MAY 1959

Covering all phases of . . . AM FM TV

BROADCAST ENGINEERING

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

MAY 1959 Vol. 1, No. 1

BROADCAST ENGINEERING

D. E. MEHL
Editor and Publisher

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DEPARTMENTS

COVER STORY

KTLA's Telecopter, a flying television remote unit, transmits picture and sound while flying over the Chicago skyline. This unique electronic unit, developed by the Los Angeles television station was a feature of the General Electric exhibit at the NAB Convention. The Telecopter contains a G. E. Vidicon Camera with variable focal-length lens, a G. E. Video Transmitter with multiplex audio feeding a helical antenna extending below the Telecopter. An air monitor and two-way communications system are also included.

Introducing

THE TECHNICAL JOURNAL OF THE BROADCAST INDUSTRY

With very few exceptions, every industry has its technical journal to keep the people of that industry informed of technological developments. Judging from the many letters and subscriptions which we have received, there is no doubt that the broadcast industry feels that it, too, needs a technical publication.

Broadcast Engineering is directed to those who are interested in the technical phases of broadcasting. The articles and information carried will be objective, informative, technical articles selected to satisfy our readers' desire to know more about broadcast engineering and to bring information which will be helpful in the daily activities of broadcasting.

In this day of rapid technical developments, it is very difficult to keep informed of the many technical phases of the industry. Broadcast Engineering is a communications medium to bring that information to everyone who wishes to subscribe. Every publication has a goal toward which its editorial policy is aimed. The goal of Broadcast Engineering is to bring to its readers as much technical information of current developments as possible, to provide a means of exchanging information between people in the industry so that all may benefit from their ideas, and to make that information available to everyone who desires it.

There are three departments of Broadcast Engineering commencing next month which are designed specifically for the participation of our readers. They are "Sounding Board," which is a letters-from-the-reader department where you have an opportunity to express your ideas concerning technical developments, "Short Circuits," where your special technical problems will be published for possible solution by others in the industry, and "Technical Hints," where your good ideas can be made available to everyone. We will pay $5 for each technical hint published. Please include glossy photographs and circuit diagrams, if possible, to help illustrate your suggestion. We invite everyone to participate in these departments.

Let us know how you like Broadcast Engineering. We will welcome your suggestions for improvement since it is our fervent hope to fill this industry need.

D E Mehl
Editor and Publisher

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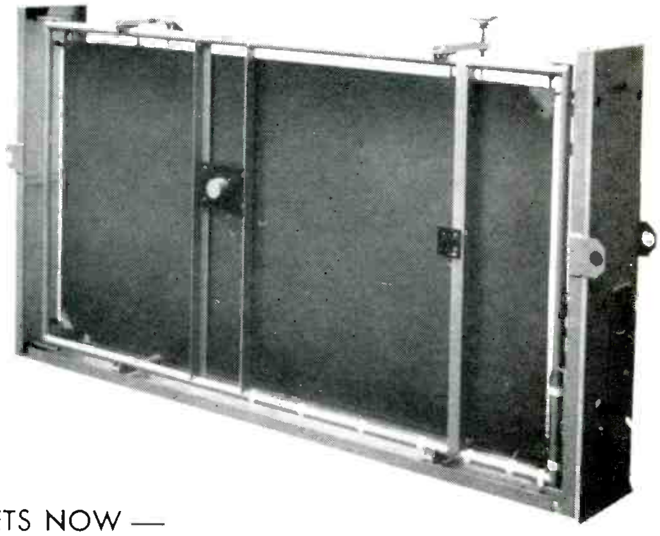

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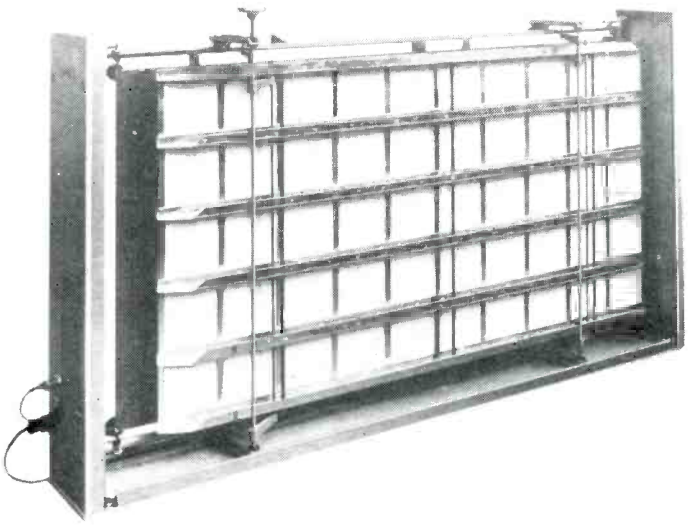

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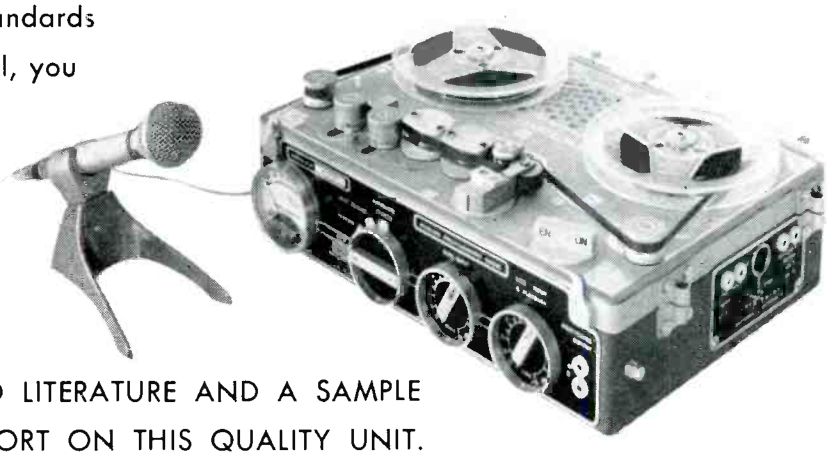

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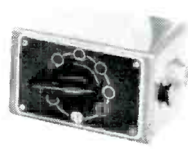

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Send us your suggestions for next month's issue!

1959 NAB CONVENTION EXHIBIT

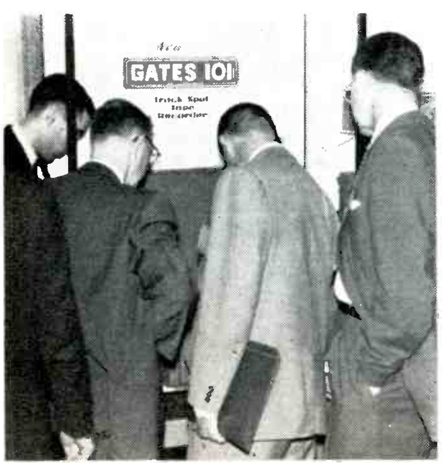
New developments and improved equipment were demonstrated at this year's exhibit

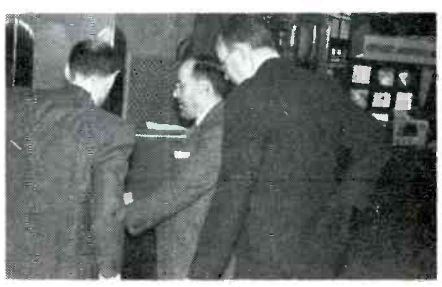
Every type of equipment for broadcasting was exhibited at the 1959 NAB Convention in Chicago and many new technical developments were demonstrated. More than $12,000,000 worth of radio and television equipment was on exhibit, including three completely equipped color television studios. This was the largest exhibition of broadcasting equipment ever held at an NAB Convention. Thirty-seven firms used 32,000 square feet of exhibition space to display their products.

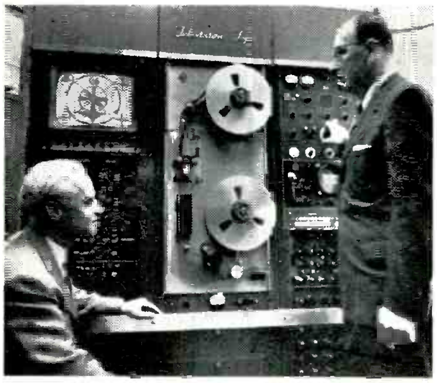
Some of the developments being featured were video tape recorders for color, stereo broadcasting, automation for both visual and aural broadcasting, newly designed TV lighting dimmers, new types of tape recorders for spot use, UHF translators and weather radar. The demonstrations of color TV tape recorders by RCA and Ampex attracted continuous attention and were a dramatic feature of the exhibit because of the competitive nature of the demonstrations. Both systems exhibited excellent pictures. The latest advances in these machines now make it possible to interchange tapes between any video tape recorders regardless of manufacturer and to splice tapes from different reels. This has been brought about by the development of a standardized recording-playback head manufactured according to standard specifications agreed to by the broadcasting industry. This interchangeability is necessary for the future growth of video tape recording, particularly in the field of tape program syndication. Interchangeability and splicing techniques were successfully demonstrated as well as other new features for video tape recorders.

The work of operators will become easier in the future due to the new, ingenious automation equipment which numerous manufacturers exhibited. The so called "panic period" in TV has received much attention from the designers and equipment is now available to perform automatically the switching operation of a typical TV station break where many functions must be performed with split-second precise accuracy. With automatic TV switching equipment now developed, the switching sequences are pre-set ahead of time. A visual display will indicate exactly what will happen during the break period. The complicated "panic period" sequence can then be handled by pushing a button to initiate the series.

The semi-hourly reading and logging of transmitter meters may become history if the Federal Communications Commission authorizes the use of equipment shown by the Minneapolis-Honeywell Regulator Co. The Automatic Meter Logger



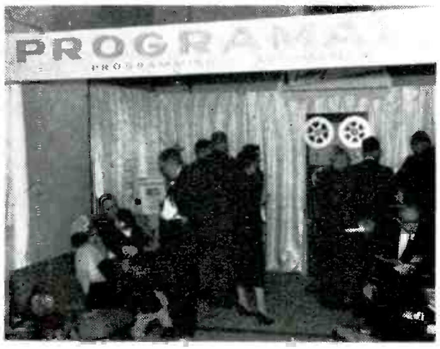




would complete the present systems used for unattended transmitter operation. Nineteen different circuits can be recorded on a 12-inch wide chart. The logging can be done either at the transmitter or at a remote point by telemetering the information from the transmitter. The Automatic Transmitter Logger could provide a more complete and accurate record of transmitter performance than is possible now by manual observation. The equipment automatically sounds an alarm if any meter reading deviates from its assigned value. This type of equipment actually is not a new development, as it has been used for years in other industries; however, its application to broadcast transmitters is relatively new. Since automatic logging in lieu of manual reading and recording is not authorized under present regulations, the National Association of Broadcasters, in cooperation with WTOP, Washington, D. C. and WSJS, Winston-Salem, N. C., will petition the FCC to authorize industry use of automatic logger records as official transcripts. This action is expected to be taken later this year when experimental tests are completed.

Automation in programming also was being shown by a number of exhibitors. These systems using both tape and disc enable a station to prepare up to 24 hours of programming in advance. Since many broadcasters are entering into multi-program operations such as an AM program, an FM program, and one or more multiplex channel programs, it is becoming increasingly necessary to simplify and streamline the task of handling the technical operations for these programs. The equipment on display could handle record programs, station breaks, newscasts and network switches. Timing is kept extremely accurate by the use of time clocks.

Another type of automation which is offered to television stations controls slide changes, lighting, special effects and any function suitable for electric remote control. This is the Telemation Control sold by Tele-PrompTer Corp. This system uses IBM type cards which are punched to operate the desired circuits. The automatic card reader accepts 150 of these cards, each of which has 12 positions where a punched hole



will cue an operation of that respective channel.

The increased use of transistors and other semiconductor products was apparent in this year's exhibit. The use of these devices means added advantages to the broadcaster in lower power consumption, greater reliability, less heat and smaller size for equipment. Equipment on display using transistors included transmitters, sync generators, miniature image orthicon orbitor tracker systems, audio consoles, power supplies, tape recorders, switchers, and amplifiers. In dimmer controls the use of the silicon-controlled rectifier offers new advantages. The size and weight of lighting control equipment can be reduced as much as 95 per cent. Other advantages are lower temperature, less noise, less maintenance, higher efficiency, quicker response and greater flexibility.

Many new and unique equipment items were on display which offer the broadcaster an opportunity to increase his service to the public. Weather radar is an example of special services which television stations in particular can offer. With this equipment a station can show its viewers actual weather conditions as they appear on the radar scope. During severe weather disturbances, thunderstorm activity can be observed on the scope and a simultaneous report made to the viewers. Collins Radio Co. and RCA both offered this type of equipment.

Equipment which offers an opportunity to develop individuality and personality for a station also attracted considerable interest. An example of this was the reverberation unit shown by Electronic Applications, Inc., which enables a station to add a natural echo of up to 4½ seconds. This could be used to add a live quality for an announcer's voice or other program material, or for use in developing unusual commercials. The unit is approximately 98 inches by 51 inches by 13 inches.

The NAB Convention exhibit is a once-a-year opportunity for those interested in broadcast equipment to see all of the latest apparatus required to build and operate a station. Many of the developments and systems shown will be described in detail in future issues of Broadcast Engineering.

NAB ENGINEERING CONFERENCE

Many papers covering current technical topics were read at the 13th annual Broadcast Engineering Conference

BROADCAST engineers attending the 1959 NAB Engineering Conference heard approximately 18 papers which discussed new developments in AM, FM and TV broadcasting. Many of the topics have been discussed elsewhere in this month's issue of BROADCAST ENGINEERING, and others will appear in later issues. The engineering problems facing the industry today and the trends which broadcast technology is taking were indicated by the topics discussed at this year's meeting.

The Conference was opened by the presentation of the results of the two-and-a-half year study by the Television Allocation Systems Organization to the Federal Communications Commission. The importance of this report, which gives the results of the study of comparisons between UHF and VHF television channels, to the FCC was indicated by the fact that the report was presented in loose form so that the Commission may have its benefit without waiting for the printed copies. The Commission has indicated that the solution of the television allocation problem is one of the major issues facing it.

Since this is the era of higher and higher towers, several papers dealt with the problems which have developed because of this trend. J. Roger Hayden, manager, commercial sales, Tower Division, Dresser-Ideco Co., delivered a paper dealing with the problems of vibrations in guy wires and antennas which have arisen to plague the structural engineer. He described experiences which illustrated these problems and told how they could be solved. He said that extra braces in a free-standing tower can prevent windstorm vibrations that generate noise that sometimes sounds like "a parade of garbage cans". "Weights strung on guy wires of supported towers," he said, "will stop annoying galloping undulations that could lead to mental fatigue and damage the tower." One of the difficulties is that designs are calculated for static loads whereas the load is actually dynamic. A film of the destruction of the Tacoma bridge caused by vibrations demonstrated what could happen to large metal structures due to vibrations.

The discussion of a new tower lighting and marking system by Orrin W. Towner, director of engineering for WHAT, Louisville, Ky., was also timely in this day of the tall tower. Mr. Towner told the Conference the new tower lighting and marking system he recommended was based on four years of study of the system now in use, tests with models, and results with an experimental WHAS tower near Louisville. He quoted a commercial pilot with more than 20 years of flying experience as saying, "The WHAS tower's multiple beacon was the best obstruction lighting I have ever seen."

The filtered red light system now used, according to Mr. Towner, is only 10 to 15 per cent as efficient as unfiltered white light. He recommended multiple white beacons placed at regular intervals along the tower all synchronized to flash once every two seconds. He said black and white offers the best possible contrast and should be used in bold alternate stripes to provide better over-all visibility. "The international orange now used with white," he said, "has less reflectance than black, loses more in weathering and does not offer as great a contrast with backgrounds in some geographical areas." Mr. Towner said all towers should be equipped with photocells to turn on the lights when daylight fades or on dark dreary days and to turn them off again when the sun is out. Sun reflectors were recommended for daylight use to help provide contrast between the tower and its background. The solid circle of white or marble chips 100 feet in diameter should be constructed at the base of the tower with a narrow circle of the same material cutting through each guy anchor.

The trend toward the use of semiconductor products was brought out by a number of papers. Lynn R. Zellmer of General Electric Co. described the use of germanium rectifiers and silicon rectifiers in General Electric products. He discussed the problems encountered in the design of semi-conductor plate supplies which include rectifier selection, adequate surge protection, inverse voltage distribution, and corona suppression.

A paper was given by J. W. Wentworth of the Radio Corp. of America which explains the basic principles of transistor operation. Since transistors are beginning to appear more and more frequently in both audio and video equipment where their small size, low power requirements and long service life offer attractive advantages to broadcasters, broadcast engineers should become familiar with the benefits and limitations of transistors. He pointed out that the advantages of long life, low power requirements, reliability and versatility of the transistor were offset by the limitations of poorer frequency response, power handling capability, temperature sensitivity, non-linearity and rapid vulnerability to overstress.

A paper was given by Herbert R. Moore of Kliegl Brothers and Albert W. Malang of the American Broadcasting Co., describing the use of silicon controlled rectifiers in TV lighting dimmers.

The silicon-controlled rectifier reduces the size and weight of lighting control equipment as much as 95 per cent. It also makes possible equipment that operates at far lower temperatures, with less noise, less maintenance, higher efficiency, quicker response and greater flexibility. SCR dimmers are now available that will handle up to 5,000 watts of lighting power with only .0015 amperes of control current. Each dimmer uses two rectifiers back to back. One rectifier controls the positive phase of an alternating current, the other controls the negative phase.

The planning, construction, and operation of a reversible intercity microwave relay system between WBTV in Charlotte, N. C., and WBTW in Florence, S. C., a distance of 93 miles, was described by M. J. Minor, engineering manager for Jefferson Standard Broadcasting Co. The system is designed for remote control, reversible transmission and includes three unattended repeater stations. The system is capable of monochrome or color video transmission in either direction, with television audio contained within the channel as a diplexed sub-carrier signal. A single telephone line is used as a medium for switching signals and for supervising the system.

In the field of automation James B. Tharpe, president, Visual Electronics Corp., delivered a paper describing TV program automation, which appears in this issue.

The FCC experiences with remote control of broadcast transmitters were described by Harold L. Kassens, Chief Aural Existing Facilities Branch, Broadcast Bureau of the FCC. He pointed out that the operator of the remote control equipment must be an employee of the station. This would prevent a station from installing remote equipment at the office of an answering service or other commercial service. Mr. Kassens discussed the remote operation of 50 kilowatt transmitters and stations with directional antennas. He indicated that stability and proper adjustment must be proven and that readings taken at each monitoring point for one year must be furnished the Commission. In answer to questions concerning improper operation due to defective equipment Mr. Kassens advised, "If anything goes wrong, fix it fast."

Dr. George H. Brown, chief engineer, Industrial Electronics Products, RCA, described a simplified means of proceeding from a desired directional radiation pattern to a physical radiating structure. He showed how a wide choice of current distributions or array configurations for obtaining a single desired pattern become available by adding to the real pattern another pattern in an imaginary zone.

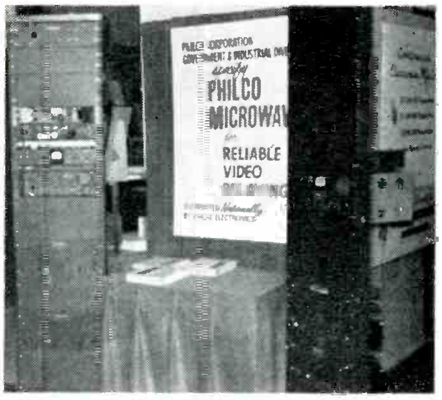
A new approach to TV antenna specifications was discussed by Donald W. Peterson of RCA Laboratories. It was brought out that the present specifications are not capable of conveying to the broadcaster an adequate description of the system. A new approach would relate system performance and antenna and transmission line specifications positively and unequivocally.

A panel composed of leading authorities in the technical and programming aspects of video tape recording discussed SMPTE Standards, maintenance, adjustment and operation of the recorder and problems involved in the production, scheduling and syndication of programs and commercials.

Mr. Dwight Harkins, of Harkins Radio, Inc., described how crosstalk problems in multiplexing had been isolated and corrected, and emphasized the importance of properly installing multiplex receivers and their antennas. An article by Mr. Harkins, which describes the conditions which are necessary to permit perfect multiplexing, is included in this issue.

The first recipient of the National Association of Broadcasters Engineering Achievement Award was presented to John T. Wilner, vice-president and director of engineering for radio and television, the Hearst Corp. The award was made in recognition of his outstanding contribution to broadcast engineering through his work on the image orthicon saver.

This year's engineering conference covered many aspects of broadcasting. Broadcast Engineering plans to carry articles in future issues covering details of these subjects and many others.



Microwave video relaying equipment was displayed and discussed at the Convention this year.


Standards and problems in video tape recording were the topics of a conference panel.


Inspecting the silicon controlled rectifier which is used in new TV lighting dimmers.

STEREOPHONIC BROADCASTING

MANY PROBLEMS HAVE TO BE SOLVED BEFORE A STANDARD METHOD IS ADOPTED

STEREO is the magic word which has captured the public's fancy in recent years. First it was stereo on tape, next the tremendous growth of stereo on discs and then the advent of stereo broadcasting. Every major city has introduced this new form of broadcast entertainment to its listeners and all indications are that the public will accept stereo broadcasting as it has accepted stereo on tape and disc.

The initial method of stereocasting used by broadcasters uses a combination of two transmitting channels such as AM-FM or AM-TV which is the only system approved for general use by the F.C.C. at the present time. This method does not require a change in transmission standards; however, it is not considered a permanent system because it is uneconomical of spectrum space and is not compatible for single receiver reception since it provides the monaural listener with only one channel.

How A System Will Be Selected

Many systems for the transmission of stereophonic broadcasts have been suggested. Since a standard system will have to be selected, the F.C.C. must establish technical standards for stereo broadcasting. The broadcast industry is faced with producing a system which will equal in quality the other stereophonic reproducing systems already introduced to the public. This indicates that a careful study must be made of all systems before a decision is reached. Two steps have been taken toward the selection of a technical standard of transmission for stereocasting. One is a Notice of Inquiry by the F.C.C. whereby written comments may be filed on or before June 10, 1959, concerning stereo. The Commission is including the stereo question in its previous broad inquiry into the techniques and potentialities of FM multiplexing because of the keen awareness of and widespread interest in FM stereophonic programming among broadcasters, equipment manufacturers, trade associations and listening groups.

Questions Raised by FCC

The Commission has asked for comments on these questions:

(a) Should stereophonic broadcasting by FM broadcast stations on a multiplex basis be permitted on a regular basis, and if so, should such broadcasting take the form of a broadcast service to the general public, or should it be available only on a subscription basis under Subsidiary Communications Authorizations, or both?

(b) What quality and performance standards, if any, should be applied to a multiplex sub-channel used for stereophonic broadcasting?

(c) Should a specific sub-carrier frequency or frequencies be allocated for stereophonic broadcasting?

(d) Should the quality and performance standards applicable to the main channel be further relaxed, beyond the point already permitted for SCA operations, to accommodate stereophonic broadcasting and, if so, to what extent?

(e) What transmission standards regarding cross-talk between the main channel and stereophonic sub-channel should be adopted?

(f) Should FM broadcast stations engaging in stereophonic broadcasting be required to use a compatible system which allows listeners tuned only to the main channel to hear an aurally balanced program?

The second step taken has been the establishment of the National Stereophonic Radio Committee, sponsored by the Electronic Industries Association, which will undertake the study of various problems of stereo broadcasting in AM, FM and TV. The NSRC is comprised of six panels which will investigate and evaluate systems specifications, interconnecting facilities, transmitters, receivers, field testing and the subjective aspects of stereo. It is estimated that this study will require one year.

Approximtaely 20 different systems have already been proposed and more will be announced. This indicates that the final selection and standardization will not be a simple matter. Some systems are applicable for AM only, some for FM only, and others can function on either medium. The FM systems propose the use of a sub-carrier using multiplexing techniques.

Multiplex Stereo

Some of the problems to be decided in multiplex stereo are the modulation level and sub-channel band width required. The higher modulation level provides an optimum transmission for the stereo channel; however, the modulation range is reduced for the monophonic listener. Cross-talk problems may also occur in some transmitters at the higher modulation levels. The band width question revolves around the determination of whether or not the stereo effect is dependent on the full audio frequency range, or if only certain mid-range frequencies are necessary to provide the effect. If it is decided that it is necessary to have only a limited band width, then advantages can be gained in modulation levels and additional services can be provided in the multiplex spectrum. This is a subjective matter with advocates for both full band width and limited band width. The proponents for limited band width would still provide a full range signal by combining the signals in the frequency ranges outside of the separate stereo range. Among the systems using FM multiplex techniques are the Halsted, Crosby, Calbest and Philco.

The Halsted system utilizes the main broadcast channel for one stereo side and a multiplex channel for the other side. Advantages claimed for the Halsted Stereoplex System are a compatibility with present AM-FM stereo transmissions which would enable the FM multiplex audience to grow as adapters are installed in homes without curtailing present stereo transmissions during the transitional period and the retention of high overall performance capability of the main channel under multiplex transmission conditions.

The Crosby system transmits the full program material on the main channel and one stereo source on the multiplex channel. Thus, a monophonic listener receives a complete compatible program. By means of the sum and difference technique two seperate channels are provided for stereo listeners. Advantages claimed for this system include a signal-to-noise-ratio gain for the two channels of the stereo system and a balancing of the frequency response realized on the two received channels.

The Calbest system also transmits the sum of the two stereo components to provide a compatible main program channel. However, the multiplex channel carries only one of the stereo components and is limited to 3500 cycles. Calbest has cited physical, psychological and other research data which indicate that frequencies below about 180 cycles and above 3500 cycles play a negligible part in stereo from the standpoint of the listener. Thus, advantages in frequency spectrum and signal-to-noise-ratio can be gained by using the restricted band width. In this system the frequencies above 3500 cycles are evenly divided between the two channels.

The Philco Corp. has proposed a system using another technique to derive separate stereo channels from a compatible main program channel. Their system utilizes the sum signal on the main channel, the difference signal in a band from 32 KC to 17 KC and a reference carrier signal of 32 KC. The audio sum and difference signals are obtained by single-side band AM modulation techniques. This combined signal then modulates the FM transmitter in the normal manner.

AM Stereo

Stereo broadcasting, of course, will not be restricted to FM stations. The double side band characteristics existing in the AM signal make it possible to add the required information for two-channel stereocasting. Numerous systems have been proposed which will provide compatible AM stereo. One of these was demonstrated at the recent NAB Convention by the Kahn Research Laboratories. This system provides an adapter which produces two independent side bands which are independently modulated by the two stereo channels. The resulting envelope wave has the same spectrum requirements as conventional AM. The envelope wave produced by the adapter permits independent upper and lower sidebands to be demodulated by standard AM detectors. Therefore, stereophonic reception can be achieved by simply tuning two receivers to the respective upper and lower sidebands. Receivers with single control tuning, dual audio channels and other features could also be introduced to receive the system. An interesting feature of this system is that the fidelity of reception from the average receiver is improved because the set is tuned slightly off-carrier, thus extending the band width of the receiver sideband.

The Philco Corp. has developed a compatible AM system using both amplitude and phase modulation. The amplitude modulation is proportionate to the sum of the stereo signals. The phase modulation is determined by the higher frequency components only of the two stereo signals. The two stereo signals are applied to separate identical modulator stages of a transmitter. The carrier wave from the master oscillator is amplified and split into two components phased 90° apart. Each phase is applied to one of the modulator stages and the outputs of these modulators are combined in a diplexer suitable to the transmitter circuit requirements. The resulting carrier in the absence of all modulation is then midway or 45° from either of the carrier currents delivered by the two modulators. During the modulation each carrier component from these modulators varies in amplitude only and may be modulated up to 100 per cent in conventional manner. The resultant carrier being the vector sum of the two will also be amplitude modulated. At times when the signal is monophonic only amplitude modulation of the resultant carrier is obtained. For a stereo signal the two channels are different and both amplitude and phase modulation of the resultant carrier is obtained. Standard receivers reproduce a full monophonic signal; however, a special receiver is required to produce stereo reception.

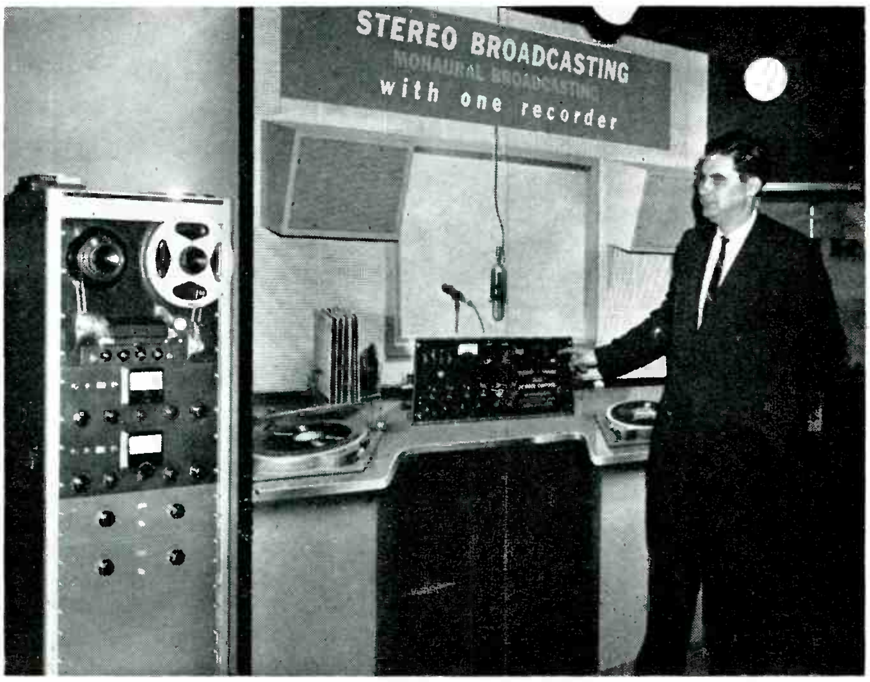
Another method of considerable interest which can be used for either AM or FM is the Percival Stereo Radio System. This system was demonstrated during the NAB Convention. The Percival System differs in that it is transmitted as a single source with a control signal used to determine the direction of the sound source. The control signal is approximately 100 cycles wide and is transmitted on a sub-carrier in the case of FM or could be applied to the AM carrier by frequency modulating the main carrier or inserting it on a sideband.

Studio Problems

The problems in stereocasting do not end with a determination of the transmission system. Mr. Frederick Chassey, Chief Engineer of Radio Station WFLN, Philadelphia, in a paper given at the NAB Engineering Conference, described the studio problems involved in broadcasting stereo programs. Because adaptations of commercial equipment for stereo proved inadequate, WLFN decided to build its own control console. The objective was to design a console which could handle two channel programs as easily as the present equipment handled single channel and, in addition, be even more versatile. It was decided that the console should have at least 16 inputs to pick up program sources from two turntables, two tape recorders, multiple voice and studio microphones and two remote control lines. One of the problems which developed was providing controls which would fade out a musical theme while a voice microphone was turned on. A dual control was required that would permit the gain of two channels to be raised or lowered with one hand while two more could be controlled with the other hand. Since stereo tapes and records vary in level between channels, a balance control was also found necessary.

It appears that the F.C.C. and N.S.R.C. have a formidable job in determining specifications for stereo broadcasting.

Broadcast Engineering will publish additional articles describing future developments and details of specific systems.



Jack Hauser, Ampex's Professional Products Division Sales Promotion Manager, operates remote control buttons for the Ampex Stereo Audio Recorder 351-2 rack-mounted unit.

PLAYING SPOTS ON TAPE

Equipment has been introduced to play short recordings conveniently and practically on magnetic tape.

THE GROWTH of the magnetic recording industry has assumed phenomenal proportions during the past decade. Since the end of World War II we have seen magnetic recording grow from the first wire recorders which were our original introduction to the marvels of magnetic recording to audio tape recorders which gave the industry faithful sound reproduction indistinguishable from the original, data recorders which store millions of pieces of information, and video recorders which can now record color television and play back with live quality.

The change in programming methods by individual stations and networks was revolutionary in the industry with the widespread adoption of audio tape just as the development of video recording is currently changing television programming practices. The development of magnetic tape brought about economy, flexibility and quality improvement for the broadcast industry.

However, since tape recorders were designed to play for relatively long periods of time, they do not provide the convenience necessary for on-the-air playing of spot announcements. The time required to thread and cue up a spot and the problems involved in filing spots on tape reels has made it difficult to utilize tape for short duration material. Some stations have attempted to overcome these problems by the use of multiple tape player systems and other improvisions. However, the lack of simplicity has discouraged the widespread adoption of tape for spot use.


The Gates "Spot Selector" in operating position.

Now equipment has been introduced which makes it as easy, if not easier, to play spot announcements on tape as on discs. Not only one system but several were introduced at the NAB Convention this year to break through the spot limitation barrier. The methods shown included the use of a magnetic tape belt 13 inches wide, tape cartridges, magnetic discs and standard tape reels with equipment to select automatically the desired spot announcement.

A spot tape recorder using a 13-inch wide magentic belt has been introduced by the Gates Radio Co. This unit accommodates 101 spot announcements which can be up to 90 seconds in length. Each announcement, jingle, theme or other material is selected from the front panel by an indexed control knob. At the completion of tape travel, the tape automatically rewinds, stops and cues up, and is ready for the selection of the next announcement. Recorded material can be erased and new material recorded just as on any other tape recorder without damaging recordings on adjacent tracks. In a paper given by Jay Blaksley, Manager, Audio, for Gates Radio Co., it was stated that five requirements are desirable for a spot tape recorder: (1) The machine must have good frequency response and low noise and distortion. This requirement is the same as that called for in any commercial tape recorder. (2) The machine shall be of such physical size that it can be either rack or desk mounted. (3) The machine shall have a time capacity of over one minute for each spot. (4) The machine shall be capable of automatically cueing and rewinding each spot announcement. (5) The machine shall be capable of recording and reproducing over 100 spots without removing the reel of the tape from the machine.

Gates has designed its recorder to satisfy these requirements. Automatic rewind and cueing are accomplished by the use of two photoelectric cells. The tape rewinds after the 90-second interval and automatically cues to the correct indexed starting point. The scale on the front of the machine is graduated into major divisions of 1 through 10. Each of these divisions is further subdivided into letters A through K. These divisions provide for the indexing of 101 separate recording tracks. The front panel contains the necessary switches for accomplishing record/play functions, bias metering and volume indicating as well as the start/stop and manual rewind switches. The machine can also be remote-controlled. Rewind time of the tape is accomplished in 20 seconds; however, manual rewind is possible at any time during the limit of tape travel.

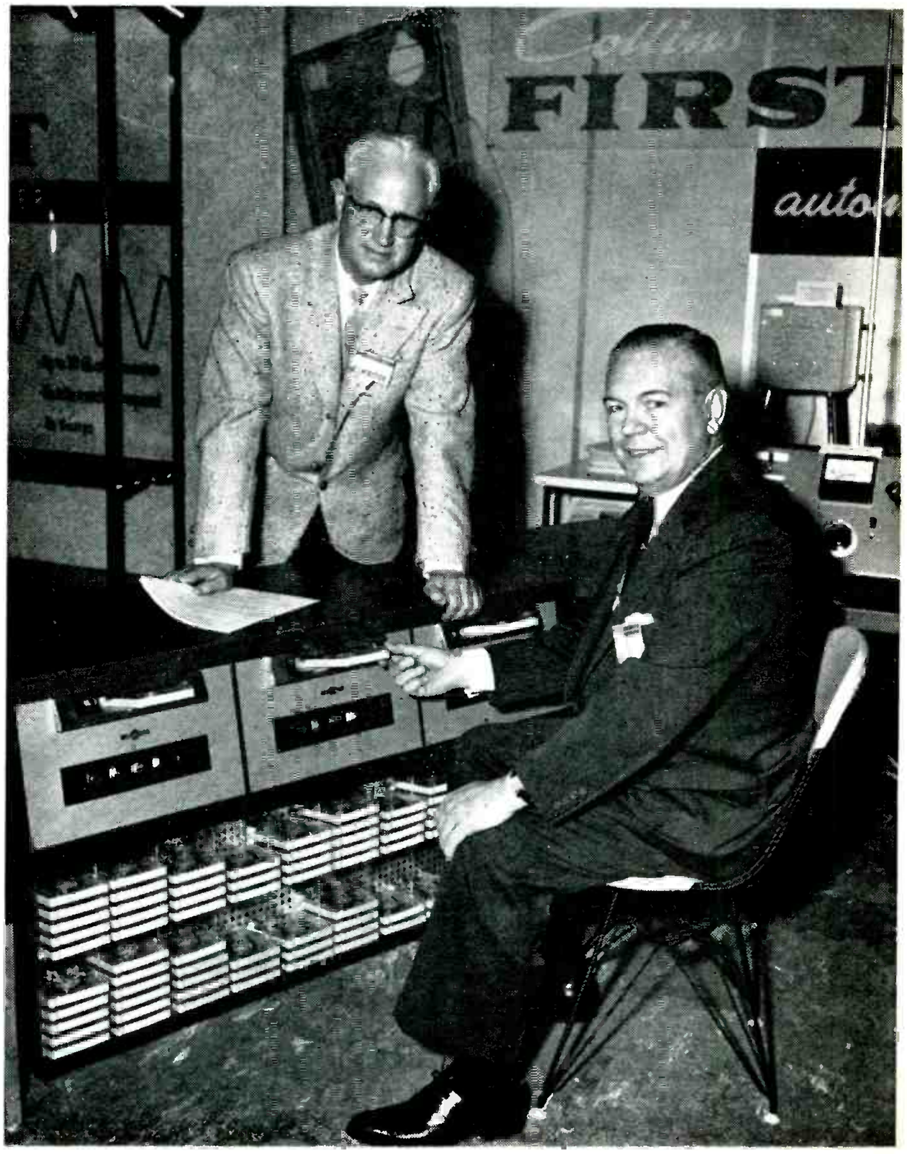
The Collins Radio Co. has introduced a system using tape cartridges. In this system each cartridge contains one announcement or other recorded material. This system is known as the Automatic Tape Control. To play a cartridge it is inserted into a slot in the unit where it automatically engages the recording head and starts the capstan motor. A "Ready" light is illuminated on the control panel indicating that the spot is ready to play. The announcement is played by depressing the "Start" button which changes the function lights from "Ready" to "Run", thus indicating the mode of the machine.

After the recorded material has been reproduced, the tape continues moving across the play-back and tone control heads until a tone burst, which is recorded on the tape, stops the equipment which then returns to the "Ready" position. In the playback function, the Automatic Tape Control is never stopped manually, the stop impulse is generated by the tone control circuit which is arranged so that the announcement is properly re-cued and ready for re-play at the end of the tape travel. Both a record/play-back unit and a playback only unit are available from Collins. As an accessory an automatic audio switcher is available which will feed multiple automatic control units into a single channel of a studio control console. Remote control of the unit function is also provided. Three sizes of cartridges are available which provide from 40 seconds to 40 minutes of recording time.

A system whereby up to 99 spots of any length can be recorded on a standard tape reel and any one of these spots automatically selected and cued up was demonstrated by the Schafer Custom Engineering Co. This machine, called the Spotter, consists of a separate console-type control head plus a tape recorder rack and other circuitry. To use the Spotter, all announcements are put on tape and each is assigned a number up to 99. Then by pushing the buttons corresponding to the desired spot number, the proper announcement is automatically selected and positioned for playing.

Another approach to the use of magnetic recording for spot use is the RCA Magnetic Disc Recorder. This unit combines the advantages of magnetic tape with those of phonograph discs by using pregrooved magnetic discs the same size and shape as conventional 45-rpm records. These are played on a turntable equipped with a tone arm using a magnetic head. The discs can also be used in automatic turntables and, by means of a cue signal, the discs will cue into the start of a message and trip out the change mechanism at the end of the message. RCA has also introduced a multiple track, wide-belt machine.

(Continued on page 36)



Harold E. Fellows, President of the National Association of Broadcasters, inspects the Collins tape player. Forest Wallace, left, points out the features of the equipment.

HOW TO GET THE MOST OUT OF MULTIPLEXING

This article details the many pitfalls of FM Multiplexing at both the transmitter and receiver end. From his experience in modifying over 50 FM transmitters, the author details the necessary conditions which will permit perfect multiplexing.

By Dwight Harkins
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In order to obtain satisfactory multiplexing the system concept must be used. The transmitter, together with its antenna, must be operated correctly in order for the receiver to function properly. Not only must the transmitting equipment create a subcarrier that is free of distortion but it must transmit without adding crosstalk. The receiver in turn must amplify the signal and detect it without contributing noise, crosstalk or distortion of its own.

The ideal set-up would be to have a transmitter that is designed and built to handle multiplexing and to use a transmitting antenna that is also designed and built for multiplexing. Thus far this author has devoted his time to the modification of existing transmitters to permit multiplexing, and in the course of so doing has uncovered many things that cause unsatisfactory operation.

The whole problem at the station has revolved around eliminating crosstalk interference of the main channel modulation products getting into the subcarrier. Some of the things occurring at the transmitter were:

(1) Multipliers created phase distortion, resulting in crosstalk.
(2) Improper couplings between stages caused crosstalk.
(3) Regenerative amplifiers caused crosstalk.
(4) Any mistuning caused crosstalk.
(5) Any conditions in the radiating system that presented a reactive load to the transmitter as indicated by high VSWR would cause crosstalk.
(6) RF pickup in audio circuits caused crosstalk.

During the course of installing our multiplexing exciters throughout the country, these and many other situations were encountered and corrected. A multiplexing station monitor was developed and proved very valuable in adjusting each individual transmitting system to give proper performance. The mysteries of crosstalk no longer existed and the station operator had clearly defined corrective measures he could apply if the economics of the situation permitted it.

Even though the transmitting problems were licked and a good signal was being generated by the station, the existing receivers were found to be contributing serious crosstalk. Even though the over-all system, including the receiver, was not perfect, background music customers were being served on a widespread basis. Commercially successful multiplexing became a reality. The receivers were out earning money. Cooperation between engineering and managemnt had brought about successful operation in many areas.

The following techniques were used. First, by holding back main channel modulation and by enforced gain riding and efficient peak limiting the main channel break through was minimized. Automatic subcarrier muting between music selections was perfected. Sta-levels and uni-levels were used on the subcarrier to insure highest modulation at all times. Volume controls and tone controls were set for balance at the locations and served to keep the presence of crosstalk least noticed.

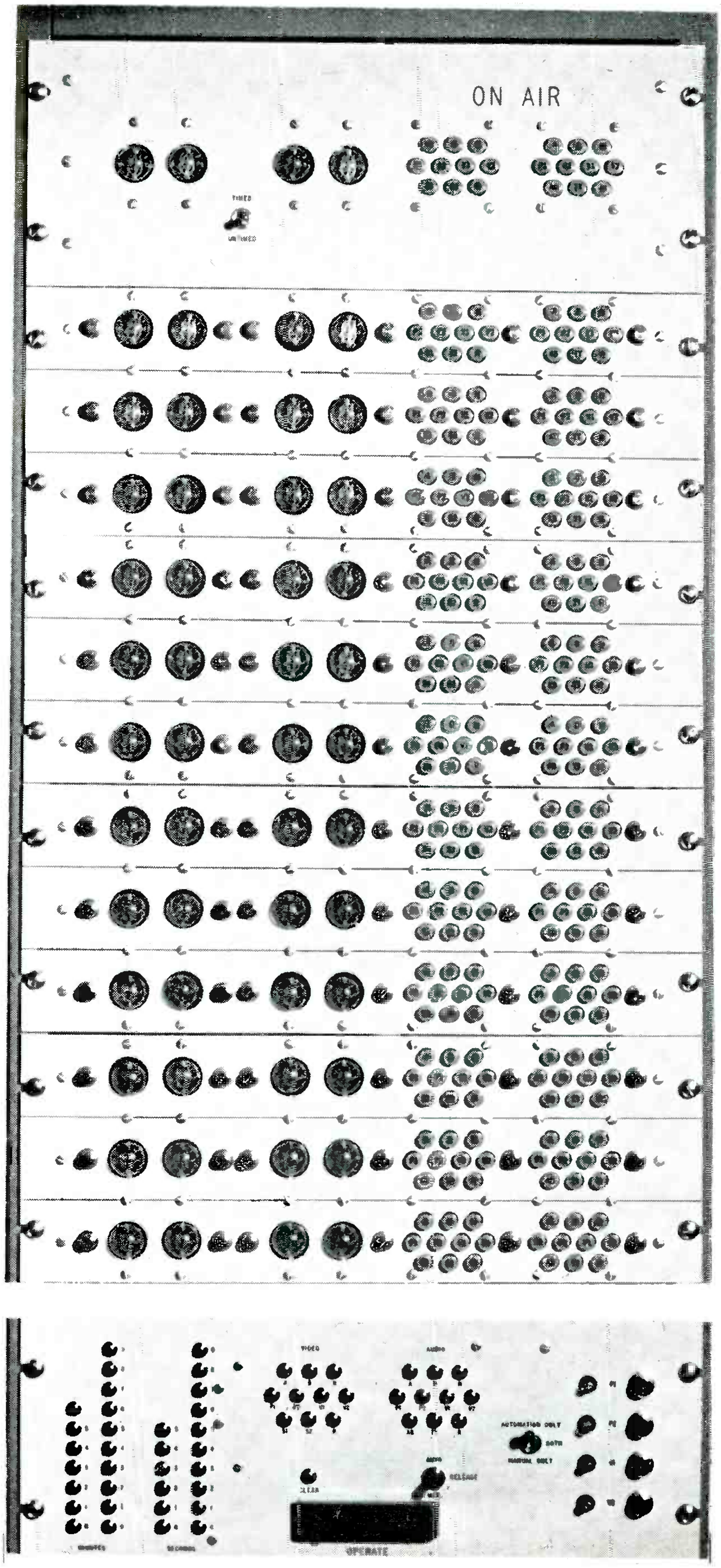
These and other similar techniques were considered par for the course. Coupled with the honest motive to make multiplexing work, a large segment of the new industry did just that.

In the face of the widespread variation of results obtained, many station owners were reluctant to get into multiplexing. This could be understood, because not only was there a lack of new equipment or a complete multiplex transmitter, but there was no widespread information regarding the methods that could be used to permit successful multiplexing with existing equipment.

With a transmitted signal that

(Continued on page 36)

The HARKINS Multiplex receiver which features an I.F. amplifier operating at 23 Mc. for high phase linearity and a subcarrier filter that enables full 10 Kc deviation.



By
JAMES B. THARPE
President
Visual Electronics Corp.

A UNITIZED electronic television program automation system is described which can be built up to provide varying amounts of station automation as required in the station development—from automating only the "panic" station break period to automation of the largest TV broadcast centers desiring to run completely automatic operations programmed by punched cards, punched tape or other means.

The system features maximum convenience and minimum confusion due to its "shift" storage and display system. All events which have been set into the equipment are continuously displayed to the operator in the order in which they are to occur. Changes or corrections can be made on any stored event at any time. When an event occurs, the indication describing it disappears from the top of the panel; all other indications shift up one position. Vacant positions at the bottom can be filled at any time either manually or by a punched card or tape device.

In order to provide ultra-reliability in this equipment, Beam Switching Tubes with 50,000-hour life expectancy are used for the heart of this system. Mercury-wetted contact relays rated at one billion operations are used for the shift function.

A BUILDING BLOCK TELEVISION PROGRAM AUTOMATION SYSTEM

Introduction

This paper describes a unitized Television Program Automation System which can provide a simple manual preset for handling the "panic" station-break period and can be expanded step-by-step as station automation develops to provide complete automatic operation of all master control switching and related functions for the largest television broadcast center through punched cards, punched tape, or other preprogrammed storage devices. The system incorporates unique features to make its operation clear and straight forward and to allow for any last minute corrections or changes. In case of any unforeseen happening this automation system can be controlled by an operator to take care of the special situation rather than have the operator be forced to shift to "manual" operation at a most difficult time. As system reliability must be of the highest possible order, "50,000-hour" life potential components have been used for the key portions of the system. Construction is modular and so arranged that the system can be easily tailored to provide for the initial requirements of any station and expanded at will. All modules are plug-in through "blue ribbon" connectors — even the key resistor and condensor groups are plug-in! If trouble does occur in one of the modular units the faulty portion of the system can be by-passed by patching and serviced later. The limited servicing and maintenance required can be easily accomplished.

General

The storage-display panel holds a series of preset stored events. (Each occasion something is to happen is an "event"—what is to happen is a "function".) The system will store a number of "events" scheduled to occur in sequence and each event will have stored the video and audio "functions" which will go on the air at that occasion. Thus a number of events is preset into the storage-display panel—each of which specifies the particular video and audio function to occur at that "event". These events are stored and displayed on the panel from top to bottom in the sequence in which they will occur. (Set in the panel here shown is sequence to occur as follows: Event No. 1, video function . . . audio function . . .; event No. 2, etc.)

Correction

Change or correction of any function in any stored event may be quickly and easily accomplished by simply touching a front panel "correction" push button associated with that function group. The unit will rapidly sequence through the functions available in the group and the desired one may be set by releasing the push button as it appears. This procedure is rapid and quite satisfactory for making corrections or changes in previously stored information when necessary.

An outstanding feature of this system provides that when the upcoming event occurs (goes on the air) that event leaves the top row on the panel and *all* succeeding events shift up one row to provide again a panel display showing the *next* upcoming event in the top row and all succeeding events in their order of scheduled occurrence reading from top to bottom. When this next event occurs (goes on the air) all succeeding events again shift up one row to *continue to provide at all times a display showing the next upcoming event at the top and each scheduled succeeding event in sequence reading down the panel.* This continuous in-sequence display of upcoming events provided by the "shift" action of the storage-display panel provides clarity in operation not heretofore available in such systems.

Manual Feed-In

Information is fed-in and stored in the storage-display panel through a remote control panel by the momentary grounding of a low voltage low current DC contact associated with the function desired for a particular event. When all functions for a given event have been so set-in, the system automatically shifts this stored event up the panel *to the last open event row.* That is, an event is set into the bottom row and automatically shifts up the board to fill the vacant row immediately following the series of stored events. Thus a complete sequence of events can be set-in from the remote operating position and the event being set-in can be checked and corrected from the remote position and then released to shift up as described. In this manner the operator can load up the panel for a station break period by reading down the program schedule (log) and setting-in the desired events in sequence from a single push button control panel — checking and correcting if necessary as he goes.

Tape Feed-In

The simplicity and straight forwardness of this shift display arrangement is evident for manual operations. The features provided also lend themselves ideally for expansion from manual feed-in of information to feed-in from a punched tape or punched card system. When using punched tape, as each event occurs, the stored information shifts up as described—leaving the bottom row empty. The tape is advanced one event through the tape reader and read out. Its information is set-in the bottom row. As the next (top row) event occurs, the board will again shift up and the tape again advance one event causing the tape reader to again fill the bottom row. Thus the storage-display panel will provide storage and read out in depth for upcoming scheduled events which can be easily read, reviewed, and quickly corrected or changed if necessary prior to going on air — thus *eliminating* the inflexibility of the tape system alone which cannot be easily read or changed.

Card Feed-In

The unique feature provided wherein an event set in at the bottom row will automatically shift up the panel to the open position immediately behind already scheduled events provides the ultimate in adaptability for punched card fed systems. For instance, if a station adopts a punched card system it would not use a card for each event—it would likely use a single card to schedule a commercial spot—this might call for a sequence of several events—say four slides plus a film clip, etc. This card could carry accounting and other information: account name, spot identification, contract number, frequency discount, etc. When this card dropped in the card reader, so timed that several events were open at the bottom of the storage-display panel, its event-function information would be automatically set-in in sequence and each shift up the board in turn, stacking in the several events called for by this card, for this spot, these being set-in in sequence and immediately following the last previously set-in event.

Thus, this system provides storage and display in depth for a number of events, always displaying them in their upcoming order from top to bottom of the panel with the next upcoming event always in the top row. Events may be scheduled and fed-in manually from a single remote control panel position or may be fed-in in sequence from punched tape, punched cards or other similar systems. An event is fed-in the bottom and automatically shifts up the board to fill the next in-sequence open event position.

"Take-Button"

In a simple manual preset system, the top row event may be made to occur by hitting a "take-button" which will put it on the air. Thus, if a station break is preset as a series of events, each succeeding event may be put on by hitting the "take-button." (As events occur and the stored schedule shifts up clearing the lower rows, additional events may be set-in.) A simple manual feed-in, manual take preset system will provide a great aid to any station large or small for relieving operator burden during "pressure" station-break periods as it allows him to think through, plan, and preset a sequence prior to the critical time — *and* to look at the preset sequence displayed in full before him for review, correction, or change prior to initiation.

Time

Operation may be augmented by the addition of a "timed" system such that each stored event will occur automatically at a pre-scheduled time rather than by manual "take-button" action. Timed systems are arranged so that when the time set-in for an event coincides with the time on the system "clock" or timer, that event receives an "operate pulse" and its designated functions are put on the air.

Count Down Time

The simplest timed system is an elapsed time or "count down" system which would be provided by the addition of three additional time storage-display units for each event on our panel—one for units of minutes, one for tens of seconds and one for units of seconds. The "clock" in this system consists of a timer which is started by activating a "start" button at the desired beginning of a timed sequence of events. After starting, it advances in time in one second steps, counting down the top row event to time coincidence at 0:00. In our storage-display panel, events are stored in sequence each with the time interval from the proceeding event. For example: we may have first slide 1 for 10 seconds, then slide 2 for 4 seconds, then film 1 for 20 seconds, then net.

We set-in:	0:00	S_1
	0:10	S_2
	0:04	F_1
	0:20	N

At the instant of "start" of the sequence, the first stored event (S_1) 0:00 would occur. The next stored event (S_2) then shifts up to the top row and the advancing "clock" timer counts it down 9-8-7-6-5-4-3-2-1 to 0:00 and it goes on the air. Then the next scheduled event (F_1) shifts up to the top row, is in turn counted down 3-2-1 to 0:00, etc. When zero time coincidence occurs for each event, that event is made to occur and remaining scheduled events shift up, always maintaining complete in-sequence display from the top reading down.

Complete Time

A complete timed system would incorporate the following:

1. A "True" time master clock supplying a time base of one second pulses.

2. A second, electronic clock which normally follows the time master clock stepping at a one second rate —but which can be pulsed much faster to run ahead or stopped as described below.

3. A 10's of minutes time column

(units of hours and 10's of hours may also be included—though not essential for most operations). In normal operation all events are set-in in scheduled sequence with their program log time, the electronic clock follows the time master clock and establishes time coincidence with the top row event at its designated time — thus causing that event's functions to go on the air automatically at that time.

In cases of failure to follow the exact preplanned time schedule of events stored according to log time, an "approximate" time base is used to maintain each event in its proper sequence time interval. For example, suppose we have a station-break all set-in scheduled to begin at 29:30 and unexpectedly the net leaves early at 29:13. As 17 seconds of dead air time is undesirable, the operator would push the "approximate time TAKE" button which would feed a rapid sequence of pulses to the electronic clock, causing it to advance rapidly to time coincidence with the first event putting it on the air. The electronic clock then reverts to one second steps and the system continues to operate on the "approximate time" of the now reset electronic clock.

Likewise, if the President speaks over 1:23 and the net is late leaving, the operator can press "approximate time HOLD" which will stop the electronic clock until released. Upon release (net leaves) the operator would switch from "approximate time HOLD" to "TAKE" as described above and pick up his preset log sequence of events at their proper intervals from the now reset "approximate time" condition. When such a break is completed, time may be shortened in any interval by rapidly advancing to the next interval by the "TAKE" or time may be increased in any interval by the "HOLD". Thus the operator may get back on true time as the opportunity arises in the same manner which he does today (without automation).

A control panel switch allows resetting of the electronic clock to the "TRUE" clock when desired to automatically reset to exact true time.

Relative Time

Another unique feature of this system allows for the electronic clock to be used to provide "relative time" as well as "approximate time". For example, if during a net show, the station were to be scheduled to take a one minute break to be on arbitrary cue rather than on specific time, the one minute break to come in at the unknown time on cue could be set up on "relative time" from 0:00 for beginning of cue. The electronic clock would be re-set to 0:00 and started in one second advances from the operator's pushing the "relative time START" button on cue. When the relative time sequence is completed, the electronic clock is re-set to the TRUE time clock. Special features in this system allow for intermixing the storage of TRUE and relative time events with the system automatically changing time base due to coding of the relative time events by having only three time digits displayed (10's of minutes indicator dark for relative time events).

Anticipation

A time base system allows the incorporation of an additional very desirable feature of this system. Consider the matter of a film projector with a 4-second roll time or a VTR with a 7-second roll time. In the simple manual preset system, one manual operation is required to "roll" the projector, a second to "take" the projector.

In the timed system, there are three possibilities:

1. To schedule projector "roll" and film "take" as two separate events 4 seconds apart. This takes up a lot of events.

2. To schedule projector "roll" only and through a 4-second fixed time delay relay associated with that projector circuit have film "take" occur after this fixed delay. This necessitates scheduling the event 4 seconds (or 7 seconds, etc.) ahead of the program log on-air time —which is confusing. It also loses control of the time of the "take" event (set for a fixed 4 seconds) unless special provision for override of each such fixed delay is provided.

3. Due to its storage in depth, the currently described system can be expanded to provide an "anticipate" circuit which, when events are scheduled at on-air time per the program log, will provide automatic starting of machines *at the correct interval before* the event. For instance, projectors 4 seconds before, VTRs 7 seconds before, etc. This tremendous advantage can be provided on elapsed or count down timed systems for any events occurring after the first seven seconds in the sequence and in the more advanced timed system described for all timed events.

This anticipate circuit operates as follows: Time coincidence is established with the top row event of the storage-display board 7 seconds prior to on-air time. The storage-display panel operates in normal fashion; however, the selected event does not immediately go on the air as it leaves the top row but rather travels down a 7-second "anticipate delay line" in one-second steps. This delay line stores the selected function in the same manner as the event functions on the storage-display panel but no display is provided (it is not necessary) and the selected function is advanced one position along the line each second by the incoming one-second timing pulses from the master clock system. Thus, a selected function leaves the top row 7 seconds before air time and goes 7-6-5-4-3-2-1-on air. Along this delay line, each function has tapped off at the appropriate step, the "machine roll" initiate information, i.e., when VTR reaches step 7 (the first following the top row) the VTR machine is caused to roll. VTR function continues down the line 6-5-4-3-2-1-on air, going on air at the scheduled time — and exactly seven seconds after VTR was "rolled". A selected film function would leave the top row 7 seconds before air time, travel 7-6-5-4 (here the tap-off to that machine would cause it to roll) 3-2-1-on air—film switching on air at the scheduled time—and exactly 4 seconds after the projector "rolled".

Note that two or more selected functions can be traveling down the "anticipate delay line" at the same time (in different sequence positions). Therefore, the system does not jam for the required start time of any machine.

For example:

Sequence (1) leave net
Sequence (2) 2 second slide
Sequence (3) take film

In this case, events would be scheduled according to on-air time.

29	30	leave net, take slide
29	31	
29	32	leave slide, take film

but, due to the anticipate feature, the 29:30 event (slide) would leave the panel top row at 29:23 (7 seconds before air time) and start through the delay line. Likewise, the 29:32 event (film) would leave the panel top row at 29:25 (7 seconds before air time) and start through the delay line. Thus they would progress through the delay line with film following behind slide by 2 steps (2 seconds).

	Slide at:	Film at:
29:22	top row	second row
29:23	7	top row
29:24	6	top row
29:25	5	7
29:26	4	6
29:27	3	5
29:28	2	4 causing projector roll
29:29	1	3
29:30	on-air	2
29:31		1
29:32		on-air

Building Block

The building block modules comprising this system provide three events in a 7-inch high standard rack panel. Thus nine event storage requires three 7-inch panels, 12 events four 7-inch panels, etc. For each horizontal event row there may be 6 ten-function groups on a 19-inch wide standard rack panel, 8 on a standard 24-inch rack, 10 on a standard 30-inch rack.

Function groups are available in multiples of 10, 20, 36 and 100. Ten takes one horizontal module space; 20 takes two; 36, or 100 takes three horizontal module spaces. Function group indicators may be numerical Nixies, alphabetical Nixies, or Neon tally clusters. In our model here, the time was displayed by numerical Nixies and video-audio functions by neon tally clusters. Complete freedom of choice as to these display indicators is available to the station in this modular system.

Reliability

The requirement to perform all of the vital functions concerned with putting a station's pictures on the air places a high premium on both visual and electronic error-free operation. To provide for the highest order of reliability in this system, a study was made of the various ways that it could be built circuit-wise and an evaluation made of the various approaches found possible. Mechanical stepping switches; relays, tubes, and transistors in both binary and decimal arrangements; magnetic storage elements, etc., all could provide such a system. The most reliable combination of circuit elements was chosen from this evaluation and is incorporated in the present system. It consists of Beam Switching Tubes for storage and switching of group functions, Nixie or neon readouts, and mercury-wetted contact relays for transfer of events. Since the heart of the storage-display system described consists primarily of these components, they are discussed briefly.

Beam Switching Tubes

Beam Switching Tubes may replace 20 or more transistors, tubes, or other components since a single cathode controls an electron beam to any one of 10 constant current output positions each with "automatic" memory and the most versatile switching imaginable.

FEATURES:

Life: Up to 50,000 hours
Reliability: Simple circuitry, few components
Shock: 375 G
Vibration: 10 G, 0-2000 cycles
Temperature: —60° to +150° C

The Beam Switching Tube is a ten-position, high vacuum, constant current distributor. It consists of ten identical "arrays" located radially about a central cathode. Each array comprises (1) a Spade which automatically forms and locks the electron beam, (2) a Target output which makes the beam current available with constant current characteristics and (3) a high impedance Switching Grid which serves to switch the beam from target to target. A small cylindrical magnet is permanently attached to the glass envelope to provide a magnetic field which, in conjunction with an applied field, comprise the crossed fields necessary for the operation of this tube. The tube may be operated in several distribution or switching modes such as (1) the tube may be in a clear or cut-off condition, (2) an electron beam may be formed in any one of the ten positions, (3) the electron beam may be switched sequentially, (4) the electron beam may be switched at random from any one position to any other positions, and (5) the electron beam may be cleared and reset to the setting of the adjacent tube. The use of the tube in various portions of this system utilizes each of these modes.

Target Output: The output efficiency of the Beam Switching Tube is without equal as a multi-position current distributor. All of the beam current is put to work in the one selected position without any current being wasted in the other nine positions. Approximately 15 per cent of the beam current is used by the spade to automatically lock the beam while the other 85 per cent is available at the target output with the constant current characteristics.

Reliability: Beam Switching Tube reliability can be directly attributed to the principle of crossed electric and magnetic fields upon which its operation is based. Its stability does not depend on any gas or secondary emission principles which are difficult to control. Beam Switching Tubes have been tested thoroughly by many individual Government and commercial agencies. Limits have been established on almost all possible mechanical and operational parameters to obtain reproducibility and dependability.

Life: The Beam Switching Tube is one of the most reliable of vacuum devices, with a life potential of 50,000 hours. Experience has indicated that a circuit may be designed reliably around Beam Switching Tubes with an end point emission level of 85 per cent. This compares most favorably with other components. The lack of a close-spaced control grid inherently contributes to this factor. The currents and voltages used are many times less than those for which the cathode is rated. The particular beam shape and the bi-stable tube characteristic which locks the receiving spade at near cathode potential both tend to minimize the effects of ion bombardment.

The beam formation has the property of using a different portion of the cathode for each beam position in a manner which results in time sharing and minimizes the effects of poor emission.

Temperature: Beam Switching Tubes are noteworthy as being one of the electron devices least sensitive to either high or low temperatures. Operation with ambient temperatures of 100° C. have been common. Tubes with special processing schedules have been successfully made for continuous operation at 200° C. and higher. Every completed tube and magnetized magnet assembly goes through a cycle at 150° C. to permanently fix the silicone cement which holds the precise magnetic field alignment. Random tests made with repeated cycling at these temperatures have shown negligible effects.

Shock and Vibration: With the increased interest in using beam switching tubes in aircraft and guided missiles for such applications as coding, radar, loran, and telemetering, many laboratories have made individual shock and vibration tests. As a result of these tests the vibration rating of the present tube has been established somewhat conservatively at 10 G, 0-2000 cycles. Design improvements have been incorporated to permit sample tubes to go the limit of existing test equipment, 20 G, 0-2000 cycles without failure.

Rugged Structure: The rugged box-like symmetrical structure is balanced and supported evenly at all points, both within the mica and to the glass envelope. It is firmly held through many tie points to the multilead stem. Finally, the tube floats within the "rubberized" silicon cement that attaches the glass envelope to the permanent magnet to obtain an additional protective effect.

Nixie Numerical Readout Tubes

The Nixie is a gas-filled, cold-cathode, ten-digit ("0" through "9") numerical indicator tube having a common anode. It is an all-electronic in-line readout device and is an ideal method of converting electromechanical or electronic signals directly to readable characters.

This simple tube contains stacked elements in the form of metallic numerals. Application of a negative voltage to the selected character with respect to a common anode results in its becoming the cathode of a simple gas discharge diode. Only the selected information is visible in a common viewing area because the visual glow discharge is considerably larger than its metallic source.

The device is an unusually efficient electronic-to-visual converter since all of its electrical energy is converted into a neon glow of relatively narrow optical band width. The eye acts as a natural filter in distinguishing this glow in high ambient light.

The Nixie tube types exhibit the following characteristics: (1) All-electronic with a minimum of power required, (2) High-speed rate of change, (3) Simplicity, (4) Wide temperature operating range, (5) Uniform characteristics from tube to tube and number to number, (6) Human-engineered numerical design, (7) Comparatively low cost, (8) Small volume for number size, (9) Light weight, (10) Rugged construction, (11) Good readability for number size.

At the present time there are four distinct sizes of Nixie. The Type 6844-A which is 1-inch in diameter and clearly visible at 30 feet, has been selected as standard for this display panel.

Nixies are available in numerals 0 - 9, and with alphabet characters. On request, a combination of alphanumeric characters can be supplied. The multiple group neon glow tally indicator functions circuitwise the same as the Nixie in-line indicator. It is provided as an alternate for the Nixies and can be used interchangeably with them as indicators. Generally, preference is to use the Numerical Nixies for time indication, the neon tally group for audio and video function indication of 10 to 20 functions, the combination of alphanumerical pairs of Nixies for indication of 20 to 36 functions, and numerical or alpha-numerical for 36 to 100 functions.

Mercury-Wetted Contact Relays

For the high speed switching device to provide accuracy and dependability of the highest order for the event transfer shift, mercury-wetted contact relays, manufactured by C. P. Clare & Co., under license agreement with Western Electric. provide electrical and mechanical stability with extraordinary uniformity of performance over very long periods of time.

It is the mercury-wetted contacts which, together with gas under pressure and the small size of parts, give these relays their distinctive character. Electric contacts between solid metal surfaces can, and often do, cause trouble in various ways: they wear down, get dirty, stick by locking or welding, and chatter. These faults are avoided by using mercury contact surfaces instead of solid metal. In the Clare Type HG Relays, platinum contact surfaces are wetted with mercury by means of a capillary connection to a mercury reservoir below the contacts. The contacting medium is a mercury film supported on the solid metal surfaces. The wick-action keeps the mercury at the contacting surfaces continuously replenished. This minimizes the amount of mercury that has to be put in motion for operation, and permits the moving contact to be carried by a light armature, capable of high speed.

ELECTRICAL FEATURES:

Long Life: Units have a conservative life expectancy of more than a billion operations when operated within their ratings.

High speed of operation: Can be driven at speeds up to 200 operations per second, with consistent performance.

Uniform and constant operating characteristics: Repetitive operation of an individual relay is such that operating time varies by only about 0.1 milli-second under constant drive conditions. The repetitive precision with which a given relay may be expected to operate is within one per cent of its minimum operating current. This precision is substantially independent of number of operations or ambient temperature.

MECHANICAL FEATURES:

Small chassis space.

Convenient mounting — plugs in like a vacuum tube.

High sensitivity.

Requires no maintenance whatsoever.

Operation unaffected by humidity, barometric pressure, or temperature changes.

Completely protected against dust and dirt, corrosive fumes, and explosive atmospheres.

No shelf deterioration.

Contacts can not wear down, get dirty, stick by locking or welding, nor chatter.

There is no possibility of change in adjustment after assembly is completed.

Steel housing reduces magnetic coupling between relays.

Plug-In Construction

The basic components, BST, Nixie, and mercury wetted relay, comprise 95 per cent of the entire system and provide ultra reliable operation in the circuits used. They are arranged in plug in modules providing (1) complete flexibility as to "building-block" expansion (2) immediate "patch around" by-passing of any trouble spot that occurs (3) ease of changing any complete module which may be faulty and (4) ease of removing and trouble shooting a unit while it is still patched into the system and, therefore, receiving its normal voltages and pulses. "Blue ribbon" connectors with special covers are used throughout and all components (resistors, capicitators, etc.) associated with each storage-display point are separate plug-in assemblies.

PROOF OF PERFORMANCE MADE EASY

By RICHARD R. HASKEY
Chief Engineer Radio Station WTTN
P. O. Box 32, Watertown, Wis.

To many broadcast engineers the regularly required "Proof of Performance" test is a dreaded task. In the following article, it is hoped that most of the mysteries of a "Proof of Performance" can be dispelled. Also to be shown is what entails a proof and why it is required as well as its value as a working tool for the station's engineer.

A Proof of Performance is a series of electrical tests applied to a broadcast station's electrical equipment. The results of the tests determine if the station's equipment complies with the minimum engineering standards set forth by the Federal Communications Commission. Furthermore, it will show the engineer if repairs or changes should be made. It can afford peace of mind by showing the engineer that everything is performing "right up to specs."

The battery of tests includes frequency response of the entire broadcast chain, distortion and noise measurements, transmitter carrier shift, and the presence of any spurious radiations caused by the transmitter, including harmonics of excessive amplitude. If there is anything wrong with the equipment, it will show up during these tests. The tests assure that there will be no signals radiated which will cause interference to other stations due to the failure of the equipment to meet the standards of good engineering. Once the proof is completed, the results, properly tabulated, must be kept at the transmitter site ready for immediate reference and inspection. In the case where the transmitter is separate from the studios, a copy of the proof must be kept at the transmitter and, in addition, many engineers will keep a duplicate at the studios.

Each station must prove its performance once a year. This proof can be made by the station's engineer or the station may hire another individual or firm to do the job. Many stations feel that it is cheaper to have the job done by an outsider for they are then not required to purchase the necessary test equipment. In addition, they feel that the time spent by their engineer will far exceed that of the outsider. On the other hand, the results of the proof will be more meaningful to the station's engineer if he himself carries out the work.

The job is not difficult. If a little time is spent studying what has to be done and in making an efficient setup of the equipment, it is just as easy as making a frequency response test on an audio amplifier. The cost of the equipment required will vary depending on which products are chosen, but adequate equipment can be obtained for approximately $500.

Five basic items are required:

(1) An audio oscillator.
(2) A distortion analyzer.
(3) A level indicator or VU meter.
(4) A pad or attenuator.
(5) A field strength meter or a communications receiver.

In addition, the following may be needed:

(1) Matching transformers or pads.
(2) RF pickup coil and rectifier-detector.

It is possible to purchase these items separately or as a complete package from many of the broadcast equipment suppliers and distributors.

A supply of forms, should be available for recording the results of the tests. The engineer must have a chart to record the over-all frequency response, over-all distortion and carrier shift. In addition to the charts, graphs must be later drawn for the data obtained during the frequency response and distortion tests. The combined hum and noise level for 25 per cent, 50 per cent, 85 per cent and 100 per cent modulation levels and a statement of the results of the spurious radiations and harmonics tests should be recorded.

With the required equipment, the connections can be made to the system and the tests begun. The most complex setup of the entire test procedure is the connection of the audio oscillator to the input circuit of the audio system.

In connecting the oscillator to the equipment, the objective is to take a signal near zero VU at 600 ohms impedance and match it to the low level amplifier input. To do this, the output of the oscillator is fed through a calibrated attenuator and matching transformer or pad into the microphone input of the station's audio equipment. The output level of the oscillator is measured and the value of the attenuation is subtracted from it in order to determine the level into the microphone circuit.

One method is to use resistance pads which will match the output of the oscillator to the input circuit of the studio console. Small changes in level can be made by using the gain control on the oscillator. It is difficult to set the output of most oscillators to very low levels; therefore, the pads are necessary. The input can usually be set at approximately zero VU and the attenuator set for a loss of 50 or 60 db. By reading the level into the pad with an ordinary VU meter and subtracting all attenuation, the input level to the microphone circuit can be determined. The pads and other equipment used between the studio input and the oscillator must introduce a minimum of hum and noise. It is essential that the connections between the oscillator and the pad and microphone input circuit be made with extreme care. Circuit balancing, grounding and adequate shielding are all things which must be considered. It is advisable to make up a set of special cable and connectors to facilitate the connections. Once the setup is made, it will be a simple matter to inject an audio signal of any frequency at any amplitude desired into the microphone input by merely adjusting two different controls.

When making the test for combined hum and noise, it will be necessary to remove the signal from the input and connect in its place a load of the same impedance as that of the circuit in use. It would be wise to provide such an impedance in a small box with appropriate connectors so that it can be inserted into the circuit. It is extremely important that this connection itself does not introduce hum or noise or the test will be rendered invalid.

Rather than provide all of these items and try to make the connections, many stations would prefer to have a piece of equipment termed a "gain set" at their disposal. This device contains a VU meter to measure the output of the oscillator, a variable attenuator and plug-in facilities for several fixed pads, means to match oscillator and amplifier impedances and the load resistor for the noise test. In addition, it contains a series of switches so that all of the operations described above can be effected by simply operating the controls and connecting the oscillator and amplifier to the unit by shielded cable. A very serviceable and complete unit of the type just described is manufactured and distributed by the Gates Radio Co. of Quincy, Ill. Other manufacturers also make similar gear.

Once the connections are made to the input, attention can be turned to the output of the system. It is important that the facilities for doing the measuring are complete and convenient.

In most cases little attention need be given to the modulation monitor as far as connections are concerned. It is ordinarily connected permanently and directly to the transmitter or to the output of an RF amplifier in the case of the monitor being located some distance from the transmitter. The monitor should be checked for accuracy of calibration. The calibration is best done by utilizing an oscilloscope. On some monitors a meter is provided for checking carrier shift. This should also be checked for proper operation. In measuring carrier shift, it is necessary to provide a diode rectifier to produce a demodulated audio signal which will operate the distortion and noise meter. This may be a separate unit or may be included as part of the noise and distortion meter. The voltage at the output of the rectifier can be measured with a high-impedance DC voltmeter. Carrier shift in per cent is defined as the difference between voltages obtained with modulation and without, divided by the voltage without modulation multiplied by 100. Any carrier shift in excess of 5 per cent violates the FCC rules and regulations.

In order to measure the harmonic distortion an audio signal is fed from a rectifier demodulator to the measuring circuits of the analyzer. The analyzer is usually a combination device which will measure both noise and hum along with the percentage of harmonic distortion.

Whatever type of equipment is used to measure the distortion, it will be wise to provide a convenient point where the audio will be available. Install a coupling loop permanently in the transmitter and similarly mount the diode rectifier, if used, in a permanent spot. These steps will provide for speedy and efficient connection to the instruments and facilitate efficient performance of the tests. The usual procedure in checking for spurious radiations is to measure the harmonic output at a point a mile or so from the transmitter. A communications receiver with an "S" meter to indicate relative signal strength or a field strength meter can be used.

Since a "Proof" is usually conducted during the period after midnight, it is well to do as much of the preliminary work prior to this time as possible. In fact, just about everything can be set up during the day and it will only be necessary to perform the actual tests during the wee small hours of the morning.

As far as the order in which the tests should be conducted, it is found that the following order works well:

(1) Over-all frequency response
(2) Over-all harmonic distortion
(3) Combined hum and noise
(4) Carrier shift
(5) Spurious radiations

Before beginning any of the tests, all of the equipment should be at proper operating temperature. The actions of all limiting, compressing and expanding amplifiers should be bypassed except for the check on spurious radiation when the equipment should be operated normally.

All of the equipment used for the tests should have a common ground which should be connected to the main station ground. If this procedure is followed, it will be found that little trouble will be incurred with stray voltages causing erroneous readings. Care should also be taken in shielding and locating wires. A good rule to follow would be to connect everything as though it would have to remain in use for a week.

Now to the testing:

Over-All Frequency Response

(1) Adjust the entire broadcasting system as though a program would be originating from a microphone in a studio.

(2) Replace the microphone with the signal from the audio oscillator properly padded and matched to the input.

(3) Adjust the oscillator to a frequency of about 3,000 cycles per second and set the output to about zero VU.

(4) Adjust the amount of attenuation between the oscillator and amplifier to provide about 55 DB of attenuation.

(5) Adjust the station's program circuits so that the transmitter is modulated 25 per cent. This will be the reference condition.

(6) Reset the oscillator to the next desired frequency and re-adjust the oscillator output for 25 per cent modulation. Leave all other factors as they are. Record any increase in oscillator output to maintain 25 per cent modulation. This is read on the oscillator VU meter.

(7) Repeat step 6 for as many frequencies as it is desired to check. A reasonable number should be chosen between about 30 and 10,000 cycles per second. Ten or twelve should be enough unless there is an indication of abnormal operation between any two frequencies.

(8) Repeat steps 5 and 6 for 50 per cent, 85 per cent and 100 per cent modulation.

With the information thus obtained, a graph of the results can be plotted. First, plot the reference point, then indicate by points the amount of change in oscillator input necessary to keep the required percentage of modulation. Connect the points with a straight line which will curve at both extremities. If any point between 50 and 5,000 cycles per second deviates more than 2 DB from the reference at 1,000 cycles per second, the equipment does not meet the standards of good engineering as set forth by the FCC.

Over-All Harmonic Distortion

It will be necessary to make these tests as per the instructions of the manufacturer of the individual analyzer. Distortion must be checked at 25 per cent, 50 per cent and 100 per cent modulation levels and is usually checked from about 30 to 10,000

(Continued on page 43)

THE ALLOCATION PROBLEM

Military and civilian requirements are increasing. How will more TV channels be provided?

THE PROBLEMS of intelligently allocating space in the radio spectrum is one that has faced our government since the beginning of radio itself. In the early years the problems were much simpler as we look back on them; however, they were probably as confusing then to the people in charge of making decisions as are today's problems. One lesson which has been learned is that sufficient information has not been available as to the propagation and other characteristics of the frequency spectrum at the time when decisions on allocations were made. Advancements in the state of the art could not be anticipated as the mysteries of radio unfolded. From the early years when everything below 200 meters was assigned to amateur radio because it was not considered of commercial value, the potential usefulness of the frequency spectrum and the demands of users have been underestimated.

The government is presently faced with another critical situation involving allocation of the radio spectrum. The demands of both non-government and government users have now outgrown the availability of spectrum space. Because the radio spectrum is a critical national resource both the executive and legislative branches of our government are now taking action to solve the present difficulty. Congressional studies have been proposed to study present and future use of the radio spectrum and legislation required to assure a fair distribution of available frequencies among the users. The President has requested legislative authority for a five-man commission which would study the entire field of frequency allocation, the methods for making the allocation, and would propose changes in the management of spectrum problems. The Federal Communications Commission is currently conducting a study of the spectrum from 25 to 890 megacycles.

The increasing requirements for spectrum space by the military for guided missile and space projects has intensified the shortage of available frequencies. This has led to apprehension and rumors that some of the frequencies allocated to broadcasters, particularly channels 2 to 6 of the television band, were imperiled. However, assurance has been given by FCC Commissioner Frederick W. Ford, who acts as FCC liaison with the Defense Department, that he has no knowledge that the Defense Department desires the use of the frequencies covered by channels 2 to 6. An interesting clarification of the position of the Defense Department was made by Lt. Gen. Arthur G. Trudeau in an address before the National Association of Broadcasters. Commenting on the serious problem of radio frequency congestion, he stated:

"This is understandable when one realizes that we must all operate in a common and limited radio spectrum. In fact, the radio spectrum can be considered one of our *critical national resources.* Some persons think that the military has its equipment in a few discreet frequency bands. This concept encourages many rumors that the military is encroaching into the area outside of its assigned frequency bands. I can clarify this misunderstanding by stating simply that the military has some type of equipment operating in practically every frequency band of the spectrum.

"However, in the operation of military radio electronic equipments, we respect the national frequency allocations that exist in peacetime. We carefully engineer our operations to insure that they will be compatible with nationally allocated services in the various frequency bands. Where engineering does not provide a possibility of sharing spectrum space, we limit the hours of operation to insure protection to the primary user. For example, some small-scale training exercises are conducted with equipment in the television band. What you may not know is that in order to insure that there is no interference with civilian television service, we conduct these operations during the night.

"We make every effort to avoid interference with any agency. I am sure you can appreciate the amount of effort required to do this while meeting military frequency requirements. You will agree, I am sure, that we have controlled this very well in the bands of most concern to you, the television and broadcast bands. This reflects our recognition of broadcasting as an essential service to the public welfare.

"The military relies upon the Federal Communications Commission in handling the radio frequency matters of industry. We have the closest working relation with the Commission and have been approached by the Commission with respect to ultimate frequency solutions for a national competitive television system. Some six different solutions have been presented to the Army, Air Force and Navy for comment as to military impact. While this action has not been staffed yet, I am advised that complete information of military operations will be provided to the Commission. If it will allay your fears, we do not seek to expand military bands by this action. We are concerned, however, that this national allocation problem must be resolved to clarify national frequency planning in the general 30 to 1000 megacycle region."

Representative William G. Bray (R.-Ind.) pointed out to the Convention delegates that in both the Radio Act of 1927 and the Communications Act of 1934 Congress provided for a divided responsibility over the radio spectrum without making any provision for a realistic division of the spectrum between government and non-government users. A comprehensive licensing system with procedural safeguards was set up with respect to use of the spectrum by non-government users. The assignment of radio spectrum to government users, on the other hand, was left to the discretion of the President.

Although both the President and the Federal Communications Commission could legally have operated without regard to the other, a negotiated division of the spectrum was achieved. Small portions of the spectrum were allocated for joint use. Concerning this division, FCC Commissioner Frederick W. Ford told the National Association of Broadcasters that the Department of Defense is perfectly willing to sit down and discuss an exchange of government and non-government frequencies on a long range basis. The Commissioner said that this is one area which must be explored in any solution to the allocation of the broadcasting spectrum.

The problem of immediate concern for the broadcasting industry is that of providing for a nationwide competitive system. Since the present 12 VHF channels are not adequate and the UHF channels have not produced the results anticipated by the FCC when it established this allocation, a new allocation system must be established by the FCC. This is one of the most urgent problems facing the Federal Communications Commission.

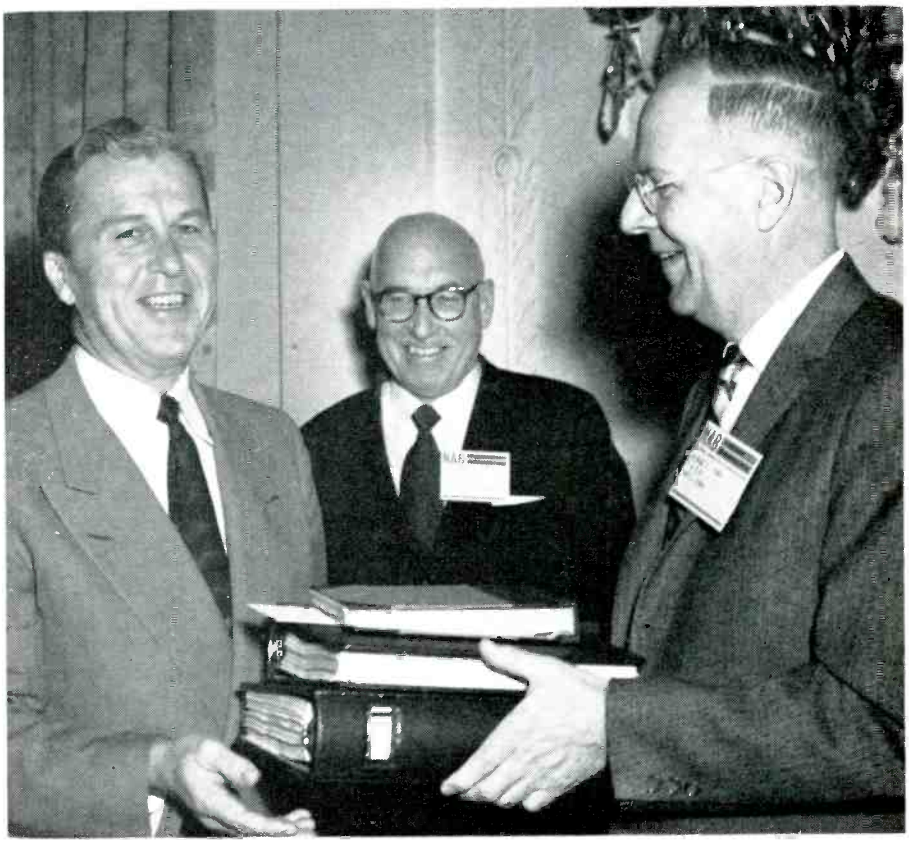
In order to have concrete information on which to base future decisions concerning the allocation of television channels, the FCC several years ago requested the television industry to establish an organization to conduct a study of the technical principles which shou'd be applied in television channel allocation. The television industry then formed the Television Allocations Study Organization, consisting of 271 engineers from 139 companies. The objectives of the organization were to develop full, detailed, reliable technical information, and engineering principles based thereon concerning UHF and VHF television service. The results of the study were presented by Dr. George R. Town, Executive Director of TASO and Dean of Engineering at Iowa State College, to John C. Doerfer, Chairman of the Federal Communications Commission, at the opening session of the NAB engineering conference. Dr. Town explained that TASO had conducted thousands of field tests to determine the comparative strengths of signals from adjacent VHF and UHF stations in many different types of terrain in all parts of the country. They interviewed more than 1,000 television viewers and observed the actual pictures received in homes. Television service men were interviewed and tests were conducted on many other aspects of television reception. It was found that the critical distance where satisfactory reception dropped off became less as frequency increased. The average critical distances were as follows:

Low VHF (Channels 2-6)—65 miles
High VHF (Channels 7-13)—55 miles
Low VHF (Channels 14-40)—40 miles
Medium and high UHF (Channels 41-83)—30 miles

These results represented an average and there were many exceptions where geographical conditions affected the propagation characteristics. The differences were explained as due to higher attenuation at UHF frequencies, less voltage developed on the UHF receiving antenna because of its smaller size and the higher noise factor in present UHF receivers. It was found that external noise was less at UHF and that the signal strengths were more variable at the UHF frequencies. In general, the investigations proved what existing theory already indicated and provided the quantitative data to substantiate the qualitative theory. As Dr. Town said, when you can measure knowledge and express it with data, you have achieved worthwhile results.

TASO suggests that the use of directional antennas for television broadcasting may be a practical approach in helping to solve the problems of allocating TV channels. Tests are continuing to be conducted on directional antennas by TASO.

The problem of frequency allocations will probably be a perpetual one as long as the technology of electronics continues to develop as it has in the past. BROADCAST ENGINEERING will carry many articles in the future on the various aspects affecting frequency allocations insofar as they affect the broadcasting channels.

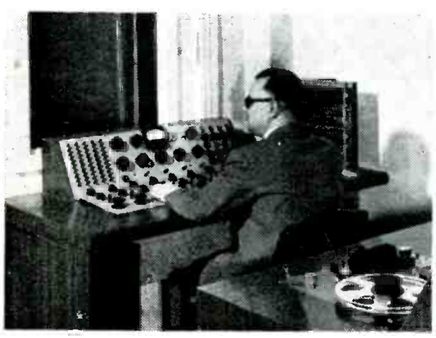


Dr. George R. Town, Executive Director of TASO, presents the TASO Report to John C. Doerfer, Chairman of the Federal Communications Commission. Presiding at the presentation (center) is Raymond F. Guy, Senior Staff Engineer of the National Broadcasting Co.

STUDIO ACOUSTICS CONTRIBUTES TO SUCCESS OF RECORDING ENGINEER

The keen sense of hearing of blind engineer demands perfection electrically and acoustically

Final operation begins with Earl Kennett at a disc cutting machine especially equipped with little metal rises corresponding to the customary numerical settings. Once again Earl uses his sense of touch to compensate for lack of sight, this time to set up the machine.



While the artist plays the piano in the studio, Earl Kennett begins putting the music on tape at a console in the control room. The console, especially built to compensate for Earl's blindness, emits a telephone-like beep whenever the music volume is too high or too low as recorded on a meter which, of course, Earl cannot see.

EARL KENNETT's remarkable talent for reproducing musical sound is in great demand among performers in the highly specialized broadcasting and theatrical fields. Nobody is too concerned that Earl has been blind since birth.

In fact, Earl has proved that blindness actually can be transformed from a handicap into an asset. In his case, he used blindness to encourage development of an unusually complete memory for sound. This sound memory had been developing within Earl since his youthful days at Horner's Conservatory in Kansas City, Mo., and his subsequent piano-playing days (and nights) with dance orchestras in the Midwest.

As he progressed musically, he came to realize there were shortcomings in the recording field. But it was not until 1954 that he was able to do anything about it by setting up his own studio. By then he had reached that stage of his career where he felt he had to give more of himself to others through the medium he knew best, music.

True, he was blind. But he had other things from which to carve a new career. He was an accomplished pianist and organist (despite a childhood accident that resulted in loss of a finger from his right hand) and had built up over the years a tremendous sound "memory" so vital in the reproduction of music. Earl, like most blind people, did

Blind audio engineer Earl Kennett uses his sense of touch in checking the tape before putting it on a disc in the control room.

Earl Kennett, an accomplished musician in his own right, plays the piano in a pre-recording equipment test in his Johns-Manville designed Carnegie Hall studio. Facing Earl are saw-tooth-shaped Imperial Transitone movable walls for accurate sound reflection. Next to the piano not in use is an even-finish movable wall, also for sound reflection, and a sound-absorbing perforated Transite acoustical panel. The floor is covered with quiet-under-foot Terraflex vinyl asbestos tile and the ceiling with Permacoustic, a sound-absorbing fissured acoustical tile.

not have any unusual hearing abilities to compensate for his lack of visual abilities. But living in a world of sound, he naturally was more aware of and "remembered" more about all kinds of sound.

Fortunately, coupled with this memory for sound, he was of a mechanical turn of mind and had a highly developed sense of touch. He could concentrate on things he could feel because he was not "distracted" by being able to see them, too. Opening his own recording studio was logical to Earl, who wanted to find out just how far a person without vision could go in such a specialized field.

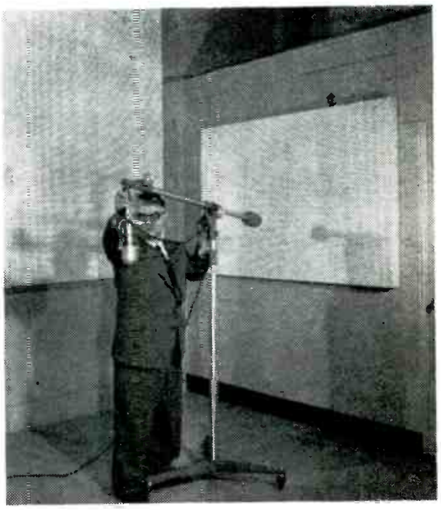
His enthusiasm was backed up vigorously by his wife, Jennie, a one-time teacher of piano music in her native Dallas, Tex. They now live in Poughkeepsie, N. Y., with twin daughters Dorothy and Mary, now six, and son Lawrence, now seven.

The decision to set himself up in business was more than rewarding when broadcasting companies and theatrical producers began beating a path to Earl's door, loaded down with tough recording assignments. This was fine, he thought, but the perfectionist in him warned there still was something missing. There still must be a newer and better way of capturing and recording the ultimate in musical values.

In the average recording studio the artist generally must work in a sound-deadened area. That is, the sound from vocalist and/or musical instrument actually is shaped electronically onto tape and then onto the master (disc) by instruments controlled by a man seated at a panel. The control man alters frequencies in such a manner as to contribute to the musical "personality" of the artist.

Earl felt his was an "average" studio. It didn't reproduce the delicate notes of a violin, for example, in quite the same way his highly-trained hearing told him they should sound. There was too much reverberation to contend with, too many undesired extraneous sounds. Residual sound was not diffused properly.

As a self-styled "juggler of acoustical effects," Earl wanted to achieve a balance between the room and the artist. He wanted to be better able to "juggle" the distances between microphone and artist, the amount of room reflection desired for specific recording sessions, the degree of artificial echo desired and the frequency response. He brought his problem to Johns-Manville, which had been providing correct acoustics



Earl Kennett positions microphone in preparation for recording in his newly-designed Carnegie Hall studio. Behind Earl and to his left are perforated Transite acoustical panels mounted on Imperial Transitone movable walls by Johns-Manville to provide varying degrees of sound absorption. The panel behind Earl is backed by a roofing felt, making for less sound absorption than the mineral-wool backed panel on his left.

for broadcasting studios since the early days of radio. The solution was a completely new recording studio, designed and built to provide the utmost in sound control.

The new studio, located in New York's famous Carnegie Hall, took about a month to build and was officially "opened" in January, 1958. The walls, featuring a dry method of construction, were Imperial Transitone movable walls designed to help reflect sound as accurately as possible. One wall was of angular or sawtooth construction. The three remaining walls were of a smooth finish. Attached to these three walls, at strategically located areas, were perforated Transite acoustical panels made from an asbestos-cement sheet material designed to absorb sound faithfully.

Some panels were backed by a roofing felt, making for less sound absorption. Other panels were backed by mineral wool, permitting greater sound absorption. By placing the performer at varying distances from these wall areas, Earl is able to achieve any number of different musical effects.

The ceiling was constructed of Permacoustic, a fissured acoustical tile that allows for a high degree of sound absorption. The floor was covered with Terraflex, a quiet-under-foot vinyl asbestos tile.

Earl had none of these materials in the old studio. A recent example of a young pianist who wanted a record made for audition purposes will serve to illustrate the differences between the "old" and the "new" studios.

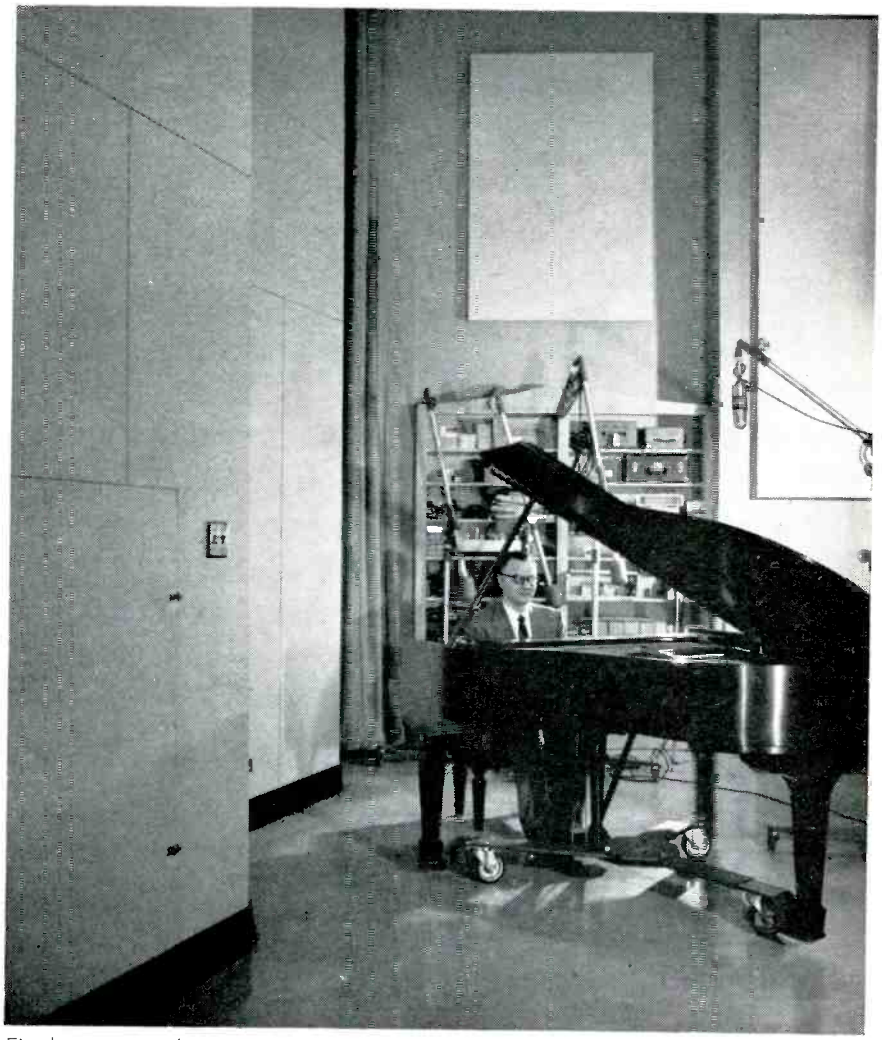
As usual, Earl began by positioning the selected microphone a few feet from the piano in the studio proper. Then, being a musician himself as well as an experienced piano tuner, he began playing, trying to detect flaws in what he calls his "studio equipment test." This, of course, was done long before it was necessary for the artist himself to appear at the studio.

Piano sounds obviously are very different from violin sounds. Accordion sounds are vastly different from those of a trumpet. In this case Earl had to get the most intended value from the notes of a piano. He succeeded because, apart from his own innate musical abilities, he had plenty of help from walls, ceiling and floor. He succeeded, too, because his sound memory automatically reminded him whenever the piano notes failed to register in exactly the way he knew they should.

The actual recording process began after Earl completed his studio equipment checks. The artist was called in, and the piano recital was piped into the adjoining control room. While the pianist played, Earl was in the control room, putting the music on tape at a console. The console, especially built for Earl by designer Fred C. Roberts of New York, emits a telephone-like beep whenever the music volume is too high or too low as recorded on a meter which, obviously, Earl cannot see.

Next Earl checked the tape for quality of reproduction on an adjoining console. The quality satisfied even Earl's rigid artistic requirements, and the final operation began at a disc cutting machine especially equipped with little metal rises corresponding to the customary numerical settings. This time Earl was able to use his sense of touch to compensate for lack of sight in setting up the machine.

Never before was musical beauty reproduced so faithfully by the blind juggler of acoustical effects. For he instantly recognized in the artist's approving voice the achievement of an artistic perfection few sighted persons can ever hope to match.



Final pre-recording equipment test in Earl Kennett's newly-designed Carnegie Hall studio. To the left of the piano is a section of sound-reflecting Imperial Transitone movable wall of angular construction. Behind the instrument are sound-absorbing Transite acoustical panels. Covering the floor is quiet-underfoot Terraflex vinyl asbestos tile.

BROADCASTING FROM SPACE

EXPERTS PREDICT SATELLITES MAY BE USED FOR:

- COMMERCIAL ADVERTISING
- INTERCONTINENTAL TELEVISION
- MICROWAVE RADIO BROADCASTING

Photos: Courtesy U. S. Army and Minnesota Mining & Mfg. Co.

TAPE RECORDERS whizzing through outer space daily are opening man's eyes to new uses for magnetic recording tape — applications which may affect lives and businesses even more than have the countless number of down-to-earth jobs found for tape during its first 10 years of life.

The next decade promises to unfold space age extensions of present-day telemetering, computer and flight testing — uses undreamed of in 1948 when tape recording first became practicable on a consumer scale.

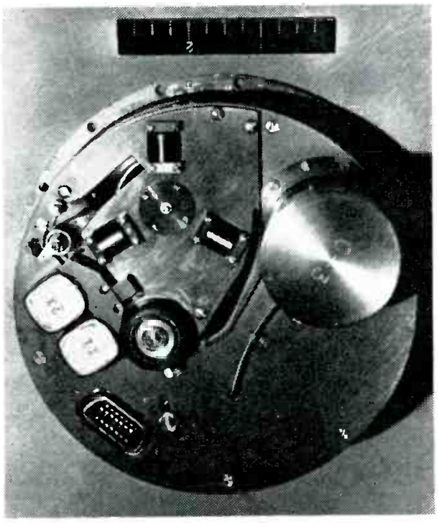
Cast into orbit Feb. 17 by the National Aeronautics and Space Administration, the Vanguard "Cloud Cover Satellite" features a tiny tape recorder which relays, by means of magnetic recording tape, a global picture of the world's weather.

The 5½-inch recorder is a more complex version of the recorder now famous as the larynx of man's first "talking" missile — the Atlas communications satellite launched in December which sent President Eisenhower's voice to earth from outer space.

This miniature recording device is the basic recorder used in satellite projects by both NASA and the Advanced Research Projects Agency, according to John Licht, Signal Corps engineer who directed production of the recorder which features special instrumentation tape developed by Minnesota Mining & Mfg. Co.

"The recorder was designed and fabricated to withstand the extreme vibration and shock associated with the high aceleration forces and flight of its carrier from blast-off to orbiting position in outer space and to operate reliably under conditions of very low pressure and extreme variations in temperature encountered," stated Licht, whose task group from the Engineering Facilities Division of the U. S. Army Signal Research and Development Laboratory developed the recording device.

The disc shaped recorder features an endless tape cartridge containing 75 feet of magnetic tape — "sufficient for the four minutes of recording possible while the satellite is in range," Licht explained. The cartridge functions by unwinding the tape from the inner wrap and winding it up on the outer wrap of a two-inch wide supply spool. Playing through a combination record-playback head and an erase head at 3¾-ips, the single track erasable tape features a lubricated backing to reduce frictional drag in the endless loop cartridge.



Heart of the communications system in the Vanguard "Cloud Cover Satellite" is a more complex version of this basic tape recorder. Only 5½ inches wide, the 1-pound 5-ounce device records "pictures" of weather on a global scale. It first became famous in December as the larynx of man's first talking satellite—the Atlas, which sent President Eisenhower's voice to earth from outer space. The recorder plays an essential role in the current satellite series of both the Advanced Research Projects Agency and the National Aeronautics and Space Administration.

Used for five years commercially in point-of-sale advertising, background music, and transportation terminal announcements, the endless loop cartridge is considered desirable for satellite recorders because it eliminates the need for rewind, thus requiring a less complicated mechanical structure.

The recorder sports several features considered new to magnetic recording:

- All-magnesium body.
- Tape belt in drive system.
- Rollers to guide tape.
- Tape suitable for the endless loop cartridge.

Rigid specifications for the tape outlined by the Signal Corps months prior to Atlas' launching: (1) low drop out, (2) good signal-to-noise ratio, and (3) a lubricated back surface so tape could glide efficiently through the endless tape cartridge.

"Back in July we were having trouble with drop out and signal-to-noise ratio in the tape we were using," Licht revealed. Biggest problem was getting the tape to work smoothly in the endless loop cartridge. "Many tapes would jam," he said, indicating that none of the tapes tried had all three specifications in combination. Some tapes that did ride freely through the cartridge could have been used, he said, but due to poor drop out count, they would have transmitted garbled messages.

It was at this point that Art Copola, another project engineer at the Laboratory, told Licht of the success he had been having with "Scotch" instrumentation tape.

Licht presented his problem to Robert Von Behren, chief of 3M's Magnetic Products Research Laboratory. Von Behren came up with the high resolution tape which had

Robert A. Von Behren, Research and Development Manager of the Magnetic Products Division, Minnesota Mining & Mfg. Co., examines the manner in which tape is threaded through recorder at the Fort Monmouth lab. Before this particular recorder would be ready for installation in a satellite's communications package, tape tension will be adjusted and cover plate will be fastened down.

in combination all three of the required features — and subsequently was used to carry to earth man's first words from outer space.

"Tolerances for satellite recorder tapes are five times tighter than for commercial recording tapes," Von Behren said, adding that the Signal Corps requires drop out tolerances within 3 per cent.

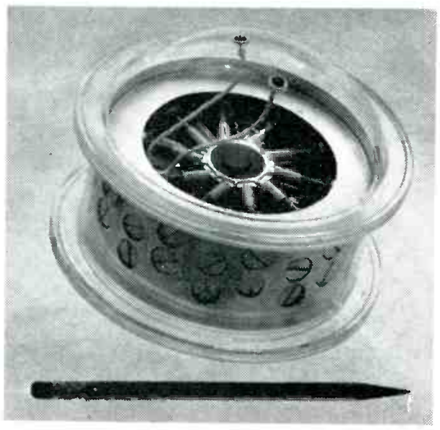
Part of the assembly process of the satellite recorder involves the manual winding of the tape itself. Seventy-five feet of the quarter-inch polyester backed tape is carefully metered off by hand from a stock "Scotch" brand reel onto the little metal cartridge reel.

"The entire recording mechanism is precision machined from magnesium to optimize stiffness to weight ratio," Licht said. Only 60 per cent as heavy as aluminum, magnesium nevertheless has the added advantage of being stronger and having more rigidity — an essential consideration in planning a recorder under strict weight limitations. The recorder, completely packed with its Lilliputian components, weighs only 1 pound, 5 ounces.

The recorder's drive system consists of a governed DC motor running at 3,950 rpm which drives a flywheel capstan asembly through a polyester belt, Licht explained. A fixed rubber pressure roller is used to hold the tape against the capstan. The continuous loop belt is fashioned at the lab by cutting a flat washer from the "Scotch" instrumentation tape and mechanically stretching it to the required 6-inch diameter flat belt. A milling machine at the lab has been adapted with conical spindles, on which the tape washer is stretched from its toroidal shape into the flat belt shape.

These belts, subjected to severe endurance tests at the lab, have lasted well over 2,000 hours when driven by a small pulley operating at 13,000 rpm, Licht pointed out. Flexible and fatigue-resistant, the belt approaches the strength of thin steel wire yet is only 1 mil thick. This thinness is extremely important to avoid variations in drive speed. A problem in any tape recorder, it was stressed, is retaining a uniform belt so the tape speed will remain constant. Most common recorders use a rubber belt.

Three auxiliary metal rollers are used in the recorder to ward off external tape loop, Licht said. As part of the assembly process of the recorder, the 2-inch wide spool of tape is installed in the recorder's cartridge well. Next a cover plate con-



Future satellite tape recorders may be powered by this thermoelectric generator, developed by Minnesota Mining & Mfg. Co. for the Atomic Energy Commission. The battery-less unit develops electrical power from heat, given off by minute quantities of radioactive material. Depending upon the isotopes used, the five-pound generator could provide electricity for from one to one hundred years. In comparison, the 20 pounds of storage batteries used in the Atlas was considered a 21-day power supply.

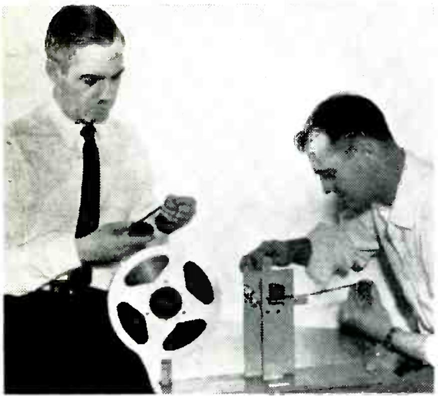
John Licht (left), engineer in charge of developing the satellite tape recorder at the Army's Signal Research and Development Laboratory, Fort Monmouth, N. J., explains to Robert A. Von Behren how the endless loop take cartridge works in the recording device. Von Behren, Research and Development Manager of the Magnetic Products Division, Minnesota Mining & Mfg. Co., checks a typical cartridge containing special instrumentation tape developed by his company for use in the satellite recorders.

taining the three rollers is set in place, tape tension is adjusted, and the tape is spliced in place with "Scotch" splicing tape No. 41 LCF.

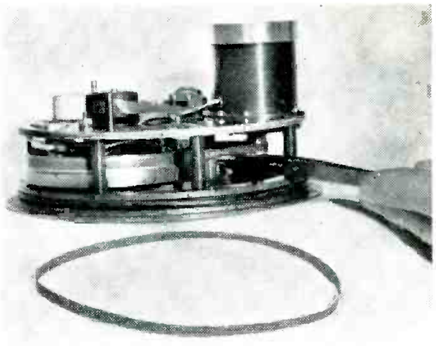
Licht pointed out that guide rollers also are used in a momentary contact switch which triggers the recorder's latch relay (turning the system from "playback" to "off"). This switch utilizes two insulated beryllium-copper ball bearings formed into a guide roller and lubricated with conductive lubricant.

A half inch long section of tape near the splice is coated with a silver conducting paint to provide a 1/10th of a second switching pulse, such as used in computers. When the coated section of tape comes in contact with the guide roller the tape has made the four-minute trip through its 75-foot length and stops. In other words, four minutes after the "Play" button is pressed at a ground station the recorder automatically shuts off its electronics, although the recorder also can be shut off from the ground control board. After four minutes the satellite is likely to be out of range for further communications.

The heart of the Atlas system was a 35½-pound package of transmitt-



Prior to insertion in the recorder, a 75-foot length of tape is meticulously metered off from a stock "Scotch" reel and wound onto the little cartridge reel. Demonstrating the care that goes into each cartridge is John Kwik of Fort Monmouth's Engineering Facilities Division lab, while Robert A. Von Behren looks over a completed cartridge. Von Behren is Research and Development Manager of the Magnetic Products Division at Minnesota Mining & Mfg. Co.



Tape is used in the miniature recorder for a purpose additional to recording messages. A governed DC motor running at 3,950 RPM drives a flywheel capstan assembly by means of a polyester belt. The continuous loop belt is fashioned at the Fort Monmouth lab by cutting a washer from "Scotch" instrumentation tape and mechanically stretching it into the required 6-inch diameter flat belt. Endurance tests at the lab have proved the belts durable for 2,000 hours when driven by a small pulley operating at 13,000 RPM.

ing, receiving and recording equipment designed to receive, store, or relay messages from ground stations. When in range of these stations the orbiting relay received and transmitted seven written messages or one voice message.

To obtain stored messages from the communications relay in the satellite, a ground station triggered off the relay transmitter by electronic command. As long as the satellite courier was in range the ground station could also transmit its own message for relay to another station. Messages could be relayed from one station to another without storage.

Messages destined for the communications relay in the satellite were fed to ground stations over standard links. Teletypewriter dispatches and a voice message were transmitted to the satellite courier when it came within range in its pass.

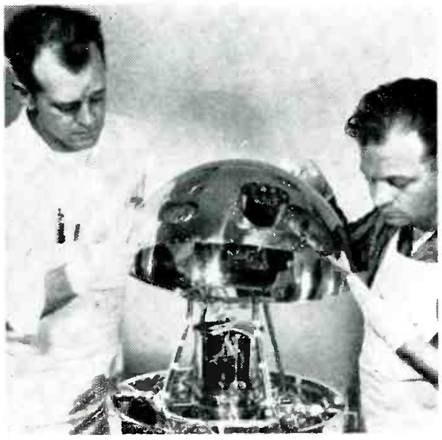
Each of four stations throughout the U. S. consisted essentially of five standard trucks, in which the communications and other equipment was mounted. The antenna array was a separate unit. Multiplexing equipment at the stations handled up to 50 words a minute on each teletypewriter channel, or a total of 420 words a minute. The recorder in the communications relay could store about 1,680 telegraphic words in its four-minute storage capacity.

Due to a limited battery supply, all moving parts of the recorder are mounted on instrument precision ball bearings. This reduces friction to a minimum, Licht said, cutting down on the amount of power required to run the recorder. So efficient is the mechanism that the recorder's motor uses only one-third the power required for an ordinary flashlight bulb.

"The problem in developing a satellite recorder," Licht observed, "is making the recorder and making it reliable with the small amount of power available and under the small size and weight limitation allowed."

The transmitter in the Atlas communications package produced eight watts of power and used zinc-silver oxide batteries with an estimated life of about three weeks. The batteries had a capacity of 9600 watt hours, weighed 20 pounds.

The Atlas battery and power converter were packaged in a stainless steel "cannister" which had been gold-plated to maintain proper temperature control. All other units — including the recorder, receiver, transmitter, tracking beacon, and control unit—were packaged in polished aluminum cannisters. Two complete communications relay packages (one a reserve unit) were packed into the Atlas. Total payload, including antennas, was about 150 pounds.



Upper half of cloud-cover satellite shell is gently lowered into place by technicians at the Astro-Instrumentation Branch of the Army's Research and Development Laboratory, where the satellite's electronic system was designed and built. The weather forecasting experiment depends upon two photocells which scan the earth's surface and cloud masses. Data are stored on 3M instrumentation tape in a recorder which is interrogated every orbit. Recorder rides in center of the 20-inch magnesium "moon".

A "pod" on either side of the Atlas contained three sets of stainless steel rails, mainly for mounting telemetering equipment. Housed in these pods, the communications packages were mounted to rails near the rocket's center of gravity "to minimize pulsating centrifugal forces on the recorder mechanism and for thermal reasons," Licht said. The rocket tumbled end over end through its orbit. Had the recording mechanism been installed in the nose cone area it would have suffered much like a ball whirled on the end of a string.

Solar cells, successfully converted for use in other satellite programs, were not utilized in the Atlas because of its anticipated short life. Originally planned to orbit for 20 days, Atlas continued to sail around the earth until Jan. 21 — 35 days after its Dec. 18 launching.

"Solar batteries in future satellites will increase the life of the recorder to the length of time required for its component parts to wear out," Licht said. When asked what the life of the recorder's tape might be, assuming it were part of a satellite in permanent orbit, Licht indicated the tape presently used should be good for "5,000 to 10,000 passes."

Due to a new development by Minnesota Mining & Mfg. Co., future satellite recorders may operate on atomic power. Developed by 3M for the Atomic Energy Commission, a pocket-sized atomic power plant was unveiled Jan. 16 by the AEC. The battery-less 5-pound thermoelectric generator produces the same amount of electrical energy as 1,450 pounds of dry cell batteries. If the new generator had been used in the Atlas it would have produced power for at least a year, in the opinion of Col. Jack Armstrong, deputy chief of the AEC's aircraft reactor division.

The cylindrical unit, 5½ inches high and 4½ inches in diameter, produces five watts of power. Its spoke-like arrangement of thermoelectric elements develops electrical power from heat, given off by minute quantities of radioactive material. Polonium 210 was used in the demonstration model. A Martin Company authority said that with use of different isotopes, such as Cerium or Plutonium 238, the device conceivably could provide electricity for more than a century.

Experts view orbiting tape recorders as more than exotic space experiments. The successful Atlas and Vanguard tests may affect our daily lives in such developments as:

- Commercial advertising by privately owned satellites.
- Intercontinental television.
- Space air mail service.
- Microwave radio broadcasting.
- World-wide weather forecasting.

The weather satellite measures distribution of cloud cover over the daylight portion of the 21½-pound sphere's orbit — during an expected lifetime of two weeks — and relates it to the overall meteorology of the earth. The experiment represents a first step toward obtaining continuous weather mapping of global scope. Dr. John P. Hagen of NASA pointed out the 20-inch diameter satellite also might be capable of detecting nuclear explosion clouds.

Clouds, sea and land masses have different qualities of reflection which can be translated into electrical impulses. As the satellite's two photocells sweep the sunlit side of the earth, intensities of sunlight reflected from the cloud areas (80 per cent), differ from the land (15 to 20 per cent) and sea (five per cent) areas. These reflections, converted to electrical signals by an infrared detector 1.25-inch thick by ⅛-inch square, are stored in the tape recorder for telemetering to ground stations (one per orbit) in compressed form when the satellite is interrogated from the stations.

The photoelectric cells project diametrically opposite each other at 45 degrees from the satellite's stable spin axis. They are placed so that one always sweeps the earth if the satellite stays within an expected maximum altitude or apogee of 1,600 miles (planned perigee: 200 to 300 miles.) Only one photocell, therefore, sees the cloud's and earth's surface reflectivity at any time.

During its approximate 16 orbits every 24 hours, it reveals cloud cover data over about 25 per cent of the earth's sunlit surface in 600-mile-wide strips.

The instrument container — 5½ inches in diameter, 12 inches long — is suspended upright inside the sphere. The electronic instruments and mercury batteries are arranged in decks within the container.

A 108.03 megacycle transmitter to send cloud cover data at one watt and a 108.00 megacycle transmitter to send Minitrack tracking information at 10 mw are included in the package. The 108.00 megacycle transmitter carries a temperature-sensitive crystal which reveals the temperature within the scientific payload.

Also within the tightly-packed, can-shaped container is the magnetic recorder containing a 75-foot loop of quarter-inch erasable tape which operates when the photocells are scanning the sunlit side of the earth — about 60 minutes of its 126-minute orbital period. The unit records data at the rate of 0.3 ips and plays it back to telemetering stations at 15 ips.

Solar cells, tucked behind gridded, three-inch diameter windows, operate a switch which halts the tape when the satellite is in the shadow of the earth, thus conserving battery power. The tape is reactivated by the same means.

When the satellite passes over the appropriate tracking station, it is interrogated from the station and transmits its 60 minutes of data in one 60-second burst. The data already telemetered to the ground are erased from the tape. A trigger resets the system to begin recording again.

The cloud cover data from each global circuit is stored on a separate tape at the ground station which interrogates it.

These half-inch wide magnetic tapes are flown to Fort Monmouth where they are fed into an electronic complex intended to transform them into crude photographs. These film strips (one earth's circuit uses about 35 to 40 feet of film) provide data which needs to be fitted together in the manner of aerial photographs.

The system whereby the data is to be converted to black and white photographic strips includes an FR 100 tape recorder, analog computer, data reduction unit, oscilloscope and a 35mm camera.

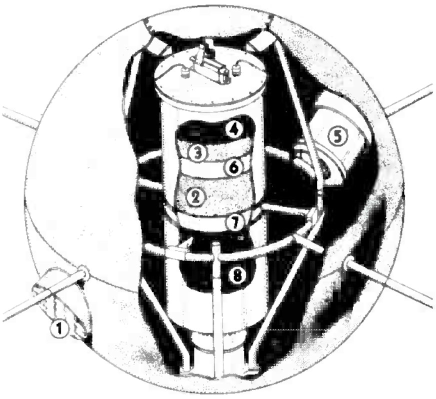
NASA's worldwide Minitrack network follows the satellite with its radio angle tracking system utilizing a miniaturized radio transmitter within the satellite. Ground tracking stations are located in Maryland, Georgia, Cuba, Ecuador, Peru, Chile, British West Indies, California, Australia and South Africa.

Success achieved by the Atlas tape recorder in relaying messages is looked upon by the Army as a "first step toward 'courier' satellites for military communications" — hoping this may be the solution to a growing radio wave traffic jam in ground-to-ground voice and code communications.

Radio wave lengths today are overcrowded. The radio industry has become increasingly alarmed that there soon will not be enough usable frequencies to handle all radio traffic. A satellite relay communications system could make available microwave channels, the Army believes, thus freeing conventional radio frequencies for everyday use.

Long distance radio communication at present is subject to interruption when magnetic storms affect the electrified layers in the upper atmosphere from which radio waves bounce back to earth. Satellites offer the possibility of direct line-of-sight radio and television transmission which would be little affected by such disturbances. As microwaves travel in straight lines—shooting right off into space—satellites could intercept and relay them back to any desired point on earth.

The Atlas communications project also suggested a system of intercontinental television-hookups. Experts visualize a chain of orbiting satellites that provide every living room with a "window to the world" — permitting the home viewer to witness news as it happens, anywhere on the earth.



Cutaway of the 21½-pound Vanguard cloud-cover satellite placed into orbit Feb. 17: (1) Photocell light shield; (2) Recorder with 75-foot loop of special 3M instrumentation tape; (3) Interrogation radio received; (4) Meteorological data transmitter; (5) Photocell; (6) Data electronics; (7) Tracking transmitter; (8) Mercury cell batteries.

And, projecting the idea yet farther into the future, contact may conceivably be made even anywhere *off* the earth. (The Army considers the Atlas recording and playback tests a major step toward future communication with manned space vehicles).

Space air mail service is seen as a possible solution to the cost problem currently plaguing the Post Office Department. The expense of physically handling the mountains of mail delivered during fiscal 1958 amounted to approximately $497 million, according to the annual report of the Postmaster General. This amount includes air, rail, truck, water and other transporation.

And despite the recent hike in postage rates, an estimated postal deficit of some $350 million is expected for fiscal 1960.

A mail transmission system utilizing satellites as message carriers not only would reduce costs, but would deliver mail at telegraphic speeds as well. A series of satellites would relay a message from one to another until it reached the satellite nearest the message's destination, where it would be transmitted to a ground station.

Orbiting about 22,000 miles high, the satellites' speed at that altitude would match exactly the speed of the earth's rotation, and they would appear to stand still. Direct radio communication with virtually any place on the globe would be possible.

The taped voice of the President greeting the world from a satellite alerted industry to the feasibility of using privately-owned satellites for commercial advertising. Andrew G. Haley, Washington broadcasting attorney and president of the International Astronautical Federation, noted that technicians of the Ford Motor Co. and Coca-Cola already are considering what could be done. Numerous technical and legal obstacles are involved, he added, not the least of which is getting space broadcasts in frequencies which can be received in homes.

Orbiting tape recorders that promise such fascinating possibilities for the future as space air mail or global weather forecasting are amazing contemplations to the layman. But the engineer takes a more mechanical attitude toward "talking" satellites.

"The amazing thing about a tape recorder orbiting through space," Von Behren said, "is that once you shoot it up there, it's on its own. There's no changing, no regulation, no dialing. The recording mechanism and the tape must be reliable enough to perform flawlessly for weeks with no human assistance.

"You can't go up there with a screw driver and adjust it, you know."

FILMING A TV DOCUMENTARY

Film Captures "LULU" for Exclusive TV Storm Documentary

Lulu — a snow storm thus christened for its sudden and capricious mid-March appearance in Rochester, N. Y. — received the full documentary film treatment March 17.

Looking after Lulu were a local utility and TV station who teamed up to tell the story behind the she-storm's white shroud — from the initial all-hands-in-call at the phone company to the D.P.W.'s all-night plowing through the mounting snow.

Film was the key to "This is Lulu," aired locally for snow-weary televiewers by WROC-TV in 30 minutes of pre-empted prime network time, (7:00-7:30 P.M.). Rochesterians watched as Rochester Gas & Electric Co., the local telephone company, D.P.W., industrial plants, up-paced their respective operations to help shrug off Lulu's knee-high deluge.

According to Don Lyon, University of Rochester Radio-TV Director and producer of "This is Lulu," recent advances in motion picture film technology made the documentary possible. Quick-moving Lulu was captured on super-sensitive black-and-white film, which enabled cameramen to track the storm and its impact on the community under near-impossible lighting conditions.

Using high-speed Kodak Tri-X Movie Film, station cameramen shot the storm around from midnight to dawn — crossing fingers and cranking when light meter readings were impossible. Dramatic highpoint of the footage was achieved in just such shoot-and-hope fashion: three D.P.W. plows in tandem V-ing through hood-high drifts at midnight.

A storm ago in late January, Rochester Gas & Electric's public relations director, Schuyler F. Baldwin conceived the documentary as a way to show the local teamwork that enables this town to take blizzards in its stride.

But how to tell viewers the story of service continuity throughout a storm was the problem. Talking about the storm on live camera from Weather Central at the airport would not be enough, so Baldwin did something about the weather before it happened.

Enlisting WROC-TV cameramen Stuart Coon, Richard Scheltz, John Hart, and Lyon (who is pretty much Mr. Public Service TV locally), Baldwin had 1,000 feet of film shot during the January storm.

As snow storm "Lulu" blizzards through Rochester, WROC-TV camerman films the counter-attack mounted by Rochester Gas & Electric Co. The TV station and utility jointly produced "This Is Lulu"—a half-hour TV show which detailed how local companies team up with city departments to keep community and business life buzzing despite the elements.

At air-time March 17, the pre-shot footage was shown in combination with film made during the height of the storm just ended. Two-thirds of the film screened was shot during the last storm, illustrating operations peculiar to all Rochester storms — from calling out the plows to calling in all available phone company people. The remaining third of the footage was shot as the snowflakes swirled, adding the blow-by-blow impact of the March storm to the presentation.

Starting live at Weather Central, the program captured the excitement of an approaching storm. The pre-shot footage was then inter-cut with the live portion to show how the town mounts its counterattack against the elements.

Commenting on the technique of using pre-shot footage for added impact in public service features, Baldwin said, "Without film, we'd have been hard-pressed to bring the show off. It would have been physically impossible to get live TV equipment around to all vantage points where the story was unfolding. With a hand-held camera, however, our photographer-director team got just what we wanted — from the dispatching of 125 snow plows to the action at the phone company when calls suddenly quadrupled."

Baldwin feels that pre-shooting plus on-the-spot documentary footage offers possibilities to any company responsible for maintaining service under emergency weather conditions. "Whether it's a flood, tornado, or an old-fashioned hurricane —pre-shot footage should help piece together an exciting service story."

The whole operation was carried off with ice-cool precision. Coon, Lyon, Baldwin, and John Williams at Rochester Weather Central for weeks carried action schedules complete with all important phone numbers necessary to get the show moving. Each knew his job and each did it.

"This Is Lulu" is not RG&E's first venture into public service TV. Shortly before Christmas, the company sponsored a live-plus-film presentation on how the local post office wades through the Christmas rush.

Widespread use of film techniques is made in most of RG&E's frequent local television appearances. Past programs, for example, have presented film clips of cashiers, service department personnel and dispatchers at their desks or on the job in the field. According to Baldwin, shooting RG&E people in their usual working surroundings comes across much better than a straight vis-a-vis interview on live camera.

MULTIPLEX starts on page 15

was known to be correct, the remaining weak link was isolated and shown to be in the receiver.

It was found that many of the faults of the transmitter which had been corrected were still occurring in the receiver. The 10.7 Mc. I.F. strip was scrutinized closely. At the limiting grid, a recovery of the main channel audio was discovered. This indicated an AM component on the carrier which wasn't there when the signal left the station. This amplitude modulation of the 10.7 carrier by the main channel music could be observed on a scope and its intensity changed by tuning various stages that preceded the limiter. The amplitude of the AM component observed correlated directly to the intensity of crosstalk heard in the subcarrier.

These observations led to the reasoning that unwanted conversion of FM to AM in the system produced a side product of intermodulation into the supersonic subcarrier of the unwanted audio products which started the whole process.

Since the subcarrier later went through complete limiting and clamping, the unwanted intermodulation product was in the form of phase shift or frequency modulation being induced into the subcarrier.

The fault appeared in the 10.7 Mc. I.F. transformer. The problem had resolved itself to one of amplifying the signal without introducing intermodulation. The I.F. frequency of the receiver was changed to 23 Mc. which brought about considerable improvement. By using I.F. transformers which operate at a frequency of 23 Mc. together with the balanced ratio detector, the phase non-linearity of the I.F. strip was cured. A receiver was produced that truly reflected the transmitted signal.

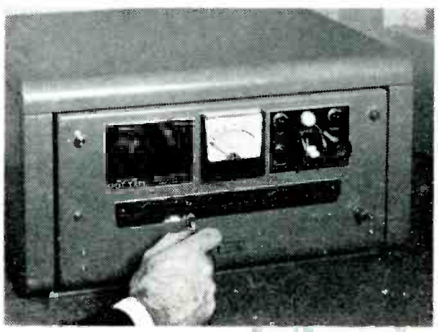
In order to increase the signal-to-noise ratio of the over-all system, the full use of the subcarrier bandwidth was required. The response curve of the audio pre-emphasis curve more closely matched the energy distribution curve of average music. By using additional de-emphasis after detection of the subcarrier at the receiver, a flat response was gained, together with the rejection of unwanted high frequency component noise. We realized the same benefits as those obtained with the LP records.

These techniques created new requirements for the filter used in the receiver at the entrance to the subcarrier amplifier. In order to handle the bandwidth of energy created in full modulation of the subcarrier plus or minus 10 Kc. up to 5000 cps., the bandpass filter in the circuit had to be phase linear. Filters that appeared broad enough when measured by amplitude response methods failed to pass the signal without contributing distortion. A low impedance filter was produced that had all of these requirements.

The requirements for successful multiplexing dictate that all elements including system operation be correctly adjusted. We start out with the transmitter and transmitting antenna which do not contribute crosstalk. Over this system we transmit a subcarrier that utilizes maximum modulation depth together with the proper pre-emphasis curve. With this transmitted signal we use a receiver which does not contribute crosstalk and is capable of handling the fully modulated subcarrier. The over-all net result is a subcarrier that is capable of 50 db signal to noise at any location over the entire coverage area of the transmitted signal. We have found any other approach to be a compromise.

SPOT TAPE starts on page 13

Thus, it seems that the industry has now devised a number of different ways to solve the problem of using magnetic recording for recorded material of short duration. These new equipments will give the broadcaster greater versatility and ease of operation. The extent to which programming quality can be improved will depend only on the ingenuity and resourcefulness of each station.



Showing the indexed control knob on the Gates Spot Selector.

F. C. C. REGULATIONS

Each month BROADCAST ENGINEERING will publish one section of the F.C.C. regulations pertaining to broadcasting. This section will be up to date and will represent the regulations as they exist at publishing time. When future amendments occur, the issue and page number of that section will be printed with the amendment so that your copy containing that section can be corrected.

In addition, other changes in the regulations will be published as they occur. The entire Part 3 of the F.C.C. Rules and Regulations will be printed during the next 12 issues so that a bound set of 12 issues will contain a complete set of up-to-date rules and regulations.

Our F.C.C. Section will expand as the journal grows and will provide information of a technical nature which will be of value to our readers.

This month we are publishing Sec. 3.181 to 3.189 which is the Standard Broadcast Technical Standards.

STANDARD BROADCAST TECHNICAL STANDARDS

§ 3.181. **Introduction.** (a) There are presented herein the Technical Standards giving interpretations and further consideration concerning the rules and regulations of the Federal Communications Commission governing standard broadcast stations. While rules and regulations form the basis of good engineering practice, these standards may go beyond the rules and regulations and set up engineering principles for consideration of various allocation problems. These standards have been approved by the Commission and thus are considered as reflecting the opinion of the Commission in all matters involved.

(b) The Technical Standards set forth herein are those deemed necessary for the construction and operation of standard broadcast stations to meet the requirements of technical regulations and for operation in public interest along technical lines not specifically enunciated in the regulations. These standards are based on the best engineering data available from evidence supplied in formal and informal hearings and extensive surveys conducted in the field by the Commission's personnel. Numerous informal conferences have been held with radio engineers, manufacturers of radio equipment and others for the guidance of the Commission in the formulation of these standards.

(c) These standards are complete in themselves and supersede any previous announcements or policies which may have been enunciated by the Commission on engineering matters concerning standard broadcast stations.

(d) While these standards provide for flexibility and set forth the conditions under which they are applicable, it is not expected that material deviation therefrom as to fundamental principles will be recognized unless full information is submitted as to the reasonableness of such departure and the need therefor.

(e) These standards will necessarily change as progress is made in the art, and accordingly it will be necessary to make revisions from time to time. The Commission will accumulate and analyze engineering data available as to the progress of the art so that its standards may be kept current with the developments.

§ 3.182 **Engineering standards of allocation.** (a) Sections 3.21 to 3.34, inclusive, govern allocation of facilities in the standard broadcast band of 535 to 1605 kc. Section 3.21 establishes three classes of channels in this band, namely, clear channels for the use of high-powered stations, regional channels for the use of medium-powered stations, and local channels for the use of low-powered stations. The classes and power of standard broadcast stations which will be assigned to the various channels are set forth in § 3.22. The classification of the standard broadcast stations are as follows:

(1) Class I stations are dominant stations operating on clear channels with powers of not less than 10 or more than 50 kw. These stations are designed to render primary and secondary service over an extended area and at relatively long distances, hence have their primary service areas free from objectionable interference from other stations on the same and adjacent channels and secondary service areas free from objectionable interference from stations on the same channels. (The secondary service area of a Class I station is not protected from adjacent channel interference. However, if it is desired to make a determination of the area in which adjacent channel groundwave interference (10 kc removed) to skywave service exists, it may be considered as the area where the ratio of the desired 50% skywave of the Class I station to the undesired groundwave of a station 10 kc removed is 1 to 4.) From an engineering point of view, Class I stations may be divided into two groups and, hereafter, for the purpose of convenience, the two groups of Class I stations will be termed Class I-A or I-B in accordance with the assignment to channels allocated by § 3.25 (a) or (b).

3.182 (i) The Class I stations in Group 1-A are those assigned to the channels allocated by section 3.25 (a), on which except to the extent therein provided, duplicate nighttime operation is not permitted, that is, no other station is permitted to operate on a channel with a Class I station of this group within the limits of the United States (the Class II stations assigned the channels operate limited time or daytime only), and during daytime the Class I station is protected to the 100 uv/m groundwave contour. Protection is given this class of station to the 500 uv/m groundwave contour from adjacent channel stations for both day and nighttime operations. The power of each Class I station shall not be less than 50 kw.

(ii) The Class I stations in group I-B are those assigned to the channels allocated by § 3.25 (b), on which duplicate operation is permitted, that is, other Class I or Class II stations operating unlimited time may be assigned to such channels. During nighttime hours of operation a Class I station of this group is protected to the 500 uv/m 50 percent sky wave contour and during daytime hours of operation to the 100 uv/m ground wave contour from stations on the same channel. Protection is given to the 500 uv/m groundwave contour from stations on adjacent channels for both day and nighttime operation. The operating powers of Class I stations on these frequencies shall be not less than 10 kw nor more than 50 kw.

(2) Class II stations are secondary stations which operate on clear channels with powers not less than 0.25 kw. or more than 50 kw. These stations are required to use a directional antenna or other means to avoid causing interference within the normally protected service areas of Class I stations or other Class II stations. These stations normally render primary service only, the area of which depends on the geographical location, power, and frequency. This may be relatively large but is limited by and subject to such interference as may be received from Class I stations. However, it is recommended that Class II stations be so located that the interference received from other stations will not limit the service area to greater than the 2500 uv/m ground wave contour nighttime and 500 uv/m groundwave contour daytime, which are the values for the mutual protection of this class of stations with other stations of the same class.

(3) Class III stations operate on regional channels and normally render primary service to the larger cities and the rural area contiguous thereto, and are subdivided into two classes:

(i) Class III-A stations which operate with powers not less than 1 kw or more than 5 kw are normally protected to the 2500 uv/m groundwave contour nighttime and the 500 uv/m groundwave contour daytime.

(ii) Class III-B stations which operate with powers not less than 0.5 kw, or more than 1 kw nighttime and 5 kw daytime are normally protected to the 4000 uv/m groundwave contour nighttime and 500 uv/m groundwave contour daytime.

(4) Class IV stations operate on local channels normally rendering primary service only to a city or town and the suburban or rural areas contiguous thereto with power not less than 100 watts, nor more than 250 watts nighttime and 1 kilowatt daytime. The stations are normally protected to the 0.5 mv/m groundwave contour daytime. On local channels the separation required for the daytime protection shall also determine the nighttime separation. Where directional antennas are employed in the daytime by Class IV stations utilizing power in excess of 250 watts, the separations required shall in no case be less than those necessary to afford protection, assuming nondirectional operation with 100 watts or 250 watts, whichever is the nighttime power of the station. In no case will 250 watts nighttime operation be authorized to a station unable to operate omnidirectionally at 250 watts in the daytime. The actual nighttime limitation will be calculated.

Zone	Inner radius	Outer radius	10 percent skywave signal (mv/m)
A	...	60	0.10
B	60	80	.12
C	80	100	.14
D	100	250	.16
E	250	350	.14
F	350	450	.12
G	450	500	.10

Where the power of the interfering station is not 250 watts, the 10% skywave signal should be adjusted by the square root of the ratio of the power to 250 watts.

Where the power of the interfering station is not 250 watts, the 10% skywave signal should be adjusted by the square root of the ratio of the power to 250 watts.

(b) The class of any station is determined by the channel assignment, the power, and the field intensity contour to which it renders service free of interference from other stations as determined by these standards. No station will be permitted to change to a class normally protected to a contour of less intensity than the contour to which the station actually renders interference-free service. Any Station of a class normally protected to a contour of less intensity than that to which the station actually renders interference-free service, will be automatically reclassified according to the class normally protected, the minimum consistent with its power and channel assignment. Likewise, any station to which the interference is reduced so that service is rendered to a contour normally protected for a higher class will be automatically changed to that class if consistent with its power and channel assignment.

(c) When it is shown that primary service is rendered by any station, beyond the normally protected contour, and when primary service to approximately 90 per cent of the population (population served with adequate signal) of the area between the normally protected contour and the contour to which such station actually serves, is not supplied by any other station or stations carrying the same general program service, the contour to which protection may be afforded in such cases will be determined from the individual merits of the case under consideration.

(d) When a station is already limited by interference from other stations to a contour of higher value than that normally protected for its class, this contour shall be the established standard for such station with respect to interference from all other stations.

(e) The several classes of broadcast stations have in general three service areas; namely, primary, secondary, and intermittent service areas. (See § 3.11 for the definitions of primary, secondary, and intermittent service areas.) Class I stations render service to all three service areas. Class II stations render service to a primary area but the secondary and intermittent service areas may be materially limited or destroyed due to interference from other stations depending on the station assignments involved. Class III and IV stations usually have only primary service areas as interference from other stations generally prevents any secondary service and may limit the intermittent service area. However, complete intermittent service may be obtained in many cases depending on the station assignments involved.

(f) The signals necessary to render primary service to different types of service areas are as follows:

Area:	Field Intensity groundwave[1]
City business or factory areas	10 to 50 mv/m.
City residentials areas	2 to 10 mv/m.
Rural—all areas during winter or northern areas during summer	0.1 to 0.5 mv/m.
Rural — southern areas during summer	0.25 to 1.0 mv/m.

[1]See section 3.184 for curves showing distances to various groundwave field intensity contours for different frequency and ground conductivities and section 3.183.

All these values are based on an absence of objectionable fading, either in changing intensity or selective fading, the usual noise level in the areas, and an absence of limiting interference from other broadcast stations. The values apply both day and night but generally fading or interference from other stations limits the primary service at night in all rural areas to higher values of field intensity than the values given. The Commission will authorize a directive antenna for a Class IV station for daytime operation only with power in excess of 250 watts. In computing the degrees of protection which such antenna will afford, the radiation produced by this antenna shall be assumed to be no less, in any direction, than that which would result from non-directional operation, utilizing a single element of the directional array, with 100 watts or 250 watts, whichever is the night-time power of the station.

Note: Standards have not been established for interference from atmospherics or man-made electric noise as no uniform method of measuring noise or static has been established. In any individual case objectionable interference from any source, except other broadcast signals, may be determined by comparing the actual noise interference reproduced during reception of a desired broadcast signal to the degree of interference that would be caused by another broadcast signal within 20 cycles of the desired signal and having a carrier ratio of 20 to 1 with both signals modulated 100 per cent on peaks of usual programs. Standards of noise measurements and interference ratio for noise are now being studied.

(g) In determining the population of the primary service area, it may be considered that the following signals are satisfactory to overcome man-made noise in towns of the population given.

Population:	Field intensity groundwave
Up to 2,500	0.5 mv/m
2,500 to 10,000	2.0 mv/m
10,000 and up	Values given in paragraph (f) of this section

These values are subject to wide variations in individual areas and especial attention must be given to interference from other stations. The values are not considered satisfactory in any case for service to the city in which the main studio of the station is located. The values in paragraph (f) of this section shall apply except as individual consideration may determine.

(h) All classes of broadcast stations have primary service areas subject to limitation by fading and noise, and interference from other stations to the contours set out for each class of station.

(i) Secondary service is delivered in the areas where the skywave for 50 per cent or more of the time has a field intensity of 500 uv/m or greater. (The secondary service area of a Class 1-A station should be considered as having this limit only for determination of service in comparison with other stations.) It is not considered that satisfactory secondary service can be rendered to cities unless the skywave approaches in value the ground wave required for primary service. The secondary service is necessarily subject to some interference and extensive fading whereas the primary service area of a station is subject to no objectionable interference or fading. Class I stations only are assigned on the basis of rendering secondary service.

Note: Standards have not been established for objectionable fading as such standards would necessarily depend on the receiver characteristics which have been changed considerably in this regard during the last several years. Selective fading causing audio distortion and the signal fading below the noise level are the objectionable characteristics of fading on modern design receivers. The AVC circuits in the better designed modern receivers in general maintain the audio output sufficiently constant to be satisfactory during most fading.

(j) The intermittent service is rendered by the groundwave and begins at the outer boundary of the primary service area and extends to the value of signal where it may be considered as having no further service value. This may be down to only a few microvolts in certain areas and up to several millivolts in other areas of high noise level, interference from other stations, or objectionable fading at night. The intermittent service area may vary widely from day to night and generally varies from time to time as the name implies. Only Class I stations are assigned for protection from interference from other stations into the intermittent service area.

(k) Section 3.23 provides that the several classes of broadcast stations may be licensed to operate unlimited time, limited time ,daytime, sharing time, and specified hours, with full explanation given in the section.

(l) Section 3.24 sets out the general requirements for obtaining an increase in facilities of a licensed station and for a new station. Section 3.24 (b) concerns the matter of interference that may be caused by a new assignment or increase in facilities of an existing assignment.

(m) [Reserved.]

(n) [Reserved.]

(o) Objectionable interference from another broadcast station is the degree of interference produced when, at a specified field intensity contour with respect to the desired station, the field intensity of an undesired station (or the root-sum-square value of field intensities of two or more stations on the same frequency) exceeds for ten (10) per cent or more of the time the values set forth in these standards. (The secondary service area of a Class 1-A station should be considered as having this limit only for determination of service in comparison with other stations.)

(1) With respect to the root-sum-square values of interfering field intensities referred to herein, except in the case of Class IV stations on local channels, calculation is accomplished by considering the signals in order of decreasing magnitude, adding the squares of the values and extracting the square root of the sum excluding those signals which are less than 50% of the RSS value of the higher signals already included.

(2) The RSS value will not be considered to be increased when a new interfering signal is added which is less than 50% of the RSS value of the interference from existing stations, and which at the same time is not greater than the smallest signal included in the RSS value of interference from existing stations.

(3) It is recognized that application of the above "50% exclusion" method of calculating the RSS interference may result in some cases in anomalies wherein the addition of a new interfering signal or the increase in value of an existing interfering signal will cause the exclusion of a previously included signal and may cause a decrease in the calculated RSS value of interference. In order to provide the Commission with more realistic information regarding gains and losses in service (as a basis for determination of the relative merits of a proposed operation) the following alternate method for calculating the proposed RSS values of interference will be employed wherever applicable.

(4) In the cases where it is proposed to add a new interfering signal which is not less than 50% of the RSS value of interference from existing stations or which is greater than the smallest signal already included to obtain this RSS value, the RSS limitation after addition of the new signal shall be calculated without excluding any signal previously included. Similarly, in cases where it is proposed to increase the value of one of the existing interfering signals which has been included in the RSS value, the RSS limitation after the increase shall be calculated without excluding the interference from any source previously included.

(5) If the new or increased signal proposed in such cases is ultimately authorized, the RSS values of interference to other stations affected will thereafter be calculated by the "50% exclusion" method without regard to this alternate method of calculation.

(6) Examples of RSS interference calculations:

(i) Existing interferences:
Station No. 1—1.0 mv/m.
Station No. 2—0.60 mv/m.
Station No. 3—0.59 mv/m.
Station No. 4—0.58 mv/m.

The RSS value from Nos. 1, 2 and 3 is 1.31 mv/m; therefore interference from No. 4 is excluded for it is less than 50% of 1.31 mv/m.

(ii) Station A receives interference from:
Station No. 1—1.0 mv/m.
Station No. 2—0.60 mv/m.
Station No. 3—0.59 mv/m.

It is proposed to add a new limitation—0.68 mv/m. This is more than 50% of 1.31 mv/m, the RSS value of Nos. 1, 2 and 3. The RSS value of Station No. 1 and of the proposed station would be 1.21 mv/m which is more than twice as large as the limitation from Station No. 2 or No. 3. However, under the above provision the new signal and the three existing interferences are nevertheless calculated for purposes of comparative studies, resulting in an RSS value of 1.47 mv/m. However, if the proposed station is ultimately authorized only No. 1 and the new signal are included in all subsequent calculations for the reason that Nos. 2 and 3 are less than 50% of 1.21 mv/m, the RSS value of the new signal and No. 1.

(iii) Station A receives interference from:
Station No. 1—1.0 mv/m.
Station No. 2—0.60 mv/m.
Station No. 3—0.59 mv/m.

No. 1 proposes to increase the limitation it imposes on Station A to 1.21 mv/m. Although the limitations from stations Nos. 2 and 3 are less than 50% of the 1.21 mv/m limitation, under the above provision they are nevertheless included for comparative studies, and the RSS limitation is calculated to be 1.47 mv/m. However, if the increase proposed by Station No. 1 is authorized, the RSS value then calculated is 1.21 mv/m because Stations Nos. 2 and 3 are excluded in view of the fact that the limitations they impose are less than 50% of 1.21 mv/m.

(p) Objectionable interference from a station on the same channel shall be considered to exist to a station when, at the field intensity contour specified in paragraph (v) of this section with respect to the class to which the station belongs, the field intensity of an interfering station (or the root-sum-square value of the field intensities of two or more interfering stations) operating on the same channel, exceeds for ten (10) per cent or more of the time the value of the permissible interfering signal set forth opposite such class in paragraph (v) of this section.

(q) Objectionable interference from a station on an adjacent channel shall be considered to exist to a station when, at the normally protected contour of a desired station, the field intensity of the ground wave of an undesired station operating on an adjacent channel (or the root-sum-square value of the field intensities of two or more such undesired stations operating on the same adjacent channel) exceeds a value specified in paragraph (w) of this section.

(r) For the purpose of estimating the coverage and the interfering effects of stations in the absence of field intensity measurements, use shall be made of Figure 8 of § 3.190 which describes the estimated effective field for one kilowatt power input of simple vertical omnidirectional antennas of various heights with ground systems of at least 120 one-quarter wavelength radials. Certain approximations, based on the curve or other appropriate theory, may be made when other than such antennas and ground systems are employed shall not be less than given in the following:

Class of station:	Effective field
1	225 mv/m
II and III	175 mv/m
IV	150 mv/m

In case a directional antenna is employed, the interfering signal of a broadcasting station will vary in different directions, being greater than the above values in certain directions and less in others, depending upon the design and adjustment of the directional antenna system. To determine the interference in any direction the measured or calculated radiated field (unabsorbed field intensity at 1 mile from the array) must be used in conjunction with the appropriate propagation curves. (See § 3.185 for further discussion and solution of a typical directional antenna case.)

(s) The existence or absence of objectionable groundwave interference from stations on the same or adjacent channels shall be determined by actual measurements made according to the method hereinafter described, or, in the absence of such measurements, by reference to the propagation curves of § 3.184. The existence or absence of objectionable interference due to skywave propagation shall be determined by reference to the appropriate propagation curves in Figure 1 or Figure 2 of § 3.190.

(t) In computing the fifty (50) per cent skywave field intensity values and the ten (10) per cent skywave field intensity values of a station on a clear channel, use shall be made of the appropriate graph set forth in Figure 1 of § 3.190 entitled "Average Ekywave Field Intensity" (corresponding to the second hour after sunset at the recording station). These graphs are drawn for a radiated field of 100 mv/m at 1 mile in the horizontal plane from a 0.311 wavelength antenna. In computing the ten (10) per cent skywave field intensity of a regional channel station, use shall be made of the appropriate curve in Figure 2 of § 3.190 entitled "10 per cent Skywave Signal Range." This graph is drawn for a radiated field of 100 mv/m at 1 mile at the vertical angle pertinent to transmission by one reflection. This curve supersedes the ten (10) per cent skywave curve of Figure 1 of § 3.190, only for regional and local channels at the present time. Adoption of revised skywave curves for use on clear channels will await the outcome of the Clear Channel Hearing (Docket No. 6741).

(u) The distance to any specified groundwave field intensity contour for any frequency may be determined from the appropriate curves in § 3.184 entitled "Ground Wave Field Intensity vs. Distance."

(v) Protected service contours and permissible interference signals for broadcast stations are as follows:

with antenna systems side by side or otherwise in proximity without any indications of interference if the interference is defined only in terms of permissible ratios listed in this paragraph. As a practical matter, serious interference problems may arise when two or more stations with the same general service area are operated on channels 10, 20 and 30 kilocycles apart.

(x) Two stations, one with a frequency twice that of the other, should not be assigned in the same groundwave service area unless special precautions are taken to avoid interference from the second harmonic of the lower frequency. In selecting a frequency, consideration should be given to the fact that occasionally the frequency assignment of two stations in the same area may bear such a relation to the intermediate frequency of some broadcast receivers as to cause so-called "image" interference. However, since this can usually be rectified by readjustment of the intermediate frequency of such receivers, the Commission in general will not take this kind of interference into consideration in allocation problems.

(y) Two stations operating with synchronized carriers and carrying the identical program will have their groundwave service subject to some distortion in areas where the signals from the two stations are of comparable intensity. For the purpose of estimating coverage of such stations, areas in which the signal ratio is between 1 to 2 and 2 to 1 will not be considered as having satisfactory service.

Class of station	Class of channel used	Permissible power	Signal intensity contour of area protected from objectionable interference[1] — Day[3]	Night	Permissible interfering signal on same channel[2] — Day[3]	Night
I-A	Clear	50 kw	SC 100 uv/m. AC 500 uv/m.	Not duplicated	5 uv/m.	Not duplicated.
I-B	Clear	10 kw. to 50 kw	SC 100 uv/m. AC 500 uv/m.	500 uv/m (50% skywave).	5 uv/m.	25 uv/m.
II	Clear	0.25 kw. to 50 kw.	500 uv/m.	2500 uv/m[5] (groundwave)	25 uv/m.	125 uv/m.
III-A	Regional	1 kw. to 5 kw	500 uv/m.	2500 uv/m (groundwave).	25 uv/m.	125 uv/m.
III-B	Regional	0.5 to 1 kw. night and 5 kw. day	500 uv/m.	4000 uv/m (groundwave).	25 uv/m.	200 uv/m.
IV	Local	0.1 kw. to 0.25 kw.	500 uv/m.	Not prescribed[6]	25 uv/m.	Not prescribed.[6]

[1] When it is shown that primary service is rendered by any of the above classes of stations, beyond the normally protected contour, and when primary service to approximately 90 percent of the population (population served with adequate signal) of the area between the normally protected contour and the contour to which such station actually serves, is not supplied by any other station or stations, the contour to which protection may be afforded in such cases will be determined from the individual merits of the case under consideration. When a station is already limited by interference from other stations to a contour of higher value than that normally protected for its class, this contour shall be the established standard for such station with respect to interference from all other stations.

[2] For adjacent channels see paragraph (w) of this section.

[3] Ground wave.

[4] Skywave field intensity for 10 percent or more of the time.

[5] These values are with respect to interference from all stations except Class I-B, which stations may cause interference to a field intensity contour of higher value. However, it is recommended that Class II stations be so located that the interference received from Class I-B stations will not exceed these values. If the Class II stations are limited by Class I-B stations to higher values, then such values shall be the established standard with respect to protection from all other stations.

[6] See paragraph (a) (4) of this section.

SC=Same channel.

AC=Adjacent channel.

NOTE: See, however, Sec. 3.25 with reference to the frequency 770 kilocycles.

(w) The following ratios are to be used for determining the minimum ratio of the field intensity of a desired to an undesired signal for interference free service. In the case of a desired groundwave signal interfered with by two or more skywave signals on the same frequency, the RSS value of the latter is used.

Frequency separation of desired to undesired signals—	Desired groundwave to— Undesired groundwave	Undesired 10 percent skywave	Desired 50 percent skywave to undesired 10 percent skywave
0 kc.	20:1	20:1	20:1
10 kc.	1:1	1:5	([1])
20 kc.	1:30	....	....

[1] The secondary service area of a Class I station is not protected from adjacent channel interference. However, if it is desired to make a determination of the area in which adjacent channel groundwave interference (10 kc. removed) to skywave service exists, it may be considered as the area where the ratio of the desired 50 percent skywave of the Class I station to the undesired groundwave of a station 10 kc. removed is 1 to 4.

From the above, it is apparent that in many cases stations operating on channels 10 and 20 kilocycles apart may be operated

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Note: Two stations are considered to be operated synchronously when the carriers are maintained within one-fifth of a cycle per second of each other and they transmit identical programs.

§ 3.183 **Groundwave signals.** (a) Interference that may be caused by a proposed assignment or an existing assignment during day time should be determined, when possible, by measurements on the frequency involved or on another frequency over the same terrain and by means of the curves in § 3.184 entitled "Ground Wave Field Intensity versus Distance."

(b) In determining interference based upon field intensity measurements, it is necessary to do the following: First, establish the outer boundary of the protected service area of the desired station in the direction of the station that may cause interference to it. Second, at this boundary, measure the interfering signal from the undesired station. The ratio of the desired to the undesired signal given in § 3.182 (w) should be applied to the measured signals and if the required ratio is observed, no objectionable interference is foreseen. When measurements of both the desired and undesired stations are made in one area to determine the point where objectionable interference from groundwave signals occur or to establish other pertinent contours, several measurements of each station shall be made within a few miles of this point or contour. The effective field of the antennas in the pertinent directions of the stations must be established and all measurements must be made in accordance with § 3.186.

(c) In all cases where measurements taken in accordance with the requirements are not available, the groundwave intensity must be determined by means of the pertinent map of ground conductivity and the groundwave curves of field intensity versus distance. The conductivity of a given terrain may be determined by measurements of any broadcast signal traversing the terrain involved. Figures M3 and R3 of § 3.190 show the conductivity throughout the United States by general areas of reasonably uniform conductivity. When it is clear that only one conductivity value is involved, Figure R3 of § 3.190, which is a replica of Figure M3 and contained in these standards, may be used; in all other situations Figure M3 must be employed. It is recognized that in areas of limited size or over a particular path, the conductivity may vary widely from the values given; therefore, these maps are to be used only when accurate and acceptable measurements have not been made. (For determination of interference and service requiring a knowledge of ground conductivities in Canada and Mexico, Appendix H to the North American Regional Broadcasting Agreement, Washington, D. C., 1950, may be used. Where different conductivities appear in the maps of the several countries on different sides of the border not explained by geophysical cleavages, such cleavages are to be considered as real. A uniform ground conductivity of 10 millimhos per meter may be assumed for Cuba.

Note: Figure M3 which is incorporated in these Standards by reference, was derived by indicating ground conductivity values in the United States on the United States Albers equal area projection map (based on standard parallels 29½° and 45½°; North American datum; scale 1/2,500,000). Figure M3, consisting of two sections, an eastern and a western half, may be obtained from the Superintendent of Documents, Washington, D. C.

(d) Example of determining interference by the graphs in § 3.184:

It is desired to find whether objectionable interference exists between a 5 kw Class III station on 990 kc and a 1 kw Class III station on 1000 kc, the stations being seperated by 130 miles; both stations use nondirectional antennas having such height as to produce an effective field for 1 kw of 175 mv/m. (See § 3.185 in case of use of directional antennas.) The conductivity at each station and of the intervening terrain is determined as 6 mmhos/m. The protection to Class III stations during daytime is to the 500 uv/m contour. The distance to the 500 uv/m groundwave contour of the 1 kw station is determined by the use of the appropriate curve in § 3.184, Graph 12. Since the curve is plotted for 10 mv/m at a mile, to find the distance to the 500 uv/m contour of the 1 kw station, it is necessary to determine the distance to the 285 uv/m contour $\left(\frac{100 \times 500}{175} = 285\right)$.

From the appropriate curve, the estimated radius of the service area for the desired station is found to be 39.5 miles. Subtracting this distance from the distance between the two stations leaves 90.5 miles for the interfering signal to travel. From the above curve it is found that the signal from the 5 kw station at this distance would be 158 uv/m. Since a one to one ratio applies for stations separated by 10 kc, the undesired signal at that point can have a value up to 500 uv/m without objectionable interference. If the undesired signal had been found to be greater than 500 uv/m, then objectionable interference would exist. For other channel separations, the appropriate ratio of desired to undesired signal should be used.

(e) Where a signal traverses a path over which different conductivities exist, the distance to a particular groundwave field intensity contour shall be determined by the use of the equivalent distance method. Reasonably accurate results may be expected in determining field intensities at a distance from the antenna by application of the equivalent distance method when the unattenuated field of the antenna, the various ground conductivities and the location of discontinuities are known. This method considers a wave to be propagated across a given conductivity according to the curve for a homogeneous earth of that conductivity. When the wave crosses from a region of one conductivity into a region of a second conductivity, the equivalent distance of the receiving point from the transmitter changes abruptly but the field intensity does not. From a point just inside the second region the transmitter appears to be at that distance where, on the curve for a homogeneous earth of the second conductivity, the field intensity equals the value that occurred just across the boundary in the first region. Thus the equivalent distance from the receiving point to the transmitter may be either greater or less than the actual distance. An imaginary transmitter is considered to exist at that equivalent distance. This technique is not intended to be used as a means of evaluating unattenuated field or ground conductivity by the analysis of measured data. The method to be employed for such determinations is set out in § 3.186.

(f) An example of the use of the equivalent distance method follows:

It is desired to determine the distance to the 0.5 mv/m and 0.025 mv/m contours of a station on a frequency of 1000 kc with an inverse distance field of 100 mv/m at one mile being radiated over a path having a conductivity of 10 mmhos/m for a distance of 15 miles, 5 mmhos/m for the next 20 miles and 15 mmhos/m thereafter. By the use of the appropriate curves in § 3.184—Graph 12, it is seen that at a distance of 15 miles on the curve for 10 mmhos/m the field is 3.45 mv/m. The equivalent distance to this field intensity for a conductivity of 5 mmhos/m is 11 miles. Continuing on the propagation curve for the second conductivity, the 0.5 mv/m contour is encountered at a distance of 27.9 miles from the imaginary transmitter. Since the imaginary transmitter was 4 miles nearer (15 — 11 miles) to the 0.5 mv/m contour, the distance from the contour to the actual transmitter is 31.9 miles (27.9+4 miles). The distance to the 0.025 mv/m contour is determined by continuing on the propagation curve for the second conductivity to a distance of 31 miles (11 + 20 miles), at which point the field is read to be 0.39 mv/m. At this point the conductivity changes to 15 mmhos/m and from the curve relating to that conductivity, the equivalent distance is determined to be 58 miles—27 miles more distant than would obtain had a conductivity of 5 mmhos/m prevailed. Using the curve representing the conductivity of 15 mmhos/m the 0.025 mv/m contour is determined to be at an equivalent distance of 172 miles. Since the imaginary transmitter was considered to be 4 miles closer at the first boundary and 27 miles farther at the second boundary, the net effect is to consider the imaginary transmitter 23 miles (27—4 miles) more distant than the actual transmitter; thus the actual distance to the 0.025 mv/m contour is determined to be 149 miles (172 — 23 miles).

§ 3.184 **Groundwave field intensity charts.** (a) Graphs 1-19A show the computed values of groundwave field intensity as a function of the distance from the transmitting antenna. The groundwave field intensity is here considered to be that part of the vertical component of the electric field received on the ground which has not been reflected from the ionosphere nor the troposphere. These 20 charts were computed for 20 different frequencies, a dielectric constant of the ground equal to 15 for land and 80 for sea water (referred to air as unity) and for the ground conductivities (expressed in mmhos/m) given on the curves. The curves show the variation of the groundwave field intensity with distance to be expected for transmission from a short vertical antenna at the surface of a uniformly conducting spherical earth with the ground constants shown on the curves; the curves are for an antenna power and efficiency such that the inverse distance field is 100 mv/m at 1 mile. The curves are valid at distances large compared to the dimensions of the antenna for other than short vertical antennas.

(b) The inverse distance field (100 mv/m divided by the distance in miles) corresponds to the groundwave field intensity to be expected from an antenna with the same radiation efficiency when it is located over a perfectly conducting earth. To determine the value of the groundwave field intensity corresponding to a value of inverse distance field other than 100 mv/m at 1 mile, simply multiply the field intensity as given on these charts by the desired value of inverse distance field at 1 mile divided by 100; for example, to determine the groundwave field intensity for a station with an inverse distance field of 1700 mv/m at 1 mile, simply multiply the values given on the charts by 17. The value of the inverse distance field to be used for a particular antenna depends upon the power input to the antenna, the nature of the ground in the neighborhood of the antenna, and the geometry of the antenna. For methods of calculating the interrelations between these variables and the inverse distance field, see "The Propagation of Radio Waves Over the Surface of the Earth and in the Upper Atmosphere," Part I, by Mr. K. A. Norton, Proc. IR. E., Vol. 25, September 1937, pp. 1203—1236.

(c) At sufficiently short distances (say less than 35 miles), such that the curvature of the earth does not introduce an additional attenuation of the waves, the graphs were computed by means of the plane earth formulas given in the paper, "The Propagation of Radio Waves Over the Surface of the Earth and in the Upper Atmosphere," Part I, by Mr. K. A. Norton, Proc. I. R. E., Vol. 24, October 1936, pp. 1367—1387. At larger distances the additional attenuation of the waves which is introduced by the effect of the curvature of the earth was introduced by the methods outlined in the papers, "The Diffraction of Electromagnetic Waves from an Electrical Point Source round a Finitely Conducting Sphere, with Applications to Radiotelegraphy and the Theory of the Rainbow," by Balth van der Pol and H. Bremmer, Part I, Phil. Mag., Vol. 24, p. 141, July 1937, Part II, Phil. Mag., Vol. 24, p. 825, Suppl., November 1937, "Ergebrisse einer Theorie uber die Fortpflanzung elektromagnetischer Wellen uber eine Kugel endlicher Leitfahigkeit," by Balth van der Pol and H. Bremmer, Hochfrequenztechnik and Elektroakustik, Band 51, Heft 6, June 1938, "Further Note on the Propagation of Radio Waves over a Finitely Conducting Spherical Earth," by Balth van der Pol and H. Bremmer, Phil. Mag., Vol. 27, p. 261, March 1939. In order to allow for the refraction of the radio waves in the lower atmosphere due to the variation of the dielectric constant of the air with height above the earth, a radius of the earth equal to 4/3 the actual radius was used in the computations for the effect of the earth's curvature in the manner suggested by C. R. Burrows, "Radio Propogation over Spherical Earth," Proc. I. R. E., May 1935; i.e., the distance corresponding to a given value of attenuation due to the curvature of the earth in the absence of air refraction was multiplied by the factor (4/3) ⅔ = 1.21. The amount of this refraction varies from day to day and from season to season, depending on the air mass conditions in the lower atmosphere. If **k** denotes the ratio between the equivalent radius of the earth and the true radius, the following table gives the values of **k** for several typical air masses encountered in the United States.

Air mass type	k Summer	k Winter
Tropical Gulf—**Te**	1.53	1.43
Polar Continental—**Pe**	1.31	1.25
Superior—**S**	1.25	1.25
Average	1.33	

It is clear from this table that the use of the average value of $k = 4/3$ is justified in obtaining a single correction for the systematic effects of atmospheric refraction.

(d) Provided the value of the dielectric constant is near 15, the curves of Graphs 1-19A may be compared with experimental data to determine the appropriate values of the ground conductivity and of the inverse distance field intensity at 1 mile. This is accomplished simply by plotting the measured fields on transparent log-log graph paper similar to that used for Graphs 1-19A and superimposing this chart over the graph corresponding to the frequency involved. The log-log graph sheet is then shifted vertically until the best fit is obtained with one of the curves on the graph; the intersection of the inverse distance line on the graph with the 1-mile abscissa on the chart determines the inverse distance field intensity at 1 mile. For other values of dielectric constant, the following procedure may be used for a determination of the dielectric constant of the ground, conductivity of the ground and the inverse distance field intensity at 1 mile. Graph 20 gives the relative values of groundwave field intensity over a plane earth as a function of the numerical distance p and phase angle b. On graph paper with coordinates similar to those of Graph 20, plot the measured values of field intensity as ordinates versus the corresponding distances from the antenna expressed in miles as abscissae. The data should be plotted only for distances greater than one wavelength (or, when this is greater, five times the vertical height of the antenna in the case of a single element, i.e., nondirectional antenna or 10 times the spacing between the elements of a directional antenna) and for distances less than 50/f (⅓ mc) miles (ie., 50 miles at 1 mc). Then, using a light box, place the sheet with the data plotted on it over the sheet with the curves of Graph 20 and shift the data sheet vertically and horizontally (making sure that the vertical lines on both sheets are parallel) until the best fit with the data is obtained with one of the curves on Graph 20. When the two sheets are properly lined up, the value of the field intensity corresponding to the intersection of the inverse distance line of Graph 20 with the 1 mile abscissa on the data sheet is the inverse distance field intensity at 1 mile, and the values of the numerical distance at 1 mile, p_1, and of b are also determined. Knowing the values of b and p_1, (the numerical distance at 1 mile), we may substitute in the following approximate formulas to determine the appropriate values of the ground conductivity and dielectric constant.

$$x \cong \frac{\pi}{p} \cdot (R/\lambda)_1 . \cos b \qquad (1)$$

$(R/\lambda)_1$ = Number of wavelengths in 1 mile.

$$\sigma_{e.m.u.} = \frac{x f_{mc}}{17.9731} \cdot 10^{-15} \qquad (2)$$

$\sigma_{e.m.u.}$ = Conductivity of the ground expressed in electromagnetic units.

f_{mc} = frequency expressed in megacycles.

$$\epsilon \cong x \tan b - 1 \qquad (3)$$

ϵ = dielectric constant of the ground referred to air as unity.

First solve for x by substituting the known values of p_1, $(R/w^*)_1$, and cos b in equation (1). Equation (2) may then be solved for o and equation (3) for e). At distances greater than 50/f (⅓ mc) miles the curves of Graph 20 do not give the correct relative values of field intensity since the curvature of the earth weakens the field more rapidly than these plane earth curves would indicate. Thus, no attempt should be made to fit experimental data to these curves at the larger distances.

*Wave Length.

(e) At sufficiently short distances (say less than 35 miles at broadcast frequencies), such that the curvature of the earth does not introduce an additional attenuation of the waves, the curves of Graph 20 may be used for determining the ground wave field intensity for transmitting and receiving antennas at the surface of the earth for any radiated power, frequency, or set of ground constants in the following manner: First, lay off the straight inverse distance line corresponding to the power radiated on transparent log-log graph paper similar to that of Graph 20, labeling the ordinates of the chart in terms of field intensity, and the abscissae in terms of distance. Next, by means of the formulas given on Graph 20, calculate the value of the numerical distance, p, at 1 mile, and the value of b. Then superimpose the log-log chart over Graph 20, shifting it vertically until the inverse distance lines on both charts coincide and shifting it horizontally until the numerical distance at 1 mile on Graph 20 coincides with 1 mile on the log-log graph paper. The curve of Graph 20 corresponding to the calculated value of b is then traced on the log-log graph paper giving the field intensity versus distance in miles.

§ 3.185 **Computation of interfering signal from a directional antenna.** (a) In case of an antenna directional in the horizontal plane, the groundwave interference can be readily computed from the calculated horizontal pattern by determining the vectors toward the service area of the station to be protected and apply these values to the groundwave curves set out in § 3.183.

(b) For signals from stations operating on clear channels, in case of determining skywave interference from an antenna with a vertical pattern different from that on which Figure 1 of § 3.190 is predicted (the basis of the night mileage separation tables), it is necessary to compare the appropriate vectors in the vertical plane.

(c) The skywave curves entitled "Average Skywave Field Intensity" (corresponding to the second hour after sunset at the recording station) as shown in Figure 1 of § 3.190 are based on antenna systems having height of 0.311 wave length (112°) and producing a vertical pattern as shown in Figure 5 of § 3.190. A nondirectional antenna system, as well as a directional antenna system having vertical patterns other than essentially the same as shown, must be converted to the pattern of a 0.311 wave length antenna having the same field intensity at the critical angle as does the pattern of the antenna involved.

(d) Example of the use of skywave curves:
Figure 6 of § 3.190 is a graph entitled "Variation With Distance of Two Important Parameters in the Theory of Sky Wave Propagation." The curve for o showing the angle above the horizon at which radiation occurs plotted against distance, must be used for this purpose. For instance, assuming the station with which interference may be expected is located at a distance of 450 miles from a proposed station, the critical angle of radiation as determined from this curve is approximately 15°. Therefore, if the vertical pattern of the proposed station in the direction of the other station is such that at 15° above the horizon the radiation is 1.3 times that from an antenna having a vertical pattern as shown in Figure 5 of § 3.190 and producing the same field intensity at 1 mile in the horizontal plane, the interfering signal would be 1.3 times that determined from Figure 1 of § 3.190 for an antenna having the same field intensity in the horizontal plane. That is, if the field intensity in the horizontal plane of the proposed station is 124 mv/m the interfering field intensity exceeded 10 per cent of the time at the other station would be

$$140 \times 1.30 \times \frac{124}{100} \text{ or } 225 \text{ uv/m}$$

and would cause interference to the 4.5 mv/m ground wave contour of the existing station.

(e) For signals from stations on regional and local channels, in computing the 10% skywave (interference) field intensity values of Class III and Class IV stations, Fig. 2 of § 3.190 is to be used in place of Figure 1 of § 3.190. (Certain simplifying assumptions may be made in the case of Class IV stations on local channels: See note to § 3.182 (a) (4). Since Figure 2 of § 3.190 is predicted upon a radiated field of 100 mv/m at one mile in the pertinent direction, no comparison with the vertical pattern of a 0.311 wavelength antenna is to be made. Instead the appropriate radiated field in the vertical plane corresponding to the distance to the receiving station, divided by 10, is multiplied into the value of 10% skywave field intensity determined from Figure 2 of § 3.190. There are two new factors to be considered, however, namely the variation of received field with latitude of the path and the variation of pertinent vertical angle due to variations of ionosphere height and ionosphere scattering.

(f) Figure 2 of § 3.190, "10% Skywave Signal Range Chart," shows the 10% skywave signal as a function of the latitude of the transmission path and the distance from a transmitting antenna with a radiated field of 100 mv/m at the pertinent angle for the distance. The latitude of the transmission path is defined as the geographic latitude of the midpoint between the transmitter and the receiver. Latitude 35° should be used in case the midpoint of the path lies below 35° North and latitude 50° should be used in case the midpoint of the path lies above 50° North.

(g) Figure 6-A of § 3.190, entitled "Angles of Departure vs. Transmission Range," is to be used in determining the angles in the vertical pattern of the antenna of an interfering station to be considered as pertinent to transmission by one reflection. Corresponding to any given distance, the curves 4 and 5 indicate the upper and lower angles within which the radiated field is to be considered. The maximum value of field intensity occurring between these angles will be used to determine the multiplying factor for the 10% skywave field intensity determined from Figure 2 of § 3.190. (Curves 2 and 3 are considered to represent the variation due to the variation of the effective height of the E-layer while Curves 4 and 5 extend the range of pertinent angles to include a factor which allows for scattering. The dotted lines are included for information only.)

(h) In the case of non-directional vertical antennas, the vertical distribution of relative fields for several heights, assuming sinusoidal distribution of current along the antenna, is shown in Figure 5 of § 3.190. In the case of directional antennas the vertical pattern in the great circle direction toward the point of reception in question must first be calculated. Then for the distance to the points, the upper and lower pertinent angles are determined from Figure 6-A of § 3.190. The ratio of the largest value of radiated field occurring between these angles, to 100 mv/m (for which Figure 2 of § 3.190 is drawn) is then used as the multiplying factor for the value of the field read from the curves of Figure 2 of § 3.190. Note that while the accuracy of the curves is not as well established by measurements for distances less than 250 miles as for distances in excess of 250 miles, the curves represent the most accurate data available today. Pending accumulation of additional data to establish firm standards for skywave calculations in this range, the curves may be used. In cases where the radiation in the vertical plane, in the pertinent azimuth, contains a large lobe at a higher angle than the pertinent angle for one reflection the method of calculating interference will not be restricted to that described above, but each such case will be considered on the basis of the best knowledge available.

(i) Example, suppose it is desired to determine the amount of interference to a Class III station at Portland, Oregon, caused by another Class III station at Los Angeles, California, which is radiating a signal of 560 mv/m unattenuated at one mile in the great circle direction of Portland, using a 0.5 wavelength antenna. The distance is 825 miles. From Figure 6-A of § 3.190 the upper and lower pertient angles are 7° and 3.5° and, from Figure 5 of § 3.190 the maximum radiation within these angles is 99% of the horizontal radiation or 554 mv/m at 1 mile. The latitude of the path is 39.8° N and from Figure 2 of § 3.190, the 10% skywave field at 825 miles is 0.050 mv/m for 100 mv/m radiated. Multiplying by (554/100) to adjust the value to the actual radiation gives 0.277 mv/m. At 20 to 1 ratio the limitation to the Portland station is to the 5.5 mv/m contour.

(j) When the distance is large, more than one reflection may be involved and due consideration must be given each appropriate vector in the vertical pattern, as well as the constants of the earth where reflection takes place between the transmitting station and the service area to which interference may be caused.

§ 3.186 **Field intensity measurements in allocation; establishment of effective field at one mile.** (a) Section 3.45 provides that certain minimum field intensities are acceptable in lieu of the required minimum physical vertical heights of the antennas proper. Also in other allocation problems, it is necessary to determine the effective field at 1 mile. The following requirements shall govern the taking and submission of data on the field intensity produced:

(1) Beginning as near to the antenna as possible without including the induction field and to provide for the fact that a broadcast antenna not being a point source of radiation (not less than one wavelength or 5 times the vertical height in the case of a single element, i.e., nondirectional antenna or 10 times the spacing between the elements of a directional antenna), measurements shall be made on eight or more radials, at intervals of approximately one-tenth mile up to 2 miles from the antenna, at intervals of approximately one-half mile from 2 miles to 6 miles from the antenna, at intervals of approximately 2 miles from 6 miles to 15 or 20 miles from the antenna, and a few additional measurements if needed at greater distances from the antenna. Where the antenna is rurally located and unobstructed measurements can be made, there shall be as many as 18 or 20 measurements on each radial. However, where the antenna is located in a city where unobstructed measurements are difficult to make, measurements shall be made on each radial at as many unobstructed locations as possible, even though the intervals are considerably less than stated above, particularly within 2 miles of the antenna. In cases where it is not possible to obtain accurate measurements at the closer distances (even out to 5 or 6 miles due to the character of the intervening terrain), the measurements at greater distances should be made at closer intervals. (It is suggested that "wave tilt" measurements may be made to determine and compare locations for taking field intensity measurements, particularly to determine that there are no abrupt changes in ground conductivity or that reflected waves are not causing abnormal intensities.)

(2) The data required by subparagraph (1) of this paragraph should be plotted for each radial in accordance with either of the two methods set forth below:

(i) Using log-log coordinate paper, plot field intensities as ordinate and distance as abscissa.

(ii) Using semi-log coordinate paper, plot field intensity times distance as ordinate on the log scale and distance as abscissa on the linear scale.

(3) However, regardless of which of the methods in subparagraph (2) of this paragraph is employed, the proper curve to be drawn through the points plotted shall be determined by comparison with the curves in § 3.184 as follows: Place the sheet on which the actual points have been plotted over the appropriate Graph in § 3.184, hold to the light if necessary and adjust until the curve most closely matching the points is found. This curve should then be drawn on the sheet on which the points were plotted, together with the inverse distance curve corresponding to that curve. The field at 1 mile for the radial concerned shall be the ordinate on the inverse distance curve at 1 mile.

(4) When all radials have been analyzed in accordance with subparagraph (3) of this paragraph, a curve shall be plotted on polar coordinate paper from the fields obtained, which gives the inverse distance field pattern at 1 mile. The radius of a circle, the area of which is equal to the area bounded by this pattern, is the effective field. (See § 3.14.)

(5) While making the field intensity survey, the output power of the station shall be maintained at the licensed power as determined by the direct method. To do this it is necesary to determine accurately the total antenna resistance (the resistance variation method, the substitution method

or bridge method is acceptable) and to measure the antenna current by means of an ammeter of acceptable accuracy. (See § § 3.39 and 3.54.)

(b) Complete data taken in conjunction with the field intensity measurements shall be submitted to the Commission in affidavit form including the following:

(1) Tabulation by number of each point of measurement to agree with the map required in (2) below and the field intensity meter reading, the attenuation constant, the field intensity (**E**), the distance from the antenna (**D**) and the product of the field intensity and distance (**ED**) (if data for each radial are plotted on semi-logarithmic paper, see above) for each point of measurement.

(2) Map showing each point of measurement numbered to agree with tabulation required above.

(3) Description of method used to take field intensity measurements.

(4) The family of theoretical curves used in determining the curve for each radial properly identified by conductivity and dielectric constants.

(5) The curves drawn for each radial and the field intensity pattern.

(6) Antenna resistance measurement:

(i) Antenna resistance at operating frequency.

(ii) Description of method employed.

(iii) Tabulation of complete data.

(iv) Curve showing antenna resistance versus frequency.

(7) Antenna current or currents maintained during field intensity measurements.

(8) Description, accuracy, date, and by whom each instrument was last calibrated.

(9) Name, address and qualifications of the engineer making the measurements.

(10) Any other pertinent information.

§ 3.187 [Reserved.]

§ 3.188 **Location of transmitters.** (a) The four primary objectives to be obtained in the selection of a site for a transmitter of a broadcast station are as follows:

(1) To serve adequately the center of population in which the studio is located and to give maximum coverage to adjacent areas.

(2) To cause and experience minimum interference to and from other stations.

(3) To present a minimum hazard to air navigation consistent with objectives (1) and (2).

(4) To fulfill certain other requirements given below.

(b) The site selected should meet the following conditions:

(1) A minimum field intensity of 25 to 50 mv/m will be obtained over the business or factory areas of the city.

(2) A minimum field intensity of 5 to 10 mv/m will be obtained over the most distant residential section.

(3) The absorption of the signal is the minimum for any obtainable sites in the area. As a guide in this respect the absorption of the signals from other stations in that area should be followed, as well as the results of tests on other sites.

(4) The population within the blanket contour does not exceed that specified by § 3.24 (g).

(c) In selecting a site in the center of a city it is usually necessary to place the radiating system on the top of a building. This building should be large enough to permit the installation of a satisfactory ground and/or counterpoise system. Great care must be taken to avoid selecting a building surrounded by taller buildings or where any nearby building higher than the antenna is located in the direction which it is desired to serve. Such a building will tend to cast "radio shadows" which may materially reduce the coverage of the station in that direction. Irrespective of the height of surrounding buildings, the building on which the antenna is located should not have height of approximately one-quarter wavelength. A study of antenna systems located on buildings tends to indicate that where the building is approximately a quarter wavelength in height, the efficiency of radiation may be materially reduced.

(d) Particular attention must be given to avoiding cross-modulation. In this connection, attention is invited to the fact that it has been found very unsatisfactory to locate broadcast stations so that high signal intensities occur in areas with overhead electric power or telephone distribution systems and sections where the wiring and plumbing are old or improperly installed. These areas are usually found in the older or poorer sections of a city. These conditions give rise to cross-modulation interference due to the nonlinear conductivity characteristics of contacts between wiring, plumbing, or other conductors. This type of interference is independent of the selectivity characteristics of the receiver and normally can be eliminated only by correction of the condition causing the interference. Cross-modulation tends to increase with frequency and in some areas it has been found impossible to eliminate all sources of cross-modulation, resulting in an unsatisfactory condition for both licensee and listeners. The Commission will not authorize, (1) new stations (2) increased facilities to existing stations, or (3) auxiliary transmitters, for use with other than the authorized antenna system of the main transmitter, located in such areas or utilizing roof-top antennas, when the operating power would be in excess of 500 watts.

(e) If it is determined that a site should be selected removed from the city, there are several general conditions to be followed in determining the exact site. Three maps should be given consideration if available:

(1) Map of the density of population and number of people by sections in the area. (See Bureau of Census series P-D and H-E available from Superintendent of Documents, Washington 25, D. C.)

(2) Geographical contour map with contour intervals of 20 to 50 feet.

(3) Map showing the type, nature and depth of the soil in the area with special reference to the condition of the moisture throughout the year.

From these maps a site should be selected with a minimum number of intervening hills between it and the center of the city. In general, because of ground conditions, it is better to select a site in a low area rather than on top of a hill, and the only condition under which a site on top of a hill should be selected is that it is only possible by this means to avoid a substantial number of hills, between the site and the center of a city with the resulting radio shadows. If a site is to be selected to serve a city which is on a general sloping area, it is generally better to select a site below the city than above the city.

(f) If a compromise must be made between probable radio shadows from intervening hills and locating the transmitter on top of a hill, it is generally better to compromise in favor of the low area, where an efficient radiating system may be installed which will more than compensate for losses due to shadows being caused by the hills, if not too numerous or too high. Several transmitters have been located on top of hills, but so far as data has been supplied not a single installation has given superior efficiency of propagation and coverage.

(g) The ideal location of a broadcast transmitter is in a low area of marshy or "crawfishy" soil or area which is damp the maximum percentage of time and from which a clear view over the entire center of population may be had and the tall buildings in the business section of the city would cast a shadow across the minimum residential area.

(h) The type and condition of the soil or earth immediately around a site is very important. Important, to an equal extent, is the soil or earth between the site and the principal area to be served. Sandy soil is considered the worst type, with glacial deposits and mineral-ore areas next. Alluvial, marshy areas and salt-water bogs have been found to have the least absorption of the signal. One is fortunate to have available such an area and, if not available, the next best condition must be selected.

(i) Figure M3 (See Note to section 3.183 (c) and Figure R3 of section 3.190 indicates effective conductivity values in the United States, and are to be used for determining the extent of broadcast station coverage when adequate field intensity measurements over the path in question are not available. Since the values specified are only for general areas and since conductivity values over particular paths may vary widely from those shown, caution must be exercised in using the maps for selection of a satisfactory transmitter site. Where the submission of field intensity measurements is deemed necessary or advisable, the Commission, in its discretion, may require an applicant for new or changed broadcast facilities to submit such data in support of its application.

(j) In general, broadcast transmitters operating with approximately the same power can be grouped in the same approximate area and thereby reduce the interference between them. If the city is of irregular shape, it is often possible to take advantage of this in selecting a suitable location that will give a maximum coverage. The maps giving the density of population will be a key to this. The map giving the elevation by contours will be a key to the obstructing hills between the site and city. The map of the soil conditions will assist in determining the efficiency of the radiating system that may be erected and the absorption of the signal encountered in the surrounding area.

(k) Another factor to be considered is the relation of the site to airports and airways. Procedures and standards with respect to the Commission's consideration of proposed antenna structures which will serve as a guide to persons intending to apply for radio station licenses are contained in Part 17 of this chapter (Rules Concerning the Construction, Marking and Lighting of Antenna Structures).

(l) In finally selecting the site, consideration must be given to the required space for erecting an efficient radiating system, including the ground or counterpoise. It is the general practice to use direct grounds consisting of a radial buried wire system. If the area is such that it is not possible to get such ground system in soil that remains moist throughout the year, it probably will be found better to erect a counterpoise. (Such a site should be selected only as a last resort.) It, like the antenna itself, must of course be designed properly for the operating frequency and other local conditions.

(m) While an experienced engineer can sometimes select a satisfactory site for a 100-watt station by inspection, it is necessary for a higher power station to make a field-intensity survey to determine that the site selected will be entirely satisfactory. There are several facts that cannot be determined by inspection that make a survey very desirable for all locations removed from the city. Often two or more sites may be selected that appear to be of equal promise. It is only by means of field-intensity surveys taken with a transmitter at the different sites or from measurements on the signal of nearby stations traversing the terrain involved that the most desirable site can be determined. There are many factors regarding site efficiency that cannot be determined by any other method. When making the final selection of a site, the need for a field-intensity survey to establish the exact conditions cannot be stressed too strongly. The selection of a proper site for a broadcast station is an important engineering problem and can only be done properly by experienced radio engineers.

§ 3.189. **Minimum antenna heights or field intensity requirements.** (a) Section 3.45 requires that all applicants for new, additional, or different broadcast facilities and all licensees requesting authority to move the transmitter of an existing station, shall specify a radiating system, the efficiency of which complies with the requirements of good engineering practice for the class and power of the station.

(b) The specifications deemed necessary to meet the requirements of good engineering practice at the present state of the art are set out in detail below.

(1) The licensee of a standard broadcast station requesting a change in power, time of operation, frequency, or transmitter lo-

cation must also request authority to install a new antenna system or to make changes in the existing antenna system which will meet the minimum height requirements, or submit evidence that the present antenna system meets the minimum requirements with respect to field intensity, before favorable consideration will be given thereto. (See § 3.186.) In the event it is proposed to make substantial changes in an existing antenna system, the changes shall be such as to meet the minimum height requirements or will be permitted subject to the submission of filed intensity measurements showing that it meets the minimum requirements with respect to effective field intensity.

(2) These minimum actual physical vertical heights of antennas permitted to be installed are shown by curves A, B, and C of Figure 7 of § 3.190 as follows:

(i) Class IV stations, 150 feet or a minimum effective field intensity of 150 mv/m for 1 kilowatt (100 watts 47.5 mv/m). (This height applies to a Class IV station on a local channel only. In the case of a Class IV station assigned to a regional channel Curve A shall apply.)

(ii) Class II and III stations, or a minimum effective field intensity of 175 mv/m for 1 kilowatt.

(iii) Class I stations, or minimum effective field intensity of 225 mv/m for 1 kilowatt.

(3) The heights given on the graph for the antenna apply regardless of whether the antenna is located on the ground or on a building. Except for the reduction of shadows, locating the antenna on a building does not necessarily increase the efficiency and where the height of the building is in the order of a quarter wave the efficiency may be materially reduced.

(4) To obtain the maximum efficiency of which any antenna is capable a good ground system must be employed (a counterpoise may be substituted under certain conditions).

(5) At the present development of the art, it is considered that where a vertical radiator is employed with its base on the ground, the ground system should consist of buried radial wires at least one-fourth wave length long. There should be as many of these radials evenly spaced as practicable and in no event less than 90. (120 radials of 0.35 to 0.4 of a wave length in length and spaced 3° is considered an excellent ground system and in case of high base voltage, a base screen of suitable dimensions should be employed.)

(6) It should be borne in mind that the above specifications are the minimum and where possible better antenna and ground systems should be installed.

(7) In case it is contended that the required antenna efficiency can be obtained with an antenna of height or ground system less than the minimum specified, a complete field intensity survey must be supplied to the Commission showing that the field intensity at a mile without absorption fulfills the minimum requirements. (See § 3.186.) This field survey must be made by a qualified engineer using equipment of acceptable accuracy.

(8) The main element or elements of a directional antenna system shall meet the above minimum requirements with respect to height or effective field intensity. No directional antenna system will be approved which is so designed that the effective field of the array is less than the minimum prescribed for the class of station concerned, or in case of a Class I station less than 90 percent of the ground wave field which would be obtained from a perfect antenna of the height specified by Figure 7 of § 3.190 for operation on frequencies below 1000 kilocycles, and in the case of a Class II or III station less than 90 percent of the ground wave field which would be obtained from a perfect antenna of the height specified by Figure 7 of § 3.190 for operation on frequencies below 750 kilocycles.

(9) Before any changes are made in the antenna system, it is necessary to submit full details to the Commission for approval. These data may be submited by letter.

FILE YOUR COPY OF BROADCAST ENGINEERING AS A CURRENT REFERENCE FOR F.C.C. REGULATIONS.

AMENDMENTS WILL BE PUBLISHED REGULARLY AND THE ISSUE AND PAGE NUMBER OF BROADCAST ENGINEERING CONTAINING THE AFFECTED SECTION WILL BE SHOWN WITH THE AMENDMENT.

Proof of Performance

(Starts on page 22)

cycles per second. In the range from 30 to 7,500 cycles per second, the harmonic distortion cannot exceed 5 per cent under 85 per cent modulation nor 7½ per cent in the increment from 85 per cent to 100 per cent. The results of the measurements are again to be tabulated and then plotted on a graph.

Carrier Shift Percentage

(1) Prepare to inject a signal of 400 cycles per second into the microphone input as in the other tests.

(2) Measure the DC voltage at the detector output with no signal applied.

(3) Apply 400 cycle modulation and modulate the transmitter 25 per cent.

(4) Read the new DC voltage at the detector output and record.

(5) Figure percentage carrier shift according to the formula:

$$\%\ \text{Carrier Shift} = \frac{\text{Carrier with modulation} - \text{Carrier without modulation}}{\text{Carrier without modulation}} \times 100$$

(6) Repeat steps 1 through 5 for 50 per cent, 85 per cent and 100 per cent modulation. The maximum permissible carrier shift is 5 per cent.

Spurious Radiations

When checking the equipment for spurious radiations, it is desirable to use musical program material rather than a steady tone. All limiters and compressors should be operated as in normal programming. The basic thing to look for is the presence of harmonics and these can be found by using a standard short wave communications receiver equipped with an "S" meter to measure relative signal strength. It is also wise to check very briefly throughout the spectrum to see if any other erratic and spurious radiations exist.

The completed report should be neatly typed with a written description of the procedures followed in the various tests. The charts and graphs should be adequately labeled in the completed folder.

And that's an AM broadcast Proof of Performance! If it is performed with preparation and planning it can be a job that will be looked forward to instead of one that is dreaded. And besides, it can provide you with a real fine first-hand summary of just what your station is capable of doing.

INDUSTRY NEWS

Telechrome Mfg. Corp., manufacturers of Color TV Broadcasting and Studio Equipment, Video Test Instruments, and Missile RF Telemetry Units, recently announced the opening of an additional plant and formation of a new Automation Division at 26 Edison Street, Amityville, N. Y.

South Carolina's Governor Ernest F. Hollings (right) congratulates B. H. Kline, President of Kline Iron & Steel Co., of Columbia, S. C., on obtaining the contract for the world's tallest man-made structure, a television tower for WGAN-TV in Portland, Maine, 1,619 feet high.

Palo Alto—Alpar Manufacturing Co., Inc., announces that they have moved to 220 Demeter St., Palo Alto, Calif., from their former Redwood City, Calif., location.

This move increases their plant area by more than three times.

The large flat area adjoining their new plant will be used in the development and check-out of various communications, instrumentation and illumination applications for aluminum structures, towers and antennas.

Alpar manufactures a wide range of aluminum fixed and crank-up towers and microwave antennas for use by communications, construction, industrial and research organizations, government agencies and radio amateurs.

ED GAGNON

Ed Gagnon, a former station manager and chief engineer, who has been Assistant to the Manager of Ground Communications Sales at Collins, has been promoted to Broadcast Sales Manager with headquarters in Cedar Rapids.

William C. Speed, president of Audio Devices, Inc., New York, has appointed Andreas Kramer Chief Engineer of the company's subsidiaries, The Audiotape Corp. and Audio Mfg. Corp., in Stamford, Conn.

Mr. Kramer received his BS Degree in Electrical Engineering from the University of Toronto. Before joining Audio Devices in 1951, Mr. Kramer was with the British Broadcasting Co. in New York. He is a member of the American Institute of Electrical Engineers and the Institute of Radio Engineers.

John R. Price, formerly Advertising Director for the Gates Radio Co., Quincy, Ill., has been named to the newly created position of Director of Advertising and Public Relations. Mr. Price will have full responsibility for all advertising, sales promotion, and public relations as concerns the broadcast, communication, and industrial electronic industries.

DONALD J. PLUNKETT

Sherman M. Fairchild, president of Fairchild Recording Equipment Corp., has appointed Donald J. Plunkett president in his place effective April first.

Mr. Plunkett has been with Capitol Records for the past six years as New York Director of Recording and was responsible for the company's East Coast recording operations. He brings to Fairchild a background in both reproduction and recording. Mr. Plunkett is also president of the Audio Engineering Society.

JOHN HAERLE

John Haerle, formerly Broadcast Sales Manager at Collins Radio Co., has been promoted to Manager of Collins, Texas Regional Sales, with headquarters in Dallas.

JAMES A. ROBBINS

James A. Robbins, Sales Engineer, will be serving an expanded Southeast territory for White Diesel Engine Division, it was announced recently.

Mr. Robbins has represented White's Superior and ATLAS engines in parts of the Southeast for the past two years, serving marine and stationary engine owners.

Mr. Robbins is a graduate of Case Institute of Cleveland with a B.S. in Mechanical Engineering, and is headquartered at Clearwater, Florida.

Increased production facilities now needed by the Ampex Corp. to meet the demand for more VR-1000 Videotape recorders from the broadcast industry has made larger quarters for the entire Professional Products Division essential, according to Neal K. McNaughten, PPD manager.

In the new quarters, engineering laboratories have been more than doubled in area, and other existing departments occupy substantially greater space. Facilities have also been provided for a new special video products application engineering section of the PPD sales department, according to McNaughten, which is staffed by engineers qualified to design special modifications or systems incorporating Videotape recording equipment.

The election of Walter C. Cooper as Assistant Vice-President has been announced by James W. Murray, President of General Precision Laboratory, Inc., Pleasantville, N. Y., a subsidiary of General Precision Equipment Corp. Mr. Cooper, who joined G. P. L. in 1949 as Manager of Government Contracts, will retain these responsibilities and assume additional duties as an officer of the company. G. P. L. develops and manufacturers air traffic control, navigation, television systems, and motion picture projection equipment.

Donald J. Plunkett, who became president of Fairchild Recording Equipment Corp. on April 1, has made the following personnel announcement.

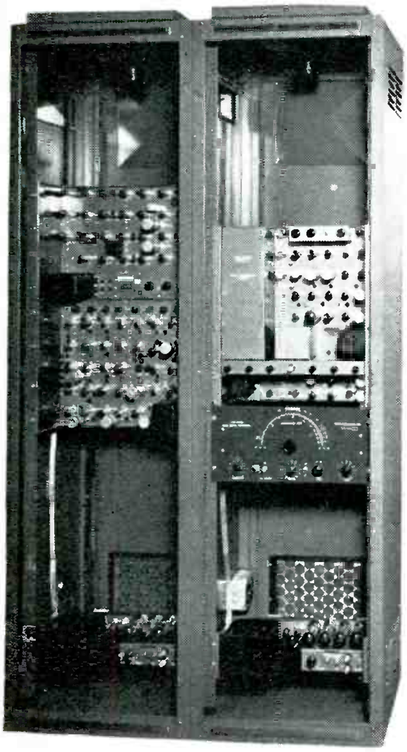
Rein Narma continues as Vice-President of Manufacturing and Engineering; Rene Snepvangers, formerly Chief Engineer, is now Director of Engineering; and George Cohen who was factory sales representative, becomes Marketing Manager.

Fairchild Recording produces sound recording equipment for the professional and consumer markets.

HUGH H. GOODWIN

The appointment of Hugh H. Goodwin, Sales Representative, to the New York Branch, has been announce by J. H. Newton, Sales Manager, White Diesel Engine Division, the White Motor Co., Springfield, Ohio. He will assist White Diesel's New York Branch Manager in expanded coverage of the New York area. He is a member of the Society of Naval Architects and Marine Engineers, New York Chapter.

PRODUCT NEWS



VIDEO TRANSMISSION TEST EQUIPMENT
Foto-Video Laboratories
Cedar Grove, New Jersey

New TV relay test equipment provides highest standards of video network operation. Consists of a high reliability TV sync generator and a keyed video signal generator that produces a "phase-locked" variable frequency sine wave as part of a composite picture signal.

SUITCASE SIZE MASTER MONITOR
Radio Corporation of America
Camden, New Jersey

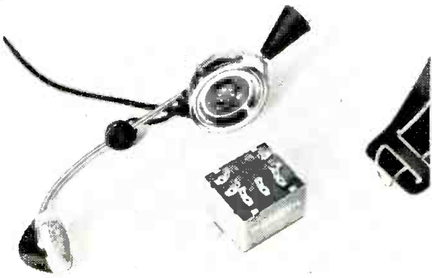
A suitcase size master monitor for commercial broadcasting and close circuit television can be used as a studio camera or preview monitor, or as part of a field camera pickup system. The unit weighs forty-nine pounds.

MODEL 1650A POLY-GAUGE
Telechrome Mfg. Corp.
28 Ranick Drive, Amityville, L. I., N. Y.

A new single instrument which measures strain, pressure, load, force and displacement simply by plugging in the appropriate transducer or strain gauge.

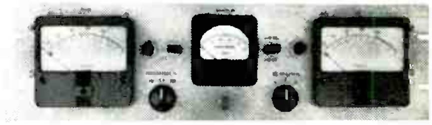
TYPE 1650-A IMPEDANCE BRIDGE
General Radio Co.
West Concord, Massachusetts

A new design replaces the 650A Bridge and improves on most of the electrical specifications as well as providing new mechanical features.



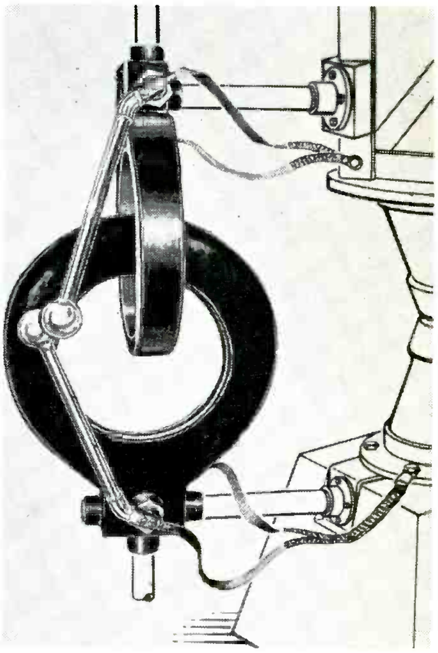
TRANSISTORIZED HEADSET AMPLIFIER
The Daven Co.
Livingston, New Jersey

The Type 90 interphone amplifier can be used in conjunction with operators' headsets to provide 20 db gain in received sound level.



MODEL 8-A MULTIPLEX MODULATION MONITOR
Electro-Plex Corp.
P. O. Box 52, Westfield, New Jersey

Used for accurately determining modulation levels of both the main program and sub-channel as well as the injection of the sub-carrier. Separate VU meters indicate channel and sub-channel modulation simultaneously. Another meter indicates injecting level. Demodulator circuits are included for speaker monitoring of all channels.

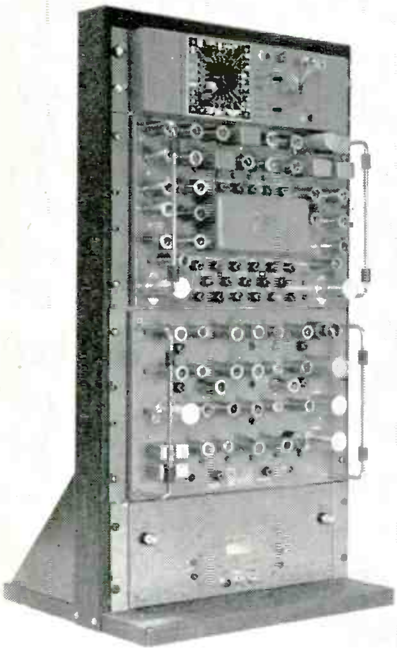


TOWER LIGHTING ISOLATION TRANSFORMER
Hughey & Phillips, Inc.
3200 N. San Fernando Rd., Burbank, Calif.

A new isolation transformer is available in three load capacities: 750, 1,750 and 3,500 watts. The transformers provide higher efficiency, improved regulation, additional tapes and epoxy encasement. Write for bulletin HPS-152.

TAPAK
Broadcast Equipment Specialties Corp.
P. O. Box 149, Beacon, New York

An all transistor Recorder-Reproducer with built-in preamps for low level mikes. Spring driven, forward or fast, reverse and volume indicator.



MODEL 490A SPECIAL EFFECTS GENERATOR
Telechrome Mfg. Corp.
28 Ranick Drive, Amityville, L. I., N. Y.

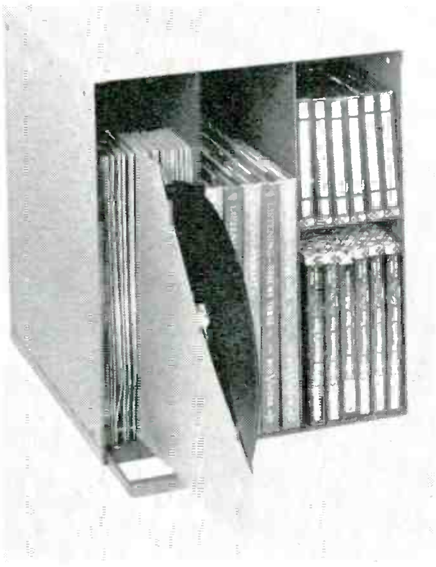
The 490A Special Effects Generator for Wipes and Matting produces 72 different wipes and limitless special insert effects in both color and monochrome.

The new Ampex Videotape Recorder is designated the VR-1000. Features include: (1) the cue and erase kit, (2) cue and erase controls, (3) the tape timer recording playing time in hours, minutes, and seconds, (4) the overhead accessory rack for easy installation of (5) switching controls, (6) wave form monitor, (7) video monitor, and (8) the 9901 audio monitor.

The first commercially available "Ham" TV Transmitter has been announced by the Electron Corp., P. O. Box 5570, Dallas, Tex. Known as the Ling-Mitter, the TV Transmitter operates in the 420-450 MC band with a power output of 50 watts. The company manufactures TV cameras for closed circuit and broadcast television.

3 KW FM TRANSMITTER
Standard Electronics
29-01 Borden Ave., Long Island City 1, N. Y.

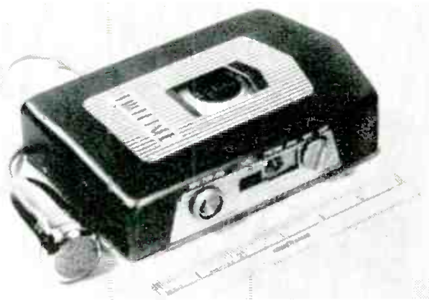
A new transmitter for FM/FM stereo, multiplex, and simplex operation. Patchover permits connecting the driver direct to the antenna. Other features include low noise and distortion, all-around economy and simple, compact design.



COMBINATION DISC AND TAPE CABINET
Wallach & Associates
1589 Addison Rd., Cleveland 3, Ohio

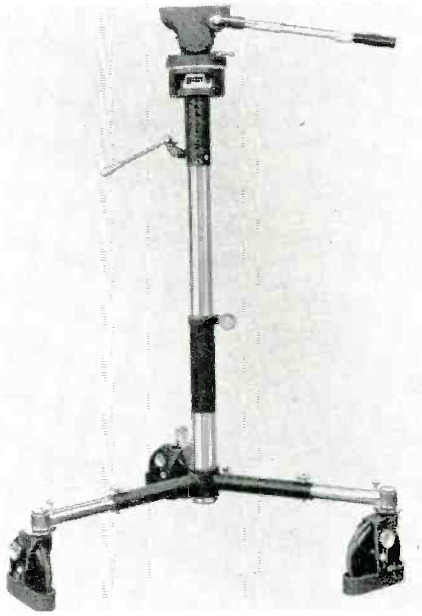
Micro Record Corp., 487 South Ave., Beacon, N. Y., has introduced the Model D31, Micro Record developing tank which processes up to 400 feet of film.

Grinnan Fixture Co., Minerva, Ohio, offers record, tape, and transcription cabinets made of ¾-inch fir plywood uprights, ¾-inch select birch cabinet veneer for the facia panel, ⅛-inch hard tempered Masonite for the back. Exposed edges of ¾-inch plywood members are capped with a hard maple molding. The panel and molding are shellacked, varnished and hand-rubbed.



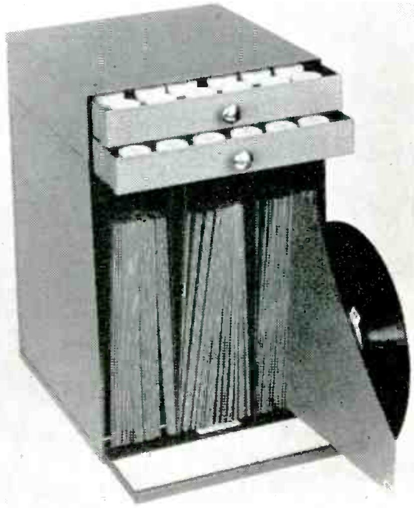
POCKETAPE
Broadcast Equipment Specialties Corp.
P. O. Box 149, Beacon, New York

A miniature 1½" x 4½" x 6⅞" tape recorder. Battery operated. Records up to 4 hours at 15/16 IPS dual track. Also operates at 7½, 3¾, or 1⅞ IPS.



LIGHTWEIGHT PORTABLE TV PEDESTAL
Houston Fearless
11851 West Olympic Blvd.,
Los Angeles 64, Calif.

The new Model PD-10 portable TV pedestal provides a rigid, steady mount for all monochrome TV cameras. Raising and lowering the camera is accomplished by means of a hydraulic jack mounted on the center column.



COMBINATION FILMSTRIP AND RECORD STORAGE CABINET
Wallach & Associates
1589 Addison Rd., Cleveland 3, Ohio

TRANS MAGNEMITE

Amplifier Corp. of America

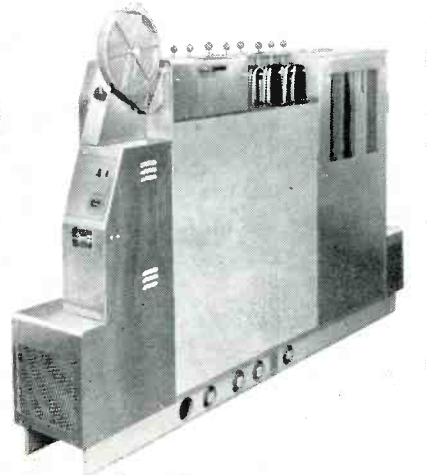
398 Broadway, New York 13, N. Y.

A professional transistorized battery-operated, spring-motor portable tape recorder. Rewinds 900 feet of tape in approximately one and three quarter minutes. Exceeds NARTB standards.

A three-speed transcription turntable with an entirely new design principle has been revealed by the Gates Radio Co., Quincy, Ill., a subsidiary of Harris-Intertype Corp.

Heart of the new turntable design is a drive hub which is part of the machined turntable platter and about one-half the radius of a 45 RPM disc. The single idler wheel for all three speeds is floating and self-aligning. A 600 RPM hysteresis synchronous motor with three-speed pulley engages the idler wheel to the inner hub. The combination of the lower speed motor, and the driver section being located inside the playing surface, reduces the rumble to such a degree that production line turntables now exceed earlier laboratory standards.

Called the "CB-500", this new turntable will come up to speed at 33⅓ RPM in ⅛ turn and at 45 RPM in ⅙ turn. Noise is 45 db down.



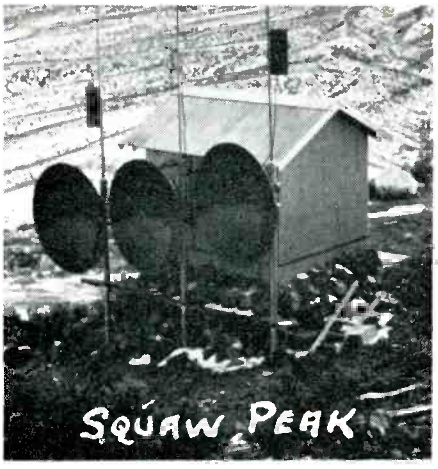
LABMASTER

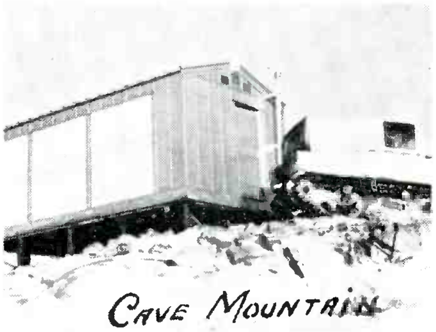
Houston Fearless

11851 West Olympic Blvd.,

Los Angeles 64, Calif.

A new 16 mm black and white film processor will process negative or positive film and with an accessory will also process reversal film. It is fully automatic, operating up to 40 F.P.M.





These Adler Translator Installations bring TV programs to Ely and McGill, Nev., and Window Rock, Ariz. The installations were made by Industrial Television, 7940 Fareholm Drive, Los Angeles 46, Calif.

Continental Electronics Mfg. Co., 4212 So. Buckner Blvd., Dallas, Tex., announces completion of their new Type MR2A FM Monitor Receiver as a companion model to the company's MR1A AM unit. Both units are available items in Continental's Type TRC Transmitter Remote Control systems—now completing the line of equipment offered for unattended control of any AM/FM broadcast facility.

The new Continental FM Monitor amplifies an off-the-air FM signal, using the common type FM/TV receiving antenna, and presents its output to the station FM Modulation/Frequency monitor, which is then located at the studio. Features of the new Type MR2A FM monitor receiver unit include a self-contained power supply employing new-type silicon rectifiers throughout; low-impedance output power in excess of three watts under normal signal conditions—which is sufficient to drive all types of FM monitoring equipment now in station use.

A new medium-power transmitter has been developed by the Radio Corp. of America to aid in reducing the cost of very high frequency (VHF) television broadcasting, it has been announced by C. H. Colledge, General Manager, RCA Broadcasting & Television Equipment Division.

Mr. Colledge said the TT-11AH, when used with an RCA high-gain antenna, enables a TV broadcaster to obtain at low cost effective radiated powers up to 190,000 watts on channels 7 to 13.

From the space viewpoint, the TT-11AH, with a rated power output of 11 peak visual kilowatts and 6 kilowatts aural, can result in the saving of up to 40 per cent in floor area over previous 10 kilowatt transmitters, he said.

CLASSIFIED

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

EQUIPMENT FOR SALE

Going 5 Kw Gates BC-1J XMTR, No. 44 ant. coupler. Best offer over $3,500. Contact Mel Stone, WLOB, Portland, Maine.

WE9A pickups and arms with equalizers, also RME pickups, arms, and equalizers. What will you offer? Phil Whitney, 200 Shawnee Avenue, Winchester, Va.

One new Bliley Type B C 46 T cystal oven with thermometer and Xtal for trade or sale. W N C A, Siler City, N. Car.

Two tape recorders, Roberts Model 90, $150, and Bell Cubcorder (battery operated), $125. Both like new. WCMC, Wildwood, N. J.

HELP WANTED

First class operators for vacation period May 1 through October 31, WSPD, AM-FM-TV, 136 Huron Street, Toledo, Ohio.

Broadcast control room and/or transmitter operator. Must have radio-telephone first license and take technical exam. Write Ralph R. Townsley, Chief Engineer, WBAA, West Lafayette, Ind.

Experienced studio engineer for 5 Kw Boston AM. 1st Class ticket and Xmtr experience desirable. $95 after 6 months. Mort Bardfield, Chief Engineer, WMEX, 70 Brookline Avenue, Boston 15, Mass.

Need experienced television engineer. Minimum requisites one year TV maintenance, familiar with camera operation. Contact Gene Phelps, KPTV, Portland, Ore.

EQUIPMENT WANTED

Robinson turntables, Western Electric consoles, Pentron tape recorders, WE 639 microphones, modulation monitor, frequency monitor, and other equipment. WCCM, 9 Valley Street, Lawrence, Mass.

Two or three RCA 44BX microphones. Please give condition and price first letter. D. H. Elliott, Chief Engineer, KINS, Box 1015, Eureka, Calif.

Used AM modulation monitor. Don M. Lidenton, 701 Poplar Street, Poplar Bluff, Mo.

PLEASE MENTION BROADCAST ENGINEERING WHEN WRITING MANUFACTURERS FOR FURTHER INFORMATION