over the "principal community" is unnecessary. CBS suggested as a reference point "the center of the area of highest concentration of population" in the area proposed to be served by the booster in applying the proposed restriction. NBC and EIA recommended that paragraph (c) be deleted and that no maximum power limit be specified. Both expressed the view that there is an automatic limit on power imposed by the practical limits on the amplification of the signals received from the primary station which can be accomplished. They maintain that since the strength of the direct signals diminish with the distance from the primary station, less power can be employed at the booster as the distance from the primary station increases, and no specified limit is necessary.

20. We adhere to our belief that a ceiling on the maximum power which may be used by a television broadcast booster station, should be included in these rules. However, we have reconsidered the original proposal which would have determined this "ceiling" on the basis of a predicted field strength over a "principal community" and conclude that this would add an unnecessary complexity to the rules. Accordingly, the rules adopted herein limit the power in only two regards; (1) the maximum effective radiated power which will be authorized is 5 kilowatts, and (2) no booster installation will be authorized which would produce a predicted field of more than 5 millivolts per meter beyond the normal Grade A (68 mile) contour of the primary station.* The problem of interference to other television stations, raised by JCET, is met by the provisions of

*The proposal in Docket 13340 if adopted as proposed would eliminate the definition of Grade A service and revise the Field Strength Charts used for estimating service ranges. If these changes are adopted the rules relating to TV boosters will be appropriately amended to be consistent with the changes.

§ 4.804 which require the TV booster licensee to correct any condition of interference to other TV stations which occurs as the result of a field strength from the booster in excess of that which could be produced at the place where the interference occurs, by the primary station if it were operating at its authorized location with an effective radiated power of 5,000 kilowatts from an antenna 2,000 feet above average terrain.

21. Deletion of the rules which would have required determination of field strength over a "principal community" eliminates the need for establishing such a reference point. For record purposes a booster will be identified with the largest community in the area which it serves, i.e., the licensee, in addition to the geographic coordinates, will specify such community.

22. With regard to CBS's suggestion that the rules clearly show that no numerical limit is placed on the number of TV boosters that may be used by a single licensee, we have added language to § 4.832 (c) which makes this clear.

23. On the basis of the comments of Adler and EIA, the Commission has reconsidered the proposal in § 4.836 (c) which would require that spurious emissions, including any emissions more than 3 megacycles above or below the upper and lower limits of the assigned channel, be suppressed at least 60 decibels below the peak visual carrier amplitude. Adler and EIA have suggested that a suppression of only 40 decibels would be adequate. In view of the statements that achieving the additional 20 decibels of suppression above 40 decibels will add substantially to the cost of equipment and our experience with UHF translators which have been operating for over a year with less than 60 decibels suppression, we are incorporating the suggested reduction in the suppression requirement in §§ 4.836 (c) and 4.850. However, § 4.836 (c) will continue to provide that additional suppression may be required in individual cases where interference is caused by out-of-band emissions.

24. JCET urges adoption of minimum geographic separations between boosters, and between a booster and a regular TV broadcast station. CBS on the other hand urges that the rules clearly show that no minimum spacings are required. JCET expresses concern at the possibility of interference if no separation requirement is specified. Application of the separation requirements of Part 3 of the rules to boosters would make it virtually impossible to find satisfactory locations in regions where boosters are needed. UHF operation is concentrated in areas of high population density. In such areas there is often little flexibility in the allocation of UHF channels since many of the allocations have been made at or near mini-

mum spacings. Therefore, boosters proposed to serve communities beyond the immediate area around the TV station would, in many cases, not meet minimum spacings to other UHF stations or assignments. By confining boosters within the theoretical Grade A contour, limiting the power to 5 kilowatts and requiring correction of interference which occurs as the result of fields in excess of those which could be produced by the primary station, we accomplish substantially the same degree of protection to other co-channel TV stations as is provided by the minimum separations. Interference can be controlled in most cases by the judicious choice of booster sites and the intelligent use of the directive properties of transmitting antennas and individual TV receiving antennas in the areas served by the booster. In circumstances where such measures are inapplicable, other means, such as translators or satellite operation may be employed to provide the needed service.

25. Sections 4.803, 4.804 and 4.832 (b) are intended to insure that the use of a TV booster does not deprive people of otherwise satisfactory service. These rules are designed (1) to guard against the destruction of the service of a TV station other than the primary station whether or not a substitute service is provided by the TV booster and (2) to prevent the degradation of service received directly from the primary station unless the substitute service provided by the booster is of equivalent quality. However, in neither of the above cases is it intended to provide protection over and above that which is provided under the rules governing TV broadcast stations. Therefore, the responsibility of the licensee of the TV booster with respect to interference, applies only in those cases where the interference results from the existence of signals from the booster having a strength in excess of that which would be produced at the same location, by the primary station operating with the maximum power and antenna height permitted under the TV rules. The provisions of § 4.804 place a continuing requirement on the licensee of the TV booster and the responsibility for resolving valid complaints of interference applies not only to interference to stations existing at the time the TV booster is placed in operation but also to interference which may develop as the result of new TV stations coming into operation. Although the rules are concerned only with actual interference, applicants should carefully consider potential interference and the hazard of interrupted operation posed thereby.

26. EIA suggested that § 4.850 (d) refer to "maximum utilized gain" rather than "maximum over-all gain." The term "over-all gain" as used in this section simply means the net gain of the booster amplifier between the input and output terminals, and refers to the actual utilized gain, not the maximum capabilities of the amplifier. Therefore, no change in the wording of this rule appears necessary.

27. We have found it unnecessary to require these boosters to transmit individual call signs. They are licensed only to the licensee of the TV broadcast station they are retransmitting and the transmission of the TV station call sign provides rapid identification. If it becomes necessary to obtain emergency suspension of operation due to interference, these devices can be turned off from the TV station by the transmission of a coded signal. The proposed rule contained a provision whereby the Commission could request that the transmissions of a booster be interrupted for short intervals of time to facilitate identification. CBS suggested that such interruptions be limited to periods when no program is being transmitted. The importance of rapid identification outweighs the slight annoyance of inconvenience of program interruption. If a TV station licensee operates more than one booster selective coding may be employed to control each booster separately. This would avoid having to turn off all the boosters when interruption of the signal of only one is needed to identify improper operation or eliminate interference. It should not be necessary to interrupt the transmission of the primary TV station for this purpose.

28. The present Television Agreements with Canada and Mexico do not cover the matter of "booster" amplifiers. Under rules such as those adopted herein, boosters may not be used to extend the service range of a TV station beyond that which it could obtain with the maximum power and antenna height at the site of its main transmitter. Consequently, such operation may be considered to come within the purview of the Agreements. However, in the interest of good international relations, the Commission will not act unilaterally in this matter and will initiate action looking toward securing concurrence of the governments of Canada and Mexico in the matter of licensing these devices in the vicinity of the borders. Pending the completion of such an arrangement, applications proposing UHF boosters in conjunction with assignments listed in the Canadian or Mexican TV Agreements and located more than 15 miles from the site of the main transmitter in the direction of the border of Canada or Mexico, will be referred to the appropriate Government on a case-by-case basis.

29. In order to implement the rules, we are adopting FCC Form 343 to be used in applying for a Construction Permit for a Television Broadcast Booster Station. This form will be available shortly.

30. Authority for the adoption of the rules herein is contained in sections 4 (i), 301, 303 (a), (b), (c), (d), (e), (f), (g), (j), and (r), and 307 (b) of the Communications Act of 1934, as amended.

31. *Accordingly, it is ordered,* That effective July 5, 1960, the Commission's rules and regulations are amended as set forth below.

1. Section 1.322(a) is amended by adding the following new subparagraph.

§ 1.322 Application forms for authority to construct a new station or make changes in an existing station.

(a) * * *

(6) FCC Form 343 "Application for Authority to Construct or Make Changes in a Television Broadcast Booster Station."

2. Section 1.325 (b) is amended by adding the following new subparagraph:

§ 1.325 Application for license to cover construction permit.

(b) * * *

(6) FCC Form 344 "Application for Television Broadcast Booster Station License."

3. Section 1.328 (d) is amended by adding the following new subparagraph:

§ 1.328 Application for renewal of license.

(d) * * *

(6) FCC Form 345 "Application for Renewal of Television Broadcast Booster Station License."

4. Section 4.15 is amended by adding the following new paragraph:

§ 4.15 License period.

* * * * *

(c) The license of a television broadcast booster station will be issued for a period running concurrently with the license of the television broadcast station (Primary Station) with which it is used.

5. Add a new Subpart H to read as follows:

Subpart H — Television Broadcast Booster Stations

Definitions and Allocation of Frequencies

Sec.
4.801 Definitions.
4.802 Frequency assignment
4.803 Interference to primary station.
4.804 Interference to other stations and services.

Administrative Procedure

4.811 Administrative procedure.

Licensing Policies

4.831 Purpose and permissible service.
4.832 Eligibility and licensing requirements.
4.833 [Reserved.]
4.834 Remote control operation.
4.835 Power limitations.
4.836 Emissions and bandwidth.
4.837 Antenna location.

Equipment

4.850 Equipment and installation.
4.851 Equipment changes.
4.861 Frequency tolerance.
4.862 Frequency monitors and measurements.
4.863 Time of operation.
4.864 Station inspection.
4.865 Posting of station and operator's licenses.
4.866 Operator requirements.
4.867 Marking and lighting of antenna structures.
4.868 Additional orders.
4.869 Copies of rules.

Operation

4.881 Station records.
4.882 [Reserved.]

Sec.
4.883 Station identification.
4.884 Rebroadcasts.

DEFINITIONS AND ALLOCATION OF FREQUENCIES

§ 4.801 Definitions.

(a) Television broadcast booster station: A station in the broadcasting service operated for the sole purpose of retransmitting the signals of a television broadcast station by amplifying and reradiating such signals which have been received directly through space, without significantly altering any characteristic of the incoming signal other than its amplitude.

(b) Primary station: The television broadcasting station radiating the signals which are retransmitted by a television broadcast booster station.

§ 4.802 Frequency assignment.

A television broadcast booster station will be assigned the channel and carrier frequencies assigned to its primary station.

§ 4.803 Interference to primary station.

(a) An application for a new television broadcast booster station or for a change in the facilities of an existing station shall be accompanied by a detailed showing and discussion of the areas of potential interference. The showing shall include:

(1) A suitable map of the area in which the booster is proposed to be operated showing the location of the booster, the direction from the booster toward the primary station and the distance to the primary station, the radiation pattern of the booster, and the areas in which an unfavorable ratio is likely to exist between the direct signal and the boosted signal. If certain terrain features are expected to confine or otherwise minimize interference, these shall be clearly marked.

(2) A statement as to the approximate number of existing receiving installations which may be adversely affected by the proposed booster operation and the measures which will be employed by the applicant to restore reception, including an estimate of the cost of such restoration and how this cost will be borne.

(b) It shall be the responsibility of the licensee of a television broadcast booster station to corect any condition of interference resulting from the operation of the booster to a receiving installation existing at the time the booster is placed in operation, which causes loss or degradation of on otherwise acceptable service from the primary station if requested to do so by the owner of the affected TV receiver. The licensee of the booster is expected to provide such advice, technical assistance, and materials as may be required to restore the lost service either by rejecting the booster signals to the extent necessary to restore the direct service to its original condition or by utilizing the booster service to replace the lost direct service. Refusal of the complainant to permit the application of remedies which are demonstrably capable of restoring the lost service will relieve the booster licensee of further responsibility for the correction of interference to that complainant.

§ 4.804 Interference to other stations and services.

(a) The licensee of a television broadcast booster station is responsible for the correction of interference to reception of other television broadcast stations or stations in other services, caused by:

(1) Radiation of radio frequency energy outside the channel assigned to the booster.

(2) Radiation of spurious emissions, i.e., emissions not contained in the visual and sound signal received from the primary TV station, within the channel assigned to the booster.

(3) Authorized emissions which produce a field strength at the affected receiver in excess of the theoretical field which would be produced by the primary TV station at that same location if the primary TV station were operating with 5 megawatts effective radiated power from an antenna 2,000 feet above average terrain, over a path of normal terrain. The theoretical value of field strength which could be produced by the primary station under the conditions stipulated, shall be determined by the use of the F(50,50) field strength charts for Channels 14-83, contained in § 3.699 of this chapter.

(b) Upon notification by the Commission that such interference has been reported, operation of the booster shall be suspended and shall not be resumed until the interference has been eliminated or it can be demonstrated that the interference is not due to any of the above causes: *Provided, however,* That short test transmissions may be made during the period of suspended operation to check the efficacy of remedial measures. In each case where suspension of operation is required, the licensee of the TV booster shall within 10 days after operation is resumed, submit a full report to the Commission of the cause and nature of the interference and the remedial steps taken to eliminate the interference.

(c) An application for a new television broadcast booster station shall contain a suitable map showing the locations of the proposed booster and all other TV boosters and television broadcast stations within 75 miles of the proposed booster site and operating on the same channel as the proposed booster or on any related channel shown in the columns opposite the proposed booster channel in Table IV of § 3.698 of this chapter.

ADMINISTRATIVE PROCEDURE

§ 4.811 Administrative procedure.

See §§ 4.11 to 4.16 inclusive.

§ 4.831 Purpose and permissible service.

Television broadcast booster stations provide a means whereby the licensees of television broadcast stations operating in the UHF television broadcast band may provide service to areas of low signal intensity in any region which would be encompassed by the theoreical Grade A contour if the station were assumed to be operating with an effective radiated power of 5,000 kilowatts from an antenna 2,000 feet above average terrain over a transmission path of normal terrain. For the purpose of this section, the distance from a UHF television broadcast station to its theoretical Grade A contour under the above assumptions is 68 miles.

(a) A television broadcast booster station is authorized to retransmit only the signals of its primary station. It shall not retransmit the signals of any other station nor make independent transmissions: *Provided, however,* That locally generated signals may be used to excite the booster apparatus for the purpose of conducting tests and measurements essential to the proper installation and maintenance of the apparatus.

(b) A television broadcast booster station will not be authorized to operate at any location more than 68 miles from its primary station and shall not be operated to produce a field strength greater than 5 millivolts per meter at a height of 30 feet above ground at a distance of more than 68 miles from its primary station.

(c) The transmission of a television broadcast booster station shall be intended for direct reception by the general public. Such stations may not be used to establish a point-to-point television relay system.

§ 4.832 Eligibility and licensing requirements.

(a) A license for a television broadcast booster station will be issued only to the licensee of a television broadcast station operating in the UHF television broadcast band, and solely for the purpose of retransmitting the signals of such television broadcast station.

(b) An application for a television broadcast booster station shall contain an adequate showing that:

(1) The proposed booster can be installed and operated so as to provide satisfactory reception without causing harmful interference to existing service, by the application of acceptable techniques.

(2) That a signal of sufficient magnitude is available from the primary station at the site of the proposed booster.

(c) No numerical limit is placed upon the number of boosters which may be licensed to a single licensee. A separate application is required for each booster transmitter. Television broadcast booster stations will not be counted as TV stations in applying the multiple ownership provisions of § 3.636 of this chapter.

§ 4.833 [Reserved]

§ 4.834 Remote control operation.

(a) A television broadcast booster station may be operated by remote control provided that such operation is conducted in accordance with the conditions set forth in subparagraphs (1) through (4) of this paragraph.

(1) The transmitter shall be equipped with automatic devices, which, in the absence of a signal from the primary station, will render the transmitter incapable of emitting radio frequency energy.

(2) The transmitter shall be further equipped with a device, which may be actuated by a coded signal or tone transmitted by the primary station, and which will permit turning the transmitter on and off at will from the primary station. The signal required to be transmitted by the primary station for this purpose shall be of such nature or of duration so short that it will not appreciably degrade normal reception of the primary station.

(3) As a precaution against loss of control due to failure of the control circuit, the circuit shall be designed so as to require reception of a cue signal from the primary station at intervals of one hour or less and failure to receive the cue signal will automatically place the booster transmitter in an inoperative condition.

(4) The transmitter and its associated controls shall be so installed and protected as to be inaccessible to unauthorized persons.

(b) An application for a new television broadcast booster station or for a change in the facilities of an existing station which proposes remote control operation, shall be accompanied by a satisfactory showing as to the manner of compliance with the above conditions. Unless remote control is specifically authorized pursuant to the above requirements, the booster transmitter shall be under the direct supervision of a qualified operator in accordance with § 4.866.

§ 4.835 Power limitations.

(a) A television broadcast booster station will not be authorized to operate with power in excess of that required to provide an adequate signal over the area intended to be served by the booster. Due consideration should be given to the provisions of § 4.804 which requires the licensee of a television broadcast booster station to correct any condition of interference which results from field strengths in excess of those which could be produced by the primary station at the place where interference occurs.

(b) In no event will a television broadcast booster station be authorized to operate with an effective radiated power of more than 5 kilowatts peak visual.

(c) In no event will a television broadcast booster station be authorized to operate at a location, and with an effective radiated power, and antenna height above average terrain, which would produce a predicted field strength of more than 5 millivolts per meter at any location more than 68 miles from the primary station. The predicted field strength of a television broadcast booster station shall be determined in accordance with the procedures set forth in Section 3.684 of this chapter. If a directive transmitting antenna is to be used to suppress radiation so as to comply with this requirement, the proposed directive pattern shall be supported with adequate engineering data.

(d) No minimum power is specified for television broadcast booster stations.

§ 4.836 Emissions and bandwidth.

(a) The license of a television broadcast booster station authorizes the transmission of the visual signal by amplitude modulation (A5) and the accompanying aural signal by frequency modulation (F3).

(b) Standard width television channels will be assigned and the emission of a television broadcast booster station shall be confined to the authorized channel in accordance with the Television Technical Standards contained in Part 3, Subpart E, of this chapter, except as provided in paragraph (c) of this section.

(c) Radio frequency harmonics of the visual and aural carriers shall be attenuated no less than 60 decibels for transmitters operating with more than 1 kilowatt power output. For transmitters operating with power output of 1 kilowatt or less, the power in such radio frequency harmonics shall not exceed 1 milliwatt. Other spurious emissions on frequencies more than 3 megacycles outside the assigned channel, including intermodulation products, signals other than those received from the primary station, and radio frequency energy generated within the booster apparatus, shall be attenuated no less than 40 decibels below the peak visual carrier amplitude. Greater attenuation of all spurious emissions may be required if interference is caused to any radio service.

§ 4.837 Antenna locations.

(a) The transmitting antenna of a television broadcast booster station shall be located within the Grade A contour of the primary station, as defined in § 4.831.

(b) An applicant for a new television broadcast booster station or for changes in an existing station shall endeavor to select a site which will provide a line-of-sight transmission path to the area intended to be served and at which there is a suitable signal available from the primary station. The transmitting antenna should be placed above growing vegetation lying in the direction of the area intended to be served to minimize

the possibility of signal absorption by foliage.

(c) Consideration should be given to accessibility of the site at all seasons of the year and to the availability of facilities for the maintenance and operation of the television broadcast booster station.

(d) Consideration should be given to the existence of strong radio frequency fields from other transmitters at the booster site and possibility that such fields may result in the retransmission of signals originating on frequencies other than that of the primary station.

EQUIPMENT

§ 4.850 Equipment and installation.

(a) An application for a new television broadcast booster station or for changes in the facilities of an existing station shall supply complete technical details of the apparatus to be employed and the over-all installation. The functioning of such automatic features or other safeguards as may be incorporated to prevent improper operation shall be fully described. If the apparatus is to be remotely controlled, a detailed description of the control features shall be included.

(b) The overall characteristics of the complete installation shall be essentially linear so as to accomplish retransmission of the incoming signals of the primary station without significantly altering any electrical characteristics other than the overall amplitude. Intermodulation products which may be generated shall be adequately removed from the transmissions of the booster so as not to constitute a source of potential interference. Provision shall be made in the circuits employed, to prevent the amplifier being driven into a non-linear condition over the full range of signal intensities within which the booster may be called upon to operate, or to cause it to cease radiating should non-linear operation or oscillation of any stage occur.

(c) The isolation between the input and output circuits of the booster, including the receiving and transmitting antenna systems, shall be at least 20 decibels greater than the maximum overall gain of the booster amplifier.

(d) The overall response of the amplifier shall not vary by more than 2 decibels over the entire assigned channel: *Provided, however,* That the amplitude of the aural signal may be decreased by a suitable amount if necessary to minimize intermodulation effects or eliminate interference between the sound and picture signals. The apparatus shall be capable of complying with the requirements of § 4.836 (c) with respect to spurious emissions.

(e) In general, the transmitter shall be mounted on racks and panels or in totally enclosed frames protected as required by Article 810 of the National Electrical Code.

(f) The installation of a television broadcast booster station shall be made only by, or under the direct supervision of, a qualified electronics engineer and any repairs or adjustments made during or subsequent to the installation, which could result in improper operation, shall be made by or under the direct supervision of such an engineer or an operator holding a valid first or second class radiotelephone operator's license issued by the Commission.

(g) In cases where the electrical characteristics of the transmitting and receiving antennas of a booster station are used to provide the required degree of isolation between the input and output circuits, the installation of such antennas shall be sufficiently rugged and protected as to withstand such hazards as may reasonably be expected to be encountered due to their exposure to the elements and the local environment.

(h) Prior to placing a television broadcast booster station in regular operation, the permittee shall perform sufficient measurements of the completed installation to insure compliance with this section. These measurements together with a detailed description of the methods used in obtaining the measurements shall be submitted with the application for license for the booster station.

(i) Type acceptance of television booster amplifiers may be granted upon request in accordance with the type acceptance procedure set forth in Part 2 of this chapter; provided that measurement data and descriptive information submitted shows that the amplifier is capable of meeting the technical requirements of this subpart. The following measurement data must be supplied:

(1) Radio frequency power output (visual peak power).

(2) Over-all gain of the amplifier vs. frequency throughout the entire channel in which it is designed to operate.

(3) Spurious emissions appearing on frequencies outside the channel in which it is designed to operate, including radio frequency harmonics up to 2,000 megacycles.

§ 4.851 Equipment changes.

(a) Formal application (FCC Form 343) is required for any of the following changes:

(1) Replacement of the transmitter as a whole, except replacement with an identical transmitter, or any modification which could result in a change in the electrical characteristics or overall performance of the booster installation.

(2) A change in the transmitting antenna system, including the direction of radiation, directive pattern, or transmission line.

(3) An increase in the authorized overall height of the antenna above ground of more than 20 feet or which will result

in an overall height above ground of more than 170 feet.

(4) A change in the control system.

(5) Any change in the location of the transmitter except a move within the same building or upon the same tower or pole, and any horizontal change in the antenna location of the transmitting antenna in excess of 500 feet.

(6) A change of frequency assignment.

(7) A change of authorized operating power.

(b) Other equipment changes not specifically referred to above may be made at the discretion of the licensee, provided that the Engineer in Charge of the radio district in which the television broadcast booster station is located and the Commission's Washington, D. C., office, are notified in writing upon completion of such changes, and provided, further, that the changes are appropriately reflected in the next application for renewal of license of the television broadcast booster station.

Technical Operation

§ 4.861 Frequency tolerance.

The visual carrier frequency and the aural center frequency of the television signals transmitted by a television broadcast booster station shall be identical with those of the primary station.

§ 4.862 Frequency monitors and measurements.

The licensee of a television broadcast booster is not required to provide means for measuring the operating frequencies of the booster transmitter.

§ 4.863 Time of operation.

(a) A television broadcast booster station is not required to adhere to any regular schedule of operation. However, the licensee of a television booster station is expected to provide a dependable service to the extent that such is within its control and to avoid unwarranted interruptions to the service provided.

(b) If causes beyond the control of the licensee require that a television broadcast booster station remain inoperative for a period in excess of 10 days, the Engineer in Charge of the radio district in which the station is located shall be notified promptly in writing, describing the cause of failure and the steps taken to place the station in operation again, and shall be notified promptly when the operation is resumed.

(c) Failure of a television broadcast booster station to operate for a period of 30 days or more, except for causes beyond the control of the licensee, shall be deemed evidence of discontinuance of operation and the license of the station will be automatically forfeited.

(d) A television broadcast booster station shall not be operated during periods when the primary station is not operating.

§ 4.864 Station inspection.

The licensee of a television broadcast booster station shall make the station and the records required to be kept available for inspection upon request by representatives of the Commission.

§ 4.865 Posting of station and operators licenses.

(a) The station license and any other instrument of authorization or individual order concerning the construction of the equipment or manner of operation shall be posted at the place where the transmitter is located, so that all of the terms thereof are visible: *Provided, however,* That if the booster transmitter is operated by remote control and is located more than 20 miles from the primary station, the station license and other instruments of authorization shall be posted in the above-described manner at the transmitter of the primary station.

(b) The call letters and assigned channel of the primary station shall be displayed at the booster site on the structure supporting the transmitting antenna so as to be visible to a person standing on the ground at the booster transmitter site. The display shall be prepared so as to withstand normal weathering for a reasonable period of time and shall be maintained in a legible condition by the licensee.

(c) The original of each station operator license shall be posted at the place where he is on duty: *Provided, however,* That if the original license of a station operator is posted at another radio transmitting station in accordance with the rules governing that class of station and is there available for inspection by a representative of the Commission, a verification card (Form 758-F) is acceptable in lieu of the posting of such license: *Provided further, however,* That if the operator in charge holds a restricted radiotelephone operator permit of the card form (as distinguished from the diploma form), he shall not post that permit but shall keep it in his personal possession.

§ 4.866 Operator requirements.

(a) The actual operation of the transmitting apparatus at a television broadcast booster station shall be carried on only by a person holding a valid first or second class radio-telephone operators license: *Provided, however,* That where the booster transmitter is remotely controlled by the transmission of coded signals from the primary station, an unlicensed person may turn the power supplied to the booster by the power mains, on and off upon instructions from the operator on duty at the primary station.

(b) The licensed operator on duty and in charge of a television broadcast booster station may, at the discretion of the licensee, be employed for other duties or for the operation of another station or stations in accordance with the class of license which he holds and the rules and regulations governing such stations. However, such duties shall in no wise interfere with the operation of the television broadcast booster station.

§ 4.867 Marking and lighting of antenna structures.

The marking and lighting of antenna structures employed at a television broadcast booster station, where required, will be specified in the authorization issued by the Commission. Part 17 of this chapter sets forth the conditions under which such marking and lighting will be required and the responsibility of the licensee with regard thereto.

§ 4.868 Additional orders.

In case the rules contained in this part do not cover all phases of operation or experimentation with respect to external effects, the Commission may make supplemental or additional orders, in each case as may be deemed necessary.

§ 4.869 Copies of rules.

The licensee of a television broadcast booster station shall have current copies of Part 3 and Part 4, and in cases where antenna marking is required, Part 17 of this chapter, available for use by the operator in charge, and is expected to be familiar with those rules relating to the operation of a television broadcast booster station. Copies of the Commission's rules may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at nominal cost.

Operation

§ 4.881 Station records.

(a) The licensee of a television broadcast booster station shall maintain an operating log showing the following:

(1) Hours of operation.

(2) A record of all repairs, adjustments, maintenance, tests, and equipment changes, showing the date of such events, the name and qualifications of the person performing the operation, and a brief description of the matter logged.

(b) Where an antenna structure is required to be illuminated, see § 17.38 of this chapter.

(c) The operating log shall be made available upon request to any authorized representative of the Commission.

(d) Station records shall be retained for a period of two years.

§ 4.882 [Reserved]

§ 4.883 Station identification.

(a) Television broadcast booster stations will not be assigned individual call signs. Station identification will be accomplished by the retransmission of the call sign of the primary station.

(b) The Commission may request the operator on duty at the primary station to interrupt the transmissions of the booster station for short intervals of time in order to facilitate identification of a particular booster.

§ 4.884 Rebroadcasts.

(a) The term "rebroadcast" means

the reception by radio of the programs or other signals of a radio or television station and the simultaneous or subsequent retransmission of such programs or signals for direct reception by the general public.

(b) A television broadcast booster station is authorized to rebroadcast only the signals of the primary station with which it is associated. In cases where the booster is located at a site where the signals of other television broadcast stations or other classes of stations may be received, care shall be exercised in the installation to insure that such other signals are not retransmitted: *Provided, however*, That occasional inadvertent retransmission of the signals of other co-channel TV stations caused by abnormal propagation conditions, will not be considered to be noncompliance.

TABLE OF GEOGRAPHIC ASSIGNMENT OF CALL SIGNS

At a session of the Federal Communications Commission held at its offices in Washington, D. C., on the 25th day of May, 1960:

The Commission, having under consideration § 2.303 of its rules and regulations, Table of Geographic Assignment of Call Signs, and

It appearing that the geographical assignment plan was devised primarily to aid the Field Engineering and Monitoring Bureau in certain of its enforcement functions, that it has been of little or no value in this regard in recent years, and that elimination of the plan will increase operating efficiency under present methods of call letter assignment;

It further appearing that the amendment adopted herein pertains to a matter of procedure, and hence that compliance with the notice, procedural, and effective date requirements of the Administrative Procedure Act is unnecessary; and

It further appearing that the amendment adopted herein is issued pursuant to authority contained in sections 4 (i), 303 (o), 303 (p), and 303 (r) of the Communications Act of 1934, as amended;

It is ordered, That, effective May 25, 1960, § 2.303 of the rules and regulations is deleted.

TELEVISION BBROADCAST STATIONS; TYPE-APPROVED, FREQUENCY AND MODULATION MONITORS; EXTENSION OF TIME FOR COMPLIANCE

At a session of the Federal Communications Commission held at its offices in Washington, D. C., on the 18th day of May, 1960;

The Commission having under consideration the provisions of §§ 3.690 (a) and 3.691 (a) of its rules, which require that television broadcast stations have type-approved frequency and modulation monitors at the station whenever the transmitter is in operation;

It appearing, that the time specified for compliance with the requirements of §§ 3.690 (a) and 3.691 (a) was last extended to June 1, 1960, and

It further appearing, that since the requirement of §§ 3.690 (a) and 3.691 (a) have not, as yet, been placed in effect and in view of the possibility that these rules may be amended in the near future, the Commission deems it desirable to postpone the effective date of these sections of the rules for an additional period of six months; and

It further appearing, that the amendment herein ordered is procedural in nature and effects a relaxation of the rules; therefore, compliance with the requirements of section 4 of the Administrative Procedure Act is not required; and

It further appearing, that authority for the amendments adopted herein is contained in sections 303 (e), (f) and (r) and 4 (i) of the Communications Act of 1934, as amended;

It is ordered, That, effective June 1, 1960, §§ 3.690 (a) and 3.691 (a) are amended by substituting the date "November 30, 1960," in the parenthetical sentence to each of these sections.

VHF TELEVISION CHANNEL ASSIGNMENTS AND ENGINEERING STANDARDS

Notice of Extension of Time for Filing Comments

In the matter of Interim policy on VHF Television Channel Assignments and amendment of Part 3 of the rules concerning Television Engineering Standards, Docket No. 13340.

On January 4, 1960, the Commission adopted a notice of proposed rule making in the above entitled matter which among other things, proposed to revise the Field Strength Charts of the rules on the basis of additional data and measurements obtained since the original charts were adopted. The revised charts were shown in that document.

On May 5, 1960, the Commission issued a further notice of proposed rule making proposing a single set of Field Strength Charts for both the upper and lower VHF television bands, in lieu of the two sets of charts originally proposed. This latter proposal was based on a recommendation by the Radio Propagation Advisory Committee (RPAC) composed of industry and Government engineers. Preliminary examination of the available data supported this proposal.

The data have been meanwhile review by RPAC and there is general agreement that the measurements and data obtained on tropospheric signals show rather conclusively that these signals are not significantly frequency sensitive in the VHF television broadcast bands and a single set of curves may be drawn for all VHF television channels. The data and measurements with respect to groundwave signals are not so conclusive. Further study and analysis is needed to establish definitely the relation of frequency to groundwave propagation.

The single set of curves proposed in the May 5, 1960, notice were derived by merging the groundwave curves based on close-in measurements, with the tropospheric measurements made at greater distances. The resulting curves are substantially the same as would be developed if the new tropospheric data curves were merged with the low VHF curves (Ad Hoc curves) of our present rules. Consequently, the revised curves issued with our May 5, 1960, notice are still valid for the low VHF channels. In view of the fact that the further study of the available data for the high VHF channels may take considerable time and perhaps require additional measurements, we believe that consistent treatment should be given the high VHF curves. Therefore, revised curves derived by merging the present high VHF Ad Hoc groundwave curves with the new and accepted tropospheric curves, will be prepared and issued in a Further Notice of Proposed Rule Making in Docket No. 13340. At the same time, the May 5th curves will be reissued and limited to use for the low VHF channels. These curves will be issued as soon as they can be prepared and printed.

Since this will go beyond the present expiration date for filing comments in Docket No. 13340, the Commission is extending the dates for filing comments and replies to comments in order to allow computation of pertinent data based upon the revised curves. Data prepared for low VHF channels and based upon the May 5th curves will still be valid. Data and comments for high VHF stations should be held in abeyance until the revised high VHF curves are issued.

Accordingly, it is ordered, This 8th day of June, 1960, that the time for filing comments herein is extended from June 20, 1960, until September 1, 1960; and that the time for filing reply comments is extended from July 5, 1960, until September 16, 1960.

NOTICE OF INQUIRY CONCERNING FULL CARRIER SINGLE SIDEBAND TRANSMISSION ON STANDARD BROADCAST BAND

In the matter of inquiry into amendment of Part 3 of the Commission's rules and technical standards to permit standard broadcast stations to operate with full carrier and single sideband, Docket No. 13596 (RM-156).

1. On Dec. 31, 1959, Kahn Research

Laboratories, Inc., Freeport, Long Island, filed a petition for rule making (RM-156) requesting an amendment of Part 3 of the Commission's rules to permit standard broadcast stations to operate with a "compatible single-sideband system of modulation" known as CSSB.

2. In support of the request, petitioner urges that the adoption of its proposal would benefit both broadcasters and the public; that the single sideband transmission system will permit reception on existing receivers without any modification; that the resulting signal will be more listenable; and that the improvement over the present system has "been foreshadowed through voluminous data compiled by means of developmental broadcasting." Petitioner claims that the proposed mode of operation will result in improved high frequency response, increased signal to noise ratio, reduction in co-channel and adjacent channel interference, reduction in television receiver radiation interference, and reduction of certain types of fading distortion.

3. Several standard broadcast stations[1] have in the past been authorized to conduct experiments in order to test the CSSB system and to gather data regarding this type of operation in the standard broadcast band. This data and the information made available by the petitioner indicate that the proposal has sufficient merit to warrant further inquiry. However, they are not conclusive with regard to establishing the advantages claimed for the system and in some very important respects do not throw any light on the problems involved. For example, little information is available with respect to the advantage claimed in the reduction of selective fading. No information or data is available with respect to the potential of interference to other stations.

4. Before deciding upon the desirability of instituting rule making and in order to provide time in which parties may gather data and information necessary for such a proceeding, we believe that it would be appropriate and useful to afford all interested parties an opportunity to submit such data and views as they feel should be taken into account.

5. Written comments may be filed on or before September 30, 1960.

6. Authority for the institution of this proceeding is found in sections 303(c) and 403 of the Communications Act of 1934, as amended.

7. In accordance with the provisions of § 1.54 of the Commission's rules, an original and 14 copies of all statements, briefs, or comments shall be furnished the Commission.

8. Data and views are desired, in particular, on the following issues:

(a) Is there a sufficient interest in single sideband operation in the broadcast band by the public and broadcasters to warrant the institution of rule making?

(b) What are the methods available for obtaining single sideband operation which are compatible with present operation, and what are the advantages and disadvantages of each?

(c) Are there any supporting data or measurements to support the claimed advantages and to evaluate the disadvantages of the methods?

(d) Is there a potential of greater interference to existing stations from such operation? If so, what means may be taken to reduce this interference to the level encountered by the present assignments and method of transmission, and with such reductions what are the advantages to these systems?

(e) What burdens are placed on existing receivers relative to tuning, bandwidth, quality, etc., in order to receive signals equal in quality to that possible under the present method of transmission?

(f) What parameters should be adopted in order to derive the maximum benefit of the proposed operation and to insure no greater level of interference to existing stations?

(g) What would be the effect on the coverage of a station operating under the proposed system and proposed standards?

(h) What co-channel and adjacent channel ratios of desired to undesired signals should be applied in the evaluation of proposals to utilize this system to insure that other stations will receive protection from interference equivalent to that afforded such stations by conventionally modulated stations under § 3.182(w) of the Commission's rules?

(i) In what respects is the proposed operation contrary to the terms of the North American Regional Broadcasting Agreement (NARBA)?

9. The comments should be in the form of technical data and measurements which in general may be obtained in a laboratory without the need for radiation through space. In the event radiation is necessary, consideration will be given to requests for experimentation for limited periods of time.

[1] KDKA, Pittsburgh, WSM, Nashville, WGBB, Freeport, L. I., WABC, New York, N. Y., and WMGM, New York, N. Y.

Industry News

Daly Named Vice-President For Magnecord Sales

Hugh J. Daly has been named vice-president, Magnecord sales, for Midwestern Instruments, M. E. Morrow, chairman of the board, MI, announced recently. In his new position Daly will be responsible for the sales and marketing program for the entire Magnecord product line manufactured by Midwestern Instruments in its Tulsa, Okla., plant.

Daly, formerly sales manager for Magnecord, Inc., Chicago, came to Midwestern Instruments in 1957. Midwestern purchased the assets of Magnecord, Inc., in December, 1956, and moved the operation to Tulsa. The Magnecord tape product line was placed into production along with Midwestern's other electronic products, and Daly moved to Tulsa to become general sales manager for the Magnecord portion of MI's products.

New Manufacturer of Muzak Background Music Amplifiers

Ray B. McMartin, president of Continental Mfg., Inc., inspects an engineering prototype of the Model 920 amplifier which was scheduled to come off Continental's line starting June 1. In addition to doing subcontract work for many electronics

firms, and marketing a line of custom receivers for the broadcast industry under the trade name McMartin, Continental also manufactures and markets world-wide a complete line of Hi-Fi components and radio intercom systems under the trade name Harmony.

Thermoplastic Recording

Starts on page 22

grating of appropriate amplitude and spacing in each picture element.

For recording color pictures on film, the electron beam is split into several beamlets, whose amplitude and separation can be determined by potentials applied to appropriate electrodes in the electron gun. This split beam forms the diffraction grating in each picture element. The superposition of two such multiple beams, one of fixed spacing, the other of variable spacing, but both of controllable intensity, creates the gratings required for fixed and variable color primaries. It is also possible, using a slightly different optical system, to project color images from patterns laid down with a single split beam. A schematic drawing of the electron beam-splitting gun is shown in Fig. 6.

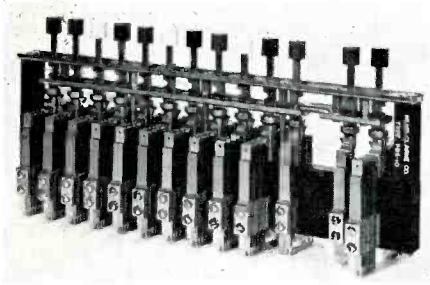
The beam emerges from the point of the hairpin cathode, and is accelerated by the field between cathode and anode. A fine wire splitter grid, slightly positive with respect to the anode, is placed in the electron beam. Electric field lines terminating on the grid wires deflect different portions of the beam by a discrete amount for all electrons passing between two wires. This creates a row of apparent sources back of the wire grids. Their separation depends upon the potential of the splitter grid, thus controlling the color of the picture element. The intensity of the element is controlled by either modulating the beam current or the focus of the grating. The average splitter grid potential is chosen such that the bundles of electrons intersect in the middle of a vertical focusing cylindrical lens. This lens focuses the beamlets in the vertical direction into a row of lines on the film. Focus and deflection in the horizontal direction is provided by another cylindrical lens and set of deflection plates. Since high resolution but no deflection is required in the vertical direction there is a considerable advantage in focusing in the two directions separately.

For alignment and focus of the gun a transparent phosphor plate replaces the film. A photograph of the split beam trace on the phosphor is shown in Fig. 7. In the photograph the defocusing at the ends of the trace was due to curvature of field of the microscope objective. The split trace was in focus for a deflection length of about 1½ inches.

A photograph of raster lines recorded on thermoplastic tape with a split electron beam is shown in Fig. 8. Each raster line is split into five grating lines. In the photograph the last grating line of one raster line overlaps the first grating line of the adjacent raster line to produce the heavier lines.

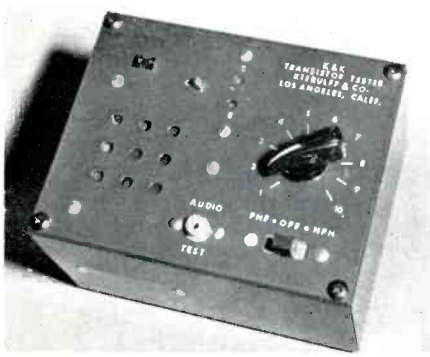
Acknowledgments—The author would like to acknowledge the contribution of Dr. E. M. Boldebuck and her colleagues of the Chemistry Department of this Laboratory for developing thermoplastic materials. The assistance and suggestions of Mr. J. L. Henkes have been valuable in all phases of this work.

Product News



PBS-10 PUSH BUTTON SWITCH

Nems-Clarke Co., 919 Jesup-Blair Drive, Silver Spring, Md., has announced its new PBS-10 push-button switch which serves as a patching field for a ten-wire control bus from the unit to the device being controlled. It features one line push key operation only at one time, positive locking of all line keys, and rugged durability. The switching unit is designed to perform a two-fold function: first to permit instant association of any equipment with any line and second to extend a ten-wire control bus from the switch-receiving apparatus to the device to be controlled. Ten conductors issuing from the equipment are inserted into a ten-wire parallel bus which is multiplied through succeeding line switching units in such fashion that all equipments associated with a given line will also be associated with the ten-wire parallel bus corresponding to that signal line. Ten control leads are thus switched whenever the associated line pair is switched. These control leads are employed to carry pulses concerned with automatic switching devices. Switching of the control leads simultaneously with the signal line pair provides complete changeability of equipments and lines. No equipment is permanently connected to a line or to another equipment.



TRANSISTOR CHECKER

A compact Model K & K tester is now available from Kierulff & Co., 6303 Corsair St., Los Angeles 22, Calif. Power and general purpose types of transistors may be tested to determine if the transistor is open, shorted, noisy or has a high value of leakage. It is suited for matching transistors in push-pull audio circuits. The ability of a transistor to oscillate in the test circuit, in which feedback is controlled, accurately and instantaneously determines the value of the unit under test without reference charts or meters. Two sockets are provided to accommodate power, general purpose, PNP or NPN types. It is powered by two 6-volt batteries and weighs 2½ lb.

SINGLE SIDEBAND RECEIVER FOR AM

Kahn Research Laboratories, Inc., 81 South Bergen Place, Freeport, N. Y., has announced a single sideband receiver using modern communications techniques and intended for use by AM broadcasters. Specifically designed for relaying radio broadcast signals, program monitoring in difficult reception areas and various Conelrad applications, the model RSSB-59-1A receiver incorporates advanced techniques for minimizing selective fading distortion and improving the signal-to-noise ratio of conventional AM and Compatible Single-Sideband transmissions. High front end selectivity redues adjacent channel interference, even when the interfering signals are much stronger than the desired station. Product demodulation, utilizing local carrier or reconditioned carried insertion to minimize selective fading distortion, or conventional AM diode detection can be selected by front panel switch to suit local reception conditions. Upper or lower sideband reception is also selected by front panel switch. Conservative design and long life transistors insure maximum reliability for continuous duty service.

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The Langevin Division of the W. L. Maxon Corp., 475 Tenth Ave., New York, N. Y., is offering an eight-watt compact amplifier which can be mounted in consoles, cabinets, portable carrying cases, racks, or directly in a monitor speaker housing. Special features include self-contained power supply, four interchangeable input panels, and output transformer taps for matching 4, 8, 16, 150, and 600 ohms.

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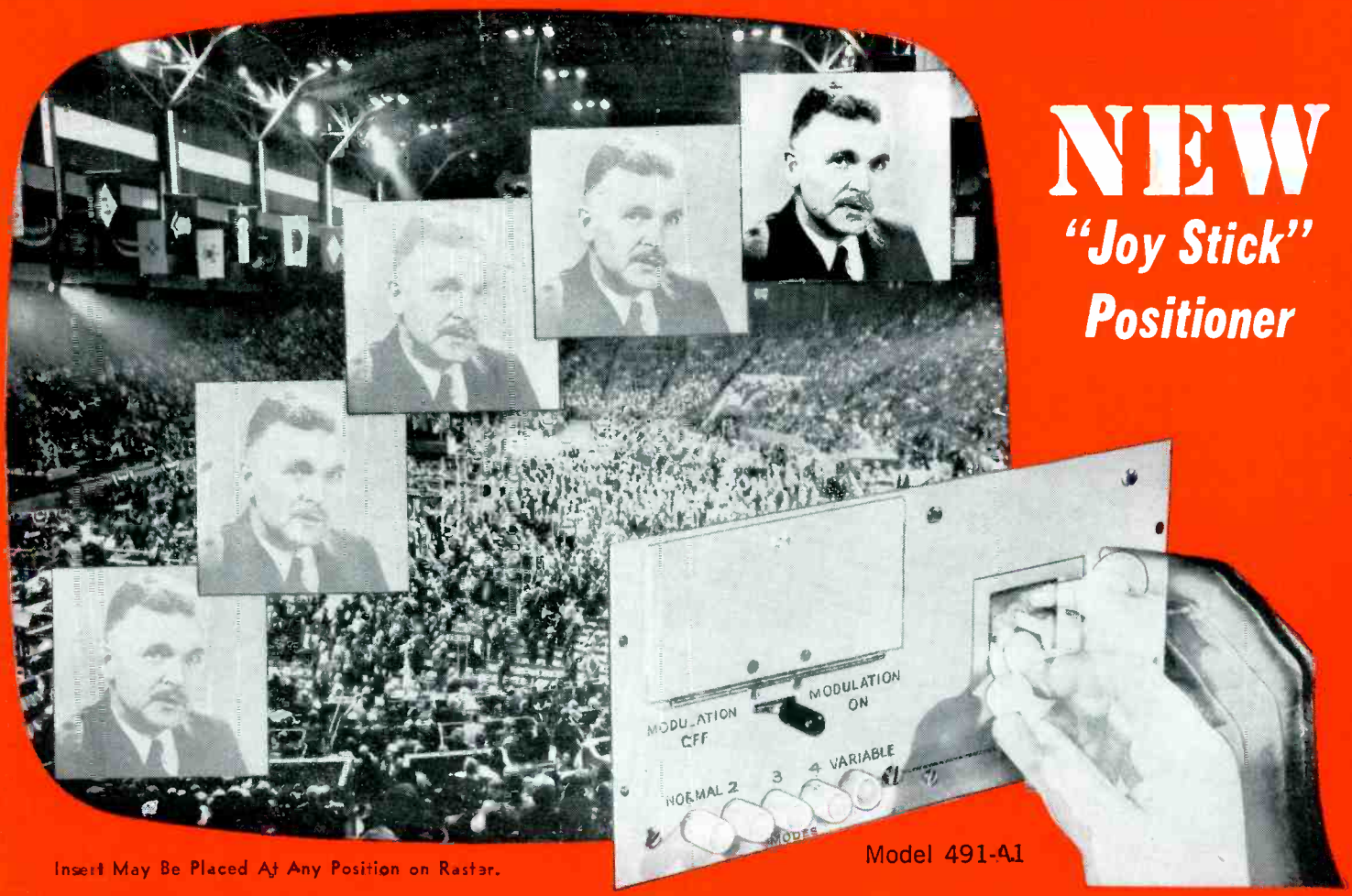

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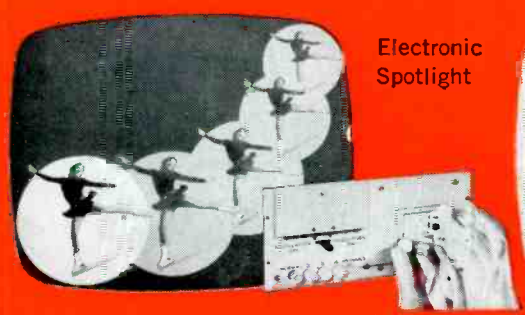

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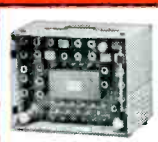

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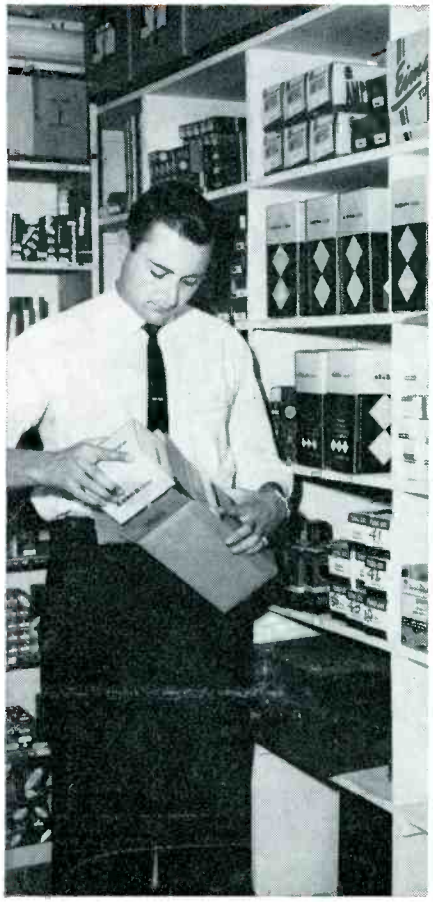

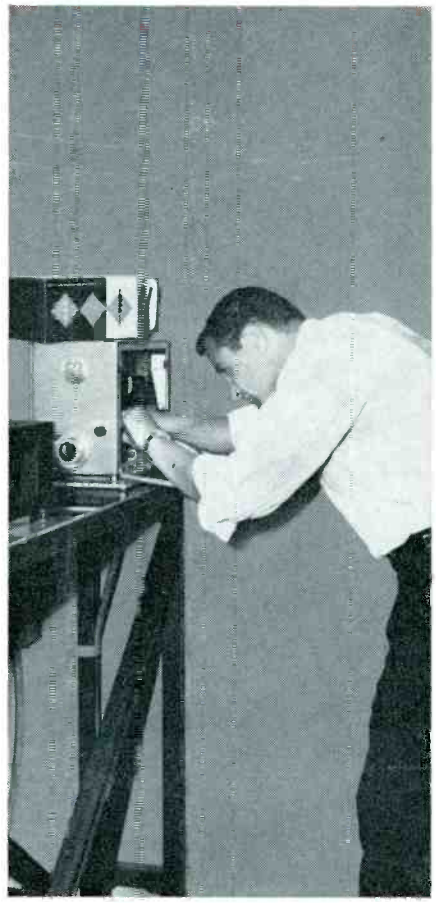

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